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ON SECOND VISIT

TO

THE REPUBLIC

OF BELAU

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by

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SUMMARY

The South Pacific Commission's Deep Sea Fisheries Development Project (DSFDP) visited the Republic of Belau (Palau) for the second time between 3 May and 1 November 1983, under the supervision of SPC Masterfisherman Pale Taumaia. The visit followed a request for assistance in conducting a survey of deep-bottom fishing grounds and for an assessment of the economic potential of a deep-bottom fishery. As part of this programme it was requested that the Masterfisherman demonstrate appropriate gear and fishing techniques to local fishermen and train a government demonstration team who would form the core of an ongoing training programme.

The project was based at Koror from where, after an initial training period for the demonstration team, visits of varying duration were made to ten state fishing co-operatives on board a vessel of the type currently being used by these groups. At each co-operative, training was conducted in gear rigging and in fishing technique, with emphasis placed on handling of deep-bottom catches to export quality standards. A total of 56 trainees, including eight women participated in at least one training trip at sea during these visits.

Project activities ranged from Kayangel State in the north to Angaur State some 200 km (125 miles) southwest, and 42 fishing trips were completed for a total catch of 10,183 kg. (22,453 lbs); 99.6 per cent of this catch was taken by deep-bottom fishing. Fifteen hundred reel hours of bottom fishing produced a catch rate of 6.8 kg (14.9 lbs) per reel hour, but 37.3 per cent of the catch was unsaleable, consisting largely of sharks and snake mackerels, and the catch rate for the saleable fish component was 4.2 kg (9.7 lbs) per reel hour. In addition, seven and a half reel or line hours were spent in trolling, for a catch of 44 kg (97 lbs), all of which was saleable (a catch rate of 6.3 kg [13.9 lbs] per reel/line hour).

The significant features which emerged during the visit were the identification of extensive grounds holding substantial deep-bottom stocks and the presence in the catch of an adequate proportion of high value species. The proportion of unsaleable species was high but the refinement of fishing techniques and innovative marketing and consumer education may lessen the significance of this component.

Local fishermen and fishing co-operative groups proved to be capable and enthusiastic at the prospect of developing a commercial deep-bottom fishery, and with the continued support of the Palau Federation of Fishing Associations and the Marine Resources Department, the potential for the development of this fishery in the immediate future appears to be sound.

RÉSUMÉ

Sous la direction de son maître de pêche, Pale Taumaia, la Commission du Pacifique Sud a, pour la deuxième fois, accompli une mission à Palau, du 3 mai au 1^{er} novembre 1983, dans le cadre de son projet de développement de la pêche au demi-large. Cette mission a fait suite à une demande d'aide concernant la réalisation d'une étude des sites de pêche au grand fond et d'une évaluation du potentiel économique de ce type de pêche. Dans le cadre de ce projet, le maître de pêche a été invité à faire la démonstration de l'utilisation des engins et des techniques de pêche appropriés aux pêcheurs locaux et à former une équipe officielle d'animateurs de stages appelés à constituer le noyau d'un programme de formation en cours.

Le projet a été installé à Koror, d'où, après une période initiale de formation de l'équipe d'animateurs, des missions de durées diverses ont été réalisées auprès de dix coopératives de pêche de l'État à bord d'un navire du type alors employé par ces coopératives. Lors de chacune d'entre elles, une formation au montage d'engins et aux techniques de pêche a été dispensée, l'accent étant surtout placé sur la manipulation des prises des grands fonds afin que les normes de qualité imposées à l'exportation soient respectées. En tout, lors de ces missions, 56 stagiaires, dont huit femmes, ont participé au moins à une sortie en mer destinée à la formation.

Les activités se sont déroulées de l'État de Kayangel à l'État d'Angaur, situé à quelque 200 km au sud-ouest, et au cours des 42 sorties, en tout, 10 183 kg de poisson ont été capturés, dont 99,6 pour cent par grand fond. On a enregistré 1 500 heures de pêche profonde, soit un taux de prise de 6,8 kg/heure/moulinet, mais 37,3 pour cent des prises étaient invendables, car essentiellement composées de requins et d'escolars; le taux de prise des poissons commercialisables était de 4,2 kg/heure/moulinet. En outre, 7,5 heures ont été consacrées à la pêche à la traîne, au moulinet ou à la ligne, pour un volume de prises de 44 kg, entièrement commercialisables (soit un taux de prise de 6,3 kg/heure/moulinet).

Cette mission a surtout été caractérisée par la découverte de vastes zones où évoluent des stocks abondants de poissons profonds et par la mise en évidence de la part raisonnable que représentent les espèces à valeur marchande élevée parmi les prises. La proportion des espèces non commercialisables était élevée, mais le raffinement des techniques de pêche et les innovations en matière de politique de commercialisation et d'éducation des consommateurs peuvent atténuer l'importance de cet élément.

Les pêcheurs locaux et les groupes fonctionnant en coopératives de pêche se sont montrés capables de développer une pêche commerciale au grand fond et enthousiastes face à cette perspective, et, grâce au soutien que ne cessent d'apporter la Fédération des associations de pêcheurs de Palau et le département des Ressources marines, le potentiel de développement de cette pêcherie semble être prometteur dans un avenir immédiat.

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1. INTRODUCTION

The South Pacific Commission's Deep Sea Fisheries Development Project (DSFDP) 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 visited eight countries and territories of the SPC region since its inception in 1978. This assignment was its twenty-ninth country visit and its second to the Republic of Belau (Palau).

The Project first visited Palau between 1 November 1979 and 31 January 1980. The aims of this earlier visit were to 'demonstrate deep-bottom fishing techniques, to train local personnel and to investigate the commercial viability of deep-bottom fishing under local conditions' (Taumaia and Crossland 1980). Difficulties encountered with the original vessel made available, which required extensive maintenance and suffered regular engine breakdown, limited fishing time and 11 fishing trips were completed for a total catch of 2,210 kg (4,873 lb) of fish. Although the catch rate recorded (3.1 kg [6.8 lb] per reel hour) was low in comparison with rates recorded by the Project elsewhere in the region, the catch was notable for the high number of species represented (50) and for the relatively large individual size of fish landed. Of special interest was the catch of good-sized specimens of the valued red snapper, *Etelis carbunculus*, in depths as shallow as 150 m (80 fathoms). It was concluded that Palau's extensive area of deep-bottom fishing grounds and the development of improved and efficient fishing techniques would enable local fishermen to land good deep-bottom catches. Constraints on development noted were the regular occurrence of strong north/south currents and the low local price then offered for deep-bottom species.

The current visit followed a request from the government of the Republic of Belau for assistance in re-vitalising the local deep-bottom fishery, and in further surveying the viability of its commercial potential in the light of recent market developments, especially the opening of marketing opportunities in Hawaii and Guam.

Specific objectives were:

- To stimulate interest in deep-bottom fishing and to train interested local fishermen in appropriate techniques;
- To survey available fishing grounds around Palau with a view to assessing the potential for a viable commercial deep-bottom fishery; and
- To train a government demonstration team who would continue training activities beyond the termination of the project visit.

In response to this request, one of the Project's three Masterfishermen, Pale Taumaia (who had participated in the earlier visit) was assigned to work in Palau for approximately six months from 3 May 1983 to 1 November 1983.

2. BACKGROUND

2.1 General

With less than 14,000 inhabitants (Anon, 1987) the Republic of Belau (Figure 1) is the smallest of the four political units to emerge from the Trust Territory of the Pacific Islands. The main Palau cluster consists of 343 islands strewn along a line which begins with Kayangel in the northeast and ends with Angaur, 200 km (125 miles) southwest. The group, which lies at the southwest corner of the Western Caroline Islands, ranges from tiny atolls to 396 square km (153 square mile) Babeldaop, the second largest island in Micronesia. In addition there are the far-flung Southwest Islands, home to less than 200 people. Together, the group totals 494 square km (190 square miles). Well over half the population lives in the capital Koror, which lies 1,300 km (800 miles) southwest of Guam and 700 km (435 miles) east of Mindanao (Philippines).

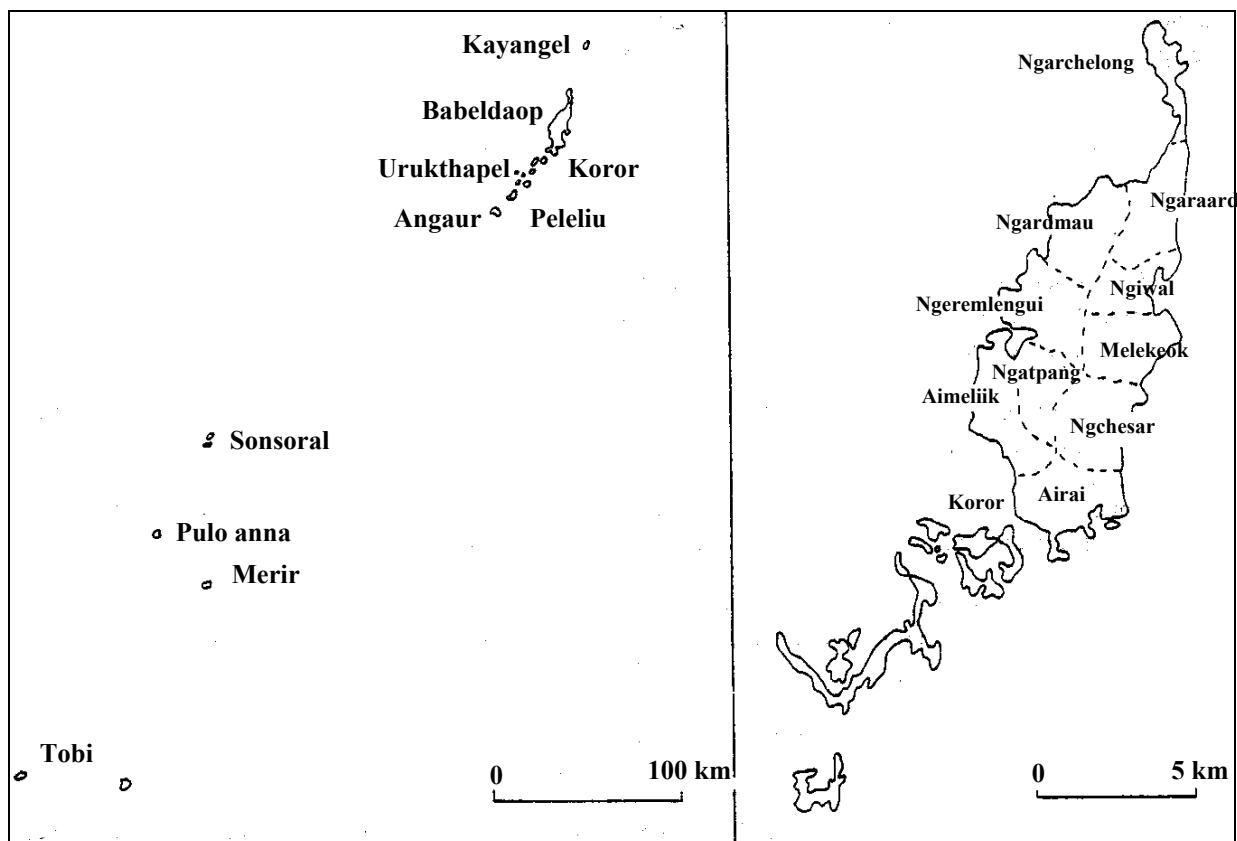


Figure 1: The Republic of Belau, detail shows the main Palau cluster

2.2 Existing fisheries

The sheltered lagoon waters inside Palau's complex of barrier reefs, some 1,300 square km (500 square miles) in area, have long fostered a tradition of inshore artisanal fishing. The proximity and broad extent of this rich ground have disinclined local subsistence fishermen to venture much into open-water fisheries and the development of local fishing skill has largely been restricted to shallow-water handlining, lagoon spearfishing and nearshore trolling for seasonal pelagic species.

Palau's commercial offshore fishery has been dominated by distant-port-vessels from the United States of America, Japan, Korea and other foreign nations. Prior to this visit, up to 25 foreign vessels were regularly engaged in tuna fishing in Palau's offshore waters. In 1981 Palau granted fishing rights to Japanese vessels in exchange for fees, vessels and ice machines. Most of the vessels engaged in the offshore fishery were Japanese-style 22 m (71 ft) pole and line boats which, before they ceased operating prior to this visit, obtained bait locally and landed their catch at a buying station in Koror operated by the Van Camp Company of San Diego.

Tuna taken by the pole and line fleet were brine frozen in the round and transshipped to the company's cannery in American Samoa for processing. In 1981 the fleet landed some 4,173 t of skipjack tuna and 635 t of yellowfin, while in 1980 the landings were 3,356 t and 72.5 t respectively (Anon. 1982). During the current visit one locally owned pole and line vessel continued to operate, supplying the domestic market, and was a valuable source of fresh skipjack for deep-bottom fishing.

Trochus is currently a seasonally important commercial fishery for many local residents. Average harvests range between 100 and 300 t, with the shell exported to Japan and other Asian countries.

Other small-scale commercial fisheries activities include the collection of beche-de-mer, shark fin, lobster, crab, clam, turtle, crocodile and aquarium fish.

Local fisheries in each state are organised as co-operatives under the umbrella of the Palau Federation of Fishing Associations (PFFA) which provides significant support services for its members. The PFFA has managed the distribution of a number of 10.6 m (35 ft) fibreglass, displacement hull, diesel vessels donated under a Japanese government grant-in-aid arrangement. These boats are operated by the fishing co-operatives both as fishing platforms and to ship surplus or premium catches to Koror for sale, though at the time of the Project visit they were generally underutilised. Some of the co-operatives' member fishermen and most of the unaffiliated fishermen favour 4.6 to 6 m (16-20 ft) Japanese fibreglass skiffs, usually powered by 35-75 hp outboard motors. There are only a few outrigger canoes still in regular use, which are either paddled or driven by small outboard motors.

The PFFA controls flake and block ice-making machines, blast freezing and cold storage facilities (around 200 tons capacity). In the outlying states and at Koror the co-operatives' members are able to purchase fuel, outboard oil, ice and bait at less than retail prices. Other facilities at Koror include an excellent small-boat harbour and a fuel dock.

Both the state co-operatives and the PFFA also provide marketing assistance. Surplus and premium-grade catches are regularly carried to Koror for local sale, export or cold storage. The PFFA has developed some export markets and during the Project visit was irregularly freighting fish to Guam, Hawaii and Japan.

In spite of the relatively extensive support infrastructure and the proximity of good inshore fishing grounds, the catch landed is often not sufficient to meet even local demand, and despite the Project's earlier demonstration of deep-bottom fishing techniques very little of this type of fishing has been conducted lately.

Other fisheries activities in Palau includes research in trochus and clam culture under the supervision of the Micronesian Mariculture Demonstration Centre (MMDC).

PROJECT OPERATIONS

3.1 General

In order to best satisfy the objectives of the Project visit, it was decided that the Masterfisherman would first work at training a demonstration team in deep-bottom fishing technique and gear rigging. This team would then accompany the Masterfisherman on visits to the outlying states and play an active part in the training programme. Boat captain Pablo Siangeldep and fisherman McCarthy Kotaro were seconded from the Palau Marine Resources Division and fisherman Sandario Kulas from the PFFA.

After the completion of the demonstration team's training at Koror the Project began a series of visits to various state fishing co-operatives. Although it was originally envisaged that each state would be visited for one week the practicalities of weather, interest, the number of aspiring trainees and suitability of fishing grounds determined that the schedule be varied to best meet the requirements of both the fishing co-operatives and the Project's work assignment.

Ten states were visited and forty-two fishing trips completed during the six months of the Project stay. Two periods of one week each were required for maintenance and repairs to the Project vessel and for leave for the demonstration team, and the Masterfisherman was absent for approximately one month to attend the Regional Technical Meeting on Fisheries (RTMF) at SPC headquarters in Noumea (during this period the demonstration team continued the programme of state visits).

During the early part of the visit slight to moderate trade winds and calm seas predominated, with little rain. Heavy rainfall and some periods of strong westerly winds slightly hampered later operations.

TABLE 1. Summary of activities in Palau, May-November 1983

Phase 1	3 May-15 May	Training of demonstration team at Koror
Phase 2	16 May - 29 May	Operations in Peleliu State
	30 May - 19 June	Operations in Koror State
	20 June - 3 July	Operations in Kayangel State
	4 July - 10 July	Repairs and maintenance to Project vessel, leave for demonstration team
	11 July - 24 July	Operations in Ngchesar and Malekeok States
	25 July - 7 August	Operations in Ngiwal State
	8 August - 11 September	Masterfisherman to Noumea for RTMF. Demonstration team operated in Ngaraard and Ngerchelongs States
	12-18 September	Operations in Angaur State
	26 September - 23 October	Operations in Ngardmau State
	24 October - 1 November	Packing, drafting of report.

3.2 Boats and Equipment

With the co-operation of the Palau Marine Resources Division one of the vessels supplied under the Japanese government grant-in-aid programme for the state fishing co-operatives was made available for Project operations. This boat, the *Mesekiu* (Figure 2), a 10.6 m (35 ft) diesel-powered, fibreglass displacement hull launch, was fitted with six FAO-Western Samoa- type wooden handreels, which are standard operating equipment for the DSFDP. Each handreel (Figure 2) was wound with 400 m (444 yds) of 130 kg or 250 kg (285 lb or 550 lb) test nylon monofilament and fitted with the standard terminal rig used by the Project (Figure 3).

Fishing sites were generally selected using the Project's Furuno F11 portable the echo-sounder which has a depth range down to 640 m (350 fathoms) and which was powered by a 12 v. battery charged from the main engine.

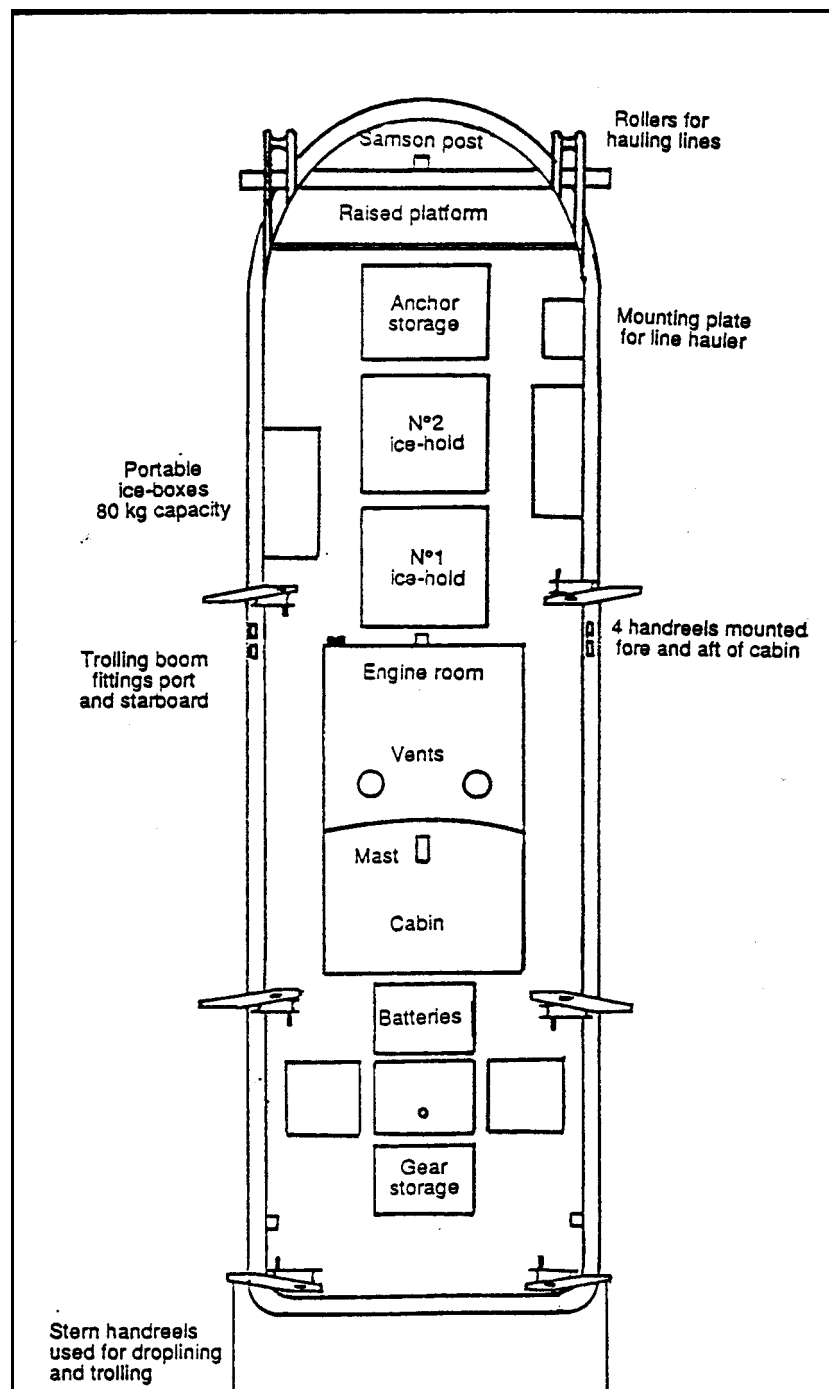


Figure 2: Deck layout of the *Mesekiu*

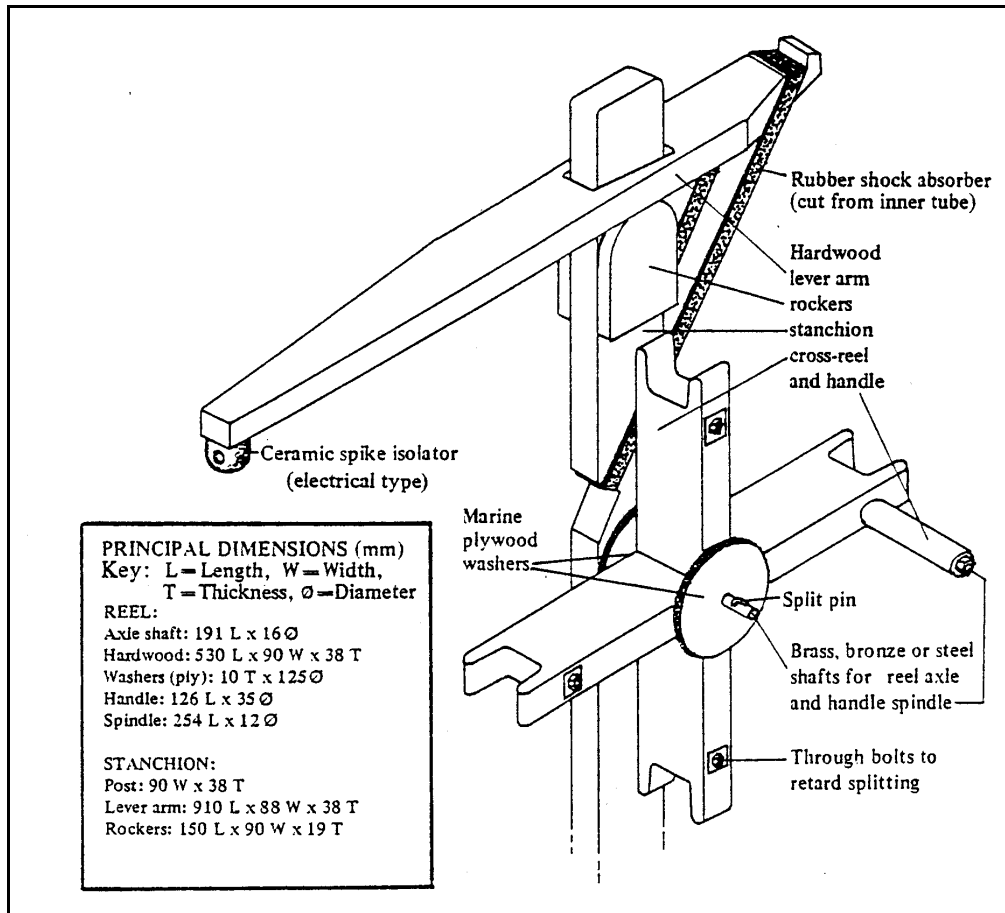


Figure 3: Wooden handreel used by the Project

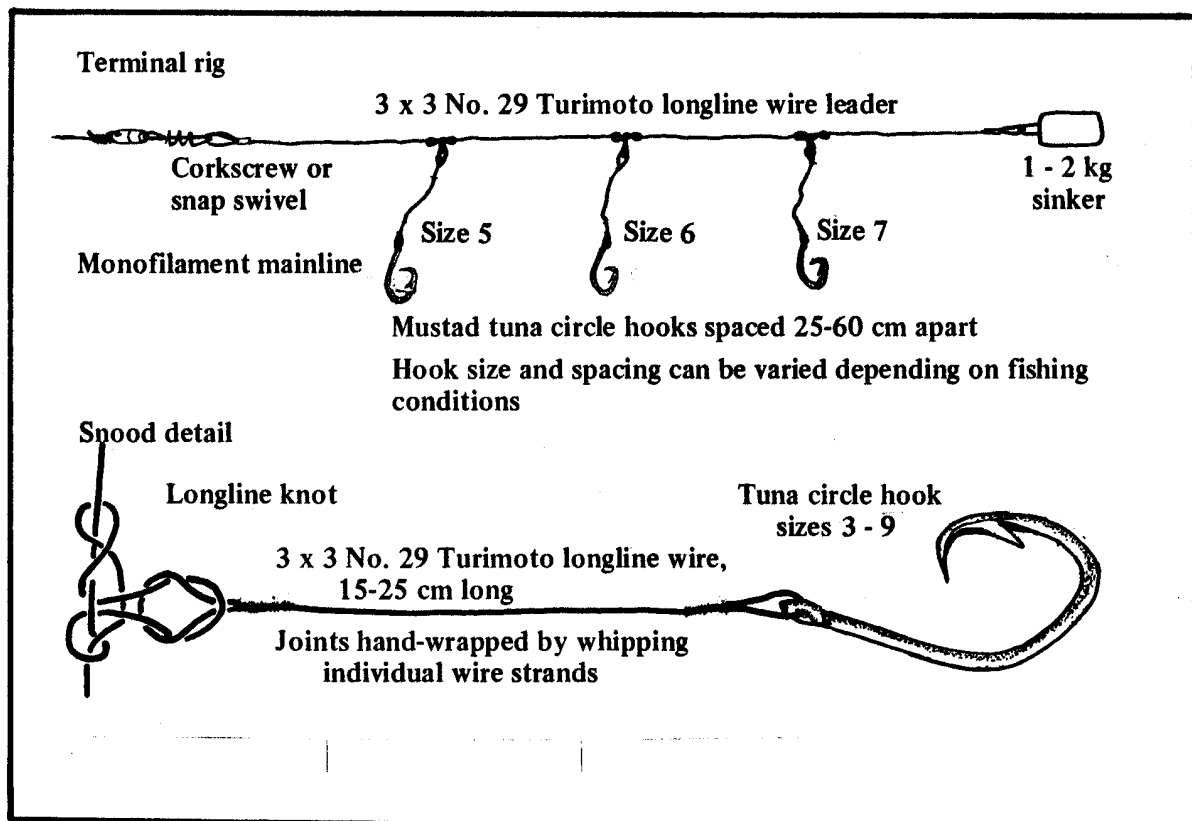


Figure 4: Typical terminal rig for deep-bottom fishing

The anchoring gear (Figure 5) was basically that standard for the Project, but, because strong currents had hampered operations during the Projects' previous visit to Palau, and because a relatively large vessel was used as the fishing platform, two complete sets of anchoring gear were carried. A modification was also made to the standard design with the addition of a free-hanging 2 m (6.5 ft) length of 16 mm (5/8 in) diameter chain shackled to the anchor eye to give the grapnel extra weight. The basic anchor was constructed from four 1.5 m (5 ft) lengths of 16 mm (5/8 in) steel reinforcing rod and 1 m (3.3 ft) of 33 mm (1 5/16 in) diameter galvanized steel water pipe, welded together and with the tines bent into a grapnel shape. The two 2 m (6.5 ft) lengths of 16 mm (5/8 in) diameter chain were shackled to the anchor eye and a 600 m (655 yd) length of polypropylene anchor warp 12 mm (1/2 in) in diameter fixed to the end of the chain. A 'no-return' barb of 4 mm (1/8 in) diameter galvanised fencing wire was whipped onto the anchor warp close to its junction with the chain and an inflatable buoy of 75 kg (165 lb) or greater flotation was fitted with a snap-shackle which could be clipped onto the anchor warp so as to slide freely along it.

A full list of basic equipment for deep-bottom fishing is detailed in Appendix 1.

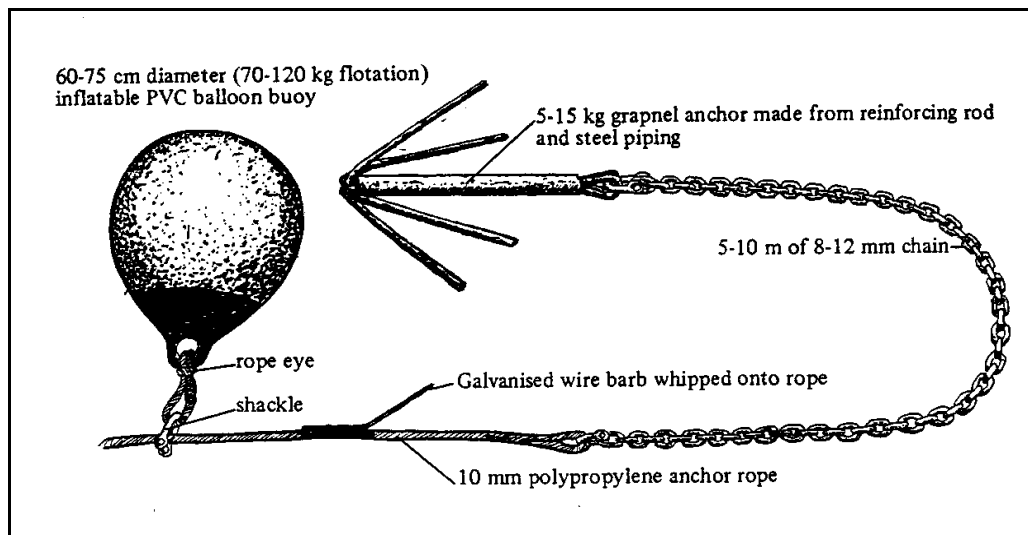


Figure 5: 'Self-hauling' anchor gear showing modification used for deep-bottom fishing in Palau

3.3 Data collection

South Pacific Commission Masterfishermen use a standard logsheet (shown at Appendix 2) to record catch, effort and other fishing data, and make detailed notes of their daily activities and of any supplementary information required. During this Project visit, data was collected at the end of each trip and comprised: time spent travelling, anchoring and on each type of fishing; fishing depth or depth range; number of crew/trainees; quantity and type of fishing gear; fuel and bait used; the specific identity of each fish caught, where this could be determined; and the total number and weight of each species taken by each fishing method.

3.4 Training activities

After the training of the three-man demonstration team, at Koror the Project proceeded to visit individual states aboard the *Mesekiu*. At each location trainees selected by the local fishing co-operative were instructed in the basics of deep-bottom droplining. The first day of each visit was spent on gear rigging, with each trainee given the materials to complete a single deep-bottom fishing line. The tying of suitable knots, rigging of wire traces and selection and rigging of hooks were covered with the assistance of the demonstration team, often in the Palauan language.

Fishing demonstration and the surveying of fishing sites were commenced on the second day and continued through the week. Topics covered by demonstration included selection of sites, anchoring procedure, handling and boating large fish, unhooking fish, efficient ways to deal with tangles, and proper on-board handling of the catch. Trainees were always encouraged to take an active role in fishing and a number of incentives devised by the Masterfisherman to encourage this, including the offering of a cash prize for the largest deep-water snapper landed and allowing trainees to keep the catch taken by them during rest periods (rest periods were declared when poor sea conditions precluded general fishing demonstration and in the early hours of the morning when the crew slept). It was decided in consultation with the Marine Resources Division that any surplus of funds derived from catch sales after operational expenses were deducted would be shared equally between trainees and the demonstration team. Any profits at each location were calculated and shared on this basis and this system served as a further incentive for trainees to fish actively. (The overall share for the individuals of the demonstration team totaled US\$690.55).

A total of 56 trainees participated in at least one training trip, including eight females who were regular fisherwomen.

At some locations the daily fishing activity was divided into two parts to allow a second group of trainees to participate on a 'shift' basis. Special emphasis was given to demonstration and instruction in the proper on-board handling and icing of the catch.

Appendix 3 details topics covered in the training programme.

3.5 Post-harvest activities

As an important aspect of the Project's brief in Palau was to encourage deep-bottom fishing as a commercial activity a good deal of attention was paid to landing catches in prime condition, to meet export quality standards set by the PFFA. Prime quality fish fetched a higher price than those even slightly damaged, showing colour loss, loss of scales or distortion, and trainees were quick to see that better returns resulted from careful catch handling.

The *Mesekiu* carried portable ice-boxes in addition to its insulated fish hold, and both flake and block ice were readily available at Koror. Supplies of ice were usually carried from Koror on visits to states and a number of the co-operatives visited had flake-ice machines as well. During trips, fish were placed in a thick slurry of ice and sea-water immediately after unhooking and extra salt added. The water was drained every 24 hours and more ice and salt added.

It was found that the portable ice-boxes were a good deal more effective than the boat's integral fish hold as they held ice longer and did not allow the catch to move around. When large catches were made and the fish hold had to be used, some damage usually resulted. During visits to state co-operatives the catch was held on-board the *Mesekiu* until operations were completed. The fish were then carried to Koror for landing at the PFFA, either by the *Mesekiu* or by a similar vessel if one happened to be heading to Koror. Early landings by the Project fetched the highest prices recorded up to that time for deep-water species and this generated a good deal of interest and enthusiasm among trainees.

4. FISHING ACTIVITIES AND RESULTS

4.1 General

Most fishing effort during the visit was in deep-bottom droplining using the wooden handreels in depths between 100-200 m (55-110 fathoms) though on occasion more shallow depths were fished as a result of bottom slope, current or sea conditions. The number of crew, including trainees, varied on each trip between five and fourteen and up to six handreels were in use at any one time, with a wide range of skill and effectiveness in fishing technique evident. Figure 6 shows the area fished by the Project.

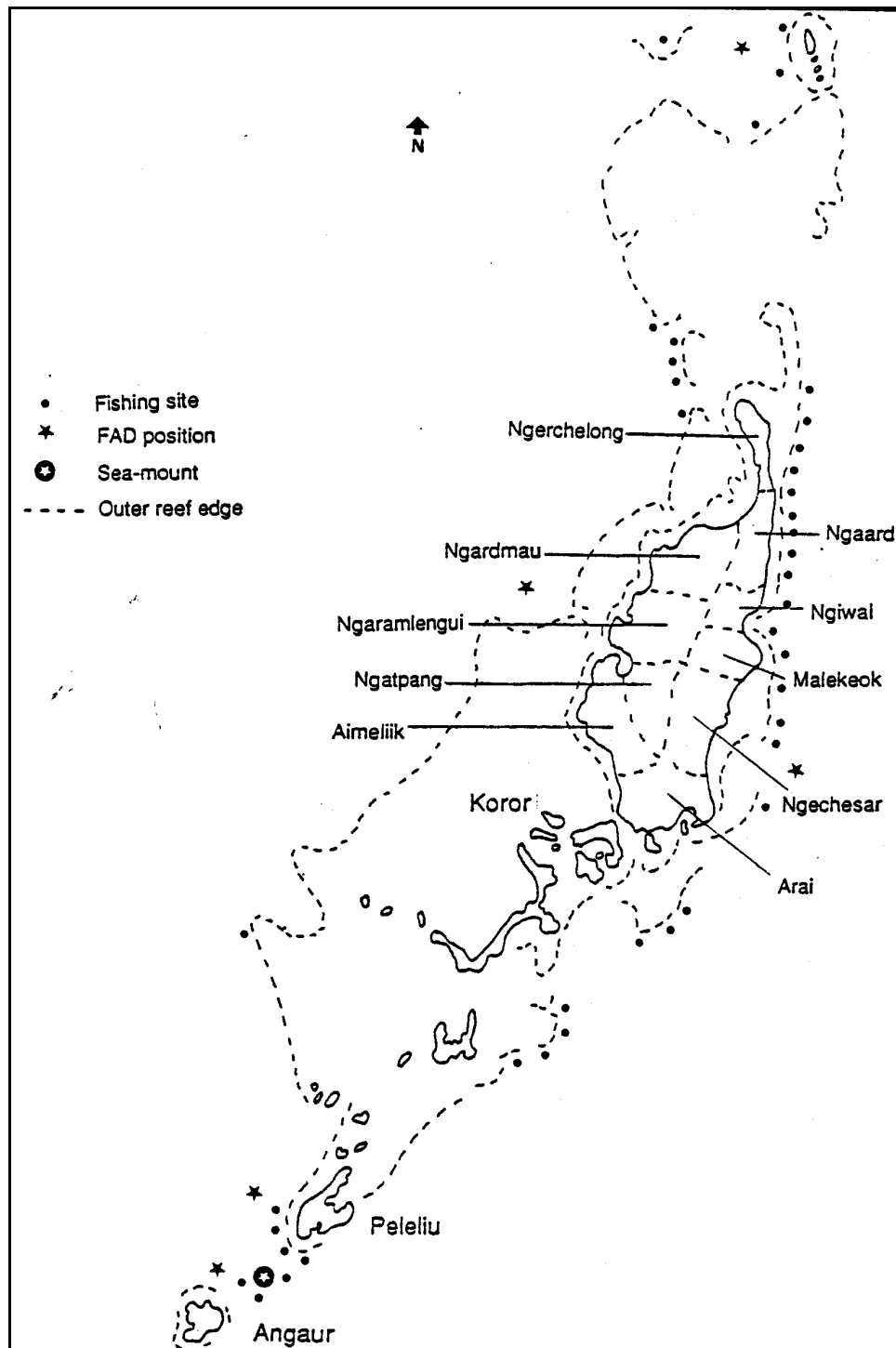


Figure 6: The Palau cluster, showing sites fished by the Project

Only a little trolling was attempted while travelling between bottom-fishing sites, and some mid-water handlining was also conducted when fish such as dolphinfish (*coryphaena hippurus*) and rainbow runner (*elegatis bipinnulata*) were observed taking bait scraps during bottom-fishing operations.

Trips lasted between 8 and 24 hours depending on weather, the number of trainees wishing to participate and the distance of the fishing grounds from base.

4.2 Deep-bottom handreeling

Deep-bottom handreeling is conducted at anchor and requires the selection of likely fishing sites of suitable depth and the effective anchoring of the boat over such sites.

During this visit sites were selected by echo-sounding and the anchor then dropped in water shallower than that of the chosen fishing spot so that wind and current would carry the boat back over the target area as the anchor warp was paid out. If the wind or current was strong two anchors were deployed. In calm conditions it was sometimes necessary to anchor in the same depth as the fishing site or even in deeper water.

Once the boat was resting at anchor, fishing commenced using the wooden handreels and the terminal rig described in Section 3.2. The sinker and baited terminal rig were lowered to the bottom and the line then kept taut by hand to allow the fisherman to respond to bites by striking, and to reduce the likelihood of fouling other lines. Because of the elasticity of the long lengths of line used, much reliance was placed on the 'self-hooking' qualities of the tuna circle hooks.

The preferred bait for deep-bottom fishing is fresh or frozen skipjack, and during this visit good supplies of frozen bait were available through the PFFA in Koror, which sold bait at subsidised prices after purchasing it from a privately owned pole-and-line boat.

A simple technique was used to retrieve the anchor after fishing, which greatly reduced the effort involved in hand-hauling. By motoring rapidly forward the anchor was broken out and streamed behind the boat. While still under way the inflatable buoy was attached to the anchor warp with the 'snap-lock' shackle and released. The boat's forward motion forced the buoy back along the warp until it was trapped by the 'no-return' barb. The boat was then motored back along the warp with the slack line being paid in by hand and the anchor, suspended at the surface by the buoy, could easily be retrieved.

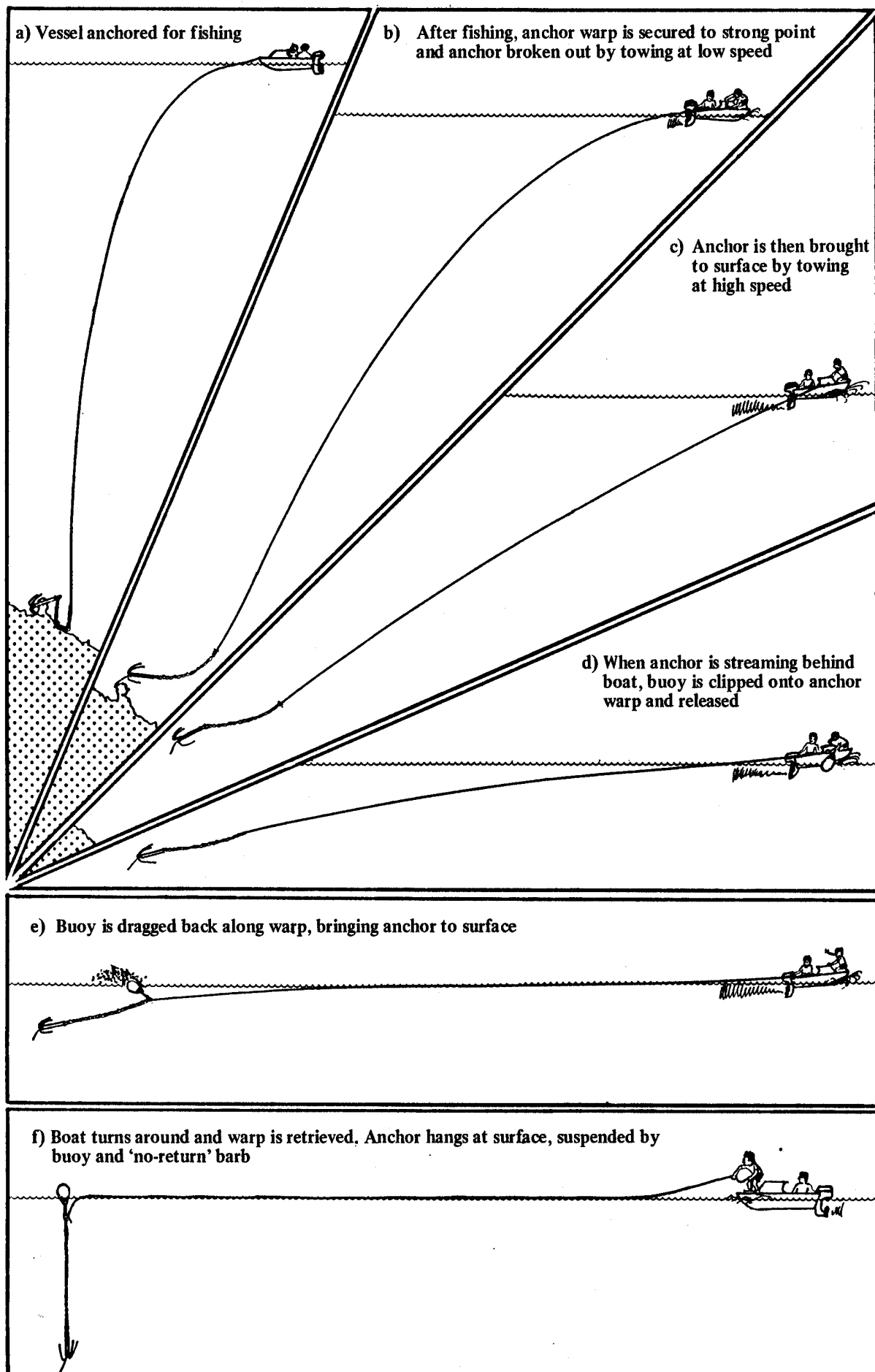


Figure 7: Anchor retrieval method

Deep-bottom fishing was conducted on all 42 fishing trips completed, with a total of 1500 reel hours (reel hours being calculated as one reel in use for one hour) producing a catch of 10,139 kg (22,356 lb). Of this, 3,800 kg (8,379 lb) were of unsaleable species consisting of sharks (3,462 kg [7,633 lb]), oilfish and snake mackerels (177 kg [390 lb]) and others. The large catch of sharks, which comprised 31.4 per cent of the bottom catch, was high compared to that recorded by the previous visit (7.4%). This may be explained in part by the somewhat shallower depths fished during this visit and by the fact that the previous visit fished only around Babeldaop while during this visit large catches of sharks were taken at the atolls of Kayangel State. In some areas, such as Angaur State, sharks were eaten although they could not be sold through the co-operatives or the PFFA at Koror.

The saleable catch from bottom-fishing operations was 6,339 kg (13,977 lbs) and comprised 31.9 per cent deep-water snappers. Small-tooth jobfish (*Aphareus rutilans*) dominated this group, making up 25.7 per cent of the catch by weight. Next most important were short-tailed red snappers (*Etelis carbunculus*); 25.5 per cent of the catch by weight. Other important species included green jobfish (*Aprion virescens*); 16.2 per cent by weight and banded flower snappers (*Pristipomoides zonatus*); 9.4 per cent by weight.

Shallow water snappers and emperors together accounted for 32.1 per cent of the saleable bottom catch, dominated by mangrove jacks (*Lutjanus argentimaculatus*) and red bass (*Lutjanus bohar*) which made up 12.1 per cent and 9.0 per cent of the saleable bottom catch by weight respectively; the red bass, which is often ciguatoxic elsewhere in the region and usually shunned was readily sold and consumed in Palau. Of this group the mangrove jack was the most numerically common fish taken while bottom-fishing, with 242 individuals landed.

The remainder of the saleable bottom catch included groupers, with 1,118 kg (2,465 lbs) accounting for 17.6 per cent by weight, trevallies and jacks, 1,251 kg (2,758 lbs) accounting for 19.7 per cent, and five other families.

The landing of prime species of deep-water snappers in good condition which fetched the highest price then on offer by the PFFA (US\$1 per lb), created a great deal of interest among local fishermen and fishing co-operative groups. At the conclusion of this visit two co-operative-run boats not previously so equipped had been fitted with wooden handreels, two similar boats were awaiting reels and the PFFA had introduced a reel construction and instalment purchase plan whereby reels could be paid for out of deductions from catches.

Between April and December of 1983, fish purchases by the PFFA totaled 22,261 kg (430,865 lbs) valued at US\$198,716 and of this amount snappers accounted for the highest value of any fish group, with sales totaling US\$59,582 or 30 per cent of the total. Between the second quarter of 1983 purchases of snapper by the PFFA increased from 1,145 kg (2,525 lbs) to 5,898 kg (13,007 lbs). (Anon, 1983).

The overall catch rate recorded for bottom fishing was 6.8 kg (14.9 lbs) per reel hour, the rate excluding sharks 4.3 kg (9.9 lbs) and the rate excluding both sharks and other locally unsaleable species 4.2 kg (9.7 lbs). Table 2 summarises catches and catch rates at each state.

Table 2: Summary of deep-bottom catches and catch rates at each fishing site

	No. Of trips	Effort (reel hours)	Saleable Catch	Unsaleable Catch	Cpue all species (kg)	Cpue Saleable species(kg)
Koror	9	307	1068	754	5.9	3.5
Peleliu	8	317	1124	639	5.6	3.5
Kayangel	6	290	1344	1751	10.7	4.6
Malekeck	4	100	653	14	6.7	6.5
Ngiwal	2	50	274	0	5.5	5.5
Ngchesar	2	115	432	24	4.0	3.8
Ngaraard	2	84	396	189	7.0	4.7
Ngerchelong	1	18	85	0	4.7	4.7
Angaur	2	83	639	66	8.5	7.7
Ngardman	6	136	324	363	5.1	2.4
TOTAL	42	1500	6339	3800	6.8*	4.2*

* Average over all areas

4.3 Trolling and mid-water handlining

Both trolling and mid-water handlining were conducted opportunistically as secondary activities during 7.5 fishing hours for a catch of 10 fish with a total weight of 44 kg (97 lbs). Only a little effort was devoted to trolling while travelling between bottom fishing sites because the typically large crew of trainees required a good deal of supervision in preparing gear, and as bait supplies were plentiful through purchases from PFFA there was little incentive to pursue schools of pelagic species observed off-shore. Three wahoo (*Acanthocybium solandri*) and one barracuda (*Sphyraena* sp.) were taken by trolling.

Mid-water handlining was conducted when fish were observed taking bait scraps around the boat during bottom-fishing operations. When fish were sighted a single tuna circle hook on an unweighted line was baited and allowed to drift below the surface, sometimes with chum being cast to keep the fish feeding. Four rainbow runner (*Elegatis bipinnulata*) and two dolphin fish (*Coryphaena hippurus*) were taken by this technique.

Catch rate, calculated for both methods, was 6.3 kg (13.8 lbs) per line hour.

5. DISCUSSION AND RECOMMENDATIONS

5.1 General conclusions

The results of deep-bottom fishing and training activities in the ten states visited during the Project's stay in Palau indicate the presence of extensive deep-bottom grounds holding substantial stocks of valued fish species which are presently unexploited or underexploited, and local fishermen appear likely to quickly develop the skills and enthusiasm to take advantage of this.

The existence of this resource together with the system of state fishing co-operatives, the availability of well-equipped boats with adequate carrying capacity, the Koror-based catch handling facilities and the operational and marketing assistance afforded by the PFFA should all contribute to the successful development of this fishery and to a subsequent increase in both the domestic catch and the cash income derived from export sales.

5.2 Training

The success of the demonstration team in both practical training and generating enthusiasm for deep-bottom fishing was apparent in each state and was reflected by the large number of trainees wishing to participate in demonstration trips. As the time available for the Project's stay was limited and operational considerations restricted the range and duration of visits it would appear important for the demonstration team to continue its activities to introduce deep-bottom fishing techniques throughout the group and to conduct follow-up visits with special emphasis on correct catch handling procedures. The team members were found to be both reliable and effective and well able to continue such a programme, as demonstrated during the Masterfisherman's absence. Future training should place more emphasis on the inclusion of both women and young people, especially school leavers, with the aim of promoting the view of fishing as a viable and rewarding occupation.

5.3 Boats and equipment

The 10.6 m vessels currently in use by the state co-operatives seem quite suited to their purpose and, although rigged only for trolling, are easily equipped for deep-bottom fishing. The only significant inadequacy noted was the poor insulation of the internal fish holds which did not hold ice well and which allowed the catch to move around resulting in damage. However, such large vessels require large crews to fish them effectively and consideration should be given to determining the most suitable boats for independent operators who may wish to fish in smaller groups and to providing some assistance for such operators to enter the fishery.

The Western Samoa type wooden handreel is both cheap and effective and the programme of construction and sale of these reels by installment purchase should be continued. It would be of benefit also, to ensure that good stocks of basic deep-bottom fishing gear are regularly available at reasonable prices.

5.4 Support services and fisheries management

The extensive shore-based catch handling facilities presently in place and the sales of ice and bait should be continued and careful attention paid to the maintenance of equipment in good condition, especially the ice-making machines located at state co-operative sites.

The present marketing expertise of the PFFA and the marketing services offered to local fishermen will become increasingly important if the fishery is to develop commercially. The present high standards of quality should be maintained and efforts made to diversify markets and to ensure reliable freighting services. Careful attention should be paid to pricing structure and consideration given to passing on surplus profits, if any, to fishermen.

In order to both diversify fisheries activity and maintain bait supplies, consideration should be given to establishing a programme of fish aggregation device (FAD) deployment. Two or three FADs laid in proximity to Koror, and others at suitable sites in the outlying states, would likely be of great benefit to both the deep-bottom fishery (through bait capture) and to the troll fishery.

Because a significant component of the bottom catch during this visit consisted of sharks which are generally locally unacceptable for consumption and unsaleable it would seem worthwhile to explore the commercial potential of secondary shark products such as dried fins, teeth and jaws.

It was apparent in all states visited that enthusiasm for this fishery was based more on the perception that the species taken had high export market value and could provide a cash income than on the desire or need to land more fish for local consumption. While this trend is gratifying in terms of economic self-sufficiency and does largely satisfy the Project's brief to determine the commercial viability of deep-bottom fishing in Palau, it also raises the question of resource management to foster the fisherie's proper development.

Catch rates recorded during this visit were from virtually unexploited stocks and it is likely that these rates would decline under sustained fishing pressure, perhaps in conjunction with an associated change in the species composition. Very little is currently known about the ability of deep-bottom resources to withstand increased exploitation, or of the long-term effects on them of fishing activities, although several nations have developed their bottom resource fishery without apparent detriment. It is important therefore that accurate catch records be kept and that diversification of fisheries be of on-going concern.

6. REFERENCES

- Anon (1987) South Pacific Economies Statistical Summary. Noumea, New Caledonia, South Pacific Commission.
- Anon (1982) Fisheries Development Project Report. Koror, Republic of Palau Community Action Agency.
- Anon (1983) Abstract of Statistics, Koror, Republic of Palau, Office of Planning and Statistics.
- Taumaia P. and Crossland J. (1980). Report on the Deep Sea Fisheries Development Project in Koror, Palau, Trust Territory of the Pacific Islands. Noumea, New Caledonia. South Pacific Commission.

BASIC EQUIPMENT REQUIRED FOR DEEP-BOTTOM HANDREEL FISHING

- 1) Western Samoa-type wooden handreels
- 2) 118 or 136 kg test nylon monofilament fishing line, in 500 m coils
- 3) 45 kg test nylon monofilament fishing line
- 4) Turimoto No. 29 galvanised longline wire, or equivalent (3 x 3 strand, 120 kg test)
- 5) Mustad tuna circle hooks, quality No. 39960ST, sizes 3–9
- 6) Berkley-McMahon swivels, size 4/0, or equivalent
- 7) Kelux stainless steel Lockfast swivels, size 4/0 or equivalent
- 8) 1 kg and 2 kg sinkers
- 9) 600 m of polypropylene anchor rope, diameter appropriate to size of boat
- 10) Grapnel fishing anchor and chain or wire
- 11) Buoy for anchor retrieval
- 12) Standard pliers
- 13) Side-cutting pliers
- 14) Crimping pliers
- 15) Bait knife
- 16) Compass
- 17) Portable battery-powered echo-sounder, depth range 0–400 metres
- 18) Gaff hook
- 19) Shark noose

STANDARD FISHING DATA COLLECTION FORM

LOCATION:		Trip number:		Departure time:		Return time:		Fishing area:		Boat:		Fuel:													
										Skipper:		Amount:													
DATE	TIME	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
ENGINE HOURS																									
METHODS																									
Trolling																									
Bottom fishing																									
Handreel																									
Handline																									
FISHING DEPTH (m)																									
CATCH RATE																									
Numbers																									
Weight (kg)																									
WEATHER																									
WIND																									
SEA																									
CURRENT																									
CREW (Names):																									
No. of trawlers:																									
BAIT																									
Type																									
Wt (kg)																									
No. of trolling lines																									
No. of handreels																									
No. of handlines																									
FISHING EFFORT																									
REMARKS:																									
TROLL CATCHES																									
Species																									
No.																									
Wt (kg)																									
TOTALS:																									
CATCHES OTHER METHODS																									
TOTALS																									
TOTALS																									
TOTAL CATCH PER TRIP																									
No.																									
Wt (kg):																									

TOPICS COVERED IN THE TRAINING PROGRAMME**1. Handling of a fishing boat**

- a. Safety at sea
- b. Knots and splices for mooring and anchor lines
- c. Construction of a grapnel anchor
- d. Use of equipment checklist before departure
- e. Anchoring in order to fish at the desired depth
- f. Use of a compass
- g. Marking of good fishing sites by landmarks and compass bearings
- h. Anchor retrieval
- i. Care and maintenance of boat after fishing trip

2. Handling of equipment and fishing gear

- a. Safety during fishing operation
- b. Use of Western Samoan-type wooden handreel
- c. Use of handcasting reel
- d. Suitable knots and splices for monofilament line, wire leaders and traces
- e. Techniques for handling large fish
- f. Operation of an echo-sounder
- g. Care of gear to prevent corrosion
- h. Rigging gear in 'tackle-balance' (appropriate matching of hook, swivel and line sizes)

3. Handling of the catch

- a. Suitable ice-boxes and coolers
- b. Unhooking fish
- c. Care in handling fish to avoid damage
- d. Use of ice/water slurry
- e. Transporting fish for sale.

SUMMARY OF OPERATIONAL ASPECTS OF FISHING TRIPS

Trip no.	Location	Total trainees	crew/Total trip hours	Fishing hours	Catch Number	Bait Wight(kg)	used(kg)	Fuel used(l)
1	Koror	5	21	8	46	168.0	45	86
2	Peleliu	8	16	9	56	466.0	75	86
3	Peleliu	8	12	7	64	248.0	60	64
4	Peleliu	6	12	7	60	221.0	45	41
5	Peleliu	6	12	5	13	40.0	31	82
6	Peleliu	9	13	9	69	163.0	27	50
7	Peleliu	9	14	8	37	314.0	34	91
8	Peleliu	9	12	7	48	102.0	32	46
9	Peleliu	9	9	4	58	209.0	18	68
10	Koror	8	23	8	65	93.0	31	123
11	Koror	7	16	9	174	316.0	45	104
12	Koror	8	19	14	106	312.0	40	78
13	Koror	8	12	4	41	519.0	32	74
14	Koror	7	11	5	45	72.0	32	74
15	Koror	6	10	5	74	168.0	34	85
16	Koror	7	10	5	86	104.0	32	90
17	Kayangel	10	13	9	62	152.0	32	69
18	Kayangel	9	11	7	99	275.0	34	56
19	Kayangel	8	10	6	62	71.0	27	56
20	Kayangel	8	10	7	133	452.0	27	80
21	Kayangel	9	26	14	212	1 412.0	55	135
22	Kayangel	9	21	12	134	752.0	59	113
23	Koror	5	11	4	36	85.0	18	68
24	Malekeok	4	8	3	26	52.0	27	27
25	Ngchesar	11	19	13	95	263.0	26	45
26	Ngchesar	11	13	10	96	193.0	28	27
27	Malekeok	4	13	7	68	239.0	20	27
28	MaJekeok	4	13	6	84	270.0	22	32
29	Malekeok	8	8	4	34	106.0	32	27
30	Ngiwal	8	9	4	17	65.0	36	41
31	Ngiwal	8	15	6	89	209.0	31	41
32	Ngaraard	14	8	4	49	158.0	31	41
33	Ngaraard	14	16	10	107	427.0	36	59
34	Ngerchelong	8	8	3	25	85.0	20	36
35	Angaur	8	24	13	110	476.0	50	54
36	Angaur	8	16	6	61	239.0	20	36
37	Ngardmau	8	9	4	24	76.0	25	36
38	Ngardmau	8	15	5	25	192.0	28	30
39	Ngardmau	8	10	4	13	44.0	29	30
40	NGardmau	10	11	5	25	191.0	26	50
41	Ngardmau	10	10	5	25	54.0	21	45
42	Ngardmau	10	12	5	35	130.0	33	54
Total			561	290	2 788	10 183	1 406	2 557

SUMMARY OF CATCH AND EFFORT BY TRIP AND FISHING METHOD

Trip no.	Fishing method	Effort (reel/line hours)	Catch(kg)		C.p.u.e. All species(kg)
			Saleable	Unsaleable	
1	Bottom handreel	40.0	95.0	73.0	4.2
2	Bottom handreel	54.0	114.0	352.0	7.1
3	Bottom handreel	35.0	222.0	26.0	7.1
4	Bottom handreel	35.0	221.0	0.0	6.3
5	Bottom handreel	25.0	40.0	0.0	1.6
6	Bottom handreel	54.0	121.0	42.0	3.0
7	Bottom handreel	48.0	95.0	219.0	6.5
8	Bottom handreel	42.0	102.0	0.0	2.4
9	Bottom handreel	24.0	209.0	0.0	8.7
10	Bottom handreel	40.0	76.0	5.0	2.0
	Troll	2.0	12.0	0.0	6.0
11	Bottom handreel	45.0	163.0	150.0	6.9
	Troll	2.0	3.0	0.0	1.5
12	Bottom handreel	70.0	243.0	69.0	4.0
13	Bottom handreel	20.0	148.0	371.0	25.9
14	Bottom handreel	25.0	72.0	0.0	2.9
15	Bottom handreel	25.0	82.0	86.0	6.7
16	Bottom handreel	30.0	104.0	0.0	3.5
17	Bottom handreel	54.0	120.0	32.0	2.8
18	Bottom handreel	35.0	165.0	110.0	7.9
19	Bottom handreel	36.0	71.0	0.0	1.9
20	Bottom handreel	35.0	286.0	157.0	12.7
	Mid-water handline	0.5	9.0	0.0	18.0
21	Bottom handreel	70.0	407.0	1 000.0	20.1
	Mid-water handline	1.0	10.0	0.0	10.0
22	Bottom handreel	60.0	295.0	452.0	12.5
23	Bottom handreel	12.0	85.0	0.0	7.0
24	Bottom handreel	15.0	52.0	0.0	3.5
25	Bottom handreel	65.0	263.0	0.0	4.0
26	Bottom handreel	50.0	169.0	24.0	3.9
27	Bottom handreel	35.0	225.0	14.0	6.8
28	Bottom handreel	30.0	270.0	0.0	9.0
29	Bottom handreel	20.0	106.0	0.0	5.3
30	Bottom handreel	20.0	65.0	0.0	3.3
31	Bottom handreel	30.0	209.0	0.0	6.9
32	Bottom handreel	24.0	128.0	30.0	6.0
33	Bottom handreel	60.0	268.0	159.0	7.1
34	Bottom handreel	18.0	85.0	0.0	4.7
35	Bottom handreel	65.0	466.0	0.0	7.2
	Troll	2.0	10.0	0.0	5.0
36	Bottom handreel	18.0	173.0	66.0	13.3
37	Bottom handreel	10.0	76.0	0.0	4.8
38	Bottom handreel	25.0	42.0	150.0	7.7
39	Bottom handreel	20.0	44.0	0.0	2.2
40	Bottom handreel	25.0	46.0	145.0	7.0
41	Bottom handreel	25.0	54.0	0.0	2.2
42	Bottom handreel	25.0	62.0	68.0	5.2
Total		1 507.5	6 383.0	3 800.0	

Appendix 4b (cont'd.)**Catch summary****Bottom catch**

Saleable	:	6 339.0 kg
Unsaleable	:	3 800.0 kg
Total		10 139.0 kg

Catch per unit of effort (c.p.u.e.) = catch in kg per reel hour

All species	:	6.8
Excluding sharks	:	4.5
Excluding sharks and other unsaleable species:		4.4

Troll and mid-water handline catch

Saleable	:	44.0 kg
Unsaleable	:	0.0 kg
Total	:	44.0 kg

Catch per unit of effort (c.p.u.e.) = catch in kg per line hour

6.3

SPECIES COMPOSITION OF THE BOTTOM CATCH

GROUP	No.	Weight
FAMILY		
<i>Species</i>		
English name,		
Palauan name (where known)		
DEEP-WATER SNAPPERS		
<i>LUTJANIDAE (sub-families ETELINAE, APSILINAE)</i>		
<i>Aphareus rutilans</i>	115	522.0
Small-tooth jobfish/silvermouth		
Metengui		
<i>Aprion virescens</i>	84	328.0
Green jobfish		
Udel		
<i>Etelis carbunculus</i>	86	516.0
Short-tailed red snapper		
Sebus		
<i>Etelis coruscans</i>	11	47.0
Longtail snapper		
Sebus		
<i>Etelis radiosus</i>	1	3.0
<i>Pristipomoides auricilla</i>	219	157.0
Gold-tailed jobfish		
Dudul		
<i>Pristipomoides flavipinnis</i>	29	76.0
Yellow jobfish		
Metengui		
<i>Pristipomoides multidentis</i>	47	138.0
Large-scale jobfish		
Metengui		
<i>Pristipomoides zonatus</i>	134	191.0
Banded flower snapper		
Dudul		
<i>Pristipomoides spp.</i>	21	47.0
Jobfish		
Sub total	747	2 025.0

Appendix 5a (cont'd.)**GROUP*****FAMILY****Species*

English name,

Palauan name (where known)

No.

Weight

SHALLOW-WATER SNAPPERS***LUTJANIDAE (sub-family LUTJANINAE)***

<i>Lutjanus argentimaculatus</i>	242	770.0
Mangrove snapper		
Kedesaulyengel		
<i>Lutjanus bohar</i>	129	574.0
Red bass		
Kedesau		
<i>Lutjanus gibbus</i>	176	126.0
Paddletail		
Keremlal		
<i>Lutjanus monostigma</i>	4	5.0
One-spot snapper		
Kesebii		
<i>Lutjanus sanguineus</i>	43	39.0
Sub-total	594	1 514.0

EMPERORS***LETHRINIDAE***

<i>Gnathodentex mossambicus</i>	58	115.0
Large-eyed sea bream		
Uloi		
<i>Gymnocranius rivulatus</i>	4	2.0
<i>Lethrinus amboenensis</i>	40	70.0
<i>Lethrinus elongatus</i>	133	249.0
Long-nosed emperor		
Melangmud		
<i>Lethrinus kallopterus</i>	6	13.0
Yellow-spotted emperor		
<i>Lethrinus rubrioperculatus</i>	10	11.0
<i>Lethrinus variegatus</i>	35	61.0
Variegated emperor		
Sub-total	286	521.0

Appendix 5a (cont'd.)

GROUP	No.	Weight
<i>FAMILY</i>		
<i>Species</i>		
English name, Palauan name (where known)		
GROUPERS, CODS AND CORAL TROUTS		
<i>SERRANIDAE</i>		
Cephalopholis igarasiensis Yellow-banded grouper	4	2.0
<i>Cephalopholis sexmaculatus</i> Rock cod	8	4.0
<i>Cephalopholis spp.</i> Rock cods	219	509.0
<i>Epinephelus albopunctulatus</i>	2	1.0
<i>Epinephelus dictyphorous</i> Spotted-finned grouper	128	180.0
<i>Epinephelus fasciatus</i> Black-tipped grouper	2	2.0
<i>Epinephelus maculatus</i> Trout cod	57	71.0
<i>Epinephelus microdon</i> Marbled cod	13	78.0
<i>Epinephelus morrhua</i> Curve-banded grouper Temekai	99	226.0
<i>Epinephelus poecilonatus</i> Brown-striped grouper	5	7.0
<i>Epinephelus spp.</i> Groupers	8	86.0
<i>Variola louti</i> Lunar-tail cod Basloki	5	2.0
Sub-total	550	1 168.0

Appendix 5a (cont'd.)

GROUP			
<i>FAMILY</i>		No.	Weight
<i>Species</i>			
English name,			
Palauan name (where known)			
JACKS AND TREVALLIES			
<i>CARANGIDAE</i>			
<i>Carangoides caeruleopinnatus</i>		1	1.0
Trevally			
<i>Carangoides fulvoguttus</i>		1	3.0
Trevally			
<i>Caranx lugubris</i>		238	681.0
Black trevally			
Omektulau			
<i>Caranx sexfasciatus</i>		45	89.0
Bigeye trevally			
Esuch			
<i>Caranx spp.</i>		48	91.0
Trevallies			
<i>Elegatis bipinnulatus</i>		9	9.0
Rainbow runner			
<i>Seriola rivoliana</i>		101	377.0
Deep-water amberjack			
Sub-total		443	1 251.0
MACKERELS AND TUNAS			
<i>SCOMBRIDAE</i>			
<i>Euthynnus affinis</i>		1	2.0
Mackerel tuna			
Soda			
<i>Gymnosarda unicolor</i>		1	9.0
Dogtooth tuna			
Kerngab			
Sub-total		2	11.0

Appendix 5a (cont'd.)

GROUP			
FAMILY		No.	Weight
<i>Species</i>			
English name,			
Palauan name (where known)			
OILFISH AND SNAKE MACKERELS			
GEMPYLIDAE			
<i>Promethichthys prometheus</i>		56	86.0
Snake mackerel			
Telouchedui			
<i>Ruvettus pretiosus</i>		13	91.0
Oilfish			
Babii			
Sub-total		69	177.0
MISCELLANEOUS BONY FISHES			
HOLOCENTRIDAE			
<i>Adioryx spinifer</i>		2	1.0
Squirrelfish			
Desachel			
<i>Polymixia japonica</i>		3	5.0
Beard fish			
SPHYRAENIDAE			
<i>Sphyraena sp.</i>		10	42.0
Barracuda			
Al			
SCORPAENIDAE			
<i>Sebasticus albofasciatus</i>		3	2.0
Red rock cod			
UNIDENTIFIED		1	10.0
Sub-total		19	60.0

Appendix 5b**GROUP*****FAMILY****Species*

English name,

Palauan name (where known)

No.

Weight

SHARKS***CARCHARHINIDAE****Carcharhiunus albimarginatus*

Whitetip shark

26

1 228.0

Carcharhinus amblyrhynchus

Grey reef shark

16

847.0

Carcharinus longimanus

Shark

6

340.0

Galeocerda cuiveri

Tiger shark

1

140.0

Unidentified sharks

5

857.0

Sub-total**54****3 412.0****TOTAL****2 764****10 139.0**

SPECIES COMPOSITION OF THE TROLL AND MID-WATER HANDLINE CATCH

GROUP***FAMILY***

No.

Weight

Species

English name,

Palauan name (where known)

JACKS AND TREVALLIES***CARANGIDAE****Eegatis bipinnulatus*

4

3.0

Rainbow runner

Desui

MACKERELS AND TUNAS***SCOMBRIDAE****Acanthocybium solandri*

3

22.0

Wahoo

Keskas

DOLPHIN FISH***CORYPHAENIDAE****Coryphaena hippurus*

2

16.0

Dolphin fish

Ersuuch

BARRACUDAS AND SEAPIKES***SPHYRAENIDAE****Sphyraena spp.*

1

3.0

Barracuda

Ai

TOTAL**10****44.0**