Part 1. CATCH FISHERIES PROFILES

By

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PREFACE

The Government of Western Samoa requested the South Pacific Forum Fisheries Agency (FFA) for assistance in the compilation of a set of fisheries resources profiles. These profiles were to document available information on various aspects of the important fisheries resources in Western Samoa.

The Terms of Reference adopted were those used for profiles already completed, which are as follows:

1. With the assistance from national fisheries staff, examine all files pertaining to fisheries resource matters in Western Samoa, held at the Fisheries Division;
2. Assess, collate and compile written matter, data, etc., which provide information relating to resource abundance, distribution, exploitation, etc., in Western Samoa;
3. Examine existing legislation controlling the exploitation of living marine resources in the country, and advise on appropriate regulations for controlling the existing fisheries for those resources currently not protected;
4. Based on the information examined, produce a comprehensive set of fisheries profiles for the fisheries resources of Western Samoa in a similar format to the profiles that have been produced for other FFA member countries.

This report was prepared during and after a two-week visit by FFA's Assistant Research Coordinator to Western Samoa in December, 1994. It provides an overview of those major fisheries resources identified by the Fisheries Division as important to the commercial, artisanal and subsistence fisheries sectors within the country.

Following the format used in the profiles already completed for some FFA countries, each fishery resource is divided into four major areas: (i) a brief description of the resource (species present, their distribution, biology and ecology); (ii) an overview of the existing fishery (utilization, production and marketing); (iii) the status of the stocks; and (iv) management concerns (current legislation and policies regarding exploitation and recommended management options). Most of the resources described in these profiles involve more than one species. In cases where aquaculture trials have been conducted, an extra section on this has been added either under the fishery or stock status sections of a particular resource.

A comprehensive bibliography, listing fisheries and fisheries related references, has been compiled for Western Samoa by Gillett and Su'a (1987) under the FAO/UNDP Regional Fishery Support Programme. It was not possible to locate some of the references listed in the bibliography, during the compilation of these profiles.

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The authors assume full responsibility for the contents of this report. Opinions, where expressed, are theirs alone and in no way reflect the policy of FFA, Fisheries Division or the Government of Western Samoa.

TABLE OF CONTENTS

A. BACKGROUND

1. The Country

Samoa was first sighted by Roggewein in 1722. He gave the Samoa Islands the name, "the Isles of the Navigators" when he noted how much the natives used canoes. Western Samoa, the "cradle of Polynesia", consists of two main and seven small islands. The two main islands, Savai'i and Upolu, and two of the small islands, Manono and Apolima, are inhabited. All of the islands are volcanic in origin and lie in the the south-west Pacific between latitudes 13° 25'S and 14° 05'S, and longitudes 171° 23'W and 172° 48'W. Savai'i island is still considered volcanically active with its most recent eruption producing a lava flow between 1905 and 1911. The topograhy is rugged and mountainous with about 40 per cent of Upolu and 50 per cent of Savai'i characterised by steep slopes descending from volcanic crests (Taule'alo, 1993). Upolu island is older and as a result of weathering and erosion, is generally more rugged. The total land area is approximately 2,930 km^2 of which the two main islands make up 99.8 per cent. Savai'i Island has a land area of approximately 1,820 km^2, Upolu 1,115 km^2, Manono 5 km^2 and Apolima 2 km^2. Land potential (in hectares) for agriculture purposes has been estimated as follows:

	Upolu	Savai'i	Total
Wright, 1963			
Cropping	55,000	69,000	124,000
Cattle grazing	26,000	45,000	71,000
Unsuitable for agriculture	32,200	56,400	88,600
TOTAL	113,200	170,400	283,600
Pak-Pay, 1972			
Intensive agriculture	61,000	80,000	141,000
Cattle ranging	26,000	39,000	65,000
Unsuitable for agriculture	26,2000	51,400	77,600
TOTAL	143,200	170,400	283,600

Land ownership in Western Samoa falls under four categories as follows:

Ownership Type	Upolu		Savai'i		Total	
	hectares	Per cent	hectares	Per cent	hectares	Per cent
Customary	76,166	26.9	153,490	54.3	229,656	81.2
Government	19,758	7.0	10626	3.8	30,384	10.7
WSTEC	9499	3.4	4476	1.6	13,975	4.9
Freehold	7800	2.8	1037	0.4	8,837	3.1
Total	113,223	40.0	169,629	60.0	282,852	100.0

The total reef and lagoon area, of depths less than 50 m, has been estimated to be approximately 23,100 ha (Johannes, 1982). Mangrove and swampy areas have been estimated to be about 1,000 ha (Bell, 1984). The islands are not well endowed with coral reefs as compared to other Pacific countries. This is due mainly to the nature of the islands which are steep-sided volcanic cones set in deep waters and recent volcanic flows which have covered previous reef areas resulting in rocky coasts with no reefs in those areas. Evidence suggest that the living barrier reefs seem to have resulted from upgrowth of a fringing reef during submergence of the island (Morton *et al.*, 1988). The Exclusive Economic Zone of Western Samoa covers an area of 120,000 km^2 and is the smallest in the South Pacific region. Wright (1993) compiled details comparing land and sea areas of countries and territories in the South Pacific from various reference as presented in Table 1.1, arranged in decreasing order of EEZ area. In terms of land area to EEZ area ration, Western Samoa has the second least, before Papua New Guinea.

Table 1.1: Land and sea area details of countries and territories of the South Pacific. (Source: Wright, 1993).

Country/Territoy	# Hight islands	# Low islads	Atolls islands and cays	Land area (km^2)	EEZ area (km^2)	Land area to EEZ ratio
French Polynesia (Tahiti)	26	>100	12	3,521	5,030,000	1 : 1,429
Kiribati	-	>100	-	690	3,550,000	1 : 5,145
Papua New Guinea	83	>350	-	462,243	3,120,000	1 : 7
Federated States of Micronesia	16	>250	-	701	2,978,000-	1 : 4,248
Marshall Islands	-	>50	23	181	2,131,000	1 : 11,773
Cook Islands	6	>200	1	237	1,830,000	1 : 7,722
Northern Marianas	16	4	-	471	1,823,000	1 : 3,870
New Caledonia	4	18	-	19,103	1,740,000	1 : 91
Solomon Islands	37	65	47	27,556	1,340,000	1 : 49
Fiji	113	>350	36	18,272	1,290,000	1 : 71
Tuvalu	-	4	-	26	900,000	1 : 34,615
Tonga	16	>150	3	747	700,000	1 : 937
Vanuatu	25	43	5	12,190	680,000	1 : 56
Palau	18	>350	9	488	629,000	1 : 1,289
American Samoa	5	-		200	390,000	1 : 1,950
Niue	-	1	11	259	390,000	1 : 1,506
Nauru	-	1	29	21	320,000	1 : 15,238
Wallis and Futuna	1	22	-	255	300,000	1 : 1,176
Tokelau	-	124	2	10	290,000	1 : 29,000
Guam	1	-	82	541	218,000	1 : 403
Western Samoa	3	2	-	2,935	120,000	1 : 41

The climate in Western Samoa "is tropical, tempered by the ocean environment, and marked by a distinctive wet season (November-April) and a dry season (May-October) (Western Samoa NEMS Task Team, 1993). Temperatures range from 17°C to 34°C with an annual average of 26.5°C in coastal areas. The rainfall average in Apia, is about 2,870 mm per year with the highest recorded in January (424 mm) and lowest in July (96 mm). "On the windward south and southeastern shores, annual rainfall averages between 5,000 and 7,000 mm. At higher elevations, rainfall averages 5,000 mm at 1,000 m elevation and 7,000 mm above 1,200 m on Savai'i" (Klinckhamers, 1992). The predominant winds over Samoa is the SE trade-wind which occurs mainly from May to October, becoming less dominant in the wet season. Storm patterns that affect the islands originate from three sources: tropical easterlies cause winds from the south-east; cold fronts from Australian system cause cold air flows and rain; and storms from the south-west Pacific generate cyclones (Western Samoa NEMS Task Team, 1993). Tropical cyclones seldom affect the Samoa Group. Sea tide is a double one, becoming full twice in 24 hours and 50 minutes and with an average fluctuation range of about 1 metre.

2. The People

The indigenous population is Polynesian in origin and is relatively homogenous. Population estimates in 1976 indicated that 89 per cent of the population are pure Samoans and there is an admixture of Chinese, European, Fijian and Tongan blood (Anon, 1980). The *aiga*, the extended family, is the basic social unit, and "remains the single most significant social and economic unit" (Western Samoa NEMS Task Team, 1993). The head *matai* of the *aiga* is responsible for the care of the family including matters concerning its *matai* titles and lands. "Western Samoa is among the most traditional of all Polynesian societies" (Western Samoa NEMS Task Team, 1993). Even though traditional arts, such as weaving, dancing, singing etc are commonly practised, "it is in the tradition of oratory that the Western Samoan arts reach their highest expression". In addition, "the *fa'a-Samoa* (the Samoan way of life) is based on its social institutions (family, village council, women's committee, church) which provide direction for individual or group behaviour and responsibilities as well as overall village organisation".

The Samoa pre-European population was estimated to be about 29,000 in 1880. The 1991 census estimated the Western Samoa population to be 161,298, an increase of only 2.6 per cent from the 1986 population. Total population for the 1961-1991 period is given in Table 2.1. The decreasing annual growth rate is attributed to a fall in the fertility rate and the high rate of overseas migration. Population estimates in mid-year 1979 recorded 25 per cent of the total population on Savai'i, 25 per cent in or around Apia and the remainder in other parts of Upolu.

Table 2.1: Western Samoa Population for the 1961-1991 period.

Year	Total population	Average annual growth (%)
1961	114,427	3.3
1966	131,377	2.8
1971	146,627	2.2
1976	151,983	0.7
1981	156,341	0.6
1986	157,158	0.1
1991	161,298	0.5

Table 2.2 presents the population by age structure during the 1981-1991 period. In terms of percentage composition, a decrease is noted in the 0-14 years category while the 15-59 and 60+ categories showed increases. However, the 15-59 year category showed a constant percent composition in the 1986 and 1991 censuses.

Table 2.2: Western Samoa Population Age Structure, 1981-1991. (Source: Taule'alo, 1993).

Age group (years)	1981		1986		1991	
	Total	Per cent	Total	Per cent	Total	Per cent
0-14	69,635	44.5	64,595	41.1	65,469	40.6
15-59	79,071	50.8	83,776	53.3	86,029	53.3
60+	7,635	3.7	8,787	5.6	9,800	6.1
TOTAL	156,341		157,158		161,298	

Population vital statistics for the intercensal period, 1982-1986, are given in Table 2.3 as reproduced from Taule'alo (1993). The figures show that even though birth rate was high and stable, and that death rate decreased, the increasing net out-migration result in a net declining population growth rate.

Table 2.3: Population vital statistics for the intercensal period, 1982-1986. (Source: Taule'alo, 1993).

Year	Birth rate (per 1,000 pop.)	Death rate (per 1,000 pop.)	Net out-migration rate	Annual population growth rate (%)
1982	31.0	7.4	16.7	6.9
1983	31.0	7.4	16.7	6.9
1984	30.5	6.3	28.0	-3.8
1985	30.0	5.2	24.3	0.5
1986	29.5	5.0	28.0	-3.5

The economically active population as estimated during the 1981, 1986 and 1991 censuses are presented in Table 2.4, by industry, as reproduced from Taule'alo (1993). The results indicate that 47.9 per cent of those 15 years and older was estimated to be economically active in 1981. This increased to 49.3 per cent in 1986 but decreased to 44.3 per cent in 1991. Using the 15-59 years old category as the potential group for economic activities, the economically active population percentages would be 52.5, 54.5, 49.4 per cent for 1981, 1986 and 1991 respectively. The trend is the same as that when using 15+ years. Manufacturing employment is expected to increase tremendously starting in 1993 due to the setting up and operation of Yasaki, an electrical car parts assembly factory for export.

Table 2.4: Economically active population in Western Samoa during 1981, 1986 and 199, by industry. (Source: Taule'alo (1993).

Industry	1981		1986		1991	
	Number	Per cent	Number	Per cent	Number	Per cent
Agriculture, forestry & fishing	25,050	60.4	29,023	63.6	26,777	63.0
Mining	-	-	22	<0.5	87	0.2
Manufacturing	757	1.8	1,565	3.4	1,194	2.8
Electricity & water	447	1.1	855	1.9	645	1.5
Construction	2,279	5.5	62	0.1	2,025	4.8
Wholesale & retail trade	1,821	4.4	1,710	3.8	1,862	4.4
Transport & communication	1,353	3.2	1,491	3.3	1,900	4.5
Financial services	1,305	3.1	842	1.8	1,373	3.2
Social & personal services	8,216	19.8	9,436	20.7	6,631	15.6
Other	278	0.7	629	1.4	0	-
Total employment	41,506	100.0	45,635	100.0	42,494	100.0
15+ years old population	86,706		92,563		95,829	
% 15+ population economically active		47.9		49.3		44.3
15-59 years old population	79,071	50.8	83,776	53.3	86,029	53.3
% 15-59 years old pop. economically active		52.5		54.5		49.4

3. The Government

Western Samoa was under colonial rule by Germany starting in 1899. At the break of World War I, Western Samoa was annexed by a force of New Zealanders. The New Zealand military occupation continued until 1920 when New Zealand ruled Western Samoa under a League of Nations Mandate. After World War II, Western Samoa became a trustee of the United Nations, administered by New Zealand. Preparations for self-government began then (Western Samoa NEMS Task Team, 1993). On 1 January 1962, Western Samoa became the first of the Pacific nations to become independent.

The governing authority within each village is the village council (*fono*), which constitutes mainly of the *matai* heading each family but also include all village *matai*. The *fono* controls village affairs, keeps order and provides direction for village development.

The Western Samoa form of parliamentary government combines Samoan and Western practices. Even though universal suffrage is used, which was only approved and applied starting in the 1990 election, only *matai* (holders of traditional titles) are eligible to be elected. [Prior to the introduction of universal suffrage, only *matai*, regardless of age, could vote and stand for election]. The only exception is for the two seats elected by citizens of non-Samoan ancestry who are registered on the individual voters' roll. Full universal suffrage principles apply in this case. The Constitution provides for a Head of State, *Ao o le Malo*, to be elected from the Council of Deputies by Parliament for a term of five years. [The Head of State, for first term, was appointed and was for life term.]. At the time of the Constitutional Convention, it was recommended that the Head of State always be chosen from the *Tama-a-aiga*. The Constitution also provides for a Council of Deputies which acts in the place of the Head of State when there is a vacancy or absenc from that office (Campell and Lodge, 1993). The Head of State acts on the advice of the Prime Minister and the Cabinet. Together they constitute the Executive Council. The Legislative Assembly is composed of 49 seats including the Speaker. Two of these seats are elected by citizens of non-Samoan ancestry who are registered on the individual voters' roll. The Prime Minister is elected by Parliament while other eight Cabinet Ministers are selected by the Prime Minister from Members of Parliament. All legislation passed by Cabinet must be assented by the Head of State who must act on the advice of the Executive Council. Elections were held every three years but was subsequently changed to five years starting in the 1990 electrons.

4. The Economy

As indicated in Table 2.4, the economically active population estimated during the 1981, 1986 and 1991 censuses for the population aged 15 years and over, were 47.9, 49.3, and 44.3 per cent respectively. This is expected to increase starting from 1993, especially in the manufacturing employment, due to the setting up and operation of Yasaki. Of the economically active population in 1991, 89 per cent are in the workforce. Bell (1984) noted that Western Samoa's economy is based on agriculture, and subsistence agriculture is the principal economic activity, involving $^2/_3$ of the labour force during the Fourth Five Year Development Plan (1980-1984). Agriculture and related primary sector activities still support around 75 per cent of the population, including almost the entire rural population (Fairbairn, 1993, cited in Western Samoa NEMS Task Team, 1993). The Agriculture Census conducted in 1989 noted that 70 per cent of Samoan families were involved in one way or another in agricultural production and about 50 per cent engage in fishing (Planning Office, 1992). The primary sector account for 50 per cent of the activities of the Gross Domestic Product (GDP), 60 per cent of the workforce and about 80 per cent of the export earnings (World Bank, 1991, cited in Western Samoa NEMS Task Team, 1993). The Western Samoa GDP, by industrial origin, for the 1982-1992 period is presented in Table 4.1 as reproduced from World Bank (1993).

Table 4.1: The Western Samoa GDP, by Industrial Origin, for the 1982-1992 period. Figures are in million Tala. (Source: World Bank, 1993).

	ANNUAL GDP ESTIMATES IN MILLION TALA										
Indistrila origin	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Subsistence	37.3	43.7	47.4	51.6	57.9	58.7	62.5	66.2	75.3	68.7	71.9
Agriculture, forestry and fishing	26.6	32.7	39.8	42.9	43.5	44.2	43.8	53.3	40.5	42.1	38.7
Manufacturing	13.9	21.3	29.0	32.0	28.9	31.1	36.5	32.3	31.9	29.4	29.8
Electricity	4.3	5.9	8.7	8.6	8.0	9.0	11.0	11.4	12.3	15.4	16.0
Construction	1.6	3.9	2.0	2.9	4.1	7.0	9.8	5.7	7.1	7.4	10.1
Distribution, restaurants and hotels	9.4	11.4	13.2	15.7	18.8	20.2	22.4	25.6	30.3	30.7	28.8
Transportation	4.7	5.4	6.6	7.0	5.1	5.6	5.1	5.2	6.7	8.3	10.5
Other services	10.9	13.0	14.8	16.5	17.5	18.7	20.8	22.3	26.3	26.5	29.4
Government	15.2	16.3	17.5	19.4	24.5	24.9	28.4	31.4	36.5	37.7	41.9
GDP at Factor Cost	123.9	153.6	179.0	196.6	208.3	219.4	240.3	253.4	266.9	266.2	277.1
Net Indirect Taxes	24.8	30.7	37.2	45.8	44.7	54.2	55.5	61.2	69.8	81.5	88.7
GDP at Market Prices	148.7	184.3	216.2	242.4	253.0	273.6	295.8	314.6	336.7	347.7	365.8

Merchandise exports during the 1982-1992 period are presented in Table 4.2 by commodity. In terms of value, total export value fluctuated between 10.5 and 18.5 million Tala per year during the 1982-1989 period with the highest recorded in 1984. Export value decreased for each consecutive year from 1989 to 1992. World Bank (1993) noted that the effects of Cyclones Ofa and Val in 1990 and 1991 were expected to cut the volumes of major export crops by 32 per cent in 1992 and was clear that exports of tree crop products would be severely affected. As a result, the surplus food production was likely to be diverted from export to domestic markets.

Table 4.2: Western Samoa's merchandise exports by commodity, 1982-1992. (Source: World Bank, 1993).

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Value (US$ '000)											
Copra	2,290	908	0	425	469	31	948	1,427	477	-	-
Copra meal	317	437	322	250	294	357	447	288	162	-	-
Coconut oil	3,419	7,200	11,276	6,963	2,927	4,117	5,622	3,086	1,805	9	
Coconut cream	615	778	899	1,263	1,263	1,466	1,863	2,245	2,414	2,200	-
Cocoa	818	2,999	1,229	1,050	1,425	1,237	606	945	217	3	-
Taro	1,808	1,540	1,498	2,279	1,939	2,394	2,502	2,578	1,516	2,869	-
Bananas	238	264	15	12	17	19	12	15	1	4	-
Timber	1,055	351	684	364	265	187	521	60	9	-	-
Veneer	261	306	177	75	215	17	-	-	-	-	-
Fruit juice	140	312	267	447	143	92	25	33	8	-	-
Beer	543	546	472	172	125	221	309	320	373	354	-
Cigarettes	303	329	314	249	308	291	329	306	254	288	-
Other exports	704	582	659	898	599	487	1,116	994	1,181	522	-
Re-exports	969	1,252	771	1,686	518	859	801	579	458	224	-
TOTAL	13,480	17,804	18,583	16,133	10,507	11,775	15,101	12,876	8,875	6,473	5,700
Volume (mt)											
Copra	10,536	4,864	-	2,796	3,350	570	3,282	5,944	2,400	-	-
Copra meal	3,963	5,200	4,290	5,926	6,152	5,170	5,281	3,058	2,215	-	-
Coconut oil	8,037	12,207	10,651	10,926	12,552	11,527	10,330	6,292	5,188	35	-
Coconut cream			589	924	923	1,002	1,166	-	1,576	1,557	-
Cocoa	782	2,157	662	590	898	852	474	605	220	2	-
Taro ('000 cases)	140	110	137	220	188	224	191	264	128	212	-
Timber ('000 bd. ft.	2,627	1,409	1,724	1,277	612	309	955	112	18	7	-

Table 4.3 presents a summary of Western Samoa's merchandise trade for the 1982-1991 period. Overall, the trade balance shows a general consistent increase in deficit for each consecutive year.

Table 4.3: Western Samoa Merchandise Trade during the 1982-1992 period. (Source: World Bank, 1993).

	BALANCE OF PAYMENTS, 1982-1992 IN US$ MILLION										
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Merchandise exports (fob)	13.5	17.8	18.6	16.1	10.5	11.8	15.1	12.9	8.9	6.5	5.7
Merchandise imports (cif)	-49.9	-48.8	-50.7	-51.2	-47.1	-61.3	-74.6	-75.5	-80.6	-93.8	-111.5
Trade Balance	-36.4	-31.0	-32.1	-35.1	-36.6	-49.6	-59.5	-62.6	-71.7	-87.3	-105.8

5. Institutions/Agencies

Fisheries Division, Department of Agriculture, Forests and Fisheries: The Fisheries Division was first established in 1970 as part of the Department of Agriculture, Forests and Fisheries. The Division was transferred to the Department of Economic Development in 1976 and remained there until 1982 (Crossland, 1986). It was transferred back to the Department of Agriculture, Forests and Fisheries in 1983 where it has remained as one of the ten divisions of the department. The Division's overall objectives of the development programme are to:

⇒ increase fish production in the country and reduce fish imports;
⇒ generate employment;
⇒ improve nutrition.

The Division's work programme now centres around the purposes given in the Fisheries Act 1988 as follows:

⇒ to promote the conservation, management and development of the fisheries of Western Samoa;
⇒ to promote the exploration of the living resources of fishery waters;
⇒ to promote marine scientific research;
⇒ to promote the protection and preservation of the marine environment.

The Division's staff increased in numbers from its inception in 1970 and that by 1980, there were 96 employed. However, this number declined thereafter and by 1985, only 26 staff were employed of which only five permanent staff had specialised fisheries training (Crossland, 1986).

Major fisheries developement projects include offshore fisheries for both oceanic pelagic fish species such as tuna, and the exploitation of the deep-sea bottomfish resource. Associated projects include boatbuilding, fish market, Fish Aggregation Devices (FADs), small-scale vertical longline. Assessment work has been conducted on the deep-sea bottomfish and reef lobster fisheries. A fisheries statistics system is in place concentrating mainly on the commercial sector. Several research studies have been conducted in the field of aquaculture.

A major undertaking recently initiated is the Fisheries Extension and Training Project, funded by AIDAB. The project will involve creation of 3 fisheries extensions on Upolu (one each in eastern, central and western) and 2 on Savai'i (one each on eastern and western side).

Division of Environment and Conservation, Department of Lands and Environment: The Environment Unit was first established within the Department of Lands and Surveys in 1990, manned by one person. However, the Unit has increased in staff. Part VIII, Division 1 of the Lands and Environment Act 1989 establishes the post of a Principal Environmental Officer. Division 3 establishes that the Director may with the approval of the Minister appoint officers or employees of the Department to be called Conservation Officers. "The Division of Environment and Conservation as such is not created (or even mentioned) under the Act" (Peteru, 1993).

The principal functions of the Department under Part VIII, Environment and Conservation of the Act, include:

(a) to advise the Minister on all aspects of environmental management and conservation;
(b) to ensure and promote the conservation and protection of the natural resources and environment of Western Samoa;
(c) to act as the advocate of environmental conservation at Government, its agencies, and other public authorities;
(d) to make recommendations to the Minister in relation to establishment of parks/nature reserves including their administration and management;
(e) prevent, control and correct pollution of air, water and land resources and to promote litter control;
(f) to carry out investigation and research relevant to the protection and conservation of natural resources and the environment;
(g) to provide and promote training in the skills relevant to its functions;
(h) to promote public awareness to the importance of the environment and its conservation.
(i) to do anything incidental or conducive to the performance of any of its functions.

Under the Lands and Environment Act 1989, two Boards are established, which are as follows:

(1) <u>Land Board</u> - the duty of the Land Board is to carry out the provisions of the Act for the administration, management, development, alienation, settlement, protection, and care of Government land. Classification of Government land are as follows:

(a) farm land, being land suitable or adaptable for any type of farming;
(b) urban land, being land suitable or adaptable for residential purposes, and being in or in the vicinity of any town or village;
(c) commercial or industrial land, being land suitable or adaptable for use for any commercial or industrial purpose.
(d) **Aquaculture land, being land, including the foreshore and seabed, that is suitable for breeding and rearing of fish

**The amendment to the Land Ordinance 1959, as mentioned in the Fisheries Act 1988, is not reflected in the Lands and Environment Act 1989. The amendment is the addition of a paragraph, (d), under Part IV, Section 28, Classification of Government Land, after paragraph (c).

(2) Environment Board - the functions of this Board include:

- ⇒ review, report on, or decide on matters referred to it by the Minister;
- ⇒ act as conciliator in cases involving disputes between the Department and proponents of development projects insofar as they relate to the environment;
- ⇒ review annual reports of the Department to the Minister and Cabinet insofar as they relate to the environment;
- ⇒ review and endorse the annual corporate plans of the Department insofar as they relate to the environment;
- ⇒ inform the Minister of development projects having an adverse effect on the environment.

O le Si'osi'omaga Society: This non-governmental society was formally established in 1990. Membership is granted to individuals and corporate bodies within Western Samoa upon payment of appropriate fee. The Society's constitution lists the goal of the society as 'to promote the balance and harmony which should characterise the Samoans' relationship with other components of their environment". The objectives are:

(a) to monitor the state of the environment in Western Samoa, with particular emphasis on the impact of human activities on land (including lava fields), fresh water, lagoons, reefs, ocean and air; and to promote only those policies and practises which have positive impacts;
(b) to disseminate information and create public awareness amongst its members and the community regarding environmental matters;
(c) to demonstrate sound ideas and practises for the purpose of promoting conservation and sustainable development through carefully selected field projects; such demonstrations should draw on traditional knowledge and practices if they are considered beneficial;
(d) to resist any attempt to bring the Society under the control of any persons or bodies other than those established by this Constitution;
(e) to ensure that rules and procedures established for the smooth operation of the Society are adhered to at all times;
(f) to cooperate with similar organisations within Western Samoa and throughout the world for the purpose of advancing the cause of conservation and sustainable development;
(g) without prejudice to its other objectives, the Society shall also carry out whatever is necessary to strengthen its capabilities, institutional arrangements, and financial support to enable its work programme to run efficiently and economically.

6. Legislations affecting the Marine Environment and its Resources

Constitution of the Independent State of Western Samoa 1960: Article 104 of the Constitution provides that all land lying below the line of high water mark in the Territorial Waters is vested in the State.

Fisheries Act 1988: The Act provides for the conservation, management and development of Western Samoan fisheries, for the licensing and control of foreign fishing and for related matters.

It repeals the Fisheries Protection Act 1972 and Fish Dynamiting Act 1972. It also amends some sections in the the Exclusive Economic Zone Act 1977 and the Land Ordinance 1959.

Part II of the Fisheries Act 1988 deals with Fisheries Conservation, Management and Development. This sub-section (1) lists the purposes of the Act as:

- ⇒ to promote the conservation, management and development of the fisheries of Western Samoa;
- ⇒ to promote the exploration of the living resources of fishery waters;
- ⇒ to promote marine scientific research;
- ⇒ to promote the protection and preservation of the marine environment.

Sub-section (2) lists the general functions of the Director as:

- ⇒ to advise the Minister in respect of matters relating to the fisheries of Western Samoa;
- ⇒ to exercise and perform such functions, powers and duties in relation to fisheries as are conferred or imposed upon

the Director by or under this Act or any other enactment;

⇒ to consult with fishermen, industry and village representatives, concerning conservation, management and development measures for fisheries.

Subsection (3) establishes powers, rights and authorities of the Director to include:

⇒ collect and analyse statistical and other information concerning fisheries;

⇒ propose management and development measures designed to obtain the maximum benefits from the fishery resources for the people of Western Samoa, both present and future;

⇒ monitor activities and proposals in other sectors and advise the Minister concerning their effect on fisheries;

⇒ in consultation with fishermen, industry and village representatives, prepare and promulgate by-laws not inconsistent with this Act for the conservation and management of fisheries;

⇒ establish, operate and maintain facilities for fishing and related activities;

⇒ act in combination or association with any other person or body, whether incorporated or not, and whether in Western Samoa or elsewhere, for any of the purposes authorised by the Act.

With respect to by-laws, the following provisions apply:

(a) by-laws shall be signed by the Director;
(b) they shall be published in the Gazette and in a newspaper circulating in Western Samoa;
(c) they shall come into force on a day fixed in the by-law, which day shall not be earlier than 7 clear days after the date of publication in the Gazette;
(d) any by-law may in like manner be altered or revoked;
(e) any by-law affecting or applying to the conservation and management of fisheries in lagoon waters shall be issued to the Pulenu'u of adjacent villages at least 7 clear days before it shall come into force;
(f) a by-law may leave any matter to be determined, applied, dispensed with, prohibited, or regulated by the Director, from time to time, either generally or for any classes of cases, or in any particular case;
(g) no by-law made by the Director shall bind the Government; and
(h) by-laws must be reasonable and consistent with the Act.

Part II, 4 of the Act prohibits the use of any explosive, poison or other noxious substance for the purpose of killing, stunning, disabling or catching fish, or in any way rendering fish more easily caught.

Part II, 5 of the Act requires local commercial fishing vessels to have a valid certificate of registration issued by the Director.

Part III of the Act deals with Foreign Fishing and include sections on Access Agreements, Other Agreements, Foreign Fishing Licences and Gear Stowage.

Part IV of the Act deals with the Authorisation of Marine Scientific Research.

Part V of the Act deals with General Licensing Provision, including Conditions of Licences and Cancellation/Suspension of Licences.

Territorial Sea Act 1971: This Act declares a 12 nautical mile territorial sea which is measured from baselines. The baseline is the low-water mark along the coast.

Exclusive Economic Zone Act 1977: This Act establishes the exclusive economic zone of Western Samoa adjacent to the territorial sea, and in the exercise of the sovereign rights of Western Samoa to make provisions for the exploration and exploitation, and conservation and management, of the resources of the zone.

Lands and Environment Act 1989: This Act derives from the Land Ordinance 1959 to which has been added environmental provisions which have been borrowed from overseas legislation (Peteru, 1993). The functions of the Department as mentioned in the Act, concerning the environment and conservation, are listed in 5 above. In addition to those, some specific items include the following:

Under (a), the advice include those concerning (i) policies for influencing the management of natural and physical resources and ecosystems as to achieve the objective of the Act, (ii) the potential environmental impact of any public or private development proposal, and (iii) ways of ensuring that effective provision is made for public participation in environmental planning and policy formulation processes in order to assist decision-making at the national and local level. Under (c), to provide advice on, (i) procedures for the assessment and monitoring of environmental impacts, (ii) pollution control and analysis of pollutants in the environment, and (iii) control and management of hazardous and potentially hazardous substances including the management of the manufacture, use, storage, transport and disposal of such substances.

Note: The amendment to the Land Ordinance 1959, as mentioned in the Fisheries Act 1988, is not reflected in the Lands and Environment Act 1989. The amendment is the addition of a paragraph under Part IV, Section 28, Classification of Government Land, after paragraph (c). This addition reads: "(d) Aquaculture land, being land, including the foreshore and seabed, that is suitable for breeding and rearing of fish."

Agriculture, Forests and Fisheries Ordinance 1959: Responsibility for the protection of the marine environment is given to the Minister of Agriculture, Forests and Fisheries under the Ordinance. In particular, Section 4(b) provides that one of the principal functions of the Department is "to promote, in conjunction with the Department of Natural Resources and Environment, the conservation, production, and development of the natural resources of Western Samoa.."

International and Regional Agreements Relating to Fisheries: Western Samoa has signed the 1982 United Nations Convention on the Law of the Sea. It has also signed the Niue Treaty on Cooperation in Fisheries Surveillance and Enforcement in the South Pacific and is a party to the Treaty on Fisheries between the Governments of Certain Pacific Island States and the Government of the United States of America (Campell and Lodge, 1993).

Proposed Local Fisheries Regulation 1994: The regulations establish minimum size limits of certain marine organisms utilized in the inshore reef and lagoon fisheries. They also establish minimum mesh size for various nets. Part II of the regulations deals with fish aggregating devices and Part III deals with local commercial fishing vessels registration and safety requirements. Details of these regulations are mentioned and discussed under each respective resource profile.

7. Management of the Fisheries Resources

The Fisheries Act 1988 provides for the conservation, management and development of Western Samoan fisheries, for licensing and control of foreign fishing and related matters. Responsibility to enforce provisions of the Act falls under the mandate of the Department of Agriculture, Forests and Fisheries.

8. Development Plans

The Seventh Development Plan, 1992-1994, (National Planning Office, 1992) lists the country's long-term development objectives as:

- ⇒ sustained economic growth;
- ⇒ improved quality of life for all Samoans;
- ⇒ greater degree of national self-reliance;
- ⇒ improved regional balance;
- ⇒ equitable distribution of socio-economic opportunities;
- ⇒ protection of the environment.

Despite increased development expenditure, progress towards achieving the objectives has not been impressive and the general situation was reported as follows:

- ⇒ the economy has been stagnant;
- ⇒ the quality of life is good but not significantly improving; in some respects there has been deterioration;
- ⇒ consumption has grown much faster than production, financed by private and official transfers from overseas without which living standards would fall drastically;
- ⇒ in general, Savai'i is now on a par with rural Upolu with respect to most economic and social development indicators;
- ⇒ the majority of Samoans are solely or principally dependent on subsistence activities while a few families with established commercial interests are best placed to take advantage of emerging investment opportunities in the modern sector;
- ⇒ statements of intent with regard to the environment have yet to be translated into action, although prerequisite policies and legislation are in palce.

A set of more precise, more measurable and more achievable objectives were adopted for the 1992-1994 developemnt period (Planning Office, 1992). These were listed as:

- ⇒ to achieve a GDP growth rate which consistently exceeds the population growth rate, taking into account the likelihood of reduced net emigration and a return flow of Western Samoan overstayers in New Zealand;
- ⇒ to achieve this through sustainable development; that is, without net consumption of capital including those capital assets which take the form of natural endowments;
- ⇒ to finance a steadily increasing proportion of national investment from domestic savings, especially savings generated in the private sector;
- ⇒ to maintain the foreign reserves at a level equivalent to not less than six months' merchandise imports;
- ⇒ to maintain the role of the village as the principal focus of social, cultural and economic life while facilitating the planned development of urban areas;
- ⇒ to make a broader range of economic opportunities available throughout the country, especially in the rural areas, and to facilitate people's access to those opportunities;
- ⇒ to reduce the size of Government so that the private sector becomes responsible for a growing share of the economy and increasingly takes the initiative in economic development;
- ⇒ to reduce the vulnerability of the economy and infrastructure to natural disaster, in particular cyclones.

Issues of concern on fisheries are stock declines recorded in recent years due to various reasons including natural disasters (Planning Office, 1992). The same document noted that the lagoons and reefs are suffering degradation and that the inshore fishery is believed to be in an advanced state of ecological collapse. This has been ascribed as a result of greatly increased inputs of sediments, nutrients and chemicals from deforestation and subsequent agricultural activity, and reclamation of highly productive coastal margins, especially mangroves.

The fishery sector was specified as a possible source for growth in production, exports and employment in the country. "A revival of the fisheries depends on the successful implementation of policies and projects to accomplish a shift of emphasis away from inshore fishing grounds to deeper water fishing and to aquaculture, where considerable progress has already been made by private investors with Government support. Stronger enforcement of fisheries regulations will be necessary to allow inshore fishing grounds to recuperate" (Planning Office, 1992).

Strategies adopted for the fisheries sector include:

* establishment of deep-water fish aggregating devices (FADs) for tuna;
* have a sail-assisted successor to the *alia* catamaran designed to enable fishermen to make longer fishing trips over greater distances for tuna;
* increase exports of high-value fish by airfreight but the principal focus is to meet domestic demands;
* re-stocking of reef in a long-term effort to neutralise past damage;
* further support to private aquaculture ventures;

* investigate the feasibility of establishing a fresh-water inland fishery in Afulilo dam, and possibly elsewhere.

Accordingly, fisheries policies centre around these strategies with the addition of establishing fisheries centres (extensions) at Salelologa and Asau on Savai'i to provide ice-making, cold storage and marketing services on a partial cost recovery basis. Research into establishing giant clam, oyster, trochus and seaweed culture as small-scale privately owned industries at selected parts of the coast was also envisaged.

9. Fisheries Bibliography

The fisheries bibliography, updating and enhancing the existing list of reports on aspects of fisheries in Western Samoa, was completed in 1987 under the FAO/UNDP Regional Fishery Support Programme by Gillett and Su'a (1988).

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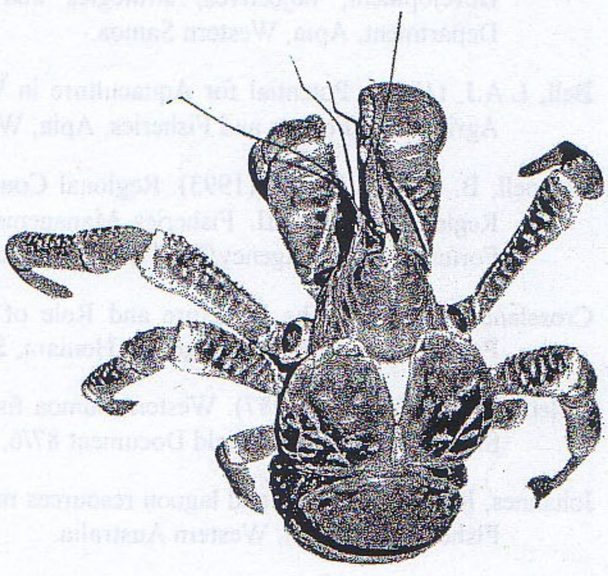
1. CRUSTACEANS

1.1 Coconut crabs - *Ūū*

1.1.1 The Resource

Species present: *Birgus latro* (coconut or robber crab -*ūū*) is found and utilised in Western Samoa.



uu - Birgus latro

Distribution: Coconut crab is widely distributed from the Seychelles in the Western Indian Ocean to the Tuamotu Archipelago in the eastern Pacific. Its occurrence is restricted to island habitats and is virtually unknown in East Africa, the Indian sub-continent, mainland Asia and Australia probably due to the presence of large animal competitors and predators in these areas (Brown and Fielder, 1991). However, several reports seem to indicate that the species' range appears to have somewhat diminished. Within certain localities, habitat destruction, uncontrolled exploitation and depredation by domestic and feral animals, have contributed to the declines and local extinctions.

No information is available on the distribution of coconut crabs in Western Samoa. However, they are known to be collected from Vini Island at Aleipata and Mulifanua for subsistence on Upolu Island. Several places on Savai'i Island (e.g. Falealupo District) are known to support very low populations.

Biology and ecology: Coconut crab is a "close relative of the hermit crab group and has evolved to become the largest and least marine-dependent of the land crabs" (Brown and Fielder, 1991). It is an omnivorous scavenger and its primary foods include coconut flesh, fruits of the screw-pine (*Pandanus*), *Canarium* spp., sago palm, *Terminalia*, *Barringtonia*, and *Artocarpus*. Coconut crabs are slow-growing and for the Vanuatu stocks, they take at least ten years to reach legal marketable size (9 cm, CTL=43 mm)[1] The growth coefficient, K, of the von Berterlanfy's growth equation, was estimated to be 0.05, which is very low (Brown, 1989). Fletcher *et al.* (1991) estimated longevity to be between 40 and 60 years and the asymptotic thoracic length (L_{∞}) of 80 mm and 50 mm for males and females respectively. Growth in coconut crabs, as in other crustaceans, has two components, the increment of growth at each moult and the time interval between each moult episode (Fletcher *et al*, 1991). Moulting is normally once a year with the exception of smaller-sized crabs that are believed to be able to moult more than once a year. For protection from predation and to minimise the risk of dehydration the crabs burrow or hide in small crevices that provide the same conditions as burrows, prior to moulting. The ecdysis process takes from one to two hours to complete while the time between moulting and emergence from the burrows is about 1 month for small crabs and up to three months for the larger individuals (Fletcher *et al.*, 1991).

Mature crabs mate on land in summer while both sexes are in the hard shell condition. However, fertilisation may require seawater. Laying of eggs is assumed to take place soon after copulation as females do not possess seminal receptacles. The females carry fertilised eggs attached to their pleopods for approximately one month, while maturing, before migrating to the sea for their release. The release

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[1] [CTL=cephalothoracic length, TL=thoracic length]

of eggs is accomplished using one of the four methods which is closely associated with the type of coastline present. Schiller *et al.* (1991) describe these methods in detail. 1. In cliff coastlines with narrow or no intertidal shelf, the berried crab climbs over the cliff edge and reorients itself so that it faces up the cliff. It then "slowly reverses down the cliff until a wet section, or wave splash, is encountered" at which point it "stops and flexes its abdomen away from the cliff face, letting the egg-bearing pleopods dangle loosely, thus exposing its entire egg mass". The crab moves further down if there is not sufficient splashes at any particular height until it is washed over by a wave which results in rapid hatching of the mature eggs and washing away of the newly eclosed zoea larvae. 2. In coastlines with intertidal shelf, the berried female walks rapidly across the shelf until it encounters a saltwater pool. It raises its abdomen to keep the egg mass clear of the water and only lowers it into the water with rapid backwards and forwards flexes of its abdomen in small rapid jerking movements, to facilitate eclosion of the eggs, when a wave swamps it. 3. The third method involves coastlines as that in 2 above but the release is not through a pool splashed by waves but a saltwater 'stream' draining the shelf. 4. The method used in coastlines having a sand or coral rubble beach is similar to that in 2 above. The crab moves down the beach into the water until it is swamped by a wave. "In each method, egg hatching/larval release is invoked by exposure of the eggs to moving water, usually via inundation by waves".

Mature eggs hatch immediately into the first zoea stage upon release into the ocean. The hatched eggs undergo four plantonic zoeal stages in approximately three weeks and the crabs (new recruits) emerge from the water as glaucothoe inhibiting small shells. The glaucothoe inhabit the wrack area above the high sea mark and are hard to find and be distinguished from other related coenobinids (Reese, 1987, quoted in Schiller *et al.*, 1991). "The glaucothoe subsequently metamorphose into juvenile crabs which maintain the shell carrying habit for one to two years" (Brown, 1989). Reese (1987, quoted in Schiller *et al.*, 1991) postulated that the fossorial nature of coconut crab glaucothoe and juveniles makes them extremely difficult to find. Fletcher (1988, quoted in Schiller *et al.*, 1991) using size-frequency data, calculated that satisfactory recruitment of glaucothoe and juveniles into Vanuatu coconut crab populations occurred every 5-10 years and could be considered both infrequent and unpredictable. Fletcher (1988) gave a possible explanation for the dearth of recruitment in Vanuatu as due to the rapid drop-offs close to shore and because of the benthic nature of the *Birgus* larvae, they merely sink to the bottom in depths beyond their capacity to return to a sandy beach from which they gain access to a terrestrial existence. Thus recruitment may only occur if the larvae become entrapped in a shallow embayment.

No study has been conducted on any biological aspect of the coconut crab population in Western Samoa.

1.1.2 The Fishery

Utilization: The collection of coconut crabs is Western Samoa is of low importance and on the subsistence level only in a few places where they are found. Coconut flesh is normally used for bait but the crabs are sometimes smoked out of their holes. No documented evidence of coconut crabs being offered for sale is available.

Production and marketing: Collection of coconut crabs is for subsistence use only and no information is available on the level of exploitation in areas where they are utilised. There may be very limited sales of coconut crabs.

In 1973, a proposal was submitted to the Janss Foundation, California, USA, for support for a six year program examining the biological and economic feasibility of the farming of coconut crabs on tropical Pacific islands, particularly in Western Samoa (Travis and Reese, 1973). This project did not materialise.

1.1.3 Stocks Status

Stocks of coconut crabs in areas where they occur in Western Samoa are not known. However, the unknown level of utilization and absence of coconut crabs in the commercial markets indicate very low levels of stocks.

1.1.4 Management

Brown and Fielder (1991) write that;

> "the biological and population characteristics of coconut crabs conspire to make the species particularly vulnerable to exploitation. They are terrestrial, relatively easy to catch, slow growing, and their recruitment success seems to be highly variable. With intensive harvesting a coconut crab population can be depleted very quickly, and the stock may only begin to recover many years after collecting has ceased"

The phenomenon of irregular recruitment was found to be common in areas where studies have been conducted.

Current legislation/policy regarding exploitation: There is current no legislation that specifically addresses the exploitation of coconut crabsin Western Samoa.

Recommended legislation/policy regarding exploitation: Even though the coconut crab resource in Western Samoa is very limited and that it is utilised only in the subsistence level in a few localities, introduction of a minimum size limit can be a useful tool. The process could form a general introduction to resource management concepts if introduced with legislation involving other, more important, fisheries resource.

Legislations applied to coconut crabs utilization in some South Pacific countries, e.g. Palau, Vanuatu, Fiji, American Samoa include:

* prohibition of buying or selling of any coconut crab smaller than four inches in the greatest distance across the width of its carapace;
* prohibition of the buying or selling of berried female coconut crabs, of any size, and coconut crabs from which eggs have been removed.

Other management measures taken in some countries where commercial utilization occurs are geared towards ensuring the sustainable utilization of the resource. These include:

Closed season: prohibited harvesting during the breeding season.

Quota allowance: this would require stock assessment in the main areas of harvesting. The appropriate government agency, e.g. Fisheries, would be empowered to halt collection of crabs in any area at any time if it is believed that the quota has been exceeded or some other problem exists with the stocks.

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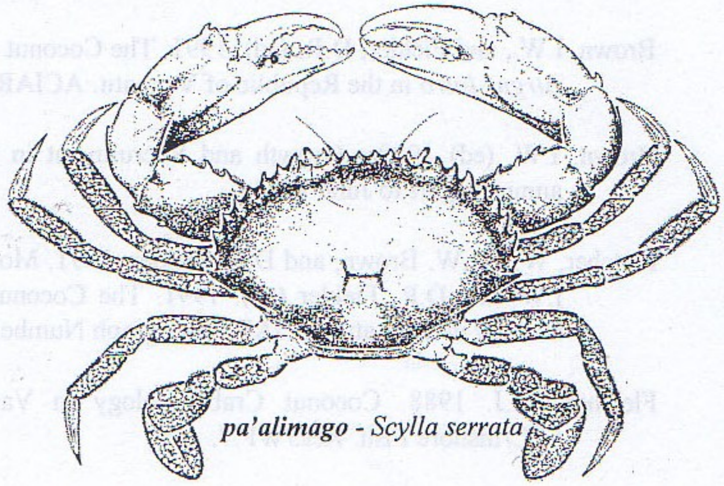
1.2 Mangrove (mud) crab - *Pa'alimago*

1.2.1 The Resource

Species present: The mangrove crab (also known as mud or Samoan crab - *pa'alimago*), species *Scylla serrata*, is present and utilized in the subsistence/artisanal and commercial levels in Western Samoa.


pa'alimago - Scylla serrata

Distribution: Dickinson (1977, quoted in Brown, 1993) describes the natural range of the mangrove crab, *S. serrata*, as extending 'from Mossel Bay in South Africa along the East African coast including Mauritius and Madagascar to the Red Sea. The range continues eastward to India and Sri Lanka and throughout Indonesia, the Philippines and Malaysia. In occurs in Thailand, China and Taiwan with its northern limit as the mouth of the Tone River in Japan. It is found along the Australian coasts from Broome, West Australia, north and east to the Northern Territoty and Queensland, and New South Wales to Port Jackson. It also occurs in New Zealand and the South Pacific Islands including, Papua New Guinea, Palau, Caroline Islands, FSM, Mariana Islands, Samoa, Tuamotu, Solomon Islands, Vanuatu, Fiji, Tonga, Cook Islands. It is probable that any tropical Pacific island which is large enough to sustain a fluvial delta with associated mangrove forests will support a population of mangrove crabs.

In Western Samoa, mangrove crabs are generally more abundant in areas where mangroves are well established. On Upolu, the main areas which support good mangrove growth and in which the mangrove crab artisanal fishery exists, include the Mulinu'u-Toamua coastline, Sale'imoa and Safata. These areas are the main sources of coconut crabs sold in the Apia Fish Market.

Biology and ecology: Information in this section is taken solely from Brown (1993). The taxonomy of the genus *Scylla* is still a debate and the number of existing species unknown. On the basis of differences in colour patterns, relative size, cheliped spination, chromosome form, and gamete development, Estampador (1949 quoted in Brown, 1993) recognised three species (*S. serrata*, *S. oceanica* and *S. tranquebarica*) and one variety (*S. serrata* var. *paramamosain*) in Philippine waters. This classification was rejected by Stephenson and Campbell (1960, quoted in Brown, 1993) due to the rather qualitative nature of the criteria used. Although some studies seem to have results in support of specific distinction between some suggested species, the need for further justification before subdividing, is required.

S. serrata is frequently found in areas characterised by a muddy substrate associated with mangrove vegetation. It is the only portunid crab characteristically found in mangrove swamps and generally have a restricted home range (Brown, 1993). Burrows are used by subadults and adults as general refuges especially when in soft-shelled satge of the moulting and when mating. However, moulting and mating also occur outside burrows. Adults can tolerate salinities of 2 ppt for a few months and as high as 60 ppt. However, the pelagic zoeal larvae suffer high mortality at temperatures above 25 °C and salinities below 17.5 ppt. *S. serrata* is an opportunistic feeder feeding mainly on slow-moving or immobile prey organisms. It eats smaller injured or weak crabs of the same species as well as algae and decaying vegetable matter. It reamins buried during daylight and feeds at night, mainly in early evening and before dawn. During mating and the late intermoult period and when temperatures fall below 20 °C, mangrove crabs reduce or completely cease to feed.

Maturity in mangrove crabs may occur in the tropics at 18 months of age whereas those in more temperate regions may take up to 3 years. Mating occurs when the female's carapace is soft. Spermatophores are transferred into the female's sperm receptacle. Sperm cells can remain viable in their gelatinous packages for periods up to 7 months and still effectively fertilize ova as they pass along the female's oviducts to the exterior. "After emerging, the eggs (ranging from 2 to 6 million) are attached in a mass to a set of pleopods beneath the abdominal flap where they are tended and aerated by the female. Egg incubation takes about 10 to 17 days. Ovulating females migrate offshore to hatch their eggs in an oceanic environment more tolerable to the pelagic larvae stages. After hatching, the planktonic zoea undergoes up to five moults over a period of about three weeks during which time it is transported back to the estuarine environment by tidal currents. The final zoeal stage changes into a megalopa which settles out on a substrate and after five to twelve days becomes a juvenile crab (Brown, 1993). Cultured crabs in Hawaii reach attained marketable size (500-700 g) in 18 months at 24° C while at 27° C they reached equivalent size in onlt 12 months. In Australia mangrove crabs can reach carapace width of 24 cm with the majority in the 15-20 cm range (Brown, 1993).

No study has been conducted on any aspect of the mangrove crab stocks in Western Samoa.

1.2.2 The Fishery

Utilization: Mangrove crabs used in the subsistence level are normally caught as part of the catch of the general finfish fishery, especially night fishing using pressured gas lantern (*lama*). Holmes (1974) reported wooden traps as being used for taking eels, lobsters, crayfish, and crabs. Buck (1930) reported the use of baited crab pots (*fagą pa'a*). Today, baited traps (Figure 1.2.1) are used in areas where mangrove crabs are fished for commercial purposes. The bait is crushed *Cardisoma carnifex* (*tupa*) or *Sesarma erythrodactyla* (*u'a*). [Forty-four gallon drums are also used. The drums are cut in half and partly buried in the mud. Crabs use these as hiding places.] In Safata Bay, one fisherman was known to dive for crabs within the bay, extracting them from their holes (*aga pa'a*) in the deeper part of the bay. Crabs are also dug up from their holes within the mangrove areas.

The increase in crab trappings has been due to the development of local markets for the crabs which are mainly the Apia Fish Market, hotels and restaurants. The commercial crab trappers fish for crabs through-out the week storing catches (alive) to be sold on Saturday. Saturdays and Sunday mornings are the seafood shopping days for Sunday meals.

Production and marketing: No estimates of mangrove crabs consumption on the subsistence level are available and data collected from the commercial market and other outlets are imcomplete. The nation-wide Fishery Catch Assessment Survey conducted in 1978 by the Department of Statistics in forty eight villages in Western Samoa, excluding the Apia area,estimated the following shellfish fishery products in broad categories:

Category	Total Catch (kg)	Per cent of Total Catch (including finfish)
Crustacea	27,960	2.56
Shellfish	18,512	1.69
Cephalopoda	31,123	2.85
Echinodermata	44,786	4.11

Crustacea category would be made up mainly of lobster and crabs.

In a survey of fish consumption on Upolu, Zann *et al.* (1984) estimated that crabs (general) comprised 2.1 per cent of invertebrate species eaten in rural areas. The results of the surveys are presented in Table 1.2.1. The estimated percentage was based on fish consumption on the day before the actual survey. Since the total invertebrate consumption was estimated to be 6,093 mt/year, and applying the crab percentage would mean a 128 mt of crabs are consumed in rural areas on Upolu per year. No crab consumption was in the Apia area during the survey period.

Table 1.2.1: Percentage of invertebrate types eaten on day before survey.

Taxon	English/Samoan name	Apia	Nort h east	North west	South east	South central	South west	Manono Is.	Rural Average
Households consuming invertebrates on previous day		24	26	28	7	14	17	50	23.7
MISC.									
Scyphozoa	jellyfish/'alu'alu	9					8		1.3
MOLLUSCA									
Gastropod	snails					19			3.2
Dolabella	seahare/gau			33					5.5
Bivalvia	**misc.**		**25**						**4.2**
Tridacna	giant clams/faisua					20			3.3
Anadara	cockles/pae	18							
Gafrarium	venus shell/tugane	9							
Pinna	penshells/fole						8		1.3
Octopoda	octopus/fe'e							14	2.3
Total		27	25	33		39	8	14	20.0
CRUSTACEA									
Crabs	**crabs/pa'a**					**13**			**2.1**
Panulirus	spiny lobster/ula								2.0
Total			12			13			4.1
ECHINIDERMATA									
Holothurian	gonads/sea	36	37	33	100	13	56	57	49.3
H. atra	sa cucumber/loli			33			4	28	10.8
Echinometra	seaurchin/tuitui	18	25			33	24		13.6
Total		54	62	66	100	46	84	85	73.7

At the Apia Fish Market, large mangrove crabs are normally sold individually while small crabs are often sold on strings of about 5-10 animals. Table 1.2.2(a) presents estimated annual shellfish landings at the Apia Fish Market and other commercial outlets for the 1986-1993 year period. The 1989 invertebrate total landings of 34,360 kg at "other commercial outlets" was estimated to be worth WS$212,561. Invertebrates recorded in 1990 at the same avenue include lobsters, mud crabs, octopuses and eels.

Table 1.2.2(a): Commercial shellfish landings at the Apia Fish Market, Other Outlets and Roadside from Apia to Faleolo. (Sources: Helm, 1987; Mulipola, 1993; Mulipola, 1994; Brotman, 1989; Winterstein, 1991).

	1986	1987	1988	1989	1990	1991	1992	1993	1994
Market									
Lobsters	10,752	9,123	2,817	3,600	1,800		3,500		5,705
Slipper lobster									680
Reef crabs									3,215
Mangrove crabs	**9,640**	**10,465**	**4,194**	**5,400**	**1,200**		**2,500**		**13,810**
Giant clams	10,010	1,878	3,144	100	100		500		484
Other crustaceans			288						2
Octopus	6,674	5,098	1,447						8,332
Squid									27
Turbo chrysostomus									2
Tectus pyramis									86
Other commercial outlets									
Lobsters				18,383				982	
Mangrove crabs				**1,684**				**51**	
Giant clams				275					
Fresh-water shrimps				103					
Octopus				756				414	
Beche-de-mer				13,091					
Invertebrates*					10,280				

*Data for January-August, 1990. *[1] only Oct-Dec,1993.

Table 1.2.1b: Commercial shellfish landings on roadside from Apia to Faleolo. (Source: Iosefa, 1992, Mulipola, 1994).

	1991	1992	1993	1994
Mangrove crabs		450	7.8*[1]	
Giant clams		78		
Trochus		39		
Sea		119 bottles		
Sea urchin		242 baskets		

*[1] only Oct-Dec,1993;

It was not possible to trace the sources of mangrove crabs sold at the Apia Fish Market and other outlets.

1.2.3 Stocks Status

No information exists on the status of mangrove crabs in areas where populations form an important component of the subsistence as well as the commercial sectors. However, anecdotal information indicate that stocks from areas which supply the Apia Fish Market have declined drastically. This is further supported by the fact that very small crabs are now often sold at the market, mostly on strings of a few individuals.

About twenty years ago, the mangrove crab fishery within Safata Bay was very important involving several trap fishermen. Now, there are only two crab trappers left and trapping activities have spread to mangroves areas outside the bay adjacent to nearby villages.

1.2.4 Management

Current legislation/policy regarding exploitation: There is currently no legislation that specifically addresses the exploitation of mangrove crabs in Western Samoa. Under Part VII, 25 of the Fisheries Act 1988 provides that the Head of State, acting on the advice of Cabinet may make regulations for the purpose of carrying out or giving effect to the principles and provisions of the Act. Subsection (b) specifically addresses prescribing measures for the conservation and management of fisheries, including closed seasons and areas, specifications of gear that may be used, prohibited fishing methods and gear, and the species, sizes and other characteristics of fish that it is permitted of forbidden to catch.

The proposed Local Fisheries Regulations 1994, Section 6 (1) deals with mangrove crabs and reads:

> No person shall undertake fishing for or sell any mangrove crab (*S. serrata*) which is:
>
> (a) less than 150 mm measured across the widest part of the carapace;
> (b) egg bearing;
> (c) soft shelled.

Recommended legislation/policy regarding exploitation: Research will be required to establish whether the minimum size limit currently proposed is the applicable width for the local mangrove crab stocks. Application of a closed season nationally, during the breeding season, once established, is a consideration. In Queensland, female mangrove crabs may not be taken by either commercial or recreational fishermen (Brown, 1993). Other management possibilities include limited entry by restricting the number of traps per fisherman, setting a quota per area etc. This would be possible to enforce if management of the resources is community based. Perhaps one of the major consideration in the management of mangrove crab stocks concerns controlling developments that affect their habitat (i.e. mangroves).

It would be necessary to make it illegal to possess, sell or purchase mangrove crabs from which eggs have been removed.

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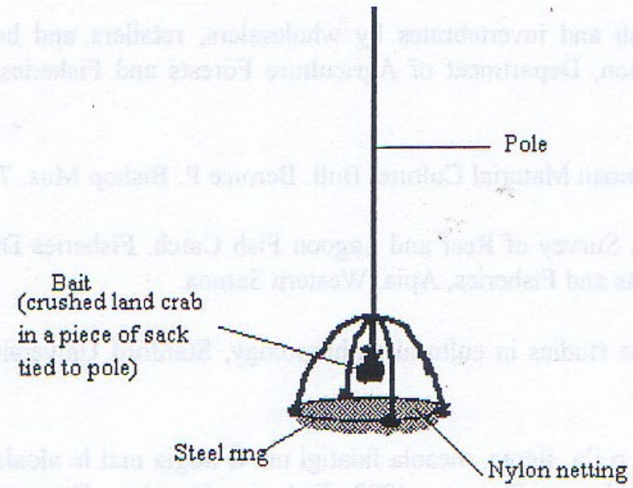
Figure 1.2.1: Mangrove crab trap.



1.3 Land crab - *pa'a (e aumau i le laueleele)*

1.3.1 The Resource

Species present: The land crab species utilised in Western Samoa for food are, *Cardisoma carnifex* (*tupa*), the red-claw mangrove crab, *Sesarma erythrodactyla* (*u'a*), and the land crab, *Cardisoma*. sp., (probably *C. hirtipes*) (*mali'o*). All of the three species are utilized only in the subsistence level and in certain villages only where they occur in abundance.

tupa
Cardisoma carnifex

Distribution: Land crabs probably occur throughout most of Western Samoa but abundance, as indicated by their being utilized for consumption, is restricted to certain localities. The *mali'o* is intensively collected by villagers of Falelima, Savai'i Island, during its annual spawning migration. Falelima is the only known village where this land crab species is present in large numbers and utilized in a large scale in the subsistence level. It is generally widespread in the forests of that village. *Tupa* is abundant in the Safata Peninsula where the resource is collected throughout the year for both consumption and bait for mangrove crab traps. The *tupa* burrows are mostly along the fringes of the peninsula in sandy/mud substrate and also amongst mangrove roots. *U'a* is only found in mangroves outlying the northern side of the peninsula, with their burrows amongst the roots of *Brugiera* mangroves. *U'a* is also utilized for food and as mangrove crab bait. However, because of its larger size, *tupa* is preferred and is mostly targetted.

Biology and ecology: Smith (1992) and Nichols (1991) give the following information concerning land crabs of *Cardisoma* species in the Federated States of Micronesia and the Republic of Palau. Adult crabs live in the inland areas of the islands amongst the ground cover vegetation, and come out at night to feed. Several days before the full moon, especially during the summer months, they undertake mass migrations to the sea. The crabs emerge at dusk, around two days before the full moon and make their way to the shore. The larvae are released from the eggs into the waves by vigorous flapping of the abdomen. Release of larvae at spring tides presumably maximizes dispersal along the coast. In Vanuatu, Amos (1993, *pers. comm.*) reckons that spawning migration is during new moon (dark nights).

The *tupa* is known to be in best eating condition, because of the presence of gonads, during the full moon?, especially in the warmer months? As is in mangrove crab, *tupa* is an opportunistic feeder feeding mainly on small animals they pick up from the mud/sand as well as algae and decaying vegetable matter (e.g. mangrove leaves). No other information is available on the biology of *tupa* and *u'a* in Western Samoa.

In Falelima, the *mali'o* migration to spawn takes place 1 week before the palolo swarming and harvesting is mainly done over a three-day period once the migration starts. [The palolo swarming correlates to the third quarter moon in October and November].

1.3.2 The Fishery

Utilization: Bell and Amos (1993) report that in Vanuatu, land crabs occur all throughout the country but abundance, as indicated by their being utilized for consumption, is restricted to certain islands. The resource is an important income earner on some islands.

All of the land crabs species utilized in Western Samoa are for subsistence consumption only. The *mali'o*, *Cardisoma* sp. (*hirtipes*?), is only known to be an important resource in Falelima, Savai'i, where it is harvested mainly during October/November, a week before the *palolo* rise. Dried coconut fronds are mainly used as source of light when collecting crabs during their migration at night to sea and back to land. Now pressured kerosene lamps are used. Three, consecutive, main days of collection are known in Falelima as follows:

suluvale- (unproductive search) migrating crabs are scarse during the first day of the migration, and thus collection is often not very profitable because only a few can be seen.

sulutele- the second day of the spawning migration is the main collection day where most of the female crabs move towards the sea to hatch their eggs.

aiagagi- the third day of the collection period is when most of the crabs migrate back to land after spawning.

In the Safata Peninsula, ***tupa*** is abundant and the resource is utilized throughout the year for both consumption in the subsistence level and as bait for traditional mangrove crab traps. Mangrove crabs caught by the use of traps are for selling either at the Apia Fish Market or to restaurants and hotels. The ***tupa*** are mainly dug out of their burrows during daytime or collected at night, when they are out of their burrows, using pressured kerosene lamps or dried coconut fronds as source of light. ***Tupa*** digging involves the use of a strong 3-4' long stick, sharpened on one end to dig into the soil where the burrow is. Digging follows the burrow, often through tree roots which are up-rooted during the process, until the ***tupa*** is within reach. An experienced hand is required to extract the crab from the burrow without getting nipped. ***U'a*** is only found in the mangrove areas with their burrows amongst the roots of *Brugiera* mangroves. ***U'a*** is also utilized for food and as a mangrove crab bait. However, because of its larger size, ***tupa*** is preferred and is mostly targetted. For bait used in mangrove crab traps, ***tupa*** (and ***u'a***) is crushed, wrapped in a piece of sack and tied to the tip of the main (upright) pole just above the base (net) of the open trap. For consumption, land crabs are boiled in coconut cream or sometimes roasted in an open fire. Sometimes, ***tupa*** collected at night are "fattened" with grated coconut flesh before they are consumed. Only a few individuals from nearby villages are known to collect *Cardisoma* crabs from the peninsula with some consistencies.

Production and marketing: No figures are available on the production/consumption level of land crabs in the subsistence level. However, good harvests of ***mali'o*** in Falelima on the main day are 2-3 sacksful (20 kg rice sacks). A good night-catch of ***tupa*** is half a sackful (20 kg rice sack). A high catch during a day of digging is a little less than a quarter of a sack. Fifteen to twenty years ago, ***tupa*** harvests from the Safata Peninsula were much higher and that digging was relative very easy.

1.3.3 Stocks Status

No information is available on the status of any land crab stock in areas where they are utilized in Western Samoa. Anecdotal information indicate that *tupa* stock in the Safata Peninsula is currently very low compared to 15 to 20 years ago. More than twenty years ago, they could be collected from mangroves at high tide during the daytime and collection at night would result in very high yields. Today, they are hard to dig out of their burrows and night collection yields are low.

1.3.4 Management

Current legislation/policy regarding exploitation: There is no legislation that deals with land crab utitization in Western Samoa, or in any other South Pacific country.

Recommended legislation/policy regarding exploitation: Land crabs are only harvested for subsistence consumption. It would be impractical to legislate their utilization. However, community-based management is a possibility, where methods, e.g. collection at night, can be periodically prohibited.

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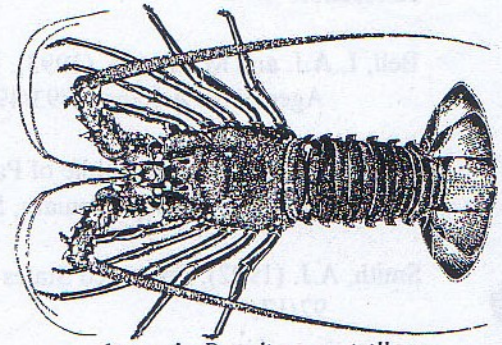
1.4 Lobsters and reef crabs - *Ula sami ma pa'a aau.*

1.4.1 The Resource



ula sami - Panulirus penicillatus

Species present: Lobster species found and utilized in Western Samoa are described below. The deep-water lobster is a newly discovered species and is not yet utilized in any level.

Spiny lobster: All spiny lobster species are known collectively in the Samoan language as *ula sami*. The main spiny lobster species found is *Panulirus penicilatus* (the pronghorn spiny lobster - ***ula sami***). *Pa. versicolor* (the painted spiny lobster - ***ula sami***) has also been recorded but only very few specimens have been reported in commercial sales. [*Pa. longipes femoristriga* (long-legged spiny lobster) is also believed to occur in Western Samoa];

Deep-water lobster: One species of deep-water lobster, *Palibythus magnificus* (musical furry lobster - ***ula moana***), caught in fish traps off Savaii at depths of 220-275 m, has just been classified.

Slipper lobster: The slipper lobster species recorded in Western Samoa include, *Parribacus antarcticus* (sculptured mitten lobster - ***papata***) and *Par. caledonicus* (the slipper or Caledonian mitten lobster - ***papata***);

Reef crabs: Reef crabs utilized in Western Samoa for consumption include, *Carpilius maculatus* (three-spot reef crab - ***kûkû***), *Leptodius* sp. ? (black-claw reef crab - ***vaevaeuli***).

King and Bell (1991) noted that during their survey period, September to November, 1989, lobsters landed at the Apia Fish Market were all *Pa. penicillatus* except for two specimens of *Pa. versicolor*. Thus commercial landings, reflecting relative species abundance, indicate that *Pa. penicillatus* make up almost 100 per cent of lobster catches in Western Samoa.

Distribution: Geographical distributions, keys to species identification as well as some biological information of all of the known marine lobster species is detailed in a recent FAO species catalogue (Holthuis, 1991). World wide distribution and biological information in this profile are derived directly from that source.

Pa. penicillatus - this is the most widespread species of spiny lobsters and is found in the Indo-West Pacific and Eastern Pacific regions, from the Red Sea, east and south east Africa to Japan, Hawaii, Samoa and the Tuamotu Archipelago and east to the islands off the west coast of America and in some localities near the continental coast of Mexico. It is found at depth from 1 to 4 m of rocky substrate in clear water not influenced by rivers. It is often found in surf zone and in surge channels and thus often near arid coasts and on small islands.

Pa. versicolor - this species is found in the Indo-West Pacific region from the entire Red Sea and east coast of Africa, southern Japan, Micronesia, Melanesia, northern Australia and Polynesia. This species is found in shallow waters from sublittoral down to 15 m depth in coral reef areas, often on seaward edges of the reef plateau. It is also found in clear water in surf areas.

Pal. magnificus - this deep-water lobster species has only been known from Western Samoa and Tuamotu Archipelago. However, those from Tuamotu Islands are only known from photographs. In Western Samoa, specimens were caught in experimental traps for deep-water fish off the coast of Savai'i at depths 220-275 m.

Par. antarcticus - this species occurs from Florida to N.E. Brazil, including the West Indian islands and the mainland coast of the Caribbean Sea. In the Indo-West Pacific region, it occurs E. and S.E. Africa to Hawaii and Polynesia.

Par. caledonicus - this species is found in the Indo-West Pacific region in Queensland, Australia, New Caledonia and Loyalty Islands, Vanuatu, Fiji and Samoa.

Spiny lobsters are generally found through-out Western Samoa in all areas where coral reefs occur. George (1972) reported fishermen catching lobsters by diving along the coralline reef edge on dark nights and that local fishermen used banana shaped wicker baskets, wedged into the cracks in the volcanic lava, to trap lobsters.

Biology and ecology: Spiny lobsters: most of the following summary of the biology of the spiny lobsters is taken from Pitcher (1993). Spiny lobsters are considered opportunistic and omnivorous scavengers living mainly on gastropods, crustaceans, echinoderms, seagrass and algae (Phillips *et al.*, 1980, quoted in Pitcher 1993). After mating, the female carries eggs under its tail for about 1 month before the tiny phyllosoma larvae are released (Pitcher, 1993). The larvae remain in the ocean for 4-12 months before moulting into the puerulus stage, about 50 mm long, which resembles a colourless miniature adult lobster. At this stage it "undertakes the transition from the oceanic to the benthic environment, where they settle in or near the adult habitat and quickly moult into pigmented juveniles" (Phillips and Sastry, 1980, quoted in Pitcher, 1993). *P. ornatus* is one of the largest *Panulirus* species and can attain a total body length of about 50 cm but is usually 30-35 cm. It has been reported as solitary or as living in pairs, but has also been found in larger concentrations (Holthuis, 1991). *P. penicilatus* has a maximum total body length of about 40 cm, averaging to about 30 cm with males usually much larger than females.It is not gregarious and is nocturnal, hiding during the daytime in crevicein the rocks and coral reefs (Holthuis, cited above). *P. versicolor* grows to a maximum total length of about 40 cm averaging less than 30 cm. It is nocturnal and not gregarious and hides in crevices and cavities of the rocks during daytime. *P. longipes femoristriga* grows to a maximum body length of 12 cm averaging 8-10 cm and is nocturnal and not gregarious.

Prescott (1988) states that for most localities in the Pacific, carapace length at first spawning for this species is around 75-80 mm. King and Bell (1991) estimated biological parameters for *P. penicillatus* in Western Samoa as compared with those estimated in Tongatapu, Tonga (Munro, 1988) and Enewetak Atoll, Marshall Islands (Ebert and Ford, 1986) as presented in Table 1.4.1.

Table 1.4.1: Biological parameters of P. penicillatus in certain localities in the South Pacific.

	L∞	Lc (mm)	tc (years)	Lr (mm)	tr (years)	K ($year^{-1}$)	Z ($year^{-1}$)
Panulirus peneicillatus							
Western Samoa							
Male	150.5 mm	64.6	2.1			0.27	0.67 (~49 % per year)
Female	122.5 mm	65.8	2.7	75.3	3.5	0.27	0.86 (~58% per year)
Tongatapu, Tonga							
Male	179	77	1.8			0.27	1.66
Female	128	62	2.6			0.32	1.33
Enewetak Atoll							
Male	146.5	64.9				0.21	0.284*
Female	96.5	64.7				0.58	0.244*

*natural mortality

The relationships between carapace length (CL, in mm), total length (TL, in mm) and whole wet weight (W, in grams) were estimated as follows (value of the coefficient of determination for each relationship is given in brackets) for *P. penicillatus* in Western Samoa by King and Bell (1991) as follows:

	Total length (mm)		Wet weight (g)	
Male	TL=47.6 + 2.16 CL	(0.985)	$W=0.0016.L^{2.74}$	(0.964)
Female	TL=26.9 + 2.56 CL	(0.986)	$W=0.0016.L^{2.76}$	(0.972)

Sex ratio was found to be almost 50:50.

Deep-water lobster: The only information in existence on the deep-water lobster species, *Pal. magnificus*, are those three female specimens caught in traps in Western Samoa. A total of seven specimens were caught but the fishermen consumed 4 leaving 3 for identification purposes. Carapace length of the female specimens range from 13.1 to 13.7 cm corresponding to a total length of about 27 cm.

Slipper (mitten) lobsters: Holthuis (1991) noted that *Par. antarcticus* is usually taken at depths from 0 to 20 m in coral or stone reefs with a sandy bottom. It is nocturnal and hides in crevices during daytime, sometimes in small groups. Carapace lengths between 2 and 9 cm and maximum total length of about 20 cm. *Par. caledonicus* thrives on reefs in shallow waters, usually on the exposed side, often in surge channels. They hide in crevices and marine caves during day time. Carapace length varies between 4.5 and 8 cm with a maximum total body length of about 18 cm (Holthuis, 1991).

Reef crabs: No biological information can be located on any species of reef crabs.

1.4.2 The Fishery

Utilization: Lobsters have always been an important component of the subsistence fishery. Buck (1930) describes crayfish pot (*faga ula*) that was traditionally used to catch lobsters. Holmes (1974) noted that wooden traps were also used for taking eels, lobsters, crayfish and crabs. George (1972) reported the traditional use of small (46 cm) banana shaped wicker baskets to trap lobsters. These traps were normally wedged into the cracks in the volcanic lava. Nelson's Store was reported as conducting a survey from the vessel PALMAR using traps. Catches were reported as fair. A project involving the live capture of lobsters was reported to have been initiated in Vaipua, Savai'i in the early 1970's. Today, lobsters are mainly caught at night using a single-barbed or three-proned spear bound to a short wooden pole.

With the introduction of a cash-based economy, the lobster fishery has become an important component in the artisanal and commercial sectors. No commercial exports of lobsters from Western Samoa have been reported. However, a few are taken, in cooked form, for relatives in American Samoa and other countries for home consumption.

Reef crabs are mostly collected for subsistence, although they also occasionally appear in the Apia Fish Market.

Production and marketing: No attempt has been made to estimate lobster and reef crab production in the subsistence level. The lobster trapping survey conducted by Nelson's Store from the vessel PALMAR I 1968 reported fair catches. A crayfish fishing scheme is reported in the 1972 Fisheries Division Annual Report. However, no details or records of catches were reported. The nation-wide Fishery Catch Assessment Survey conducted in 1978 by the Department of Statistics in forty eight villages in Western Samoa, excluding the Apia area, estimated the following non-finfish fishery products in broad categories:

Category	Total Catch (kg)	Per cent of Total Catch (including finfish)
Crustacea	27,960	2.56
Shellfish	18,512	1.69
Cephalopoda	31,123	2.85
Echinodermata	44,786	4.11

The "crustacea" category is probably made up mostly of lobsters.

In a fish consumption survey conducted on Upolu between December, 1983 and February, 1984, Zann *et al.* (1984) estimated the total Upolu invertebrate consumption to be 7,614 mt per year. Of this figure, 6,093 mt was estimated to be consumed in rural areas. Lobster was estimated to comprise 2 per cent of invertebrates eaten in rural areas on Upolu the day before the survey, while none was recorded in the Apia area. The estimated invertebrate composition consumption are presented in Table 1.4.2.

Table 1.4.2: Percentage of invertebrate types eaten on day before the fish consumption survey, December 1983-February, 1984. (Source: Zann *st al.*, 1984).

Taxon	English/Samoan name	Apia	Nort h east	North west	South east	South central	South west	Manono Is.	Rural Average
Households consuming invertebrates on previous day		24	26	28	7	14	17	50	23.7
MISC.									
Scyphozoa	jellyfish/'alu'alu	9					8		1.3
MOLLUSCA									
Gastropod	snails					19			3.2
Dolabella	seahare/gau			33					5.5
Bivalvia	**misc.**		**25**						**4.2**
Tridacna	giant clams/faisua					20			3.3
Anadara	cockles/pae	18							
Gafrarium	venus shell/tugane	9							
Pinna	penshells/fole						8		1.3
Octopoda	octopus/fe'e							14	2.3
Total		27	25	33		39	8	14	20.0
CRUSTACEA									
Crabs	crabs/pa'a					13			2.1
Panulirus	**spiny lobster/ula**								**2.0**
Total			12			13			4.1
ECHINIDERMATA									
Holothurian	gonads/sea	36	37	33	100	13	56	57	49.3
H. atra	sa cucumber/loli			33			4	28	10.8
Echinometra	seaurchin/tuitui	18	25			33	24		13.6
Total		54	62	66	100	46	84	85	73.7

The limited data available from the commercial outlets within the Apia area is presented in Table 1.4.3. Aprroximately 25,000 kg of lobsters were landed in the commercial sector each year for the 1984-1986 period (King and Bell, 1991).

Table 1.4.3: Commercial shellfish landings at the Apia Fish Market, and Other Commercial Outlets. (Sources: Helm, 1987; Mulipola, 1993; Mulipola, 1994; Brotman, 1989; Winterstein, 1991).

	1986	1987	1988	1989	1990	1991	1992	1993	1994
Market									
Lobsters	**10,752**	**9,123**	**2,817**	**3,600**	**1,800**		**3,500**		**5,705**
Slipper lobster									**680**
Reef crabs									**3,215**
Mangrove crabs	9,640	10,465	4,194	5,400	1,200		2,500		13,810
Giant clams	10,010	1,878	3,144	100	100		500		484
Other crustaceans			288						2
Octopus	6,674	5,098	1,447						8,332
Squid									27
Turbo chrysostomus									2
Tectis pyramis									86
Other commercial outlets									
Lobsters				18,383				982	
Mangrove crabs				1,684				51	
Giant clams				275					
Fresh-water shrimps				103					
Octopus				756				414	
Beche-de-mer				13,091					
Invertebrates*					10,280				

*Data for January-August, 1990. *[1] only Oct-Dec,1993.

King and Bell (1991) estimated the total commercial catch of lobsters for 1989 to be about 26 mt with an additional 40 mt estimated to be consumed at home and sold in villages. The data for the Apia Fish Market, comprises of data collected from the open side (public) but excludes those at the privately-operated side. The total estimated lobster landed in 1989 both in the open and the private side was 7.5 mt.

1.4.3 Stocks Status

King and Bell (1991) noted that the substantially lower values of total mortality estimated for lobsters in Western Samoa suggested that the resource may not be exploited at such a high rate as in Tonga. However, the mean carapace length at first reproduction for female lobsters was found to be significantly below the mean length of first capture and thus the risk of recruitment overfishing exists if the number of reproducing females is reduced. Results from yield-per-recruit analuses suggest that a delay of 1 year in the age of first capture would increase the harvestable yield by 10 per cent for both male and female lobsters.

1.4.4 Management

Current legislation/policy regarding exploitation: There is currently no legislation that regulates the exploitation of the lobster fishery in Western Samoa. However, the Local Fisheries Regulations 1994 has been passed by Cabinet and awaiting the signature of the Head of State before they come into force. Section 6 (2) of the regulations proposes to prohibit fishing and selling of reef crab, ***tûtû***, *Carpilius maculata*, which is less than 120 mm when measured across the widest part of the carapace.

Section 8 (1) proposes to prohibit the fishing and selling of lobsters, ***ula sami***, *Panulirus versicolor* and *P. Penicillatus*, with a carapace length of less than 80 mm measured from the horns to the rear edge of the carapace. Section 8 (2) proposes to prohibit selling of separated lobster tails with length of less than 140 mm measured from the stretched tail segment to the tip of the tail. Section 8 (3) proposes to prohibit fishing and selling of egg-bearing or soft shelled lobster.

Section 9 of the regulations proposes to prohibit fishing and selling of slipper lobster, ***papata***, *Scyllarus cuttrifer*, with a carapace length less than 70 mm when measured from the horns to the rear edge of the carapace.

Recommended legislation/policy regarding exploitation: Application of an appropriate minimum carapace length is a useful tool in the commercial exploitation of lobster. However, this must be formulated from research using local stocks rather than adapting lengths used elsewhere.

King and Bell (1991) noted that introduction of a minimum size regulations present practical difficulties especially in policing a large number of isolated fishermen, and the use of catching methods in which lobsters may be speared in crevices where it is difficult to estimate size before capture. The same authors recommended a compromise of introducing of regulations preventing the sale and purchase of lobsters below a legal minimum size. The minimum size limit suggested was 75 mm carapace length.

To avoid difficulty in enforcing the minimum size limit, especially where only lobster tails are required for a specific market, consideration may be taken to prohibit the selling/buying of lobster without the head (i.e. the form when selling or buying must be in whole). Prohibition of the sale etc of lobsters from which eggs have been removed is an additional consideration. The experience in countries which have prohibited the sale etc of lobster carrying eggs, is that fishermen naturally remove the eggs in an effort to avoid the law. However, pleopod formation of lobsters carrying eggs are different from those which are not carrying eggs. Therefore those from which eggs have been removed can be easily distinguished. In addition, removed or damaged pleopods are indications of eggs removal. For a fishery in which the lobster head is not available, it might also be more appropriate to apply a minimum size limit using tail width instead of tail length.

Recent biological evidence tends to suggest that prohibiting the catch of berried female lobsters above the minimum size limit, does not seem to be of much value to the fishery, both in landing and recruitment.

The scientific name given for the slipper lobster (*papata*), *Scyllarus cuttrifer*, in the proposed Local Fisheries Regulations 1994 is wrong. The slipper lobster species found in Western Samoa are *Parribacus antarcticus* and *P. caledonicus*. The minimum size limit for the slipper lobster should apply to the whole carapace length, as slipper lobsters do not have horns as do spiny lobsters.

Prescott (1988) suggests there may be little requirement for management to conserve stocks because of the small size of maturity, large size at recruitment to the fishery and the fact that many adults are always inaccessible to fishermen due to the nature of the habitat which continue to produce recruits. However, management may be considered necessary in order to maximise returns to fishermen and to allow a profitable collection and marketing infrastructure. For example, King and Bell (1991) estimated that yield-per-recruit analyses suggest that a delay of 1 year in the age of first capture would increase the harvestable yield by 10 per cent for both male and female lobsters in Western Samoa.

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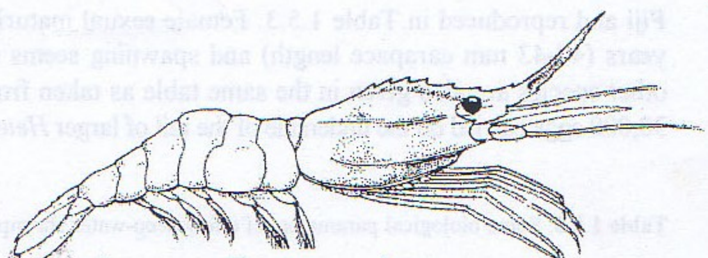
1.5 Deep-water shrimps
ula moana

1.5.1 The Resource



ula moana - Heterocarpus laevigatus

Species present: King (1980; 1993) identified six species, belonging to two genera, of deep-water carid species and one *Penaeid* sp. caught in a survey undertaken in September 1980 to investigate the resource as a potential fishery in Western Samoa. The species inlcude: *Plesionika edwardsii(=longirostris)* (stars and stripes shrimp); *P. ensis* (stripes gladiator shrimp); *P. martia* (golden shrimp); *Heterocarpus sibogae* (mino nylon shrimp); *H. laevigatus* (smooth nylon shrimp); *H. dorsali* (Madagascar nylon shrimp); *Penaeid* sp.

The deep-sea lobster recently identified in Western Samoa in discussed under the lobster profile.

Distribution: The distribution of *Heterocarpus* species is at least in the Indo-Pacific and has been found in India and islands in the Indian Ocean as well as the Pacific Islands from Palau in the west to French Polynesia in the east (King, 1993). Species occupy particular depths but with overlapping ranges with the smaller shrimps (*P. serratifrons* and *P. edwardsii*) being widely distributed in shallower waters (< 400 m). The medium-sized *Heterocarpus*, *H. sibogae* and *H. ensifer*, predominate catches over 400 m and *H. laevigatus*, one of the largest species, is common in depths of more than 500m.

King (1980; 1984) recorded species composition by weight expressed as a percentage of the total shrimp catch at each depth range in Western Samoa during the 1980 survey. These are presented in Table 1.5.1 as reproduced from the same reference.

Table 1.5.1: Percentage composition of deep-water shrimp species catches at different depth ranges in Western Samoa. (Source: King, 1980 and 1984).

Depth (m)	*P. longirostris*	*H. ensifer*	*H. laevigatus*	Other species
300-399	9	90	0	1
400-499	0	97	2	1
500-599	0	61	36	3
600-699	0	62	36	2
700-899	0	0	44	56

H. ensifer occurred over the widest depth range and length frequency data showed that this species is distributed in distinct size groups in most depths as given in Table 1.5.2 as reproduced from King (1980).

Table 1.5.2: Depth distribution of various size groups of *H. ensifer* in Western Samoa. (Source: King, 1980).

	Carapace length group		
Depth (m)	≤ 19 mm	20 to 30 mm	≥ 31 mm
306	6	86	8
387	6	82	12
486	28	67	5
545	17	75	8
635	24	60	16

Biology and ecology: Deep-water caridean shrimps have separate sexes (King, 1993). Biological parameters for *H. laevigatus* in three countries are given in the same reference with figures obtained in

Fiji and reproduced in Table 1.5.3. Female sexual maturity in this species is attained between 4 to 4.6 years (40-43 mm carapace length) and spawning seems to be in winter. Growth parameters for some other species are also given in the same table as taken from the same reference. Brood sizes may exceed 30,000 eggs carried on the underside of the tail of larger *Heterocarpus* species (King and Butler, 1985).

Table 1.5.3: Some biological parameters of a few deep-water shrimps (King, 1993).

Species	Area	Sex	Growth		Mortality	Reproduction	
			L_∞ (mm)	K(yr^{-1})	M (yr^{-1})	L_m	t_m
H. laevigatus	Fiji	both	57.0	0.27	0.66	40.5	4.6
	Hawaii	male	57.9	0.35			
		female	62.5	0.25		40.0	4.0
	Marianas	both	55.2	0.30	0.75	42.7	4.5
P. edwardsii			29.5	0.66			
H. sibogae			41.0	0.38			
H. gibbosus			45.0	0.35			

In general male *H. laevigatus* grow more quickly than females but reach a smaller ultimate size (King, 1993). Furthermore, he notes that the "combination of slow growth rates with high natural mortality rates suggests that the biomass (weight) of shrimps from a given recruitment is maximized at an early age, after which the available biomass rapidly declines".

In Western Samoa, King (1980) found that at about 28 mm carapace length, half the population of *H. ensifer* consists of ovigerous females and at 36 mm carapace length and over, the population consists entirely of ovigerous females. In addition, both *H. ensifer* and *H. laevigatus* appear to be protandrous hermaphrodites.

1.5.2 The Fishery

Utilization: A few species of carid shrimps form the bases of commercial fisheries in other parts of the world. For example, carid shrimps are commercially harvested in Alaska, North America and Chile (King, 1986) and also in Europe, Japan and Chile (Crossland, undated).

There has been no fishery based on deep-water shrimps in Western Samoa, even though this resource can be utilized for speciality food items in local restaurants and possibly export.

Two-entrance conical traps, baited with skipjack heads were used for the survey in Western Samoa by King (1980).

In parts of the world where carid shrimps are commercially exploited, trawls of various types are the main method of harvesting. "This method is of little use to the South Pacific region as, apart from the Gulf of Papua in PNG, there are no areas of continental shelf. Most of the potential fishing grounds in the Pacific consists of uneven or sloping bottoms unsuitable for trawling, which can best be fished with traps" (Crossland, undated).

Production and marketing: During the 1980 deep-water shrimp trapping surveys in Western Samoa, King (1980) obtained mean catch rates of 0.9 kg per trap in the shallowest depths and reached a maximum of 1.4 kg per trap in the 500 to 600 m depth range.

King (1986) provided the following table comparing catch rates and optimum depths of Caridean shrimps from different countries:

Location	Catch Rate (kg/trap)	Optimum Depth (m)	Comments and Reference
Hawaii Northwestern group	2.9	550-600	Catch of *H. ensifer* and *H. laevigatus* combined (Gooding,1984)
Guam Western coast	2.1	440-680	Catch of *H. ensifer* and *H. laevigatus* combined (Wilder,1977)
Western Samoa near Apia	1.4	500-600	Catch of *H. sibogae* and *H. laevigatus* combined (King, 1980, 1984)
Tonga near Nuku'alofa	0.6	600-700	Catch of *H. sibogae* and *H. laevigatus* combined (King, 1981b, 1984)
Fiji near Suva	1.2	450-650	Catch of *H.sibogae H. gibbosus* and *H. laevigatus* combined (King,1984)
Vanuatu	2.8	500-600	Catch of *H. sibogae* and *H. laevigatus* combined (King, 1981a, 1984)
New Caledonia	2.0	800	Catch of *H. laevigatus* (Intes, 1978)

No attempt has been made to further assess the feasibility of deep-water shrimp exploitation for commercial purposes in Western Samoa.

1.5.3 Stocks Status

The resource is not exploited and information on standing stocks is not known. More detailed assessment research is needed. In the Marianas, Ralston (1986, quoted in King, 1993) reported a drastic decline in catch rates, from 3.3 to 1.8 kg per trap-night over a 16 day intensive trapping experiment for *H. laevigatus*. The decline in catch rates was attributed to the decline in shrimp numbers suggesting that the species may be vulnerable to even moderate trapping in that area (King, 1993). King (1980) suggested that the mean catches of 1.4 kg of shrimp per trap in the 500 to 600 m depth range in Western Samoa were encouraging and worth further examination to examine its fishery potential.

King (1986) noted that trap abundance for *P. edwardsii*, *H. sibogae* and *H. laevigatus* as common, while *P. ensis* and *H. dorsalis* as occasional in Western Samoa. Only small numbers of *P. martis* were caught.

1.5.4 Management

A more comprehensive assessment on this particular potential resource is required to give some indications of stocks available for exploitation and its likely economic potential. Results of such research work will indicate strategies to be taken if exploitation is likely.

Current legislation/policy regarding exploitation: Deep-water shrimps is not exploited in Western Samoa in any level. Thus there is no legslation concerning this resource.

Recommended legislation/policy regarding exploitation: None is considered necessary until the resource stock is assessed and utilization envisaged.

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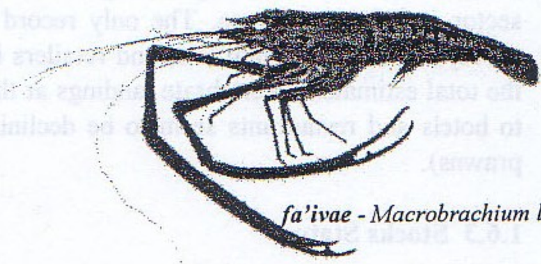
1.6 Fresh-water prawns - *Ulavai*

1.6.1 The Resource



fa'ivae - Macrobrachium lar

Species present: Indigenous fresh-water prawn species found and utilized in Western Samoa include *Macrobrachium lar* (*fa'ivae*) and *Palaemon* sp. (*ulavai*). [Garlovsky (1970) gave *Palaemon* sp. as *P. euryrhynchus* and *P. ornatus*].

The giant Malaysian fresh-water prawn, *M. rosenbergii*, post-larvae were introduced into Western Samoa from Tahiti in 1979 for aquaculture purposes. It is not known whether this species has become established in the Falefa river system. In 1993, juveniles of fresh-water crayfish, *Chelax quadricarinatus* (redclaw) and *C. destructor* (yabby) were introduced from Australia and cultured in ponds used originally for *Macrobrachium* culture (Mulipola, 1994). This profile deals only with the indigenous species as the introduced species are discussed under the aquaculture section of this document.

Distribution: Fresh-water prawns occur in all main stream systems in Western Samoa and are distributed throughout the stretches of these streams. People of Manunu, Falefa, Falevao, Solaua, Sauniatu and Vailima are known to be consistent fresh-water prawn suppliers to the hotels and restaurants in Apia. The main source is the Falefa river system.

Biology and ecology: Because there has been no interest to culture *M. lar* due to slow growth rates and relatively complicated larval cycle, its life cycle has not been studied much. Biology of the giant Malaysian prawn, *M. rosenbergii*, is well known and numerous articles have been published on its larval cycle during the hatchery phase as well as the species grow-out performance in aquaculture. These are discussed under the Aquaculture Section of these profiles.

1.6.2 The Fishery

Utilization: The fresh-water prawn fishery has been an important source of protein on the subsistence level. In the past, fresh-water crayfish snare (*sele ula*) was commonly used in Western Samoa by boys and even adults as a makeshift method readily available (Buck, 1930). The same author describes the snare as follows: The snare is made from a thick fibre (*muia'a*) of a coconut husk, with one end passed around the running end and tied to itself with an overhand knot to provide an open loop through which the running part readily passes in opening out or closing the noose. The other end of the fiber is tied to a stick whch is used as a handle.The noose is lowered by the handle into the pool and brought along behind the crayfish and gently worked along and insinuated under the tail. Much care is required not to startle the crayfish by any sudden movement. Once the tail is in the loop, the handle is drawn up quickly and the crayfish thus "caught by the tail".

Fresh-water prawn has become an important artisanal fishery in certain inland communities close to streams. Prawn catches are sold directly to hotels and restaurants. The main method used now is a single small spear made from umbrella spokes or three-prone spear tied to piece of stick. A small piece of rubber is attached at the end of the stick or spoke for propelling. Prawns are also caught by hand by groping under and between rocks and under vegetation along the pool banks.

The main source of indigenous fresh-water prawns for hotels and restaurants in Apia are villages along the Falefa river system e.g. Manunu, Falevao, Falefa, Solaua.

Traditionally, fresh-water prawns are preferred cooked in coconut cream (*faiai ula*).

Production and marketing: No figures are available on the production of fresh-water prawns in any sector in Western Samoa. The only record found was 103 kg of shrimps recorded in 1989 during surveys of hotels, restaurants, and retailers by Brotman (1989). This corresponded to 0.3 per cent of the total estimated invertebrate landings at these avenues for that year. There are indications that sales to hotels and restaurants seem to be declining (with some hotels advertising over the local radio for prawns).

1.6.3 Stocks Status

No study has been conducted on the status of this fishery and thus stock status are unknown.

1.6.4 Management

Current legislation/policy regarding exploitation: There is no legislation that specifically deals with the exploitation of fresh-water prawns. However, "fish" as defined under the Fisheries Act 1988 seems to also cover fresh-water fisheries. Part II, 4 of the same Act prohibits the use, attempt to use of any explosive, poison or other noxious substance for catching "fish".

Recommended legislation/policy regarding exploitation: None seems to be required. However, incidences have occurred where house-hold bleach was used to catch fresh-water prawns. A clearer definiton of "fish" in the Fisheries Act may be necessary to specifically indicate the inclusion of fresh-water fishery in the definition of "fish".

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2. MOLLUSCS

2.1 Giant clams - *faisua*

2.1.1 The Resource

faisua - Tridacna maxima

Species present: Giant clams are collectively known in the Samoan language as *faisua*. Of the nine giant clam species found through-out the world, only two species occur naturally in Western Samoa, *Tridacna squamosa* (the fluted or scaley giant clam - *ta'afua* when large and unattached) and *T. maxima* (the elongated or rugose giant clam). *Hippopus hippopus* (the horse's hoof, rolling, bear baw or strawberry giant clam) is believed to have become locally extinct. However, this species has been re-introduced for aquaculture purposes. Under the same project, *T. derasa* (the smooth giant clam) and *T. gigas* (the giant clam) have been introduced into Western Samoa.

Large *T. squamosa* found unattached to any substrate are referred to as '*ta'afua*', which means solitary/unattached.

Distribution: Giant clams, Tridacnids, are restricted to the Indo-Pacific region and are well adapted to tropical clear waters such as those which favour coral growth. Munro (1993) gives brief geographical distributions of each of the nine species currently known in the world. Due to over-exploitation or climatic changes the range of *T. gigas* has diminished a great deal. However, several of the species, especially, *T. gigas*, *T. derasa* and *H. hippopus* have been introduced to some countries outside of their natural ranges. *T. tevoroa* is limited to Fiji and Tonga.

T. gigas - this species has become extinct in some of its original range locations. Good populations still exist in Australia, Philippines, Solomon Islands, and possibly Burma, Kiribati, Marshall Islands, Palau, Papua New Guinea, and the west coast of Thailand. Extinctions have been reported in Fiji, Guam, New Caledonia, Northern Marianas, most of Japan, Federated States of Micronesia, Taiwan, Tuvalu, and Vanuatu. The species has been re-introduced to Fiji and introduced to Cook Islands, Tonga, American Samoa and Western Samoa.

T. derasa - this species occurs in 13 countries and territories with good standing stocks reported from Australia, Fiji, New Caledonia, Palau, northern Papua New Guinea, Solomon Islands and Tonga. It has become extinct in Guam and Northern Marianas. The species has been introduced to Cook Islands, FSM, American Samoa and Western Samoa.

T. squamosa - this species range extend from the Red Sea and the East coast of Africa across the Indo-Pacific to the Pitcairn Islands and has been recorded in 41 countries. It could be extinct in Japan and Guam.

T. maxima - this species' range is about the same as that of *T. squamosa*. It is extinct in Hong Kong.

H. hippopus - this species occurs in 19 countries in the region extending from Burma to Marshall Islands in the east and New Caledonia in the south. It has become extinct in American Samoa, Fiji, Tonga and Western Samoa but have been re-introduced to all of these localities.

T. squamosa and *T. maxima* are generally found through-out the Samoa islands. However, stocks are known to be very low in areas of high human populations especially where the clams are collected for commercial sales. Most of the giant clams are now collected from deeper waters beyond the barrier reefs.

In Western Samoa, giant clams are found throught-out the islands where coral reefs occur. However, they are very rare on the shallow parts of the reefs. Harvesting is now done in the deeper areas beyond the barrier reefs.

Biology and ecology: The giant clam family, Tridacnidae, currently has nine living species in two genera, *Tridacna* (Bruguiere) and *Hippopus* (Lamarck) which includes the largest bivalve molluscs known. A unique characteristic of the giant clams is their symbiotic relationship with dinoflagellate algae, zooxanthellae, which live in the blood system of the giant clams, concentrating in the tissues of the brightly-coloured mantle that is exposed to light in the shallow sunlit waters of coral reefs (Munro, undated). Giant clams acquire the symbiotic algae at age 7-15 days. They receive photosynthetic sugars and oxygen from the algae while the algae receives waste carbon dioxide and nutrients from the clams. In addition, giant clams also filter-feed, as is typical of other bivalves, but all of its maintenance requirements can be derived from the symbiotic algae (Munro, 1993). The relationship with zooxanthellae restricts clams to shallow waters.

All species of giant clams mature initially as males (protandrous hermaphrodites) at the age of two or more years, depending on the species, and eventually become simultaneous hermaphrodites. Reproduction in the central tropics does not seem to show seasonality. However, seasonality is shown in gonad ripening at the northern and southern limits of distribution (Munro, 1993). Some degree of lunar periodicity has been observed. During spawning, sperm are normally released first followed by egg release after a short interval (generally ~30 minutes). Munro (cited above) reported that a 20 cm *T. maxima* specimen with ripe gonads would contain 20 million eggs. Specimens of 70-80 cm *T. gigas* were known to produce up to 240 million eggs. Fertilized eggs develop into swimming trochophores within 12 hours and shelled veligers within 36 hours. The larval phase lasts between 5 and 15 days after which it settles on the bottom. Soon after this it metamorphoses into a juvenile clam. Recruitment is low and erratic. Growth parameters for most of the giant clam species in several localities are given in Munro (1993). Overall, for the first few years, growth rates range between 3.5 to 10 cm per year depending on species. Natural mortality is low.

Munro (1993) quotes biological parameters for a few giant clam species in some countries as reported in several references. These are recorded in Table 2.2.1 for some selected locations for comparison.

Table 2.2.1: Biological parameters of some of the giant clam species. (Source: Munro, 1993).

Species/Locality	L_∞ (cm)	K	t_0	Age (Years) 1	2	4	6	8	10	15	20	Reference
				Shell length (cm)								
T. gigas												
Palau	100.0	0.136	0.64	4.80	16.91	36.69	51.77	63.26	72.01	85.82	92.82	Beckvar, 1981
PNG	100.0	0.087	0.43	4.80	12.73	26.67	38.38	48.22	56.49	71.84	81.77	Munro and Heslinga, 1983
Michaelmas Reef	88.7	0.07	0.03		11.4	21.50	30.28	37.91	44.55	57.58	66.77	Pearson and Munro, 1991
Orpheus Is., GBR				3-4	9-13							
T. derasa												
Palau	50.0	0.167	0.41	4.7	11.67	22.55	30.35	35.93	39.92	45.63	48.10	Beckvar, 1981
Palau				5.0	10.0	20.0	27.50					Watson and Heslinga, 1988
Tonga	50	0.132	0.25	4.7	10.30	19.51	26.59	32.02	36.19	42.86	46.31	McKoy, 1980
Michaelmas Reef	46.9	0.108	-0.20		9.87	17.06	22.86	27.55	31.31	37.81	41.60	Pearson and Munro,1991
Fiji	47.3	0.134	0.22	4.7	10.04	18.80	25.50	30.63	34.55	40.77	43.96	Watson and Heslinga, 1988
Philippines				5.0	8.5							
T. squamosa												
Palau	40.0	0.091		4.75	7.82	13.17	17.64					Beckvar, 1981
Tonga	40.0	0.187		4.75	10.76	19.89	26.16					McKoy, 1980
PNG	38.5	0.14		4.75	9.16	16.32	21.74					Munro and Heslinga, 1983
H. hippopus												
Palau	40.0	0.10		5.04	8.37	14.10	18.80					Beckvar, 1981
PNG	40.0	0.213		5.04	11.75	21.55	27.95					Munro and Heslinga, 1983
Orpheus Is., GBR	34.7	0.205		5.04	10.54	18.66	24.06					Shelley, 1988

No study has been done on any biological aspect of indigenous giant clam species in Western Samoa. However, four *T. squamosa* readily spawned at the Fisheries hatchery in April, 1988, producing viable embryos leading to the production of several thousands of juvenile clams by the end of the same year. In nearby American Samoa, mature *T. derasa* were successfully induced to spawn almost through-out the year (Bell, 1993).

2.1.2 The Fishery

Utilization: Giant clam meat is a local delicacy in Western Samoa and clams form part of the traditional folklore. [It is believed that the reason why men, instead of women, are traditionally tattooed in Samoa is because the two ladies that swan to Samoa from Fiji, bringing tattooing equipment, got their song mixed up after diving for a huge giant clam beyond Falealupo]. Giant clams have always form an important component of the subsistence fishery and with the advent of the cash-based economy, it has been a lucrative item at the fish markets where the big clams are sold individually and small ones sold in piles of two to five individual clams. Clam meat sold in small plastic cups used to be a commodity in one of the local seafood store but this was discontinued due to shortage of supply.

Fisheries Division initiated a giant project aimed at re-seeding depleted areas in 1985. Successful propagations were obtained using *T. squamosa*.

Production and marketing: The level of giant clam production and consumption in the subsistence fishery is not known. Data on commercial landings is limited and incomplete. Table 2.2.2 presents shellfish estimates calculated from a nation-wide fishery catch assessment conducted by the Department of Statistics in 1978. Shellfish were lumped in broad categories as given in the table. The results indicate that slightly more than 50 per cent of shellfish, under which giant clams would be included, was landed on Upolu. The Apia area was not included in the survey.

Table 2.2.2: Invertebrate composition of fishery landing in Western Samoa in 1978. (Source: Department of Statistics, undated).

	Upolu				Savai'i		Total	
Category	1*[1]	2*[2]	3*[3]	4*[4]	5*[5]	6*[6]	Weight	Per cent
Crustacea	4,416	3,900	5,209	13,318	1,117	0	27,960	22.8
Shellfish	839	3,475	4,097	1,918	1,992	6,191	18,512	15.1
Cephalopoda	4,110	11,070	4,504	4,255	907	6,277	31,123	25.4
Echinodermata	21,451	9,065	3,304	6,638	2,481	1,847	44,786	36.6
Total	**30,816**	**27,510**	**17,114**	**26,129**	**6,497**	**14,315**	**122,381**	**100.0**
Per cent	**25.2**	**22.5**	**14.0**	**21.4**	**5.3**	**11.7**	**100.0**	
Per cent shellfish	**4.5**	**18.8**	**22.1**	**10.4**	**10.8**	**33.4**	**100.0**	

*[1]=Upolu Northeast (Fagali'i to Uafato); *[2]=Upolu Southeast (Tiavea to Sa'aga); *[3]=Upolu Southwest (Siumu to Matafa'a); *[4]=Upolu Northwest (Falevai to Vailoa including Manono and Apolima); *[5]= Savai'i North (Samalaulu to Falelima); *[6]=Savai'i South (Fagafau to Pu'apu'a).

In a fish consumption survey conducted on Upolu between December, 1983 and February, 1984, Zann *et al.* (1984) estimated the total Upolu invertebrate consumption to be 7,614 mt per year. Of this amount, 6,093 mt/year was estimated to be consumed in the rural areas and 1,523 mt in the Apia area. Giant clams was estimated to comprise 3.3 per cent of the total invertebrates eaten in rural areas on Upolu the day before the survey. No giant clam consumption was recorded during the survey period. Relative composition of invertebrate consumption on Upolu is given in Table 2.2.3.

Table 2.2.3: Percentage of invertebrate types eaten on day before the fish consumption survey, December 1983-February, 1984. (Source: Zann *st al.*, 1984).

Taxon	English/Samoan name	Apia	Nort h east	North west	South east	South central	South west	Manono Is.	Rural Average
Households consuming invertebrates on previous day		24	26	28	7	14	17	50	23.7
MISC.									
Scyphozoa	jellyfish/'alu'alu	9					8		1.3
MOLLUSCA									
Gastropod	snails					19			3.2
Dolabella	seahare/gau			33					5.5
Bivalvia	**misc.**		25						4.2
Tridacna	**giant clams/faisua**					20			3.3
Anadara	cockles/pae	18							
Gafrarium	venus shell/tugane	9							
Pinna	penshells/fole						8		1.3
Octopoda	octopus/fe'e							14	2.3
Total		27	25	33		39	8	14	20.0
CRUSTACEA									
Crabs	crabs/pa'a					13			2.1
Panulirus	spiny lobster/ula								2.0
Total			12			13			4.1
ECHINIDERMATA									
Holothurian	gonads/sea	36	37	33	100	13	56	57	49.3
H. atra	sa cucumber/loli			33			4	28	10.8
Echinometra	seaurchin/tuitui	18	25			33	24		13.6
Total		54	62	66	100	46	84	85	73.7

Fisheries Division currently conducts three main surveys on the commercial trade of fish and fishery products. These include 1) Apia Fish Market; 2) Other Outlets (wholesalers, retailers, restaurants and hotels); and 3) Roadside from Apia to Faleolo. Available data from those surveys are recorded in Tables 2.2.4(a), 2.2.4(b) and 2.2.4(c) for the 1986-1994 period. (The most complete annual data are those from Apia Fish Market for 1986 and 1987). Data collected from the Apia Fish Market for years before 1986 were lumped under shellfish.

Table 2.2.4(a): Commercial shellfish landings at the Apia Fish Market. (Sources: Helm, 1987; Mulipola, 1993: Mulipola, 1994; Fisheries Division Database).

		1986	1987	1988	1989	1990	1991	1992	1993	1994
Giant clams	**Wt (kg)**	**10,010**	**1,905**		**1,110**	**120**		**500**	**102*[2]**	**484*[4]**
	Value (WS$)				**3,757**	**457**				
Lobsters	Wt (kg)	10,752	9,203		3,637	1,858	269*[3]	3,500	1,385*[2]	5,705*[4]
	Value (WS$)				21,993	8,220	1,288			
Mangrove crabs	Wt (kg)	9,640	10,572		5,397	1,218	438*[3]	2,500	2,091*[2]	13,810*[4]
	Value (WS$)				28,085	8,407	5,187			
Reef crabs	Wt (kg)				152	182			552*[2]	3,215*[4]
	Value (WS$)				945	1,572				
Slipper lobsters	Wt (kg)				85				206*[2]	680*[4]
	Value (WS$)				307					
Other crustacean	Wt (kg)					16	3*[3]		33*[2]	1.6*[4]
	Value (WS$)					112	18			
Turban	Wt (kg)								24*[2]	2.4*[4]
	Value (WS$)									
Tectis	Wt (kg)				101				22*[2]	86.4*[4]
	Value (WS$)				169					
Octopus	Wt (kg)	6,674	5,152		2,077	2,309	557*[3]		924*[2]	8,332*[4]
	Value:(WS$)				12,814	11,573	3,470			
Total	Wt	37,076	26,832		12,559	5,703	1,267	6,500	5,339	32,316
	Wt									?8,448
	Value	-	-	-	68,070	30,341	9,963	-	?49,512	57,206
Giant clams % wt		27.0	7.1		8.8	2.1	0.0	7.7	1.9	1.5

*[3] data extrapolated from Jan-May data; *[4] Figures extrapolated from Jan-Sept data.

Table 2.2.4(b): Commercial shellfish landings at Other Commercial Outlets. (Sources: Brotman, 1989; Winterstein, 1991; Mulipola, 1994).

		1989	1990	1991	1992	1993	1994
Giant clams		275					
Lobsters		18,383				982	
Mangrove crabs		1,684				51	
Fresh-water shrimps		103					
Octopus		756				414	
Beche-de-mer		13,091					
Invertebrates*			10,280				
Total	Weight (kg)	34,292					
	Value (WS$)	212,561					

*Data for January-August, 1990.

Table 2.2.4(b): Commercial shellfish landings on roadside from Apia to Faleolo. (Source: Iosefa, 1992, Mulipola, 1994).

	1991	1992	1993	1994
Mangrove crabs		450	7.8*[1]	
Giant clams		78		
Trochus		39		
Sea		119 bottles		
Sea urchin		242 baskets		

*[1] only Oct-Dec,1993;

2.1.3 Stocks Status

No stock assessment has been conducted on giant clam stocks in Western Samoa. Searches conducted by the Fisheries Division in 1987 for giant clam broodstock to be used for propagation purposes, indicated stocks to be very low in areas on Upolu where diving took place. It was estimated that populations were so low in most areas that the capacity of the giant clams to successfully reproduce naturally is unlikely. Generally, *T. squamosa* is now rare and *T. maxima* uncommon in most areas. Market landings indicate drastic decreases of giant clams, indicating that stock overfishing has occurred.

2.1.4 Management

Current legislation/policy regarding exploitation: Local Fisheries Regualtions 1994 have been passed by Cabinet and are awaiting the signature of the Head of State for them to be in force. Part 1, 10 of the Local Fisheries Regulations 1994 prohibits the fishing for or selling of giant clams (Tridacna, Hypocates) which are less than 200 mm across the shell at its widest part.

Recommended legislation/policy regarding exploitation: Regulation of the subsistence fishery for giant clams would be very difficult to enforce, except through the system of traditional marine tenure. Where traditional ownership rights are still recognised and traditional conservation regulations can be enforced, village chiefs can play an important role in conserving wild clam stocks.

Application of minimum size limits (different for each species) has been employed as a management tool for giant clam stocks in many countries. This is especially beneficial when giant clams have low natural mortality and thus "the largest yields will be obtained by taking giant clams at relatively large sizes" (Munro, 1993). Munro further noted that a combination of minimum size limits and the imposition of annual quotas to be harvested in a single short season, offer the best prospects. Even though the establishment of reserves has not been proven to increase recruitment in depleted areas, it would at least play a role in conserving the genetic pool of the remaining stocks.

Enforcement of the minimum size limits would be difficult in cases when only clam meat is sold. A consideration here is the banning of clam meat sales without the shells.

Other management options suggested by McKoy (1980) include; quotas on catches, closed areas and closed seasons. In addition, prohibition of the use of SCUBA and other compressed air breathing apparatus for the taking of giant clams, is suggested.

The proposed regulation applies only one size limit for three different species that have different growth rates and sizes at first maturity. It is suggested to apply different minimum size limits to each species. The word Hypocates should have been *Hippopus*.

<u>Minimum size limits (shell length) currently used in other countries</u>:

Tridacna maxima:

Tonga	155 mm
American Samoa	7 inches (180 mm)

Tridacna squamosa:

Tonga	180 mm
American Samoa	7 inches (180 mm)

T. derasa

Tonga	260 mm

Suggested minimum size limit for the indigenous giant clam species: *T. maxima* - 160 mm (6.3 inches); *T. squamosa* - 200 mm (7.9 inches).

Harvesting of the introduced giant clam species, *T. giags*, *T. derasa* and *H. hippopus* should be prohibited at this stage if the intention is for these species to establish local breeding populations.

It is also recommended that the export of giant clams in any form, except cultured specimens, be prohibited.

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2.2 Venus shell - *tugane*

2.2.1 The Resource

Species present: The venus shell identified as being found and utilized in Western Samoa is *Gafrarium tumidum* (venus shell - *tugane*). However, it is likely that an additional species, probably *G. pectinatum*, is collected together with *G. tumidum*.

tugane *- Gafrarium tumidum*

Distribution: In New Caledonia, *G. tumidum* is preferentially distributed on substrates located close to the lower limit of neap tide and seems to be independent of sediment granulometry (Baron and Clavier, 1992). However, Baron (1992a) reported that *G. tumidum* is preferentially distributed on sandy-muddy substrate.

Garlovsky (1970) noted that ***tugane*** was common on the shores of Apia. On Upolu Island, ***tugane*** is known to occur in significant levels in Vaiusu Bay near mangroves from Sogi to Vaigaga and within Safata Bay in areas adjacent to Fusi and Fausaga villages. Both areas are sheltered lagoons, and venus shell are common in muddy sand areas near mangrove with water salinity below oceanic.

Biology and ecology: The biology and ecology of venus shell have not been studied in Western Samoa. *G. tumidum* is dioecious and is a suspension-feeding bivalve. Baron (1992b) reported that in New Caledonia, sexual differentiation begins at a shell length of 20 mm with first spawning occurring at 24 mm. Sex ration was found to be M/F 1.13 ($\chi^2 = 6.28$, $P<0.05$). At one locality, it was found that females significantly outnumbers males at the shell length of 30-32 mm but males outnumbers females at shell length of 38-40 mm. The numbers of males and females were found to be not significantly different in other length ranges. Three sexual phases were identified as follows:

- maturation in July and August;
- sexual maturity from September to March;
- sexual-regression phase from April to June.

However, the author noted that the distinction between the three pahses was not clear-cut as fully mature individuals were found through-out the year. "From September onwards, the G. tumidum population is characterized by nearly continuing partial spawning, though only in March does spawning occur simultaneously in a large number of individuals" (Baron, 1992b).

Preliminary studies in Tonga indicated the following for species found there, as reported in Sone (1994):

G. tumidum - gonads shrank from April to June, followed by a 3-month inactive period. Gonads developed rapidly after this period and by the beginning of December most of the sample was in spent condition. Ripe gonads were again observed in the January sample but the majority of the February sample was also in spent condition. The breeding season was estimated to be from November to April. The smaller size group sampled (mean shell length ranging from 26.3 mm to 37.9 mm) showed the presence of gametes throughout the survey period.

G. pectinatum - Ripe gonads were found throughout the survey period, except January, which tends to indicate spawning throughout the year. However, completely spent individuals were found in February, indicating perhaps the period of December to January as a peak spawning period. A lot of *G. pectinatum* spat were settling out in the land-based giant clam tanks at the end of March. The smaller size sample group had no significant difference from those of the bigger size. The minimum size that had gametes (eggs) was 19.5 mm. The investigator suggested that the majority might reach sexual maturity at over 20 mm in shell length.

2.2.2 The Fishery

Utilization: Subsistence harvesting of *tugane* is a common activity in the main areas where it occurs in significant numbers, especially within the Vaiusu Bay area and in Safata Bay. The resource has been an important source of income (artisanal level) to the gleaners in the two main areas mentioned above, where mainly women and/or children do the collecting. At low tide, *tugane* can be found buried a few mm below the surface in muddy sand areas where sea-water has gone out. A hard object, e.g bushknife can be dragged along the surface with its point a few mm into the substrate. When a solid object (normally a *tugane*) is hit, it is picked up. Collection at high tide or in areas where the substrate is still covered with sea-water, feet are used to feel into the top layer for *tugane*. Venus shells are normally sold, in small baskets or plastic bags containing about 50 shells, along the roadside, infront of shops or in the agriculture market in Apia.

Zann (1991) noted that the major target species within the Vaiusu Bay by nearby villages is *G. tumidum* (*tugane*) especially off Vaitoloa. Together with mangrove crabs, *tugane* constitutes the major invertebrate catch within the Safata Bay.

Production and marketing: Consumption of *tugane* in the subsistence level is not known. Data available on its sales is limited and incomplete. Table 2.2.1 presents shellfish estimates calculated from a nation-wide fishery catch assessment conducted by the Department of Statistics in 1978. The Apia urban area was excluded in the survey. Shellfish were lumped in broad categories as given in the table. Safata Bay and Vaiusu Bay are in Strata 3 and 4 respectively. The Apia area was not included in the survey.

Table 2.2.1: Fish type composition of fishery landing in Western Samoa in 1978. (Source: Department of Statistics, undated).

	Upolu				Savai'i		Total	
Category	1*[1]	2*[2]	3*[3]	4*[4]	5*[5]	6*[6]	Weight	Per cent
Crustacea	4,416	3,900	5,209	13,318	1,117	0	27,960	22.8
Shellfish	839	3,475	4,097	1,918	1,992	6,191	18,512	15.1
Cephalopoda	4,110	11,070	4,504	4,255	907	6,277	31,123	25.4
Echinodermata	21,451	9,065	3,304	6,638	2,481	1,847	44,786	36.6
Total	**30,816**	**27,510**	**17,114**	**26,129**	**6,497**	**14,315**	**122,381**	**100.0**
Per cent	**25.2**	**22.5**	**14.0**	**21.4**	**5.3**	**11.7**	**100.0**	
Per cent shellfish	**4.5**	**18.8**	**22.1**	**10.4**	**10.8**	**33.4**	**100.0**	

*[1]=Upolu Northeast (Fagali'i to Uafato); *[2]=Upolu Southeast (Tiavea to Sa'aga); *[3]=Upolu Southwest (Siumu to Matafa'a); *[4]=Upolu Northwest (Falevai to Vailoa including Manono and Apolima); *[5]= Savai'i North (Samalaulu to Falelima); *[6]=Savai'i South (Fagafau to Pu'apu'a).

During a fish consumption survey conducted between December, 1983 and February, 1984, Zann *et al.* (1984) estimated the total Upolu invertebrate consumption to be 7,614 mt per year, of which 1,523 mt per year was estimated to be consumed in the Apia area. *Gafrarium* was estimated as constituting 9 per cent of the inverterate seafood consumption in the Apia area the day before the survey. No *Gafrarium* consumption was recorded in the rural areas during the survey period.

Most of the *tugane* sales take place in the Agriculture Market. However, Fisheries Division surveys do not cover this market. *Tugane* sales along the road in the Vaimoso-Vaiusu area are not normally recorded during the Road Side surveys by the Fisheries Division as they are usually sold after 4 pm.

2.2.3 Stocks Status

No study has been conducted on *Gafrarium* sp. in Western Samoa. However, heavy exploitation of the resources in the main areas has resulted in apparent declines of catches and dimishing sizes in individual shells. In addition to the over-exploitation of the resource, pollution from land-based developments, particularly in the Vaiusu Bay, have contributed to this trend in the fishery. Vaiusu Bay harbours a municipal rubbish dump within its mangroves, and effluents from factories are drained directly into the bay. Dredging and reclamation are also persistant activities within the bay.

2.2.4 Management

Current legislation/policy regarding exploitation: There is no existing regulation that specifically addresses the exploitation of the *Gafrarium* spp. resource in Western Samoa.

Recommended legislation/policy regarding exploitation: Most shellfish resource management involves the application of a minimum size limit, quotas, closed season and sometimes the creation of reserves. However, adaptation of any of these management tools requires the input of research to confirm the appropriate management strategy to adopt. Of equal importance to direct approach of management on this paticular resource is the elimination or minimising of pollution input into the fishery areas and destruction on its habitat and vital associated resources such as mangroves.

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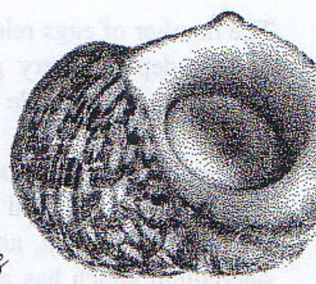
2.3 Trochus/top shell and Turban shell - '*aliao* ma *alili*.

2.3.1 The Resource



***alili** - Turbo chrysostomus*

Species present: Species found in Western Samoa include:

Topshell: *Tectus pyramis* (*aliao*). Kramer (1903, cited in Garlovsky, 1970) listed *T. niloticus* as the *aliao* species found in Samoa. This was a misidentification. Garlovsky also listed *Polyodomata verrucosa*. In 1990, ~~118~~ 128 live trochus, *Trochus niloticus*, specimens were introduced into Western Samoa from Fiji and were released on the reef at Namu'a Island.

Turban: *Turbo chrysostomus* (*alili*). Morton *et al.* (1988) listed the turban species found in Western Samoa as *T. setosus*. Garvolsky (1970) listed *alili* species in Western Samoa from various sources as, *T. canaliculatus*, *T. crassus*, *T. argyrostomus* and *T. margaritaceus*. These are either old names which are no longer used or misidentifications.

Distribution: The natural distribution of trochus is dependent on the presence of coral reefs. It occurs in the intertropical belt between the Andaman Islands in the Indian Ocean and the islands of Fiji and Wallis in the Pacific (Bour, 1988). The edge of its natural habitat in the Western Pacific was marked by an oblique line running from Palau down to Wallis. However, with the many successful translocations and introductions, the area now inhabited by trochus extends more to the east.

Within Western Samoa, *Te. pyramis* and *Tu. chrysostomus* are generally spread throughout reefs with suitable habitats. During the Fisheries Division roadside surveys in 1990 and 1992, ***aliao*** were offered for sale at Faleasi'u. ***Alili*** were normally collected by fisheries staff on the Faleula barrier reef. Both ***alili*** and ***aliao*** are generally found on barrier reefs on the north and south coasts of Upolu island. *T. niloticus* was introduced to Western Samoa in 1990 and were released on the reef at Namu'a Island at Aleipata.

Biology and ecology. Trochus inhabits shallow, sunlit waters rarely being found deeper than a few metres. It is primarily herbivorous, feeding on small algae, diatoms and foramaniferas on dead coral and rock surfaces. A trochus radula is estimated to comprise of about 150 teeth. This enables it to graze. In the stomach content of 20 specimens, ranging from 60 to 75 mm in diameter, Asano (1944) found Foramanifera, Cyanophyceae, and Phaeophyceae in large quantities and also a lesser proportion of other small red and green algae mixed with a large quantity of sand.

Trochus do not have secondary external sexual features by which the sexes can be distinguished. The only definite method to determine the trochus sex is to break the apex of the shell to reveal the gonad which, when mature, is a deep green colour in the female and milky white in the male. However, another method of determining the sex of an adult trochus without sacrificing it is to force the living trochus to retract far into its shell by pressing with one's thumb on the operculum. This will cause the animal to eject some water in the paleal cavity; if the water is examined under a microscope it will usually be found to contain some spermatozoa and sometimes some green ovocytes. This method is usually reliable during the spawning season when selecting genitors to obtain spawn for aquaculture.

Sexual maturity is reached in the second year (size 5-6 cm). Male and female gametes are released into the sea where fertilization takes place. The fertilized eggs are covered with a thick chorion which protects the embryo. After hatching, the trochophore develops a larval shell (the protoconch) and swims towards the surface using the ciliated velum. At this stage it has become a lecithtrophic veliger. After a few days, the veliger settles on a substrate, sheds its velum and begins to crawl along on its single foot feeding on microscopic algae.

The number of eggs release by a female trochus depends on the size of the shell (basal length). Trochus growth depends very greatly on environmental factors such as water temperature, quality of the substrate and available food.

The green snail, *T. marmoratus* (family turbinidae) is the largest of the turban snails. It has a thick shell which can exceed 20.0 cm in shell width and 3 kg in total weight. The foot of the conical shell of the adult is swollen, and that of the young, round and smooth. The green snail has a massive white operculum which has a smooth inner surface. Green snails inhabit the seaward reef slopes in shallow water down to about 15 metres. They are nocturnal in nature and feed on algae growing on dead corals and rock surfaces. Green snails are dioecious broadcast spawners. Male and female gametes are released into the sea where fertilization takes place. A study on sexual maturity of green snails in Vanuatu made by L.C. Devambez (Devambez, 1961) in 1961 concluded that green snails reach sexual maturity at a size between 11.0 cm and 15.0 cm in diameter. However hatchery observations on green snail spawning carried out by the Vanuatu Fisheries Research Officers indicate that the snails spawn throughout the year, at night during few nights before full moon or after full moon. During the green snail spawning inductions at the Vanuatu Fisheries Department Trochus Hatchery, 5.5 million eggs were collected from a 12.0 cm size female snail. In fact, fecundity of large green snails can go up to 7 million eggs per female (Bell and Amos, 1993).

Parrotfishes have been known to feed on young *Trochus* and *Turbo* shells.

2.3.2 The Fishery

Utilization: *Alili* and *aliao* are collected mainly for subsistence with limited amounts entering the commercial markets which are sold in bundles of about 6 specimens for $2-5. Trochus and turban are sometimes collected as a by-catch of general fishing and gleaning on the reef during daytime. However, specific collection of these species are done during moonless nights when they come out of their "hiding places" under coral (ledges?).

Production and marketing: Total production/consumption of *alili* and *aliao* in the subsistence level is not known. Table 2.3.1 presents shellfish estimates calculated from a nation-wide fishery catch assessment conducted by the Department of Statistics in 1978. Invertebrates were lumped in broad categories as given in the table. *Aliao* and *alili* are included in the "shellfish" category. The survey did not include the Apia area.

Table 2.3.1: Invertebrate composition of fishery landing in Western Samoa in 1978. (Source: Department of Statistics, undated).

	Upolu				Savai'i		Total	
Category	1^{*1}	2^{*2}	3^{*3}	4^{*4}	5^{*5}	6^{*6}	Weight	Per cent
Crustacea	4,416	3,900	5,209	13,318	1,117	0	27,960	22.8
Shellfish	839	3,475	4,097	1,918	1,992	6,191	18,512	15.1
Cephalopoda	4,110	11,070	4,504	4,255	907	6,277	31,123	25.4
Echinodermata	21,451	9,065	3,304	6,638	2,481	1,847	44,786	36.6
Total	**30,816**	**27,510**	**17,114**	**26,129**	**6,497**	**14,315**	**122,381**	**100.0**
Per cent	**25.2**	**22.5**	**14.0**	**21.4**	**5.3**	**11.7**	**100.0**	
Per cent shellfish	**4.5**	**18.8**	**22.1**	**10.4**	**10.8**	**33.4**	**100.0**	

*[1]=Upolu Northeast (Fagali'i to Uafato); *[2]=Upolu Southeast (Tiavea to Sa'aga); *[3]=Upolu Southwest (Siumu to Matafa'a);
*[4]=Upolu Northwest (Falevai to Vailoa including Manono and Apolima); *[5]= Savai'i North (Samalaulu to Falelima);
*[6]=Savai'i South (Fagafau to Pu'apu'a).

In fish consumption surveys conducted in Upolu during the December 1983 - February, 1984 period, Zann *et al*. (1984) estimated that gastropods (snails, mainly *alili* and *aliao*) constituted 3.2 per cent of the average rural invertebrates consumption on Upolu. This estimate was based on fishery products consumed the day before the survey. The total invertebrate consumption on Upolu was estimated at 7,614 mt per year, of which 6,093 mt/year was estimated to be consumed in the ruarl areas. No gastropod consumption was recorded in the urban area, Apia, during the survey period. Table 2.3.2 presents estimates from the survey. The gastropod consumption was recorded only in south central Upolu.

Table 2.3.2: Percentage of invertebrate types eaten on day before the fish consumption survey, December 1983-February, 1984. (Source: Zann *st al.*, 1984).

Taxon	English/Samoan name	Apia	Nort h east	North west	South east	South central	South west	Manono Is.	Rural Average
Households consuming invertebrates on previous day		24	26	28	7	14	17	50	23.7
MISC.									
Scyphozoa	jellyfish/'alu'alu	9					8		1.3
MOLLUSCA									
Gastropod	snails					19			3.2
Dolabella	seahare/gau			33					5.5
Bivalvia	misc.		25						4.2
Tridacna	giant clams/faisua					20			3.3
Anadara	cockles/pae	18							
Gafrarium	venus shell/tugane	9							
Pinna	penshells/fole						8		1.3
Octopoda	octopus/fe'e							14	2.3
Total		27	25	33		39	8	14	20.0
CRUSTACEA									
Crabs	crabs/pa'a					13			2.1
Panulirus	spiny lobster/ula								2.0
Total			12			13			4.1
ECHINIDERMATA									
Holothurian	gonads/sea	36	37	33	100	13	56	57	49.3
H. atra	sa cucumber/loli			33			4	28	10.8
Echinometra	seaurchin/tuitui	18	25			33	24		13.6
Total		54	62	66	100	46	84	85	73.7

Most of the *alili* and *aliao* sales take place in the Agriculture Market from where Fisheries Division does not collect data. Winterstein (1991) mentioned that amount of shells sold at the market is more than 500 per week.

The only data available are from the Fisheries Division roadside surveys in 1992 and 3 months in 1993. These are as follows:

Year	Village		Weight (kg)	Value in WS$
1992	Faleasi'u	*Aliao*	39.30	?
		Alili		
1993*	Faelasi'i	*Aliao*	?	346.67
		Alili	?	121.33

*November only.

2.3.3 Stocks Status

No information is available on the status of the topshell and turban shell stock in Western Samoa. The absence of data make it impossible to trace any trends in this particular fishery. Zann (1991) noted that *Te. pyramis* (*aliao*) and *Tu. chrysostomus* (*alili*) were generally uncommon in all areas surveyed (presumably all around Upolu). Winterstein (1991) wrote that trochus harvest numbers have been declining for the last couple of years. However, no data was given by the author. No information is available of the status of the 118 *T. niloticus* live animals that were introduced from Fiji and transplanted to Namu'a Island in 1990. Zann *et al.* (undated) listed factors contributing to dramatic decline in landings at the Apia Fish Market as follows:

⇒ changes in distribution patterns;
⇒ increase in domestic consumption in villages of origin;
⇒ decrease in artisanal fishing effort;
⇒ decrease in fish and invertebrate stocks due to ovefishing and loss of nursery habitat.

2.3.4 Management

Current legislation/policy regarding exploitation: There is currently no legislation that deals with the exploitation.management of the trochus/turban resources in Western Samoa. The proposed Fisheries Regulations 1994 include the following:

Part I, 11 (1) prohibits the fishing for or selling trochus (*aliao*) *Trochus niloticus* which measures less than 75 mm across the basal length. Possession of shell of the same less than 75 mm across the basal length is illegal. Part I, 11, (2) of the same regualtions prohibits fishing or selling of turbo shells (*alili*), *Tectis pyramis* less than 65 mm across the basal length. Part I,13 prohibits fishing for or selling of *alili* (*Turbo mamoratus*) less than 30 mm across the whorl opening.

Recommended legislation/policy regarding exploitation: The *alili* species in Western Samoa is *Turbo chrysostoma*, not the green snail, *T. marmorata*. *T. marmorata* is not found in Western Samoa. *T. marmorata* is wrongly called *aliao* in Part I, 13 of the Regulations. It should be *alili*.

Regulations need revision for correction of minimum size limits and names.

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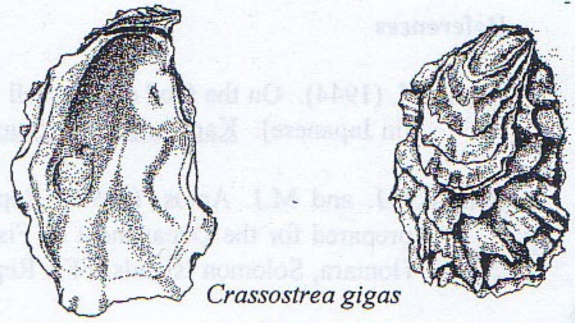
2.4 Oysters (including pearl oysters) - *tio*

2.4.1 The Resource



Crassostrea gigas

Species present: Oyster species found and utilized in Western Samoa include:

Mangrove oyster, rock oyster - *tio* (*Crossostrea mordax*);

Thorny oyster - *fatuaua* (*Spondylus* sp., *S. avicularis*? or *S. ducalis?*). Morton *et al*. (1988) called the thorny oyster in Western Samoa, *S. ducalis*;

Black-lip pearl oyster - *tifa* (*Pinctada margaritifera*).

The exact species of *Crossostrea* oyster occuring in Asau and Safata Bays have not been properly identified. Those at Asau Bay are relatively smaller in size than those in Safata Bay. However, this could be attributed to over-crowding in Asau.

C. gigas was introduced from US in 1990 for aquaculture trials. This is discussed in detail under the Aquaculture Section of this document.

Distribution: With the exception of the Arctic and Antarctic regions, oysters are found in all the sea areas of the world. Species of oysters vary widely, from those living on the rocky reefs of outer ocean coasts with high salinity waters to those living in the inner recesses of bays with a high degree of fresh water flow. Among their species can be found a wide variety of life patterns as well. Approximately 200 species of oyster are known to exist in the world (Yamaha, 1989).

Black-lip pearl oyster, *P. margaritifera*, is widespread throughout Oceania. It is found down to 40 m, but mostly just below low water mark. Gold-lip pearl oyster, *P. maxima*, has a more restricted distribution, not being found in commercial quantities east of Solomon Islands. Where it occurs naturally, it is found on coral reefs down to a depth of 80 m with maximum abundance generally between 10 and 60 m.

Large *Crossostrea* oyster beds occur within the Asau Bay, inhabiting the intertidal strip almost all around the bay coastline. At low tide, these oysters appear as a white strip just above the water level on the lava rocks around the coastline. A small numbers of *Crossostrea* oysters occur in Safata Bay on rocks and mangrove roots in the intertidal zone. *Spondylus* oysters are generally found in small numbers through-out the islands on the barrier reefs. High populations have been observed in the Asau Bay on bottom lava rocks (Mulipola, 1994, *pers. comm.*). High populations have also been observed on wharf posts at Apia and Asau. No stocks of black-lip pearl oysters are known in Western Samoa. However, a large live speciman was found in Safata Bay attached to a wooden rack used for green mussel culture in 1986? This indicates the existence of black-lip pearl oysters, perhaps on or off the barrier reefs nearby. The embryo must have been carried into the bay and managed to attach to the substrate and grew.

Biology and ecology: Among the varieties of shellfish presently inhabiting the earth, the most prolific are the conch (Gastropoda) and bivalve (Pelecypoda) families. Of the conches, about 85,000 species exist while the Pelecypoda family has about 25,000 species. The conches actively search for food on the ocean floor with eyes and feelers, the bivalves such as scallops tend to bury themselves in the ocean floor or, in the case of oysters, attach themselves to rock outcroppings or reefs.

The soft body of the bivalves is fully enclosed in a shell and a mantle with which the shell is, so to speak, lined. There is also a gill between the mantle and internal organs. On the back edge of the body are a number of water pores through which water is drawn in to pass through the gill and thus constitute the breathing function. At the same time, the gill also functions to separate debris in the water from edible suspended matter such as plankton for the ingestive process. The volume of water thus processed by the gill in the case of "Magaki" (Pacific cupped oyster) is said to be about 10 litres per hour. Virginia oyster (American cupped oyster) filters about 5-25 litres/hour at a water temperature of 20 C°. This means that some oysters process more than 1000 times their body weight (without shell) of water every hour (Yamaha, 1989). The amount of vegetable planktons consumed by an adult oyster in one day is thought to be between 1 and 5 grams.

Within the same species of oyster there are considerable differences in the shape of the shell and other biological characteristics depending on the environment conditions within they live.

The number of eggs produced by a single mature oyster ranges from 50 to 100 million (Yamaha, 1989). Fertilized eggs and larvae begin a random process of dispersion and reconcentration in accordance with the whims of forces like tides, wave motion and eddying currents. After two or three weeks in this drifting phase they enter the fixed stage of their life cycle in which they attach themselves to some stationary object.

Oysters feed primarily on vegetable planktons and detritus, but the amount of food consumed varies with species and also in accordance with the stage of growth and life environment conditions.

Shell growth is greatly influenced by such factors as water temperature and salinity, currents and gestation. It is generally most active in the spring and autumn, and tends to stagnate in the spawning season of summer and in winter.

An excellent reference on the biology, culture and other aspects of pearl oyster species is Gervis and Sims (1992). The following information was extracted from that reference. *Pinctada* species are protandrous hermaphrodites, with ratios of males to females tending to be 1:1 with increasing age. Black-lip pearl oysters reach full maturity in the second year while *P. maxima* matures as a male at 110-120 mm during its first year of life, and it is possible for wild *P. fucata* to spawn twice in the first year. Spawning is often associated with temperature extremes or sudden changes in the environment, and that for tropical oysters is not limited to a single season. Fertilization takes place in the water after the release of both sperm and eggs, and the larval cycle ranges from 16 to 30 days depending on species, temperature, food and the availability of settlement substrates. Growth is affected by temperature and food availability. *P. margaritifera* reaches a shell diameter of 7 or 8 cm within one year and 11 cm by the second year while *P. maxima* averages 10-16 cm after two years. *P. fucata* reaches a maximum 9 cm (DVM, dorso-ventral measurement) within the first twelve months and has a lifespan of only four years. The von Bertalanffy growth parameters of wild stocks, in Cook Islands, of *P. margaritifera* were estimated by Sims (1990) to be; L_∞ = 79.31 mm, K=0.0756 and t_0=0.44 months. Predator fish, especially on the young oysters, include, *Balistes* sp., *Tetradon* sp. *Lethrinus* sp., *Serranus* sp., and various species of sharks and rays. Other predators include octopus, starfish, crabs and a variety of predator gastropods such as *Murex* and *Cymatium* sp.

Maximum sizes have been calculated for blacklip and goldlip as 14-17 cm and 20-25 cm diameter respectively. Like many bivalves, *Pinctada* species are hermaphrodites, reaching maturity in the second year of growth, but with uneven sex ratios until the fourth or fifth years, with greater numbers of males up to that time. Spawning is often not limited to distinct seasons, and a larval stage occurs lasting 2-4 weeks prior to settlement (Sims, 1988).

Crossostrea oysters found in the Asau Bay grow to small sizes. This is probably due to oyster overcrowding that occur there as oysters are clustered together. Those in Safata Bay are relatively larger and single specimens are normally found growing on rocks and mangrove roots.

2.4.2 The Fishery

Utilization: As stated above, the only area with substantial populations of *Crossostrea* oyster is within the Asau Bay on Savai'i Island with a small population in Safata Bay. The gear used in oyster collection is a strong small knife used to wedge oysters open, and a bottle or bowl to hold the extracted oyster. Collection is usually done by women and children. *Spondylus* is also harvested in the same manner except that goggles are needed.The limited collection of oysters is for subsistence with a very small portion going for sale. With the exception of oyster collection in Asau, collection of oysters normally forms a portion of the general shellfish gleaning.

No information could be located on the occurrence of the black-lip pearl oyster beds in Western Samoa. The shell of blacklip pearl oyster was used for making lures (hook shanks) for catching bonito and other pelagic fish species. Garvolsky (1972) noted that pearl shells were mostly imported.

Production and marketing: There is no information available on consumption/production of oysters in any level of exploitation. However, it is believed to be small except for oysters in Asau where collection takes place almost everday.

2.4.3 Stocks Status

Spondylus is generally rare on reefs except fair populations that occur in Asau Bay and on posts of wharves in Asau and Apia. The existence of any black-lip pearl oyster bed is not known. Rock (mangrove) oyster population is very low in Safata Bay while a substantial rock oyster population exists in Asau Bay.

2.4.4 Management

Current legislation/policy regarding exploitation: There is currently no legislation in force that deals with the exploitation/management of the oyster resource in Western Samoa. However, the proposed Local Fisheries Regulations 1994 cover the black-lip pearl oyster resource. Part I, 12 of the Local Fisheries Regulations 1994 proposes to prohibit the harvesting of pearl oyster, *tifa* (*P. margaritifera*) less than 100 mm from the hinge to the opposite edge at its longest point.

Recommended legislation/policy regarding exploitation: There does not seem to be any fishery for pearl oysters in Western Samoa as the existence of stocks is not known. However, if stocks do exist, it might be beneficial to include prohibition of harvesting for commercial purposes. Harvesting of rock oysters is mostly on the sibsistence level and application of regulations on their utilization do not seem necessary. Rock oysters in Asau Bay are naturally small due to overcrowding, and application of any minimum size limit would be inappropriate.

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2.5 Other shellfish - *isi figota fai atigi*

2.5.1 The Resource

pae - Anadara antiquata (scapha)

Species present: Apart from those included in other profiles in this document, several other bivalve, gastropod and echinoderm species are taken in Western Samoa for consumption, mainly on the subsistence level. The shells of some of these species are sold as specimen shells to the tourists. The more important ones include:

Bivalves: *Anadara* sp. (most probably *A. antiquata* also called *A. scapha*, ark shell - ***pae***), *Vasticardium* sp. (coconutscraper cockle - ***matatuai, 'asi?***), *Periglypta puerpera* (hardshell clam - ***pae***?) *Pinna* sp. (pen shell - ***fole***), *Atactodea striata* (surf clam - ***li***), *Asaphis deflorata* (sand? cockle - ***pipi***).

Gastropods: *Lambis lambis* (spider conch - ***palaua***), *Cypraea tigris* (tiger cowry - ***pule uli***), *Charonia tritonis* (giant triton or Pacific trumpet shell - ***foafoa***), *Strombus gibberulus* (stromb - ***panea***), *Cassis cornuta* (trumpet shell - ***pu***);

Distribution: Most shellfish are habitat specific but are found in every type of marine habitat, from coral reefs and sand to silt and mud (Smith, 1992). They occur throughout the world but the centre of distribution and maximum diversity is generally considered to be the area of ocean bordered by Indonesia, Papua New Guinea and the Philippines.

Anadara can either be intertidal or shallow subtidal. In New Caledonia, Baron and Clavier (1992) found that adults of *Anadara scapha* (= *A. antiquata*) occur at lower bathymetric levels, with sediment composed of 40% medium, fine and very fine sand, and 30% very coarse and coarse sand (20% of mud and 40% medium, fine and very fine sand according to Baron, 1992). For this species, Baron and Clavier (cited above) showed differential distribution of young and adults. Baron *et al.* (1993) showed that *Gafrarium tumidum* and *A. scapha* constituted the greater part of the animal biomass in two intertidal seagrass-bed communities (one in Saint-Vincent Bay and one in Deama Bay) in New Caledonia. In Tonga, *A. antiquata* and *A. maculosa* are harvested from by hand on the intertidal flat in sea grass beds with sandy substrate (Sone, 1994).

Most of the species included in this particular profile are harvested at low tide from the intertidal and subtidal zones in the tidal flats, in lagoons and on the reef. Gastropods and echinoderms are generally found through-out the country in areas where reefs exist especially lagoons (dead coral substrate).

Biology and ecology: The biology of the locally found species as included in this section has not been studied in Western Samoa. Cockles commonly inhabit muddy/sand seashore and burrow only into the surface of the mud.

A. scapha (= *antiquata*) is a suspension-feeder and is a protandric hermaphrodite. Baron (1992) found that in New Caledonia, sexual differentiation begins at a shell length of 22 mm with first spawning occurring at 30 mm shell length. Sex ratio was found to be M/F=1.47, (χ^2 = 8.62, $P<0.05$) thus significant different from 1. Examination of specimens at different length-classes indicated that, for A. scapha, males significantly outnumber females at shell length of 34-42 mm, sex ratio is about 1 at shell lengths 42-46 mm, and that females significantly outnumbers males at shell lengths of 46-54 mm (Baron, 1992). This trend in sex inversion was believed to reflect protandric hermaphroditism. Three phases of reproduction in *A. scapha* were distinguished in Anadara populations in study areas New

Caledonia. These were:

- a maturation and /or sexual-maturity phase from September to December;
- a regression and/or resting phase from January to May;
- a resting phase from June to August.

Thus, massive spawning in *A. scapha* was estimated to occur between December and January. However, Baron (1992) noted that "the presence of sexually regressing individuals from September onwards shows that partial spawning is taking place in the population during the period preceeding massive spawning".

Farmed cockles, *Anadara granosa*, in Thailand are harvested after 18 months when they reach about 4 cm in shell length and 24 g in weight (Tookwinas, 1983). In India the same species is found to spawn throughout the year and can have 2-4 reproductive cycles in a year. First maturity is attained at 20 and 24 mm for males and females respectively (Narasimham, 1988).

In a study of *Anadara* breeding season in Tonga, the following information were obtained in the first year as recorded in Sone (1993): *A. antiquata* - gonads are easy to identify as ovaries are reddish/orange in colour while testes are creamy white. Swift gonad deflation in April and the May-July period was shown as the inactive period for this species. The August-September period was found to be mostly inactive with only small amounts of gametes found in one specimen. Gonads rapidly develop during the October/November period. The majority of the sample were in fully ripe condition during the December sampling and that the January samples were mostly in spent stage. The majority of February and March samples were again in ripe condition with half in spent stage on 9 March, two days after full moon. The breeding season for this species in Tongatapu was then estimated to be from October to March. Sex differentiation and shell length relationship in *A. antiquata* is shown below for the specimens examined (the numbers are the numbers of individuals from the total number sampled). Females under 40 mm in shell length were difficult to find and it is assumed here that males reach sexual maturity at smaller sizes.

Shell length (mm)	Undetermined sex	Female	Male
20⁻	-	-	-
20-30	19	0	0
30-40	42	8	34
40-50	30	4	14
50-60	16	19	14
60-70	17	29	12
70-80	14	6	0
80-90	-	-	-
90+	2	0	0

A. maculosa - inactive period is the same as *A. antiquata,* but the breeding season was determined to be from November to March. Sex differentiation and shell length relationship for this species is presented in the following table.

Shell length (mm)	Undetermined sex	Female	Male
-20	-	-	-
10-30	12	0	4
30-40	7	1	16
40-50	4	3	27
50-60	0	16	22
60-70	0	19	12
70-80	0	23	13
80-90	1	7	4
90+	0	5	4

C. tritonis shell can reach 40 cm or more in length and is usually found among corals on coral reefs and feeds mainly on starfish, including *Culcita novaeguinea*, the blue starfish *Linckia laevigata* and the crown-of-thorns, *Acanthaster planci*, but also occasionally on holothurians (Wells *et al*, 1983).

Maximum size is attained in up to six years and female lays clumps of sausage-shaped egg capsules under protective rocks. Larvae are long-lived and have considerable dispersal abilities.

2.5.2 The Fishery

Utilization: Most of the species discussed in this profile form important components in the subsistence fishery in areas where they are found and harvested. For most of the gastropods, the meat is consumed and the shell sold as ornamental shell, or used for decorations in homes. The shell of the tiger cowry was used as the outer upper layer of the traditional octopus lure (*ma'a ta'ife'e*). Shells of the giant triton (*foafoa*) and trumpet shell (*pu*) are used traditionally to sound curfews, village meetings etc.

The only species covered under this profile which is known to have been offered for sale, though very rare, is *Anadara*. When offered for sale, they are sold in a bundle of about 5-8 animals.

Production and marketing: Information on the consumption/production of shellfish species included in this profile at all levels of expoitation is lacking.

The nation-wide fishery catch assessment survey conducted in 1978 by the Department of Statistics estimated invertebrate landings as recorded in Table 2.5.1. The invertebrates were classified in broad categories. The field survey form indicates that the Echinodermata category included sea urchins and sea cucumbers (***neti***, ***tuitui***) while the shellfish category included giant clams and other bivalves (***faisua***, ***pipi***).

Table 2.5.1: Invertebrate composition of fishery landing in Western Samoa in 1978. (Source: Department of Statistics, undated).

	Upolu				Savai'i		Total	
Category	1*[1]	2*[2]	3*[3]	4*[4]	5*[5]	6*[6]	Weight	Per cent
Crustacea	4,416	3,900	5,209	13,318	1,117	0	27,960	22.8
Shellfish	839	3,475	4,097	1,918	1,992	6,191	18,512	15.1
Cephalopoda	4,110	11,070	4,504	4,255	907	6,277	31,123	25.4
Echinodermata	21,451	9,065	3,304	6,638	2,481	1,847	44,786	36.6
Total	**30,816**	**27,510**	**17,114**	**26,129**	**6,497**	**14,315**	**122,381**	**100.0**
Per cent	**25.2**	**22.5**	**14.0**	**21.4**	**5.3**	**11.7**	**100.0**	
% of Shellfish	**4.5**	**18.8**	**22.1**	**10.4**	**10.8**	**33.4**	**100.0**	
% of Echinodermata	**47.9**	**20.2**	**7.4**	**14.8**	**5.5**	**4.1**	**100.0**	

*[1]=Upolu Northeast (Fagali'i to Uafato); *[2]=Upolu Southeast (Tiavea to Sa'aga); *[3]=Upolu Southwest (Siumu to Matafa'a);
*[4]=Upolu Northwest (Falevai to Vailoa including Manono and Apolima); *[5]= Savai'i North (Samalaulu to Falelima);
*[6]=Savai'i South (Fagafau to Pu'apu'a).

In fish consumption surveys in rural areas of Upolu during the December 1983 - February, 1984 period, Zann *et al.* (1984) estimated invertebrates consumption rates as recorded in Table 2.5.2. Those specifically discussed in this profile are in bold. Figures are in percentages and landing estimates were based on fishery products consumed the day before the survey. Of the species included in this profile, gastropods (which are mostly top shell and turbans) was estimated to make up 3.2 per cent of the rural invertebrate consumption, *Pinna* (*fole*), 1.3 per cent and Miscellaneous bivalves, 4.2 per cent. *Anadara* was recorded to be consumed in the Apia area only, making up 18 per cent of the invertebrate consumption there. The total invertebrate landing on Upolu was estimated to be 7,614 mt per year of which 6,093 mt was in the rural areas.

Table 2.5.2: Percentage of invertebrate types eaten on day before survey.

Taxon	English/Samoan name	Apia	North east	North west	South east	South central	South west	Manono Is.	Rural Average
Households consuming invertebrates on previous day		24	26	28	7	14	17	50	23.7
MISC.									
Scyphozoa	jellyfish/'alu'alu	9					8		1.3
MOLLUSCA									
Gastropod (misc)	**snails**					**19**			**3.2**
Dolabella	seahare/gau			33					5.5
Bivalvia	**misc.**		**25**						**4.2**
Tridacna	giant clams/faisua					20			3.3
Anadara	**cockles/pae**	**18**							
Gafrarium	venus shell/tugane	9							
Pinna	**penshells/fole**						**8**		**1.3**
Octopoda	octopus/fe'e							14	2.3
Total		27	25	33		39	8	14	20.0
CRUSTACEA									
Crabs	crabs/pa'a					13			2.1
Panulirus	spiny lobster/ula								2.0
Total			12			13			4.1
ECHINIDERMATA									
Holothurian	gonads/sea	36	37	33	100	13	56	57	49.3
H. atra	sa cucumber/loli			33			4	28	10.8
Echinometra	seaurchin/tuitui	18	25			33	24		13.6
Total		54	62	66	100	46	84	85	73.7

As is the case with venus shell, species included in this profile are sold mainly in the agriculture market which the Fisheries Division surveys do not cover.

2.5.3 Stocks Status

No information is available on the status of sea urchins as well as other species included in this profile in Western Samoa. In the absence of time series landing data, trends in the fishery cannot be traced. Nevertheless, observations indicate that all of the species have drastically declined from former levels. This decline could be attributed to over-harvesting and habitat destruction by land-based development, employment of destructive fishing methods, pollution and natural disasters such as cyclones.

2.5.4 Management

Current legislation/policy regarding exploitation: There is currently no legislation that controls the exploitation of any of the species included in this particular profile. The proposed Fisheries Regulations 1994 do not cover any of these species as well.

Recommended legislation/policy regarding exploitation: Harvesting of the trumpet shell, *C. tritonis*, should be legislated. Other countries in the South Pacific have prohibited the taking and selling of this species less than 20 cm in length, when measured along the outside of the shell from one end to the other.

Other considerations for possible management of these resources include the prohibition of the export of *C. tritonis* for commercial purposes. Application of minimum size limits to other shellfish species, especially those in the artisanal fishery, is a possible management strategy. However, biological research into the appropriate areas concerning those species would be required first. In addition, minimum size limits seem to be only practical when applied to the selling and buying, but not on subsistence harvesting. Subsistence harvesting can be dealt with via extension and conservation educational programmes.

Regulations that have been suggested in other countries concerning the shell trade include; restriction on harvesting areas and annual rotation together with the banning of the use of SCUBA or dredging in the collecting process. Recommendations have also been made for the prohibition of the collection of shells listed as threatened in the IUCN Red Data Book especially the giant triton, *C. tritonis*. This is presumably directed at the collection of shells for the shell trade, not including the subsistence fishery.

Although difficult, efforts should be made to collect consistent data on all resources where possible.

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2.6 Octopus and squid - *fe'e, gufe'e*

2.6.1 The Resource

fe'e - *Octopus* spp.

Species present: Octopus (*fe'e*) species found and fished for food in Western Samoa have not been properly identified. However, distribution of octopus and squid given in Roper *et al.* (1984) include several species found throughout the Indo-Pacific region, and in tropical seas, including the benthic, shallow-water reef-dwelling big blue octopus, *Octopus cyaneus* and the epipelagic, oceanic greater argonaut, *Argonauta argo* which occur in near-surface waters. The octopuses utilized in Western Samoa are those from the shallow-water reefs. *Fe'e po* is the name given to small octopuses caught only at night in very shallow waters in places where there are holes in the sand or limestone substrate near sandy beaches. It is not known whether this is a separate species or juveniles of the common octopus. Squids do not seem to be an important resource. Current classification is *Octopus* spp. (octopus) and *Sepia* spp. (cuttlefish - *gufe'e*). Kramer (1903, cited in Garlovsky, 1972) classified *fe'e* in Western Samoa as *O. verrucosus* while Milner (1966, in Garlovsky, 1972) classified *gufe'e* as *Sepioteuthis* sp.

Distribution: Geographical distribution of cuttlefishes of the family Sepiidae is restricted to the Old World, thus it is absent from the Americas (Roper *et al.*, 1984). They are primarily demersal inhabitants of nearshore and continental shelf zones in warm and temperate waters. Their habitats range from rocky, sandy and muddy bottoms to grassflats, seaweed beds and coral reefs. *S. latimanus* is distributed in the Indo-Pacific region from southern Mozambique, throughout the periphery of the Indian Ocean, Coral Sea, Melanesian Islands, South China Sea, Philippine Sea and East China Sea to southern Japan (Roper *et al.*, 1984).

Squids of the family Loliginidae (inshore squids) inhabit all shelf and upper slope areas of the world's oceans except the polar seas and are demersal or semipelagic inhabitants of coastal and continental shelf areas to a maximum depth of about 400m (Roper *et al.*, 1984). Some species are restricted to extremely shallow waters with some penetrating into brackish waters. They aggregate near the bottom during the day and disperse into the water column at night.

Roper *et al.* (1984) noted that most octopuses are benthic and representatives of the family are usually encountered throughout the world from the coast down to at least 1,000 m depth. "Many have cryptic habits hiding in crevices, empty mollusc shells and seagrass beds during the day and hunting at night, while others occur over open trawlable bottoms". *O. cyaneus* occurs throughout the Indo-Pacific region, from East Africa to Hawaiian Islands in tropical and warm waters including the Red Sea, India and Australia. It is a benthic species occurring in shallow waters on coral reefs, and unlike other octopuses, it hunts during daylight hours (Roper *et al.*, 1984).

Octopus generally "hide" in small holes in reefs and are found both inter-tidally and sub-tidally around reefs and rocky areas.

Biology and ecology: As in all cephalopods, sexes in octopus are separate, exhibiting external sexual dimorphism, either in structure or size. Females are generally larger than males. Prior to mating there is often an elaborate mating ritual involving colour changes and touching of tentacles. One of the male's tentacles is modified to carry sperm to the mantle cavity of the female, and eggs are usually brooded while they develop directly into tiny adult form (Smith, 1992). They actively prey on crustaceans, fish and molluscs and are usually solitary (Roper *et al.*, 1984). Octopus are preyed upon by tunas, billfishes, sharks, rays and moray eels. Wrasse, *Chelinus* sp., is also known to be able to take octopus tentacles, being able to escape its grasp becuase of their slimy body.

Most inshore squids have extended spawning season with peaks in spring or early summer and in fall. Eggs are encapsuled in gelatinous, fingerlike strings and are attached to various substrates. Hatchlings resemble adults (Roper *et al.*, 1984). Inshore squids are short-lived, reaching maturity in about one year and having a life span ranging between 1 and 3 years. They predate on crustaceans and small and juvenile fishes.

2.6.2 The Fishery

Utilization: Buck (1930) wrote that octopus is a great delicacy and much sought after in Samoa. The same author described fishing methods for octopus in Western Samoa as follows:

1) ***Tao fai fe'e*** - this is a 3 to 4 feet long stick as thick as a finger and used by women at low tide on the reef to draw octopus out of the holes in the corals. The stick is thrust down into the hole and twirled about. The motion drives the octopus out and is quickly seized by the body and killed by biting between the eyes. An additional stick, which is shorter (~18 inches) and slender, is also often carried to use on awkward holes with a bend.

2) ***Ma'a ta'i fe'e*** (or *pule ta'i fe'e*) - Buck (1930) mistakenly translated this to mean squid lure. It is actually the octopus lure. This method is used only by men. The author described the making of the lure in detail. But in summary, it constitutes of a dark basaltic stone shaped like a spinning top with two plates of *Cypraea tigris* (*pule*) fitted to one side, and a long strip of coconut root bearing pieces of coconut leaflet attached to the other. The lure is made to the shape of a rat. The lure is dangled and jerked about in the water, just above the bottom, from the end of a line from the canoe. The shark jerks make the lure look like a drowning rat while the shells make squeaking sounds of a rat. The combination of these two factors attract the octopus which reaches out one of its tentacles first to rest on the lure. The fisheman who sees this through clear water steaddily draws his lure upwards. "As it nears the surface, the octopus which follows it up still with only one tentacle on it, probably realizing from the increasing light, or lesser weight of the water that it stands a chance of losing whatever the lure represents to it, suddenly pounces on the lure, rests its body on it, and clasps its tentacles around it". The fisherman quickly draws the lure with the octopus out of the water, into the canoe and kills it by biting between the eyes.

At present, octopus is mainly caught with spears used during normal reef fishing and is a by-catch of that fishery. Octopus fishing using the traditional ***ma'a ta'i fe'e*** is not practised anymore because of the time taken in preparing the lure and it has become less effective.

Available data indicate that octopus forms an important component in the subsistence/artisanal and commercial sectors in Western Samoa.

Production and marketing: Current level of consumption/production on the subsistence is not known. Data available from commercial market and outlets are limited and incomplete.

Table 2.6.1 presents estimates calculated from a nation-wide fishery catch assessment survey conducted by the Department of Statistics in 1978. Shellfish were lumped in broad categories as given, and finfish categories are also given for comparison. The Cephalopoda category comprises octopus and squid landings. Of the invertebrate species, Cephalopoda made up 25 per cent of the total, second only to Echinodermata during the year. Overall, Cephalopoda made up about 3 per cent of the total finfish and invertebrate landings for the whole country during the survey period. It must be noted however, the Apia area was excluded from the survey.

Table 2.6.1: Fish type composition of fishery landing in Western Samoa in 1978. (Source: Department of Statistics, undated).

Category	Total catch (kg)	% Invertebrate Catch	% of Total Fishery Catch
Invertebrates			
Cephalopoda	31,123	25.43	2.85
Crustacea	27,960	22.85	2.56
Shellfish	18,512	15.13	1.69
Echinodermata	44,786	36.60	4.11
Invertebrates Total	122,381	100.00	11.21
Fin-fish		% Finfish Catch	
Lutjanidae	13,735	1.42	1.26
Lethrinidae	68,470	7.07	6.28
Other deep-water fish	133,603	13.80	12.25
Sharks, rays and skates	7,328	0.76	0.67
Reef fish	422,552	43.65	38.76
Carangidae	27,132	2.80	2.49
Mugilidae and Chanidae	30,003	3.10	2.75
Skipjack	183,359	18.94	16.82
Other tuna mackerel and barracuda	7,811	0.81	0.71
Eels	23,442	2.42	2.15
Other fish	50,687	5.24	4.65
Finfish Total	968,122	100.00	88.79
GRAND TOTAL	1,089,963		100

Table 2.6.2 records estimated Cephalopoda landings (kg) by quarter and Stratum as used in the 1978 nation-wide Fishery Catch Assessment Survey. The figures indicate that the catching of Cephalopoda is generally through-out the year with the highest landing recorded in Stratum II (Tiavea-Saaga) on Upolu Island.

Table 2.6.2: Cephalopoda landing recorded during the 1978 Fishery Catch Assessment Survey through-out Western Samoa. Figures are in kg. (Source: Department of Statistics, undated).

Cephalopoda		Quarter of the Year				
Stratum #	Area	1	2	3	4	TOTAL
I	Upolu Northeast - Fagali'i to Uafato	119	679	711	2,601	4,110
II	Upolu Southeast -Tiavea to Saaga	6,831	89	2,885	1,265	11,070
III	Upolu Southwest - Siumu to Matafa'a	138	1,473	1,913	980	4,504
IV	Upolu Northwest Falevai to Vailoa, including Manono and Apolima	0	801	617	2,837	4,255
V	Savaii North - Samalaeulu to Falelima	0	382	196	329	907
VI	Savaii South - Fagafau to Puapua	262	2,521	2,330	1,164	6,277
Total		7,350	5,945	8,652	9,176	31,123

In fish consumption surveys conducted in rural areas of Upolu during the December 1983 - February, 1984 period, Zann *et al.* (1984) estimated invertebrates consumption as recorded in Table 2.6.3. Figures are in percentages which were calculated from estimates based on fishery products consumed the day before the survey. Octopus was estimated to make up 2.3 per cent of the rural invertebrate consumption. No oetopus consumption was recorded in the Apia area during the survey period. The total invertebrate landing estimated for Upolu was 7,614 mt per year, of which 6,093 mt was estimated to be in the rural areas.

Table 2.6.3: Percentages of invertebrate types eaten on day before survey between December 1983 and February 1984 on Upolu. (Source: Zann, *et al.*, 1984).

Taxon	English/Samoan name	Apia	North east	North west	South east	South central	South west	Manono Is.	Rural Average
Households consuming invertebrates on previous day		24	26	28	7	14	17	50	23.7
MISC.									
Scyphozoa	jellyfish/'alu'alu	9					8		1.3
MOLLUSCA									
Gastropod (misc)	snails					19			3.2
Dolabella	seahare/gau			33					5.5
Bivalvia	misc.		25						4.2
Tridacna	giant clams/faisua					20			3.3
Anadara	cockles/pae	18							
Gafrarium	venus shell/tugane	9							
Pinna	penshells/fole						8		1.3
Octopoda	**octopus/fe'e**							14	2.3
Total		27	25	33		39	8	14	20.0
CRUSTACEA									
Crabs	crabs/pa'a					13			2.1
Panulirus	spiny lobster/ula								2.0
Total			12			13			4.1
ECHINIDERMATA									
Holothurian	gonads/sea	36	37	33	100	13	56	57	49.3
H. atra	sa cucumber/loli			33			4	28	10.8
Echinometra	seaurchin/tuitui	18	25			33	24		13.6
Total		54	62	66	100	46	84	85	73.7

Commercial invertebrate landings at the Apia Fish Market, Other Outlets and Roadside from Apia to Faleolo during the 1986-1993 period, as collected by the Fisheries Division, are presented in Tables 2.6.4a, 2.6.4b, 2.6.4c.

Table 2.6.4a: Commercial invertebrate landings at the Apia Fish Market. (Sources: Helm, 1987; Mulipola, 1993: Mulipola, 1994; Fisheries Division Database).

Invertebrate	Unit	1986	1987	1988	1989	1990	1991*[1]	1992	1993*[2]	1994*[3]
Octopus	Wt (kg)	6,674	5,152	1,447	2,077	2,309	557		924	8,332
	Value (WS$)			9,531	12,814	11,573	3,470			
Squids	Wt (kg)									26.7
	Value (WS$)									
Giant clams	Wt (kg)	10,010	1,905	3,144	1,110	120		500	102	484
	Value (WS$)			15,702	3,757	457				
Lobsters	Wt (kg)	10,752	9,203	2,817	3,637	1,858	269	3,500	1,385	5,705
	Value (WS$)			25,718	21,993	8,220	1,288			
Mangrove crabs	Wt (kg)	9,640	10,572	4,194	5,397	1,218	438	2,500	2,091	13,810
	Value (WS$)			52,526	28,085	8,407	5,187			
Reef crabs	Wt (kg)				152	182			552	3,215
	Value (WS$)				945	1,572				
Slipper lobsters	Wt (kg)				85				206	680
	Value (WS$)				307					
Other crustacean	Wt (kg)			288		16	3		33	1.6
	Value (WS$)			1,560		112	18			
Turban	Wt (kg)								24	2.4
	Value (WS$)									
Tectus	Wt (kg)				101				22	86.4
	Value (WS$)				169					
Total	Wt	37,076	26,832	11,890	12,559	5,703	1,267	6,500	5,338	32,343
	Value			105,037					49,512	245,560
Octopus & squids % of Total Invertebrate		18.0	19.2	12.2	16.5	40.5	44.0	0.0	17.3	25.8

*[1] estimates extrapolated from Jan-May data; *[2] estimates extrapolated from Aug.-Dec. data; *[3] estimates extrapolated from Jan-Sept data.

Table 2.6.4b: Commercial invertebrate landings at Other Commercial Outlets. (Sources: Brotman, 1989; Winterstein, 1991; Mulipola, 1994; Fisheries Division 1992/1993 Annual Report).

Category	Unit	1989	1990*	1991	1992**	1993	1994
Octopus	Wt (kg)	756					
Giant clams	Wt (kg)	275					
Lobsters	Wt (kg)	18,383				982	
	Value (WS$)					5,947	
Mangrove crabs	Wt (kg)	1,684				51	
	Value (WS$)					334	
Fresh-water shrimps	Wt (kg)	103					
Beche-de-mer	Wt (kg)	13,091					
Invertebrates*	Wt (kg)		10,280				
Crustacea	Wt (kg)				10,500		
Shellfish	Wt (kg)				5,000		
Total	Weight (kg)	34,292	10,280				
	Value (WS$)	212,561					
% Wt octopus		2.2					

*include lobsters, mudcrabs, octopuses and eels; **includes Roadside Data.

Table 2.6.4c: Commercial invertebrate landings recorded during roadside surveys from Apia to Faleolo, 1990-1994. (Sources: Iosefa, 1992; Fisheries Division Database).

Inverterate	Unit	1990	1991	1992	1993*	1994
Octopus	**Wt (kg)**				414	
	Value (WS$)				3,671	
Mangrove crabs	Wt (kg)			450	8	
	Value (WS$)				98	
Giant clams	Wt (kg)			78		
	Value (WS$)				234	
Trochus (aliao)	Wt (kg)			39		
	Value (WS$)				347	
Alili	Wt (kg)					
	Value (WS$)				121	
Sea	Wt (kg)			119 bottles		
	Value (WS$)				2,490	
Sea urchin	Wt (kg)			242 baskets		
	Value (WS$)				7,209	

* Data for only August-December,1993.

2.6.3 Stocks Status

No information is available and detail catch and effort data are lacking to detect any trend in this fishery. However, there is a decline of octopus landings at the Apia fish market from about 7 mt estimated in 1986 to to about 0.5 mt in 1991 and 0.9 mt in 1993. Between 1986 and 1994 , estimated octopus landings at the Apia Fish Market was highest in 1994. It must be noted though that the estimates for 1991, 1993 and 1994, were extrapolated for the whole year from months in which data were recorded. It is suspected that the wide fluctuations of landings between years seem to be reflective of the inconsistency in data collection rather than the resource.

2.6.4 Management

Current legislation/policy regarding exploitation: There is no specific regulation that covers the exploitation of the octopus fishery in Western Samoa.

Recommended legislation/policy regarding'exploitation: The exploitation of the octopus resource seems to be limited to the subsistence and artisanal levels with no apparent huge commercial demand. It seems that the major threat to this resource in Western Samoa is the destruction of habitat, coral reefs, and pollution. Habitat (coral) destruction is caused by both fishing for octopus and employment of destructive fishing methods to catch other sea-food, and natural disasters such as cyclones.

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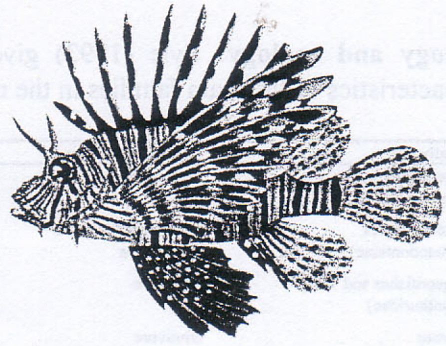
3. FIN-FISHES

3.1 Aquarium fish - *I'a mo tane teufale?*

3.1.1 The Resource



sa'usa'ulele - Pterois volitans

Species present: A comprehensive listing of individual species exported from Western Samoa for the aquarium trade is given in Appendix 3.1. Species targeted for this enterprise involve those which are small in size and have bright or ornate colouration. Other important species' features that are considered include non-restrictive diets and overall adaptability to a captive environment (Pyle, 1993). Records of exports indicate that some of the species, sometimes at juvenile stage, are those that form a portion of the catch in the local artisanal and subsistence fisheries. Due to the numerous species involved, species collected for aquarium purposes can be categorized under their families. The more important fish families included; Acanthuridae (surgeonfishes and tangs), Balistidae and Monacanthidae (triggerfishes and filefishes), Blenniidae and Gobiidae (blennies and gobies), Chaetodontidae (butterflyfishes), Cirrhidae (hawkfishes), Labridae (wrasses), Pomacanthidae (angelfishes), Pomacentridae (damselfishes) and Serranidae (groupers and basslets).

The 1993/1994 aquarium fish export was dominated by damsel fishes, especially *Pomacentrus* spp. and *Chrysiptera* spp. This was followed by wrasses (*Labroides* spp), clownfishes (*Amphiprion* spp.) and hawkfishes (*Paracirrhitus* spp.). The flame hawkfish (*Neocirrhites armatus*) is the main target species. Some of the fish species exported are important in the local subsistence/artisanal fisheries and sometimes they are collected in the juvenile stage.

Distribution: Fish exploited for the aquarium trade in Western Samoa, as is done in other South Pacific islands are all wild-caught marine species mostly from the shallow-water coral reefs surrounding the islands. However, in some countries and for certain species, depths where collection take place can be very deep. For example, in Cook Islands, habitat depths for most of the commercially valuable aquarium fish species on Rarotongan reefs range from about 8 to 30 m (Passfield and Evans, 1991, quoted in Richards, 1993). Myers (1989) describes the flame hawkfish as a spectacular and fairly common along surge-swept reef fronts and submarine terraces to a depth of about 11 m. "It inhabits heads of corals *Stylophora mordax*, *Pocillopora elegans*, *P. eydonxi* or *P. verrucosa* but fairly secretive and will retreat to the innermost recesses of the coral when approached. It is a highly prized aquarium fish, but requires well-oxygenated water and tends to fade in captivity".

The six-month aquarium fish operation in Western Samoa from October 1986 to March 1987 recorded collections from villages as follows (Source: Bell, 1987):

Village	# collections
Lefaga	7
Salamumu (Nuu-a-Vasa Point)	3
Salamumu village	2
Mulivai Safata	4

Village	# collections
Tufulele	5
Faleolo	6
Apia	2
Faleula	1

Village	# collection
Manono	1
Matautu-uta	1
Fasitootai	1
Faleatiu	1
Salelesi	1

The current aquarium fish operator utilises a hookah system for collecting fish from deeper waters. Collection, especially for the flame hawkfish, has been concentrated at the depth range of 30-60 feet. The shallower reef fish species have been used mainly as "fill ins" for shipments.

The 1993/1994 aquarium fish operation is currently concentrating collection at Lefaga. Records indicate that collection have also been conducted at Salelavalu on Savaii Island, and Manono and Apolima, and Mulifanua on Upolu Island.

Biology and ecology: Pyle (1993) gives the following table of some biological and ecological characteristics of the main families in the marine aquarium trade from the South Pacific:

Family	Feeding Strategy	Reproductive Strategy	Habitat
Angel fishes (Pomacanthidae)	herbivore/omnivore	harem-forming/pair-forming; some species protogynous; spawn at dusk; pelagic eggs	shallow to deep reef; rubble/coral
Butterfly fishes (Chaetodontidae)	omnivore/plantivore/ corrallivore	pair-forming/school-forming; pelagic eggs	shallow to deep reef; coral and ledges
Surgeonfishes and Tangs (Acanthuridae)	herbivore	school-forming; spawn at dusk in large groups; pelagic eggs	all habitats, depending on species
Wrasses (Labridae)	omnivore	harem-forming/school-forming; protogynous; spawn at all time of day (depending on species); pelagic eggs	all habitats, depending on species
Groupers and Basslets (Serranidae)	carnivore/herbivore/ planktivore	harem-forming/pair-forming/aggregate forming; protogynous; spawn at dusk; pelagic eggs	all habitats, depending on species; Anthiinae form aggregation
Damselfishes (Pomacentridae)	herbivore/plantivore/ omnivore	harem-forming/aggregate-forming; spawn in morning; demersal eggs	shallow reef coral/rubble; *Amphiprion* inhabit sea anemones
Triggerfishes and Filefishes (Balistidae and Monacanthidae)	omnivore	harem-forming/aggregate-forming; demersal sometimes pelagic eggs; some species build nests	all habitats, depending on species; refuge in holes on reef
Hawkfishes (Cirrhitidae)	carnivore	harem-forming; spawn at dusk; pelagic or demersal eggs	shallow reef often in association with coral
Blennies and Gobies (Blenniidae and Gobiidae)	omnivore	wide variety of reproductive strategies, depending on species	all habitats, depending on species

No study has been conducted in Western Samoa on any aspect of any of the fin-fish species exported in the aquarium fish trade.

3.1.2 The Fishery

Utilization: The export of ornamental aquarium organisms from Western Samoa began in 1986 for 6 months by one company, the Exotic Tropicals of Samoa, which was registered locally. The company also had a similar operation in American Samoa at the time. The Western Samoa operation employed 3 local divers as fish collectors. The divers operated only in shallow water areas in lagoons, over reefs and just beyond the reefs, where only a mask and snorkel were required. The use of a boat was not required but a holding tank for fish transfer from a dive site to the base, which was at Faleolo, was set on a pick-up truck on shore. Each diver carried a 5-6 ft long x 2 ft high net with 0.5 in. square mesh, a scoop net and a fish-holding bucket. The bucket top is covered with a fine-mesh net which had a zipper. When a good spot was located, the net was set on the bottom and the fish herded towards it. Fish are either hand-picked or scooped from the barrier net and transferred to the holding bucket. The zipper on the bucket is only opened when putting in fish. Often, individual fish specimen were chased after without the use of the barrier net and sometimes, when fish sought refuge in coral heads, the corals are broken to extract them. Even though an extension of 1 year for this particular operation was granted, it ceased after the first 6-month permit period. All of the fish were exported to the USA market.

The current and sole aquarium fish operation in the country, Legafa Seaboard Limited, was initiated in 1992 and is locally owned and employs four divers as collectors, two of whom are Philippinos. The method of collecting fish is barrier nets and hand nets which is mostly operated individually. The land-based holding and packing facilities are based in Gagaifo, Lefaga. All of the aquarium fish export by the company is to the USA.

Production and marketing: Bell (1987) recorded average number of fish caught per collector per dive in sites where collection occurred more than once, on different occasions, between October, 1986 and March, 1987 as presented in Table 3.1.1.

Table 3.1.1: Mean numbers of fish caught per collector per dive for sites where fish collection ocurred more than once during the October,1986-March, 1987 aquarium fish operation.

	Mean numbers of fish caught per collector per dive						
Site ↓ Dive number →	1	2	3	4	5	6	7
Lefaga	90.0	115.0	93.5	47.0	67.5	94.5	31.0
Nuu a Vasa Point	86.0	77.0	64.0				
Salamumu	68.2.0	242.0					
Hide Away	53.7	102.3	50.5	55.5			
Tufulele	51.5	92.0	82.0	12.7	(27.0)		
Faleolo	54.9	82.3	39.4	16.5	57.0	32.0	
Apia	193.0	124.5					

Table 3.1.2 records the export figures of aquarium fish by the Exotic Tropicals of Samoa during the permit period from Western Samoa during the October, 1986 to March, 1987. These records may not constitute the total exports during the period but involved 12 different shipments (2 in October, 1986; 1 in November, 1986; 1 in December, 1986; 3 in January, 1987; 2 in February, 1987; 3 in March, 1987).

Table 3.1.2: Aquarium fish export by Exotic Tropicals of Samoa from October 1986 to March, 1987. Data maybe incomplete. (Source: Fisheries Division Aquarium fish File).

Common name	Quantity # pieces	Value (US$)	Common name	Quantity # pieces	Value (US$)
Atadorsalis	150	262.50	Gobies	116	91.00
Clathrata	5	12.50	Hawkfish	7	12.25
Urodelius	3	9.00	Heniochus	34	70.50
Gold head sleeper	41	61.50	Moorish idol	10	38.00
Angelfish	261	1135.50	Other	134	131.80
Butteflyfishes	226	505.50	Pufferfish	2	4.00
Clownfishes	492	820.25	Squirrelfish	4	3.00
Damselfishes	2,485	1603.25	Surgeonfishes & Tangs	108	282.50
Filefishes	89	125.00	Triggerfishes	98	220.50
Goatfish	53	80.50	Wrasses	691	1844.00
Sub-total	3,805	4,615.50	Sub-total	1,204	2,697.55
GRAND TOTAL	5,009	7,313.05			

Table 3.1.3 presents available aquarium fish exports by the Lafaga Seaboard Limited during the 1993-1994 period. These were dominated by damsel fishes (especially *Pomacentrus* spp. and *Chrysiptera* spp.). This was followed by wrasses (*Labroides* spp), clownfishes (*Amphiprion* spp.) and hawkfishes (*Paracirrhitus* spp.).

Table 3.1.3: Aquarium fish export by Lefaga Seaboard Limited for the 1993-1994 period. (Source: Fisheries Division database).

Fish	Quantity # pieces	Average price	Value US$	Recorded Value	Fish	Quantity # pieces	Average price	Value US$	Recorded Value
Arothrons	60	1.00	60.00	60.00	Filefish	16	0.25	4.00	4.00
Assorted angelfishes	354	0.88	311.52	327.00	Flagfin angel	196	1.44	282.24	257.40
Assorted anthias	241	1.33	320.53	345.50	Flame hawkfish	1,264	3.00	3,792.00	3,892.00
Assorted blennies	282	0.50	141.00	141.00	Harwick wrasse	397	0.88	349.36	326.50
Assorted butterflyfishes	800	0.77	616.00	654.50	Heniochus butterfly	828	0.51	422.28	418.50
Assorted clownfishes	1,694	0.50	847.00	847.00	Humu humu triggerfish	567	0.94	532.98	551.00
Assorted damselfishes	26,801	0.25	6,700.25	6,675.25	Imperator angel	22	10.00	220.00	220.00
Assorted gobies	107	0.30	32.10	32.10	Lemon angel	66	1.00	66.00	66.00
Assorted tangs	2,081	0.53	1,102.93	1,154.00	Lipstich tang	2	0.50	1.00	1.00
Assorted triggerfishes	78	0.75	58.50	72.50	Naso tang	106	0.86	91.16	69.00
Assorted wrasses	8,736	0.69	6,027.84	6,429.50	Orange tang	93	0.55	51.15	51.50
Bicolor Angel	281	1.02	286.62	282.50	Other aquafish	2,732	0.72	1,967.04	1,613.62
Bicolor parrotfish	13	1.00	13.00	13.00	Parrotfish	2	0.75	1.50	1.50
Black & white snapper	1	1.00	1.00	1.00	Powder cray tang	2	0.50	1.00	1.00
Blennies	250	0.47	117.50	100.00	Regal angel	94	2.00	188.00	188.00
Blue damsel	9,883	0.35	3,459.05	2,575.25	Sailfin tang	5	0.75	3.75	3.50
Boxfish	140	1.00	140.00	140.00	Scopas tang	682	0.53	361.46	341.50
Cleaner wrasse	4,569	0.50	2,284.50	2,284.50	Sebae clown	608	0.51	310.08	308.75
Clown trigger	22	1.40	30.80	24.50	Tomato clown	576	0.50	288.00	288.00
Coral beauty angel	289	0.98	283.22	288.00	Yellow angel	281	1.39	390.59	401.00
Domino damsel	404	0.28	113.12	120.25	Yellow popper	2	1.00	2.00	2.00
					Yellow tang	4	0.83	3.32	3.50
Subtotal 1	57,086		22,946.48	22,567.35	Subtotal 2	8,545		9,328.91	9,009.27
Grand Total	65,631		32,275.39	31,576.62					

3.1.3 Stocks Status

No information is available on the status of stocks of species collected for the aquarium fish trade. Bell (1987) recorded average number of fish caught per diver-hour for each dive at sites where collection occurred more than once on different occasions. These are recorded inTable 3.1.4.

Table 3.1.4: Average number of fish caught per diver-hour at sites where collections were repeated. (Source: Bell, 1987).

Site ↓ Dive number →	1	2	3	4	5	6	7
Lefaga	18.0	23.0	20.8	11.6	27.0	31.5	10.3
Nuu a Vasa Point	28.6	25.5	13.9				
Salamumu	17.2	69.3					
Mulivai, Safata	13.6	27.9	11.0	12.2			
Tufulele	13.3	23.3	21.1	6.3	(8.1)		
Faleolo	14.1	18.2	15.6	7.7	16.9	7.0	
Apia	64.5	41.6					

Average numbers of fish per dive-hour for each dive for sites where collection occurred more than twice and for species caught in more than three different dives are recorded in Tables 3.1.5a-e as reproduced from Bell (1987). Fluctuating CPUEs were observed in sites where diving occurred more than once when considering the total number of specimens caught. However, changes in species catch composition and decreases in CPUEs were observed when analysing fish on the species level. For example, steady decreases in CPUEs were noted for assorted wrasses and *Coris gaimardi* for each consecutive dive at Lefaga (Table 3.1.5a). The same pattern was observed for *Centropyge flavissimus* and *Amphiprion melanopus* at the Hideaway site (Table 3.1.5c), and *C. gaimardi* at the Nuu-a-Vasa Point (Table 3.1.5b) Some species, however, showed increases in CPUEs, e.g. *Chaetodon falcula* at Faleolo (Table 3.1.5e) and *Heniochus chrysostomas* at Tufulele (Table 3.1.5d). However, because of the lomited amount of data, these observed trends are considered inconclusive.

Table 3.1.5a: Average number of fish per dive-hour per dive for species caught in more than three different dives at Lefaga. Figures are in numbers of fish per dive-hour.

Lefaga Fish species ↓ / Dive number →	1	2	3	4	5	6	7
Assorted wrasses	6.4	10.4	7.7	5.5	4.4	0.5	2.2
Gold head sleeper			1.8	0.9	1.4		0.3
Acanthurus olivaceus			0.9		0.8	0.3	1.5
Amphiprion chrysosterus		0.6	0.6	0.1	0.6	0.2	
Centropyge flarissimus	0.4		0.2	0.1	0.4		
Coris gaimardi	10.8	9.8		1.2	0.6	1.0	
Abudefduf elizabethae			5.6	1.8	26.2	4.0	
Pomacanthus imperator	0.4	0.4	0.2	1.0			1.3
Yellow goatfish		1.6	0.3	0.4		0.7	1.0

Table 3.1.5b: Average number of fish per dive-hour per dive for species caught in more than three different dives at Salamumu. Figures are in numbers of fish/dive-hour.

Salamumu (Nuu a Vasa Point Fish species ↓ / Dive number →	1	2	3
Coris gaimardi	19.7	2.7	0.4

Table 3.1.5c: Average number of fish per dive-hour per dive for species caught in more than three different dives at Mulivai, Safata. Figures are in numbers of fish/dive-hour.

Mulivai, Safata Fish species ↓ / Dive number →	1	2	3	4
Centropyge flarissimus	6.4	5.6	1.1	0.7
Amphiprion melanopus	3.0	1.3	0.4	1.0
Assorted wrasses	1.1	1.0	0.4	0.9
Rhinecanthus aculeatus	0.3	1.0	2.0	0.3
Assorted gobies	0.2	2.3	0.1	0.9

Table 3.1.5d: Average number of fish per dive-hour per dive for species caught in more than three different dives at Tufulele. Figures are in numbers of fish/dive-hour.

Tufulele Fish species ↓ / Dive number →	1	2	3	4
Heniochus chrysostoma	0.6	0.3	0.5	0.8
Amphiprion melanopus	7.0	1.9	15.0	3.5

Table 3.1.5e: Average number of fish per dive-hour per dive for species caught in more than three different dives at Faleolo. Figures are in numbers of fish/dive-hour.

Faleolo Fish species ↓ / Dive number →	1	2	3	4	5	6
Chaetodon ephippium	1.4	0.3	0.8		2.6	1.8
Chaetodon falcula	0.1	0.2	0.1	0.3	2.0	2.2
Amphiprion chrysopterus		0.8	0.7	0.5		
Amphiprion melanopus	1.8		1.3	2.5		
Assorted wrasses	0.4	1.6	0.9	0.8		
Assorted damsels	2.8	0.7	1.5	1.8		0.4

Observations made during the 1986/1987 operation were:

⇒ collection method employed was acceptable except the breaking up of corals to extract certain fish specimens;

⇒ the average number of fish specimens collected per dive hour remained about the same in sites where collection took place more than once. However, species composition varied;

⇒ changes (decreases/increases) were observed in CPUEs for specific species in certain sites.

The author noted that the above observations were not conclusive due to the following:

⇒ the number of dives per site were too few especially when considering that it is a multi-species fishery;

⇒ collectors had varying abilities, thus varying effectiveness in the catching process;

⇒ the state of the tide was not considered. Since collection was mainly on the reefs and in adjacent lagoons, tides could have an effect on species composition.

No catch and effort data are being collected or recorded for the current aquarium fish operation.

3.1.4 Management

Current legislation/policy regarding exploitation: Fisheries Act, Part II, 4 (1) prohibits the use of explosive, poison or other noxious substance for the purpose of killing, stunning, disabling or catching fish, or in any way rendering fish more easily caught. The proposed Local Fisheries Regulation 1994 include minimum size limits for certain reef fish species utilised in the artisanal fishery in Western Samoa and are listed under the Shallow-Reef Fishes Profile.

The Fisheries Division issued Exploitation Guidelines for the Aquarium Fish Trade as follows:

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The proposed Local Fishing Regulations does not include any regulations on the exploitation of aquarium fish.

Recommended legislation/policy regarding exploitation: Consistent collection of accurate and detail data, including catch and effort data, is important in an effort to monitor this development. A sample data collection form is attached as Attachment 3.2. A consideration here is the inclusion of a regulation for anyone engaged in fishing, fish processing, fish marketing or the export of fish or fish products to provide to the Chief Fisheries Officer such information and statistics relating to such fishing, processing, marketing or export activities and in such form as may be prescribed.

A policy statement could be developed giving guideline as to the operation concerning harvesting of marine animals for aquarium purposes. Some areas that can be covered by such a statement include:

- requirement for operator to notify Fisheries Division of all collection expeditions before they take place detailing areas and dates so that if necessary, Fisheries Division staff will accompany such collecting expeditions;
- standing requirement for operator to notify Fisheries Division to inspect packaging of animals for each shipment to be made;
- an export permit to be required every time a shipment is scheduled. Submission of detailed catch statistics per site of collection prior to a shipment is made. Summary of species to be shipped (including numbers and estimated value) each time application for export is made. For ease of databasing by Fisheries Division, recording of statistics by species on packing list forms should be made under separate headings such as, fin-fish, corals, soft corals, crustacean, bivalves, echinoderms etc. Fin-fish can be broken down to further subheadings to account for the different families and/or species;
- establishing means for ease identification and monitoring of collection vessels.

- in order to increase the spread of the benefits to local people efforts could be made to train individuals within communities in which collections take place so they will be able to collect and sell to the exporter.

Non-authorisation of shipments by Fisheries Division shall be the penalty for not complying.

In the absence of biological information on which to base decision, it would be beneficial to limit the number of aquarium fish operators until proper assessment of the resource is completed. It would be desirable to prohibit the export of corals, giant clams and fish species currently utilized in the subsistence/artisanal fisheries, unless artificially propagated.

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Appendix 3.1: The Main Fish Species Exported in the Aquarium Fish Trade from Western Samoa with their corresponding average unit prices.

Lefaga Seaboard Limited, 1993/1994

Fish	Average Price	Fish	Average Price
Arothrons	1.00	Filefish	0.25
Assorted angelfishes	0.88	Flagfin angel	1.44
Assorted anthias	1.33	Flame hawkfish	3.00
Assorted blennies	0.50	Harwick wrasse	0.88
Assorted butterflyfishes	0.77	Heniochus butterfly	0.51
Assorted clownfishes	0.50	Triggerfish	0.94
Assorted damselfishes	0.25	Imperator angel	10.00
Assorted gobies	0.30	Lemon angel	1.00
Assorted tangs	0.53	Lipstich tang	0.50
Assorted triggerfishes	0.75	Naso tang	0.86
Assorted wrasses	0.69	Orange tang	0.55
Bicolor Angel	1.02	Other aquafish	0.72
Bicolor parrotfish	1.00	Parrotfish	0.75
Black & white snapper	1.00	Powder cray tang	0.50
Blennies	0.47	Regal angel	2.00
Blue damsel	0.35	Sailfin tang	0.75
Boxfish	1.00	Scopas tang	0.53
Cleaner wrasse	0.50	Sebae clown	0.51
Clown trigger	1.40	Tomato clown	0.50
Coral beauty angel	0.98	Yellow angel	1.39
Domino damsel	0.28	Yellow popper	1.00
		Yellow tang	0.83

Exotic tropicals of Samoa, 1986/1987

Fish	Average Price	Fish	Average Price
Pomacanthus imperator (sm)	10.00	Amphripion chrysopterus (sm0	2.50
Pomacanthus imperator (juv)	15.00	Amphripion chrysopterus (lg0	3.50
Pomacanthus imperator (adt)	30.00	A. melanopus	1.50
Ptgo Diacantyus	8.00	A. peridion	1.00
Apol Trimaculatus	8.00	A. sandraciones	1.50
Centropyge Bicolor	3.25	Coris Aygula	6.00
C. bi-spinosis	3.25	Thalassoma lutescens	3.00
C. flavicauda	2.50	T. hardwicki	3.00
C. flavissimus	3.25	Blobometapon bi-color	3.50
C. heraldi	4.00	Cirrihilabrus (wrasses) (xsm)	2.00
C. loriculus	6.00	C. w (sm)	3.00
C. auranthias		C. w (med)	4.00
Chaetodon auriga	2.00	C.w (lg)	5.00
C. bennetti	3.00	C.w (xlg)	6.00
C. citronells	1.25	Wrasses common	2.00
C. ephippium (sm)	2.50	W. fancy	3.00
C. ephippium (lg)	3.00	Balistoides conspiculatum	20.00
C. falcula (sm)	2.50	Odonus niger	3.00
C. falcula (lg)	3.00	Rhinecanthus aculeatus	2.25
C. Klienii	1.25	R. undulated	2.25
C. lunula (sm)	2.00	R. rectangulus	2.25
C. lunula (lg)	2.50	Anthius disbar	2.00
C.melanotus	2.00	Psudanthias pleur (f)	3.00
C. mertensii	3.00	Psudanthias pleur (m)	6.00
C. pelewensis	2.00	Hawk fish falco	1.75
C. polyepsis	3.00	Hf. armatus	6.00
C. quadramaculatus	1.75	Variola louti (sm)	4.00
C. Raffesi	2.00	Variola louti (lg)	8.00
C. reticulated	2.50	Longirosis	1.50
C. semion	5.00	Forcipinger flavis	1.75
C. unimaculatus	1.50	Zanclus can.	4.00
C. vagabond	2.00	Pseudochromis por.	4.00
Heniocus acuminatus	2.00	Eiulis flavescens	4.00
H. chrysostomus	2.00	Arothon nigropunc,	2.00
H. monocerus	2.50	Arothon nigropunc, (yellow)	20.00
H. singularus	2.50	Macolor niger	4.50
H. varius	2.50	Atadorsalis	1.75
Damsel assorted	0.50	Orientalis	4.00
D. Fiji devil	0.75	Clathrata	2.50
Acanthurus achilles	6.00	Urodelius	3.00
A.glucopareius	3.50	File fish	1.00
A. guttatus (sm)	4.00	Chaetadon hybrid	5.00
A. guttatus (lg)	6.00	Gold head sleepper	1.50
A. lineatus	7.00	Yellow goatfish	2.00
A. pyroferus (yellow)	2.50	Assorted gobbies	1.00
A. pyroferus (mimic)	4.00	Small damselfish	1.00
Paracanthus hepatus	4.50	Hardclown wrasses	1.00
Naso literatus	2.00	Tang	2.00
Zebrasoma scopas	1.50	Other aquafish	1.50
Z. velieferum (sm)	2.50	Surgeon fish	1.00
Z. velieferum (lg)	3.00	Squirrel fish	1.00

Appendix 3.2: Suggested form for use in the collection of aquarium fish catch data.

AQUARIUM FISH CATCH DETAILS FOR EACH SITE	
Operator (company):	License number:
Collection (dive) date:	Number of collectors (divers):
Catching method used:	SCUBA used?: Hookah used?:
Area of collection (dive):	Specific area within site:
*[1]Time collection (dive) start:	*[1]Time collection (dive) finish:
Collection (dive) duration (in hours and minutes):	

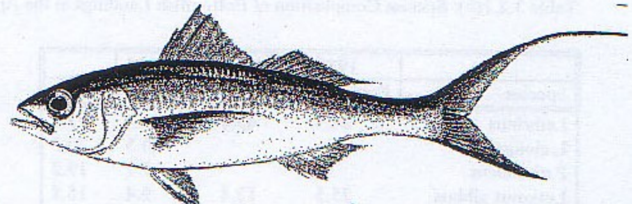
CATCH DETAILS OF THE ABOVE OPERATION					
FIN-FISH		INVERTEBRATES		INVERTEBRATES	
Species	Total #	Species	Total #	Species	Total #

Name of person filling the form (signature and date):

Fisheries Officer receiving the form (signature and date):

*[1] =use separate forms for different dives, even if it is within the same area.

3.2 Offshore deep-sea bottomfish - *i'a alalo (i'a o le loloto)*



paluloa - Etelis coruscans

3.2.1 The Resource

Species present: The major deep-sea bottomfish species of commercial importance in Western Samoa include:

Etelis carbunculus (short-tailed red snapper - ***palu malau***), *E coruscans* (longtail snapper - ***palu loa***);
Pristipomoides typus (sharp-tooth jobfish - ***palu sina***), *P. multidens* (goldbanded jobfish - ***palu sina ugatele***), *P. flavipinnus* (golden eye jobfish - ***palu sina***), *P. filamentosus* (crimson jobfish - ***palu 'ena'ena***), *P. zonatus* (oblique-banded jobfish - ***palu sega***);
Paracaesio kusakarii (saddle-back or Kusakar's snapper - ***palu mutu***), *P. stonei* (cocoa or Stone's snapper - ***palu tuauli***);
Aphareus rutilans (rusty jobfish - ***palu gutusiliva***);
Lutjanus gibbus (paddletail or humpback snapper - ***malaî***), *L. timorensis* (Timor snapper - ***malaî pa'epa'e***), *L. kasmira* (blue-line snapper - ***savane***), *L. bohar* (two-spot red snapper - ***mu***)
Lethrinus miniatus (long nosed emperor - ***filoa va'a***), *Le. kallopterus*, now called *Le. erythracanthus* (orange-spotted emperor - ***filoa laugutu***)
Aprion virescens (green jobfish - ***utu*** or ***asoama***)
Epinephelus morrhua (comet grouper - ***'ata'ata***), *Ep. septemfaciatus* (convict grouper - ***'ata'ata***), *Variola louti* (lunar-tailed cod - ***papa***)
Caranx ignobilis (great trevally - ***malauli***), *C. lugubris* (black trevally - ***tafauli***), *Seriola rivoliana* (amberjack - ***tusi***)
Promethichthys prometheus (snake mackerel - ***palu kamulo***);
Ruvettus pretiosus(castor oilfish - ***pala***).

Species composition of deep-sea bottomfish landings by the commercial vessels in the Apia Fish Market (processor side) during 1989 are recorded in Table 3.2.1(a) for Falealupo and other fishing areas combined (King *et al*., 1990). Species accounting for less than 0.1 per cent are not included. Table 3.2.1(b) presents bottomfish species composition landed at the Apia Fish Market (open side) for 1989, 1990 and 1993.

Table 3.2.1(a): Percentage (by weight) of deep-water bottom fish caught in Western Samoa waters by commercial fishing vessels at Falealupo and other (unexploited) areas. Only species accounting for at least 0.1 per cent of the total have been included. (Source: King *et al*., 1990).

Species	Falealupo	Other Areas	Species	Falealupo	Other Areas
Etelis coruscans	52.3	26.9	*Aprion virescens*	2.7	5.3
E. carbunculus	1.9	3.9	*Lutjanus gibbus*	0.6	0.6
E. radiosus		0.5	*L. timorensis*		3.1
Aphareus rutilans	6.9	13.3	*L. kasmira*		0.2
Paracaesio kusakarii	7.0	11.6	Oilfish	0.1	-
Paracaesio stonei	0.6	0.4	Carangids*	2.6	8.4
Pristimoides typus	3.2	1.2	Groupers	0.2	3.0
P. multiden	1.3	3.8	Lethrinids	-	1.2
P. flavipinnis	0.7	0.3	Shark	-	5.7
P. filamentosus	0.5	0.6	Large fish**	4.4	2.3
P. zonatus	0.2	0.4	Small fish***	14.8	7.3

* mainly the great trevally, *Caranx ignobilis* (malauli); ** fish graded as 'large' were mainly groupers; *** fish graded by the factory as 'small' were generally shallower-water Lethrinids and Lutjanids, but included some smaller (less than 40 cm) individuals of the deep-water species listed above.

Table 3.2.1(b): Species Composition of Bottomfish Landings at the Apia Fish Market, 1989, 1990 and 1993.

	1989	1990	1993	
Species	Per cent	Per cent	Per cent	Mean
Lethrinus	24.3	45.6	1.3	23.7
L.elongatus			20.5	20.5
P.multidens			19.2	19.2
Lutjanus gibbus	25.5	12.4	9.4	15.8
Other prist.	15.2	12.9		14.1
Aphareus rutilans	3	7.9	12.4	7.8
D.tooth			7	7.0
Aprion visercens	8.2	7	4.2	6.5
Lutjanus kasimira	6		4.3	5.2
Trevally	4.6	7.2	2.7	4.8
Groupers	2.3	2.7	3.4	2.8
Cephalophalis	2.6	2.6		2.6
Variola louti			2.5	2.5
Other bottomfish	3	1.7	2.6	2.4
L.variegated			2.4	2.4

	1989	1990	1993	
Species	Per cent	Per cent	Per cent	Mean
Baracuda	1		3.4	2.2
Lm	1.6			1.6
M.niger			1.5	1.5
Etelis spp	1.4			1.4
L.kalloptorus			1	1.0
L.monostigma			1	1.0
L.button			0.6	0.6
Other lutjan.	0.3			0.3
M.grandoculis			0.2	0.2
Paraca. kusakarii	0.1		0.3	0.2
Prist. typus	0.4		0	0.2
Pristi. flavipinnis	0.2		0	0.1
Squirrelfish	0.2		0	0.1
P. zonatus			0	0.0
Paracae. stonei	0			0.0

A total of 45 deep reef fish species were recorded in Western Samoa during the South Pacific Commission deep-sea bottomfish project in Western Samoa (Dalzell and Preston, 1992). Comparison of the number of deep reef fish species recorded from dropline catches and length of the 100-fm isobath in different locations in the South Pacific is given in the same reference as summarised in Table 3.2.2. In terms of deep-sea bottomfish species diversity, the number of species occurring in Western Samoa is just below the average number for the countries listed.

Table 3.2.2: Number of deep reef fish species recorded from dropline catches by SPC and length of 100-fm isobath. in the South Pacific. (Source: Dalzell and Preston, 1992).

Location	Land Area (km^2)	Linear distance east from Palau (km)	100-fm Isobath length (n.mi.)	No. of deep reef slope fish species
Palau	460.0	0	232.0	102
Yap	100.2	500		69
Truk	99.9	2,000		88
PNG	462,243.0	2,250	7,305.0	94
Kosrae	109.6	3,250		63
Solomon Islands	27,556.0	3,375	2,444.3	23
Marshall Islands		4,000	1,420.0	44
Kiribati		4,500	708.7	78
Vanuatu	11,880.0	4,500	1,400.0	51
New Caledonia	19,103.0	4,750	1,556.0	65
Tuvalu		5,250	128.2	51

Location	Land Area (km^2)	Linear distance east from Palau (km)	100-fm Isobath length (n.mi.)	No. of deep reef slope fish species
Fiji	18,272.0	5,625	3,000.0	107
Wallis & Futuna	265.0	5,875	69.9	61
Tokelau		6,250	56.4	49
Western Samoa	**2,482.0**	**6,250**	**307.8**	**45**
Tonga	646.0	6,375	893.0	68
American Samoa	200.0	6,500	143.3	41
Niue	259.0	6,750	53.1	42
Kiritimati	363.4	7,655		26
Penrhyn	1.0	7,900		37
Rarotonga	64.0	8,170		29
French Polynesia		9,655	2,970.9	47

Distribution: Throughout the South Pacific, the most important fish catch components of the deep-water fishery, in terms of total landing and value, comprise snappers and groupers. Most of the species in these two families are "widely distributed throughout the central, western and South Pacific although species richness tends to decline with distance from the Indo-Pacific faunal centre, leaving areas like Hawaii with somewhat fewer species" (Moffitt, 1993). Allen (1985) gives an overall general distribution pattern by subfamilies in the family Lutjanidae as well as the known distribution and identification of individual species. He also writes that "the family is divisible into four discrete geographical faunas: eastern Pacific, Indo-West Pacific, eastern Atlantic and western Atlantic" with no species found in more than a single region. Furthermore, "many species, particularly members of *Aphareus, Aprion, Etelis, Lutjanus, Macolor, Paracaesio, Pinjalo* and *Pristipomoides* have broad distributions encompassing wide areas of the Indo-West Pacific region. Some of these species such as *Lutjanus bohar, L. gibbus, L. kasmira, L. monostigma,* and *L. rivulatus*, as well as species of *Etelis, Paracaesio* and *Pristipomoides* are frequently associated with oceanic insular localities. Relatively few species have greatly restricted distribution and some of these may be more widespread, but because of their relatively deep habitat, they are seldom collected".

Moffitt (1993) notes that even though most of these species are wide ranging, their relative composition in catches varies considerably with location.

Even though studies of the deep-water bottomfish resource in Western Samoa have used the length of the 200 m isobath as an estimate of the habitat of the export species, bottom fishing occurs in depths ranging from about 35 m (20 fathoms) to 370 m (200 fathoms). The total length of the 200 m isobath has been estimated to be 204 n.mi. (Crook, 1988). Dalzell and Preston (1992) estimated the 100-fm isobath length to be 243 n.mi., including those for the two offshore banks, the Pasco and 17-Fathom Banks.

King (undated draft) divided offshore bottomfish species (fisheries) in Western Samoa into two categories, using depths, as follows:

- shallow-water species - at depths < 100 m, mainly emperors (lethrinids) and snappers (lutjanids), groupers (serranids) and trevally (carangids);
- deep-water species - at depths > 100 m (limited between 100 and 300 m depths), mainly snappers (lutjanids) with catch consisting almost entirely of species belonging to four genera, *Etelis*, *Aphareus*, *Paracaesio* and *Pristipomoides*.

Bottomfishes have been harvested commercially from fishing grounds around Western Samoa's coastline and offshore areas since the mid-1970's with the most deep-water snapper catches harvested from the Falealupo fishing area. Other important bottomfish fishing areas include offshore areas at Aleipata, Falelatai, north and south of Salelologa and north of Apia. Only two offshore banks have been identified in Western Samoa's EEZ, the 17 Fathom Bank and Pasco Bank which are near and on the border with Wallis and Futuna on the northwest. Both these banks are beyond the range of the *alia* vessels. King *et al.* (1990) presented a table summarising information concerning exploited deep-water bottomfish areas (area between 125 m and 275 m depth). The table is reproduced as Table 3.2.3. The parameters give indications of the general distribution of the resource in Western Samoa waters. Due to more suitable habitat available, deep-water bottomfish is highest around Upolu Island corresponding to highest standing stocks and unexploited biomass. However, in terms of CPUEs and standing stocks per unit of suitable habitat, those at the offshore banks and around Savai'i yield higher values.

Table 3.2.3: Bottomfish areas and some information concerning existing bottomfish resource in Western Samoa. (Source: King *et al.*, 1990).

Fishing Area	Habitat Area (nmi^2)	CPUE (no/hr)	Standing Stock (numbers)	Standing Stock (mt)	Standing Stock (t/nmi^2)	Unexploited Biomass (mt)
UPOLU						
northern side	54.9	0.77	42,273	96.0	1.75	243.8
southern side	35.3	0.80	28,240	64.1	1.82	156.7
Manono	44.7	0.73	32,631	74.1	1.66	198.5
SAVAI'I						
northern side	17.3	1.07	18,511	42.0	2.43	76.8
southern side	18.9	0.98	18,522	42.0	2.22	83.9
Falealupo	3.4	1.58	5,372	15.1	4.44	15.1
OFFSHORE BANKS						
17-fathom	2.5	1.95	4,875	13.7	5.48	13.7
Pasco	14.4	1.65	23,760	66.8	4.64	66.8
TOTAL (MEAN)	191.4	(1.19)	174,184	394.4	(2.71)	855.3

Depth distributions of the five major species in the deep-water bottomfish fishery were estimated by King *et al.* (1990) using CPUE data collected by the Fisheries Division research vessel from all fishing areas. The mean CPUEs were calculated by 20-fathom depth range. The results are as follows:

Species	Range	Major peak	Second major peak(s)	Other peaks
	Depths in fathoms			
Etelis coruscans	40 to 200	140	120, 160	80, 180
Etelis carbunculus	40 to 200	120	180	140, 100
Aphareus rutilans	40 to 180	60	100	160, 80
Paracaesio kusakarii	40 to 160	80	120	60, 140, 100
Pritipomoides typus	20 to 160	120	40, 60	80, 100, 140

The possibility that fish of specific species but different sizes exist in different depths was examined by regressing mean lengths against depth of capture for the major species. It was found that none of the slopes of the regressions was significantly different from zero and thus fish size is unrelated to depth (King, *et. al.*, 1990).

Biology and ecology: It has been established that benthic fish and crustaceans form an important dietary component for deep-water snappers and groupers, and that pelagic urochordates are important prey items for many *Pristipomoides* species (Moffitt, 1993). Deep-water snappers are serial spawners, able to spawn several times over a prolonged breeding season. Reproduction takes place in the summer, May to September in the North Pacific and November to May in the South Pacific. Fecundity increases with size and for some species it has been estimated to be between 300,000 and 2,000,000 eggs. Groupers on the other hand are protogynous hermaphrodites with an abbreviated breeding season peaking for 1-2 months. Groupers aggregate in large numbers during spawning and they usually become susceptible to fishing during this period. Fecundity has not been determined. Both snappers and groupers are long lived and slow growing. For natural mortality (M), Ralston (quoted in Moffitt, 1993) found the relationship $M=0.0189+2.06K$ for snappers and groupers.

The biology of three reef-slope snapper species, *L. kasmira*, *L. rufolineatus* and *P. multidens*, in Western Samoa was investigated and reported by Mizenko (1984). Biological investigations on the deep-water bottomfish resource in Western Samoa, involving assistance from FAO and USAID, started in 1987 and continued until 1990. King *et al.* (1990) recorded mean length and mean weight for the major species landed in the commercial bottomfish catch from exploited and unexploited fishing areas, as recorded in Table 3.2.4. Species specimens from the "unexploited" areas consistently had higher mean lengths and corresponding weights than those caught in the exploited areas.

Table 3.2.4: Comparative mean lengths and weights of deep-water bottomfish species caught in the commercial fishery from "exploited" and "unexploited" fishing grounds in Western Samoa. (Source: King *et al.*, 1990).

Species	Exploited Areas		Unexploited Areas	
	length (cm)	weight (kg)	length (cm)	weight (kg)
Etelis coruscans	59.7	3.91	63.0	4.57
Aphareus rutilans	55.0	2.94	57.6	3.38
Paracaesio kusakarii	49.1	3.28	49.3	3.29
Pristipomoides typus	28.8	0.55	33.6	0.83

An interesting feature in the length-frequency table for *E. carbunculus* was that 2 distinct and separate modes were observed. The lower mode centred around 31 cm and the higher one around 74 cm. Examination of gonads of some speciemens indicated that these modes correspond mostly with sex of the fish. The females corresponded to the lower mode and males, the higher mode.

Mizenko (1984) reported that advanced sexual development was found in *L. kasmira* specimens he examined spanning the entire size range of females, 145-250 mm FL and male, 180-290 mm FL. The same was found in *L. rufolineatus* specimens but female range was 170-230 mm FL and males, 180-260 mm FL. However, although sexual development was apparent in all *P. multidens* specimens examined, the smallest having 197 mm FL, ripe ovaries were never found among specimens smaller than 320 mm FL. Table 3.2.5 records population parameters of four major deep-water snapper in Western Samoa as estimated in King *et al.* (1990).

Table 3.2.5:Population parameters of four major species in the Western Samoan deep-water bottomfish fishery. (Source: King *et al.*, 1990).

Species	von Bertalanffy growth parameters K ($year^{-1}$)	L_∞ (cm)	Natural mortality M ($year^{-1}$)	Age at first capture t_c (yr)	Length at first capture L_c
Etelis coruscans	0.15	85.0	0.17	5.3	41.8
Aphareus rutilans	0.20	96.7	0.48	3.6	49.6
Paracaesio kusakarii	0.15	75.0	0.42	5.3	41.1
Pristipomoides typus	0.18	41.6	0.28	7.1	30.0
P. filamentosus		52.9			

Mizenko (1984) found that *L. kasmira* and *L. rufolineatus* depended primarily on prey living on sand or mud, such as, Foraminifera, benthic Gastropoda, Anomura and Brachyura whereas *P. multidens* fed mainly on prey that swim off the bottom, including, Caridea, Teleostomi and Octopodidae. Detailed composition of all food items for each species are given in the same reference. Both *Lutjanus* species spawn at about full moon during autumn (March-June) and winter (June-September) , while *P. multidens* spawns at about the first quarter moon during winter (June-September) and summer (December-March). All three species indicated multiple spawning within a single spawning season. Fecundity of two species was estimated as follows:

Date	Species	Body wt (g)	Fecundity (x 1,000) Ripe ova	Ripening ova
3 April, 1982	*L. rufolineatus*	206	37	40
17 July, 1982	*P. multidens*	1,488	144	238
17 July, 1982	*P. multidens*	894	126	88

Length/weight relationships have been estimated for certain species assuming the relationship is of the power curve form, $L=aW^b$, where L is the fish caudal fork length (cm), W is the weight (kg), a and b are constants of the equation, and r^2 is the coefficient of determination. These are presented in the following table as reported in various reports:

Species	a	b	r^2	Reference
Etelis coruscans	0.0000559	2.712	0.984	King *et al.*, 1990
Aphareus rutilans	0.0000984	2.683	0.948	King *et al.*, 1990
Paracaesio kusakarii	0.0000536	2.781	0.939	King *et al.*, 1990
Pristipomoides typus	00000328	2.884	0.919	King *et al.*, 1990
Etelis carbunculus	0.0000376	2.9	0.99	Su'a, undated
Pistipomoides filamentosus	0.0000051	2.1	0.87	Su'a, undated
Pristipomoides flavipinnis	0.0000016	2.5	0.87	Su'a, undated
Pristipomoides zonatus	0.0000014	2.5	0.77	Su'a, undated
Pritipomoides multidens	0.0000229	2.95	0.99	Mizenko, 1984
Lutjanus rufolineatus	0.00000661	3.18	0.96	Mizenko, 1984
L. kasmira	0.0000049	3.24	0.97	Mizenko, 1984

Several estimates have been made of the bottomfish resource sustainable yield in Western Samoa. Gulbrandsen (1977) estimated the potential yield of bottomfish as approximately 1,000 tonnes per year. Philip (Fisheries Division Annual Report for 1983) also estimated that the sustainable yield of bottomfish caught in known areas to be about 1,100 tons/year. Crook (1988) estimated the bottomfish resource sustainable yield to be 37.4 mt during the preliminary assessment of the deep-water stock based on catch data of the *Leilani.* Based on catch data of the Tautai Matapalapala and commercial landings at local processors in Apia, King, *et al.* (1990) estimated the deep-water bottomfish resource as having an annual yield of 88 metric tonnes, including 8.3 tonnes for the offshore banks. This estimated sustainable yield is equivalent to 0.46 tonnes/nmi^2 (0.13 tonnes/km^2) or 0.29 tonnes/nmi of 200 m depth contour.

3.2.2 The Fishery

Utilization: Offshore fishing for deep-water species was not a tradition in Samoa. However, traditional subsistence fishing from canoes for the shallow-water bottomfish, mainly emperors, groupers and small snappers, on submerged reefs beyond the main reefs, was practised. Gulbrandsen (1977) noted that handlining at depth of 20-50 fathoms (~36.6-91.5 m) has been known in Samoa for a very long time. Fishing on these submerged reefs were mostly determined by the weather and the ability of the fisherman to locate these "spots". Canoes also took fishermen offshore to fish for tuna and other oceanic pelagic fish species and sharks. These particular fisheries required specialized gear and skills where only certain fishermen were able to perform.

The development of the deep-sea fishery was initiated from a village project funded by the DANIDA/FAO in the 1970s to increase fish production to meet local demand and provide employment opportunities for local people. The FAO/DANIDA project resulted in the construction of more than 500 FAO designed fishing vessels powered by an outboard or an inboard engine targeting oceanic pelagic fishes (such as tuna) and the offshore bottomfish resource (for fish such as groupers and snappers). Fishing vessel design that was eventually selected for the offshore fishery development was the 28 ft catamaran type, which was based on the local type of double-hulled canoe, ***alia***. Between 1975 and 1979, about 120 plywood versions were constructed. Over 200 aluminium versions were subsequently built some of which were exported to other South Pacific countries. The following table gives the number of motorized fishing units in operation during the 1974-1977 period as reported in FAO (1978).

	1974	1975	1976	1977
Upolu	44	98	115	222
Savai'i	30	36	37	49
Total	74	134	152	271

Assistances from the government of Japan resulted in the construction of more than 10 walk-in freezers stationed around the country for storage of fish and to promote better quality fish for export.

The current local fishing fleet for deep-sea bottomfish is based on the 28 ft aluminium catamarans (*alia*) constructed locally. By 1989, approximately 90 *alia* were active in the offshore fisheries concentrating more on the catch of pelagic fish species, mainly skipjack and yellowfin tuna. However, up to 14 of these vessels were consistently active in the deep-sea snapper fishery during that time (King, *et al*., 1990). Through a Fisheries Division rehabilitation ***alia*** project initiated in 1990 after Cyclone Ofa, new ***alias*** were constructed and sold to the fishermen. The Government subsidized 50 per cent of the boat costs. In June 1993, Mulipola and Vaofusi (1994) conducted a survey of operational fishing boats in Western Samoa. Survey results are recorded in Table 3.2.6. Of the total 92 operational ***alias***, 30 per cent (28 boats) were based in Apia. A total of 26 ***alias*** (28 per cent) were recorded as involved mainly in bottomfish fishing of which 23 were based on Upolu (12 in Apolima and 11 in Apia). An additional 11 *alias* (7 on Savai'i and 4 on Upolu) were recorded as fishing both for oceanic pelagic fishes as well as bottomfish. Two additional alias were recorded as involved in both bottomfish and vertical longline operations. All of the *alias* operate on a commercial basis.

Table 3.2.6: Number of alias operational in 1994 in different fisheries in Western Samoa. (Source: Mulipola and Vaofusi, 1994).

Location	Total	Bottomfish	Tuna	Bottomfish & Tuna	Longline	Bottomfish & Longline	Inshore
UPOLU							
Apia	28	11	15	0	2	0	
Aleipata	3	0	3	0	0	0	0
Apolima	12	12	0	0	0	0	0
Falealili	5	0	3	0	2	0	0
Faleasi'u	1	0	1	0	0	0	0
Fusi Anoama'a	5	0	1	4	0	0	0
Faleatiu	1	0	0	0	0	0	1
Lefaga	4	0	4	0	0	0	0
Mulifanua	1	0	0	0	0	0	1
Siumu	7	0	7	0	0	0	0
Si'usega	1	0	0	0	0	0	1
Upolu Total	**68**	**23**	**34**	**4**	**4**	**0**	**3**
SAVAI'I							
Savai'i Total	**24**	**3**	**12**	**7**	**0**	**2**	**0**
GRAND TOTAL	**92**	**26**	**46**	**11**	**4**	**2**	**3**

The result of the Inshore Resources Assessment in 1991/1992 indicated that the inshore fisheries resources are heavily depleted thus encouraging the further promotion of the development of the offshore fishery to alleviate the existing fishing pressure on the inshore fisheries resources.

Production and marketing: During the FAO/DANIDA Village Fisheries Project, which was initiated in 1976, Gulbrandsen (1977) estimated the potential yield of Western Samoa's "outer reef" bottomfish resource to be 1,000 tonnes a year. This figure was calculated from a production rate of 0.5 tons/sq. km and using a shelf area of 2,000 sq. km for Western Samoa. Recent data indicate that this was clearly an over-estimate. Fishing conducted by the Fisheries Division demonstration team in an 11-month period during the project, 16.7 mt (36,800 lbs) of bottomfish were landed in 108 fishing trips in 27 villages. Thus, an average of about 155 kg (340 lbs) were landed per trip. Species composition of landings, based on 31,000 lbs. caught on bottom handlines by Fisheries Division in the 1974-1976 period, are presented in Table 3.2.7. It indicates that the largest proportion of the catches was made up of snapper species combined (36.7 per cent), followed by sharks (32.0 per cent).

Table 3.2.7: Species composition of bottomfish caught by Fisheries Division during the 1974-1976 period. (Composition based on 31,000 lbs of fish). (Source: Gulbrandsen, 1977).

Samoan name	Common English name	Species	Per cent of total
Malie	shark	?	32.0
Palumalau	sharptooth snapper	**Pristipomoides typus*	14.8
Palusina	rosy jobfish	**Aprion microlepus*	11.1
Malai	malabar rd snapper	**Lutjanus malabaricus*	10.4
Filoa	longface emperor	Lethrinidae	7.1
Palutalatala	oilfish	*Ruvettus pretiosus*	4.7
Mu	red snapper	*Lutjanus bohar*	4.6
Gatala	grouper	Serranidae	4.5
Utu	green jobfish	*Aprion virescens*	2.1
Palukamulo	snake mackerel	*Promethichthys prometheus*	1.4
Palusega	small toothed jobfish	**Aphareus furcatus*	0.4
Isi i'a	Others		5.4

*possible misidentification.

During the SPC Outer Reef Fisheries Project in Western Samoa from April to October, 1975, 6,370 kg of deep-sea fish were caught in 77 trips, averaging 82.7 kg per trip (Hume and Eginton, 1976, reported in Dalzell and Preston, 1992). The catches include sharks. The expeditions were at the Asau area, Savai'i, using two 7.3 m (LOA) monohull vessels.

In the survey of forty-eight (48) villages conducted by the Department of Statistics in 1978 throught-out Western Samoa, an estimated 967,582 kg of finfish were landed of which 215,268 kg (22.3 per cent) were reported as offshore bottomfish. Details of estimates are presented in Table 3.2.8. The three categories of bottomfish make up 22.3 per cent of the total fin-fish estimated landing of which Lutjanidae accounted for 1.4 per cent, Lethrinidae 7.1 per cent and "other" deep-water fish 13.8 percent, of the total fin-fish landings.

Table 3.2.8: Estimated fish and shellfish landing details in Western Samoa during the Department of Statistics nation-wide fishery assessment survey in 1978.

	Offshore Bottomfish			Reef and Lagoon Fish					Tuna & Pelagic		Other	Molluscs & Crustaceans				Total
Stratum	Lutjanidae	Lethrinidae	Other deep-water fish	Shark rays,	Reef fish	Carangidae	Mugillidae	Eel	Skipjack	Other tuna mackerel etc	Other fish	Crustacea	Shellfish	Cephalopoda	Echinodermata	Total
UPOLU																
I																
Inshore					38,010	237	644	5,183			3,224	4,416	839	4,110	21,451	78,114
Offshore		865	5,494						909	815						8,083
Sub-total	0	865	5,494	0	38,010	237	644	5,183	909	815	3,224	4,416	839	4,110	21,451	86,197
II																
Inshore					80,184	929	10,086	2,639			36,403	1,353	3,475	11,070	9,065	155,204
Offshore		728	9,924	1,148					25,937			2,547				40,284
Sub-total	0	728	9,924	1,148	80,184	929	10,086	2,639	25,937	0	36,403	3,900	3,475	11,070	9,065	195,488
III																
Inshore					37,489	733	503	6,518			1,876	4,673	4,097	4,504	3,304	63,161
Offshore	1,504	2,210	3,852	368					45,106			536				54,112
Sub-total	1,504	2,210	3,852	368	37,489	733	503	6,518	45,106	0	1,876	5,209	4,097	4,504	3,304	117,273
IV																
Inshore					169,402	10,954	4,585	5,781			2,143	13,318	1,918	4,255	6,638	217,335
Offshore	7,511	58,534	75,884	1,342					4,208	5,117						154,255
Sub-total	7,511	58,534	75,884	1,342	169,402	10,954	4,585	5,781	4,208	5,117	2,143	13,318	1,918	4,255	6,638	371,590
SAVAI'I																
V																
Inshore					35,939	10,454	2,401	1,510			4,770	1,117	1,992	907	2,481	61,325
Offshore	2,709	2,337	15,066	3,416					29,786	379						53,939
Sub-total	2,709	2,337	15,066	3,416	35,939	10,454	2,401	1,510	29,786	379	4,770	1,117	1,992	907	2,481	115,264
VI																
Inshore					61,528	3,825	11,784	1,811			2,271		6,191	6,277	1,847	91,094
Offshore	2,011	3,796	22,843	1,054					77,413	1,500						113,057
Sub-total	2,011	3,796	22,843	1,054	61,528	3,825	11,784	1,811	77,413	1,500	2,271	0	6,191	6,277	1,847	204,151
TOTAL																
Inshore	0	0	0	0	422,552	27,132	30,003	23,442	0	0	50,687	24,877	18,512	31,123	44,786	666,233
Offshore	13,735	68,470	133,063	7,328	0			0	183,359	7,811	0	3,083	0	0	0	423,730
Total	13,735	68,470	133,063	7,328	422,552	27,132	30,003	23,442	183,359	7,811	50,687	27,960	18,512	31,123	44,786	1,089,963

Bottomfish landings estimated by the Fisheries Division for the 1975-1986 period are given in Table 3.2.9. as reported in various Fisheries Division Annual Reports. These landings are rough approximations only. Recent estimates indiate that these were over-estimates.

Table 3.2.9. Estimated annual bottomfish landings in Western Samoa from several sources.

Year	Weight (mt)	Reference
1975	819*	Fisheries Division 1975 Annual Report
1976	865*	Fisheries Division 1976 Annual Report
1977	819*	Fisheries Division 1977 Annual Report
	600	FAO, 1978
1978	774*	Fisheries Division 1978 Annual Report
1979	728*	Fisheries Division 1979 Annual Report
1980	727	Fisheries Division 1980 Annual Report

Year	Weight (mt)	Reference
1981	772	Fisheries Division 1981 Annual Reprt
1982	545	Fisheries Division 1982 Annual Report
1983	772	Fisheries Division 1983 Annual Report
1984	1000	Fisheries Division 1984 Annual Report
1985	822	Fisheries Division 1985 Annual Report
1986	440	Fisheries Division 1986 Annual Report

*converted from short ton by multiplying by 0.91.

During the SPC Deep Sea Fisheries Development Project in Western Samoa during November-December, 1982, a total of 11 fishing trips, involving a total of 101 hours of deep-bottom fishing, caught a total of 1,748 kg of bottomfish including 358.9 kg of sharks (Preston *et al.*, reported in Dalzell and Preston, 1992). Fishing expeditions were conducted in sites north of Upolu using the Fisheries Division *alia*. Species composition details are presented in Table 3.2.9 and the stocks were considered unexploited then. Catches (weights) were dominated by oilfishes and snake mackerels (36.4 per cent), deep-water snappers (32.6 per cent) and sharks (20.5 per cent).

Table 3.2.9: Bottomfish catch details during the SPC Deep Sea Fisheries Development Project between November 1982 and January 1983 in sites north of Upolu, Western Samoa. (Source: Dalzell and Preston, 1992).

Family	Species	Common name	Number	Weight (kg)	% weight	Av. weight
Lutjanidae - Etelinae	*Aprion virescens*	green jobfish	1	3.3	0.2	3.3
Deep-water snappers	*Aphareus rutilans*	small-tooth jobfish	14	27.6	1.6	2.0
	Etelis carbunculus	short-tail red snapper	23	101.7	5.8	4.4
	E. coruscans	long tail snapper	66	382.9	21.9	5.8
	Paracaesio kusakarii	saddled fusilier	6	13.6	0.8	2.3
	Pristipomoides amoenus	flower snapper	2	0.4	0.0	0.2
	P. flavippinis	yellow jobfish	25	27.7	1.6	1.1
	P. zonatus	banded flower snapper	19	12.0	0.7	0.6
		Sub-total	**156**	**569.2**	**32.6**	**3.6**
Lutjanidae - Lutjanidae	*Lutjanus argentimaculatus*	mangrove jack	1	5.2	0.3	5.2
Shallow-water snappers	*L. bohar*	red bass	2	4.4	0.3	2.2
	L. gibbus	paddle-tail	5	6.0	0.3	1.2
	L. rufolineatus	rufous seaperch	8	1.8	0.1	0.2
	Other/unidentified	unidentified	8	4.5	0.3	0.6
		Sub-total	**24**	**21.9**	**1.3**	**0.9**
Lethrinidae	*Wattsia mossambica*	large-eye bream	3	3.5	0.2	1.2
Emperors	Other/unidentified	unidentified	1	0.5	0.0	0.5
		Sub-total	**4**	**4.0**	**0.2**	**1.0**
Serranidae	*Cephalopholis aurantia*	orange rock-cod	2	0.7	0.0	0.4
Groupers	*Epinephelus areolatus*	areolated grouper	3	0.9	0.1	0.3
	E. cometae	snakeskin grouper	6	16.7	1.0	2.8
	E. morrhua	curve-banded grouper	2	10.5	0.6	5.3
	Other/unidentified	unidentified	6	3.5	0.2	0.6
		Sub-total	**19**	**32.3**	**1.8**	**1.7**
Carangidae/Scombridae	*Caranx lugubris*	black trevally	3	8.8	0.5	2.9
Trevallies, jacks, tunas	*Seriola rivoliana*	amberjack	3	23.3	1.3	7.8
	Gymnosarda unicolor	dogtooth tuna	5	34.2	2.0	6.8
	Other/unidentified	unidentified	6	7.4	0.4	1.2
		Sub-total	**17**	**73.7**	**4.2**	**4.3**
Gempylidae	*Promethichthys prometheus*	snake mackerel	30	543.6	31.1	18.1
Oilfishes, snake mackerels	*Ruvettus pretiosus*	oil fish	52	77.8	4.5	1.5
	Other/unidentified	unidentified	3	15.2	0.9	5.1
		Sub-total	**85**	**636.6**	**36.4**	**7.5**
Miscellaneous	Other bony fishes	other	13	51.4	2.9	4.0
		Sub-total	**13**	**51.4**	**2.9**	**4.0**
Carcharhinidae	*Carcharhinus albimarginatus*	white-tip shark	1	83.0	4.7	83.0
	C. amblyrhynchos	grey reef shark	1	91.0	5.2	91.0
	Triaenodon obesus	reef white-tip shark	1	6.4	0.4	6.4
	Other/unidentified	unidentified	20	178.5	10.2	8.9
			23	**358.9**	**20.5**	**15.6**
Grand Total		Bony fish	318	1,389.1	79.5	4.4
		Sharks	23	358.9	20.5	15.6
		All species	341	1,748.0	100.0	5.1

CATCH RATES	**Average per trip (kg)**	**Average per reel-hour (kg)**
All species	158.9	5.2
Excluding sharks	126.3	4.1

A total of 969 lbs of bottomfish (including 113 lbs of sharks) were caught during trials conducted by the Australian survey vessel, M.V. Cape Pillar, in 1985 at Pasco Bank (Fisheries Division Annual Report 1985). A total of 15.5 hours were spent fishing at a depth range of 80-150 m.

Assessment of the deep-water snapper stocks was initially carried out by the Fisheries Division using a chartered fishing vessel, *Leilani*, in 1987. A total of 5 trips were taken around Savai'i and one on the 17-Fathom Bank from November 21, 1987 to December 23, 1987. The total catch in number of pieces landed, weight and average weight by species is presented in Table 3.2.10. Data in columns marked with an asterisk (*) are those as reported in Dalzell and Preston (1992) for the six trips including that at the 17-Fathom Bank. Figures in other columns are for the 5 trips around Savai'i only. The catches were dominated by *E. carbunculus* (26.1 per cent) and *P. kusakarii* (23.2 per cent) followed by *E. coruscans* (11.7 per cent), Unidentified species (10.5 per cent) and *A. rutilans* (8.8. per cent).

Table 3.2.10: Catch summary of deep-water fish caught by the *Leilani* in five trips from 21 Nov - 23 Dec, 1987. (Sources: Crook, 1988; Dalzell and Preston, 1992).

Species	Pieces	Weight (kg)	Avg. wt (kg)	*Pieces	*Weight (kg)	*% weight	*Avg. wt (kg)
Etelis carbunculus	51	212.8	3.77	51	212.8	26.1	4.2
E. coruscans	24	180.13	3.94	24	95.5	11.7	4.0
E. radiosus				2	8.5	1.0	4.3
Pristipomoides flavipinnis	32	20.72	1.24				
P. multiden	23	30.07	1.27	30	36.0	4.4	1.2
P. zonatus	40	30.7	0.75	40	30.7	3.8	0.8
P. amoenus	5	1.37	0.27				
P. auricilla	5	2.32	0.54	5	2.3	0.3	0.5
P. filamentosis	2	1.85	0.93				
P. argyrogammics	6	1.89	0.32				
Other unidentified				50	85.2	10.5	1.7
Paracaesio kusakarii	47	188.82	3.68	49	188.8	23.2	3.9
P. stonei	12	47.32	3.00				
P. mossambica	9	14.75	1.31				
Serranidae	18	51.52	2.86				
Aphareus rutilans	24	72.02	2.90	24	72.0	8.8	3.0
Lethrinus elongatus	3	12.80	4.26	2	9.5	1.2	4.8
Wattsia mossambica				10	14.8	1.8	1.5
Lutjanus gibbus	10	15.80	1.53	10	15.8	1.9	1.6
L. kasmira				3	0.7	0.1	0.2
L. rufolineatus				1	6.1	0.7	6.1
Other lutjanidae	5	7.30					
Aprion virescens	1	2.00	2.00	1	2.0	0.2	2.0
Other fish	4	5.98	1.50				
Epinephelus septemfasciatus				6	26.0	3.2	4.3
Other grouper				7	7.0	0.9	1.0
Promethichthys prometheus				2	1.1	0.1	0.6
TOTAL	321	900.16	2.00	317	814.8	100.0	2.6

Note: *L. bohar* catches were excluded.

During the continuation of the deep-water snapper stock assessment project between November, 1988 and October, 1989, using the Fisheries Division research vessel, Tautai Matapalapala, about 7 mt of bottomfish were landed in 21 fishing trips around the islands of Upolu and Savai'i and at the offshore Pasco and 17-Fathom Banks. Catch details are presented in Table 3.2.11. The top ten species were, *E. carbunculus* (15.1 per cent), *E. coruscans* (12.5 per cent), *A. rutilans* (8.9 per cent), *P. kusakarii* (8.6 per cent), *L. bohar* (7.5 per cent), unidentified grouper (5.1 per cent), *C. lugubris* (5.0), *P. flavippinis* (4.1 per cent), *W. mossambica* (2.6 per cent) and *P. filamentosus* (2.5 per cent). Catch rates recorded were 282.8 kg per trip, equivalent to 3.5 kg per reel-hour.

Table 3.2.11: Deep-water bottomfish catches by Fisheries Division, 29 November, 1988 to 20 October, 1989. (Source: Anon, 1989, cited in Dalzell and Preston, 1992).

Species	Weight (kg)	% weight	Species	Weight (kg)	% weight
Aprion virescens	106.2	1.8	*Lutjanus argentimaculatus*	12.7	0.2
Aphareus rutilans	526.1	8.9	*L. bohar*	442.8	7.5
Etelis carbunculus	899.7	15.1	*L. gibbus*	13.6	0.2
E. coruscans	743.9	12.5	*L. kasmira*	2.0	0.0
E. radiosus	4.6	0.1	*L. monostigma*	0.6	0.0
Paracaesio kusakarii	509.4	8.6	Other/unidentified	52.4	0.9
Pristipomoides amoenus	3.5	0.1	*Wattsia mossambica*	154.7	2.6
P. auricilla	13.1	0.2	Othe/unidentified	97.0	1.6
P. filamentosus	147.4	2.5	Grouper /unidentified	305.0	5.1
P. flavipinnis	241.1	4.1	*Caranx lugubris*	299.0	5.0
P. multidens	24.4	0.4	Other/unidentified	500.0	8.4
P. zonatus	142.5	2.4	*Promethichthys prometheus*	57.8	1.0
Other unidentified	290.1	4.9	*Ruvettus pretiosus*	68.8	1.2
			Other	281.0	4.7
Total				**5,939.0**	**100.0**

During the FAO/UNDP assessment study in 1989, an estimated annual landing of 75.4 tonnes of deep-water snappers in Western Samoa was made by King *et al.* (1990). Four lutjanid species, *E. coruscans, A. rutilans, P. kusakarii* and *P. typus,* were estimated to account for approximately 98 per cent of deep-water (depth >100 m) snappers species landed from Falealupo and 84 per cent from other exploited areas. Relative composition, by weight, of these four species, extrapolated from data collected from local markets, are presented in Table 3.2.12(a), as reproduced from the above reference. In addition, approximately 44 mt of offshore demersal shallow-water species were estimated to be landed annually. Relative compositions, by weight, of species in this category are given in Table 3.2.12(b) as reproduced from King (undated).

Table 3.2.12(a): Annual catch of deep-sea bottom fish caught in Western Samoa estimated from catch data during 1989. (Source: King *et al.*, 1990).

Genus	Catch (in mt)
Etelis	38.3
Pristipomoides	16.1
Paracaesio	14.5
Aphareus	6.5
TOTAL	75.4

Table 3.2.12(b): Species composition of commercial offshore demersal shallow-water species in 1989. (Source: King, undated).

Species	%	Wt (mt)	Comments
Carangids	23	10.1	mainly Caranx ignobilis
Small fish	20	8.8	generally lethrinids, lutjanids
Shark	15	6.6	
Aprion virescens	14	6.2	
Lutjanus timorensis	8	3.5	
Groupers	8	3.5	
Large fish	6	2.6	mainly groupers
Lethrinids	3	1.3	
L. gibbus	2	0.9	
L. kasmira	1	0.4	
Total	100	44.0	

Commercial landings at the Apia Fish Market for the 1989-1994 period are presented in Table 3.2.13 as given in various references. Species composition of landings in 1989, 1990 and 1993 are appended as Appendix 3.2.1 with their corresponding values. The 1990-1993 figures are for the open side of the market, excluding data from the processor side.

Table 3.2.13: Estimated commercial bottomfish landings at the Apia Fish Market for the 1989-1994 period. The monthly figures were extracted from the Fisheries Division database. Figures as given in other references are given after the reference.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Adjusted
1989														
Wt (kg)	2,571	7,891	6,941	1,656	2,353	7,879	7,879	11,394	7,027	2,843	5,802	[illegible]	64,236	70,076
Value	11,782	41,283	14,412	2,588	5,877	11,364	11,363	28,970	13,467	9,215	19,001	-	169,322	184,713
Deep-water snappers. (King *et al.*, 1990).					Wt. (kg)								75,400	
Shallow-water bottomfish (King, undated)					Wt. (kg)								44,000	
					Total								119,400	
Annual Report, 1989.					Wt. (kg)								39,400	
1990														
Wt (kg)	135	810	0	0	358	385	590	149	1,013	1,018	30	0	4,488	. 5,600
Value	1,069	2,069	?	?	1,201	952	1,604	376	1,493	2,939	87	?	20,244	26,992
Annual Report 1990												Wt	30,000?	
*Wt (kg)	2,700	1,900	2,200	3,100	2,800	2,400	2,100	1,200	1,300	1,700	6,300	5,100	32,800	
Value	15,750	11,400	12,970	18,750	16,720	13,050	11,470	7,000	5,500	10,100	30,150	27,900	180,760	
1991**														
Wt (kg)	3,700	2,600	3,000	4,200	3,800	3,200	2,700	1,700	1,800	2,300	8,500	6,800	44,300	
Value	21,000	15,200	17,300	25,000	22,300	17,400	15,300	9,300	7,300	13,500	40,200	37,200	241,000	
1992														
Wt (kg)	6,800	4,300	14,300	17,300	9,000	15,000	14,000	7,700	11,000	7,500	8,000	6,000	121,000	***
Value	35,800	18,200	80,400	93,400	47,200	88,100	78,800	42,400	67,200	43,800	44,500	37,499	677,200	***
Wt (kg)													172,800	****
Value													967,100	****
1993														
Wt (kg)	1,193	910	512	1,174	329	1,446	359	1,572	1,264	2,200	2,536	436	13,900	13,900
Value	6,265	3,373	2,842	5,279	1,452	3,444	1,910	6,698	6,054	4,202	11,546	2,222	55,286	55,286
1994														
Wt (mt)														
Value														

*Source: Mulipola, 1991; **Source: Mulipola, 1991; ** *Source: Mulipola, 1994 and total include bottomfish landings at the Apia Fish market, other outlets and roadside; ****Source: Fisheries Annual Report for 1992/1993 and is the total bottomfish estimate.

Bottomfish purchased by wholesalers, retailers, hotels and restaurants (Other outlets) for the 1989-1994 period are as follows:

Year	Unit	Amount	Comments	Source
1989	Wt (mt)	117		Brotman, 1989.
	Value (WS$)	444,600		
1990	Wt (mt)	60.1	Bottomfish in 8 months. Bottomfish include all	Winterstein, 1990.
	Value (WS$)	?	lagoon, reef and deep-water bottomfish	
1991	Wt (mt)	??		
	Value (WS$)			
1992	Wt (mt)	121.0	Total bottomfish landings at Apia Fish Market, other	Mulipola, 1994.
	Value (WS$)	677,200	outlets and Roadside.	
1993	Wt (mt)	9.0		Fisheries Division Database.
	Value (WS$)	54,565		
1994	Wt (mt)			
	Value (WS$)			

Estimates of offshore fin-fish landings estimated for the January-June period, 1993 for Savai'i are recorded in the following table, as recorted in Mulipola and Filifili (1993). From the bottomfish price rate column, it looks like the recorded weights for bottom-fish starting from March are over estimated by a factor of ten. In addition, a bottomfish landing of 127 mt on Savai'i alone for 6 months is too high. The adjusted monthly bottomfish landings are given in the table following that taken from Mulipola and Filifili (1993).

	Number	Number	Fuel used	Pelagics			Bottomfish		
Month	operating boats	trips	(gals)	Wt (kg)	Price (WS$)	Rate $/kg)	Wt (kg)	Value (WS$)	Price ($/kg)
January	2	19	268	4,500	1,900	0.42	0	0	
February	6	72	787	9,200	4,700	0.51	500	1,400	2.80
March	10	127	1,493	17,000	9,000	0.53	8,500	4,500	0.53
April	10	182	2,108	32,200	16,800	0.52	16,100	8,400	0.52
May	10	195	19,017	21,000	12,700	0.60	41,800	25,500	0.61
June	9	212	13,373	22,700	16,200	0.71	60,400	32,300	0.53
Totals	47	807	37,046	106,600	61,300	0.58	127,300	72,100	0.57

Adjusted table for Savai'i offshore fish landing for the January-June period, 1993.

	Number	Number	Fuel used	Pelagics			Bottomfish		
Month	operating boats	trips	(gals)	Wt (kg)	Value (WS$)	Rate ($/kg)	Wt (mt)	Value (WS$)	Rate ($/kg)
January	2	19	268	4,500	1,900	0.42	0	0	
February	6	72	787	9,200	4,700	0.51	500	1,400	2.80
March	10	127	1,49 3	17,000	9,000	0.53	850	4,500	5.29
April	10	182	2,108	32,200	16,800	0.52	1,610	8,400	5.22
May	10	195	19,017	21,000	12,700	0.60	4,180	25,500	6.10
June	9	212	13,373	22,700	16,200	0.71	6,040	32,300	5.35
Totals	47	807	37,046	106,600	61,300	0.58	13,180	72,100	5.47

Export of bottomfish from Western Samoa started about 1987 with the establishment of the SAMPAC Company that operated the Government Fish Market. Export figures in 1990 and 1991 by that company are summarised in Table 3.2.14 (a) by month and Table 3.2.14 (b) by species. These exports were to Niue, Honolulu, Pagopago, Sydney, Rarotonga and New Zealand markets.

Table 3.2.14 (a): SAMPAC's monthly exports of bottomfish in 1990 and 1991. (Source: Mulipola, 1994).

	1990	1991
Month	**Total weight (kg)**	**Total weight (kg)**
January	101.50	2,569.56
February	244.00	2,040.94
March	13.00	143.40
April	186.00	99.04
May	275.00	133.78
June	1,803.00	80.90
July	1,188.50	-
August	76.00	-
September	2,495.85	497.20
October	3,391.34	2,019.90
Novermber	967.82	-
December	630.50	-
Total	**11,372.51**	**7,584.72**

Table 3.2.14 (b): SAMPAC's exports of bottomfish by major species in 1990 and 1991. (Source: Mulipola, 1994).

	1990	1991
Family \ Species	**Total weight (kg)**	**Total weight (kg)**
Aprion virescens	575.54	-
Etelis spp.	-	4,254.00
Lutjanus spp.	6,965.79	-
Lethrinid spp.	1,153.36	128.74
Epinephelus spp.	293.50	-
Carangidae spp.	439.04	138.38
Paracaesio spp.	1,554.97	129.74
Pristipomoides spp.	-	2,933.86
Oilfish	390.31	-
Total	**11,372.51**	**7,584.72**

Export records by the Savai'i Fishermen Association are presented in Table 3.2.15. Deep-water bottomfish were exported by the association mostly to the Hawaiian market once a week from 1993 up to October of 1994. Totals by species were not available but according to the President of the association, more than 50 per cent of exported bottom fish were *Etelis* species, the other half consisted mainly of *Aprion virescens, Aphareus rutilans* and *Pristipomoides* species (*per comm*, Maulalo, 1995).

Appendix 3.2.1: Species Composition of Bottomfish Landings at the Apia Fish Market, 1989, 1990 and 1993.

		1989		1990		1993	
Species		Total	Per cent	Total	Per cent	Total	Per cent
Aphareus rutilans	Wt (kg)	2,128.7	3.0	328.4	7.9	1,722.8	12.4
	Value	5,889.3	3.2	902.8	4.5	8,039.4	14.5
Aprion virescens	Wt (kg)	5,722.8	8.2	292.6	7.0	587.1	4.2
	Value	18,650.6	10.1	1,658.8	8.2	2,964.3	5.4
Baracuda	Wt	684.7	1.0			470.4	3.4
	Value	1,750.3	0.9			1,265.7	2.3
Cephalophalis	Wt	1,792.1	2.6	109.5	2.6		
	Value	4,095.7	2.2	745.1	3.7		
D.tooth	Wt					981.0	7.0
	Value					4,664.8	8.4
Etelis spp	Wt	973.6	1.4				
	Value	2,536.2	1.4				
Groupers	Wt	1,633.0	2.3	113.3	2.7	473.0	3.4
	Value	6,181.6	3.3	982.5	4.9	2,380.0	4.3
L.button	Wt					87.0	0.6
	Value					297.7	0.5
L.elongatus	Wt					2,853.7	20.5
	Value					6,703.0	12.1
L.kalloptorus	Wt					133.0	1.0
	Value					638.8	1.2
L.monostigma	Wt					143.0	1.0
	Value					441.4	0.8
L.variegated	Wt					337.8	2.4
	Value					1,538.5	2.8
Lethrinus	Wt	17,038.6	24.3	1,900.9	45.6	181.0	1.3
	Value	42,688.9	23.1	6,453.5	31.9	673.9	1.2
Lm	Wt	1,134.0	1.6				
	Value	2,459.8	1.3				
Lutjanus gibbus	Wt	17,884.6	25.5	517.2	12.4	1,313.8	9.4
	Value	52,392.8	28.4	3,893.4	19.2	6,848.0	12.4
Lutjanus kasimira	Wt	4,192.8	6.0			598.7	4.3
	Value	11,405.2	6.2			4,137.2	7.5
M.grandoculis	Wt					30.0	0.2
	Value					116.4	0.2
M.niger	Wt					206.5	1.5
	Value					705.6	1.3
Other bottomfish	Wt	2,133.9	3.0	72.4	1.7	365.9	2.6
	Value	7,902.2	4.3	310.6	1.5	1,836.2	3.3
Other lutjan.	Wt	241.1	0.3				
	Value	397.1	0.2				
Other prist.	Wt	10,659.2	15.2	536.0	12.9		
	Value	19,869.2	10.8	3,748.1	18.5		
P. zonatus	Wt					6.4	0.0
	Value					18.0	0.0
P.multidens	Wt					2,670.2	19.2
	Value					7,959.3	14.4
Paraca. kusakarii	Wt	90.6	0.1			45.0	0.3
	Value	530.2	0.3			198.0	0.4
Paracae. stonei	Wt	33.1	0.0				
	Value	132.5	0.1				
Prist. typus	Wt	310.7	0.4			0.0	0.0
	Value	2,035.7	1.1			0.0	0.0
Pristi. flavipinnis	Wt	112.4	0.2			0.0	0.0
	Value	426.3	0.2			0.0	0.0
Squirrelfish	Wt	111.3	0.2			3.9	0.0
	Value	178.9	0.1			9.0	0.0
Trevally	Wt	3,198.5	4.6	299.2	7.2	375.4	2.7
	Value	5,190.4	2.8	1,549.4	7.7	2,321.7	4.2
Variola louti	Wt					343.3	2.5
	Value					1,529.4	2.8
Monthly totals	Wt	70,075.7	100.0	4,169.5	100.0	13,928.9	100.0
	Value	184,712.9	100.0	20,244.1	100.0	55,286.1	100.0

Table 3.2.15: Monthly export records of bottom fish exported to Honolulu, Hawaii market in 1993 and 1994, by the Savai'i Fishermen Association.

	1993	1994
Month	**Total weight (kg)**	**Total weight (kg)**
January	591	
February	-	
March	-	500
April	-	300
May	-	1,824
June	-	250
July	374	1,400
August	914	946
September	1,332	996
October	860	402
November	974	
December	2,465	
Total	7,510	6,618

3.2.3 Stocks Status

Several estimates have been made of potential and sustainable yield of the bottomfish resource in Western Samoa. Estimates made by Gulbrandsen (1971) and Philip (1983) obout about 1,000 mt a year are considered to be very optimistic. Recent estimates, based on more accurate data, have indicated that these were over-estimates. Based on catch data of the *Leilani* during the preliminary assessment of the deep-water stock, Crook (1988) estimated the fishery sustainable yield in Western Samoa to be 37.4 mt. Su'a (undated) estimated the maximum sustainable yield for bottomfishes, from data during the first few months of the assessment project in 1989, to be between 17 and 50 mt per year. Based on catch data by the Fisheries Division research vessel, Tautai matapalapala, and commercial landings at local processor side of the Apia Fish Market, King, *et al.* (1990) suggested the maximum sustainable yield to be 88 metric tonnes per year, including 8.3 tonnes for the two offshore banks. Overall, this is equivalent to 0.46 tonnes/nmi^2 (0.13 tonnes/km^2) or 0.29 tonnes/nmi of the 200 m depth contour.

King *et al.* (1990) calculated the CPUE (kg/line/hr) of individual vessels whose catch data from Falealupo area were used in the assessment as ranging from 0.6 to 8.3 kg per line hour. Up to 9 vessels fished at Falealupo for a total of 13 weeks catching over 10 mt of deep-water snappers and 3.6 mt of shallow-water bottomfish species. The vessels left the area when catches of the target species, deep-water snappers, dropped by almost 50 per cent. The total fishing effort and numbers of the major species caught during the 12 weeks of intensive commercial fishing off Falealupo are presented in Table 3.2.16, as reproduced from King *et al.* (1990). Relative CPUEs have been included to see trends for each species. It indicates a decline in CPUEs for *E. coruscans* and *P. kusakarii* but an increase in CPUEs for both *A. rutilans* and *P. typus*. These trends were also detected in plots of CPUE against adjusted cumulative catch. This could mean that *A. rutilans* and *P. typus* compete poorly with *E. coruscans* and *P. kusakarii* (King *et al.*, 1990).

Table 3.2.16: Fishing effort (line hours) and catch (numbers) of some deep-water snappers. (Source: King *et al.*, 1990).

Week	Effort (line/hr)	*Etelis coruscans* (nos.)	*Etelis coruscans* CPUE (nos./line/hr)	*Paracaesio kusakarii* (nos.)	*Paracaesio kusakarii* CPUE (nos./line/hr)	*Aphareus rutilans* (nos.)	*Aphareus rutilans* CPUE (nos./line/hr)	*Pristipomoide typus* (nos.)	*Pristipomoide typus* CPUE (nos./line/hr)
22 May	-	104		68		65		136	
29 May	-	4		55		29		61	
5 June	-	6		8		10		21	
12 June	170.6	60	0.35	23	0.13	9	0.05	20	0.12
19 June	453.8	274	0.60	27	0.06	16	0.04	33	0.07
26 June	513.4	240	0.47	46	0.09	27	0.05	57	0.11
3 July	714.4	244	0.34	8	0.01	8	0.01	16	0.02
10 July	679.1	301	0.44	16	0.02	13	0.02	35	0.05
17 July	419.9	151	0.36	20	0.05	8	0.02	16	0.04
24 July	470.3	127	0.27	2	0.00	65	0.14	29	0.06
31 July	318.4	90	0.28	8	0.03	21	0.07	51	0.16
4 Sept	136.8	31	0.23	6	0.04	14	0.10	23	0.17
2 Oct	177.6	7	0.04	3	0.02	42	0.24	33	0.19

King *et al.* (1990) obtained estimates of vulnerable standing stocks of the four main deep-water snappers at Falealupo by plotting the total CPUE against the adjusted cumulative catch of the four species. These estimates were as follows:

Species	Stock (numbers)	90 % Confidence limit	Catchability (q)	Coefficient of determination (r^2).
E. coruscans	2,372	± 483	0.00032	0.70
A. rutilans				
P. kusakarii	291	± 36	0.00106	0.68
P. typus				
All 4 species	4,493	± 1,431	0.00026	0.71

The assessment study concluded that the CPUE's at previously unexploited areas, Falealupo and the offshore banks, are significantly higher than the exploited areas. King *et al.* (1990) also estimated standing stock of vulnerable bottom fish in each area fished based on the CPUE (the catch rate in numbers per line hour) of the Tautai matapalapala in each area. Table 3.2.17 presents the total unexploited recruited biomass and standing stock for each exploited area based on the unexploited recruited biomass value of 4.44 tonnes/nmi^2 obtained from Falealupo (the only previously unexploited mainland area) as reproduced from King *et al.* (1990). Deep-water bottomfish is highest around Upolu Island corresponding to highest standing stocks and unexploited biomass. This is due mainly to more habitat availability. However, in terms of CPUEs and standing stocks per nmi^2, those at the offshore banks and around Savai'i yield higher values.

Table 3.2.17: Estimated areas of habitat (sq. nmi between 125 m and 275 m depth), research vessel CPUE (kg per line hour), vulnerable standing stocking size (numbers, biomass in tonnes, and tonnes/sq.nmi), and estimated unexploited biomass (tonnes) of deep-water snappers in Western Samoa, by area. (Source: King *et al.*, 1990).

Area name	Area (nmi^2)	CPUE (no/hr)	STANDING STOCK (no)	STANDING STOCK (t)	STANDING STOCK (t/sq. nmi)	Unexploited Biomass (t)
UPOLU						
Northern side	54.9	0.77	42,273	96.0	1.75	243.8
Southern side	35.3	0.80	28,240	64.1	1.82	156.7
Manono	44.7	0.73	32,631	74.1	1.66	198.5
SAVAII						
Northen side	17.3	1.07	18,511	42.0	2.43	76.8
Southern side	18.9	0.98	18,522	42.0	2.22	83.9
Falealupo	3.4	1.58	5,372	15.1	4.44	15.1
OFFSHORE	**BANKS**					
17 fathom	2.5	1.95	4,875	13.7	5.48	13.7
Pasco	14.4	4.65	23,760	66.6	4.64	66.8
TOTAL (mean)	191.4	(1.19)	174,184	394.4	(2.71)	855.3

For each of the eight areas, the biomass was divided into five fish group components, *Etelis coruscans*, *Paracaesio kusakarii*, *Aphareus rutilans*, and *Pristipomoides typus*, and 'Others'. The combined unexploited recruited biomass for each component were estimated as follows:

Species	Unexploited recruited biomass (mt)
Etelis coruscans	393.7
Aphareus rutilans	134.1
Paracaesio kusakarii	63.0
Pristipomoides typus	44.5
Others	220.0
TOTAL	855.3

Overall, it was estimated that the sustainable yield of the deep-water snapper stocks in all Western Samoa (excluding the two offshore banks) can be harvested by only 14 ***alia*** catamarans (King *et al*., 1990). The estimate was based on the fishing strategies at the time, which was as follows: an alia catamaran fishes with a mean of 2.7 lines for 9.8 hours per day; an estimated 70% of this time spent in depths greater than 100 m, where the mean catch rate is 2.2 kg per line hour; 150 fishing days per year, excluding travel time, per boat, thus an annula catch of 6 mt/vessel.

3.2.4 Management

Current legislation/policy regarding exploitation: There is no legislation that specifically deals with the management of the bottomfish resource in Western Samoa. Part III of the Fisheries Act 1988 requires foreign fishing vessels to have a fishing license in order to fish in Western Samoa's EEZ. Part II (5) of the Act requires local commecial fishing vessels to have a valid certificate of registration issued by the Director. The Act defines "local fishing vessel" as a fishing vessel wholly owned and controlled by:

(a) the Government of Western Samoa;
(b) a company, society or other associations of persons incorporated or established under the laws of Western Samoa, at least 51% of which is beneficially owned by citizens or the Government of Western Samoa;
(c) Citizens of Western Samoa; or
(d) A joint veture, consortium or partnership arrangement or agreement between 2 or more parties, where at last 51% of the beneficial ownership and control of the joint venture, consortium or partnership is vested in or held by citizens or the Government of Western Samoa.

Recommended legislation/policy regarding exploitation: Continued monitoring of the fishery is necessary to confirm biological parameters of the resource, as well as MSYs. Using these biological parameters, the number of fishing vessels which can fish the resource on a sustainable basis can then be re-aadjusted if necessary. King *et al*. (1990) recommended the following:

* immediate steps to restrict the entry of more fishing vessels from the existing fleet into the deep-water snapper fishery;
* apply a licensing system as such a sytem will not be difficult to enforce due to the limited number of landing sites;
* introduce licences for particular fishing zones. However, patrolling costs will not warrant this option.

In addition, King (undated) recommended that "the system of subsidizing the supply of ***alia*** catamarans to fishermen should be discontinued or at least reduced.

Additional comments for consideration include:

- Licensing system and limited number of commercial vessels: This seems to be the most practical and applicable form of controlling fishing effort and catch. As deep-water snappers are landed at only small number of locations, mainly at Apolima, Salelologa, Asau and Apia fish market, and small shops, therefore a licensing system would not be very difficult to enforce. In the established licensing system, ą provision should be included which makes it illegal for processors to purchase deep-water snappers from unlicensed vessels.

- Quotas: some countries have suggested applying this option in the management of their bottomfish resource. King (1992) did not recommend this option for application to the Tonga snapper fishery because of the considerable difficulties in policing the quota.

- Limited boat size and gear: in association with limiting the number of commercial fishing vessels for the fishery, it would be necessary to define vessel sizes to which the limitation applies. In addition, limiting the amount of fishing gear and number of fishermen on a vessel could be possible. Special consideration should be given to those vessels constructed under local development programmes specifically for this fishery.

Recording and submission of data to the Fisheries Division should be made a necessesity by fish operators, especially those involved in the export of bottomfish. The Fisheries Division will need to develop a mechanism to ensure compliance by the operators and improve the data collecting system to obtain these data. Submission of data should be taken into consideration when the concerned government agency considers permits to export fish for commercial purposes.

In terms of continuing research, King (undated) recommended low priority be given to the offshore shallow-water (<100 m) bottomfish fishery. However he recommended that "catch and effort in the fishery should be monitored, and catch composition and length-frequency data can be gathered from fish processors for major species such as *Aprion virescens* (green jobfish - *utu*). For species such as this, which presumably have higher growth rates than deeper-water species, a time series of length-frequency ata may allow growth rates to be estimated".

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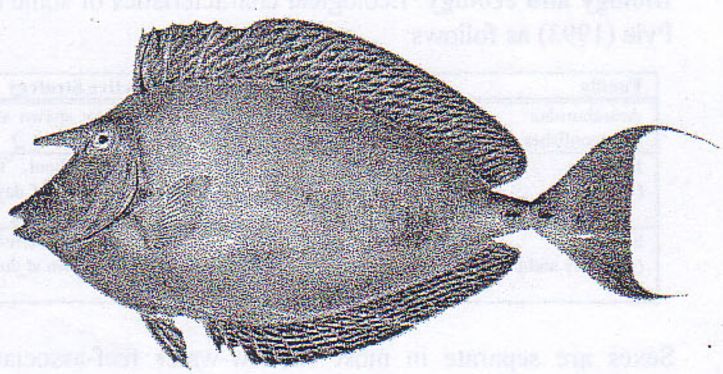
3.3 Shallow-water reef fish species - *i'a e maua i le aau ma le aloalo.*

3.3.1 The Resource



ume - Naso unicornis

Species present: Numerous shallow-water reef fish species are utilised both in the subsistence and artisanal fisheries in Western Samoa. The more important families or genera in the artisanal fishery, as listed in Mulipola (1994) include:

Acanthuridae (surgeonfishes *pone, alogo* etc; unicornfishes - *ume, iliilia, pa'umalo*), Scaridae (parrotfishes - *fuga*), Serranidae (groupers - *gatala* etc.), Siganidae (rabbitfishes - *lo, pa'u ulu*), Lutjanidae (snappers *tamala, taiva* etc), Mullidae (goatfishes - *i'a sina, ulaoa, vete, ta'uleia* etc.), Holocentridae (soldierfishes and squirrelfishes - *malau, tamalau*), Lethrinidae (emperors - *mataeleele, filoa* etc), Muraenidae (moray eels - *pusi*), Carangidae (trevallies and jacks - *lupo, malauli*), Gerreidae (silver biddies/mojarras - *matu*), Mugilidae (mullets - *aua, anae*), Leiognathidae (pony fishes, slipmouths - *mumu, lufi*). Mullets are discussed under the Mullet profile.

Distribution: Shallow-water coral reefs, lagoons and mangrove areas are the main habitats for the fish species discussed in this section. As such, fishing activities for these fishes are normally confined within or near these habitats. Shallow-water reef fishes are found in coral reefs through-out the islands. Zann (1991) provides an atlas/database of the more important fish species in various zones on Upolu as summarised in Table 3.3.1.

Table 3.3.1: Major reef and lagoon fish species in coastal areas of Upolu Island. (Source: Zann, 1991).

Zone	Major reef fin-fish species	Zone	Major reef fin-fish species
Apia East (Vaipuna-Letogo	surgeonfish, mullet, scad (in season)	Safata (Vaie'e-Siumu)	mullet, surgeonfish, trevally, parrotfish, goatfish, majorras, herrings, coral cod, scad
Apia west (Vaiala-Vaigaga)	mullet, scad	O le Pupu (Aganoa-Togitoniga)	surgeonfish, rockcod, parrotfish, mullet, coralfish, trevally, unicornfish
Faleula (Saina-Tuana'i)	surgeonfish, mullet, parrotfish, sweetlips, snappers, trevally	Falealili (Iliili-Satalo)	surgeonfish, rockcod, mullet, sweetlips, soldierfish, parrotfish, scad.
Ututali'i (Leauva'a-Fasito'outa)	surgeonfish, parrotfish, sweetlips, soldierfish, trevally, mullet	Salani (Sapunaoa-Lotofafa)	surgeonfish, trevally
Fasito'otai (Vaialua-Faleolo)	surgeonfish, parrotfish, soldierfish, sweetlips, trevally, mullet	Lepa (Vavau-Saleapaga)	surgeonfish, soldierfish, rockcod, sweetlips, snappers, mullet, trevally, unicornfish
Apolimafou-Faleolo	mullet, surgeonfish, soldierfish, sweetlips, rock cod	South Aleipata (Lata-Satitoa)	snapper, parrotfish, surgeonfish, soldierfish, trevally,
Manonouta and Apolimafou	mullet, surgeonfish, rockcod, soldierfish, trevally, unicornfish, parrotfish, trevally, scad	North Aleipata (Malaela-Amaile)	surgeonfish, unicornfish, parrotfish, trevally, sweetlips, mullet, soldierfish, ponyfish, moray eels, coralfish
Manono and Apolima Islands	surgeonfish, unicornfish, mullet, soldierfish, parrotfish, coral cod, scad	Uafato (East point-Tiavea)	scad etc
Falelatai (Si'ufaga-Fagaiofu Bay)	mullet, surgeonfish, soldierfish, rockcod, trevally , parrotfish, emperors, angelfish, unicornfish	Fagaloa Bay (Samamea-Sauano)	surgeonfish, parrotfish, angelfish, rockcod, mullet, sweetlips, scad
Lefaga (Mata'afa-Matautu)	surgeonfish, parrotfish, rockcod, soldierfish, mullet, unicornfish	Saluafata (Falefa-Solosolo)	surgeonfish, scad, parrotfish, barracuda, wrasses, milkfish, rockcod,
Sa'anapu (Salamumu-Lotofaga)	mullet, surgeonfish, rockcod, sweetlips, soldierfish, scad	Luatuanu'u (Utumau'u-Lauli'i)	scad, mullet, surgeonfish, parrotfish

Biology and ecology: Ecological characteristics of some of the fish families in this category is given in Pyle (1993) as follows:

Family	Feeding Strategy	Reproductive Strategy	Habitat
Acanthuridae (surgeonfishes and tangs)	herbivorous	school-forming; spawn at dusk in large groups; pelagic eggs	all habitats depending on species
Labridae (wrasses)	omnivorous	harem-forming/school forming; protogynous; spawn at all times of day depending on species; pelagic eggs	all habitats depending on species
Serranidae (groupers and basslets)	carnivorous/ herbivorous/ planktivorous	harem-forming/pair-forming/aggregate-forming; protogynous; spawn at dusk; pelagic eggs	all habitats depending on species; Anthiinae form aggregations above the substrate

Sexes are separate in most shallow-water reef-associated fishes including holocentrids, mugilids, mullids, gerrids, siganids, carangids (Wright, 1993). Protogynous (change from female to male) fishes include serranids, lethrinids, nemipterids and labrids while platycephalids, sparids, gobiids and muraenids change sex from male to female (protandrous). Most species produce pelagic eggs except for the majority of siganids, tetradontids and balistids which nest. Spawning migration, to a reef location contiguous to oceanic water, vertically in the water column or inshore, is common (Wright, 1993).

With the exception of the deep-water snappers, there has been no study conducted in Western Samoa on the biology and ecology of any of the shallow-water reef fish species.

3.3.2 The Fishery

Utilization: The shallow-water reefs and lagoons surrounding the islands have always been an integral part of the Samoan way of life. The resources from these areas have been a vital source of protein at the subsistence level, providing the main source of protein, and with the change from a barter to a cash economy, these have become important in the artisanal/commercial fisheries.

Buck (1930) describes various traditional methods of fishing in Samoa, which range from simple groping (*noanoa*) in crevices between rocks to sophisticated snares, traps and hooks. The fishing methods described by Buck are listed as follows:

Rock heaps;

Octopus stick;

Snares: sea centipede snare (mantis shrimp snare - ***sele valo***); trevally/jack snare (***sele malauli*** - wrongly named by Buck as skipjack snare); crayfish snare (***sele ula***); sea eel snare (***sele pusi***); shark noosing ((***sele***) ***noa malie***);

Floats: flying fish float (***uto malolo***);

Sweeps: long leaf sweep (***lauloa***); short leaf sweep with scoop net (***lau i'a sina*** - for goatfish);

Leaf weirs and dams: leaf weirs (tupa); dams (***puni***);

Lures: octopus (squid) lure (***pule (ma'a) ta'i fe'e***);

Fish spears: one-point spear (***tao mata tasi***); three-pointed spear (***tao mata tolu***); many-pointed spear (***tao fuifui***); bow and arrow (***u***);

Scoops: palolo scoop (***'enu, ta palolo***); whitebait scoop (***fonoti***);

Fish narcotizing: kernel of the fruit of *Barringtonia* sp (***futu***); stem, roots and leaves of plant *Tephrosia piscatoria* (***'avasa***); roots of the plant, *Derris* sp. (***ava niugini***);

Walled fish weirs (***pa i'a***);

Fish traps: manipulated trap (***faga fa'atau tu'u'u*** - for Chromis); self acting traps; lobster (crayfish) pot trap (***faga ula***); fish pot (***faga i'a***); crab pot (***faga pa'a***); separate funnel trap (***'enu***); double entrance trap (***faga uli?***); bamboo trap (***faga 'ofe***); sea eel trap (***faga pusi***);

Nets: small dip net (***upega lama*** or ***lalama***), medium dip net (***'upega sae'e***), long-handled dip net (for catching flying fish?), double-handled dip net (***upega saosao'o***), arched hand net (***se'i***), arched net with line (***upega sumu*** - for catching triggerfish), mullet hand net (***alagamea*** - for catching mullet jumping over net), cast net (***upega tili***), short seine net (***upega fa'alava***), winged net (***upega matalili'i, upega tu'i tuu'u***), long net (***upega tolomatu***), shark net (***upega malie*** - for catching sharks), breadfruit bast net (***upega 'ulu***), turtle net (***upega 'afa*** - for catching turtles);

Hooks (matau) and lures: Buck (1930) described different hooks and lures used in general fishing and those made for specific fishes.

In village communities, the subsistence inshore fishery provides the major source of protein for the people. It is also the primary source of income for individuals in certain villages. However, fishing is mostly secondary to agriculture. Even with the advent of the offshore fisheries for bottomfish, tunas and other oceanic pelagic species using modern gear and motorised boats, the shallow-water reef organism landings still dominate fisheries landings. The nation-wide survey of fishery catch assessment in 1978 by the Department of Statistics indicated that overall, inshore catches (fin-fish and invertebrates) constitute 61 per cent (666,233 kg) of the total fishery catches in the country. These are summarised in Table 3.3.2. by stratum used in the survey.

Table 3.3.2: Total fishery landings by stratum during 1978. (Source: Department of Statistics, undated).

Stratum	Fishery	Total (kg)	Per cent
1. Upolu northeast - Fagalii to Uafato	Inshore	78,114	90.6
	Offshore	8,083	9.4
2.Upolu southeast - Tiavea to Saaga	Inshore	155,204	79.4
	Offshore	40,284	20.6
3. Upolu southwest - Siumu to Matafa'a	Inshore	63,161	53.9
	Offshore	54,112	46.1
4. Upolu Northwest - Falevai to Vailoa, including Manonon and Apolima	Inshore	217,335	58.5
	Offshore	154,255	41.5
5. Savai'i North - Samalaeulu to Falelima	Inshore	61,325	53.2
	Offshore	53,939	46.8
6. Savai'i south - Fagafau to Pu'apu'a	Inshore	91,094	44.6
	Offshore	113,057	55.4
TOTAL	**Inshore**	**666,233**	**61.1**
	Offshore	**423,730**	**38.9**

King (undated) estimated the relative importance of fishing methods employed in artisanal fishing in various coastal ecosystems, given as percentage of respondents listing the method as most important, as follows:

Fishing method	Fringing Reef	Lagoon with Barrier Reef	Mangroves with Lagoon and Reef
hand collecting	6.1	16.3	8.3
diving/spearing	42.9	37.2	41.6
hook and line	14.3	9.3	<0.1
trolling	12.2	9.3	<0.1
gill netting	16.3	16.2	16.7
cast netting	8.2	9.3	8.3
trapping	<0.1	<0.1	25.0
% households using a canoe	39	90	88

Zann (1991) documented fishing methods and places where fishing takes place in all coastal zones on Upolu Island as summarised in Table 3.3.3. Spear-diving dominates fishing methods, accounting for 50 per cent. It is followed by netting (29.7 per cent) then collection (4.8 per cent). Fish fence and poisoning was recorded in only zone. Of the places where fishing takes place, lagoons account for 50 per cent followed by reef (30 per cent), then shore (11.4 per cent).

Table 3.3.3: Fishing methods used in the shallow-water fisheries in Western Samoa. (Source: Zann, 1991).

Zone	% Fishing method						% Fishing place			
	Netting	Spear-diving	Hook & line	Collect	Fish fence	Poison	Shore	Lagoon	Reef	Open sea
Apia East (Vaipuna-Letogo										
Apia west (Vaiala-Vaigaga)	55	38	6	2			7	68	25	
Faleula (Saina-Tuana'i)	41	32	19				8	56	35	15
Ututali'i (Leauva'a-Fasito'outa)		62	4	34	17	4	14	68	17	
Fasito'otai (Vaialua-Faleolo)	12	76		12			20	80		
Apolimafou-Faleolo	54	37	9				37	50	13	
Manonouta and Apolimafou	90	5		5			14	68	17	
Manono and Apolima Islands	18	57	25				13	60	17	
Falelatai (Si'ufaga-Fagaiofu Bay)	30	53	17				14	68	17	
Lefaga (Mata'afa-Matautu)	14	71		3			15	68	18	
Sa'anapu (Salamumu-Lotofaga)	40	60					0	80	20	
Safata (Vaie'e-Siumu)	38	30	27	5			10	80	10	
O le Pupu (Aganoa-Togitoniga)	7	72	14				0	50	50	
Falealili (Iliili-Satalo)	23	68	8				10	10	80	
Salani (Sapunaoa-Lotofafa)		50	50					100		
Lepa (Vavau-Saleapaga)		66	33				0		100	
South Aleipata (Lata-Satitoa)	20	50	30				20	20	30	20
North Aleipata (Malaela-Amaile)	45	45	7	4			2	34	57	7
Uafato (East point-Tiavea)										
Fagaloa Bay (Samamea-Sauano)	21	56	17	25			8	27	13	53
Saluafata (Falefa-Solosolo)							19	35	32	17
Luatuanu'u (Utumau'u-Lauli'i)	57	25	15	2			17		38	45
MEAN	**29.7**	**50.2**	**15.6**	**4.8**	**0.9**	**0.2**	**11.4**	**51.1**	**29.5**	**7.9**

Notes: Apia east and Apia west are combined. Hook and line fishing and open sea fishing in Luatuanu'u are mainly *atule* fishing at Lauli'i. 34% for north Aleipata is inner lagoon while 57% for reef includes outer lagoon and barrier reef. Lepa has no lagoon and 100% reef is fringing reef. 80% lagoon in Safata comprises of 43% inner lagoon and 37% outer lagoon.

Group canoe fishing was recorded in Manono and Apolima Islands as common. Spearfishing takes place at day and night. Artisanal fishing is mostly done from wooden canoe or skiffs.

Special fisheries targeting juveniles of certain reef fish, although uncommon, still exist. These incluse catching juvenile rabbitfish (*lo*); juveniles of surgeonfish (*palaia*), and whitebait (*igaga*). Specially scoops are made for the harvesting of these fisheries. Buck (1930) describes the whitebait scoop in details. This particular fishery is discussed under frsesh-water fish profile.

Production and marketing: Shallow-water reef-fish production for Western Samoa in the subsistence level is not known. However, several surveys have been attempted which give some general information on this portion of the fishery. The Department of Statistics conducted an assessment survey on fishery catch in Western Samoa in 1978. The results are summarised, by stratum, in Table 3.3.4, comparing shallow-water reef and lagoon, deep-water bottomfish fish, offshore tuna and oceanic species and inshore invertebrate landings. Offshore pelagics include skipjack and other tunas as well as other oceanic pelagic species. The data recorded under mullet and carangidae which were reported as offshore catches, have been moved to inshore catches. Even though the offshore fisheries development had already started at the time using modern gear and motorised boats, the inshore landings (including invertebrates) accounted for 61 per cent of the overall national fish landings for that year.

Table 3.3.4: Estimated fishery catch in Western Samoa during 1978, by stratum. Figures, except percentages, are in kg. (Source: Department of Statistics, undated).

	Shallow-water Reef and Lagoon Fin-fish						Inverte-brates	Deep-water	Offshore Pelagics	All	Pecentages of All	
Stratum	Reef fish	Carangidae	Mugilidae	Eel	Others	Total	Total	Total	Total	Total	Shallow-water Fin-fish	Shallow-water Fin- fish + Invertebrates
I												
Inshore	38,010	237	644	5,183	3,224	47,298	30,816			78,114	60.5	
Offshore								6,359	1,724	8,083		
Sub-total	38,010	237	644	5,183	3,224	47,298	30,816	6,359	1,724	86,197	54.9	90.6
II												
Inshore	80,184	929	10,086	2,639	36,403	130,241	27,510			157,751	82.6	
Offshore								11,800	25,937	37,737		
Sub-total	80,184	929	10,086	2,639	36,403	130,241	27,510	11,800	25,937	195,488	66.6	80.7
III												
Inshore	37,489	733	503	6,518	1,876	47,119	17,114			64,233	26.6	
Offshore								7,934	45,106	53,040		
Sub-total	37,489	733	503	6,518	1,876	47,119	17,114	7,934	45,106	117,273	14.6	54.8
IV												
Inshore	169,402	10,954	4,585	5,781	2,143	192,865	26,129			218,994	88.1	
Offshore								143,271	9,325	152,596		
Sub-total	169,402	10,954	4,585	5,781	2,143	192,865	26,129	143,271	9,325	371,590	51.9	58.9
V												
Inshore	35,939	10,454	2,401	1,510	4,770	55,074	6,497			61,571	89.4	
Offshore								23,528	30,165	53,693		
Sub-total	35,939	10,454	2,401	1,510	4,770	55,074	6,497	23,528	30,165	115,264	47.8	53.4
VI												
Inshore	61,528	3,825	11,784	1,811	2,271	81,219	14,315			95,534	85.0	
Offshore								29,704	78,913	108,617		
Sub-total	61,528	3,825	11,784	1,811	2,271	81,219	14,315	29,704	78,913	204,151	39.8	46.8
TOTAL												
Inshore	422,552	27,132	30,003	23,442	50,687	553,816	122,381			676,197	81.9	
Offshore								222,596	191,170	413,766		
Total	422,552	27,132	30,003	23,442	50,687	553,816	122,381	222,596	191,170	1,089,963	50.8	62.0

I. =Upolu northeast - Fagalii to Uafato; II. =Upolu southeast - Tiavea to Saaga; III. =Upolu southwest - Siumu to Matafa'a; IV. =Upolu Northwest - Faleyaj to Vailoa, including Manonon and Apolima; V. =Savai'i North - Samalaeulu to Falelima; VI. =Savai'i south - Fagafau to Pu'apu'a.

Total landings by quarter is given in the following table. The inshore data includes inverterates.

FISHERY	Quarter1	Quarter 2	Quarter 3	Quarter 4	Total	Per cent
Inshore	80,190	108,183	175,160	302,700	666,233	61.1
Offshore	84,091	172,288	56,100	111,251	423,730	38.9
Total	164,281	280,471	231,260	413,951	1,089,963	100.0

The inshore landings increased from the beginning of the year and peaking in the last quarter. This can be attributed to increase in fishing efforts towards the end of the year for extra income for special occasions such as White Sunday, Christmas and New Year and the fact that most marine organisms are in season (e.g. sea urchin, *palolo*) or are more susceptible to catching due to spawning behaviour (e.g. mass migration of mullet), in the warmer/wetter months, especially the September-December period. The ***atule*** run occurs between March and August and the rock cod (*gatala*), *Epinephelus merra*, is more susceptable to fishing when in spawning season around June. Fishermen note that when this species is in spawning behaviour, individuals just roll about in the open. This behaviour is known as ***fa'agoa*** and the fish is easily speared.

In a preliminary survey between December, 1983 and February, 1984, of the inshore fisheries of Upolu Island, Zann *et al.* (1984) estimated coral reef fin-fish production to the 8 m isobath on Upolu to be 5,593.8 mt (5,022.1 mt in rural areas and 571.1 mt in the urban area) per year and reef invertebrates to be 7,613.9 mt (6,092 mt in rural areas and 1,523.1 mt in the urban area) per year. These estimates were calculated for rural areas using a fish consumption rate of 203g/capita/day and the human population of 77,640 people. For the urban area, consumption used was 80g/capita/day and a population of 32,100. It was also assumed that reef fish comprised 87.2 per cent of total rural fish consumption but 61.0 per cent in the urban area. Based on answers for fish consumed the day before the survey, the relative percentages of fin-fish groups were estimated for Upolu, as presented in Table 3.3.5. The shallow-water reef and lagoon fin-fish groups are in bold. Excluding mullet and herring, which are discussed under separate profiles, reef and lagoon fish make up 71.1 per cent of the total fin-fish consumption in the rural areas and 60.0 per cent in the urban area. Relative composition of fish groups within the reef and lagoon catches are given under "per cent*" columns. These indicate that in the rural areas of Upolu, the five most important reef and lagoon fin-fish groups are, surgeonfish (30.0 per cent), emperor (14.3 per cent), snappers (12.9 per cent), squirrelfish (12.8) and parrotfish (10.8 per cent). In the urban area, only 6 reef and lagoon fin-fish groups were recorded, of which the most important ones include, surgeonfish (36.7 per cent), barracuda and trevally (18.3 per cent each) and snappers (10.0 per cent). There were 12 groups of reef and lagoon fin-fish recorded in rural areas whereas only six were recorded in the rural area. This is likely to be reflection of the dependence of the urban area on what is available in the commercial fish market, in addition to the limited resource available as compared to the subsistence fishery which harvests a wide range of marine animals.

Table 3.3.5: Percentage of fish types eaten (caught) on the day before the survey. (Source: Zann *et al.*, 1984).

		URBAN AREA		RURAL AREAS							
Taxon & habitat	Samoan name	Apia	Per cent*	North west	North east	South east	South central	South west	Manono Is.	Average	Per cent*
OCEANIC PELAGICS											
Skipjack	atu	28		6		6	36 (25)	13	18	8.6	
Yellowfin	asiasi	11				6	2 (6)			2.1	
Dolphinfish	masimasi						(3)			0.2	
Rainbow runner	samani						10 (12)			1.8	
CORAL REEF											
Snappers		6	10.0	8	4 (5)	33 (38)	3 (3)	(11)		9.2	12.9
Emperor	mataelele	5	8.3	5		22 (46)	5 (6)	4 (11)	12 (7)	10.2	14.3
Coral cods	gatala			6	4 (5)	11 (8)	2	13 (8)	(7)	5.3	7.5
Moray eels	pusi	5	8.3		4			4 (12)		2.1	3.0
Goatfish	i'a sina etc					6		2		0.6	0.8
Parrotfish	fuga			20	20 (23)			6 (11)	6 (7)	7.7	10.8
Squirrelfish	malau			26	4 (5)	(8)	8 (9)	13 (31)	6	9.1	12.8
Surgeonfish	pone etc	22	36.7		40 (33)		18 (22)	21 (31)	41 (50)	21.3	30.0
Angelfish	tifitifi			6	(5)	6		(4)	12 (14)	3.1	4.4
Butterflyfish	tifitifi							(4)		0.3	0.4
REEF & LAGOON											
Barracuda	saosao, sapatu	11	18.3								
Trevally	lupo, malauli	11	18.3		(5)	6		4 (8)		1.9	2.7
Silver biddy	matu							4		0.3	0.4
Mullet	anae				4 (5)		10 (3)	6 (12)	6 (7)	4.4	
Herring	pelupelu			6			2 (3)			0.9	
DEEP WATER											
Jobfish	utu						(3)			0.2	

*these percentages are calculated using only total reef and lagoon fin-fishes, to indicate realtive importance of fish groups with this particular fishery.

Estimates of inshore fin-fish landings were only initiated by Fisheries Division in 1985. Those for the 1985-1988 period are presented in Table 3.3.5. Estimates for other fisheries are also given for comparison. These estimates were based on data collected from the Apia Fish Market, and for reef and lagoon resources, the estimates are clearly under-estimates. They are more likely to be commercial landings.

Table 3.3.5: Estimates of fish and invertebrate landings in Western Samoa for the 1985-1988 period. (Sources: Fisheries Division Annual Reports for 1988 and 1990).

	Estimated Landings (mt)					Total	
Year	Inshore fin-fish	Shellfish	Bottomfish	Tuna	Other	Weight (mt)	Value (WST)
1985	545	96	822	2,082	96	3,641	10,566,000
1986	617	144	440	1,688		2,889	8,040,600
1987	480	106	384	1,034		2,004	6,727,600
1988	440	80	616	1,536		2,672	7,862,720

King (undated) estimated inshore artisanal catches (vertebrates plus invertebrates) for the whole of Western Samoa (with 95 % confidence limits) to be 4,593 mt (in 1989). Mean catch per person per week by type of ecosystem were estimated as follows, with the estimated annual catch for the whole of

Western Samoa:

Ecosystem	Invertebrates		Vertebartes		ANNUAL CATCH (mt)	
	mean	sdev	mean	sdev		
fringing coral reef	0.10	0.12	0.52	0.36	1,435	(± 25%)
lagoon and barrier reef	0.19	0.27	0.85	0.79	2,420	(± 35%)
mangroves, lagoon, and reefs	0.21	0.24	0.97	0.94	738	(± 35%)
TOTAL					4,593	

Estimated species or taxa landings collected in the artisanal fisheries in Western Samoa using three coastal ecosystem types are presented in Table 3.3.6 as reproduced from King (undated). The total estimated shallow-water finfish landing in the Western Samoa artisanal fishery is 3,267 mt, representing about 71 per cent of the total inshore reefs and lagoons (vertebrates and invertebrates) landing. The three major fin-fish groups are emperor, surgeonfish and trevally.

Table 3.3.6: Major fish groups collected in artisanal fisheries in Western Samoa as estimated in 1989. (Source: King, undated).

English Name	Samoan Name	Fringing coral reef (*Total Annual Catch = 1,435 mt)		Lagoons and a barrier reef (*Total Annual Catch = 2,420 mt)		Lagoons, reefs and mangroves (*Total Annual Catch = 738 mt)		All ecosystems (*Total Annual Catch = 4,593 mt)	
		Per cent	Weight (mt)	Per cent	Weight (mt)	Per cent	Weight (mt)	Total Weight (mt)	Per cent of Total Fin-fish
Bigeye scad	*atule*	1.2	17.220	2.5	60.500	0.2	1.476	79.196	2.4
Mullet	*anae*	8.8	126.280	5.4	130.680	9.3	68.634	325.594	10.0
Goatfish	*ulaoa*	1.1	15.785	0.1	2.420	3.3	24.354	42.559	1.3
Rabbitfish	*lo*	2.7	38.745	5.2	125.840	4.4	32.472	197.057	6.0
Emperor	*mataeleele*	9.7	139.195	18.6	450.120	11.7	86.346	675.661	20.7
Trevally	*lupo, malauli*	1.8	25.830	14.2	343.640	4.7	34.686	404.156	12.4
Surgeonfish	*pone*	17.9	256.865	5.2	125.840	13.2	97.416	480.121	14.7
Parrotfish	*fuga*	7.8	111.930	4.8	116.160	3.4	25.092	253.182	7.7
Unicornfish	*ume*	5.7	81.795	1.5	36.300	1.9	14.022	132.117	4.0
Soldierfish	*malau*	4.4	63.140	6.6	159.720	13.2	97.416	320.276	9.8
Rock cod	*gatala*	7.3	104.755	4.5	108.900	2.1	15.498	229.153	7.0
Moray eel	*pusi*	2.1	30.135	3.9	94.380	0.5	3.690	128.205	3.9
Total								3,267.277	100.0

*these Total Annual Catch figures include vertebrates and invertebrate landings, and the percentage entires under the "per cent" columns indicate percentage weight of the corresponding fish group of the total (invertebrates + vertebrates) landings.

Zann (1991) recorded details concerning fisheries information in zones around Upolu Island as presented in Table 3.3.7. The total inshore landings on Upolu was thus estimated to be about 2,000 mt.

Table 3.3.7: Details of fishing activities in coastal communities on Upolu. (Source: Zann, 1991).

Upolu Zone	FISHING EFFORT				CATCH			ECONOMICS		YIELD
	Number fishermen	Number canoes	Number trips/yr	# trips /reef area/yr (#/ha/yr)	Ave. catch fish/trip (kg)	CPUE (kg/man/hr)	Annual fish landing (mt)	Per cent catch sold	Percent fish bought	Reef & lagoon yield (10m) (kg/ha/yr)
Apia East (Vaipuna-Letogo) and Apia West (Vaiala-Vaigaga)	198	30	13,572	7.5	2.6	0.40	33	17	92	28
Faleula (Saina-Tuana'i)	340	142	37,440	17	3.5	0.55	131	15	33	60
Ututali'i (Leauva'a-Fasito'outa)	466	146	45,084	33	3.4	0.83	160	27	30	117
Fasito'otai (Vaialua-Faleolo)	225	79	21,216	10..8	4.6	-	100	27	35	57
Apolimafou-Faleolo	103	42	5,916	8	4.5	0.90	47	24	20	40
Manonouta and Apolimafou	100	53	19,240	10	8.7	1.07	120	43	10	65
Manono and Apolima Islands	145	53	18,564	5.7-8.1	5.6	1.27	110	40	0	45
Falelatai (Si'ufaga-Fagaiofu Bay)	388	61	28,600	63	4.5	0.76	105	11	33	110
Lefaga (Mata'afa-Matautu)	356	89	30,784	67	3.6	0.70	103	39	25	206
Sa'anapu (Salamumu-Lotofaga)	462	170	43,160	43	3.5	0.78	130	16	20	130
Safata (Vaie'e-Siumu)	402	230	47,476	37	5.2	1.1	175	17	30-40	130*+ 250**
O le Pupu (Aganoa-Togitoniga)	41	31	5,252	52	4.0	0.75	21	20	15	170?
Falealili (Iliili-Satalo)	358	167	37,000	33	5.0	0.85	185	24	20	168
Salani (Sapunaoa-Lotofafa)	361	115	~20,000	39	3.6	-	56	18	35	110
Lepa (Vavau-Saleapaga)	177	24	30,800	141	4.0	0.9	55	7	0	250
South Aleipata (Lata-Satitoa)	175	116	25,064	62	5.0	1.1	100	25	30	200
North Aleipata (Malaela-Amaile)	265	128	25,500	35	5.3	0.75	118	12	10	164
Uafato (East point-Tiavea)							12			
Fagaloa Bay (Samamea-Sauano)	190	59+4*!	16,800	71	2.3	0.70	54	25	15	225
Saluafata (Falefa-Solosolo)	327	116	28,400	56	2.3	0.8	65	27	44	130
Luatuanu'u (Utumau'u-Lauli'i)	168	85	13,832	138	3.8	1.0	55	15	30	520***
TOTAL							1,935			

*reefs and lagoon; **Safata lagoon . *!catamarans. ***very high yields due to mullet and *atule* migrations, whereas yields of resident reef species is about 200 kg/ha/yr.

Commercial inshore reef fish landings at the Apia Fish Market for the 1986-1994 period are given in Table 3.3.8. It indicates that the most important fish families in the artisanal fishery are emperors, mullet, surgeonfishes, parrotfishes, trevallies, goatfishes, unicornfishes, big-eye scads and groupers

Table 3.3.8: Shallow-water reef fish landings at the Apia Fish Market for the 1986-1993 period. Figures are in kg. (Sources: Mulipola, 1993; Mulipola, 1994; Helm, 1987; Fisheries Database).

Fish family	1986	1987	1988*	1989	1990	1991**	1992	1993***	1994****
Acanthuridae-surgeonfish	27,100	28,600	12,042	6,790	10,767	2,605	5,200	6,787	6,568
Scaridae-parrotfish	27,100	31,500	17,235	4,996	4,867	2,569	6,100	6,650	8,054
Acanthuridae-unicornfish	15,000	16,400	11,085	6,888	5,120	1,857	5,000	6,778	5,310
Serranidae-grouper	6,900	12,000	1,616	1,671	591	579	1,800	3,374	2,343
Siganidae-rabbitfish	2,500	2,100		6,769			700	1,507	1,493
Lutjanidae-snapper	5,200	3,400		2,096			1,700	3,134	2,261
Mullidae-goatfish	18,000	16,800	820	4,701		542	3,000	4,466	3,620
Holocentridae-soldierfish	2,700	6,500		650			1,400	2,580	2,849
Lethrinidae-emperor	59,000	28,700	12,962	5,681	5,893	2,060	7,500	7,608	6,963
Gymnothorax?-moray eel	8,400	4,600	7,483	1,924	1,375	284	1,000	2,086	2,987
Mugulidae-mullet	27,100	18,900	7,234	5,101	2,542	3,056	4,400	5,093	4,393
Carangidae-jacks and trevally	19,900	5,000	2,699	11,079	1,019	891	2,000	2,177	2,210
Gerreidae-silver biddy	2,000	400	1,588			89	200	1,536	1,460
Carangidae?-scad	12,500	600	3,529	497		1,200	200	48	4,864
Labridae-wrasses	2,000	1,500							
Other	10,800	15,100	19,089	198	6,997	4,950	1,300	1,982	1,549
Chanidae-milkfish				7,776				864	418
Kyphosidae-drummerfish				222					
Ponyfish				5,060					
Total weight (kg)	246,200	192,100	97,382	72,099	39,171	20,682	41,500	56,671	57,342
Total value (WS$)									

*extrapolated from Jan-Oct data; **extrapolated from Jan-May data; ***extrapolated data from Aug to Dec data; **** extrapolated from Jan-Sept data. The 1994 Lutjanidae were all *savane & malai*.

Brotman (1989) estimated shallow-water reef fish (inshore) landings at other commercial outlets in 1989 to be 55,940 kg worth WS$203,319.00. Family breakdown was not give. For 1990, Winterstein lumped lagoon, reef and deep-water bottomfish together under the bottomfish category for the same outlets. The estimated landing for this category for the January-August period for 1991 was 60,129 kg. The survey on the roadside from Apia to Faleolo recorded the following statistics for reef fish in 1992:

Fish	Wt (kg)	Fish	Wt (kg)
Surgeonfish	1,069	Snapper	328
Parrotfish	1,192	Soldierfish	273
Unicornfish	603	Emperor	5,430
Grouper	566	Trevally	359
Rabbitfish	212	Mullet	1,913
Moray eel	270	Silver biddy	4
Scad	104	Other fish	1,970
Sub-total	**4,016**	**Sub-total**	**10,277**
TOTAL	**14,293**		

3.3.3 Stocks Status

The total inshore fin-fish landing estimated for Western Samoa during the 1978 fishery catch assessment was 553,816 kg. In addtion, a total of 122,380 kg of invertebrates was also estimated. Recent estimates indicate that the 1978 estimates were low. However, these estimates do not seem to be reflective of fish stocks but rather of method used for estimations. Inshore reef and lagoon fishery resources landings are summarised in Table 3.3.9 as reported in various reports.

Table 3.3.9: Summaries of inshore reef and lagoon fisheries landings in Western Samoa as recorded in various reports.

		INSHORE						INSHORE TOTAL	
		UPOLU		SAVAI'I		WESTERN SAMOA		F-fish+Invert	F-fish+Invert
Island/Source	Description	Fin-fish	Invertebrates	Fin-fish	Invertebrates	Fin-fish	Invertebrates	Upolu	W. Samoa
Statistics Dept., 1978	All	417.5	101.5	136.3	20.8	554	122	548	676
Zann *et al*., 1984	All	5,594.0	7,616.0					13,210	
Fisheries Division, 1985	All					545	96		
Fisheries Division, 1986	All					617	144		
Fisheries Division, 1987	All					480	106		
Fisheries Division, 1988	All					440	80		
King (undated) 1989	Artisanal					3,267	1,326		4,593
Zann, 1991	All							1,935	

In January, 1991, under water visual census surveys of reef fish stocks were conducted on Upolu in lagoons and reef slope (<20 m) at Aleipata, Nuutele Island and Siumu. Assessments were based on five fish families; Serranidae (cods - ***gatala*** etc), Lethrinidae (emperor - ***mataeleele***, ***filoa*** etc), Lutjanidae (snappers - ***savane***, ***tamala*** etc), Acanthuridae (surgeonfishes - ***pone***, ***alogo*** etc) and Scaridae (parrotfishes - ***fuga*** etc). Major findings, as reported in Zann (1991), indicate:

⇒ biomasses are lowest and mean sizes of individual fishes are generally smallest in the heavily fished inshore lagoons (Aleipata mainland);

⇒ biomasses are higher, and mean sizes of selected species are larger in the deeper outer reef slopes (Aleipata, Siumu);

⇒ highest biomass and sizes are found on reef slopes at the least fished site, Nu'utele Island.

Zann (1991) concluded that the survey results indicate that inshore stocks are overfished but that the upper reef slopes appear to be important refuges for many reef fish species and probably provide recruits for the heavily fished shallow reefs and lagoons.

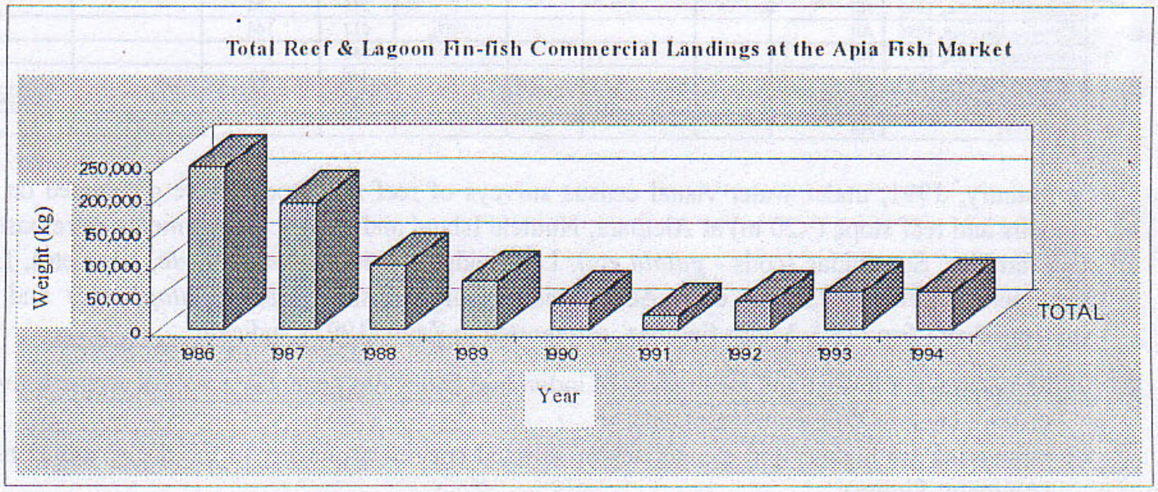
On the trends of fish landings on Upolu, Zann (1991) recorded the results of interviews in the different zones and the results are presented in Table 3.3.10.

Table 3.3.10: Results of interviews with fishermen on Upolu concerning fisheries trends. (Source: Zann, 1991).

Upolu Zone	Fish stocks trends
Apia East (Vaipuna-Letogo) and Apia West (Vaiala-Vaigaga)	85% of fishermen interviewed stocks had declined over past decade
Faleula (Saina-Tuana'i)	70 % of fishermen believed stocks had declined over past decade
Ututali'i (Leauva'a-Fasito'outa)	75 % of fishermen believed stocks had declined over past decade
Fasito'otai (Vaialua-Faleolo)	lagoons and reefs off the airport are only moderately fished as no adjacent villages
Apolimafou-Faleolo	10 % of fishermen believed stocks had declined over past decade
Manonouta and Apolimafou	50 % of fishermen believed stocks had declined over past decade
Manono and Apolima Islands	50 % of fishermen believed stocks had declined over past decade
Falelatai (Si'ufaga-Fagaiofu Bay)	63 % of fishermen believed stocks had declined over past decade
Lefaga (Mata'afa-Matautu)	42 % of fishermen believed stocks had declined over past decade
Sa'anapu (Salamumu-Lotofaga)	55 % of fishermen believed stocks had declined over past decade
Safata (Vaie'e-Siumu)	60 % of fishermen believed stocks had declined over past decade
O le Pupu (Aganoa-Togitoniga)	67 % of fishermen believed stocks had declined over past decade
Falealili (Iliili-Satalo)	66 % of fishermen believed stocks had declined over past decade
Salani (Sapunaoa-Lotofafa)	60 % of fishermen believed stocks had declined over past decade
Lepa (Vavau-Saleapaga)	72 % of fishermen believed stocks had declined over past decade
South Aleipata (Lata-Satitoa)	55 % of fishermen believed stocks had declined over past decade
North Aleipata (Malaela-Amaile)	18 % of fishermen believed stocks had declined over past decade
Uafato (East point-Tiavea)	?
Fagaloa Bay (Samamea-Sauano)	64 % of fishermen believed stocks had declined over past decade
Saluafata (Falefa-Solosolo)	42 % of fishermen believed stocks had declined over past decade
Luatuanu'u (Utumau'u-Lauli'i)	73 % of fishermen believed stocks had declined over past decade

Commercial reef and lagoon fin-fish landings at the Apia Fish Market during the 1986-1994 period, as recorded by the Fisheries Division, indicate declines for most of the inshore reef and lagoon fisheries. Figure 3.3.1 presents the overall trend of those landed at the Apia Fish Market. Drastic declines are seen from 1986 to 1991. The overall landing started to gradually increase again after 1991. The lowest landings were observed in 1990 and 1991. The worst cyclones that ever hit Samoa were in these years, Ofa in February, 1991 and Val in December, 1991. Landing trends for other reef and lagoon fin-fishes are appended at the end of this profile. One concern that could contribute to possible error in the data are consistency in data collection and analysis method used.

Figure 3.3.1: Trends of total commercial reef and lagoon fin-fishes landed at the Apia Fish Market.



3.3.4 Management

Current legislation/policy regarding exploitation: Fisheries Act 1988: Part II, 3 (2) of the Act defines the general functions of the Director of Agriculture, Forests and Fisheries. Subclause (c) lists the functions as to consult with fishermen, industry and village representatives, concerning conservation, management and development measures for fisheries. Part II, 3 (3) empowers the Director to:

(a) collect and analyse statistical and other information concerning fisheries;
(b) propose management and development measures designed to obtain the maximum benefits from the fishery resources for the people of Western Samoa both present and future;
(c) monitor activities and proposals in other sectors and advise the Minister concerning their effect on fisheries;
(d) in consultation with fishermen, industry and village representatives, prepare and promulgate by-laws not inconsistent with the Act for the concervation and management of fisheries;

Part II, 4 (1) (a) of the Act prihibits the use or attempt to use of any explosive, poison or other noxious substance for the purpose of killing, stunning, disabling or catching fish, or in any way rendering fish more easily caught. Paragraph (b) makes it illegal to carry or have in possession or control any explosive, poison or other noxious substance in circumstances indicating an intention to use such for any of the purposes referred to in (a). Under subsection (2), any explosive, poison or other noxious substance found on board any fishing vessel shall be presumed, unless the contrary is proved, to be intended for the purpose referred to in subsection (1)(a). Subsection 3 makes it illegal for any person to land, sell, receive or possess fish taken in contravention of subsection (1)(a), which he knows or has reasonable cause to believe they were so taken. Part II, 5 requires local commercial fishing vessels to have a valid certificate of registration.

Part IV, 10 requires any vessel or person to undertake marine scientific research operations in the fishery waters to obtain authorisation from the Minister. Subsection (3) makes it illegal to undertake or assist in any marine scientific research in the fishery waters without authorisation.

Fines: A breach of any by-law made under Part II, 3 of the Act is a fine not exceeding $100 and where the breach is a continuing one, a further fine not exceeding $20 for every day on which the breach has continued. A breach of Section 10 is a fine not exceeding 50,000 tala. Contravention of Section 4(1) is a fine of 1,000 tala and imprisonment for a term not exceeding 2 years except that no sentence of imprisonment shall be imposed under this subsection for an offence committed in the exclusive economic zone. Contravention under Section 4(3) is a fine not exceeding 1,000 tala.

Proposed Local Fisheries Regulations: Part I, 3 (1) and (2) of the proposed Local Fisheries Regulations 1994 propose to prohibit the catching and selling of fish species under the minimum size limits as follows:

Common name	Samoan name	Family	Genus	Minimum length (mm)
Grey mullet	Anae, afa, ulupona	Mugilidae	Mugil	200
Trevally, pompano	Malauli, Lupo	Carangidae	Caranx	250
Rabbitfish, spinefeet	Lo, pa'uulu, malava	Siganidae	Siganus	200
Long-jaw mackerel	Ga	Scombridae	Rastrelliger	200
Big-eye sca	Atule	Scombridae	Selar	150
Longtom, Garfish	Ise, a'u	Belonidae	Belone	300
Milkfish	Ava	Chanidae	Chanos	300
Mojarra	Matu, mumu	Gerreidae	Gerres	100
Parrotfish	Fuga	Callyodontidae	Scarichthys	200
Wrasse	Sugale	Labridae	Labrinus	200
Rock cod, Groupers	Gatala	Serranidae	Serranus	200
Sea bream, Emperor	Mataeleele, Filoa	Lethrinidae	Lethrinus	200
Goatfish	Ululaoa, vete, taulaia,i'a sina	Mullidae	Upeneus, Pseudupeneus	150
Surgeonfish	Alogo, pone, palagi	Hepatidae	Hepatus	200
Unicornis	Ume, iliilia	Hepatidae	Naso	200
Drummerfish	Ganue		Kyphosus	200
Snapper	Malai, Taiva, Tamala	Lutjanidae	Lutjanus	200

The same Section prohibits the sales of eggs or gonads of any fish, crustacean and *Dolabella* sp. In addition, the sale of certain fin-fish species have been proposed to be prohibited due to their known or potentially toxic nature. These are listed as follows:

Common name	Samoan name	Scientific name
FISH		
Twinspot snapper (red snapper)	Mu, ~~a'a~~ (mua'a)	*Lutjanus bohar*
Great barracuda	Sapatu	*Sphyraena barracuda*
~~Great barracuda~~ (Forster's seapike)	Saosao	*Sphyraena forsteri*
Herring	Pelupelu	*Herklosichthys quadrimaculatus*
Herring	Pelupelu	*Sardinella albella*
INVERTEBRATES		
Egg/Gonads of the following:		
Any fish		
Any crustacean		
Green (sea) hare	Gau	*Dolabella auricularia*

Part I, 4, proposes to establish closed fishing season for the following species as the Director sees necessary:

Common name	Samoan name	Scientific name
Grey mullet	anae, afa, ulupona	Mugil species
Rock cods, groupers	gatala	Serranus species
Bigeye scad	atule	Selar crumenophthalmus
Hawksbill turtle	laumei (una or faiuna)	Eretmochelys imbricata
Green turtle	laumei	Chelonia mydas

Part I, 5, proposes to allow only the following fishing gear unless authorised by a license issued in accordance with the Fisheries Act 1988:

a. beachnets and castnets with a mesh size not less than 30 mm, measured when wet and stretched;
b. all other nets shall have mesh size of not less tham 50 mm, measured when wet and stretched;

c. fishfences shall have a mesh size not less than 50 mm measured when wet and stretched irrespective of the material used to make them.

Recommended legislation/policy regarding exploitation: Fishing using dynamites, though prohibited, is still practised in some areas. More effective measures to enforce restrictions on dynamite fishing are necessary.

Other options that may need to be considered for regulations include:

Fish fences *(pa i'a)*:

- ban fish fence or introduce a permitting system to control the number of operating fish fences;
- limit the number of operating fish fences in certain zones within the country;
- limit fish fence size; fish fence permit holder to be responsible for the removal of damaged or rusting fence from the sea and dispose of responsibly on land.

Fishery statistics: a requirement for those who fish or buy and re-sell fish and marine products on a commercial basis, whether on the local market or for export, to submit all statistics involved in the operation to the Fisheries Division (this may require the Fisheries Division to issue receipt books to these operators for convenience of both the operators and the Division).

The proposed Local Fisheries Regulations need revision, due to several errors, before they become law. The table (schedule) for minimum size limits require some changes due to ambiguous classification used, erroneous application of one minimum size limit to different species within families which have different growth rates and lengths at first maturity etc. It is not necessary to prohibit the sale of some of the species listed as there have been no recorded cases of fish poisoning from eating them, e.g. barracuda and seapike. The schedule covering species which the Director may prohibit fishing for in certain periods by declaration, should be expanded to include invertebarte species such as giant clams, trochus, turbo etc. In addition, these periods can be defined as these periodic prohibition are geared towards spawning periods. Other fishing gear could be included in the schedule dealing with gear. Consideration could be given to the prohibition of the use of SCUBA or any under-water breathing apparatus, except a snorkel and goggles, to harvest reef fish.

Additional regulations are required for the exploitation and export of marine animals for the aquarium trade.

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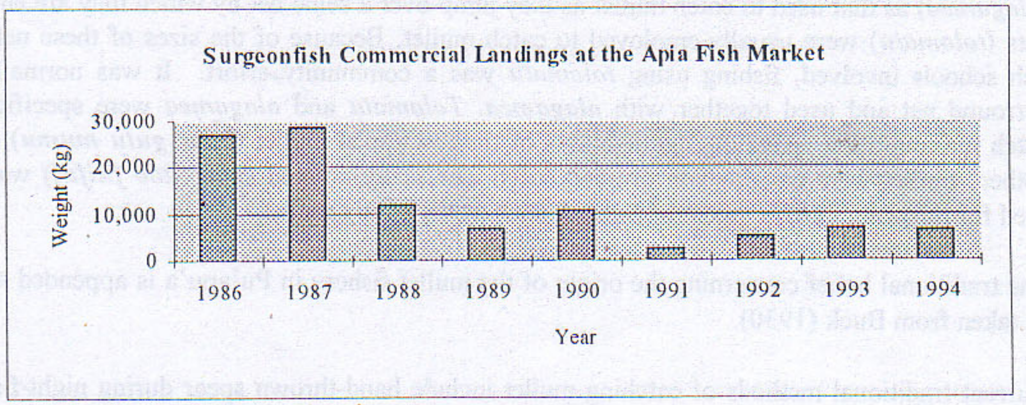
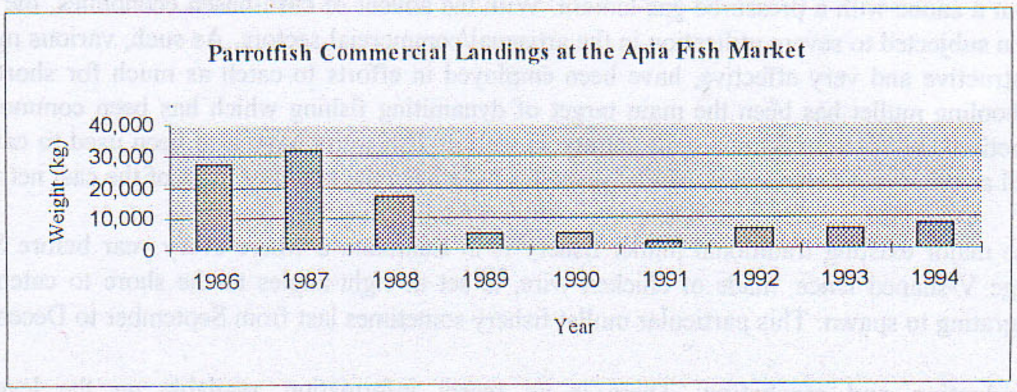
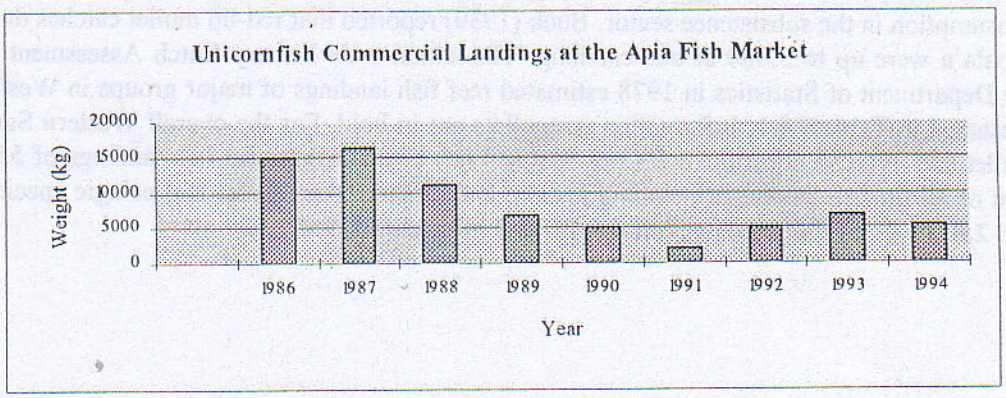
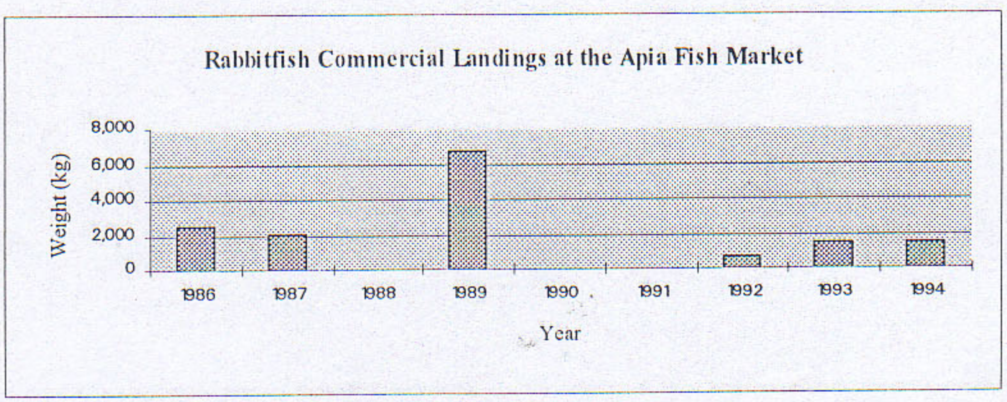
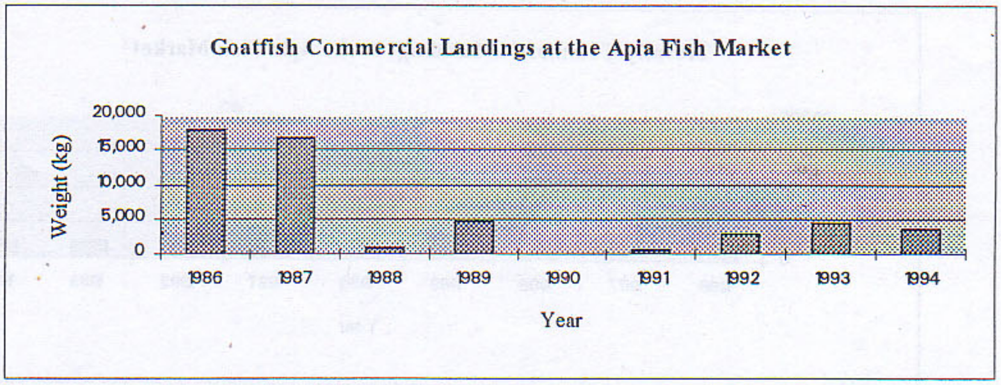
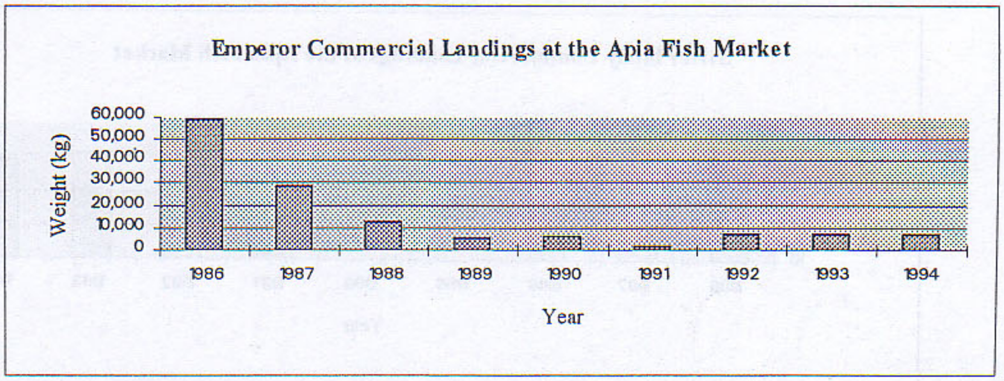

Surgeonfish Commercial Landings at the Apia Fish Market
Weight (kg)
30,000
20,000
10,000
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
Year

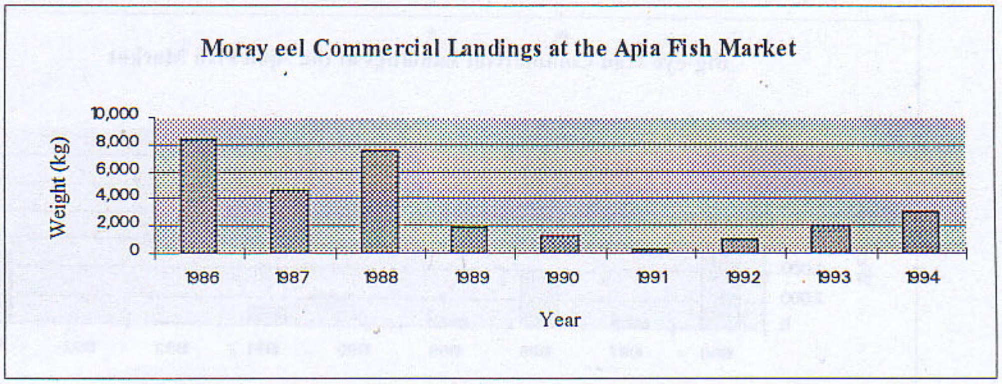

Parrotfish Commercial Landings at the Apia Fish Market
Weight (kg)
40,000
30,000
20,000
10,000
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
Year

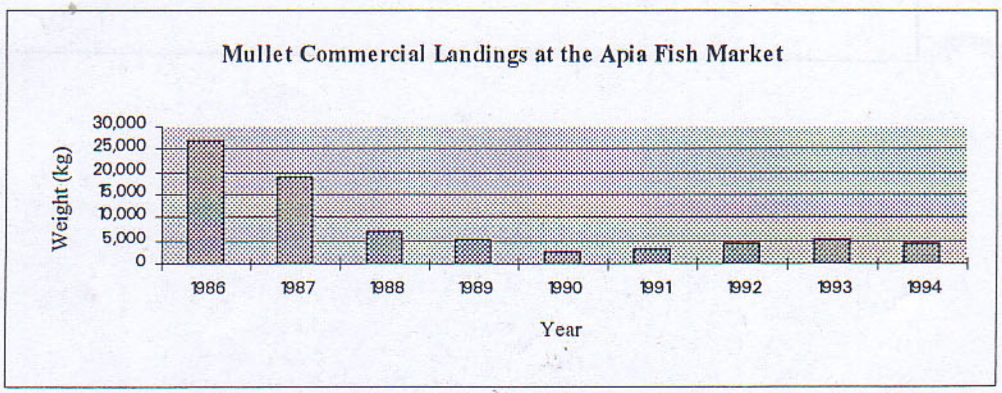

Unicornfish Commercial Landings at the Apia Fish Market
Weight (kg)
20000
15000
10000
5000
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
Year

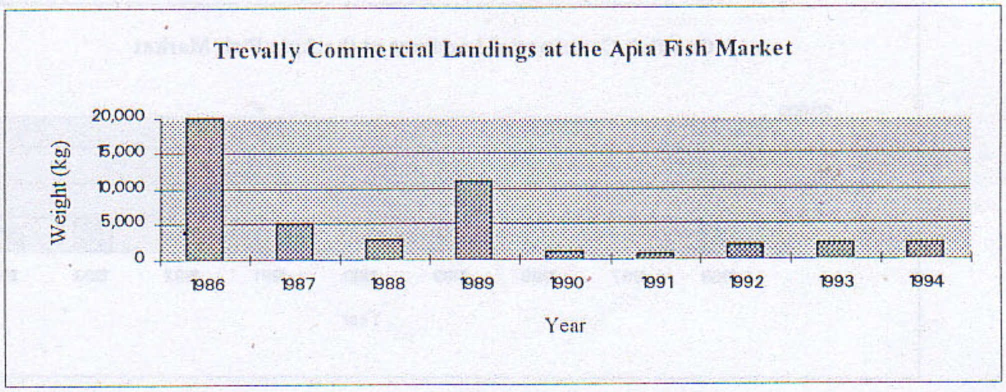

Rabbitfish Commercial Landings at the Apia Fish Market
Weight (kg)
8,000
6,000
4,000
2,000
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
Year

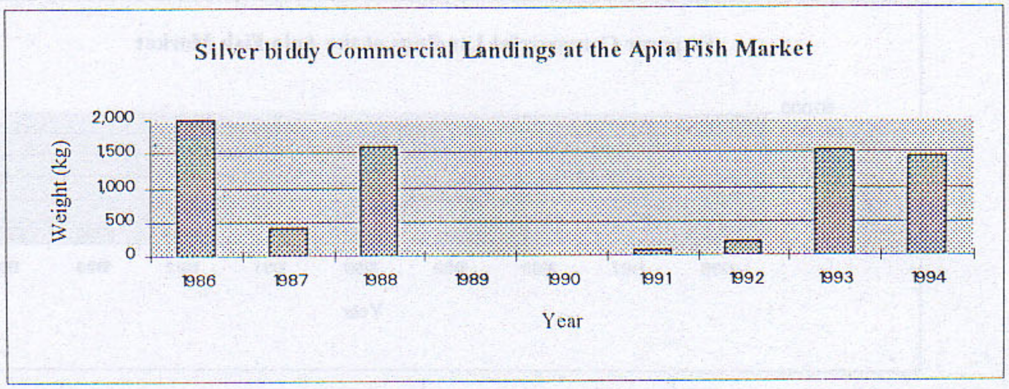

Goatfish Commercial Landings at the Apia Fish Market
Weight (kg)
20,000
15,000
10,000
5,000
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
Year

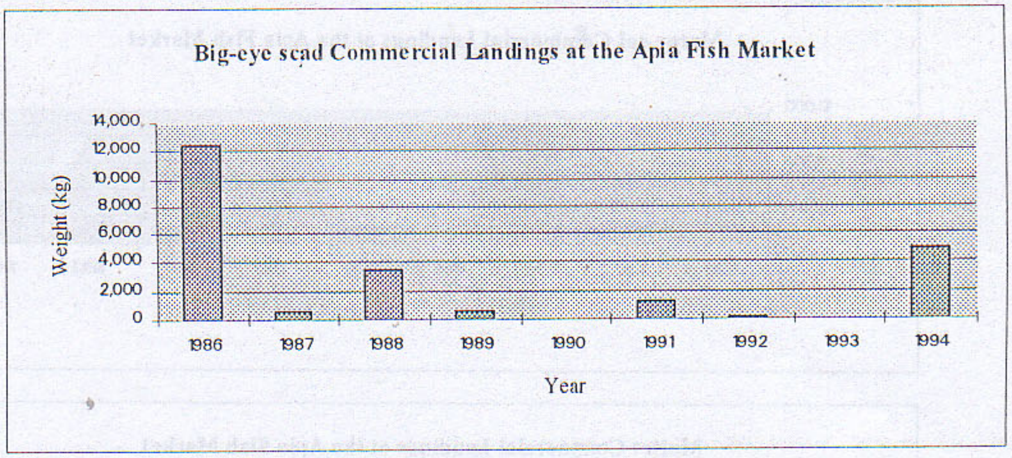

Emperor Commercial Landings at the Apia Fish Market
Weight (kg)
60,000
50,000
40,000
30,000
20,000
10,000
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
Year


Moray eel Commercial Landings at the Apia Fish Market
Weight (kg)
10,000
8,000
6,000
4,000
2,000
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
Year


Mullet Commercial Landings at the Apia Fish Market
Weight (kg)
30,000
25,000
20,000
15,000
10,000
5,000
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
Year

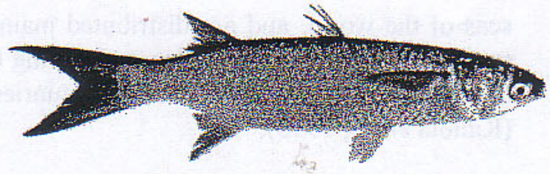

Trevally Commercial Landings at the Apia Fish Market
20,000
15,000
10,000
5,000
0
Weight (kg)
1986
1987
1988
1989
1990
1991
1992
1993
1994
Year


Silver biddy Commercial Landings at the Apia Fish Market
2,000
1,500
1,000
500
0
Weight (kg)
1986
1987
1988
1989
1990
1991
1992
1993
1994
Year


Big-eye scad Commercial Landings at the Apia Fish Market
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Weight (kg)
1986
1987
1988
1989
1990
1991
1992
1993
1994
Year

3.4 Mullet - *aua, anae*

3.4.1 The Resource



anae - *Crenimugil crenilabis*

Species present: Mullet species occurring in Western Samoa have not been properly identified. Fowler (1963) listed mullet species in Samoa as *Mugil trihilus* and *M. macrolepis*. In addition, Garlovsky (1972) listed *Liza caeruleomaculata*, *L. troscheli*, *M. seheli* and an unidentified *Mugil* sp. (*afa*). *Afa* (*utuali'i*) has been identified as *Liza vaigiensis*. Wass (1984) listed seven mullet species in American Samoa. The same species were listed by Zann (1991a) as those in Western Samoa. These are: *Chaenomugil leuciscus* (acute-jawed mullet), *Crenimugil crenilabis* (warty-lipped or fringelip mullet), *Liza macrolepis* (big-belly mullet), *L. subviridis* ?, *L. vaigiensis* (yellowtail mullet), *Valamugil engeli* (Engel's mullet), *V. seheli* (bluespot mullet). *Mugil cephalus* (sea or grey mullet) probably also occurs in Western Samoa but has not been listed because species have not been scientifically identified. Myers (1989) listed *Liza melinoptera* (the giant scale mullet) as occurring in the Ino-Pacific from E. Africa to Samoa, n. to the Philippines, s. to Tonga, and in Palau.

With the exception of *'afa* (*utuali'i*), the general Samoan name given for *L. vaigiensis*, all mullet species are generally known in the Samoan language according to their sizes. However, Wass (1984) also gave Samoan names, as known in American Samoa, of the different *'afa (L. vaigiensis)* sizes as follows:

fuitogo < 10 cm TL; *'afa* 10-25 TL; *'anaeafa* > 25 cm TL.

Samoan names given for different sizes of mullet have been estimated to correspond to the following approximate lengths:

poi (*poipoi*) <8 cm; *aua* 8-12 cm; *matapona* 12-20 cm; *anae* >20 cm.

Distribution: *C. crenilabis* occurs in the Indo-Pacific from the Red Sea to the Line and Tuamotus Islands, north to south of Japan, south to Lord Lowe Islands; Ifaluk, Marianas and Marshall Islands in Micronesia (Myers, 1989). It is commonly found in sandy lagoons and on shallow seaward reef flats (Randall. *et. al.*, 1990).

L. vaigiensis occurs in East Africa to the Tuamotus, north to south Japan, south to the south Great Barrier Reef and New Caledonia. It is found throughout Micronesia in lagoons and on reef flats where it is most common along protected sandy shorelines (Myers, 1989). This species forms large schools frequently in mangrove areas (Randall *et. al.*, 1990).

V. engeli occurs from E. Africa to the Marquesan and Tuamotu Is., n. to the Yaeyamas; Ifaluk, Marshalls, and Marianas in Micronesia; introduced to the Hawaiian Is. (Myers, 1989). The same author noted that this species species was found to be the most common mullet of shallow protected sandy to muddy areas of reef flats and shallow lagoons in Marianas.

V. seheli occrs in the Red Sea to Samoa, n. to s. to New Caledonia; Marianas in Micronesia (Myers, 1989).

C. leuciscus occurs in Mariana and Bonin IS. to the Hawaiian, Line, and Ducie Is.; Ifaluk, Marianas, and Marshalls in Micronesia (Myers, 1989). The author noted that this is the most common mullet in lagoon and seaward reef in the Marshalls.

Sea mullet, *M. cephalus*, inhabits coastal waters and estuaries in tropical and temperate waters of all seas of the world, and are distributed mainly between the latitudes 42° N and 42° S. It has a strong tendency to school as juveniles, and during the spawning season, as adults. Juvenile schools commonly disperse over sand and mud flats of estuaries when feeding during high tide, but re-form on the ebb tide (Kailola *et al*., 1993).

In Western Samoa, mullet is generally found through-out the country, especially near mangrove estuaries but are also caught in lagoons and on coral reefs and in reef channels. Mangrove areas serve as nursery areas for mullet juveniles. Mullet fishery during their spawning migration through the lagoons during September-December is well known in the villages of Luatuanu'u and Moata'a on Upolu, Pu'apu'a on Savai'i and Manono Island. The mullet species at Pu'apu'a is known as red-lipped. The red-lipped mullet species was also known to migrate from offshore around September and remain between Manono Island and Nu'ulopa islet for three months (Tuilaepa Puava, Apai village, 1993, *pers. comm.* to A. Mulipola, Fisheries Officer). This particular stock had been subjected to heavy dynamite fishing and is known to be almost non-existant.

Zann (1991), from surveys and interviews conducted through-out Upolu, recorded the following important fish species within zones indicated, in order of importance. Mullet are in **bold**.

Zone	Major reef fin-fish species
Apia East (Vaipuna-Letogo & Apia west (Vaiala-Vaigaga)	surgeonfish, **mullet**, scad
Faleula (Saina-Tuana'i)	surgeonfish, **mullet**, parrotfish, sweetlips, snappers, trevally
Ututali'i (Leauva'a-Fasito'outa)	surgeonfish, parrotfish, sweetlip, soldierfish (trevally, **mullet**)
Fasito'otai (Vaialua-Falcolo)	surgeonfish, parrotfish, soldierfish, sweetlip (trevally, **mullet**)
Apolimafou-Faleolo	**mullet**, surgeonfish, soldierfish, sweetlip, rock cod, (trevally)
Manonouta and Apolimafou	**mulllet**, surgeonfish, rockcod, soldierfish, trevally (unicornfish, parrotfish, scad)
Manono and Apolima Islands	surgeonfish, **mullet**, soldierfish, parrotfish, coral cod, scad
Falelatai (Si'ufaga-Fagaiofu Bay)	**mullet**, surgeonfish, soldierfish, rockcod, trevally, parrotfish, emperor, angelfish, (unicornfish)
Lefaga (Mata'afa-Matautu)	surgeonfish, parrotfish, rockcod, soldierfish, **mullet**, coralfish
Sa'anapu (Salamumu-Lotofaga)	**mullet** , surgeonfish, rockcod, sweetlip, soldierfish, (scad)

Zone	Major reef fin-fish species
Safata (Vaie'e-Siumu)	**mullet** , surgeonfish, trevally, parrotfish, goarfish, majorras, herring, (coral cod, scad)
O le Pupu (Aganoa-Togitoniga)	surgeonfish, rockcod, parrotfish, **mullet**, coralfish (trevally, unicornfish)
Falealili (Iliili-Satalo)	surgeonfish, rockcod, **mullet**, sweetlip, soldierfish, parrotfish, scads
Salani (Sapunaoa-Lotofafa)	major groups not recorded (surgeonfish, trevally)
Lepa (Vavau-Saleapaga)	surgeonfish, soldierfish, rockcod, sweetlip, snapper, **mullet** (trevally, unicornfish)
South Aleipata (Lata-Satitoa)	snappers, parrotfish, surgeonfish, soldierfish (trevally)
North Aleipata (Malaela-Amaile)	surgeonfish, parrotfish, sweetlip, **mullet**, soldierfish, ponyfish, trevally, moray eels, coralfish (unicornfish)
Uafato (East point-Tiavea)	groups not recorded but scad reputed to be common
Fagaloa Bay (Samamea-Sauano)	surgeonfish, parrotfish, angelfish, rockcod, **mullet**, sweetlip, scad
Saluafata (Falefa-Solosolo)	surgeonfish, scad, parrotfish, barracuda, wrasses, milkfish, rockcod
Luatuanu'u (Utumau'u-Lauli'i)	**mullet** , scad, surgeonfish, parrotfish

Biology and ecology: Mullet feed on detritus, diatoms, algae and microscopic invertebrates in estuarine waters, which they filter from mud and sand through their mouth and gills (Kailola *et al*., 1993). Fish eggs may also be consumed (Randall *et al*., 1990). Most mullet species can tolerate a wide range of salinities, with some ranging into purely fresh-water, and are important in aquaculture. A few species are most at home on coral reefs (Myers, 1991).

Spawning migrations of certain mullet stocks in Western Samoa are well known in certain villages, as mentioned above, which occur during the September-November period every year. However, no biological aspect of the mullets has been studied in Western Samoa.

3.4.2 The Fishery

Utilization: Mullet is of high value in the Samoa tradition. The mullet fishery has been one of the major resources in Western Samoa in the subsistence level. Buck (1930) describes the mullet hand net (*alagamea*) as that used to catch mullet as they jump over a seine net by which they are enclosed. Long nets (*tolomatu*) were usually employed to catch mullet. Because of the sizes of these nets and of the fish schools involved, fishing using *tolomatu* was a community effort. It was normally used as a surround net and used together with *alagamea*. *Tolomatu* and *alagamea* were specifically used to catch the migrating spawning aggregations of the red-lipped mullet (*anae gutu mumu*), whereas the "other" mullet were caught with ordinary nets. The many-pointed spear (*tao fuifui*) was especially used for throwing into the midst of a shoal, such as the young mullet.

The traditional belief concerning the origin of the mullet fishery in Pu'apu'a is appended to this profile as taken from Buck (1930).

Current traditional methods of catching mullet include hand-thrown spear during night-fishing (*lama*) from a canoe with a pressured gas lantern. With the advent of cash-based economies, the resource has been subjected to severe utilisation in the artisanal/commercial sectors. As such, various methods, some destructive and very effective, have been employed in efforts to catch as much for short term needs. Schooling mullet has been the main target of dynamiting fishing which has been common and is still practised, in Western Samoa. Gill netting as well as fish weirs have also been used to catch mullet as well as other reef fish species. Mullet juveniles have been the target of most of the cast net fishery.

The major existing traditional mullet fishery is in Luatuanu'u where every year before September, a large V-shaped fence, made of chicken wire, is set at right-angles to the shore to catch the schools migrating to spawn. This particular mullet fishery sometimes last from September to December.

Production and marketing: There is no recent information available on the level of mullet consumption in the subsistence sector. Buck (1930) reported that red-lip mullet catches during its run at Moata'a were up to 3,000 at one catching. The nation-wide Fishery Catch Assessment conducted by the Department of Statistics in 1978 estimated reef fish landings of major groups in Western Samoa as presented in Table 3.4.1. Information on mullets are in bold. For the overall Western Samoa landings, mullet and milkfish constituted 5.4 per cent (30 mt) of the inshore fin-fish landings of 554 mt, 3.1 per cent of all fin-fish landings (including inshore and offshore deep-water and pelagic species) of 968 mt, and 2.8 per cent of all landings (all fin-fish and invertebrates) of 1,089 mt.

Table 3.4.1: Fishery product landings in Western Samoa as estimated during the Fishery Catch Assessment in 1978. (Source: Department of Statistics, undated).

Department of Statistics, Fishery Catch Assessment in 1978														
Island	Inshore Fin-fish					Total Inshore	**% mullet Inshore**	Total Deep-	Total Offshore	Total	**% mullet All**	Inverte-brates	Fin-fish + Inverte.	**% mullet finfish +**
Stratum	Reef fish	Caran-gidae	**Mugil-idae**	Eel	Others	Fin-fish	**Fin-fish**	water	Pelagics	Fin-fish	**Fin-fish**	Total	Total	**Inverte.**
I														
Inshore	38,010	237	644	5,183	3,224	47,298	**1.36**			47,298	**1.36**	30,816	78,114	**0.82**
Offshore								6,359	1,724	8,083			8,083	
Total	38,010	237	644	5,183	3,224	47,298	**1.36**	6,359	1,724	55,381	**1.16**	30,816	86,197	**0.75**
II														
Inshore	80,184	929	**10,086**	2,639	36,403	130,241	**7.74**			130,241	**7.74**	27,510	157,751	**6.39**
Offshore								11,800	25,937	37,737			37,737	
Total	80,184	929	**10,086**	2,639	36,403	130,241	**7.74**	11,800	25,937	167,978	**6.00**	27,510	195,488	**5.16**
III														
Inshore	37,489	733	**503**	6,518	1,876	47,119	**1.07**			47,119	**1.07**	17,114	64,233	**0.78**
Offshore								7,934	45,106	53,040			53,040	
Total	37,489	733	**503**	6,518	1,876	47,119	**1.07**	7,934	45,106	100,159	**0.50**	17,114	117,273	**0.43**
IV														
Inshore	169,402	10,954	**4,585**	5,781	2,143	192,865	**2.38**			192,865	**2.38**	26,129	218,994	**2.09**
Offshore								143,271	9,325	152,596			152,596	
Total	169,402	10,954	**4,585**	5,781	2,143	192,865	**2.38**	143,271	9,325	345,461	**1.33**	26,129	371,590	**1.23**
V														
Inshore	35,939	10,454	**2,401**	1,510	4,770	55,074	**4.36**			55,074	**4.36**	6,497	61,571	**3.90**
Offshore								23,528	30,165	53,693			53,693	
Total	35,939	10,454	**2,401**	1,510	4,770	55,074	**4.36**	23,528	30,165	108,767	**2.21**	6,497	115,264	**2.08**
VI														
Inshore	61,528	3,825	**11,784**	1,811	2,271	81,219	**14.51**			81,219	**14.51**	14,315	95,534	**12.33**
Offshore								29,704	78,913	108,617			108,617	
Total	61,528	3,825	**11,784**	1,811	2,271	81,219	**14.51**	29,704	78,913	189,836	**6.21**	14,315	204,151	**5.77**
TOTAL														
Inshore	422,552	27,132	**30,003**	23,442	50,687	553,816	**5.42**			553,816	**5.42**	122,381	676,197	**4.44**
Offshore								222,596	191,170	413,766			413,766	
Total	422,552	27,132	**30,003**	23,442	50,687	553,816	**5.42**	222,596	191,170	967,582	**3.10**	122,381	1,089,963	**2.75**

I. =Upolu northeast - Fagalii to Uafato; II. =Upolu southeast - Tiavea to Saaga; III. =Upolu southwest - Siumu to Matafa'a; IV. =Upolu Northwest - Falevai to Vailoa, including Manonon and Apolima; V. =Savai'i North - Samalaeulu to Falelima; VI. =Savai'i south - Fagafau to Pu'apu'a.

Mullet landings comprised about 4 per cent (or 15,818 kg) of the total Upolu inshore landing (415,328 kg), and about 9.2 per cent (or 14,185 kg) of the total Savai'i inshore landing (153,966 kg). Of the total Upolu fin-fish (inshore and offshore) landing of 668,979 kg, mullet made up 2.4 per cent and of the total fin-fish landing of 265,476 kg in Savai'i, mullet made up 5.3 per cent. These are summarised as follows:

	Total Inshore (kg)	Total Mullet (kg)	mullet %	Total Finfish (kg)	mullet %
Upolu	415,328	15,818	3.8	668,979	2.4
Savaii	153,966	14,185	9.2	265,476	5.3
Western Samoa	546,935	30,003	5.5	967,582	3.1

In a preliminary survey between December, 1983 and February, 1984, of the inshore fisheries of Upolu Island, Zann *et al.* (1984) estimated coral reef fin-fish production to the 8 m isobath on Upolu to be 5,593.8 mt per year and invertebrates to be 7,613.9 mt per year. Based on answers for fish consumed the day before the survey, mullet was estimated to make up 4.4 per cent of the rural production (consumption). The results are presented in Table 3.4.2 for fin-fishes, as reproduced from the same reference.

Table 3.4.2: Percentage of fish types eaten (caught) on the day before the survey. (Source: Zann *et al.*, 1984).

Taxon & habitat	Samoan name	Apia	North west	North east	South east	South central	South west	Manono Is.	Rural average
OCEANIC PELAGICS									
Skipjack	atu	28	6		6	36 (25)	13	18	8.6
Yellowfin	asiasi	11			6	2 (6)			2.1
Dolphinfish	masimasi					(3)			0.2
Rainbow runner	samani					10 (12)			1.8
CORAL REEF									
Snappers		6	8	4 (5)	33 (38)	3 (3)	(11)		9.2
Emperor	mataeleele	5	5		22 (46)	5 (6)	4 (11)	12 (7)	10.2
Coral cods	gatala		6	4 (5)	11 (8)	2	13 (8)	(7)	5.3
Moray eels	pusi	5		4			4 (12)		2.1
Goatfish	i'a sina etc				6		2		0.6
Parrotfish	fuga		20	20 (23)			6 (11)	6 (7)	7.7
Squirrelfish	malau		26	4 (5)	(8)	8 (9)	13 (31)	6	9.1
Surgeonfish	pone etc	22		40 (33)		18 (22)	21 (31)	41 (50)	21.3
Angelfish	tifitifi		6	(5)	6		(4)	12 (14)	3.1
Butterflyfish	tifitifi						(4)		0.3
REEF & LAGOON									
Barracuda	saosao, sapatu	11							
Trevally	lupo, mal[illegible]	11		(5)	6		4 (8)		1.9
Silver biddy	matu						4		0.3
Mullet	**anae**			**4 (5)**		**10 (3)**	**6 (12)**	**6 (7)**	**4.4**
Herring	pelupelu		6			2 (3)			0.9
DEEP WATER									
Jobfish	utu					(3)			0.2

King (undated) estimated species or taxa collected in the artisanal fisheries in Western Samoa using coastal ecosystems. Reef and lagoon fish estimates are given in Table 3.4.3 as reproduced from the same reference. The total artisanal annual catch (vertebrates and invertebrates) o be about 4,600 mt uming survey results depict typical fishing weeks. The mullet annual catch was estimated to be 326 mt for the whole country.

Table 3.4.3: Major fish groups collected in artisanal fisheries in Western Samoa estimated in 1989. (Source: King, undated).

English Name	Western Samoan Name	Fringing coral reef Total Annual Catch* 1,435 mt		Lagoons and a barrier reef Total Annual Catch* 2,420 mt		Lagoons, reefs and mangroves Total Annual Catch* 738 mt		All ecosystems Total Weight
		%**	Weight (mt)	%**	Weight (mt)	%**	Weight (mt)	mt
Mullet	anae	8.8	126.280	5.4	130.680	9.3	68.634	325.594
Bigeye scad	atule	1.2	17.220	2.5	60.500	0.2	1.476	79.196
Goatfish	ulaoa	1.1	15.785	0.1	2.420	3.3	24.354	42.559
Rabbitfish	lo	2.7	38.745	5.2	125.840	4.4	32.472	197.057
Emperor	mataeleele	9.7	139.195	18.6	450.120	11.7	86.346	675.661
Trevally	lupo, malauli	1.8	25.830	14.2	343.640	4.7	34.686	404.156
Surgeonfish	pone	17.9	256.865	5.2	125.840	13.2	97.416	480.121
Parrotfish	fuga	7.8	111.930	4.8	116.160	3.4	25.092	253.182
Unicornfish	ume	5.7	81.795	1.5	36.300	1.9	14.022	132.117
Soldierfish	malau	4.4	63.140	6.6	159.720	13.2	97.416	320.276
Rock cod	gatala	7.3	104.755	4.5	108.900	2.1	15.498	229.153
Moray eel	pusi	2.1	30.135	3.9	94.380	0.5	3.690	128.205
		70.5		72.5		67.9		

*includes vertebrates and invertebrates; **percentage of whole catch, vertebrates and invertebrates.

King (cited above) noted that because of the intensive nature of the survey, species which are important seasonally are absent or poorly represented. Seasonal fin-fish species are mullet and *atule*. Likewise, the species which are large and caught occasionally, e.g. sharks and turtles, may be under-represented. [However, if the surveys were during the mullet and *atule* seasons, then these species could be over-estimated]. Data collected from Luatuanu'u during the mullet run in 1989 indicate that up to 800 kg of mullet were caught per day in the village fence (trap). The mullet run during that year started in September and lasted about December. Total catch for the period was not available. [Assuming an average of 400 kg are caught per day in two 26-day months, the total mullet landing would be more 20 mt for those two months.]

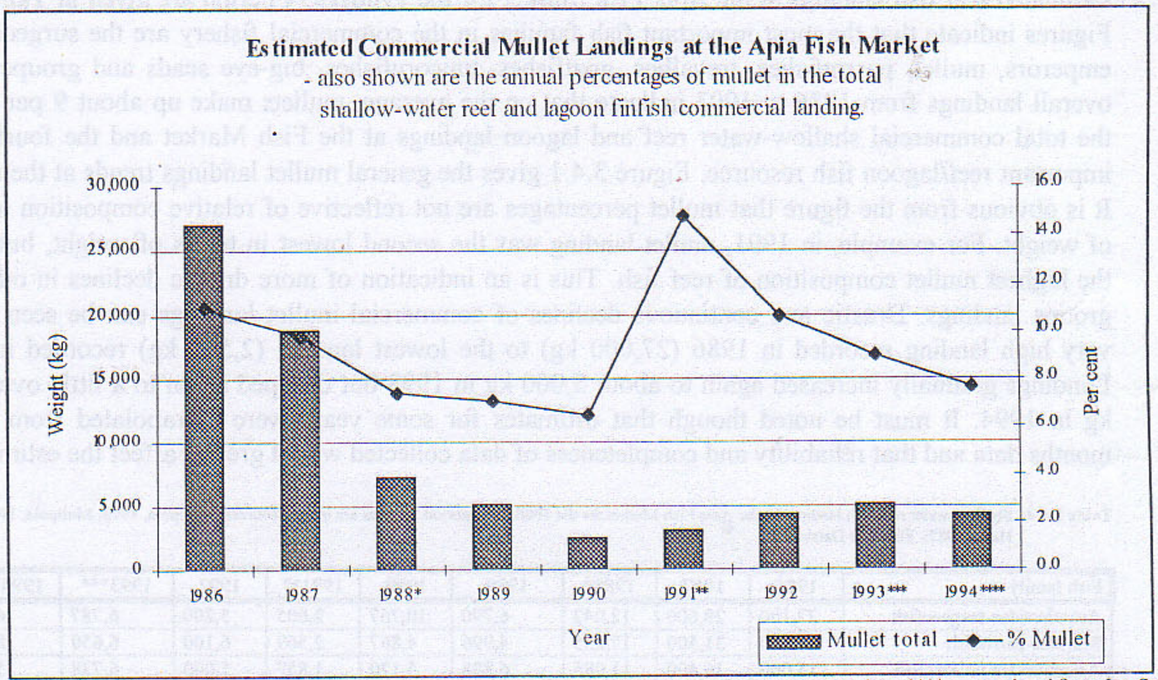
Estimated reef fish landings at the Apia Fish Market for the 1986-1994 period are given in Table 3.4.4 Figures indicate that the most important fish families in the commercial fishery are the surgeonfishes, emperors, mullet, parrotfishes, trevallies, goatfishes, unicornfishes, big-eye scads and groupers. The overall landings from 1986 to 1993 indicate that on the average, mullets make up about 9 per cent of the total commercial shallow-water reef and lagoon landings at the Fish Market and the fourth most important reef/lagoon fish resource. Figure 3.4.1 gives the general mullet landings trends at the market. It is obvious from the figure that mullet percentages are not reflective of relative composition in terms of weight. For example, in 1991, mullet landing was the second lowest in terms of weight, but it was the highest mullet composition of reef fish. This is an indication of more drastic declines in other fish groups landings. Drastic and continuous declines of commercial mullet landings can be seen from a very high landing recorded in 1986 (27,000 kg) to the lowest landing (2,500 kg) recorded in 1990. Landings gradually increased again to about 5,000 kg in 1993 but dropped again to a little over 4,000 kg in 1994. It must be noted though that estimates for some years were extrapolated from several months data and that reliability and completeness of data collected would greatly affect the estimates.

Table 3.4.4: Shallow-water reef fish landings at the Apia Fish Market for the 1986-1993 period. Figures are in kg. (Sources: Mulipola, 1993; Mulipola, 1994; Helm, 1987; Fisheries Database).

Fish family	1986	1987	1988*	1989	1990	1991**	1992	1993***	1994****
Acanthuridae-surgeonfish	27,100	28,600	12,042	6,790	10,767	2,605	5,200	6,787	6,568
Scaridae-parrotfish	27,100	31,500	17,235	4,996	4,867	2,569	6,100	6,650	8,054
Acanthuridae-unicornfish	15,000	16,400	11,085	6,888	5,120	1,857	5,000	6,778	5,310
Serranidae-grouper	6,900	12,000	1,616	1,671	591	579	1,800	3,374	2,343
Siganidae-rabbitfish	2,500	2,100		6,769			700	1,507	1,493
Lutjanidae-snapper	5,200	3,400		2,096			1,700	3,134	2,261
Mullidae-goatfish	18,000	16,800	820	4,701		542	3,000	4,466	3,620
Holocentridae-soldierfish	2,700	6,500		650			1,400	2,580	2,849
Lethrinidae-emperor	59,000	28,700	12,962	5,681	5,893	2,060	7,500	7,608	6,963
Gymnothorax?-moray eel	8,400	4,600	7,483	1,924	1,375	284	1,000	2,086	2,987
Mugulidae-mullet	**27,100**	**18,900**	**7,234**	**5,101**	**2,542**	**3,056**	**4,400**	**5,093**	**4,393**
Carangidae-jacks and trevally	19,900	5,000	2,699	11,079	1,019	891	2,000	2,177	2,210
Gerreidae-silver biddy	2,000	400	1,588			89	200	1,536	1,460
Carangidae?-scad	12,500	600	3,529	497		1,200	200	48	4,864
Labridae-wrasses	2,000	1,500							
Other	10,800	15,100	19,089	198	6,997	4,950	1,300	1,982	1,549
Chanidae-milkfish				7,776				864	418
Kyphosidae-drummerfish				222					
Ponyfish				5,060					
Shallow-water reef fish total	246,200	192,100	97,382	72,099	39,171	20,682	41,500	56,671	57,342
Mullet total	**27,100**	**18,900**	**7,234**	**5,101**	**2,542**	**3,056**	**4,400**	**5,093**	**4,393**
% Mullet	11.01	9.84	7.43	7.07	6.49	14.78	10.60	8.99	7.66

*extrapolated from Jan-Oct data; **extrapolated from Jan-May data; ***extrapolated data from Aug to Dec data; **** extrapolated from Jan-Sept data. The 1994 Lutjanidae were all savane & malai.

Figure 3.4.1: Trends in the commercial mullet landings in the Apia Fish Market. Mullet percentages are mullet composition of the total shallow-water reef anf lagoon fin-fish landings at the market.



*extrapolated from Jan-Oct data; **extrapolated from Jan-May data; ***extrapolated from Aug to Dec data; **** extrapolated from Jan-Sept data.

Brotman (1989) estimated the shallow-water reef and logoon fin-fish landings at wholesalers, retailers and hotels to be about 56 mt. Mullet was noted as one of the major groups contributing to the estimated landing. However, the author did not give relative estimates for each fish group.

The survey on the roadside from Apia to Faleolo recorded the following statistics for reef fish in 1992:

Fish	Wt (kg)	Fish	Wt (kg)
Surgeonfish	1,069	Snapper	328
Parrotfish	1,192	Soldierfish	273
Unicornfish	603	Emperor	5,430
Grouper	566	Trevally	359
Rabbitfish	212	Mullet	1,913
Moray eel	270	Silver biddy	4
Scad	104	Other fish	1,970

3.8.3 Stocks Status

There has been no attempt to assess the stocks of mullet in Western Samoa or study any biological aspect of the species present. However, observations on catches in areas where mullet are important all indicate the declining trends not only in numbers but in average mullet size captured. Mullet used to be an important resource for the gillnet fishery within Safata Bay. Gillnet is no longer used as the big mullets are absent. The traditional red-lip mullet fishery at Pu'apu'a, Savai'i has virtually disappeared. The villagers believe that this has come about "because catches were offered for sale" (Bell, 1989). Mullet catches at Luatuanu'u during spawning migrations are known to be declining both in numbers and in average sizes of individual fishes. Traditional beliefs in this particular village does not allow people from outside the village to be present during fishing operations, and mullet caught in the trap are not allowed to be sold. Even though these beliefs, in a way, may seem to help in controlling the harvesting of the migrating stocks, in reality, the village would catch as much as can be caught. Mullets that manage to jump over the trap are mostly caught by villagers standing outside the trap with mullet hand nets (*alagamea*) individually operated. Mullets caught in this manner do not go into the village catch. Apart from catches made in the trap, villagers are allowed to fish these stocks outside the reef or nearby areas after the village catch has been made, mostly in the late afternoon. The red-lip mullet fishery at Manono Island and Nu'ulopa islet has become seriously affected by overfishing through the extensive use of gillnets and dynamiting on spawning stocks. Schools of mullet have always been the main target of the dynamite fishery. [Cases of dynamite fishing have been recorded in Toamua, Faleula, Leauva'a, Manono, Falelatai, Safata.] Zann (1991) noted that Vaiusu Bay used to be a major nursery ground for mullet but has been degraded by dumping, sand mining, industrial pollution and reclamation. Juvenile mullet schooling in nursery areas like mangroves, have been targets of the cast-net fishery in areas where they occur.

Commercial landings recorded at the Apia Fish Market indicate a drastic and continuous decline in mullet landings from 27,000 kg estimated in 1986 to 2,500 kg in 1990. This represents a decline of about eleven fold. Even though the estimated landings started to gradually increase in the following years (after 1990), a decrease was again noted from 1993 to 1994. Mullet landings for the last four years were around 4-5000 kg per year, which is about 5 to 6 times lower than that recorded in 1986. Three possible explanations or combinations of these contribute to the recorded drastic declines in commercial mullet landings, especially from 1986 to the 1990's:

(1) actual drastic declines in mullet stocks due to overfishing;
(2) development of additional distribution outlets thus product landing at the Apia Fish Market has been "thinning" out;
(3) inconsistency and inaccuracy in data collection and analysis systems employed.

It is suspected that all of the three factors mentioned above contribute in varying degree. However, it is presumed that actual declines in mullet stocks due to various type of over-fishing is the main factor affecting the declines.

3.8.4 Management

Current legislation/policy regarding exploitation: Fisheries Act 1988: Part II, 4 (1) (a) of the Act prihibits the use or attempt to use of any explosive, poison or other noxious substance for the purpose of killing, stunning, disabling or catching fish, or in any way rendering fish more easily caught. Paragraph (b) makes it illegal to carry or have in possession or control any explosive, poison or other noxious substance in circumstances indicating an intention to use such for any of the purposes referred to in (a). Under subsection (2), any explosive, poison or other noxious substance found on board any fishing vessel shall be presumed, unless the contrary is proved, to be intended for the purpose referred to in subsection (1)(a). Subsection 3 makes it illegal for any person to land, sell receive or possess fish taken in contravention of subsection (1)(a), which he knows or has reasonable cause to believe they were so taken. Part II, 5 requires local commercial fishing vessels to have a valid certificate of registration.

Fines: Contravention of Section 4(1) is a fine of 1,000 tala and imprisonment for a term not exceeding 2 years except that no sentence of imprisonment shall be imposed under this subsection for an offence committed in the exclusive economic zone. Contravention under Section 4(3) is a fine not exceeding 1,000 tala.

Proposed Local Fisheries Regulations: Part I, 3 (1) and (2) of the proposed Local Fisheries Regulations proposes to prohibit the catching and selling of mullet (genus *Mugil*) less than 200 mm in length measured from the furthermost point of the snout to the middle of the tailfin when the fish is laid flat. Part I, 4 of the same proposed regulations empowers the Director to declare a period or periods as prohibited for fishing mullet and other fish species as follows:

Common name	Samoan name	Scientific name
Grey mullet	**anae, afa, ulupona**	**Mugil species**
Rock cods, groupers	gatala.	Serranus species
Bigeye scad	atule	Selar crumenophthalmus
Hawksbill turtle	laumei (una or faiuna)	Eretmochelys imbricata
Green turtle	laumei	Chelonia mydas

Part I, 5, proposes to allow only the following fishing gear unless authorised by a license issued in accordance with the Fisheries Act 1988:

a. beachnets and castnets with a mesh size not less than 30 mm, measured when wet and stretched;
b. all other nets shall have mesh size of not less tham 50 mm, measured when wet and stretched;
c. fishfences shall have a mesh size not less than 50 mm measured when wet and stretched irrespective of the material used to make them.

Recommended legislation/policy regarding exploitation: Rigorous enforcement of the existing laws, e.g. dynamite fishing, is necessary. Additional considerations could include:

⇒ banning or limiting the number of fish fences that can be set up in various zones along the country's coastline. Limiting the number can be done through a permiting system in which a fisherman wanting to set up a fish fence must obtain an annual permit first. The Fisheries Division can determine the number of fish fences that can be erected in fisheries zones within the country. In addition, specific legislations must be added to limit fish fence size and to hold every fish fence permit holder responsible for the removal (disposal) of damaged or rusting fence, he/she has set up, from the sea and dispose of in a responsible manner, on land. Likewise, fences must be so placed that it will not damage any coral during the set-up and removal operations or unlikely to affect corals in the event of a cyclone or rough weather. [Specifics can include setting a minimum distance from corals and reefs, interfer with other uses of the area, such as navigation, subsistence fishing etc].

⇒ controlling the use of cast nets, by banning use or limiting numbers. Limiting numbers can be done via a permiting system in which numbers are controlled in the sales or number of fishermen involved in a particular zone.

⇒ limit length sizes of various nets.

Because there are more than one genus of mullet in Western Samoa, it would be necessary to list all the mullet genera in regulations that cover them in general. Listing *Mugil* spp. to refer to all mullet species is wrong, unless Mugil sp. is defined in the regulations to mean all genera and species of mullet. And due to the fact that different specieshave different growth rates and reach sexual maturity at different sizes, application of one minimum size limit to cover all mullets is impractical. Therefore, it might be necessary to list species with its specific corresponding minimum size limit, except for species that may have similar growth and maturity parameters.

A major problem concerning the application of and upholding national legislation for the mullet fishery in certain locations during their spawning migrations, e.g. Luatuanu'u, is the involvement of community in a traditional way. It has been documented that fishing on spawning aggregations render the fish exceptionally vulnerable to overfishing leading to possible local extinction. However, traditional fishing of spawning aggregations present opportunities for integration of traditional knowledge and management with modern scientific management tools. This of course would require education and training which can be done through extension work. Because of traditional ties to the fishery, introduction of any management strategy will have to be done through traditional means geared towards a community-based management system. Possible starting points for the introduction of some management ideas in the Luatuanu'u mullet fishery is for the village to prohibit the catching of mullet that jump over the trap, and to prohibit fishing of the migrating stock in any other method and time except in the village trap. Gradually, and with accumulation of scientific knowledge on stock yields, migration patterns and other biological factors, limiting the number of catching days and setting a quota can be introduced, all through the community. This would mean conducting extensive research first, on migration patterns and to determine other biological parameters concerning the stocks.

In order to establish management strategies that would be appropriate to apply, especially on migrating aggregations, research is required first to determine lunar periodic, seasonal and interannual variation in aggregation sizes, their functions, and the fishing pressure on them (Johannes, 1993).

One of the most important factors that is affecting the shallow-water fishery is the destruction of mangrove through various undertakings such as reclamation, dredging for sand, pollution, and manual destruction by cutting and rubbish dumps. Any development that is likely affect the mangroves should be discouraged and be subjected to proper and thorough environmental impact assessments.

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Fowler (1963? 1934?)

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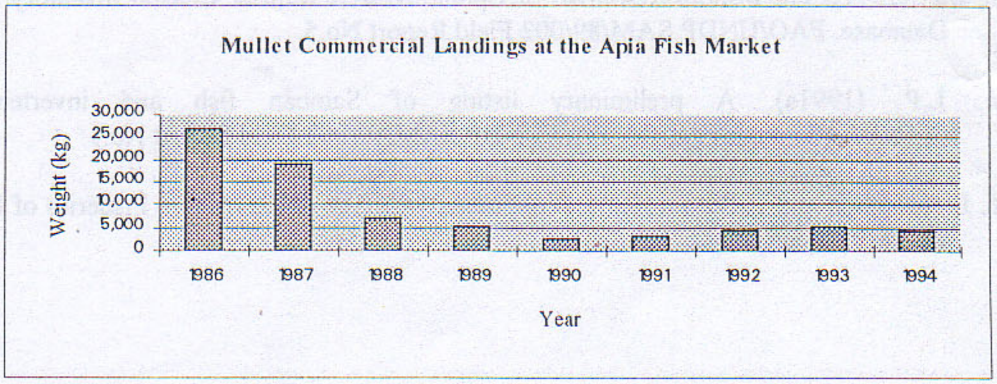
Mullet Commercial Landings at the Apia Fish Market
Weight (kg)
30,000
25,000
20,000
15,000
10,000
5,000
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
Year

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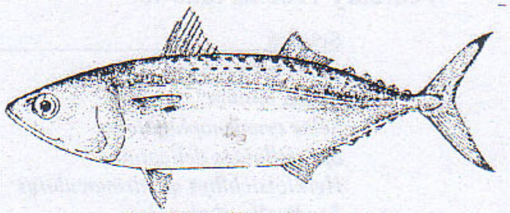
3.5 Small pelagics (baitfish)

3.5.1 The Resource


ga - Rastrelliger kanagurta

Species present: Most of the species discussed in this section include those which are normally considered as bait-fish for the skipjack pole-and-line fishery. Some species, especially big-eye scad (Selar), mackerel (Rastrelliger), and a sardine, form important components of both the subsistence and artisanal local fisheries.

Small pelagic species reported from Western Samoa include the following, which have been categorized into common family names as defined by Dalzell (1993):

Anchovies	*Stolephorus indicus* (*nefu*), *S. devisi* (gold anchovy - *nefu*), *S. buccaneeri* (*nefu*, *file*), *Thrissina baelma*?? (*nefu*).
Flyingfish:	: *Cheilopogon unicolor*, *C. antoncichi*, *C. spilonotopterus*, *C. atrisignis*. (*malolo*).
Fusiliers	: *Caesio diagramma*, *C. chlorurus*.
Half-beaks	: Hemirhamphidae (*ise*)
Herrings	: *Herklotsichthys quadrimaculatus* (gold spot herring - *pelupelu*), *Allanetta forskali* (round herring - *sali*), *Harengula ovalis* (herring - ??).
Mackerels	: *Rastrelliger kanagurta* or *R. brachysoma*? (*ga*).
Round herrings	: *Dussumieri acuta* (*pelupelu*).
Sardines	: *Amblygaster sirm* (spotted sardinella - ?), *Sardinella albella* (? - *pelupelu*), *S. gibboas* (*salala*, *pua*?).
Scads	: *Selar crumenopthalmus* (bigeye scad - *atule*), *Atule mate* (yellowtail scad -), *Decapterus macrosoma* (scad - *atuleau*), *D. macarellus* (roundscad - *atuleau/opelu*), *D. russelli*.
Silversides	: *Athrinomorus lacunosus* (broad-band silverside - ?), *Hypoatherina ovalaua* (ovalaua silverside - ?), *Atherinomorus lacunosa* (=*Pranesus pinguis*).
Sprats	: *Spratelloides delicatulus* (blue sprat - *nefu/poi*), *S. gracilis*, (? - *nefu/poi*).

Anon (1969) noted that *nefu*, despite its similarity in name to the Hawaiian *nehu*, *Stolephorus purpureus*, by virtue of its habitat is more likely to be a round herring, *Sprateloides delicaturus*, although it was described as *Stolephorys delicaturus* by Jordon and Seale (1906).

Garlovsky (1972) listed *pelupelu* as *Harengula commersoni* as reported by Jordon and Seale (1906). Kramer (1903, translated by Beer and Bear, 1930) classified *pelupelu* as *Clupea atricauda*. ***Unavau*** was reported as a poisonous stage of *pelupelu* at *palolo* season. Other species names given were *C. venenosa* and *C. thissa*. Milner (1966, cited by Garlovsky, 1972) stated that ***unavau*** "is a poisonous species of Acanthurus, or perhaps a morbid condition of a fish of genus Sardinella". ***Atule*** was wrongly identified by Kramer (1903) as *Caranx affinis*, and ga as Bennett's *Thynnus germo*. Jordon and Seale (1906) identified *ga* as *Scomber loo*.

Tuna Programme (1984) reported the catches of the 10 dominant baitfish species in 14 bouki-ami hauls made by the SPC Skipjack Programme in five diffferent sites in Western Samoa in June 1978 and

February 1980 as follows:

Species	Catch (kg)	% of Total
Stolephorus devisi	752	66.5
Gazza minuta	263	23.3
Selar crumenophthalmus	33	2.9
Spratelloides delicatulus	16	1.4
Herklotsichthys quadrimaculatus	9	0.8
Sardinella clupeoides	4	0.4
Sardinella melanura	4	0.4
Sphyraenidae sp.	3	0.3
Parapriacanthus sp.	3	0.3
Priacanthus sp.	2	0.2

Distribution: Dalzell (1993) gives some details of the distribution of the small pelagics in the South Pacific. The smaller gracile stolephorid anchovies, particularly *E. heteroloba* and *E. devisi* and the sprats, *Sp. gracilis* and *Sp. delicatulus* (and *Sp. lewisi* in the waters of PNG and Solomon Islands) are found in the coastal lagoons of the coralline areas. The larger anchovies, including *Thryssa balaema*, *T. setirostris* and the larger stolephorids such as *St. indicus* and *St. waitei*, are often found in lagoons and passages that are bordered by mangroves. The bigeye scads inhabit about the same area as anchovies and clupeids. The fusiliers' (*Caesio* and related genera) distribution is determined largely by the extent of coral cover, which is associated with shallow coastal water (<30 m depth). The mackerels (*Rastrelliger* spp) occur further offshore whereas the roundscads (*Decapterus* spp.) are found between the neritic and oceanic areas, with flying fishes inhabiting both inshore waters and open ocean (Dalzell and Lewis, 1989). Kovalevskaya (1982, quoted in Gillett and Ianelli, 1993) notes that flyingfish species common in the tropical Pacific have limits of distribution bounded by 40° S and 40° N. Gillett and Ianelli (1993) note that depth at which flyingfish occurs affect the catchability in night surface fisheries. During the night, flyingfish is distributed as deep as 18 m with about 86 per cent found in the first 0-2 m layer (Nesterov and Bazanov, 1986, quoted in Gillet and Ianelli, 1993).

In Western Samoa the *atule* is in season from around March to August, and is caught in lagoons and just beyond the barrier reefs. Anon (1969) noted that *nefu*, probably *S. delicaturus*, was reported to be abundant in the open waters beyond reefs of Poutasi village. The same reference reported that an unusually large number of young *atule* (bigeye scad), measuring about 8 inches in length or seven specimens to a pound, were observed, during May, migrating into the shoal waters of Apia Harbour where they were netted in large quantities by the canoe fishermen. During the FAO Local Tuna Fisheries Project in the early 1970s, some baitfishing operations were undertaken. Results of species occurrences in catches made in different sites are as follows, as given in Gulbrandsen and Paulo (1974). Unfortunately, species were not given:

Area	Month, Year	Time	Species
Apia harbour	May, 1974	day	sardines and *nefu* (anchovy)
Apia harbour	June, 1974	night	no bait
Apia harbour	June, 1974	day	sardines
Apia harbour	"	day	sardines and *nefu*
Apia harbour	July, 1974	day	*nefu*
Apia harbour	"	day	*sali* (silverside)
Apia harbour	"	day	*nefu* (anchovy)
New Market	July, 1974	day	*sali*
Mulinu'u	May, 1974	day	sardines and mullets
			sardines, mullets and goatfishes
Vaitele Bay	May, 1974	day	*sali* and *iiha*
Matautu Point	June, 1974	day	silver-side
Fagaloa Bay	July, 1974	day	nefu and sardine

The SPC Skipjack Programme conducted baitfish operations in five diffferent sites in Western Samoa in June 1978 and February 1980. Species recorded in catches from these operations are reproduced in Table 3.5.1 from Tuna Programme (1984).

Table 3.5.1: Baitfishing results during the SPC Skipjack Programme in Western Samoa in June 1978 and February 1980. (Source:Tuna Programme, 1984).

Anchorage	Time	Number of hauls	Dominant species	Other common species
Apia harbour	night	2	*Selar crumenophthalmus* *Herklotsichthys quadrimaculatus* *Sardinella melanura*	*Gazza minuta* Sp. of Sphyraenidae *Stolephorus devisi*
Fagaloa Bay	night	8	*Stolephorus devisi* *Spratelloides delicatulus* *Priancanthus* sp.	Sp. of Acanthuridae Sp. of Balistidae *Gastrophysus* sp.
Manono Island	night	1	*Spratelloides delicatulus* *Parapriacanthus* sp. *Xiphasia* sp.	*Siphamia* sp. Sp. of Acanthurus *Bregmaceros* sp.
Vailele Bay	night	1	*Sardinella leiogaster* *Spratelloides delicatulus* *Atherinomorus lacunosa*	*Spratelloides gracilis* *Stolephorus indicus* *Bregmaceros* sp.
Falefa Harbour	night	2	*Stolephorus devisi* *Gazza minuta* *Spratelloides delicatulus*	*Herklotsichthys quadrimaculatus* *Selar crumenophthalmus* Sp. of Holocentridae

The Western Samoa Department of Statistics conducted a nation-wide Fishery Catch Assessment Survey in 1978. Carangidae (which included jacks and scads) were recorded in all of the six strata used.

Zann *et al*. (1984) recorded herring as important in northwest Upolu and south central Upolu. King (undated) reported *atule* landings in artisanal fisheries to be more in coastal ecosystems with lagoons and a barrier reef and lesser in those with lagoons, reefs and mangroves and with fringing coral reefs. Zann (1991), from surveys and interviews conducted through-out Upolu, recorded the following important fish species within zones indicated, in order of importance. *Atule* and herring are in **bold**.

Zone	Major reef fin-fish species
Apia East (Vaipuna-Letogo & Apia west (Vaiala-Vaigaga)	surgeonfish, mullet, **bigeye scad**
Faleula (Saina-Tuana'i)	surgeonfish, mullet, parrotfish, sweetlips, snappers, trevally
Ututali'i (Leauva'a-Fasito'outa)	surgeonfish, parrotfish, sweetlip, soldierfish (trevally, mullet)
Fasito'otai (Vaialua-Faleolo)	surgeonfish, parrotfish, soldierfish, sweetlip (trevally, mullet)
Apolimafou-Faleolo	mullet, surgeonfish, soldierfish, sweetlip, rock cod, (trevally)
Manonouta and Apolimafou	mulllet, surgeonfish, rockcod, soldierfish, trevally (unicornfish, parrotfish, **bigeye scad**)
Manono and Apolima Islands	surgeonfish, mullet, soldierfish, parrotfish, coral cod, **bigeye scad**
Falelatai (Si'ufaga-Fagaiofu Bay)	mullet, surgeonfish, soldierfish, rockcod, trevally, parrotfish, emperor, angelfish, (unicornfish)
Lefaga (Mata'afa-Matautu)	surgeonfish, parrotfish, rockcod, soldierfish, mullet, coralfish
Sa'anapu (Salamumu-Lotofaga)	mullet , surgeonfish, rockcod, sweetlip, soldierfish, (**bigeye scad**)

Zone	Major reef fin-fish species
Safata (Vaie'e-Siumu)	mullet , surgeonfish, trevally, parrotfish, goarfish, majorras, **herring**, (coral cod, **bigeye scad**)
O le Pupu (Aganoa-Togitoniga)	surgeonfish, rockcod, parrotfish, mullet, coralfish (trevally, unicornfish)
Falealili (Iliili-Satalo)	surgeonfish, rockcod, mullet, sweetlip, soldierfish, parrotfish, **bigeye scad**
Salani (Sapunaoa-Lotofafa)	major groups not recorded (surgeonfish, trevally)
Lepa (Vavau-Saleapaga)	surgeonfish, soldierfish, rockcod, sweetlip, snapper, mullet (trevally, unicornfish)
South Aleipata (Lata-Satitoa)	snappers, parrotfish, surgeonfish, soldierfish (trevally)
North Aleipata (Malaela-Amaile)	surgeonfish, parrotfish, sweetlip, mullet, soldierfish, ponyfish, trevally, moray eels, coralfish (unicornfish)
Uafato (East point-Tiavea)	groups not recorded but **bigeye scad** reputed to be common
Fagaloa Bay (Samamea-Sauano)	surgeonfish, parrotfish, angelfish, rockcod, mullet, sweetlip, **bigeye scad**
Saluafata (Falefa-Solosolo)	surgeonfish, scad, parrotfish, barracuda, wrasses, milkfish, rockcod
Luatuanu'u (Utumau'u-Lauli'i)	mullet , **bigeye scad**, surgeonfish, parrotfish

Biology and ecology: Most studies on the small pelagic fishes in the Pacific have concentrated on the species that are important to the pole-and-line fishery, which include anchovies, sprats and clupeids. However, "the biology of the small mackerels, flying fishes, scads and halfbeaks has tended to be neglected in the region" (Dalzell, 1993). But one important study was conducted by Conand (1986) on the biology and ecology of the larger small pelagic fishes and the smaller clupeoid species in the lagoon of New Caledonia (quoted in Dalzell, 1993). Based on their life history parameters, Conand (1986), Lewis (1990) and Dalzell (1993) separated the tropical small pelagic fishes into three groups as follows:

Group	Life cycle	Size	Growth	Age sexual Maturity	Spawning period	Batch fecundity
1	< 1 year	7-10 cm max	rapid	3-4 months	extended period	500-1500 oocytes/grm of fish
Species: Stolephorid anchovies (*E. heteroloba, E. devisis, E. punctifer*), Sprats (*S. gracilis, S. delicatulus, S. lewisi*) and Silverside (*Hypoatherina ovalau*)						
2	1 to 2 years	10-24 cm max	-	towards end first year	restricted seasonal	300-500 oocytes/grm of fish
Species: Herring and sardines (*Herklotsichthys* spp., *Amblygster* spp., *Sardinella* spp.), Larger anchovies (*Thrissina* spp.,*Stolephorus*spp), Sharp nosed sprats (*Dussumieris* spp.).						
3	2-5 years	20-35 cm max	-	-	restricted seasonal	400-600 oocytes/grm of fish (50-100 for flying fish)
Species: Round scads (*Decapterus* spp), Big eye scads (*Selar* spp), Small mackerels (*Rastrelliger* spp), Flying fish (Exocoetidae), Half beaks (Hemiramphidae).						

Tropical flyingfishes grow rapidly with many species spawning several times per year. Small species spawn between 400 and 1,100 eggs at a time, with the larger forms in certain species in the genera *Cheilopogon*, *Cyselurus*, and *Hirundichthys*, having fecundity ranging between 16,000 and 24,000 eggs (Gillett and Ianelli, 1993; Kovalevskaya, 1982, quoted in Gillett and Ianelli, 1993).

Dalzell (1993) gave a summary table for the growth, mortality and maturity parameters for a number of small pelagic fish species in the South Pacific, and is reproduced in Table 3.5.2. The parameters calculated for Tonga, only for those species listed, are also included, for comparison.

Table 3.5.2: Biological parameters for some small pelagic fish species in the South Pacific.

Species	Location	$L\infty$ (cm)	K (yr^{-1})	M (yr^{-1})	t_{max} (year)	Lm (cm)	$L_m/L\infty$	Ref
Encrasicholina heteroloba	PNG	7.9	2.6	4.9	1.0	5.1	0.65	Dalzell (1984)
Stolephorus waitei	PNG	10.9	1.7	3.4	1.5	7.3	0.67	Dalzell (1987, 1989)
Spratelloies delicatulus	Fiji	7.3	4.6	6.9	0.4	4.0	0.55	Dalzell *et al* (1987)
Atherinomorus lacunosus	New Caledonia	11.4	2.5	4.1	1.2	8.5	0.75	Conand (1988)
Herklotsichthys quadrimaculatus	Fiji	12.6	2.0	3.5	1.6	9.5	0.75	Dalzell *et al* (1987)
Herklotsichthys sp.	Vava'u, Tonga	14.7	1.30	2.0		16.0		King *et al.* (1994)
Amblygaster sirm	New Caledonia	22.9	1.5	2.4	2.0	15.0	0.66	Conand (1988)
	Vava'u, Tonga	23.2	0.97	1.5		270		King *et al.* (1994)
Decapterus russelli	New Caledonia	24.9	1.3	2.1	3.0	18.0	0.72	Conand (1988)
Selar crumenophthalmus	Hawaii	27.0	2.57	3.4	2.0	23.0	0.85	Kawamoto (1973)
Rastrelliger kanagurta	New Caledonia	23.7	3.0	3.7	1.0	20.0	0.87	Conand (1988)

Gillett and Ianelli (1993) note that flyingfish in the tropics generally live to about 2 years of age and are mature after 10-14 months. In addition, many of the commercially important flyingfish species from the genera *Hirundichthys*, *Cypselurus*, and *Cheilopogon* grow to about 20-25 cm and attain weights of 300-450 g.

Most of the small pelagics are considered planktivorous, though scads, mackerel and the larger anchovies feed on small fishes. For flyingfishes, their food consists mainly of large zooplankton and small fish (Gillett and Ianelli, 1993). Flyingfish fall prey to skipjack tuna and large pelagics in the Pacific islands as well as yellowfin tuna as recorded in the eastern Pacific (South Pacific Commission, 1980-1985; Olson and Boggs, 1986, quoted in Gillett and Ianelli, cited above).

In Western Samoa, fishing for *atule* takes place when it migrates inshore before moving offshore to spawn. *Atule* starts appearing in inshore areas around March, peaking in the May-July period and gradually decrease in numbers until October.

3.5.2 The Fishery

Utilization: Small pelagic species, especially ***atule*** (big-eye scad), ***ga*** (mackerel) and ***pelupelu*** (a sardine), have been important in the subsistence fishery. ***Atule*** and ***ga***, especially the former, form major portions of inshore catches in the subsistence and artisanal/commercial landings when in season. Traditionally, ***atule*** is caught by trolling from canoes within lagoons or just off the reefs using lures which are made from bird feathers or shells. Traditional lures have been replaced by those commercially available. In some communities, e.g. Moata'a, large monofilament surround nets are used to catch ***atule*** during its run (season). Fish weirs (fnce) made from chicken wire are specially placed in certain areas in Apia to catch ***atule*** during the season. Large ***atule*** are often caught in set gillnets. ***Pelupelu*** is caught by cast nets and is mainly for subsistence use only. Large schools of ***atule*** have also been targets of dynamite fishing in certain areas in Western Samoa. ***Atule*** forms a major portion in the commercial inshore fin-fish landing at the Apia Fish Market.

Production and marketing: No accurate data is available on the production/consumption of the small pelagic species in the subsistence sector in Western Samoa. However, these resources have been important sources of food to the local communities, especially when they are in season.

Five day time seine sets made in the Apia Harbour by the NMFS research vessel Charles H. Gilbert, in April, 1970, caught 13 buckets of large (3-4 inches) silverside (*Hepsetia pinguis*?) and 5 buckets of small (2.5 inches) sardines (Hida, 1970). Baitfishing operations during the FAO Western Samoa Local Tuna Fisheries Project, 1971-1974 established that the baitfish resource is not sufficient to support the operation of commercial pole-and-line vessels. Data from some of these baitfishing operations (using beach seine?) as recorded in Gulbrandsen and Paulo (1974) are recorded in Table 3.5.3.

Table 3.5.3: Catches of beach seine baitfishing during the FAO Local Tuna Fisheries Project in Western Samoa in 1974. (Source: Gulbrandsen and Paulo, 1974.

Area	Date	Time	No. of sets	Bait species	No. of buckets
Apia habour	5/1974	day	3	Sardines & Nefu	0.5
	6/1974	day	3	Sardines	1
	6/1974	day	5	Sardine & Nefu	2.5
	6/1974	day	1	Nefu (anchovy)	?
	7/1974	day	3	Nefu	8
	7/1974	night	1	none	
	7/1974	night	1	none	
	7/1974	day	5	Sali & silver-side	2
	7/1974	day	1	Nefu (anchovy)	5
	7/1974	day	1	Nefu	8
	7/1974	day	2	Nefu	5
	7/1974	day	1	Nefu	5
	8/1974	day	3	Sardines	1
	8/1974	day	6	Nefu & Sardines	2
	8/1974	day	3	Nefu & Sardines	5
	8/1974	day	2	Nefu, Sardines & Goatfish	5
	6/1974	night	2	none	

Area	Date	Time	No. of sets	Bait species	No. of buckets
Fagaloa Bay	7/1974	night	-	no bait	
	7/1974	night	-	no bait	
	7/1974	day		Nefu & Sardines	0.5
Manono-uta	5/1974	day	shoreline scouting	observed 100 buckets of juvenile mullet over sandy bottom	
Matautu Point	5/1974	day	shoreline scouting	observed 30 buckets of silverside over coral bottom	
	5/1974	day	3	Silverside	25%
Mulifanua	5/1974	day	shoreline scouting	observed 20? buckets of juvenile mullet over rocky bottom	
Mulinu'u	5/1974	day	7	Sardines & mullets	7
	5/1974	day	7	Sardines, mullet & goatfish	1
New Market, Apia	7/1974	day	1	Sali	2
Safata Bay	8/1974	day	8	Nefu and Sardines	4
Vaiala Beach	6/1974	day	1	none	
Vaitele Bay	5/1974	day	1	Sali and Iiha	0.5

Catch and effort summaries from baitfishing operations, using bouki-ami, in Western Samoa waters by the SPC Skipjack Programme are presented in Table 3.5.4a, by anchorage, as reproduced from Tuna Programme (1984). Table 3.5.4b gives the overall catch composition for the 10 dominant baitfish species, also reproduced from the same reference.

Table 3.5.4a: Baitfishing results during the SPC Skipjack Programme in Western Samoa in June 1978 and February 1980. (Source: Tuna Programme, 1984).

Anchorage	Time	Number of hauls	Dominant species	Est. Av. Catch per haul (kg)	Mean length (mm)	Other common species
Apia harbour	night	2	*Selar crumenophthalmus*	17	151	*Gazza minuta*
			Herklotsichthys quadrimaculatus	5	78	Sp. of Sphyraenidae
			Sardinella melanura	3	100	*Stolephorus devisi*
Fagaloa Bay	night	8	*Stolephorus devisi*	31	69	Sp. of Acanthuridae
			Spratelloides delicatulus	1	23	Sp. of Balistidae
			Priancanthus sp.	1	45	*Gastrophysus* sp.
Manono Island	night	1	*Spratelloides delicatulus*	9	46	*Siphamia* sp.
			Parapriacanthus sp.	3	39	Sp. of Acanthurus
			Xiphasia sp.			*Bregmaceros* sp.
Vailele Bay	night	1	*Sardinella leiogaster*	5	200	*Spratelloides gracilis*
			Spratelloides delicatulus			*Stolephorus indicus*
			Atherinomorus lacunosa			*Bregmaceros* sp.
Falefa Harbour	night	2	*Stolephorus devisi*	252	62	*Herklotsichthys quadrimaculatus*
			Gazza minuta	130	89	*Selar crumenophthalmus*
			Spratelloides delicatulus			Sp. of Holocentridae

Table 3.5.4b: Baitfish species composition from bouki-ami hauls in Western Samoa waters made by the SPC Skipjack Programme. (Source: Tuna Programme, 1984).

SUMMARY	
Number of bouki-ami hauls	14
Total weight bait caught	1,130.0 kg
Average catch per haul	130.3 kg

CATCH DETAILS		
Species	**Catch (kg)**	**% of Total**
Stolephorus devisi	752	66.5
Gazza minuta	263	23.3
Selar crumenophthalmus	33	2.9
Spratelloides delicatulus	16	1.4
Kerklotsichthys quadrimaculatus	9	0.8
Sardinella clupeoides	4	0.4
Sardinella melanura	4	0.4
Sp. of Sphyraenidae	3	0.3
Parapriacanthus sp.	3	0.3
Priacanthus sp.	2	0.2
TOTAL		96.5

It was not possible to obtain results of baitfishing operations conducted in Western Samoa through a JICA project during the 1978-1980 period.

The Department of Statistics conducted a fishery catch assessment survey throught-out Western Samoa in 1978. Estimated fin-fish landings and relative proportion of each fish group used are given in Table 3.5.5. The figures obtained have been considered as under-estimates. Scads (lumped with trevallies and jacks) is the only small pelagic species identified. Other small pelagic species could be included in the "Reeffish" and "Other fish" categories. Of the total fin-fish landings (inshore and offshore), Carangidae (jacks, trevallies and scads) made up about 2 per cent in Upolu, and about 5.4 per cent in Savai'i. Overall, they made up about 3 per cent of the total fin-fish landings in Western Samoa during the survey year.

Table 3.5.5: Estimated fin-fish landings and relative proportions of important fish groups in Western Samoa during 1978. (Source: Department of Statistics, undated).

Department of Statistics, Fishery Catch Assessment in 1978													
		Lutjanidae	Lethrini	O_Deep	Shark*	Reef fish	Carangidae**	Mullet	Eels	Other fish	S/jack	O_pela	Total
Upolu													
Total wt	(kg)	9,015	62,337	95,154	2,858	325,085	12,853	15,818	20,121	43,646	76,160	5,932	668,979
Per cent	**total wt.**	**1.3**	**9.3**	**14.2**	**0.4**	**48.6**	**1.9**	**2.4**	**3.0**	**6.5**	**11.4**	**0.9**	**100.0**
Savaii													
Total wt	(kg)	4,720	6,133	37,909	4,470	97,467	14,279	14,185	3,321	7,041	107,199	1,879	265,476
Per cent	**total wt.**	**1.8**	**2.3**	**14.3**	**1.7**	**36.7**	**5.4**	**5.3**	**1.3**	**2.7**	**40.4**	**0.7**	**100.0**
W. Samoa													
Total wt	Fish	13,735	68,470	133,063	7,328	422,552	27,132	30,003	23,442	50,687	183,359	7,811	967,582
Per cent	**total wt.**	**1.4**	**7.1**	**13.8**	**0.8**	**43.7**	**2.8**	**3.1**	**2.4**	**5.2**	**19.0**	**0.8**	**100.0**

* Shark includes sharks and rays; **Carangidae include jacks and scads. O_Deep=Other deep-water fish; O_pela= Other oceanic pelagic species.

A preliminary survey was conducted between December, 1983 and February, 1984, on the inshore fisheries of Upolu Island. Zann *et al.* (1984) estimated coral reef fish production to the 8 m isobath on Upolu to be 5,593.8 mt per year and that for reef invertebrates to be 7,613.9 mt per year. The only small pelagic species recorded is herring. Based on answers for fish consumed the day before the survey, the rural (excluding the Apia area) average production (consumption) of herring was estimated to be only 0.9 per cent on Upolu. The results are presented in Table 3.5.6 for fin-fishes, as reproduced from the same reference. Herring was recorded in only two of the strata used, Northwest and South Central. No *atule* catch was recorded as the survey period was outside the *atule* season.

Table 3.5.6: Percentage of fish types eaten (caught) on the day before the survey. (Source: Zann *et al.*, 1984).

Habitat & Taxon	Samoan name	Apia	North west	North east	South east	South central	South west	Manono Is.	Rural average
OCEANIC PELAGICS									
Skipjack	atu	28	6		6	36 (25)	13	18	8.6
Yellowfin	asiasi	11			6	2 (6)			2.1
Dolphinfish	masimasi					(3)			0.2
Rainbow runner	samani					10 (12)			1.8
CORAL REEF									
Snappers		6	8	4 (5)	33 (38)	3 (3)	(11)		9.2
Emperor	mataeleele	5	5		22 (46)	5 (6)	4 (11)	12 (7)	10.2
Coral cods	gatala		6	4 (5)	11 (8)	2	13 (8)	(7)	5.3
Moray eels	pusi	5		4			4 (12)		2.1
Goatfish	i'a sina etc				6		2		0.6
Parrotfish	fuga		20	20 (23)			6 (11)	6 (7)	7.7
Squirrelfish	malau		26	4 (5)	(8)	8 (9)	13 (31)	6	9.1
Surgeonfish	pone etc	22		40 (33)		18 (22)	21 (31)	41 (50)	21.3
Angelfish	tifitifi		6	(5)	6		(4)	12 (14)	3.1
Butterflyfish	tifitifi						(4)		0.3
REEF & LAGOON									
Barracuda	saosao, sapatu	11							
Trevally	lupo, malauli	11		(5)	6		4 (8)		1.9
Silver biddy	matu						4		0.3
Mullet	anae			4 (5)		10 (3)	6 (12)	6 (7)	4.4
Herring	**pelupelu**		**6**			**2 (3)**			**0.9**
DEEP WATER									
Jobfish	utu					(3)			0.2

King (undated) estimated species or taxa collected in the artisanal fisheries in Western Samoa using three coastal ecosystem types. Shallow-water fin-fish estimates are given in Table 3.5.7 as reproduced from that reference. The only small pelagic species included is *atule*. The total artisanal annual catch in Western Samoa was estimated to be about 4,600 assuming survey results depict typical fishing weeks. The *atule* annual catch was estimated to be about 79 mt. King (cited above) noted that because of the intensive nature of the survey, species which are important seasonally are absent or poorly represented. Likewise, the species which are large and caught occasionally, e.g. sharks and turtles, may be under-represented. [However, if the surveys were during the mullet and *atule* seasons, then these species could be over-estimated]. Fin-fish species that occur in abundance seasonally in Western Samoa include mullet and *atule*.

Table 3.5.7: Major fish groups collected in artisanal fisheries in Western Samoa as estimated in 1989. (Source: King, undated).

English Name	Western Samoan Name	Fringing coral reef (*Total Annual Catch = 1,435 mt)		Lagoons and a barrier reef (*Total Annual Catch = 2,420 mt)		Lagoons, reefs and mangroves (*Total Annual Catch = 738 mt)		All ecosystems (*Total Annual Catch = 4,593 mt)	Per cent of Total Fin-fish
		Per cent	Weight (mt)	Per cent	Weight (mt)	Per cent	Weight (mt)	Total Weight (mt)	
Bigeye scad	***atule***	**1.2**	**17.220**	**2.5**	**60.500**	**0.2**	**1.476**	**79.196**	2.4
Mullet	*anae*	8.8	126.280	5.4	130.680	9.3	68.634	325.594	10.0
Goatfish	*ulaoa*	1.1	15.785	0.1	2.420	3.3	24.354	42.559	1.3
Rabbitfish	*lo*	2.7	38.745	5.2	125.840	4.4	32.472	197.057	6.0
Emperor	*mataeleele*	9.7	139.195	18.6	450.120	11.7	86.346	675.661	20.7
Trevally	*lupo, malauli*	1.8	25.830	14.2	343.640	4.7	34.686	404.156	12.4
Surgeonfish	*pone*	17.9	256.865	5.2	125.840	13.2	97.416	480.121	14.7
Parrotfish	*fuga*	7.8	111.930	4.8	116.160	3.4	25.092	253.182	7.7
Unicornfish	*ume*	5.7	81.795	1.5	36.300	1.9	14.022	132.117	4.0
Soldierfish	*malau*	4.4	63.140	6.6	159.720	13.2	97.416	320.276	9.8
Rock cod	*gatala*	7.3	104.755	4.5	108.900	2.1	15.498	229.153	7.0
Moray eel	*pusi*	2.1	30.135	3.9	94.380	0.5	3.690	128.205	3.9
Total								**3,267.277**	100.0

*these Total Annual Catch figures include vertebrates and invertebrate landings, and the percentage entires under the "per cent" columns indicate percentage weight of the corresponding fish group of the total (invertebrates + vertebrates) landings.

In a survey of fisheries products sold to retailers, wholesalers and hotels from the Apia-Apolima area, Brotman (1989) estimated landings at these outlets for the same year as follows:

Inshore fin-fish	: 55.94 mt, valued at WS$203,319.
Offshore fin-fish	:175.32 mt, valued at WS$ 665,747.
Invertebrates	: 34.36 mt, valued at WS$212,561.

Of the offshore fin-fish landing, 66.5 per cent (116 mt) was bottomfish and 33.5 per cent (59 mt) were pelagic fish species. Bigeye scad (*atule*) made up only 0.8 per cent (472 kg ~0.5 mt) of the pelagic fish species. Relative composition of the pelagic fish species were given as follows:

	Wahoo	Sailfish	Dolphinfish	Marlin	Dogtooth tuna	Rainbow runner	Trevally	**Bigeye scad**	Skipjack	Yellowfin tuna	Total
%	0.5	2.4	4.8	3.6	3.6	0.4	3.9	**0.8**	32.4	47.6	100
Wt (kg)	295	1,416	2,832	2,124	2,124	236	2,301	**472**	19,116	28,084	59,000

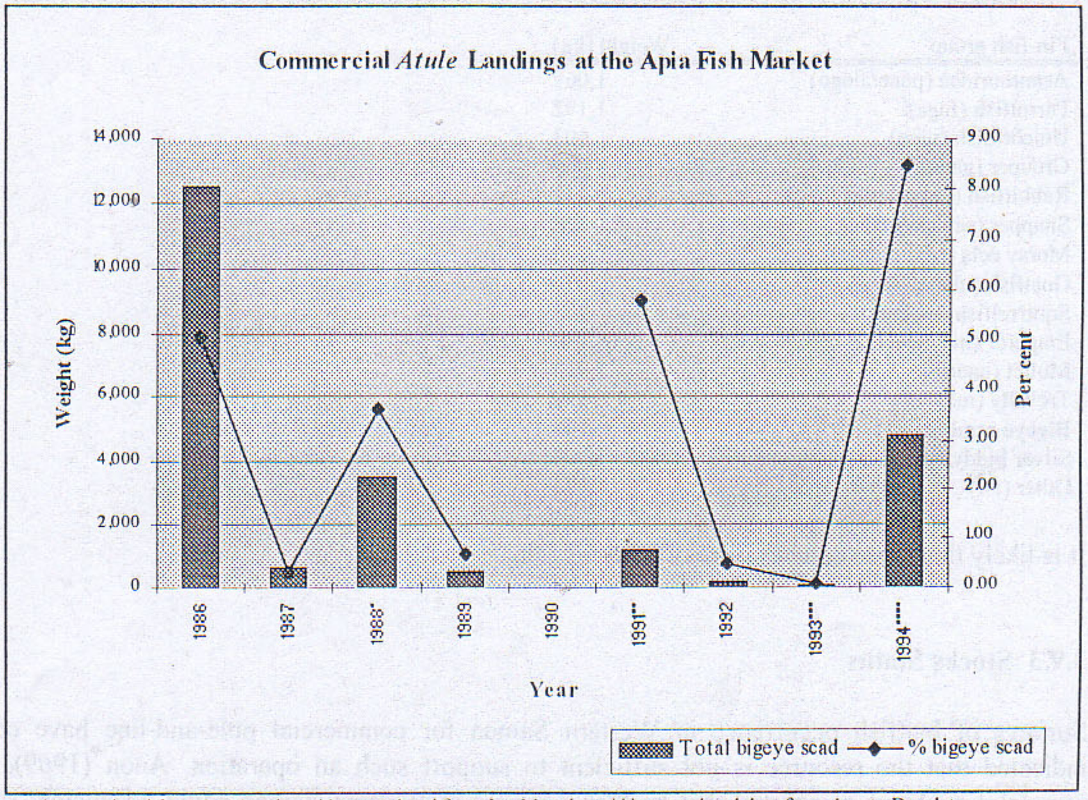
Winterstein (1991) reported on results from the continution of this survey in 1990 for the first 8 months only. However, she lumped all lagoon, shallow-water reef and deep-water bottomfish fishes into one category, "Bottomfish". Even eels were lumped under the "Invertebrate" category. No relative compositions of fish groups within each category were given. Estimates made for the January-August period were: Invertebrates - 10,280 kg; Bottomfish - 60,129; Pelagics - 47,251.

Commercial landings of shallow-water reef fish at the Apia Fish Market is presented in Table 3.5.8 for the 1986-1993 period. The only small pelagic species present is the ***atule***. Data indicates that big-eye scad (***atule***) is one of the important fin-fish families in the artisanal/commercial fishery. The overall landings from 1986 to 1994 indicate that, on the average for years in which they were recorded, bigeye scad make up about 3.07 per cent (an annual average of 2,929 kg for the period) of the total commercial reef fish landings at the Fish Market. However, more accurate figures for ***atule*** landings in 1991 and 1993 would probably be higher than those recorded for these years as figures were extrapolated from only part of the years which were outside the peak months for ***atule*** landings. The peak months for ***atule*** landings are May-July but available data in 1991 and 1993 covered only January-May and August-December respectively. Conversely, the 1994 estimate for ***atule*** could be an over-estimate as landings were extrapolated using data from months in which ***atule*** season fall. However, there is a general decrease in commercial ***atule*** landings at the Apia Fish Market in years for which data were believed to be "properly" collected, e.g. 1986, 1987, and 1988. Helm (1987) noted that *atule* made up a large portion of the Fish Market inshore fin-fish landing during the March-June period, 1986. Furthermore, the appearance of the *atule* during that year was reported to be a regular seasonal event, whereas that in 1987 was not. Helm concluded that the decline was due to stock over-fishing.

Table 3.5.8: Shallow-water reef fish landings at the Apia Fish Market for the 1986-1993 period. Figures are in kg. (Sources: Mulipola, 1994; Helm, 1987; Fisheries Database).

Fish family	1986	1987	1988*	1989	1990	1991**	1992	1993***	1994****
Acanthuridae-surgeonfish	27,100	28,600	12,042	6,790	10,767	2,605	5,200	6,787	6,568
Scaridae-parrotfish	27,100	31,500	17,235	4,996	4,867	2,569	6,100	6,650	8,054
Acanthuridae-unicornfish	15,000	16,400	11,085	6,888	5,120	1,857	5,000	6,778	5,310
Serranidae-grouper	6,900	12,000	1,616	1,671	591	579	1,800	3,374	2,343
Siganidae-rabbitfish	2,500	2,100		6,769			700	1,507	1,493
Lutjanidae-snapper	5,200	3,400		2,096			1,700	3,134	2,261
Mullidae-goatfish	18,000	16,800	820	4,701		542	3,000	4,466	3,620
Holocentridae-soldierfish	2,700	6,500		650			1,400	2,580	2,849
Lethrinidae-emperor	59,000	28,700	12,962	5,681	5,893	2,060	7,500	7,608	6,963
Gymnothorax?-moray eel	8,400	4,600	7,483	1,924	1,375	284	1,000	2,086	2,987
Mugulidae-mullet	27,100	18,900	7,234	5,101	2,542	3,056	4,400	5,093	4,393
Carangidae-jacks and trevally	19,900	5,000	2,699	11,079	1,019	891	2,000	2,177	2,210
Gerreidae-silver biddy	2,000	400	1,588			89	200	1,536	1,460
Bigeye scad (*atule*)	**12,500**	**600**	**3,529**	**497**		**1,200**	**200**	**48**	**4,864**
Labridae-wrasses	2,000	1,500							
Other	10,800	15,100	19,089	198	6,997	4,950	1,300	1,982	1,549
Chanidae-milkfish				7,776				864	418
Kyphosidae-drummerfish				222					
Ponyfish				5,060					
Total fin-fish wt (kg	246,200	192,100	97,382	72,099	39,171	20,682	41,500	56,671	57,342
Total fin-fish value (WS$)	??	??	??						
Total *atule* weight (kg)	**12,500**	600	**3,529**	**497**		**1,200**	**200**	**48**	**4,864**
Est. *atule* value (WS$)	**46,500**	2,778	**15,459**						
% wt *atule*	5.08	0.31	3.63	0.69	-	5.80	0.48	0.08	8.48

*extrapolated from Jan-Oct data; **extrapolated from Jan-May data; ***extrapolated data from Aug to Dec data; **** extrapolated from Jan-Sept data. The 1994 Lutjanidae were all savane & malai.



*extrapolated from Jan-Oct data; **extrapolated from Jan-May data; ***extrapolated data from Aug to Dec data; **** extrapolated from Jan-Sept data.

Relative proportions (percentages) of reef fish groups in Table 3.5.8 above are presented in Table 3.5.9. Figures indicate that *atule* composition of the reef fish landings at the Fish Market has decreased from 5.1 per cent (12,500 kg) in 1986 to 3.6 per cent (3,529 kg) in 1988, 0.7 per cent (497 kg) in 1989. However, an increase was observed for 1994 with *atule* accounting for 8.5 per cent (4,864 kg) of the reef fish landing for that year. Even though bigeye scad per cent was highest in 1994, the highest landing in terms of weight was recorded in 1986. Thus the high *atule* percentage recorded in 1994 was also due to relative decreases in landings of other fish groups.

Table 3.5.9: Relative per cent composition of shallow-water reef and lagoon fin-fish group commercial landings at the Apia Fish Market during the 1986-1994 period.

Fish family	1986	1987	1988	1989	1990	1991	1992	1993	1994
Acanthuridae-surgeonfish	11.0	14.9	12.4	9.4	27.5	12.6	12.5	12.0	11.5
Scaridae-parrotfish	11.0	16.4	17.7	6.9	12.4	12.4	14.7	11.7	14
Acanthuridae-unicornfish	6.1	8.5	11.4	9.6	13.1	9.0	12.0	12.0	9.3
Serranidae-grouper	2.8	6.2	1.7	2.3	1.5	2.8	4.3	6.0	4.1
Siganidae-rabbitfish	1.0	1.1		9.4			1.7	2.7	2.6
Lutjanidae-snapper	2.1	1.8		2.9			4.1	5.5	3.9
Mullidae-goatfish	7.3	8.7	0.8	6.5		2.6	7.2	7.9	6.3
Holocentridae-soldierfish	1.1	3.4		0.9			3.4	4.6	5
Lethrinidae-emperor	24.0	14.9	13.3	7.9	15.0	10.0	18.1	13.4	12.1
Gymnothorax-moray eel	3.4	2.4	7.7	2.7	3.5	1.4	2.4	3.7	5.2
Mugulidae-mullet	11.0	9.8	7.4	7.1	6.5	14.8	10.6	9.0	7.7
Carangidae-jacks and trevally	8.1	2.6	2.8	15.4	2.6	4.3	4.8	3.8	3.9
Gerreidae-silver biddy	0.8	0.2	1.6			0.4	0.5	2.7	2.5
Carangidae - bigeye scad	**5.1**	**0.3**	**3.6**	**0.7**		**5.8**	**0.5**	**0.1**	**8.5**
Labridae-wrasses	0.8	0.8							
Other	4.4	7.9	19.6	0.3	17.9	23.9	3.1	3.5	2.7
Chanidae-milkfish				10.8				1.5	0.7
Kyphosidae-drummerfish				0.3					
Ponyfish				7					

In surveys conducted on the roadside from Apia to Faleolo during January to December, 1992, the following shallow-water reef and lagoon finfishes were recorded (Iosefa, 1993). Again, the only small pelagic species recorded is *atule* :

Fin-fish group	Weight (kg)
Acanthuridae (pone/alogo)	1,069
Parrotfish (fuga)	1,192
Unicornfish (ume)	603
Grouper (gatala)	566
Rabbitfish (lo/pa'uulu)	212
Snapper (savane/malai)	328
Moray eels (pusi-gatala)	270
Goatfish (ulaoa/vete)	370
Squirrelfish (malau)	273
Emperor (mataeleele)	5,430
Mullet (anae)	1,913
Trevally (malauli)	359
Bigeye scad (atule)	**104**
Silver biddy/Ponyfish (matu/mumu)	4
Other (isi)	1,970

It is likely that these catches were offered for sale.

3.9.3 Stocks Status

Surveys of baitfish occurrence in Western Samoa for commercial pole-and-line have consistently indicated that the resource is not sufficient to support such an operation. Anon (1969), based on anecdotal evidence, suggested that baitfish resource in Western Samoa could adequately support the operations of at least one pole-and-line-vessel. However, subsequent surveys did not support such an assertion. Tuna Programme (1984) summarised results of these surveys as follows:

> In 1970, the Charles H. Gilbert caught very little bait while fishing in Apia Harbour at night and only about 63 kg of silversides and sardines in five sets of a beach seine during daylight hours.
>
> In 1972, the Angela crew reported only one vry small school of sprats in Apia Harbour at daytime and no baitfish in Asau Harbour. Night baiting was attempted at Asau but "appreciable quantities" of baitfish were not attracted.
>
> In 1979, night-baiting by the *Townsend* yielded only low catches. The Western Samoa pole-and-line vessel occasionally attempted to capture bait, but without success.
>
> The SPC Skipjack Programme made 14 bouki-ami hauls at night at five locations around Upolu Island in June 1978 and February 1980. Catches per haul were consistently low, averaging 20 kg except for one haul made at Falefa Harbour which yielded 870 kg. This haul was not considered representative as another haul made earlier the same evening yielded only 12 kg.

Baitfish catches made by SPC were dominated by the anchovey, *S. devisi*. "Sprats, sardines and herrings were very low in abundance although they occurred in many hauls" (Tuna Programme, 1984). The leiognathid, *G. minuta*, was considered moderately abundant. Tuna Programme (1984) concluded that the baitfish resource in Western Samoa is small and inadequate to support more than occasional pole-and-line fishing by small vessels.

No recent informatin exists on the status of the resource especially for those species which are important to the domestic commercial market and the subsistence sector. There are some indications that stocks of *atule* have been reduced in Western Samoa through over-harvesting using highly effective means such as large surround nets and fish weirs (fences) as well as illegal dynamite fishing. [This is only based on subjective reports of declines in seasonal abundance rather than accurate time series of catch and fishing effort records and supporting biological data]. Helm (1987) noted that *atule* made up a large portion of the Fish Market inshore fin-fish landing during the March-June period in 1986 and that the appearance of the *atule* during that year was reported to be a regular seasonal event. However, it never appeared in 1987. Helm concluded that the decline was due to stock over-fishing. *Atule* landing shows an increase from 1987 to 1988, followed by a wider decrease from 1988 to 1989. No *atule* was recorded in 1990 but an increase from 1989 was recorded in 1991 but the amount was lower than that in 1988. Catches continued to decrease further in 1992 and 1993 but increased again to about the third of the 1986 level. One aspect that might also have an effect on these estimates is the consistency and accuracy of data collection, compilation and analysis used.

3.9.4 Management

Current legislation/policy regarding exploitation: Fisheries Act 1988: Part II, 4 (1) (a) of the Act prihibits the use or attempt to use of any explosive, poison or other noxious substance for the purpose of killing, stunning, disabling or catching fish, or in any way rendering fish more easily caught. Paragraph (b) makes it illegal to carry or have in possession or control any explosive, poison or other noxious substance in circumstances indicating an intention to use such for any of the purposes referred to in (a). Under subsection (2), any explosive, poison or other noxious substance found on board any fishing vessel shall be presumed, unless the contrary is proved, to be intended for the purpose referred to in subsection (1)(a). Subsection 3 makes it illegal for any person to land, sell receive or possess fish taken in contravention of subsection (1)(a), which he knows or has reasonable cause to believe they were so taken. Part II, 5 requires local commercial fishing vessels to have a valid certificate of registration.

Fines: Contravention of Section 4(1) is a fine of 1,000 tala and imprisonment for a term not exceeding 2 years except that no sentence of imprisonment shall be imposed under this subsection for an offence committed in the exclusive economic zone. Contravention under Section 4(3) is a fine not exceeding 1,000 tala.

Proposed Local Fisheries Regulations: Part I, 3 (1) and (2) of the proposed Local Fisheries Regulations proposes to prohibit the catching and selling of small pelagics less than the minimum size limit, measured from the furthermost point of the snout to the middle of the tailfin when the fish is laid flat, as follows:

Long-jaw mackerel (*ga*)	200 mm
Bigeye scad (*atule*)	150 mm
Longtom and Garfish (ise, a'u)	300 mm

Under the same section, the herrings, *Herklosichthys quadrimaculatus* and *Sardinella albella*, are proposed to be prohibited for sale.

Part I, 4 of the same proposed regulations empowers the Director to declare a period or periods as prohibited for fishing bigeye scad (*atule*) and other fish species as follows:

Common name	Samoan name	Scientific name
Grey mullet	anae, afa, ulupona	Mugil species
Rock cods, groupers	gatala	Serranus species
Bigeye scad	**atule**	**Selar crumenophthalmus**
Hawksbill turtle	laumei (una or faiuna)	Eretmochelys imbricata
Green turtle	laumei	Chelonia mydas

Part I, 5, proposes to allow only the following fishing gear unless authorised by a license issued in accordance with the Fisheries Act 1988:

a. beachnets and castnets with a mesh size not less than 30 mm, measured when wet and stretched;
b. all other nets shall have mesh size of not less tham 50 mm, measured when wet and stretched;
c. fishfences shall have a mesh size not less than 50 mm measured when wet and stretched irrespective of the material used to make them.

Recommended legislation/policy regarding exploitation: Recommendations for this section are the same as those listed under mullet and are as follows:

Rigorous enforcement of the existing laws, e.g. dynamite fishing, is necessary. Additional considerations could include:

⇒ banning or limiting the number of fish fences that can be set up in various zones along the country's coastline. Limiting the number can be done through a permiting system in which a fisherman wanting to set up a fish fence must obtain an annual permit first. The Fisheries Division can determine the number of fish fences that can be erected in fisheries zones within the country. In addition, specific legislations must be added to limit fish fence size and to hold every fish fence permit holder responsible for the removal (disposal) of damaged or rusting fence, he/she has set up, from the sea and dispose of in a responsible manner, on land. Likewise, fences must be so placed that it will not damage any coral during the set-up and removal operations or unlikely to affect corals in the event of a cyclone or rough weather. [Specifics can include setting a minimum distance from corals and reefs, interfer with other uses of the area, such as navigation, subsistence fishing etc].

⇒ limit length sizes of various nets.

Application of a minimum size limit to the *ga* and *atule* might be best addressed in the control of fishing gear used.

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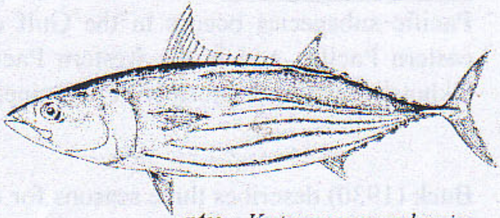
3.6 Tuna

3.6.1 The Resource



atu *- Katsuwonus pelamis*

Species present: The tuna species of importance in Western Samoa include: *Katsuwonus pelamis* (skipjack tuna - ***atu***), *Thunnus albacares* (yellowfin tuna - ***asiasi***), *T. alalunga* (albacore - ***alapakoa***), *T. obesus* (bigeye tuna - ***tauo***), *Gymnosarda unicolor* (dogtooth tuna - ***tagi***), *Euthynnus affinis* (mackerel tuna - ***tavalau***) and Auxis thazard (frigate tuna?? - ***atualo***). Large yellowfin is also normally referred to as ***tauo***. Skipjack Programme (1981) reported 15 bluefin tuna caught in Western Samoa waters by Taiwanese longliners in 1970 and 110 in 1973 during the 1967-1977 period. Klawe (1978) reported both Northern bluefin tuna (*T. thynnus*) and Southern Bluefin tuna (*T. maccoyii*) in catches by the Taiwanese longliners in Western Samoa waters during 1973.

Distribution: Collette and Nauen (1983) give the general geographical distribution of the scombrids including the tunas. They provide the following geographical distribution information concerning the tuna species, for those which have been recorded in Palau waters. Additional and more specific information from Hampton (1993) is also included:

Skipjack tuna - cosmopolitan in tropical and warm-temperate waters but absent in the Black Sea. "Skipjack are highly mobile and are capable of unrestricted movement throughout the Pacific Ocean. Most spawning seems to occur in the western Pacific where most of the catch is also taken. Tagging results show substantial mixing of skipjack from Philippines and eastern Indonesia to at least 150° W. However movement, at least of adult skipjack, between the central and eastern Pacific appears more limited".

Yellowfin tuna - worldwide in tropical and subtropical seas of the Pacific Ocean, without any obvious barriers to movement, but absent from the Mediterranean Sea. "There is some evidence from fisheries, tagging and biological data that interchange between the eastern and western Pacific (divided at 150° W) is limited".

Mackerel tuna - throughout the warm waters of the Indo-West Pacific including oceanic islands and archipelagos. A few stray specimens have been collected in the eastern tropical Pacific.

Dogtooth tuna - tropical Indo-West Pacific from the Red Sea and East Africa east to Japan, the Philippines, PNG, and Australia and out into the islands of Oceania.

Albacore - cosmopolitan in tropical and temperate waters of all oceans, including the Mediterranean Sea, extending north to 45 to 50° and south to 30 to 40° but not at the surface between 10°N and 10°S. "Fishery data and tag returns suggest that albacore in the North and South Pacific constitute separate stocks. These data, along with gene frequency data, further suggest that albacore throughout the South Pacific should be considered as a single stock".

Bigeye tuna - worldwide in tropical and subtropical waters of the Atlantic, Indian and Pacific oceans, but absent from the Mediterranean. There are currently limited data to test stock structure hypotheses.

Frigate tuna - probably cosmopolitan in warm waters but there are only a few documented occurrences in the Atlantic Ocean.

Southern bluefin tuna - probably found throughout the Southern Ocean south of 30° S.

Northern bluefin tuna - at least two subspecies with one in the Atlantic and the other in the Pacific. The Pacific subspecies occurs in the Gulf of Alaska to southern California and Baja California in the eastern Pacific, and in the western Pacific it is known from Sakhalin Island in the southern Sea of Okhotsk south to the northern Philippines.

Buck (1930) describes three seasons for catching bonito during the year which also corresponded to the breadfruit seasons in Western Samoa. These seasons were:

- January and February
- May, June, July
- October, November, and part of December.

Anon (1969) reported that skipjack is present in Western Samoan waters all year round but reported to be most abundant during the months of November through April with the large specimens being most abundant during February to April. An area of enrichment exists off Falealupo where skipjack tend to congregate in large numbers, which attracts fishermen as far off as Asau. Poutasi, on Upolu was another village which was noted for its skilled traditional tuna fishermen and that an area about 5 miles from the reef was known as the cave of the *atu*. This is believed as an offshore bank. The area was believed to sustain large concentrations of ***nefu*** which attract skipjack and other pelagic species such as yellowfin tuna, little tuna, and dolphinfish. These fish species are found there all year round. Commercial catches indicate that tunas are generally caught throught-out the islands. However, major landings on Upolu are from the Falealili/Siumu area, Aleipata/Fagaloa area and Apia. These are mostly associated with FADs.

Biology and ecology: Nichols (1991) noted that all tuna species produce buoyant eggs, containing an oil droplet. Tuna eggs are around 0.04 mm diameter (billfish eggs tend to be rather larger). Larvae at hatching are around 2.5 mm long, and grow at a rapid rate. All species are highly fecund, producing around 100,000 eggs per kg body weight. All tunas and tuna-like species are apex predators of fish, squid and crustacea. The smallest species, the bullet and frigate tunas, rarely exceed 3 kg weight (6.6 pounds), whereas the Northern bluefin can exceed 700 kg (1,500 pounds), and black marlin in excess of 1,300 kg (2,900 pounds) have been taken by commercial longliners. Yellowfin attain 2.4 kg in 1 year, 15 kg at 2 years, 43 kg at 3 and around 80 kg at 4 years. Detailed information on growth rate, longevity and biology of most species is poor (Joseph *et. al.*, 1988).

Smith (1992) notes that even though the tunas form the basis of one of the world's largest fisheries[1], many of the parameters regarding their life history are still unknown. Many tuna species migrate considerable distances, swimming continuously. They eat substantial amounts of food and have rapid growth. Many species maintain core body temperatures several degrees above the surrounding sea temperature. Open sea species feed largely on epipelagic fishes, squids, and crustaceans. Near-reef species also utilize the larval and early juvenile stages of reef fish and crustaceans as prey. Reef-associated species prey on large zooplankton or fish occupying the water above the reef (Myers, 1989).

During the South Pacifc Commission Skipjack Survey and Assessment Programme between October, 1977 and August, 1980, fourteen days were spent in Western Samoa from 6 to 14 June, 1978 and 22 to 26 February, 1980. Fish caught in Western Samoa were examined for various information. Food items found in stomachs of 33 skipjack examined showed diet as typical of those from other tropical waters in the South Pacific (Tuna Programme, 1984). Excluding chum from the research vessel, the most

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[1]Stamatopoulus (1993) ranks the production, in the Pacific Ocean, of tunas, bonitos and billfishes fourth on the list of ISSCAAP species groups for diadromous and marine fish and crustaceans and molluscs for 1990, after 1). herrings, sardines, anchovies 2). cods, hakes, haddocks and 3). misc. fish species

common food items were unidentified fish, fish remains, leather jackets (Aluteridae) and surgeonfishes (Acanthuridae). Food items found in stomachs of skipjacks sampled are given in Table 3.6.1, as reproduced fromTuna Programme (1984). The results reflect the opportunistic nature of skipjack feeding. Out of 66 skipjacks examined for tuna juveniles as prey, only one had 3 skipjack and four albacore juveniles in its stomach.

Table 3.6.1: Stomack contents of skipjack sampled in Western Samo. (Source: Tuna Programme, 1984).

Item #	Diet Item	Number of stomachs	Per cent occurrence	Item #	Diet Item	Number of stomachs	Per cent occurrence
01	Chum from research vessel	29	87.9	13	Stomatopoda (alima stage)	2	6.1
02	Unidentified fish	13	39.4	14	Mullidae (goatfish)	1	3.0
03	Fish remains (not chum)	8	24.2	15	Mullidae (blue goatfish)	1	3.0
04	Aluteridae (leather jackets)	7	21.2	16	Crustacean remains	1	3.0
05	Acanthuridae (surgeonfiah)	7	21.2	17	Hemirhamphidae	1	3.0
06	Decapoda (shrimp)	6	18.2	18	Leiognathidae	1	3.0
07	Cephalopoda (octopus)	5	15.2	19	Sphyraenidae (barracuda)	1	3.0
08	Holocentidae (squirrelfish)	5	15.2	20	Theraponidae (seaperch)	1	3.0
09	Cephalopoda (squid)	5	15.2	21	Gempylidae	1	3.0
10	Stomatopoda	4	12.1	22	Syngnathidae	1	3.0
11	Balistidae (triggerfish)	2	6.1	23	Chaetodontidae	1	3.0
12	Empty stomach	2	6.1				
Total stomachs examined = 33							

Examination of female skipjacks in two SPC visits during the Programme indicated that skipjack caught in Western Samoa were predominantly in stages 2 and 3 (maturing gonads) with a few mature fish (Tuna Programme, 1984). Of the 1,926 skipjack tagged in Western Samoa waters, nineteen were recovered locally and four in othet countries. The four recaptured in other countries were caught after periods of up to 700 days at liberty. Of these, one was recaptured in each of New Zealand, Solomon Islands, American Samoa and Society Island of French Polynesia. Twenty three skipjacks, tagged in Wallis and Futuna (11), New Zealand (5), Fiji (2), American Samoa (1), Kiribati (1), New South Wales, Australia (1), Tonga (1) and Tuvalu (1), were recaptured in Western Samoa. This indicates that some proportion of the skipjack stock in Western Samoa waters originate in other parts of the central and western Pacific.

Mean skipjack fork lengths caught during the SPC surveys were as follows:

	1978	1980
Tagged skipjack	48.63 cm (n= 1,247)	47.91 cm (n= 47.91 cm)
Sampled skipjack	48.39 cm (n= 139)	48.33 cm (n= 31)

3.6.2 The Fishery

Utilization: Buck (1930) wrote that in Samoa, the canoe took men outside the reef to seek the deep sea fish that came within the possibilities of their attainment. Traditional fishing for skipjack in Western Samoa was carried out by trolling from specially built paddled canoes for skipjack trolling, *va'aolo*, using traditional hooks on a line tied to the bamboo rod (*launiu* - long rod or *matila*, short rod). Bonito hooks composed of a shell shank and a point made from turtle shell. Buck (1930) describes bonito hook making and bonito fishing in detail. Bonito trolling is known as *aloga atu* or *alofaga*. Three bonito seasons were traditionally known to occur during the year: January and February; May-July; and October-part of December. Buck (1930) writes that during the month itself, certain days are particular fishing days, and the bonito caught or sought after were accordingly named as follows:

atu pulapula	- bonito of the new moon;
atu fa'afitu	- bonito of the seventh day;
atu oa toa	- bonito of the full moon;
atu o gafoa	- bonito of the half moon waning.

Buck further explained that the bonito sought at the end of the month, when they are scarce, are called "*atu o le sela ma le miti loa*", meaning the "bonito of weariness and profuse perspiration".

It is customary in Samoa for fishermen coming in to give a fish or a portion of fish to anyone they meet in the water of the lagoon or on the shore. In bonito fleet fishing, those who come to the beach to meet it and help with lifting the canoes and carry fishing gear to storage place will be given a share. Buck (1930) noted that 'the custom applies equally to men of rank such as chiefs and talking chiefs. They have only to meet the fisherman anywhere on his journey to his house and the fishermen have to recognize their superior position by giving them the best". The same author also noted that in bonito fishing with the fleet, the catch is subject to a levy for the communal feast of the fishermen.

By 1960, van Pel (1960) reported that the outrigger canoe, propelled by paddles, was by far the most common fishing craft. However, some canoes were reported to be powered with an outboard motor by then. Trolling using traditional canoes and hooks does not exist anymore as fishermen claim the bonitos are too fast now for their paddled canoes. In addition, the motorised boats has made it possible for bonito to be available through-out the year in quantities.

Villaluz (1972) reported that offshore fishing was a daily activity among a few fishermen in 1972. The Fisheries Division had then initiated village fishermen associations with the following operational components:

⇒ interested villages built their own deep-sea fishing catamaran;
⇒ the Fisheries Division trained two members of the association in engine repair and maintenance;
⇒ the Fisheries Division equipped each boat with two outboard motors, ice boxes, a shore ice-silo unit, and a variety of fishing gear;
⇒ each association was given a two-month trial period at the end of which:
- the association either began to repay the cost of equipment out of fishing profit, or
- the equipment was withdrawn and re-issued to other newly formed organisations.

⇒ The number of registered associations in 1972 was 44
- Number of associations in the waiting list was 68
- potential number of associations 160-168.

The use of the double-hulled canoe, 8.5-metre (28 ft) *alia* (catamarans), powered by a 25 hp outboard motor, was introduced by the FAO/DANIDA Village Fisheries Project, signed at the end of 1975. The thrust of the project was to increase fish production to meet local demand and provide employment opportunities for local people. The main objective of the project was the production of 120 x 28 ft *alias*. Major components of the project, as given in FAO (1978), included:

⇒ establishment of a boatyard for the production of these boats;
⇒ provision of tools and equipment for outboard engine repair shops in Apia and Salelologa;
⇒ training in operation and maintenance of the boats' engines and fishing gear;
⇒ fish marketing scheme for collecting surplus fish in villages to be sold in Apia;
⇒ establishment of a revolving fund at the Development Bank for construction of additional boats.

The FAO/DANIDA project resulted in the construction of more than 500 FAO designed fishing vessels powered by an outboard or an inboard engine targeting both the offshore oceanic pelagic fishes (such as tuna) and offshore bottomfish resource (for fish such as deep-water snappers and groupers). Between 1975 and 1979, about 120 plywood versions were constructed. Over 200 aluminium versions were subsequently built some of which were exported to other South Pacific countries. The following table gives the number of motorized fishing units in operation during the 1974-1977 period as reported in FAO (1978).

	1974	1975	1976	1977
Upolu	44	98	115	222
Savai'i	30	36	37	49
Total	74	134	152	271

More than 10 walk-in frezers were provided under assistance from the Governement of Japan during that time. These were stationed around the country for storage when necessary before transportation to market.

The current local fishing fleet fishing for offshore fish is based on the 28 ft aluminium catamarans (*alia*) constructed locally. By 1989, approximately 90 ***alia*** were active in the offshore fisheries concentrating more on the catch of pelagic fish species, such as tuna. Through a Fisheries Division rehabilitation *alia* project initiated in 1990 after Cyclone Ofa, new ***alias*** were constructed and sold to fishermen at a cost which was 50 per cent subsidized. In June 1993, Mulipola and Vaofusi (1994) conducted a survey of operational fishing boats in Western Samoa. Survey results are recorded in Table 3.6.1. Of the total 92 operational *alias*, 30 per cent (28 boats) were based in Apia. A total of 46 *alias* (50 per cent) were recorded as involved mainly in tuna fishing of which 34 were based on Upolu (15 in Apia), and 12 in Savai'i. An additional 11 *alias* (7 on Savai'i and 4 on Upolu) were recorded as fishing both for oceanic pelagic fishes as well as bottomfish. Four additional boats were concentrating with vertical longlining and 2 additional alias were recorded as involved in both bottomfish and vertical longline operations. All of the ***alias*** operate on a commercial basis.

Table 3.6.2: Number of alias operational in 1994 in different fisheries in Western Samoa. (Source: Mulipola and Vaofusi, 1994).

Location	Total	Bottomfish	Tuna	Bottomfish & Tuna	Longline	Bottomfish & Longline	Inshore
UPOLU							
Apia	28	11	15	0	2	0	
Aleipata	3	0	3	0	0	0	0
Apolima	12	12	0	0	0	0	0
Falealili	5	0	3	0	2	0	0
Faleasi'u	1	0	1	0	0	0	0
Fusi Anoama'a	5	0	1	4	0	0	0
Faleatiu	1	0	0	0	0	0	1
Lefaga	4	0	4	0	0	0	0
Mulifanua	1	0	0	0	0	0	1
Siumu	7	0	7	0	0	0	0
Si'usega	1	0	0	0	0	0	1
Upolu Total	68	23	34	4	4	0	3
SAVAI'I							
Savai'i Total	24	3	12	7	0	2	0
GRAND TOTAL	92	26	46	11	4	2	3

With the introduction and utilization of modern fishing gear including powered boats, tuna has become the major resource of importance in the commercial fishery for the local market. The fishing method employed is trolling, targeting skipjack, yellowfin, dogtooth tuna, and other oceanic pealgic species such as dolphin fish, marlin and rainbow runner. The sustained success of the offshore tuna fishery for local harvesting has been partly attributed to the development of Fish Aggregating Devices (FADs).

Apart from estimates made for the Japanese and Taiwanese fishing operations recorded in Western Samoan waters between 1962 and 1977, prior to the acceptance of the 200-nautical mile EEZ worldwide, no data is available from large scale commercial tuna fishing operations in Western Samoa waters. Otsu (1966) and Otsu and Sumida (1968) reported longline operations in certain countries' waters, including that of Western Samoa, by the Japanese fleet based in Pago Pago during the 1954-

1965 period. The only large scale pole-and-line fishing in Western Samoa waters was by the Japanese distant-water fleet 1975 and 1976. Only 11 boat-days were involved during both years (Skipjack Programme, 1980). Longline fishing in Western Samoa waters by Japanese, Taiwanese and Korean vessels were known to have started at least in 1960. Philipp (1980, cited in Tuna Programme, 1984) noted that longlining by Japanese vessels ceased in Western Samoa waters in 1979. Philipp (1982, cited in Tuna Programme, 1984) reported two purse seine (one from Nauru and one from US) conducted limited fishing in Western Samoa in 1980. Anon (1983, cited in Tuna Programme, 1984) reported that an agreement was made between the American Tuna Association (ATA) and a group of four central Pacific countries, including Western Samoa, in August 1983 permitting access of US purse-seiners in return for license fees. No further information could be obtained concerning this.

Exploratory pole-and-line fishing was conducted by the Fisheries Division using a 16-tonne Japanese style vessel (Tautai Samoa) donated by the Government of Japan in 1978. A Fisheries Division ***alia*** was modified for exploratory pole-and-line operation new FADs. Two privately owned ***alia*** were also modified and were operational in 1981. With the exception of some pole-and-line fishing by Tautai Samoa in which only limited quantities of wild bait was used, all of the fishing expetitions, including those by the privately owned ***alias***, use cultured mollies (*Poecilia mexicana*) as live bait.

Western Samoa signed the Multilateral Treaty on Fisheries Between the Governments of Certain Pacific Islands States and the Government of the United States of America on 2 April, 1987. This allows US purse seiners to fish in EEZs of those Pacific Island States that sign the treaty for a set fee.

A bilateral agreement was initiated in 1988 between the Taiwanese longline vessels based in American Samoa and Western Samoa to permit 43 longliners to fish in Western Samoa's EEZ for a set per vessel fee for the first year of the agreement. The number of Taiwanese longliners licensed for each year are as follows:

Year	⇒	1989?	1990	1991	1992	1993	1994	1995
Number of longliners licensed	⇒	43?	??	??	??	??	37	37
Fee level per vessel	⇒						1,208	1,208

The South Pacific Commission, under its Deep Sea Fisheries Development Project, conducted experimental vertical longline in Western Samoa from September, 1990 to July 1991. This was in reponse to the request by the Western Samoa Fisheries Division to conduct experimental fishing trials utilizing pelagic longline techniques to assess the commercial potential of small-scale longlining in Western Samoa (Watt, 1991). During the project, a modified verticle longline system was designed and constructed for the ***alia*** (catamaran). The modified verticle dropline gear developed for the alia was found to be very effective (Watt, cited above). More than 10 local fishermen were trained in the new fishing technique and in proper handling of the catch (i.e. bleeding, gilling, gutting and packing in ice).

Production and marketing: There are no recorded estimates of tuna landings in the subsistence level using traditional trolling gears both prior to and after the introduction of modern fishing gear and equipment. However, the development of specialized traditional canoes, bonito hooks and gear are indications of the importance of this fishery in Samoa at the subsistence level, before the introduction of the cash-based economy.

Commercial long-lining for albacore seems to have started in Western Samoa waters around 1954 when the tuna fishery based in American Samoa began. Otsu (1966) and Otsu and Sumida (1968) gave general locations where the Japanese American Samoa-based longliners fished between 1954 and 1965. Fishing was originally concentrated near Samoa but gradually expanded to nearby countries' waters. Even though catch statistics were given in the references for these operations during the 1954-1965 period, it was not possible to derive those made in Western Samoan waters. Catch statistics derived from published records of Japanese and Taiwanese longliners catches within the estimated EEZs of the

South Pacific Commission area between 1962 and 1977 are summarized in Table 3.6.3 for Western Samoa as reported in Skipjack Programme (1981). Catches are in numbers of fish and effort in 1,000 hooks, and include catches of other fishes such as billfishes (marlins and sailfishes) which are discussed under the "Other Pelagics" profile in this document. The tuna species landings are in bold. The catches in terms of numbers, were dominated by albacore and yellowfin. A few bluefin tuna were caught in 1970 and 1973 by Taiwanese longliners.

Table 3.6.3: Fishing effort and catch by the longline fleets of Japan and Taiwan within the estimated 200 miles zone of Western Samoa. (Source: Skipjack Programme, 1981). Catches are in numbers of fish while effort in 1,000 hooks.

Year/ Country	Effort hooks/ 1,000	Blue-fin	Alba-core	Big -eye	Yellow -fin	Skip -jack	Small tuna	Tuna Total	Broad bill	Str. marlin	Blue marlin	Black marlin	Sail-fish	Total Oceanic pelagics
1962														
Japan	207	0	10,855	200	528	0	0	11,790	5	10	283	3	40	341
1963														
Japan	232	0	8,731	430	1,329	2	0	10,724	12	18	282	6	35	353
1964														
Japan	90	0	4,075	215	720	0	0	5,100	8	1	111	3	8	131
1965														
Japan	70	0	1,679	127	457	9	0	2,342	6	32	40	1	6	85
1966														
Japan	62	0	1,560	172	402	21	0	2,217	13	6	41	3	19	82
1967														
Japan	73	0	1,583	96	192	2	0	1,946	16	6	81	0	12	115
Taiwan	166	0	6,497	590	1,214	0	608	9,075	3	57	190	3	0	253
Total								11,021						368
1968														
Japan	0	0	8	0	2	0	0	10	0	0	0	0	0	0
Taiwan	168	0	5,193	709	1,317	0	191	7,578	10	1	142	3	0	156
Total								7,588						156
1969														
Japan	7	0	43	5	29	10	0	94	0	0	13	0	18	31
Taiwan	241	0	9,850	225	1,389	0	0	11,705	7	14	414	5	144	584
Total								11,799						615
1970														
Japan	1	0	29	1	9	1	0	41	0	1	0	0	0	1
Taiwan	252	15	8,023	675	1,158	0	383	10,506	13	27	176	13	9	238
Total								10,547						239
1971														
Japan	21	0	337	8	101	0	0	467	0	6	45	0	0	51
Taiwan	284	0	8,121	292	1,491	0	0	10,188	38	13	161	0	13	225
Total								10,655						276
1972														
Taiwan	267	0	5,523	504	2,972	0	0	9,266	9	18	268	2	36	333
1973														
Taiwan	327	110	7,216	843	2,391	0	0	10,887	5	0	314	0	0	319
1974														
Taiwan	44	0	467	17	107	0	0	635	25	0	11	0	0	36
1975														
Taiwan	226	0	5,580	176	308	0	0	6,290	3	15	117	0	0	135
1976														
Taiwan	272	0	6,436	261	351	49	0	7,369	17	8	194	5	3	227
1977														
Taiwan	225	0	3,018	231	805	0	0	4,279	9	5	158	20	0	192

Klawe (1978) estimated catches by weight, as caught by the Japanese, Korean and Taiwanese longliners between 1972 and 1976. As most of the catches were converted from numbers of fish to live weight, the totals are thus nominal catches and are presented in Table 3.6.4. The tuna estimated landings are in bold. The tuna landings, in terms of weight, were dominated by albacore, followed by yellowfin and bigeye. A large proportion (20,312 kg) of the 1973 landing was made up of the northern bluefin tuna. The 20,312 kg correspond to 110 fish recorded in Table 3.6.3.

Note Data now available from SPC is considerably different after 1968

Table 3.6.4: Korean and Taiwanese estimated longline catches in Western Samoa waters, 1972-1976. Catches in kg. (Source: Klawe, 1978).

Year/ Flag	Effort	Nor. B/F	Sou. B/F	Yellow Fin	Alba-core	Bigeye	Skip-jack	Sword-fish	Blue marlin	Stripe marlin	Black marlin	Sail fish	Total
1972													
Taiwan	266,855			94,813	87,516	19,601	0	402	18,060	1,124	94	472	222,088
1973													
Taiwan	319,281	20,312	2	75,047	115,469	32,994	0	234	19,747	3	10	0	263,823
1974													
Taiwan	34,856	0	0	2,578	5,762	578	0	892	757	0	5	0	10,577
1975													
Korea	29,602	0	0	1,804	526	9,712	0	0	0	0	0	0	12,043
Taiwan	233,198	0	0	9,373	95,013	7,392	0	119	7,811	1,074	0	0	120,785
Total	262,800	0	0	11,177	95,539	17,104	0	119	7,811	1,074	0	0	132,828
1976													
Korea	78,596	0	0	4,958	15,205	11,138	269	447	693	246	86	230	33,281
Taiwan	245,032	0	0	9,986	93,137	9,459	329	749	12,103	485	221	48	126,522
Total	323,628	0	0	14,944	108,342	20,597	598	1,196	12,796	731	307	278	159,803

Skipjack Programme (1980) reported skipjack fishing effort and catch by the Japanese pole-and-line fleet within 200 Miles of the Countries in the Area of the South Pacific Commission for the 1972-1978 period. The only catches made in Western Samoan waters were 34 mt of skipjack in 8 boat-days during 1975, and 20 mt of skipjack and 7 mt of bigeye during 3 boat-days in 1976.

van Pel (1960) reported that a crew of two using the traditional paddled canoe and gear for skipjack trolling can bring in as many as 50 fish in a day. Anon (1969) reported catches of 60 skipjacks at Falealupo in an hour, by traditional canoes and gear, as not uncommon. The same author reported that a Peace Corp on Savai'i outfitted a two-man canoe with an outboard motor and caught skipjack and yellowfin in excess of 4,000 lb in six months. Anon (cited above) recorded data on catches made by one fisherman (Mr. Ted Porter) by trolling from a powered vessels of various sizes using 6 lines within 12 miles of Apia in the 1967-1969 period. These are recorded in Table 3.6.5 as reproduced from Anon (1969).

Table 3.6.5: Ted Porter's catch data from trolling within 12 miles of Apia using a 40, 41 and 60-foot boats and 6 lines. (Reference: Anon, 1969).

Year/Month	Vessel	Est. no. of trips	Total Weight (lbs)	Value (WS$)	Catch per trip (lbs)	Catch composition
1967						
October	40 ft	10	4,185.5	418.45	418.5	50 % skipjack, 50 % yellowfin & dolphinfish
November	as above	15	2,666.0	266.60	177.7	as above
December	as above	15	3,374.5	337.45	225.0	as above
1968						
January	as above	15	2,507.0	250.70	167.1	as above
February	as above	2	1,165.0	116.50	582.5	as above
March	60 ft	5	3,370.0	337.00	674.0	50 % skipjack (5-7 lbs) and 50 % yellowfin
April	as above	4	4,584.5	458.45	1,146.1	as above
May	as above	1	187.0	18.70	187.0	as above
June	no fishing					
July	51 ft	not recorded	720.0	72.00	?	not recorded
August	51 ft	not recorded	1,922.0	192.20	?	not recorded
September	51 ft	not recorded	2,583.0	258.30	?	not recorded
October	51 ft	not recorded	1,168.0	116.80	?	not recorded
November	51 ft	not recorded	42.0	4.20	?	not recorded
December	51 ft	not recorded	558.0	55.80	?	not recorded
1969						
January	51 ft	not recorded	1,779.0	177.90	?	not recorded
February	51 ft	not recorded	113.0	11.30	?	not recorded

FAO (1978) recorded fish bought by the Apia Fish Market from August, 1977 to March, 1978 as follows:

	1977					1978		
	August	September	October	November	December	January	February	March
Tuna (lbs)	75,000	72,000	68,000	52,000	15,000	128,000	25,000	45,000
Total (lbs)	152,000	175,000	165,000	142,000	45,000	192,000	64,000	89,000
% Tuna	49.3	41.1	41.2	36.6	33.3	66.7	39.1	50.6

Catches made by pole-and-line fishing during the SPC Skipjack Programme in Western Samoa waters in six fishing days in 1978 and 2 fishing days in 1980 are as follows, as reproduced from Tuna Programme (1984). The data are for fishing days only:

Date	General area	Hours fishing	Catch (kg)			Number schools sighted				
			Skipjack	Yellowfin	Total	SJ	YF	S+Y	OT	UN
07/06/78	N. Upolu Island	6	24	0	24	7	1	0	0	10
08/06/78	N. Upolu Island	5	317	124	448	0	0	0	2	1
09/06/78	E. Upolu Island	10	0	0	0	1	0	0	0	15
10/06/78	N. Upolu Island	6	3	0	23	3	0	0	0	11
11/06/78	Upolu-Savai'i	9	10	1	17	5	1	0	2	24
14/06/78	Apia	3	4,342	502	4,924	0	0	0	0	0
25/02/80	Upolu	5	0	0	2	1	1	0	1	2
26/02/80	Upolu	12	441	4	463	4	2	0	1	2
TOTAL		56	5,137	631	5,901	21	5	2	6	65

The Department of Statistics conducted a nation-wide survey on Fishery Catch Assessment in 1978. The results are summarised in Table 3.6.6. The landings from the survey have been considered as very low (underestimated). On Upolu, skipjack made up 11.4 per cent (76,160 kg) of the total fin-fish landing for the year, while skipjack made up 40.4 per cent (107,199 kg) of the Savai'i fin-fish landing for the year. Overall, skipjack was estimated to make up 19.0 per cent (183,359 kg) of the total Western Samoa fin-fish landing of 967,582 kg for 1978. The "O_pela" column (other oceanic pelagic species) includes other tuna species, mackerel and barracuda, and make 0.8 per cent (7,811 kg) of the fin-fish landing

Table 3.6.6: Summary of fin-fish landings in Western Samoa in 1978. (Source: Department of Statistics, Fishery Catch Assessment in 1978)

		Lutjanidae	Lethrini	O_Deep	Sharks*	Reef fish	Carangidae**	Mullet***	Eels	Other fish	S/jack	O_pela	Total
Upolu													
Total Wt	(kg)	9,015	62,337	95,154	2,858	325,085	12,853	15,818	20,121	43,646	**76,160**	**5,932**	668,979
Per cent		1.3	9.3	14.2	0.4	48.6	1.9	2.4	3.0	6.5	**11.4**	**0.9**	100.0
Savaii													
Total Wt	(kg)	4,720	6,133	37,909	4,470	97,467	14,279	14,185	3,321	7,041	**107,199**	**1,879**	265,476
Per cent		1.8	2.3	14.3	1.7	36.7	5.4	5.3	1.3	2.7	**40.4**	**0.7**	100.0
Western Samoa Total Estimates													
Total Wt	(kg)	13,735	68,470	133,063	7,328	422,552	27,132	30,003	23,442	50,687	**183,359**	**7,811**	967,582
Per cent		1.4	7.1	13.8	0.8	43.7	2.8	3.1	2.4	5.2	**19.0**	**0.8**	100.0

*includes sharks and rays; **includes jacks, trevallies and bigeye scads; ***includes mullet and milkfish; O_pela is "other oceanic pelagic species".

Catches made by the Fisheries Division vessels during pole-and-line operations in the 1979-1980 period using mostly cultured bait are summarised in Table 3.6.7. *Tautai Samoa* is the 16-tonne, Japanese-style pole-and-line vessel while *Tautai Nouei* is the *alia* (catamaran).

Table 3.6.7: Pole-and-Line catches made by the Fisheries Division Boats during the 1979-1980 period. (Source: Philipp *et al.*, 1980).

	Number of trips	Amount bait used (kg)		Number of Fish Caught	Total weight (kg)	Catch per Unit Bait
		Cultured	Wild			
TAUTAI SAMOA, Non-FAD, July, 1979 to July, 1980	34	1,798	310	2,946	7,828	3.7:1
TAUTAI SAMOA, Near FAD, February, 1980 to May, 1980	18	960	235	3,280	6,942	5.8:1
TAUTAI NOUEI, Near FAD October, 1980-November, 1980	10	381	0	504	1,497	3.9:1

Fisheries Division estimated Western Samoa fisheries landings from 1975 to 1984 using data obtained from the Government Fish Market and assuming that those data represented 5 per cent of the total landings. These estimates are given in Table 3.6.8 but have been considered as over-estimates.

Table 3.6.8: Estimates of fish landings in Western Samoa for the 1975-1984 period.
(Sources: Fisheries Division, Annual Reports for 1984, 1988).

Year		Tuna	Bottomfish	Shellfish	Others	TOTAL
1975	Wt (short ton)	650	900	25	80	1,655
	Wt (mt)	591.5	819.0	22.8	72.8	1,506.1
	Value (WS$)	420,000	630,000	30,000	40,000	1,120,00
1976	Wt (short ton)	700	950	20	100	1,770
	Wt (mt)	637.0	864.5	22.8	91.0	1610.7
	Value (WS$)	525,000	760,000	35,000	50,000	1,370,00
1977	Wt (short ton)	700	900	20	100	1,720
	Wt (mt)	637.0	819.0	22.8	91.0	1,569.8
	Value (WS$)	595,000	900,000	50,000	70,000	1,615,000
1978	Wt (short ton)	750	850	20	100	1,720
	Wt (mt)	682.5	773.5	22.8	91.0	1,569.8
	Value (WS$)	675,000	1,020,000	60,000	80,000	1,835,000
1979	Wt (short ton)	950	800	20	100	1,870
	Wt (mt)	864.5	728.0	22.8	91.0	1,706.3
	Value (WS$)	855,000	960,000	65,000	90,000	1,970,000
1980	Wt (short ton)	1,800	800	20	100	2,720
	Wt (mt)	1,636	727	18	91	2,472
	Value (WS$)	1,620,000	1,040,000	80,000	100,000	2,840,000
1981	Wt (short ton)	2,200	850	20	100	3,170
	Wt (mt)	2,000	772	18	91	2,881
	Value (WS$)	3,300,000	1,100,000	100,000	110,000	4,610,000
1982	Wt (short ton)	2,400	600	20	100	3,120
	Wt (mt)	2,182	545	18	91	2,836
	Value (WS$)	3,840,000	1,000,000	100,000	120,000	5,060,000
1983	Wt (short ton)	2,550	850	20	100	3,520
	Wt (mt)	2,318	772	18	91	3,199
	Value (WS$)	4,080,000	1,700,000	100,000	120,000	6,000,000
1984	Wt (short ton)	510	1,100	30	100	1,740
	Wt (mt)	464	1,000	27	91	1,582
	Value (WS$)	863,600	2,640,000	156,000	200,000	3,859,00

In a preliminary survey between December, 1983 and February, 1984, on fish consumption on Upolu Island, Zann *et al.* (1984) estimated fish production in the rural areas to be 5,752.7 mt of which the oceanic pelagic fish species (tuna and non-tuna) made up 12.7 per cent (690.3 mt). Responses to the questionnaire indicated that, in the rural areas, fish consumed the day before the survey comprised of 12.7 per cent oceanic pelagic species, which was made up of 8.6 per cent skipjack, 2.1 per cent yellowfin, and 2.0 per cent other species. The total urban fish consumption was estimated to be 937.3 mt per year of which 39 per cent (366 mt) was made up of oceanic pelagic species (tuna and non-tuna). Again, based on fish types eaten on the day before the survey, the Apia average fish consumption was estimated to comprise 39 per cent oceanic pelagic species which was made up of 28 per cent skipjack and 11 percent yellowfin. No other oceanic fish pelagic were recorded in the urban area except the tuna species. This is a reflection of relying on what is available in the Apia Fish Market.

Different formulae for estimating total fish landings of various fisheries in Western Samoa were used for the 1985-1988 period using data collected from the Apia Fish Market. The estimates for that year period are given in Table 3.6.9. Figures are in mt. The tuna category in the table include data for those labelled as "others" in Table 3.6.8 which was for the oceanic pelagic species.

Table 3.6.9: Fish landing estimates in Western Samoa for the 1985-1988 period. (Sources: Fisheries Division Annual Report for 1988).

Year	Tuna	Bottomfish	Inshore fin-fish	Shellfish	Total wt (mt)	Total value (WS$)
1985	2,178	822	545	96	3,641	19,566,000
1986	1,688	440	617	144	2,889	8,040,600
1987	1,034	384	480	106	2,004	6,727,600
1988	1,536	616	440	80	2,672	7,862,720

Monthly landings of tuna and oceanic fish species at the Apia Fish Market for the 1989-1994 period are recorded in Table 3.6.10. Skipjack clearly dominates the tuna and offshore fish landings.

Table 3.6.10: Monthly tuna and other oceanic pelagic fish species at the Apia Fish Market. (Sources: Fisheries Division Annual Reports for 1989, 1990, and 1992/1993; Mulipola, 1994; Mulipola, undated and Fisheries Database).

		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Total
1989														
Skipjack	Wt (kg)	56,022	25,024	47,806	35,282	31,727	33,085	20,540	19,252	26,869	29,993	34,408	23,003	383,011
	Value $	72,713	67,333	11,031	97,415	70,942	117,473	75,309	63,465	70,028	95,283	203,089	94,010	1,038,090
Yellowfin	Wt (kg)	6,878	9,916	19,461	9,312	6,010	2,474	2,878	1,482	607	699	1,855	1,573	63,144
	Value $	9,813	38,006	53,827	20,454	18,558	23,894	13,143	6,126	3,764	9,684	7,970	9,173	214,410
Rainbow run	Wt (kg)	24	108	72										204
	Value $	28	495	212										735
Other	Wt (kg)	20,720												20,720
	Value $	24,886												24,886
1990														
Skipjack	Wt (kg)	15,954	7,202	11,189	7,170	7,223	7,274	6,411	10,150	5,687	15,611	19,881		124,093
	Value $	44,101	23,018	33,178	20,112	22,405	23,956	21,231	28,670	18,400	22,691	54,701		340,869
Yellowfin	Wt (kg)	891	2,175	1,080	533	1,176	1,476	2,719	1,906	7,333	1,755	6,840		30,420
	Value $	4,912	10,700	3,947	1,920	6,305	7,964	12,661	8,473	25,840	6,156	23,586		122,686
Dogtooth tuna	Wt (kg)	63						49	3		27			155
	Value $	158						196	8		162			572
Dolphin	Wt (kg)		81			14		108	92	240		217		819
	Value $		50			68		344	392	975		1,278		3,388
Rainbow run	Wt (kg)	18	22		8	142	39			7		17		277
	Value $	81	86		39	430	185			37		69		1,011
Other	Wt (kg)		27					8						38
	Value $		135					62						215
Total	Wt (kg)	16,926	9,508	12,269	7,711	8,554	8,788	9,295	12,151	13,267	17,393	26,956		155,802
	Value $	49,251	33,989	37,125	22,071	29,207	32,105	34,494	37,543	45,253	29,009	79,634		468,741
1991														
Tuna	Wt (kg)	10,500	9,800	13,700	10,700	30,600	24,900	12,300	9,900	9,500	12,600	15,600	5,500	165,600
	Value $	34,200	28,500	49,500	40,400	79,900	64,400	36,300	28,600	33,100	41,200	48,300	18,400	502,800
1992														
Tuna	Wt (kg)	32,800	39,200	23,500	28,400	27,100	37,100	82,200	60,000	180,900	102,100	64,300	46,900	724,500
	Value $	71,910	110,200	68,900	87,300	82,000	92,980	234,530	161,350	414,800	595,230	186,950	140,340	2,246,500
1993														
Skipjack	Wt (kg)	47,722	29,313	21,561	46,703	36,984	99,801	54,333	45,622	43,140	47,438	40,895	38,442	551,954
	Value $	147,132	81,082	53,046	110,388	64,101	217,299	99,779	101,001	95,367	117,123	84,407	64,068	1,234,793
Yellowfin	Wt (kg)	8,580	7,195	8,348	19,955	3,371	1,526	1,928	4,036	671	1,699	2,492	1,446	61,246
	Value $	50,397	26,362	51,696	85,986	17,308	11,436	16,690	24,602	4,773	10,541	12,448	7,277	319,517
Dolphinfish	Wt (kg)	372	321	84	218	102	252	954	532	668	1,696	1,474	54	6,727
	Value $	2,489	1,577	701	1,048	512	1,501	6,385	3,194	4,094	9,196	9,138	362	40,196
Rainbow runner	Wt (kg)	377	8	138	110			14	51	21	9	12		740
	Value $	1,784	30	358	286			28	93	63	24	60		2,725
Sailfish	Wt (kg)	18						45	36					99
	Value $	45						450	389					884
Wahoo	Wt (kg)			51	126		88	33		18	18			334
	Value $			261	409		338	119		45	104			1,277
Shark	Wt (kg)									6				6
	Value $									20				20
G.barracuda	Wt (kg)					12				98	16			126
	Value $					60				185	40			285
Total	Wt (kg)	57,069	36,837	30,182	67,112	40,469	101,667	57,307	50,277	44,622	50,876	44,873	39,942	621,231
	Value $	201,847	109,051	106,061	198,118	81,981	230,574	123,451	129,279	104,547	137,029	106,053	71,707	1,599,698

In a survey of 25 "other" commercial fishery product outlets (retailers, hotels and restaurants) during February-November 1989, Brotman (1989) recorded the following statistics concerning fin-fish landings:

Invertebrates:	34 mt (valued WS$ 212,561);
Inshore fin-fish:	56 mt (valued WS$ 203,319);
Offshore fin-fish:	175 mt (valued WS$ 665,747).

The offshore landings comprised of 66.5 per cent (116 mt) bottomfish and 33.5 per cent (59 mt) pelagic species. Pelagic species composition were given as follows:

	Wahoo	Sailfish	Dolphinfish	Marlin	Dogtooth tuna	Rainbow runner	Trevally	Bigeye scad	**Skipjack**	**Yellowfin tuna**	Total
%	0.5	2.4	4.8	3.6	3.6	0.4	3.9	0.8	**32.4**	**47.6**	100
Wt (kg)	295	1,416	2,832	2,124	2,124	236	2,301	472	**19,116**	**28,084**	59,000

The survey was continued in 1990 for the January-August period. However, Winterstein (1991) lumped tunas and other pelagics together in one category, "pelagics". The estimated "pelagics" landing for the eight-month period was 60,129 kg.

The Taiwanese longline fleet based in American Samoa were licensed to fish in Western Samoa starting in 1988, and has been renewed every year since. The only data which could be obtained for this undertaking were those for the first 6 months in 1994 which are as follows:

Number of different vessels involved	Period	Number of trips	Albacore		Bigeye		Yellowfin		Other		Total	
			pieces	weight	pieces	weight	pieces	weight	pieces	weight	Pieces	Wt
13	Jan-Jul, 1994	30	20,094	243,298	108	2,788	1,179	26,910	316	10,470	21,697	283,466

Watt (1991a and 1991b) recorded catches made during small scale experimental longline expeditions in Western Samoa as presented in Table 3.6.11.

Table 3.6.11: Catches made by the SPC vertical longline trials in Western Samoa. (Source: Watt, 1991a and 1991b).

Tautai Matapalapala		Dates: September, 1990 to March, 1991			
Method	No. of trips	No. of sets	Fish type	No. of fish	Total weight (kg)
Vertical longline	11	39	Target species?	134	1,866.1
42 sharks were also caught					
Horizontal longline	2	6	Target species	39	175.3
5 sharks were also caught					
Alia		**Dates: March to July, 1991**			
	No. of trips	No. of sets	Fish type	No. of fish	Total weight (kg)
Vertical longline	20	32	Target species?	187	2,819.2
47 sharks were also caught					

Watt (1991a and 1991b) listed species composition, in number of pieces, of the catches as follows:

	Tautai Matapalapala		Alia
	Vertical longline	Horizontal longline	Vertical longline
Thunnus alalunga	45	1	36
T. albacares	67	5	116
T. obesus	1		3
Coryphaena hippurus	5	3	16
Istiophorus platypterus	1		
Sphyraeidae barracuda		15	
Acanthacybium solandri		3	
Tetrapterus angustirostris		1	
Others	16		10

Tables 3.6.12(a) and (b) present available data from two of the local small fishing boats fishing vertical longline in Western Samoan waters. The Marengo Bay tuna catches were dominated by albacore, followed by bigeye and yellowfin. However, the Pua'anifo's catches were dominated by yellowfin, folowed by albacore.

Table 3.6.12(a): Vertical longline catches by Marengo Bay. (Source: Fisheries Division Database).

MARENGO BAY															
1992			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
# fishing	days												8	12	20
# hooks													3,350	4,750	8,100
	Albacore	Pieces											145	134	279
		Weight (kg)											2,175	2,010	4,185
	Yellowfin	Pieces											8	38	46
		Weight (kg)											180	760	940
	Bigeye	Pieces											52	18	70
		Weight (kg)											1,300	450	1,750
	Others	Pieces											11	50	61
		Weight (kg)											200	500	700
	Total	# pieces											216	240	456
	Total	Wt (kg)											3,855	3,720	7,575
	Total	Value											21,588	20,832	42,420
	CPUE	Fish/day											27.0	20.0	23.5
	CPUE	Wt/day											481.9	310.0	395.9
	CPUE	Fish/100hks											6.4	5.1	5.8
	CPUE	kg/100 hks											115.1	78.3	96.7
1993															
# fishing	days		6	7	5	7	9	9	11	9	13	11	12	7	106
# hooks			2,250	3,650	2,250	3,650	4,750	3,950	4,500	3,800	6,600	5,000	5,400	3,050	48,850
	Albacore	Pieces	73	55	9	7	61	202	190	113	186	144	130	88	1,258
		Weight (kg)	1,095	825	135	220	1,007	3,079	2,774	1,378	2,750	2,125	1,950	1,315	18,653
	Yellowfin	Pieces	19	15	8	23	63	47	29	28	25	2	14	3	276
		Weight (kg)	475	375	200	354	1,048	1,858	796	866	460	80	235	44	6,791
	Bigeye	Pieces	5	17	20	10	0	24	21	30	4	14	4	4	153
		Weight (kg)	125	427	570	250	0	500	427	663	80	210	115	75	3,442
	Others	Pieces	25	56	23	40	49	31	52	37	98	142	91	17	661
		Weight (kg)	300	800	350	100	800	400	590	525	525	1,525	1,060	85	7,060
	Total	# pieces	122	143	60	80	173	304	292	208	313	302	239	112	2,348
	Total	Wt (kg)	1,995	2,427	1,255	924	2,855	5,837	4,587	3,432	3,815	3,940	3,360	1,519	35,946
	Total	Value	11,172	13,591	7,028	5,174	15,988	32,687	25,687	19,219	21,364	22,064	18,816	8,506	201,298
	CPUE	Fish/day	20.3	20.4	12.0	11.4	19.2	33.8	26.5	23.1	24.1	27.5	19.9	16.0	21.4
	CPUE	Wt/day	332.5	346.7	251.0	132.0	317.2	648.6	417.0	381.3	293.5	358.2	130.0	217.0	361.8
	CPUE	Fish/100hks	5.4	3.9	2.7	2.2	3.6	7.7	6.5	5.5	4.7	6.0	4.4	3.7	4.8
	CPUE	kg/100 hks	88.7	66.5	55.8	25.3	60.1	147.8	101.9	90.3	57.8	78.8	62.2	49.8	969.6

Summaries of monthly catch information for Marengo Bay is presented in Figure 3.6.1 for 1993. The highest catch was recorded in June, which also corresponded to the highest CPUE and value. High values for these three parameters are recorded in the June-November period. Actual weight (in kg) are x 10 those given in the figure, value (WS$) x 100 and CPUE (kg/100 hooks) as it is.

Figure 3.6.1: Marengo Bay Longline Monthly Catch Summaries to show peak month in catch, CPUE and value.

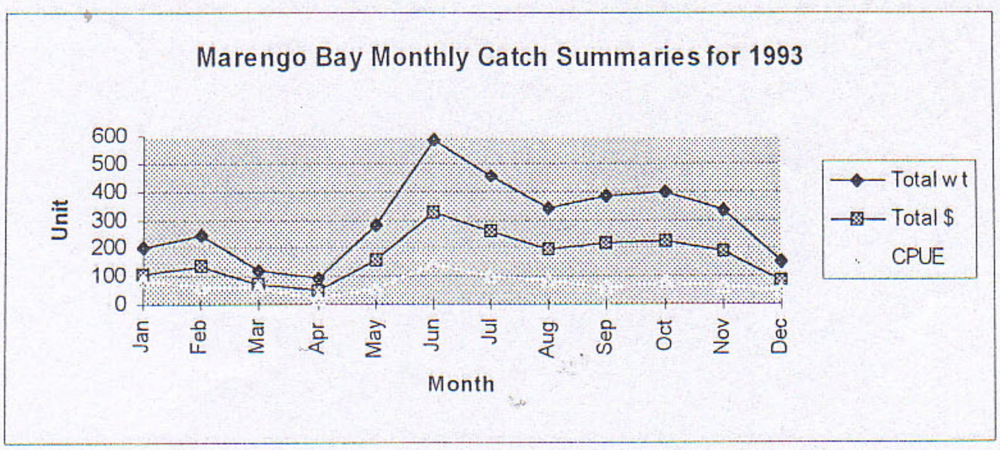

Table 3.6.12(b): Vertical Longline Catches by the Pua'anifo II (alia). (Source: Fisheries Division Database).

PUAANIFO II - *alia*																
1993	Crew	# Trips	# lines	Tot # hooks	Yellow-fin	Alba-core	Big-eye	Skip-jack	Dolp-hinfish	R. runner	Shark	Others	Total Wt	Total # Fish	# fish per 100 hks	Wt per 100 hks
June																
Total		6.0	24.0	364.0	937.0	262.0	39.0	18.0	60.0	4.0	0.0	6.0	1,326.0	122.0	33.5	364.3
Value $					3,729.3	1,100.4	167.7	18.0	246.0	14.0	0.0	12.0	5,287.4			
Average	2.8		4.0	60.7	156.2	43.7	6.5	3.0	10.0	0.7	0.0	1.0	221.0	20.3	33.4	362.6
July																
Total		15.0	54.0	879.0	1,605.0	386.0	66.5	20.5	106.5	1.0	270.0	7.0	2,462.5	185.0	21.0	280.1
Value					6,387.9	1,621.2	286.0	20.5	436.7	3.5	297.0	14.0	9,066.7			
Average	2.3		3.6	58.6	114.6	25.7	4.4	1.4	7.1	0.1	18.0	0.5	164.2	12.3	21.2	276.9
August																
Total		8.0	20.0	323.0	476.0	66.0	29.0	15.0	32.0		82.0	13.0	713.0	61.0	18.9	220.7
Value					1,894.5	277.2	124.7	15.0	131.2		90.2	26.0	2,558.8			
Average	2.1		2.5	40.4	59.5	8.3	3.6	1.9	4.0	0.0	10.3	1.6	89.1	7.6	18.5	213.4
September																
Total		5.0	12.0	198.0	177.0	56.0	52.0		21.0		24.0		330.0	28.0	78.1	895.1
Value					704.5	235.2	223.6		86.1		26.4		1,275.8			
Average	2.2		2.4	39.6	35.4	11.2	10.4	0.0	4.2	0.0	4.8	0.0	66.0	5.6	15.6	179.0

Skipjack tuna - even though skipjack catches has trebled in the last decade, with recent catches being of the order of 1 million mt, CPUE by purse seiners and pole-and-line remains high and has shown a tendency to increase since the early 1980s. There are no currently known indicators that would suggest the stock as being heavily exploited. Recent tagging experiments suggests that the impact of fishing remains modest despite the increase in catch over the past decade and that maximum safe skipjack harvest of the order of 1.5-2.0 million mt could be sustained.

Bigeye - the current levels of catch, up to 150,000 mt by longline and 60,000 mt by surface fisheries, are sustainable as indicated by the stability of the longline CPUE time series and related abundance indices. However analysis of one age-structure indicates that this level represents moderate to high exploitation of age classes vulnerable to longline. Tagging results of surface fishery catch suggest that the current average exploitation rate of juvenile bigeye by the surface fisheries is no higher than those of yellowfin and skipjack which is believed to be modest.

Albacore - longline CPUE for the South Pacific albacore is high relative to CPUE in tropical tuna longline fisheries. However the longline CPUE time series has been fairly stable although recent levels have been the lowest on record. In the troll fishery, time series CPUE, although short, has been generally declining since the start of the fishery in the mid-1980s. Preliminary results from assessments using age-structured models, as well as tagging results, suggest that the surface fishery exploitation rates are low. It is also possible that higher catches of juvenile albacore could be sustainable. This however requires confirmation.

In Western Samoa, the tuna resource is the only catch fishery that presents the opportunity for further development in terms of increasing catches. Because of the small size of the EEZ, Western Samoa is at a disadvantage in attracting large scale commercial fishing operations. However, through regional and subregional approaches, maximum benefits can be derived from the tuna resource.

3.6.4 Management

The distribution and structure of tuna stocks in the Pacific region show that the management of these resources requires a regional approach. Management can be in the form of prohibition of certain fishing techniques employed, such as drift net, and limiting the number of fishing vessels in a particular fishery within a defined area. However the level of exploitation, especially that of skipjack, currently seems to be sustainable with some allowances for increase. At present the existing control of fishing for tunas within the region is geared towards maximizing benefits to the South Pacific countries from the utilization of the tuna resources by distant water fishing nations (DWFN) fishing in their EEZ's through bi-lateral and multi-lateral agreements. The SPC Tuna and Billfish Assessment Programme is geared towards obtaining sufficient statistical and biological information on which to base management of the South Pacific tuna fisheries.

Current legislation/policy regarding exploitation: Section 5(1) of the Fisheries Act 1988 requires local commercial fishing vessels to have a valid certificate of registration. Part III deals with Foreign Fishing. Section 6 deals with Access Agreements as follows:

(1) the Minister may, on behalf of the Governemnt of Western Samoa, enter into international bilateral or multilateral agreements or arrangements providing for the allocation of licenses for fishing and elated activities;
(2) Fishing licences allocated under access agreements shall ot exceed a level consistent with the conservation and management of fishery resources and the protection of Western Samoa fishing.

Section 8 deals with Foreign Fishing Licences and reeds as follows:

(1) No foreign fishing vessel shall be used for fishing or related activities in the fishery waters except in accordance with a valid licence issued pursuant to;
this section; or
an access agreement in force in Western Samoa; or as other authorised under the Act.

(2) No person, being abroad a foreign fishing vessel oe being a member of the crew of or attached to or employed on a foreign fishing vessel, shall in Western Samoa or in the fishery waters engage in fishing or related activities unless he is authorised to do so in accordance with the Act.

(3) Subject to subsection (4), the Minister may, upon application in writing, issue a foreign fishing vessel licence in respect of any foreign fishing vessel authorising that vessel to be used in such areas of the fishery waters for such fishing or related activities as may be specified in the licence.

(4) No licence shall be issued in respect of any foreign fishing vessel unless-

(a) there is in force an acess agreement in accordance with Section 6; or

(b) the Minister determines that an access agreement is not practical and the applicant provides sufficient financial and other guarantees for the fulfillment of all obligations under the Act.

Part IV section 10 deals with authorisation of Marine Scientific Research:

(1) The Minister may, in writing, after the submission of a satisfactory research plan, authorise any vessel or person to undertake marine scientific research operations in the fishry waters, subject to such conditions as he may specify or as may be prescribed.

(2) An authorisation made under this section may exempt such vessel or person from any provision of the Act.

(3) No person shall undertake or assist in any marine scientific researh in the fishery waters without an authorisation under this section.

Fines:

(1) Where a foreign fishing vessel is used in contravention of section 8(1), the master, owner and charterer shall each be guilty of an affence and shall each be liable on conviction to a fine not exceeding 1,000,000 tala.

(2) Where a foreign fishing vessel in respect of which a licence has been issued under section 8 is used in contravention of any condition of that licence, the master, owner and charterer shall each be guilty of an offence and shall each be liable on conviction to a finenot exceeding 500,000 tala.

(3) Where any foreign fishing vessel contravenes section 9, the master, owner and charterer shall each be guilty of an offence and shall each be liable on conviction to a finenot exceeding 500,000 tala.

(4) Any person who undertakes or assists in any scientific research in the fishery waters without authorisation under section 10, or in contravention of any term of condition of the authorisation, commits an offence and shall be liable on conviction to a fine of not exceeding 50,000 tala.

Recommended legislation/policy regarding exploitation: Current legislations appear to be sufficient for the management of the tuna resources in Western Samoa. However, there is a need for the establishment of better schemes for the enforcement of provisions under access agreements especially on the timely submission of catch statistics. Database systems need to be properly upgraded for the compilation and analysis of each of the different fisheries data. Prompt entering of data into the databases is necessary to avoid loss of data as has been the case.

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3.7 Other oceanic pelagic fishes - *isi i'a aluga o le moana*

3.7.1 The Resource

sa'ula - Makaira indica

Species present: Apart from tuna, other oceanic pelagic fish species of importance include *Coryphaena hippurus* (dolphinfish - ***masimasi***), *Elegatis bipinnulatus* (rainbow runner - ***samani***), *Makaira nigricans* (blue marlin - ***sa'ula***), *M. indica* (black marlin - ***sa'ula oso***), *Tetraturus audax* (striped marlin - ***sa'ula***), *Xiphias gladius* (broadbill swordfish - ***sa'ula***), *Istiophorus platyterus* (sailfish - ***sa'ula lele***), *Acanthocybium solandri* (wahoo - ***pala***), and *Sphyraena* spp. (barracudas - ***saosao***, ***sapatu***).

Distribution: Species discussed under this profile are normally distributed throughout the oceans in varying abundance, determined mostly by food availability, but they have been documented as being associated with Fish Aggregating Devices (FADs).

Geographical distributions of the billfish species are given in Nakamura (1985). Generally, they are primarily oceanic and epipelagic, inhabiting tropical and temperate waters, and seasonally, also the cold waters of all oceans. They are usually confined to the water layers above the thermocline but some may occur at greater depths.

Biology and ecology: Smith (1992) notes that all of these fish species are predators, mostly on fish and squid. The larger coastal pelagics are usually opportunistic second level predators. Spawning is seasonal in many species, the timing varying between areas throughout the region (McPherson, 1988). The biology of the coastal pelagic species in Western Samoa has not been studied, but McPherson (1988) provides and overview for other areas in the Pacific and Lewis *et. al.* (1983) provides data on pelagics studies in Fiji. Dalzell and Lewis (1988) review Pacific fisheries for small inshore pelagics in the Pacific.

Some biological information for the billfishes is given in Nakamura (1985). Sexes are separate and they are active and voracious predators but during their younger stages, they are occasionally preyed on by large oceanic fishes such as tunas, wahoo and dolphinfish. The young are sometimes also taken by adult billfishes. Smith (cited above) also notes that billfishes are solitary while other species tend to form small to medium sized schools. Migrations associated with spawning are known for billfish and dolphinfish.

3.7.2 The Fishery

Utilization: As noted under the tuna profile, traditional fishing outside the reef was an important but specialized component of the subsistence fishing activity in the Samoan way of life. Canoes, hooks etc were developed specifically for offshore bonito fishing. In addition, only specialized fishermen were able to participate. Buck (1930) noted that specialized canoe took men outside the reef to seek the deep sea fish that came within the possibilities of their attainment. Even though fishing for bonito and other tuna species constituted the major portion of the traditional offshore fishing, other species, e.g. dolphinfish, sharks and flying fish were also taken. For example, ***tiuga masimasi*** has been mentioned in literature as a form of fishing in Samoa. Pratt (cited in Buck, 1930) referred to ***masimasi*** as a dolphin and Demandt (cited in Buck, 1930) referred to it as a species of Caranx. These are very likely to be mis-identification as ***masimasi*** is currently the Samoan name given to dolphinfish, *C. hippurus*. Buck (1930) cited Hon. O.F. Nelson describing canoes used for ***tiuga masimasi*** as fast sailing canoes which were bigger than the bonito canoes. "Loose bait was thrown overboard during one sweep. The canoe, after tacking, came sweeping down over the same ground with baited trolling hooks out". Buck cited one Mr. Gosche of Savai'i as seeing such canoes trolling for dolphin (most probably dolphinfish) without a rod. Kramer (cited in Buck, 1930) noted that canoes with five cross booms (*iato lima*) were used in trolling a *pa* hook for *masimasi*. The hook was believed to be made of two pieces of wood tied together at an angle to form a large hook. The hook was baited with a whole fish when trolling for *masimasi*.

Today, the oceanic pelagic species form a portion of the catches made in the troll and longline fisheries for the tunas, in the commercial operations in Western Samoa. They are an important component of the catch around FADs.

Production and marketing: Catch statistics derived from published records of Japanese and Taiwanese longliners catches within the estimated EEZs of the South Pacific Commission area between 1962 and 1977 are summarized in Table 3.7.1 for Western Samoa as reported in Skipjack Programme (1981). Catches are in numbers of fish and effort in 1,000 hooks and include catches of tuna species and oceanic pelagic species (in bold) discussed in this profile. Blue marlin dominated the non-tuna portion of the catches. The non-tuna species made up less than 10 per cent of the total longline catches, except that in 1969, the Japanese boats had catches comprised of about 25 per cent of other pelagic species. The Japanese vessels fishing effort in Western Samoa waters was low during that year.

Table 3.7.1: Fishing effort and catch, in numbers of fish, by the longline fleets of Japan and Taiwan wihtin the estimated 200 miles zone of Western Samoa between 1962 and 1977. (Source: Skipjack, 1981).

Year/Country	EFFORT	TUNA	OCEANIC PELAGIC FISH SPECIES						
	(hooks/1,000)	total	Broadbill	Striped marlin	Blue marlin	Black marlin	Sailfish	Total	Per cent of total catch
1962									
Japan	207	11,790	5	10	283	3	40	341	2.8
1963									
Japan	232	10,724	12	18	282	6	35	353	3.2
1964									
Japan	90	5,100	8	1	111	3	8	131	2.5
1965									
Japan	70	2,342	6	32	40	1	6	85	3.5
1966									
Japan	62	2,217	13	6	41	3	19	82	3.6
1967									
Japan	73	1,946	16	6	81	0	12	115	5.6
Taiwan	166	9,075	3	57	190	3	0	253	2.76
1968									
Japan		10							
Taiwan	168	7,578	10	1	142	3	0	156	2.0
1969									
Japan	7	94	0	0	13	0	18	31	24.8
Taiwan	241	11,705	7	14	414	5	144	584	4.8
1970									
Japan	1	41	0	1	0	0	0	1	2.4
Taiwan	252	10,506	13	27	176	13	9	238	2.2
1971									
Japan	21	467	0	6	45	0	0	51	9.8
Taiwan	284	10,188	38	13	161	0	13	225	2.2
1972									
Taiwan	267	9,266	9	18	268	2	36	333	3.5
1973									
Taiwan	327	10,887	5	0	314	0	0	319	2.8
1974									
Taiwan	44	635	25	0	11	0	0	36	5.4
1975									
Taiwan	226	6,290	3	15	117	0	0	135	2.1
1976									
Taiwan	272	7,369	17	8	194	5	3	227	3.0
1977									
Taiwan	225	4,279	9	5	158	20	0	192	4.3

Klawe (1978) estimated catches by weight, as caught by the Japanese, Korean and Taiwanese longliners between 1972 and 1976. As most of the catches were converted from numbers of fish to live weight, the totals are thus nominal catches and are presented in Table 3.7.2. The oceanic pelagic species estimated landings are in bold. In terms of weight, the non-tuna made up less than 10 per cent of the total catches with blue marlin dominating the non-tuna portion of the catches.

Table 3.7.2: Korean and Taiwanese estimated longline catches in Western Samoa waters, 1972-1976. Catches in kg. (Source: Klawe, 1978).

		TUNA SPECIES							OTHER OCEANIC PELAGIC FISH SPECIES						
Year/ Flag	Effort	Nor. B/F	Sou .B/F	Yellow Fin	Alba-core	Bigeye	Skip-jack	Total	Sword-fish	Blue marlin	Stripe marlin	Black marlin	Sail fish	Total	% all species
1972															
Taiwan	266,855			94,813	87,516	19,601	0	201,930	402	18,060	1,124	94	472	20,152	9.1
1973															
Taiwan	319,281	20,312	2	75,047	115,469	32,994	0	563,105	234	19,747	3	10	0	19,994	3.4
1974															
Taiwan	34,856	0	0	2,578	5,762	578	0	43,774	892	757	0	5	0	1,654	3.6
1975															
Korea	29,602	0	0	1,804	526	9,712	0	41,644	0	0	0	0	0	0	0.0
Taiwan	233,198	0	0	9,373	95,013	7,392	0	344,976	119	7,811	1,074	0	0	9,004	2.5
Total	262,800	0	0	11,177	95,539	17,104	0	386,620	119	7,811	1,074	0	0	9,004	2.3
1976															
Korea	78,596	0	0	4,958	15,205	11,138	269	110,166	447	693	246	86	230	1,702	1.5
Taiwan	245,032	0	0	9,986	93,137	9,459	329	357,943	749	12,103	485	221	48	13,606	3.7
Total	323,628	0	0	14,944	108,342	20,597	598	468,109	1,196	12,796	731	307	278	15,308	3.2

The nation-wide survey conducted on Fishery Catch Assessment in 1978 by the Department of Statistics recorded the following fin-fish landing statistics in Western Samoa as summarized in Table 3.7.3.

Table 3.7.3: Estimates of fish landings in Western Samoa during the Fishery Catch Assement Survey in 1978 by the Department of Statistics. (Source: Department of Statistics, undated).

	Unit	Snapper	Emperor	O_deep	Sharks *	Reef fish	Caranx **	Mullet ***	Eels	Other fish	S/jack	O_pela ****	Total
Upolu													
Total Wt	kg	9,015	62,337	95,154	2,858	325,085	12,853	15,818	20,121	43,646	76,160	5,932	668,979
Per cent	%	1.3	9.3	14.2	0.4	48.6	1.9	2.4	3.0	6.5	11.4	0.9	100.0
Saval'i													
Total Wt	kg	4,720	6,133	37,909	4,470	97,467	14,279	14,185	3,321	7,041	107,199	1,879	265,476
Per cent	%	1.8	2.3	14.3	1.7	36.7	5.4	5.3	1.3	2.7	40.4	0.7	100.0
Western Samoa Total Estimates													
Total wt	kg	13,735	68,470	133,063	7,328	422,552	27,132	30,003	23,442	50,687	183,359	7,811	967,582
Per cent	%	1.4	7.1	13.8	0.8	43.7	2.8	3.1	2.4	5.2	19.0	0.8	100.0

*also includes rays; ** includes jacks, trevallies and bigeye scads; *** also include milkfish; ****O_pela is "other oceanic pelagic fish species" but includes other tuna, mackerel and barracuda. (Source: Department of Statistics, undated).

The "O_pela" column (other oceanic pelagic species) includes non-skipjack tuna species, mackerel and barracuda. It made up 0.9 per cent of the total fin-fish landings on Upolu and 0.7 per cent on Savai'i, averaging 0.8 per cent for the whole country for the year.

Fish landings for the 1975-1983 period were estimated by the Fisheries Division for Western Samoa using data obtained from the Government Fish Market and assuming that those data represented 5 per cent of the total landings. These estimates are given in Table 3.7.4. The "Others" column constitutes fish species considered here as oceanic pelagic species and are in bold. These fish make up between 2 and 6 per cent of landings both in weight and value. The weight figures were given in short tonnes but have been converted to mt.

Table 3.7.4: Estimates of fish landings in Western Samoa for the 1975-1984 period by the Fisheries Division. (Sources: Fisheries Division, Annual Reports for 1984,and 1988).

Year	Unit	Tuna	%	Bottomfish	%	Shellfish	%	**Others**	%	TOTAL
1975	Wt (mt)	591.5	39.3	819.0	54.4	22.8	1.5	**72.8**	**4.8**	1,506.1
	Value (WS$)	420,000	37.5	630,000	56.3	30,000	2.7	**40,000**	**3.6**	1,120,00
1976	Wt (mt)	637.0	39.4	864.5	53.5	22.8	1.4	**91.0**	**5.6**	1610.7
	Value (WS$)	525,000	38.3	760,000	55.5	35,000	2.6	**50,000**	**3.6**	1,370,00
1977	Wt (mt)	637.0	40.6	819.0	52.2	22.8	1.5	**91.0**	**5.8**	1,569.8
	Value (WS$)	595,000	36.8	900,000	55.7	50,000	3.1	**70,000**	**4.4**	1,615,000
1978	Wt (mt)	682.5	43.5	773.5	49.3	22.8	1.5	**91.0**	**5.8**	1,569.8
	Value (WS$)	675,000	36.8	1,020,000	55.6	60,000	3.3	**80,000**	**4.4**	1,835,000
1979	Wt (mt)	864.5	50.7	728.0	42.7	22.8	1.3	**91.0**	**5.3**	1,706.3
	Value (WS$)	855,000	43.4	960,000	48.7	65,000	3.3	**90,000**	**4.6**	1,970,000
1980	Wt (mt)	1,636	66.2	727	29.4	18	0.7	**91**	**3.7**	2,472
	Value (WS$)	1,620,000	57.0	1,040,000	36.6	80,000	2.8	**100,000**	**3.5**	2,840,000
1981	Wt (mt)	2,000	69.4	772	26.8	18	0.6	**91**	**3.2**	2,881
	Value (WS$)	3,300,000	71.6	1,100,000	23.9	100,000	2.2	**110,000**	**2.4**	4,610,000
1982	Wt (mt)	2,182	76.9	545	19.2	18	0.6	**91**	**3.2**	2,836
	Value (WS$)	3,840,000	75.9	1,000,000	19.8	100,000	2.0	**120,000**	**2.4**	5,060,000
1983	Wt (mt)	2,318	72.5	772	24.1	18	0.6	**91**	**2.8**	3,199
	Value (WS$)	4,080,000	68.0	1,700,000	28.3	100,000	1.7	**120,000**	**2.0**	6,000,000
1984	Wt (mt)	464	29.3	1,000	63.2	27	1.7	**91**	**5.8**	1,582
	Value (WS$)	863,600	22.4	2,640,000	68.4	156,000	4.0	**200,000**	**5.2**	3,859,00

In a survey of fish consumption on Upolu Island, Zann *et al.* (1984) estimated total rural fish consumption to be 5,752.7 mt per year of which 12.7 per cent (690.3 mt) was made up of oceanic pelagic species (tuna and non-tuna). Based on fish types eaten (and caught) on the day before the survey, the Upolu rural average fish consumption was estimated to comprise of 0.2 per cent ***masimasi*** (dolphinfish), 1.8 per cent ***samani*** (rainbow runner) and 10.7 per cent tuna. The total urban fish consumption was estimated to be 937.3 mt per year of which 39 per cent (366 mt) was made up of oceanic pelagic species (tuna and non-tuna). Again, based on fish types eaten (and caught) on the day before the survey, the Apia average fish consumption was estimated to comprise 39 per cent oceanic pelagic species which was made up of 28 per cent skipjack and 11 percent yellowfin.

For the 1985 -1988 period, data collected from the Apia Fish Market were used to estimate landings of various fisheries using different formula. The estimates for that year period are given in Table 3.7.5 with figures in mt. However, the "others" category, which was used to accommodate non-tuna fish species, has been lumped together under the tuna category.

Table 3.7.5: Fish landing in Western Samoa for the 1985-1988 period as estimated by the Fisheries Division. (Source: Fisheries Division Annual Report for 1988).

Year	Tuna	Bottomfish	Inshore fin-fish	Shellfish	Total wt (mt)	Total value (WS$)
1985	2,178	822	545	96	3,641	19,566,000
1986	1,688	440	617	144	2,889	8,040,600
1987	1,034	384	480	106	2,004	6,727,600
1988	1,536	616	440	80	2,672	7,862,720

King (undated) estimated the annual catch of all offshore pelagic species (tuna or non-tuna) in Western Samoa in 1989 to be over 500 mt.

Estimated monthly commercial landings of tuna and other oceanic fish species (non-tuna) at the Apia Fish Market for the 1989-1994 period are recorded in Table 3.7.6. The tuna species have been combined and included for comparison. Details of tuna species composition in this table is included under the tuna profile. Data indicate that non-tuna oceanic pelagic fish species make up between less than 1 and 6 per cent, in weight and value, of the offshore commercial pelagic fish landings at the Apia Fish Market. These percentages correspond to 1 to 20 mt a year.

Table 3.7.6: Estimated monthly commerial landings of tuna and other oceanic pelagic fish species at the Apia Fish Market. (Sources: Fisheries Division Annual Reports for 1989, 1990, and 1992/1993; Mulipola, 1994; Mulipola, undated, and Fsiheries Database).

		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Total
1989														
Skipjack	Wt (kg)	56,022	25,024	47,806	35,282	31,727	33,085	20,540	19,252	26,869	29,993	34,408	23,003	383,011
	Value $	72,713	67,333	11,031	97,415	70,942	117,473	75,309	63,465	70,028	95,283	203,089	94,010	1,038,090
Yellowfin	Wt (kg)	6,878	9,916	19,461	9,312	6,010	2,474	2,878	1,482	607	699	1,855	1,573	63,144
	Value $	9,813	38,006	53,827	20,454	18,558	23,894	13,143	6,126	3,764	9,684	7,970	9,173	214,410
Rainbow run	**Wt (kg)**	**24**	**108**	**72**										**204**
	Value $	**28**	**495**	**212**										**735**
Other	**Wt (kg)**	**20,720**												**20,720**
	Value $	**24,886**												**24,886**
1990														
Skipjack	Wt (kg)	15,954	7,202	11,189	7,170	7,223	7,274	6,411	10,150	5,687	15,611	19,881		124,093
	Value $	44,101	23,018	33,178	20,112	22,405	23,956	21,231	28,670	18,400	22,691	54,701		340,869
Yellowfin	Wt (kg)	891	2,175	1,080	533	1,176	1,476	2,719	1,906	7,333	1,755	6,840		30,420
	Value $	4,912	10,700	3,947	1,920	6,305	7,964	12,661	8,473	25,840	6,156	23,586		122,686
Dogtooth tuna	Wt (kg)	63						49	3		27			155
	Value $	158						196	8		162			572
Dolphin	**Wt (kg)**		**81**			**14**		**108**	**92**	**240**		**217**		**819**
	Value $		**50**			**68**		**344**	**392**	**975**		**1,278**		**3,388**
Rainbow run	**Wt (kg)**	**18**	**22**		**8**	**142**	**39**			**7**		**17**		**277**
	Value $	**81**	**86**		**39**	**430**	**185**			**37**		**69**		**1,011**
Other	**Wt (kg)**		**27**					**8**						**38**
	Value $		**135**					**62**						**215**
Total	Wt (kg)	16,926	9,508	12,269	7,711	8,554	8,788	9,295	12,151	13,267	17,393	26,956		155,802
	Value $	49,251	33,989	37,125	22,071	29,207	32,105	34,494	37,543	45,253	29,009	79,634		468,741
1991														
Tuna	Wt (kg)	10,500	9,800	13,700	10,700	30,600	24,900	12,300	9,900	9,500	12,600	15,600	5,500	165,600
	Value $	34,200	28,500	49,500	40,400	79,900	64,400	36,300	28,600	33,100	41,200	48,300	18,400	502,800
1992														
Tuna	Wt (kg)	32,800	39,200	23,500	28,400	27,100	37,100	82,200	60,000	180,900	102,100	64,300	46,900	724,500
	Value $	71,910	110,200	68,900	87,300	82,000	92,980	234,530	161,350	414,800	595,230	186,950	140,340	2,246,500
1993														
Skipjack	Wt (kg)	47,722	29,313	21,561	46,703	36,984	99,801	54,333	45,622	43,140	47,438	40,895	38,442	551,954
	Value $	147,132	81,082	53,046	110,388	64,101	217,299	99,779	101,001	95,367	117,123	84,407	64,068	1,234,793
Yellowfin	Wt (kg)	8,580	7,195	8,348	19,955	3,371	1,526	1,928	4,036	671	1,699	2,492	1,446	61,246
	Value $	50,397	26,362	51,696	85,986	17,308	11,436	16,690	24,602	4,773	10,541	12,448	7,277	319,517
Dolphinfish	**Wt (kg)**	**372**	**321**	**84**	**218**	**102**	**252**	**954**	**532**	**668**	**1,696**	**1,474**	**54**	**6,727**
	Value $	**2,489**	**1,577**	**701**	**1,048**	**512**	**1,501**	**6,385**	**3,194**	**4,094**	**9,196**	**9,138**	**362**	**40,196**
Rainbow runner	**Wt (kg)**	**377**	**8**	**138**	**110**			**14**	**51**	**21**	**9**	**12**		**740**
	Value $	**1,784**	**30**	**358**	**286**			**28**	**93**	**63**	**24**	**60**		**2,725**
Sailfish	**Wt (kg)**	**18**						**45**	**36**					**99**
	Value $	**45**						**450**	**389**					**884**
Wahoo	**Wt (kg)**			**51**	**126**		**88**	**33**		**18**	**18**			**334**
	Value $			**261**	**409**		**338**	**119**		**45**	**104**			**1,277**
Shark	Wt (kg)									6				6
	Value $									20				20
G.barracuda	**Wt (kg)**					**12**				**98**	**16**			**126**
	Value $					**60**				**185**	**40**			**285**
Total	Wt (kg)	57,069	36,837	30,182	67,112	40,469	101,667	57,307	50,277	44,622	50,876	44,873	39,942	621,231
	Value $	201,847	109,051	106,061	198,118	81,981	230,574	123,451	129,279	104,547	137,029	106,053	71,707	1,599,698

In a survey of 25 "other" commercial fishery products outlets (retailers, hotels and restaurants) from Apia to Apolima during February-November 1989, Brotman (1989) recorded the following statistics:

Invertebrates:	34 mt (valued WS$212,561);
Inshore fin-fish:	56 mt (valued WS$203,319);
Offshore fin-fish:	175 mt (valued WS$665,747).

The offshore landings comprised of 66.5 per cent (116 mt) bottomfish and 33.5 per cent (59 mt) pelagic species. Pelagic species composition were given as follows the non-tuna oceanic pelagic fish species included in this profiles are in bold:

	Wahoo	**Sailfish**	**Dolphinfish**	**Marlin**	**Rainbow runner**	Dogtooth tuna	Trevally	Bigeye scad	Skipjack	Yellowfin tuna	Total
Per cent	**0.5**	**2.4**	**4.8**	**3.6**	**0.4**	3.6	3.9	0.8	32.4	47.6	100
Wt (kg)	**295**	**1,416**	**2,832**	**2,124**	**236**	2,124	2,301	472	19,116	28,084	59,000

The survey was continued in 1990 for the January-August period. However, Winterstein (1991) lumped tunas and other pelagics together in one category, "pelagics". The estimated "pelagics" landing for the eight-month period was 60,129 kg.

The Taiwanese longline fleet based in American Samoa were licensed to fish in Western Samoa's EEZ starting from 1989. The only data available were those for the first half of 1994.

Number different Vessels involved	Period	Number of trips	Albacore		Bigeye		Yellowfin		Other		Total	
			Pieces	Weight	Pieces	Weight	Pieces	Weight	Pieces	Weight	Pieces	Weight
13	Jan-Jul, 1994	30	20,094	243,298	108	2,788	1,179	26,910	316	10,470	21,697	283,466

During the SPC experimental vertical longline expeditions in Western Samoa, Watt (1991) recorded the following catches using the *alia*:

Thunnus alalunga	36 pieces
T. albacares	116 pieces
T. obesus	3 pieces
Coryphaena hippurus	16 pieces
Others	10 pieces

Tables 3.7.7(a) and (b) present available data from two of the local small fishing boats fishing vertical longline.

Table 3.7.7(a): Vertical longline catches by Marengo Bay. (Source: Fisheries Division Database).

MARENGO BAY															
1992			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
# fishing	days												8	12	20
# hooks													3,350	4,750	8,100
	Albacore	Pieces											145	134	279
		Weight (kg)											2,175	2,010	4,185
	Yellowfin	Pieces											8	38	46
		Weight (kg)											180	760	940
	Bigeye	Pieces											52	18	70
		Weight (kg)											1,300	450	1,750
	Others	**Pieces**											**11**	**50**	**61**
		Weight (kg)											**200**	**500**	**700**
	Total	# pieces											216	240	456
	Total	Wt (kg)											3,855	3,720	7,575
	Total	Value											21,588	20,832	42,420
	CPUE	Fish/day											27.0	20.0	23.5
	CPUE	Wt/day											481.9	310.0	395.9
	CPUE	Fish/100hks											6.4	5.1	5.8
	CPUE	kg/100 hks											115.1	78.3	96.7
1993															
# fishing	days		6	7	5	7	9	9	11	9	13	11	12	7	106
# hooks			2,250	3,650	2,250	3,650	4,750	3,950	4,500	3,800	6,600	5,000	5,400	3,050	48,850
	Albacore	Pieces	73	55	9	7	61	202	190	113	186	144	130	88	1,258
		Weight (kg)	1,095	825	135	220	1,007	3,079	2,774	1,378	2,750	2,125	1,950	1,315	18,653
	Yellowfin	Pieces	19	15	8	23	63	47	29	28	25	2	14	3	276
		Weight (kg)	475	375	200	354	1,048	1,858	796	866	460	80	235	44	6,791
	Bigeye	Pieces	5	17	20	10	0	24	21	30	4	14	4	4	153
		Weight (kg)	125	427	570	250	0	500	427	663	80	210	115	75	3,442
	Others	**Pieces**	**25**	**56**	**23**	**40**	**49**	**31**	**52**	**37**	**98**	**142**	**91**	**17**	**661**
		Weight (kg)	**300**	**800**	**350**	**100**	**800**	**400**	**590**	**525**	**525**	**1,525**	**1,060**	**85**	**7,060**
	Total	# pieces	122	143	60	80	173	304	292	208	313	302	239	112	2,348
	Total	Wt (kg)	1,995	2,427	1,255	924	2,855	5,837	4,587	3,432	3,815	3,940	3,360	1,519	35,946
	Total	Value	11,172	13,591	7,028	5,174	15,988	32,687	25,687	19,219	21,364	22,064	18,816	8,506	201,298
	CPUE	Fish/day	20.3	20.4	12.0	11.4	19.2	33.8	26.5	23.1	24.1	27.5	19.9	16.0	21.4
	CPUE	Wt/day	332.5	346.7	251.0	132.0	317.2	648.6	417.0	381.3	293.5	358.2	130.0	217.0	361.8
	CPUE	Fish/100hks	5.4	3.9	2.7	2.2	3.6	7.7	6.5	5.5	4.7	6.0	4.4	3.7	4.8
	CPUE	kg/100 hks	88.7	66.5	55.8	25.3	60.1	147.8	101.9	90.3	57.8	78.8	62.2	49.8	969.6

Table 3.7.7(b): Vertical Longline Catches by the Pua'anifo II (alia). (Source: Fisheries Division Database).

PUAANIFO II - *alia*																
1993	Crew	# Trips	# lines	Tot # hooks	Yellow-fin	Alba-core	Big-eye	Skip-jack	**Dolp-hinfish**	**R. runner**	Shark	**Others**	Total Wt	Total # Fish	# fish per 100 hks	Wt per 100 hks
June																
Total		6.0	24.0	364.0	937.0	262.0	39.0	18.0	**60.0**	**4.0**	0.0	**6.0**	1,326.0	122.0	33.5	364.3
Value $					3,729.3	1,100.4	167.7	18.0	**246.0**	**14.0**	0.0	**12.0**	5,287.4			
Average	2.8		4.0	60.7	156.2	43.7	6.5	3.0	**10.0**	**0.7**	0.0	**1.0**	221.0	20.3	33.4	362.6
July																
Total		15.0	54.0	879.0	1,605.0	386.0	66.5	20.5	**106.5**	**1.0**	270.0	**7.0**	2,462.5	185.0	21.0	280.1
Value					6,387.9	1,621.2	286.0	20.5	**436.7**	**3.5**	297.0	**14.0**	9,066.7			
Average	2.3		3.6	58.6	114.6	25.7	4.4	1.4	**7.1**	**0.1**	18.0	**0.5**	164.2	12.3	21.2	276.9
August																
Total		8.0	20.0	323.0	476.0	66.0	29.0	15.0	**32.0**		82.0	**13.0**	713.0	61.0	18.9	220.7
Value					1,894.5	277.2	124.7	15.0	**131.2**		90.2	**26.0**	2,558.8			
Average	2.1		2.5	40.4	59.5	8.3	3.6	1.9	**4.0**	**0.0**	10.3	**1.6**	89.1	7.6	18.5	213.4
September																
Total		5.0	12.0	198.0	177.0	56.0	52.0		**21.0**		24.0		330.0	28.0	78.1	895.1
Value					704.5	235.2	223.6		**86.1**		26.4		1,275.8			
Average	2.2		2.4	39.6	35.4	11.2	10.4	0.0	**4.2**	**0.0**	4.8	**0.0**	66.0	5.6	15.6	179.0
TOTAL	**Wt**	34	110.0	1,764.0	3,195.0	770.0	186.5	53.5	**219.5**	**5.0**	376.0	**26.0**	4,831.5	396.0		
	Value				12,716	3,234	802	54	**900**	**18**	414	**52**	18,189			

3.7.3 Stocks Status

There has been no research conducted in Western Samoa on the status of the non-tuna oceanic pelagic fish species. However, preliminary indications are that the resource could sustain an increase in fishing pressure, and no major concern is apparent as these are not targeted specifically for any current industrial fishery. Futher development of fisheries based on these species, e.g. gamefishing, is unlikely to have any detrimental effect on the stocks. Nevertheless, collection of catch data from such undertakings would be desirable.

3.7.4 Management

Current legislation/policy regarding exploitation: There is no legislation that specifically cover the fish species discussed under this profile. However, they are also generally covered under laws applied under foreign fishing as specified under the tuna profile.

Recommended legislation/policy regarding exploitation: There does not seem to be any additional legislation required except those discussed under other profiles in terms of data submission to the Fisheries Division.

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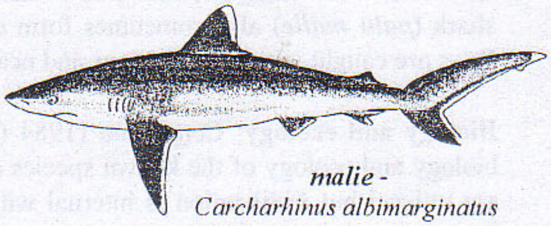
4. CARTILAGINOUS FISHES

4.1 Sharks and rays - *Malie* ma *fai*

4.1.1 The Resource



malie -
Carcharhinus albimarginatus

Species present: Sharks are collectively known in the Samoan language as *malie*, while rays are known as *fai*. The following shark species are believed to occur in Western Samoa as recorded in Zann (1991) from various references, and Dalzell and Preston (1992):

Sharks

Hexanchidae: *Hexanchus griseus* (bulldog shark or bluntnose sixgill shark - ***palu malie***);

Orectolobidae: *Nabrius ferrugineus* (nurse shark - ***moemoeao***), *Stegostoma faciatum* (spotted nurse shark - ***taneva***);

Lamnidae: *Isurus oxyrinchus* (mackerel shark - ***aso polota***);

Alopiidae: *Alopias caudatus* (thresher shark);

Carcharhinidae: *Carcharhinus melanopterus* (blacktip reef shark - ***apeape***), *C. amblyrhynchos* (grey reef shark - ***malie aloalo***), *C. albimarginatus* (white-tip shark - ***malie***) *C. longimanus* (oceanic whitetip shark - ***apoapo***), *C. falciformis* (silky shark - ***malie***), *Triaenodon obesus* (white-tip reef shark - ***malu***), *Galeocerdo cuvier* (tiger shark - ***naiufi***);

Sphyrnidae: *Sphyrna lewini* (scalloped hammerhead shark - ***mataitaliga***).

Dalzell and Preston (1992) also listed an unidentified shark species caught in deep-sea bottomfishing.

Preston (1984, quoted in Nichols, 1993) listed twelve species of dogfish sharks (Squalidae), all of which are found throughout the FFA region, which produce high quality oil with a squalene content of over 50 per cent. These species include: *Centrophorus atromarginatus*, *C. granulosus*, *C. squamosus*, *C. molucensis* (=*scalpratus*), *C. uyato*, *C. lusitanicus*, *Dalatias licha*, *Centroscymnus crepidater*, *C. owstoni*, *Deania calcea*, *D. profundorum*, and *D. quadrispinosum*. Dogfish shark normally caught in the deep-sea bottomfishery in Western Samoa are collectively known as *palu malie*.

Rays

Stingrays (Dasyatididae): *Dasyatus kuhlia* (blue spot stingray - ***fai tala, fai malie***), *Himantura fai* (coachwhip stingray - ***fai tala, fai malie***);

Eagle ray (Myliobatidae): *Aetobatis narinari* (spotted eagle ray - ***fai tamanu***).

Manta ray: *Manta* sp. (manta ray - ***fai pe'a***)

Distribution: Smith (1992) notes that sharks occur from the reef and inshore areas through to the open oceans, at all depths. Nichols (1993) notes that "on a global basis, 55 per cent of the chondrichthyians inhabit the continental shelf area from the inter-tidal zone to a depth of 200 m". The same author also adds that the most common sharks in reefs and lagoons belong to the family Carcharhinus (the requiem sharks) including the black-tip reef shark and white-tip shark. Grey reef sharks as well as the larger species, including tiger sharks and hammerhead sharks, are found in deeper waters off coral reefs (Nichols, cited above).

Stingrays occur in all tropical and subtropical seas with most species found in coastal waters, estuaries, off beaches and river mouths, and on flat bottoms on sand or mud (Randall *et al.*, 1990). Relatively few species occur in the vicinity of coral reefs. Eagle rays are found worldwide in tropical and warm temperate sea and are usually found inshore near reefs. Manta rays occur in all warm seas and are often seen far out to sea but are also encountered in the vacinity of coral reefs.

In Western Samoa, traditional shark noosing took place in deeper waters beyond the reefs. Dogfish shark (*palu malie*) also sometimes form an important component of the deep-sea bottomfish fishery. Rays are caught within the lagoons and near barrier reefs.

Biology and ecology: Compagno (1984 (a) and (b) gives some information on habitat, distribution, biology and ecology of the known species of sharks in the world. For reproduction, a variety of modes are utilized but fertilization is internal with most species bearing their young alive in broods ranging from a few individuals to nearly one hundred (Smith, 1992). Sharks are generally slow growing with the majority of the commercially important species in the South Pacific having a long gestation period and low fecundity (Nichols, 1993). Further more, some species display sex and size segregation and females of some species may move inshore to give birth in selected nursery areas (Nichols, cited above).

"Stingrays feed on a variety of sand and mud-dwelling organisms, including crabs, prawns, worms, molluscs and fishes" (Randall, *et al.*, 1990). They give birth to fully developed young resembling miniature adults. A few species of eagle rays, like mantas, can leap high into the air from the water. Manta rays are among the largest fishes with some growing to a width of nearly 7 m weighing more than 1,300 kg (Randall *et al.*, 1990). Manta rays use their cephalic flaps to direct planktonic food items into the mouth and can leap above the water surface.

There is no available information concerning work conducted in Western Samoa on the biology and ecology of any shark or stingray species.

4.1.2 The Fishery

Utilization: As was the practise in other Polynesian societies, traditional shark fishing in Samoa was regarded as one of the most specialized. Buck (1930) describes the different component gear as well as the operation of traditional shark noosing. The gear comprise of the following as described by Buck:

Noose (***maea noa malie***): the noose is made of full-size sennit rope. The rope is made of strands of three-ply sennit braid but each ply contains as many as eight or nine strands of braid.

Shark rattle (***tu'i ipu or lutu***): this is made from discarded half coconut shells which are strung in pairs with shells of each pair facing each other. A rattle normally consists of five pairs of half cocnut shells. The rattle is lowered well down into the sea and working the handle part violently up and down. Sharks are attracted by the noise made by the shells as if it comes from a school of fish. As the shark gets near the rattle, the bait is sensed and the rattle drawn up.

Bait lures (***maunu***): three bait lures are used; the deep, the float and the near bait.

Deep bait (***maunu tau lafo***) - the bait, an old fowl or a piece of port, is tied to a ten-foot rope and thrown overboard to sink down to the bottom. When a shark is attracted to it, the bait is withdrawn up with the shark following. The bait is taken in when the shark comes in the sphere of the near bait.

Float bait (***uto***) - the far bait (usually dried bonito head - *pa'o'o*) is tied to a float (***uto***). The float is tied to a long rope and thrown out. When a shark is making for or biting at the float, it is drawn in slowly to draw the shark after it. When the shark is close to the canoe and within the sphere of the near bait, the float bait is drawn into the canoe. Certain works are cited either while putting on bait or when throwing out the ***uto***.

Near bait (***maunu taufino***) - the near bait (bonito ***pa'o'o***) hangs on a short line near the canoe. The bait is to maneuver the shark into position for the noose.

The shark club (***fa'apo***): a short wooden club used for killing shark when landed in the canoe.

The shark spear (***taova'a***): the spear was made of hard heavy wood and is used to thrust into the mouth of a large shark caught in the noose when the crew becomes worried (afraid). It is thus used as a gag.

The large shark species, ***naiufi*** (tiger shark, *G. cuvier*) was regarded as the king of sharks and was always treated with ceremonial respect even while planning its capture. 'If not prepared to noose it on first meeting, the fisherman makes a speech addressing it a chief of the highest rank in the terms, "afio mai lau afioga". He apologises to it for not being able to deal with it that night but he will return the next day". Before noosing the *naiufi*, a ceremonial speech is made on the part of the *tautai*.

Buck (1930) also described shark nets (*upega malie*) as being used which were made of the thick three-ply twisted sord of *matiata* bast. Floats were made of breadfruit wood and stones as anchors and sinkers. Bait, attached to the net, were used. A large net (*upega tanifa*) was reported to have been used in Asau to net *tanifa* (a type of shark) which came into the lagoon in large numbers at a certain time.

There is currently no specific fishery targeting sharks in any level in Western Samoa. However, shark can be an important by-catch of the deep-water bottomfish fishery. When deep-water bottomfishing is poor, a catch of one large dogfish could mean a profitable trip. Rays are usually caught within the lagoons by net or spear. Shark and ray meat as well as shark liver, cut up in chunks, are readily sold at the commercial fish market.

The preferred method of cooking shark and ray meat is in coconut cream (the cooked producted known as *faiai malie, faiai fai*).

Production and marketing: No figures could be obtained on the number of sharks that were normally caught during a day's traditional shark noosing.

Skipjack Programme (1980), Skipjack (1981) and Klawe (1978) estimated catches made by longliners in the estimated EEZs of SPC members during the 1962-1975 period. However, shark landings were not reported.

Fish species composition, based on 31,000 lbs caught on bottom handlines by Fisheries Division in the 1974-1976 period, are presented in Table 4.1.1. The table indicate that the highest catch was that of sharks.

Table 4.1.1: Species composition of bottomfish caught by Fisheries Division during the 1974-1976 period. (Composition based on 31,000 lbs of fish). (Source: Gullbrandsen, 1977).

Samoan name	Common English name	Species	Per cent of total
Malie	shark		32.0
Palumalau	sharptooth snapper	**Pristipomoides typus*	14.8
Palusina	rosy jobfish	**Aprion microlepus*	11.1
Malai	malabar rd snapper	**Lutjanus malabaricus*	10.4
Filoa	longface emperor	Lethrinidae	7.1
Palutalatala	oilfish	*Ruvettus pretiosus*	4.7
Mu	red snapper	*Lutjanus bohar*	4.6
Gatala	grouper	Serranidae	4.5
Utu	green jobfish	*Aprion virescens*	2.1
Palukamulo	snake mackerel	*Promethichthys prometheus*	1.4
Palusega	small toothed jobfish	**Aphareus furcatus*	0.4
Isi i'a	Others		5.4

*possible misidentification.

The nation-wide survey conducted in 1978 by the Department of Statistics on Fishery Catch Assessment recorded the fin-fish landing statistics throughtout Western Samoa as summarised in Table 4.1.2. On Upolu, 0.4 per cent (~2.9 mt) of the total fin-fish landing comprised of sharks and rays while a higher per cent, 1.7 per cent (4.5 mt), and volume were recorded on Savai'i. Overall, shark and rays was estimated to comprise 0.8 per cent (7.3 mt) of the total fin-fish landings in Western Samoa in 1978. Estimates from the survey have been considered as under-estimates although relative compositions could be useful.

Table 4.1.2: Estimated fin-fish landings in Western Samoa as summarised from the Department of Statistics Survey on Fishery Catch Assessment conducted in 1978). (Source: Department of Statistics, undated).

	Unit	Lutjanidae	Lethrini	O_Deep	Sharks & rays	Reef fish	Carangidae**	Mullet***	Eels	Other fish	S/jack	O_pela	Total
Upolu													
Total Wt	(kg)	9,015	62,337	95,154	**2,858**	325,085	12,853	15,818	20,121	43,646	76,160	5,932	668,979
Per cent		1.3	9.3	14.2	**0.4**	48.6	1.9	2.4	3.0	6.5	11.4	0.9	100.0
Savaii													
Total Wt	(kg)	4,720	6,133	37,909	**4,470**	97,467	14,279	14,185	3,321	7,041	107,199	1,879	265,476
Per cent		1.8	2.3	14.3	**1.7**	36.7	5.4	5.3	1.3	2.7	40.4	0.7	100.0
Western Samoa Total Estimates													
Total Wt	(kg)	13,735	68,470	133,063	**7,328**	422,552	27,132	30,003	23,442	50,687	183,359	7,811	967,582
Per cent		1.4	7.1	13.8	**0.8**	43.7	2.8	3.1	2.4	5.2	19.0	0.8	100.0

**includes jacks, trevallies and bigeye scads; ***includes mullet and milkfish; O_pela is "other oceanic pelagic species".

During the SPC Dropline Fishing Project in Western Samoa in 1975 and 1982, the catches made are presented in Table 4.1.3 as summarized from Dalzell and Preston (1992).

Table 4.1.3: Summaries of bottomfish catche made by the SPC dropline fishing in Western Samoa. (Source: Dalzell and Preston, 1992).

			CATCH			
Dates	No. trips	Fish types	Numbers	% number	Weight (kg)	% weight
1 April-31 October, 1975 Area: Asau, Savai'i	77	Bony fishes Sharks All species	? ?	? ?	? ? 6,370.0	? ?
8 Nov., 1982-20 Dec., 1982 Area: North Upolu	11	Bony fishes Sharks All species	318 23 341	93.3 6.7 100.0	1,389.1 358.9 1,748.0	79.5 20.5 100.0

Since the average deep-bottom fishing catch per trip (82.7 kg) and the total deep-bottom fishing catch (6,370.0 kg) were given for the 1 April-31 October, 1975 SPC expeditions, the number of trips were estimated to be 77. The total catch for that period seem to also include sharks.

During trial fishing conducted by the Australian survey vessel, M.V. Cape Pillar, in 1985 at Pasco Bank, a total of 15.5 hours were spent fishing at a depth range of 80m-150 m. The total fish landing recorded was 969 lbs of bottomfish of which 113 lbs (~12 per cent) were sharks (Fisheries Division Annual Report for 1985).

Catches made during the initial assessment of the deep-water snapper stocks carried out by the Fisheries Division using a chartered fishing vessel, *Leilani*, in 1987, did not record shark landings. No sharks were also recorded during the continuation of the deep-water snapper stock assessment project between November, 1988 and October, 1989, using the Fisheries Division research vessel, Tautai Matapalapala. Summaries of catches are as follows, as recorded in Dalzell and Preston (1992):

Dates	No. trips	Fish types	Numbers	% number	Weight (kg)	% weight
12 Nov. -22 Dec., 1987 Area: Savai'i and 17-Fathom Bank	6	Bony fishes Sharks All species	317 0 317	100.0 0 100.0	814.8 0 814.8	100.0 0 100.0
29 Nov., 1988 - 20 Oct., 1989 Area: Upolu, Savai'i, Pasco Bank, 17-Fathom Bank	21	Bony fishes Sharks All species			5,939.0 0 5,939.0	100.0 0 100.0

Fish production surveys conducted in 1989 using questionnaires distributed through district juniour high schools did not record shark consumption in the rural areas. (King (undated) noted that due to the intensive nature of the survey, the species which are large and caught occasionally, i.e., sharks and turtles, may be under-represented or missed out altogether.

Due to its minor importance in terms of volume landed, shark commercial landings at the Apia Fish

Market as collected by the Fisheries Division are combined with other species of minor importance under the "Others" category.

During the longline operations conducted by the SPC's Deep Sea Fisheries Project in Western Samoa from September 1990 to July, 1991, the catches made using different vessels and types of longline are presented in Table 4.1.4.

Table 4.1.4: Catches made during the SPC small scale longline trial in Western Samoa. (Sources: Watt, 1991a., and Watt, 1991b.).

Tautai Matapalapala		Dates: September, 1990 to March, 1991			
Method	No. of trips	No. of sets	Fish type	No. of fish	Total weight (kg)
Vertical longline	11	39	Target species? Shark	134 42*	1,866.1
Horizontal longline	2	6	Target species Shark	39 5*	175.3
Alia		**Dates: March to July, 1991**			
	No. of trips	No. of sets	Fish type	No. of fish	Total weight (kg)
Vertical longline	20	32	Target species? Shark	187 47*	2,819.2

*Note: sharks were recorded as the figures with "sharks were also caught". These are likely to be referring to numbers.

The only other shark landing figures recorded are those from the local *alia* fishing using vertical longline. Catches are given in Table 4.1.5 for all species including sharks in bold. From June to September, shark made up 7.8 per cent of the total landing but only 2.3 per cent of the total value.

Table 4.1.5: Vertical Longline Catches by the Pua'anifo II (alia). (Source: Fisheries Division Database).

PUAANIFO II - *alia*															**Shark**
1993	Crew	# Trips	# lines	Tot # hooks	Yellow-fin	Alba-core	Big-eye	Dolp-hinfish	Skip-jack	R. runner	**Shark**	Others	Total Wt	Total # Fish	**% Wt & $**
June															
Total		6.0	24.0	364.0	937.0	262.0	39.0	60.0	18.0	4.0	**0.0**	6.0	1,326.0	122.0	**0.0**
Value $					3,729.3	1,100.4	167.7	246.0	18.0	14.0	**0.0**	12.0	5,287.4		**0.0**
Average	2.8		4.0	60.7	156.2	43.7	6.5	10.0	3.0	0.7	**0.0**	1.0	221.0	20.3	
July															
Total		15.0	54.0	879.0	1,605.0	386.0	66.5	106.5	20.5	1.0	**270.0**	7.0	2,462.5	185.0	**11.0**
Value					6,387.9	1,621.2	286.0	436.7	20.5	3.5	**297.0**	14.0	9,066.7		**3.3**
Average	2.3		3.6	58.6	114.6	25.7	4.4	7.1	1.4	0.1	**18.0**	0.5	164.2	12.3	
August															
Total		8.0	20.0	323.0	476.0	66.0	29.0	32.0	15.0		**82.0**	13.0	713.0	61.0	**11.5**
Value					1,894.5	277.2	124.7	131.2	15.0		**90.2**	26.0	2,558.8		**3.5**
Average	2.1		2.5	40.4	59.5	8.3	3.6	4.0	1.9	0.0	**10.3**	1.6	89.1	7.6	
September															
Total		5.0	12.0	198.0	177.0	56.0	52.0	21.0			**24.0**		330.0	28.0	**7.3**
Value					704.5	235.2	223.6	86.1			**26.4**		1,275.8		**2.1**
Average	2.2		2.4	39.6	35.4	11.2	10.4	4.2	0.0	0.0	**4.8**	0.0	66.0	5.6	
TOTAL	**Wt**	34	110.0	1,764.0	3,195.0	770.0	186.5	219.5	53.5	5.0	**376.0**	26.0	4,831.5	396.0	**7.8**
	Value				12,716	3,234	802	900	54	18	**414**	52	18,189		**2.3**

4.1.3 Stocks Status

There is no information available on the stocks of sharks in Western Samoa waters. However, since there is no fishery that specifically targets shark or shark products on a large scale, it is believed that they are still abundant. Observations elsewhere indicate that because of their generally slow growing, populations can be greatly reduced by heavy fishing. Randall *et al* (1990, quoted in Smith 1992) note that removal of these top level carnivores from a community such as a reef system, results in adverse effects.

4.1.4 Management

The low fecundity, long gestation, slow growth, and often very localised movements result in many shark populations being very prone to recruitment over-fishing (Holde, 1977; Okera *et al.*, 1981, cited in Nichols, 1993). However, there is no commercial fishing operation in Western Samoa which is based on the shark resource though it forms part of the tuna longline and the bottomfish fishery catches.

Current legislation/policy regarding exploitation: There is no legislation that specifically deals with the exploitation of the shark resource in Western Samoa.

Recommended legislation/policy regarding exploitation: Considering the current status and expoitation of sharks, there does not seem to be any legislation required.

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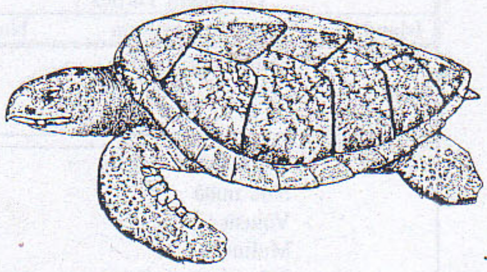
5. REPTILES

5.1 Turtles - *laumei*

5.1.1 The Resource



laumei fai uga - Eretmochelys imbricata

Species present: Two sea turtle species are common in Western Samoa. These are: *Eretmochelys imbricata* (hawksbill turtle - *laumei fai uga*) and *Chelonia mydas* (green turtle - *laumei*). However, *Dermochelys coriacea* (leatherback turtle) and *Natator depressus* (flatback turtle) have occasionally been sighted (Schuster *et al.*, 1994). Hirth (1971, cited in Zann, 1991) considered green turtles to be more common. However, only hawksbill turtles have known to have established breeding populations in Western Samoa.

Distribution: Sea turtles are marine reptiles which have inhabited the earth for over 100 million years. Eight species of turtles exist worldwide with all but one occurring in the Pacific region. The most frequently seen species in the Pacific are the hawksbill and green turtles, although the leatherback (*D. coriacea*), loggerhead (*C. caretta*) and olive or Pacific Ridley (*L. olivaccea*) turtles also occur. Details of the distribution of all sea turtles are reported in Márquez (1990) as summarised below for the two most important species found in Western Samoa:

Hawksbill turtle: this species, togehter with green turtle, is the most tropical of all sea turle species and is distributed throughout the central Atlantic and Indo-Pacific regions. Nesting is widespread with very few major nesting places and is confined between the 25° N and 35° S, mostly within the tropical region. It is more common where reefs are and are also seen in shallow waters with seagrass or algal meadows including coastal lagoons and bays.

Green turtle: this species is widely distributed in tropical and subtropical waters, near continental coasts and around islands. It is rare in temperate waters and together with hawkbill, is also the most tropical of the marine turtles. The normal latitudinal range is within the northern and southern limits of the 20° C isotherms.

Generally, turtles occur through-out the islands of Western Samoa. Turtle fishing has been a tradition of Gataivai village on Savai'i Island and Luatuanu'u village on Upolu Island. These areas are probably important feeding grounds that turtle frequent at certain times. The Aleipata islands of Nu'utele and Nu'ulua are the most important hawksbill nesting sites in Western Samoa. Namu'a, another Aleipata Island is believed to have been an occasional nesting site as recorded in Witzell and Banner (1980). Schuster *et al.* (1994) noted that within the last twenty years, turtle nestings were reported from Savai'i along the Tafua/Faala Peninsula, Falelima beach, Falealupo coastal area, Papa Sataua beach, and Fo'a beach east of Asau village. On Upolu, turtle nesting was also reported from the area between Sa'anapu and Salamumu villages in the 1980's.

In a survey conducted during the October, 1993/August, 1994 period, a total of 22 hawksbill and 21 green turtles caught by fishermen in certain areas in Western Samoa (presumably during their normal fishing activities) were tagged and released (Schuster *et al.*, 1994). These are summarised in Table 5.1.1.

Table5.1.1: Turtles captured, tagged and released in Western Samoa during the October 1993/August 1994 period. (Source: Schuster *et al.*, 1994).

Hawksbill Turtles		
Island	Approximate Area	Number
Savai'i	Fagamalo/Saleaula	2
Upolu	Mulifanua/Fasito'o	13
	Sale'imoa	1
	Vaiusu	1
	Mulinu'u	2
	Solosolo/Saluafata	2
	Falealili	1

Green Turtles		
Island	Approximate Area	Number
Savai'i	Asau	1
	Saleaula	1
	Salelologa/Salelavalu	1
Upolu	Mulifanua/Fasito'o	5
	Mulinu'u/Apia	4
	Saluafata	1
	Lalomanu	1
	Falealili	2
	Safata	4
	Lefaga	1

During a fisheries household survey in the Aleipata District, Time (1994) added turtles to the survey due to the significant nestings, and thus turtle occurrence there.

Biology and ecology: In the Pacific, hawksbills are considered the least migratory species, whereas greens are highly migratory (Vaugh, 1980).

The hawksbill turtle feeds on a diet of invertebrates, sponges and soft corals. The green turtle, by contrast, is mainly herbivorous, feeding on seagrasses and algae. Because the seagrass beds often do not occur close to suitable breeding beaches, green turtles may have to migrate from a resident habitat to breeding beaches and back at intervals. Loggerheads and olive Ridleys are also carnivorous and, with the hawksbill, do not appear to migrate to the same extent as the green turtle, though some long distance movement has been recorded (Pickering, 1983). Movements of the olive Ridley are particularly poorly known. The loggerhead nests mainly outside the tropics, on subtropical and warm temperate coasts.

While green turtles often nest together in large numbers at sites called "rookeries", the nesting of the hawksbill is diffused, with no great concentrations of nests. The single largest known green turtle rookery is Raine Island, on the northern Great Barrier Reef in Queensland, with 80,000 nesting females per year (Pickering, 1989). Other major rookeries occur around Australia, on the Caribbean coast of Costa Rica (Tortuguero), the Pacific coast of Mexico, Ascension Island, the coasts of Oman and Pakistan and islands in the Mozambique Channel (Pickering, 1989). Hawksbill nesting density is low throughout its range, with moderate concentrations in a few localities such as the Torres Straits islands of Queensland, the southern Red Sea and the Gulf of Aden and the Arnavon Islands near Santa Ysabel in Solomon Islands. Eggs incubation period varies from about 50 to 65days but vary among conspecific populations with differences between incubation periods on mainland and on islands (Hirth, 1993). The length of the incubation period can be affected by weather conditions and that researches have shown that sexual differentiation in all sea turtles is determined by the substrate temperature during incubation (Miller, 1985 and Packard and Packard, 1988, cited in Hirth, 1993).

There is evidence that 7-14 months after hatching, young green and hawksbill turtles spend their time drifting passively in beds of floating seaweed, such as *Sargassum* spp., in the deep ocean. Green turtles are then thought to spend a developmental period in inshore estuarine, coastal and reef habitats before moving to their main resident areas (Pickering, 1989).

Hirth (1993) noted that size and age of sea turtles at sexual maturity varies both within and among populations depending on feeding regimes, abiotic factors of the habitat and the process of natural selection. Age at first sexual maturity in green turtles has been estimated to be between 8 and 13 or more years (Márquez, 1990). The same author reported that in captivity (Cayman Turtle Farm), green turtles reach 35 kg in about three years and start to reproduce in less than 10 years. Hirth (1993) reported age at maturity for the green turtles, as recorded in several localities, as follows:

Species	Location	Estimated age at maturity	Reference
Green turtle	off southern part of Great Barrier Reef ,Australia	do not reach maturity in fewer than 30 years and could 50 years	Limpus (1979)
	Hawaiian waters	require 9-48 years to reach maturity	Balazs (1982)
	Hawaiian waters	40-50 years	Zug and Balazs (1985)
	Ascension Island	17-33 years	Frazer and Ladner (1986)
	Costa Rica	12-25 year	Frazer and Ladner (1986)
	Suriname	23-35 year	Frazer and Ladner (1986)
	Florida, USA	18-27 years	Frazer and Ehrhart (1985)
Farm-reared greens	?	8-9 year but average may exceed 15 years	Wood and Wood (1980) and Wood and Wood (1990)

Hirth (1993) noted that there are significant regional differences in sizes of conspecific nesters. However, for comparison he gave the carapace lengths and weights of typical nesting turtles as follows:

Species	Nester size (cm)	Nester weight (kg)
Hawksbill turtle	78	57
Green turtle	100	130
leatherback turtle	155	325
loggerhead turtle	93	112
ridleys turtle	65	40
flatback	90	70

Some reproductive data of hawskbill turtle in Western Samoa were given in Witzell and Banner (1980) as follows:

Nester carapace length (cm)		Nesting season	Eggs diameter (mm)	Eggs weight (g)	Clutch size	Incubation length (days)	Hatchling carapace length (mm)	Weight hatchling (g)
Mean	Range							
68.6	60.0-73.5	Sept-July	34.0-36.0	23.0-25.9	60-219	59-70	38-41	12.1-13.2

Balazs (1981, cited in Zann, 1991) reported that the Aleipata nesting season extends from October to June, with most activity in January and Febuary. This cycle was confirmed by the 1993/1994 survey although it only covered the October, 1993/March, 1994 period, as reported in Schuster *et al.* (1994).

5.1.2 The Fishery

Utilization: Turtle has been an important component in the traditional Samoan way of life. It is often included in legends, forklores and songs of the past and is often referred to as the ***i'a sa*** (sacred fish). It was one of the few marine animals that in certain communities, it was presented to a certain chiefly title within the village when caught during a fishing expedition. [Sometimes, the chief in turn would give the turtle for the village *fono*.] Schuster *et al.* (1994) reported that the practise still exists in many villages although in recent years, through increased hunting for sale at markets, turtles have "become available to ordinary consumers". Fishing for turtles has also been a special tradition in certain villages even up to the present time, e.g. Luatuanu'u on Upolu and Gataivai on Savai'i. Schuster *et al.* (cited above) noted that "two villages on Savai'i and one on Upolu still have special turtle fishing trips when traditional ceremonial events occur, such as ***matai*** title bestowment, dedications, funerals and weddings".

Two traditional methods are known to have been specifically used for catching turtles. These involve the use of banana (or elephant taro - *ta'amu* ??) leaves and a specifically made net for catching turtle. The method where leaves are used is known as ***tumatuma laumei*** while the turtle net is known as ***upega afa***. The traditional turtle net used before the introduction of commercial nets was made from three-ply sennit braid with mesh size of 13 by 12 inches. Floats were made from round sections of wood while stones were used as sinkers. A turtle net observed by Buck (1930) at Gataivai village was 24 meshes deep and in two parts of about 34 fathoms long each. The net was owned by the village and the head fisherman decided on time to fish for turtles. Buck (1930) describes the turtle catching operation at Gataivai as follows:

> the turtle net is used on the rockbound cliff-girt coast west of Gataivai where there is no reef. The net is carried on canoes with the netting party while lookouts travel along the top of the cliffs looking out for turtles. On seeing turtles, the lookouts signal the canoes and indicate where the tutles are. The net is dropped in a line parallel with the shore opposite the point indicated. The men then jump overboard and form lines from the ends of the net to the shore. They beat the surface of the water with sticks. The shore ends of the lines then work inwards to join and then advance towards the net driving the turtle into it. The turtles get their heads through the meshes and are caught in the net. In removing turtle, the front fins are held and the turtle guided in the required direction. Larger turtles are caught in night netting. Due to darkness, the net and turtle are bundled up together and taken ashore.

Holmes (1974) briefly describes the use of banana leaves in turtle catching as follows:

> Turtles are captured by men in boats who place large banana leaves on the water as shade for the animals. The men return later and pick up the leaves. If they are lucky they will find at least one turtle under the leaves and be able to wrestle it into the boat.

A turtle resting under a leaf is easily noticed as the turtle will make the leaf to hump up.

Today, turtles are caught as a by-catch of daytime or night-time dive fishing using a spear, as well as in gillnet set at night. During the Fisheries Household Survey of the Aleipata District, Time (1994) reported that turtles were caught in that area by spear and net and when they go ashore to nest. Thirty-three per cent of the households surveyed indicated having turtle meals or tasting turtle eggs within the last five years. Turtle egg collecting was reported to be a continuing practise in the 1994 turtle nesting season. Schuster *et al.* (1994) reported that "turtles have increasingly been hunted for sale at the markets" in recent years. During a tagging project conducted throughout Western Samoa from October, 1993 to August, 1994, four green turtles were purchased by the project from sellers at the Apia Fish Market.

The tortoiseshell of the harksbill was used in the manufacture of bonito hooks (*pa 'atu*), which is a composite two-piece hook with a shell shank and a turtle shell point (Buck, 1930). The tortoise shell is also used in the manufacture of combs, rings, bracelets and other "traditional jewelry" and decorations.

Production and marketing: The level of exploitation of the adult turtle stock for food in Western Samoa is not known. However, turtle meat and eggs continue to be consumed mainly at the subsistence level.

On the international turtle shell trade, Japan has traditionally been the main one where hawksbill shell (*'bekko'*) is in high demand. Japan holds a reservation on hawksbill under CITES, and imports around 30 tonnes per year from sources world-wide. Between 1976 and 1988, an average of 50,000 adult hawksbill turtles were killed each year for international trade (Daly, 1989). Major exporting countries of tortoiseshell were Cuba, Haiti and Jamaica in the Caribbean; the Maldives and Comoros Islands in the Indian Ocean; and the Solomon Islands and Fiji in the Pacific. Japan is by far the major importer providing the stimulus behind the international trade in tortoiseshell. However, Singapore, Taiwan, Hong Kong and China also import turtle shell for their carving industries. In 1988, Japan imported just under 30 tonnes of tortoiseshell which represented some 28,000 adult hawksbills (Daly, 1989).

There is little information available from most Pacific nations on the extent of sea turtle product exports although it appears that only shell had been traded internationally. The most reliable source for figures on the exports of tortoiseshell from the Pacific is the Japanese Custom Statistics (Daly, 1989). These show that during the period of 1985 to 1988, Japan imported significant quantities from both the

Solomon Islands and Fiji, with limited imports from Vanuatu as shown below.

Year	Solomon Islands	Fiji
1985	1556 Kg	294 Kg
1986	1793 Kg	497 Kg
1987	4723 Kg	1859 Kg
1988	3911 Kg	817 Kg

Year	Vanuatu
1980	33 kg
1984	25 kg
1985	12 kg

No data is available on turtle and turtle eggs consumption and production in any level of utilization in Western Samoa. With the exception of specific turtle fishing activities in villages where this is a tradition, turtles generally only form a rare by-catch of daytime and night spear fishing and set gillnetting at night. On the traditional turtle catching using leaves, Holmes (1974) noted that the fishermen would be lucky if they would find at least one turtle under the leaves and be able to wrestle it into the boat. Schuster *et al.* (1994) stated that catches made by villages that have special turtle fishing trips range from five to forty turtles depending on the magnitude of the occasion the fishing is for. A full day turtle hunting trip by a village on Upolu in 1994 resulted in a catch of only seven turtles (Schuster *et al.*, 1994).

In a survey of 167 households in eleven villages in the Aleipata District, Time (1994) reported that 33 per cent indicated having turtle meals or tasting turtle eggs within the last five years. During a tagging project during the October 1993-August 1994 period, a total of 22 hawksbill and 21 green turtles, caught by fishermen in certain areas in Western Samoa (presumably during their normal fishing activities), were tagged and released (Schuster *et al.*, 1994). Four of the green turtles were purchased from sellers at the Apia Fish Market. One of the hawksbill turtles (47 cm CCL) captured, tagged and released in Malie in November, 1993 was re-captured in the same area in June, 1994 and was eaten. Location of turtle catches and corresponding numbers are summarised as follows:

Hawksbill Turtles		
Island	Area	Number
Savai'i	Fagamalo/Saleaula	2
Upolu	Mulifanua/Fasito'o	13
	Sale'imoa	1
	Vaiusu	1
	Mulinu'u	2
	Solosolo/Saluafata	2
	Falealili	1
Total		22

Green Turtles		
Island	Area	Number
Savai'i	Asau	1
	Saleaula	1
	Salelologa/Salelavalu	1
Upolu	Mulifanua/Fasito'o	5
	Purchased from Apia Fish Market	4
	Saluafata	1
	Lalomanu	1
	Falealili	2
	Safata	4
	Lefaga	1
Total		21

If the turtles tagged during the above tagging programme were obtained from fishermen who caught them during their normal fishing activities, and in addition to the seven turtles caught during one day's fishing in one village on Upolu, the total number of turtles landed in Western Samoa for consumption would be in excess of 50 turtles a year.

No consistent recorded data is available on sales of turtles at the Apia Fish Market. However, it is known that on a few occasions, turtles have been offered for sale there. Zann (1991) estimated 20-30 turtles as offered for sale in the Apia Fish Market per year. The tagging programme mentioned above purchased four green turtles there during the 10-month 1993/1994 tagging project.

5.1.3 Stocks Status

Throughout the world, sea turtles are generally declining. This trend is primarily due to over-exploitation for food, habitat destruction, and entanglement with fishing nets and other debris (Groombridge, 1982). The IUCN lists five of the seven species of sea turtle as endangered (including the hawksbill) and one been classified as 'vulnerable'. All sea turtle species are listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Animals listed in the CITES Appendix I are considered endangeredd by international trade to such an extent that, if commercial trade is not eliminated with respect to these species, they will become extinct. Commercial trade with these species is therefore absolutely prohibited under CITES. Hawksbill nesting density is low throughout its range, with moderate concentrations in a few localities such as the Torres Straits islands of Queensland, the southern Red Sea and the Gulf of Aden and the Arnavon Islands near Santa Ysabel in Solomon Islands.

Zann (1991) noted that turtles are endangered around the world due to over-hunting for their shells and meat, and over-collection of eggs from their nurseries. The same author believed that turtle declines in the South Pacific are worsened by the breakdown of traditional conservvwtion practices, such as taboos on consumption of turtles by commoners, the use of power boats in turtle hunting, commercial sale, and large scale harvesting of eggs in the rookeries.

Williams (1837, cited in Schuster *et al*., 1994) reported that turtles were abundant around the coastlines of Savai'i and Upolu. Zann (1991) estimated that the numbers of subadult hawksbills around Upolu are moderately high (averaging around 0.25-0.5 sightings per ocean dive). Schuster *et al.* (1994) noted that turtles in Western Samoa waters have declined. The decline was attributed to be associated with rapid increase in the human population, the general breakdown of traditional "constraints" on turtle hunting and consumption, and the transition of turtles and their shells into saleable commodities.

In an effort to augment hawksbill turtle stocks in Western Samoa, a turtle hatchery was established in 1971 at Apleipata by the Fisheries Division. The project was "primarily concerned with restocking the hawksbill population by attempting to eliminate the high fatality rate young turtles were presumed to experience during their first few days of life" (Banner, 1972). Eggs, in batches of 500, were collected from nests on Nu'ulua and Nu'utele islands and transferred to a fenced area of sand at the hatchery (Zann, 1991). Hatchlings were reared in concrete tanks flushed once daily, and fed minced fish. They were released 3-7 km from the reef, after one month, by which time the hatchlings would have grown 30-40 per cent in length and 100-120 per cent in weight. (Zann, cited above) recorded the headstart programme results from various references, as reproduced in Table 5.1.2. Bell (1984) reported that annual turtle egg collection ranged from 4,000 to 9,000 with the number of turtles released ranging from 2,000 to 5,300.

Table 5.1.2: Results of the turtle headstart programme at Aleipata, Western Samoa. (Source: Zann, 1991).

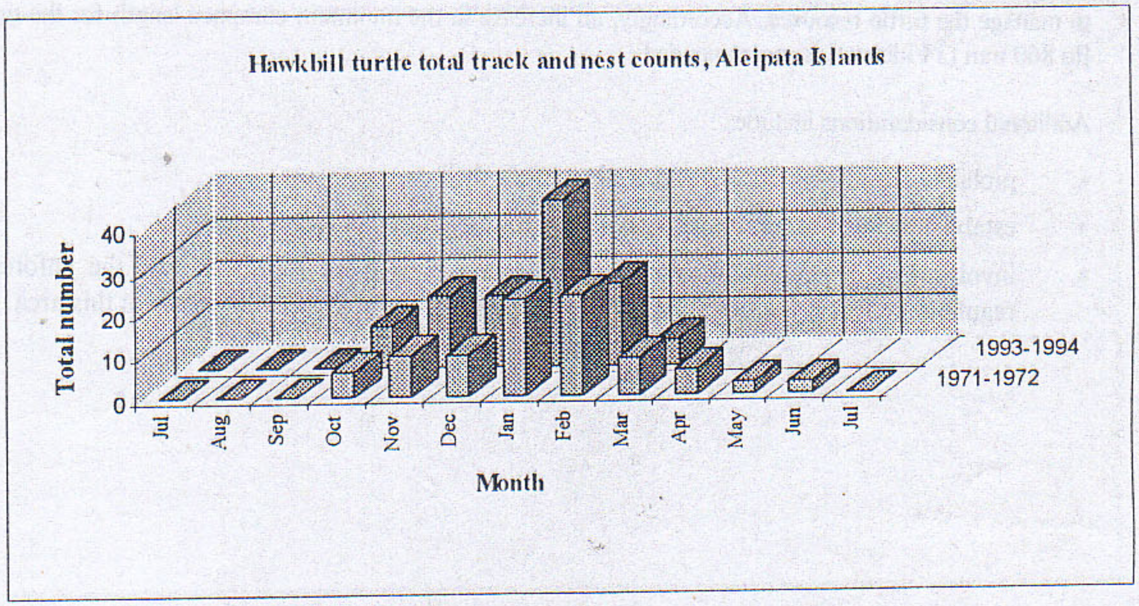
Year	# eggs collected	# hatched	Per cent survival	Notes
1971	700			Project commencement year
1972	2,000/10,000?			First full year of operation
1973	4,656	3,257	70	
1974	6,231	4,951	79	
1975	5,159	2,460	48	
1976	na			
1977	na			
1978	na			
1979	2,883	1,186	41	
1980	4,208	3,257	77	
1981	7,277	4,890	67	
1982	4,420	3,740	85	

The project was closed down at the end of 1982 due to economic reasons (Bell, 1984).

Data on hawksbill turtle track and nest counts in four beaches of the Aleipata Islands during surveys in the 1971/1972 and 1993/1994 year periods are given in Table 5.1.3 as reproduced from Schuster *et al.* (1994). For the July/March periods, for which data were collected during the two surveys, more turtle tracks and nest counts were made in the 1993/1994 survey than in the 1971/1972 survey. Nu'ulua dominated tracks and nest counts for both surveys accounting for more than 80 per cent of the total in 1971/1972 and more than 80 per cent in 1993/1994. About a 50 percent decline in track and nest counts was noticed on Nu'utele from 1971/72 to 1993/94. A marked increase in the number of track and nest counts was observed on Vini Beach from the 1971/71 survey to that in the 1993/94 survey. Schuster *et al.* (1994) attributed this to the effects of the cyclones in 1990 and 1991, where habitat suitable for turtle nesting were more affected on other sites than on Vini Beach. Two track and nest counts were made on Namu'a Island in the 1971/72 survey whereas none was observed there in 1993/94. This could have been caused by recent development on that particular island. Monthly totals for the two surveys are presented graphically in Figure 5.5.1.

Table 5.1.3: Hawksbill turtle track and nest counts in four beaches on the Aplepata Islands for the 1971/1972 and 1993/1994 periods. (Source: Schuster *et al.*, 1994).

	NU'ULUA		NU'UTELE		VINI BEACH		NAMU'A		TOTAL	
Month	1971-1972	1993-1994	1971-1972	1993-1994	1971-1972	1993-1994	1971-1972	1993-1994	1971-1972	1993-1994
July	0	0	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0	0	0
October	6	10	0	0	0	0	0	0	6	10
November	8	16	2	1	0	0	0	0	10	17
December	8	10	1	1	1	6	0	0	10	17
January	18	30	3	3	1	6	1	0	23	39
February	19	13	3	1	1	6	1	0	24	20
March	7	1	1	0	1	5	0	0	9	6
April	4	-	1	-	1	-	0	-	6	-
May	3	-	0	-	0	-	0	-	3	-
June	3	-	0	-	0	-	0	-	3	-
July	0	-	0	-	0	-	0	-	0	-
Total July- March	66	80	10	6	4	23	2	0	82	109
Total July-June	76		11		5		2		94	
Per cent	82	73	12	6	5	21	1	0	100	100



The lack of statistics concerning the utilization of the turtle resoure in Western Samoa has made it impossible to trace trends in effort and landings, thus the status of turtles. However, anecdotal information from catches made by villages that traditionally fish for turtles indicate declining catches.

5.1.4 Management

Current legislation/policy regarding exploitation: There is currently no legislation that deals with the utilization of turtles in Western Samoa. However, the proposed Local Fisheries Regulations 1994 include:

⇒ the prohibition of fishing, selling or having any turtle (*Eretmochelys imbricata* and *Chelonia mydas*) which has a carapace length less than 700 mm (27.6 inches) measured from the top of the head to the tip of the tail;

⇒ the prohibition to disturb the nest of any turtles, or take, use or destroy the eggs of any turtle;

⇒ the prohibition of fishing for turtles during periods which the Director may declare.

Recommended legislation/policy regarding exploitation: A recent survey on fisheries households in the Aleipata District indicated that turtles continue to be taken as they come to shore to nest. In order to protect the local breeding population and to avoid disrupting their breeding cycle, specific considerations should be given to prohibit the taking of turtles during this process/period. A possible means is to prohibit the taking and disrupting etc. of turtles on land, including the time when they come to nest, during nesting and after nesting. However, the most effective and appropriate management tool is to prohibit the taking of turtles during their breeding season. Hawksbill breeding is known to occur in Western Samoa starting in October and ending in June. Surveys in 1971/1972 and 1993/1994 indicate that high nesting activities occur from November to February peaking in the January/February months. It is recommended to impose a closed season for turtle hunting, especially hawksbill, from 1 November to 28/29 February

The proposed minimum carapace size of 700 mm (27.6 inches) seems to be adequate for the hawksbill turtles. However, it is probably too small for the green turtles. Hirth (1993) reported that a typical hawksbill nester has a carapace length of of 780 mm while that for a green turtle is 1,000 mm. Even though green turtles have not been known to nest in Western Samoa, it should be part of the regional and world-wide effort to manage the turtle resource. Accordingly, an increase in the minimum carapace length for the green turtle [to 860 mm (34 inches)] is recommended.

Additonal considerations include:

* prohibition of the export of turtle, turtle meat or shell;
* establishment of some islands as reserves for turtles and other animals;
* involvement of communities in the management of these resources and the enforcement of regulations. It is probably the most practical means towards attaining goals in this area.

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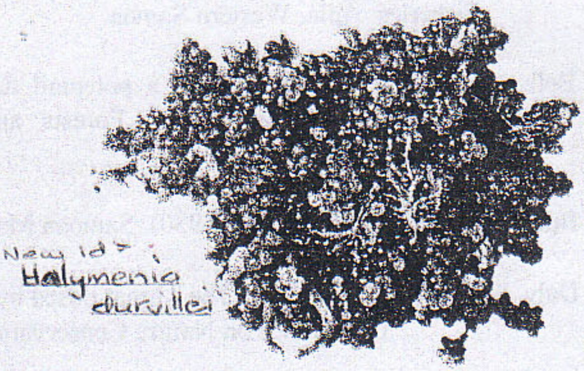
6. FLORA

6.1 Seaweeds - *limu*

6.1.1 The Resource



limu fuafua - Caulerpa sp.

Species present: Eatable seaweeds found and utilized in Western Samoa include: two species of seagrapes (*Caulerpa racemosa* and *Caulerpa.* sp.), known locally as *limu fuafua*, and the glassweed (*Gracilaria verrucosa*), known as *limu a'au*. Euchema for aquaculture experimental culture was introduced from Fiji. This species is discussed under the aquaculture section of this document.

Distribution: Seaweeds thrive on coral reefs in clear waters. Because they require sunlight their distribution is limited to shallow waters. Some species prefer sandy substrates.

In Western Samoa, eatable seaweeds are generally found through-out the islands in areas with good growth of corals, in clear sandy lagoons with coral limestone substrate. Morton *et al*. (1988) noted that the leeward north coast on Upolu offers rich sites for algal collection. It was further noted that the calm lagoons of the north, as illustrated by the short fringing reef west of Leusoali'i, are rich in brown algae. This particular lagoon has several typical green algae. "Large compact hummocks of *Halimeda opuntia* can be frayed out to reveal the chains of calcified segments aggregated side by side. Rhizoids of *Caulerpa racemosa* which branches like small bunches of grapes, may creep over the soft bottom. However, seaweeds, especially seagrapes, are more common in certain villages and at certain times of the year.

Biology: Some seaweed species have been intensively grown in aquaculture enterprises since they require only sunlight and nutrients in the water. However, predation by rabbitfish, *Siganus* sp. has resulted in the failure of some of these mariculture undertakings.

6.1.2 The Fishery

Utilization: Collection of seaweeds for home consumption is one of the activities included in the general reef gleaning, mostly by women. It is only in certain areas and times of the year when *limu* is abundant that special collection takes place. Special seaweed collections are normally targetted for sale. Seaweeds used to be an important marine resource in the subsistence level. They are sometimes sold in bundles wrapped in leaves. Seagrape seaweeds (*limu fuafua*) are eaten raw while the glassweed (*limu a'au*) is cooked before eating. Cooking is in coconut cream.

Production and Marketing: No information is available on the consumption and production of seaweed on any level in Western Samoa. However, they are collected for consumption whenever found in the sea. Seaweed wrappings were common commodities in the market several years ago. It is only on rare occasions are seaweeds seen sold.

6.1.3 Stocks Status

There is no infomation available to suggest the current status of eatable seaweeds in Western Samoa. However, their rare occurrence in the market place and the fact that they are hardly seen on reefs and in suitable lagoons, indicate their declining state. The resource seems to be environmentally sensitive and easily over-exploited. Some seaweed beds seem to exist in a few areas around Western Samoa which do not seem to expand but are seasonal in abundance. Destruction of suitable habitats through the application of destructive fishing practices on the reef and increased siltation resulting from land-based development seem to be a major factor affecting this resource.

6.1.4 Management

Current legislation/policy regarding exploitation: There is no legislation that specifically deals with the utilisation of the seaweed resource in Western Samoa.

Recommended legislation/policy regarding exploitation: No specific legislation seems to be required. However, better enforcement of existing legislations that deal with destructive fishing methods are necessary for the enhancement of the marine environment and its resources. This also includes managing development that either directly or indirectly affect the marine environment.

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7. OTHER RESOURCES

7.1 Sea cucumber - *fugafuga*

7.1.1 The Resource

susuvalu - *Holothuria fuscogilva*

Species present: Sea cucumber species of importance that are present and utilized in Western Samoa include those in the following table:

Common name	Samoan name	Scientific name
Surf redfish	*mama'o*	*Actinopyga mauritiana*
Redfish	*mama'o*	*A. echinites*
Leopardfish	*ulutunu/ fugafuga gatae*	*Bohadschia argus*
Tiger fish	*fugafuga ai*	*B. marmorata*
Seahare	*gau*	*Dolabella* sp.
Lollyfish	*loli*	*Holothuria (Halodeima) atra*
Black teatfish	*susu valu (uliuli)*	*Holothuria (Microthele) nobilis*
White teatfish	*susu valu pà'epa'e*	*H. fuscogilva*
Pinkfish	*sea amu'u*	*H. edulis*

Common name	Samoan name	Scientific name
Elephant's trunk fish	*??*	*H. fuscopunctata*
Pinkfish	*sea amu'u*	*H. edulis*
Curryfish	*neti*	*Stichopus variegatus*
Pricklyfish	*sea*	*S. horrens*
Greenfish	*maisu*	*S. chloronatus*
Prickly redfish	*fa'atafa, sauai*	*Thelenota ananus*
Giant bêche-de-mer	*??*	*T. anax*
Elephant's trunkfish	*saua'i*	*Microthele axiologa*

Distribution: Sea cucumbers are found throughout the world at depths from shallow coastal seas to the abyssal plain (Preston, 1993). Species of commercial value tend to predominate tropical coastal waters.

Because bacteria constitutes the major nutritional component for most holothuroids, "the complex relationship between bacterial populations and sediment structure may have a major influence on the distribution of holothuroids" (Preston, cited above).

In Western Samoa, holothurian species occur in sheltered lagoons and on the reefs and the outer reefs enclosing each islands. The surf redfish (*mama'o*) is found mainly under coral ledges on the surge zone of the barrier reefs during daytime and come out at night to feed. Other species, mainly the *fugafuga*, are found on sandy bottom areas in lagoons. Species of high commercial value, e.g. black and white teatfishes (*susuvalu*) and prickly redfish (*fa'atafa*) tend to occur more in the deeper region of lagoong, deep reef channels and the outer-reef areas with sandy bottom. Species of low commercial value, e.g. *H. atra (loli) and S. chloronatus (maisu), are common in many lagoons, possible because of their* eutrophication (Zann, 1989). In Safata Bay, the pricklyfish (*sea*) is found on submerged boulders, especially at night, and amongst seagrass beds in sandy bottom areas, sometimes together with lollyfish (*loli*). *Dolabella* sp. (*gau*) also used to be found within the bay. Now it is found only in sandy lagoons. Along the northern coast of Upolu, *sea* is common on boulders and (dead corals?) in sandy lagoon areas in certain villages from the Toamua/Nofoali'i stretch. It is particularly common in villages of Toamua, Puipa'a and Faleasi'u which harvest it for sale.

Biology and ecology: Conand (1989) reviews what is known of the biology of the main species of holothurian exploited commercially in the South Pacific. Additional information is provided in Preston (1993). Summaries of information from both sources on certain species of commercial interest are given in Appendix 7.1.

It is known that most aspidochirote holothurians are deposit-feeders, swallowing the upper few millimetres of sediment on which they live. The sediment consists of inorganic compounds, organic detritus, micro-organisms and their own or other animals' faecal material, with bacteria making up the major nutritional component for most species. They generally feed continuously or have a daily rhythm in their feeding frequency, often related to light levels. Species that live in reef flat areas "vacuum" the surfaces of their habitat, cleaning off the film of sediment that settles there.

7.1.2 The Fishery

Utilization: Collection of sea cucumbers for consumption forms an important component of subsistence fishing activities in Western Samoa. Collection is done mostly by women during their general gleaning, but is also picked up by fishermen during dive fishing operations, especially if fish catches are not fruitful. In a survey of fish consumption on Upolu, Zann *et al.* (1984) recorded ***sea*** in all zones used, i.e. Apia, North east, North west, South east, South Central, South west and Manono Island. ***Loli*** consumption was only recorded in three zones, North west, South west and Manono Island. Some species of sea cucumbers are sold in local markets and along the roadsides. ***Sea*** (the viscera of *S. horrens*) is collected and sold in bottles. [Note: ***sea*** is the Samoan word given to the animal itself as well its viscera after collection]. During collection, the animal is cut open, viscera extracted into a bottle and the rest thrown back to the sea to regenerate. Fishing for this species is known as ***tuiga sea***. When sold, ***sea*** is sometimes mixed with other sea cucumber species such as, white sandfish (***fugafuga ai***), brown sandfish (***fugafuga***), lollyfish (***loli***), tigerfish (***ulutunu***), and *Dolabella* (***gau***). These other species are normally used to fill up the ***sea*** bottle. The deposited eggs of the *Dolabella* sp., known locally as ***ape***, is a favourite local delicacy.

The survey of fisheries items sold along roadside from Apia to Faleolo in 1992 and 1993 indicated sales of ***sea*** bottles (both small and large standard coke bottle), often mixed with other sea cucumber species, at Toamua and Puipa'a.

All of the sea cucumbers utilized locally are consumed raw, with the exception of Dolabella (***gau***) which is often preferred to be cooked in coconut cream. The ***gau*** cooked in coconut cream dish is called ***faiai gau*** and is a favourite food.

The history of commercial exploitation of sea cucumbers for bechê-de-mer production in Western Samoa for export is not very clear. There have been some indications that exploitation started sometime in the late 1960's and early 1970's (Talo and Leiataua 1993, *per comm* to Mulipola, 1994). No records of exported volume have been found for these undertakings. The sea cucumber fishery for the production of bechê-de-mer started again in the late 1980's with four shipments made during the second half of 1989 (Brotman, 1989). Each shipment was estimated to contain 3.7 metric tonnes of dried bechê-de-mer exported to Fiji by a company called A. Mosese and Sons Company.

The bechê-de-mer fishery for export was again revived in the late 1992, presumably as a result of the collapse of the industry in neighbouring countries, Fiji and Tonga. By the end of 1994, seven licences had been granted to companies to harvest and export bechê-de-mer from Western Samoa but only five exporters have been registered to have exported sea cucumber products. [By the end of 1994, only two companies were actively collecting and exporting bechê-de-mer.] Commercial production of bechê-de-mer in Western Samoa during the 1993/1994 period indicated that the species landed and collected most are greenfish (***maisu*** - 47 per cent), brown sandfish (***fugafuga*** - 26 per cent) and surf redfish (***mamao*** - 21 per cent). Data obtained from the monitoring program of harvesting sea cucumber at landing sites is presented in Table 7.1.1. Data indicate that bechê-de-mer production in Western Samoa is made up mostly of the low valued species.

Table 7.1.1: Summary of sea cucumbers collected and landed (unprocessed) during the 1993/1994 period for bechê-de-mer production.

Species name	Pieces (% numbers landed)	Average price (tala/pcs)
Greenfish	47.00	0.05
Brown sandfish	26.00	0.40
Surf redfish	21.10	0.50
Tigerfish	4.00	0.80
Lollyfish	1.60	0.20
Black teatfish	0.15	1.80
White teatfish	0.11	2.00
Prickly redfish	0.04	1.60

Production and marketing: No reliable figures could be located on the levels of exploitation of sea cucumber resources in the local subsistence fishery. The information available on landings of sea cucumbers collected in the artisanal fishery is very limited. A survey conducted by the Department of Statistics in 1978 on fishery catch assessment recorded Echinodermata in one category without giving any details of relative composition. Echinodermata recorded for Upolu (excluding the Apia area) was estimated to be 40,458 kg and that for Savai'i was 4,328 kg, giving a total for the whole Western Samoa 44,786 kg.

In a preliminary survey of fish consumption on Upolu from December 1983 to February 1984, involving 135 rural households and 29 households in Apia, Zann *et al.* (1984) estimated major invertebrates consumed in rural areas as, ***sea*** (49 %), sea urchin (14 %), sea cucumber bodies (11%), miscellaneous bivalve (9 %), and gastropod molluscs (9%). Dolabella sp. (***gau***) made up 5.5 per cent of the total inverterates consumed in rural areas. Overall, sea cucumbers made up 65.6 per cent of the total invertebrate seafood consumption in the rural areas. For the urban area, ***sea*** was estimated to make up 36 per cent of the invertebrate consumption. These percentages were estimated from invertebrates consumed the day before the survey and are rural averages. The invertebrates relative composition are given in Table 7.1.2 as reproduced from Zann *et al.* (1984).

Table 7.1.2: Percentage of invertebrate types eaten on the day before the survey on Upolu. (Source: Zann *et al.*, 1984).

Taxon	English/Samoan name	Apia	North east	North west	South east	South central	South west	Manono Is.	Rural Average
Households consuming invertebrates on previous day		24	26	28	7	14	17	50	23.7
MISC.									
Scyphozoa	jellyfish/'alu'alu	9					8		1.3
MOLLUSCA									
Gastropod (misc)	snails					19			3.2
Dolabella	**seahare/gau**			**33**					**5.5**
Bivalvia	misc.		25						4.2
Tridacna	giant clams/faisua					20			3.3
Anadara	cockles/pae	18							
Gafrarium	venus shell/tugane	9							
Pinna	penshells/fole						8		1.3
Octopoda	octopus/fe'e							14	2.3
Total		27	25	33		39	8	14	20.0
CRUSTACEA									
Crabs	crabs/pa'a					13			2.1
Panulirus	spiny lobster/ula								2.0
Total			12			13			4.1
ECHINIDERMATA									
Holothurian	**gonads/sea**	**36**	**37**	**33**	**100**	**13**	**56**	**57**	**49.3**
H. atra	**sa cucumber/loli**			**33**			**4**	**28**	**10.8**
Echinometra	seaurchin/tuitui	18	25			33	24		13.6
Total		54	62	66	100	46	84	85	73.7

During the Fisheries Division survey of fisheries products sold on the roadside from Apia to Faleolo, 119 bottles of ***sea*** were estimated to be sold in 1992 (Iosefa, 1992). In 1993, only data for the October-December period were found and were expressed in value (WS$) only as follows:

	October	November	December
Small bottles (WS$)	214.50	996.67	117.00
Large bottles (WS$)	117.00	719.33	325.00

The only figures available on the export of beché-de-mer from Western Samoa are those estimated in

1989 and in the 1993/1994 period. Brotman (1989) estimated the 1989 beche-de-mer exports as follows:

	June	August	October	December	Total
Estimate wt (mt)	3.7	3.7	3.7	~3.7	14.8
Estimated value (WS$)	12,000	12,000	12,000	~12,000	48,000

During the 1993/1994 period, the total beche-de-mer export was estimated to be 41.3 mt of dried products and valued at around US$ 193,000. Export by species is presented in Table 7.1.3. Of the total weight exported, sandfish made up the largest portion (44 per cent) followed by surf redfish (29.8 per cent) and tigerfish (19.1 per cent). In terms of total value, surf redfish made up the highest (43 per cent) followed by sandfish (29 per cent) and tigerfish (16.40 per cent). Table 7.1.3 lists the species in order of decreasing unit value, listing white teatfish as the most highly valued species, followed by greenfish.

Table 7.1.3: Species composition of beche-de-mer exports from Western Samoa in the 1993/1994 period.

Species	Weight (kg)	Per cent wt	Value (USD)	Per cent value	Avg price / kg
White teatfish	153	0.4	1,810.00	0.94	12.33
Greenfish	1,056	2.6	9,542.64	4.95	9.00
Prickly redfish	97	0.2	870.45	0.45	8.90
Black teatfish	977	2.4	7,370.00	3.83	8.00
Surf redfish	12,299	29.8	83,370.13	43.27	6.04
Tigerfish	7,875	19.1	31,594.85	16.40	3.78
Sandfish	18,078	43.7	56,284.74	29.21	2.72
Lollyfish	771	1.9	1,634.00	0.85	1.75
Others	27	0.1	229.9	0.12	6.21
TOTAL	**41,333**	**100.0**	**192,667.71**	**100.00**	

The exports were mainly to Australia and Hong Kong markets. Market prices range from US$1 per kg for low graded species to US$15 per kg for top 'A' grade high valued species. Table 7.1.4. breaks down the 1993/1994 period beche-de-mer export by company.

Table 7.1.4: Total beche-de-mer exports by companies in 1993/1994 period.

Company	Total Weight (kg)	Total Value (US$)
SDL	1,040.0	7,020.00
CIL	23,221.8	87,615.78
IFP	14,936.0	92,365.00
SRC	2,135.0	5,668.20
TOTAL	**41,332.8**	**192,668.98**

7.1.3 Stocks Status

No study has been conducted on any aspect of the sea cucumber stock in Western Samoa. However, it is known that several species of sea cucumbers important to the subsistence/artisanal fisheries have been declining. In a few cases, certain fisheries, have disappeared completely. Bell (1985) noted that the *Dolabella* (*gau*) fishery within the Vaiusu Bay area has recently disappeared. Apart from harvesting of the animals themselves, its eggs, when deposited on corals etc, are also collected for consumption. In additional, the Vaiusu Bay has suffered from all types of pollution which include; effluent pollution from land-based industries, sand dredging, municipal garbage disposal, reclamation etc. Klinckhamers (1992) lists sources of pollution in Western Samoa and further noted that the most impacts of pollution on the environment are expected in Apia-Vaitele area (Vaiusu Bay). The ***gau*** fishery has also disappeared from within Safata Bay, while the ***sea*** and ***loli*** fisheries have drastically declined within the bay.

The collection of *gau* at night was a tradition in certain villages. During full moon of certain months (October/November?, especially when the moon is encircled by a white ring), it is said that the Dolabella is out and plentiful (*tolo le gau*). The village children and adults go out and collect *Dolabella* from the reef and sandy lagoon at low tide. Some take canoes to put *Dolabella* in while others take sacks. Hundreds or even thousands of *Dolabella* are collected during this particular night.This phenomenon does not seem to be common at present, probably due to the over-fished status of the stocks.

When the current sea cucumbers fishery for the production of beche-de-mer was started again in 1993; efforts were concentrated on the more valuable species including, white teatfish (***susuvalu pa'epa'e***), black teatfish (***susuvalu uliuli***), the prickly redfish (***fa'atafalsauai***) and the greenfish. Due to drastic declines in catches of these species, harvesting has spread to the low valued species such as, the surf redfish (*mama'o*) and various sandfish species. The main species currently landed is the surf redfish. The current number of beche-de-mer operators can be used as an indication of the status of the sea cucumber stocks for beche-de-mer production in Western Samoa. By 1994, seven individual licenses were issued for processing and export of beche-de-mer. Five were registered to have exported beche-de-mer by mid-1994 and that only two were still operating by the end of the year. Records of exported beche-de-mer by company per month have been monitored by the Fisheries Division since the revival of the industry. During inspection of exported item prior to shipping, average size or length have been recorded. Table 7.1.5 summarises average length (in cm) of exported items per species per month. From available data, the surf redfish has shown a gradually decline in average length from 10.1 cm recorded in September, 1993 to 8.3 cm recorded in June, 1994.

Table 7.1.5: Average size (length in cm) of exported items collected during inspection prior shipment.

Species	Sept - 93	Oct - 93	Nov - 93	Dec - 93	May - 94	Jun - 94
White teatfish	15.6	14.8				
Black teatfish	13.1			16.0		13.0
Surf redfish	10.1	9.5	9.9	9.5		8.3
Brown sandfish		8.5		10.1	10.2	9.8
Tigerfish		11.0		11.2	12.5	11.6
Pricklyfish		17.4				
Greenfish				7.7		
Lollyfish				12.1		

7.1.4 Management

Current legislation/policy regarding exploitation: The harvesting of sea cucumber for the production of beche-de-mer for exporting are currently controlled by formulated terms and conditions. Pursuant to Part II 3 (1) of the Fisheries Act (1988), the following terms and conditions are applied for export of beche-de-mer outside Western Samoa:

1. Size limit: specimens of all species except, *Stichopus chloronatus* will not be less than 7.6 cm in length measured from anterior to posterior for all processed product. The minimum size limit for *S. chloronatus* (*maisu*/greenfish) is 6.3 cm.
2. All beche-de-mer to be exported are to be inspected by authorised Fisheries Officers prior to packing.
3. It is the responsibility of the licencee to inform the Fisheries Division for inspection of products in no less than 48 hours before shipment takes place.
4. Any processed product less than 7.6 cm except for *Stichopus chloronatus* will be charged a penalty

of $10 tala per kilogram of confiscated products.

5. For *Stichopus chloronatus* similar penalty as in 4 above will imposed for product less than 6.3 cm.
6. No beche-de-mer is allowed to be exported either in natural or in processed form without a proper export permit approved by the Director of Fisheries.
7. Volume to be exported will be controlled by Fisheries from time to time.
8. No other zone (refer to map) is permitted for operation except those approved.
9. The applicant should have the 'technical know how' on all aspects of post harvest for the fishery resource applied for.
10. The applicant should provide evidence that there is enough initial capital investment for the commencement of his project.
11. Fisheries reserves the right to withhold export permit should any of the above condition is not adhered to.

The issuance of licence to harvest and export sea cucumber is subjected to an approval or consent from villages within the zone the licencee intended to harvested from. The country is zoned up in 33 zones, 12 on Savaii Island and 21 on Upolu Island. The main purpose of this particular management approach is to allow each village to co-participate in the management and conservation of sea cucumber resources within their jurisdiction with the Fisheries Division.

Recommended legislation/policy regarding exploitation: The exploitation of sea cucumber resources in many Pacific island countries for the production of bêche-de-mer for export has been mostly characterised by "boom-and-bust" cycles. These have been mainly caused, not only by the export nature of the development but mainly by the absence of management strategies guiding exploitation and the absence of local scientific information on which to base sound management. Bêche-de-mer production has contributed not only as a foreign exchange earner but it has offered an alternative means of income generation for local communities. It is a potential resource for export development provided guidelines are in place to ensure sustainable utilisation.

The lack of available information on the population dynamics and existing fishery, makes it difficult to establish management requirements. Baseline data on catch rates, areas of production, species and size composition of the catch, and fishing effort are required, especially for the areas of known high exploitation.

Chambers (1990) recommended the following for sea cucumber harvesting in Vanuatu:

> "the correct strategy with regard to bêche-de-mer harvesting is to collect intermittently from sites which are both large enough and support sufficient densities of commercial species to be economic. Stocks should then be left for however long it takes them to recover to economic levels."

Conand (1989) and Preston (1993) describe several options available for the management of sea cucumber resources for sustainable utilisation. One such means is the application of minimum size limits regulations. Conand (1989) notes:

> "the seasonal fishing ban can hinder exports, since the buyers on the Hong Kong and Singapore markets have always insisted that suppliers should be regular. A longer closed season can be considered where yields drop drastically. It is difficult to enforce closures of fishing zones and their boundaries must respect local customs, when these non-mobile resources are exploited under a system of traditional ownership. Limiting fishable sizes tends to favour recruitment. When applied to catches, such restrictions are hard to verify but when applied to the processed product, they are realistic and can be checked through exports. The limits should be set out on the basis of scientific results relating to size at first sexual maturity".

Length and weight values for processed bêche-de-mer with corresponding total wet length and weight at first sexual maturity have been calculated for some species with commercial value. These are presented in Table 7.1.6 as reproduced from Conand (1989). These can be used as a basis for setting legal size on the processed product. However, the author notes "that these are minima and that better knowledge about growth remains essential so as to be able to leave individuals undisturbed for one or more breeding seasons before harvesting them".

Table 7.1.6: Wet length and weight values at first sexual maturity for some sea cucumber species, with their corresponding processed values. (Source: Conand, 1989).

Species	Common name	Length (mm)		Weight (g)	
		Wet	Processed	Wet	Processed
H. scabra	sandfish	160	60	184	10
H. scabra var *versicolor*	sandfish	220	85	490	30
H. nobilis	black teatfish	260	130	800	70
H. fuscogilva	white teatfish	320	140	1,175	95
T. ananas	prickly redfish	300	115	1,230	60
A. echinites	redfish	120	55	90	10
H. fuscopuncata	elephant's trunkfish	350	150		
H. atra	lollyfish	165	80		

Other management options taken in other countries include the prohibition of the use of SCUBA gear or any form of under-water breathing apparatus, e.g. hookah, for the collection of sea cucumbers. This particular prohibition not only protects animals to seek refuge at deeper region of the reefs in order to guarantee continuous recruitment of the harvested stock, but it also covers for the safety of divers/collectors. Several fatal incidences have been known in countries where these have been used for collection.

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Appendix 7.1.1: Biological Information on some species of sea-cucumbers exploited commercially in the Pacific (Conand 1989; and Preston, 1993).

H. scabra and *H. scabra* variety *versicolor* (the "sandfish"): Sexes are separate and sex-ratio does not significantly diverge from 1:1, with individuals showing a single annual sexual cycle. Reproduction is sexually and takes place mainly during the warmer months, peaking in October-December, with absolute fecundity ranging from 9-12 x 10^6 oocytes per gram of ovary weight. Sizes at first sexual maturity for *H. scabra* and *H. scabra* var. *versicolor* were found to be 140 g and 320 g drained weight respectively with corresponding lengths of 16 cm (total weight 184 g) and 22 cm (total weight=490 g). Growth is difficult to measure, however, Shelley (1985) studied the species length-frequency and concluded that in the size range of 10-25 cm *H. scabra* were growing at 0.5 cm per month, equivalent to an average monthly whole weight increase of 14 g. Juveniles (recruits) are rarely seen and Shelly (1981 - quoted in Preston, 1993) did not find any juveniles of *H. scabra* less than 60 mm in length. Length-weight relationship for *H. scabra* has been calculated by Conand (1989) to be Log W = 2.28 Log L-6.35 (correlation coeficient=0.78) and Shelly (1981) W = $3.06L^{1.61}$ (correlation coeficient=0.75) while that for *H. scabra* var *versicolor* is Log W=2.26 Log L-5.97 (correlation coefficient 0.76) (Conand, 1989). (L in cm and W in g).

H. nobilis (the "black teatfish") and *H. fuscogilva* (the "white teatfish"): Sexes are separate with a ratio of about 1:1. Reproduction is sexual. A five-stage maturity scale has been identified which is typical for the family Holothuriidae and details are given in Conand (1989). Male and females develop synchronously and for *H. nobilis*, spawning occurs during the cold months (June-August) while *H. fuscogilva* spawns in the warmer months, peaking in November-January. Spawning periods for these two species do not overlap. (Fission can be induced in *H. nobilis*). Absolute fecundity for *H. nobilis* was estimated to be between 13 and 78 million oocytes with *H. fuscogilva* recording lower fecundity of between 8 and 14 million oocytes per gram of ovary weight. Total weights at first sexual maturity were estimated to be 800 g and 1,175 g for *H. nobilis* and *H. fuscogilva* respectively. Juveniles are only rarely seen. Length-weight relationship was calculated by Conand (1989) for *H. nobilis* to be Log W=2.34 Log L-6.39 (correlation coefficeint=0.80) and for *H. fuscogilva* W=11.94 L-2712 (correlation coefficient=0.70). (L in cm and W in g).

A. echinites (the "deep-water redfish"): Sexes are separate with a ratio of about 1:1. Spawning takes place during the warmer months, peaking in January-February, with absolute fecundity ranging from 4 to 25 million oocytes. Drained weight at first sexual maturity is 75 g corresponding to total weight of 90 g and total length of 12 cm. Shelly (1985) estimated the growth parameters of this species in PNG to be; L_∞= 23 cm, K=0.78 with a monthly length increase of 0.60 to 0.9 cm corresponding to a monthly weight increase of 1 to 5 g. Conand (1988 - quoted in Preston, 1993) gave estimates for growth and mortality parameters to be: L_∞=29.5 cm, K=0.09 and M=0.64. Length-frequency data for this species in New Caledonia showed the absence of animals less than 40 mm in length (Conand 1986, quoted in Preston, 1993). Length-weight relationship was calculated as W=0.68 $L^{2.00}$ (correlation coefficient =0.61) (Shelley, 1982, quoted in Preston, 1993).

A. miliaris (the "blackfish"): Little is known about this species. Some observations on spawning in natural environment during February and early March on the Great Barrier Reef suggests that reproduction takes place in the hot season. Measurements of small specimens, in July 1982, weighing 5 to 30 g (3 to 9 cm) indicated their growth rates were approximately 1 cm (5 g) per month assuming these were spawned in February of the same year. The Length-weight relationship for this species was calculated by Conand (1989) to be W=0.824 x 10^3 $L^{2.441}$ (correlation coefficient=0.96).

T. ananas (the "prickly redfish"): Spawning occurs during the warmer months, probably from January to March. Fecundity is not high with absolute fecundity ranging from 2 to 7 million oocytes per gram of ovary weight. First sexual maturity is reached at total length of 30 cm (total weight of 1,230 g and drained weight of 1,150 g). Conand (1988, quoted in Preston, 1993) gave growth parameters for this species as; L_∞=66.3 cm, K=0.20, M=0.63 and Length interval=160-640. The species is long-lived, with a low mortality and high asymptotic length. In New Caledonia no animals were recorded with lengths less than 180 mm. Using growth and mortality estimates, Conand (1988, quoted in Preston, 1993) estimated the biomass of theoretical cohorts of this species as it aged which enabled her to estimate the average length at which the biomass of the cohort is greatest and fishing will give the highest yields ("critical length"). The critical length was found to be 28 cm, slightly lower than the length at first sexual maturity. The length-weight relationship was calculated to be W=1.27 x 10^{-3} $L^{2.441}$.

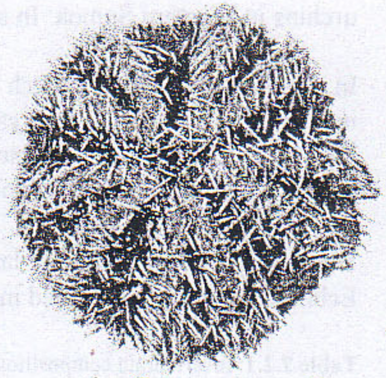
H. atra (the "lollyfish"): The lollyfish is the most common and abundant species on the tropical shore. Asexually reproduction through fission is thought to be very important in this species and the products of fission may comprise up to 70 percent of the population. Growth and mortality parameters were estimated in Conand (1988-quoted in Preston, 1993) as: L_{∞}= 324 mm, K=0.11, M=1.02 and Length interval=130-220. The length-weight relationship has been calculated to be Log W=2.13 Log - 5.64 (correlation coefficient=0.90).

A. mauritiana (the "surf redfish"): This species is widespread in the tropical Indo-Pacific region and its habitat is restricted to outer reef flats subject to strong waves and currents. Its diet is mainly of plant debris. Reproduction is sexual but fission can be induced in this species. Absolute fecundity was estimated to be between 22-33 million oocytes per gram ovary weight. The growth and mortality parameters have been calculated to be L_{∞} = 340, K=0.12, M=1.45, and length interval=70-280 (Conand, 1988, quoted in Preston, 1993).

7.2 Sea urchins - *tuitui, vaga etc*

7.2.1 The Resource

Species present: The three main species of sea urchins utilized for consumption in Western Samoa are as follows:



sava'e - Tripneustes gratilla

Samoan name	Common name	Scientific species
Tuitui	(boring) sea urchin	*Echinometra matthaei*
Sava'e, satula	sea urchin (short spine)	*Tripneustes gratilla*
Vaga	long spined sea urchin	*Diadema setosum*

The most important species, in terms of volume, in the subsistence and artisanal fisheries for sea urchins in Western Samoa is the *tuitui* (boring sea urchin, *E. matthaei*).

Distribution: Sea urchins are harvested at low tide from the intertidal and subtidal zones in the tidal flats, in lagoons and on the reef. The boring urchins are mostly found in sandy lagoons abrading coral rock, while the *vaga* are normally found on the reef under coral ledges. The *tuitui* are also found living freely on the open surface on coral rubble, as was recorded by Morton *et al.* (1988) at Tafitoala and Luatuanu'u. *Sava'e* and *satula* are found on sand near corals. Sea urchins are generally found throughout the country although villages near Apia, e.g. Moata'a, Saina, Toamua, and Puipa'a, extensively harvest them during the October/December period for sale. In a survey of fish consumption on Upolu from December 1983 to February 1984, Zann *et al.* (1984) recorded sea urchin consumption in the Apia area, North east Upolu, South central Upolu and South west Upolu.

Biology: The collection of sea urchin, especially the boring urchin *E. matthaei*, for consumption and sale is from October to December. This is when the gonads are full. Thus reproduction in sea urchin takes place in the warmer and wetter months of the year in Western Samoa, especially during the above period.

7.2.2 The Fishery

Utilization: Because it is the gonads of the sea urchins that are consumed, collection is limited to the period in which gonads are in the late developing stage or when full. For Western Samoa, this period is mainly from October to December. Sometimes, the collection period can include one or two months at each end of the period but the highest peak is in November. Sea urchin has always been an important component in the subsistence fishery in communities whose adjacent lagoon and reef areas support sea urchin populations. With the advent of cash-based economies, sea urchins, especially *tuitui*, has become an importance source of income for certain villagers in the artisanal fishery. This is particularly noted in the villages of Moata'a, Toamua, Puipa'a, Leauva'a. *Tuitui* are sold in baskets of about 50 animals per basket. *Sava'e* and *satula*, which are much bigger than *tuitui* are sometimes sold in bundles of 3 or 4 individual animals.

Collection of *tuitui*, which is mainly in the shallow parts of the lagoon, are done by hand picking. Sometimes, coral rocks or even coral are broken up using a hard piece of stick to extra urchins. *Vaga*, because of its long and venomous spines, are always collected using tongs made from the spine of coconut fronds (*iofi*). Spines are broken off using the tong while still in the sea before taking it into the canoe.

Sea urchin gonads are always eaten raw.

Production and Marketing: No reliable estimate has been made on the subsistence consumption of sea urchins in Western Samoa. In addition, very limited data has been collected on their sales.

In a nation-wide fishery catch assessment survey conducted by the Department of Statistics in 1978, invertebrate production was estimated for Western Samoa, excluding the Apia area, as presented in Table 7.2.1. Sea urchins and sea cucumbers were combined in the Echinodermata category. The results indicate that on Upolu, Echinodermata made up 40 per cent of the invertebrate landings while on Savai'i it made up about 21 per cent. Overall, Echinodermata made up about 37 per cent of the Western Samoa invertebarte landing for the survey year. In terms of landings per area, the highest of Echinodermata was recorded in the Upolu northeast.

Table 7.2.1: Invertebrate composition of fishery landing in Western Samoa in 1978. (Source: Department of Statistics, undated).

	Upolu						Savaii				Western Samoa	
Category	1*1	2*2	3*3	4*4	Total	%	5*5	6*6	Total	%	Weight	Per cent
Crustacea	4,416	3,900	5,209	13,318	26,843	26	1,117	0	1,117	5.4	27,960	22.8
Shellfish	839	3,475	4,097	1,918	10,329	10	1,992	6,191	8,183	39.3	18,512	15.1
Cephalopoda	4,110	11,070	4,504	4,255	23,939	24	907	6,277	7,184	34.5	31,123	25.4
Echinodermata	21,451	9,065	3,304	6,638	40,458	40	2,481	1,847	4,328	20.8	44,786	36.6
Total	30,816	27,510	17,114	26,129	101,569	100	6,497	14,315	20,812	100.0	122,381	100.0
Per cent Echinodermata	69.6	33.0	19.3	25.4	39.8		38.2	12.9	20.8		36.6	

*[1]=Upolu Northeast (Fagali'i to Uafato); *[2]=Upolu Southeast (Tiavea to Sa'aga); *[3]=Upolu Southwest (Siumu to Matafa'a); *[4]=Upolu Northwest (Falevai to Vailoa including Manono and Apolima); *[5]= Savai'i North (Samalaulu to Falelima); *[6]=Savai'i South (Fagafau to Pu'apu'a).

In fish consumption surveys conducted in rural areas of Upolu during the December 1983 - February, 1984 period, Zann *et al.* (1984) estimated invertebrates consumption as recorded in Table 2.7.2. Figures are in percentages which were calculated from estimates based on fishery products consumed the day before the survey. Sea urchins (*tuitui*) were estimated to make up 18 per cent of the Apia invertebrate marine product consumption and 13.6 per cent in the rural areas. The invertebrate landing in rural areas of Upolu was estimated to be 6,093 mt and 1,523 mt in the urban area per year.

Table 2.7.2: Percentage of invertebrate types eaten on day before survey in 1983/84 on Upolu. (Source: Zann *et al.*, 1983).

Taxon	English/Samoan name	Apia	North east	North west	South east	South central	South west	Manono Is.	Rural Average
Households consuming invertebrates on previous day		24	26	28	7	14	17	50	23.7
MISC.									
Scyphozoa	jellyfish/'alu'alu	9					8		1.3
MOLLUSCA									
Gastropod (misc)	snails					19			3.2
Dolabella	seahare/gau			33					5.5
Bivalvia	misc.		25						4.2
Tridacna	giant clams/faisua					20			3.3
Anadara	cockles/pae	18							
Gafrarium	venus shell/tugane	9							
Pinna	penshells/fole						8		1.3
Octopoda	octopus/fe'e							14	2.3
Total		27	25	33		39	8	14	20.0
CRUSTACEA									
Crabs	crabs/pa'a					13			2.1
Panulirus	spiny lobster/ula								2.0
Total			12			13			4.1
ECHINIDERMATA									
Holothurian	gonads/sea	36	37	33	100	13	56	57	49.3
H. atra	sa cucumber/loli			33			4	28	10.8
Echinometra	**seaurchin/tuitui**	**18**	**25**			**33**	**24**		**13.6**
Total		54	62	66	100	46	84	85	73.7

The only recent information available on sea urchin production are those recorded during Fisheries Division roadside surveys in 1992 (Iosefa, 1992) and 1993 (Fisheries database). These are as follows:

Year	Villages	Value (WS$)	# baskets
1992	Toamua, Puipa'a, Leauva'a	1,085?	242
1993*	Toamua, Puipa'a, Leauva'a	7,208	1,400?

*data for only October-December.

Using an average price of WS$4.50 per sea urchin basket, the 1992 sales of 242 baskets is worth WS$1,085 while the 1993 WS$7,208 would translate to 1,400 baskets using an average price of WS$5.00 each. The 1993 data covers only October, November and December with the highest landing recorded in November followed by October. During this period, sea urchin in probably the most abundant artisanal invertebrate.

7.2.3 Stocks Status

No information is available on sea urchin resource in Westren Samoa. As with most other marine organisms utilized in the subsistence/artisanal/commercial fisheries, sea urchins are generally believed to be declining in abundance as well as average sizes. Apart from the increased fishing pressures due to the development of small local markets, sea urchins as is in the case of bivalves and sea cucumbers, have suffered from pollution and habitat destruction from natural disasters, increased siltation from land and employment of destructive fishing methods. The trends in the fishery cannot be traced due to the absence of time series statistics in any level.

7.2.4 Management

Current legislation/policy regarding exploitation: There is currently no legislation that that deals with the exploitation of the sea urchin resource.

Recommended legislation/policy regarding exploitation: Management of the sea urchin resource seems to be best addressed through the reduction of pollution and destructive fishing methods, which is dealt with in other areas.

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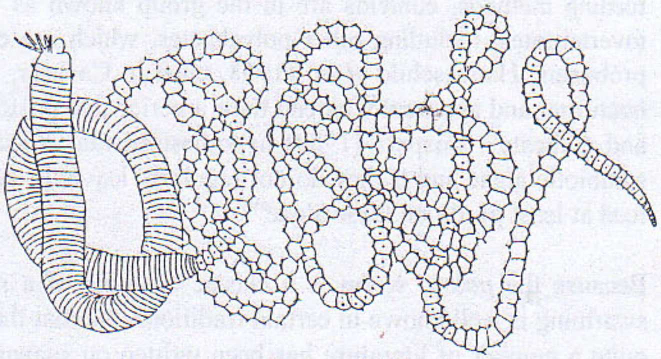
7.3 Palolo worm - *palolo*

7.3.1 The Resource



palolo- Eunice viridis

Species present: The polychaete, *Eunice viridis* (*palolo*), is harvested in both Western Samoa and American Samoa when its epitokous segments swarm to the sea surface during spawning. Barnes (1968) noted that "the name *palolo* worm originally referred to a Samoan species of eunicid, *Eunice viridis*, but is now applied to a number of nereid, eunicid, and syllid polychaetes, all of which exhibit a similar swarming behaviour".

Distribution: A different species of *palolo*, *Eunice schemacephala*, occurs in the Atlantic. "This West Indian worm lives in rock and coral crevices below the low-tide mark" (Barnes, 1968). They are negatively phototrophic and emerge from their burrows only at night to feed. Swarming takes place at 3 or 4 o'clock in the morning in July during the the first and third quarters of a lunar cycle.

The Samoan *palolo* worm, *E. viridis*, also occurs in Fiji but swarming occurs in November and December. Itano (undated) noted that *palolo* is found in the Hawaiian islands and throughout the south central Pacific although swarming has not been recorded in all of these locations. Furthermore, *palolo* swarming has never been observed in Hawaii but the phenomenon is also well known in other South Pacific islands, Fiji, Vanuatu (Ambae Island), Solomon Islands (Malaita), Tonga and Rarotonga.

In Western Samoa, *palolo* occurs in the southern and eastern coasts of Upolu island. On Savai'i, it still occurs in certain areas on the northern and southern coasts. The most popular areas on Upolu for palolo collection due to easy access to places where they swarm are, Lefaga, Salamumu and Tuialamu. However, it generally occurs in the south coast of Upolu from Lefaga to Siumu and Falealili. At Aleipata, Time (1994) reported that favourite sites for palolo collection are villages of Amaile, Samusu, Saleaaumua, Satitioa, Vailoa and Lalomanu. Palolo no longer swarm in the north coast of Upolu although earlier reports indicated occurrence there.

On Savaii, major palolo sites are at Tafua, Falelima, Papa, Safotu. It was reported that at Satupa'itea and Palauli, palolo disappeared about 15 years ago, but it has started to appear again starting in 1993.

Caspers (1984) describes the *palolo* worm as living in branching tunnels throughout the compact coral blocks of reefs. All tunnels have contact with the surface. The worms concentrate at about the 3 to 5 cm level below the coral block surface. This level corresponds to the blue-green layer of symbiotic algae. Two theories have been discussed as to the formation of these tunnels. Hauenschild *et al.* (1968, cited in Caspers, 1984) suggested that the tunnels originate from sipunculid worms living in the coral, thus making palolo secondary inhabitants of abandoned tunnels. Caspers (1984) argues that "this would mean a full dependence of the *palolo* on the activity of other boring animals and would not explain its abundance". He further explained that the *palolo* worm possess strong mandibles indicating "the probability that the worms gnaw their tunnels themselves".

Biology and ecology: Gillett (1987) lists some of the references on the Samoa *palolo*. The *palolo*, *E. viridis*, belongs to the phylum Annelida which comprises the segmented worms. Earthworms and leeches belong to the same phylum. *Palolo* belongs to the class Polychaeta, Family Eunicidae. Barnes (1968) describes Eunicids as representing the first group of tubicolous polychaetes. They are carnivorous and extend from the opening of the tube they live in to sieze passing prey. In terms of feeding methods, eunicids are in the group known as raptorial feeders which prey on various small invertebrates, including other polychaetes, which are captured by means of an eversible pharynx or proboscis. Hauenschild *et al.* (1968, cited in Caspers, 1984) noted that "*palolo* worms are primarily nocturnal and apparently extend their anterior and posterior ends temporarily out of the tunnels to feed and defacate". Caspers (1984) hypothesized that since the *palolo* worms are mostly in the layer of symbiotic algae and if they do not regularly leave the tunnel system to feed at the coral surface, "they feed at least partly on these algae".

Because the *palolo* worm is a classic example of a marine animal exhibiting lunar periodicity, its swarming is well known in certain traditions and that the epitokous parts are a delicacy, e.g. in Samoa, quite a number of literature has been written on spawning. *Palolo* worms, as with most Polychaetes, are dioecious (male and female animals are separate). In Polychaetes, "gonads are not distinct organs but are masses of developing gametes, which develop as projections or swellings of the peritoneum in different parts of some segments. A reproductive phenomenon known as epitoky, the formation of a reproductive individual or epitoke, is characteristic of eunicids and other Polychaete families such as nereids and syllids. Epitoke is different from the nonsexual form, called atoke, in the formation of the head, the structure of the parapodia, the size of the segments, the segmental musculature etc. (Barnes, 1984). "Often the gamete-bearing segments are the most strikingly modified, so that the body of the worm appears to be divided into two markedly different regions". In *E. viridis* (*palolo*), epitokous individuals arise from atokous forms by direct transformation. The anterior of the *palolo* is unmodified while the epitokal region consists of a very long chain of narrower but longer posterior segments each with an eye spot on the ventral side. Caspers (1984) noted that maturation of the *palolo* in the reefs starts about one month before swarming and that results of studies in the laboratory suggested the existence of a hormone in the worm head which induces sexual maturation in the posterior end of the worms. The factor(s) that triggers the onset of sexual maturity in fully grown specimens is not known. Hauenschild *et al.* (1968, cited in Caspers, 1984) argues that:

> "a full year of synchronized sexual development within a whole population does not occur because the duration of the spawning periods varies between 12 and 13 synodic months. Therefore, the periodicity of spawning cannot be based on an endogenic annual rhythm. There must be an external zeitgeber which correlates the onset of sexual maturity in fully grown specimens shortly before the emergence date, perhaps by synchronizing endogenic rhythms. Due to the fact that season (October/November). date (last quarter of the moon), and local hour of the day are exactly fixed, there must be a hierarchy of annual, lunar and diurnal zeitgeber".

Fertilization is external and occurs in the the surrounding sea-water. In order for this to take place, the epitokous sections of the *palolo* worm, each containing eggs or sperm, swim to the surface of the sea. This process is called swarming. During the night of swarming, the *palolo* worm backs out of its burrow and the caudal sexual epitokal region, about 20 cm in length, breaks free. "The epitoke swims to the surface where it undergoes spiral swimming movements". The epitokes containing eggs are blue-green in colour while those containing sperm are tan (brownish). [Epitokous of *Nereis irrorata*, another polychaete worm, have been observed in *palolo* catches in some areas, e.g. Tuialamu]. At sunrise, the swimming epitokes rupture releasing eggs and sperms. This is immediately followed by fertilization. A ciliated larval stage is attained by the following day, and in three days the larvae sink to the bottom (Barnes, 1968).

In Samoa, *palolo* swarming occurs only in October and/or November, and is strictly correlated with the third quarter of the moon. Swarming is limited to three days in these months with the main swarming occurring in the second day. However, sometimes the swarming occurs in one or two days only. Each of the three days has a Samoan name (*motusaga* - first day, the *palolo* is weak, breaking up easily into pieces (burst) when collected on the *ta palolo*; *ta telega* - the main collecting day; *??* - the last *palolo*). Based on data of previous dates in which swarming occurred, Caspers (1984) developed *palolo* rules for predicting the dates of swarming in future years. The *palolo* rules as developed by Caspers are as follows:

(1) *The swarming never occurs before October 8th. If the third quarter of the moon is on October 7th or earlier, the* ***palolo*** *appears during the next quarter of the moon, i.e. on November 6th or a few days earlier. In such years, there is no* ***palolo*** *emergence during October;*

(2) *An emergence in October does not always occur if the third quarter of the moon falls between October 8th and 18th. Very often in such years, there is no emergence in October,or at most, a very minor one;*

(3) *The worms will certainly emerge in October if the third quarter of the moon comes after October 18th;*

(4) *An emergence in November is certain if the third quarter moon appears before November 7th. This swarming period is not followed by a second one (see point (1));*

(5) *A third quarter moon between November 8th and 17th provokes a major* ***palolo*** *emergence, which may follow an earlier one between October 8th and 18th (see point (2));*

(6) *A minor emergence in November is possible until 23rd of the month, although the main swarm has occurred in October (see point (3)).*

Furthermore, Caspers (1984) showed, using swarming dates data as far back as 1843, that *palolo* swarming appears to be an example of the Metonic Cycle, i.e. every 19 years, the palolo emergence occurs on the same dates. (Exactly after 19 years, the same relative positions of the sun and moon to the earth occur on the same solar date). However, the factors stimulating simultaneous breeding during one to three days in October and/or November are not known.

In Western Samoa, *palolo* swarming commences at about 04:00 to 05:00. Anecdotal information indicates that maximum swarming occurs about 30 minutes after the beginning of the swarming and that emergence from the reefs seems to be limited to about 30 minutes. Collection duration is about 2 hours and is finished by 06:00 or 07:00. In nearby American Samoa, swarming takes place at about 20:00 hrs near Manu'a and at about 01:00 hours off Tutuila Island. Buck (1930) noted that on the *palolo* nights, *palolo* swarming commences earliest in the east at the Manu'a Group in the Samoa islands. From Tutuila westward, the hour of appearance is progressively later until at the extremity of the chain, Savai'i, palolo appear at sunrise, where they are caught (scooped) in daylight. The cause of the differences in palolo emergence timing in the Samoa Group has not been explained. Swarming occurs in Malaita, Solomon Islands, around 8-10 at night (Oreihaka, Fishries Officer, Solomon Islands, *pers. comm.* 1994) and after dusk in Vanuatu (Ambae Island) (Carlot, FFA, *pers. comm.* 1994).

7.3.2 The Fishery

Utilization: Palolo is greatly esteemed by the Samoans. "The palolo season is of importance in the Samoan calender and some of the months are referred to as before and after *palolo* (Buck, 1930). There is no other fishing activity that attracts so many Samoans at one particular time. In the past, because of limited transport available then, catching was mostly limited to people in villages near the *palolo* fishing site. Today, with improved means and availability of transportation, people, by the hundreds, from other parts of the islands and town, travel and camp on beaches at palolo sites on the night of the swarming. The target sites are those close to shore where no canoe is required. On Upolu, the notable sites for these are Legafa, Salamumu, and Tuialamu.

As discussed above, swarming is limited to a maximum of three consecutive days in October and/or November which correlate to the third quarter of the moon during those months. It has become well known because of its popularity with the local population. Harvesting of *palolo* for food has been a tradition in Samoa for centuries and preparation for its appearance involves special basket and scoop net making as well as necklaces made from the fragrant *mosooi* (*Cananga odorata*) flowers. Several natural signals have been known to occur before the *palolo* day. On a broader spectrum, the flowering of the *mosooi* tree occurs before and during the *palolo* season. A day or two before the swarming, mucus discharge is found in the water in the reef area. Buck (1930) noted that a night or so before the *palolo* appears, *pua palolo*, a peculiar indefinite reef smell that is supposed to get very strong immediately preceeding the palolo appearance, could be detected in the air coming from the sea. In addition, the weather sometimes changes abruptly, resulting in thunderstorms and lightning. Traditionally, the *palolo* day is counted as the seventh day after the full moon during the *palolo* months.

Apart from the use of a canoe, in sites where they are required because of depth, the only fishing "gear" needed for catching *palolo* are a scoop with fine mesh and a receptacle. Even though the palolo are long, they are also thin, thus requiring material of fine mesh for netting and keeping them in during scooping activities. Buck (1930) describes the two types of traditional scoop and the receptacle used in the olden days as follows:

Scoops: 1. coconut fabric scoop (*'enu laua'a* or *taepa*): the fabric-like sheet, *laua'a*, an outgrowth from the base of coconut leaves on the coconut tree, is used as the netting material supported by an oval shaped frame made of wood.

2. coconut leaflet midrip scoop (*'enu tuaniu*): this was considered a much better article. Coconut leaflet midrips are made into a cone by rows of single pair twining.

Receptacle: the same *laua'a* material used to make the scoop was also used to cover the basket (*ola*) into which palolo are scooped. The *laua'a* sheet is doubled, folded at the ends over the rim of the *ola* and tied with a strip of bark. The *laua'a* forms a bowl-shaped basket lining suspended within the basket.

Today, the *laua'a* is substituted with fine mesh mosquito netting or cottom gauze. The basket (*ola*) is still used, mostly by those scooping *palolo* from a canoe, while those catching *palolo* walking in shallow areas, any container, mostly basin, bowl, keg etc are used. The advantage of using the lined *ola* is that sea-water is freely drained out preventing the caught *palolo* from bursting.

Canoes are used in areas where walking is not possible. These are in reef channels, just off the reefs and in deeper parts of lagoons.

Palolo has been, and still is, a valued traditional subsistence food. Because it only appears in three days in October and/or November, it is well sought after and received. *Palolo*, wrapped in leaves, locally known as *ofu palolo*, are sent from families in areas with good catches to their unfortunate relatives living in other parts of Samoa. It is only sold when catches are plentiful. A fist-size ball of palolo is sold wrapped in leaves and sold for $15-20 each.

Production and marketing: No attempt has been made to estimate annual *palolo* landings in Western Samoa. This is due mainly to the nature of the fishery where heavy fishing, involving thousands of people in any particular site. In addition, different sizes and types of containers are used to hold the catch.

Caspers (1984) recorded *palolo* emergence dates for most of the years from 1843 to 1983 as recorded in various references. These are presented in Table 7.3.1(a). Fisheries Division has been keeping records that indicate emergence dates and intensity of emergence for several years during the palolo months at several major sites on Upolu and Savai'i. These are presented in Table 7.3.1(b).