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REPORT OF VISIT

TO

WESTERN SAMOA

1 November 1982 – 3 January 1983

by

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SUMMARY

The South Pacific Commissions' Deep Sea Fisheries Development Project operated in Western Samoa from 1 November 1982 – 3 January 1983, under the supervision of SPC Master Fisherman Pale Taumaia, with assistance from SPC Master Fisherman Lindsay Chapman and SPC Assistant Fisheries Officer Garry Preston. The objectives of the visit were to gather information which might confirm or refute the Fisheries Divisions' growing concern that deep-bottom resources in the Apia area were becoming depleted as a result of local overfishing.

A programme of survey deep-bottom fishing was carried out, with 11 fishing trips completed, giving a total fishing effort of 339 line-hours. Detailed catch records were kept and these enabled a superficial comparison of the size and species composition of the catch from the three areas sampled. Overall, no significant differences between fishing results from the areas were detected.

The survey data were supplemented by statistical information drawn from the purchase records of the Western Samoa Fishing Marketing Authority. These data were of only limited usefulness for purposes of scientific analysis and few firm conclusions could be drawn from them. In general, they did not support the contention that deep-bottom fishing catch rates or species composition varied significantly between coastal localities around Upolu. There was, however, some indication that shallow water snappers and emperors were under-represented in the catch around Apia, and this may warrant further investigation.

The conclusion is that the deep-bottom catch achieved by local fishermen in and around Apia are lower than could be expected. However, this appears to be a result of less-than-effective fishing on the part of local fishermen, rather than an indication of the state of the resource.

Several recommendations are made in line with the above conclusions. These include: the collection of statistics on the deep-bottom fishery; a detailed study on the shallow-water inshore resources around Apia; a programme of deep-bottom test fishing; and a training programme for local deep-bottom fishermen.

RÉSUMÉ

Sous la direction du maître de pêche, Pale Taumaia, aidé de son collègue Lindsay Chapman et du conseiller adjoint aux pêches, Garry Preston, la Commission du Pacifique Sud a conduit des activités au Samoa-Occidental, du l^{er} novembre 1982 au 3 janvier 1983, dans le cadre du projet de développement de la pêche au demi-large. Cette mission avait pour objet de recueillir des informations susceptibles de confirmer ou d'infirmer les inquiétudes grandissantes de la division des pêches qui craignait que la surexploitation des ressources des grands fonds de la région d'Apia par les pêcheurs locaux n'entraîne leur épuisement.

Une campagne de pêche profonde a été entreprise à des fins exploratoires; 11 sorties ont été effectuées pour un effort total de 339 heures/ligne. Des relevés détaillés des prises ont été tenus et ont permis d'établir une comparaison superficielle entre la composition par tailles et par espèces des poissons capturés dans les trois régions échantillonnées. Dans l'ensemble, les résultats obtenus dans les différérentes zones n'ont fait apparaître aucune différence significative.

Les données recueillies a l'issue de cette prospection ont été complétées par des statistiques établies à partir des relevés d'achat émanant de la direction du Samoa-Occidental pour la commercialisation des produits de la pêche *(Western Samoa Fishing Marketing Authority)*. Ces informations n'ont présenté qu'un intérêt limité aux fins d'analyse scientifique et elles n'ont guére permis de tirer des conclusions irréfutables. De manière générale, elles n'ont pas confirmé que les taux de prise de poissons des grands fonds ou la composition par espèces variaient substantiellement suivant les sites de pêche côtière situés à proximité d'Upolu. Néanmoins, ces informations ont permis de constater que les lutjanidés évoluant en eaux peu profondes et les becs de canne étaient sous-représentés parmi les prises réalisées autour d'Apia – situation qui pourrait être examinée de plus près.

On peut en conclure que les prises réalisées par de grandes profondeurs par les pêcheurs locaux dans les eaux qui baignent Apia et ses environs sont inférieures à ce que l'on pourrait attendre. Cependant, cette situation semble être davantage la consxequence des méthodes employées par les pêcheurs locaux qu'une indication de l'état de la ressource.

Conformément aux conclusions présentées ci-dessus, plusieurs recommandations ont été formulées, concernant notamment : le recueil de statistiques sur la pêche au grand fond, une étude détaillée sur les res sources côtières en eaux peu profondes dans la région d' Apia, une campagne de pêche expérimentale au grand fond et un programme de formation à l'intention des pêcheurs locaux opérant par de grandes profondeurs.

CONTENTS

1. INTRODUCTION

The South Pacific Commission's Deep Sea Fisheries Development (DSFD) Project is a mobile village-level rural development project which operates in Pacific Island nations at specific Government request, and which has the following broad objectives:

- to promote the development or expansion of artisanal fisheries throughout the region, based on fishery resources which are at present underutilised, in particular the deep bottom resources of the outer reef slope;

- to develop and evaluate new simple technology, fishing gear and techniques suitable for use by village fishermen, which will enable fishermen to substantially increase catches while reducing dependence on costly imported fuels;

- to provide practical training in appropriate fishing techniques to local fishermen and government fisheries extension workers.

The DSFD Project in 1978 superseded the SPC Outer Reef Artisanal Fishing (ORAF) Project, which, visited Western Samoa in 1975. The aim of this earlier visit was to demonstrate the economic viability of village-level fishing operations, and this was done by operating four small fishing vessels on a semi-commercial basis from a base in Asau on Savai'i. Most fishing was for demersal species, mainly in deep water, and catches were very encouraging (Hume and Eginton, 1976).

Subsequent to the 1975 ORAF Project visit, considerable commercial development of bottom fishing activities has taken place, alongside which have come reports from fishermen that catches have declined. Consequently, the government of Western Samoa requested the South Pacific Commission to assess the degree to which these assertions might be true. As a result, a visit by the DSFD project was scheduled for the end of the year, with the following objectives:

- to evaluate the impact of sustained fishing pressure on the bottom resource in three selected areas;

- to assess the commercial feasibility of full-time bottom fishing operations in these areas.

To achieve these objectives, the following activities were planned:

(i) Conduct survey fishing in the selected areas to ascertain catch rates and collect fishing data;

(ii) Collect basic biological information on key species;

(iii) Collect information on economic aspects of fishing operations;

(iv) Collect historical and anecdotal information on local fishing activities.

In line with these objectives, the Deep Sea Fisheries Development Project operated in Western Samoa from 1 November 1982 — 3 January 1983, under the supervision of SPC Master Fisherman Pale Taumaia and, during the second half of the visit, with the assistance of newly recruited SPC Master Fisherman Lindsay Chapman. At the end of the project visit, SPC Assistant Fisheries Officer Garry Preston joined the survey team specifically to assist with the collection of historical fishing information and available fishery statistics.

2. BACKGROUND

2.1 General

Western Samoa (Figure 1) consists of two main islands, Upolu and Savai'i, which together bear most of the population, and several much smaller ones, of which three, namely Apolima, Manono and Nu'utele, are inhabited. The islands are grouped closely together between approximately 13.3 deg and 14.2 deg. S latitude, and 171.2 deg. and 172.8 deg. W longitude, and are of recent volcanic origin. The two main islands are mountainous, particularly Savai'i, which rises to over 1850 metres and has several active volcanoes. The island chain extends eastward to American Samoa, which is less than 100 miles away, and with whose people the Western Samoans have strong historical and cultural links.

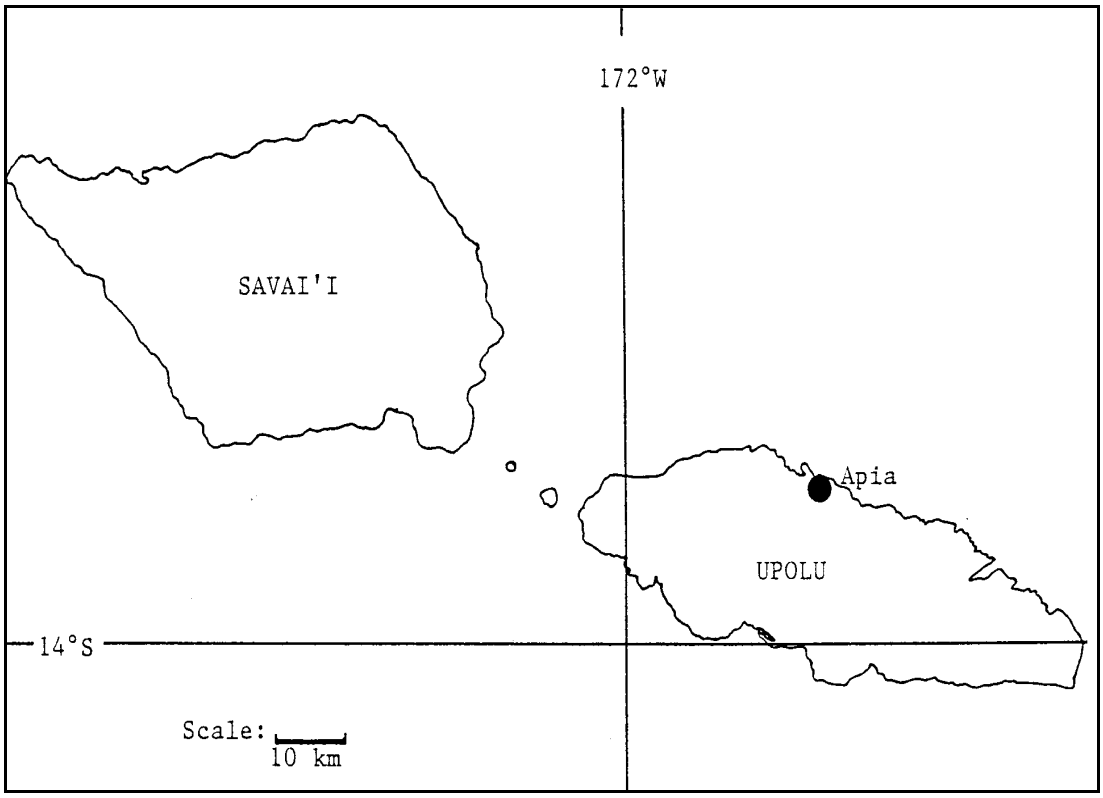

Figure 1: Western Samoa

The total land area of Western Samoa is 2,935 square kilometres, the second largest of any Polynesian country (after French Polynesia). However, unlike many Pacific island groups, the land is not in the form of a scattered archipelago, and the area of ocean enclosed by Western Samoa's 200 mile exclusive economic zone (which has not yet been declared, although the necessary legislation for its declaration has been passed by Parliament) of 117,807 square kilometres (SPC estimate) is the smallest of any Pacific nation.

All the islands have narrow fringing coral reefs which give onto a shallow continental shelf of varying width. The true drop off into deep or abyssal waters occurs several miles offshore along most of the coast.

In 1962 Western Samoa became the first Pacific nation to achieve complete independence, having previously been a German colony, then a British colony administered from New Zealand, and finally a trustee of the United Nations. Historically, the Western Samoans had frequent contact, often in war, with the peoples of other Pacific nations, in particular with what is now America Samoa, and Tonga. These contacts, and subsequent colonisation, have introduced into the predominantly Polynesian population elements of German, British, American, Chinese, Tongan, Niuean, Fijian and Melanesian origin, to name only some. Altogether about ten percent of the populace are part-Samoan, and a small number of foreigners are resident there. The total population is approximately 158,000, with about 43,000 living in Savai'i, 1,500 on Apolima and Manono, and the remainder (113,500) on Upolu, where some 33,000 live in urban Apia.

2.2 Fisheries

Fishing is a traditionally important part of the Samoan lifestyle, and fish have always been a major dietary component. Bottom fishing (in depths to 100 metres or so) and trolling were practised from outrigger sailing or paddling canoes before the advent of outboard motors and larger fishing vessels.

Although traditional canoes are still frequently seen, commercial fishing now tends to be conducted from larger vessels of modern design. In particular, the introduction of the 'alia', a 9m outboard-powered fishing catamaran (developed in 1976 by the Government's Fisheries Division in conjunction with FAO), has had a very significant effect on the development of the country's fisheries. At the end of 1980, 206 had been sold, mainly to individual fishermen but also to village or other communal associations and it is estimated that in January 1983 between 250 and 300 were in use, most of them actively fishing for commercial or subsistence purposes. During this time, substantial increases in fish landings have occurred, prompting the development of improved fish marketing and freezer storage facilities in Apia. There is now a well established fish market in the town centre, where fishermen can sell their catch direct to the public, and from which ice can be purchased. In the same building the Government Fish Marketing Authority (FMA) operates a retail outlet and also buys fish from fishermen, but at lower than normal retail prices. The FMA has freezer storage facilities and supplies fish to institutional or wholesale buyers in Samoa, as well as consigning occasional export shipments of tuna to canneries in American Samoa.

In 1975 the Outer Reef Artisanal Fishing (ORAF) Project, the forerunner of the Deep Sea Fisheries Development Project, visited Asau on the island of Savai'i, and conducted exploratory fishing operations and training activities for a seven-month period. Most fishing was for deep bottom species and catch rates were good, averaging 83 kg (182 lb) per fishing night for a boat with a two-man crew. The results of the ORAF Project visit indicated that villagelevel fishing activities of this nature would be adequately profitable to local operators, and the project personnel recommended that the Western Samoan government take measures to encourage expansion of the fishery (Hume and Eginton, 1976). The training activities of the Project concentrated mainly on deep-bottom line fishing using hand-operated and electric reels. Trainees included both private fishermen and government officers who then became involved as instructors in the Fisheries Division straining activities.

Deep-bottom fishing by handreel subsequently became widely used by Samoan fishermen, alongside the development of the alia fleet. However, as Samoa's coast is bordered in many places by a wide (up to 15 miles) shelf of shallow

(generally less than 100 fathoms) sea floor, substantial travelling time is involved in trips to deep bottom fishing grounds. In fact, many fishermen frequently operate in these shallower inshore waters, where several species characteristic of the true deep-bottom catch do not occur.

A major development in Samoa's fishery came in 1979 with the installation of five Fish Aggregation Devices (FADs) designed to generate local concentrations of pelagic fish, such as tunas, which could then be harvested by small boats. Many alias shifted the emphasis of their activities from bottom-fishing to tuna trolling (or in one or two cases, pole and line fishing) at this time. More FADs have subsequently been deployed and it is currently estimated that about 65–75 percent of fishing time by alia catamarans is spent tuna fishing and 25–35 percent bottom fishing, the converse of the situation prior to the installation of the FADs (*A. Phillipps*, pers comm.). However, as the quantity of fish around the FADs at any given time is variable, fishing effort tends to shift irregularly from the tuna resource to the bottom resource and back again. Trolling is more consumptive of fuel and produces a lower-value product than bottom fishing but catches can be very high and the work is easier. Despite the decline in the proportion of effort directed towards bottom fishing, the continuing expansion of the fishing fleet maintains substantial pressure on the resource. Many vessels are based in Apia and a good deal of fishing occurs on grounds adjacent to the town. In recent years, the Fisheries Division has become increasingly concerned at the likelihood of over-fishing occurring in these areas.

3. PROJECT OPERATIONS

3.1 General

The SPC Deep Sea Fisheries Development Project was based in Apia from 1 November 1982 — 3 January 1983 under the direction of Master Fisherman Pale Taumaia, and served as a familiarisation period for newly recruited Master Fisherman Lindsay Chapman. During this period, fishing was carried out in selected areas off the north coast of Upolu, corresponding to the coastal localities of Leulumoega, Apia and Falefa (see Figure 2). Fishing was exclusively for deep-bottom species, and was carried out on overnight trips using a government vessel and a one- or two-man government crew. The presence of two Master Fishermen on all but the first four trips made it possible for comprehensive fishing, biological and economic information to be recorded. Anecdotal information and local experience was also recorded from conversations with fishermen and others. All fish caught *was* sold to the FMA, or, in the case of unsaleable species, given to the crew or to individuals who had rendered assistance to the project. A substantial period of time wa*s* spent in examining FMA records in an attempt to obtain historical landing information.

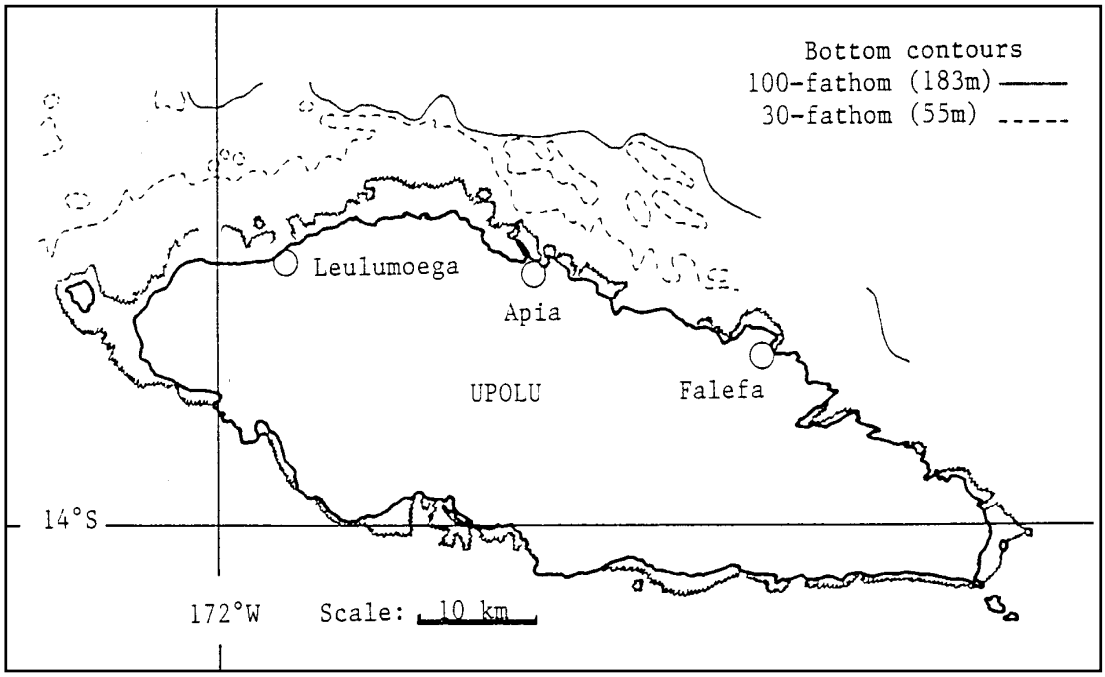

Figure 2: Coastal areas off which fishing was carried out

3.2 Boat and Equipment

In order to minimise the number of variables in the fishing regime, the gear and techniques employed were kept constant throughout the survey. The vessel used was the *Tautai Nioue*, a 9m (30') aluminium alia catamaran (see Figure 3) built in 1980 and belonging to the Fisheries Division. *Tautai Nioue* was in use for experimental tuna pole and line fishing concurrently with the present survey, and was accordingly rigged with a spray system on the stern, and two live-bait tanks which on bottom fishing trips were used for storage of spare fuel drums and the anchor rope. The vessel was powered by a Mariner 25 hp lonGshaft outboard motor belonging to the Project. A spare Tohatsu 25 hp longshaft outboard was carried for safety, but was never used as the Mariner operated reliably throughout the survey.

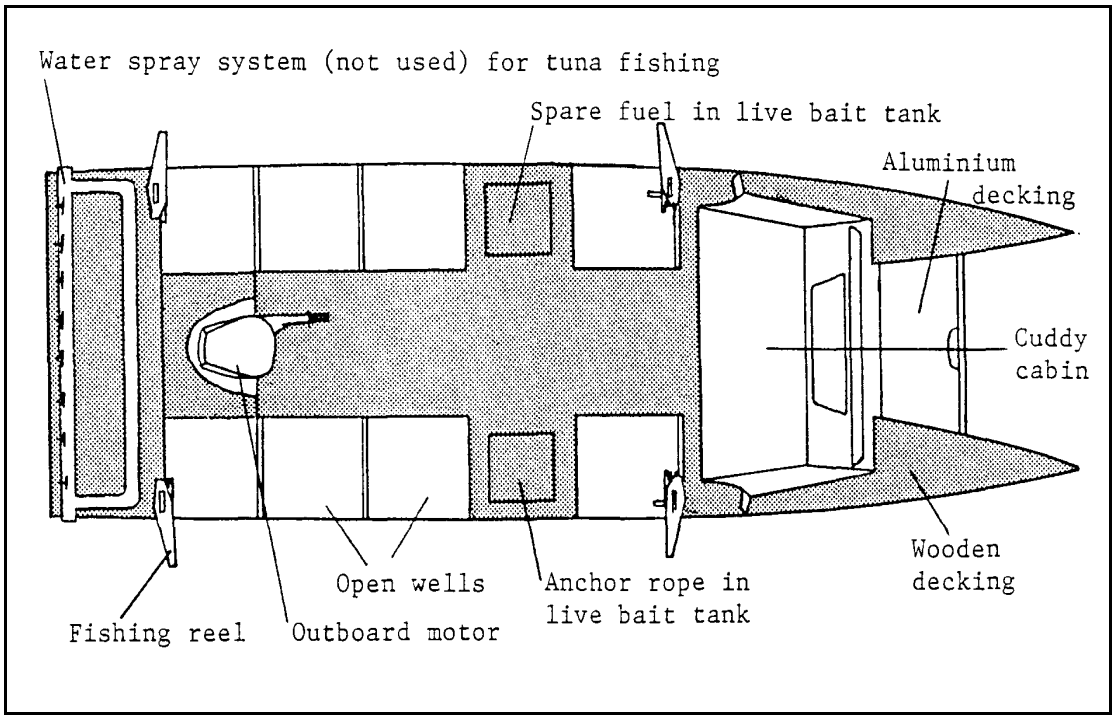

***Figure 3: Fishing arrangement of the* Tautai Nioue**

The FAO/Samoan wooden hand reels shown in Figure 4 have become standard equipment for the DSFD Project and were used for all bottom fishing. Four reel assemblies were mounted on the *Tautai Nioue*: three of the reels were the 'standard' type, shown in figure 4a; the fourth shown in figure 4b, incorporated some modifications, including an experimental drag braking system and a pivoting lever to prevent unwinding of the line. Each reel carried 500 m of 130 kg test nylon monofilament line which ended in the detachable terminal rig shown in Figure 5. The rig was constructed of Turimoto No. 29 galvanised longline wire and bore three Tuna circle hooks on short traces, and a 1–2 kg terminal sinker. When fishing in depths of less than 120 metres (which was only done on one trip) a lighter terminal rig, made of 60 kg test monofilament and carrying smaller hooks and a lighter weight, was used. A Furuno FG–11 MK III battery-powered portable echo sounder, with a range of 0 to 640 metres, was used on all trips to locate suitable anchoring and fishing depths and bottom types.

The anchor gear for the *Tautai Nioue* is illustrated in Figure 6. A simple grapnel was constructed from two 3 m lengths of 8 mm or 10 mm reinforcing bar, bent into the appropriate shape and welded together (when welding equipment is not available, the bars can be held together by lashing with strong wire, or by inserting them through a length of galvanised pipe prior to bending and driving a wooden stake up the centre. This was then connected by a shackle to a 2 m doubled length of 4 mm diameter galvanised fence wire, and thence to a 400 m length of 10–12 mm diameter polypropylene rope. The use of galvanised wire on the grapnel led to anchoring difficulties on several occasions, and on some trips it was necessary to attach a second grapnel to the line about 4 m above the first one to augment its holding power. Chain is far preferable to galvanised wire but was not available in Apia during the Project visit.

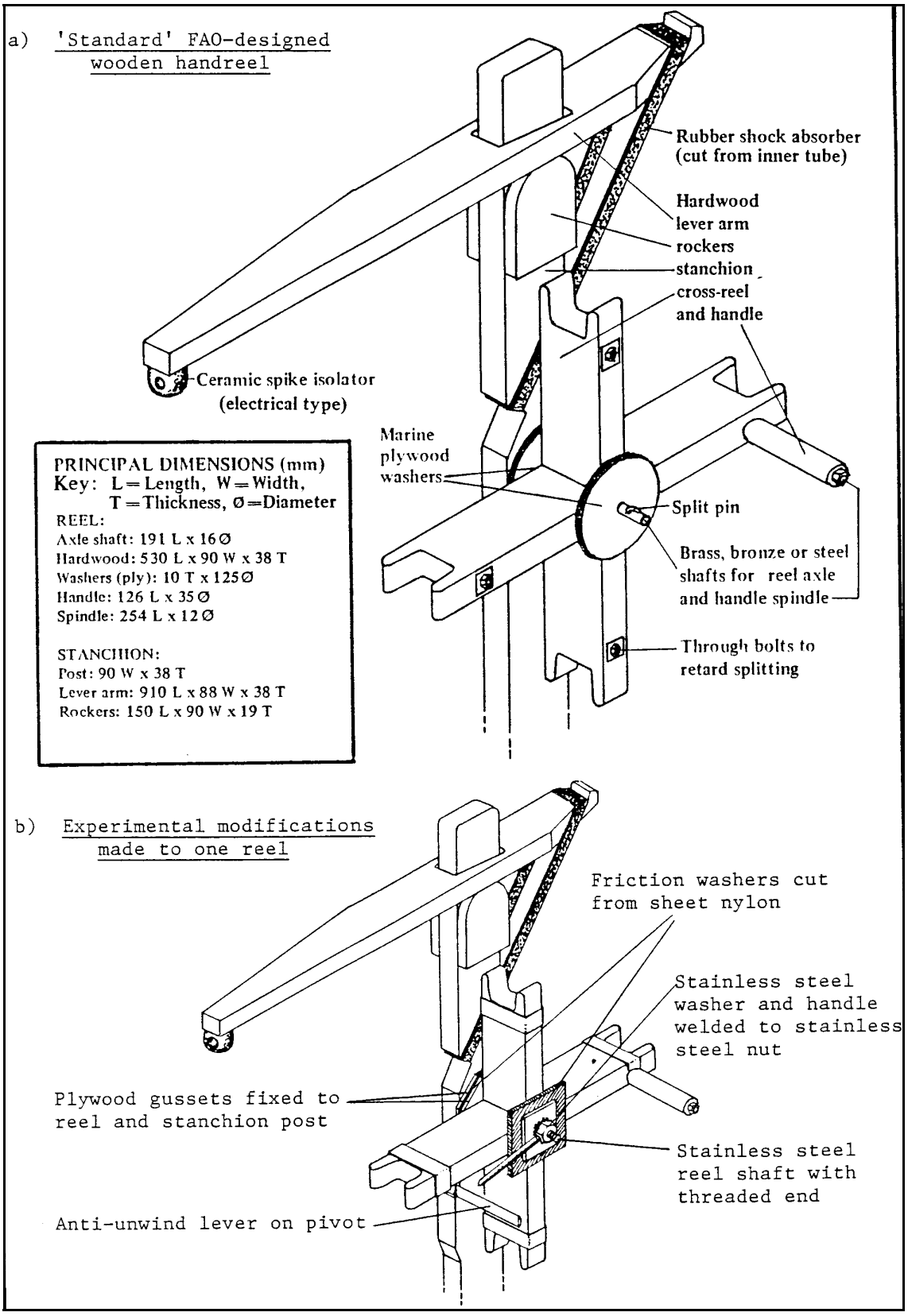

Figure 4: Wooden handreels used for fishing during the survey

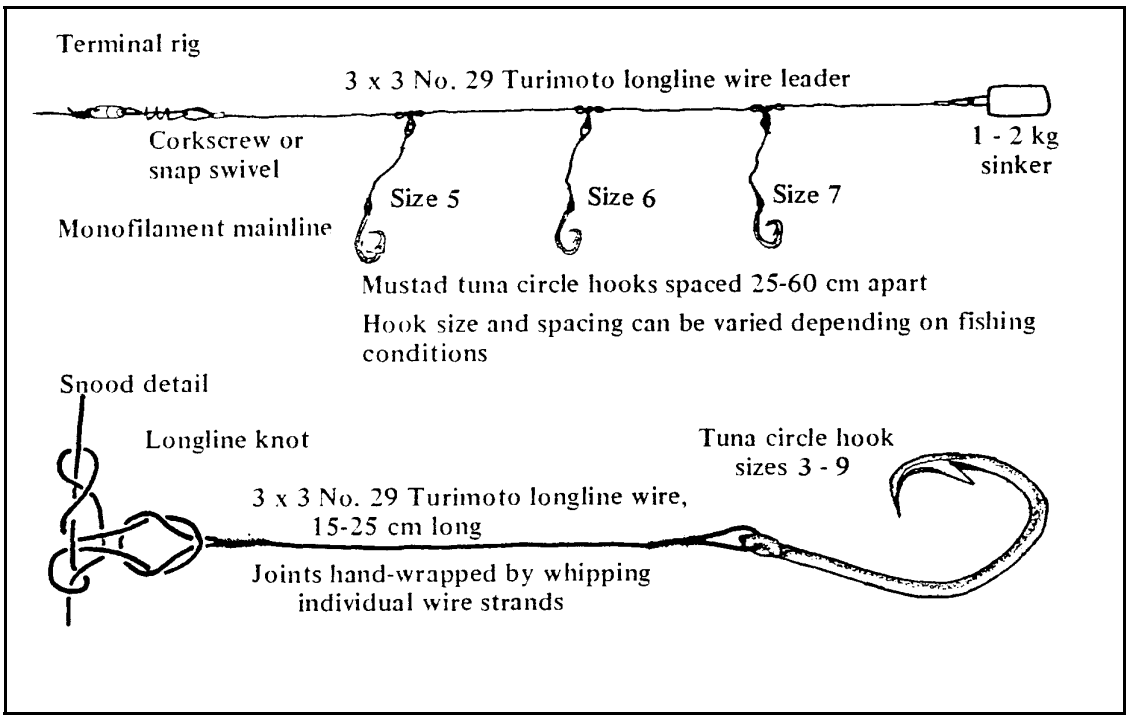

Figure 5: Typical terminal gear for bottom fishing

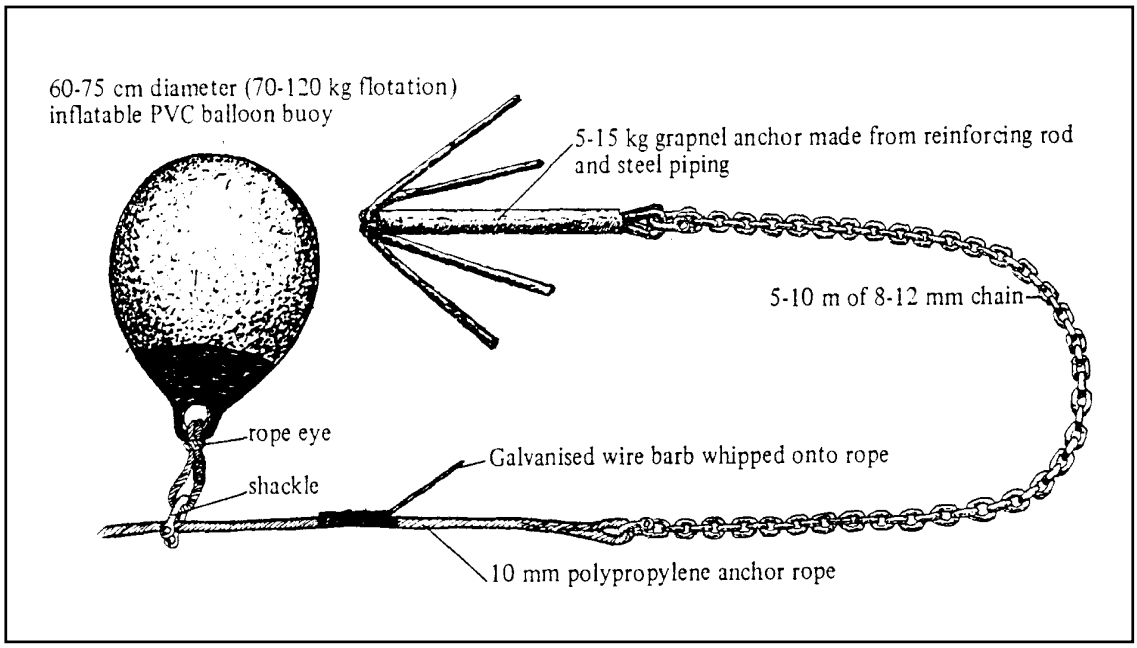

Figure 6: 'Self-hauling' anchor gear

A 1.8 m (72-inch) circumference inflatable polyethylene balloon buoy was also carried and used when hauling the anchor, according to the technique described in section 3.3.

A complete list of the basic fishing gear recommended by the Project for use in deep-bottom fishing can be found at appendix 1.

3.3 Fishing regime and methods

All fishing was conducted on overnight trips, the *Tautai Nioue* leaving port around mid-afternoon and returning by mid-morning of the following day. This schedule ensured that the quality of the catch was maintained at a high standard, and was required to allow the use of the vessel by two other projects. Because of the catamaran's multiple use, it was necessary to remove all the fishing gear, including the motor and the crossreels (but not the stanchion posts), from the vessel at the end of each trip and replace it at the beginning of the next one, thus adding considerably to the preparation and winding-up time involved. Unfortunately this situation could not be avoided as no alternative vessels were available.

The first trip was conducted on the night of 10 November 1982, but subsequent strong winds and rough seas allowed only two more trips to be made in that month, and the rest of the survey was completed in December, the last trip being made on 21 December. The remainder of the project visit was taken up in drafting the report, and partial analysis of the data collected.

Fishing effort was concentrated wholly on deep-bottom fishing using the wooden handreels. All fishing was done from an anchored position in depths of 100–400 metres, suitable fishing areas being located using the echosounder. Where possible, the anchor was dropped in waters shallower than those of the chosen fishing spot, in a position selected so that the prevailing wind and current would carry the boat back over the deeper areas. Paying out the anchor warp after the anchor had settled thus allowed the boat to be manoeuvered into a suitable depth. If the wind or current changed and caused the boat to swing into water of the wrong depth, the anchor was hauled and reset. On many occasions the anchor arrangement was inadequate to hold the vessel due to the bottom type, the steepness of the drop-off, and the fact that fishing was being carried out miles offshore in open waters with large swells. When the anchor broke loose it would have to be re-set. On some nights the vessel re-anchored six or eight times.

Once the boat was resting at anchor, bottom fishing was conducted using the handreels fitted with a terminal rig as described and a 1–2 kg sinker. The sinker was lowered to the bottom and thereafter the line was kept tight by hand, to allow the fisherman to respond to bites by striking, and to reduce the possibility of tangling with other lines. Because of the length and elastic properties of the monofilament line, which make rapid striking difficult, much reliance is placed on the effectiveness of the self-hooking tuna circle hooks used.

A simple technique (shown in Figure 7) was used to retrieve the anchor after fishing, greatly reducing the effort involved in hauling. By motoring rapidly forwards the anchor was broken out and towed until it streamed behind the boat. With the vessel still under way, a free-running buoy shackled onto the line and released would be forced back along the rope until, close to the anchor, it was trapped by a 'no-return' wire barb whipped onto the line (see Figure 6). The anchor thus remained suspended by the buoy at the sea surface. The boat could then be motored slowly back to the buoy, and the anchor line and anchor easily recovered.

The preferred bait for deep-bottom fishing is skipjack, and this was purchased fresh from the municipal market prior to each trip. Artificial lures were trolled while travelling to and from the fishing grounds, but, because of the time restrictions caused by limited vessel availability, no effort was made to chase tuna schools or work promising areas, and only one fish was caught trolling.

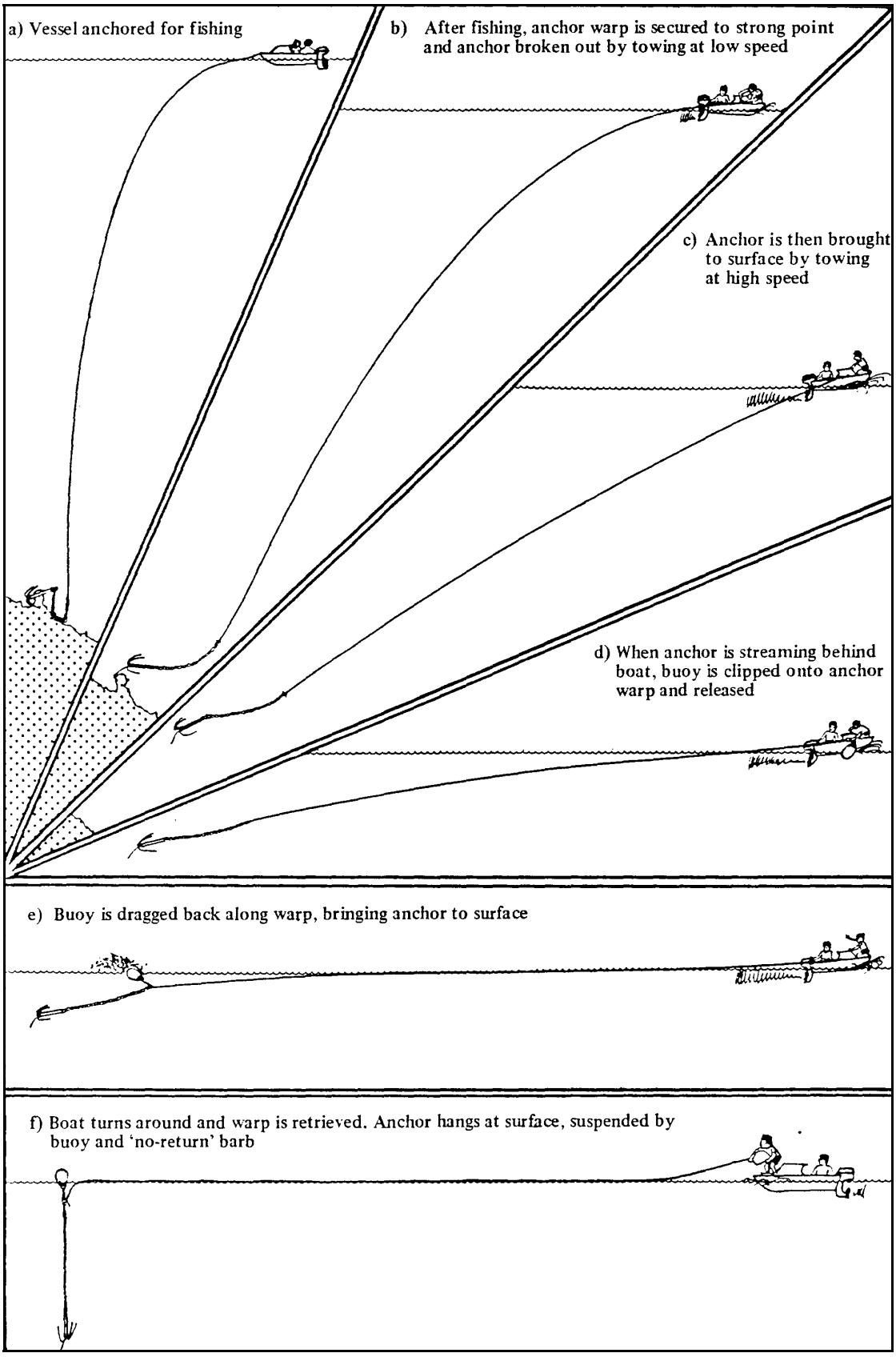

Figure 7: Anchor hauling technique

3.4 Data Collection

SPC Master Fishermen use a standard data form, shown at appendix 2, to maintain detailed records of each fishing trip, including: time spent steaming, anchoring and fishing; fishing area; fishing depth or depth range; number of crew; quantity and type of gear, fuel and bait used; the specific identity of each fish caught, where this could be determined; and the total number and weight of each species taken.

Because of the nature of this assignment, additional data were also collected. In particular, accurate positions were noted and continuous echo soundings made on outward trips, from about one mile outside the reef to the fishing area. While fishing, the water depth was measured each hour, and the time of capture of each fish was noted to the nearest hour, so that catch data were available in one-hour time blocks. For each fish the total weight, fork length, sex and relative stage of gonad development were recorded.

Additionally, historical information on local fishing activities was sought. Detailed information was collected from the purchase and sales records of the FMA since its establishment in 1979. Some fishery statistics were also obtained from Fisheries Division files.

3.5 Handling and disposal of the catch

Small ice boxes were carried in order to keep the catch cool and ensure a good quality product. Most fish were iced after the relevant biological data had been collected, this being done every two hours. Larger fish that would not fit in the ice boxes were left on deck and kept well shaded while travelling back to market. The fish were sold to the FMA, all responsibility for financial transactions resting with the Fisheries Department.

In general, Samoan consumers prefer fish not to be gutted and gilled, so most were landed in the round. Only large (greater than 20 kg) oilfish (*Ruvettus pretiosus*) were butchered, in line with the buying policy of the FMA. The FMA did not accept shark, eels, or snake mackerel, and these were distributed among the fishing crew or people who had rendered assistance to the project. Commercial operators would, however, have been able to sell all these types whole in the municipal fish market adjacent to the FMA.

4. FISHING RESULTS

4.1 General

Eleven fishing trips were completed during the survey period, with a total of 202 hours spent at sea.. 100.5 hours were spent actively fishing, with the remainder being time spent travelling, changing position, or setting and hauling the anchor. All trips were overnight and ranged from 16 to 22 hours in duration, with fishing time on individual trips ranging between 6 and 14 hours. Fishing was by the use of the wooden handreels with two, three or four reels in operation at anyone time, depending on fishing conditions and the number of crew on board. Fishing effort varied between 18 and 56 line-hours on individual trips. Appendix 3 gives further details of the operational aspects of each fishing trip.

Fishing was carried out at 12 sites (one of the fishing trips included two fishing locations) off the northern coast of Upolu as shown in Figure 8. In some areas, poor holding grounds, strong winds and a large swell combined with inadequate anchor gear to cause dragging of the anchor, which thus had to be reset one or more times.

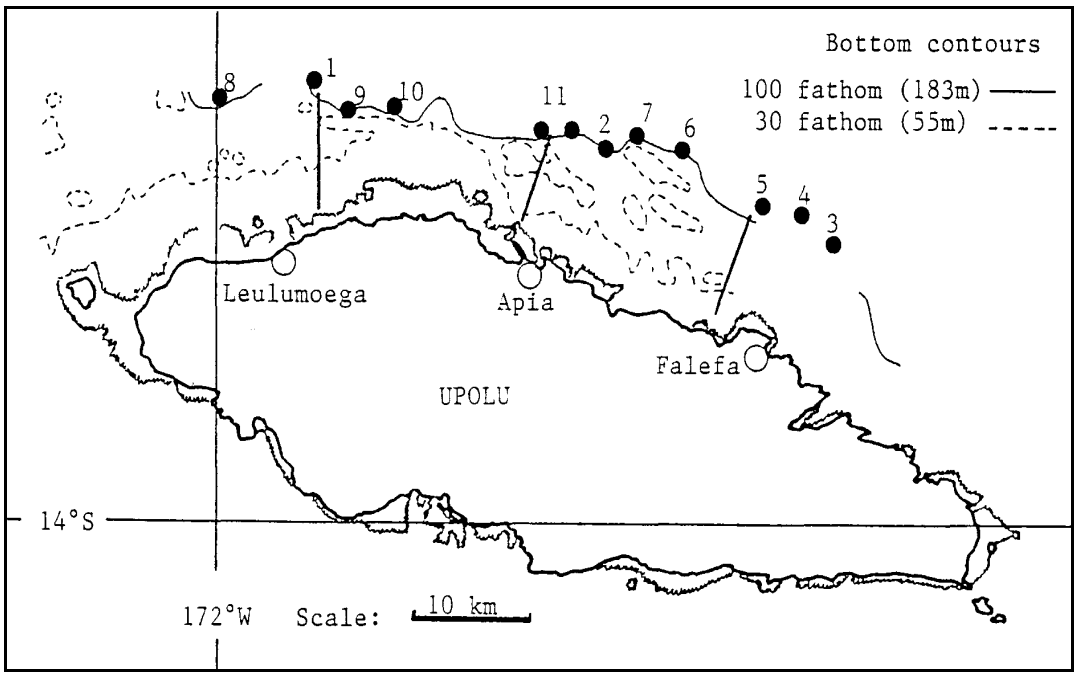

Figure 8: Echo-sounder Transects (A-C) and areas fished on each fishing trip (1-11).

Echo sounder transects were made on three outward journeys to obtain continuous seabed profiles. The locations of these runs are shown in Figure 8, and the profiles obtained illustrated in Figure 9.

4.2 Catches and catch rates

The total deep bottom fishing effort was 339 line hours, which yielded a catch of 341 fish weighing approximately 1745.5 kg (round weights). Trolling was a fishing method of negligible importance to the survey and yielded only one fish, weighing 2.5 kg. The total catch was thus 1748 kg, of which approximately 359 kg were shark, which was not acceptable for purchase by the FMA. A further 138 kg consisted of other types (eels and snake mackerels)

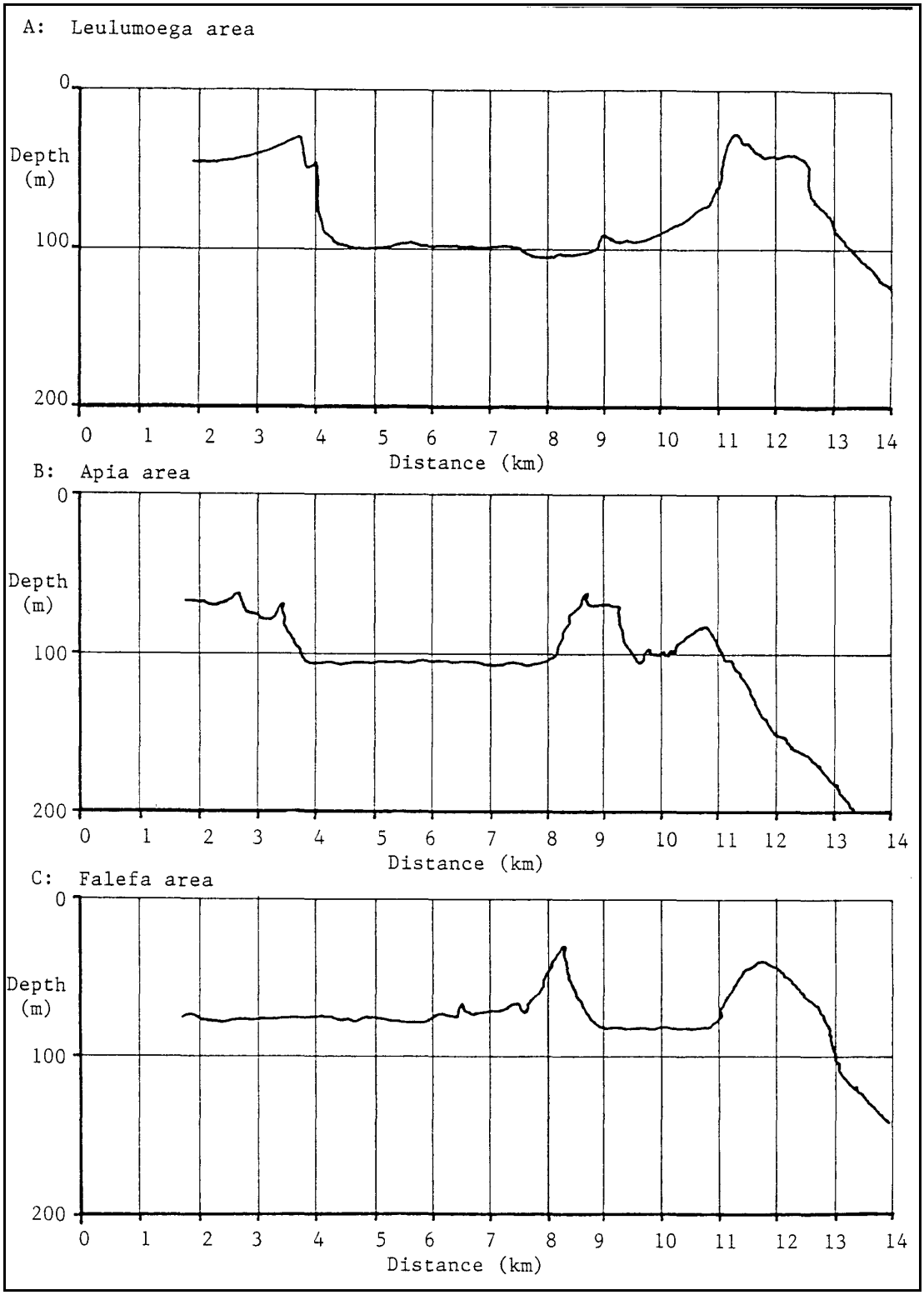

Figure 9: Bottom profiles from three echo sounder transects (see figure 8 for transect locations).

unacceptable to the FMA. Additionally the FMA required all oilfish (*Ruvettus pretiosus*) over 20 kg in weight to be butchered (i.e., head and guts removed) prior to purchase, which resulted in an estimated further loss of 105 kg. As a result only 1146 kg of the catch were actually sold (although all the 602 kg of fish not accepted by the FMA could have been sold by a private operator via the public market next door).

Consequently, the saleable deep-bottom catch rate was 3.4 kg/line-hour; the catch rate excluding sharks (but including other 'unsaleable' types) was 4.1 kg/line-hour; and the total catch rate was 5.1 kg/line-hour. These latter two figures are indicative of the productivity of fishing activities, and are below average in comparison to the catch rates obtained by the Project in other Pacific Island countries in proximity to Western Samoa, shown in Table 1.

Table 1. Catch rates obtained by the Deep Sea Fisheries Development Project in selected Pacific Island locations.

		Catch rate (kg/line-hour)		
Location	Year	Total	Excluding sharks	Reference
American Samoa	1978	–	4.9	Mead, 1978
Niue island	1978	–	2.8	Fusimalohi, 1978
Niue island	1979	8.5	7.0	Mead, 1980
Niue island	1982/83			Mead, in press a
Niue–Beveridge reef	1979	6.1	5.6	Mead, 1980c
Tonga–Nuku'alofa	1978	–	3.6*	Mead, 1979a
Tonga	1979	7.6	5.7	Mead, 1980a
Tonga	1980/81	3.3**	–	Mead, 1987
Fiji–W. Viti Levu	1979/80	14.1	9.3	Mead, 1980b
Fiji–S. Viti Levu	1981/82	4.6	4.6	Mead, 1987
Fiji–Lau group	1981/82	16.6	8.9	Mead, 1987
Wallis island	1980	9.3	8.7	Fusimalohi and Grandperrin, 1980
Futuna island	1980	5.6	5.2	Fusimalohi and Grandperrin, 1980
Tokelau	1982	2.7	2.1	Taumaia and Preston, 1985
W. Samoa (Savai'i)	1975	–	4.1	Crossland and Grandperrin, 1980
W. Samoa (Upolu)	1982	5.1	4.1	(this visit)

* estimate, excludes *Lutjanus bohar*
** this figure excludes some trips in which fishing was done by handline.

As Table 1 shows, catch rates may vary widely between localities, or between different time periods at the same locality (e.g. at Niue island). Catch rates from Western Samoa are, however, reasonably consistent (4.1 off Savai'i in 1975; 4.1 off Upolu this visit) with each other and with the catch rate of 4.9 obtained in America Samoa in 1978.

During this visit the average deep-bottom catch per trip was 158.7 kg, which is reduced to 126.1 kg/trip if sharks are discounted and to 104.0 kg/trip if those species unacceptable to the FMA are also excluded. In 1975, the SPC ORAF Project, operating from Asau in Savai'i, completed 77 overnight bottom fishing trips over a six-month period and obtained an average saleable catch of 82.6 kg (182lb)/trip (Hume and Eginton, 1976). These authors estimated sharks to comprise approximately 7 percent of the catch (as compared

to 20 percent during this visit); hence, if sharks are discounted, catches during the earlier project were below those achieved during this visit, presumably because of fewer fishing lines or hours per trip during the 1975 fishing operations.

4.3 Species composition of the catch

The bottom catch consisted of 46 species representing 14 families, with one individual being caught trolling. Figure 10 shows the relative contribution of each taxonomic group to the catch, by weight and by number.

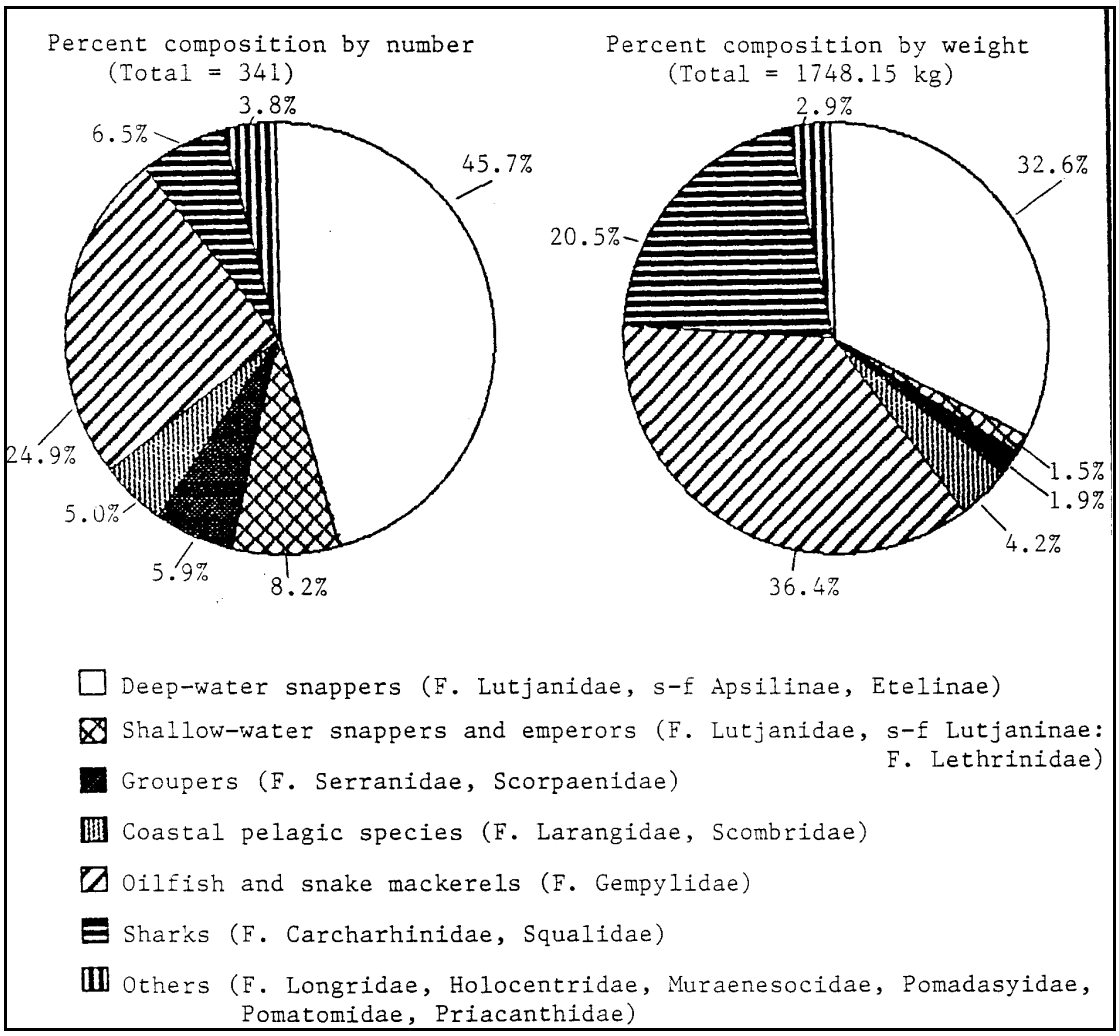

Figure 10: Taxonomic composition of the catch

In terms of weight, the *Lutjanidae*, sub-family *Etelinae* (deep-water snappers and jobfish), *Gempylidae* (oilfish and snake mackerels), *Carcharhinidae* (whaler sharks) and *Squalidae* (spiny dogfish) made the most significant contributions to the catch due to their abundance or large individual sizes, and together comprised 90 per cent of the total weight. Of secondary importance were *Lutianidae*, sub-family *Lutjaninae* (shallow water snappers), *Serranidae* (groupers and rock cods) and *Lethrinidae* (emperors),

which together comprised a further 3.3 per cent of the total weight — a surprisingly low figure as these groups often make up a significant part of the catch. Semi-pelagic members of the families *Carangidae* (jacks, trevallies) and *Scombridae* (mackerels, tunas) plus a miscellany of eels, squirrel fish and other species made up the remainder of the catch.

Numerically, the most important group were the eteline lutjanids which made up 46 per cent of the total. Within this group, the two *Etelis* species, *E. coruscans* and *E. carbunculus*, were dominant. The second most numerous group was the *Gempylidae,* with snake mackerels (*Promethichthys prometheus*) dominating.

While conducting bottom-fishing operations in deep water, it is usual for the vessel to swing at anchor, and due to the usual steep gradients normally found on outer reef slopes this generally results in a range of depths being fished. Consequently, the catch usually contains a significant proportion of species normally associated with shallower or intermediate waters.

It is noteworthy that during this visit an unusually high proportion of the catch comprised deep-water species which seldom or never occur in shallower depths. These include: all the *Etelinae* except *Aprion virescensa*; *Gnathodentex mossambicus* in the *Lethrinidae*; *Epinephelus cometae* and *E. morrhua* in the *Serranidae*; *Pontinus macrocephalus* (*Scorpaenidae*); all the *Gempvlidae*; and *Squalus megalops* (*Squalidae*). Together these species comprised 79 per cent (270 fish) of the catch number, and 81 per cent (1,412 kg) of the weight. The amberjack (*Seriola rivoliana*) is also generally caught in deep water, although neritic in its habits. The high proportion of these species in the catch argues strongly that, despite vessel swing, most fishing effort was concentrated in depths of 200m or more.

4.4 Fishing areas and depths

Three areas were fished during the 11 trips made by the project, as shown in Figure 8. Trips 1, 8, 9 and 10 were in the Leulumoega area; trips 2, 6, 7 and 11 off Apia; and trips 3, 4 and 5 off Falefa. The catches and catch rates obtained are shown in Table 2.

Table 2. Deep-bottom catches and catch rates by fishing area.

Area	Number of trips	Effort Line–hours	Catch		C.P.U.E.	
			Number	Weight	No./line-hour	kg/line-hour
Leulumoega	4	110	104	602.45	1.0	5.5
Apia	4	148	142	787.70	1.0	5.3
Falefa	3	81	94	355.50	1.2	4.4
Total	**11**	**339**	**340**	**1,745.65**	**1.0**	**5.1**

A slightly higher hook rate (number of fish/line-hour) was obtained in Falefa than in Leulumoega or Apia, but in terms of weight the catch rate is slightly lower.

Table 3 presents catch composition information for the three areas fished, using the same groupings as in Figure 9. No pronounced differences in broad species composition were evident between the three localities, particularly among the major groups.

Table 3. Species composition of the deep-bottom catch by fishing area.

Family Group	Leulumoega		Apia		Falefa		Total	
	% no	% Wt	% no	% Wt	% no	% Wt	% no	% Wt
Lutjanidae (Etelinae)	44.2	22.5	44.5	35.5	49.5	43.0	45.9	32.6
Lutjanidae (Lutjaninae)	10.6	1. 5	9.2	1.5	4.2	1.5	8.2	1.5
Serranidae and Scorpaenidae	5.8	1.6	4.2	1.1	8.4	4.1	5.9	1.9
Carangidae and Scombridae	8.7	6.1	3.5	3.8	3.1	1. 9	4. 7	4.1
Gempylidae	20.2	42.4	31.0	37.8	21.1	23.4	25.0	36.4
Carcharhinidae and Squalidae	4.8	20.6	3.5	18.0	12.6	25.9	6.5	20.5
Others	5.8	5.4	4.2	2.3	1.1	0.2	3.8	2.9

However, minor differences exist between the composition of the catch from Fa1efa and from the other two areas. The Fa1efa catch showed marginally higher proportions (by number) of eteline lutjanids, scorpaenids and serranids, which are characteristic deep-water species, and correspondingly lower numbers of lutjanine lutjanids, carangids and scombrids, usually encountered in a shallower coastal or neritic habitat. Sharks also contributed more to catch numbers in Falefa than in other areas, and these were all *Squalus megalops*, again a characteristic deep-water species. These features suggest that fishing tended to be deeper in Falefa than in the other two areas. This is confirmed by an examination of the fishing depths recorded on each trip, which are summarised in table 4.

Table 4. Fishing effort distribution by depth and fishing area.

Depth range (m)	Fishing effort by depth range							
	Leulumoega		Apia		Falefa		Total	
	Line-hours	%	Line-hours	%	Line-hours	%	Line-hours	%
0 – 99	4	(3.6)	0	(0.0)	0	(0.0)	4	(1.2)
100 – 199	56	(50.9)	100	(67.6)	18	(22.2)	174	(51.3)
200 – 299	50	(45.4)	44	(29.7)	45	(55.6)	139	(41.0)
300 – 399	0	(0.0)	0	(0.0)	9	(11.1)	9	(2.7)
400 – 519	0	(0.0)	4	(2.7)	9	(11.1)	13	(3.8)
Total	110		148		81		339	
Average fishing depth (m)	192		188		262		206	
Standard deviation (m)	56		64		90		77	

As can be seen, although fishing covered a wide depth range in each area, proportionally more fishing was carried out in deeper waters in Fa1efa than in the other two areas.

4.5 Biological information on the catch

Information on gonad condition was collected for 238 of the 340 fish caught by deep bottom fishing. However, for any given species, the sample size was too small to allow meaningful assessment of the population's reproductive condition. For the best sampled species, somewhat distorted sexratios were noted. For *Ete1is coruscans*, females outnumbered males at a ratio of 37:14 (2.6) and this disproportion is statistically significant at well over the 99 per cent confidence level (2 = 3.22). The same trend was seen in the catch of *E. carbuncu1us*, with 9 females to 5 males, while a converse ratio was evident in *Aphareus ruti1ans* (9 males to 2 females) and *Pristipomoides f1avipinnis* (8 males to 3 females). For the latter three species, small sample size may be the main factor responsible for the distorted sex ratio: however, the highly significant result attached to the *E. coruscans* catch strongly suggests a sex imbalance in the fished population, selection for females by the fishing gear, or a combination of these two factors.

5. HISTORICAL INFORMATION ON LOCAL FISHERY PRODUCTION

5.1 General

In an effort to supplement data gathered from field activities during this project visit, historical information on deep-bottom fishing was sought, with the aim of detecting any obvious indications that the productivity of deep-bottom fishing activities has declined in recent years. Unfortunately, useful statistics were found to be scarce, fragmentary and incomplete, and a shortage of time prevented a more exhaustive search of files and literature for scattered pieces of information.

A number of attempts to establish fishery statistics programmes or to document local fishery production have been made in Western Samoa, but these have been sporadic and short-lived.

5.2 Buying records of the Government Fish Marketing Authority (FMA)

The most useful data on local fishery production located during this survey came from the FMA, whose staff maintain records of fish purchases by date, species group, and seller. At the time of the survey, 40 months continuous landing data had been compiled by the FMA staff. Considerable effort was required to convert this to a form useful for analysis during which several limitations on the data became evident, as follows:

i) *Small volume of fish passing through FMA*. Total landings to the FMA in 1979, 1980 and 1981 were 76, 82 and 96 tonnes respectively, with 7 tonnes in the first four months of 1982. FAO estimated total landings in Western Samoa in these years were 1890, 1990, 3095 tonnes (FAO, 1987): if these estimates are accurate, then FMA's throughput constitute only between 7 and 9 per cent of the total. At the time of this visit, the then Chief Fisheries Officer, Mr A. Phillipp, estimated that between 5 and 6 percent of landings passed through the FMA (and that the FAO estimate of 1067 tonnes total landings in 1978 was about 30 per cent too low). (A. Phillipp, pers.comm.).

ii) *Biased sampling*. The composition of landings to FMA, by species and by size, probably differs markedly from the composition of fish landings overall, for two reasons.

Firstly, FMA offers a lower price to commercial fishermen than they can obtain for their produce by selling it directly to consumers. FMA also declines to accept certain species (sharks, eels, etc.) and requires others to be semi-processed (butchering of oilfish over 20 kg). As a result, fishermen naturally regard the FMA as a market of last resort, and tend to dispose of as much of their fish as possible locally in their home areas, or via the Apia retail market, bringing the remainder to the FMA towards the end of the day. As consumers tend to select for certain preferred species and sizes of fish, these will be reduced among the fish ultimately offered for sale to the FMA.

The second reason for bias in the composition of FMA purchases occurs during times of tuna abundance around the FADs. At these times, most fishermen switch to a routine of twice-daily trolling trips to the FADs, fishing for as long as possible in order to maximise catches. Landings being higher during these periods, the fishermen also find it more difficult to rapidly dispose of their catches via the municipal

markets. In order to dispose of all their catch and gain fishing time, many fishermen therefore tend to unload straight to the FMA in times of glut. The result is that over the long term, tuna and other pelagic species may constitute a higher proportion of FMA purchases than they do of the catch as a whole. In 1979, 1980 and 1981, tuna and pelagic species constituted 94, 89 and 84 per cent (by weight) of FMA purchases.

iii) *Species groupings.* As in many Pacific island countries, the traditional perception of fish taxonomy in Samoa is not the same as that held by Western marine scientists, and Samoan fish names do not necessarily correspond to English, or, more importantly, Linnaean equivalents. Some fish species may have several Samoan names depending on their size or sex. More of a problem from the viewpoint of the fisheries scientist is that many Samoan names are generic and may apply to several species having similar appearances or habits. The FMA's 22 fish purchasing names reflect the Samoan perception of fish taxonomy. For the purposes of analysis in this report, these have been grouped into 6 categories as follows:

a) DEEP-BOTTOM SPECIES:

Sinepa (deep-water jobfish, *Pristipomoides* spp)
Palu sina (small-tooth jobfish, *Aphareusrutilans*) Palu malau (short-tailed red snapper, *Etelis carbunculus*)
Palu talatala (oilfish, *Ruvettus pretiosus*)

b) SHALLOW-BOTTOM SPECIES:

Malai (paddletail, *Lutjanus gibbus*)
Filoa (emperors, *Lethrinus* spp, greater than about 2Scm total length)
Mataeleele emperors, *Lethrinus* spp, smaller than filoa)
Taiva (mangrove jack, *Lutjanus argentimaculatus,* and black-spot snapper, *Lutjanus monostigma*)

c) GROUPERS:

Gatala (small groupers, family *Serranidae,* less than about J0cm total length)
Ataata (medium to large groupers, family *Serranidae*)
Ulutui (very large groupers, family *Serranidae,* typically greater than 1m total length)
Papa (orange rock cod, *Cephalopholis aurantias*)

d) COASTAL PELAGIC SPECIES:

Malauli (medium sized trevallies*, Caranx* and *Carangoides* spp, 20–50cm total length)
Tagi (dogtooth tuna, *Gymnosarda unicolor*)
Utu (green jobfish, *Aprion virescens*)
Sapatu (barracuda, family *Sphyraenidae*)

e) OFFSHORE PELAGIC SPECIES:

Atu (skipjack tuna, *Katsuwonus pelamis*)
Asiasi (yellowfin tuna, *Thunnus albacares*)
Tavalau (mackerel tuna, *Euthvnnus affinis*)
Masimasi (dolphin fish, *Coryphaena hippurus*)
Pala (wahoo, *Acanthocybium solandri*)
Sa'ula (billfishes, family *Istiophoridae*)

f) OTHERS:

Ume (unicorn fishes, *Naso* spp)
Laea (large parrot fish, family *Scaridae*)
Ava (bonefish, *Albula vulpes*)
Anae (mullet, family *Mugilidae*)

As can be seen, the generic nature of some of these terms reduces their usefulness for purposes of scientific analysis. The other limitations on the data already discussed adds further to the need for caution in interpreting it. It is nevertheless useful to examine FMA's purchase records in more detail.

5.3 Fish landings to FMA

Figure 11 shows total fish landings to the FMA, and the relative contributions of offshore pelagic species (as defined above) and all other species combined.

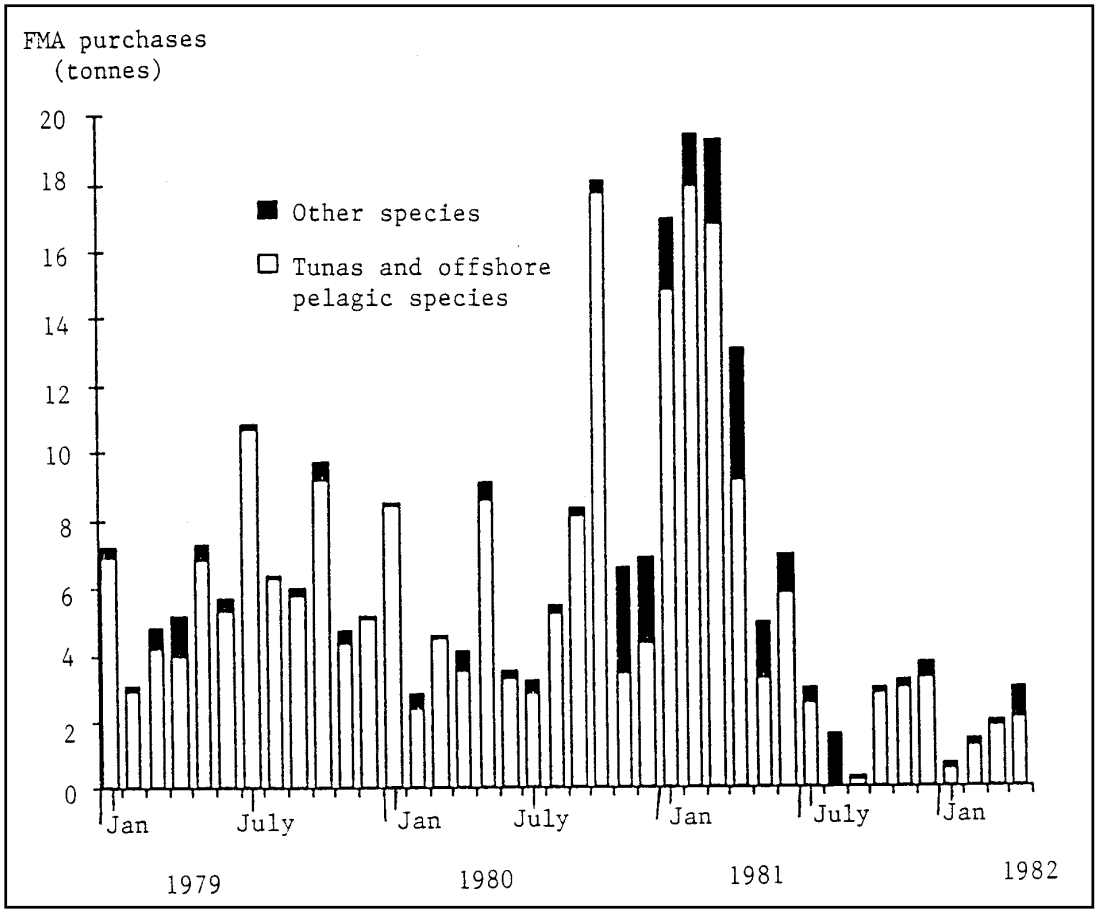

Figure 11: Proportions of offshore pelagic and other species in FMA purchases, January 1979 – April 1982

During the period for which data is available, tunas and offshore pelagic species dominated the catch. Of the total FMA purchases of about 260 tonnes between January 1979 and April 1982, 230 tonnes, or 88 per cent, were tunas or related types. On a monthly basis, the percentage of

offshore pelagic species ranged from 99.1 per cent down to a low of 5.5 per cent (in August 1981), but for the most part was above 80 per cent. Table 5 shows annual purchase weights for all groups.

Table 5. Annual FMA fish purchases by weight (kg), January 1979 April 1982.

Year	Deep-bottom Species (excluding oilfish)	Oil-Fish	Shallow-bottom Species	Groupers	Coastal Pelagic Species	Offshore Pelagic Species	Others	Total*
1979	1062.3	196.4	839.0	199.9	1737.0	71500.8	565.5	76100.9
1980	733.0	9.5	3003.7	223.1	3785.7	72467.5	1323.8	81546.3
1981	3858.0	44.0	7038.9	505.9	3083.7	79987.7	1189.1	95707.3
1982**	271.7	0.0	436.9	148.8	244.1	5690.8	365.1	7157.4
TOTAL*	5925.0	249.9	11318.4	1077.7	8850.5	229646.8	3443.5	260511.9

* Total figures may not tally exactly due to rounding.

** January–April (inclusive) only.

As noted, offshore pelagic species dominated the catch over the 3.3 year period. Next in importance were shallow bottom species followed by coastal pelagic species, and then deep-bottom species. Purchases of this latter group were 5.9 tonnes or 2.3 per cent of the total.

The proportion of deep-bottom species in the FMA purchases, while usually small, fluctuated widely from time to time, presumably in response to fluctuations in supply and demand. Figure 12 shows the extent of these fluctuations in relation to total FMA purchases.

Deep-bottom species normally fluctuated between 0 and 10 per cent of total purchases, except between June and August 1981, when they rose to relatively high levels (11.3 per cent and 27.1 per cent). During this time, total monthly catches were well below average, in September 1981 falling to a low of only 313.5 kg. The low catches during this period were attributed to disruption of the supply of outboard engine spares in Apia. Between August 1981 and April 1982, no basic supplies for the maintenance and repair of outboard engines were imported into Western Samoa, and as a result many fishermen had to temporarily curtail their fishing expeditions or tie up altogether (A. Phillipp, pers.comm.). Fish landings were thus drastically reduced during this period, and it is possible that the relative importance of trolling, and therefore of landings of offshore pelagic species, were also reduced.

5.4 FMA purchases from individual fishermen

The FMA does not normally keep detailed records of the composition of every purchase of fish it makes. However, this is done for those purchases for which the fisherman concerned require a receipt (usually those individuals who are selling fish on behalf of several fishermen or a fishing group). In such cases, the weight and number of each type of fish is recorded, as is the fisherman's name and home village.

On the assumption that a given fisherman (or fishing group) will tend to fish mainly in proximity to his home area, the detailed purchase records were classified according to coastal region in an attempt to detect any obvious differences in the size or species composition of catches from localities close to Apia and those at a distance.

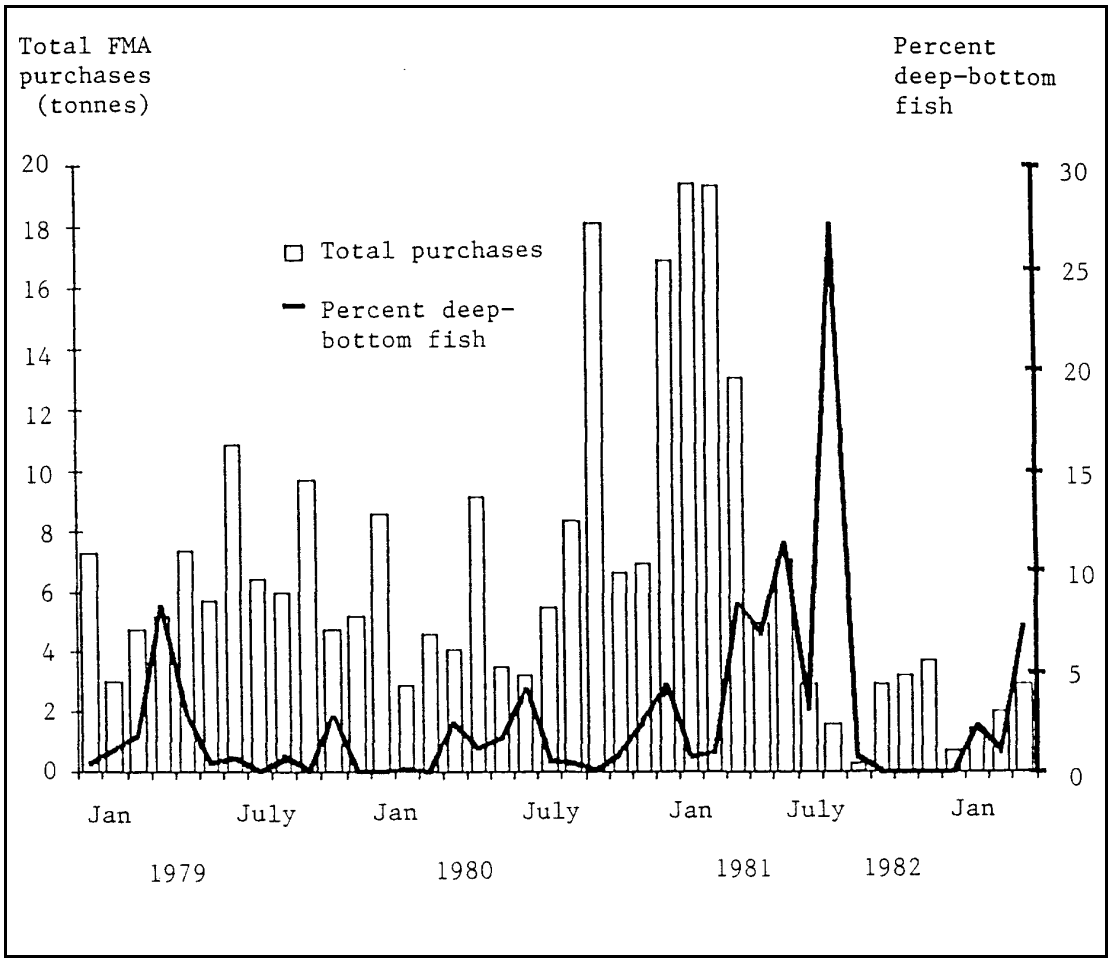

Figure 12: Percent deep-bottom fish in FMA purchases, January 1979 – April 1982.

A total of 304 purchases from individual fishermen were documented in detail by the FMA over the period January 1979 to November 1982. Of these, two were unusable because the localities named in the record were not traceable. The remaining 302 records, which accounted for 44.7 tonnes of fish, related to landings by 137 fishermen, some of them regular suppliers, operating from 42 villages or named locations. These were arbitrarily grouped into the fishing areas shown in figure 13. Some of these correspond to the fishing areas used to analyse the fishing data collected by the SPC Master Fishermen during this project visit.

Table 6 shows total purchases from each of the coastal areas depicted in figure 13, and the relative contributions of each of the species groups defined in section 5.2.

The proportion of offshore pelagic species among these records averages only 8.2 per cent, the reverse of the situation with FMA purchases as a whole, where offshore pelagic species accounted for over 88 per cent of the total over the same period. Conversely, deep-bottom species which represented only 2.3 per cent of total purchases over the period January 1979 –April 1982, comprised 34.3 per cent of the records summarised in Table 6 (which covers a slightly different time period, January 1979 – November 1982). The low prevalence of offshore pelagic species is probably explained by two factors.

Firstly, most trolling is carried out by the numerous boats based in Apia town itself. These vessels tend to unload frequently, sometimes twice a day, and many have accounts with the FMA, or may be paid at the end of the fishing week. In general, these purchases are not covered by the detailed receipts issued to 'out-of-town' fishermen.

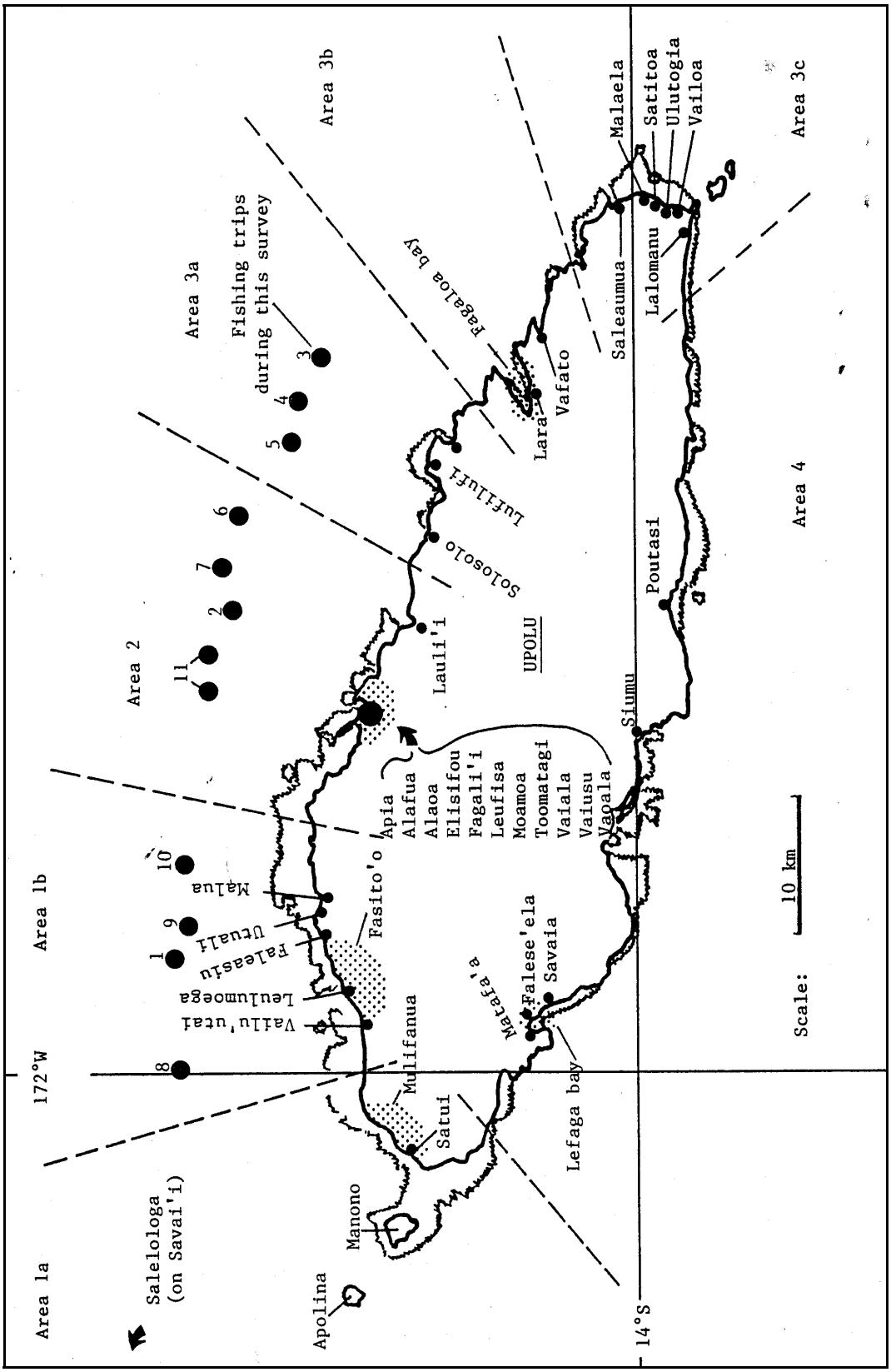

Figure 13: Coastal villages/areas featuring in FMA purchase records. (see text for more detail)

Table 6. Composition of FMA purchases from rural fishermen, January 1979 –November 1982.

Area	Number of records	Total Purchases (kg)	Per cent composition by weight						
			Deep-Bottom Spp (excluding oilfish)	Oil-fish	Shallow Bottom spp	Groupers	Coastal pelagic	Off-shore pelagic	Others
1a	109	27256	27.4	0.9	40.0	3.6	20.2	5.3	2.6
1b	60	5886	33.9	2.4	35.7	2.9	16.3	5.2	3.6
Total 1	**169**	**33142**	**28.6**	**1.2**	**39.2**	**3.5**	**19.5**	**5.3**	**2.8**
2	39	2766	72.7	7.6	4.3	0.3	10.6	1.8	2.5
3a	10	783	62.2	8.4	10.6	2.4	14.0	0.0	2.3
3b	7	408	36.5	11.8	26.2	0.0	24.8	0.0	0.7
3c	25	2418	56.3	1.6	8.5	1.4	2.6	24.3	5.3
Total 3	**42**	**3609**	**55.4**	**4.2**	**10.9**	**1. 5**	**7.6**	**16.3**	**4.1**
4	52	5136	34.3	0.2	19.9	3.5	14.6	24.8	2.7
Unknown	2	214	77.6	22.4	0.0	0.0	0.0	0.0	0.0
Total	**304**	**44867**	**34.3**	**1.8**	**32.4**	**3.1**	**17.3**	**8.2**	**2.8**

For these rural fishermen (including those from the many small villages clustered in the Apia 'hinterland') a more limited access to FADs, limited availability of fuel, and a greater access to inshore resources all combine to reduce the amount of trolling carried out relative to other types of fishing. Offshore pelagic species therefore make up a smaller proportion of the catch.

Secondly, tunas are among the more popular fresh fish in Samoa, and are the first to be disposed of through incidental sales. Hence, when the catch arrives at the FMA, many of the tunas have been "creamed off". This is particularly true in the villages around Apia, where fishermen have access to a relatively large market and hence land very few offshore pelagic fish to the FMA.

The same reasoning may also apply, to a lesser extent, to the inshore lethrinids and lutjanids which comprise the "shallow bottom species" category. These are species which are known to consumers and tend to be favoured as a second choice to tunas. Again, in 'rural' Apia, the relatively large market allows fishermen to dispose of many of these species, hence there is a much smaller proportion of 'shallow bottom species' in the FMA purchases from Apia fishermen than from other areas. However, there may also be a second factor influencing the relative quantities of shallow bottom species, that of local exploitation rate. In the urban areas around Apia, fishing pressure on these inshore species would be expected to be substantially higher than in more rural areas, and this may have resulted in lower proportions of shallow bottom species in local fishermen's catches. With the limited data available, it is not possible to confirm that this is actually the case.

The converse situation seems to apply in the case of deep bottom species, which comprise 72 per cent of the sales to the FMA by rural fishermen from the Apia area. This percentage is not

likely to be a true reflection of their prominence in the fishermen's catch. Rather, it would seem that these species are perceived by consumers as being less desirable than tunas' or the more familiar shallow-water species, and that a large proportion thus ends up being sold to the FMA. This is especially true of the larger fish, which are much less attractive to consumers than are the smaller individuals.

5.5 Size composition of deep-bottom fish purchased by FMA

Size (weight) information is not available for individual fish landed to FMA, but can be deduced from monthly landing data and from details of purchases from individual fishermen. Both these types of record include total weight and total number of fish in each of the 22 categories defined in section 5.2, and average weights for each 'species' in each record can therefore be calculated.

Figure 14 shows monthly average weight information for three deep-bottom species or species groups, derived from the total purchase records maintained by the FMA. There is very little evidence of a consistent trend in any of the data over the 3.3 year period. Regression coefficients for the three series are well below levels of statistical significance (Palu malau, 0.08: Palu sina – 0.06: Sinepa – 0.002). There is no evidence of declining average weights during the time series.

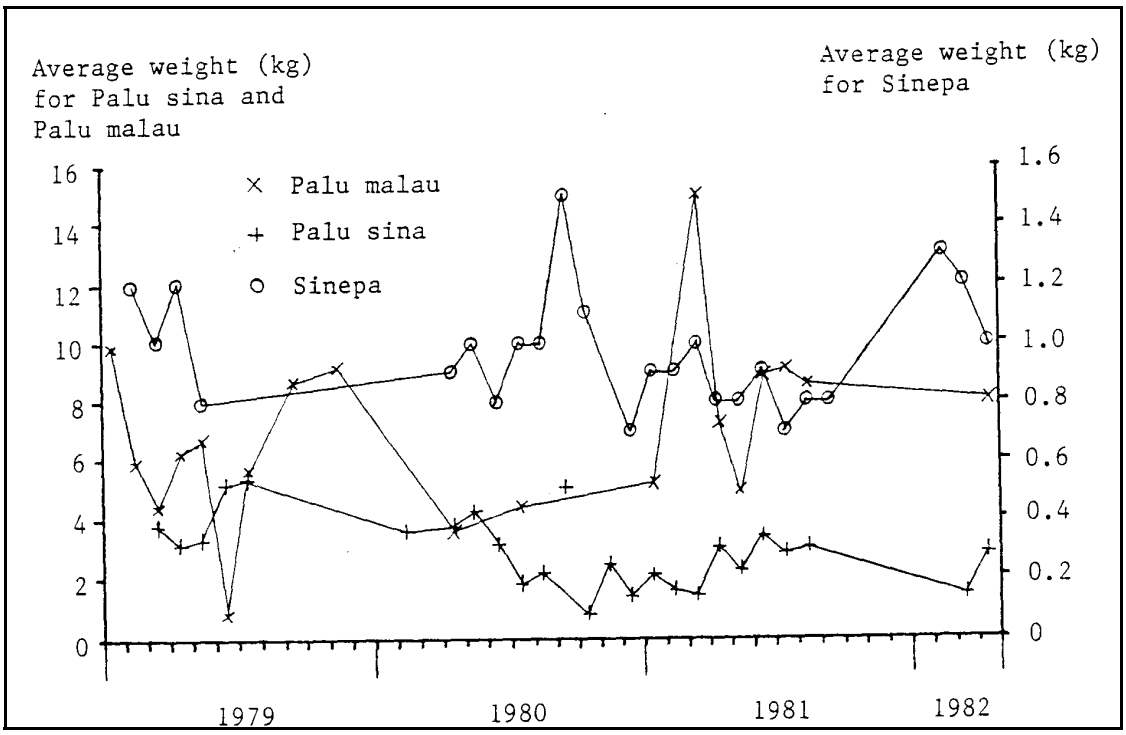

Figure 14: Average weights of three deep-bottom fish 'species' over time.

Figure 15a shows the average weights of the same three species groups of fish from the coastal areas of Western Samoa defined in section 4.4, and is based on the purchase records from individual fishermen, described in this section. Again, it is difficult to perceive any clear trends in the data, and there is no indication that the average weights of fish landed from the Apia region are significantly less than those from other areas. In fact they are about average.

As a comparison, figure 15b shows, for the same three species groups, average weight information for the fish caught during this survey. Again, the data are characterised by lack of consistent trends, and by lack of any indication that the values from the Apia area are lower than those from other areas. Incidentally, comparison of these average weight figures with those in figure 15a gives some indication of the extent to which smaller sized fish are being selected out of fishermen's catches before they are sold to the FMA.

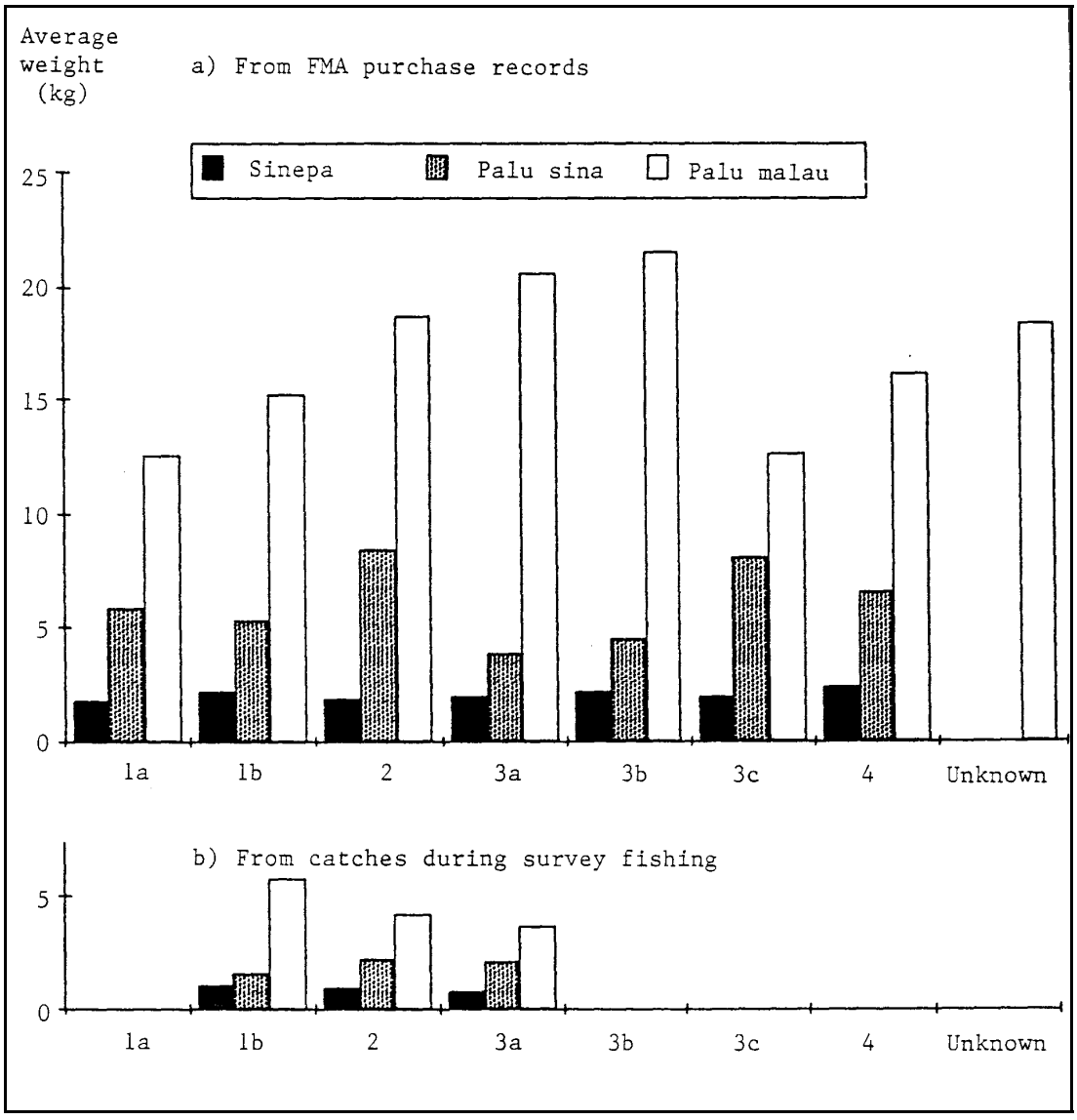

Figure 15: Average weights of three deep-bottom fish 'species' from the coastal areas of Upolu shown in figure 13.

6. DISCUSSION AND CONCLUSIONS

6.1 Results of survey fishing

While admittedly limited in extent, the programme of deep-bottom fishing during this survey provided baseline catch, effort and species composition data for three areas off Upolu island. Perhaps more importantly, it also gave an insight into standard deep-bottom fishing practice among Samoan fishermen based in Apia, and allowed a subjective comparison of the apparent effectiveness of local fishing activities with that of the survey fishing.

Catch data from the three survey areas revealed no obvious real differences, either in catch rates or species composition, which could be attributed to variation between localities. The catch rates obtained during this survey were consistent with those obtained during earlier visits to Savai'i in Western Samoa (1975), and to American Samoa (1979).

Observation of landings by local fishermen engaged in deep-bottom fishing during the survey period indicated that their catch rates were approximately half those of the SPC Master Fishermen. Anecdotal information gathered during discussions with these fishermen further indicated that they were not ranging so far from shore as the SPC Master Fishermen, nor were echosounders used to locate suitable fishing depths. These facts together suggest that Apia fishermen are tending to fish in less productive areas too close inshore.

The overall conclusion from the survey results is that commercial deepbottom fishing activities around Apia are less productive than would be expected. However, there is no evidence to suggest that this is connected with the state of the deep-bottom resource. Rather the cause appears to be that the fishing operations of local fishermen are not fully effective. A change in the pattern of local fishing activities, with fishermen venturing further afield, and sounding the fishing depth using echo-sounders or their fishing lines, would probably result in an improvement in catch rates.

6.2 Historical information

Available statistics on Western Samoan fisheries are extremely limited. Those which are available are fragmentary and highly biased because they are based on commercial records. Nevertheless, this data was examined, and the following conclusions drawn, with the limitations of the data being borne in mind.

Overall FMA purchases indicate that deep-bottom snappers comprise only a small portion of landings (about 2.3%). Various estimates suggest that total fish landings in Western Samoa lie somewhere between 1,000 and 1,500 tonnes annually. If the same proportion of this catch is deep-bottom species, this would therefore be equivalent to between 23 and 35 tonnes annually. However, it seems likely that the importance of deep-bottom species is under-emphasised in FMA landing, and that offshore pelagic species are over-emphasised. More subjective estimates claim that deep-bottom species comprise a much greater proportion of Western Samoa's total fish landings, up to 25% in some estimates.

Average weight data from the FMA's overall purchase records show no clear long-term trends which could be interpreted as reflecting changes in the state of the resource. Similarly, differences in the average size of selected deep-bottom species from different coastal areas, based on a subset of FMA's individual purchase records, do not support the contention that the deep

bottom resource close to Apia is being harder-fished than in other areas. This conclusion is consistent with that drawn from the survey fishing results, although the actual pattern of average weight is not.

Differences in species composition between different coastal localities, based on FMA's individual purchase records, are heavily masked by the biased nature of the data. However, there is some suggestion that catches in Apia comprise an above-average content of deep-bottom species, and a below-average content of inshore or shallow-water species. It is not possible to state whether this is a reflection of what Apia fishermen are actually catching or whether the difference is attributable to local market factors.

6.3 Status of the fishery

From the previous discussions, it has been concluded that there is no evidence to suggest long-term declines in deep-bottom catch rates or fish abundance in the Apia area. Equally, no evidence was discovered of significant disparities in the species composition of fish landings in and around the survey area which might suggest resource depletion close to Apia. Therefore, the results of this project visit do not support the suggestion that deep-bottom fish stocks offshore of Apia are depleted relative to those, of other parts of Western Samoa or neighbouring American Samoa.

There is, however, strong evidence to suggest that deep-bottom fishing catch rates among Western Samoan commercial fishermen are not as high as they could be. This is attributed to local fishing activities not being fully effective, and in particular to fishermen operating too close inshore, and not sounding to determine optimum fishing locations.

There may also be evidence that inshore or shallow-water fishery resources are under-represented in the landings of Apia fishermen, and this in turn may be due to resource considerations. Further investigation into this possibility are probably warranted.

6.4 Future development potential

Although this survey found no evidence of over-exploitation of deep-bottom resources in Western Samoa, much important information pertaining to the resource is unavailable. A sizeable fishing fleet exists in Apia and, to a lesser extent at various points around the Samoan coast, and this fleet has the potential to increase fishing pressure on the resource. Without basic information on the actual quantities of deep-bottom fish being landed at present, it is difficult to predict to what extent deep-bottom fishing effort can or should be increased, but a cautious approach is clearly required.

In the first instance, a programme for collecting basic fishery statistics is needed, which can provide information on the quantity and type of fish being landed by Samoa's commercial and subsistence fishermen. With reasonable estimates of present landings, and a means of monitoring changes to these, cautious attempts can be made to develop the fishery further.

The results of this survey have indicated that some, and probably most, of Western Samoa's commercial fishermen are not carrying out deep-bottom fishing operations fully effectively. Future attempts to develop this fishery would be best directed towards improving the performance of existing fishing boats, rather than encouraging new ones to enter the fishery, at least to begin with.

The following recommendations are formulated with the above points in mind.

7. RECOMMENDATIONS

1. That, in line with its expressed concern about the possibility of overfishing the deep-bottom resource in Western Samoan waters, the government Fisheries Division *implement a programme of fishery statistics collection*. The aim of the programme should be to provide descriptive information on patterns of commercial and subsistence fishing in Western Samoa, and in particular the activities of the 'alia' fleet. A specific objective of the programme should be to estimate present landings of deep-bottom species, and to collect size distribution data for these species in different coastal localities, as a basis to formulating a meaningful assessment of the status of the resource, which could in turn act as a basis for its management. Such a statistical programme could also serve to provide information for other purposes, particularly on the economics of small-scale fishing operations in Western Samoa, and could assist in the interpretation of FMA records. The specific aims of a statistics programme, and the procedures to be involved in collecting information, would need to be clearly defined in the first instance, perhaps with the assistance of a specialist body having experience in this field.

2. That, in connection with the statistics programme, a more specialized *study be carried out on the status of inshore marine resources in Western Samoa*, particularly lethrinids and lutjanids in the Apia region. This study should aim to establish whether inshore marine resources around Apia are being subjected to excessivlely heavy fishing pressure, and if so, to recommend management measures which might alleviate it.

3. That the Fisheries Division also *establish a deep-bottom test fishing programme* aimed at establishing baseline catch-and-effort information for this fishery in selected coastal regions and under controlled conditions. This programme should also be designed to obtain biological information on selected species, and to assess the likely effects of possible management measures (eg. hook size) on fishing effectiveness. The test fishing vessel should be an 'alia' and care should be taken to ensure that its fishing practice is standardised to be fully effective.

4. That, in conjunction with the test fishing programme, the Fisheries Division *provide training which will enable selected commercial fishermen to improve the effectiveness of their deep-bottom fishing operations*. This programme should operate on the basis that commercial fishermen accompany the test fishing vessel to observe good fishing practices. These should include: sounding methods to identify suitable fishing depths; coastal navigation and the use of landmarks and bearings to re-locate good fishing spots; good record-keeping; and good on-board fish handling practice. It may also be appropriate to incorporate other subject areas into the training programme.

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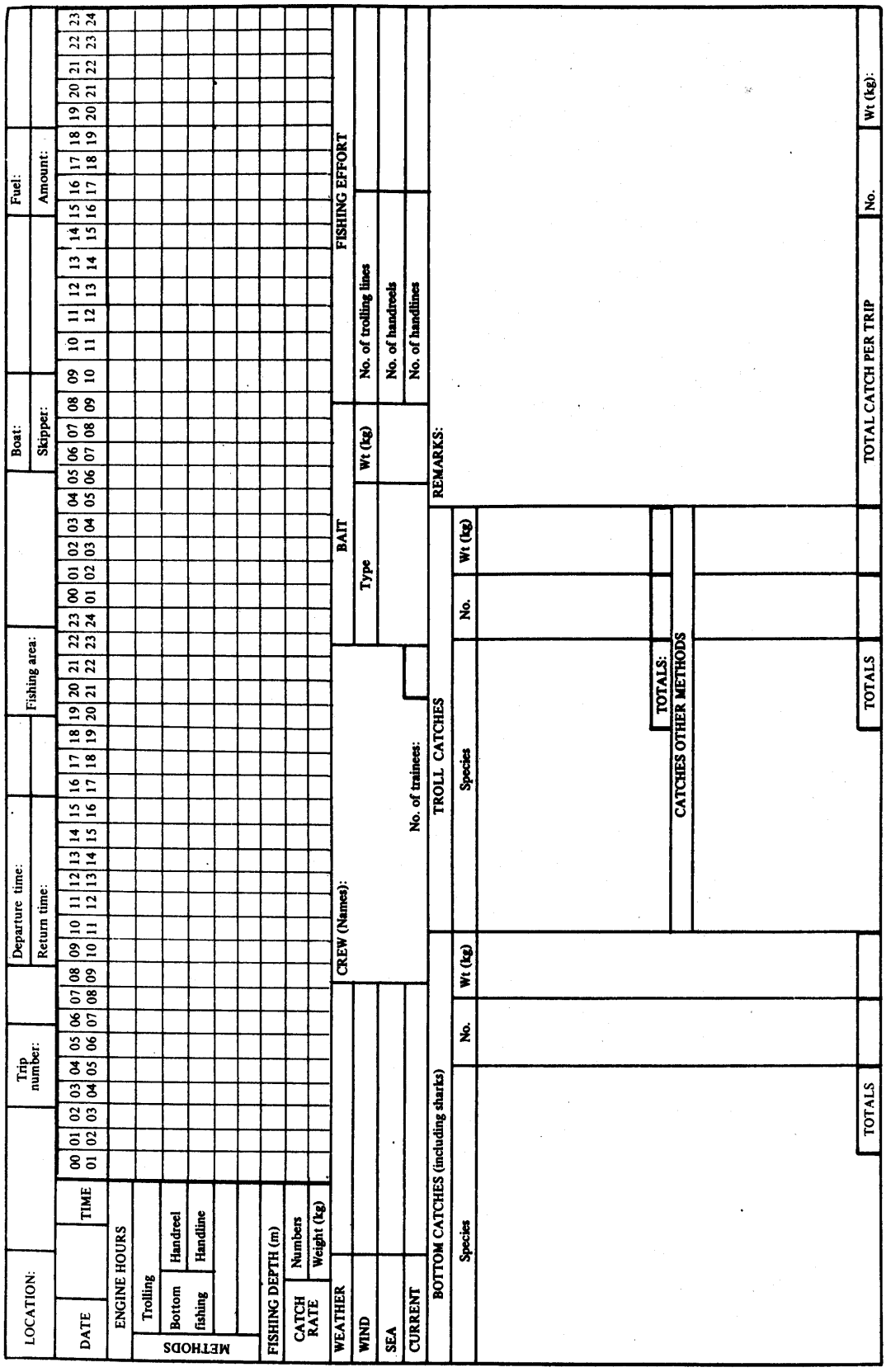
APPENDIX 1: Basic equipment for deep-bottom fishing

1. Western Samoan-type wooden handreels
2. 115 kg or 130 kg test monofilament, 500 m per reel
3. Turimoto No.29 longline wire or equivalent (3x3 braided, 120 kg test)
4. Sizes 3–9 Mustad 39960ST tuna circle hooks
5. Size 4/0 Berkeley-McMahon swivels or equivalent
6. Size 4/0 Kelux stainless lockfast swivels or equivalent
7. 1 kg and 2 kg sinkers
8. 400–500 m polypropylene anchor rope, diameter appropriate to boat size
9. Grapnel anchor and chain or wire
10. Large buoy (with clip or shackle to attach to anchor rope) for anchor retrieval
11. Standard pliers
12. Side cutting pliers
13. Crimping pliers
14. 15 cm bait knife

APPENDIX 2: Standard form for data collection



APPENDIX 3: Operational aspects of fishing trips

Trip No.	Date	Wind Speed (knots) and Direction	Current	Time at sea (hours)				Effort (line - hours)	Catch		Fuel (l)	Bait (kg)	No. on board
				Travel	Anchor	Fishing	Total		No.	Weight (kg)			
1	10/11	20–25 E	Strong	9.0	4.0	9.0	22	18	21	22.00	55	9	3
2	16/11	15–20 SE	Light	5.0	2.0	9.0	16	18	20	57.50	27	15	3
3	29/11	15–20 SE	Light	7.0	2.0	9.0	18	27	42	203.80	36	9	4
4	1/12	20–25 E	Strong	6.0	2.0	8.0	16	24	20	71.70	46	11	4
5	3/12	15–20 SE	Strong	7.0	4.0	1.0	21	30	33	82.50	36	12	4
6	6/12	15–20 E	Moderate	8.0	2.0	7.0	17	28	26	158.65	41	20	5
7	8/12	10–15 E	Light	5.0	1.5	11.5	18	46	47	404.50	32	26	5
8	13/12	10–15 E	Moderate	6.0	3.0	8.0	17	32	26	245.90	50	18	5
9	15/12	10–15 E	Moderate	6.0	5.0	9.0	20	36	44	178.85	46	20	5
10	17/12	15–20 E	Strong	6.0	6.0	6.0	18	24	13	155.70	41	25	5
11	20/12	5– 8 E	Light	4.0	1.0	14.0	19	56	49	167.05	27	21	5
Total				**69.0**	**32.5**	**100.5**	**202**	**339**	**341**	**1,748.15**	**437**	**186**	**–**

APPENDIX 4: Species composition of the catch

All weights are whole weights (not gutted or gilled).
Classification of Lutjanidae and Lethrinidae follows Johnson (1980).

FAMILY/Species English name, Samoan name (when known)	CATCH Number	 Weight (kg)	Average Weight (kg)
a) Deep-water snappers, jobfish			
LUTJANIDAE, sub-family ETELINAE			
Aphareus rutilans Small-tooth jobfish, palusina	14	27.60	2.0
Aprion virescens Green jobfish, utu	1	3.30	–
Etelis carbunculus Short-tailed red snapper, palumalau	23	101.70	4.4
Etelis coruscans Ribbon-tailed red snapper, paluloa	66	382.90	5.8
Paracaesio kusakarii Saddled fusilier, palu-tuauli*	6	13.60	2.3
Pristipomoides amoenus Large-eyed flower snapper, palusavane	2	0.40	0.2
Pristipomoides flavipinnis Yellow jobfish, sinepa	25	27.70	1.1
Pristipomoides zonatus Banded flower snapper, palusavane	19	12.00	0.6
Sub-total	**156**	**569.20**	–

APPENDIX 4 (continued): Species composition of the catch

FAMILY/Species English name, Samoan name (when known)	CATCH Number	 Weight (kg)	Average Weight (kg)
a) Shallow-water snappers			
LUTJANIDAE, sub-family LUTJANINAE			
Lutjanus argentimaculatus Mangrove jack, taiva	1	5.20	–
Lutjanus bohar Red bass, mu	2	4.40	2.2
Lutjanus gibbus Paddletail, malai	5	6.00	1.2
Lutjanus monostigma Black-spot snapper, taiva	2	2.50	1.2
Lutjanus rufolineatus Red-lined snapper, savane	8	1.75	0.2
Lutjanus spilurus ? ? ? , savane	6	2.10	0.3
Sub-total	**24**	**21.95**	–
b) Emperors			
LETHRINIDAE			
Gnathodentex mossambicus Large-eyed sea bream (mumu?)*	3	3.50	1.2
Lethrinus sp. Emperor, filoa	1	0.50	–
Sub-total	**4**	**4.00**	–

APPENDIX 4 (continued): Species composition of the catch

FAMILY/Species English name, Samoan name (when known)	CATCH Number	Weight (kg)	Average Weight (kg)
d) Groupers, rock cods			
SERRANIDAE			
Cephalopholis aurantias Orange rock cod, papa	2	0.70	0.3
Cephalopholis sp. Coral trout	2	1.20	0.6
Epinephelus areolatus Yellow-spotted rock cod, gatala	3	0.90	0.3
Epihephelus cometae Snakeskin cod, ataata	6	16.70	2.8
Epinephelus fuscus Grouper,	1	1.50	–
Epinephe1us merra Wine netting cod, gatala	1	0.40	–
Epinephelus morrhua Curve-banded grouper, ataata	2	10.50	5.2
Epinephelus sp. Grouper	2	0.35	0.2
SCORPAENIDAE			
Pontinus macrocephalus Red rock cod, palunofu	1	0.2	–
Sub-total	**20**	**32.45**	–

APPENDIX 4 (continued): Species composition of the catch

FAMILY/Species English name, Samoan name (when known)	CATCH Number	CATCH Weight (kg)	Average Weight (kg)
e) Coastal pelagic species			
CARANGIDAE			
Carangoides sp. Trevally	1	0.60	–
Caranx lugubris Black trevally, tafauli	3	8.80	2.9
Caranx sexfasciatus Bigeye trevally, malauli	4	4.30	1.1
Elegatis bipinnulata** Rainbow runner, samani*	1	2.50	–
Seriola rivoliana Amberjack, tafala*	3	23.30	7.8
SCOMBRIDAE			
Gymnosarda unicolor Dogtooth tuna, tagi	5	34.20	6.8
Sub-total	**17**	**73.70**	**–**
f) Oilfish, snake mackerels			
GEMPYLIDAE			
Thyrsitoides marleyi Snake mackerel, Palutalatala	3	15.20	5.4
Ruvettus pretiosus Oilfish, palutalatala	30	543.60	18.1
Promethichthys prometheus Snake mackerel, palukamuro	52	77.80	1.5
Sub-total	**85**	**636.60**	**–**

APPENDIX 4 (continued): Species composition of the catch

FAMILY/Species English name, Samoan name (when known)	CATCH Number	CATCH Weight (kg)	Average Weight (kg)
g) Sharks			
CARCHARHINIDAE			
Carcharhinus albimarginatus Silvertip shark, aso*	1	83.00	–
Carcharhinus amblyrhynchos Grey reef shark, malie-aloaloe*	1	91.00	–
Trianenodon obesus Whitetip reef shark, malu*	1	6.40	–
SQUALIDAE			
Squalus megalops Shortnose spurdog	19	178.50	9.4
Sub-total	**22**	**358.90**	–

APPENDIX 4 (continued): Species composition of the catch

FAMILY/Species English name, Samoan name (when known)	CATCH Number	 Weight (kg)	Average Weight (kg)
h) Miscellaneous			
CONGRIDAE			
Conger cinereus Conger eel, i'aui*	5	37.60	7.5
HOLOCENTRIDAE			
Myripristis pralinius Squirrelfish, malau-va'ava'a*	2	0.25	0.1
Os,tichthys j aponicus Squirrelfish	1	0.60	–
MURAENIDAE			
Muraenesox cinereus Moray eel, pusi*	1	7.00	–
POMADASYIDAE			
Plectorhynchus orientalis Harlequin sweetlip, unalii	1	2.00	–
POMATOMIDAE			
Neoscombrops pacificus	2	2.10	1.0
PRIACANTHIDAE			
Priacanthus hamrur Bigeye, matapula*	1	1.80	–
Sub-total	**13**	**51.35**	–
GRAND TOTAL	**341**	**1,748.15**	–

* Samoan names from Wass (1984)
** Caught trolling