# Capture Section Report

# of

# Wallis and Futuna

# Fish Aggregating Device (FAD)

# Technical Assistance Projects

25 August to 15 September 1992;

7–11 November 1992; and

23–29 July 1995

by

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Project funding came from SPC's core-funded Deep Sea Fisheries Development Project—DSFDP—and United Nations Development Project's—UNDP—Offshore Fisheries Development Project—OFDP (1992); and funding for the purchase of the FAD materials came from the European Development Fund—EDF—for the 1992 deployments and the Government of Japan, under a bilateral treaty arrangement, for the 1995 deployments.

# SUMMARY

In conjunction with a programme to enhance local fisheries through the deployment of fish aggregating devices (FADs), the Territory of Wallis and Futuna sought technical assistance from the South Pacific Commission (SPC) under its Deep Sea Fisheries Development Project—DSFDP. The assistance requested, on behalf of the Territory's Service de l'Economie Rurale et de la Pêche (SERP), was for advice and assistance in the surveying and charting of FAD deployment sites off the Territory's two main islands, Wallis and Futuna; for rigging and deploying several FADs on the chosen sites; and for follow-up counterpart training.

In August 1992 Masterfisherman, Steve Beverly, travelled to Wallis and Futuna and, equipped with echo-sounding and navigation equipment provided by the DSFDP, supervised the survey work and demonstrated reliable FAD site survey principles and techniques to counterpart SERP staff.

Three potential FAD deployment zones were selected in consultation with SERP staff, two off Wallis and one off Futuna. These zones were surveyed with the participation of SERP staff from small local craft fitted using DSFDP survey equipment—a GPS or Global Positioning System and a deep-water echo-sounder. Detailed bathymetric charts of these zones were prepared and three suitable FAD deployment sites were selected, one in each survey zone.

During the course of the survey work SERP staff became adept at the use of echo-sounding and GPS equipment from local craft and it was considered that, so long as SERP acquired suitable equipment, further FAD site surveys could be successfully conducted without outside assistance.

Secondly, in November 1992, as part of the same project, SERP, with assistance from New Caledonia's Service Territorial de la Marine Marchande et des Pêches Maritimes—Merchant Marine and Sea Fisheries Department, usually just called Marine Marchande—and the French Navy vessel, La Glorieuse, set three FADs at the chosen sites. Marine Marchande's Masterfisherman, Aymeric Desurmont, supervised the deployments.

Following the successful introduction of FADs in 1992, the Territory of Wallis and Futuna again sought the assistance of the SPC's fisheries programme in 1995 to provide more technical assistance on FADs. The FAD at Futuna and the FAD on the northeast side of Wallis were lost before 1995. The FAD on the south side of Wallis remained on station for two-and-a-half years, but was lost during 1995. The requested assistance centred on providing hands-on training to SERP counterparts on FAD construction and rigging and on FAD deployment techniques.

The third visit took place during 1995. Assistance was provided to the Territory through a collaborative effort between SPC and Marine Marchande in which the services of SPC's Fisheries Development Officer, Satalaka Petaia, and Marine Marchande's Masterfisherman, Philippe Simoni, were utilised. SERP counterparts were trained on all aspects of FAD technology and two FADs were rigged and deployed from the French Navy vessel La Glorieuse, one at Futuna and one at the northeastern Wallis site.

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# 1. Introduction and Background

## 1.1 General

Wallis and Futuna, an overseas territory of France, consists of two distinct island groups (Figure 1). The Wallis group consists of Uvea island (80 km2 in area) as well as a number of small islands lying inside an encircling barrier reef. Four reef passages give access to the open sea—one of these being sufficiently deep to accommodate large vessels. The administrative capital of the territory, Mata Utu, is on the east coast of Uvea (Douglas & Douglas, 1989).

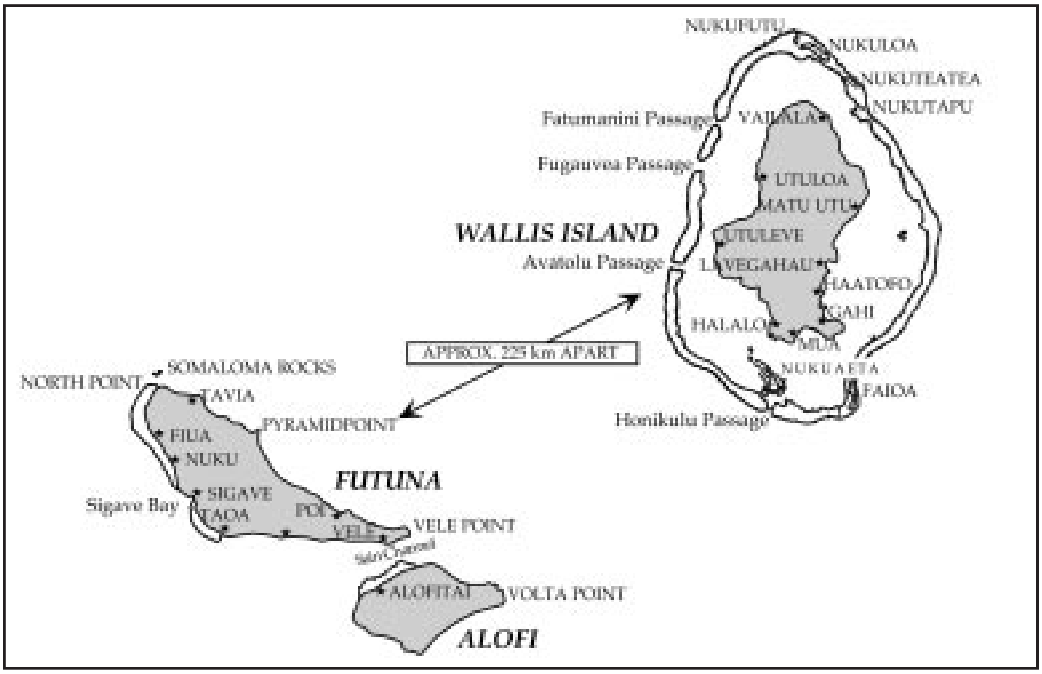


*Figure 1: Wallis and Futuna, with declared 200-mile EEZ*

Some 220 km to the southwest of Wallis, and about 275 km northeast of Vanua Levu, Fiji, are the islands of Futuna (44 km2) and Alofi (18.5 km2), which comprise the Futuna group. Neither Futuna nor Alofi islands have fringing reefs.

In the Wallis group the high points and bluffs are composed of basaltic lava. Uvea is composed of broad, low lava domes merging to form an undulating plateau, with sand flats in places along the shore. The surface, which is deeply weathered, is porous and there are no streams. Futuna and Alofi contain ancient, deeply eroded volcanic cores fringed by an uplifted terrace of marine sediments (Douglas & Douglas, 1989).

Vegetation on Uvea is lush around the coastal fringe, with tall, open forests interspersed with coconut palms and food gardens of taro, yam, kumara and bananas. The interior is mostly covered in open savanna-like growth, known locally as 'toafa', which mainly consists of fern or low shrubs. Vegetation on Futuna and Alofi is similar. Futuna has wooded valleys, with fern scrub and some grassland on the ridges, and most of Alofi is wooded. Although there is provision for land to be held by individuals, and the Administration and the Church have holdings, most land is held communally according to customary law.

Climate in both groups is warm and humid, with two distinct seasons. From May to October, during the southeast trade winds, the weather is relatively cool and dry. From November to April winds are variable with periods of calm—this is also the cyclone season. Mean annual rainfall is 2,700 mm but its distribution is irregular.

The Territory's population in 1990 totalled 13,705—8,973 in Wallis and 4,732 in Futuna. In 1990 there were 14,186 from the Territory living in New Caledonia (Anon, 1990). Local tradition connects the people of Wallis with the early inhabitants of Tonga; and the people of

Futuna appear to have originally come from Samoa. The common languages in use are Wallisian and Futunan, both Polynesian dialects—the former related to Tongan and the latter to Samoan. French is the administrative language. Wallis, or Uvea, is also a kingdom. Futuna has two kingdoms—the west side of Futuna is the Kingdom of Sigave while the east side and the island of Alofi are part of the Alo Kingdom.

The people of Wallis and Futuna are engaged mainly in subsistence agriculture and fisheries. Remittances to their families by islanders from the Territory who work in New Caledonia are an important source of income. Subsidies and grants are provided by the French government. Handicrafts and trochus shell are the only exports. Currency in use is the French Pacific Franc—CFP Franc.

## 1.2 Existing fisheries

### *1.2.1 Domestic fisheries*

Fish has long been a favoured staple in the diet of both Wallisians and Futunans. In the past it has provided almost the only source of animal protein, and in more recent times a still preferred but increasingly scarce and expensive foodstuff. Catches have seldom been sufficient to meet demand and overfishing was reported at Futuna as early as 1932 (Burrows, 1937), while a 1969 SPC survey of fisheries resources noted a decline in lagoon fish stocks at Wallis (Hinds, 1969). An artisanal trochus fishery produces the Territory's only significant export, with 88.2 t of trochus exported to Italy in 1990 for button manufacture. The value of these sales was 35.38 million CFP (Anon, 1990).

Most harvesting of seafoods has been confined to the sheltered waters inside the islands' barrier reefs or along the reef flats. A variety of modern and traditional fishing techniques are employed including: netting, spearing, trapping in stone weirs, bottom handlining, trolling, and the indiscriminately destructive use of poisonous plant extracts and illicit explosives. Most fisheries production is for home consumption or is exchanged under traditional custom. Some excess catch is sold by way of a fish market at Vailala in the north of Uvea Island and through retail stores. Species observed on sale during this visit comprised mostly shallow water demersal fishes, cephalopods, and crabs, although some pelagic species were also observed.

Fishing for tuna and other pelagic species offshore has been very limited since the exodus of many fishermen to New Caledonia's nickel industry during the 1950s. The rapid growth of a cash-based economy fuelled by remittances from overseas workers has resulted in growing reliance on expensive imported foods. For example, a standard 185 g can of tuna imported from France retailed for 300 CFP in 1992 on Wallis.

In an attempt to diversify local fisheries and to promote fishing as an income-earning activity, the Territorial Assembly of Wallis and Futuna adopted a long-term development plan in 1979. The plan took into consideration the state of reef and lagoon fisheries and the local demand for fish, and stated that the utilisation of resources outside the reef was a major objective (Dijoud, undated). Under this development programme a boatyard was established at Mata Utu in 1979. A boatyard was also established at Futuna in 1981. They have since produced hundreds of outboard-powered fishing boats of various designs which have been made available to local fishermen under assisted purchase arrangements. In 1990 the boatyard at Mata Utu produced 14 craft ranging from five to seven metres. A 1990 census of motorised craft counted 330 boats in the territory, 272 in Wallis and 58 in Futuna. Although 198 of these craft were described as fishing boats, none were said to be engaged in fishing full time and, of the 20 fishing cooperatives previously established, only two were considered to be active. In 1991 the Territory's Service de l'Economie Rurale et de la Pêche—SERP, initiated a new offshore fishing programme with the construction of a 9 m vessel equipped for deep-bottom fishing on the outer reef slope.

During a 1983–84 SPC visit, fishing took place aboard a variety of vessels ranging from 7.3 m monohulls, to outrigger canoes, to 8.5 m 'Alia' catamarans (Taumaia & Cusack, 1997). SPC fished with two cooperatives in Futuna and five in Wallis in 1983–84. Most of the fishing from these boats was bottom handlining or handreel fishing for snappers, but there was some trolling for skipjack tuna. The skipjack tuna was used as bait for the bottom fishing.

As Futuna has no lagoon and only limited fringing reef, fishing activities there centred on gill-netting for scads, or atule (*Selar* sp.) and bottom fishing for snappers using handreels. Both the FAO-type wooden handreel introduced by the DSFDP during two visits in the early 1980s (Fusimalohi & Grandperrin, 1980; Taumaia & Cusack, 1997), and Alvey reels manufactured in Australia were in use in 1992. Atule netting was mostly conducted from shore or from canoes, while deep-water snapper fishing was most often conducted from flat-bottomed, half-cabin boats built in the SERP boatyard. There was no fish market on Futuna in 1992, but snappers and tuna were observed for sale in some shops, and local lobster and reef fish were available in the restaurants.

The potential for the commercial exploitation of deep reef-slope fisheries in Wallis and Futuna has been discussed in an SPC study that was based on data from the two previous visits by SPC Masterfishermen (Dalzell & Preston, 1992) . Catch rates for dropline fishing varied from 6.6–9.3 kg/line-hour at Wallis and from 5.6–8.7 kg/line-hour at Futuna. Landings were dominated by deep-water snappers (family *Etelidae*), which comprised nearly 57 per cent of the catch by weight. Deep-water snappers comprised a greater percentage of the total catch by weight at Futuna (68.3%) than at Wallis (51.3%). The report estimated that the maximum sustainable yield (MSY) from a deep-water snapper fishery in Wallis and Futuna would be expected to be in the neighbourhood of 10.2–30.7 t/year.

In 1992, when the above mentioned report was written, there had been no commercial deep-water snapper fisheries within the Territory. However, the owner-operator of the vessel used for the Futuna FAD survey work in the present report was just starting a small-scale deep-water snapper fishery for local sales and possible export to Fiji. He was fishing with two Alvey reels from his 7 m aluminium vessel using an echo-sounder and a hand-held compass to locate fishing grounds. No catch and effort data were available, however.

#### *1.2.2 Distant water fishing nation (DWFN) fisheries*

Prior to the establishment of the exclusive economic zones (EEZs) in the Pacific, DWFNs fished for pelagic species, mostly tuna, in waters adjacent to Wallis and Futuna. SPC (Klawe, 1978) gives data for the Japanese, Taiwanese, and Korean DWFN's longline catches for 5° square areas surrounding Wallis and Futuna. Three such squares are included, all between 10–15° S. Wallis and Futuna's EEZ barely touches two of these squares (175–180° E (6%) and 175–170° W (7%)), but includes 82 per cent of 180–175° W. Catch data for the years 1972–1976 are for the Japanese and Taiwanese fleets, while data for the years 1975–1976 include Korea as well.

During 1972 the DWFN longline fleet caught a total of 1,016 t of all species of pelagic fish on 1,061,879 hooks in the vicinity of Wallis and Futuna including: 541 t of yellowfin tuna (*Thunnus albacares*), 353 t of albacore tuna (*T. alalunga*), and 52.7 t of bigeye tuna (*T. obesus*). By 1973 the catch and effort had dropped to 513 t of all species caught on 570,410 hooks. The remaining years had catches and effort as follows: 1974: 56.8 t on 136,135 hooks; 1975: 189 t on 359,034 hooks; and 1976: 386 t on 760,431 hooks (Klawe, 1978). The estimated catch per unit effort (CPUE), based on the above figures is 74.8 kg/100 hooks for all pelagic longline species.

Since the establishment of Wallis and Futuna's EEZ, the French Government has signed bilateral treaties with DWFNs, in particular with Japan and Korea, for annual fishing quotas of 3,000 t in the Territory's EEZ. Revenue derived from these treaties amounted to CFP 20 million in 1981 (Douglas & Douglas, 1989).

## 1.3 Initiation of the project

The SPC's Deep Sea Fisheries Development Project (DSFDP) was a mobile field-based development programme that operated in the Pacific Islands at specific government request. The DSFDP had the following broad objectives: to promote the development and expansion of artisanal and small-to-medium scale commercial fisheries throughout the region, based on fishery resources which were locally under utilised, in particular deep-bottom resources of the outer reef slope and offshore aggregations of pelagic fishes; to develop and evaluate affordable and appropriate technology, fishing gear, fishing techniques and fisheries enhancement methods which would enable both subsistence and artisanal fishermen to increase sustainable catch levels; and to provide practical training in fishing techniques and fisheries enhancement methods to local fishermen and government fisheries extension workers.

In an attempt to diversify local fishing effort away from inshore resources, and being aware of increasing successful regional use of fish aggregating devices (FADs) in the development of small-scale offshore fisheries, the Service de l'Economie Rurale et de la Pêche (SERP) of Wallis and Futuna secured funding in 1991 for a FAD programme with the aim of installing three FADs in the Territory. As no such programme had been attempted in the territory previously, Wallis and Futuna sought technical assistance from their sister territory, New Caledonia, and from SPC in initiating this programme. Under this arrangement, advice on FAD material specifications and sources of supply were provided by SPC, while New Caledonia's Marine Marchande assisted with the construction of buoys and anchors, and provided technical assistance in mooring configuration and rigging.

As Wallis and Futuna had no vessels capable of deploying FADs it was planned to land all materials in Noumea where, under the supervision of Marine Marchande, the moorings would be rigged.

Once materials sufficient to rig and deploy three FADS had been ordered, SERP requested further DSFDP technical assistance and training in the conducting of FAD site surveys around the islands of Wallis and Futuna to identify suitable deployment sites. A Masterfisherman was assigned to the Territory for three weeks to work alongside SERP counterparts conducting FAD surveys using equipment supplied by DSFDP. This work was to include the identification and accurate charting of three deployment sites; two off Uvea Island in Wallis and one off Futuna Island. Once the FAD site depths and positions from the survey work were made available, the moorings were to be rigged by Marine Marchande staff in Noumea. The FADs were to be delivered and deployed by a French navy ship under Marine Marchande supervision. A second similar FAD deployment exercise was requested in 1995 after two of the first three FADs were lost. The second FAD deployments were to include counterpart training in FAD rigging and construction, as well as in FAD deployment.

# 2. FAD Site Surveys Conducted in 1992

Site surveys were conducted in both Wallis and Futuna to identify specific details of site bathymetry and FAD site positions.

## 2.1 Electronic equipment used by the project

SPC Masterfisherman, Steve Beverly, carried a Furuno FCV 362 Chromoscope echo-sounder and a Japan Radio Corporation JRC JLR-4110 GPS receiver to Wallis and Futuna. The same units had been used in a previous DSFDP FAD survey and deployment in Papua New Guinea (Beverly & Cusack, 1993).

The echo-sounder was a 2 kW model with a colour video display, and it came equipped with both 50 kHz and 28 kHz transducers, suited to fish finding or bottom surveying in deep water. It required 24 VDC power and had a power consumption of approximately 6.5 amperes per hour. This unit featured the range of capabilities typical of late model sounders, including dual frequency–split screen display, frequency shifting, phased ranging, bottom and fish alarms, etc., but proved quite simple to operate, with clearly marked, easy to manipulate controls.

The echo-sounder was adequate for sounding depths up to 1,500 m, but in average conditions could not give reliable readings to the manufacturer's given range of 2,000 m. The critical factor was output power. The FCV 362 produced a 2 kW signal. Higher output models are available which produce 3 kW signals, but they consume more power. The FCV 362 was chosen for general FAD survey work because its power draw was about at the level that typical, medium-sized fishing vessels in the region could supply. Alternatively it could be powered by rigging two 12 V batteries in series to produce 24 VDC. The dual frequency capability of this unit allowed for a wide range of fish-finding applications as well.

To assist the use of the echo-sounder in DSFDP fieldwork, a portable aluminium transducer housing (Figure 2) that had been fabricated for an earlier project (Desurmont, 1992) was used. This allowed the transducer to be fitted to a wide range of vessels with bolts, clamps, and ropes.

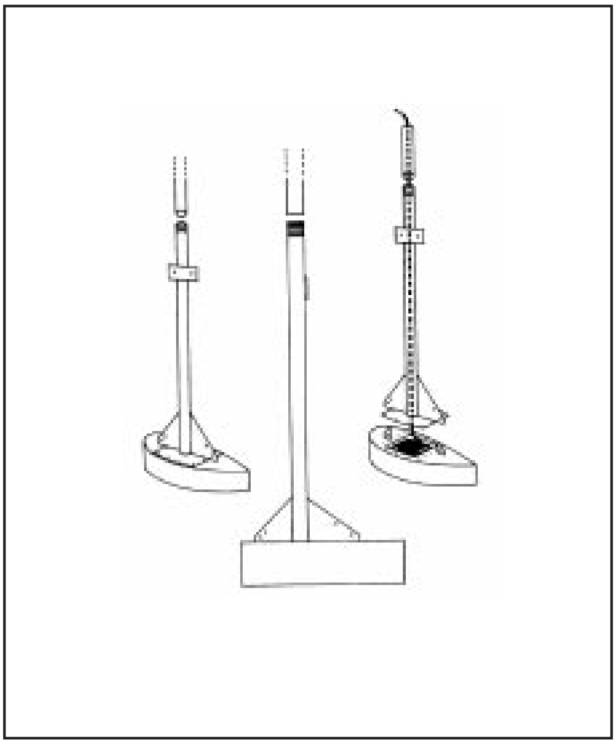

*Figure 2: Portable aluminium transducer mounting used by the project*

A Global Positioning System, or GPS unit, is a necessity for making accurate bottom surveys. The GPS unit used during the surveys incorporated a GPS receiver and a simple plotting screen. Thus the vessel's position was constantly indicated either in digital display of latitude and longitude—at a resolution of 0.000'—or graphically on the plotting screen. The GPS had a high degree of reliability and accuracy and was relatively simple to operate. Apart from the ship's position, the GPS was able to give information on course made good, speed made good, range and bearing to a waypoint, and time to go to a waypoint. The GPS used 12 VDC power.

## 2.2 Wallis survey

### *2.2.1 Fitting out the survey vessel*

The vessel made available for the survey work on Wallis was a 9 m plywood half-cabin, flat-bottom, fishing vessel of local design (Figure 3) built by SERP at its workshop in Mata Utu. The boat, designated F/V *W 001* (Wallis number 1) was equipped with two Johnson 40 HP electric start outboard motors.

*Figure 3: F/V* **W 001** *used for the Wallis site surveys*

The echo-sounder transducer, fitted into the portable housing (Figure 2), was mounted on the port side of F/V *W 001* in such a way that the unit could be removed at the end of each day. This was necessary as the boat's mooring position left it out of the water at low tide. The transducer would have been damaged had it not been removed. Petelo Mufutuna, SERP boat builder and operator, fabricated a timber bracket that served this purpose well. The transducer was lashed in place on the bracket with two short lines—no other lines or supports were necessary.

Installing and powering the echo-sounder and GPS monitors on F/V *W 001* proved to be a relatively simple task. The GPS unit was fixed to the top casing of the echo-sounder and the echo-sounder was mounted onto a sturdy piece of timber screwed in place across the vessel's fore-and-aft benches inside the cabin. This provided for a clear view of both display screens, while keeping the equipment protected from rain and sea spray. The GPS antenna was mounted to a short length of timber attached to the cabin just aft of the bulkhead.

Some initial difficulties were encountered in providing the required 24 VDC power to the echo-sounder. The engines' batteries were first cross-connected in series in the expectation that one battery could be used for the GPS (12 VDC) and both batteries used for the echo-sounder (24 VDC). This proved to be unworkable, however, as the steering linkage connecting the two motors acted as a common ground and only one of the vessel's batteries was taking the combined charge of the alternators of both outboard engines. The problem was solved by using a third battery linked in series to one of the vessel's engine start batteries to supply the required 24 VDC. Previous consultation with TECAIR, the Furuno agent in Suva, Fiji, revealed that the FCV 362 echo-sounder would consume 6.5 amperes per hour. As the vessel's batteries were rated at 50 amp-hours, a fully charged battery would have been sufficient to run the echo-sounder for six or seven hours without re-charging. The batteries were rotated daily so they each could be fully charged during the vessel's runs to the survey sites.

The GPS consumed negligible 12 VDC power and was successfully operated from one of the engine start batteries. The GPS had to be corrected, however. GPS positions in latitude and longitude are generally referenced to the World Geodetic System 1984—WGS 84. When plotting positions on marine navigation charts, which are normally referenced to local or regional datums, it is necessary to make corrections. Recent publications of standard navigational charts typically include GPS correction figures. In this case the chart used for the FAD survey work was British Admiralty Chart No. 968—*Islands between Fiji and Samoa*, which used data from several sources and gave no indication of any geodetic system employed. Therefore, before plotting GPS positions using this chart, corrections had to be calculated.

Because the survey vessel was moored in the same position each day, it was possible to check the reliability of the given GPS position; the greatest deviation noted was 0.07 nm. The GPS was left with the factory settings for geodetic system—WGS 84. The GPS was corrected at the landing at Gahi Bay where the boat was kept. It was difficult to determine the exact location of the vessel's mooring from local landmarks as the portion of B.A. Chart No. 968 describing the site was taken from United States data from 1942. Many of the structures indicated on the chart were present during World War II but no longer exist except as ruins. However, corrections were calculated as accurately as possible and the following corrections were programmed into the GPS unit: 0.12' N and 0.25' W.

On the first day of the survey the corrected GPS reading was checked at the beacon in Passe Honikulu against the chart, and a variance of 0.10' was noted. At the completion of the Wallis surveys the GPS unit was taken to Mata Utu wharf and rigged to the battery of a vehicle parked at the end of the wharf. The variance between the chart position for the end of the wharf and the position given by the GPS was: 0.077' S; and 0.030' E. Thus it appeared that the corrections previously programmed into the GPS gave a slightly increased accuracy over uncorrected settings. The original corrections were based on a calculated position in Gahi Bay of 13° 20.05' S and 176° 11.30' W, which corresponds closely to the position for the wharf given on French chart No. 6876, *Iles Wallis, accès à Mata Utu et Halolo*.

#### 2.2.2 Survey procedure

Two survey zones were selected based on Chief Fisheries Officer Daniel Tahimili's knowledge and experience of Wallis and his consultations with local fishermen. The survey method was identical to that used in a 1990 SPC visit to the Cook Islands (Desurmont, 1992), and a 1992 SPC visit to Port Moresby, Papua New Guinea (Beverly & Cusack, 1993). Transects were run going either north–south or east–west in the chosen survey zone. The GPS and echo-sounder were both monitored during these transects. Depth data were taken at every 0.25' intervals—approximately equal to 0.25 nm or one quarter of a minute of latitude—on the GPS along each transect line. The transect lines were also exactly 0.25' apart. Thus, depth data was acquired for every 0.25' interval in every direction within the survey zone. Later, depth contours or iso-bath lines were drawn on graph paper at 100 m intervals. The location of the 100 m intervals was found by interpolation as described in Petaia & Chapman (1997).

The first survey area selected was just to the south and west of the main pass into Wallis, Passe Honikulu. As this is the pass used by visiting cargo ships, the approaches had to be avoided. The other considerations for survey zone selection were based on available bathymetric information and convenience to fishermen. The first trial echo-sounding transects indicated a generally flat bottom with extensive areas between 700–1,000 m. It was decided to conduct a detailed survey to the west of the pass, away from the shipping lanes and where the reef would provide protection from prevailing winds. The survey zone selected at Honikulu was roughly bounded by 13°22.00'–13°26.00' S and 176°14.00'–176°19.00' W (Figure 4).


*Figure 4: The two zones where site surveys were conducted off Wallis Island*

The second survey zone selected was to the north-west of Uvea Island, just outside of Passe Fatumanini. This pass is used by fisherman living in the north of Uvea. In general, this zone appeared to be a better location than Passe Honikulu. It is near the only fish market on Uvea, at Vailala and is probably safer as it is well in the lee of prevailing winds and free of strong tidal currents. The FAD survey zone selected was bounded by 13° 11.25'–13° 14.25' S and 176° 16.00'–176° 19.00' W (Figure 4).

*2.2.3 Survey results*

Once the survey off Passe Honikulu was completed, contours were drawn from the collected soundings (Figure 5) and a FAD site was selected at 13° 23.50' S, 176° 17.50' W in 1,008 m of water. Skipjack tuna (Katsuwonus pelamis) schools were spotted near the site on two occasions during the survey and an undersea rise was detected on the echo-sounder just to the south—both good signs. The only drawback to placing a FAD near Passe Honikulu was that the tidal current in the pass can reach up to six knots and can be quite dangerous. On the ebb tide, whirlpools form and dangerous breakers can appear without warning in the mouth of the channel. It was reported that a fisherman and boat were lost there just prior to the survey—neither was ever found. However, the local fishermen are well aware of the danger of the pass and generally time their trips accordingly.

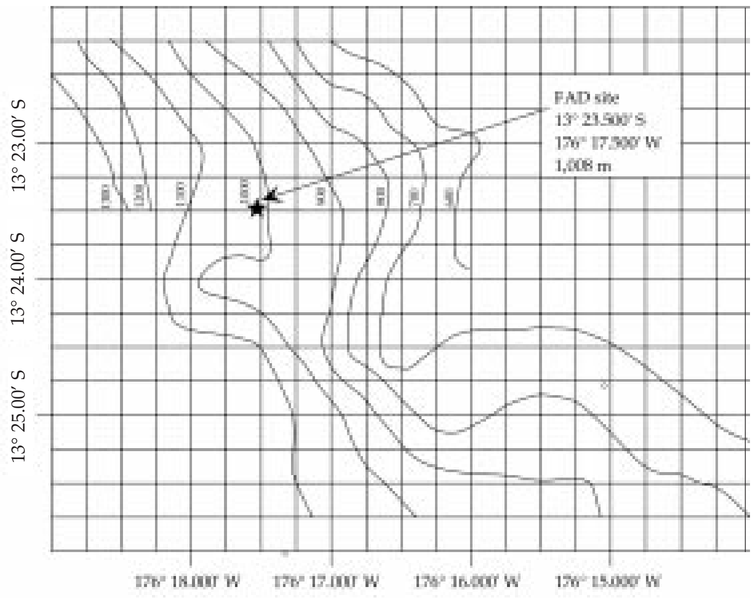


***Figure 5: Bottom contour map and FAD site selected in the Passe Honikulu survey zone***

The survey off Passe Fatumanini revealed an extensive flat area at 900–1,100 m depth just to the north of the pass. A later examination of French Chart No. 6067, *Océan Pacifique Sud, des Îles de Horne et Wallis à l'Île Keppel*, indicated that this flat area may extend several miles to the north. Unfortunately there was no time to survey the entire area, but a suitable FAD site was selected at 13° 11.75' S, 176° 17.75' W in 991 m (Figure 6). Two large skipjack tuna were caught in the survey zone by trolling during the survey.

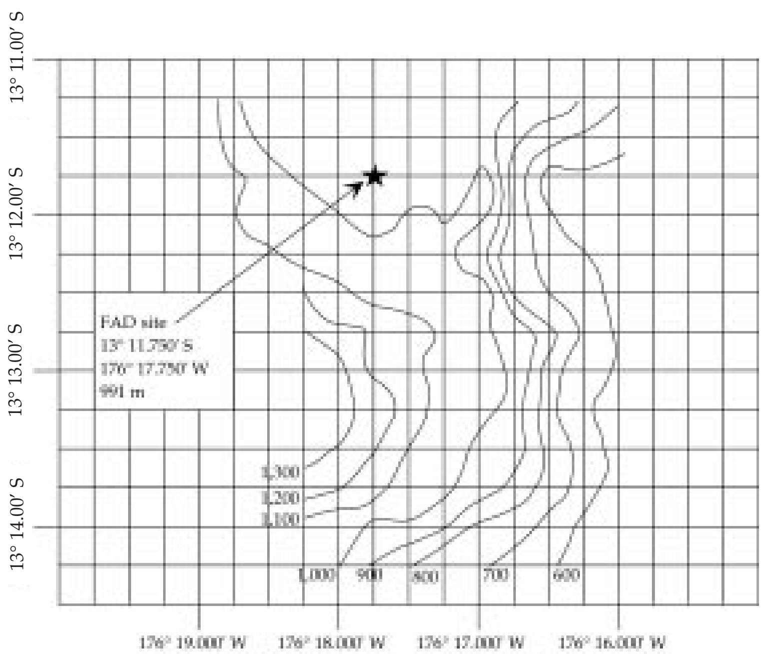


***Figure 6: Bottom contour map and FAD site selected in the Passe Fatumanini survey zone***

As most vessels on Wallis did not have GPS units, compass directions to both Wallis FAD sites from the respective reef passages were drawn (Figure 7) to assist local fishermen in locating the FADs.

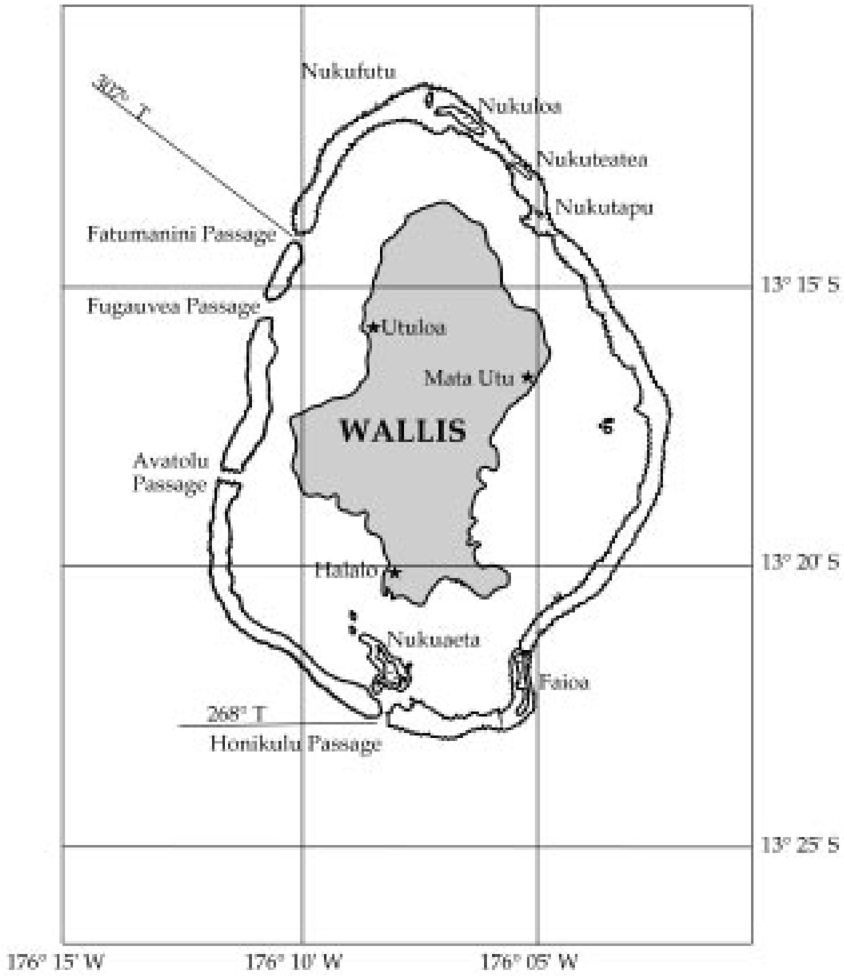


*Figure 7: Compass bearings from passages to locations identified for FAD placement*

## 2.3 Futuna survey

### *2.3.1 Fitting out the survey vessel*

After completion of the Wallis surveys, the survey equipment was removed from F/V W 001 and packed for shipping to Futuna. Bruno Mugneret of SERP accompanied the Masterfisherman to Futuna to help with the survey and to learn more about FAD site survey techniques. He also acted as interpreter.

The boat made available to SERP on Futuna was a privately owned 7 m aluminium, half-cabin sport-fishing boat—Australian-made Yellowfin—fitted with a 130 hp Yamaha outboard motor and a 25 hp auxiliary Suzuki outboard (Figure 8). The boat was chartered along with owner–operator, Patrick Tortey, who piloted the boat and was very helpful in setting up the electronics. Mr Tortey had a well-equipped workshop at his home where the boat was kept on a trailer, and the boat was made ready for survey work in a matter of hours.

*Figure 8: The 7 m aluminium 'Yellowfin' design boat used for the Futuna site survey*

The echo-sounder was mounted securely to two large planks laid across the vee-berth inside the cabin where it would be protected from rain and sea spray. The transducer housing was bolted to a swim step on the port side of the transom and was also lashed to a cleat. It was removed each day prior to hauling the boat out by trailer. An auxiliary battery was connected in series to the engine start battery to supply power to the echo-sounder. This battery was removed each day and charged overnight with a 240 VAC battery charger. No difficulties were encountered with the echo-sounder, even when using it continuously over eight hours.

The GPS unit, powered by the engine start battery, was mounted on the dashboard of the boat in such a way that the operator could view it easily while steering. This proved to be more convenient than having the observer give directions to the pilot as was done in Wallis. The pilot merely had to steer along a GPS line of latitude or longitude of 0.000', 0.250', 0.500' or 0.750'. By the end of the survey on Futuna Mr Mugneret became quite proficient at piloting the boat using the GPS as a compass in this manner. The GPS antenna was mounted on a broomstick using electrician's tape and this was placed in one of the boat's fishing rod holders.

Corrections to the GPS were made at the wharf at Sigave, by Leava village. The position of the wharf on B.A. Chart No. 968 was 14° 17.85' S, 178° 09.86' W. In order to correct the GPS to match the chart, the following entries were programmed into the unit: 0.09' S and 0.25' W. These corrections varied slightly from those made for the Wallis survey, but as the Futuna portion of B.A. Chart No. 968 was drawn from different data—various French surveys—this was not unexpected.

*2.3.2 Survey procedure*

The actual survey method was identical to that used for the Wallis survey. However, other considerations had to be made when selecting a survey zone. In selection of a FAD site-survey zone on Futuna consideration was given not only to the bottom topography and proximity to the port, but to the desire of SERP to ensure that fishermen of the two kingdoms of Futuna—Alo and Sigave—had approximately equal access to the FAD. The border between these two traditional kingdoms runs north and south through Futuna, approximately on a line from Mont Pyramides to Rocher du Sud Ouest.

Since most of Futuna's population lives on the south coast of the island it was decided to conduct the survey in an area off this coast overlapping the maritime boundary of the two kingdoms. The survey zone selected was roughly bordered by 14° 18.50'–14° 22.00' S and 178° 06.00'–178° 10.50' W (Figure 9). During the course of the survey it became apparent that the bottom on the west side of the survey zone was generally too steep to be suitable for FAD deployment.

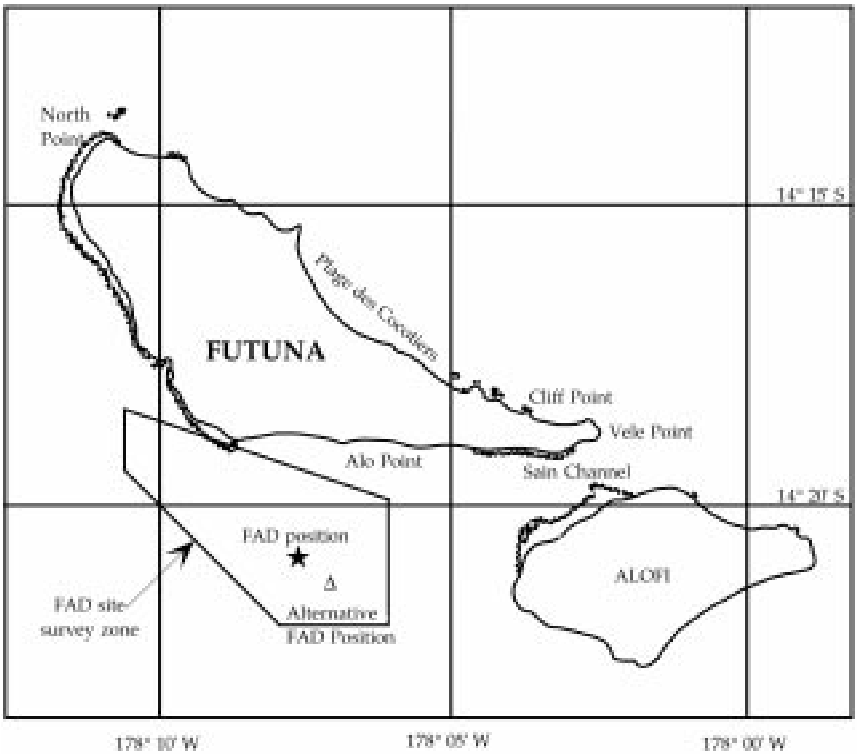


*Figure 9: Site-survey zone off Futuna*

*2.3.3 Survey results*

The eventual site selected, at 14° 21.05' S, 178° 07.25' W (Figure 10) in 960 m, lies just east of the border between Sigave and Alo. The site, in the lee of Alofi Island, is protected from the prevailing winds. The site lies close to bottom fishing grounds presently visited by fishermen from Leava village, and sea birds, which commonly indicate the presence of tuna, were sighted in the area during the survey. A disadvantage of this site is its proximity to the shipping lane used by cargo vessels calling at Leava. At the request of SERP an alternate site was identified and charted nearby in case they later needed to deploy a standby FAD while the primary FAD was removed for maintenance. The alternate site was 14° 21.64' S, 178° 06.50' W in 940 m (Figure 10).

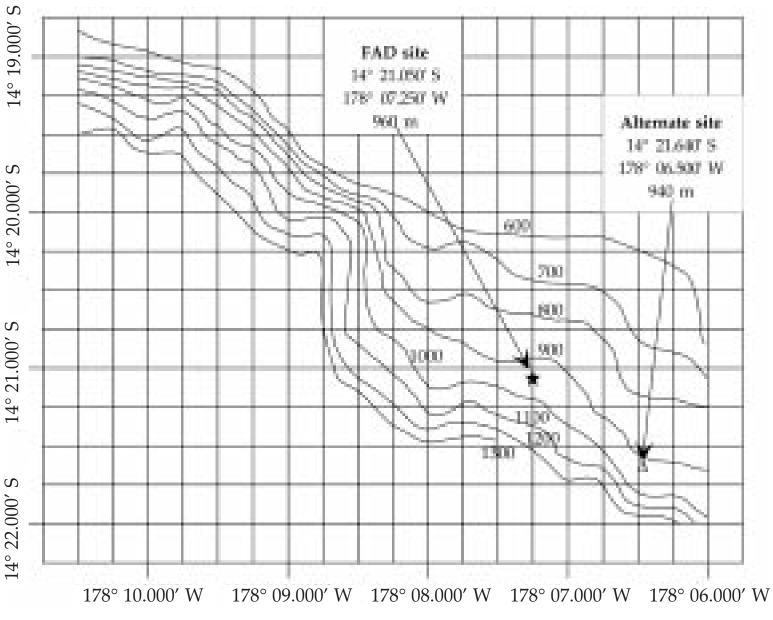


***Figure 10: Bottom contour map and FAD sites identified in the survey zone of Futuna***

The survey was extended to other areas around Futuna in the hope that another potential FAD site could be located. Transects were run on the following lines:

- north–south along 178° 08.00' W from 14° 15.25' S to 14° 13.25' S;
- east–west along 14° 15.00' S from 178° 11.75' W to 178° 13.25' W;
- east–west along 14° 16.00' S from 178° 12,00' W to 178° 13.25' W;
- east–west along 14° 17.00' S from 178° 11.25' W to 178° 12.50' W; and
- east–west along 14° 18.00' S from 178° 10.50' W to 178° 12.50' W.

None of these transects revealed a potentially suitable FAD site. It was found that the bathymetry on the north and west sides of Futuna generally mirrored the topography of the island. In other words, the undersea slope was very steep and not suitable for FAD deployment sites. It is possible that good sites exist further offshore from Futuna in deeper water, but any such sites would likely be out of the effective operating range of the Futuna fishing fleet. It is also possible that suitable FAD sites exist in the waters around Alofi, but there was no time during this project to survey these waters.

# 3. FAD Deployments

Mooring components used for deploying the three FADs in Wallis and Futuna were ordered from a company in the United States of America (USA). Following the deployments, SERP produced records indicating all three FADs were productive, as well as providing catch records for part of 1993, which are incorporated below.

## 3.1 FAD deployments—1992

Three FADs were deployed in 1992 at the sites identified during the surveys described in the previous section.

### *3.1.1 The FAD deployment vessel*

The deployment vessel for this project was *La Glorieuse*, a P 400 French Navy patrol boat (Figure 11), which was 55 m long and was powered by two 4,000 HP diesel engines. Her cruising speed was approximately 18 knots. She was equipped with an MLR brand GPS and a full range of modern navigation electronics—radar, gyrocompass, Omega system—but her echo-sounder did not measure depths over 300 m. *La Glorieuse* had a crew complement of 32 persons. *La Glorieuse* also had a hydraulic deck crane for loading and unloading heavy equipment and supplies. The crane allowed the FAD anchors and buoys to be deployed from the deck.


*Figure 11: French Navy patrol boat,* **La Glorieuse**, *used for the FAD deployments in Wallis and Futuna*

From her base in Noumea, *La Glorieuse's* main task had been to exercise surveillance of New Caledonia's EEZ. She often took part in official visits and courtesy calls to other South Pacific island countries. The visits to Wallis and Futuna were the first times that La Glorieuse was involved in FAD deployments.

*3.1.2 The FAD moorings*

The FAD moorings were ordered from a USA company before the bathymetric survey could be carried out (Appendix A contains a list of FAD mooring components). Because of this the mooring line lengths for the three FADs were pre-set for depths of 1,100 m. However, the sites selected were all in approximately 1,000 m or less. It was decided not to change the mooring line lengths, but to leave them as is. This would make the catenary curve to site depth ratio greater than the usually recommended 25 per cent (Gates et al., 1996). However, the upper part of the catenary curve would still remain well below the surface, whatever the sea conditions.

Some problems were encountered with the pre-fabricated FAD moorings. Although the order sent from Noumea to the company in the US was very precise concerning component specifications and size, the supplier made several errors. The shackles were supposed to be made from hot-dip galvanised steel with a low carbon content—the shackles that were supplied with the moorings contained a bolt made from non-galvanised high carbon steel. This created a risk of electrolysis between the body of the shackle and the bolt, which are not made from the same metal. Stainless steel pins were ordered for these safety shackles—only a few of those supplied were stainless steel. The anchor chain was supposed to be long-link chain—the chain supplied was short-link chain which made connections to the shackle on the anchor difficult, and short-link chain is much heavier than long-link chain metre-for-metre so the length of bottom chain raised from the bottom by the polypropylene rope would be therefore reduced. Last but not least, the mooring lines had been connected upside down, with the polypropylene ropes attached to the upper chains and the nylon ropes to the lower chains.

Fortunately, the moorings were thoroughly checked in Noumea before being loaded onto *La Glorieuse*. New components were purchased in New Caledonia and the moorings were disassembled and then re-assembled properly. Had these moorings been delivered directly to Wallis, the deployments would have been aborted.

*3.1.3 FAD deployments*

There are basically two ways to deploy FADs: the anchor-first method and the anchor-last method. The anchor last method is the safest of the two and is the method usually employed by oceanographers (Boy & Smith, 1984) and by SPC in most of their FAD deployments. The technique could not, however, be used aboard *La Glorieuse* for two reasons. First, the anchor was tied to the boom of the hydraulic crane and hung over the side of the ship ready for dropping. *La Glorieuse* tended to roll, especially when side-on to the sea—in the trough. The anchor would have swung dangerously while the FAD mooring rope was being paid out if the anchor-last method had been used, as the ship would have been in the trough part of the time while it was manoeuvring. Second, while going dead slow, *La Glorieuse* made a speed of seven knots. At this rate, it would have been difficult to tow the buoy and the mooring line without damaging them.

It was therefore decided to use the anchor-first method. The danger involved in using this method is that the line could foul as it is going over the side. The anchor can not be stopped once it is released, so if the line catches on anything the mooring could be damaged—or worse, someone could be injured or killed if they were caught in the bight of the line. It was very important for the mooring rope and chains to be flaked out perfectly and for the buoy to be ready for quick deployment.

The anchor was suspended over the starboard quarter of the ship. This made it possible to flake the chain and approximately 100 m of the polypropylene rope along the rail of the ship, over the side. This portion of the line was secured to the rail with light twine that served as a breakaway. The mooring line then passed back onto the deck via a fairlead at the stern. The rest of the line was flaked on the after deck (Figure 12) so it would pay out through the fairlead. The top chain was flaked along the port side of the after deck and the buoy was tied down on the port quarter over the side. All of this had been done while the ship was making its way to the deployment site. The anchor was slung over the side and secured at the last minute (Figure 13).

*Figure 12: Mooring line flaked on back deck with ends going over the stern through a fairlead*

*Figure 13: Anchor block suspended from crane over the side with bottom chain and start of polypropylene rope secured to rail with light twine as a breakaway*

The positions for each FAD site had previously been entered into the GPS as waypoints. The FAD sites were approached so that *La Glorieuse* would not be in the trough during deployment. Communication between the bridge and the aft deck was possible by means of a loud-hailer. The bosun in charge of the aft deck could also communicate with the bridge by means of a portable VHF radio. When the ship arrived at a selected site the bridge gave the order to release the anchor and a crewman then cut the rope binding the anchor to the crane.

The entire deployment operation took approximately 12 minutes. When all the mooring line and chain were paid out, the FAD buoy was cut loose. All three FAD deployments went smoothly without any problems. In fact, the mooring lines paid out rather slowly at a regular pace.

### *3.1.4 FAD positions*

The two Wallis FADs were deployed at the exact positions that had been previously chosen. The Futuna FAD, however, was not deployed in the exact position due to a temporary failure in deck to bridge communications. The final positions after deployment were close to the original sites chosen during the survey. The FAD positions (WGS 84 references) are provided in Table 1.

**Table 1: Position, depth and buoy rotation radius for the three FADs deployed at Wallis and Futuna in 1992.**

| FAD location | Position in latitude and longitude | Depth | Buoy rotation radius |
|---|---|---|---|
| Futuna | 14° 21.05' S, 178° 07.25' W | 960 m | 0.55 nm |
| Honikulu Passage (Wallis No. 1) | 13° 23.50' S, 176° 17.50' W | 1,008 m | 0.50 nm |
| Fatumanini Passage (Wallis No. 2) | 13°11.75' S, 176° 17.75' W | 991 m | 0.50 nm |

### *3.1.5 Catch records*

SERP submitted catch records for the three FADs deployed in 1992 (Anon, 1993). The data are for three-month periods during 1993 (Tables 2, 3, and 4). Effort was given only as number of boats fishing, although no vessel number was given for the Futuna FAD. SERP also reported that aside from the 17 boats that gave catch data on Wallis, there were other boats fishing the FADs, especially on Sundays. Some attempts were made at mid-water handlining but sharks became a problem. Some vessels that trolled around the FAD at Passe Honikulu caught yellowfin tuna as large as 58 kg.

**Table 2: Catch results from 8 boats fishing around the FAD at Passe Honikulu (Passe Sud) for three months from January through March 1993**

| Species | Number | Weight in kg |
|---|---|---|
| Skipjack tuna (*Katsuwonus pelamis* ) | 70 | 357 |
| Yellowfin tuna (*Thunnus albacares* ) | 85 | 863 |
| Wahoo (*Acanthocybium solandri* ) | 58 | 396 |
| Mahi mahi (*Coryphaena hippurus* ) | 5 | 35 |
| Barracuda (*Sphyraena barracuda* ) | 22 | 189 |
| Trevallies (*Seriola* sp.) | 2 | 28 |
| Albacore tuna (*T. alalunga* ) | 2 | 53 |
| **TOTAL** | 244 | **1,921** |

**Table 3: Catch results from 9 boats fishing around the FAD at Passe Fatumanini (Passe Nord) for three months from January through March 1993**

| Species | Number | Weight in kg |
|---|---|---|
| Skipjack tuna | 77 | 397 |
| Yellowfin tuna | 43 | 832 |
| Wahoo | 6 | 56 |
| Mahi mahi | 12 | 75 |
| Barracuda | 1 | 14 |
| Trevally | 6 | 40 |
| Broadbill swordfish (*Xiphias gladius* ) | 2 | 68 |
| TOTAL | 147 | 1,482 |

**Table 4: Catch results from fishing around the FAD at Futuna for three months from February through April 1993**

| Species | Number | Weight in kg (estimated) |
|---|---|---|
| Skipjack tuna | 60 | 180 |
| Yellowfin tuna | 40 | 600 |
| Rainbow runner (*Elagatis bipinnulata* ) | 5 | 30 |
| Sharks (unknown species) | 6 | 90 |
| Marlins (unknown species) | 1 | no weight |
| Wahoo | 6 | 42 |
| **TOTAL** | **118** | **942** |

## 3.2 FAD DEPLOYMENTS—1995

The effectiveness of the FADs set in 1992 was demonstrated by an increase in fish production in Wallis and Futuna and the appearance on local markets of fresh FAD-caught fish. However, two of the three FADs deployed in November 1992 were lost prior to July 1995. The Fatumanini FAD at Wallis went missing in October 1993 and the Futuna FAD went missing in April 1994. The third FAD, at Passe Honikulu, went missing just after the third visit, in July 1995. It had been on station for over two-and-a-half years.

The FAD moorings and deployment techniques used in 1995 for replacing the Futuna FAD and the Wallis FAD at Fatumanini were basically the same as used in 1992. One difference between the 1992 and 1995 deployments was that SERP counterparts participated in the construction, rigging, and deployment of the 1995 FADs as a training exercise, while in 1992 everything was done either in New Caledonia or on board *La Glorieuse* by Marine Marchande. *La Glorieuse* was used once again as the deployment vessel in 1995. The FAD mooring materials, however, had been previously shipped to Wallis and were assembled onshore at SERP headquarters.

*3.2.1 The FAD moorings*

All the FAD materials for the 1995 deployments were provided by the Japanese Government as part of its bilateral assistance to the Territory of Wallis and Futuna. These were provided according to specifications and quantities recommended by Marine Marchande and SPC on behalf of SERP. All FAD hardware materials were made of hot-dip galvanised low-carbon steel. The materials were similar to those used in 1992 (refer Appendix A) except for the FAD ropes. The mooring ropes were 8-strand nylon (sinking rope) and 8-strand polypropylene (floating rope). The 1992 FADs were made with 12-strand ropes. The steel spar buoys and the 1,200 kg anchor blocks were designed and constructed in Japan according to specifications provided by the Marine Marchande and SPC (Gates et al., 1996). All other FAD mooring materials were delivered to Wallis in bulk.

The FAD moorings were rigged at SERP headquarters in Wallis. SERP counterparts were trained in all relevant aspects of FAD construction and rigging, with special emphasis on mooring rope and buoyancy calculations, hardware connections and arrangements, rope connection and splicing, and FAD design and arrangements. These activities were conducted in the form of a practical training exercise for SERP counterparts under the direct supervision of SPC and Marine Marchande.

Before the FAD construction work started, the materials were checked for quantities and specifications. Once this was done, rope mooring and buoyancy calculations were undertaken to determine the lengths of nylon and polypropylene ropes required on the different sections of the catenary mooring, as well as the number of pressure floats required, if any, to lift 3 m of bottom chain off the sea bed. All calculation works were prepared on calculation work sheets developed by SPC (Appendix B) and were based on average site depths of 1,000 m that resulted from the site-surveying work undertaken in 1992.

Each coil of rope was uncoiled using an improvised turntable. This was made out of an old rotating chair with a round plywood sheet screwed down onto it. The plywood sheet had a hole in the centre into which a length of galvanised pipe was fitted. The galvanised pipe fitted into the centre of the coil of rope. The coil of rope was placed on the turntable (Figure 14) and rotated in a clockwise direction and the rope was flaked out properly on the floor. Once the ropes had been uncoiled and properly flaked out, they were measured and spliced together end-to-end. The upper and lower ends of the rope which were to be connected to the upper and lower hardware were eye-spliced. The hardware—chain, shackles, thimbles, and swivels—were also connected together and laid out separately. These were connected later to the main mooring buoy and anchor block, after everything had been loaded onto *La Glorieuse*. The arrangement and connection of the hardware, mooring ropes, and other components of the FAD mooring system followed the SPC recommendations for a steel spar buoy mooring design (Gates et al., 1996). The construction and rigging on the two FAD units were completed in three days.

***Figure 14: Turntable arrangement used for uncoiling ropes for the FAD mooring***

*3.2.2 FAD deployments*

The two completed FAD units were checked thoroughly before being loaded onto the vessel. The ropes had been flaked into a box in a figure-eight style with the polypropylene rope end first, followed by the nylon rope. The box was then transported by truck to the vessel together with the steel spar buoy, the anchor, and the other hardware. At the wharf, the rope (nylon top end first) was pulled out of the box and flaked out carefully on the after deck of *La Glorieuse*. The mooring rope was flaked out in a such a way that the polypropylene rope section—connected to the lower hardware and anchor block—would run out first after the anchor was dropped (Figures 12 & 13). The lower chain was hung over the side with breakaway twine near the anchor, and the upper chain was hung the same way near the buoy. The twine would automatically snap as the anchor pulled the mooring rope down.

The Wallis FAD was deployed by the anchor-first method, similar to the method used for the 1992 deployments. While the boat was drifting very slowly near the deployment site, the buoy was lifted off the deck, lowered into the sea and pulled to the stern, where it was lashed securely to the rail above the water line near the upper chain. When this was done and the boat was at the deployment site, the anchor was lifted off the deck and lowered down slowly on the starboard side of the vessel until it reached the surface of the water. The bosun who was in charge of the after-deck operation reached over the side and cut the rope binding the anchor bail to the hook of the hydraulic crane. As the anchor descended it pulled the bottom chain loose from the break-away twine and pulled the mooring rope out through the fairlead at the stern.

Once the polypropylene rope had been paid out, and the anchor had landed at the bottom of the sea bed, the remaining nylon rope continued to pay out very slowly as the boat drifted away from the site with the wind. When all the rope was out, the lines securing the buoy were cut and the buoy and chain were dropped into the sea (Figure 15).

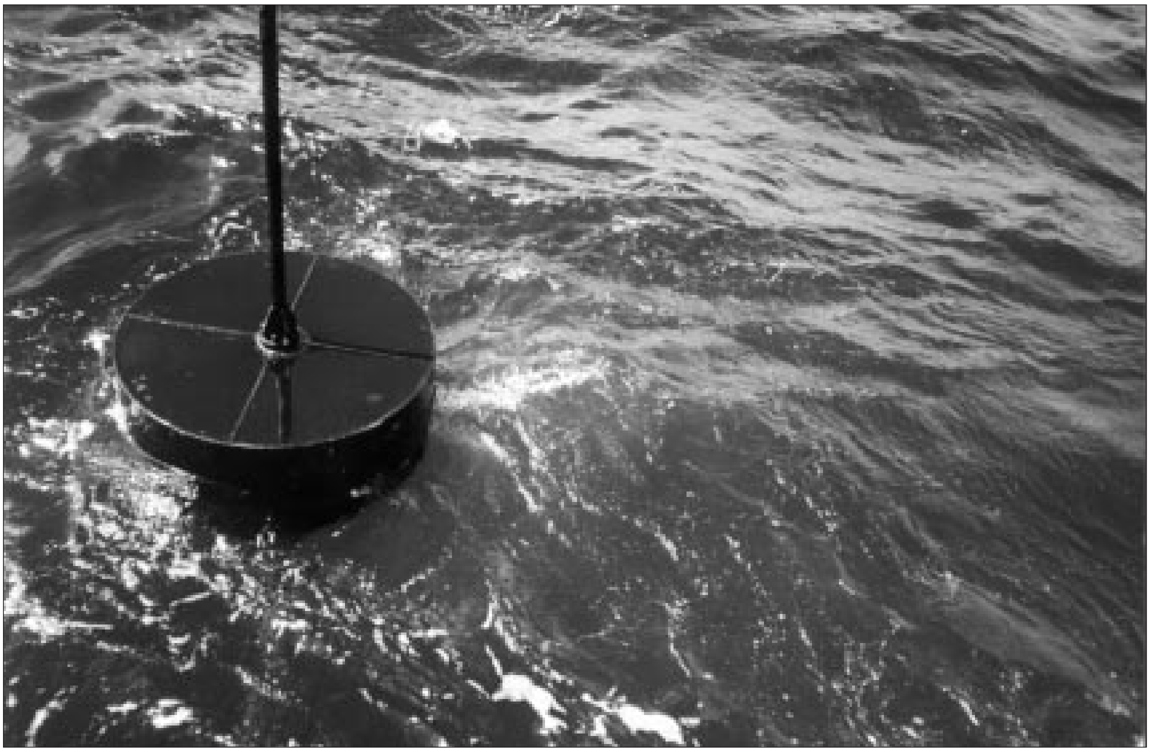

***Figure 15: Spar buoy released at the completion of deploying the Wallis FAD anchor first***

*3.2.3 FAD positions*

The FADs were deployed as close as possible to the same positions as those deployed in 1992, with Table 5 giving the position and depth information for the 1995 deployments.

**Table 5: Position and depth for the two FADs deployed at Wallis and Futuna in 1995.**

| FAD location | Position in latitude and longitude | Depth |
|---|---|---|
| Futuna | 14° 21.05' S, 178° 07.25' W | 960 m |
| Fatumanini Passage (Wallis No. 2) | 13° 11.75' S, 176° 17.75' W | 991 m |

# 4. Conclusions and Recommendations

## 4.1 Conclusions

The introduction of FADs in Wallis effectively served two functions: the potential reduction of fishing pressure in the lagoon and on the reef and reef slopes; and the increase in local supply of fresh fish, thus partially reducing the need for costly fish imports. In Futuna, the introduction of a FAD benefited the bottom fishery by enhancing the supply of bait. The local supply of fresh fish was also increased.

There is probably little prospect for the export marketing of domestically caught fresh fish from either Wallis or Futuna. Both islands have some of the infrastructure necessary for this, including working freezers and ice machines, but there is very limited air cargo space leaving Wallis and Futuna (two flights per week to either Tahiti or New Caledonia and one to Nadi, Fiji during school holidays). It may be possible for Wallis to export some tunas to Fiji for transshipment to markets developed by Fiji companies, but for the present, FAD deployments in the territory are likely to be solely for the benefit of subsistence and artisanal fishermen. Sports fishermen might also be expected to capitalise on FAD aggregations and this may positively affect tourism.

During the 1995 deployments, the SERP team gained experience in FAD mooring calculations, construction, rigging, and deployments. SERP counterparts should now be capable of conducting all of the technical phases of their FAD programme from site surveying to deployments. Both islands have boats adequate for conducting site surveys and SERP maintains well-equipped workshops in both Matu Utu and in Leava capable of providing the necessary technical services. In addition, materials required to outfit local vessels for survey work are readily available through local commercial dealers. However, in order to conduct further surveys without external assistance, SERP will have to acquire an echo-sounder with a depth range of 1,500–2,000 m and a GPS and plotter.

Since *La Glorieuse* did not have an echo-sounder capable of reaching depths of over 300 m, the deployment teams in 1992 and 1995 had to rely solely on the accuracy of the previous survey work. As it turned out, the recommended FAD sites proved to be in good positions and the depths given for the sites were accurate. Any future FAD deployments by SERP, unless new sites are identified by survey work, should be in these positions. There is an advantage to having other locations for FADs, if necessary, which would require additional site surveys. Any future surveys for potential FAD sites should concentrate on the north and east sides of Wallis and around Alofi in the Futuna group.

The most important constraint to SERP's FAD programme is the lack of a suitable deployment vessel. There is no vessel in the territory capable of carrying FAD anchors and deploying them safely. SERP will therefore have to continue to rely on the cooperation of visiting vessels, such as French naval craft, or eventually acquire a suitable vessel. Acquiring a suitable vessel could also have other advantages, in developing offshore fishing techniques or conducting research.

Since two of the 1992 FADs went missing prematurely, it is apparent that SERP needs to incorporate a regular FAD maintenance schedule into their FAD programme. It is well recognised that regular monitoring of the buoy and upper mooring components of FADs may extend time on station through early detection and replacement of worn or damaged hardware and ropes. A routine part of such inspections should be the replacement of appendage material as required to enhance effectiveness.

Catch records were collected during early 1993 for catches taken around the FADs by species. This is valuable data that should be collected as a matter of course, as without this data it is impossible to assess the economic advantage, or otherwise, of having FADs. It is essential that catch monitoring is an ongoing part of any FAD programme.

Fishermen should be encouraged to use the FADs more and to provide their catch data. Ways for SERP to encourage fishermen to use the FADs can include the provision of deployment notices (and loss of FAD notices) that give the position of each FAD with compass directions from the main passes in the reef. These notices would also be valuable for shipping agents, recreational and sport fishermen and any other interested parties. Another approach could be for SERP to run training courses or workshops in different fishing techniques that can be used in association with FADs. Such methods usually target the deeper-swimming, larger tunas that congregate, and include vertical longlining, dropstone and palu-ahi fishing methods. Also as part of any training or workshop, sea safety should be stressed as boats are venturing further offshore to fish around the FADs.

Finally, the materials supplied for the FADs in Wallis and Futuna in 1995 were supplied through Japanese aid. SERP will need to identify local suppliers within the region for suitable FAD materials in the future for their FAD programme, especially if there are small orders for specific items.

**Note**: On 11 August 1995 the SERP team successfully deployed a replacement FAD at the Passe Honikulu (Passe Sud) site from a visiting Navy ship, *La Place*. The Commander of *La Place* preferred to deploy the FAD mooring using the anchor-last method. The FAD materials used were part of the same store of materials supplied by the Government of Japan for the earlier 1995 deployments.

### 4.2 Recommendations

Based on information collected during 1992 and 1995, and the experience of those involved in the work, it is recommended that SERP:

(a) Acquire a suitable deep-water echo-sounder with a depth range of at least 1,500–2,000 m and a GPS unit with plotter;

(b) Conduct additional site surveys to locate other suitable FAD deployment sites, once they acquire echo-sounding and GPS equipment, concentrating on the north and east sides of Wallis and around Alofi in the Futuna group;

(c) Look at acquiring a suitable vessel for FAD deployment, that could also be used for other offshore fishing techniques or research purposes;

(d) Implement a planned monitoring and maintenance programme, as part of their FAD programme, to try to increase the lifespan of each FAD once deployed through regular checking and maintenance;

(e) Reinstate regular catch monitoring and marketing data into their FAD programme to collect the data required for assessing the economic effectiveness or otherwise of their FAD programme over time;

(f) Should issue FAD deployment notices giving position and compass directions (and notices about missing FADs) to fishermen, shipping agencies, and all other concerned persons;

(g) Should organise workshops for fishermen on FAD fishing techniques, to target the deeper-swimming tunas that congregate around FADs, as well as emphasising sea safety and how to fish around a FAD without damaging the mooring; and

(h) Should identify a reliable supplier of FAD materials for any future deployments as part of their FAD programme.

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## FAD mooring components

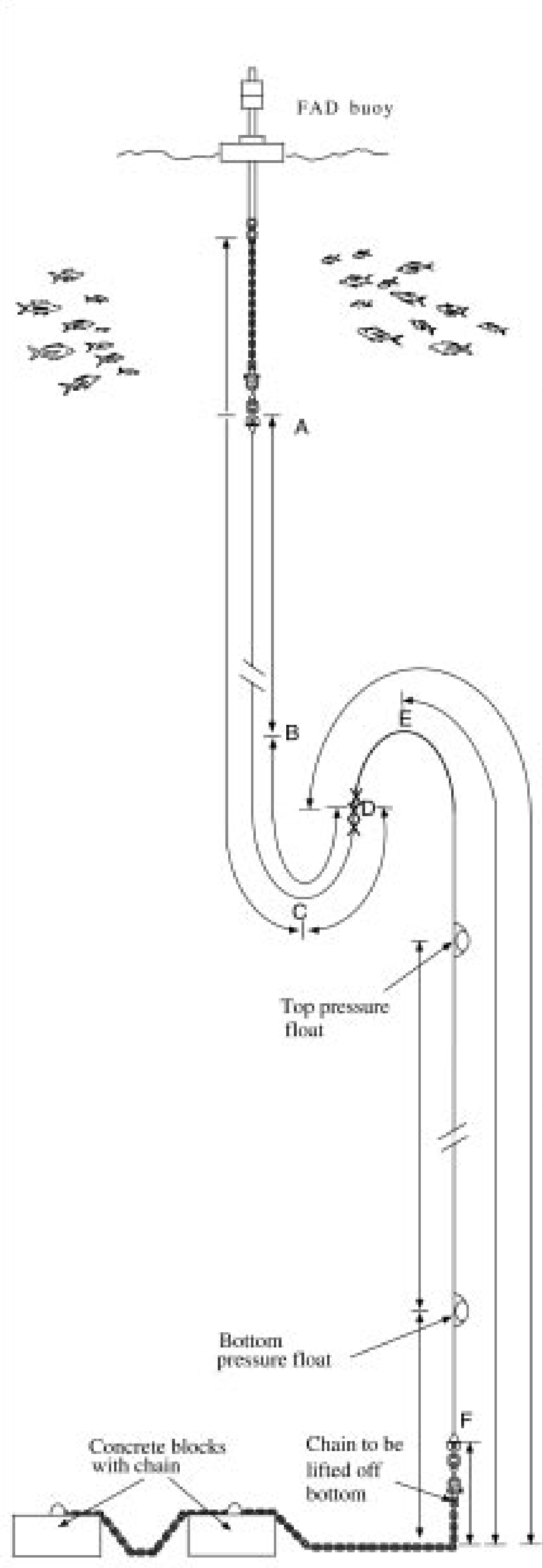
Material list for FAD mooring materials purchased from Continental Western Corporation for the 1992 FAD deployments. This list is everything needed for one FAD mooring—1,100 m site depth—except for the steel spar buoy, anchor block, and appendage:

- 2 x 25 mm safety shackles;
- 2 x 16 mm safety shackles;
- 3 x 19 mm safety shackles;
- 1 x 16 mm eye-to-eye swivel;
- 1 x 19 mm eye-to-eye swivel;
- 1 x 19 mm Samson Nylite connector;
- 1 x 22 mm Samson Nylite connector;
- 1 x 15 m length of 13 mm long link chain;
- 1 x 15 m length of 19 mm long link chain;
- 6 x zinc anodes;
- 1 x buoy light—Buny 1317 PE 71.6.SB amber colour;
- 316 m x 12-strand 19 mm nylon rope (sinking rope); and
- 1,033 m 12-strand 19 mm polypropylene rope (floating rope).

Specifications for a steel spar buoy can be found in Gates et al. (1996).

## FAD mooring calculations used in 1995

The following calculations were for a 1,000 m FAD site as all of the identified FAD sites in Wallis and Futuna were close to 1,000 m depth. These calculations were used for both of the 1995 deployments.




**Rope buoyancy calculations:**

From calculations below, EF = m
Weight of 1 m of rope in air = kg
.... m of rope supports .... % of its weight in sea-water (multiply by .....)
Buoyance of rope = .... x .... x ....
= ....kg

**Rope length calculations:**

AB = Site depth – (EF + .... m + .... m)
= .... m – .... m
= .... m

BC and CDE = Site depth x ..... / 2
= .... m x ..... / 2
= .... m (rounded down)

ABCD = AB + BC + CD
= .... m + .... m + .... m
= .... m

DEF = DE + EF
= .... m + .... m
= .... m

| ROPE SECTIONS | | VERIFICATION | |
|---|---|---|---|
| Upper chain | .... m | | |
| AB | .... m | Site depth | .... m |
| BCD | .... m | | |
| DEF | .... m | Catenary | |
| Lower chain | .... m | curve | .... m |
| TOTAL | .... m | TOTAL | .... m |

**Supplementary buoyancy calculation :**

Weight of .... m of hardware in air = .... kg
Steel weighs .... % of its weight in sea-water
Weight of hardware in sea-water = .... x ....
= .... kg
Buoyancy of rope EF = .... kg of hardware
Supplementary buoyancy needed = .... – ....
= .... kg
Pressure floats (.... m) available had .... kg of buoyancy, so .... floats were needed

**Placement of top and bottom float:**

Top float located just below catenary curve
= .... – .... – .... (.... % safety factor)
= .... m from bottom (or .... m from rope splice)
Bottom float located at .... % of its depth rating
.... – .... = .... m from bottom

**Site Name:** Wallis and Futuna

**PRELIMINARY INFORMATION**

Recommended minimum lengths appear in 2, 3 and 4, below (all lengths in metres)

| | | |
|---|---|---|
| Site depth | (1) 1,000 | minimum |
| Length of upper chain/cable | (2) 20 | 15 m |
| Length of nylon rope from upper chain to catenary curve | (3) 150 | 150 m |
| Length of hardware/chain to be lifted off the seabed | (4) 3 | 3 m |

**ROPE CALCULATIONS**

(1) Length of nylon rope from upper chain to catenary curve (AB) = 150

(2) Length of catenary curve (BCDE): preliminary calculation: 20 % of site depth
BCDE = site depth x 0.25 1,000 x 0.25 = 250 BCDE = 250

(3) Length of nylon in the catenary curve (BCD): preliminary calculation: 75% of catenary curve
BCD = BCDE x 0.75 250 x 0.75 = 187.5 BCD = 187.5

(4) Total length of nylon (ABCD): 150 + 187.5 = 337.5
ABDC = AB + BCD = ABCD = 337.5

(5) Length of polypropylene in the catenary curve (DE):
preliminary calculation: 25% of catenary curve 250 x 0.25 = 62.5
DE = BCDE x 0.25 = DE = 62.5

(6) Length of polypropylene segment (EF):

EF = site depth – (upper chain + AB + 3 m lower chain) EF = 827
EF = 1,000 – (20 + 150 + 3) = 827

(7)Total length of polypropylene (DEF):

DEF = DE + EF = 62.5 + 827 = 889.5

Now that the lengths of ropes for the mooring have been calculated, determine whether there is sufficient buoyancy in the polypropylene segment (EF) to lift 3 metres of hardware/chain off the seabed.

**BUOYANCY CALCULATIONS**

**Weight in air of bottom hardware:**

| | |
|---|---|
| 3 m chain: | 21.9 kg |
| 1 swivel: | 2.75 kg |
| 2 shackles: | 4.2 kg |
| Total weight in air: | 28.85 kg |

**Weight in seawater of 3 m of bottom hardware:**

Weight in seawater = weight in air x 0.867
Weight in seawater = 28.85 x 0.867 = 25.0 kg

Calculation of weight to be lifted off the seabed plus a 5 kg safety margin

Weight to be lifted = weight in seawater + 5 kg safety margin
Weight to be lifted = 25 kg + 5 kg = 30 kg

**Weight in air of polypropylene: either weigh a minimum of 30 metres of polypropylene or use rope specifications given by supplier:**

Weight in air of 1 m polypropylene = $\frac{\text{weight of rope}}{\text{length or rope}}$

Weight in air of 1 m polypropylene = 0.242 kg/m

**Buoyancy in seawater of 1 m polypropylene:**

Buoyancy in seawater of polypropylene = weight in air x 0.116
Buoyancy in seawater of polypropylene = 0.242 x 0.116 = 0.028 kg/m

**Buoyancy of the polypropylene segment (EF) that lifts the bottom hardware:**

Buoyancy = length of polypropylene (EF) x buoyancy in seawater of polypropylene
Buoyancy = 827 m x 0.028 kg/m = 23.2 kg

**Calculations to determine the needs for supplementary buoyancy:**

Weight to be lifted = 30 kg
Buoyancy of polypropylene segment (EF) = 23.2 kg

If buoyancy of EF is less than weight to be lifted: supplementary buoyancy is necessary.

Complete supplementary buoyancy calculations (see next page).

| SUPPLEMENTARY BUOYANCY CALCULATIONS | | |
|---|---|---|
| Calculation supplementary buoyancy:<br><br>Supplementary buoyancy = weight to be lifted – buoyancy of polypropylene (EF)<br><br>Supplementary buoyancy = 30 kg – 23.2 kg = 6.8 kg<br><br>(1 litre of buoyancy lifts 1 kg of weight) | | |
| **Float information: brand, size, type** | **Buoyancy** | **Rated depth** |
| Not available | 1.7 kg | 2,500 m |
| Number of floats needed to supply supplementary buoyancy:<br><br>Number floats = $\frac{\text{Supplementary buoyancy}}{\text{Float buoyancy}}$ = 4 floats | | |
| **CALCULATIONS FOR PLACEMENT OF FLOATS ON POLYPROPYLENE SEGMENT(EF)** | | |
| 1) Calculation for placement of shallowest float on EF:<br>(shallowest float must be below the bottom of the catenary curve)<br><br>Distance from the bottom hardware to the shallowest float:<br><br>Distance = EF – (50% of catenary curve BCDE) – 30 m safety margin<br>Distance = 827 – (0.5 x 250 ) – 30 m = 672 m<br><br>2) Calculation for placement of deepest float:<br><br>Maximum depth for deepest float = 1/2 x depth rating = 0.5 x 2,500 = 1,250 m<br><br>Placement of deepest float = not applicable as site depth is only 1,000 m<br>Site depth – (3 m bottom hardware + maximum depth for deepest float)<br><br>Placement = .... – (3 m + .....) = ..... m<br><br>Floats should be placed anywhere on EF between calculation (1) and (2) | | |