SOUTH PACIFIC COMMISSION

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REPORT ON

FISH AGGREGATING DEVICE (FAD)

TECHNICAL ASSISTANCE TO FIJI

12–23 October 1992

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This unpublished report forms part of a series compiled by the Capture Section of the South Pacific Commission's Coastal Fisheries Programme.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

Following discussions between South Pacific Commission's Capture Section and the Fiji Fisheries Division during August 1992, it was decided that two fish aggregating devices (FADs) would be deployed near Suva during October 1992. The FADs would replace lost FADs from two previous productive and popular locations, and would be in place before both the cyclone season and the summer skipjack tuna and yellowfin tuna seasons. Fiji Fisheries Division had previously requested help from the Commission's Deep Sea Development Project's FAD Assistance Programme. SPC Masterfisherman, Steve Beverly, was assigned to the project to supervise the temporary fitting of an SPC GPS (global positioning system) and colour echo-sounder on the Fisheries Division vessel, R/V *Tui-ni-wasabula*; to conduct site surveys in zones offshore from Nukulau passage and Beqa island; to rig two FADs; and to safely deploy the FADs at the chosen sites. SPC Masterfisherman, Tuainetai Rata, coordinated the re-fitting of two FAD buoys prior to the start of this project.

The GPS was corrected at Fisheries Division's jetty in Lami, and the first survey was conducted south of Nukulau Passage in an area encompassing several previous FAD sites. A contour map was drawn following the survey and a suitable FAD site selected. The first FAD was rigged at Fisheries Division in Lami using polypropylene and nylon ropes left over from a previous FAD programme. The FAD was fully assembled except for the last welds on the anchor chain and everything was loaded onto R/V *Tui-ni-wasabula*. Deployment was carried out with no mishaps.

As the second week of the project was coming to an end with only one FAD in the water, some rush work had to be done to ensure that the second FAD was deployed before the project's end. The second FAD was assembled—except for the final splices—and all materials were loaded onto R/V *Tui-ni-wasabula.* Vessel, crew, and gear spent the night in Beqa Lagoon. Work on the survey was begun at 0600 and, by noon of the last day of the project, the survey was completed, a FAD site had been selected, and all mooring calculations were finished on board the survey vessel. The final splices were done after the ropes were measured, and the FAD was deployed. R/V *Tui-ni-wasabula* was back at the Fisheries' jetty in Lami at 1900 hours.

Some shortcuts had to be taken during this project as FAD deployment was a priority over such considerations as counterpart training. Recommendations for the continuation of Fisheries Division's FAD programme include nothing less than a complete re-organisation from record keeping to staff training. New designs for FAD buoy and anchors need to be explored, as well as a safer method of deploying the anchor(s) from R/V *Tui-ni-wasabula*.

RÉSUMÉ

Suite aux entretiens qui ont eu lieu entre la section Techniques de pêche de la Commission du Pacifique Sud et le service des pêches de Fidji en août 1992, il a été décidé que deux dispositifs de concentration du poisson (DCP) seraient mouillés près de Suva en octobre 1992. Ces DCP remplaceraient ceux qui ont été perdus dans deux zones productives et très prisées et seraient mis en place avant la saison des cyclones et la saison d'été de la pêche de la bonite et du thon jaune. Auparavant, le service des pêches de Fidji avait sollicité l'aide des responsables des opérations d'assistance dans le domaine des DCP du projet de développement de la pêche au demi-large. Le maître de pêche de la CPS, Steve Beverly, a été affecté au projet afin de surveiller la mise en place provisoire d'un GPS (système mondial de localisation par satellite) et d'un échosondeur en couleurs de la CPS à bord du bateau du service des pêches, le *Tui-ni-wasabula*, de réaliser des études de site dans des zones situées au large de la passe de Nukulau et de l'île Beqa, de monter deux DCP et de les mouiller en toute sécurité sur les sites sélectionnés. Le maître de pêche de la CPS, Tuainetai Rata, a coordonné la révision de deux bouées de DCP avant le démarrage de ce projet.

Le GPS a été corrigé sur la jetée du service des pêches à Lami, et la première étude a été réalisée au sud de la passe de Nukulau, dans une zone où plusieurs DCP avaient été mis à l'eau au préalable. Une carte bathymétrique a été établie suite à l'étude, et un site adapté au mouillage d'un DCP a été choisi. Le premier DCP a été monté au service des pêches à Lami à l'aide de cordes en polypropylène et en nylon qui n'avaient pas été utilisées à l'occasion d'un précédent programme de DCP. Le DCP a été entièrement assemblé, à l'exception des dernières soudures sur la chaîne d'ancre, et tout les éléments ont été chargés à bord du *Tui-ni-wasabula*. Le mouillage s'est effectué sans heurt.

La deuxième semaine d'exécution du projet arrivant à son terme et seul un DCP ayant été mouillé, il a fallu faire quelques travaux d'urgence pour s'assurer que le second DCP serait mouillé avant la fin de la période de mise en œuvre du projet. À l'exception des dernières épissures, ce second DCP a été assemblé et tous les éléments ont été chargés à bord du *Tui-ni-wasabula*. Le navire, l'équipage et les engins ont passé la nuit dans le lagon de Beqa. Les travaux de l'étude ont débuté à 6 heures, et à midi, le dernier jour, ils étaient terminés :, un site a été retenu pour le mouillage du DCP et tous les calculs nécessaires au mouillage ont été effectués à bord du bateau utilisé pour réaliser cette étude. Les dernières épissures ont été faites après que les cordages eurent été mesurés et le DCP a été mis à l'eau. le *Tui-ni-wasabula* était de retour à la jetée du service des pêches, à Lami, à 19 heures.

Le mouillage du DCP étant prioritaire par rapport à des considérations telles que la formation d'agents locaux, certains raccourcis ont dû être empruntés pendant la mise en œuvre de ce projet. Les recommandations en faveur de la poursuite des opérations d'assistance dans le domaine des DCP du service des pêches sont majeures : elles suggèrent une réorganisation complète allant de la tenue des livres de pêches à la formation du personnel. De nouveaux modèles de bouées et d'ancres de DCP doivent être étudiés, de même qu'une méthode plus sûre de mouillage de(s) (l')ancre(s) mise(s) par le *Tui-ni-wasabula*.

CONTENTS

1. INTRODUCTION AND BACKGROUND

Fiji's first fish aggregating devices (FADs) were deployed in the second half of 1981 for use by purse-seiners, and subsequently for pole-and-line boats, and artisanal and subsistence fisherman (Preston 1982). By the end of 1982, over 100 FADs had been deployed in Fiji by commercial pole-and-line and purse-seine operators. Many of these FADs were lost due to a range of causes, mainly adverse weather conditions (cyclones), fish-bite and vandalism. In the following years, many more FADs were deployed to aggregate small tunas to assist the industrial fishing fleet operating in Fijian waters.

By contrast to 1981/82, only ten FADs were deployed in 1991: eight by Fisheries Division and two by Ika Corporation (Anon 1992). Unfortunately, most of these FADs had been reported missing long before their life expectancy was over. FADs have played an important role in developing and expanding commercial, artisanal, subsistence, and sport fishing in Fiji.

The purpose of this short-term project was to re-start Fisheries Division's FAD Programme by quickly replacing FADs in two popular and very productive locations near Suva. This was necessary as several staff of the Fisheries Division with the expertise required for constructing and deploying FADs had transferred or left the division. As a follow up, SPC and Fisheries Division planned to work together for six months during 1992 and 1993 to re-vitalise the very important Fiji FAD Programme and train additional Fisheries Division staff.

2. FITTING ELECTRONICS ON R/V *TUI-NI-WASABULA*

R/V *Tui-ni-wasabula* was equipped with a GPS navigator and a colour echo-sounder. However, SPC supplied electronics were installed and used for this project as the Masterfisherman was more familiar with their use and had more confidence in their capabilities. The JRC JLR 4110 GPS was mounted, as in past FAD surveys, onto the Furuno FCV 362 colour echo sounder (Beverly & Cusack 1993). This was achieved by drilling holes in the sounder display housing and fixing the GPS unit's mounting bracket to it with stainless steel machine screws. This arrangement enabled monitoring of both instruments simultaneously.

The GPS was powered from a 12 VDC buss-bar located near the chart table in R/V *Tui-ni-wasabula's* wheelhouse. The antenna was clamped to a broomstick which was lashed to the canopy frame on the flybridge. Admiralty Chart No. 745—Kadavu to Suva Harbour, was used throughout the survey work—the GPS was initialised with WGS 84 datum as per the chart. A correction was made at Fisheries' jetty in Lami of 0° 0.150' S from a chart position of 18° 0.600' S and 178° 23.700' E.

The colour echo-sounder was mounted onto the chart table and was powered by a 24 VDC supply also powering a JRC radio direction finder, which was not used during survey work. Some problems were encountered with the supply of 24 VDC during the first day's survey and a portable generator had to be brought on board on subsequent days to supplement the engine alternator that charged the 24 VDC battery bank. No problems were encountered after the first day.

The transducer and aluminium transducer housing (Figure 1) were mounted onto a cross of timber which was then lashed to the starboard side of the boat. This position was a little bit further aft than is recommended in the user's manual but it was the easiest place to do the lashing (Figure 2). At slow speeds the readout and picture were fine but at higher speeds the transducer vibrated too much. This may have contributed to the power problems: at low engine speeds the alternator could not keep up with the power demand. At higher speeds the transducer vibrated. The portable generator and battery charger eliminated this problem.

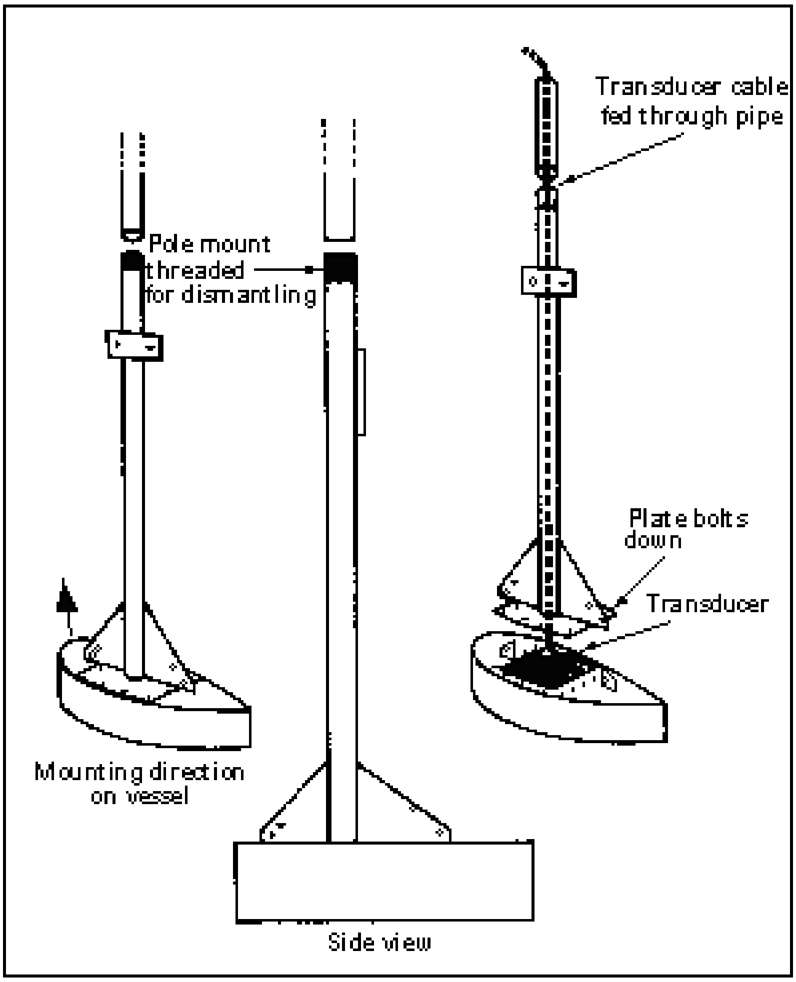


Figure 1: SPC's portable aluminium transducer housing

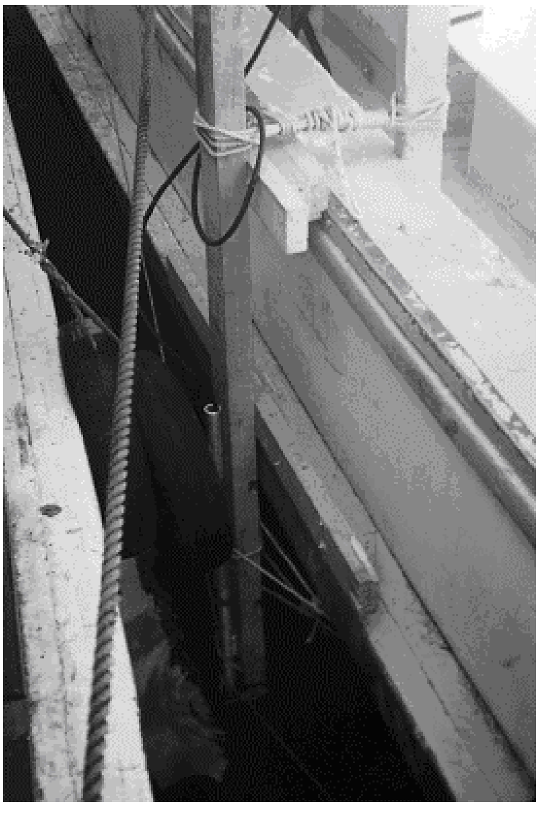


Figure 2: Transducer housing mounted on timber and lashed in place on starboard side of vessel

3. SELECTING FAD SURVEY ZONES AND SITES

FADs deployed in the areas south and southwest of Suva had been very productive over the years for commercial, artisanal and sport fishing operations. With Suva being the main commercial centre in Fiji, and where a large percentage of the population lived, it was obvious that FADs needed to be deployed and maintained in this area on a regular basis.

3.1 Nukulau FAD survey zone

From the records at Fisheries Division, there seems to be some confusion over the naming of past FADs in the area just south of Suva. Old FAD sites are referred to in the records as Suva Pt., Nukubuco, or Nukulau. These were all generally in the same area—the shelf waters off Laucala Bay barrier reef (Figure 3). Chronologically, some of the old FAD positions were as follows:

- 1984: 18° 12' S—178° 29' E in 400 m
- 1985: 18° 14' S—178° 28' E in 660 m
- 1986: 18° 17' S—178° 32' E in 1,400 m
- 1986: 18° 14' S—178° 27' E in 1,100 m
- 1991: 18° 14' S—178° 29' E in 400 m

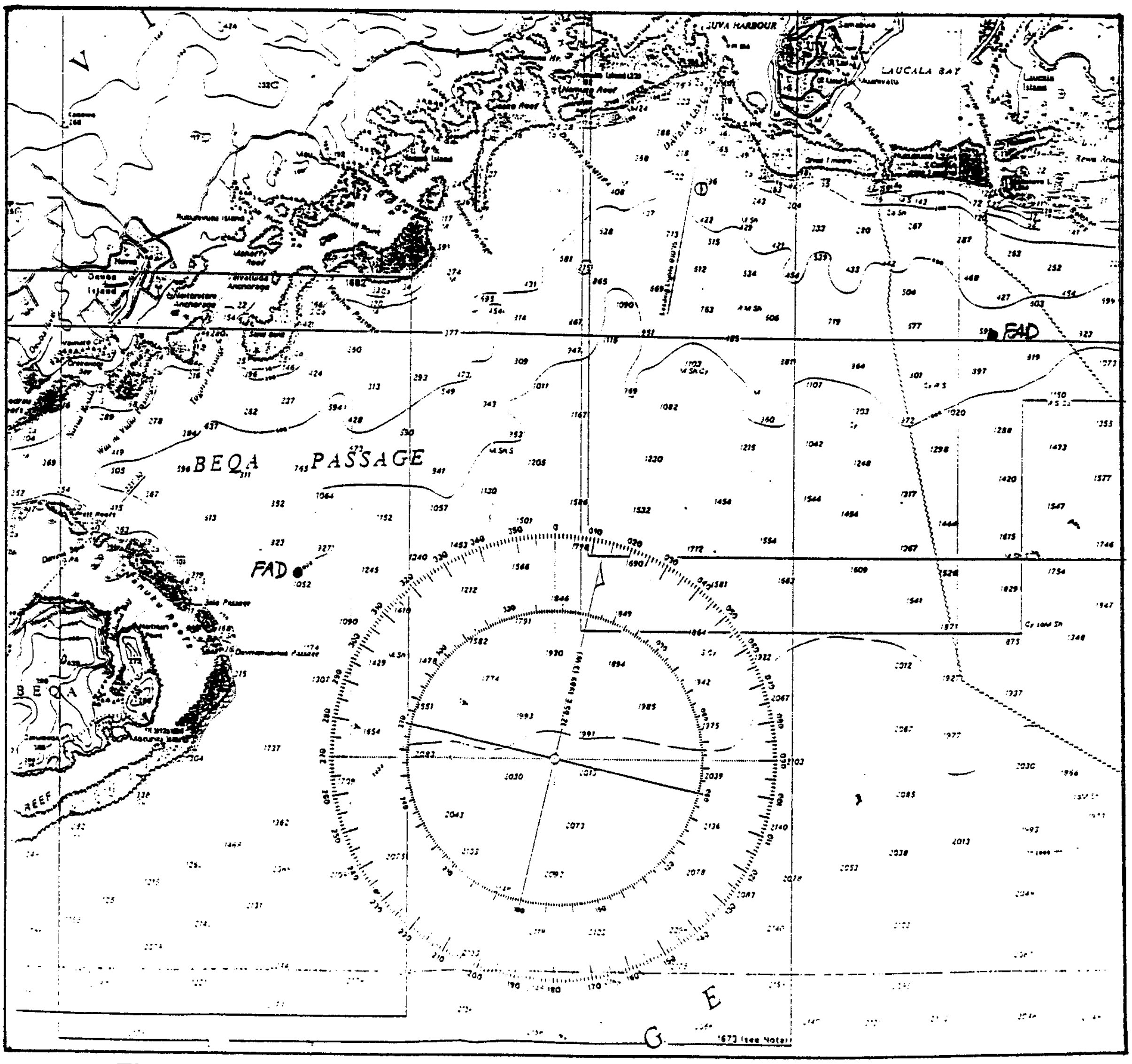


Figure 3: Areas south and southwest of Suva where two FADs were to be deployed

The FADs that did survive the usual array of man-bite, fish-bite, hardware failure, and cyclones in this area have been very productive in the past. Therefore, it was decided to conduct the survey in an area adjacent to most of these sites. The area chosen was bordered by: 18° 13.500' S—18° 15.500' S and 178° 28.000' E—178° 33.000' E.

3.2 Beqa FAD survey zone

From the records, there were two FAD sites from 1985 deployments by Fisheries Division just east of Beqa (southwest of Suva—Figure 3). Anecdotal reports indicate that these FAD positions have been very productive fishing spots both for artisanal fishermen and for sport fishermen. The east side of Beqa has been a good source of marlin as well as the usual species associated with FADs. The positions of these FADs were as follows:

No. 1: 18° 22.8' S—178° 14.9' E

No. 2: 18° 24.3' S—178° 16.7' E

Both FADs had been deployed in 1,350 m of water.

It was decided to conduct the survey around the 1,000 m curve just north of the first position given above. The FAD survey zone was bordered by: 18° 20.500' S—18° 22.000' E and 178° 12.000' S—178° 16.000' E.

3.3 Site survey method and deployment sites selected

The R/V *Tui-ni-wasabula* was steered along transects at both survey zones, using the echo-sounder and GPS to provide depth and position. Starting at the northern-most and eastern-most position of the site survey zone, the helmsman was directed to steer due west. On this course the readout for latitude on the GPS should not vary by much. Each transect was run with the resolution of latitude and longitude set at ‘0.001’ rather than ‘0.01’ for greater accuracy. In reality, slight adjustments to the course had to be made along each transect, depending on whether the vessel had drifted south or north of the desired course.

While following such a course, the GPS and the colour echo-sounder were constantly monitored simultaneously. At each 0.250 minute of longitude interval on the GPS screen (0.25 nm) the depth in metres was recorded. After one transect was run in this way the vessel was steered south to the next transect 0.25 nm away and the reciprocal course steered. The process was repeated going in an easterly direction. This method eliminated the need to enter waypoints into the GPS.

A log sheet was prepared prior to each day’s survey work with latitude and longitude filled in, so that only depth data and any observations (eg. steep bottom, birds in area) had to be recorded. Recorded depths were later transferred to a grid using graph paper as a plotting sheet. Intervals in 100 m increments were determined by extrapolation and contour lines were drawn for each 100 m contour.

The contour drawing made from the bathometric survey data for the Nukulau survey zone revealed a canyon and a ridge within the area surveyed (Figure 4). It was decided to deploy the FAD on the flat bottom near the middle of the ridge in 603 m of water. The position chosen was 18° 14.750' S—178° 30.750' E (Figures 3 & 4).

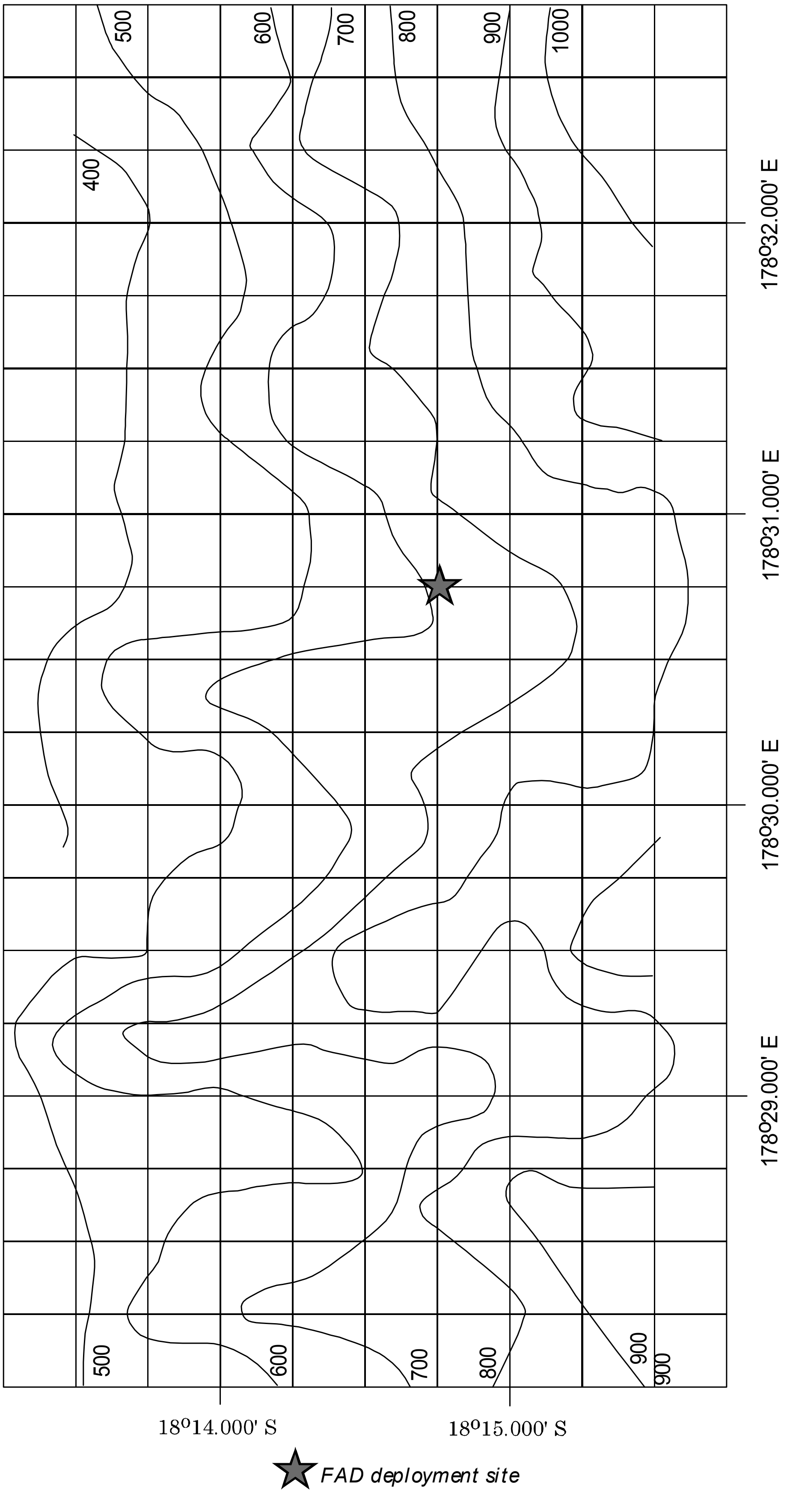


Figure 4: Contour drawing of the survey zone off Nukulau with selected FAD deployment site

The survey in the Beqa zone revealed a large flat area within the area surveyed of 1,000 m depth. The slope appeared to rise gently going from east to west towards Beqa (Figure 5). The chosen FAD site was in 1,003 m at 18° 20.750' S—178° 14.000' E (Figures 3 & 5).

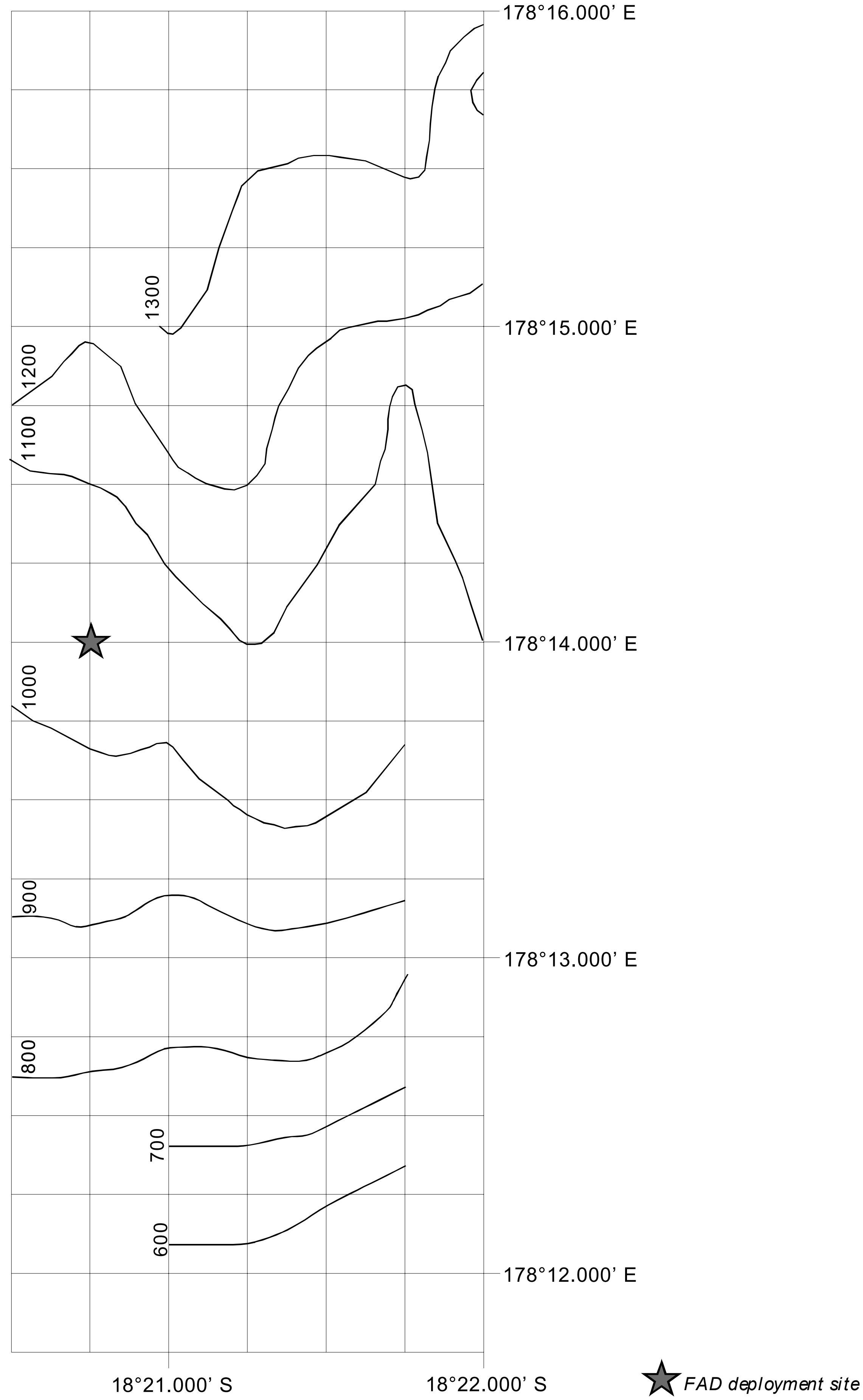


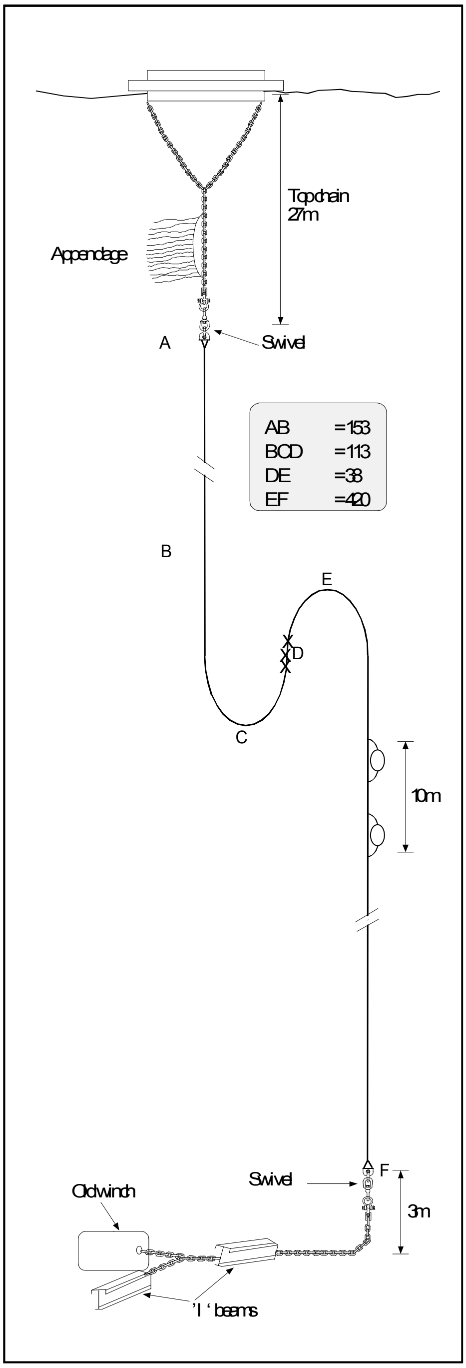
Figure 5: Contour drawing of the survey zone off Beqa with selected FAD deployment site

4. MOORING CALCULATIONS, CONSTRUCTING AND DEPLOYING THE FADs

All mooring calculations and construction for both FADs were done following SPC recommendations, which have since been published in Gates et al (1996).

4.1 Mooring rope calculations

The ropes used for both FAD moorings—Nukulau and Beqa—were eight strand braided Japanese made ropes. The nylon rope was 19 mm and the polypropylene rope was 22 mm diameter. The SPC recommendation for catenary curve moorings is that point E (Figure 6) should be around 180 m below the surface. This was the case for the FAD deployed off Nukulau, however, in the rush to get underway for deploying the Beqa FAD, not quite enough nylon rope was taken. This problem was overcome by lengthening the polypropylene segment of the line, section EF (Figure 7), by a slight amount. The result was that point E on rope section EF was less than the recommended 180 m below the surface. Table 1 shows the rope calculations for the moorings at both locations.



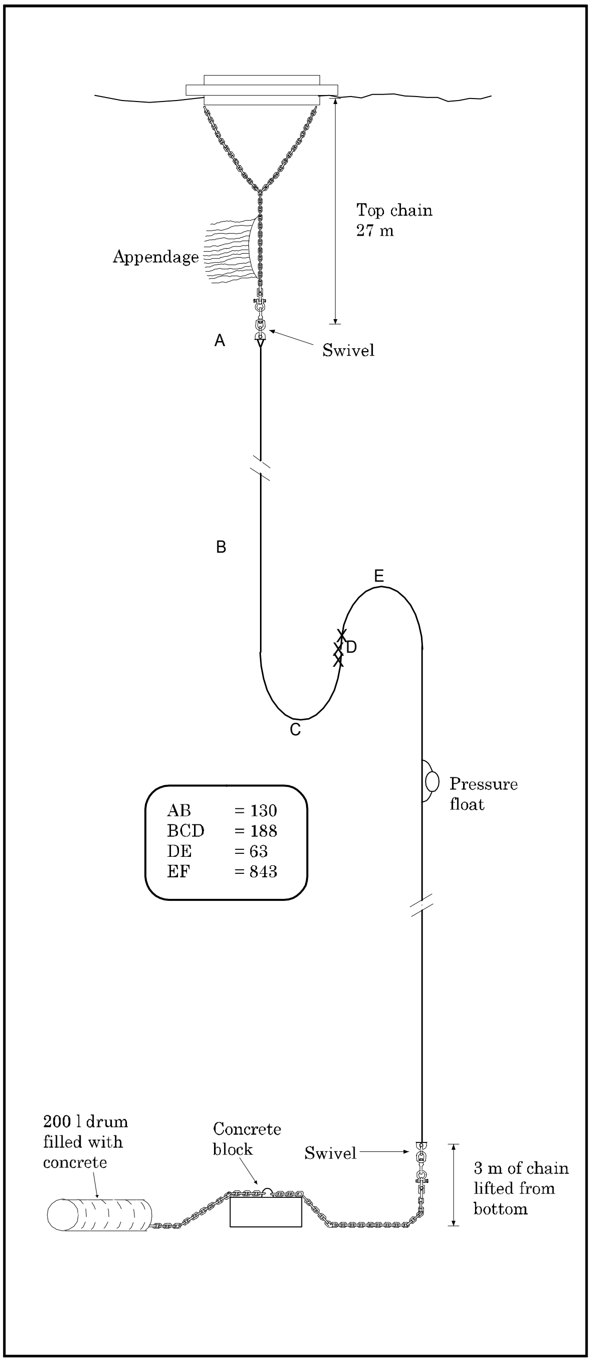


Table 1: Mooring rope calculations for FADs deployed of Nukulau and Beqa

Nukulau FAD deployed in 603 m (Figure 6)	Beqa FAD deployed in 1,003 m (Figure 7)
AB = 180 – 27 = 153 EF = 603 – (180 + 3) = 420 BCDE = 603 x 0.25 = 151 DE = 151 x 25% = 38 BCD = 151 – 38 = 113 Total nylon = AB + BCD or 153 + 113 = 266 m Total polypropylene = DE + EF or 38 + 420 = 458 m **Cross-check** Upper chain 27 ABCD 266 DEF 458 Lower chain 3 Total = 754 m Site depth 603 Catenary curve 151 Total = 754 m	AB = 130 EF = 1,003 – (130 + 27 + 3) = 843 BCDE = 1,003 x 0.25 = 251 DE = 251 x 25% = 63 BCD = 251 – 63 = 188 Total nylon = AB + BCD or 130 + 188 = 318 m (total available) Total polypropylene = DE + EF or 63 + 843 = 906 m **Cross-check** Upper chain 27 ABCE 318 DEF 906 Lower chain 3 Total = 1,254 m Site depth 1,003 Catenary curve 251 Total = 1,254 m

4.2 Supplementary buoyancy calculations

Since 603 m was relatively shallow for a FAD site, the Nukulau FAD mooring would have to be an adjusted mooring using pressure floats as a supplement to the buoyant polypropylene rope. This was anticipated ahead of time and pressure floats were supplied by SPC. The bottom hardware and chain were not weighed, however, an approximate figure of 20 kg was used in all supplementary buoyancy calculations. This would allow for more than three metres of chain to be lifted off the bottom, as only 13 mm chain was used for the bottom chains on both FADs—13 mm chain weighs approximately 6 kg/m.

Weight of steel to be lifted = 20 kg x 0.869 (weight of 1 kg of steel in salt water) = 17.38 kg.

The weight of the 22 mm polypropylene rope was 0.19 kg/m with a buoyancy of 0.116 = 0.02204 kg/m. The buoyancy of polypropylene and supplementary buoyancy needed is calculated in Table 2.

Table 2: Supplementary buoyancy calculations for both FADs

Nukulau FAD deployed in 603 m (Figure 6)	Beqa FAD deployed in 1,003 m (Figure 7)
DEF (22 mm polypropylene rope) = 458 m Buoyancy of rope in salt water = 0.02204 kg/m 458 x 0.02204 = 10.09 kg of buoyancy Weight of bottom hardware to be lifted = 17.38 kg 458 m of polypropylene rope will lift 10.09 kg. Therefore additional buoyancy needed to lift an additional 7.29 kg of bottom hardware.	DEF (22 mm polypropylene rope) = 906 m Buoyancy of rope in salt water = 0.02204 kg/m 906 x 0.02204 = 19.97 kg of buoyancy Weight of bottom hardware to be lifted = 17.38 kg 906 m of polypropylene rope will lift 19.97 kg. Therefore no additional buoyancy is needed.

The 10.09 kg of flotation that would be provided by 458 m of polypropylene rope was insufficient to lift 17.38 kg of bottom chain on the Nukulau FAD, so additional flotation was necessary. Pressure floats supplied by SPC were Viny (Japan) No. 10B-8 with 5.2 litres of buoyancy. One litre of salt water weighs 1.027 kg, so 5.2 litres of buoyancy will lift 5.2 x 1.027 kg, or 5.34 kg. Therefore, two pressure floats were needed to give the supplementary buoyancy needed.

With the Beqa FAD, the 906 m of polypropylene rope provided adequate buoyancy to lift 3 m of bottom hardware clear of the seabed. However, as a safety margin, one 5.2 litre pressure float was used on this mooring.

4.3 Rigging the FADs

Several FAD buoys of a Fisheries Division design were on hand at their headquarters in Lami. These consisted of a steel drum with an angle-iron frame supporting several lengths of bamboo as well as pad-eyes for a chain bridle (Figure 8). The bamboo on these buoys was decomposing and had to be replaced. SPC Masterfisherman, T. Rata, supervised this phase of the work. After the survey work for the Nukulau site was completed, Masterfisherman S. Beverly supervised the rigging of the FADs. Bridle chains were shackled to the buoys and to the top chain. A swivel and a nylon block thimble were then shackled to the other end of the top chain. All shackles were welded to prevent FAD loss due to hardware failure.

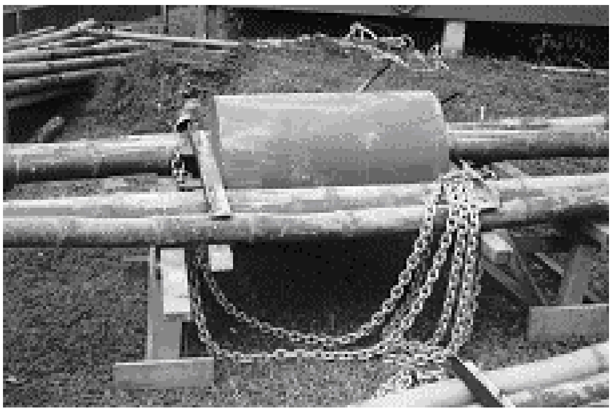


Figure 8: Fiji Fisheries Division design FAD buoy used

Rope splices were completed after a little practice. Eye splices were done according to instructions from Wall Rope Works given in SPC Handbook No. 24 (Boy & Smith, 1984). The end-to-end splice, however, could not be done according to these instructions. Since the nylon and polypropylene ropes were different diameters and textures, the Wall Rope Work's method did not work. The splice that was used was more like a short splice on three strand rope, ie., rope was unlaid and the two ends were butted together and taped in place. Tucks were then made as per instructions. The result was a tight, compact splice that appeared to be quite strong .

4.3.1 Nukulau FAD anchor and appendage

The anchor used for this mooring was selected from an assortment of discarded junk at Fisheries. Two steel "I" beams and an old winch were chained together with a bridle (Figure 6) which was then shackled to a 25 m length of 13 mm anchor chain. Again, all shackles were welded. The resulting anchor was not weighed but it was estimated to be about 800 kg. A swivel was also installed between the anchor chain and the polypropylene rope using a nylon block thimble on the rope.

An appendage, or aggregator, was made from old netting woven into a 10 m length of 22 mm polypropylene three strand rope. This was attached in the middle of the top chain with shackles in such a way that it could not entangle the swivel at the bottom of the chain (Figure 6).

The two previously mentioned pressure buoys were spliced into the polypropylene rope 10 m apart and far enough down the line to be out of danger of fouling. Gates et al (1996) recommends a spacing of at least 2 m between pressure floats with the deepest float being at half the rated depth. The floats were attached using three strand 22 mm polypropylene rope knotted at each end to prevent movement of the buoy. The three strand rope was unlaid and tucked into the eight strand polypropylene rope at both ends.

4.3.2 Beqa FAD anchor and appendage

The Beqa FAD was rigged the same as the Nukulau FAD—with a few differences. The final splices were done at sea and the anchor was a bit different. The anchor for this FAD was made from two salvaged concrete anchor blocks. One was a 200 litre drum filled with concrete, the other a one metre square block 30 cm thick (Figure 7). The two blocks were chained together with a bridle which was then shackled to 25 m of 13mm chain. The weight of the resulting anchor was estimated at 750 kg. This was based on a figure of 1.5 for the specific gravity of concrete in salt water (information obtained from a Suva architect).

The appendage was the same as on the Nukulau FAD but with a different kind of net. One pressure float was attached in the same way as for the Nukulau FAD as a safety measure. Lastly, since two coils of polypropylene were used, another splice had to be done. The splice used was an end-to-end splice, but was done using a double splice.

4.4 Deployment of FADs

Deployment was by the buoy first method. The buoy was stored on the aft canopy of R/V *Tui-ni-wasabula* (Figure 9) for each deployment. The only problem with deploying the buoy from the canopy was that it flipped over and had to be righted. The line was paid out as R/V *Tui-ni-wasabula* steamed in a circle that eventually brought it back to the buoy. As there was not much wind or current, the anchor was pushed over at the chosen site. Deployment of the anchor on the Nukulau FAD turned out to be not entirely safe, as the two "I" beams swung around in an arc when the winch went over. Fortunately, no one was injured.

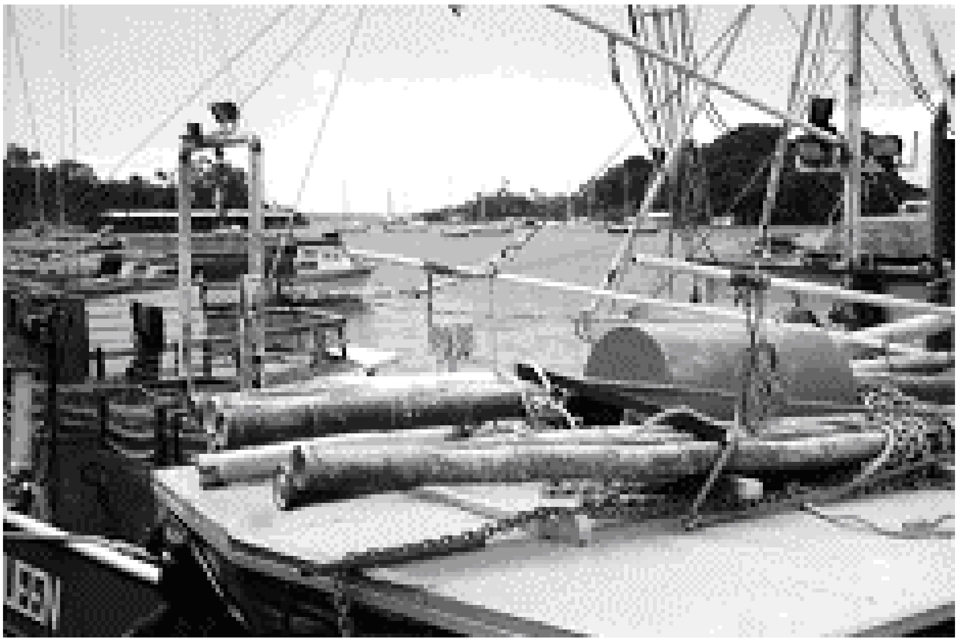


Figure 9: FAD buoy stored on aft canopy for transport to deployment site

After deployment of the FAD, R/V *Tui-ni-wasabula* stayed on station for 30 minutes to check the final position. The position of the Nukulau FAD after 30 minutes was 18° 13.870' S—178° 30.870' E in 620m. This was very near the chosen site of 18° 14.750' S—178° 30.750' E. The final settling position for the Beqa FAD was 18° 20.550' S—178° 13.700' E in 1016 m. This was relatively close to the intended site and depth. The slight difference in position and depth may have been because the anchor drifted while sinking—which is very likely considering the awkward shape—or the buoy could have been stretched out to the extent of scope available.

There was no time during this project for further position checks of either FAD.

5. RECOMMENDATIONS

Fisheries Division FAD Programme needs to be completely re-organised. A concise record should be assembled of all past FAD sites including exact position, productivity, dates, depth, longevity, buoy type, appendage type, etc. A uniform format for storing such information should be devised. An attempt was made in the past to do this but the format was either inadequate or incomplete and, in any event, was not used consistently.

Information should be noted in a uniform manner (depth should always be given in metres, not fathoms). Potential FAD sites should be surveyed and bathometric data should also be recorded and contour maps drawn for each site. Information on bottom topography can be obtained from SOPAC—South Pacific Applied Geoscience Commission—in Suva. This information should be compared with data from survey work. Records should also show mooring calculations and give information on rope types, anchor types, and probable cause of failure when each FAD fails.

Information on FAD positions given to the public, as in press releases, should include compass directions and distances from passages to FAD sites—and radar bearings. Most artisanal fishing boats do not have GPS.

FAD materials that are on hand at Fisheries Division need to be sorted out and an inventory taken. FAD materials were found in at least three different locations during this project and on one occasion crucial parts were located after an effort was made to purchase the same materials. A search turned up 100 swivels when none were thought to be available. Such duplication of effort and expense could be avoided with a little organisation.

New FAD buoy designs should be explored. A simple design using a buoy with a light spar is desirable. Bamboo, although inexpensive, requires time and labour to install and it does not last long in sea water. Also, addition of a light and a radar reflector may increase FAD life by reducing chances of collisions with boats. During this project, reflective tape was added to the buoys for this purpose. Identification marks or numbers should be applied to all FAD buoys to aid in recovery after loss.

The bridle chain design should be eliminated from the present design of FAD buoys. At least eight shackles would be eliminated if the bridle design was discarded. This is a needless expense as designs exist that use only one chain (refer Gates et al 1996).

The FAD Programme also needs a reliable and inexpensive anchor design that is easy to fabricate and safe to deploy. The simplest design is a concrete block. One other possibility is a concrete mushroom anchor—mushroom anchors would be easy to deploy as they could be rocked back and forth off of a ramp during deployment. They also have the advantage of having more holding power by weight than blocks or cylinders of concrete. Mushroom anchors dig into mud or sand—and the chain is not likely to foul as with other anchor designs.

The method of deploying anchors from R/V *Tui-ni-wasabula* needs to be made safer. A wide ramp that is well made and sturdy is a minimum requirement.

At least one staff member of Fisheries Division should be chosen to supervise the FAD Programme. This person should be trained in all phases of FAD mooring work. Training should include survey work, mooring calculations, splicing, maintenance, and record keeping. A possible tool for this could be a video on FADs and FAD deployment. In the short time available during the present project visit, not much counterpart training relating to theory took place—but a real need for such training was identified. Future efforts in counterpart training would be fully justified.

6. REFERENCES

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