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ON SMALL-SCALE TUNA

FISHERIES DEVELOPMENT

IN

WESTERN SAMOA

27 September 1990–27 July 1991

by

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This unpublished report forms part of a series compiled by the Capture Section of the South Pacific Commission's Coastal Fisheries Programme.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.

On 6 February 1998 the South Pacific Commission (SPC) became the **Pacific Community**. The Secretariat of the Pacific Community (retaining the acronym SPC) is now the name for the body which administers the work program of the **Pacific Community**. The names have changed, the organisation and the functions continue.

This report was prepared when the organisation was called the South Pacific Commission, and that is the name used in it. Please note that any reference to the South Pacific Commission, could refer to what is now the Secretariat of the Pacific Community, or, less likely, to the Pacific Community itself.

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The Commission is particularly grateful to the Government of Western Samoa for its co-operation during the visit.

SUMMARY

At the request of the Government of Western Samoa, South Pacific Commission Masterfisherman, Peter Watt was assigned to provide technical assistance during a tuna longline fishing trial to be conducted over six months by Western Samoa's Fisheries Division, from September 1990 to July 1991. This assignment was arranged under the Commission's Deep Sea Fisheries Development Project (DSFDP).

The project was implemented in two phases. Phase I was conducted from September 1990 to March 1991. The Masterfisherman's primary responsibilities included the development and rigging of tuna fishing gear suited to the Fisheries Division research vessel *Tautai Matapalapala* and supervision of experimental vertical and horizontal longline fishing trials. In addition nine Fisheries Division staff, including the vessel's crew, were to be trained in gear rigging and handling, fishing techniques and strategies, catch handling to produce sashimi grade tuna, and aspects of seamanship.

During 13 fishing trips a total catch of 2,378.3 kg was taken. The catch comprised 11 species, dominated by the target species, yellowfin tuna (*Thunnus albacares*) and albacore tuna (*Thunnus alalunga*). The catch was sold either to the commercial fish market in Apia or to individuals. Catch revenues totalled approximately WS $5,700.00.

Three fishing techniques were employed, and contributed to the catch as follows:

- Vertical longlining: 1,866.1 kg in 39 sets (average of 47.8 kg/set);
- Horizontal longlining: 175.3 kg in 6 sets (average of 29.2 kg/set); and
- Trolling: 336.9 kg over 13 trips (average of 25.9 kg/trip).

The vertical longline trials were conducted in the vicinity of seven fish aggregation devices (FADs) anchored offshore from Upolu and Savai'i islands. Horizontal longline trials were conducted offshore in the areas of banks lying to the north of Upolu and Savai'i. Trolling was usually conducted opportunistically during the course of other fishing operations.

Results of the fishing trials indicated that the vertical longline method had good potential for local commercial development, if the technique were to be adopted, in modified form, by the existing commercial 'alia' catamaran fleet, with a consequent increase in productivity for time spent at sea and the increased harvest of presently under-utilised resources. Small-scale horizontal longlining, on the other hand, was thought to be unsuited to local small-boat operations; the principle restraint being the bulk and cost of the gear required.

It was recommended that trials of a modified vertical longline gear be conducted on board alia catamarans; that FADs be deployed in inshore waters specifically to gather baitfish—the harvest of which could support vertical longlining effort; and that efforts be made to develop a regular export market for sashimi-grade fish.

Phase II of the project was conducted from March to July 1991. A modified vertical longline system was designed and constructed for an alia catamaran. The gear consisted of a vertical longline drum mounted mid-ships, a plywood snood box and surface rope box custom designed to fit into the hulls, and a pulley mount fastened to the transom.

A total of 20 fishing trips yielded 181 fish; a total weight of 2,819.2 kg (gilled and gutted) for 32 sets: an average of 140.9 kg/trip; an average of 88.1 kg/set and 15.0 kg/line. In addition to the targeted species 47 sharks were caught.

A submerged bait aggregating device was deployed at a depth of 36 m north-east of Apia harbour. An inexpensive parachute sea-anchor was designed and constructed for the alia catamaran fleet to increase the potential fishing area of the targeted species.

Local fishermen were encouraged to bleed, gill and gut the fish then pack them in ice immediately when brought aboard the boat. Tuna weighing over 30 kg were exported to either Hawaii or New Zealand.

The modified vertical longline gear developed for the alia catamaran proved very effective. It increased the average daily catch of the alia fishermen and reduced fuel consumption. Many of the local fishermen designed their own vertical longline drums.

The Masterfisherman recommended that further training programmes be conducted to demonstrate the multiple applications of the parachute sea-anchor. Further experimentation with inshore FADs should be conducted to determine the most appropriate sites and designs. Finally, it was recommended that a thorough marketing survey be undertaken to determine potential export markets and post-harvest procedures to ensure a high-value export product.

RÉSUMÉ

À la demande du Samoa-Occidental, le maître de pêche de la Commission du Pacifique Sud, Peter Watt, a été chargé d'une mission d'aide technique à l'occasion d'essais de pêche thonière à la palangre, réalisée pendant six mois, entre septembre 1990 et juillet 1991, par le service des pêches du Samoa-Occidental, dans le cadre du projet de développement de la pêche au demi-large.

Le projet a été exécuté en deux phases. La phase I s'est déroulée de septembre 1990 à mars 1991. Le maître de pêche était principalement chargé de mettre au point et de monter un engin de pêche thonière adapté au bateau de recherche du service des pêches, le *Tautai matapalapala*, et de superviser des essais de pêche à la palangre verticale et horizontale. En outre, il a été chargé de former neuf agents du service des pêches, y compris l'équipage du navire, au montage et à la manipulation de l'engin de pêche, aux techniques et aux stratégies de pêche, à la manipulation des prises – permettant d'obtenir du thon de qualité *sashimi* et à des aspects du matelotage.

En tout, 2 378,3 kg de poisson ont été capturés lors de 13 sorties. Les espèces cibles, à savoir le thon jaune (*Thunnus albacares*) et le germon (*Thunnus alalunga*), constituaient l'essentiel des prises, qui étaient composées de 11 espèces différentes, et ont été vendues soit sur le marché de poissons d'Apia, soit à des particuliers. Les recettes tirées de la pêche se sont élevées à 5 700 WST environ.

Grâce aux trois techniques de pêche ci-après, les quantités de poissons suivantes ont été capturées :

- pêche à la palangre verticale : 1 866,1 kg en 39 poses (moyenne : 47,8 kg/pose);
- pêche à la palangre horizontale : 175,3 kg en 6 poses (moyenne : 29,2 kg/pose); et
- pêche à la traîne : 336,9 kg en 13 sorties (moyenne : 25,9 kg/sortie).

Les essais de pêche à la palangre verticale ont été mesurés à proximité de sept dispositifs de concentration du poisson (DCP) ancrés au large des îles d'Upolu et de Savai'i. Les essais de pêche à la palangre horizontale ont été entrepris dans les zones de hauts fonds situés au nord d'Upolu et de Savai'i. Les opérations de pêche à la traîne se sont généralement déroulées de façon ponctuelle au cours d'autres activités de pêche.

Les résultats de ces activités de pêche expérimentale ont indiqué que la méthode de pêche à la palangre verticale offrait un bon potentiel de développement commercial, au plan local, si la technique devait être adoptée, sous une forme modifiée, par la flottille de catamarans *alia* pratiquant la pêche commerciale. Dans cette éventualité, on enregistrerait une augmentation de la productivité par rapport au temps passé en mer et une augmentation des prises, la ressources étant actuellement sous-exploitée. Par ailleurs, il est apparu que la pêche artisanale à la palangre horizontale était considérée comme mal adaptée aux opérations conduites par les petites embarcations locales, à cause surtout de la place prise par l'engin de pêche nécessaire et de son coût.

Il a été recommandé que des essais d'un engin de pêche à la palangre verticale modifié soient menés à bord de catamarans *alia*, que des DCP soient mouillés dans les eaux côtières spécialement pour concentrer des poissons-appâts – dont la capture pourrait accompagner l'effort de pêche à la palangre verticale – et que des efforts soient déployés afin de développer un marché d'exportation régulier pour le poisson de qualité *sashimi*. La phase II du projet s'est déroulée de mars à juillet 1991. Un système de palangre verticale modifiée a été conçu et construit pour un catamaran *alia*. L'engin était composé d'un enrouleur de palangre verticale montée au centre du bateau, d'une caisse à avançons en contreplaqué et d'une caisse pour l'entreposage de la ligne de surface qui a été conçue sur mesure pour pouvoir être logée dans les coques ainsi que d'un support de poulie attaché au tableau arrière.

En tout, 20 sorties ont permis de capturer 181 poissons d'un poids total de 2 819,2 kg (vidés et sans branchies) pour 32 poses, soit une moyenne de 140,9 kg/sortie, de 88,1 kg/pose et de 15 kg/ligne. Outre les espèces ciblées, 47 requins ont été pêchés.

Un dispositif de concentration de poissons-appâts immergé a été mouillé par une profondeur de 36 mètres au nord-est du port d'Apia. Une ancre flottante de type parachute, peu coûteuse, a été conçue et fabriquée pour la flottille de catamarans *alia* afin d'étendre la zone de pêche potentielle des espèces ciblées.

Les pêcheurs locaux ont été encouragés à saigner, à vider et à éviscérer le poisson puis à le mettre immédiatement sous glace dès qu'il était ramené à bord. Les thons de plus de 30 kg ont été exportés soit vers Hawaii, soit vers la Nouvelle-Zélande.

La palangre verticale modifiée mise au point pour le catamaran *alia* s'est révélée très efficace. Elle a fait augmenter la moyenne des prises quotidiennes des pêcheurs embarquant à bord d'*alias* et permis de réduire la consommation de carburant. Nombre des pêcheurs locaux ont conçu leur propre enrouleur à palangre verticale.

Le maître de pêche a recommandé que d'autres actions de formation soient menées afin de démontrer les applications multiples de l'ancre flottante de type parachute. De nouveaux essais de pêche autour de DCP mouillés dans les eaux côtières devraient être entrepris afin de déterminer les sites et les modèles les plus appropriés. Enfin, il a été recommandé d'entreprendre une étude de marketing approfondie pour définir les marchés d'exportation potentiels et les procédures de valorisation des produits de la pêche qui permettront d'obtenir un produit d'exportation à valeur commerciale élevée.

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PHASE 1

1. INTRODUCTION

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

– To promote the development and expansion of artisanal fisheries throughout the region, based on fishery resources which are at present under-utilised;

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

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

During 1990 it was agreed that, at the request of the Government of Western Samoa, the South Pacific Commission would provide the services of a Masterfisherman to assist in assessing the potential for development of a local offshore tuna longline fishery.

Under the Commission's Deep Sea Fisheries Development Project, Masterfisherman Peter Watt was subsequently assigned to work with the Western Samoa Fisheries Division for six months between 27 September 1990 and 27 March 1991.

2. BACKGROUND

2.1 General

Western Samoa is an independent Polynesian nation of two large and four small volcanic islands with a total land area of some 2,934 km^2 (Figure 1). The group lies at the western edge of Polynesia, between 13° 20'–14° 05' S and 172° 55'–171° 15' W. The population is 160,000, almost all of whom are indigenous; approximately the same number of Samoans have migrated to other countries, particularly New Zealand.

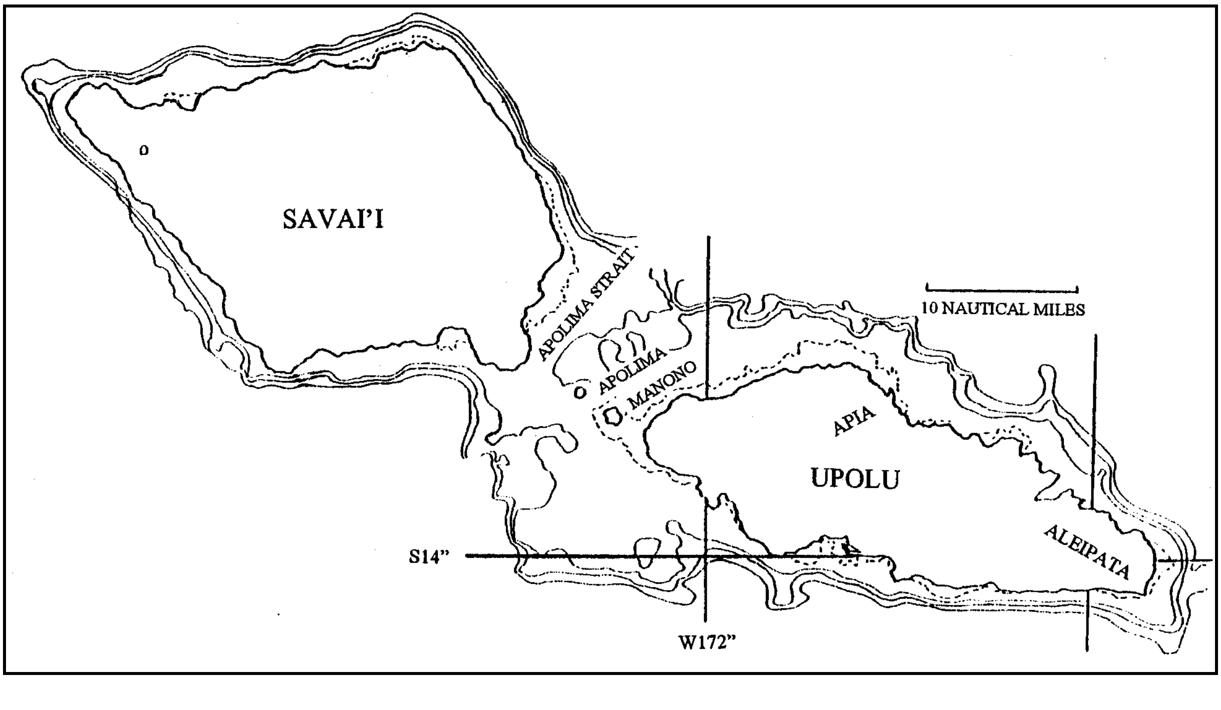


Figure 1: The islands of Western Samoa

Thick tropical vegetation covers the islands except on recent lava flows. The shores are characterised by second growth woodland, coconut, pandanus and other trees, and some areas of mangrove swamp.

South-east trade winds prevail from April to November, with a marked dry season from May to August. In the wet season, December to March, the trade winds are interrupted by north-westerlies. Tropical cyclones can occur from January to March. Temperatures are relatively constant, the mean annual temperature being 27° C.

The economy is largely dependent on three principal agricultural crops—coconuts, cocoa and bananas, tourism and remittances from Samoans living overseas.

2.2 Existing fisheries

As in most of Polynesia, fresh fish is in great demand throughout Western Samoa and a wide variety of subsistence and small-scale commercial fishing activity is practised. It is estimated that 5,000 t of fish are harvested on the inshore reefs and lagoons annually and this level of exploitation is considered high in relation to the available resource. The deep, outer-reef slopes have been fished commercially since the mid-1970s. Recent surveys have estimated that the maximum sustainable yield for deep-slope species is 118 t annually, while the present year catch is around 75 t. The offshore fishery and the fishery for coastal pelagic species is estimated to produce 155 t annually. With little opportunity for expansion of inshore fisheries, and growing population pressure, the Fisheries Division is seeking to expand the productivity of offshore fisheries. It hopes to do this by encouraging increased efficiency of current efforts and diversification into techniques that target offshore resources presently believed to be under-utilised. An on-going fish aggregation device (FAD) deployment programme and development of improved FAD-based fishing systems are considered to be important in furthering this aim.

The main centre for commercial fishing and marketing is the capital, Apia. Fresh fish landings by small-scale commercial fishermen are sold to SAMPAC, the local fish market, which was originally managed by the Government but is now leased by private interest, or to local residents, restaurants and hotels. Some export sale of frozen or chilled fish have been made to American Samoa, Australia and Hawaii.

Fishermen of Western Samoa engaged in bottomfishing and trolling from canoes and motor-powered skiffs before the introduction of a novel offshore fishing craft, the alia catamaran, in the mid-1970s. This design proved both popular and successful because it was based on a traditional hull design, it provided a large and stable work platform, it was fast enough to work schools of tuna offshore, and it proved to be relatively inexpensive to build and run. The adoption of this efficient design fostered a sharp growth in commercial fishing activity.

Originally constructed in marine plywood and later in welded aluminium, more than 300 alias have been completed by a local boatyard. Today, most boats involved in the commercial fishery are alia catamarans. Although designed to be powered by a 25 hp outboard motor, most alias are now fitted with 40 hp units. Before the severe damage caused by cyclone Ofa in early 1990 there were about 100 alias in operation, about 50 of these were engaged in full-time commercial fishing.

Although these craft are used in a variety of fisheries including commercial deep-bottom droplining, most commercial fishing activity centres on trolling. This troll fishery is now estimated to account for nearly 70 per cent of commercial landings.

2.3 Tuna fisheries development

Accurate data on pelagic fish landings was not recorded before 1989, however, landings have been estimated by the Fisheries Division since 1980. Table 1 lists these estimates.

Table 1: Estimates of tuna landings, 1980–1988

Year	Tuna landings (kg) *
1980	1,636,000
1981	2,000,000
1982	2,182,000
1983	2,318,000
1984	464,000
1985	2,082,000
1986	1,688,000
1987	1,034,000
1988	1,536,000

* How these figures were arrived at is unknown.

A market survey of pelagic fish landings was begun in 1989. The monthly totals for pelagic species sold through the Apia fish market in that year are shown in Table 2.

Table 2: Monthly totals of offshore pelagic fish sold at the Apia fish market, 1989

Month	Total number	Total weight (kg)	Total value (WS$)
January	26,436	96,034	123,357.85
February	14,322	39,253	118,533.42
March	17,129	77,315	188,606.07
April	11,390	51,455	136,002.00
May	15,345	43,327	102,758.47
June	12,325	41,030	163,115.80
July	10,850	26,887	101,555.44
August	7,060	20,600	69,145.04
September	15,048	39,628	106,431.23
October	12,148	35,238	120,517.15
November	16,906	41,841	243,529.30
December	11,147	33,859	142,162.90
Total	**170,106**	**546,467**	**3,705,000.00**

At the time of this project, there was no record of the use of horizontal or vertical longlines to catch pelagic species in Western Samoa, although surveys were conducted to determine the commercial potential of the pelagic fishery using other techniques.

In the late 1960s, Masterfisherman Ted Porter conducted a two year survey trolling for pelagic species. He had the use of two vessels, one 10.5 m and the other 15.5 m. Results of that survey, conducted with up to six lines and a fishing crew of five are shown in Table 3.

Table 3: Results of Ted Porter's trolling survey

Year & Month	Weight (kg)	Estimated no. of trips
1967		
October	1,897.73	10
November	1,209.07	15
December	1,529.02	15
1968		
January	1,136.96	15
February	528.34	2
March	1,528.34	5
April	2,079.13	4
May	84.80	1
June	-	-
July	326.53	no estimate
August	871.65	"
September	1,171.42	"
October	529.70	"
November	19.04	"
December	253.06	"
1969		
January	806.80	"
February	51.24	"

A further trolling survey was undertaken in 1975 by the Pacific Tuna Development Foundation (PTDF) in American Samoa and Western Samoa. Masterfisherman Alexander Munro outfitted the *Alofaga*, a 13 m by 3.5 m vessel powered by a 871 GMC engine. The initial trolling efforts used 10 lines of 136 kg test braided nylon, 5 per side, (9, 11, 22 and 27 m in length) and each with 4 m of 90 kg test monofilament. Lures used were jap-heads and hex-heads fitted with either coloured feathers or plastic skirts. A total of 31 days were fished, with a trolling effort of 298 hours. About 4,005 kg of fish were caught, mostly skipjack tuna. Catch rates were 155 kg/fishing day and 16 kg/hour. Munro concluded that even if the catch rate was doubled, the gross revenue would not be enough to support a 13 m vessel. He suggested that 10–20 small local vessels could be upgraded and outfitted for trolling and would generate sufficient income to be self-supporting. The records of this survey are given in Table 4.

Table 4: Pacific Tuna Development Foundation survey data

Month	Days fished	Number of fish	Weight (kg)	Hours trolled
February	5	316	957.82	51
March	13	548	2,691.15	123
April	6	277	697.50	56
May	7	150	455.32	68

In 1980 a small-scale pole-and-line skipjack tuna survey was undertaken by the Fisheries Division. The culture of top minnows (*Poecilia mexicana*) in a local hatchery made it possible to develop the fishery. Trials were carried out on the *Tautai Samoa*, a 24 t Japanese-built pole-and-line vessel, and the *Tautai Nouei*, a 8.4 m alia outfitted with two 400 l bait wells and a spray system. A total of 2,840 fish were caught, weighing approximately 7,500 kg, and 1,400 kg of baitfish were used on 60 fishing trips. Average catch per trip was 155 kg and an average of 6.3 kg of fish was caught with 1 kg of baitfish. Further development of the pole-and-line fishery was impeded when the hatchery was closed.

In 1989, for the first time, the Fisheries Division issued licences allowing foreign vessels to fish within the Western Samoan EEZ. At present 54 Korean longlining vessels have been licensed. No data have yet been collected to determine the amount of fish being harvested within the EEZ under this arrangement, however, reports supplied to the Fisheries Division indicate that the longlining fleet’s main fishing effort is taking place in the northern area of the EEZ. It is hoped that a data collection programme will be initiated in the near future.

3. PROJECT OPERATIONS

3.1 General

Because inshore fish resources are considered to be at or near maximum sustainable yield levels it is thought that offshore fisheries, i.e. tuna fisheries, offers most opportunity for development. Although the alia troll fishery is significant and the Fisheries Division has maintained an on-going FAD programme in support of this fishery, the greater part of the catch is of small tunas, especially skipjack tuna (*Katsuwonus pelamis*). It has been demonstrated during DSFD Project work elsewhere in the region, notably in American Samoa and Tonga, that important resources of large deep-swimming tuna are commonly associated with FAD systems and that this resource can be effectively harvested by small-boat fishermen equipped with the appropriate gear. In addition, work by DSFD Project Masterfishermen demonstrated that targeting these deep-swimming fish can effectively complement customary trolling operations.

The target species of such FAD-associated mid-water fishing are albacore tuna (*Thunnus alalunga*), yellowfin tuna (*Thunnus albacares*), and bigeye tuna (*Thunnus obesus*). The aim of this project was to assess these resources locally and to develop suitable means to fish them. A further aim was to land fish in such condition as to render them suitable for export marketing trials.

During the 34 fishing trips conducted, experimental vertical longlining was conducted around the seven FADs positioned at various locations offshore from Upolu and Savai’i, and horizontal longlining at offshore banks. Opportunistic trolling was also conducted, most often in transit to FAD sites.

3.2 Boat and equipment

The Fisheries Division vessel *Tautai Matapalapala* (Figure 2) is an 11 m by 3.8 m vessel. The hard-chine hull is constructed of fibreglass-reinforced plastic. The mould was originally designed as a gillnetter for the salmon fishery in the Pacific north-west. The wheelhouse is a large ‘charter-boat’ design that stretches from the bow past mid-ships. The reason for this was apparently to keep most of the living quarters above decks as the vessel was to be used in the tropics. The fish-hold aft of the wheelhouse has a 2–2.5 t capacity and is insulated with 10 cm thick polyurethane covered with fibreglass. It is designed with bin-boards inside to preserve fish in bulk ice, or hold large ice chests. The vessel is powered by a 6 cylinder Detroit Diesel 6-71N engine. The maximum speed is 12 knots; at 1600 rpm the speed is 8 knots. There are two 2,250 l welded aluminium fuel tanks a capacity sufficient for multiple-day fishing trips.

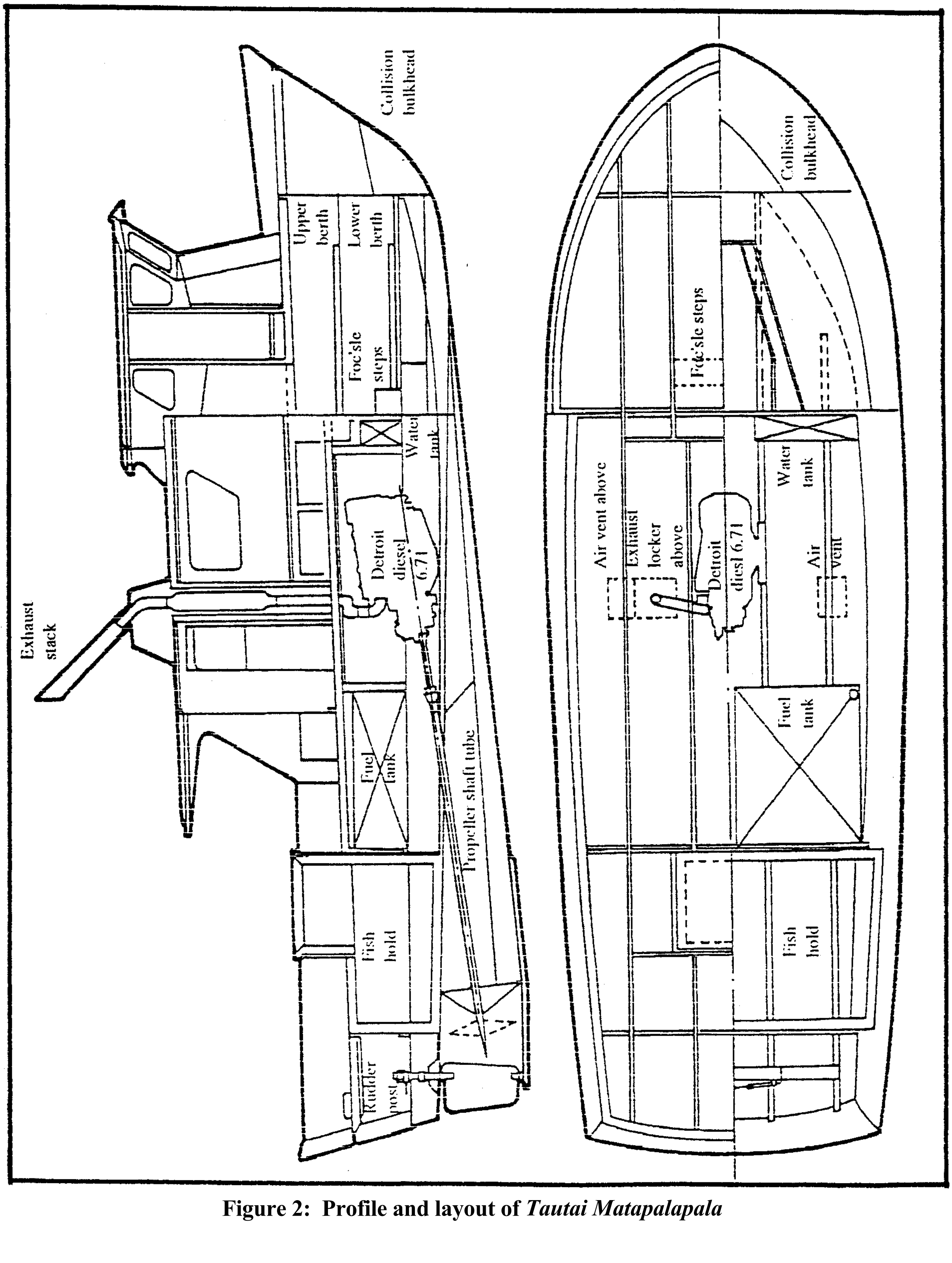


Figure 2: Profile and layout of *Tautai Matapalapala*

The *Tautai Matapalapala* is equipped with the following electrical gear:

– a Raytheon R-20 radar with a nominal range of 24 miles;

– a Sitex 310A Satellite Navigator which receives on one frequency only and is not hooked up to a speed log or compass sensor;

– a Stephen's Sea-22 HF radio which is capable of transmitting and receiving on all ITU channels;
– an ICOM M-100 VHF radio;

– a Furuno FE-881 Mark II paper echo-sounder which has a 50kHz wide beam transducer, an output of 1,000 watts and a maximum range of 2,100 m; and

– a JRC video echo-sounder with a 50 kHz transducer, an output of 600 watts and a maximum range of 2,000 m.

The vessel is also equipped with the following fishing gear:

– four wooden FAO-design bottomfish handreels,

– one Custom Sea Gear electric bottomfish reel,

– a Custom Sea Gear hydraulic longline hauler (Figure 3) mounted mid-ships on the starboard side and equipped with three interchangeable drums that each hold approximately one mile of 545 kg test monofilament longline.

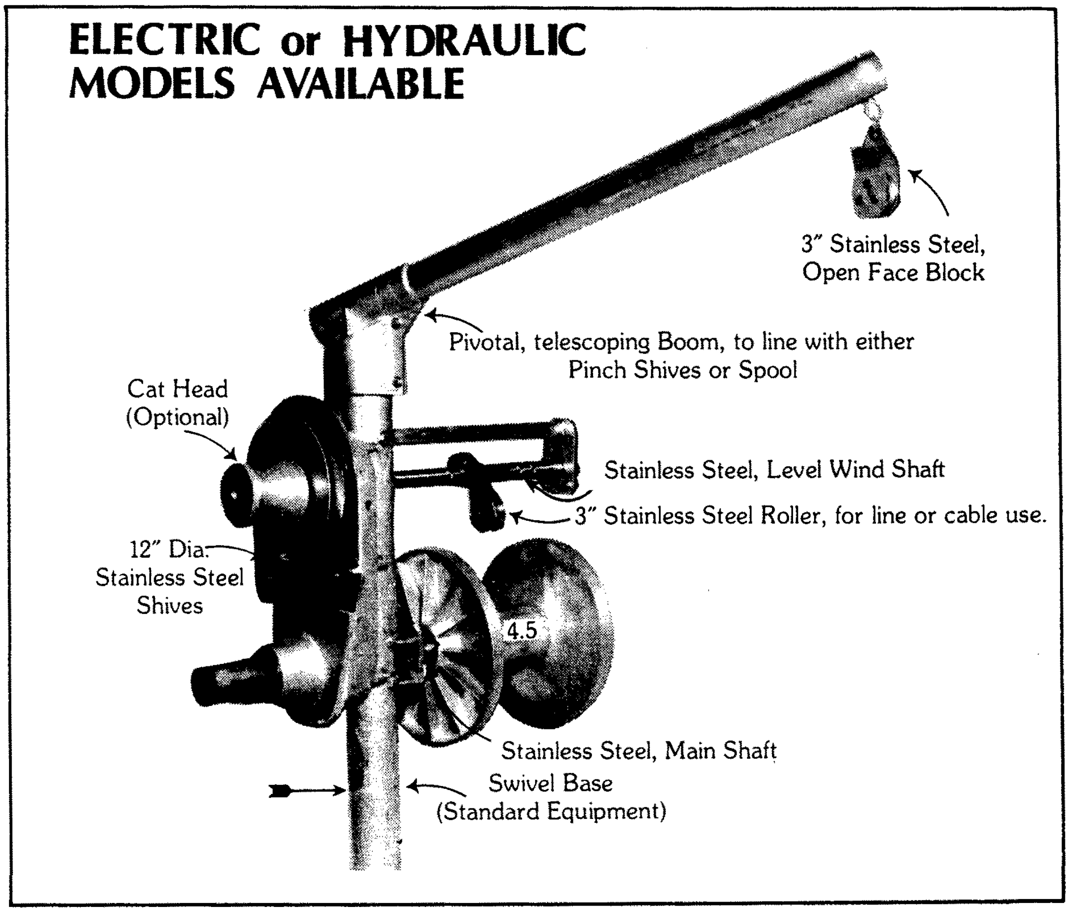


Figure 3: Custom Sea Gear hydraulic longline reel

3.3 Vertical longline gear

Gear items used during vertical longlining are listed in Table 5, while detailed illustrations of the vertical longlining gear are shown in Figures 4, 5, and 6.

Table 5: Gear components for making up a vertical longline

Gear item	Description
Surface float	Standard 300 mm hard plastic longline float with 125 mm stainless clip attached.
Marker buoys	4 m length of bamboo; 4 x 30 cm sections of 25 mm diameter steel reinforcing rod (re-bar) attached to the lower end of the bamboo pole with strips of rubber cut from an inner tube; One 20 cm inflatable plastic buoy tied 1.5 m from the bottom; One 125 mm stainless steel clip.
Surface line	90 m lengths of 8 mm polypropylene rope with eye splices at each end and with 1 m length of the same rope, ending with an eye splice, spliced into the surface line 1 m from one of the ends.
Mainline	A 90 m length of 545 kg test nylon monofilament followed by 18 m sections joined by swivels. The entire length of the mainline was thus 275 m.
Swivels	The swivels joining the mainline sections serve as attachment points for the snoods and lower sinker. Two types were used; No. 12 McMahon Heavy Duty or leaded, stainless longline barrel types.
Longline clips	Standard stainless steel longline clips fitted with swivel; 100 mm clips were used for attaching the snoods to the mainline swivels. 125 mm clips were used for attaching the floats to the surface line.
Snoods	7 m lengths of 204 kg test nylon monofilament fitted with a 100 mm clip at one end and a hook at the other.
Hooks	Both No. 4 Mustad Tuna Circle and No. 48 BKN hooks were used.
Sinkers	4 x 20 cm lengths of 25 mm diameter steel reinforcing rod strapped together with rubber strips cut from an inner tube and fitted with a 100 mm clip for attachment to the lower end of the mainline.
Snood box	A plywood box 1.2 m x 0.9 m x 0.9 m with copper wire strung around the interior 50 mm from the top edge. Snoods were loaded into the box with the stainless steel clips attached to the copper wire and the hooks passed through the clip's swivel eye to prevent fouling and for easy access when baiting.
Surface line bin	A plywood box 1.2 m x 1.2 m x 0.9 m.
Swages	All monofilament connections were made with aluminium swages (crimping sleeves) of appropriate size.

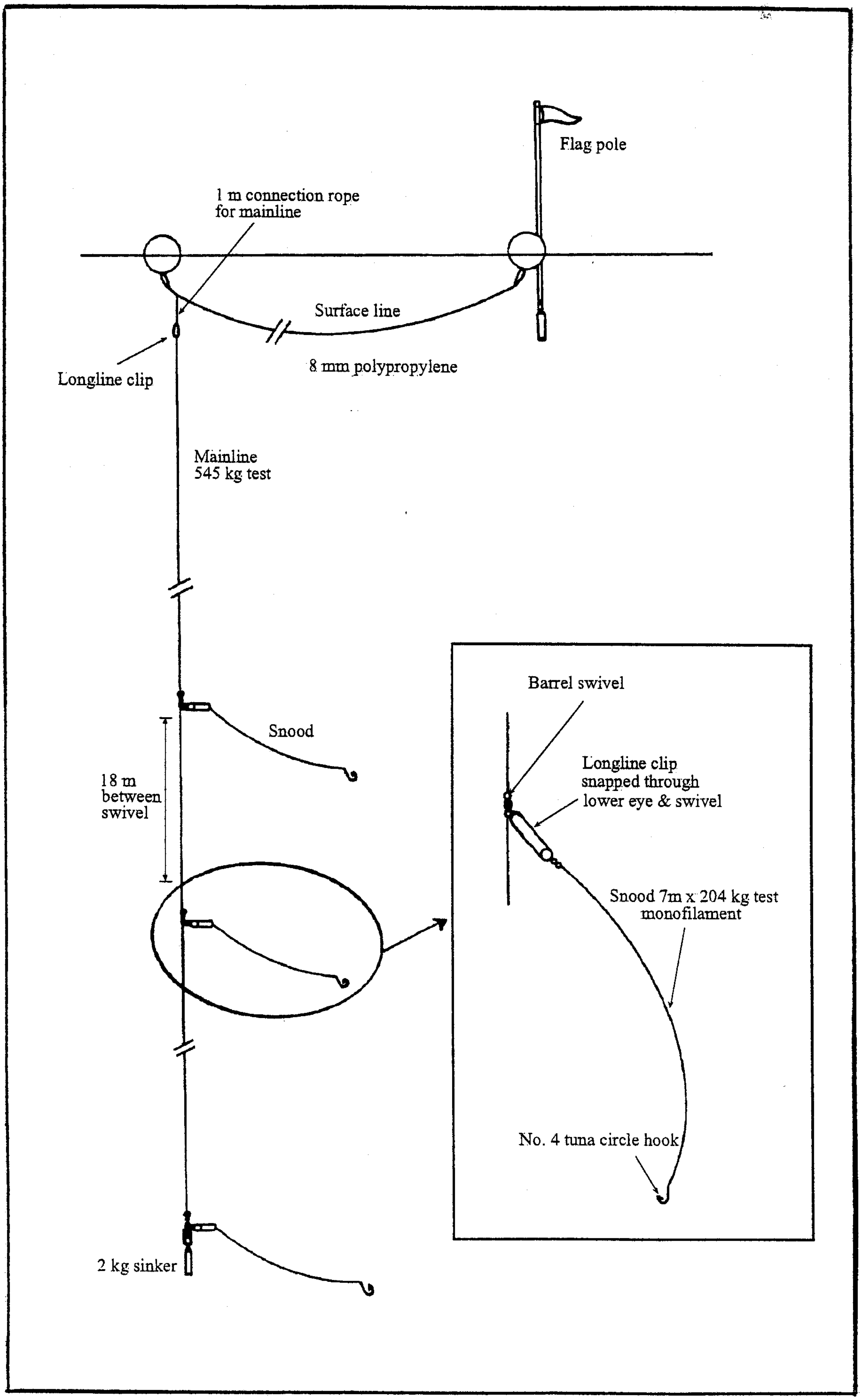


Figure 4: Vertical longline configuration

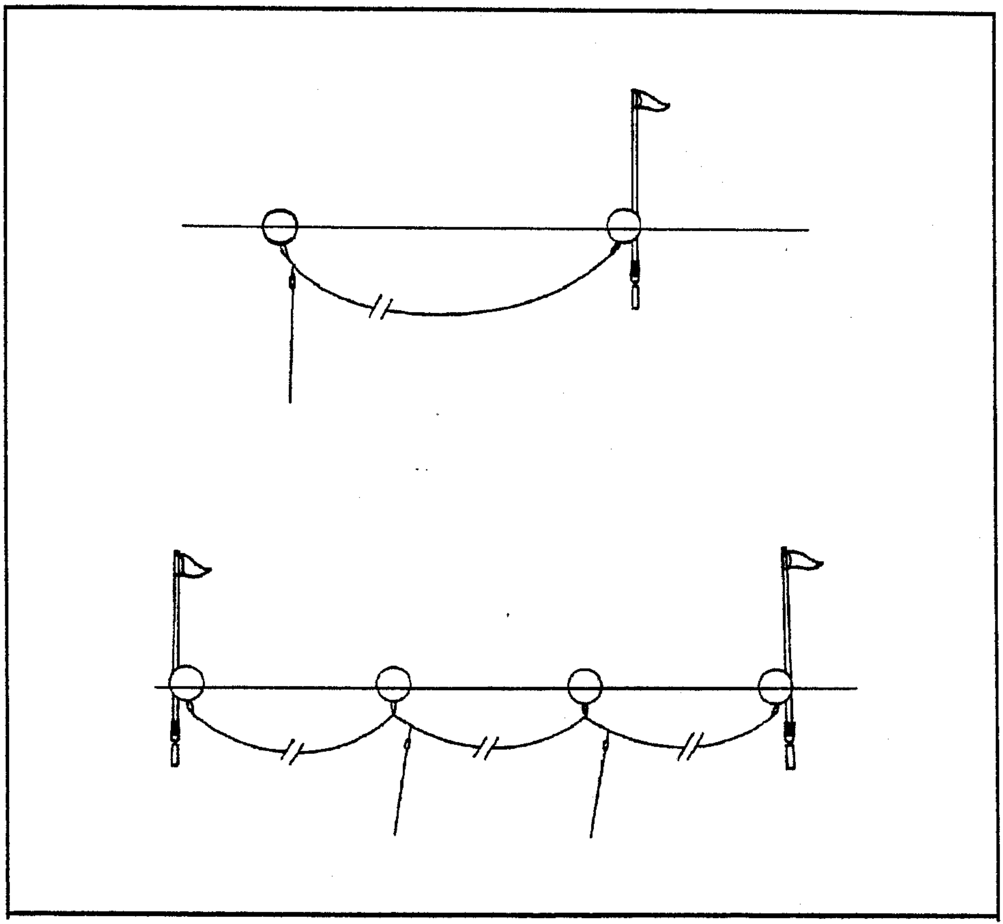


Figure 5: Vertical longlines attached together by surface ropes with buoys

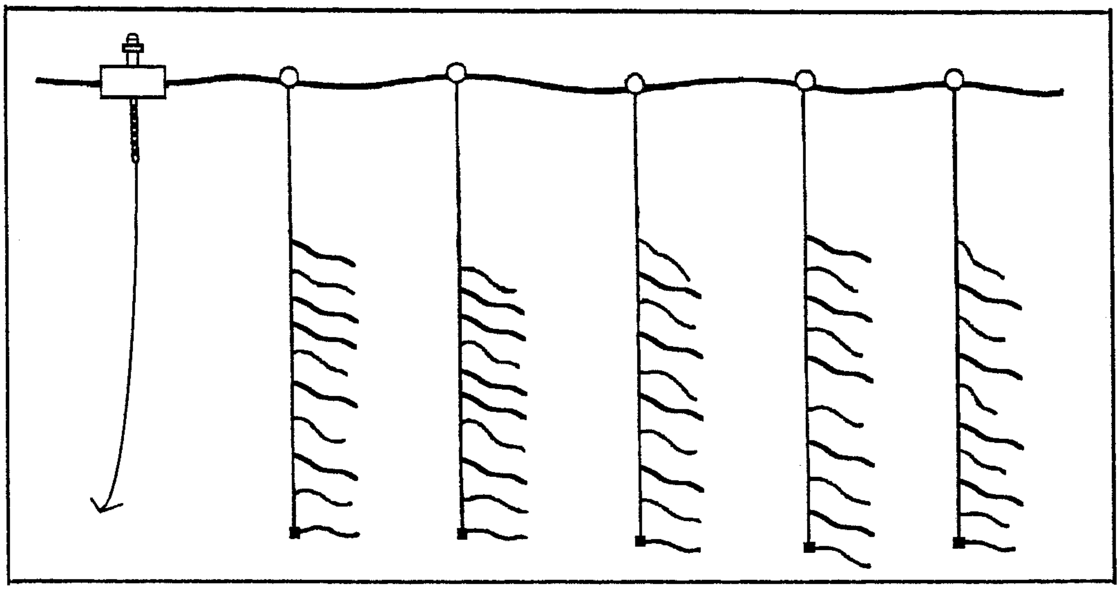


Figure 6: Vertical longlines attached to an FAD

3.4 Horizontal longline gear

The gear components used during horizontal longlining are listed in Table 6 and illustrated in Figure 7.

Table 6: Gear used for horizontal longlining during project visit

Gear item	Description
Surface float	Standard 300 mm hard plastic longline float.
Buoy lines	35 m lengths of tarred *Kuralon* (standard Asian longline cord). Fitted with a 125 mm stainless steel longline clip at one end and with an eye-splice formed at the other.
Marker buoys	4 m length of bamboo; 4 x 30 cm sections of 25 mm diameter steel reinforcing rod (re-bar) attached to the lower end of the bamboo pole with strips of rubber cut from an inner tube; One 200 mm inflatable plastic buoy attached 1.5 m from the lower end of the pole; One 125 mm stainless steel longline clip.
Mainline	545 kg test, 3.5 mm diameter nylon monofilament.
Snoods	204 kg test nylon monofilament. Each snood was 6 m long with a 100 or 125 mm stainless steel clip attached at one end and a hook at the other.
Hooks	No. 4 Mustad Tuna Circle and No. 48 BKN hooks were used.
Snood Box	A plywood box 1.2 m x 0.9 m x 0.9 m with copper wire strung around the interior 5 cm from the top edge. Snoods were loaded into the box with the stainless steel clips attached to the copper wire and the hooks passed through the clip's swivel eye to prevent fouling and for easy access when baiting.

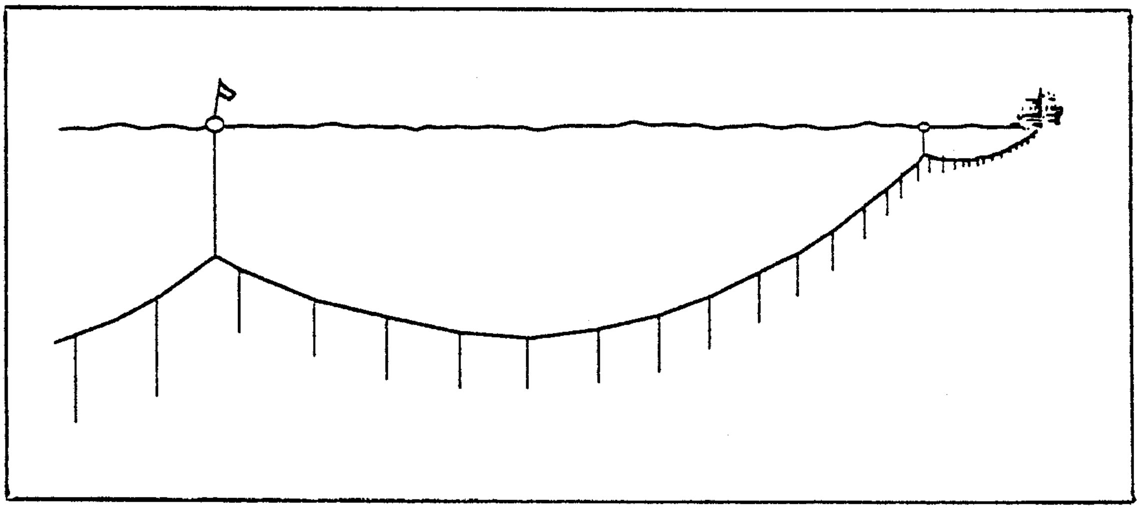


Figure 7: Horizontal tuna longline configuration

4. FISHING OPERATIONS

4.1 Vertical longlining

SPC Masterfishermen have developed various vertical longlining techniques in recent times, all of which are essentially designed to present multiple baited hooks at a range of depths on a single vertical line supported at the surface by a buoy. Such lines may be set in series, linked together at the surface so that many hooks can be deployed simultaneously in a relatively small area. The technique and gear were developed in an attempt to enable small-scale operators to target the large deep-swimming tunas that are commonly associated with FADs. The most significant problem to be overcome for small-boat fishermen using this technique is the difficulty presented in efficiently storing, setting and hauling the heavy monofilament line used. The design, construction and test fishing by SPC Masterfishermen of a variety of cheaply-constructed wooden hauling and storage drums and reels has done much to solve this problem.

During this assignment it was decided to make use of the hydraulic hauling gear fitted to the *Tautai Matapalapala* to fish multiple vertical longlines in the area of FADs in an attempt to assess the technique's local effectiveness and productivity.

Twelve complete vertical longlines were made up using the components listed in Table 5 and according to the arrangement in Figure 4. Each of the Custom Sea Gear hauler drums were capable of holding six vertical longlines. By loading two drums, 12 vertical longlines could be worked and a total of 120–180 hooks set.

4.1.1 Setting

The boat, on arriving at the FAD, determined the direction of the current by tying a 36 m length of polypropylene rope to the FAD. The other end of the rope had a small styrofoam float attached. The float and rope gradually drift down-current from the FAD, indicating the direction of current flow. The surface rope for the longline is then tied to the 36 m current direction rope. The boat then motors down-current, paying out the surface rope from the box until the first 90 m section comes to an end. The second 90 m surface line is then connected to the first. The surface rope is then tied to the stanchion post on the transom of the boat if the sea is relatively calm, or to the bow of the boat if it is not. A plastic longline float is then snapped onto the join of the two surface ropes. The boat is now ready to set the first vertical longline.

The crew position themselves on the boat so that one operates the hydraulic line hauler, one handles the snoods from the box and the other baits the hook and snaps the snood onto the mainline. The mainline is unwound from the hauler drum; a sinker and baited snood are snapped onto the last swivel on the mainline. The mainline is slowly lowered, stopping at each swivel so a baited snood can be attached by snapping the clip through the lower eye of the swivel. Care is take to ensure the baited hook is in the water before the snood is attached to the mainline, in case a fish strikes a baited hook as the line is being set.

When all 10 snoods (15 snoods on the three longer lines) have been snapped onto the mainline, the 125 mm stainless steel longline clip at the end of the mainline is clipped to the 1 m length of rope spliced into the surface rope (see Figure 4). The surface rope is untied from the boat and the plastic longline float dropped into the water. The boat motors down-current paying out the second surface rope until the end is reached. The third surface rope is then attached, the second vertical longline set and the process continued until the desired number of vertical longlines are set. A flagpole is clipped onto the last vertical longline at the end of the surface rope for visual location of the lines. Figure 8 depicts the setting of a string of vertical longlines attached to an FAD.

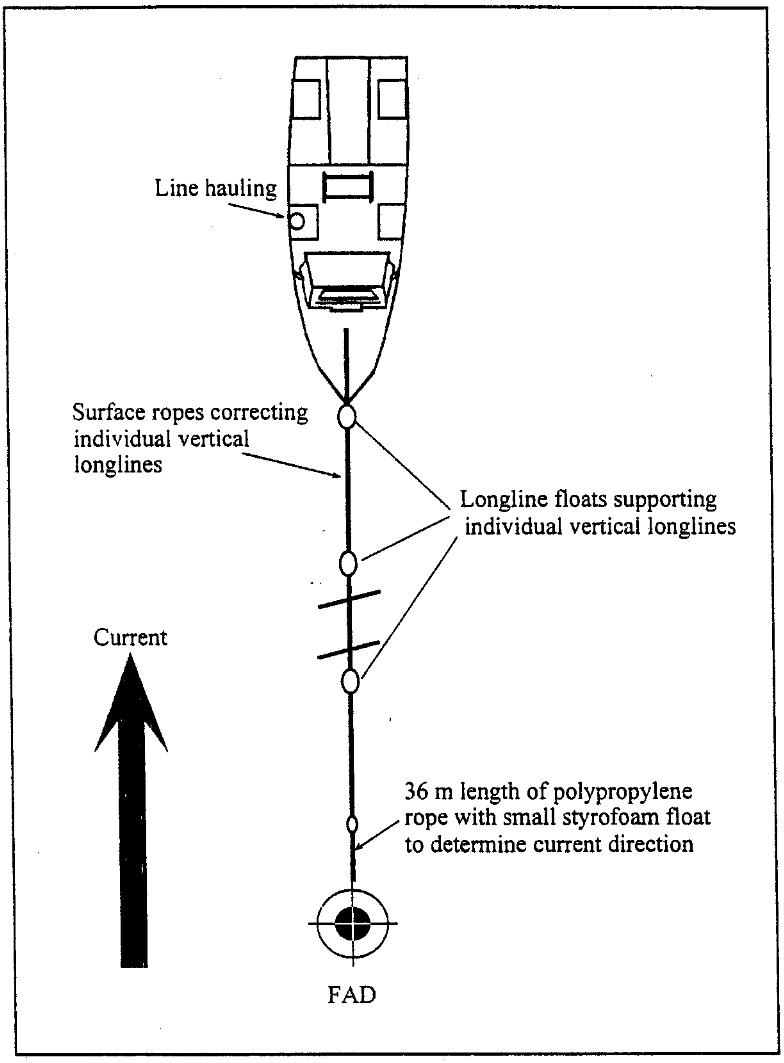


Figure 8: Setting a string of vertical longlines attached to an FAD

4.1.2 Hauling

With all the gear set, the boat regularly patrols the lines as they are soaking. Usually it is possible to identify whether a line has a fish on it or not by the float either bobbing up and down in the water or the float being partially submerged. When it has been determined that a fish in on a line, the boat is motored up to the longline float and ties the attached surface rope to the transom or bow depending on weather conditions. The individual mainline is then clipped onto the hydraulically-powered drum and wound up. The line is stopped where the snoods are snapped onto it and each one is removed. When a snood that has a fish is bought to the surface, one man pulls in the snood and another gaffs the fish in the head taking care not to puncture the body or bruise the flesh. Once the fish is boated, the snood is unsnapped from the mainline and the hauling process continued. At this point the mainline can be re-baited and re-set or left on the drum. The boat can patrol the lines for hours, hauling individual mainlines as they catch fish and re-setting them.

When the crew decide to haul in all the gear, the boat begins at the mainline attached to the flagpole. The surface rope is tied to either the bow or transom and the flagpole and mainline unclipped. The mainline is hauled back onto the drum, snoods placed back in the storage box, and the sinker placed on the deck. The boat is then motored forward hand-hauling the surface rope and coiling it into it's storage box. When the boat reaches the next mainline, the surface line is tied off and the longline float unclipped. The mainline is clipped onto the last swivel of the previously hauled mainline and hauled onto the drum. This procedure is followed until all of the mainlines have been hauled, with the snoods placed in their storage box and the surface ropes coiled into theirs. Finally, the current direction rope is untied from the FAD and stowed, and the boat returns to port.

4.2 Horizontal longlining

4.2.1 Operational set-up

The three interchangeable drums of the Custom Sea Gear line hauler enabled the vessel to deploy approximately 4.8 km (2.6 nm) of longline in one set, with loaded drums being exchanged for empty ones during setting. A description of the gear is given in Section 3.4.

4.2.2 Setting

To set the horizontal longline, the hydraulic drum holding the monofilament mainline was positioned to face the stern. The mainline was passed through a nylon pulley suspended over the transom and a marker buoy with flashing light attached to the end and placed in the water. The vessel then motored forward down-wind, running at a 45° angle to the current, paying out mainline from the first drum. As the vessel motored forward, baited branchlines (6 m long) were snapped onto the mainline at 25–35 m intervals. After 15–20 hooks had been clipped to the mainline, a 35 m floatline with float was attached. When the first drum of mainline was fully paid out the end of the mainline on the next drum was attached and the setting continued. This pattern was repeated until the three drums of monofilament had been set. A final marker buoy with flashing light was then attached to the end of the mainline.

4.2.3 Hauling

After the longline had soaked from 4–5 hours the hauling process began. The vessel motored back to the first flagpole deployed and retrieved it. The hydraulic drum was now positioned so that it faced the vessel's starboard side. A davit with a nylon pulley was then fitted to the hauler so that it extended out over the gunwale. The marker buoy was then detached from the mainline and the mainline secured to the first empty hauling drum. The vessel was then motored forward so as to keep the mainline positioned off the starboard side to ensure the line did not come from under the boat. As the mainline was retrieved by the hauler, each snood was unclipped as it appeared and stowed in the snood storage box after the removal of any remaining bait. As floatlines appeared they were unclipped, coiled and stowed. When a branchline holding a fish appeared, the vessel was stopped and turning to port to allow the boat to drift away from the line. This also allowed the crew to play and land the fish. This process was repeated until all the mainline was retrieved back onto the drums and the final marker buoy pulled aboard.

4.3 Bait

In Western Samoa there was a limited supply of fresh bait suitable for longline fishing activities. Bigeye scad (*Selar crumenophthalmus*) is seasonal and expensive. As there was no commercial longline fishery in Western Samoa, one tonne of saury (*Corolabis sairi*) was purchased from Pago Pago in American Samoa, from a commercial tuna longline company.

5. DATA COLLECTION

The South Pacific Commission requires the use of standard logsheets to record data pertaining to catch, effort, weather conditions and detailed daily fishing activities. For these fishing trials a logsheet was devised to record details of both horizontal and vertical longline sets (Appendix 1). Data recorded included prevailing weather conditions, current conditions, number of hours setting and hauling, number of hooks, type of bait, and length and weights of fish taken. Numerical codes were used for recording data on the logsheet and computer programme. In addition, narrative reports were prepared which recorded details of each set including; locations fished, departure and arrival times, baits consumed, fish taken by sharks, and the depths at which individual fish were taken.

6. TRAINING ACTIVITIES

As the fishing trials were experimental, formal training was not a feature of this phase of the project. Rather, the Fisheries Division staff who worked with the SPC Masterfisherman on the *Tautai Matapalapala* learned with him, by trial and error, the most effective and efficient methods of using the vessel and gear available to set pelagic longlines. Several local fishermen joined the vessel on occasion to observe the method.

7. DISPOSAL OF THE CATCH

Fish taken by the *Tautai Matapalapala* were sold either to SAMPAC (the local fish market) or to Fisheries Division staff. Although the catch comprised large albacore, yellowfin and bigeye tuna, which were handled on board with great care and landed in prime condition, the prices obtainable were no higher than those offered at the time for pelagic fish landings taken by local trollers. Prices were as follows: WS $2.40/kg in October and November 1990; WS $2.60/kg in December 1990; and WS $2.80/kg in January 1991. From January onwards the price remained the same. During the period of the project WS $1.00 was valued at approximately US $0.50.

As the fish landed were considered of sashimi grade and suitable for export, extensive discussions were held with SAMPAC to encourage trial exports by airfreight to markets in Hawaii. It was agreed between the Fisheries Division and SAMPAC that if the fish fetched good returns on the overseas market an appropriate bonus would be paid for the catch. SAMPAC reported, however, that the best prices obtained for fish airfreighted to Hawaii during the term of the project were US $4.60/kg for albacore tuna and up to US $9.00/kg for yellowfin tuna, and that these relatively low returns precluded any buying price increase. The low returns on catch sales served to discourage interest among local fishermen in longlining techniques.

As an incentive to the Fisheries Division staff who crewed the *Tautai Matapalapala*, and who did not receive any overtime payments for the time spent at sea outside of normal working hours, it was arranged that they share 20 per cent of the proceeds of catch sales.

8. RESULTS

8.1 Vertical longlining

Thirty-nine vertical longline sets were made in the areas of the seven FADs located offshore from Upolu and Savai'i in the course of 11 fishing trips. Each set usually comprised ten vertical longlines, nine linked in series and suspended down-current from the FAD, and one set free-drifting up-current of the FAD. The mainlines varied in length from 275 to 365 m, and carried 10 or 15 hooks depending on the mainline length. Sets were made at various times of the day and usually left to soak for 2–4 hours.

Results using the vertical longline method were quite successful. A total of 39 sets were completed with a catch of 130 fish for a total weight of 1,866.1 kg. The average catch per trip was 169.6 kg; the average catch per set was 47.8 kg; and the average catch per mainline was 4.8 kg. The three target species—yellowfin tuna, bigeye tuna and albacore tuna—comprised the majority of the catch. The vertical longline catch by species and the average weights are summarised in Table 7, with detailed trip records contained in Appendix 2a.

Table 7: Summary of vertical longline catch by species

Species	Number	Total weight (kg)	Average weight (kg)
Thunnus alalunga Albacore tuna	44	860.2	19.55
Thunnus albacares Yellowfin tuna	69	787.4	11.41
Thunnus obesus Bigeye tuna	1	65.0	65.00
Coryphaena hippurus Mahi mahi	5	49.2	9.84
Istiophorus platypterus Sailfish	1	54.0	54.00
Sphyraena barracuda Barracuda	4	25.7	6.43
* Other species	6	24.6	4.10
TOTAL	**130**	**1,866.1**	

* 'Other species' indicates those not targeted.

Vertical longline fishing trials began in October 1990 and were completed by the end of February 1991. This is a relatively short period of time in which to assess the abundance, seasonality, and vulnerability to the gear in use, of the targeted tuna species. However, from the 39 sets undertaken, the following observations were made:

(a) Larger tunas (from 15–60 kg) were most often taken on the lowest three hooks of the 275 m mainline. This indicates that these fish commonly swim in the mixed layer above the thermocline.

(b) Smaller pelagic species, including skipjack tuna, dolphinfish and wahoo, were often caught while setting or hauling the mainline. This indicates that hooks set more shallow than the minimum 90 m depth used during these trials may be productive. It is also considered likely that the movement of the baits during setting and hauling produced bites by these species at shallow depths, much as trolling does.

(c) Three mainlines of 365 m length were used on various occasions, but produced less catches on the lowest hooks than the 275 m rigs.

(d) The most productive sets were made during daylight hours. Nightime sets produced sharks almost exclusively.

(e) The FADs to the north of Upolu and Savai'i were more productive than those off the south coasts.

(f) Mainlines set in series down-current from the FAD were more productive than the free-floating line deployed up-current. It had been expected that the productivity of the up-current line would be higher as tuna schools are observed to commonly gather up-current of FADs.

8.2 Horizontal longlining

The horizontal longline gear described in section 3.4 was deployed offshore north of Upolu and Savai'i. Two fishing trips using horizontal longline gear were completed and a total of six sets made. Each set consisted of 3.5–4.5 km of monofilament mainline being used. The mainline was supported by 36 m floatlines earlier described, attached at around 730 m intervals. This floatline spacing was calculated so as to allow the mainline to sag to form catenary curves reaching to around 275 m. Fifteen to twenty baited branchlines were snapped onto the mainline at 27–36 m intervals during setting. Sets were made during daylight hours and left to soak for 3–4 hours before hauling.

Results of the horizontal longline fishing trials were inconclusive given the limited trials undertaken. Six sets were completed with a catch of 27 fish with a total weight of 175.3 kg. The average catch per trip was 87.7 kg with the average catch per set being 29.2 kg. Most of the fish caught were surface-feeding species. Table 8 summarises the catch by species for this method with the average weights, while detailed catch records are contained in Appendix 2a.

Table 8: Summary of horizontal longline catch by species

Species	Number	Total weight (kg)	Average weight (kg)
Thunnus alalunga Albacore tuna	1	21.5	21.5
Thunnus albacares Yellowfin tuna	4	10.5	2.6
Coryphaena hippurus Mahi mahi	3	25.8	8.6
Sphyraena barracuda Barracuda	14	68.4	4.9
Tetrapterus angustirostris Short-billed spearfish	1	8.2	8.2
Acanthocybium solandri Wahoo	3	31.8	10.6
Other species	1	9.1	9.1
TOTAL	**27**	**175.3**	

The Masterfisherman reported that the poor results of the horizontal longline fishing trials were in part due to the mainline being too short and the Custom Sea Gear hydraulic hauler being inappropriate for this technique. Commercial vessels deploying horizontal longline gear set from 24–64 km of mainline. When the *Tautai Matapalapala* set only 4.5 km of mainline, the chances of a school of tuna passing and feeding were minimal. Also the inner diameter of the Custom Sae Gear drums were very small. As the mainline rotated off the drum the amount of line that was being deployed with each rotation became less and less the closer it came to the centre of the drum. When the mainline was approaching the end, only 15 cm rolled off with each rotation. This made deploying and hauling the gear a very slow process. It was estimated that a maximum of 6 drums or 9.0 km of horizontal longline could be set efficiently with the Custom Sea Gear hauler. It would require 3–4 hours to set and 5–7 hours to haul.

8.3 Trolling

Trolling was carried out on an opportunistic basis to and from the FADs, as well as some trolling around the FADs, on all 13 trips. A total of 117 fish weighing 336.9 kg were caught with an average catch per trip of 25.9 kg. The most predominant species were skipjack tuna and yellowfin tuna as shown in Table 9. Detailed catch records are presented in Appendix 2a.

Table 9: Summary of trolling catch by species

Species	Number	Total weight (kg)	Average weight (kg)
Katsuwonus pelamis Skipjack tuna	62	139.6	2.3
Thunnus albacares Yellowfin tuna	44	114.3	2.6
Coryphaena hippurus Mahi mahi	7	48.7	7.0
Sphyraena barracuda Barracuda	1	8.7	8.7
Euthynnus affinis Mackerel tuna	2	3.3	1.7
Acanthocybium solandri Wahoo	1	22.3	22.3
TOTAL	**117**	**336.9**	

PHASE II

9. INTRODUCTION

Due to the success of the vertical longline trials conducted using *Tautai Matapalapala* and following a recommendation that the vertical longline gear be modified for the existing commercial alia catamaran fleet, the Fisheries Division requested the Masterfisherman extend his visit for another four months. The aim of this second phase was to develop an appropriate vertical longline system for the alia catamaran and conduct experimental fishing trials. To support the alia vertical longline programme, the Masterfisherman was also requested to:

– train interested local fishermen in vertical longline techniques;

– deploy bait aggregating devices to ensure a stable supply of bait for local fishermen using the vertical longline technique;

– demonstrate proper fish-handling techniques to ensure high-quality fish for the local, and in particular, the export market; and

– encourage **SAMPAC** to develop an export market for sashimi-quality pelagic fish.

Masterfisherman, Peter Watt began the alia vertical longline programme in March 1991. A modified vertical longline system was designed for the alia catamaran and trials were conducted for ten weeks. All fishing trips were conducted using the FADs located offshore north of Upolu Island. Over ten local fishermen were trained in vertical longlining techniques. Fisheries Division staff also assisted the fishermen in outfitting their boats with vertical longline gear. The project was completed in July 1991.

10. PROJECT OPERATIONS

10.1 Boat and equipment

The vertical longline system for the alia catamaran was designed to meet the following conditions:

– it had to be relatively simple and inexpensive to set up;

– it should require only two or three men to deploy the line;

– it should required minimal time and effort to deploy and haul the lines; and

– its components should be easily portable for loading and off-loading from the boat.

The alia was fitted out with the following gear and equipment:

– eight vertical mainlines each consisting of 270 m of 545 kg breaking strain nylon monofilament line; heavy duty McMahon swivels (No.12/0) attached every 18 m; and a 125 mm stainless steel longline clip attached to the beginning of the mainline;

– a mainline drum that the eight mainlines were rolled onto, placed on the working platform just forward of the outboard engine;

– a snood box constructed of plywood designed to fit inside the starboard hull aft of the fish cleaning box; 100 or more snoods were clipped onto a line that was strung around the interior of the box, 5 cm from the top;

– a surface rope box constructed of plywood designed to fit inside the port hull forward of the fish cleaning box; 540 m of rope was placed inside enough for 6 vertical longlines;

– a 200 mm plastic pulley suspended from a 50 by 100 mm post that was bolted 90 cm above the transom to two upright posts bolted to the port and starboard hulls;

– eight 2 kg sinkers placed in the furthest aft compartment of the starboard hull;

– eight hard plastic 300 mm longline floats placed aft of the fish cleaning box in the port hull;

– two flagpoles tied to the roof of the cabin;

– three insulated fish boxes placed inside the cabin; and

– a para-anchor placed in the cabin.

A detailed profile of the alia catamaran and gear is shown in Figure 9.

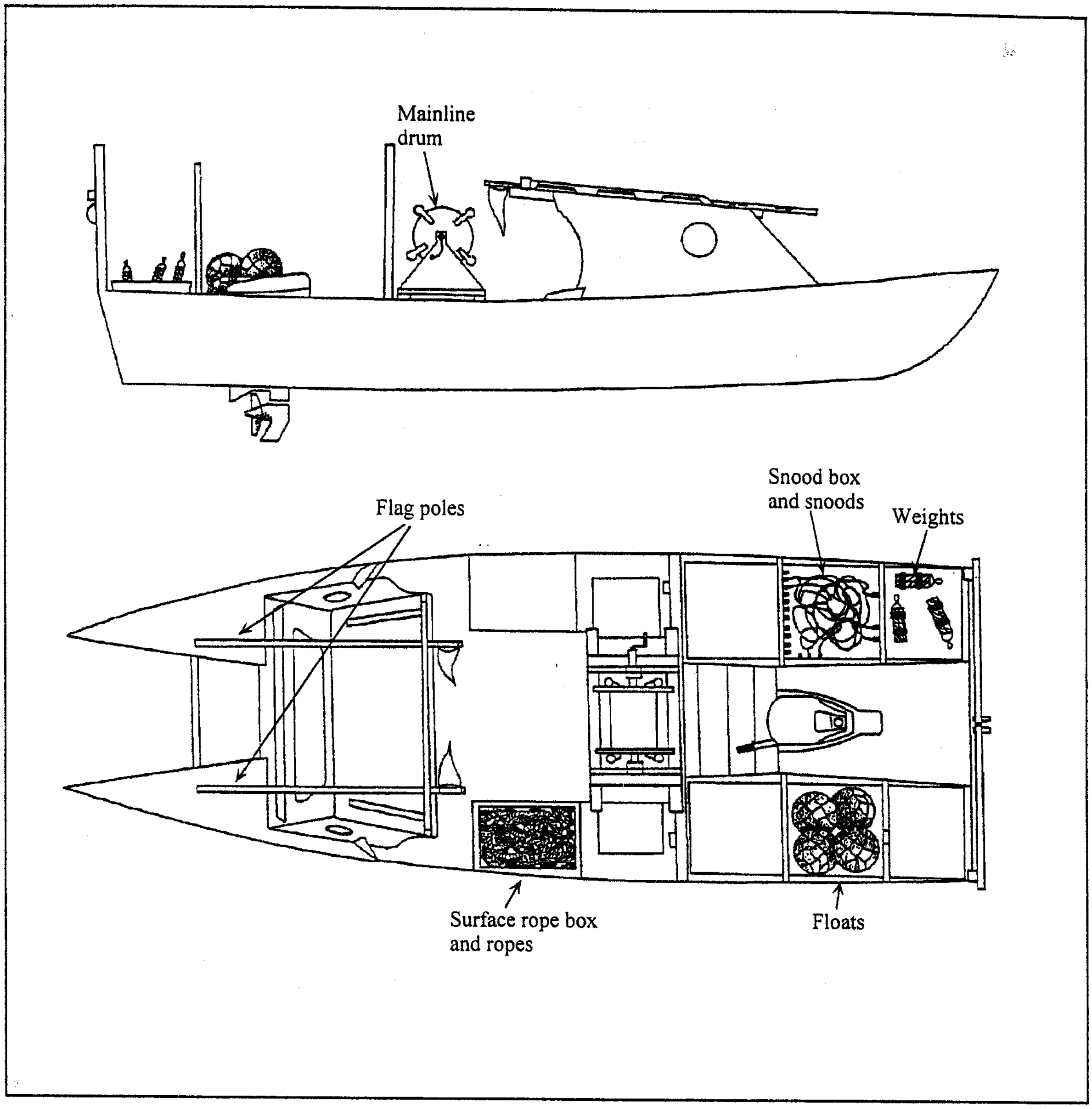


Figure 9: Alia catamaran showing gear and gear placement

10.1.1 Vertical longline components

Gear items used for the vertical longline (surface float, surface line, swivels, longline clips, hooks and sinkers) are listed in Table 5. Additional equipment for the vertical longline is as follows:

Flagpole—4 m length of bamboo; 4 pieces of re-bar (25 mm dia x 30 cm long) wrapped to one end of the bamboo with rubber strips; one 200 mm inflatable plastic buoy tied 1.5 m from the end containing the re-bar; one 125 mm stainless steel clip.

Mainline—15 pieces of 545 kg breaking strain nylon monofilament cut in 18 m lengths; the pieces are joined together with swivels to make a mainline of 270 m; one 125 mm stainless steel clip is attached at the top.

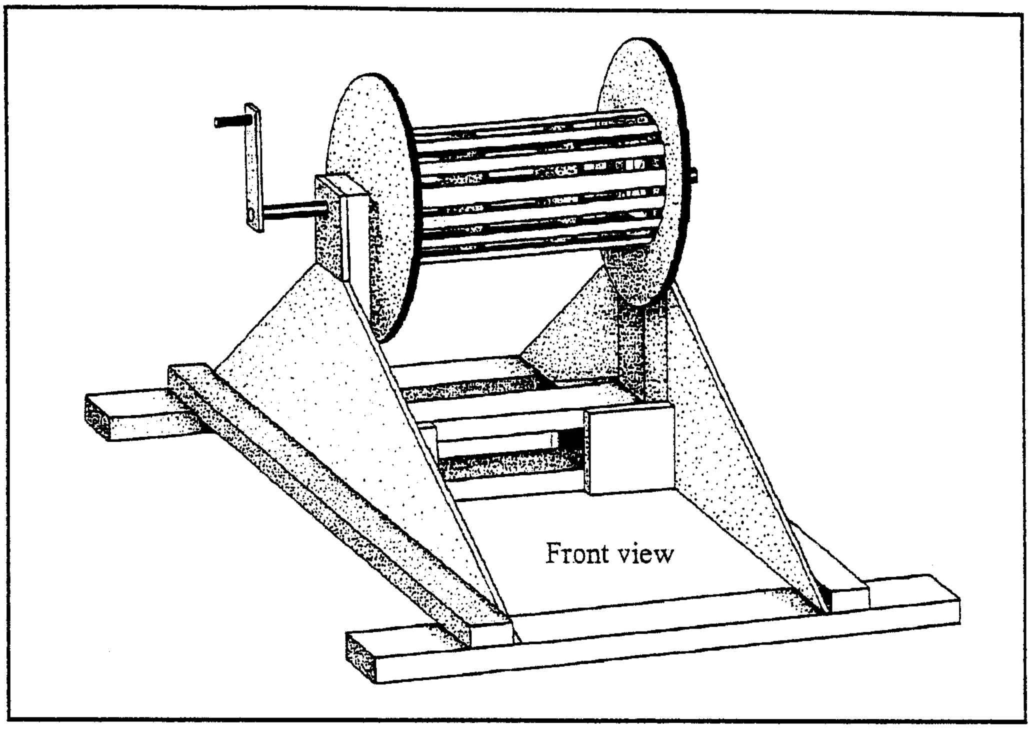
Snoods—204 kg breaking strain nylon monofilament cut in 4 m lengths with 100 mm stainless steel clip at one end and a hook on the other.

Swages—two sizes for 204 kg and 545 kg breaking strain nylon monofilament.

Detailed illustrations of the vertical longline are shown in Figures 4, 5 and 6.

10.1.2 Vertical longline drum

A vertical longline drum (Figure 10), snood and rope box were designed for deploying and hauling the vertical longlines. Construction details for the drum, snood and rope box can be found at Appendix 3a and 3b respectively.



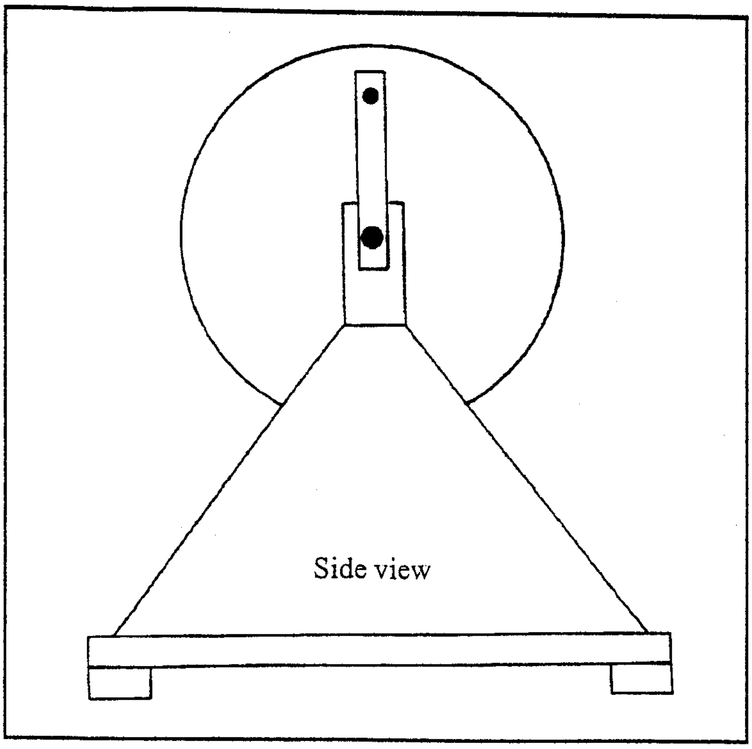


Figure 10: Vertical longline drum

10.1.3 Setting and hauling the gear

Setting

The alia vertical longline system was designed so that two or three fishermen could deploy and haul the vertical longlines. On a regular vertical longline fishing trip the following techniques are used when setting the gear:
The boat upon arriving at the FAD determines the direction of the current by tying a 36 m section of 8 mm polypropylene rope with a small styrofoam float to the FAD. The float and rope gradually drift down-current from the FAD, indicating the direction of flow. The surface rope for the longline is then tied to the current direction rope. The boat motors down-current paying out the surface rope from the box until the first 90 m section comes to the end and is joined to the next 90 m section. The surface rope is then tied to the stanchion post on the transom of the boat if the sea is relatively calm, or tied to the bow of the boat if the sea is relatively rough. The plastic longline float is then clipped onto the join of the surface ropes. The alia is now ready to deploy the first vertical longline.

The crew position themselves on the boat so that one turns the longline drum, one handles the snoods from the box and the other clips the snoods onto the mainline. The mainline is unwound from the drum and is passed through a pulley suspended above the transom of the alia. A sinker and snood are clipped onto the last swivel of the mainline. As the mainline is gradually lowered it is stopped where the swivels are attached to the mainline, and a baited snood is clipped through the lower eye of the swivel. When all 15 snoods have been clipped onto the mainline, the 125 mm stainless steel longline clip at the end of the mainline is clipped to the 1 m length of rope spliced into the surface rope. The surface rope is then untied from the boat and the plastic float dropped into the water. The boat motors down-current paying out surface rope until it comes to the next join. This process is repeated until all the longlines are deployed. A flagpole is clipped onto the last longline at the end of the surface rope for visual location of the gear.

Hauling

The following techniques are used for hauling the gear:

The alia regularly patrols the string of longlines as they are soaking. Usually it is possible to identify whether a line has a fish on it or not by the longline float either bobbing up and down in the water, being partially submerged, or floating high in the water (no weight on it). When it has been determined that there is a fish on a line, the boat motors up to the longline float and ties the attached surface rope to the transom or the bow. The individual mainline is then clipped onto the longline drum and wound up slowly. The line is stopped where the snoods are clipped onto it and each one is removed. When the snood that has caught a fish is brought to the surface, one man pulls in the line and the other reaches over the transom of the boat and brings the fish aboard by placing one hand under the gill cover and pulling up. This eliminates misplaced gaff punctures in the flesh and bruising. After the fish has been removed, the mainline can either be re-baited and deployed again or remain on the drum. An alia can patrol the longlines for hours hauling mainlines as they catch fish and re-setting them.

When the crew decide to haul in all the gear, the boat begins at the mainline attached to the flagpole. The surface rope is tied to either the bow or transom and the flagpole and longline unclipped. The mainline is wound back onto the drum, snoods placed back into the box and the sinker placed in the aft starboard hull of the alia. The boat then motors forward and the surface rope is coiled into the box. When the boat reaches the next longline, the surface line is tied either to the bow or transom. The float and longline are unclipped from the surface rope. The float is placed in the aft port hull and the mainline is clipped onto the last swivel of the last mainline and reeled back onto the drum. This process is continued until all the mainlines have been wound back onto the drum, snoods placed in their box and the surface rope coiled in their box. The current direction rope is then untied from the FAD and the boat returns to port.

10.1.4 Submerged shallow-water fish aggregating device

The most essential item in the development of the longline fishery in the Pacific region whether it be horizontal, vertical or bottom, is bait. Bait fish such as **akule** or **opelu** in many countries are caught seasonally by subsistence fishermen using either small nets or handlines from canoes. These fish are either eaten by the family or sold for a relatively high price at local markets.

For the longline trials in Western Samoa the Fisheries Division was fortunate in that it was able to purchase 1,000 kg of imported saury from the Korean longline fleet based in American Samoa. Not all Pacific countries have access to a constant source of imported bait. The price was US $14.00 for a carton containing 130 pieces. As the longline project was experimental, the price of the bait was not considered as a commercial factor until the data from the project were collected. The results of the trials for vertical longline fishing were quite promising and the method was judged to be commercially viable.

During the second phase of the project, (alia vertical longline programme), the catch rate per mainline tripled. Many factors contributed to this, but the use of fresh **akule** for bait was considered to be one of the most important. **Akule** was purchased at the local market for WS $10.00 (US $4.75) for a string of 30 fish. At this price the **akule** were more expensive than the imported saury but the increased catch rate negated the difference.

Akule in Western Samoa and all other countries in the Pacific region are a seasonal species. Usually they school inside the inshore reefs and lagoons in April and May. To extend the period when they school in the inshore reefs and lagoons, a submerged shallow-water FAD (Figure 11) was deployed. The FAD was deployed approximately 1 km north-east of Apia harbour, offshore from Vaiala Beach. It was deployed in 36 m of water with the submerged buoy suspended 9 m below the surface. Pieces of frayed polypropylene rope and nylon cloth were spliced into the mainline immediately above and below the submerged buoy to aggregate the baitfish. Unfortunately the FAD was cut off before the project was able to utilise it. Three inspections were made while the FAD was in place and there were a large number of bait fish around the submerged buoy.

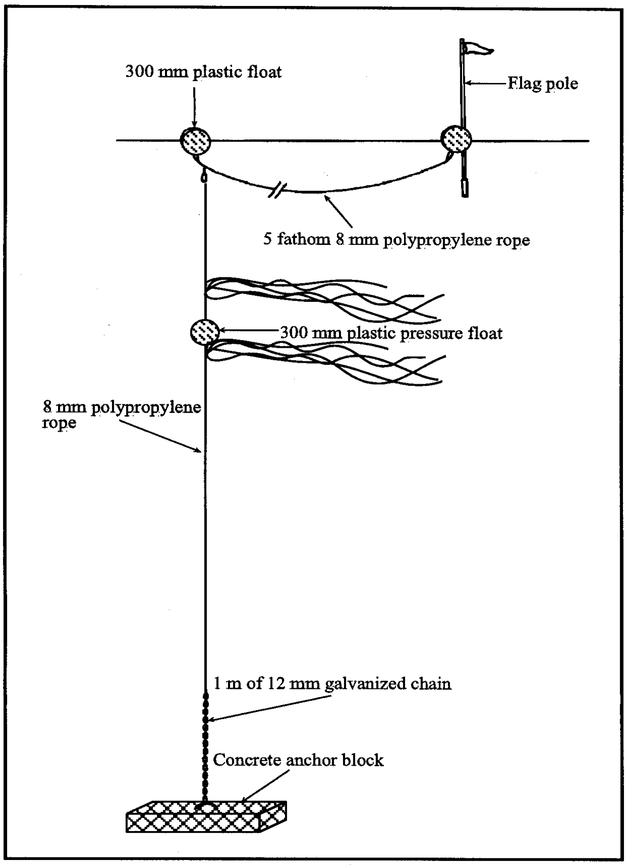


Figure 11: Submerged shallow-water FAD

The components of the submerged shallow-water FAD were:

- a flagpole;
- a surface float;
- a submerged float;
- a frayed polypropylene aggregator; and
- an anchor

The materials of the submerged shallow-water FAD are listed in Table 10.

Table 10: Materials of submerged shallow-water FAD designed for 36 m of water

Gear item	Size or length	No. of pieces
Plastic float	300 mm	1
Flagpole float	300 mm	1
Submerged float	300 mm	1
8 mm polypropylene rope	11 m 27 m 2 m	1 1 10
12 mm galvanised chain	1 m	1
Galvanised shackles	10 mm	4
Galvanised swivels	10 mm	2
Nylon cloth	1 sq. meter	1
Concrete	22.5 kg bag	1

10.1.5 Para-anchor for the alia catamaran

The vertical longline gear used for the trials with the alia catamaran was deployed at the three FADs nearest Apia harbour. In the first week of June, the FAD north of Apia harbour drifted away. Only the FAD north between Upolu and Savai'i and the FAD north of Fagaloa Bay remained for the duration of the trials. Many of the local fishermen became interested in the vertical longline technique after one month of fishing. The high catch rates, low fuel consumption and the use of the alia were all contributing factors to local fishermen wanting to change from trolling to the vertical longline technique. A training programme was initiated whereby Fisheries Division staff demonstrated the technique and assisted the fishermen in assembling the gear. When the programme was completed, over 10 boats had been outfitted for vertical longline fishing.

With over 10 boats competing for the use of the two FADs north-east and north-west of Apia harbour, problems started arising. Only one or two fishermen could tie off their fishing gear to the FAD using the technique demonstrated to them by the Fisheries staff. Usually the fisherman who would tie off to the FAD first had a better catch than the second. Lines tied closest to the FAD had a considerably higher catch rate during trials with the *Tautai Matapalapala* and the alia. If more boats arrived at the FAD wanting to set vertical longlines there was no place for them. The only alternative was to deploy free-floating or drifting vertical longlines (Figure 12), which are difficult to monitor and have a lower catch rate.

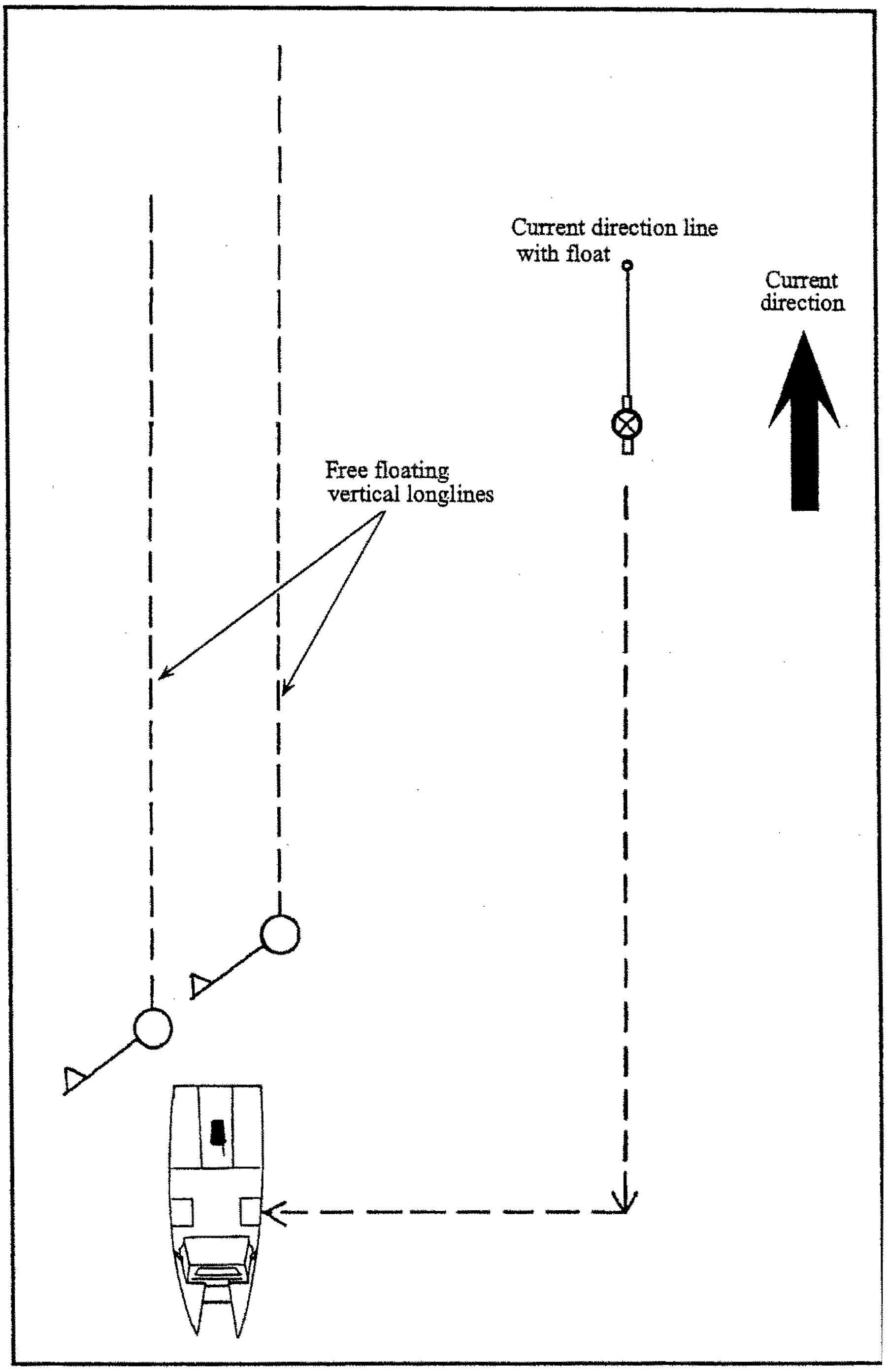


Figure 12: Technique for setting a free-floating or drifting vertical longline

Another method of using this gear had to be developed. The para-anchor (Figure 13) was designed and implemented in Western Samoa for this purpose. An alia could set the vertical longline gear, tie it to the bow then deploy the para-anchor and drift slowly down-wind from the FAD. This enabled a number of fishing boats to deploy vertical longline gear around an FAD at the same time. It also allowed the alia fleet to expand their fishing effort to areas where tuna naturally tend to aggregate on reef drop-offs and holes.

The para-anchor was designed to meet the following criteria:

– it had to be inexpensive to construct;

– it had to use materials that could be purchased locally; and

– it had to be easily deployed and retrieved from an alia.

The para-anchor and the necessary components are depicted in Figure 13, while Figure 14 shows more detail of the main connection points. Table 11 lists the materials needed to construct a para-anchor suitable for an alia catamaran.

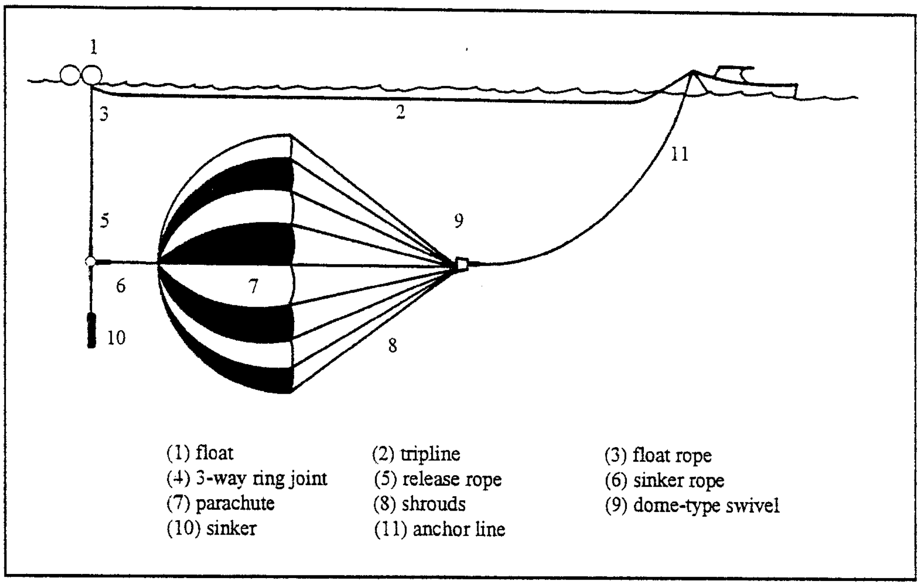


Figure 13: Para-anchor showing the main components

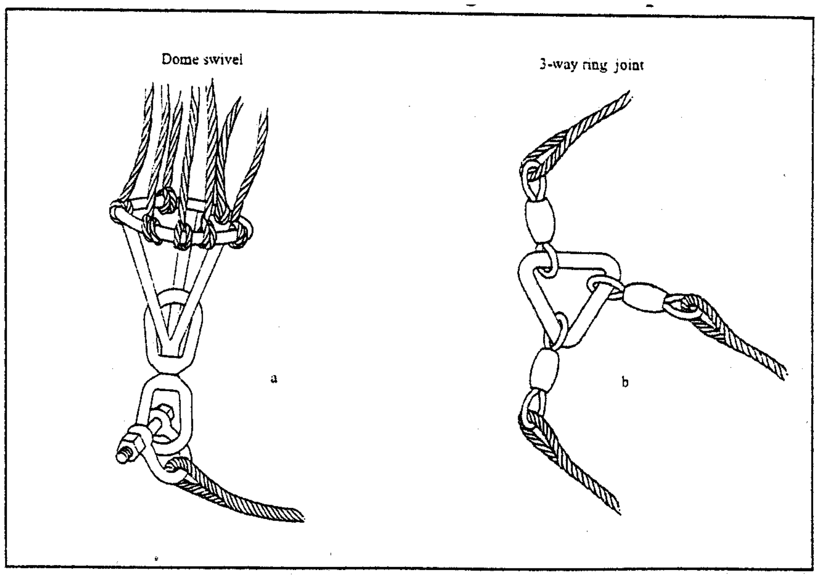


Figure 14: Detail of the dome swivel (a) and 3-way ring (b) connections of a para-anchor

Table 11: Materials required to construct a para-anchor

Gear item	Size or length	No. of pieces
Plastic coated cloth	1.3 m^2	12
25 mm re-bar	300 mm length	4
Nylon cloth	0.1 m^2	1
8 mm polypropylene rope	45 m 4 m 2 m	2 1 2
6.4 mm kuralon rope	7 m	12
Galvanised swivel	19 mm	1
10 mm brass rod	600 mm	1
Stainless steel longline swivel	extra large	3
Shackle	10 mm	1
Plastic float	300 mm	1

10.1.6 Construction of a para-anchor for an alia catamaran

Step 1: Cut 12 sections of the plastic coated cloth 1.8 m long, tapering at one end from 0.8 m to 0.15 m at the other; cut 12 pieces of kuralon rope 7.5 m each; lay out the 12 sections of plastic coated cloth placing all the 0.15 m ends at the top and all the 0.8 m ends at the bottom; lay a piece of kuralon rope where each section joins another with 5.25 m extending out the 0.8 m ends and 0.45 m extending out from the 0.15 m ends.

Step 2: Sew the sections together by folding the edges back 25 mm on each section; wrap the kuralon rope inside the fold of each section that is being sewn together; when sewing, run the thread up and down the seam of each section for added strength and to hold the kuralon rope in place. Reinforce the ends of each section by sewing the seam at each end repeatedly. After the basic parachute has been sewn together, lay out the 12 pieces of kuralon rope that extend out from the top of the parachute; each one should extend out 0.45 m. Lay them out so that the ropes opposite each other on the parachute are placed together; splice the ropes opposite each other together. Take a 0.6 m length of kuralon rope and tie the 6 loops that have been sliced together to make one large loop.

Step 3: Fabricate a 3-way ring by sliding 3 extra large stainless steel longline swivels over a piece of 10 mm brass rod; bend the brass rod in a triangular shape (see Figure 14b) and weld the two ends together.

Step 4: Fabricate a dome-type swivel by cutting a 10 mm brass rod into three 125 mm sections and one 300 mm section. Bend the 300 mm section into the shape of a circle and weld the two ends. Place the three 125 mm sections so that one end of each is spaced equally apart on the circle; the other ends of the 125 mm sections are placed on either side of the top shaft of a 19 mm galvanised swivel; the top ends are welded to the brass circle and the bottom ends are welded to the galvanised swivel (see Figure 14a).

Step 5: Splice the 12 ends of the kuralon rope extending out 5.25 m from the bottom of the parachute to the ring of the dome-type swivel (these become the shrouds of the parachute); make sure that the kuralon ropes are spliced onto the dome-type swivel in the proper sequence; fasten a 10 mm shackle to the top end of the swivel.

Step 6: Cut 5 pieces of 8 mm polypropylene rope, 2 pieces 45 m, 2 pieces 2 m and 1 piece 4 m. Take a 45 m piece, make an eye splice at one end and attach a plastic longline float. Take the other 45 m piece, pass one end through the shackle at the end of the dome-type swivel and make an eye splice. Take the 4 m piece and make an eye splice on one end and attach it to the plastic float, then pass the other end through one of the longline swivels on the 3-way ring and make an eye splice. Take one of the 2 m pieces, pass one end through one of the longline swivels on the 3-way ring and make an eye splice; take the other end and pass it through the large loop of kuralon ropes fastened together at the top of the parachute and make an eye splice. Take the other 2 m piece, pass one end through the last longline swivel on the 3-way ring and make an eye splice; make an eye splice on the other end ready to attach the sinker.

Step 7: Attach the sinker made up of 4 pieces of 300 mm re-bar tied together to the end of the 2 m rope attached to the 3-way ring.

10.1.7 Deploying and hauling the para-anchor

The following steps are required when deploying the para-anchor:

– check the shrouds are free of entanglement;

– attach the swivel to the anchor line and the dome-swivel;

– attach the release rope to the release vent section, then to the float and sinker ropes; the lengths of rope should be adjusted according to the wind strength, the height of the waves and the strength of the current;

– attach the float to the tripline;

– lower the float and then the sinker into the water from the bow of the boat facing the wind;

– lower the para-anchor into the water, release the vent section first; and

– when the para-anchor has opened completely, lower the dome-swivel into the water in such a way as to avoid tangling the shrouds; the para-anchor will open out more quickly if slight reverse throttle is used when lowering it into the water.

The following steps are required when hauling in the para-anchor:

– while using slight forward throttle, haul in the tripline and pull in the float, then the sinker;

– pull in the parachute, release vent first, then the shrouds, ensuring that the latter do not get entangled; and

– store inside a canvas bag for future use.

10.1.8 Deploying and hauling vertical longline gear when using the para-anchor

A vertical longline is deployed using exactly the same method with a para-anchor as that used when tying to an FAD, except the gear is tied to the bow of the boat instead of the FAD. Vertical mainlines are lowered into the water and suspended with plastic longline floats. The lines are tied together in a series 90 m apart with a polypropylene surface rope. Once all the lines have been deployed and tied together, the end of the surface rope is tied to the bow of the boat. The para-anchor is then lowered into the water and fastened to the bow. Another vertical longline can be deployed and fished directly from the side of the boat (Figure 15).

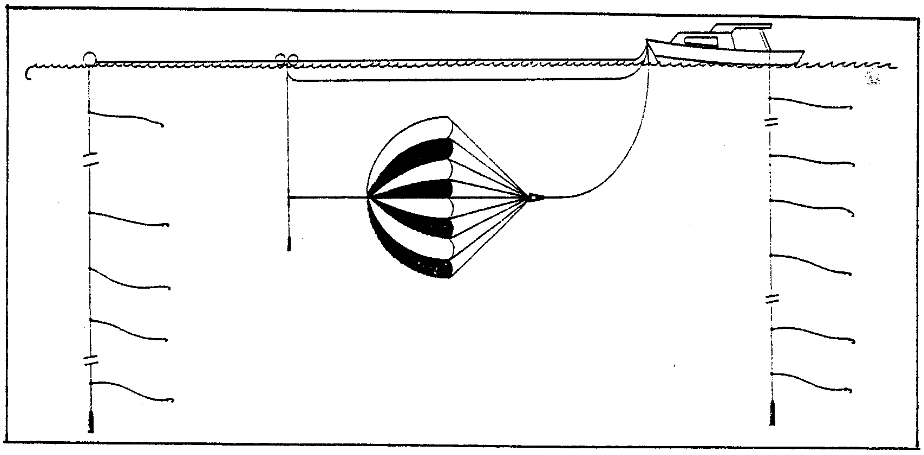


Figure 15: Vertical longline fishing with para-anchor

When a fish is caught on one of the lines floating forward of the bow, the line at the side of the boat can be released to free-float with the current. The para-anchor is then hauled aboard the boat and the surface rope connecting the lines is released from the bow. The boat motors forward to the mainline with the fish and unclips it from the surface rope. The line is then pulled a short distance away from the now free-floating series of vertical longlines to avoid drifting down wind into the other lines. It is then hauled up. To re-deploy the mainline, the boat motors back to the free-floating longline to the space where it was removed from the surface rope. The line is then lowered back into the water; some skill is required by the skipper with the engine to keep the boat in position so that the boat does not drift down-wind and tangle with the other mainlines. It is not advisable to set any more than two or three vertical longlines from the bow of the boat in strong winds or currents.

10.1.9 Another uses for the para-anchor

Bottom fishing

The para-anchor used for bottom fishing has many advantages over the traditional grapnel anchor.

– A para-anchor can be deployed and retrieved in a matter of minutes with minimal effort. A grapnel anchor requires time to sink to the ocean floor then has to be set with the proper amount of scope. Many times the anchor does not hold due to the steep bottom contours or strong winds and currents. Hauling the anchor is time consuming, the boat has to motor forward dragging two plastic longline floats that slide along the anchor line, forcing the anchor to the surface.

– When there is a strong current and the boat is anchored to the bottom the handlines are pulled in the direction of the current. The drag on the line alters the proper fishing depth, sometimes so dramatically that the baited hooks are beyond the targeted species habitat when they reach the bottom or the hooks never reach the bottom. Also the drag on the lines make it difficult for the fisherman to feel the fish biting and increases the amount of effort required to haul a caught fish from the bottom. When using a para-anchor, the boat drifts slowly with the current reducing the amount of drag on the handlines.

– An anchored boat is only capable of fishing a limited area. The anchor rope can be adjusted on steep slopes to fish at different depths but still the area is minimal. When using a para-anchor the boat can slowly drift over an extensive fishing area. If the boat drifts into water that is either too deep or too shallow, the para-anchor can be re-set at the proper depth without effort.

– Steep contours on the outer-slope, where it would be impossible to set a grapnel anchor, can be fished.

– Anchors and anchor ropes can be lost when the anchor will not release from the bottom or the rope is chaffed off by coral.

Safety

Often when an engine fails aboard a boat there is no spare. Many fishermen have been lost at sea due to the boat drifting rapidly away from land. In an emergency a para-anchor can be deployed to reduce a boat's drift rate. Lives could be saved and the expense of search and rescue reduced if more boats carried and used a para-anchor.

A boat caught in a storm with strong winds and high seas can deploy a para-anchor to point the boat into the wind and reduce drift.

10.1.10 Training activities

Training courses were carried out on Upolu and Savai'i. They consisted of demonstrating either the use of the para-anchor for vertical longline or bottom fishing. The Masterfisherman and a staff member from the Fisheries Division went out with local fishermen on their alias for one-day fishing trips to demonstrate the various uses of the para-anchor. Ten fishermen participated in the training programme, as detailed in Table 12.

Table 12: Para-anchor training activities

Location	No. of trainees	Method
Upolu	6	Vertical longline
	1	Bottom fishing
Savai'i	2	Vertical longline
	1	Bottom fishing
Total	**10**	

11. DATA COLLECTION

Data from the second phase of the project were recorded on the logsheet developed during Phase I (see Appendix 1). An individual report for each fishing trip was completed describing activities, locations fished, departure and arrival and other pertinent information.

12. TRAINING ACTIVITIES

Construction of the fishing equipment and experimental trials exhausted the first two months of the alia catamaran vertical longline programme. Local fishermen only became interested in the fishing technique once it was proven on the alia catamaran. The first month of the trials were so successful that the majority of fishermen who were exclusively trolling for tuna wanted to outfit their boat with vertical longline gear. The advantages of vertical longline fishing compared to trolling were obvious—a much higher catch rate, higher price per kg for the fish caught and lower fuel consumption.

The Masterfisherman and the Fisheries Division staff assisted the local fishermen in the following ways:

– demonstrating how to deploy and haul the vertical longline gear aboard the Fisheries Division alia;

– demonstrating how to deploy and haul the vertical longline gear aboard the interested fisherman's alia;

– demonstrating fish handling aboard the alia;

– donating vertical longline gear to certain fishermen;

– providing assistance in assembling the vertical longline gear on individual alias;

– making two training videos to illustrate the components and basic technique of vertical longline fishing; and

– writing a draft manual for the construction of the vertical longline gear and equipment.

Over 10 alias participated in one part or the other of the programme.

13. DISPOSAL OF THE CATCH

Fish caught on the alia were either sold to **SAMPAC** (local fish market) or to the Fisheries Division staff. The prices varied throughout the trials for the main targeted species. The prices varied as follows:

1–10 May	all species	WS $2.00
1–24 May	*T. albacares* (<15 kg)	WS $1.30
	" " (>15 kg)	WS $1.50
	" " (>32 kg)	WS $2.50
	T. alalunga	WS $1.25
	T. obesus (>32 kg)	WS $2.50
25 May – 15 July	*T. albacares* (<32 kg)	WS $1.50
	" " (>32 kg)	WS $2.50
	T. alalunga	WS $1.50
	T. obesus (>32 kg)	WS $2.50

The manager of **SAMPAC** explained that the prices were lowered during the second week of May because the market in Hawaii was flooded with *T. albacares* weighing less than 32 kg. Fish that weighed over 32 kg were in great demand and therefore awarded a higher market price. He also mentioned that the price for *T. alalunga* was very low and that it was not profitable to export the fish to Hawaii. Prices were later raised after a number of complaints from the fisherman were lodged and the Chief Fisheries Officer had a discussion with the manager.

At present most of the fish caught are being exported to New Zealand. The fish are filleted at **SAMPAC,** then packed in cartons and shipped air freight to Auckland. According to its manager, **SAMPAC** can ship as much as 5 t/week on the two international flights coming from New Zealand. Hopefully in the near future whole fish will be air freighted to Auckland, repacked and sent on a direct flight to Japan. If the fish are handled properly and landed in Japan in good condition, the local fishermen should receive a higher price for their catch.

14. FISHING ACTIVITIES AND RESULTS

14.1 Vertical longline fishing

The vertical longline gear described in section 3.1 was deployed from the three FADs located offshore north of Upolu. The alia catamaran completed 20 fishing trips during the survey. A total of 32 sets were made. Each set usually consisted of 6 vertical longlines tied together in a series floating down-current from the FAD. Each line had 15 snoods clipped onto the mainline spaced 18 m apart. The last snood was clipped to the mainline at 270 m with a sinker. The majority of sets were deployed between 6:00 and 13:00 hours.

Summary of the vertical longline catch and catch rates are detailed in Table 13, while detailed trip records are contained in Appendix 2b.

Table 13: Summary of vertical longline catch

No. of trips	No. of sets	No. of fish *	Total weight	Kg/trip	Kg/set	Kg/line
20	32	181	2819.2	140.9	88.1	15.0

* 47 sharks were also caught but not recorded

14.2 Comments relating to vertical longlining activities

Results from the trials conducted during the project's second phase far exceeded those of the first phase. The catch rate per vertical longline tripled during the alia catamaran phase. The average catch rate per line for the first 6 months was 5.0 kg compared to 15.0 kg for the following 4 months. There are numerous possible explanations for this incredible increase in catch rate. Some of these are:

– Saury was used exclusively as bait during the first six-month trial period. During the second phase local akule was available and on most trips it was used along with saury as bait. It was observed that when a line was baited with both saury and akule, the akule always had a better catch rate.

– The snoods on the mainline began at 90 m and finished at 270 m for the first phase of the programme. During that phase, tuna were observed taking the baits in shallow water as the lines were being deployed or hauled. The vertical longlines were modified during the second phase and the first snood was clipped to the mainline at 18 m instead of 90 m. The rest of the snoods were clipped at 18 m intervals making a total of 15 snoods for each line. The modified vertical longlines caught a number of large yellowfin tuna, mahi mahi and one marlin on the 5 snoods clipped nearest the surface.

– The snoods were cut down from 7 m long as used in the first phase to 4 m for the second phase. This minimised the chance of the snoods wrapping around the mainline.

– Possibly there are more pelagic fish in Western Samoan waters between March and July. Little is know about the migratory patterns of pelagic species in Western Samoa, particularly tunas that remain near the thermocline.

– Large fish hauled up with the handreel could be played by the fisherman when the fish ran with the line or pulled with extreme pressure. The hydraulic hauler was set up to have a constant pull and there was minimal give when pressure was put on the line.

It was also observed that whenever there was a strong current, the vertical longlines had a very low catch rate. With the drag of the current the lines did not reach the proper depth. At times the current was so strong the lines were floating almost horizontally in the water and the fish that were caught were surface-feeding species. When the current was running consistently, with minimal change in speed, rarely were there schools of fish feeding around the FAD. It was hypothesised that the fish left the FAD during periods with strong currents to search out areas of slack water. Fishermen using the vertical longline technique were advised to consult a tide chart to determine periods of slack tides when planning a trip.

15. SPECIES COMPOSITION OF THE CATCH

The species composition of the targeted pelagic fish caught using the vertical longline technique on the alia catamaran is summarised in Table 14. The groupings are based on a combination of method, taxonomy, and number of fish.

Table 14: Species Composition of the catch

Method	Species	No. of fish
Vertical longline	*Thunnus alalunga*	36
	T. albacares	116
	T. obesus	3
	Coryphaena hippurus	16
	Others*	10
TOTAL		**181**

* Others represents fish that were not targeted

16. CONCLUSIONS AND RECOMMENDATIONS

16.1 General

Results from the vertical longline trials conducted on the *Tautai Matapalapala* and the alia catamaran indicate that a viable commercial fishery could be sustained in Western Samoa. The first vertical longline trials conducted on the *Tautai Matapalapala* produced 1,866.9kg of pelagic fish, with an average catch rate of 5.0 kg/line. Results from the alia catamaran with modified vertical longline gear far exceeded those of the *Tautai Matapalapala*. The alia catamaran trials produced 2,819.2 kg of fish (gilled and gutted), with an average catch rate of 15.0 kg/line.

The advantages of the vertical longline method for the average alia fisherman over the present technique of surface trolling were numerous, with some of them being:

– The vertical longline technique has a much higher catch rate. The average catch rate using the trolling technique is approximately 50 kg/trip. The average catch rate using the vertical longline technique is 140.9 kg/trip (Phase II). During the trials a few of the trips were limited to one set as there was not enough holding capacity on the alia to safely carry any more fish.

– The fuel consumption on an average fishing trip is reduced by approximately 50 per cent. A fisherman using the vertical longline technique motors the alia to an FAD, sets the gear, turns off the engine and waits for the fish to bite. The engine is only started again when approaching the lines with fish, periodically patrolling the string of vertical longlines, or hauling up the entire longline arrangement. When trolling, the fisherman arrives at the FAD, chases at high speed after schools of skipjack tuna and small yellowfin tuna feeding on the surface, until the fish stop biting. Once there are no more fish to be caught, the fisherman leaves the FAD and heads further offshore in search of other schools. A few alias in Western Samoa have been known to burn as much as 200 litres of fuel on one trip.

– If the large pelagic fish are handled properly aboard the boat, the fishermen receive a higher price for their catch. The fishermen are encouraged to gaff the fish in the head when bringing it aboard the boat; bleed, gill and gut, then immediately pack it on ice. This ensures a high-quality product for export.

There are over 10 alia catamaran fishing vessels using the vertical longline technique at present. Other fishermen are interested in outfitting their boats with the gear but will have to wait for the equipment to arrive from overseas.

The local fish market **SAMPAC** has established export markets in New Zealand and Hawaii. The price in Hawaii fluctuates in accordance with supply and demand; this makes it difficult for **SAMPAC** to establish a consistent price for the fishermen's catch. The fillet market in New Zealand for *Thunnus albacares* is stable and the price to fishermen in Western Samoa for their catch has remained the same for two months. Unfortunately there is not a demand for *Thunnus alalunga* overseas but there is enough demand locally for **SAMPAC** still to be able to give fishermen a reasonable price for their catch.

16.2 Recommendations

The present level of commercial fisheries in Western Samoa and the exploratory survey undertaken during the South Pacific Commission's DSDF visit prompt the following recommendations:

(1) The Fisheries Division should implement a large scale programme to deploy FADs both inshore and offshore of Upolu and Savai'i.

(2) The South Pacific Commission should send a qualified Masterfisherman to co-ordinate the programme.

(3) A training programme should be set up to demonstrate the use of a para-anchor for various fishing methods.

(4) A marketing survey should be carried out to compile information regarding all possible export markets; determine the appropriate handling and packaging procedures for promoting a high-quality product and draft a future development plan for the deep-water pelagic fishery.

(5) Further experiments should de conducted with inshore bait aggregating devices and bait capture techniques.

17. REFERENCES

Anon (1975) *Samoan Trolling Survey.*

King, M., L. Bell, T. Sua, and M. Brotman (1989). *An assessment of deep-water snapper stocks in Western Samoa.*

Popper, D. M. and A.L. Phillip (1982). *Small scale pole-and-line skipjack fishery in Western Samoa.*

APPENDIX 1

LOGSHEET DEVELOPED FOR THE VERTICAL AND HORIZONTAL LONGLINE FISHING TRIALS

FISHERIES DIVISION GOVERNMENT OF WESTERN SAMOA
PELAGIC LONGLINE FISHING

Vessel ____________________Captain __________________
Date ____________Trip No. ____________ Set No. ______
Location____

Fishing Conditions
Wind direction___________ Speed____________ Sea ____
Weather ____________ Current_____ Speed___________

Fishing Gear
Verticle Longline ____ Horizontal ___ Trolling____

Details
Length of Mainline ____ No. of Droplines___________
Total No. of Hooks______
Length of Buoylines ___ Size of Hooks_____________
Length of Snoods_____ Bait Type __No. of Pieces

Fishing Times
Setting: Start _____________ Finish________________
Hauling: Start _____________ Finish________________

Catch Details
Species Length Weight Sex

SPECIES CODE FOR PELAGIC FISHES

Carangidae....................................050
- Elagatis bippinnulatus........................ 0111
- Caranx ignobilis.............................. 0112
- C. lunqubris.................................. 0113
- C. melampygas 0114

Coryphaenidae.................................066
- Coryphaenla equiselis......................... 0539
- C. hippurus................................... 0540

Scornbridaem..................................110
- Acanthocybium solandri........................ 1314
- Auxis thazard................................. 1315
- Euthynnus affirnis............................ 1316
- Grammatorcynus bilineatus................... .. 1317
- Gynosarda unicolor............................ 1318
- Katsuwonus pelamis............................ 1319
- Rastrelliqer brachvsoma....................... 1320
- R.kanaqurta1...................................1321
- Scomber japanicus 1322
- Scomberomorus commerson.......................1323
- Thunnus alalunqa..............................1324
- T. albacares 1325
- T. obesus 1326

Istiophoridae 111
- Istiophorus patypterus 1327
- Makaira indica................................1328
- M. nigricans 1329
- Tetrapterus anqustirostris 1330

Sphyraeidae 092
- Sphvraena acutippinnis 0972
- S. barracuda 0973
- S. forsteri 0974
- S. qenie 0975
- S. novaehollandiae............................0976
- S. obtusata 0977

***** CATEGORIES *****

***** FISHING TECHNIQUES *****

01 = VERTICLE LONGLINE
02 = HORIZONTAL LONGLINE
03 = TROLLING

***** BAIT *****
01 = SAURY
02 = AKULE
03 = SKIPJACK
04 = SQUID

***** WIND DIRECTION *****
01 = NORTH
02 = NORTH-EAST
03 = EAST
04 = SOUTH-EAST
05 = SOUTH
06 = SOUTH-WEST
07 = WEST
08 = NORTH-WEST

***** WIND SPEED *****
01 = NO WIND
02 = 5 TO 10 MPH
03 = 11 TO 20 MPH
04 = 21 TO 30 MPH
05 = GREATER THAN 30 MPH

***** WEATHER *****
01 = CLEAR(O TO 30 %)
02 = PARTLY CLOUDY (30 TO 60%)
03 = MOSTLY CLOUDY (60 TO 90%)
04 = OVERCAST (90 TO 100 %)

***** CURRENT *****
01 TO 08 SAME AS WIND DIRECTION

***** CURRENT SPEED *****
01 = NONE
02 = SLIGHT
03 = MODERATE
04 = FAST

***** SEA *****
01 = CALM
02 = MODERATE
03 = ROUGH

***** SEA *****
01 = MALE
02 = FEMALE

APPENDIX 2a

CATCH RECORDS FOR PHASE I FISHING ACTIVITIES

DATE	TRIP_NO	SET_NO	S_START	S_FINISH	H_START	H_FINISH	GEAR	DLINE_NO	HOOK_NO	SPECIES	LENGTH	WEIGHT
23-Oct-90	1.0	1.0	9:30	11:05	14:00	16:15	1	9	90	1325	106.0	30.20
23-Oct-90		1.0					1	9	90	1325	76.0	7.10
23-Oct-90		1.0					1	9	90	1319	74.0	6.20
23-Oct-90		2.0	16:55	18:15	6:00	7:40	1	9	90	1325	78.0	9.20
24-Oct-90		3.0	13:00	13:52	16:00	17:30	1	9	90	1324	105.0	28.20
24-Oct-90		3.0					1	9	90	1324	102.0	27.30
24-Oct-90		3.0					1	9	90	1324	102.5	27.40
24-Oct-90		4.0	17:45	18:30	6:30	8:30	1	9	90	0	0.0	0.00
06-Nov-90	2.0	5.0	16:30	17:20	18:50	20:30	1	10	100	540	110.0	11.80
06-Nov-90							1	10	100	1324	95.0	18.20
06-Nov-90							1	10	100	1325	65.0	5.80
07-Nov-90		6.0	5:30	.6:20	8:20	10:20	1	10	100	1325.	67.5	6.10
07-Nov-90							1	10	100	1325	69.0	6.30
07-Nov-90							1	10	100	1325	63.0	5.80
07-Nov-90							1	10	100	1325	68.5	6.00
07-Nov-90							1	10	100	1324	103.0	28.10
07-Nov-90	2.0	0.0	0	0	0	0	3	0	0	1314	143.5	22.30
07-Nov-90							3			1316	42.3	2.40
07-Nov-90							3			1319	48.3	2.80
07-Nov-90							3			540	99.0	8.20
07-Nov-90	2.0	7.0	12:15	13:10	14:45	16:10	1	10	100	0	0.0	0.00
14-Nov-90	3	0	0	0	0	0	3	0	0	1325	49.0	2.20
14-Nov-90							3			540	102.0	8.25
14-Nov-90							3			1319	58.0	4.20
14-Nov-90							3			1319	52.0	2.14
14-Nov-90							3			1325	65.0	5.00
14-Nov-90							3			1319	57.0	3.95
14-Nov-90							3			540	91.0	6.45
14-Nov-90							3			1319	41.0	1.90
14-Nov-90							3			1325	52.0	2.85
14-Nov-90							3			540	101.0	7.30
14-Nov-90							3			540	74.0	3.50
15-Nov-90	3	8	5:45	6:45	8:40	10:10	1	10	100	1325	75.0	7.20
15-Nov-90							1	10	100	1325	73.0	6.50
15-Nov-90	3	9	12:00	15:00	17:45	19:00	1	10	100	1324	105.0	24.00
15-Nov-90							1	10	100	1324	84.0	11.90
15-Nov-90	3						1	10	100	1324	93.0	16.60
15-Nov-90							1	10	100	1325	73.0	6.50
15-Nov-90							1	10	100	1325	65.0	4.85
15-Nov-90	3						1	10	100	1325	72.0	6.85
15-Nov-90							1	10	100	1325	71.0	6.50
15-Nov-90							1	10	100	1325	67.0	5.15
15-Nov-90							1	10	100	1325	69.0	6.80
15-Nov-90							1	10	100	1319	45.0	1.50
15-Nov-90							1	10	100	0	89.0	4.75
15-Nov-90							1	10	100	1324	93.0	16.60
15-Nov-90							1	10	100	1325	69.0	6.75
15-Nov-90							1	10	100	1325	68.0	5.65
15-Nov-90							1	10	100	1325	73.0	6.20
15-Nov-90							1	10	100	1325	74.0	6.80
16-Nov-90	3	10	5:45	6:30	8:30	10:30	1	10	100	1325	66.0	5.40
16-Nov-90							1	10	100	1325	72.0	6.00
20-Nov-90	4	11	15:50	16:40	19:10	20:50	1	10	100	1324	103.0	25.00
20-Nov-90	4	12	3:45	4:40	7:10	8:30	1	10	100	1324	89.0	15.20
20-Nov-90	4	0	0.00	0	0	0	3	0	0	1319	72.0	3.20
20-Nov-90	4						3			1316	36.0	0.90
20-Nov-90							3			1325	69.0	6.80
20-Nov-90	4	13	12:50	13:50	15:30	17:00	1	10	100	1324	85.0	14.80
20-Nov-90							1	10	100	1325	71.0	7.50
20-Nov-90							1	10	100	1325	106.0	30.90
20-Nov-90							1	10	100	1325	73.0	8.30
20-Nov-90							1	10	100	1324	94.0	18.60
20-Nov-90							1	10	100	1324	97.0	18.40
20-Nov-90	4						1	10	100	1324	89.0	15.20
21-Nov-90							1	10	100	1325	71.2	7.20
21-Nov-90							1	10	100	1325	70.0	7.00
08-Jan-91	5	14	14:00	15:00	17:00	18:20	1	10	100	1324	95.0	16.80
09-Jan-91	5	15	10:15	11:00	13:00	15:15	1	10	100	1324	91.0	14.60
09-Jan-91							1	10	100	1324	94.0	18.20
09-Jan-91							1	10	100	1325	123.0	33.20
09-Jan-91							1	10	100	540	96.0	7.00
09-Jan-91							1	10	100	1324	101.0	21.20
09-Jan-91							1	10	100	1324	94.0	18.20
09-Jan-91							1	10	100	540	96.0	7.00
09-Jan-91	5	16	15:30	16:25	18:30	20:45	1	9	90	1325	101.0	18.80
09-Jan-91							1	9	90	1324	101.0	21.20
15-Jan-91	6	18	14:40	15:43	18:40	19:12	1	10	100	0	0.0	0.00
15-Jan-91	6	0	0.00	0	0	0	3	0	0	973	103.0	8.70
16-Jan-91	6	19	6:45	7:45	9:30	11:30	1	10	100	1325	84.0	9.20
16-Jan-91							1	10	100	1325	117.0	25.00
16-Jan-91							1	10	100	1324	97.0	18.60
16-Jan-91	6	20	11:35	13:00	15:30	18:00	1	10	100	1324	107.0	22.70
16-Jan-91							1	10	100	1325	120.0	29.00
16-Jan-91	6	0	0.00	0	0	0	3	0	0	1325	53.0	3.10

DATE	TRIP_NO	SET_NO	S_START	S_FINISH	H_START	H_FINISH	GEAR	DLINE_NO	HOOK_NO	SPECIES	LENGTH	WEIGHT
16-Jan-91							3			1325	52.0	3.00
16-Jan-91							3			1325	54.0	2.90
16-Jan-91							3			1325	52.0	2.50
16-Jan-91							3			1325	52.0	3.00
16-Jan-91							3			1325	51.0	2.50
16-Jan-91							3			1325	55.0	2.60
16-Jan-91							3			1325	51.0	3.00
16-Jan-91							3			1325	45.0	1.70
16-Jan-91							3			1325	45.0	1.80
16-Jan-91	6						3			1325	53.0	2.60
16-Jan-91							3			1325	53.0	2.70
16-Jan-91							3			1325	60.0	4.20
16-Jan-91							3			1325	53.0	3.20
16-Jan-91	6						3			1325	52.0	2.50
16-Jan-91							3			1319	54.0	2.50
16-Jan-91							3			1319	46.0	1.80
16-Jan-91							3			1319	51.0	3.00
16-Jan-91							3			1319	46.0	1.80
16-Jan-91							3			1319	52.0	2.80
16-Jan-91							3			1319	55.0	3.40
16-Jan-91							3			1319	50.0	2.10
16-Jan-91							3			1319	55.0	3.30
16-Jan-91							3			1319	52.0	2.80
17-Jan-91	6	0	0.00	0	0	0	3	0	0	1319	44.0	1.60
17-Jan-91							3			1319	50.0	2.00
17-Jan-91							3			1319	49.0	2.30
17-Jan-91							3			1325	52.0	2.50
17-Jan-91							3			1325	40.0	1.70
17-Jan-91							3			1319	42.0	1.50
17-Jan-91							3			1319	55.0	3.40
17-Jan-91							3			1319	55.0	3.40
17-Jan-91							3			1319	55.0	2.60
17-Jan-91							3			1325	55.0	3.30
17-Jan-91							3			1319	61.0	4.70
17-Jan-91							3			1319	36.0	0.80
17-Jan-91							3			1319	53.0	2.60
17-Jan-91							3			1319	53.0	2.50
17-Jan-91							3			1325	54.0	2.90
17-Jan-91							3			1325	45.0	1.30
17-Jan-91							3			1319	44.0	1.60
17-Jan-91							3			1319	54.0	3.40
17-Jan-91							3			1325	53.0	3.00
17-Jan-91							3			1319	45.0	1.60
17-Jan-91							3			1319	46.0	1.80
17-Jan-91							3			1319	54.0	3.30
17-Jan-91							3			1319	44.0	1.60
17-Jan-91							3			1325	44.0	1.60
23-Jan-91	7	21	14:10	15:25	17:20	19:00	1	10	115	1325	81.0	10.10
23-Jan-91							1	10	115	1325	84.0	10.50
23-Jan-91							1	10	115	973	90.0	4.90
23-Jan-91							1	10	115	1325	83.0	10.60
23-Jan-91							1	10	115	1325	88.0	13.90
23-Jan-91							1	10	115	1325	79.0	10.40
23-Jan-91							1	10	115	1319	59.0	4.60
23-Jan-91							1	10	115	1325	76.0	8.00
23-Jan-91							1	10	115	1325	81.0	9.10
23-Jan-91							1	10	115	1325	83.0	8.70
23-Jan-91							1	10	115	0	88.0	5.40
24-Jan-91							1	10	115	1325	84.0	10.90
24-Jan-91	7	22	7:00	8:00	10:00	11:30	1	10	115	1324	103.0	23.00
24-Jan-91							1	10	115	1325	85.0	10.40
24-Jan-91							1	10	115	1324	91.0	15.60
24-Jan-91							1	10	115	1325	102.0	22.50
24-Jan-91							1	10	115	1324	104.0	24.00
24-Jan-91							1	10	115	1325	82.0	9.80
24-Jan-91	7	23	11:45	13:00	15:00	16:30	1	10	115	1325	106.0	31.00
25-Jan-91							1	10	115	1326	138.0	65.00
25-Jan-91							1	10	115	1325	92.0	16.90
25-Jan-91							1	10	115	1325	102.0	22.50
25-Jan-91							1	10	115	1324	98.0	20.00
25-Jan-91							1	10	115	1325	86.0	11.10
25-Jan-91	7	24	6:45	8:00	10:00	11:30	1	10	115	1325	83.0	10.10
25-Jan-91							1	10	115	1327	220.0	54.00
25-Jan-91							1	10	115	1325	84.0	10.30

DATE	TRIP_NO	SET_NO	S_START	S_FINISH	H_START	H_FINISH	GEAR	DLINE_NO	HOOK_NO	SPECIES	LENGTH	WEIGHT
25-Jan-91	7	0	0.00	0	0	0	3	0	0	1325	53.0	2.40
25-Jan-91							3			540	96.0	6.50
25-Jan-91							3			1319	51.0	2.20
25-Jan-91							3			1325	54.0	2.50
25-Jan-91							3			1325	51.0	2.10
29-Jan-91	8	25	14:00	15:00	17:00	18:30	1	10	115	540	102.0	9.30
29-Jan-91							1	10	115	540	127.0	14.10
29-Jnn-91	8	0	0.00	0	0		3	0	0	1319	44.0	1.60
29-Jan-91							3			1319	46.0	1.80
29-Jan-91							3			1319	48.0	1.80
29-Jan-91							3			1319	46	1.7
29-Jan-91							3			1319	52	2.6
29-Jan-91							3			1319	49.0	1.80
29-Jan-91							3			1319	53.0	2.50
29-Jan-91							3			1319	51.0	2.10
29-Jan-91							3			1319	45.0	1.60
29-Jan-91							3			1319	50	2.1
29-Jnn-91							3			1319	47.0	1.70
29-Jan-91							3			1325	55.0	2.6
29-Jan-91							3			1325	57.0	2.90
29-Jan-91							3			1325	59.0	3.10
29-Jan-91							3			1325	59	3.1
29-Jan-91							3			1319	43	1.3
29-Jan-91							3			1319	46	1.8
30-Jan-91	8	26	7:00	8:30	10:30	12:15	1	10	115	1325	82	9.1
30-Jan-91							1	10	115	1325	67	5.2
30-Jan-91	8	0	0.00	0	0	0	3	0	0	1319	46	1.8
30-Jan-91							3			1319	44	1.5
30-Jnn-91							3			1319	43	1.3
30-Jan-91							3			1319	47	1.6
30-Jan-91							3			1319	48	1.7
30-Jan-91							3			1319	48	1.8
31-Jan-91	8	28	6:30	7:45	10:00	11:30	1	10	115	0	99	2.2
04-Feb-91	9	29	16:50	18:10	20:00	22:00	1	9	105	0	0	0
05-Feb-91	9	30	6:00	7:45	10:00	11:15	1	9	105	1325	92	17.1
05-Fcb-91							1	9	105	1325	76	8.9
05-Feb-91							1	9	105	1325	83	10.9
05-Feb-91							1	9	105	1325	79	10.1
05-Feb-91							1	9	105	1325	80	10.6
05-Feb-91	9	31	13:30	15:00	16:15	17:30	1	9	105	1325	94	19.95
05-Feb-91							1	9	105	1324	94	18.7
05-Feb-91							1	9	105	1325	92	16.4
05-Feb-91							1	9	105	1325	80	10.6
06-Feb-91	9	32	6:40	7:45	9:45	11:15	1	10	115	1324	94	18.6
06-Feb-91							1	10	115	1324	93	17.6
06-Feb-91							1	10	115	1325	82	9.8
06-Feb-91							1	10	115	1325	93	15.1
06-Feb-91							1	10	115	1325	82	11.2
06-Feb-91	9	33	11:30	12:30	14:15	15:50	1	10	115	1325	556	3.25
06-Feb-91							1	10	115	1325	57	3.35
06-Feb-91	9						1	10	115	1324	94	22.6
06-Feb-91							1	10	115	1324	110	28.1
06-Feb-91							1	10	115	1324	69	8.2
06-Fcb-91							1	10	115	1324	82	9.9
06-Feb-91							1	10	115	1324	89	16.1
27-Feb-91	10	34	16:30	17:30	18:10	20:00	1	10	115	1324	102	22.5
27-Feb-91	10						1	10	115	1324	93	18.4
27-Feb-91							1	10	115	1324	90	17.35
28-Feb-91	10	35	6:30	7:30	9:45	10:30	1	6	60	1324	98	20.25
28-Fcb-91							1	6	60	1324	92	18.35
28-Feb-91	10	0	0	0	0	0	3	0	0	540	99	8.5
06-Mar-91	11	1	13:00	14:00	16:00	17:45	2	0	170	1325	64	2.7
06-Mar-91							2		170	1325	53	2.5
06-Mar-91							2		170	1325	59	3.1
06-Mar-91							2		170	1314	126	12.3
06-Mar-91	11	0	0	0	0	0	3	0	0	1325	40	1.2
06-Mar-91							3			1325	45	1.6
06-Mar-91							3			1325	52	2.5
06-Mnr-91							3			1325	54	2.6
06-Mnr-91							3			1325	46	1.6
06-Mar-91							3			1325	49	2.1
06-Mar-91							3			1325	41	1.3
06-Mar-91							3			1325	55	2.8
06-Mar-91							3			1325	52	2.6
06-Mar-91							3			1325	43	1.4
06-Mar-91							3			1325	45	1.5
06-Mar-91							3			1319	52	2.5
06-Mnr-91							3			1319	50	1.9
06-Mnr-91							3			1319	48	1.5
06-Mar-91							3			1319	54	2.8
06-Mnr-91							3			1319	44	1.5
06-Mar-91							3			1319	46	1.9
06-Mar-91							3			1319	46	1.6
06-Mar-91							3			1319	50	2.3
06-Mar-91							3			1319	45	1.7
06-Mar-91							3			1319	55	3.2
07-Mar-91	11	2	7:00	8:00	10:00	11:30	2	0	170	540	107	9.2

DATE	TRIP_NO	SET_NO	S_START	S_FINISH	H_START	H_FINISH	GEAR	DLINE_NO	HOOK_NO	SPECIES	LENGTH	WEIGHT
07-Mar-91							2		170	540	98	6.7
07-Mar-91							2		170	540	108	9.9
07-Mar-91							2		170	1314	128	13.9
11-Mar-91	12	3	13:15	14:40	17:30	19:10	2	0	150	973	92	6.1
11-Mar-91							2		150	973	83	3.7
11-Mar-91							2		150	973	81	3.9
11-Mar-91							2		150	973	80	3.4
11-Mar-91							2		150	973	117	10.9
11-Mar-91							2		150	973	82	3.6
12-Mar-91	12	4	6:10	7:40	10:00	12:00	2	0	150	973	85	4.5
12-Mar-91							2		150	973	85	4.5
12-Mar-91							2		150	973	76	2.8
12-Mar-91							2		150	1325	55	2.2
12-Mar-91							2		150	1314	87	5.6
12-Mar-91	12	5	12:30	14:00	16:30	18:10	2	0	150	973	93	6.2
12-Mar-91							2		150	973	88	5.1
12-Mar-91							2		150	1319	78	9.1
12-Mar-91							2		150	1330	133	8.2
13-Mar-91	12	6	6:50	8:10	10:20	12:10	2	0	150	973	88	5.2
13-Mar-91							2		150	973	81	4.1
13-Mar-91							2		150	973	83	4.4
13-Mar-91							2		150	1324	103	21.5
18-Mar-91	13	36	14:28	15:30	17:30	19:30	1	10	100	1325	90	12.7
18-Mar-91							1	10	100	1325	88	12.1
18-Mar-91							1	10	100	1324	98	19.1
18-Mar-91							1	10	100	1324	100	22.2
19-Mar-91	13	37	4:50	6:10	8:10	9:50	1	10	100	973	106	10.7
19-Mar-91	13	38	14:50	16:10	18:00	19:30	1	10	100	0	0	0
20-Mar-91	13	39	6:40	7:55	10:00	12:40	1	10	100	1325	88	12.4
20-Mar-91							1	10	100	1325	85	12.1
20-Mar-91							1	10	100	1324	98	20.2
20-Mar-91							1	10	100	1324	104	22.4
20-Mar-91							1	10	100	973	82	4.3
20-Mar-91							1	10	100	973	90	5.8

APPENDIX 2b

CATCH RECORDS FOR PHASE II FISHING ACTIVITIES

DATE	TRIP_NO	SET_NO	S_START	S_FINISH	H_START	H_FINISH	GEAR	DLINE_NO	HOOK_NO	SPECIES	LENGTH	WEIGHT
01-May-91	1	1	14:30	15:30	15:40	19:00	1	7	105	1324	102.0	20.00
01-May-91	1	1					1	7	105	1324	102.0	21.00
01-May-91	1	1					1	7	105	1325	100.0	17.00
01-May-91	1	1					1	7	105	1325	101.0	21.00
01-May-91	1	1					1	7	105	1325	100.0	17.00
01-May-91	1	1					1	7	105	1325	101.0	17.00
01-May-91	1	1					1	7	105	1325	102.0	18.00
01-May-91	1	1					1	7	105	1325	95.0	14.50
01-May-91	1	1					1	7	105	1325	102.0	16.00
01-May-91	1	1					1	7	105	1325	96.0	16.00
01-May-91	1	1					1	7	105	1325	98.0	17.00
01-May-91	1	1					1	7	105	1325	97.0	15.50
01-May-91	1	1					1	7	105	1325	98.0	17.00
01-May-91	1	1					1	7	105	1325	99.0	15.50
01-May-91	1	1					1	7	105	540	100.0	14.00
01-May-91	1	1					1	7	105	1329	188.0	64.00
02-May-91	2	2	6:15	7:00	8:30	9:20	1	5	75	1324	101.0	21.00
02-May-91	2	2					1	5	75	1324	97.0	15.00
02-May-91	2	2					1	5	75	1324	92.0	13.50
02-May-91	2	2					1	5	75	1325	95.0	14.00
02-May-91	2	2					1	5	75	1325	92.0	11.00
02-May-91	2	2					1	5	75	1325	96.0	15.00
02-May-91	2	2					1	5	75	540	100.0	12.00
02-May-91	2	2					1	5	75	1314	68.0	3.50
02-May-91	2	3	9:30	10:15	11:15	12:10	1	5	75	1326	160.0	41.00
02-May-91	2	3					1	5	75	1326	162.0	42.00
02-May-91	2	3					1	5	75	1325	95.0	14.50
02-May-91	2	3					1	5	75	1325	95.0	14.50
02-May-91	2	3					1	5	75	1325	96.0	15.00
03-May-91	3	4	7:00	7:40	9:00	10:10	1	5	75	1324	100.0	20.00
03-May-91	3	4					1	5	75	1324	102.0	21.50
03-May-91	3	4					1	5	75	1324	102.0	22.00
03-May-91	3	4					1	5	75	1325	93.0	17.50
03-May-91	3	4					1	5	75	540	85.0	8.50
03-May-91	3	4					1	5	75	540	86.0	8.50
03-May-91	3	5	10:30	11:15	13:00	14:00	1	5	75	1324	125.0	36.00
03-May-91	3	5					1	5	75	1324	102.0	22.50
03-May-91	3	5					1	5	75	1325	95.0	18.00
03-May-91	3	5					1	5	75	540	82.0	7.00
07-May-91	4	6	7:00	7:45	8:50	9:45	1	5	75	1325	103.0	15.40
07-May-91	4	6					1	5	75	1325	101.0	14.20
07-May-91	4	6					1	5	75	1325	97.0	13.00
07-May-91	4	6					1	5	75	1325	98.0	15.00
07-May-91	4	6					1	5	75	1325	102.0	15.00
07-May-91	4	6					1	5	75	1325	101.0	13.00
07-May-91	4	6					1	5	75	1325	98.0	14.00
07-May-91	4	7	10:45	11:30	12:15	13:00	1	5	75	1325	101.0	18.00
07-May-91	4	7					1	5	75	1325	99.0	14.00
07-May-91	4	7					1	5	75	1325	107.0	19.00
07-May-91	4	7					1	5	75	1325	101.0	16.00
07-May-91	4	7					1	5	75	1325	100.0	14.00
07-May-91	4	7					1	5	75	1324	109.0	20.50
09-May-91	5	8	9:30	10:00	11:00	13:00	1	7	105	1325	99.0	15.50
09-May-91	5	8					1	7	105	1325	103.0	16.50
09-May-91	5	8					1	7	105	1325	98.0	14.00
09-May-91	5	8					1	7	105	1325	99.0	15.00
09-May-91	5	8					1	7	105	1325	90.0	11.50
09-May-91	5	8					1	7	105	1325	99.0	14.00
09-May-91	5	8					1	7	105	1325	90.0	11.00
09-May-91	5	8					1	7	105	1325	95.0	13.50
09-May-91	5	8					1	7	105	1325	93.0	13.00
09-May-91	5	8					1	7	105	1325	103.0	17.00
09-May-91	5	8					1	7	105	1325	93.0	13.00
09-May-91	5	8					1	7	105	1325	94.0	13.00
09-May-91	5	8					1	7	105	1325	96.0	15.00
09-May-91	5	8					1	7	105	1325	93.0	13.00
09-May-91	5	8					1	7	105	1325	92.0	11.50
09-May-91	5	8					1	7	105	1325	99.0	14.50
09-May-91	5	8					1	7	105	1325	80.0	7.00
09-May-91	5	8					1	7	105	1319	56.0	4.00
09-May-91	5	8					1	7	105	1324	97.0	17.00
09-May-91	5	8					1	7	105	540	97.0	8.00
13-May-91	6	9	10:00	10:40	12:20	13:30	1	6	90	1324	101.0	23.00
13-May-91	6	9					1	6	90	1324	102.0	24.50
13-May-91	6	9					1	6	90	1324	100.0	21.00
13-May-91	6	9					1	6	90	1325	97.0	16.00
13-May-91	6	9					1	6	90	540	110.0	18.00
13-May-91	6	10	13:40	14:20	15:45	16:45	1	6	90	1324	97.0	19.00

DATE	TRIP_NO	SET_NO	S_START	S_FINISH	H_START	H_FINISH	GEAR	DLINE_NO	HOOK_NO	SPECIES	LENGTH	WEIGHT
13-May-91	6	10					1	6	90	1324	99.0	21.00
13-May-91	6	10					1	6	90	540	100.0	10.00
15-May-91	7	11	6:30	7:15	8:15	9:15	1	6	90	1325	126.0	35.00
15-May-91	7	11					1	6	90	1325	95.0	15.00
15-May-91	7	11					1	6	90	1325	104.0	19.00
15-May-91	7	11					1	6	90	1325	103.0	16.00
15-May-91	7	11					1	6	90	1325	103.0	16.50
15-May-91	7	11					1	6	90	1324	104.0	23.00
15-May-91	7	11					1	6	90	1324	102.0	19.00
15-May-91	7	12	9:20	10:10	11:15	12:15	1	6	90	1325	104.0	17.00
15-May-91	7	12					1	6	90	1325	100.0	16.00
15-May-91	7	12					1	6	90	1325	70.0	7.30
15-May-91	7	12					1	6	90	1319	50.0	4.00
17-May-91	8	13	8:30	9:15	11:30	12:15	1	6	90	540	0.0	0.00
21-May-91	9	14	7:30	8:15	9:30	10:30	1	6	90	1325	96.0	15.00
21-May-91	9	14					1	6	90	1325	106.0	19.00
21-May-91	9	14					1	6	90	1325	95.0	14.00
21-May-91	9	14					1	6	90	1325	99.0	18.00
21-May-91	9	14					1	6	90	1324	97.0	19.00
21-May-91	9	15	10:40	11:15	12:20	13:30	1	6	90	1325	98.0	14.00
21-May-91	9	15					1	6	90	1325	97.0	13.00
21-May-91	9	15					1	6	90	1324	102.0	20.00
24-May-91	10	16	10:45	11:50	13:00	14:10	1	6	90	1325	102.0	15.00
24-May-91	10	16					1	6	90	1325	78.0	8.00
24-May-91	10	16					1	6	90	1325	98.0	14.00
24-May-91	10	16					1	6	90	1325	84.0	9.00
24-May-91	10	16					1	6	90	1325	107.0	21.00
24-May-91	10	16					1	6	90	540	105.0	8.00
24-May-91	10	16					1	6	90	973	82.0	4.00
28-May-91	11	17	7:15	8:05	9:10	10:20	1	6	90	1325	150.0	62.50
28-May-91	11	17					1	6	90	1325	105.0	17.50
28-May-91	11	17					1	6	90	1325	100.0	13.00
28-May-91	11	17					1	6	90	1325	96.0	12.00
28-May-91	11	17					1	6	90	1325	98.0	14.00
28-May-91	11	17					1	6	90	1325	87.0	10.00
28-May-91	11	17					1	6	90	1324	96.0	13.00
28-May-91	11	17					1	6	90	540	114.0	9.50
28-May-91	11	17					1	6	90	540	115.0	11.00
28-May-91	11	18	10:30	11:10	12:00	13:00	1	4	60	1325	103.0	17.00
28-May-91	11	18					1	4	60	1325	100.0	15.50
28-May-91	11	18					1	4	60	1324	105.0	22.50
29-May-91	12	19	7:15	8:15	9:00	10:00	1	6	90	1325	100.0	12.80
29-May-91	12	19					1	6	90	1325	103.0	16.00
29-May-91	12	19					1	6	90	1325	101.0	15.70
29-May-91	12	19					1	6	90	1325	99.0	14.80
29-May-91	12	19					1	6	90	1325	98.0	15.00
29-May-91	12	19					1	6	90	1325	101.0	15.50
29-May-91	12	19					1	6	90	1325	97.0	15.50
29-May-91	12	19					1	6	90	1325	98.0	14.80
29-May-91	12	19					1	6	90	1325	99.0	16.60
07-Jun-91	13	20	7:15	8:10	9:00	10:00	1	6	90	1325	90.0	13.75
07-Jun-91	13	20					1	6	90	1325	105.0	18.75
07-Jun-91	13	20					1	6	90	1325	90.0	13.35
07-Jun-91	13	20					1	6	90	1325	100.0	16.50
07-Jun-91	13	20					1	6	90	1325	60.0	4.50
07-Jun-91	13	20					1	6	90	1325	61.0	4.50
07-Jun-91	13	20					1	6	90	1324	104.0	22.00
07-Jun-91	13	20					1	6	90	1324	70.0	13.80
07-Jun-91	13	20					1	6	90	540	105.0	8.20
07-Jun-91	13	21	10:10	10:50	11:45	12:45	1	6	90	1325	65.0	5.20
07-Jun-91	13	21					1	6	90	1325	107.0	22.00
07-Jun-91	13	21					1	6	90	1324	95.0	16.30
07-Jun-91	13	21					1	6	90	540	120.0	13.20
07-Jun-91	13	21					1	6	90	540	110.0	7.80
11-Jun-91	14	22	8:10	8:50	9:45	10:45	1	6	75	1325	100.0	14.50
11-Jun-91	14	22					1	6	75	1325	83.0	10.00
11-Jun-91	14	22					1	6	75	1325	41.0	5.90
11-Jun-91	14	22					1	6	75	973	65.0	5.90
11-Jun-91	14	23	10:50	11:30	12:30	13:30	1	6	75	1325	108.0	19.50
11-Jun-91	14	23					1	6	75	1324	93.0	20.90
11-Jun-91	14	23					1	6	75	1324	102.0	22.30
12-Jun-91	15	24	7:00	7:50	9:00	10:20	1	6	75	1325	99.0	14.50
12-Jun-91	15	24					1	6	75	1325	99.0	14.50
12-Jun-91	15	24					1	6	75	1325	98.0	14.00
12-Jun-91	15	24					1	6	75	1325	100.0	14.50
12-Jun-91	15	24					1	6	75	1325	99.0	14.50
12-Jun-91	15	24					1	6	75	1325	103.0	16.50
12-Jun-91	15	24					1	6	75	1326	125.0	37.50
19-Jun-91	16	25	7:00	7:40	9:00	10:00	1	5	60	1325	101.0	15.45
19-Jun-91	16	25					1	5	60	1325	100.0	15.00
19-Jun-91	16	25					1	5	60	1325	101.0	15.45
19-Jun-91	16	25					1	5	60	1325	104.0	16.90
19-Jun-91	16	25					1	5	60	1325	103.0	16.40

DATE	TRIP_NO	SET_NO	S_START	S_FINISH	H_START	H_FINISH	GEAR	DLINE_NO	HOOK_NO	SPECIES	LENGTH	WEIGHT
19-Jun-91	16	26	10:10	10:50	11:45	12:30	1	5	60	1325	96.0	12.75
20-Jun-91	17	27	8:30	9:15	13:30	14:45	1	6	80	1325	92.0	10.00
20-Jun-91	17	27					1	6	80	1324	97.0	13.50
20-Jun-91	17	27					1	6	80	1314	86.0	5.00
20-Jun-91	17	27					1	6	80	1314	84.0	4.50
20-Jun-91	17	27					1	6	80	973	60.0	3.00
26-Jun-91	18	28	8:00	8:40	9:20	10:10	1	6	80	1324	100.0	20.00
26-Jun-91	18	28					1	6	80	1324	94.0	16.00
26-Jun-91	18	28					1	6	80	1324	87.0	14.00
26-Jun-91	18	28					1	6	80	1324	99.0	19.50
26-Jun-91	18	28					1	6	80	1325	71.0	7.00
26-Jun-91	18	29	10:10	10:50	11:50	12:40	1	6	80	1324	96.0	17.50
26-Jun-91	18	29					1	6	80	1324	98.0	19.50
26-Jun-91	18	29					1	6	80	1324	96.0	17.00
28-Jun-91	19	30	7:45	8:30	10:00	11:00	1	6	80	1325	72.0	6.40
28-Jun-91	19	30					1	6	80	1325	64.0	4.90
28-Jun-91	19	30					1	6	80	1325	70.0	5.90
28-Jun-91	19	30					1	6	80	1325	73.0	6.30
28-Jun-91	19	30					1	6	80	973	75.0	2.80
08-Jul-91	20	31	15:30	16:15	17:30	18:30	1	3	45	1325	99.0	13.75
08-Jul-91	20	31					1	3	45	1324	93.0	18.25
09-Jul-91	20	32	5:00	5:45	8:00	9:15	1	6	80	0	0.0	
										TW	2819.2	
										AVG	15.4	

APPENDIX 3a

MATERIAL LISTS AND NOTES FOR CONSTRUCTING A VERTICAL LONGLINE DRUM UNIT

For the construction of the vertical longline drum, the materials presented in the table below are required.

Item	Size or length	No. of pieces
Timber		
Marine plywood	12 mm	3
50 x 25 mm hardwood	3.6 m	1
50 x 100 mm timber	7.2 m	2
50 x 50 mm hardwood	1.2 m	1
Hardware		
Epoxy paint		1.0 litre
Hardener for epoxy paint		0.5 litre
Wood glue		0.6 litre
Galvanised flathead nails	38 mm	1.0 kg
	19 mm	0.5 kg
Galvanised bolts	88 mm x 8 mm	22
	113 mm x 8 mm	8
	163 mm x 10 mm	8
Galvanised flat washers	8 mm	60
	10 mm	16
Galvanised nuts	8 mm	30
	10 mm	8
Galvanised screws	38 mm	8
	88 mm	4
Galvanised water pipe	12 mm	1.5 m
Sealed bearings	16mm	2
Plastic pulley	200 mm	1
Sandpaper	Medium grade	3 sheets
Paint brushes	38–50 mm wide	3

The following tools are required for the construction of the vertical longline drum system:

Hammer; drill; skill saw or handsaw; jigsaw; wood drill bits (3 mm, 8 mm, 10 mm, 22 mm, & 25 mm); square; steel drill bit (8 mm); compass; screwdriver; wood rasp; tape measure; knife; and metal lathe (optional).

The vertical longline drum (Figure A1) has six basic parts: two endplates; a reel spool; a reel axle; two steel bearings; handles on the outside of the end plates; and a handle for cranking the line onto the spool.

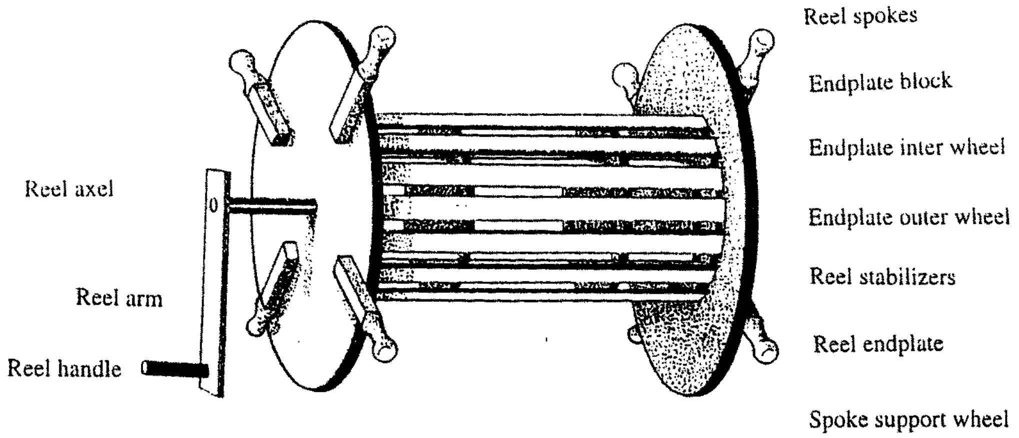
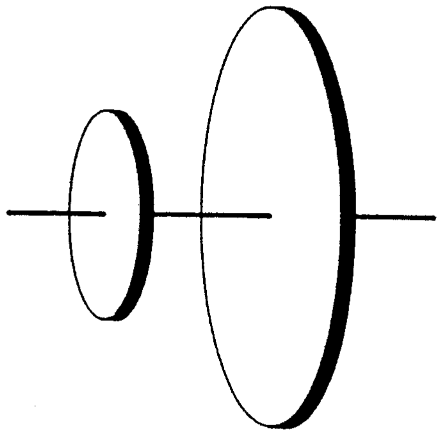


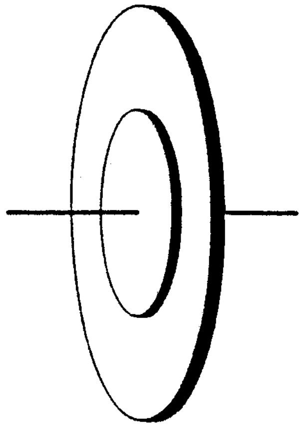
Figure A1: Assembled vertical longline drum

The following table provides a list of the parts needed to make the vertical longline drum (Figure A1) with the end plate assembly described in Figure A2; the spoke support and reel stabiliser described in Figure A3; the mounting spokes on the reel frame described in Figure A4; and the construction of the reel handle and arm described in Figure A5.

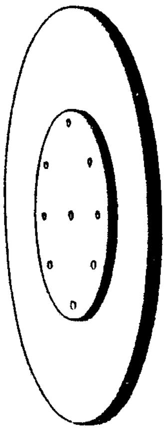
Material	Size	No. of pieces	Part
12 mm marine plywood	62 cm dia	2	Endplate outer wheel
	30 cm dia	2	Endplate inner wheel
	30 cm dia	2	Spoke support wheel
50 x 100 mm timber	24 cm	2	Endplate block
8 mm galvanised bolts	88 mm	4	Hold endplate block
25 x 50 mm hardwood	65 cm	14	Reel spoke
	62.5 cm	2	Reel spoke stabiliser
12 mm inside dia. galvanised pipe	110 cm	1	Reel axle
Sealed bearings	16 mm	2	Reel axle bearings
8 mm galvanised bolts	88 mm	2	Reel axle locks
50 x 50 mm hardwood	32 cm	1	Reel arm
	10 cm	1	Reel handle
	30 cm	8	Reel handles



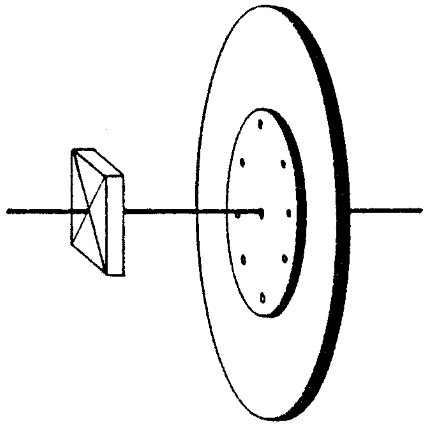
Step 1: Drill 6 mm guide hole at the centre of each endplate wheel



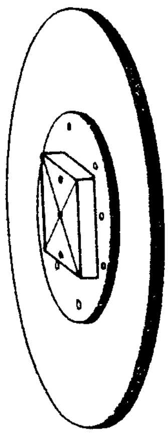
Step 2: Glue the inner and outer plates together with epoxy making sure the guide holes line up



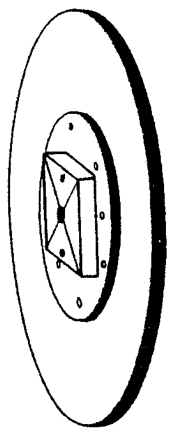
Step 3: Nail the wheels together



Step 4: Epoxy the endplate with 19 mm block to the inner endplate wheel making sure the guide holes line up

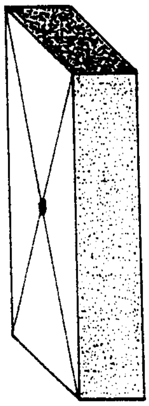


Step 5: Drill pilot holes at both ends of the block and bolt it to the wheel with the 88 mm by 8 mm galvanised bolts

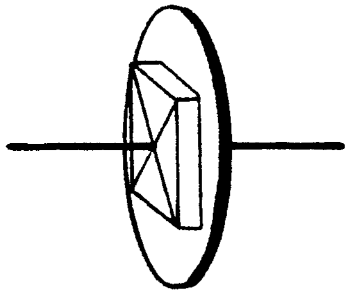


Step 6: After the epoxy has dried, drill the centre hole to 22 mm

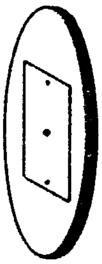
Figure A2: Reel endplate assembly



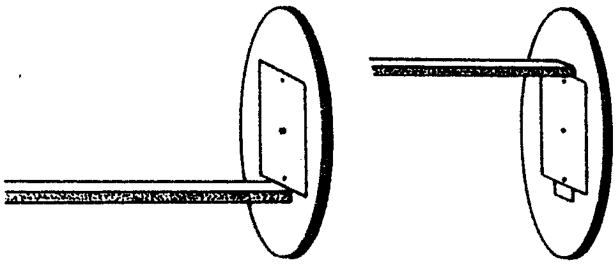
Step 1: Drill a 6 mm guide hole at the centre of the spoke support wheel and in one of the endplate blocks



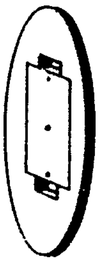
Step 2: Hold the block firmly against the wheel and draw an outline of the block onto the wheel



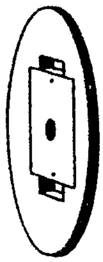
Step 3: Mark the midpoint of both narrow ends of the outline



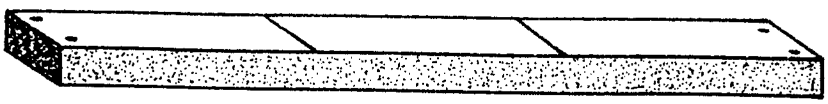
Step 4: Centre the end of the reel stabiliser along the narrow ends of the outline, hold it firmly in place and outline the end of the stabiliser onto the spoke support wheel



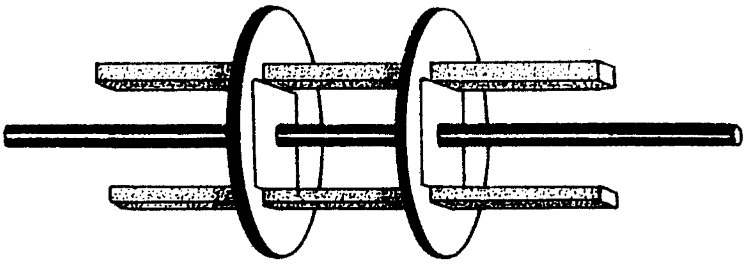
Step 5: Use a drill and jigsaw to cut the holes for the reel stabiliser



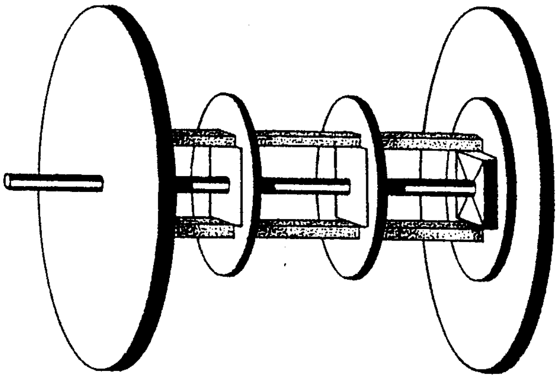
Step 6: Drill the centre hole to 22 mm



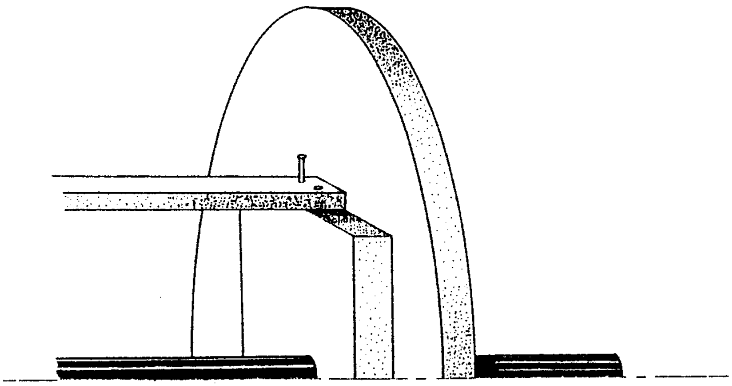
Step 7: Drill two by 3 mm pilot holes at both ends of each reel stabiliser and draw a line for the positioning of each of the spoke support wheels



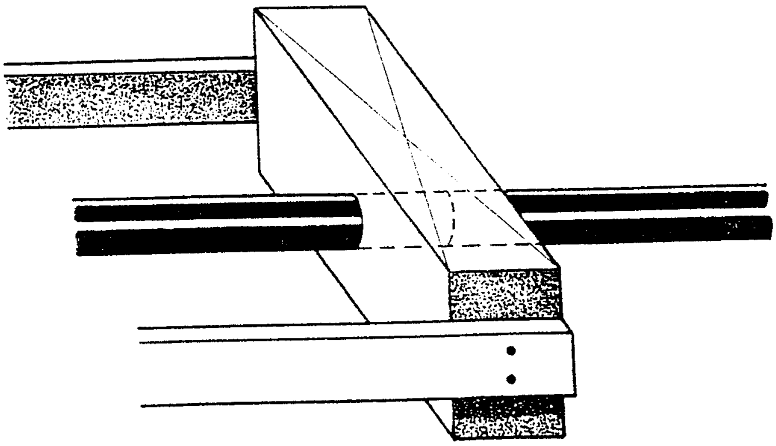
Step 8: Slip the spoke support wheels onto the 110 cm reel axle then slide the reel stabilisers through the holes in the spoke support wheels



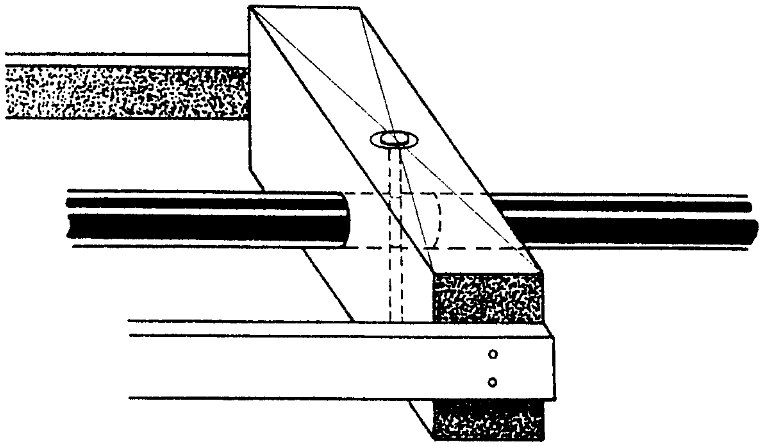
Step 9: Slip both endplates on the reel axle so they face each other with the endplate blocks oriented vertically



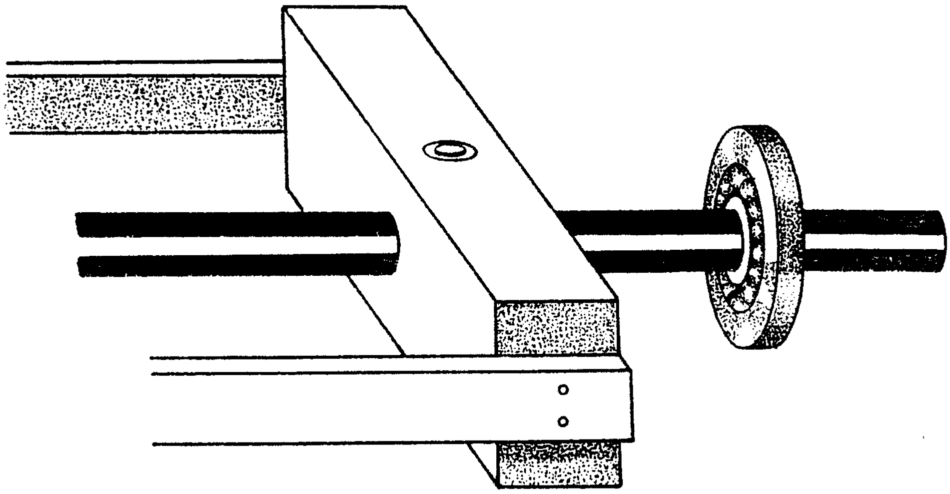
Step 10: Coat the end of the stabiliser with epoxy, centre it on the end of the block, butt it squarely against the endplate wheel and nail it in place



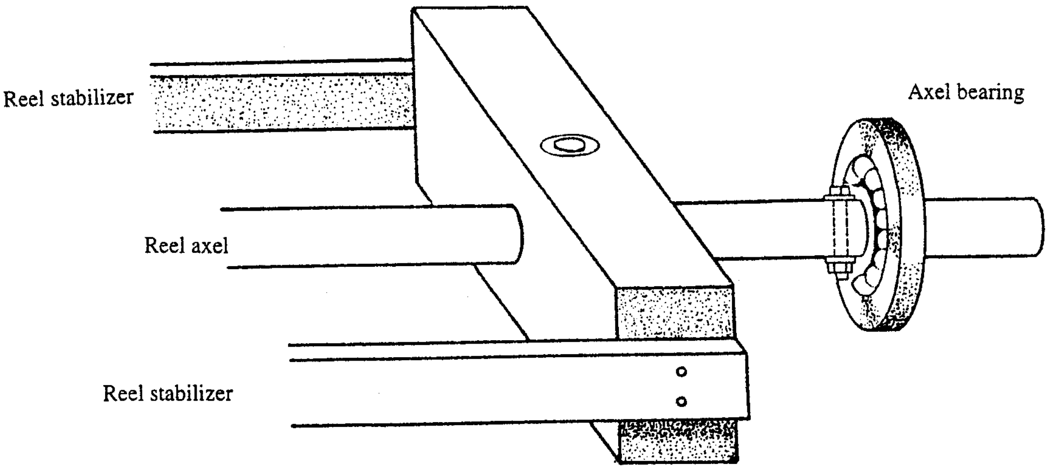
Step 11: Locate the centre of the long side of the endplate block and adjust the axle so that 15 cm sticks out one end of the endplate wheel and 30 cm sticks out the other end



Step 12: Drill an 8 mm hole through the endplate block and axle and them insert an 8 mm bolt, use flat washers on both sides and tighten the nut to lock the reel axle in place

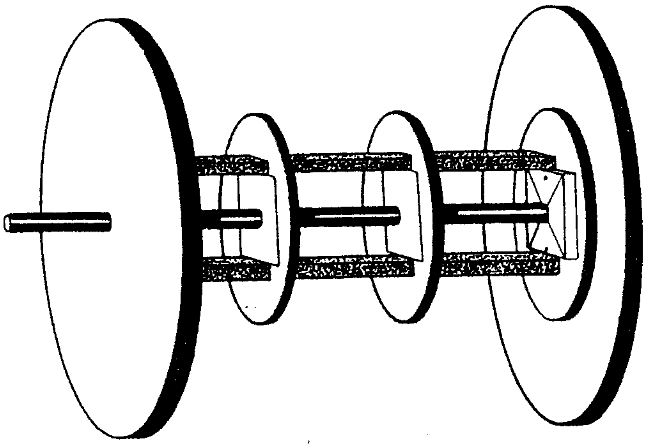


Step 13: Slide the steel bearing over the tapered reel axle ends and lightly hammer them in place until they are tight enough that they will not slide back on the reel axle, making sure they are both 5 cm away from the outside of the endplate wheel

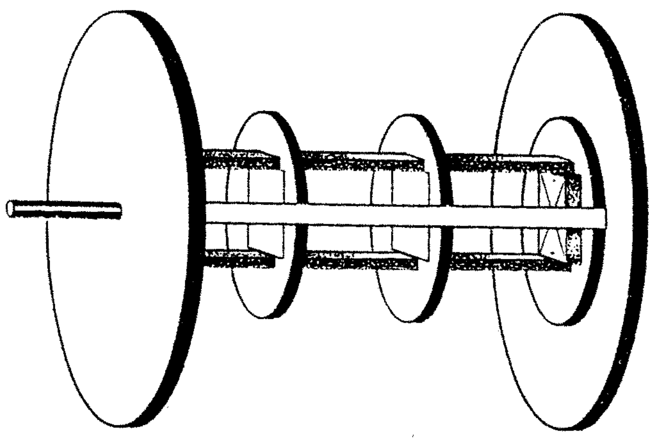


Step 14: With the bearings in place, drill an 8 mm hole on both sides of each bearing, insert a 25 mm by 8 mm bolt into each hole, and using flat washers on both sides of each bolt, tighten the nuts to lock the bearing in place

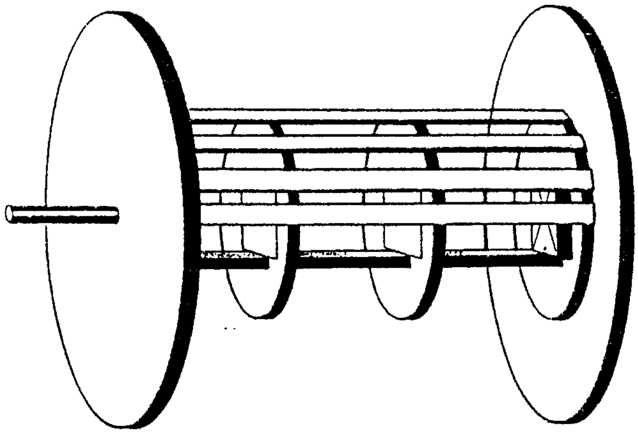
Figure A3: Assembly of the spoke support, reel stabiliser and reel endplate



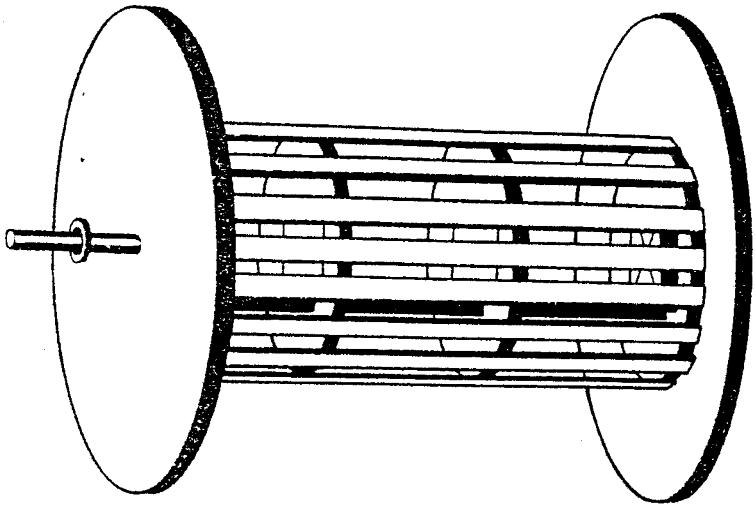
Step 1: Mount spokes to the completed reel frame when the stabilisers are nailed in place and the reel axle is locked into position. Drill two pilot holes at the ends of each spoke, 25 mm in from the ends before fitting them to the frame



Step 2: Paint both ends and the back of the spoke with epoxy before mounting it on the reel. Push the spoke against the edge of the inner endplate with the end butted tight against the outer wheel and nail the spoke to both inner wheels and to the spoke support wheel with 38 mm galvanised nails

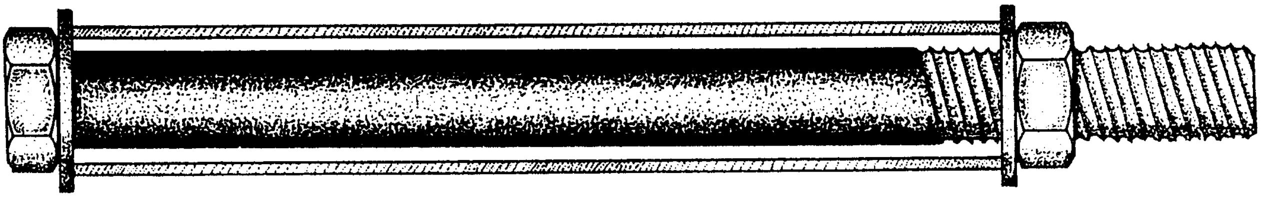


Step 3: Use the first spoke as a reference and space the other spokes every 3 cm around the wheel and fit all spokes in place remembering to paint epoxy on both ends and back of each spoke before nailing it

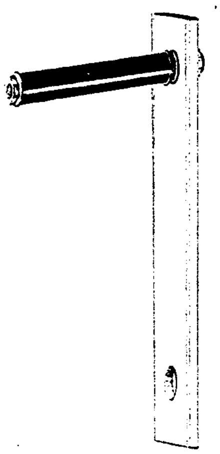


Step 4: Paint all the wooden parts of the reel with epoxy and apply a good coat of epoxy at all points where pieces of wood touch

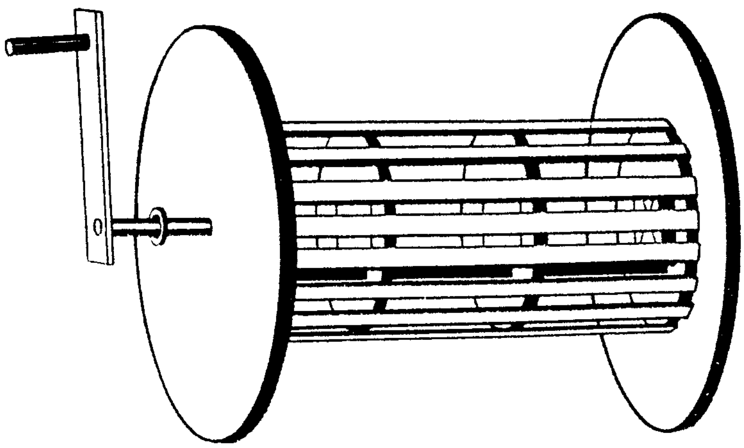
Figure A4: Mounting spokes on the reel frame



Step 1: Cut a piece of 19 mm PVC pipe 125 mm long and slide it over a 138 mm by 12 mm galvanised bolt, put flat washers on both ends and two nuts to tighten the handle to the reel arm



Step 2: Cut a flat piece of 50 mm by 6 mm flat steel 32 cm long and drill a 12 mm hole 4.5 cm from one end and mount the reel handle by tightening both nuts against the reel arm



Step 3: Weld the end of the reel arm to the end of the reel axle (note the reel arm needs to be made out of steel as wood is not string enough to withstand the pressure of reeling in large fish)

Figure A5: Construction of reel handle and arm assembly

The table below lists the materials required to make the vertical longline drum stand to complete the reel, while Figure A6 shows the assembled stand, Figure A7 showing the step by step construction of the stand, and Figure A8 showing the completed vertical longline drum unit.

Material	Size	No. of pieces	Part
50 mm x 100 mm timber	75 cm	2	Upright
	95 cm	2	Base mount
	65 cm	2	Cross piece
	140 cm	2	Base mount cross piece
12 mm marine plywood	20 x 95 x 120 cm	2	Stand brace
	20 x 50 cm	4	Corner brace
	10 x 20 cm	2	Axle support
Sealed bearings	1.6 cm	2	Axle bearings

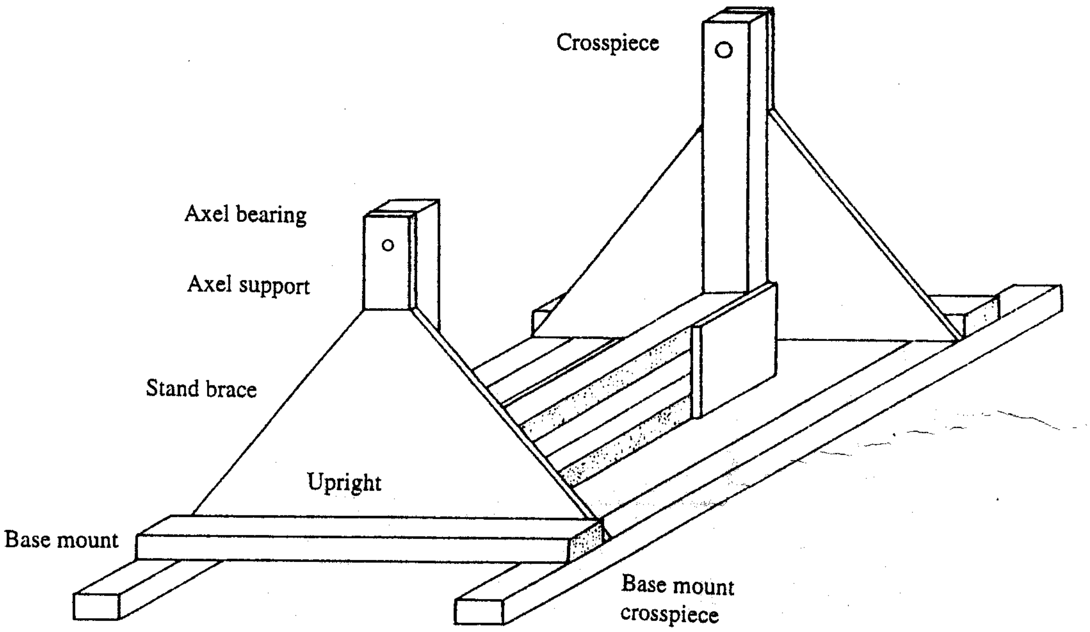
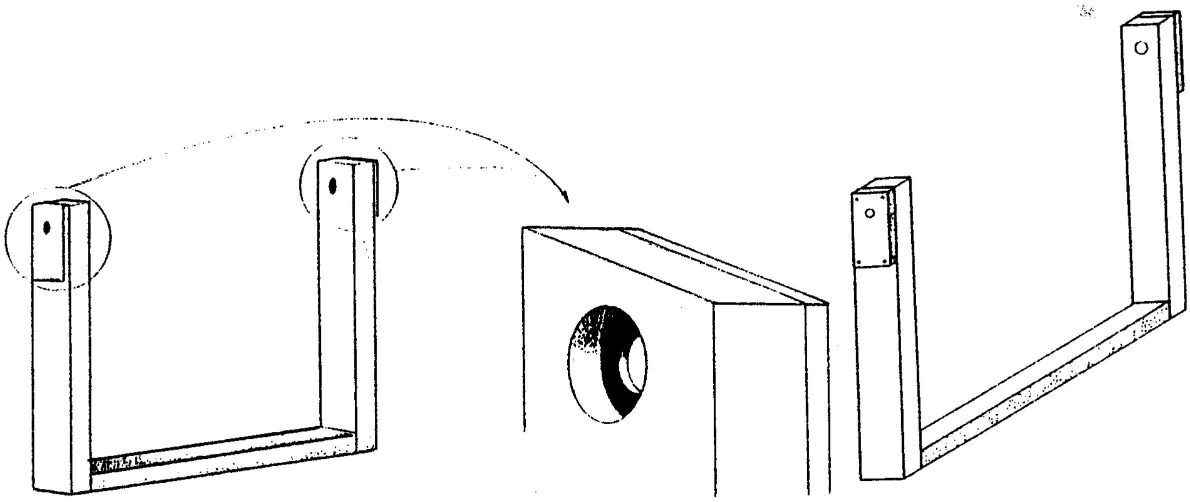
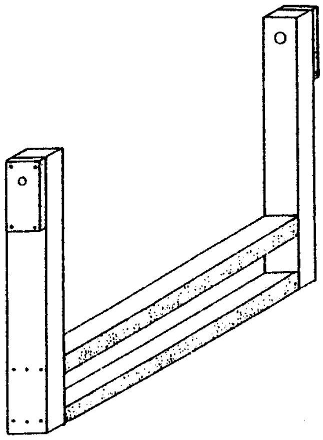


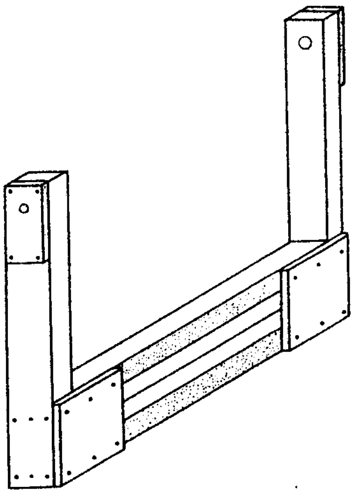
Figure A6: Stand to support the vertical longline drum



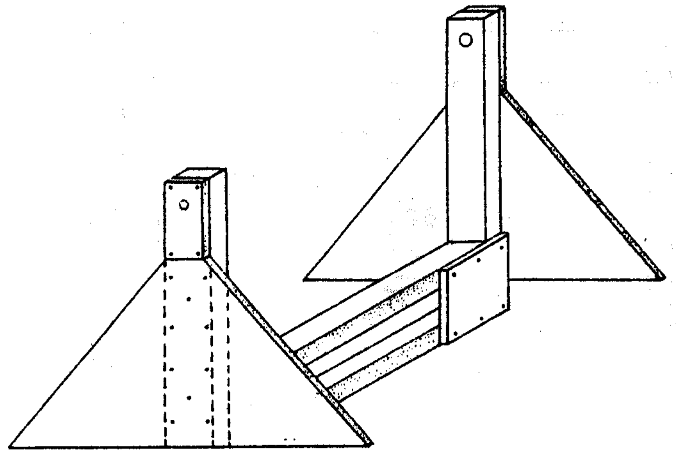
Step 1: Locate the midpoint of one end of the upright and then drill a 25 mm hole, 6 cm down from the midpoint. Drill a 12 mm hole, 6 cm down from the top midpoint of the axle support and nail the axle support to the outside of the upright with 19 mm galvanised nails, making sure the 12 mm hole in the axle support is lined up properly with the 25 mm hole in the upright support by first sliding the reel axle through the 25 mm hole in the upright until the sealed bearing fits tightly inside the hole. Slide the reel axle through the 12 mm hole in the axle support, then nail the axle support against the outside of the upright. Drill a 6 mm guide hole in each corner of the axle support and insert a 38 mm galvanised screw in each.



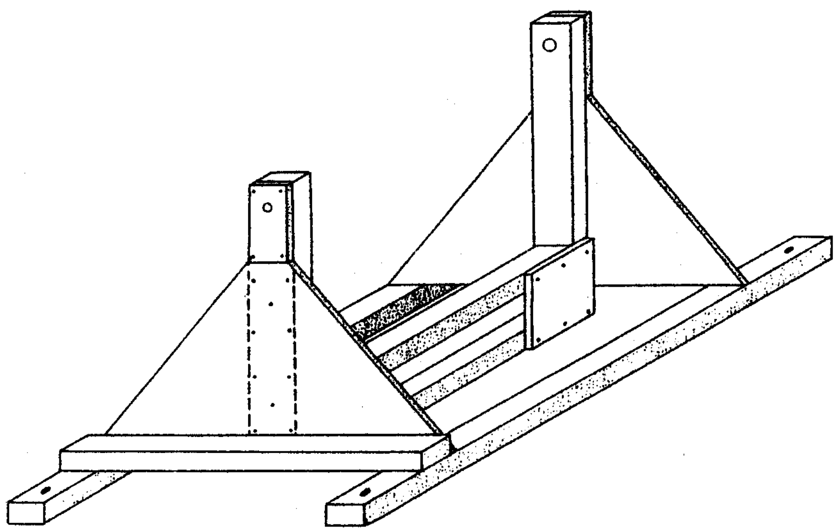
Step 2: Drill three by 6 mm guide holes across each upright, 2 cm from the bottom and then drill three more 6 mm holes across each upright 18 cm from the bottom. Epoxy and screw the upper and bottom cross pieces in place with 38 mm galvanised screws.



Step 3: Epoxy and nail the cross piece braces in place



Step 4: Epoxy and nail the reel stand braces in place



Step 5: Centre the base mounts along the bottom of the uprights, then drill three by 8 mm holes across the bottom of where the uprights meet the base mounts and uprights. 5 cm from each end of the base mounts, drill an 8 mm hole and then 15 cm from the end of the base mount cross pieces drill an 8 mm hole. Place the base mount cross pieces under the base mounts, line up the 8 mm holes and insert a 112 mm bolt and tighten with a flat washer on each side and a nut. Paint the entire stand with epoxy.

Figure A7: Construction of a vertical longline drum stand

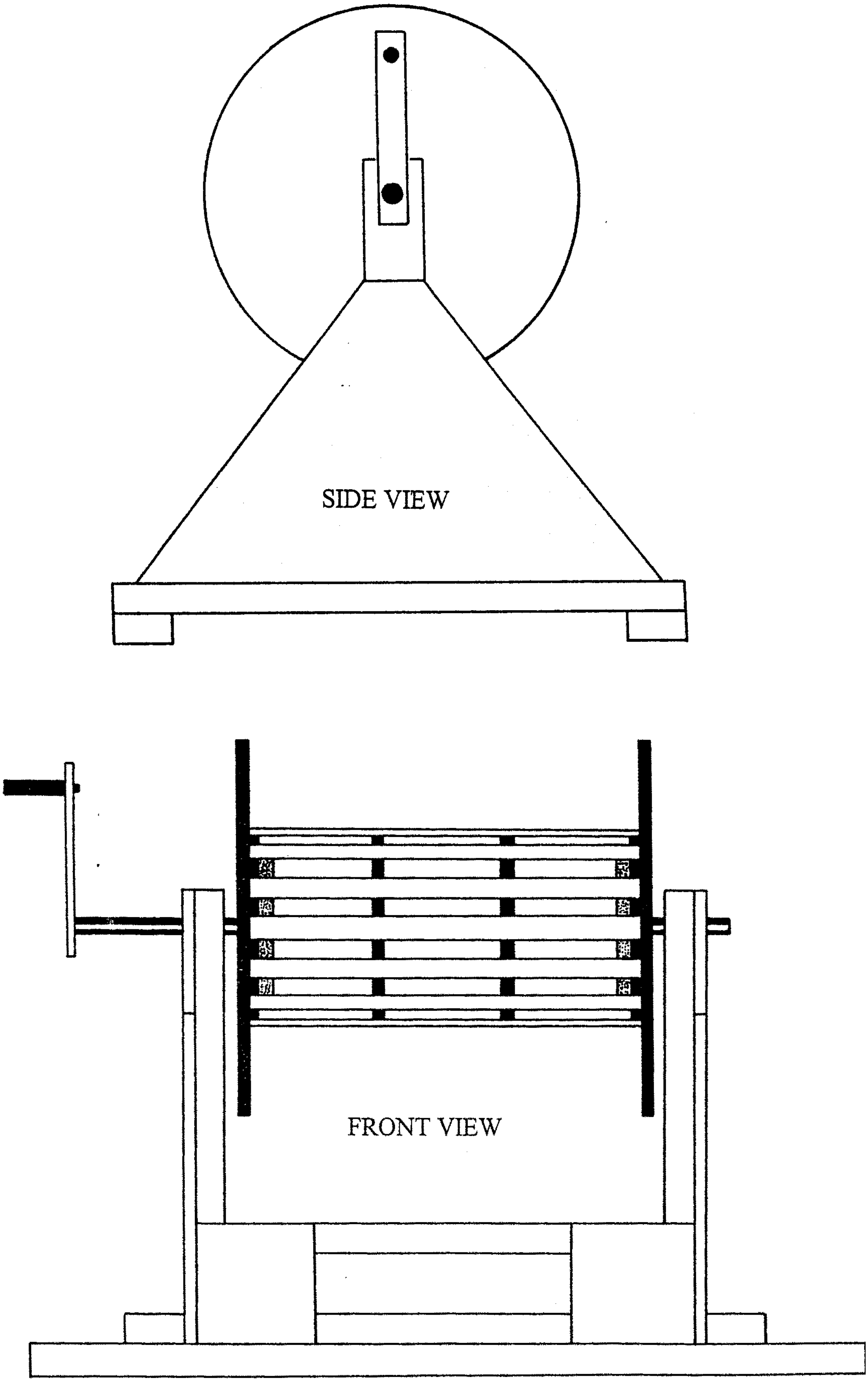


Figure A8: Completed vertical longline drum and stand assembly

APPENDIX 3b

MATERIAL LISTS AND NOTES FOR CONSTRUCTING SURFACE ROPE AND SNOOD BOXES

The table below provides a list of the materials required to construct a surface rope box, while Figure B1 shows that actual box. Construction notes are also provided.

Materials	Dimensions	No. of pieces
12 mm marine plywood	60 x 50 x 90 cm 50 x 50 cm	4 1
38 mm galvanised nails		30
10 mm rope	40–50 cm long	2

Figure B1: Surface rope box

To construct a surface rope box, cut four pieces of 12 mm marine plywood 90 cm long and tapering from 60 to 50 cm. Glue the edges with epoxy and nail them together with 38 mm galvanised nails to make a tapered box. Cut a piece of plywood, 50 x 50 cm, glue the edges with epoxy and nail to the bottom of the box. Drill four by 25 mm holes in the bottom to allow water to drain from the box. Drill two by 10 mm holes, 30 cm apart and 30 cm from the top of two opposite sides of the box. Pass a piece of 10 mm rope through each set of holes and tie the ends to make carrying handles. Epoxy the entire surface of the box.

The table below provides a list of the materials required to construct a snood box, while Figure B2 shows that actual box. Construction notes are also provided.

Materials	Dimensions	No. of pieces
12 mm marine plywood	50 x 70 x 100 cm 50 x 50 cm	4 1
38 mm galvanised nails		30
copper wire	100 cm	4
10 mm rope	40–50 cm long	2

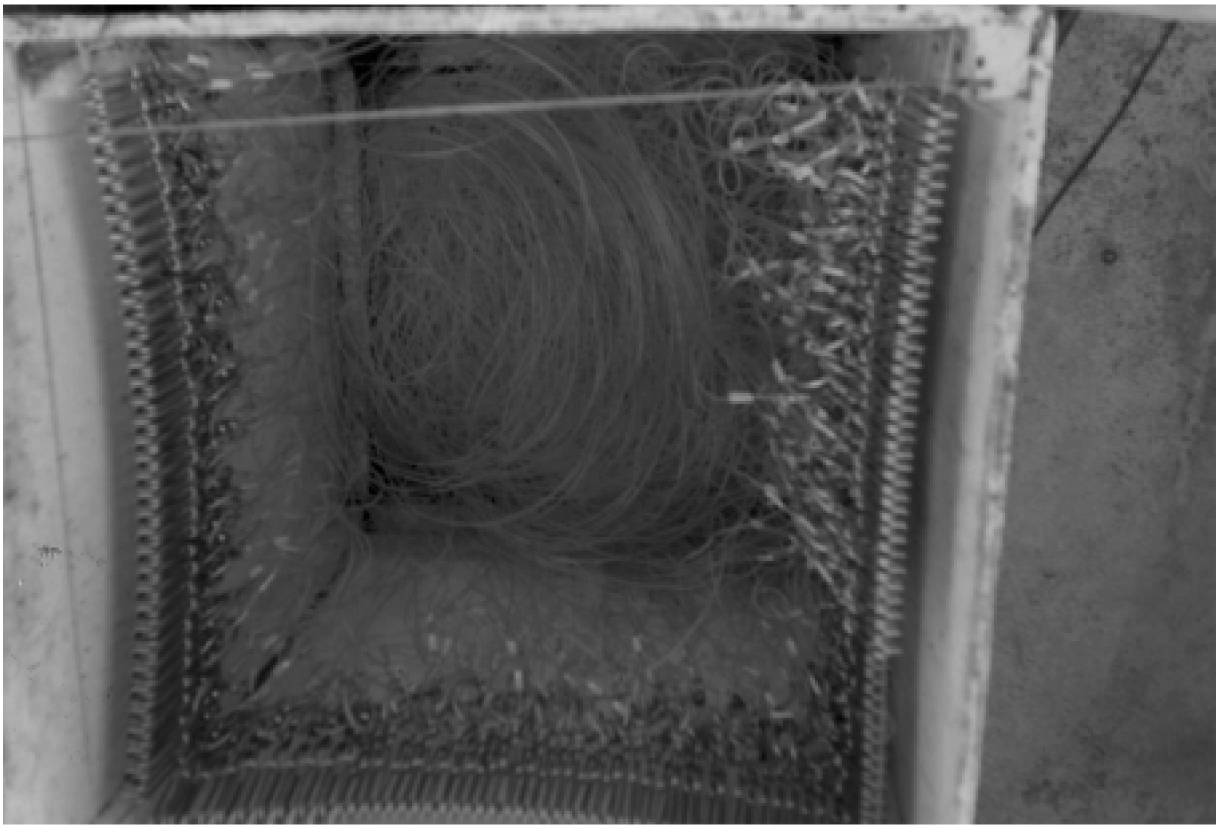


Figure B2: Snood box

To construct a snood box, cut four pieces of 12 mm marine plywood 100 cm long and tapering from 70 to 50 cm. Glue the edges with epoxy and nail them together with 38 mm galvanised nails to make a tapered box. Cut a piece of plywood, 50 x 50 cm, glue the edges with epoxy and nail to the bottom of the box. Drill four by 25 mm holes in the bottom to allow water to drain from the box. Drill a 10 mm hole, 5 cm down from the top of each corner of the box and pass the copper wire through the holes to make a line for the snoods to be clipped onto on the inside of the box. Drill two by 10 mm holes, 30 cm apart and 30 cm from the top of two opposite sides of the box. Pass a piece of 10 mm rope through each set of holes and tie the ends to make carrying handles. Epoxy the entire surface of the box.