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REPORT ON SECOND VISIT

TO

YAP STATE

FEDERATED STATES OF MICRONESIA

12 July 1984 to 4 April 1985

by

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SUMMARY

The South Pacific Commission's Deep Sea Fisheries Development Project (DSFDP) operated in Yap State, Federated States of Micronesia, for the second time between July 1984 and April 1985, under the supervision of SPC Masterfisherman Lindsay Chapman.

The purpose of the visit was to assist in the rigging and deployment of fish aggregation devices (FADs) in support of a fisheries development project initiated by the Yap Community Action Program (YAPCAP) in conjunction with Yap Fishing Authority (YFA). The Project was also requested to undertake a monitoring programme once the FADs were in place and to conduct fishing trials to gauge their effectiveness.

Eighty-seven fishing trips were completed during the visit, 83 of these in Yap District and 4 at Ngulu atoll. Most fishing trips targeted one or the other of the five FADs deployed during the visit and most fishing effort on such trips was devoted to trolling.

Because FADs are known to take some time to mature and become effective in gathering pelagic fishes, secondary fishing activity was conducted in the early stages of the visit, including deep-bottom droplining along the outer reef-slope and trolling along the reef drop-off. The overall catch rate recorded for deep-bottom fishing was 6.2 kg (13.7 lbs)/reel hour, though the catch rate around Yap district was only half that figure. The reef-edge trolling was largely opportunistic, often being conducted in transit between bottom fishing sites and, when combined with opportunistic trolling in transit to offshore FAD sites, the catch and effort recorded resulted in a catch rate of only 1.4 kg (3 lbs)/line hour, a low return for time and fuel expended.

Trolling around the FADs was conducted regularly throughout the visit, even before it could be expected that exploitable stocks had gathered, in order to monitor the FADs' development as fishing targets. Most of these trips were conducted well out of the recognised peak tuna season. Catches taken at the FADs largely comprised juvenile tunas, the size of individual fish increasing steadily over successive months. The catch rate recorded by this activity was 8.4 kg(18.5 lbs)/line hour, a much better return than the reef and open-water trolling results.

A variety of secondary fishing techniques was employed occasionally to sample the species gathered at the FADs. The more important of these, vertical longlining and ‘palu ahi’ fishing, are mid-water techniques which target the large, deep-swimming tunas commonly associated with FADs. Although no catches were taken by these two methods, the gear and methods were demonstrated to YFA personnel and to local fishermen for possible use during the seasons when large tunas move through the area.

The catch taken by all fishing methods in both fishing areas totaled 3,517.1 kg (7,755 lbs), of which only 159.9 kg (352 lbs) were of unsaleable species. Although catch rates varied widely from one technique to another and, in the case of deep-bottom fishing, from one area to another, it was concluded that the areas fished hold significant fish resources which may be amenable to commercial exploitation by small-scale operators.

During the course of the visit a number of factors were noted which might serve to restrain the commercial development of local fisheries. The more significant of these relate to the availability of suitable fishing craft and gear, and the difficulty which local operators may face in accumulating sufficient capital to properly equip themselves. In addition it is likely that commercial fisheries will have to rely on export sales which are not properly developed as yet, and there will be a need for expanded fish handling and storage facilities. Other problems relate to the difficulty likely to be encountered in providing technical and material support in the more remote areas and the limitations likely to be imposed by traditional fishing rights. This report includes recommendations aimed at alleviating these restraints.

RÉSUMÉ

Dans le cadre de son Projet de développement de la pêche au demi-large, la Commission du Pacifique Sud a mené, de juillet 1984 à avril 1985, une seconde mission dans l'État de Yap (États fédérés de Micronésie) sous la supervision de Lindsay Chapman, maître de pêche à la CPS.

Visant à appuyer un projet de développement des pêches entrepris au titre du programme d'action communautaire de Yap (YAPCAP) avec la participation de la direction des pêches de Yap (YFA), cette mission avait pour objet d'aider à la fabrication et au déploiement de dispositifs de concentration du poisson (DCP). Les autorités compétentes ont également demandé que le responsable du projet mette en place des activités de suivi dès le mouillage des DCP et fasse quelques essais de pêche afin d'en vérifier l'efficacité.

Sur les 87 sorties de pêche effectuées pendant la mission, 83 se sont déroulées dans le district de Yap et 4 près de l'atoll Ngulu, le plus souvent autour de l'un ou l'autre des cinq DCP mouillés pendant la mission; le gros de l'effort de pêche portait sur la traîne.

Il est notoire que les DCP doivent être mouillés pendant quelque temps avant d'être efficaces et d'attirer les espèces pélagiques. C'est la raison pour laquelle des activités de pêche accessoires ont été entreprises au début de la mission, notamment la pêche au grand fond à la ligne à main, le long du tombant récifal externe et à la traîne sur le tombant du récif. Le taux de prise global était de 6,2 kg/heure/moulinet pour la pêche au grand fond, mais il était moitié moindre dans le district de Yap. La traîne le long du bord du récif était essentiellement opportuniste, puisqu'elle était souvent pratiquée en cours de route entre deux lieux de pêche au grand fond. Quand on y associe les prises réalisées par la même méthode lors des trajets vers les DCP mouillés au large, les données de prises et d'effort se soldent par un taux de prise d'à peine 1,4 kg/ligne/heure, ce qui constitue un faible rendement pour le temps et le carburant qui ont été investis.

Avant même que l'on puisse espérer que des stocks exploitables se soient concentrés, des activités de pêche à la traîne ont été régulièrement conduites autour des DCP pendant toute la durée de la mission, afin de vérifier si les dispositifs évoluaient dans le sens escompté. La plupart de ces sorties se sont déroulées bien en dehors de la haute saison de la pêche thonière. Les prises réalisées autour des DCP étaient en grande partie composées de thons juvéniles, la taille des individus croissant régulièrement d'un mois à l'autre. Le taux de prises était de 8,4 kg/ligne/heure, un rendement bien supérieur à celui des activités de traîne au large, le long du tombant du récif.

On a eu recours à diverses techniques de pêche moins couramment employées pour réaliser un échantillonnage des espèces concentrées autour des DCP. Parmi les plus importantes figurent la palangre verticale et le *palu ahi*, qui sont des techniques de pêche pélagique ciblant les thons de grande taille nageant en profondeur qui sont habituellement associés aux DCP. Bien qu'elles n'aient pas permis de prendre de poisson, les techniques ainsi que les engins ont été montrés aux agents de l'YFA et aux pêcheurs locaux afin qu'ils puissent éventuellement s'en servir pendant les saisons de migration des thons de grande taille dans les eaux de leur région.

Dans les deux zones de pêche considérées, le volume total des prises, toutes méthodes de pêche confondues, s'est élevé à 3 517,1 kg, dont seulement 159,9 kg d'espèces non commercialisables. Bien que les taux de prise aient été très variables d'une technique à l'autre et, dans le cas de la pêche au grand fond, d'une zone à l'autre, on a pu conclure que ces zones de pêche étaient suffisamment poissonneuses pour justifier une éventuelle exploitation commerciale par de petits entrepreneurs.

Plusieurs facteurs observés en cours de mission pourraient entraver le développement des pêcheries locales à des fins commerciales. Il s'agit notamment de l'absence d'engins et de bateaux de pêche permettant d'opérer dans de bonnes conditions et de la difficulté que pourraient rencontrer les entrepreneurs locaux à trouver des fonds suffisants pour se doter de l'équipement et du matériel adéquats. En outre, il est probable que, pour écouler les produits de la pêche, les exploitants soient obligés de compter sur des ventes à l'exportation qui sont encore peu développées et qui exigeront un agrandissement des installations de manipulation et d'entreposage du poisson. Il convient aussi de signaler qu'il sera probablement difficile d'apporter un concours matériel et technique aux régions les plus éloignées, ou encore qu'il est vraisemblable que les détenteurs des droits de pêche traditionnels imposeront des restrictions. Plusieurs recommandations qui visent précisément à atténuer toutes ces difficultés sont formulées dans le présent rapport.

ACKNOWLEDGEMENTS

The South Pacific Commission gratefully acknowledges the friendly support and co-operation offered by the many individuals and organisations associated with the Deep Sea Fisheries Development Project's stay in Yap. Particular thanks are due to Mr Tim Thornbergh of the Yap Community Action Program, Mr Chris Friberg, Manager of Yap Fishing Authority, and the management of Marine Resources Division. In addition, boat skippers Mr Thomas Garong and Mr Pius Palui worked long and irregular hours in support of the Project, and Waab Transportation provided assistance in FAD deployment.

CONTENTS

1. INTRODUCTION

The South Pacific Commission's Deep Sea Fisheries Development 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; and

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

The Project has operated in Yap State previously; a 1978/79 visit being conducted to survey deep-bottom resources along the outer reef-slopes in Yap District and at Ulithi and Ngulu atolls. The average catch rate recorded from the three areas fished (7.2 kg[16.1 lbs]/reel hour) indicated the presence of a significant resource. Catch rates at Ulithi and Ngulu atolls were particularly high, but the report on the visit (Mead and Crossland, 1980) noted that the outer reef-slopes fished around Yap proper were quite steep, and that the extent of deep-bottom grounds was therefore limited. The report concluded that a successful local deep-bottom fishery would likely rely on supplementary troll catches and recommended that the development of local fisheries be linked to the development of export markets.

The current visit was made in response to a request to SPC for assistance in the rigging and deployment of fish aggregation devices (FADs) as part of a major FAD deployment programme designed to promote offshore catches of pelagic species in Yap District and some of the outer islands. The Project's work programme was to include monitoring of deployed FADs to gauge their effectiveness and survivability, and the demonstrations of effective fishing techniques to exploit them. The Project operated in Yap State for nearly nine months between 12 July 1984 and 4 April 1985, under the supervision of SPC Masterfisherman Lindsay Chapman.

This was the DSFD Project's fortieth country visit, it's second to Yap State and the fourth made to the Federated States of Micronesia.

Note: Measurements in this report are given in metric units, with a rounded figure, in parentheses, of U.S. customary measure.

2. BACKGROUND

2.1 General

The State of Yap (Figure 1), part of the Western Caroline Islands and now one of the political units forming the Federated States of Micronesia, comprises four large, adjoining islands of sedimentary structure (Yap, Gagil-Tamil, Map and Rumung), and eleven outlying atolls or coralline islands. The group lies scattered over more than 1,000 km (620 miles) east and west, but land area amounts to only 118.4 sq km (46 sq miles).

The four islands forming Yap proper, site of the administrative capital Colonia, are separated by narrow channels and encircled by a single barrier reef. These islands are hilly and clothed in forests of coconut and areca palms, pandanus, and thickets of bamboo and low scrub. There are some sandy beaches but much of the coast is fringed by mangroves.

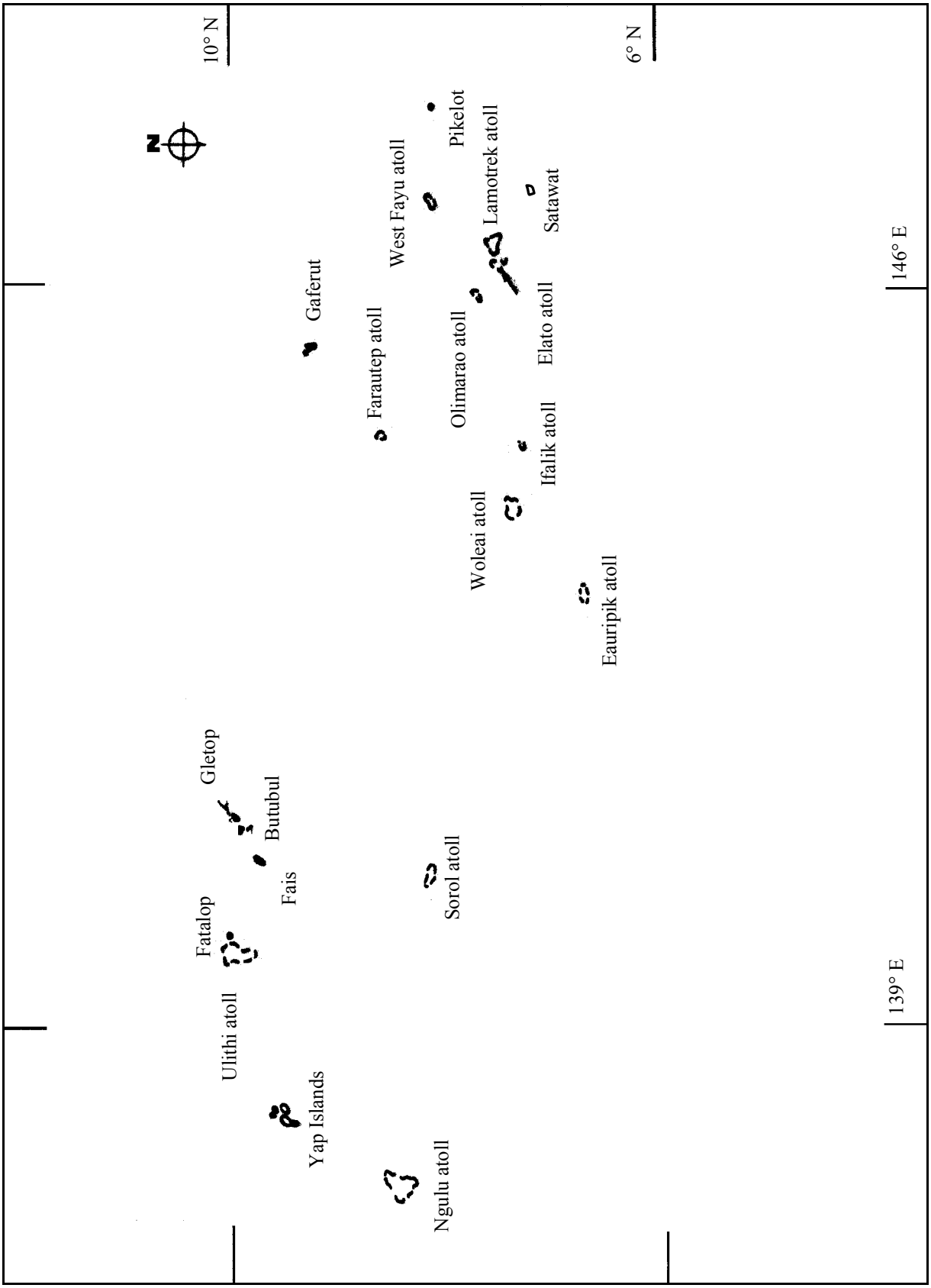

Figure 1: The islands of Yap State

Ngulu atoll lies 200 km (125 miles) to the south, while Ulithi atoll, with its large lagoon, and Fais, a raised coralline island, are situated to the north-east. Sorol atoll lies to the east, as does Woleai atoll and a cluster of other small atolls and islets.

2.2 Existing fisheries

Artisanal fisheries are well developed throughout Yap's outlying islands, where a strong sea-faring and fishing tradition survives. Offshore fishing techniques, including mid-water handlining for large tuna, traditional tuna poling from canoes and flying fish scooping, are widely practised. Spearfishing, gillnetting and shallow-water handlining are common in the lagoons. Only the islands of Satawal and Fais are less than self-sufficient in fisheries due to their relatively limited reef areas. At Ulithi, where ciguatoxicity occurs among lagoon fishes, occasional shortages occur during bad weather when fishermen are unable to reach ciguatera-free fishing grounds.

Around Yap proper, artisanal fisheries are more sophisticated. Numerous timber and fibreglass outboard-powered skiffs, in the 4 m to 5 m range, fish within the lagoon or troll for pelagic species offshore. The size of these craft means that fishing activities are significantly influenced by weather conditions. Most offshore fishing is conducted between June and October when good catches of yellowfin tuna (*Thunnus albacares*) and skipjack tuna (*Katsuwonus pelamis*) are taken.

During the season of the north-east trade winds, limited trolling of the outer reef-edge is conducted along the lee coast, but catches are inconsistent.

Access to lagoon waters and reef flats is limited by traditional fishing rights and a good part of Colonia's burgeoning urban population have neither the right nor the means to engage in subsistence fishing.

Fisheries development in the State is the responsibility of two governmental bodies, the Marine Resources Department and Yap Fishing Authority, each with its own areas of concern:

– Marine Resources Department (MRD) has responsibility for marine research, fisheries management, data collection and projects such as clam aquaculture within the lagoon.

– Yap Fishing Authority (YFA) is directly engaged in promoting local fisheries, providing technical and material support for fishermen and the negotiation of fishing access agreements with foreign fishing interests.

During the course of this visit a small export market was established in the airfreighting of chilled, high-value species to Guam and Saipan. Most of these consignments derived from catches taken by the YFA vessel *Crockodile Maru*, a converted Taiwanese-built longliner confiscated by the YFA, which made a number of fishing trips to Ngulu atoll.

3. PROJECT OPERATIONS .

3.1 General

All fishing trips conducted during this visit originated at Colonia and all catches were landed there. Most trips ranged around Yap proper, either along the outer reef-slope, or offshore, in transit between base and FAD sites or in the vicinity of FADs. Two trips were made to Ngulu atoll, each one involving a three-day round trip.

A major Project activity involved the supervision by the Masterfisherman of the rigging and deployment of five FADs, under the direction of the Yap Community Action Program (YAPCAP) with the assistance of YFA personnel.

Some fishing time was lost following a major mechanical breakdown in the Project's assigned fishing vessel and a long delay in securing spare parts. A smaller fishing craft used during this period was limited in its range and effectiveness by persistently strong north-east trade winds and rough sea conditions.

3.2 Boats and equipment

A 9.7 m (32 ft) fibreglass, diesel-powered launch, the *Mgerger* (Figure 2*)*, was assigned for Project use during this visit. This vessel, owned by YFA, was powered by a 3TE30 Yanmar motor, and was in generally good condition. Two 200 l (50 U.S. gallon) fuel tanks and four integral ice-holds were fitted below deck; three of these ice-holds situated forward. Portable ice-boxes were carried on deck for ease of landing. When fully laden for fishing, the vessel was heavy by the bow and tended to consume excessive fuel with a head sea. It was usually necessary to stow all added weight, apart from catches, toward the stern to counteract this.

The deck hatch-covers (illustrated in Figure 2) proved to be poorly designed; being at different levels, spaced only 10 cm (4 in) apart (providing a trap for feet), and providing unsure footing in all but calm conditions. The vessel was equipped with a Furuno echo-sounder, with a depth range to 450 m (250 fathoms), and a compass.

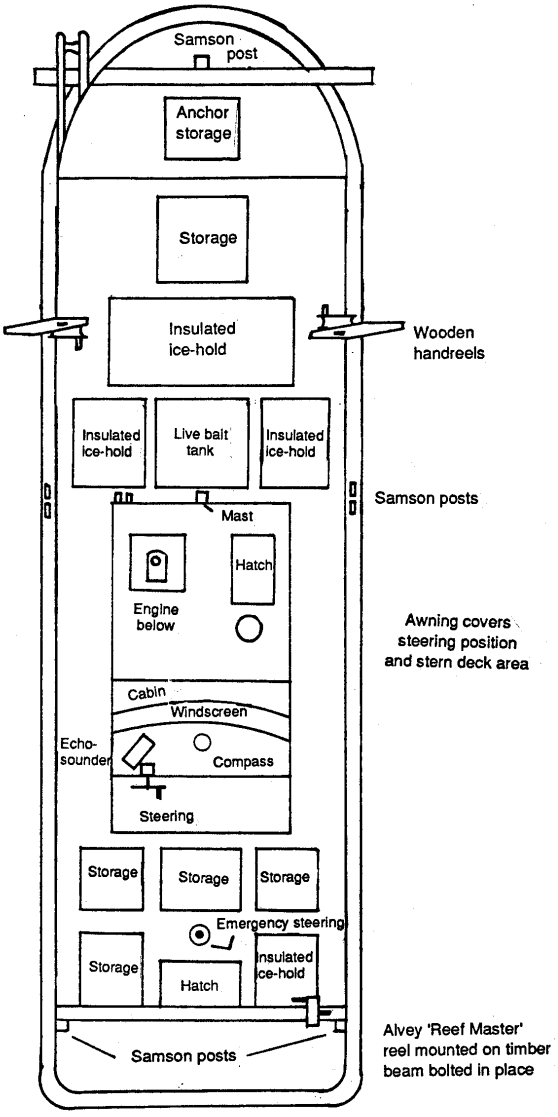

***Figure 2: Deck layout of the* Mgerger**

Two FAO, Western Samoan-design handreels (Figure 3) were mounted toward the bow. A third, metal-framed handreel, was fitted near the stern and used during early trips.

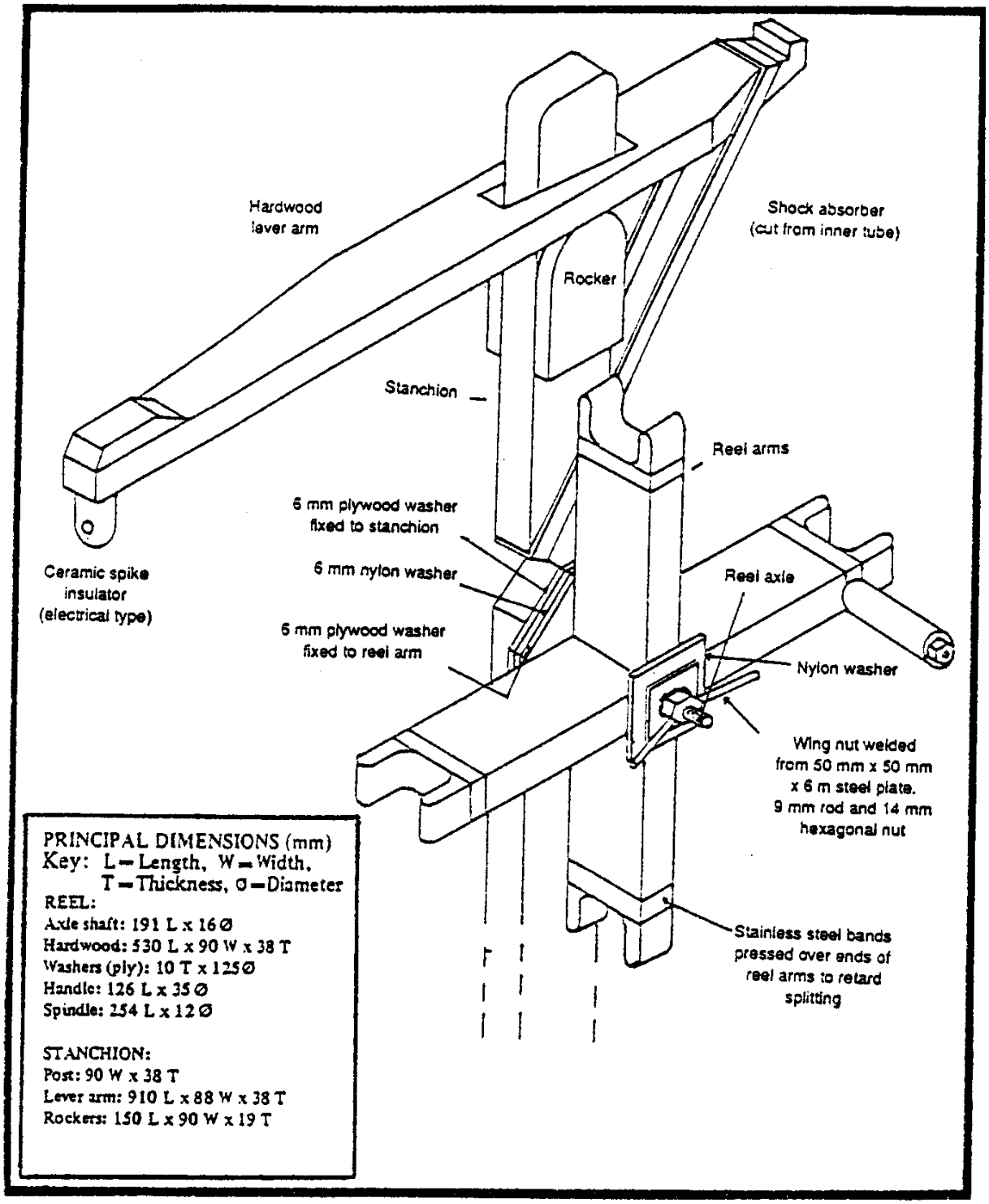

Figure 3: FAO, Western Samoan-design wooden handreel used by the Project

Following the breakdown of the *Mgerger*, the MRD made available a fibreglass 5.2 m (17 ft) Boston Whaler. This outboard-powered vessel was employed for fishing over seven weeks while awaiting repairs to be effected on the *Mgerger*, but was found to be generally unsuitable for offshore work in the weather and sea conditions prevailing at that time. Two trips were made aboard a privately-owned 6.7 m (22 ft) diesel-powered timber whaleboat.

Bottom anchoring gear for the *Mgerger* consisted of a simply-constructed grapnel anchor, 400 m (440 yds) of 12 mm (1/2 in) diameter polypropylene anchor warp, and an inflatable balloon buoy, as illustrated in Figure 4. A parachute-type sea anchor was also used occasionally when bottom-fishing while drifting, this is illustrated in Figure 5.

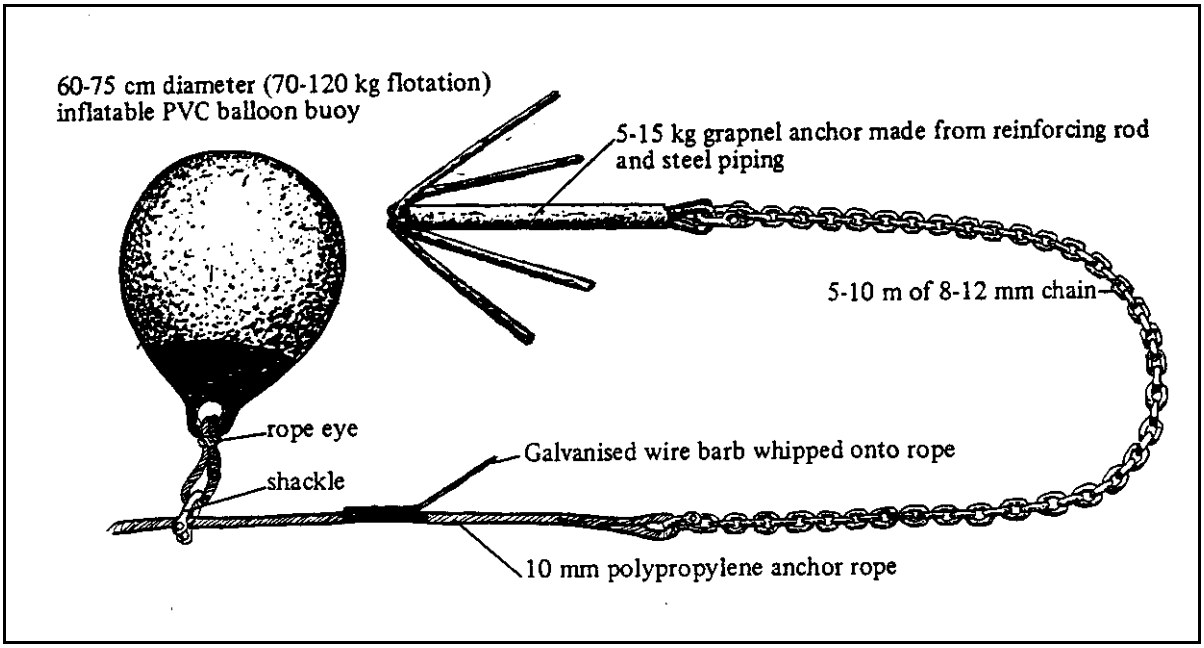

Figure 4: 'Self-hauling' anchor gear

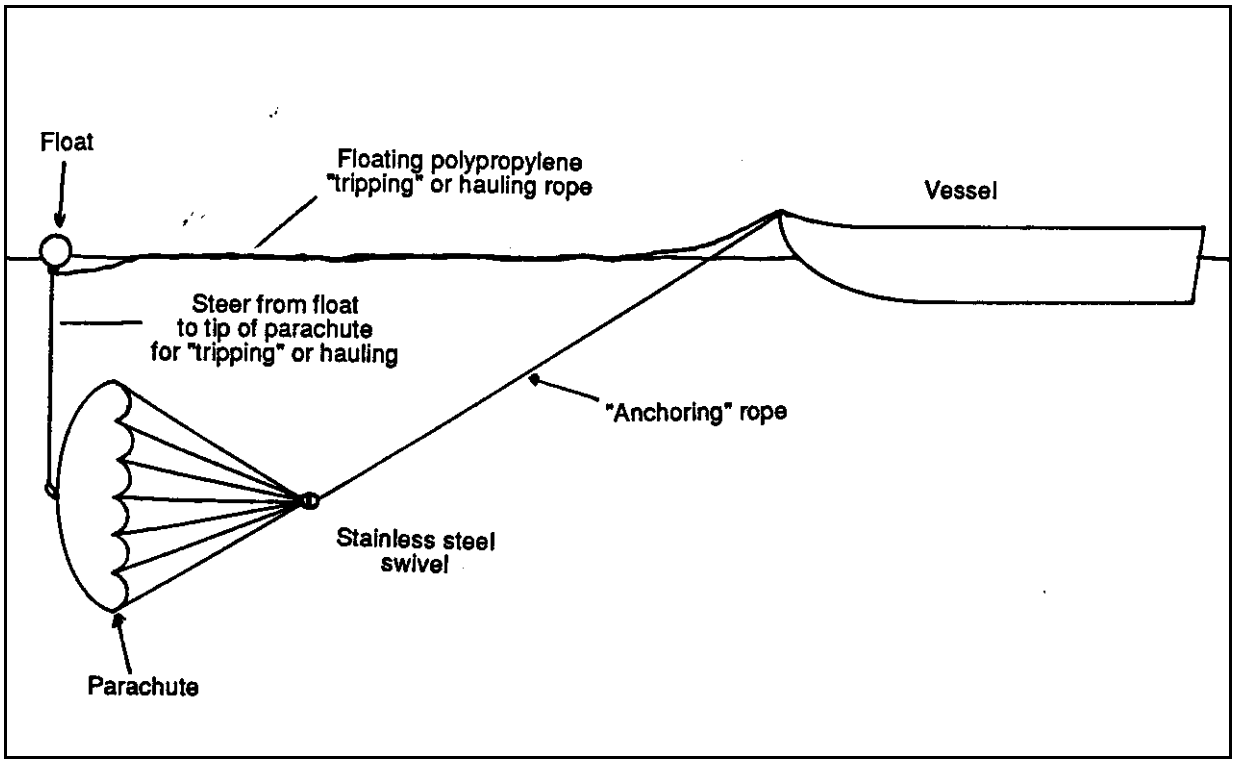

Figure 5: Parachute sea-anchor used by the Project

3.3 FAD rigging and deployment

An important part of the Project's work programme involved the supervision by the Masterfisherman of a FAD rigging and deployment programme sponsored by YAPCAP. Materials for fifteen FADs were supplied under a U.S. Government grant and arrived in Yap some three weeks after the commencement of the Project visit.

While awaiting the arrival of the mooring materials work was done on the 1.4 m (54 in) spherical steel buoys to be used as FAD floats and the construction of concrete block anchors was undertaken by the locally-based, U.S. Navy Civil Action Team.

FADs were rigged after the design standards recommended by the SPC report published following the Fifteenth SPC Regional Technical Meeting on Fisheries, 1983, which reviewed previous SPC studies of FAD design in the Pacific region (Boy and Smith, 1984). Some of the FADs were deployed with bamboo rafts attached by a variety of tethering systems.

Table 1 details the standard components for this design and indicates their incorporation in the six FADs rigged during the visit. Figure 6 illustrates the design arrangement.

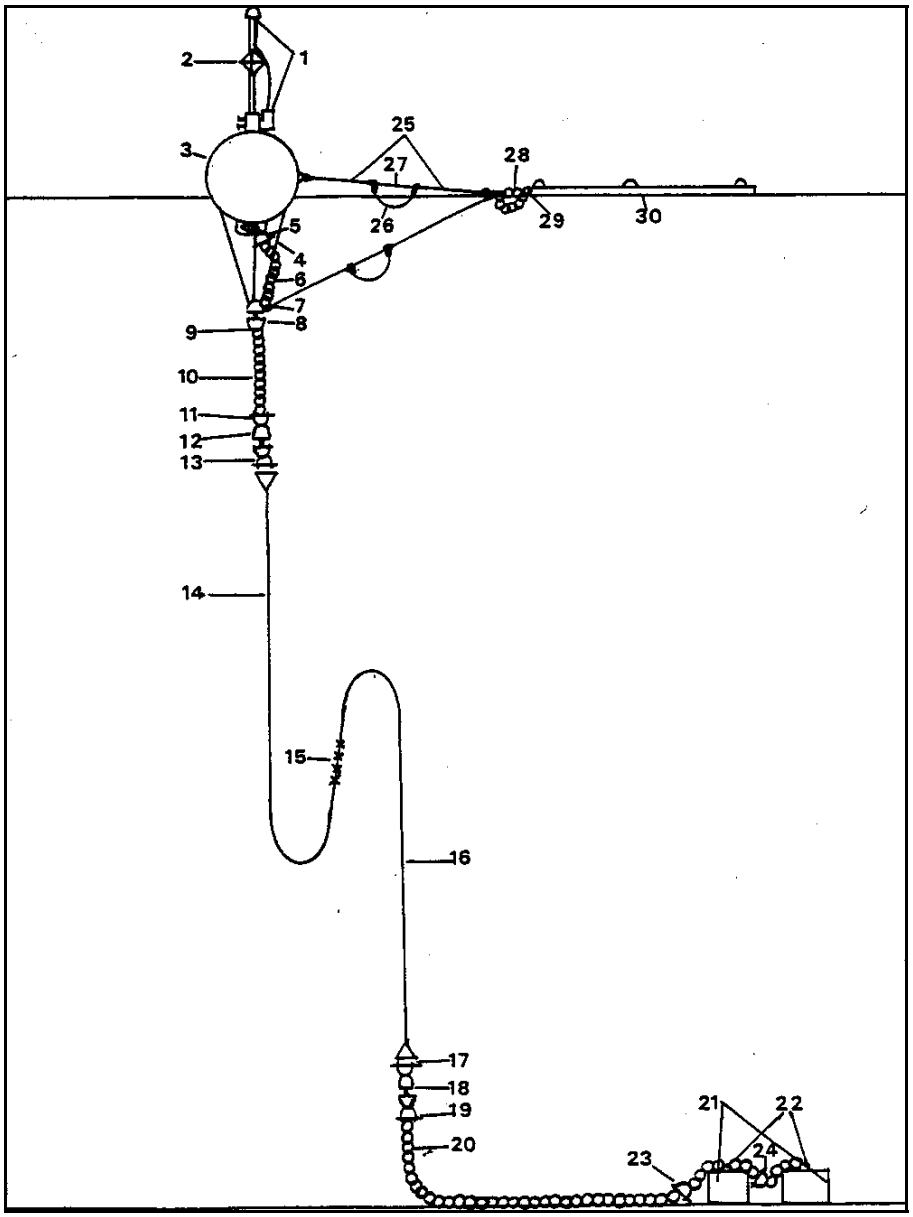

Figure 6: SPC-recommended FAD design

Table 1: Standard components of the SPC-recommended FAD design and their incorporation in the six FADs rigged by in the DSFDP at Yap

Component number	Description	Incorporation in FADs rigged (X indicates the use of the component)					
		FAD 1	FAD 2	FAD 3	FAD 4	FAD 5	FAD 6
1	Battery-operated beacon light					X	X
2	Radar reflector	X	X	X	X	X	X
3	1.4 m (54 in) diameter spherical steel buoy	X	X	X	X	X	X
4	1.8 m x 30 mm (6 ft x 1 ¼ in) diameter galvanized pipe tripod counterweight	No counter weight,	X	X	X	X	X
5	19 mm (¾ in) galvanized safety shackle	chain	X	X	X	X	X
6	2.1 m x 19 mm (7 ft x ¾ in) galvanized safety chain	shackled	X	X	X	X	X
7	16 mm (5/8 in) safety shackle	directly	X	X	X	X	X
8	16 mm (5/8 in) eye-to-eye swivel welded to tripod	to buoy	X	X	X	X	X
9	16 mm (5/8 in) safety shackle	X	X	X	X	X	X
10	15 m x 12 mm (50 ft x ½ in) galvanized chain	X	X	X	X	X	X
11	16 mm (5/8 in) safety shackle	X	X	X	X	X	X
12	16 mm (5/8 in) eye-to-eye swivel	X	X	X	X	X	X
13	Eye splice in rope, 12 mm (½ in) Nylite thimble	X	X	X	X	X	16 mm shackle
14	16 mm (5/8 in) diameter x 12 strand nylon rope	X	X	X	X	X	X
15	End-to-end splice between nylon rope and polypropylene rope	overlap splice	X	X	X	X	X
16	12 strand, 19 mm (¾ in) diameter polypropylene rope	X	X	X	X	X	X
17	Eye splice in rope with Nylite thimble and 15 mm (5/8 in) shackle	X	X	X	X	X	X
18	15 mm (5/8 in) galvanized eye-to-eye swivel	X	X	X	X	X	X
19	19 mm (¾ in) galvanized safety shackle	X	X	X	X	X	X
20	30 m (100 ft) of 19 mm (¾ in) galvanized chain	X	X	X	X	X	X
21	Rectangular concrete blocks, approx. 680 kg (1,500 lb) each	X	X	X	X	X	X
22	2.4 m (8 ft) of 19 mm (¾ in) galvanized chain set in block	reinfor-cing rod eye	X	X	X	X	X
23	16 mm (5/8 in) safety shackle	X	X	X	X	X	X
24	2 x 19 mm (¾ in) safety shackles	1 shackle	X	X	X	X	X
25	19 mm (¾ in) diameter nylon connecting rope					X	X
26	19 mm (¾ in) diameter x 3 strand nylon safety rope					X	X
27	25 mm (1 in) rubber shock absorber					X	X
28	5 mm (3/16 in) galvanized chain		lost	lost	lost	X	X
29	19 mm (¾ in) reinforcing rod through bamboos	lost				X	X
30	9 x 2.4 m (8ft) bamboo lengths made into raft					X	X

The components used varied from the SPC-recommended standard as follows:

Items 1 and 9 — Recommended 19 mm (3/4 in) shackle was replaced by 16 mm (5/8 in) size, because 19 mm shackle would not fit through the eye of 13 mm (1/2 in) link chain.

Item 13 — Recommended 16 mm (5/8 in) safety shackle and matching thimble was replaced by 13 mm (1/2 in) shackle and Nylite thimble, as per manufacturer's specifications for 16 mm (5/8 in) diameter nylon rope.

Item 17 — Recommended 19 mm (3/4 in) safety shackle and matching thimble was replaced by 16 mm (5/8 in) safety shackle and Nylite thimble, as per manufacturer's specifications for 19 mm (3/4 in) polypropylene rope.

Item 21 — Recommended single concrete anchor was replaced by 2 smaller blocks for ease of handling on small craft.

Five of the FADs rigged were deployed around Yap proper under the supervision of the Masterfisherman, the sixth was deployed off Ulithi atoll by local counterpart officers. An inspection and maintenance programme was initiated to monitor the FADs' survival; this, and other details of depth, location and raft connection components are given in Table 2.

Table 2: Details of depth, location, survival and raft connection component

	FAD 1	**FAD 2**	**FAD 3**	**FAD 4**	**FAD 5**	**FAD 6**
Deployment date	8/8/84	6/9/84	12/9/84	19/9/84	20/2/85	14/3/85
Depth - designed	700 fa (1,280 m)	700 fa (1,280 m)	800 fa (1,463 m)	600 fa (1,097 m)	650 fa (1,188 m)	650 fa (1,188 m)
Depth - deployed	640 fa (1,170 m)	600 fa (1,097 m)	750 fa (1,371 m)	560 fa (1,024 m)	650 fa (1,188 m)	620 fa (1,133 m)
Status at close of Project visit (4 April 1985)	In place	Lost (28/10/84)	Lost (27/1/85)	In place	In place	In place
Duration of deployment (to 4 April 1985)	239 days	52 days	143 days	197 days	43 days	21 days
Assessment of loss		Rope failure through abrasion	Unknown			
Bottom gradient	Mostly level	Very steep	Very steep	Mostly level	Very steep	Moderate slope
Distance offshore	6.4 km (4 miles)	2.4 km (1.5 miles)	3.2 km (2 miles)	10.5 km (6.5 miles)	2.4 km (1.5 miles)	4.0 km (2.5 miles)
Approximate position	9° 27'N 138° 14'E	9° 31'N 138° 4'E	9° 38.5'N 138° 8.5'E	9° 20.5'N 138° 0'E	9° 37'N 138° 14'E	10° 2.5'N 139° 50'E
Maintenance inspections	SCUBA check to 18 m (60 ft)	-	-	-	-	-
Stainless steel cotter pins used on all shackles	No	Yes	Yes	Yes	Yes	Yes
SURVIVAL OF RAFT CONNECTIONS TO FAD	**DURATION**					
Single rope	7 days	7 days	7 days	-	-	-
Single rope with shock absorber	120 days	-	-	25 days	-	-
Chain	-	7 days	7 days	7 days	-	-
Double rope with shock absorber	-	-	-	-	In place	In place
Stainless steel cotter pins used on all shackles	No	Yes	Yes	Yes	Yes	Yes

The two FADs lost within a relatively short period were deployed on steeply sloping bottoms. FAD 2 was recovered and expert analysis of the mooring line by Dr B. Prindle of the U.S. Coastguard indicated that the failure occurred through abrasion, presumably by the mooring rope making contact with the bottom; the scope of the mooring rope was therefore probably excessive. It is likely that the failure of FAD 3 had similar causes.

3.4 Training activities

Although not scheduled as a major activity, training played an important role in the visit. Fourteen fisheries personnel participated in at least one fishing trip, as did a total of 42 local fishermen or government officials.

The participation of trainees and observers was organised on an informal basis. All those who expressed interest in the Project's activities were accommodated where possible. The interest generated by Project catches was considerable, especially in the latter stages of the visit. In support of the ongoing FAD programme four fisheries personnel underwent comprehensive training in FAD rigging techniques; in particular, eye-splicing and butt-splicing of 3-strand and 12-strand nylon and polypropylene rope.

3.5 Fishing methods

Of the 705.5 hours spent at sea during this visit, discounting sea-time involved in FAD deployment, a total of 520.5 hours was spent engaged in a variety of fishing methods. Early fishing effort was devoted to deep-bottom droplining along the outer reef-slope around Yap proper, both at anchor and drifting under parachute sea-anchor. Once the FAD programme was under way and the first devices deployed, trolling became the primary fishing activity, both along the outer reef drop-off and in the vicinity of the FADs in order to sample the species gathered there.

A variety of FAD-fishing techniques were engaged in experimentally once the FADs had ‘matured’; including vertical longlining, mid-water handlining by the palu ahi technique, the use of a drifting mid-water line designed to take sharks, and handlining. One trip was devoted to scooping flying fish at night in an attempt to capture bait. A description of these techniques and the catches recorded by each is contained in Section 4.

3.6 Disposal of the catch

Catches landed became the property of the boat captain in compensation for unpaid overtime worked in support of the Project; although the boat captain was also responsible for meeting fuel bills and for boat maintenance from these sale revenues.

Catches were most often sold to the public market in Colonia, which was supplied with ice by YFA. On occasions when the market was closed, catches were sold directly to private retail outlets around Colonia. For a period of three weeks, when the market shut down for renovation, YFA purchased the Project catch for later re-sale.

Fish were sold chilled and unprocessed, as determined by local preference, at US$1.76 kg (US$0.80 lb) for most deep-water and pelagic species, and US$1.10 kg (US$0.50 lb) for less favoured species including red bass (*Lutjanus bohar*), groupers and cods. Although part of the catch of sharks was processed and offered for sale, a strong local resistance to consuming these fish meant that it was unsaleable. Sharks were therefore either dumped or given to the Department of Agriculture for use in experimental pig feed. During the last few weeks of the Project stay, substantial tuna catches taken by local fishing boats around the FADs produced an oversupply on the local market.

3.7 Data collection

SPC Masterfishermen use a standard data form, shown at Appendix 1 to maintain detailed records of each fishing trip. During this Project visit, data collected on each trip included; 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 identification of each fish caught, where this could be determined; and the total number and weight of each species taken.

4. FISHING ACTIVITIES AND RESULTS

4.1 General

The majority of the 87 fishing trips completed involved a combination of fishing methods; the use of a particular method being determined by the purpose of the trip (whether surveying bottom resources or monitoring the FADs), training considerations, and weather and sea conditions.

The most commonly combined techniques were reef/open-water trolling and FAD trolling; which together occupied 345 fishing hours (74% of overall fishing time around Yap proper), as a consequence of the importance of the FAD monitoring programme and the opportunistic fishing done in transit to FAD sites.

Deep-bottom droplining was the next most common fishing activity. At Yap proper this technique was most commonly used during the early stages of the visit — before the FADs were deployed — but only occasionally thereafter. At Ngulu atoll the technique was used during all four trips completed.

A total of 22.5 hours was devoted to a variety of experimental fishing techniques used to sample the presence of various species of fish around the FADs, and two hours were devoted to the scooping of flying fish. Trips conducted around Yap proper are detailed in Appendix 2A and those at Ngulu atoll in Appendix 2B.

4.2 Trolling

Trolling along the outer reef drop-off, or in open-water between the Project base and FAD sites, was largely opportunistic in nature. Lines were usually trailed whenever the boat was under way, in order to maximise fishing effort for time spent at sea. On occasion, this fishing method was used specifically to take fish along productive stretches of reef or in areas where surface schooling fish were observed.

The wooden handreels were used for trolling. Lines were trailed directly from the reels with a clip-swivel fitted to the terminal end for attachment of leaders and lures. A third reel, a commercially produced Alvey Reef Master, loaded with 300 m (330 yds) of 125 kg (275 lb) test 7 x 7 strand stainless steel wire, and fitted with a clip-swivel for trace and lure or bait attachment, was used for sub-surface trolling. Fixed-length trolling lines were also trailed directly from the stern. These incorporated a length of shock-cord to lessen the likelihood of the gear breaking when struck and were useful in taking smaller fish quickly.

When fishing the reef drop-off, the boat was driven parallel to the reef edge at the point where the reef-slope could be seen to descend into blue-water. Lines were fitted with large pearl-heads dressed with 125–200 mm (5–8 in) vinyl skirts rigged on wire traces to take the species which commonly inhabit this area; principally barracuda (*Sphyraena* spp.), dogtooth tuna (*Gymnosarda unicolor*), and trevallies (family Carangidae). By moving 50–100 m (55–110 yds) further offshore, catch composition usually changed to include wahoo (*Acanthocybium solandri*), tunas (family *Thunnidae*), and dolphinfish (*Coryphaena hippurus*).

Trolling in the vicinity of FADs offers a good opportunity to vary the elements of fishing effort in order to arrive at an effective combination. Fish around FADs may be expected to be gathered in a relatively confined area, so that if none are taken with a particular combination of line weights, lure sizes and colours, and boat speeds, these may be varied until strikes are made. Other variables, including time of day, sea condition, position in relation to the FAD, and light, are also likely to affect fishing success.

When trolling around the FADs, initial passes were usually made quite close to the buoy while trailing the larger lures used along the reef edge, targeting larger fish which might be feeding in the area. Thereafter it was usual to change to 8–12 mm (5/16–1/2 in) pearl heads dressed with 75 mm (3 in) vinyl skirt and rigged on monofilament nylon. These lures target the smaller tunas which commonly gather at FADs, particularly skipjack tuna (*Katsuwonus pelamis*) and yellowfin tuna (*Thunnus albacares*). It was found that these fish usually remained close to the FAD, and upcurrent of it, at first light and dispersed as the day progressed, though invariably preferring the upcurrent side of the FAD (presumably gathered along the line of the mooring gear which will always angle toward current direction).

FAD-associated trolling was the most productive of the fishing techniques employed during this visit; producing 43.6 per cent of the total catch by all methods in 23.2 per cent of the overall fishing hours.

The catch rate or CPUE (catch per unit of effort - one unit of effort being calculated as the use of one trolling line for one hour) recorded for the technique was high, at 8.4 kg (18.5 lbs)/line hour. This figure represents a satisfactory return for effort expended and a much higher catch rate than those recorded for reef/open-water trolling at Yap proper (1.1 kg[2.4 lbs]/line hour), and at Ngulu atoll (3.0 kg[6.6 lbs]/line hour). A total of 256 hours engaged in reef/open-water trolling (49.2% of overall fishing time) produced only 16.4 per cent of the overall catch. Table 3 summarises catch and effort for open-water/reef trolling conducted at Yap proper and at Ngulu atoll, and Table 4 catch and effort for FAD-associated trolling around Yap proper only (Yap proper being the only area where this technique was used).

Table 3: Summary of catch and effort by reef/open-water trolling at both areas fished

Location	No. of trips	Fishing hours	Effort (line hours)	Saleable catch		Unsaleable catch		Total catch (kg)	CPUE (kg)
				No.	Weight (kg)	No.	Weight (kg)		
Yap proper	72	224.0	446.0	115	475.9	0	0.0	475.9	1.1
Ngulu atoll	4	32.0	94.5	50	283.1	0	0.0	283.1	3.0
Total	**76**	**256.0**	**540.5**	**165**	**759.0**	**0**	**0.0**	**759.0**	***1.4**

*Average CPUE for both areas.

Table 4: Summary of catch and effort by FAD-associated trolling at Yap proper

Location	No. of trips	Fishing hours	Effort (line hours)	Saleable catch		Unsaleable catch		Total catch (kg)	CPUE (kg)
				No.	Weight (kg)	No.	Weight (kg)		
Yap proper	67	121.0	242.0	1,486	2,024.1	0	0.0	2,024.1	8.4

The higher catch rate recorded for reef/open-water trolling at Ngulu atoll as compared to Yap proper may be attributed, at least in part, to the island having a very extensive reef system but only a tiny population to exploit it.

Only a small component of the troll catch by both methods was of unsaleable species, comprising two small sharks (*Carcharhinus falciformis*). The balance of the catch (2,783.1 kg[6,137 lbs]) was made up almost entirely of pelagic species and dominated by tunas (63.0% of the total catch by weight), of which yellowfin tuna and skipjack tuna were the most significant. Other important components of the troll catch were dolphinfish, 18.9 per cent of the total by weight, and wahoo, 14.4 per cent of the total by weight. Appendix 3 details the species composition of the troll catch by both methods and Figure7 presents the species composition of the troll catch by species group, graphically.

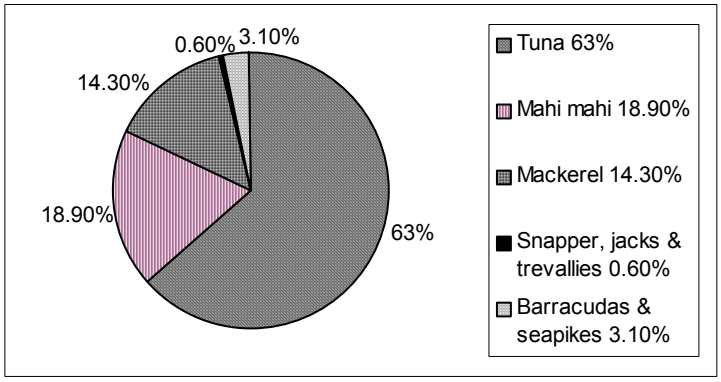

Figure 7: Species composition of the troll catch by group

4.3 Deep-bottom droplining

Fishing at depths between 150 m and 250 m along the outer reef-slope, employing a baited multiple-hook terminal rig which was lowered and hauled by handreel, was conducted at both fishing sites. One of the pair of wooden handreels was wound with 500 m (550 yds) of 130 kg (280 lb) test nylon monofilament and the second with 400 m (440 yds) of 150 kg (330 lb) test *Supertoto* line. Each line was fitted with a wire terminal rig bearing three tuna circle hooks, as shown in Figure 8. Hook sizes most often used were Nos. 5, 6 and 7.

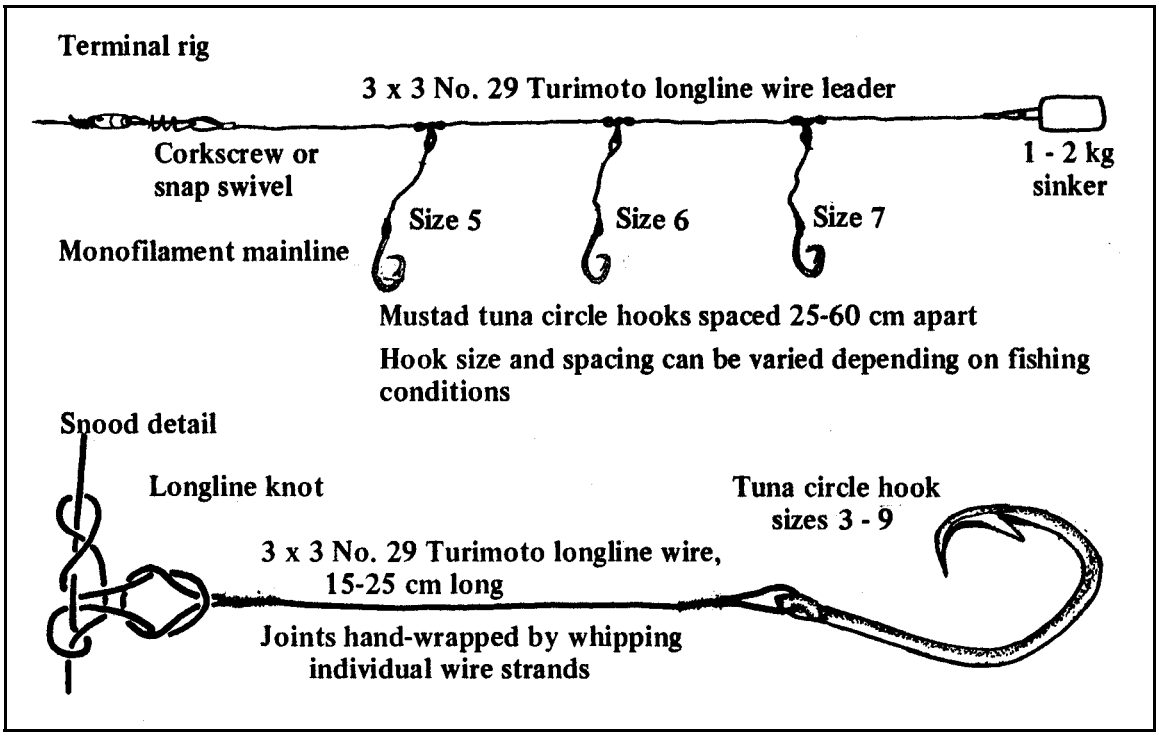

Figure 8: Typical terminal rig for deep-bottom fishing

This technique was used both with the boat resting at anchor and drifting under a parachute sea-anchor.

When fishing was to be conducted at fixed anchor, an area of suitable depth was first identified by echo-sounding. The anchor was then dropped, where possible, in shallower water and in a position selected so that prevailing wind or current would carry the fishing craft back over the selected site as the anchor warp was paid out. At many of the locations fished during this visit wind and current were such that the boat had to be anchored in water of the same depth, or deeper, than that of the chosen fishing site.

Once the boat was resting at anchor a 1–2 kg (2 –4 lb) sinker fitted to the lower part of the terminal rig was used to carry the line to the bottom. Lines were thereafter kept taut by hand to allow the fisherman to respond to bites by striking and to adjust the line in relation to the lift of the boat in swells. Once fish were felt to be hooked four or five turns were quickly taken on the handreel to lift fish clear of the bottom so as to avoid fouling on other lines or the bottom. Because of the elasticity of the long lengths of monofilament nylon line in use much reliance is placed on the self-hooking qualities of the tuna circle hooks. When using Supertoto line, which is non-elastic, care must be taken to play hooked fish, as too much tension may tear the hook from the fish's mouth.

A simple technique was used to retrieve the anchor at the conclusion of fishing or preparatory to moving to a new fishing site, which greatly reduced the effort involved in hand hauling from depth. The boat was motored slowly ahead and slack anchor warp was hauled in until the warp was near vertical. Then, by motoring rapidly forward, the anchor was broken out and then towed until it streamed behind the boat. While still under way the balloon buoy was clipped or shackled onto the anchor warp and released. Water resistance forced the buoy back along the warp until it was trapped by the `no-return' barb whipped in placed (refer Figure 4). The boat was then motored slowly back along the warp, which was fed inboard by hand, and the chain and anchor, suspended at the surface by the buoy, easily recovered.

When strong wind conditions prevented fixed anchoring a parachute sea-anchor was occasionally used so that the fishing craft could drift through the target area. This sea-anchor was also used when the set of local currents was such that the boat could be drifted slowly along the line of suitable depth contours and extensive bottom grounds thus sampled.

Before deploying the parachute anchor the boat was stopped in the selected area and allowed to drift free for a while in order to gauge the set of the current or wind. The boat was then turned bow to wind or current, the floating tripping rope and buoy paid out over one side of the boat, and the parachute, tethered by the sinking nylon line, over the other. Once the parachute was at the full stretch of the tether line, and beginning to open as the boat drifted, deployment could be completed by reversing the boat slowly along the line of drift.

Once the boat was drifting through the desired area, lines were lowered to the bottom and kept taut by hand. It was usually necessary to make constant adjustments to the line length as the bottom contour changed and it proved useful to raise the lines a little every few minutes to lift them clear of bottom obstructions, and to keep them perpendicular.

To retrieve the sea-anchor the parachute was first collapsed by hauling on the tripping line. The tripping line, buoy, and parachute were then hauled on board and the nylon tether line retrieved last.

The best proven bait for deep-bottom fishing is fresh skipjack and this or other tuna was used whenever available. During the early part of the visit, tuna were locally scarce and some consignments were ordered by airfreight from Palau. In addition, attempts were made to capture local baitfish (bigeye scad [*Selar crumenophthalmus*]) and this species proved effective both for deep-bottom droplining and for vertical longlining. Once the FADs began to be effective in gathering small tunas, ample bait was caught regularly.

The species targeted by this fishing technique include the valued deep-water snappers and jobfishes (Lutjanida*e* of the *Etelinae* and Apsilinae sub-families), and sea-breams (*Gnathodentex* and *Gymnocranius* spp.). A wide variety of other deep-dwelling species are also taken, including less desirable Gempylids and sharks. Species characteristic of more shallow depth also commonly occur in catches because both anchoring techniques, and variations in bottom contour, usually result in a range of depths being fished.

The deep-bottom catch comprised 779 fish with a combined weight of 1,830.7 kg (4,037 lbs) or 39.5 per cent by weight of the total catch by all methods; this catch being taken during a total deep-bottom fishing effort of 295 reel hours for a catch rate (CPUE) of 6.2 kg (13.7 lbs)/reel hour.

Table 5: Summary of catch and effort by deep-bottom droplining at both fishing sites

Location	No. of trips	Fishing hours	Effort (line hours)	Saleable catch		Unsaleable catch		Total catch (kg)	CPUE (kg)
				No.	Weight (kg)	No.	Weight (kg)		
Yap proper	23	98.0	230.0	558	1,004.5	17	148.9	1,153.4	5.0
Ngulu atoll	4	22.0	65.0	189	541.3	15	136.0	677.3	10.4
Total	**27**	**120.0**	**295.0**	**747**	**1,545.8**	**32**	**284.9**	**1,830.7**	***6.2**

Note: If sharks are excluded from the catch, CPUE = 5.3
If sharks and other locally unsaleable species are excluded, CPUE = 5.2
*Average for both areas.

As indicated in Table 5, the CPUE recorded during deep-bottom droplining operations at Ngulu atoll at 10.4 kg (23 lbs)/reel hour was more than double the CPUE recorded by this technique around Yap proper (5.0 kg (11 lbs)/reel hour. As with the results of reef/open-water trolling effort at both locations, the better catch rate at Ngulu may be attributed to the extensive deep-bottom fishing grounds there. The grounds around Yap proper appeared quite sensitive to fishing pressure, as successive catches from the same areas tended to diminish.

The unsaleable portion of the catch (284.9 kg [628 lbs] or 15.6% of the total deep-bottom catch by weight) included snake mackerels (*Promethicthys prometheus*) and moray eels (*Gymnothorax* spp.) but was dominated by sharks (*Carcharhinus* spp.). The notoriously ciguatoxic red bass (*Lutjanus bohar*) was readily saleable in Colonia, there being no experience of ciguatoxicity in this species in the areas fished. Although experimental processing and smoking trials were done with shark flesh a strong local tradition against eating shark was apparent.

The saleable portion of the catch, 1,545.8 kg (3,408 lbs) or 84.4 per cent of the total deep-bottom catch by weight, included a high proportion of the valued deep-water snappers (40.8% of the saleable catch by weight) and an adequate proportion of other easily marketable species including emperors and shallow-water snappers (22.8% of the saleable catch by weight). The species composition of this catch is detailed in Appendix 4.

The productivity of this fishing technique on a per trip basis was satisfactory, with an average 67.8 kg (149.5 lbs) of fish (including all species) taken on each of the 27 trips completed. Bait use over these trips amounted to some 115.0 kg, (253.5 lbs), or an average of 4.3 kg/trip (9.5 lbs).

4.4 Vertical longlining

A variety of secondary fishing techniques were employed at one time or another in conjunction with the FAD monitoring programme around Yap proper or, in the case of flying fish scooping, to obtain supplies of bait. Two of these techniques, vertical longlining and mid-water fishing by the palu ahi method, target deep-swimming tunas commonly associated with FADs.

A vertical longline was set on three occasions. This twenty-hook vertical longline was rigged from 6 mm (1/4 in) diameter Kuralon (Japanese longline cord), with heavy duty swivels spliced in place at the head and foot and at 15 m (8 fa) intervals along the line. The swivels served as attachment points for a float at the head, a sinker at the foot, and at the intervals for snoods of 135 kg (300 lb) test monofilament nylon rigged with No 4 or No 5 tuna circle hooks. Figure 9 shows the gear arrangement for this line.

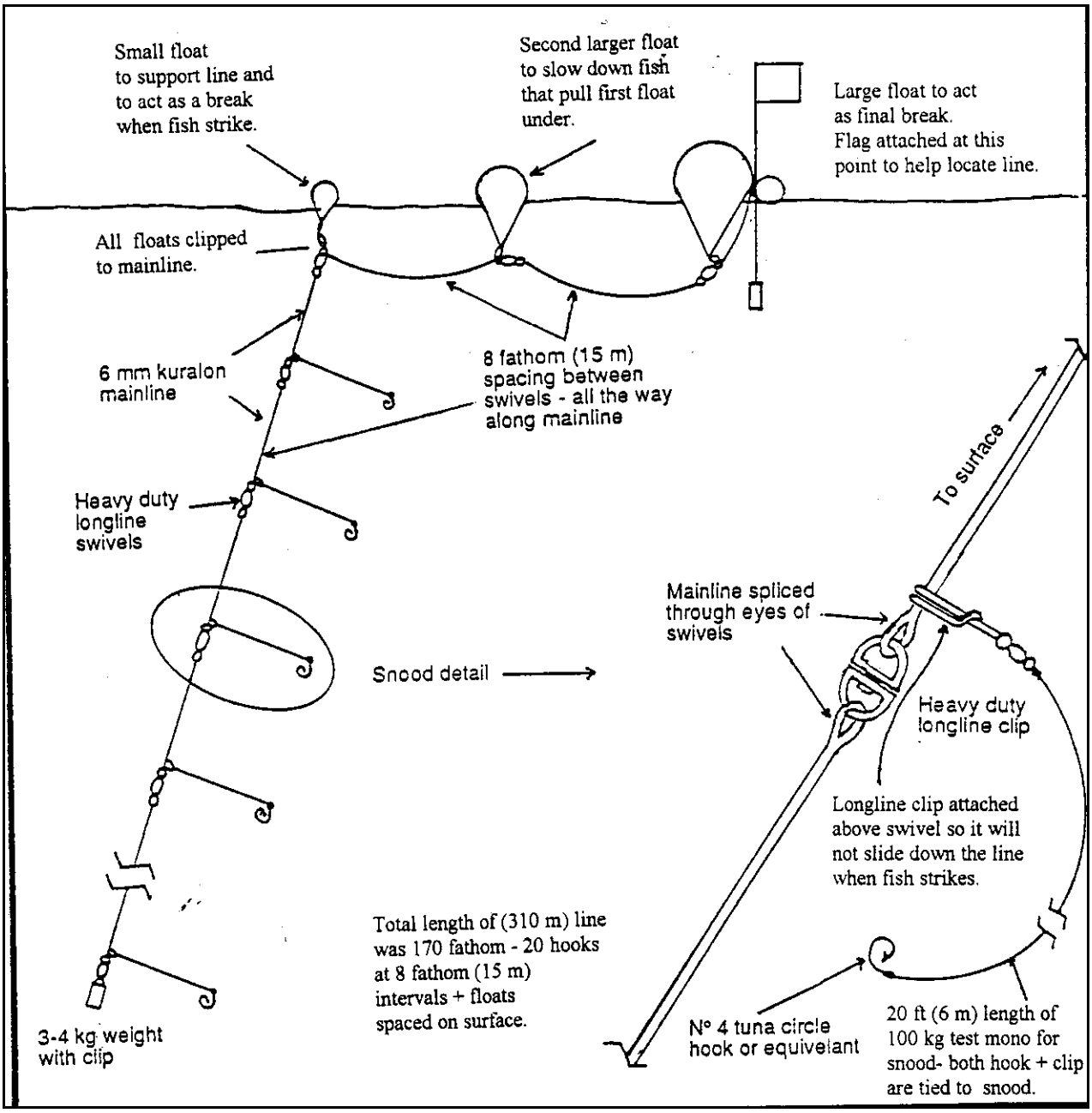

Figure 9: Vertical longline, gear arrangement

The technique employed was to position the fishing vessel approximately 800 m (1/2 mile) up current of the FAD in a position selected so that when cast free the longline would drift close by the FAD fully deployed. Snoods were baited with bigeye scad by inserting a tuna circle hook from the throat and rolling the hook so that the point emerged at the top of the head behind the eyes. The baited hooks were placed in the water and the snoods were then attached to the mainline by one crewman, while another lowered it, the longline clips being snapped onto the line just above the swivels spliced in place. With this arrangement hooked fish were unable to drag the snoods down the line.

Once all snoods were attached and the mainline lowered to the desired depth a small float (sufficient to support the line) was clipped in place. An 15 m (18 fa) length of mainline was then let our and a second, larger float attached. A further 15 m of mainline was then let out and the third, and largest float, complete with a marker flag, attached at the end. The string of progressively larger floats was used so as to provide only enough resistance to set a struck hook without it tearing out.

Although no fish were taken with this gear, the proper hauling procedure is as follows; the floats are first picked up in reverse order to their setting then the mainline hauled by hand. Snoods are unclipped and stowed (or rebaited for the next set) as they appear. When a snood holding a hooked fish is raised the fish should be boated and killed before the snood is unclipped or, in the case of sharks, tailroped and secured alongside before unclipping. The fact that no catch was taken by this method, which has proven effective elsewhere, indicates that the large tunas targeted by the technique had not yet gathered at these newly deployed FADs.

4.5 Palu ahi fishing

The mid-water handlining technique known as palu ahi fishing derives from a traditional Polynesian technique for capturing deep-swimming tunas. This mid-water handline had as its main component 450 m (500 yds) of 135 kg (300 lb) test braided dacron. The line was passed through the eye of a heavy-duty swivel and a second, similar, swivel then fitted to the end. This swivel served as the attachment point for a 3 m (10 ft) monofilament nylon leader bearing a tuna circle hook. A flat lead sinker, around 1 kg (2 lb) in weight, was attached to the free-running swivel by a 15 cm (6 in) length of line, and a 30 cm (12 in) square of durable cloth also tied to this swivel by one corner. This arrangement is illustrated in Figure 10.

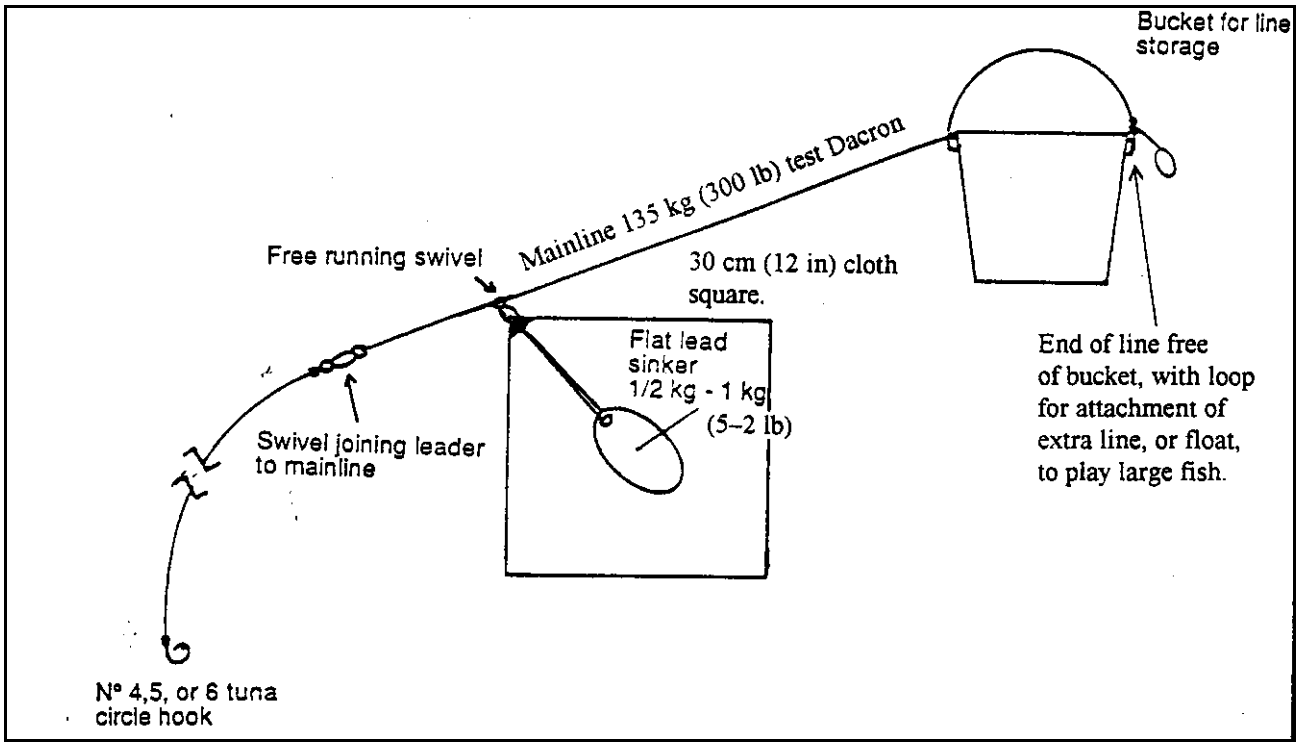

Figure 10: `Palu ahi' line; gear arrangement

This gear is used to carry a baited hook and chum to a predetermined depth where the release of a slip knot presents the unencumbered hook in a chum trail.

To prepare the gear for fishing, the nylon leader was rolled into a coil about 100 mm (4 in) in diameter and laid on the square cloth underneath the flat lead sinker. The hook, baited with a whole bigeye scad, was laid on the lead's upper face so as to avoid tangling with the leader on deployment. A handful of chum, consisting of green-coconut flesh, bread, and chopped baitfish, was placed over the bait and the cloth then folded over to form a parcel. The corner attached to the mainline was folded last.

Before dropping the parcel, the boat was manoeuvered upcurrent of the FAD in a position selected so that wind or current would drift the boat close by it. If winds were strong the parachute sea-anchor was used to retard the boat's drift. Once drifting correctly, some slack line was paid out into the water and the mainline

checked to ensure that it would run freely. The parcel was then dropped and when it had reached the desired depth, measured by knots previously tied into the mainline, the line was jigged vigorously to release the slip-knot. Once the bait parcel was felt to unroll about 3–5 m (2 fa) of line was quickly hauled in. This had the effect of pulling the cloth and sinker away from the bait, at the same time straightening the coiled leader to lessen the possibility of it tangling on the hook. Thereafter, the mainline was held by hand and gradually let out at a rate estimated to match that of the sinking chum. The length of time before hauling and moving upcurrent to repeat the process depended on the fisherman's judgment and the rate of drift through the target area.

When a fish is taken by this method it is played by hand, with care taken, once the sinker and cloth are raised, to keep the sinker free of any obstructions on the boat in case the fish makes another run. Any inhibiting of the free run of the mainline through the swivel eye could result in line breakage when playing a large fish.

4.6 Miscellaneous fishing techniques

The drifting mid-water shark line illustrated in Figure 11 was set near the FADs on several occasions, most often baited with a live, freshly-caught, small tuna. The hook was inserted either just behind the head or near the tail so that the fish would stay alive for some time. Tuna hooked in this way tend to swim deep as soon as released and can be very effective in attracting strikes by billfish and other large predator fish. Once set, this line was allowed to drift and kept under observation while other fishing activities continued.

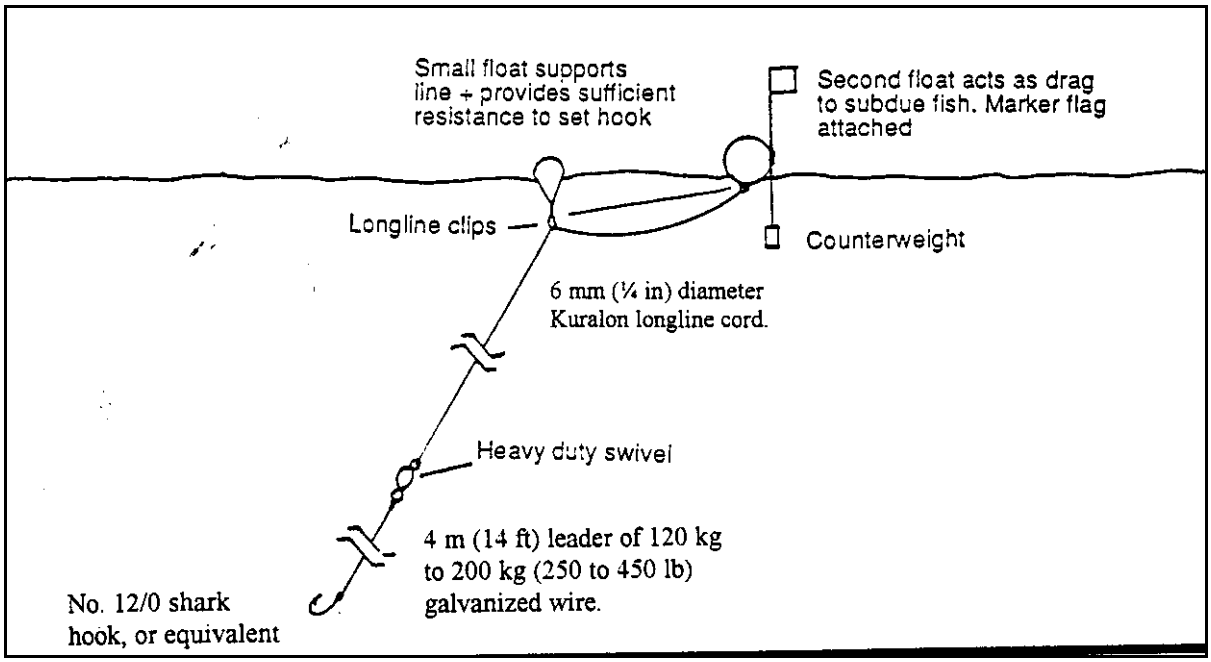

Figure 11: Drifting mid-water shark line; gear arrangement

Light handlines rigged with small baited hooks were occasionally used around the FADs to sample the composition of species gathered. The catch by this method included small rainbow runner (*Elegatis bipinnulata*) and oceanic triggerfish (*Canthidermis maculatus*).

A night trip was made from Colonia to capture flying fish with scoop nets. This technique employs a light source to attract and blind the fish and long handled scoop nets to take the fish from the water. The catch of 33 fish (family Exocetidae) was later used for bait in support of FAD fishing trials. Table 6 summarises the

catch and effort recorded for each of these secondary fishing activities. All of these methods were employed only around Yap proper. The species composition of catches by these methods is detailed in Appendix 5.

Table 6: Summary of catch and effort by vertical longlining, Palu ahi fishing and miscellaneous fishing techniques conducted around Yap proper

Fishing method	No. of trips	Fishing hours	Effort (line hours)	Saleable catch		Unsaleable catch		Total catch (kg)	CPUE (kg)
				No.	Weight (kg)	No.	Weight (kg)		
Mid-water S. Line	7	10.5	11.5	0	0.0	1	8.0	8.0	0.7
Handline FAD	5	5.0	3.5	16	6.6	0	0.0	6.6	1.9
Vertical longline	3	5.0	9.8	0	0.0	0	0.0	0.0	0.0
Flying fish netting	1	3.0	3.0	33	6.0	0	0.0	6.0	2.0
Palu-ahi	1	2.0	4.0	0	0.0	1	3.0	3.0	0.8
Total	**17**	**25.5**		**49**	**12.6**	**2**	**11.0**	**23.6**	

5. FISHING AREAS

5.1 Yap District

Figure 12 shows the four islands forming Yap proper, the site of the Project base at Colonia, deep-bottom fishing sites, and the approximate position of the five FADs deployed in this area. The four islands which form the cluster are encircled by a barrier reef, broken in a number of places by passages into the lagoon. Deep-bottom fishing surveys conducted offshore from Rumung island showed the outer reef-slope to be very steep with an abrupt drop-off. Surveys offshore from Map island and between the Pelak Entrance and Tamil Harbor mouth, where the outer reef lies further offshore, presented a milder, but still quite steep, bottom slope.

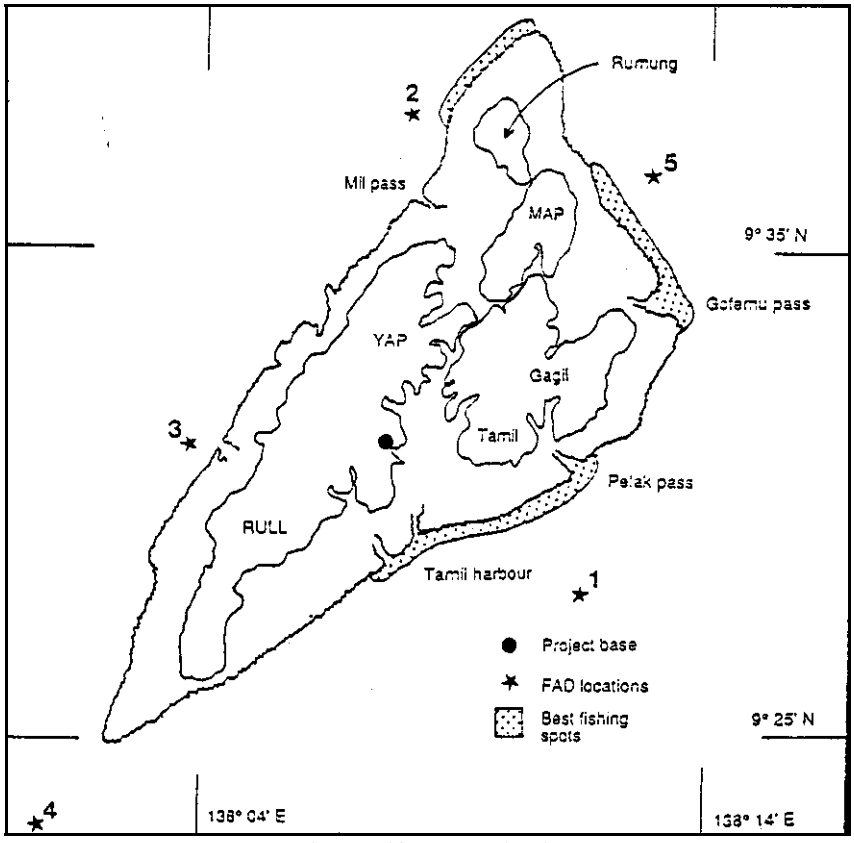

Figure 12: Yap District

Weather conditions were generally favourable during the early part of the visit, but later strong north-east trade winds limited deep-bottom fishing activity; deep-bottom grounds along the lee shore being subject to strong currents or having unsuitably steep bottom slopes. With the loss of the two FADs situated in the lee of the island (FADs 2 and 3) fishing effort had to be directed to the windward FADs. The planned programme of mid-water FAD fishing trials, although conducted occasionally, was largely curtailed due to the rough sea conditions and the absence of the deep-swimming tunas targeted. Most FAD fishing effort was therefore devoted to trolling — the most effective monitoring technique in the circumstances.

The catches by the two main fishing methods were quite satisfactory, as shown in Table 7, indicating good potential for the development of these fisheries around Yap proper. The results of the experimental FAD fishing trials were inconclusive for the reasons given, but it is likely that the FADs will become quite productive once they 'mature'.

Table 7: Summary of catch and effort for each fishing method employed at Yap district

Fishing method	No. of trips	Fishing hours	Effort (line hours)	Saleable catch		Unsaleable catch		Total catch (kg)	CPUE (kg)
				No.	Weight (kg)	No.	Weight (kg)		
Droplining	23	98.0	230.0	558	1,004.5	17	148.9	1,153.4	5.0
Trolling 1	72	224.0	446.0	115	475.9	0	0.0	475.9	1.1
Trolling 2	67	121.0	242.0	1,486	2,024.1	0	0.0	2,024.1	8.4
Mid-water S. line	7	10.5	11.5	0	0.0	1	8.0	8.0	0.7
Handline FAD	5	5.0	3.5	16	6.6	0	0.0	6.6	1.9
Vertical longline	3	5.0	9.8	0	0.0	0	0.0	0.0	0.0
Flying fish netting	1	3.0	3.0	33	6.0	0	0.0	6.0	2.0
Palu-ahi	1	2.0	4.0	0	0.0	1	3.0	3.0	0.8
Total	***83**	468.5		**2208**	**3,517.1**	**19**	**159.9**	**3,677.0**	

Trolling 1 = Trolling reef-edge and open water
Trolling 2 = Trolling around FAD's
*Some trips combined more than one fishing method

5.2 Ngulu atoll

Figure 13 shows Ngulu atoll and the areas fished by deep-bottom droplining during the four trips conducted there by the Project. Ngulu lies some 200 km (125 miles) to the south-west of Colonia and two visits were made there, each involving three-day round trips. Approximately two days were spent at the atoll on each trip, and two fishing trips completed each visit.

Ngulu's lagoon is some 16 km x 25 km (10 miles x 15 miles) in extent, fringed by numerous sandy islets. There is only one permanent settlement located on an islet in the south-east corner of the lagoon, and a total population of only 20.

The two trips to Ngulu were made during periods of calm weather. Later projected trips were cancelled because conditions were unsuitable. The limited fishing time allowed only a small area to be surveyed, most effort being concentrated around the northern tip of the island. Catch rates by both fishing techniques employed were considerably higher than those recorded around Yap proper, as indicated in Table 8. It was apparent that both deep-bottom stocks and coastal pelagic species had been only little exploited, and that both resources offered considerable scope for fisheries development.

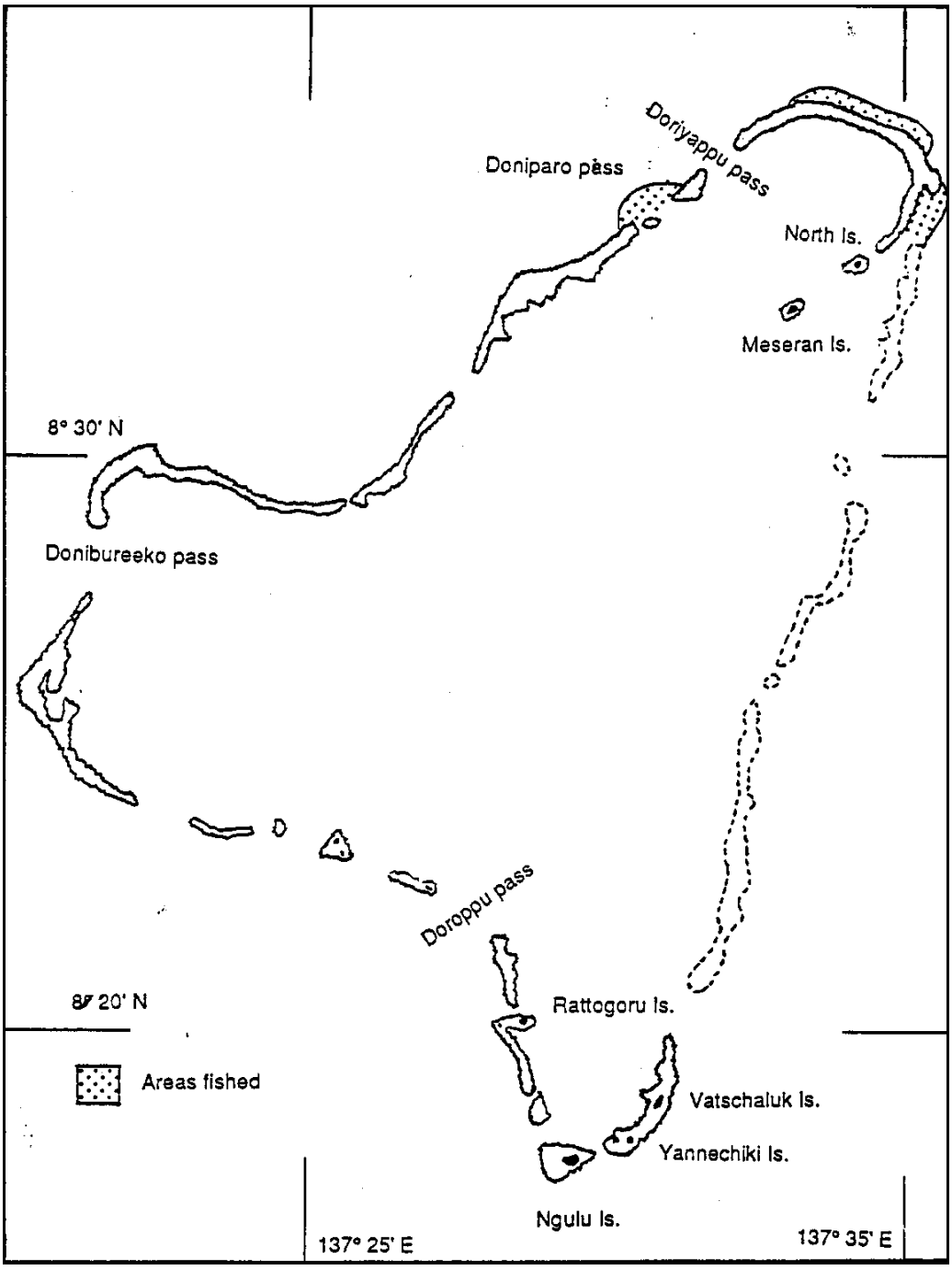

Figure 13: Ngulu atoll

Table 8: Summary of catch and effort for each fishing method employed at Ngulu atoll

Fishing method	No. of trips	Fishing hours	Effort (line hours)	Saleable catch		Unsaleable catch		Total catch (kg)	CPUE (kg)
				No.	Weight (kg)	No.	Weight (kg)		
Droplining	4	22.0	65.0	189	541.3	15	136.0	677.3	10.4
Trolling 1	4	32.0	94.5	50	283.1	0	0.0	283.1	3.0
Total	***4**	**54.0**		**239**	**824.4**	**15**	**136.0**	**960.4**	

Trolling 1 = Trolling reef-edge and open water
*All trips combined more than one fishing method

6. FISHING ECONOMICS

Table 9 summarises the direct operational expenses incurred during the 83 fishing trips completed by the Project around Yap proper, and the potential value of the catch taken by all methods. Trips conducted at Ngulu atoll have been omitted because of the long distance from markets and local recognition of traditional fishing rights which would exclude independent commercial fishing there.

Values have been calculated on prices current in Colonia at the time of the visit. No allowance has been made for wages, possible boat purchase loan repayments, nor the cost of buying and replacing fishing gear.

Table 9: Operational expenses and revenues for trips completed at Yap district

	Expenditure US$	Income US$
Fish sales* - 3,517.1 kg (7,775 lbs) at an average of US$1.43/kg (US$0.64 lb)		5,029.45
Fuel** - 2,952 l. (780 gallons) at average US$0.36/l (US$1.36/gallon)	1,065.67	
Ice - average 90 kg/trip (200 lb/trip) at US$2.00/100 lb (83 trips)	332.00	
Bait*** - 113.7 kg (250 lbs) at US$1.76/kg (US$0.80/lb)	200.11	
Grease and oil; other maintenance	300.00	
TOTAL EXPENSES:	1,897.78	
SURPLUS:	3,131.67	

* Fish value is calculated as an average of the prices offered for different species.
** Fuel value is calculated as an average price for the two fuels used, petrol/oil and diesel.
*** Valued at saleable price.

The surplus indicated in Table 9 accrued over approximately seven months of fishing and if wages were paid, as they would be in a commercial fishing venture, the surplus would be very much smaller. In addition, an owner/skipper would likely be liable for significant other expenses not taken into account here, such as loan repayments, insurance, the purchase and replacement of fishing gear and possibly boat or engine repairs.

However, the catch by the Project was taken during what were essentially training, resource survey, and FAD monitoring trips (regular FAD trips being particularly fuel expensive even when it was known that few fish were gathered there). A commercial fishing operation would be free of many of the constraints affecting the Project's trips, and fishing effort would be determined principally by considerations for maximising saleable catches.

A well developed knowledge of local fishing grounds, and of the most locally effective fishing techniques and bait (especially those effective in exploiting FADs), and the tendency to maximise market returns (perhaps through export sales), would all serve to increase the economic viability of such fishing activities.

7. CONCLUSIONS

7.1 The resource

The results of the Project's fishing activities suggest that the State's deep-bottom and pelagic fish resources constitute a significant resource.

Deep-bottom fishing catch rates compared well with results recorded by the Project elsewhere in the region (see Table 10), though catch rates varied considerably between fishing area, the catch rate at Yap District being 50 per cent lower than that at Ngulu.

Table 10: Deep-Bottom catch rates recorded by the DSFD project at selected Pacific Countries and Territories

Country	Fishing area	Year of visit	Deep bottom catch rate excluding sharks (kg/reel/hour
Yap state (F.S.M.)	Yap district	(this visit)	4.4
	Ngulu	(this visit)	8.3
	Yap district	1978/79	4.6
	Ulithi	"	14.4
	Ngulu	"	13.2
Kosrae State	Kosrae	1979	9.6
Republic of Belau	Palau	1979/80	3.0
Truck State (F.S.M.)	Truk	1980	4.1
Tuvalu	Funafuti	1983	7.5
	Vaitupu	"	7.9
	Nukulaelae	"	14.9
	Nukufetau	"	4.8

The lower catch rate around the eastern coast and north-west corner of Yap's reef probably reflects, in part, the generally narrow band of suitable bottom ground resulting from the steep reef slopes noted. The higher rate at Ngulu is typical of deep-bottom fishing productivity in areas with large lagoons and extensive unexploited reefs.

It is likely that the reef and atoll clusters in the east of the State and at Ulithi also harbour significant deep-bottom resources, and it is known that foreign vessels have in the past regularly fished on banks and shoals in these areas.

The deep-bottom catch included a commercially adequate proportion of high-value species, some of which have good export market potential, and the unsaleable component of the catch was low. There is some possibility that with proper processing and marketing the shark catch (15% by weight of the total) could become commercially valuable, although there is presently a strong traditional prejudice against shark consumption. The absence of ciguatoxicity in all species taken adds to the value of the resource.

Catch rates recorded during this visit were taken from mostly unexploited grounds and it is possible that catch rates would decline under increased or sustained fishing pressure in particular areas, perhaps with an associated change in species composition. Little is currently known about the ability of deep-bottom resources to withstand increased exploitation or of the long-term effects on them of such fishing activity. Several Pacific nations have, however, developed deep-bottom fisheries to a limited extent without apparent detriment. Yap's apparently extensive deep-bottom grounds suggest that such a fishery could well be profitably developed there.

Trolling the reef-edge, or in open-water offshore, was not adequately productive. Although a better catch rate was recorded along Ngulu's little-exploited reef, fuel use was high in relation to catches at both fishing areas. These results are typical for trolling in the region and it is likely that small-scale operators could engage profitably in this fishery only during seasonal peaks, when the target species school in the area in large number.

The ability of FADs to concentrate pelagic fish resources and render them amenable to productive fishing was well demonstrated during this visit. Although the FADs were relatively new and had not yet attracted the larger tunas which are known to move through the area, good catches of small tunas were taken. It seems likely that this offshore resource will be limited only by the continuity of the FAD deployment programme and the development of effective FAD fishing techniques.

7.2 Restraints on commercial development

Despite the indications that local deep-bottom and offshore resources could support a degree of commercial exploitation, and the existence of economic circumstances likely to provide a reasonable financial return for such activity, there are a number of factors evident which have the potential to restrain commercial fisheries development. The more significant of these relate to the availability of the technical and material support likely to be required by small-scale operators undertaking commercial fishing activities, especially those in more remote areas.

A basic requirement for development will be the availability of suitable fishing craft at affordable prices or under assisted-purchase schemes. The fibreglass diesel launch used by the Project during this visit was generally suited to its assigned use. The hull was solidly constructed, low maintenance, and handled well in moderate to rough seas. Stowage space was adequate, as was the capacity and effectiveness of the insulated fish holds. The Yanmar 3TE30 diesel engine proved to be fuel efficient and reliable, but the vessel was uncomfortable for extended trips.

Whether this type of vessel would be best suited to fisheries development in Yap, however, is open to question. There are presently no fibreglass construction facilities in the State and the imported cost of this hull and engine would be beyond the range of most local fishermen. If purchased under loan at commercial rates, fishermen would likely have difficulty in meeting repayments. Diesel engine repair requires specialised skills which may not be locally available, particularly in remote areas. This vessel also proved to be slower than ideal.

Irrespective of which vessel type may come into general use, the availability of fuel, oil, grease and engine spares will influence the efficiency of local fishing operations. Maintaining adequate supplies of such necessities will be most difficult in the outer islands, but in all cases will be made worse by the widespread use of a variety of motor makes and models rather than a single standard. The availability of suitable fishing gear at reasonable prices will also be important and, once again, the outer island fishermen will be most difficult to cater for.

At some stage of development the ready availability of ice to chill catches on board fishing craft, freezer and cold storage facilities at fishing sites, and freezer shipping services between islands will become vital.

Marketing will also be a major influence on successful commercial development. The local market is quite limited and during peak fishing seasons, or if many operators enter the fisheries, may quickly become oversupplied. Local consumers demonstrate a strong preference for tunas over deep-bottom species, and what are elsewhere high-value varieties may not present such a high return locally.

The entry of numerous new operators into fisheries, who are likely to have only limited business experience, may require the provision of widespread advisory support, particularly during establishment phases. The recognition of traditional fishing rights along the outer reef slope will limit the range of commercial fishing operators to home territories and may exclude them from good grounds that are not exploited by traditional owners.

8. RECOMMENDATIONS

The following recommendations have been prepared in support of the Yap State Government's goal of developing local fisheries enterprises. Some relate to the development restraints already noted and others may be useful in consideration of the State's long term fisheries development.

Boats, fishing gear and catch handling infrastructure

Attempts should be made to select a standard suitable boat design and then either initiate a local boat-building programme or perhaps negotiate bulk purchase from an established manufacturer. Alternatively, encouragement of the use of a single outboard and/or diesel motor would be advantageous.

Whether boats are locally constructed or imported it may be necessary to introduce a programme of assisted purchase, soft loans, or other arrangements to assist bona fide fishermen acquire vessels.

Attention should be paid to making fuel, oil, maintenance stores, and spare motor parts widely available; particular attention should be paid to the outer islands in this regard.

Stocks of appropriate fishing gear should be purchased by YFA and made available to fishermen at cost.

A major development effort should be devoted to expanding ice-making, freezing, and cold storage facilities, and consideration given to establishing a fish handling and processing plant to process excess catches, or prime species catches, for later local sale or export.

Marketing

Attempts should be made to regularise the local fish market. YFA could become a wholesale buyer and supply local retail outlets, as well as exploring export markets.

It would be beneficial to establish buying standards and to set species prices which would be adhered to even in times of oversupply. The development of export markets should be of highest priority. The establishment of such markets will require strict handling and processing standards, and sound business management skills. The export potential of both deep-water snappers and larger tunas should be further explored.

Support should be given to private entrepreneurs wishing to enter the local and export markets.

Fishing technology and business management advice should be provided for new fishing operators who do not have sound backgrounds in these fields.

FAD programme

The FAD monitoring and maintenance programme begun by the Project during this visit should be continued. An effective programme should include the collection of basic catch and effort data, and not less than six-monthly inspections of the FADs' top hardware, either by diving or by hauling onto a workboat.

Because the success or otherwise of the Yap State and American Samoa FAD programmes will have bearing on future support for such projects, it would be appropriate to conduct a full-scale review of the FADs set off Yap after an average one year's deployment. Such a programme would conduct fishing trials, especially investigating the incidence of large tunas at mid-water, and review the FADs' survival rate.

Fishing survey of banks and shoals

Efforts should be made to explore the commercial potential of the submerged reefs known to lie to the east of Yap District. A survey of this type already projected in co-operation between YFA and Japanese fishing interests, at the Sunken Shoals, may provide a model for such a programme.

Marketing of outer island catches

In areas without freezer or cold storage facilities, or where it is not practical to ship fresh fish to market, it would be useful to introduce simple preservation techniques such as smoking, salting and drying. Once processed, such catches could be consumed locally or perhaps marketed at Colonia. Export markets for such processed products should also be investigated.

The successful commercial exploitation of Yap's fish resources will likely depend heavily on the level of government support available, particularly in the provision of major catch handling facilities, technical advice, and the development of export markets. It would appear that such responsibilities should fall to YFA, and that both expertise and development funding may be sought from overseas sources, perhaps in conjunction with joint-venture or fishing access agreements.

Once trends in commercial exploitation of either deep-bottom stocks or FAD associated stocks become apparent, thoughtful management of these fisheries and clear delineation of the responsibilities of the twoÊfisheries development authorities will become increasingly important to avoid over-exploitation or negative marketing developments.

9. REFERENCES

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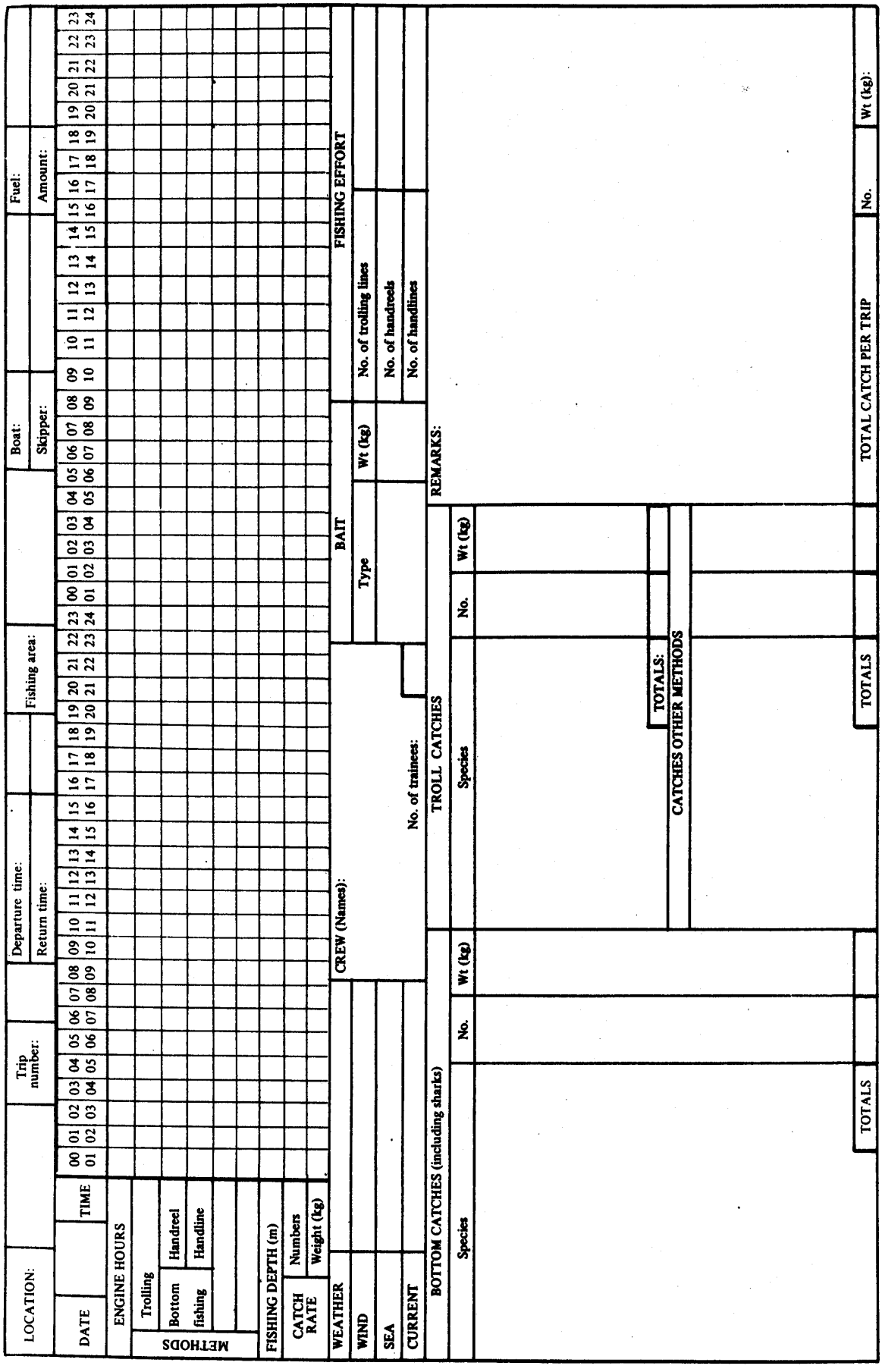
APPENDIX 1

STANDARD FORM FORDATA COLLECTION



APPENDIX 2A

TRIP RECORDS FOR YAP DISTRICT

Trip No.	Fishing method	Duration hours	Engine hours	Fishing hours	Effort line hrs	Saleable catch		Unsaleable catch		Bait kg	Fuel litres
						No.	kg	No.	kg		
1	**Droplining**	**8.5**	**3. 0**	**5.5**	**16.5**	**30**	**54.6**	**0**	**0.0**	**5.0**	**18 D**
2	Droplining			9.5	28.5	36	55.4	7	23.2	6.0	
	Trolling 1			1.5	3.0					0.5	
	Total	**21. 0**	**6.5**	**11.0**		**36**	**55.4**	**7**	**23.2**	**6.5**	**36 D**
5	**Droplining**	**8.0**	**2.5**	**5.5**	**16.5**	**22**	**92.7**	**0**	**0.0**	**6.0**	**15 D**
6	**Droplining**	**18.0**	**3.5**	**8.0**	**24.0**	**20**	**166.1**	**2**	**1.7**	**8.0**	**22 D**
7	Droplining			2.0	6.0	7	8.0	1	35.0	3.0	
	Trolling 1			3.5	7.0	6	35.5			1.0	
	Total	**8.5**	**6.5**	**5. 5**		**13**	**43.5**	**1**	**35.0**	**4.0**	**45 D**
8	Trolling 1			1.0	2.0						
	Trolling 2			1.0	2.0	16	25.0				
	Total	**3.5**	**3.0**	**2.0**		**16**	**25.0**	**0**	**0. 0**	**0. 0**	**20 P**
9	Droplining			3.0	6.0	16	40.9			3.5	
	Trolling 1			4.5	9.0	2	6.7			1.0	
	Trolling 2			0.5	1.0	5	4.0				
	Total	**12. 0**	**7.5**	**8.0**		**23**	**51.6**	**0**	**0.0**	**4.5**	**50 D**
10	Droplining			4.5	9.0	38	61.3			5.5	
	Trolling 1			4.0	8.0					1.0	
	Trolling 2			0.5	1.0	4	2.5				
	Total	**12.0**	**7.5**	**9.0**		**42**	**63.8**	**0**	**0.0**	**6.5**	**50 D**
11	Trolling 1			1.0	2.0					0.5	
	Trolling 2			1.5	3.0	12	9.9				
	M.W.S.L.			1.0	2.0					1.0	
	Total	**3.5**	**3.0**	**3.5**		**12**	**9.9**	**0**	**0.0**	**1.5**	**15 P**
12	Droplining			2.5	5.0	8	12.7	1	10.0	2.5	
	Trolling 1			1.0	2.0						
	Trolling 2			1.0	2.0						
	Total	**7.0**	**4.0**	**4.5**		**8**	**12.7**	**1**	**10.0**	**2.5**	**25 D**
13	**Trolling 2**	**2.5**	**2.5**	**1.0**	**2.0**	**10**	**7.0**	**0**	**0.0**	**0.0**	**15 P**
14	Droplining			4.0	8.0	22	24.8			3.0	
	Trolling 1			3.5	5.0						
	Total	**11.5**	**7.0**	**7.5**		**22**	**24.8**	**0**	**0.0**	**3.0**	**50 D**
15	**Trolling 2**	**4.0**	**4.0**	**1.5**	**3.0**	**29**	**19.7**	**0**	**0.0**	**0.0**	**30 P**
16	Trolling 1			0.5	1.0						
	Trolling 2			2.0	4.0	13	10.1				
	M.W.S.L.			2.0	2.0					0.4	
	H.Line FAD			0.5	0.5	6	3.5			0.1	
	Total	**6.5**	**6.0**	**5.0**		**19**	**13.6**	**0**	**0.0**	**0.5**	**36 D**
17	**Droplining**	**7.5**	**3.0**	**4.5**	**9.0**	**17**	**44.5**	**1**	**4.0**	**3.0**	**18 D**

APPENDIX 2a: TRIP RECORDS FOR YAP DISTRICT (Cont'd)

Trip No.	Fishing method	Duration hours	Engine hours	Fishing hours	Effort Line hrs	Saleable catch		Unsaleable catch		Bait kg	Fuel litres
						No.	kg	No.	kg		
20	Droplining			2.5	5.0	22	50.6			2.5	
	Trolling 1			1.0	2.0						
	Trolling 2			1.0	2.0	8	7.0				
	Total	**6.0**	**3. 5**	**4.5**		**30**	**57.6**	**0**	**0.0**	**2.5**	**22 D**
2 1	Trolling 1			8.5	17.0	3	16.1				
	Trolling 2			2.5	5.0	47	48.7				
	M.W.S.L.			1.0	1.0			1	8.0	1.0	
	Total	**13.0**	**12.0**	**12.0**		**50**	**64.8**	**1**	**8.0**	**1.0**	**75 D**
22	Droplining			3.0	6.0	5	6.9	1	35.0	2.0	
	Trolling 1			1.0	2.0						
	Trolling 2			1.5	3.0	8	7.1				
	Total	**7.0**	**4.0**	**5.5**		**13**	**14.0**	**1**	**35.0**	**2.0**	**25 D**
23	Trolling 1			1.5	3.0						
	Trolling 2			1.5	3.0	19	16.4				
	H.Line FAD			1.0	1.0	6	2.0			0.1	
	Total	**5.5**	**4.0**	**4.0**		**25**	**18.4**	**0**	**0.0**	**0.1**	**25 D**
24	Droplining			3.5	7.0	37	77.4			4.0	
	Trolling 1			3.5	7.0	1	8.6				
	Trolling 2			1.5	3.0	20	15.1				
	M.W.S.L.			1.0	1.0					0.5	
	Total	**10.5**	**7.0**	**9.5**		**58**	**101 .1**	**0**	**0.0**	**4. 5**	**40 D**
25	Trolling 1			7.5	15.0						
	Trolling 2			0.5	1.0	1	1.0				
	Total	**11.0**	**9.0**	**8.0**		**1**	**1.0**	**0**	**0. 0**	**0. 0**	**55 D**
26	Droplining			5.0	10.0	39	50.6	1	35.0	4.5	
	Trolling 1			3.0	6.0						
	Trolling 2			2.0	4.0	42	34.4				
	Total	**12.5**	**7.5**	**10.0**		**81**	**85.0**	**1**	**35.0**	**4.5**	**40 D**
27	Droplining			3.0	6.0	11	14.7			2.5	
	Trolling 1			3.0	6.0	2	8.5				
	Trolling 2			0.5	1.0	17	12.4				
	Total	**8.5**	**5.5**	**6.5**		**30**	**35.6**	**0**	**0.0**	**2.5**	**30 D**
28	Trolling 1			1.5	3.0						
	Trolling 2			3.0	6.0	44	39.3				
	M.W.S.L.			3.0	3.0					0.4	
	H.Line FAD			0.5	1.0	2	0.5			0.1	
	Total	**6.0**	**5.5**	**8.0**		**46**	**39.8**	**0**	**0.0**	**0.5**	**30 D**
29	Droplining			4.0	8.0	23	24.6	1	2.0	4.0	
	Trolling 1			3,0	6.0						
	Trolling 2			2.0	4.0	65	64.9				
	Total	**12.0**	**8.0**	**9.0**		**88**	**89.5**	**1**	**2.0**	**4.0**	**45 D**
30	Trolling 1			9.5	19.0	2	3.0				
	Trolling 2			1.0	2.0	1	1.0				
	Total	**11.5**	**11.5**	**10.5**		**3**	**4.0**	**0**	**0. 0**	**0.0**	**70 D**

APPENDIX 2a: TRIP RECORDS FOR YAP DISTRICT (Cont'd)

Trip No	Fishing method	Duration hours	Engine hours	Fishing hours	Effort line hrs	Saleable catch		Unsaleable catch		Bait kg	Fuel litres
						No.	kg	No.	kg		
31	Droplining			5.0	10.0	24	38.0			3.0	
	Trolling 1			1.5	3.0						
	Trolling 2			0.5	1.0	1	1.5				
	Total	**11 .0**	**6.0**	**7.0**		**25**	**39.5**	**0**	**0. 0**	**3.0**	**35 D**
32	Trolling 1			1.0	2.0						
	Trolling 2			2.0	4.0	30	22.0				
	Total	**5.0**	**5.0**	**3.0**		**30**	**22.0**	**0**	**0.0**	**0.0**	**25 D**
33	Trolling 1			5.0	10.0	2	6.3				
	TroJling 2			1.5	3.0	18	16.8				
	H.Line FAD			0.5	0.5	2	0.6			0.1	
	Total	**8.0**	**7.5**	**7.0**		**22**	**23.7**	**0**	**0.0**	**0.1**	**45 D**
34	**Droplining**	**5.0**	**1.5**	**3.5**	**7.0**	**10**	**64.6**	**0**	**0.0**	**2.0**	**10 D**
35	Droplining			4.0	8.0	20	41.2			3.5	
	Trolling 1			4.0	8.0	2	2.9				
	Trolling 2			0.5	1.0						
	Total	**11.0**	**7.0**	**8.5**		**22**	**44.1**	**0**	**0.0**	**3.5**	**45 D**
36	Trolling 1			2.0	4.0						
	Trolling 2			1.5	3.0	10	5.9				
	Vert. L.line			1.5	3.0					4.0	
	Total	**4.5**	**4.5**	**5.0**		**10**	**5.9**	**0**	**0.0**	**4.0**	**25 D**
137	Trolling 1			1.0	2.0						
	Trolling 2			2.0	4.0	41	44.9				
	Total	**5.5**	**4.5**	**3.0**		**41**	**44.9**	**0**	**0.0**	**0.0**	**25 D**
38	Trolling 1			1.0	2.0						
	Trolling 2			2.5	5.0	78	88.0				
	Total	**4.5**	**4.5**	**3.5**		**78**	**88.0**	**0**	**0.0**	**0.0**	**25 D**
39	Trolling 1			1.5	3.0						
	Trolling 2			2.0	4.0	33	34.2				
	Total	**4.5**	**4.5**	**3.5**		**33**	**34.2**	**0**	**0.0**	**0.0**	**25 D**
40	Trolling 1			5.0	10.0	1	7.2				
	Trolling 2			3.0	6.0	51	56.0				
	Total	**9.0**	**9.0**	**8.0**		**52**	**63.2**	**0**	**0.0**	**0.0**	**55 D**
4 1	Trolling 1			1.0	2.0						
	Trolling 2			2.5	5.0	35	37.5				
	Total	**5.5**	**5.5**	**3.5**		**35**	**37.5**	**0**	**0.0**	**0.0**	**30 D**
42	Droplining			3.5	7.0	9	22.5			1.5	
	Trolling 1			2.0	4.0						
	Trolling 2			3.0	6.0	23	32.0				
	Total	**11.5**	**8.0**	**8.5**		**32**	**54.5**	**0**	**0.0**	**1.5**	**45 D**
43	Trolling 1			1.5	3.0	1	2.1				
	Trolling 2			2.0	4.0	9	15.4				
	Total	**4.5**	**4.5**	**3.5**		**10**	**17.5**	**0**	**0.0**	**0.0**	**25 D**

APPENDIX 2a: TRIP RECORDS FOR YAP DISTRICT (Cont'd)

Trip No.	Fishing method	Duration hours	Engine hours	Fishing hours	Effort line hrs	Saleable catch		Unsaleable catch		Bait kg	Fuel litres
						No.	kg	No.	kg		
44	Droplining			1.5	3.0	2	1.8			0.5	
	Trolling 1			1.0	2.0						
	Trolling 2			1.0	2.0	1	1.2				
	Total	**5.5**	**4.0**	**3.5**		**3**	**3.0**	**0**	**0.0**	**0.5**	**25 D**
45	Trolling 1			1.0	2.0						
	Trolling 2			1.0	2.0	1	0.4				
	H.Line FAD			0.5	0.5					0.1	
	Vert. L.line			2.5	4.8					2.4	
	Total	**4.5**	**3.0**	**5.0**		**1**	**0.4**	**0**	**0.0**	**2.5**	**20 D**
46	Trolling 1			4.0	8.0						
	Trolling 2			1.0	2.0						
	Total	**6.0**	**6.0**	**5.0**		**0**	**0.0**	**0**	**0.0**	**0.0**	**40 D**
47	Trolling 1			1.0	2.0						
	Trolling 2			3.0	6.0	25	30.7				
	Total	**5.0**	**5.0**	**4.0**		**25**	**30.7**	**0**	**0.0**	**0.0**	**30 D**
48	Trolling 1			5.5	11.0	2	7.3				
	Trolling 2			1.5	3.0	3	6.4				
	Total	**8.0**	**8.0**	**7.0**		**5**	**13.7**	**0**	**0.0**	**0.0**	**50 D**
49	Trolling 1			3.0	6.0	1	3.6				
	Trolling 2			1.0	2.0						
	Total	**9 0**	**5.0**	**4.0**		**1**	**3.6**	**0**	**0.0**	**0.0**	**30 D**
50	Trolling 1			0.5	1.0						
	Trolling 2			4.0	8.0	33	144.0				
	Total	**5.5**	**5. 5**	**4.5**		**38**	**144.0**	**0**	**0.0**	**0.0**	**45 P**
51	Trolling 1			3.5	7.0						
	Trolling 2			1.5	3.0	3	11.0				
	Total	**6.0**	**6.0**	**5.0**		**3**	**11.0**	**0**	**0.0**	**0.0**	**50 P**
52	Trolling 1			4.5	9.0						
	Trolling 2			1.5	3.0	4	12.0				
	Total	**7.5**	**7.0**	**6.0**		**4**	**12.0**	**0**	**0.0**	**0.0**	**60 P**
53	Trolling 1			5.0	10.0						
	Trolling 2			1.0	2.0	2	10.0				
	Total	**6.5**	**6.5**	**6.0**		**2**	**10.0**	**0**	**0.0**	**0.0**	**45 P**
54	Trolling 1			2.5	5.0						
	Trolling 2			0.5	1.0						
	Total	**4.0**	**4.0**	**3.0**		**0**	**0.0**	**0**	**0.0**	**0.0**	**35 P**
55	Trolling 1	**2.0**	**2.0**	**0.5**	**1.0**	**0**	**0.0**	**0**	**0.0**	**0.0**	**20 P**
56	Trolling 1			4.0	8 0	1	0.5				
	Trolling 2			1.0	2.0	4	18.0				
	Total	**6.0**	**6.0**	**5.0**		**5**	**18.5**	**0**	**0.0**	**0.0**	**50 P**

APPENDIX 2a: TRIP RECORDS FOR YAP DISTRICT (Cont'd)

Trip No.	Fishing method	Duration hours	Engine hours	Fishing hours	Effort line hrs	Saleable catch		Unsaleable catch		Bait kg	Fuel litres
						No.	kg	No.	kg		
57	Trolling 1			7.0	14.0	3	12.0				
	Trolling 2			1.0	2.0	1	4.0				
	Total	**9.0**	**9.0**	**8.0**		**4**	**16.0**	**0**	**0.0**	**0.0**	**20 D**
58	Trolling 1			3.5	7.0	1	1.5				
	Trolling 2			1.0	2.0	2	8.0				
	Paiu-ahi			2.0	4.0			1	3.0	5.0	
	Total	**7.0**	**5.0**	**6.5**		**3**	**9. 5**	**1**	**3.0**	**5.0**	**40 P**
59	Droplining			7.5	18.5	133	36.4			5.0	
	Trolling 1			7.0	14.0	8	29.3			3.0	
	Flying fish.			3.0	3.0	33	6.0				
	Total	**22.0**	**13.0**	**17.5**		**174**	**71.7**	**0**	**0. 0**	**8.0**	**30 D**
60	Trolling 1			3.5	7.0						
	Trolling 2			2.0	4.0	7	36.0				
	Total	**6.5**	**6.5**	**5.5**		**7**	**36.0**	**0**	**0.0**	**0.0**	**55 P**
61	**Trolling 1**	**6.0**	**6.0**	**3.5**	**7.0**	**5**	**37.0**	**0**	**0.0**	**0.0**	**80 D**
62	Trolling 1			3.0	6.0	2	23.0				
	Trolling 2			1.5	3.0	8	41.5				
	Total	**5.5**	**5. 5**	**4.5**		**10**	**64.5**	**0**	**0.0**	**0.0**	**35 D**
63	Trolling 1			8.0	16.0	6	230				
	Trolling 2			3.0	6.0	12	39.0				
	Total	**12.0**	**12.0**	**11.0**		**18**	**62.0**	**0**	**0.0**	**0.0**	**70 D**
64	Trolling 1			3.5	7.0	4	18.0				
	Trolling 2			2.5	5.0	38	64.6				
	Total	**7.0**	**7.0**	**6. 0**		**42**	**82.6**	**0**	**0.0**	**0.0**	**40 D**
65	Trolling 1			3.0	6.0	4	17. 7				
	Trolling 2			1.5	3.0	8	28.3				
	Total	**5.5**	**5.5**	**4.5**		12	**46.0**	**0**	**0.0**	**0.0**	**35 D**
66	Droplining			3.0	6.0	7	14.2	2	3.0	5.0	
	Trolling 1			6.5	13.0	4	17.5				
	Total	**14. 5**	**9.5**	**9.5**		**11**	**31.7**	**2**	**3.0**	**5.0**	**60 D**
67	Trolling 1			4.0	8.0	2	8.8				
	Trolling 2			2.0	4.0	16	47.5				
	Total	**7.0**	**7.0**	**6.0**		**18**	**56.3**	**0**	**0.0**	**0.0**	**40 D**
68	Trolling 1			4.5	9.0	21	4.6				
	Trolling 2			3.0	6.0	37	86.5				
	Total	**9.5**	**9.5**	**7.5**		**39**	**91.1**	**0**	**0.0**	**0.0**	**55 D**
69	Trolling 1			1.0	2.0						
	Trolling 2			2.0	4 0	20	19.6				
	M.W.S.L.			1.5	1.5					1.5	
	Total	**4.0**	**4.0**	**4.5**		**20**	**19.6**	**0**	**0.0**	**1.5**	**25 D**

APPENDIX 2a: TRIP RECORDS FOR YAP DISTRICT (Cont'd)

Trip No.	Fishing method	Duration hours	Engine hours	Fishing hours	Effort fine hrs	Saleable catch		Unsaleable catch		Bait kg	Fuel litres
						No.	kg	No.	kg		
70	Trolling 1			1.0	2.0						
	Trolling 2			3.0	6.0	64	86.0				
	M.W.S.L.			1.0	1.0					0.5	
	Total	**5.5**	**5.5**	**5. 0**		**64**	**86.0**	**0**	**0. 0**	**0.5**	**30 D**
71	Trolling 1			1.0	2.0	1	7.5				
	Trolling 2			3.5	7.0	62	93.0				
	Total	**5.5**	**5.5**	**4.5**		**63**	**100.5**	**0**	**0.0**	**0.0**	**35 D**
72	Trolling 1			1.5	3.0						
	Trolling 2			3.5	7.0	96	139.0				
	Total	**6.0**	**6.0**	**5.0**		**96**	**139.0**	**0**	**0. 0**	**0.0**	**35 D**
73	Trolling 1			3.0	6.0	1	0.8				
	Trolling 2			1.5	3.0	14	30.2				
	Total	**5.5**	**5.5**	**4.5**		**15**	**31.0**	**0**	**0. 0**	**0.0**	**35 D**
74	Trolling 1			4.5	9.0	1	2.2				
	Trolling 2			4.0	8.0	67	109. 8				
	Total	**9.5**	**9.5**	**8.5**		**68**	**112. 0**	**0**	**0. 0**	**0.0**	**55 D**
75	Trolling 1			4.0	8.0	4	9.1				
	Trolling 2			2.0	4.0	10	10.9				
	Total	**7.0**	**7.0**	**6.0**		**14**	**20.0**	**0**	**0.0**	**0.0**	**40 D**
76	Trolling 1			4.5	9.0						
	Trolling 2			2.0	4.0	17	25.6				
	Total	**7.5**	**7.5**	**6.5**		**17**	**25.6**	**0**	**0. 0**	**0.0**	**45 D**
77	Trolling 1			2.5	5.0	1	1.8				
	Trolling 2			3.0	6.0	43	71.2				
	Total	**7.0**	**7.0**	**5.5**		**44**	**73.0**	**0**	**0.0**	**0.0**	**45 D**
78	Trolling 1			2.5	5.0	1	3.2				
	Trolling 2			2.5	5.0	31	38.3				
	Total	**7.0**	**7.0**	**5.0**		**32**	**41.5**	**0**	**0.0**	**0.0**	**40 D**
79	Trolling 1			4.0	8.0	1	6.6				
	Trolling 2			2.0	4.0	5	13.9				
	Total	**7.0**	**7.0**	**6.0**		**6**	**20.5**	**0**	**0.0**	**0.0**	**40 D**
80	Trolling 1			2.5	5.0						
	Trolling 2			3.5	7.0	61	77.3				
	Vert. L.line			1.0	2.0					4.0	
	Total	**8.5**	**8.0**	**7.0**		**61**	**77.3**	**0**	**0.0**	**4.0**	**50 D**
81	Trolling 1			2.5	5.0						
	Trolling 2			3.0	6.0	62	87.0				
	Total	**7.0**	**7.0**	**5.5**		**62**	**87.0**	**0**	**0.0**	**0.0**	**40 D**

APPENDIX 2a: TRIP RECORDS FOR YAP DISTRICT (Cont'd)

Trip No.	Fishing method	Duration hours	Engine hours	Fishing hours	Effort Line hrs	Saleable catch		Unsaleable catch		Bait kg	Fuel litres
						No.	kg	No.	kg		
82	Trolling 1			2.5	5.0						
	Trolling 2			3.0	6.0	68	89.5				
	Total	**7.0**	**7.0**	**5.5**		**68**	**89.5**	**0**	**0.0**	**0.0**	**40 D**
83	Trolling 1			1.0	2.0						
	Trolling 2			1.0	2.0	4	8.0				
	Total	**3.0**	**3.0**	**2.0**		**4**	**8.0**	**0**	**0.0**	**0.0**	**20 D**
	SUMMARY										
23	Droplining			98.0	230.0	558.0	1004.5	17.0	148.9	85.5	
72	Trolling 1			224.0	446.0	115	475.9	0	0.0	7.0	
67	Trolling 2			121.0	242.0	1486	2024.1	0	0.0	0.0	
7	M.W.S.L.			10.5	11.5	0	0.0	1	8.0	5.3	
5	H.Line FAD			3.0	3.5	16	6.6	0	0.0	0.5	
3	Vert. L.line			5.0	9.8	0	0.0	0	0.0	10.4	
1	Flying fish.			3.0	3.0	33	6.0	0	0.0	0.0	
1	Palu-ahi			2.0	4.0	0	0.0	1	3.0	5.0	
83	**TOTAL**	**611.0**	**479.5**	**466.5**		**2208**	**3517.1**	**19**	**159.9**	**113.7**	**480 P**
											2472 D

Trolling 1 = Trolling reef edge and open water
Trolling 2 = Trolling around FAD's
M.W.S.L. = Mid-water shark line
H.Line FAD = Light handline used around FAD's
Vert. L.line = Vertical longline
Flying fish. = Flying fish scoop netting
Palu-ahi = Heavy handline used with weight and chum around FAD's

D = Diesel
P = Pre-mix outboard fuel

APPENDIX 2 B

TRIP RECORDS FOR NGULU ATOLL

Trip No.	Fishing method	Duration hours	E,ngine hours	Fishing hours	Effort line hrs	Saleable catc,h		Unsaleable catch		Bait kg	Fuel litres
						No.	kg	No.	kg		
3	Droplining			4.0	20.0	53	95.0			6.0	
	Trolling 1			9.5	38.0	23	134.6				
	Total	**22.5**	**11.0**	**13.5**		**76**	**229.6**	**0**	**0.0**	**6.0**	**198 D**
4	Droplining			6.0	21.0	36	123.9	4	50.0	11.0	
	Trolling 1			11.5	34.5	16	89.6				
	Total	**32.5**	**16. 0**	**17.5**		**52**	**213.5**	**4**	**50.0**	**11.0**	**256 D**
18	Droplining			4.5	9. 0	34	113.2	6	41.0	5.0	
	Trolling 1			9.5	19.0	7	43.3				
	Total	**15.5**	**10.5**	**14.0**		**41**	**156.5**	**6**	**41.0**	**5.0**	**75 D**
19	Droplining			7.5	15.0	66	209.2	5	45.0	7.5	
	Trolling 1			1.5	3.0	4	15.6				
	Total	**24.0**	**12.5**	**9.0**		**70**	**224.8**	**5**	**45.0**	**7.5**	**90 D**
	SUMMARY										
4	**Droplining**			**22.0**	**65.0**	**189**	**541.3**	**15**	**136.0**	**29.5**	
4	**Trolling 1**			**32.0**	**94.5**	**50**	**283, 1**	**0**	**0.0**		
4	**TOTAL**	**94.5**	**50.0**	**54.0**		**239**	**824.4**	**15**	**136.0**	**29.5**	**619 D**

* This figure includes a large proportion of fuel used for traveling to and from the fishing area
Trolling 1 = Trolling open water and the reef edge D = Diesel

APPENDIX 3

SPECIES COMPOSITION OF THE TROLL CATCHES FROM BOTH FISHING AREAS

Family *Species* English name	Yap proper Trolling 1 No.	 Weight (kg)	 Trolling 2 No.	 Weight (kg)	Ngulu atoll Trolling 1 No.	 Weight (kg)	Total No.	 Weight (kg)
LUTJANIDAE								
Aprion virescens Green jobfish					2	5.3	2	5.3
CARANGIDAE								
Caranx ignobilis Great trevally	1	3.6					1	3.6
Caranx sexfasciatus Bigeye trevally			1	0.2			1	0.2
Elegatis bipinnulatus Rainbow runner	2	3.8	1	0.3	2	4.0	5	8.1
Selar crumenophthalmus Bigeye scad			5	0.8			5	0.8
Seriola rivoliana Deep-water amberjack			1	0.1			1	0.1
SCOMBRIDAE								
Acanthocybium solandri Wahoo	26	166.4	50	185.6	7	47.9	83	399.9
Gymnosarda unicolor Dogtooth tuna	2	11.6			22	162.0	24	173.6
THUNNIDAE								
Euthynnus affinis Mackerel tuna	1	0.5	7	15.6	8	19.1	16	35.2
Katsuwonus pelamis Skipjack tuna	6	31.8	496	641.4			502	673.2
Thunnus albacares Yellowfin tuna	6	19.8	795	802.8	2	23.0	803	845.6
Thunnus obesus Bigeye tuna			29	26.1			29	26.1
CORYPHAENIDAE								
Coryphaena hippurus Dolphinfish	7	30.8	139	495.2			146	526.0
SPHYRAENIDAE								
Sphyraena barracuda Great barracuda	26	63.6			7	21.8	33	85.4
TOTAL	**77**	**331.9**	**1,524**	**2,168.1**	**50**	**283.1**	**1,651**	**2,783.1**

Trolling 1 = Trolling along the reef edge and open water
Trolling 2 = Trolling around FAD's only

APPENDIX 4

SPECIES COMPOSITION OF THE DEEP-BOTTOM CATCHES FROM BOTH FISHING AREAS

FAMILY *Species* English name	Colonia Yap area No.	 Weight (kg)	Ngulu Island area No.	 Weight (kg)	Total No.	 Weight (kg)
DEEP-WATER SNAPPERS						
LUTJANIDAE (sub-families ETELINAE, APSILINAE)						
Aphareus furcatus Blue small-tooth jobfish	3	0.8	3	1.9	6	2.7
Aphareus rutilans Small-tooth jobfish/silvermouth	50	188.0			50	188.0
Aprion virescens Green jobfish	9	42.2	3	10.2	12	52.4
Etelis carbunculus Short-tailed red snapper	32	134.9			32	134.9
Etelis coruscans Longtail snapper	6	26.2			6	26.2
Paracaesio xanthurus Southern fusilier	1	0.7			1	0.7
Pristipomoides auricilla Gold-tailed jobfish	87	79.7	5	4.0	92	83.7
Pristipomoides filamentosus Rosy jobfish	24	75.1	3	12.1	27	87.2
Pristipomoides multidens Large-scale jobfish	3	6.4			3	6.4
Pristipomoides sieboldi Small-scaled jobfish	3	2.4			3	2.4
Pristipomoides zonatus Banded flower snapper	29	38.1	5	8.0	34	46.1
Sub-total	**247**	**594.5**	**19**	**36.2**	**266**	**630.7**
SHALLOW-WATER SNAPPERS						
LUTJANIDAE (sub-family LUTJANINAE)						
Lutjanus argentimaculatus Mangrove jack			2	12.0	2	12.0
Lutjanus bohar Red bass			60	262.3	60	262.3
Lutjanus gibbus Paddletail	6	4.0	31	25.1	37	29.1

Lutjanus kasmira Blue-lined snapper	1	0.4			1	0.4
Lutjanus monostigma Onespot snapper	1	0.4			1	0.4
Macolor niger Black snapper			1	2.5	1	2.5
Sub-total	**8**	**4.8**	**94**	**301.9**	**102**	**306.7**
EMPERORS						
LETHRINIDAE						
Gnathodentex mossambicus Large-eye sea bream	7	7.1	1	1.4	8	8.5
Gymnocranius greseus Sea bream	8	6.5			8	6.5
Lethrinus amboinensis Ambon emperor			1	0.3	1	0.3
Lethrinus kalopterus Orange spotted emperor			2	2.7	2	2.7
Lethrinus microdon Emperor	5	6.2			5	6.2
Lethrinus miniatus Long-nose emperor	4	9.9	2	10.9	6	20.8
Lethrinus spp Unidentified emperor	2	1.2			2	1.2
Sub-total	**26**	**30.9**	**6**	**15.3**	**32**	**46.2**
GROUPERS, CODS AND CORAL TROUTS						
SERRANIDAE						
Cephalopholis aurantius Orange rock-cod	4	3.0	1	0.8	5	3.8
Cephalopholis igarasiensis Yellow-banded grouper	3	1.7			3	1.7
Epinephelus chlorostigma Brown-spotted grouper	1	2.6	4	6.7	5	9.3
Epinephelus maculatus Spotted grouper	4	1.2	3	3.5	7	4.7
Epinephelus miliaris Grouper	20	18.0	2	4.2	22	22.2
Epinephelus morrhua Curve-banded grouper	5	14.6	1	3.0	6	17.6
Epinephelus poecilonotus Deep-water grouper	1	4.0			1	4.0

Epinephelus retouti Red-spined grouper	1	0.9	1	0.9	2	1.8
Epinephelus septemfasciatus Seven-banded grouper	1	91.0			1	91.0
Epinephelus spp Unidentified grouper			2	1.4	2	1.4
Variola albimarginatus Coronation trout	2	0.8			2	0.8
Variola louti Luna-tail trout			1	1.0	1	1.0
Sub-total	**42**	**137.8**	**15**	**21.5**	**57**	**159.3**
JACKS AND TREVALLIES						
CARANGIDAE						
Carangoides orthogrammus Yellow-spotted trevally	2	2.8			2	2.8
Caranx lugubris Black trevally	57	75.9	41	111.1	98	187.0
Caranx melampygus Blue trevally	3	1.6			3	1.6
Caranx sexfasciatus Bigeye trevally	1	2.1	3	5.9	4	8.0
Elegatis bipinnulatus Rainbow runner			1	1.0	1	1.0
Seriola rivoliana Deep-water amberjack	48	90.5	6	20.0	54	110.5
Sub-total	**111**	**172.9**	**51**	**138.0**	**162**	**310.9**
MACKERELS AND TUNAS						
SCOMBRIDAE						
Gymnosarda unicolor Dogtooth tuna	5	28.5	2	11.0	7	39.5
Sub-total	**5**	**28.5**	**2**	**11.0**	**7**	**39.5**
OILFISH AND SNAKE MACKERELS						
GEMPYLIDAE						
*Promethicthys prometheus** Snake mackerel	7	6.9	2	1.0	9	7.9
Sub-total	**7**	**6.9**	**2**	**1.0**	**9**	**7.9**

SOLDIERFISH, SQUIRRELFISH AND GLASSEYES						
HOLOCENTRIDAE						
Flammeo scythrops Squirrelfish	18	2.3			18	2.3
Myripristis adustus Squirrelfish	20	5.0			20	5.0
Myripristis berndti Squirrelfish	7	0.8			7	0.8
Myripristis violaceus Squirrelfish	52	9.1			52	9.1
Ostichthys japonicus Deep-water squirrelfish	1	0.3			1	0.3
Sargocentron caudimaculatus	6	0.6			6	0.6
Sargocentron spiniferum Squirrelfish	7	3.0	1	0.4	8	3.4
Sub-total	**111**	**21.1**	**1**	**0.4**	**112**	**21.5**
BARRACUDAS AND SPIKES						
SPHYRAENIDAE						
Sphyraena barracuda Great barracuda	1	7.4	1	17.0	2	24.4
Sphyraena forsteri Forster's seapike	1	1.1			1	1.1
Sub-total	**2**	**8.5**	**1**	**17.0**	**3**	**25.5**
MISCELLANEOUS BONY FISHES						
BALLISTIDAE						
Sufflamen spp. Unidentified triggerfish	1	0.4			1	0.4
MURAENIDAE						
Gymnothoras spp.* Unidentified moray eel	2	3.0			2	3.0
SCORPAENIDAE						
Pontinus macrocephalis Deep-water scorpionfish	3	4.1			3	4.1
Sebasticus albofasciatus	2	1.0			2	1.0
Sub-total	**8**	**8.5**	**0**	**0.0**	**8**	**8.5**

SHARKS

CARCHARHINIDAE

*Carcharhinus albimarginatus** Silver-tip reef shark	6	119.0	4	45.0	10	164.0
*Carcharhinus amblyrhynchus** Black-tip reef shark	2	20.0	9	90.0	11	110.0
Sub-total	**8**	**139.0**	**13**	**135.0**	**21**	**274.0**
TOTAL	**575**	**1,153.4**	**204**	**677.3**	**779**	**1,830.7**

*indicates locally unsaleable species

APPENDIX 5

SPECIES COMPOSITION OF THE CATCHES BY SECONDARY FISHING METHODS

Family *Species* English name	Fishing method	Catch No.	Catch Weight (kg)
	Mid-water shark line		
CARCHARHINIDAE			
*Carcharhinus falciformes** Silky shark		1	8.0
Sub-total		**1**	**8.0**
	Light handline used around FAD's		
CARANGIDAE			
Elegatis bipinnulatus Rainbow runner		2	0.5
Seriola rivoliana Deep-water amberjack		1	0.1
BALISTIDAE			
Canthidermis maculatus Oceanic triggerfish		13	6.0
Sub-total		**16**	**6.6**
	Flying fish scoop netting		
EXOCOETIDAE			
Cypselurus spp. and *Parexocoetus* spp. Unidentified flying fish		25	5.0
HEMIRAMPHIDAE			
Hemiramphus spp. Unidentified garfish		8	1.0
Sub-total		**33**	**6.0**
	Palu ahi around FAD's		
CARCHARHINIDAE			
*Carcharhinus falciformes** Silky shark		1	3.0
Sub-total		**1**	**3.0**
TOTAL		**51**	**23.6**

*Indicates locally unsaleable species