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REPORT ON THIRD VISIT

TO

NIUE

19 May 1982–16 February 1983

by

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Masterfisherman

South Pacific Commission
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This unpublished report forms part of a series compiled by the Capture Section of the South Pacific Commission's Coastal Fisheries Programme. These reports have been produced as a record of individual project activities and country assignments, from materials held within the Section, with the aim of making this valuable information readily accessible. Each report in this series has been compiled within the Capture Section to a technical standard acceptable for release into the public arena. However, they have not been through the full South Pacific Commission editorial process.

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SUMMARY

The South Pacific Commission's Deep Sea Fisheries Development Project (DSFDP) visited Niue for the third time between 19 May 1982 and 16 February 1983 under the supervision of SPC Master Fisherman Paul Mead.

Priority activities during the visit were gear-development trials in vertical longlining, sub-surface trolling and ika shibi fishing. As well, the Master Fisherman was to supervise the construction, rigging and deployment of fish aggregation devices (FADs), to explore the potential for bait capture around the FADs and to explore further local deep-bottom resources.

Four FADs were constructed, rigged and successfully deployed during this visit, under the Master Fisherman's supervision, followed by inspection dives to monitor the FADs' effectiveness and trials with variations in appendages and buoy systems. Once set, the FADs provided the focus for subsequent fishing trials, especially vertical longlining operations.

Seventy-two fishing trips were completed, during which trolling, vertical longlining, ika shibi and deep-bottom fishing operations were carried out, most often in combination during anyone trip. These trips produced a total catch of 3,049.8 kg, with the various fishing methods contributing as follows: vertical longlining, 920.5 kg in 29 trips totalling 174 hours; trolling, 1,356.1 kg in 38 trips totalling 655 hours; ika shibi fishing, 84 kg in 7 trips totalling 59 hours; and deep-bottom fishing, 593.7 kg in 12 trips totalling 43 hours. Additionally, bait traps set at the FADs produced 55.5 kg of fish on hauls made by the Master Fisherman and flying-fish scooping produced 40 kg.

The significant features which emerged during this visit were the promising results obtained in vertical longlining and sub-surface trolling trials. Important progress in gear development was made in both these fishing operations, especially in identifying those variations in depth and bait type which increased productivity. Of particulalr note was the capture of substantial numbers of albacore tunas, *Thunnus alalunga*, in vertical longlining trials below 200 m, as these do not commonly occur in catches taken by other fishing methods in Niue.

Sub-surface trolling trials, targeted on the coastal drop-off, produced catches significantly better than is the usual experience with surface trolling. Progress was made in identifying the combinations of trolling depth and lures which proved most productive, especially in the capture of wahoo, *Acanthocvbium solandri*.

Although productive on occasion, the limited trials in ika shibi fishing indicated that a good deal of work remains to be done in identifying the baits, gear configurations, fishing depths and anchoring arrangements best suited to this fishing method.

The deep-bottom fishing operation produced good catch rates (6.2 kg/reel hour), comparable to those obtained during the Project's 1978 (2.8 kg/reel hour) and 1979 (6.0 kg/reel hour) visits.

The innovative bait traps set at the FADs, although beset by problems of unrecorded hauling and regular damage, produced promising results and provided the fresh bait that played a significant role in the success of the vertical longlining trials.

RÉSUMÉ

Sous la direction de son maître de pêche, Paul Mead, la Commission du Pacifique Sud a, pour la troisième fois, mené une mission à Niue, du 19 mai 1982 au 16 février 1983, dans le cadre de son projet de développement de la pêche au demi-large.

Lors de cette mission, les activités prioritaires ont été les essais de mise au point d'engins de pêche à la palangre verticale, à la traîne prés de la surface et à l'*ika shibi.* En outre, aux termes de son mandat, le maître de pêche devait surveiller la fabrication, Ie montage et le mouillage de dispositifs de concentration du poisson (DCP), explorer le potentiel de pêche d'appâts autour des DCP et inspecter de manière plus poussée les res sources locales des grands fonds.

En tout, quatre DCP ont été fabriqués, montés et mouillés avec succés, sous la surveillance du maître de pêche, lors de cette mission; ultérieurement, des plongées d'inspection ont été réalisées afin de vérifier l'efficacité des DCP et de tester divers types de montage et de bouées. Apré Ie mouillage des DCP, des essais de pêche, en particulier de pêche à la palangre verticale, ont eu lieu.

En tout, 72 sorties ont été effectuées au cours desquelles des opérations de pêche à la traîne, à la palangre verticale, à l'*ika shibi* et au grand fond ont été conduites, le plus souvent en combinaison les unes avec les autres, dans le cadre d'une même sortie. Ces sorties se sont soldées par un volume total de prises de 3 049,8 kg, capturées au moyen des différentes méthodes de pêche indiquées ci-après : palangre verticale : 920,5 kg en 29 sorties, pour un total de 174 heures; palangre : 1 356,1 kg en 38 sorties, pour un total de 655 heures; *ika shibi* : 84 kg en 7 sorties, pour un total de 59 heures; et pêche profonde, 593,7 kg en 12 sorties, pour un total de 43 heures. En outre, des nasses mouillées près des DCP pour capturer des appâts ont permis au maître de pêche de relever 55,5 kg de poisson, et la pêche au haveneau a permis de prendre 40 kg de poissons volants.

Cette mission a été essentiellement caractxerisée par les résultats prometteurs obtenus lors des essais de pêche à la palangre verticale et à la traine près de la surface. Ces deux opérations de pêche ont permis de réaliser d'importants progrés dans la mise au point d'engins, et en particulier de déterminer les profondeurs et le type d'appât donnant les meilleurs rendements. Le nombre élevéde germons, *Thunnus alalunga,* capturés à plus de 200 métres de profondeur à la palangre verticale mérite d'être signalé, puisque cette espèce n'est pas fréquemment présente dans les prises réalisées à l'aide d'autres méthodes de pêche à Niue.

Les essais de pêche effectués près de la surface sur le tombant ont permis de capturer un volume de poissons bien plus important que celui habituellement pêché lors d'opérations de pêche à la traîne en surface. Ces essais ont permis de mieux connaitre les combinaisons de profondeur de pêche à la traîne et de leurres les plus productives, surtout pour la pêche du thazard du large, *Acanthocybium solandri.*

Bien que parfois productifs, les essais limités de pêche à l'*ika shibi* ont montré qu'il restait encore beaucoup à apprendre en matiere de choix des appâts, de configuration d'engins, de profondeurs de pêche et de systèmes d'ancrage les mieux adaptés à cette méthode de pêche.

Les opérations de pêche profonde se sont soldées par de bons taux de prises (6,2 kgiheure/moulinet), comparables à ceux obtenus lors des missions entreprises en 1978 (2,8 kg/heure/moulinet) et 1979 (6 kg/heure/moulinet) dans le cadre du projet.

Les modèles novateurs de nasse à poisons-appâts qui ont été placés près des DCP, quoi qu'ayant fait l'objet de problemes de relevage non enregistré et ayant été périodiquement endommagés, ont donnxe des résultats prometteurs et assuré l'approvisionnement en appât frais qui a joué un rôle important dans le succès des essais de pêche àla palangre verticale.

CONTENTS

1. INTRODUCTION

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

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

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

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

This third visit to Niue was the twenty-third country or territory visit since the DSFD Project commenced its operations in 1978.

The visit followed a request from the government of Niue for assistance with their programme of FAD deployment and with developing effective fishing techniques to exploit FAD-associated species. Various FAD-fishing techniques under development by the DSFD Project were to be tested and demonstrated, and trials conducted in the capture of bait-fish. Secondary objectives were to conduct follow-up exploration of local coastal and deep-bottom resources and to draft recommendations to assist the Office of Marine Resources in furthering the development of local fisheries through a programme of support services. Detailed recommendations are contained in Appendix 1.

One of the DSFD Project's three Master Fishermen, Mr Paul Mead, who had supervised the Project's earlier visit to Niue in 1979, was assigned to work in Niue in approximately eight months between 19 May 1982 and 16 February 1983. This period included an absence of approximately one month when the Master Fisherman was required to attend SPC headquarters in New Caledonia for administrative duties.

2. BACKGROUND

2.1 General

Niue Island (Fig. 1) is a large raised limestone island nearly 64 km in circumference lying between 18° 56' S to 19° 10' Sand 169° 57' W to 169° 46' W. *The Pacific Islands Pilot*, Volume II describes Niue as 'an elevated coral outcrop, taking the form of two terraces, the lower coastal terrace being about 90 feet (27 m) high; the upper terrace is bordered by cliffs from 20–70 feet (6-23 m) high which are eroded with numerous caverns, some of which extend a considerable distance inland. The island is heavily wooded and is fringed by a reef which is steep, extending about half a cable offshore at Alofi'.

Along most of the coast the bottom drops off very steeply to over 800 m within 1 km of Shore, known exceptions being a 6.5 km long ridge running due west off Halagigie Point, which has depths varying from 260–800 m and then rises to a pinnacle of 320 m, with a subsequent steep drop off. Another pinnacle lies 1.4 km west of the village of Tamakautonga, rising from depths around 600 m shoreward to 320 m before dropping off almost vertically to 800 m. This pinnacle appears to lie generally north-south, with the 320 m plateau about 300 m by 100 m in area. There is also a small 300 m shelf, extending approximately 1 km off the southeastern point of the island. Both the Halagigie and Tamakautonga pinnacles were located by the Master Fisherman.

The main anchorage on Niue, off Alofi, is an open roadstead and there are no protected harbours anywhere along the coast. The wharf at Alofi, which extends directly into the open sea, lies in the lee of the prevailing easterly winds but is exposed to all westerly weather.

There are three boat moorings anchored in 12–15 m within 60 m of the wharf and the Niue Fisheries Division's three 8.6 m 'alia' catamarans, built in Western Samoa, are tied to these when weather permits. Access to the alias is by a 3.7 m aluminium dinghy, which is launched from the wharf and must be hauled onto the wharf again after use. In times of rough westerly weather, the alias are lifted from the water by a Public Works Department mobile crane and hauled to a protected area on a trailer. Most of the local fishing boats, generally 3–3.7 m aluminium dinghies, are also launched by hand from the wharf and hauled back onto the wharf after fishing.

2.2 Existing fisheries

Since 1980, the Niue Fisheries Division has attempted to maintain two out of its fleet of three alias on the moorings at Alofi, when weather permits. One of the boats is generally available to local fisherman on a charter basis, whereby a flat fee is paid for the use of the boat, a Fisheries Division skipper, fuel, bait and four fully-rigged Western Samoan-type handreels. This service is popular, and in good weather the alia is usually booked out one to two weeks in advance. The other alia is fished by a Fisheries Division crew. Accurate trip records are required to be kept for both boats.

As well as the alias, there are more than thirty 3–3.7 m (10–12 ft) outboard-powered aluminium dinghies in the Alofi area, another small group which fishes out of the village of Avatele and a few others at canoe landings around the island.

Most of these boats are used for trolling, scooping flying-fish and shallowwater handlining. Since the second visit of the DSFDP in 1979, a number of than have been fitted with the FAO-Western Samoan wooden handreels which, though primarily used for trolling, enable them to engage in deep-water bottom-fishing, most often in combination with trolling trips or when pelagic species are scarce.

There are a number of one-man canoes based in the coastal villages around Niue and these are involved in handlining for pelagic species, bottom handlining down to 200 m, fishing around the reef for 'ulihenga' (*Decapterus* sp.) and 'atule' (*Selar crumenophthalmus*) at early morning and dusk, and at night for soldier fish (*Myripristis* sp.).

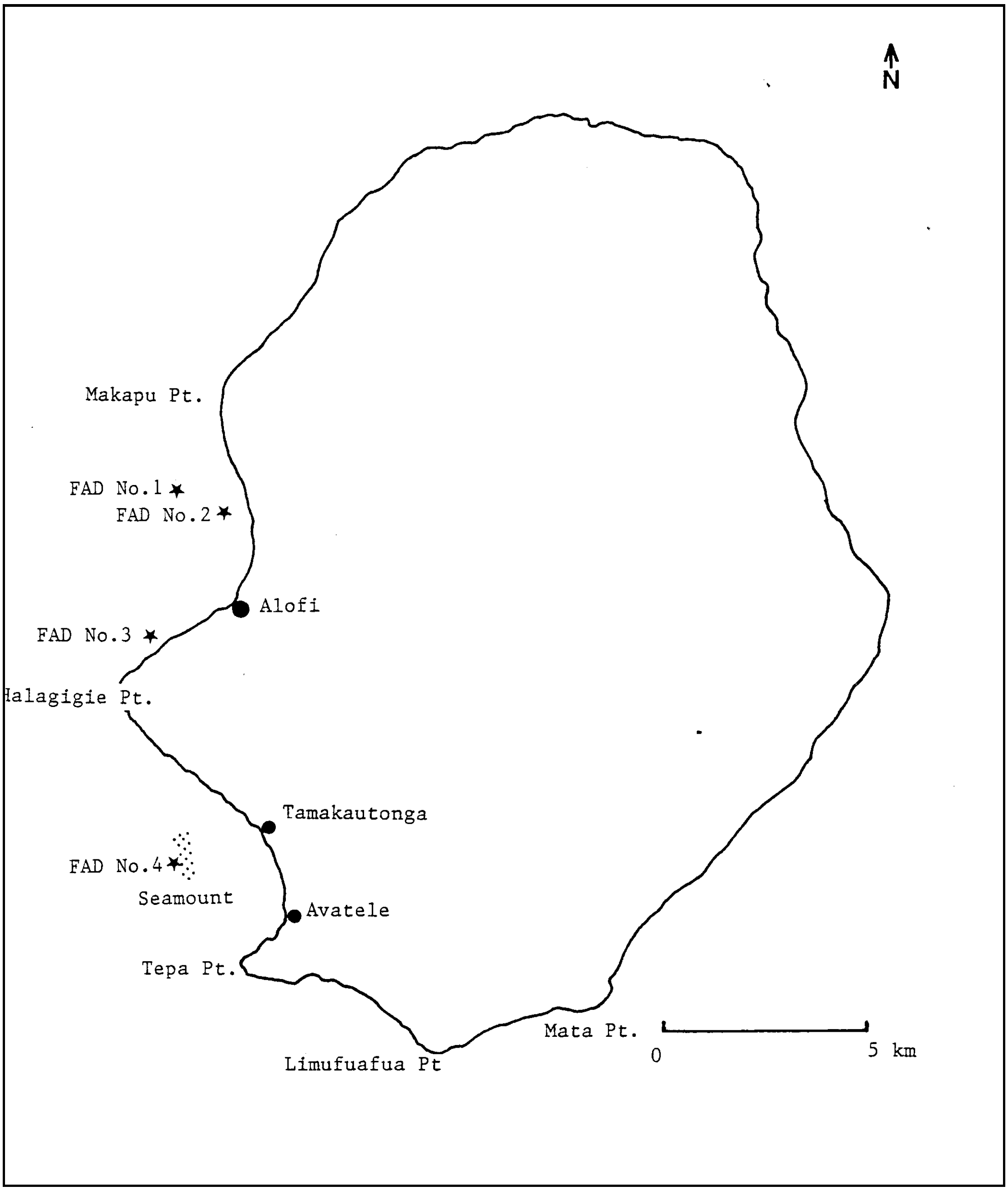

Figure: Niue island, showing FAD sites and seamount

Because of the difficulty in launching canoes from the rocky shore on the weather coast, canoes based along the west-north-west coast, in the lee of the prevailing easterly winds, are able to fish considerably more days per year than those based on the east coast. During favourable weather it is common for thirty to forty canoes to fish offshore from the lee coast.

3. PROJECT OPERATIONS

3.1 General

During the period of this visit, weather conditions varied from fair to good. Moderate (10–15 knot) east to south-east winds and moderate seas with occasional 2–5 day periods of strong (15–25 knot) east to south-east winds and rough seas predominated throughout May to August. A three day period of westerly squalls, with wind gusts exceeding 30 knots and heavy westerly swells at the end of August, preceded a period of mostly slight to moderate (5–15 knot) easterly winds and slight seas which continued, with only occasional 2–5 day rough periods, until the middle of February. Table 1 details the Project's activities.

Table 1: Summary of activities

Date	Activities
19–31 May, 1982	Preparation of alia used by Project, mounting handreels, preparation of fishing gear.
1–25 June, 1982	Construction and deployment of FAD No. 1, trolling, vertical longlining and ika shibi trials. Trips 1–7.
26 June–21 July, 1982	Trolling, vertical longlining and ika shibi operations, preparation of FAD No. 2. Trips 8–14.
22 July–18 August, 1982	Master Fisherman to New Caledonia for administrative duties.
19–26 August, 1982	Sub-surface trolling trials. Trips 15–17.
27 August–7 Sept, 1982	Alia badly damaged during heavy weather at mooring, repairs to boat and gear.
8 Sept–5 Oct, 1982	Fishing operations and preparation of second alia. Trips 18–28.
6–22 Oct, 1982	Fishing operations, changed buoy on FAD No. 1 , maintenance work on alia. Trips 29–31.
13–31 Oct, 1982	Deployed FAD No. 2, prepared bait-trap, fishing operations. Trip 32.

Table 1: Summary of activities (continued)

Date	Activities
1–20 Nov, 1982	Rigged and deployed FAD No. 3, bait captures made with trap at FAD No. 1, trolling and longlining operations, maintenance work ashore due to heavy weather. Trips 33–38.
21–30 Nov, 1982	Rigged and deployed FAD No. 4, longlining operations at FADs, bait-trap maintenance. Trips 39–46.
1–5 Dec, 1982	Heavy weather, hauled alia for maintenance on engines and gear.
6–31 Dec, 1982	Longlining, bait capture, trolling and bottom-fishing operations, Inspection dives on FADs Nos. 1 and 2, repairs to boat trailer, hauled second alia. Trips 47–59.
l–26 Jan, 1983	Construction of new raft for FAD No. 1, added appendages to FAD No. 4. Trolling, longlining and ika shibi operations. Trips 60–68.
27 Jan–1 Feb, 1983	Heavy weather, alia hauled for maintenance.
2–15 Feb, 1983	Longlining operations, preparation of report, packing of gear. Trips 69–72.
16 Feb, 1983	Departed Niue.

3.2 Boats and equipment

All deep-bottom fishing and trolling carried out by the Project around Niue was from a Fisheries Division alia (Fig. 2). The alia was powered by a 28 hp Suzuki outboard, backed up by an 8 hp Suzuki. Both engines were supplied by the Project.

Vertical longlining operations were initially conducted from an alia, to establish basic setting procedures, and a 3.7 m aluminium dinghy used for fishing trials thereafter. The smaller boat was chosen in an attempt to establish efficient setting procedures from a boat type commonly in use by local fishermen, as boat size plays an important part in this fishing technique.

Suitable bottom-fishing areas were located using the Project's JMC Model 707 AIB echo-sounder, which was especially useful when searching for offshore seamounts.

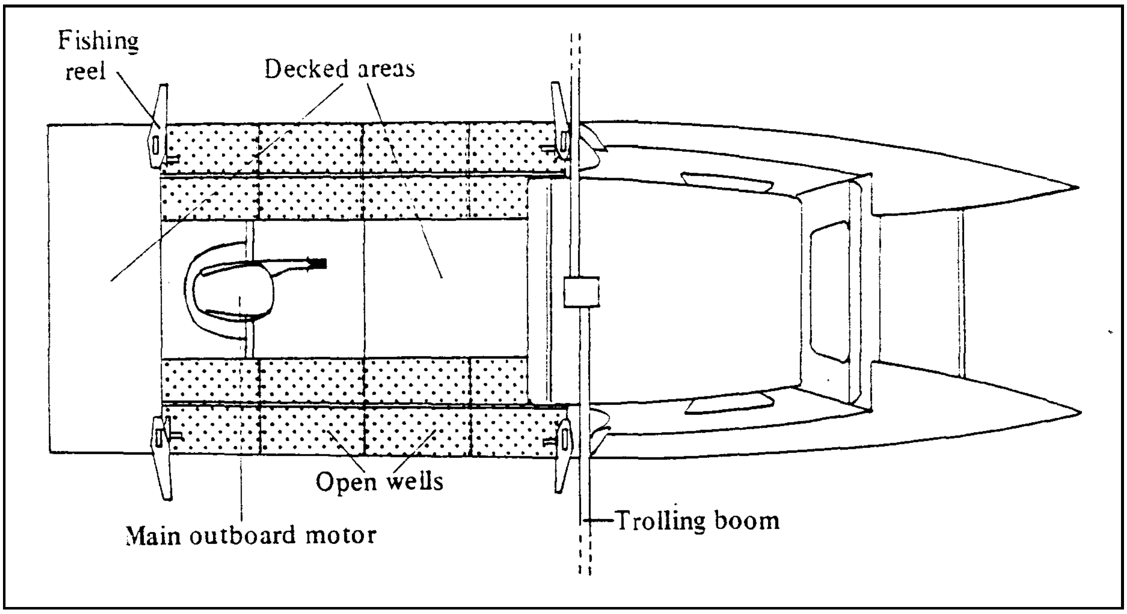

Figure 2: Alia catamaran as used in Niue

Fish were hauled using the alia's three FAO-Western Samoan type wooden handreels (Fig. 3), each equipped with approximately 500 m of 136 kg test monofilament line. The terminal rigs (Fig. 4) were constructed of No. 29 Turimoto 3 x 3 strand galvanised steel longline wire, rigged with Mustad tuna circle hooks and a sinker varying in weight from 1 to 2.5 kg. On this type of terminal rig, hooks could be easily changed. Combinations of larger hook sizes (No.6–No.3) were usually used in depths over 160 m and smaller hook combinations (No.9–No.6) in the shallower depths. Whatever the depth, a larger hook was always used on the top position of the terminal rig, with the hook size reducing by a size on each of the two lower positions of the rig.

Anchoring gear consisted of 500 m of 16 mm diameter polypropylene Superfilm rope tied to a 5 m length of 10 mm diameter chain. This was shackled to a grapnel anchor made from two 3 m lengths of 10 mm diameter steel rod, bent and spot welded as shown in Fig. 5.

A simple technique was used to retrieve the anchor after fishing, greatly reducing the effort involved in hauling. By motoring rapidly forward the anchor was broken out and towed until it streamed behind the boat. While still under way, a buoy was shackled onto the anchor line so as to run freely along it. When released, the buoy was forced back along the rope until trapped, near the anchor, by a 'no-return' barb of galvanised wire whipped onto the anchor line (see Fig. 6). The anchor thus remained suspended by the buoy at the surface. The boat could then be motored slowly back to the buoy, and the anchor line and anchor easily recovered.

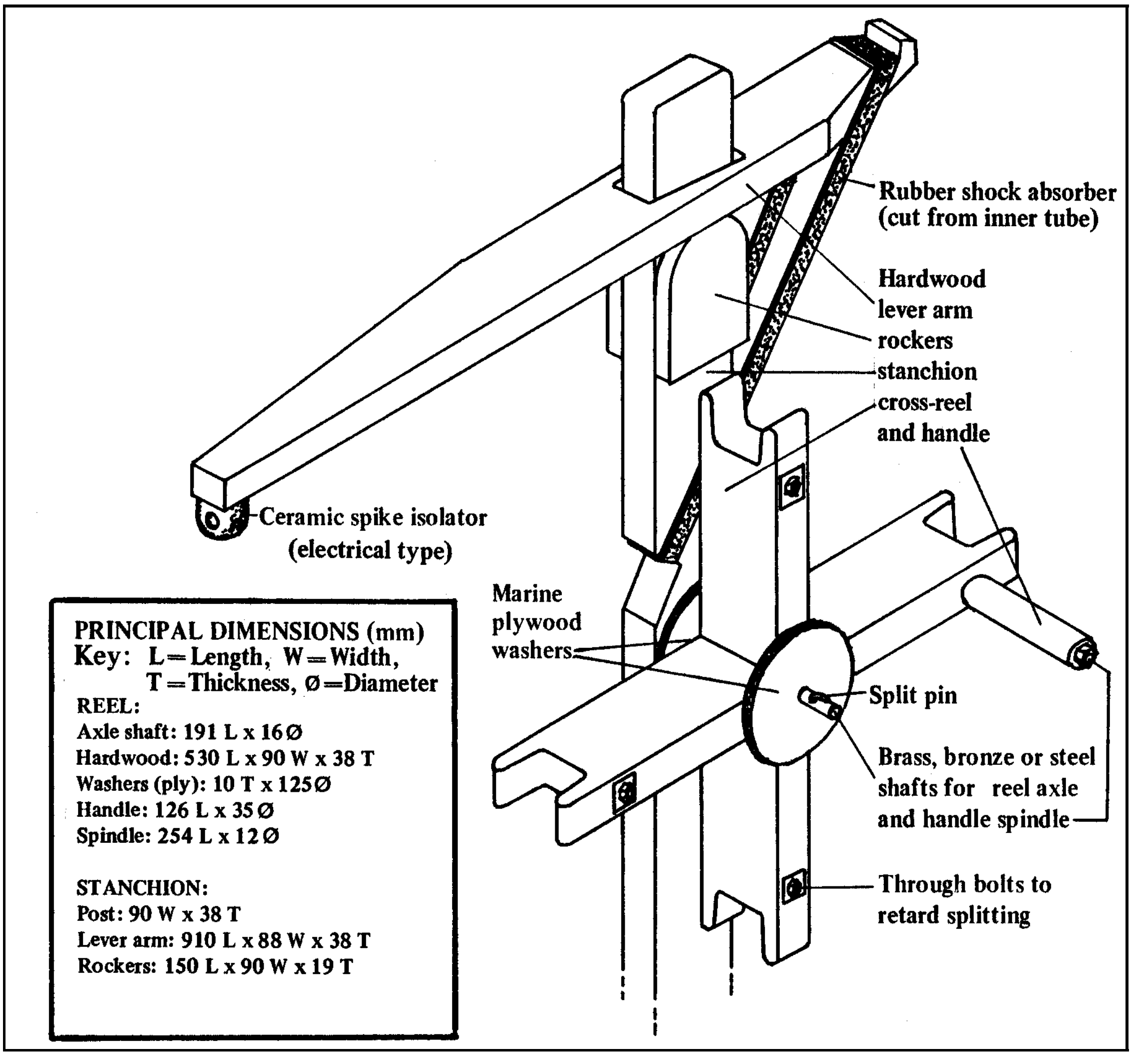

Figure 3: The Western Samoan handreel used by the Project

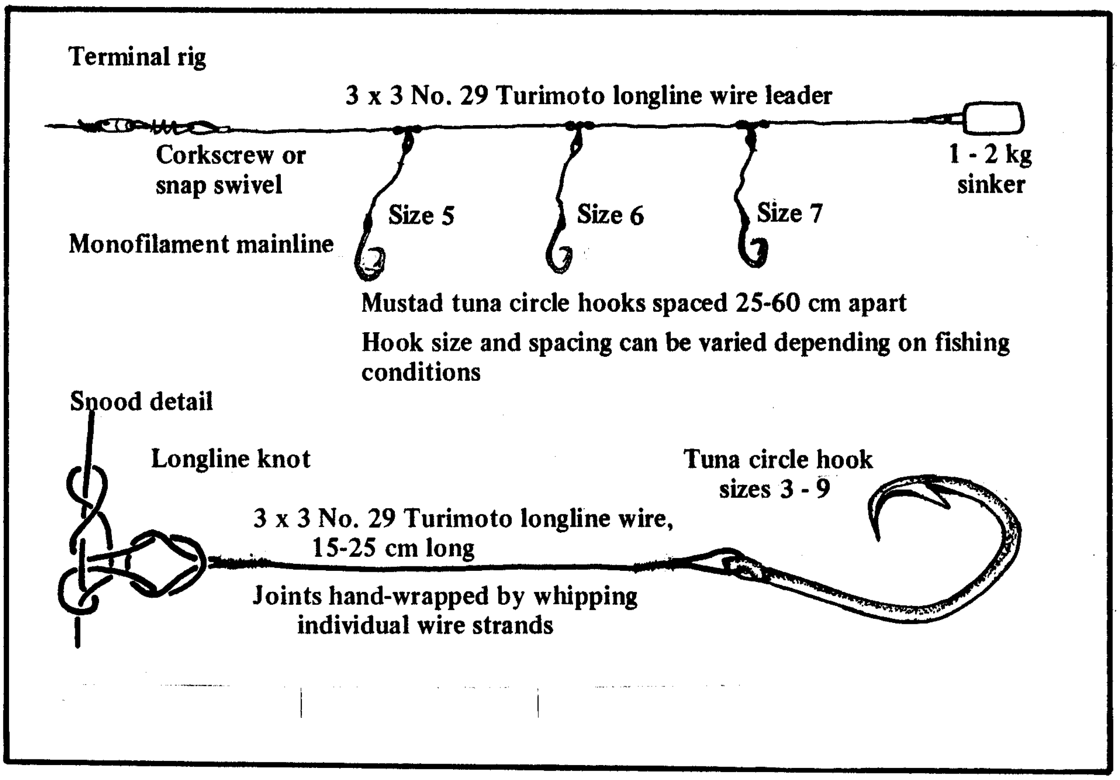

Figure 4: Typical terminal gear for bottom-fishing

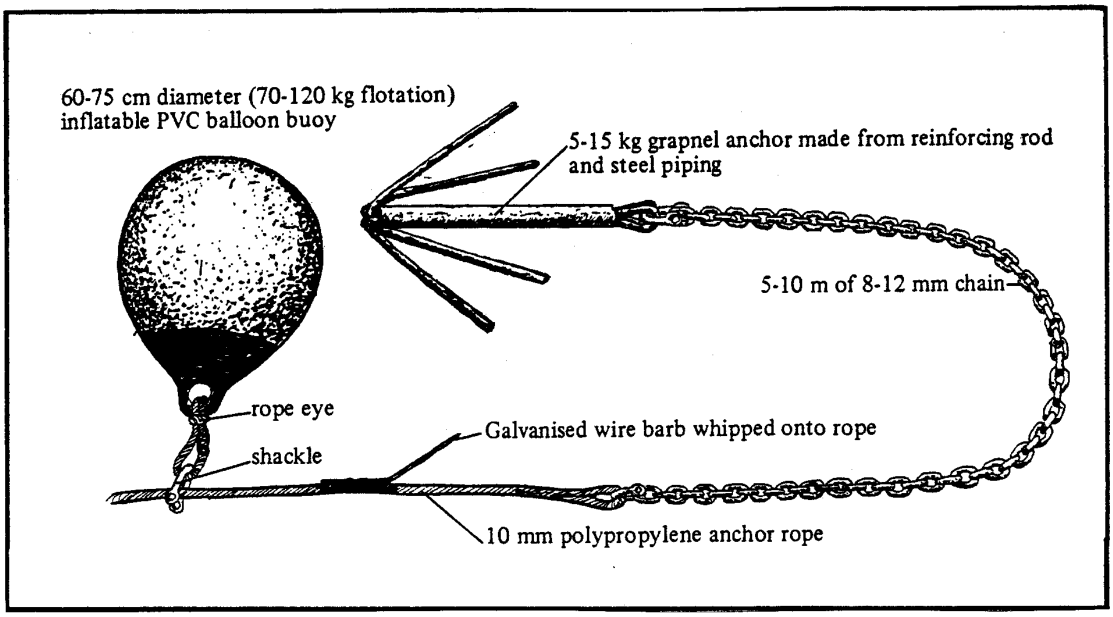

Figure 5: Self-hauling anchor gear

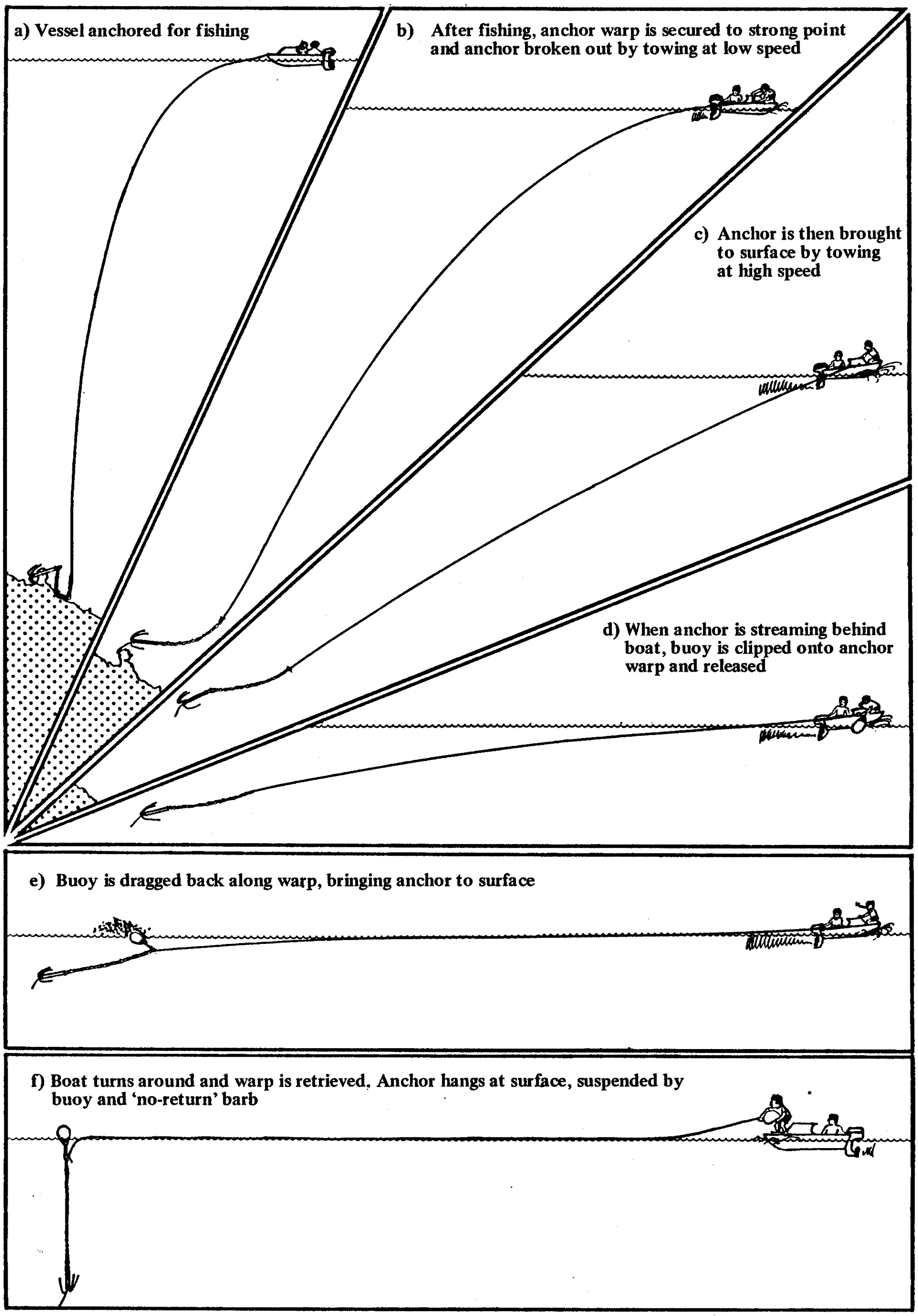

Figure 6: Anchor recovery method

3.3 Fish aggregation devices

Central to the Master Fisherman's brief during this visit were the construction and deployment of a number of fish aggregation devices (FADs), of various designs. The requisite material and equipment for this aspect of the project were supplied under United Nations Development Project funding, and staff from the Niue Fisheries Division worked under the supervision of the Master Fisherman to lay a total of four FADs between June and November (see Fig. 1). Much of the fishing activity and gear-development trials conducted during the Project visit was centred on these FADs, which were sited as follows:

FAD No.1 deployed (on 11/6/82) approximately 2.5 km offshore and 3.5 km NNW of Alofi was anchored at 560 m.

FAD No.2 was laid closer inshore (on 26/10/82) approximately 1 km due west of Makato at 240 m.

FAD No.3 was the closest to shore, off Opaahi and anchored at 220 m (on 2/11/82).

FAD No.4, the final and deepest FAD deployed during this visit, was anchored (on 25/11/82) at a depth of 780 m approximately 3.75 km WSW of Tamakautonga (see Fig. 7).

3.4 Data collection

SPC Master Fishermen use a standard data form, shown at Appendix 2, 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.

3.5 Training activities

Training activities during this visit were centred on the rigging and use of the vertical longline. The success of this technique created a good deal of interest among local fishermen and a number of than participated in both the initial trials and subsequent fishing trips.

The Master Fisherman also worked closely with Fisheries Division staff in the construction, rigging and deployment of the FADs set during this visit.

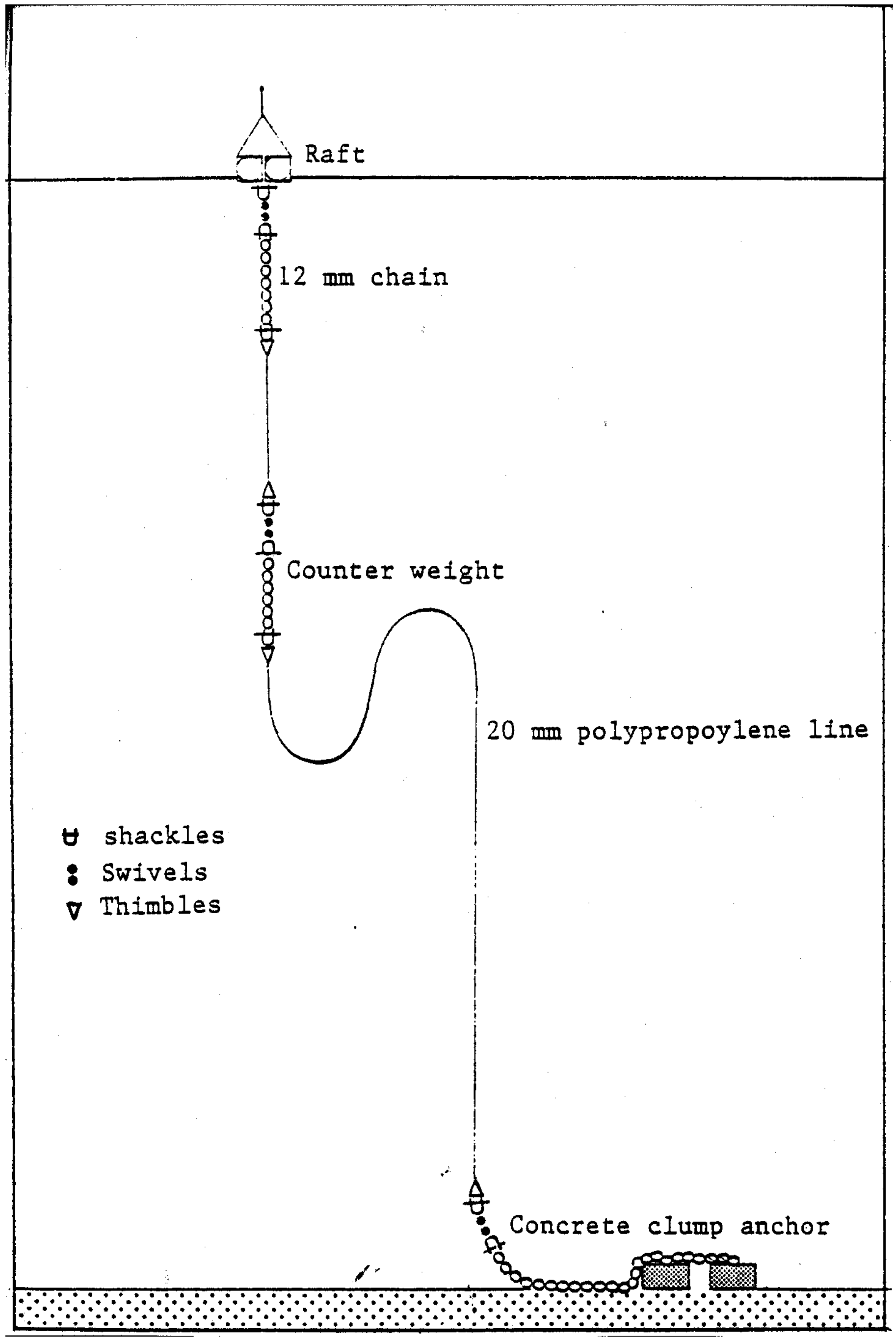

Figure 7: Typical FAD design deployed in Niue

4. FISHING ACTIVITIES AND RESULTS

4.1 General

Fishing activities, and therefore the gear and techniques used, varied from trip to trip, depending on trip objectives, weather and operating conditions. Vertical longlining, surface and sub-surface trolling, ika shibi fishing, bait-trap setting and hauling, and bottom-fishing were all carried out in a variety of combinations.

Most fishing was done from an alia catamaran, the exception being the use of a 3.7 m dinghy to test vertical longlining gear and techniques from a locally 'typical' boat.

The vertical longline, ika shibi and bait-trap activities were focused on the FADs deployed during the visit, while the trolling and bottom-fishing trips ventured further offshore. Trolling effort was concentrated on the edge of the drop-off, paralleling the coast, and bottom-fishing most often in the lee of offshore winds.

4.2 Vertical longlining

Vertical longlines were fished by the Project from an alia and a 3.7 m aluminium dingy around FADs No.1 and No.3, to depths of approximately 300 m. Due to the limited amounts of gear and bait available, a maximum of two longlines were fished from anyone boat.

As most fishing around Niue is from canoes or small dinghies, it was decided to experiment as much as possible with longlining methods which could be adapted for use by fishermen using these boats. Following initial trials in which the basic gear designs and techniques were tried from the larger, more stable working area of the alia, improvements and modifications were developed during trials carried out from a 3.7 m dinghy privately owned by a member of the Niue Fisheries Department staff. After various hook sizes, snood lengths, distances between snoods, lengths of mainline, etc. had been tried, the most satisfactory arrangement, under the conditions which were generally experienced at that time, was that shown in Fig 8. This consisted of a mainline of 7 mm 'Kuralon' with 15 snoods, each made up of 5.5 m (18 ft) of 145 kg (320 lb) test monofilament and a No.5, No.4, or No.3 Mustad tuna circle hook, clipped to the mainline every 15 m (50 ft) by an 8 mm (5/16 in) diameter 'snap-on connector' (size 8/10 McMahon clip/swivel combination). Hook size was determined by depth; the No. 5s at the top, No. 4s in the middle and No. 3s at the bottom. Snoods were stored on a caster, the hook of each snood being passed through the eye in the snap-on connector of the preceding one as they were wound onto the caster. The longline was attached to a longline float at the surface and terminated in a 2–4 kg sinker, sinker size depending on the strength of the current.

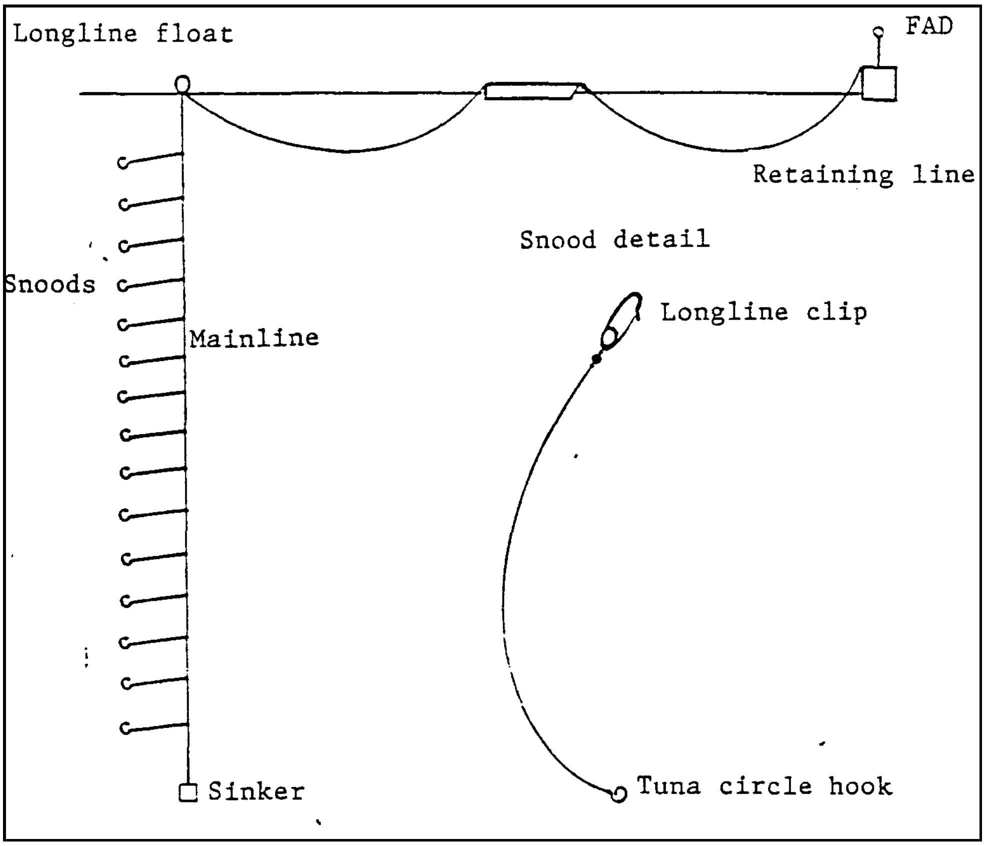

Figure 8: Vertical longline arrangement used in Niue

When the longline was being fished from the dinghy, the boat was first made fast to a 30 m length of 20 mm polypropylene 'Superfilm' rope, which was permanently trailed from the FAD. The top end of the longline was then tied onto the end of the same rope. A sinker was looped onto the bottom end of the longline, a snood clipped on just above the sinker, and the weighted line with baited snood let down 15 m (50 ft). The line was paid out fairly slowly to prevent the baited snood fouling on the mainline. Snoods were removed from the caster and baited as they were attached to the longline. Bait was hooked and then tossed as far as the length of the snood would allow, down-current from the mainline. The mainline was then lowered slowly another 15 m (50 ft). This process was repeated until the fifteen snoods on the caster were all clipped on the longline. The longline was then lowered a further 37–73 m125–250 ft), depending on the time of day (deeper during mid-day, shallower in early morning and late afternoon), and a float attached. The baited longline and float were let out on a surface line slowly with the current until they were approximately 60 to 80 m down current from the dinghy. The fisherman in the dinghy kept watch for a jerk on the float signalling a fish on the line. Fish were hauled immediately because it was observed, from the tangles and empty hooks resulting at times when the line was left untended, that a large percentage of fish escaped if left on the line for even a short period.

To recover the longline on days with winds over 5 knots (usual conditions), the dinghy was simply untied from the 20 mm rope and allowed to drift away from the FAD along the longline. The line was hauled across the dinghy and let out over the opposite side from which it was hauled. This avoided the need for unclipping the baited snoods from above the hooked fish when hauling, and reclipping when setting again. The drift of the dinghy away from the FAD exerted sufficient pull on the line to keep it taut enough to avoid tangles. When a snood with a fish was reached, the fish was gaffed, boated, killed, unhooked, and the hook rebaited. Hauling then continued until the entire line had been checked, even if the fish caught had been on one of the upper hooks. After the last hook had been checked, the sinker was dropped, allowing the entire line to swing slowly back to a vertical position. The dinghy was then either rowed or motored back to the 20 mm rope and tied up until the line needed to be hauled again. Hauling was usually undertaken only to remove fish or when the day's fishing was over, not simply to check the bait.

The most important requirement for successful vertical longlining around the FADs was bait. Variations of snood length, different types and sizes of hook, and different types of line could all be used with some success if baited with fresh bait of the right type; but no combination of gear caught anything without the right bait. Baits used by the Project included fresh and frozen cut tuna, fresh whole flying-fish, and fresh flying-fish cut into strips, but the only baits which caught tuna were 'atule' (*Selar crumenophthalmus*) and 'ulihenga' (*Decapterus* sp.). The atule and ulihenga were obtained from fish traps (see Section 4.3), from canoe fishermen who caught than along the reefs in early morning and late afternoon, and by catching them using small baited hooks around the FADs.

When the atule and ulihenga were fresh (caught on the spot rather than purchased from other fishermen), they were, when possible, used as live-bait on the longline, with the hook being passed through the back just below and to the rear of the spiny dorsal fin. Atule, being a more hardy bait than ulihenga, could be kept on the hook alive and swimming for several hours and were a more effective bait than a dead fish.

When more baitfish were captured than were immediately needed they were transferred as quickly as possible to a small chicken-wire basket (live-box) tied alongside the dinghy just beneath the surface. Surplus ulihenga, being less hardy than the atule, could be kept alive for only a few minutes, while the atule could sometimes be kept alive all day until needed for bait.

Several sets of the longline were made at night, but most were made around dawn, with fishing continuing well into the day. One hundred and seventy-four fishing hours were completed, producing a catch of 86 fish with a total weight of 920.5 kg. This gave a return of 5.3 kg per hour's fishing. The bulk of the catch comprised yellowfin and albacore tunas, as shown in Table 2. Catch per unit of effort, calculated as catch in kilograms per 10 hooks per hour fished, was 3.5 kg (see Appendix 3a).

Table 2: Vertical longline catch from FADs in Niue

Species	Catch Number	Catch Weight (kg)
Thunnus albacares, yellowfin tuna	52	467.0
Thunnus alalunga, albacore tuna	16	300.0
Thunnus obesus, bigeye tuna	2	22.0
Katsuwonus pelamis, skipjack tuna	1	8.5
Coryphaena hippurus, dolphin fish	13	77.0
Ruvettus pretiosus, oilfish	1	13.0
Prionace glauca, blue shark	1	33.0
TOTAL	**86**	**920.5**

The capture of albacore in substantial quantities is of particular significance as these do not often occur in catches taken by other fishing methods in Niue.

Considerable effort was devoted to identifying those variations in technique which increased productivity. In particular, the effects of fishing depth and bait type or quality were closely examined, and modifications to both these factors were made frequently. Different fishing depths proved to yield very different catches, both in quantity and type.

Substantially higher catch rates were recorded from depths below 200 m than from the upper part of the water column. Different catch rates also occurred for different species, with yellowfin dominating above 200 m, an approximately even distribution of yellowfin and albacore between 200–300 m and only albacore taken below 300 m.

Bait type and quality also significantly influenced catches as discussed earlier. Atule and ulihenga baits took 81 of the 86 fish caught and of the five fish taken on inferior baits, one oilfish and one shark made up the only unsaleable component of the catch.

4.3 Bait trapping

The first fish trap constructed was a simple rectangle 0.9 m x 0.9 m x 2.4 m (3 ft x 3 ft x 8 ft), with a frame of 25 mm x 50 mm (1 in x 2 in) hardwood strips nailed together and covered with 32 mm (1 1/4 in) mesh galvanized chicken-wire, a simple funnel opening at each end made of the same chicken-wire, and a 0.6 m x 0.9 m (2 ft x 3 ft) hinged door on the top for easy access to the interior. Total cost of the trap, including 14 man hours construction, and materials, was less than

$NZ50.00. On the first day of November the trap was suspended horizontally from FAD No.1 by a simple rope harness at a depth of 10 m, so that it hung near the centre of the FAD appendages.

Observation dives (snorkelling) were made three days and nine days after the trap was set, and although large shoals of baitfish were around the FAD, none were inside the trap. Between 15 November and 19 November, local fishermen took an unknown amount of atule and ulihenga from the trap, as well as two yellowfin tuna. On 20 November the trap was hauled by Fisheries Division personnel and 30 baitfish and a 5 kg yellowfin tuna removed. Although it is known that catches of baitfish were taken out of the trap every week, numbers were impossible to monitor as the trap was hauled several times a day by local fishermen. On 6 December the trap was hauled early in the morning by Fisheries Division personnel, who had remained at the FAD overnight, and approximately 140 atule and ulihenga removed.

Because of the success of this trap, two additional ones were constructed for use on FAD No.2 and FAD No.4. These were of different sizes, one being 0.9 m x 0.9 m x 1.8 m (3 ft x 3 ft x 6 ft), and the other 0.9 m x 0.9 m x 3 m (3 ft x 3 ft x 10 ft). Although the larger trap seemed to work well, it proved to be difficult to handle by hand from the alia. The smaller trap was much easier to handle than the two larger ones. It did not seem to catch the large numbers of fish that were occasionally taken from the larger traps, but overall it was as consistent in catching fish.

The entrances on the first three traps were simple funnels at each end, having an opening of 31–46 cm (12–18 in) that tapered down to 10–15 cm (4–6 in) inside the trap. From observations made while snorkelling, it was clear that bait catches could be increased by increasing the size of the entrance to the funnel to include the entire end of the trap, as bait entered the trap not by accident or in seeking food, but to escape from predatory fish. When being pursued by predators, the baitfish would try to hide in the appendages and around the trap. If two or three of the bait entered the trap, the entire school would attempt to follow. Often part of the school would miss the entrance to the trap, then mill around outside trying to enter.

The main problem associated with the traps was the need for constant maintenance and repair, as predator fish breached the wire mesh in attacking baitfish inside; other damage was caused by unsupervised fishermen hauling the traps to remove baitfish. The unsupervised hauling of the traps on a 'first come first served' basis made it impossible to monitor the catch rate accurately and led to uneven distribution of baitfish among local fishermen.

Although accurate catch records could not be kept, the amount of bait taken at times when it was possible to estimate the catch indicated that, at least from September to February, substantial catches could be maintained. This would be most likely if at least one properly constructed and maintained trap was installed on each of the three FADs, and on FADs installed in the future. As the atule season in Niue is known to continue through March in some years, the traps would probably be effective until April. However, until they are used for a full year, the seasonality of the bait and the year-round effectiveness of the traps will not be known. To prevent unnecessary damage by predator fish, these traps would need to be checked at least every other day, preferably every day. In order to avoid problems with unsupervised hauling, it would probably be advantageous to attach the traps at depths of 6–9 m (20–30 ft) on the FAD mooring chain by diving with SCUBA gear.

The development of a successful trap fishery around the FADs would contribute significantly to the successful development of a vertical longline fishery from the dinghies. Baitfish (ulihenga and atule) taken from the traps could be sold directly to the fishermen after they had been counted and weighed. Immediately upon removal from the traps, ulihenga should be packed directly in ice to preserve their freshness. Healthy atule should go straight into a live-box or live-well kept aboard the alia, injured ones directly onto ice with the ulihenga.

4 .4 Sub-surface trolling

All trolling was carried out from an alia catamaran, usually running four lines, two from wooden handreels and two from American snapper reels.

The two wooden handreels, which belonged to Niue Fisheries Division, were each loaded with approximately 500 m (550 yds) of 136 kg (300 lb) test nylon monofilament. The reels were mounted in the port and starboard hulls, just behind the cabin. Trolling lines from these reels passed through the reel arm insulator, then through an insulator screwed into a simple pole outrigger, extending 3 m (10 ft) out from the cabin top. One or two rubber bands of approximately 40 mm (1.5 in) width (cut from old 33 cm (13 in) inner tubes) tied to the gunwale and looped over the reel handle served as a simple but effective braking system. The monofilament line terminated in a 9 mm (3/8 in) pigtail (corkscrew) swivel attached with a clinch knot.

On the port side the line was trolled at the surface with the lure or bait, rigged on a short wire trace, connected directly to the pigtail swivel. The starboard line was trolled sub-surface by rigging the line with a sinker. This rig comprised a 30 cm (12 in) length of 145 kg (320 lb) test stainless steel monofilament wire onto which two 225 g (8 oz) torpedo shaped lead weights were threaded. A 20 m (65 ft) length of 136 kg (300 lb) test nylon monofilament was attached to the weighted wire and terminated in a 9 mm pigtail swivel for attaching the lure or bait.

The two American snapper reels were mounted in the hulls on the last independent crossbrace at the stern of the alia. Each reel was used with a mainline of approximately 460 m (500 yds) of 125 kg (275 lb) test 7 x 7 strand stainless steel cable crimped at the end to a 9 mm barrel, or 4/0 Berkley McMahon, swivel. To this was fixed a 20 m length of 136 kg test monofilament, ending with a 9 mm pigtail swivel for lure or bait attachment. Braking on these reels is by a simple pressure plate system, which can be adjusted by tightening or loosening a hand lug.

On trolling trips, the alia usually left the wharf area as soon as there was enough light to judge distance from the reef or cliffs accurately. The two outrigger lines were let out first, the lures or bait on the weighted line (starboard reel) being trolled about 60 reel turns (approx. 74 m <80 yd>) astern. This length of line with the weights attached and a trolling speed of 4–6 knots resulted in the lure or bait being trolled below the surface. Actual depth varied with boat speed and with the type of lure or bait used a heavy compact lure running deeper than a light, bulky flying–fish bait. Lures and baits on the port side outrigger were trolled 60–90 reel turns (approx. 74–110 m <80–120 yds>) astern. Depth of trolling again depended on lure/bait type, weight, and trolling speed, but was usually within two metres (6.5 ft) of the surface. Wire on each of the two American snapper reels was let out 90–120 turns, giving the wire plus the monofilament a trolling length of approximately 74–100 metres (80–120 yds). The long length of wire, combined with the weight of a heavy lure, resulted in approximate trolling depths of 410 m (14–32 ft). On one trip the lure became fast on the bottom while trolling and was retrieved from a depth of 10 m.

When targeting on wahoo, a crew of at least three was essential to handle four trolling lines on the alia. Experience soon proved that the wahoo were often in schools and that when a strike occurred, all the lines, especially those next to the line on which the strike occurred, should be retrieved as quickly as possible. After a wahoo was landed the alia would troll on for a few hundred metres, turn around, and troll back through the area where the strike had occurred. The number of passes through an area depended on further strikes and the judgment of the crew. Fast retrieval of the lines adjacent to the struck line not only helped prevent tangles but resulted in multiple strikes in over 30 per cent of strike incidents.

It was important when using the wooden handreels that the brake strap not be removed until the fish had settled, as a powerful fish making a second run could cause the reel handle to spin dangerously. If fish were large enough to pull line from the outrigger reels, boat speed was reduced to 1–3 knots and the fish left to fight the resistance of the reel brake and outrigger until exhausted; the fish were then played by hand.

The boat was always kept under way to avoid slack in the line which could cause reel backlash, the fish dropping the hook, or tangles with other lines. It was always attempted to keep the fish astern as it was brought in for gaffing. If possible, all fish were gaffed before being boated. His practice helps prevent the loss of poorly hooked fish and allows for greater control of the fish for killing. Although a limited number of yellowfin tuna (*Thunnus albacares*), barracuda (*Sphyraena barracuda*), and dogtooth tuna (*Gymnosarda unicolor*) were caught, the greater portion of the sub–surface catch was wahoo (*Acanthocvbium solandri*). Catch composition probably reflected more the depth and/or distance offshore worked, rather than the species available to be caught around the coast. When trolling specifically for wahoo the alia was most often run at a constant speed of 4–6 knots parallel to the coast and 100–200 m (110–220 yds) off the reef or cliff. Trolling this distance offshore also produced the occasional yellowfin and dogtooth tuna, usually just after sunrise.

Barracuda were most often caught just off the edge of the shallow water dropoff (depths of 10–30 m <30–100 ft>), in specific areas which were marked physically by small areas of reef extending further offshore than was normal along that particular section of coast.

Significantly different catch rates were recorded for the various trolling rigs employed. The most successful gear arrangement was the wire reels rigged with lures, which produced 68.4 per cent of the catch for 44.7 per cent of the total trolling effort, giving a c.p.u.e. figure of 3.1 (see note 1 below Table 3). Wire reels rigged with baits, surface lines rigged with lures and weighted lines rigged with lures all produced much lower catch rates, and the poorest catch rates were produced from weighted lines rigged with baits and surface lines rigged with baits. Table 3 summarises catch and effort for each trolling arrangement.

Table 3: Summary of catch and effort by various trolling gear arrangements

Gear	Catch (kg)	Percentage of troll catch	Effort (line hours) Note 1	Percentage of troll effort	Catch (kg) per unit of effort Note 2
Wire reels/lures	927.0	68.4	302	44.7	3.1
Wire reels/baits	91.0	6.7	50	7.2	1.8
Weighted lines/ lures	127.5	9.4	102	15.1	1.3
Surface lines/ lures	178.6	13. 1	143	21.2	1.2
Weighted lines/ baits	20.0	1.5	33	4.9	0.6
Surface lines/ baits	12.0	0.9	46	6.9	0.3
Total	**1,356.1**	**100%**	**676**	**100%**	

Note 1. Effort in line hours is calculated as number of lines trolled x number of hours fishing.

Note 2. Catch per unit of effort (c.p.u.e.) in kg is calculated as catch per *line* hour.

A total of 172 hours of trolling with up to four lines *in* use produced a total catch of 1,356.1 kg, giving a return per fishing hour of 7.9 kg.

Details of catch effort and fuel consumption for each trolling trip are given in Appendix 3b.

4.4 Bottom-fishing

Although the main emphasis of the Project visit was on gear-development in sub-surface trolling, vertical longlining, and trap fishing, a limited amount of deep-bottom fishing was also carried out. Bottom–fishing methods were the same as those used successfully by the Project in other countries in which it has operated, and as those used in the 1979 visit to Niue. All bottom-fishing was carried out from an anchored position in depths of 100–400 m (50220 fathom), with the main effort being between 260 and 340 m (140–190 fathoms).

When fishing the drop-off along the island, areas fished were usually those in the lee of an off–shore wind. In these areas, the anchor was most often dropped in 80–120 m (40–65 fathoms) and rope paid out until the boat was positioned over the required depth. If, after 20 to 30 minutes, no fish were landed, rope would again be paid out until the boat was positioned over an area 20–30 m (10–15 fathoms) deeper and fishing again tried. This process of slackening off the anchor to position the boat over progressively deeper water and fishing for 20–30 minutes would continue until fish were being caught, or a depth of 300 m reached. If the 300 m depth was reached without landing fish, lines would normally be hauled, the anchor pulled, and the exercise repeated at a new location.

When fishing offshore seamounts, the anchor was dropped just to the windward of the highest point of the mount, usually in a depth of 260–340 m (140–190 fathoms), and the anchor rope paid out, initially only enough to keep the anchor from breaking free under existing sea conditions, and to position the boat far enough away from the anchor rope to prevent fishing lines fouling on it during fishing operations. Positioning the boat over seamounts was sometimes as difficult as anchoring along the coast, due to the more exposed position and strong currents running over the mount, usually into or across the wind. When anchoring in strong currents, once the anchor was set, rope was slacked off equal to approximately 20 per cent of the depth and a longline float attached to the rope. More anchor rope was then let out until the boat was positioned over a suitable area. By attaching a float it was possible to payout considerable lengths of rope without the risk of it fouling or chafing on the bottom.

The catch was dominated by deep-water snappers (family Lutjanidae, sub-families Etelinae, Apsilinae) with 85 fish taken totalling 339.5 kg and comprising 57.2 per cent of the total bottom-catch weight. The most significant species occurring was the ribbon-tailed red snapper (*Etelis coruscans*) represented by 38 individuals with a total weight of 253 kg (42.6% of the total bottom-catch weight).

Oilfish and snake mackerel (family Gempylidae) accounted for a relatively high 19.9 per cent of the catch by weight, with large oilfish predominating.

Shallow-water snappers (sub-family Lutjaninae) were next most important, making up 9 per cent of the total weight; the generally ciguatoxic red bass (*Lutianus bohar*) accounted for 17 of the 29 shallow-water snappers taken. Groupers (family Serranidae) comprised 6.3 per cent of the total bottom-catch weight, trevallies and jacks (family Carangidae) 6.1 per cent and squirrel fishes (family Holocentridae) 0.9 per cent.

Forty-three hours spent bottom-fishing produced a catch of 193 fish with a total weight of 593.7 kg for an overall catch rate of 6.2 kg/reel hour, slightly higher than that recorded by the Project during its 1979 visit (6.0 kg/reel hour) and significantly better than the 2.8 kg/reel hour recorded in 1978. A detailed summary of the catch by trip and effort is given in Appendix 3c, while Table 4 gives catch rates recorded elsewhere by the Project.

Table 4: Deep bottom-catch rates obtained by the Deep Sea Fisheries Development Project in selected Pacific countries and territories

Location	Year	Deep-bottom catch rate (kg/reel hour)	
		Total	Excluding sharks
Niue (this visit)	1982/83	6.2	6.2
Niue	1979	8.5	6,.0
Niue (Beveridge reef)	1979	6.1	5.6
Niue	1978	–	2.8
Tonga	1978	–	3.6*
Tonga	1979	7.6	5.7
American Samoa	1978	–	4.9
Tuvalu	1980	11.1	8.0
Cook Islands (Rarotonga)	1981/82	1.9	1.9
Western Samoa	1982/83	4.1	3.4

* Estimate only, excludes Lutjanus bohar.

4.6 Ika shibi fishing

Ika shibi fishing is conducted at night, using a weighted line carrying a single baited hook on a trace, and usually a chum-bag or basket. The line is fished in conjunction with an underwater light, which attracts deep-swimming tuna (or small baitfish, which in turn attract the tuna) to the vicinity.

Fifty-nine hours were spent in preliminary trials of this technique during seven overnight fishing trips. The lines used were as shown in Figure 9, and were fished from an alia in depths from 16 to 480 m (9–260 fathoms), with the boat variously at anchor, on a sea anchor or drifting free. Up to five lines were used at anyone time.

Few problems were experienced in the use of the underwater lights, but a good deal of work remains to be done in identifying optimum baits, gear configurations, fishing depths and anchoring arrangements. The potential for this fishing method in areas where baitfish are present, as in the vicinity of FADs, seems quite promising.

A total of 6 fish, weighing 84 kg (3 yellowfin tuna, 25 kg, 2 oilfish, 57 kg, 1 snake mackerel, 2 kg) were caught, yielding a catch rate of 1.4 kg per fishing hour.

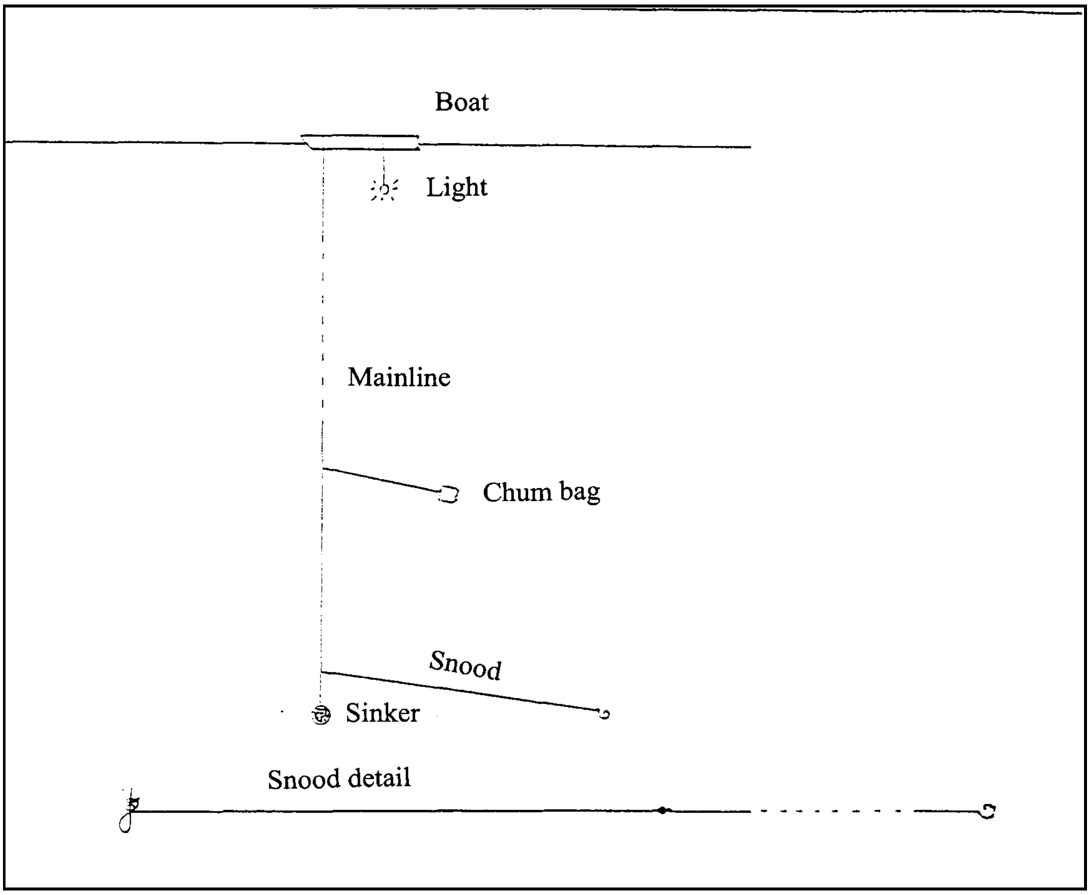

Figure 9: Ika shibi gear arrangement

5. DISCUSSION AND CONCLUSIONS

The seventy-two fishing trips completed during this visit, and the catch rates achieved, indicate that good potential exists for the development of a viable vertical longline fishery targeted on FADs. Bait appears to be available for a long enough period to make this fishery quite effective. It would be essential, however, to maintain FADs in place and to establish a regular bait-capture operation.

The sub-surface trolling trials conducted produced catches considerably better than is the norm in Niue, especially of wahoo.

Returns from bottom-fishing operations during this visit, and especially from the previous DSFDP visit in 1979, during which bottom-fishing was the primary activity, indicate that this fishing method is worthwhile in Niue and may on occasions provide an alternative activity when other operations are precluded by adverse weather. However both trolling and bottom-fishing resources are limited.

Although little work was done in ika shibi and mid–water handlining, these activities are worthy of further investigation and development.

A set of recommendations drafted as a result of the Project visit is contained in Appendix I.

6. ACKNOWLEDGMENTS

The South Pacific Commission gratefully acknowledges the friendly support and co-operation extended during the Project's stay in Niue. Of great importance was the active support of Mr Frank Lui, Minister of Agriculture and the Director of Agriculture, Mr Morris Tafatu. The staff of the Niue Fisheries Division, including Mr Isi Puna, Mr Pea Poe, Mr Tito Esita and especially, Mr Apisai Inia, were of great assistance. Public Works Department staff, particularly Mr John Barnes and his gang, are to be thanked for their expert repair of the storm-damaged alia.

Among those in the private sector who assisted the Project were Mr Frank McCoy, Mr Sankia, Mr Russel Kares and Mr Desmond Hipu.

Very special thanks are due Mr Archie Moana, Mr Soni and the other fishermen of Niue whose encouragement and advice played a large part in the Project's success.

7. REFERENCES

Anon. (1969). *Pacific Islands Pilot* vol. 11. Ninth edition, 1969. Somerset, England, Hydrographic Department, Ministry of Defence.

Anon. (1981). *Pacific Islands Year Book*. Fourteenth edition. Sydney, Australia, Pacific Publications Ltd.

Boy, R.L. and B.R. Smith (1984). *Design improvements to fish aggregation device (FAD) mooring svstems in general use in Pacific Island countries*. South Pacific Commission Handbook No. 24 (1984). Noumea, New Caledonia, South Pacific Commission.

Fusimalohi, T. (1978). *Report of the South Pacific Commission Deep Sea Fisheries Development Project in Niue. 3July–31 August 1978*. Noumea, New Caledonia, South Pacific Commission.

APPENDIX 1: RECOMMENDATIONS

A. One alia should be assigned to a programme of maintenance/research crewed by two Marine Resources staff responsible for the maintenance of FADs and bait-traps. An appropriate schedule would probably require two days at sea and three days ashore. Shore work would include:

(i) Construction, inspection and repair of bait-traps;

(ii) Collection, preparation and attachment of FAD appendages;

(iii) Construction and rigging of standby FADs;

(iv) Repair and maintenance of Marine Resources shore equipment, e.g. boat trailers.

B. Full-time skippers should be assigned to each of the public-use alias with each skipper to be responsible for the care and maintenance of his assigned boat and gear. Initial fishing gear, safety equipment and tool kit to be issued to each skipper and thereafter inspected weekly by a senior staff member. Skippers to keep accurate records of fishing hours, fuel use, catch, expenses, etc.

Two strong, new moorings should be laid for the alias at a depth of around 25 m, as the present moorings lie too close to the breakers in rough weather, and only one alia should be moored to each buoy at any time.

Each alia should carry the following basic equipment on each fishing trip:

Five gallons of fresh water in a sealed container;

A main and emergency outboard motor (regularly checked and maintained);

Polypropylene anchor warp 660 m x 10 mm;

Grapnel type anchor (or similar) complete with 10 m of 10 mm chain, and a spare anchor;

Polypropylene anchor warp 60 m x 16 mm for anchoring in 15 m or lesser depth;

Emergency position indicating radio beacon (E.P.I.R.B.).

C. The outboard motor mechanic should:

(i) Carry out repairs to private motors and keep accurate records of labour and parts;

(ii) Make regular inspections and carry out preventive maintenance on the alias' outboards;

APPENDIX 1: RECOMMENDATIONS (continued)

(iii) Be in charge of his own workshop and tools;

(iv) Be engaged in a basic care/maintenance training programme for outboard motors at village level. Such a programme could include care maintenance procedures for other small motors such as motorcycles and lawn-mowers;

(iv) Be supplied with the tools and materials necessary for the simple repair of aluminium dinghies. He could also supervise the proper mounting of the Western Samoan handreels on private dinghies. It would be of benefit if the Public Works Department would undertake the construction of the handreel s for local sale.

D. The Office of Marine Resources should:

(i) Install an ice-making machine and make ice available to fishermen at cost;

(ii) Make ready-mixed fuel available to fishermen at cost;

(iii) Conduct trials in the supply to local fishermen of Hawaiian ice bags;

(iv) Contract with the Public Works Department for the manufacture of wooden handreels for sale to fishermen and assist with their correct mounting;

(v) Stock a comprehensive supply of fishing gear, especially tuna circle hooks (sizes 3–9), pigtail swivels, longline clips, Turimoto leader wire, stainless steel wire, 6 mm Kuralon longline and a wide range of lures, hooks, monofilament and rope;

(vi) Maintain stocks of aluminium plate and rivets for dinghy repair;

(vii) Initiate a bait capture operation (as previously described) and make the bait available to local fishermen engaged in longlining.

APPENDIX 2: STANDARD FORM FOR DATA COLLECTION

LOCATION:		Trip number:		Departure time:		Fishing area:		Boat:		Fuel:	
				Return time:				Skipper:		Amount:	

DATE	TIME	00 01	01 02	02 03	03 04	04 05	05 06	06 07	07 08	08 09	09 10	10 11	11 12	12 13	13 14	14 15	15 16	16 17	17 18	18 19	19 20	20 21	21 22	22 23	23 24	00 01	01 02	02 03	03 04	04 05	05 06	06 07	07 08	08 09	09 10	10 11	11 12	12 13	13 14	14 15	15 16	16 17	17 18	18 19	19 20	20 21	21 22	22 23	23 24
ENGINE HOURS																																																	
METHODS: Trolling																																																	
Bottom fishing	Handreel																																																
	Handline																																																
FISHING DEPTH (m)																																																	
CATCH RATE	Numbers																																																
	Weight (kg)																																																

WEATHER		CREW (Names):	BAIT		FISHING EFFORT	
WIND			Type	Wt (kg)	No. of trolling lines	
SEA					No. of handreels	
CURRENT		No. of trainees:			No. of handlines	

BOTTOM CATCHES (including sharks)			TROLL CATCHES			REMARKS:		
Species	No.	Wt (kg)	Species	No.	Wt (kg)			
			TOTALS:					
			CATCHES OTHER METHODS					
TOTALS			TOTALS			TOTAL CATCH PER TRIP	No.	Wt (kg):

APPENDIX 3a: SUMMARY OF VERTICAL LONGLINE CATCH BY TRIP AND EFFORT

Trip No.	Fishing hours	Effort (Note 1)	Catch		Catch (kg) per unit of effort (Note 2)
			Number	Weight (kg)	
2	9	9.0	0	0	0
3	11	11.0	1	13.0	1.2
5	11	11.0	0	0	0
7	12	12.0	0	0	0
8	11	11.0	1	33.0	3.0
39	5	6.0	8	73.0	12.2
40	3	3.6	2	12.0	3.3
41	3	4.5	3	50.0	11.1
42	5	10.0	4	50.0	5.0
43	6	18.0	0	0	0
44	5	10.0	8	57.0	5.7
45	2	4.0	1	18.0	4.5
46	4	4.8	1	3.0	0.6
47	3	3.6	0	0	0
48	6	18.0	10	89.0	4.9
49	8	24.0	1	3.0	0.1
51	12	18.0	8	84.0	4.7
52	6	9.0	3	30.0	3.3
53	6	17.4	4	73.0	4.2
54	2	5.8	0	0	0
58	5	7.5	1	23.0	3.1
62	7	8.4	1	20.0	2.4

APPENDIX 3a: SUMMARY OF VERTICAL LONGLINE CATCH BY TRIP AND EFFORT (continued)

Trip No.	Fishing hours	Effort (Note 1)	Catch		Catch (kg) per unit of effort (Note 2)
			Number	Weight (kg)	
63	7	8.4	0	0	0
66	6	7.2	2	24.0	4.0
67	5	5.0	5	61.0	12.2
68	3	3.6	8	75.0	20.8
70	4	4.8	1	17.0	3.5
71	2	2.4	5	54.0	22.5
72	4	4.8	8	58. 5	12.2
TOTAL	**173**	**262.8**	**86**	**920.5**	**3.5**

Note 1. The unit of effort used is ten hook-hours, indicating a 10-hook longline set for 1 hour, or a 20-hook longline set for 1/2 hour, etc.

Note 2. Catch per unit of effort (in kg) is calculated as the catch per 10 hooks per hour.

APPENDIX 1b: SUMMARY OF TROLL CATCH BY METHOD, EFFORT, TRIP AND FUEL CONSUMPTION

Trip No.	Method (Note 1)	Line hours (Note 2)	Catch		Fuel Used (litres)	C.P.U.E (Note 3)
			Number	Weight (kg)		
1	Wire reels/lures	14	9	16.0	32	1.1
	Surface lines/lures	7	0	0		0
4	Wire reels/lures	14	2	4.0	34	0.3
	Weighted lines/lures	7	0	0		0
	Surface lines/baits	7	1	12.0		1.7
6	Wire reels/lures	12	4	14.0	35	1.2
	Weighted lines/bait	6	0	0		0
	Surface lines/bait	6	0	0		0
9	Wire reels/lures	10	1	3.0	35	0.3
	Weighted lines/bait	5	1	4.0		0.8
	Surface lines/bait	5	0	0		0
10	Wire reels/lures	9	1	10.5	40	1.2
	Wire reels/bait	3	1	23.0		7.6
	Weighted lines/lures	6	0	0		0
	Surface lines/lures	6	0	0		0
11	Wire reel s/bait	12	0	0	38	0
	Weighted lines/bait	6	0	0		0
	Surface lines/bait	6	0	0		0
12	Wire reels/lures	1	0	0	2	
	Wire reels/bait	1	0	0		0
14	Wire reels/bait	10	4	40.0	20	4.0
	Weighted line/bait	5	0	0		0
	Surface line/bait	5	0	0		0
15	Wire reels/bait	14	1	12.0	44	0.9
	Weighted lines/bait	7	0	0		0
	Surface lines/bait	7	0	0		0
16	Wire reels/lures	6	0	0	10	0
	Weighted lines/lures	3	0	0		0
	Surface lines/lures	3	0	0		0
17	Wire reels/lures	4	1	12.0	40	3.0
	Wire reels/bait	4	2	16.0		6.5
	Weighted lines/bait	4	1	16.0		1.5
	Surface lines/bait	4	0	0		0
18	Wire reels/lures	4	2	10.0	15	2.5
19	Wire reels/lures	2	1	31.0	5	15.5

APPENDIX 3b: SUMMARY OF TROLL CATCH BY METHOD. EFFORT. TRIP AND FUEL CONSUMPTION (continued)

Trip No.	Method (Note 1)	Line hours (Note 2)	Catch		Fuel used (litres)	C.P.U.E. (Note 3)
			Number	Weight (kg)		
20	Wire reels/lures	12	7	169.0	44	14.0
	Surface lines/bait	6	0	0		0
21	Wire reels/lures	12	4	78.0	30	6.5
	Surface lines/lures	6	2	32.0		5.3
22	Wire reels/lures	12	1	19.0	38	1.6
	Surface lines/lures	6	0	0		0
23	Wire reels/lures	8	0	0	20	0
	Weighted line/lures	4	0	0		0
	Surface lines/lures	4	0	0		0
24	Wire reels/lures	12	3	59.0	30	4.9
	Weighted lines/lures	6	1	23.0		3.8
	Surface lines/lures	6	1	18.6		3.1
25	Wire reels/lures	16	6	92.0	46	5.8
	Weighted lines/lures	8	1	21.0		2.6
	Surface lines/lures	8	2	22.0		2.6
26	Wire reels/lures	14	4	65.0	40	4.6
	Weighted lines/lures	7	0	0		0
	Surface lines/lures	7	0	0		0
27	Wire reels/lures	4	0	0	20	0
	Weighted lines/lures	2	0	0		0
	Surface lines/lures	2	0	0		0
28	Wire reels/lures	16	2	32.0	40	2.0
	Weighted lines/lures	8	1	9.0		1.1
	Surface lines/lures	8	0	0		0
29	Wire reels/lures	16	3	40.0	30	2.5
	Weighted lines/lures	8	1	14.0		1.8
	Surface lines/lures	8	0	0		0
30	Wire reels/lures	4	9	25.0	21	6.3
	Surface lines/lures	4	4	6.0		1.5
31	Surface lines/lures	1	10	25.0	6	25.0
32	Wire reels/lures	12	1	24.0	20	2.0
	Weighted lines/lures	6	0	0		0
	Surface lines/lures	6	0	42.0		0

APPENDIX 3b: SUMMARY OF TROLL CATCH BY METHOD, EFFORT, TRIP AND FUEL CONSUMPTION (continued)

Trip No.	Method (Note 1)	Line hours (Note 2)	Catch		Fuel used (litres)	C.P.U.E (Note 3)
			Number	Weight (kg)		
33	Wire reels/lures	6	0	0	20	0
	Weighted lines/lures	3	0	0		0
	Surface lines/lures	3	0	0		0
34	Wire reels/lures	6	2	39.0	18	6.5
	Weighted lines/lures	3	1	33.0		11.0
	Surface lines/lures	3	0	0		0
35	Surface lines/lures	12	4	9.0	11	0.8
36	Wire reels/lures	10	1	15.0	20	1.5
	Weighted lines/lures	5	0	0		0
	Surface lines/lures	5	0	0		0
38	Wire reels/lures	14	1	12.0	38	0.9
	Weighted lines/lures	7	0	0		0
	Surface lines/lures	7	0	0		0
50	Wire reels/lures	2	1	10.0	12	5.0
56	Wire reels/lures	6	1	15.0	48	2.5
	Wire reels/bait	6	0	0		0
	Weighted lines/lures	6	1	3.0		0.5
	Surface lines/lures	6	0	0		0
57	Wire reels/lures	4	1	10.0	16	2.5
59	Wire reels/lures	12	7	76.5	50	6.3
	Weighted lines/lures	6	2	16.5		2.7
	Surface lines/lures	6	0	0		0
60	Wire reels/lures	14	3	22.0	60	1.6
	Weighted lines/lures	7	1	8.0		1.1
	Surface lines/lures	7	2	12.0		1.7
64	Wire reels/lures	2	1	14.0	4	
65	Wire reels/lures	12	2	10.0	37	0.8
	Surface lines/lures	12	1	13.0		1.0
TOTAL		**676**	**143**	**1,356.1**		**2.0**

Note 1. Method refers to the trolling equipment used and whether artificial lures or baits (dressed flying fish) were trolled. See text (Section 4.4) for more details.

APPENDIX 3c: SUMMARY OF BOTTOM–CATCH BY TRIP AND EFFORT

Trip No.	Fishing hours	Reel hours	Catch		Catch per unit of effort (kg per reel hour)
			Number	Weight (kg)	
8 (night)	4	8	25	29.0	3.6
9 (night)	5	15	16	41.5	2.8
12 (night)	4	168	29	14	1.8
14 (night)	4	12	22	41.2	3.2
15 (night)	5	10	15	90.0	9.0
19 (night)	4	8	4	33.0	4.1
50 (day)	2	4	23	116.0	29.0
55 (day)	3	6	15	54.5	4.3
56 (day)	4	8	9	45.0	5.0
57 (day)	3	6	22	59.0	9.8
61 (day)	3	6	7	26.0	4.3
69 (night)	0	4	6	44.5	11.1
TOTAL	**43**	**95**	**193**	**593.7**	**6.2**

APPENDIX 4a: SPECIES COMPOSITION OF THE BOTTOM–CATCH

Family, Species English name, Niuean name (where known)	Catch Number	 Weight (kg)
LUTJANIDAE		
Etelis carbunculus Short-tailed red snapper, palufangamea	34	70.5
Etelis coruscans Ribbon-tailed red snapper	38	253.0
Pristipomoides auricilla Gold-tailed jobfish	2	1.0
Pristipomoides filamentosus Rosy jobfish	1	1.0
Tropidinius zonatus	10	14.0
Sub-total: Deep-water snappers	**85**	**339.5**
LUTJANIDAE (Sub-family LUTJANINAE)		
Lutjanus bohar Red bass, fangamea	17	47.5
Lutjanus kasmira Blue-lined snapper, foigo	13	7.4
Lutjanus monostigma One-spot snapper	1	1.0
Sub-total: Other snappers	**31**	**55.9**
SERRANIDAE		
Cephalopholis igarasiensis Kulakula	2	3.0
Cephalopholis urodelus Flag-tail rock cod	5	1.5
Cephalopholis spp.	3	0.8
Epinephelus fasciatus Black-tipped grouper	5	1.5

APPENDIX 4a: SPECIES COMPOSITION OF THE BOTTOM–CATCH (continued)

Family, Species English name, Niuean name (where known)	Catch Number	 Weight (kg)
Epinephelus truncatus Orange rock-cod	8	9.5
Saloptia powelli Grouper, palu malau	4	7.0
Variola louti Lunar-tailed rock cod, hikumaga	11	14.0
Sub-total: Groupers	**38**	**37.3**
CARANGIDAE		
Caranx lugubris Black trevally, tafauli	5	11.0
Seriola rivoliana Deep-water amberjack	5	25.5
Sub-total: Trevallies and jacks	**10**	**36.5**
HOLOCENTRIDAE		
Adioryx spinifer Armoured squirrel fish	9	4.5
Myripristis amanaeus Big-eye soldier fish	4	0.5
Sub-total: Squirrel fishes	**13**	**5.0**
MISCELLANEOUS FISHES		
GEMPYLIDAE		
Ruvettus pretiosus Oilfish, palu sehi	7	114.0
Promethichthvs prometheus Snake mackerel	7	4.0
BALISTIDAE		
Balistes sp. Triggerfish	2	1.5
Sub-total: Miscellaneous fishes	**16**	**119.5**
TOTAL	**193**	**593.7**

APPENDIX 4b: SPECIES COMPOSITION OF THE TROLL CATCH

Family, Species English name, Niuean name (where known)	Catch Number	 Weight (kg)
SCOMBRIDAE		
Acanthocybium solandri Wahoo, paala	55	885.0
Gymnosarda unicolor Dog-tooth tuna, valu	5	81.5
Katsuwonus pelamis Skipjack tuna, takua	53	107.6
Thunnus albacares Yellowfin tuna, vatiakula	9	133.5
CORYPHAENIDAE		
Coryphaena hippurus Dolphinfish, lai/palelafa	2	14.5
SPHYRAENIDAE		
Sphyraena spp. Barracuda, utu/koho	19	134.0
TOTAL	**143**	**1,356.1**

APPENDIX 4c: SPECIES COMPOSITION OF THE VERTICAL LONGLINE CATCH

Family, Species English name, Niuean name (where known)	Catch Number	 Weight (kg)
SCOMBRIDAE		
Katsuwonus pelamis Skipjack tuna, takua	1	8.5
Thunnus alalunga Albacore tuna, vahaloloa/vahaleleva	16	300.0
Thunnus albacares Yellowfin tuna, vahakula	52	467.0
Thunnus obesus Big-eye tuna, hakua	2	22.0
CORYPHAENIDAE		
Coryphaena hippurus Dol phin fish, lai/palelafa	13	77.0
GEMPYLIDAE		
Ruvettus pretiosus Oilfish, palu sehi	1	13.0
CARCHARCHINIDAE		
Prionaceglauca Blue shark	1	33.0
TOTAL	**86**	**920.5**

APPENDIX 4d: SPECIES COMPOSITION OF THE IKA SHIBI CATCH

Family, Species English name, Niuean name (where known)	Catch	
	Number	Weight (kg)
SCOMBRIDAE		
Thunnus albacares Yellowfin tuna, vahakula	3	25.0
GEMPYLIDAE		
Ruvettus pretiosus Oilfish, palu sehi	2	57.0
Promethichthys prometheus Snake mackerel	1	2.0
TOTAL	**6**	**84.0**

APPENDIX 4e: SPECIES COMPOSITION OF THE BAIT CATCH

Family, Species English name, Niuean name (where known)	Catch	
	Number	**Weight (kg)**
CARANGIDAE		
Decapterus spp. Mackerel scad, ulihenga	260	40.0
Selar crumenophthalmus Big-eye scad, atule	146	15.5
EXOCOETIDAE		
Cypselurus spp. Flying fish	220	40.0
TOTAL	**626**	**95.5**