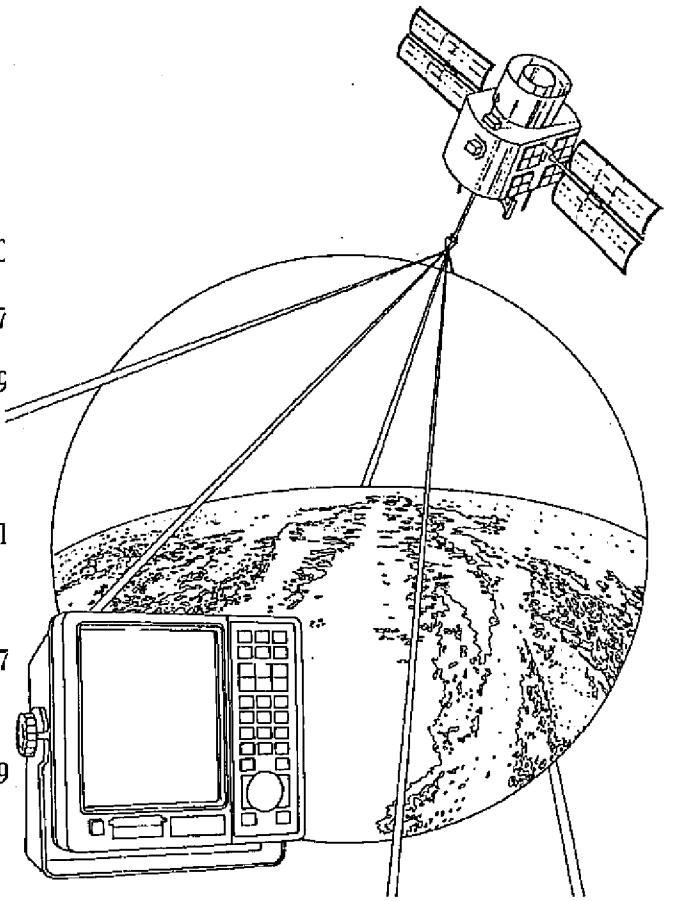
SOUTH PACIFIC COMMISSION

FISHERIES NEWSLETTER

NUMBER 56
JANUARY — MARCH 1991

IN THIS ISSUE



GLOBAL POSITIONING SYSTEM: AN AID FOR NAVIGATION?

Original text: English

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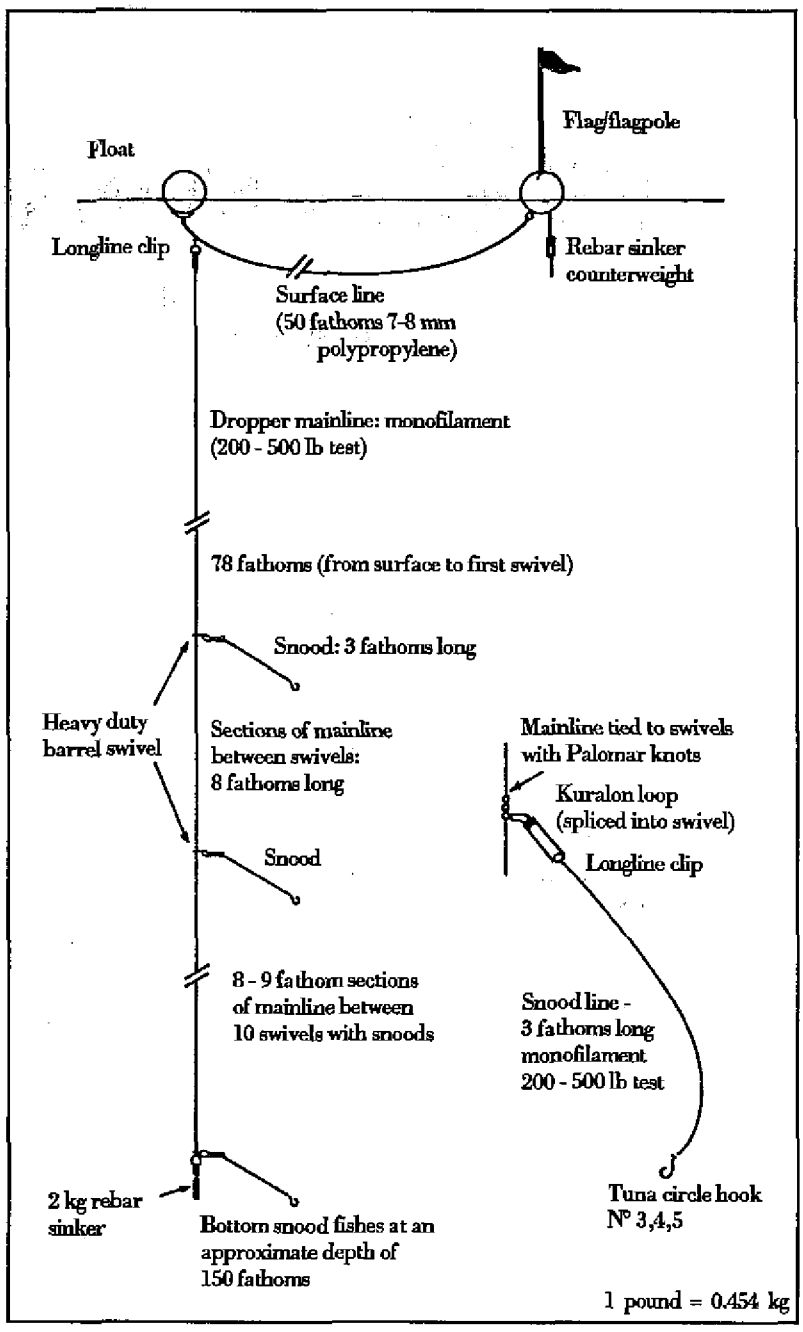
DEEP SEA FISHERIES DEVELOPMENT PROJECT NOTES

Western Samoa — Tuna longlining project

Canadian consultant masterfisherman, Peter Watt, who last worked for the DSFD Project in the Northern Mariana Islands, has been working in Western Samoa since late September 1990. The aims of the visit are to develop a workable longlining system for the Fisheries Division vessel *Tautai Matapalapala*; to train the vessel's crew in the use of the gear; and to train selected crew members in aspects of seamanship and navigation. The vessel, provided to Western Samoa by USAID, is a 13 m fibreglass-hulled launch, fitted out as a sea-going fishing/research vessel, complete with hydraulic line hauling gear, echo-sounder, and large iced-fish hold.

The hydraulic longline hauler fitted onto the vessel is manufactured by Custom Sea Gear of Florida, USA, a Miller-King model. It is designed to handle heavy monofilament nylon fishing line using a removable spool, or drum, system.

Three spools were available, each of which could take approximately 1 mile (1600 m) of 545 kg test line. In practice, the hauler proved to be too slow to haul the long lengths of line required for horizontal longlining. The equipment was therefore adapted to haul the type of vertical longlines developed by the DSFD Project over the last couple of years. By employing multiple vertical droppers, each rigged with ten hooks on snoods, and linked together at the surface for ease of handling, around 90 hooks could be set at a time, and fished through a wide range of depths. This type of rig is regarded as especially effective when fishing around fish aggregation devices (FADs) or on known tuna concentrations. The rig is illustrated in the drawing above and the materials and measurements are listed on page 3.



Vertical longline gear arrangement

As with all longlining operations, the supply of good bait was critical to these fishing trials. Western Samoa is fortunate in having a major commercial tuna fishing port in neighbouring American Samoa.

Vertical longline components

Surface float	Standard 300 mm hard plastic longline float with 12.5 cm stainless steel longline clip attached.
Marker buoys	4 m length of bamboo. 4 pieces of steel rod (2.5 cm diameter x 30.5 cm length) lashed to the bottom of the bamboo with rubber strips. One 200 mm inflatable plastic buoy tied 1.5 m from the bottom. One 12.5 cm stainless steel longline clip.
Surface line	8 mm polypropylene rope in 50 fathom lengths. Eye splice on each end with a 1 m length of the same rope spliced into the surface line 1 m from one of the ends.
Mainline	545 kg test nylon monofilament cut up into sections, the first section cut at 50 fathoms and thereafter at 10 fathom intervals. The cut sections are rejoined with swivels. This makes the length of the entire longline 150 fathoms.
Swivels	Swivels are incorporated into the mainline to attach the snoods and the sinker. The swivels used were either McMahon Heavy Duty # 12 or leaded stainless steel longline barrel types.
Longline clips	Standard stainless steel longline clips with swivels. 10 cm clips were used for attaching the snoods to the mainline swivels. 12.5 cm clips were used for attaching the floats to the surface line.
Snoods	200 kg test nylon monofilament. Each snood was 3 fathoms long with a 10 cm clip at one end and a hook at the other.
Hooks	Both Mustad (No.4) tuna circle and BKN (No.48) hooks were used.
Sinkers	Four pieces of (2.5 cm. diameter x 20 cm.) steel rebar lashed together, with a 10 cm clip attached for clipping onto the mainline.
Swages	Various sizes were used according to the diameter of the nylon monofilament.

The Fisheries Division was therefore able to arrange to buy supplies of frozen Japanese saury from commercial interests there. The *Tautai Matapalapala* made the crossing to Pago Pago under Peter's command, to collect 100 cartons of bait, each around 10 kg and containing an average 120 saury. This shakedown cruise also provided an opportunity to begin training in offshore seamanship and navigation.

Fishing operations commenced shortly afterwards; nine vertical longline droppers having been rigged, each carrying ten hooks. A comprehensive data collection system was devised to record the results. The initial sets produced promising results, as Peter's report of the first trip indicates:

Left the Fisheries wharf in Apia at 6.00 for the FAD 13°35'00"S 172°00'75"W. Arrived at the FAD at 8.45, trolled around it for 30 minutes and hooked a mahi mahi, but lost it while pulling it in. There were small schools of skipjack feeding in the area, but there was no response to our lures, probably because the size was too big for the fish. The wind was moderate at 5-10 knots from the south-east, the sky partially overcast, seas relatively calm and the current running south-west at 2-3 knots.

Started setting the gear at 9.30. A polypropylene rope was tied to the FAD and 100 fathoms was played out down current before attaching the first vertical longline. The vertical longline was set with the line and hooks being paid out first before attaching the sinker. Nine vertical longlines were attached altogether, with a total of ninety hooks. As this was the first time for the crew to use this technique it took until 11.30 to finish setting the gear.

The longlines soaked for three hours and we began hauling the gear at 14.00. The lines were hauled from the last line set forward towards the FAD. At first we tried reeling the lines up with a wooden, FAO/ Samoan handreel, then transferring them onto the drum. This way the lines would be rolled onto the drum so that the clip came off first, and swivel for the sinker last. This process seemed labour-intensive and time consuming so we decided to try just rolling the lines directly onto the drum with the hydraulics. This meant that the lines would now have to be set sinker first. We finished hauling the gear at 16.30.

The catch for the first set was three yellowfin, the biggest being 27 kg, one large skipjack and two sharks. The first line out from the FAD caught the big yellowfin, the second caught two yellowfin and one skipjack, and the third two sharks. Three hooks were cut off by sharks. All the fish which were caught were close to the FAD; the lines further out were unproductive.

The second set was made at 16.55. Polypropylene rope was attached to the FAD and 100 fathoms again paid out before the first line was attached. This time the sinker was attached first and the vertical longline lowered from the drum. This method was as fast, if not faster, than attaching the sinker last. The advantages of this procedure are that the boat can remain stationary while letting the longline sink to the desired depth, rather than motoring in circles paying out the longline and polypropylene line. When the longlines are being hauled, they go directly back onto the drum. We finished setting the gear at 18.15. This was 15 minutes faster than the first time, with less effort. We let the line soak until daylight. The boat drifted for the night, but watches were kept so as to have the flashing light of the last flag-buoy always in sight.

Started hauling the gear at daylight. The gear came up quickly as it all went directly onto the drum. We finished hauling at 7.40; this was 35 minutes faster than the first time. Most of the baits were either totally eaten or partially eaten. Only one yellowfin was caught, on the fifth longline, and one unidentified, small black fish with large teeth on the seventh line. It may be worthwhile to try chemical light sticks attached near the hooks for future night sets.

Decided to go try another FAD close to Apia harbour. This FAD is number D-2 (the first FAD was not given a number) located at 13°41'28"S 171° 43' 15" W. Arrived at the FAD at 12.30 and started setting the gear at 13.00. We finished setting at 13.52; this was the fastest setting time yet. At this rate it could be possible to set, soak and haul three times during daylight hours — a total of 300 hooks. Started hauling the line at 16.00 and finished at 17.30. Three good-sized albacore were taken; one on the ninth line and two on the first.

Started setting the longlines again for the night at 17.45 and finished at 18.30.

At 4.00 the third watch lost sight of the flashing light from the flag buoy. We searched for a couple of hours and finally located the FAD at 6.00, but the longline had disappeared. The line had not been tied to the FAD correctly. Fortunately, we located the longline drifting about one mile south of the FAD, but it was badly tangled. It took two hours to straighten out all the gear. There were no fish on any of the lines. We headed back to Apia harbour arriving at 10.30.

An example of the catch logsheets used during these trials is reproduced below; this is from the third set made during the first trip. It shows the data being collected, which on later analysis may show trends in productivity according to time of day, current, depth of set, etc.

FISHERIES DIVISION GOVERNMENT OF WESTERN SAMOA
PELAGIC LONGLINE FISHING

Vessel	*TAUTAI MATAPALAPALA*		Captain	*Peter Watt*	
Date	*24/10/90*	Trip N°	*1*	Set N°	*3*
Location	*FAD 13°41'28" S - 171°43'15" W*				
Fishing conditions					
Wind Direction	*South-East*	Speed	*10-20 knots*	Sea	*Moderate*
Weather	*Mostly cloudy*	*Current*	*South-East*	Speed	*Moderate*
Fishing Gear					
Vertical longline	*X*	Horizontal		Trolling	
Details					
Length of Mainline		*150 fath.*	N° of droplines		*9*
Total number of hooks		*90*			
Length of Buoylines			Size of hooks		
Length of snoods	*3 fath.*	Bait type	*Saury*	N° of pieces	*90*
Fishing Times					
Setting: Start	*13h00*	Finish	*13h52*		
Hauling: Start	*16h00*	Finish	*17h30*		
Catch details					
Species		Length	Weight	Sex	
Thunnus alalunga (albacore tuna)		*105*	*28.2 kg*	*M*	
"	"	*102*	*27.3 kg*	*M*	
"	"	*102.5*	*27.4 kg*	*M*	

INSHORE FISHERIES RESEARCH PROJECT

Fisheries Technical Paper Series

Several assessments of fisheries development problems in the region, including the major review carried out by Fakahau and Shephard in 1986 (*Fisheries Research Needs in the South Pacific*: FFA/ICOD), have identified poor dissemination and exchange of fisheries information within the region as an important constraint on the cost-effectiveness of fisheries research and development activities region-wide.

Fishery investigations and development projects may be duplicated in two or more locations if the results of individual projects are not written up and distributed to those who might be interested. There are numerous examples to prove the point, including cases where work has been repeated in the same country because the results of earlier, identical projects have not been recorded in a permanent way.

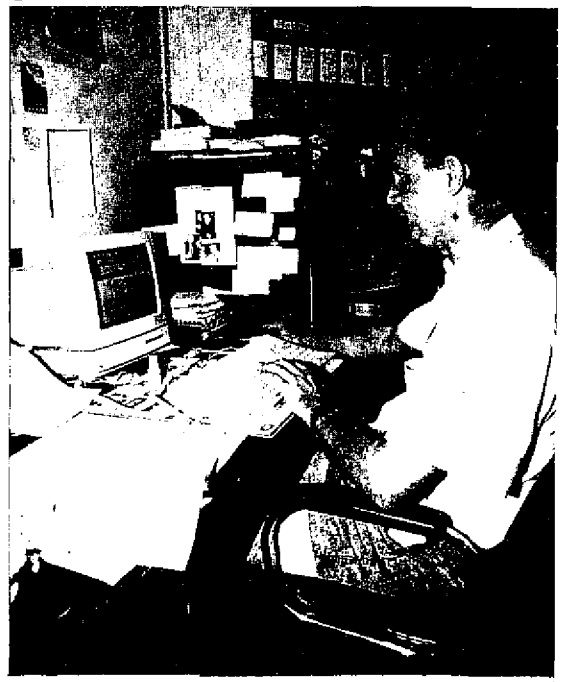
This point was underlined strongly at the SPC Workshop on Pacific Inshore Fishery Resources, held in Noumea in March 1988. At that workshop, 157 papers on fishery research and development activities were presented. Of these, about half were based on work that, without the impetus of the meeting (and the sometimes fairly heavy pressure on participants from the organisers), would probably have remained as data sheets stored in someone's filing cabinet and would never have been written up. The demand for the papers since the workshop has been such that most are now out of print. This strongly underscores the usefulness of reporting on work, even if the report can sometimes take a long time to produce.

There are a variety of reasons why the results of fisheries work often go undocumented. Important among these are the poor communications that exist inside and between Pacific Island countries, the absence of suitable mechanisms or vehicles for publishing and distributing reports, and lack of funds for widespread distribution of reports in most national-level departments or agencies that undertake fisheries work. In addition, many fisheries workers are unfamiliar with the procedures of writing and publishing technical documents, and are somewhat averse to writing them in the first place.

In order to address the first group of these problems, the SPC Inshore Fisheries Project and Fisheries Information Project plan jointly to encourage and assist fisheries workers to write up and publish the results of their work so that it will be accessible to other users. As well as providing vehicles for publication, and supporting distribution and publication costs, SPC will also assist authors with production of finished manuscripts through help with editing, graphics and technical advice as necessary. Where appropriate, assistance can be provided to authors in finalising papers for submission to outside journals.

The first step in the process is already under way. The second quarter of 1991 will see the publication of a volume of seven collected papers on fishery topics within the region, with further collections planned for later in the year. An SPC staff member will shortly visit Papua New Guinea in response to a specific request for assistance in the analysis and write-up of data from several research projects which have so far gone undocumented. SPC is providing assistance in distributing the Kiribati Fisheries Division's annual report more widely. The production of annual reports by Fisheries Divisions is a commendable step and one that SPC is keen to encourage.

It is hoped that by developing these publication vehicles, we will encourage more people to write up their work so that it can be useful to others. The next logical step will be to develop mechanisms for training fisheries workers in report writing and associated skills, and approaches to this are currently being developed by the Commission.

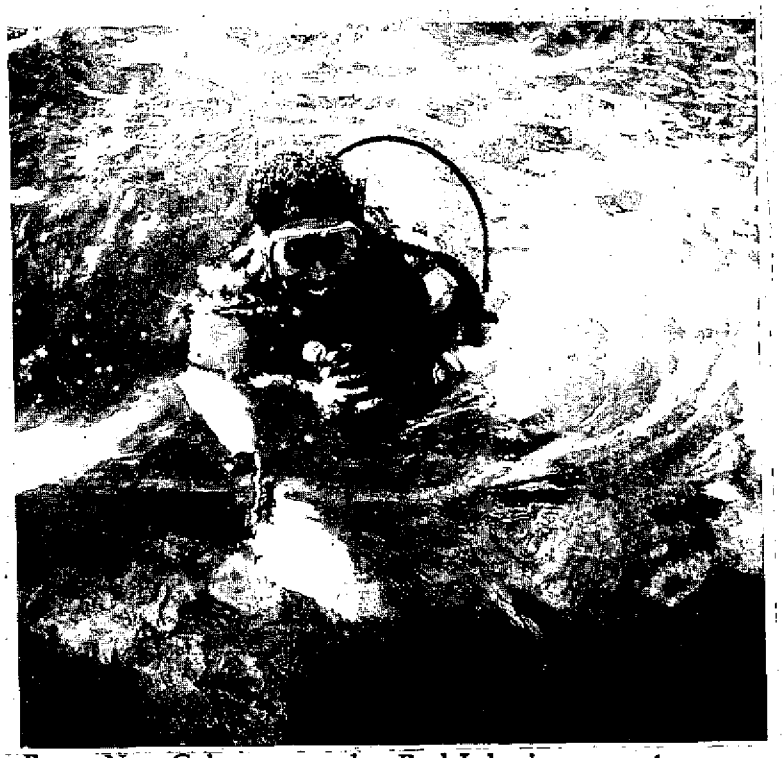


Survey of beche-de-mer resources in Ha'apai, Tonga

At the request of the Tongan Fisheries Department, the SPC Inshore Fisheries Research Project assisted with a survey of beche-de-mer resources in Tonga's Ha'apai group during June 1990.

The survey was carried out by SPC Senior Inshore Fisheries Scientist Garry Preston, PNG beche-de-mer researcher Paul Lokani, and Tongan Fisheries Department staff members Naita Manu, Peni Lolohea and Tevita Atana.

The aim of the work was to assess the degree to which local beche-de-mer resources would be able to support the harvesting and processing activities proposed under a development project to which the government was already more or less committed.



Papua New Guinean researcher Paul Lokani prepares to survey another transect during the Ha'apai beche-de-mer survey

TUNA AND BILLFISH ASSESSMENT PROGRAMME

South Pacific Albacore Tagging Programme

SPC's Tuna and Billfish Assessment Programme is to conduct a South Pacific albacore tagging programme. The project is designed to provide essential information on the population dynamics of albacore (*Thunnus alalunga*) and the interaction of the various gear types used in the South Pacific.

The aim is to tag troll-caught albacore in the Tasman Sea, in the New Zealand West Coast surface fishery, and in the Sub-tropical Convergence Zone (STCZ) ranging from east of New Zealand to an area south of French Polynesia. The vessel used will also be equipped for pole-and-line fishing which will be the preferred method for catching taggable fish whenever conditions suit. Assessing the viability of bait fishing in the STCZ will therefore be a bonus from the programme. Bait for this option will be obtained from New Zealand bait grounds.

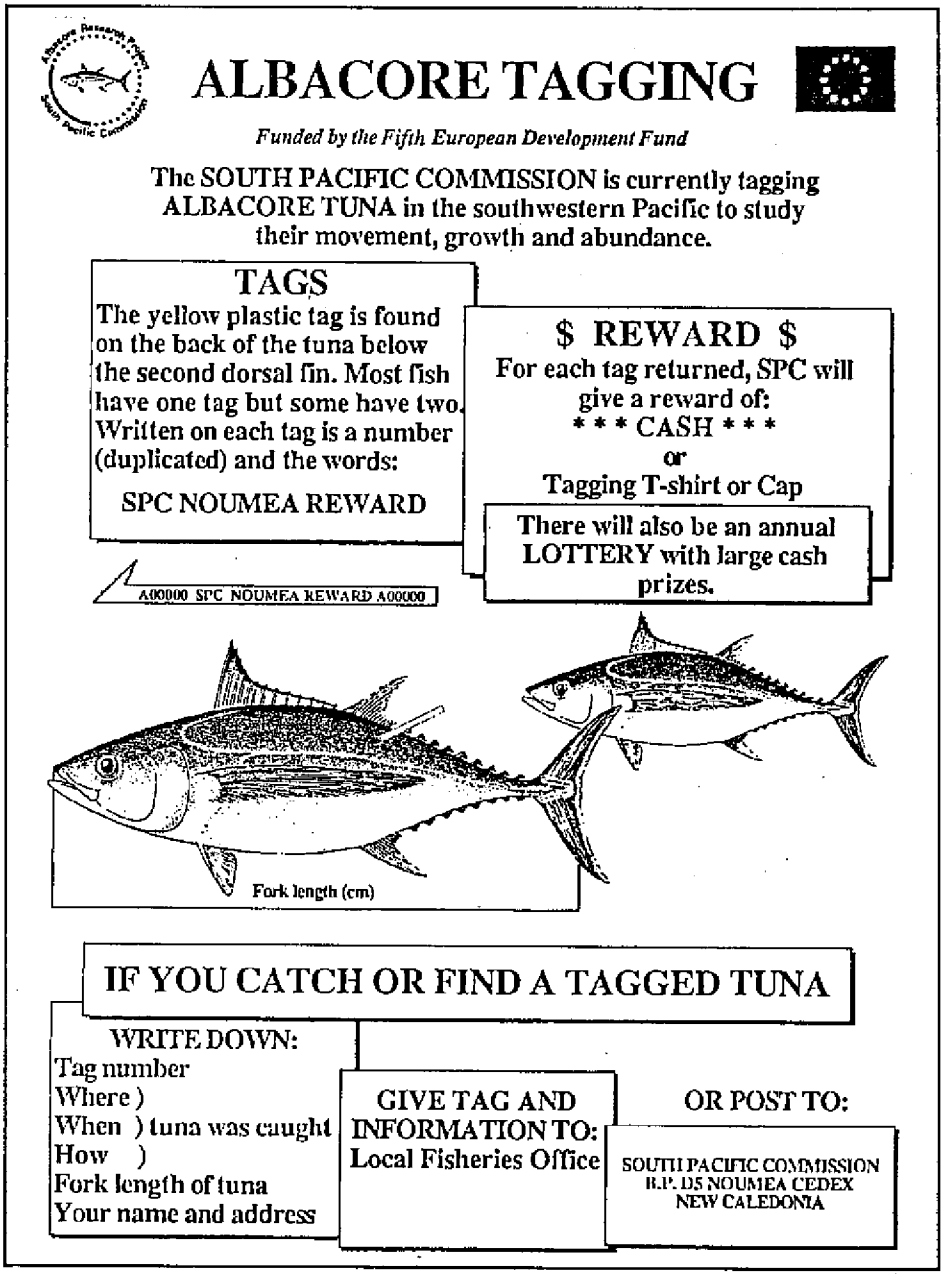
Impetus to the project's development came from concern over the rapid increase in fishing by gillnetters from distant water fishing nations. However, several Pacific Island countries also have an active involvement in the albacore fishery, including American Samoa, the Cook Islands, Fiji, French Polynesia, New Caledonia, Tonga and Vanuatu. Although driftnet operations in the coming season will all but cease, the driftnetting issue has highlighted the need for a better understanding of the fishery with its implications to all concerned.

The F.V. *Solander III*, based in Fiji, was chartered for the tagging cruise which commenced in Whangarei, New Zealand, on 12 December 1990. As well as its Fijian crew, the vessel will carry up to three SPC scientific staff, supplemented at times by a New Zealand Ministry of Agriculture and Fisheries (MAF) scientist. MAF is also providing logistic and administrative support ashore in New Zealand.

It is expected that tag returns will come from troll fisheries, the remaining driftnet surface fisheries, longline fishermen, transshipment points, Pacific and Asian canneries, and perhaps from as far afield as South America. The yellow plastic tags used carry the words 'SPC Noumea Reward' and a number.

A copy of the poster describing the project is shown below.

Recovered tags should be returned to a local fisheries office or sent to: South Pacific Commission, B.P. D5, Noumea Cedex, New Caledonia. Each tag should be accompanied by a record which includes the tag number, a description of where, when and how the tuna was caught, the fork length and the name and address of the tag recoverer. For each tag returned SPC will give a reward of cash, or a tagging T-shirt or cap. There will also be an annual lottery with large cash prizes.



Fourth Southeast Asian Tuna Conference

The Fourth Southeast Asian Tuna Conference was held from 27 to 30 November 1990 in Bangkok, Thailand, with participants from Canada, Indonesia, Japan, Malaysia, the Maldives, the Philippines, Thailand and the United States. Delegates from the Association Thonière of the Indian Ocean Commission, the Food and Agriculture Organization of the United Nations, the Southeast Asian Fisheries Development Centre and the South Pacific Commission also attended.

The delegate from Indonesia reported that 309,700 mt of tuna, or 14 per cent of the total marine fish catch, were caught in 1989 in Indonesia. Exports of fisheries commodities included 56,700 mt of tuna and tuna-like species, valued at US$ 103 million. Between 1979 and 1989, the catch of tuna has increased by 10 per cent annually, while exports have increased annually by 53 per cent in weight and 118 per cent in value.

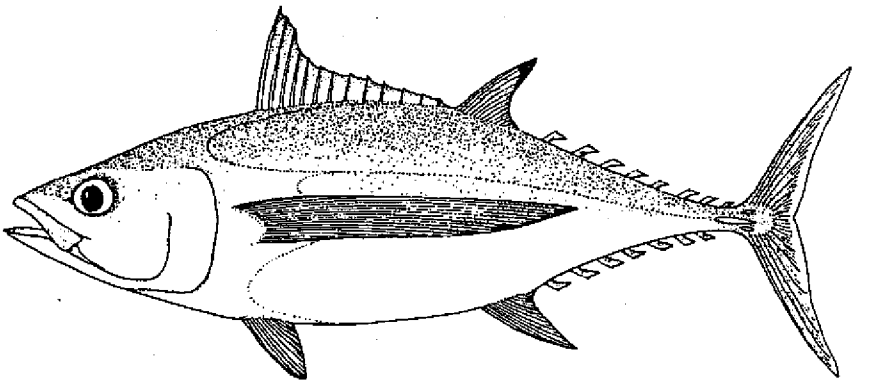
Most tuna caught in Indonesia (86 per cent) are caught in the eastern part of the country, bordering the Western Pacific. Skipjack caught by small-scale and industrial pole-and-line fisheries in eastern Indonesia make up 70—80 per cent of the total tuna catch.

Current tuna research carried out at the Research Institute for Marine Fisheries, Jakarta, includes collection of catch data through sampling, tagging programmes, fisheries oceanography research, socio-cultural studies of fishermen and socio-economic aspects of tuna fisheries, including fish marketing. The delegate from Malaysia reported that recent tuna landings have contributed only about five per cent of the total marine catch. Though catches increased from 1970 to 30,000 mt in 1987, catches decreased to 22,200 mt in 1989. Most of the tuna are caught off the east coast of peninsular Malaysia by hook and line, with the remainder caught by various gear types off the west coast, Sabah and Sarawak. In eastern Malaysia, the major species include longtail tuna, kawakawa and frigate tuna, with skipjack caught further offshore. While the neritic species are also caught in western Malaysia, the landings in Sabah are dominated by oceanic species, such as bigeye, yellowfin, albacore and skipjack. The species landed in Sarawak vary, becoming more oceanic towards the east.

Current tuna research in Malaysia includes biological studies, which were initiated by the FAO/UNDP Indo-Pacific Tuna Programme in 1987, tagging programmes off the east coast of peninsular Malaysia, and a preliminary study of the use of payaos.

The tuna fishery in the Philippines contributed 18 per cent of the total fish production and 39 per cent of all fish exports in 1989. Six species are caught (yellowfin, skipjack, bigeye, frigate tuna, bullet tuna and eastern little tuna). The most important gears employed by municipal vessels (less than 3 gross tons) include handline, small purse seine and gillnet, while the commercial vessels (greater than 3 gross tons) use purse seines and ringnets in conjunction with payaos.

Exports of frozen and chilled tuna from the Philippines increased from 5,700 mt in 1976 to 47,200 mt in 1989, while exports of canned tuna increased from less than 100 mt in 1980 to 47,500 mt in 1989. Frozen and chilled tuna are exported to the United States, Italy, Japan, Singapore, Hawaii and Thailand. Canned tuna are exported to Germany, the United States, the United Kingdom, Canada, the Netherlands, Switzerland and Japan.



Tuna research in the Philippines includes tuna stock assessment and tagging. The National Tuna Fisheries Research and Development Plan includes studies on tuna distribution, early life-history stages, electrophoresis, biology and socio-economics.

The delegate from Thailand stated that the total catch of tuna was 146,400 mt in 1988, caught mostly by purse seine. About 90

per cent were caught in the Gulf of Thailand, including the South China Sea, and the remainder in the Andaman Sea. Longtail tuna, kawakawa and frigate tuna contributed 59 per cent, 29 per cent and 12 per cent, respectively, to the total catch.

The total Thai catch was supplied to tuna canneries in Thailand. In addition to domestic production, 274,900 mt were imported from the Western Pacific and Indian Oceans in 1988.

Several research papers were presented covering statistics, fisheries, biological studies, stock assessment and socio-economics. In summary it was noted that:

— there is a need to improve the collection of tuna statistics in the region;

— national statistics are still incomplete;

— there appears to be a need to convene a workshop on statistics;

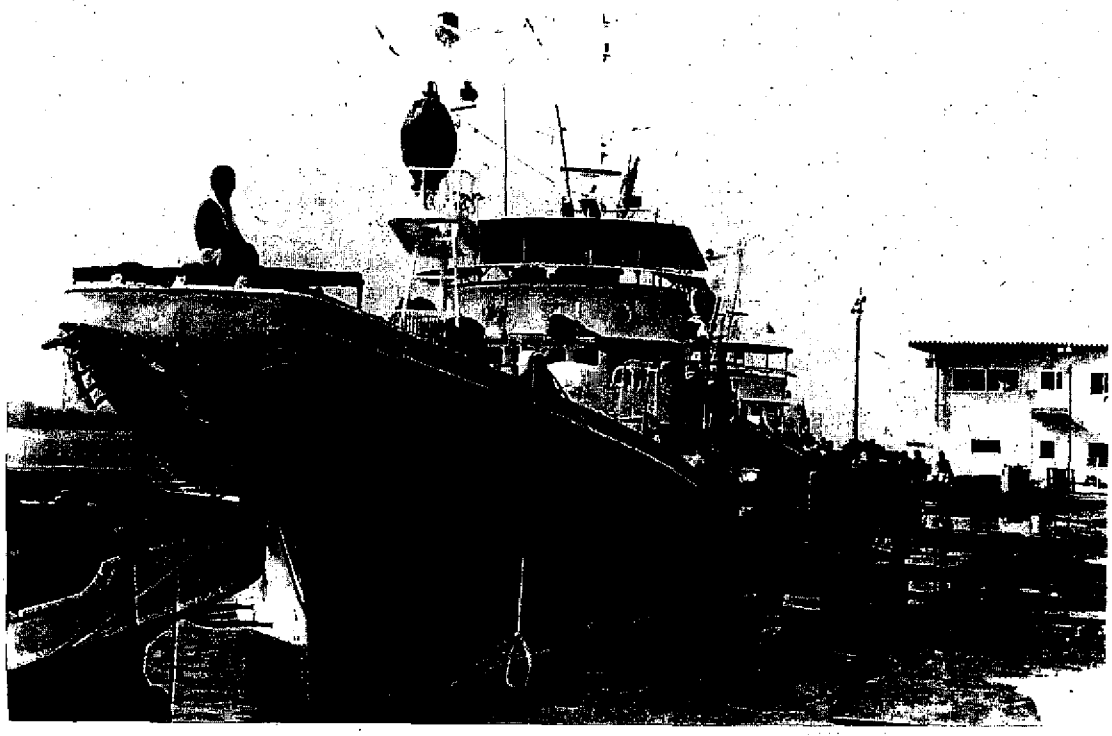
— while considerable biological studies on tuna have been reported worldwide, there is a lack of research on spawning and the early life history stages of tuna;

— caution should be exercised in using length data to determine tuna growth and mortality; and

— the inability to utilise conventional methodologies for tuna stock assessment suggests that there may be a need to convene a workshop to review tuna stock assessment techniques.

A one-day session was held on tuna tagging, with presentations on tagging in the Western Pacific by the Regional Tuna Tagging Project of the South Pacific Commission (48,000 releases by pole-and-line vessels in 1990), tagging in the Western Pacific by Japan (annual target of 7,500 releases by pole-and-line vessels), tagging in the Philippines (5,324 releases to November 1990), tagging in Indonesia (7,888 releases by pole-and-line vessels since 1983), tagging in Malaysia (3,803 releases of troll-caught tuna during June/July 1990), tagging in the Indian Ocean by Japan (7,000 releases since 1980 by the purse seiner *Nippon Maru*), tagging in the Indian Ocean by the Association Thonière (950 releases from a pole-and-line vessel over 15 weeks) and tagging in the Maldives (nearly 10,000 releases using pole-and-line and handline during 88 fishing days).

A proposal for a large-scale tuna tagging programme in the Indian Ocean was discussed at length. It was recommended that such a tagging programme be modelled on SPC's highly successful Regional Tuna Tagging Project.



Okinawan pole-and-line boat unloading skipjack (Solomon-Taiyo base, Noro, Solomon Islands)

TUNA SURPLUS HITS MARKETS

Tuna catches this summer in the Eastern Pacific were exceptional, according to the Inter-American Tropical Tuna Commission. But none of the fish will go to the US market because of the 'dolphin-safe' policy adopted by major canneries.

Ironically, the dolphin mortality rate in the zone has declined during the 1990 season by about 40 per cent, the Commission reports. Nonetheless, Bumble Bee and Chicken of the Sea continue to refuse deliveries from this source.

By the end of July some 250,000 tonnes of tuna had been harvested by fleets operating in the Eastern Tropical Pacific. That figure represents an increase of more than 13,000 t on the same period last year.

The catch included 178,000 t of high-value yellowfin tuna. In 1989 the total for this part of the season was 157,000 t.

Much of the yellowfin from the Eastern Pacific is expected to end up as a canned product in Asia and Europe. It is being processed in Far Eastern canneries and in Mexico, among other countries.

Fortunately for the US companies, fishing in the Western Pacific has also been favourable. But high catches throughout the Pacific have inevitably depressed landing prices—at some ports by as much as 20 per cent.

Canning capacity in autumn 1990 was lower, due to shutdowns. In Puerto Rico, both Van Camp and Neptune have halted production, but Neptune announced that its closure was temporary.

(Source: *Fishing News International*)

1988 WORLD CATCH

The world catch is estimated to have increased by nearly five per cent in 1988, to reach a new record total of 97,985,300 mt. Preliminary figures for 1989 indicate that the harvest reached and exceeded 100 million mt for the first time.

Details of the world-wide production of fish, shellfish and seaweeds are given in the latest editions of the *FAO Yearbooks of Fishery Statistics*.

Aquaculture production is included in the totals, but the yearbook does not separate what is caught and what is farmed.

However, FAO now issues a booklet of aquaculture statistics (*Fisheries Circular* No. 815), which shows that aquatic production through farming jumped by 9.4 per cent over 1987 to a total of 14,466,306 mt in 1988. This means that aquaculture now contributes nearly 15 per cent to the world total harvest.

The *Yearbooks* list catches for some 185 countries and territories. Japan was again in the lead with a smaller catch than in 1987, but still close to 12 million mt. China, joining the ten million mt nations for the first time, reported a catch increase of more than a million mt for a total 10.36 million mt.

A big increase over 1987 made Peru the fourth largest producer, with a total of 6.64 million mt. The United States came just short of six million mt, followed by Chile with another year yielding over five million mt. India took her aquatic harvest over three million mt, while Indonesia reported an increase of some 115,000 mt for a total of 2.73 million mt.

Three Nordic countries, Denmark, Norway and Iceland, in that order, topped the Western European producers. Denmark's catch rose by some 265,000 mt to 1.97 million mt.

Alaska pollack was again the main catch in volume (see Table 1), although the total fell slightly from the record hauls of 1986 and 1987. The catch of Japanese pilchards topped five million mt for the third year in succession, with a record haul of 5.43 million mt. The South American pilchard catch was just below 5 million mt. With the total for European and other pilchards added, the world total for this species was around 12 million mt.

Of the 1988 world harvest, nearly 70 million mt is estimated to have been used directly for human consumption, and 29 million mt went for reduction to fish meal and oil. The amount consumed by humans and marketed fresh rose from 18.9 to 21.15 million mt, and the share of frozen product from 22.25 to 22.8 million mt.

(Source: *Fishing News International*)

Table 1: World catch by species, 1986 — 1988

Species	Catch in metric tons		
	1986	1987	1988
Alaska pollack	6,758,900	6,723,939	6,657,655
Japanese pilchard	5,191,036	5,321,064	5,428,922
South American pilchard	4,333,301	4,686,386	4,998,058
Anchoveta	4,945,315	2,100,548	3,613,107
Chilean jack mackerel	1,960,897	2,681,762	3,245,699
Atlantic cod	2,027,514	2,078,552	1,970,704
Chub mackerel	2,007,594	1,565,136	1,797,689
Atlantic herring	1,541,910	1,591,910	1,678,196
Silver carp	1,196,566	1,343,517	1,508,484
European pilchard	937,705	1,124,688	1,263,445
Skipjack tuna	1,067,284	1,017,048	1,242,150
Common carp	903,026	1,116,499	1,194,603
Capelin	1,407,713	1,107,606	1,143,611
Yellowfin tuna	794,115	878,523	863,305
European anchovy	665,439	644,470	850,307
Pacific cupped oyster	618,647	689,316	706,849
Bighead carp	599,663	638,392	705,263
Atlantic mackerel	607,984	699,428	704,998
Southern African anchovy	315,110	969,401	682,457
Blue whiting	815,259	708,355	668,167

AUSTRALIA INVESTS IN TRAINING

The School of Fisheries at the Australian Maritime College (AMC), which offers the only integrated fisheries training in Australia, can provide training packages to suit the needs of many fishing industry sectors. Its facilities are among the best in the world.

AMC graduate courses in fisheries are designed for graduates seeking careers in areas such as fisheries management, gear technology, seafood technology and fisheries research.

Courses cover up-to-date technology and practice in the fishing industry from four main aspects: fishing technology (fish locations, catching methods and gear technology); seafood handling and processing; fisheries science (fisheries biology and resource assessment); and fisheries economics and management.

A new Master of Applied Science in Fisheries course will allow candidates to undertake an in-depth study of one area of fisheries science, management or technology. The School of Fisheries' new course joins several other successful award courses, including a Certificate Course for trainee fishermen, a Bachelor of Applied Science and a Graduate Diploma Course.

A compendium of short courses seeking to publicise this area of the School's activity is now available. Other short courses are offered for fishermen, small boat operators, seafood processors and fish farmers. These include statutory certificates of competency, fisheries management, vessel handling, seafood handling and processing, small business organisation for small vessel operators, introductory seafood marketing and the handling and processing of sashimi finfish.

Other short courses and in-service training designed for fisheries researchers, managers, industry executives, fish farmers and teachers are available too.

They include the use of computers in fish stock assessment, length-based methods of assessing fish stocks, navigation for fisheries officers, economics of

trade in fish and fishery products, the economics of fisheries management, financial appraisal of fisheries projects, economics and policy marketing for aquaculture, and fisheries law and policy making.

AMC is a national, federally-funded institution. It is a young institution — the first undergraduates enrolled in 1980 — but it has come a long way.

Today, the college's training facilities are claimed to be unrivalled in the southern hemisphere and it attracts students from all over the world, as well as from throughout Australia.

Being one of the best-equipped maritime training institutions in the world, AMC points out that it can back up each course and programme with the latest technology, tools and techniques— providing the most effective training in each case.

College boats are used extensively at sea. They include the 64 m seamanship and navigation training vessel *Wyuna*, the 35 m fisheries training vessel *Bluefin*, and a range of smaller boats and life rafts.

Bluefin is a purpose-built 'hands on' training vessel mainly for bottom and mid-water trawling, but is also used for purse seining and deep-water work.

There is accommodation for 12 plus a crew of six. *Bluefin* is available for charter and is said to be ideal for fisheries survey work and any trawling requirement.

Specialist personnel and facilities of AMC are available to industry and commerce for research, consultancy and packaged training programmes through the college company, AMC Search Ltd.

AMC Search recently carried out a two-week training programme for Australian fisheries zone observers. This included instruction in shipboard safety, fishing gear technology, communications, deep-sea trawling and seafood handling.

Other work carried out includes researching into the types, capabilities, locations, ownership, etc., of Australia's fishing fleet. Towing tank tests and research have also been carried out over a two-year period to determine optimum hull design for trawlers.

AMC Search has run net-making and mending courses for fishermen, provided deep-water trawling training for the crew of an Antarctic research vessel, chartered *Bluefin* to the Department of Sea Fisheries, and held a flume tank workshop for shrimp fishermen.

AMC Search has also developed and presented fisheries surveillance and protection methods and techniques for the Forum Fisheries Agency and surveyed the South Australian fishing industry for the Australian Maritime Museum.

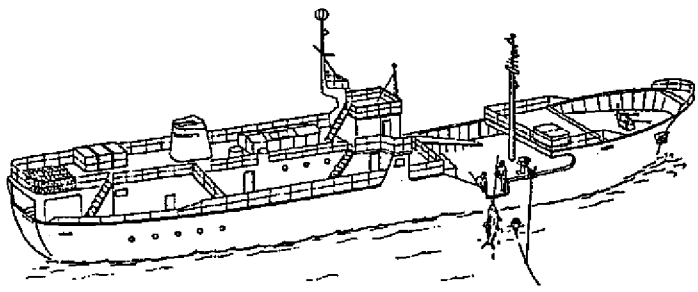
(Source: *Fishing News International)*

SOLOMON ISLANDS SIGNS NEW FISHING AGREEMENT WITH JAPAN

The Solomon Islands Government has signed a new fisheries agreement with the Japanese Tuna Association, which licenses the association's fishing boats to operate within the Solomons' 200-mile exclusive economic and fisheries zone. The annual catch is limited to 6,500 tonnes caught by longliners and 6,000 tonnes by pole-and-line. Solomon Islands Broadcasting Corporation reports that the country will earn about $US1 million under the agreement, about $US300,000 more than under the old agreement. The catch quota is also slightly more than the old one.

The Overseas Fishery Co-operation Council of Japan has earmarked $US1.4 million for the upgrading of the shipyard at Tulagi, Solomon Islands' old capital under the British Protectorate, and an important centre for the fishery industry. Solomon Taiyo Ltd, a partnership between the government and Japanese interests, has a base and a tuna canning factory in Tulagi. Work on the project is expected to begin in February.

(Source: *The South Sea Digest)*



NEW TUNA-RELATED PROJECTS FUNDED BY ACIAR

ACIAR (The Australian Centre for International Agricultural Research) is funding two new projects of interest to the region's tuna fisheries.

Economics of the tuna fisheries industry in Papua New Guinea

Tuna is the most important fishery in Papua New Guinea. Success of the industry in PNG depends on continued international demand, minimising harvesting and processing costs, continued high productivity of the fisheries in PNG waters, and an efficient market structure.

A study funded by ACIAR will provide a rigorous analysis of the international tuna market and highlight the implications for PNG. It will address two issues of major concern to the country: the effect of market and cost conditions on distant water licence fees, and initiatives by PNG to revitalise its domestic tuna industry. The study will also benefit other South Pacific nations which rely on the export revenue generated by the tuna industry.

Research on baitfish in Solomon Islands, Kiribati and Fiji for use in the tuna industry

This research will extend the work carried out in an earlier project which examined the biology of baitfish for the tuna industries of Solomon Islands and Maldives. Data from that project showed that extraction of baitfish had a minimal effect on the artisanal reef fisheries of Solomon Islands. Therefore tuna fishermen could continue to gather baitfish without jeopardising the reef fish populations.

This new project will focus on areas where the earlier project found large gaps of knowledge, and continue collection of biological data on the species composition, recruitment and ecology of baitfishes to ensure ongoing sound management practices in Solomon Islands, Kiribati and Fiji.

(Source: *ACIAR Newsletter*)

MILKFISH FARMING IN TUVALU?

Milkfish farming is being explored as a new venture for three islands in Tuvalu. Hideyuki Tanaka, aquaculture specialist with the Food and Agriculture Organization, and Tokyo-based aquaculture consultant Takeichiro Kafuku recently visited the islands of Funafuti, Vaitupu, Niutao and Nui.

They found that milkfish farming might be feasible for the first three islands, but not for Nui, which has no natural site for such a project. However, Kafuku said Nui could support seaweed farming.

Tanaka and Kafuku are expected to complete their feasibility study soon and follow that with a visit to the other five islands in the group.

(Source: *Pacific Magazine*)

REMOTE SENSING AND INSULAR ENVIRONMENTS IN THE PACIFIC: INTEGRATED APPROACHES MEETING (PIX-ILES)

The aim of this meeting, held from 19 to 24 November 1990, was to review the use and application of remote sensing technology to problems of natural resource development and management in the Pacific Islands region. The first three days of the meeting were held in Noumea, where local organisation was by the New Caledonian Remote Sensing Laboratory. The remaining three days were held in Papeete, hosted by the Polynesian Remote Sensing Station (STP).

Many of the presentations were on specific uses of remote sensing technology to answer resource management questions. Others focused on aspects of remote sensing technology, or on experiments to use this technology. Some were descriptions of the facilities, tools or services available through different institutions, including LATICAL in Noumea, SPT in French Polynesia, DSIR in New Zealand,

SPOT Image in France and Australia, and GDTA in France. The Pacific Island participants gave presentations describing the status and application of remote sensing in their own countries. Cook Islands, Fiji, Papua New Guinea, Solomon Islands, Tonga, and Vanuatu were represented. Additionally, several service-oriented presentations were made to smaller groups outside the meeting proper.

The most interesting applications presentations from a fisheries viewpoint concerned the following topics: enhancement of marine charts (especially poor and incomplete ones) by the addition of remotely sensed data; bathymetric mapping; mapping and monitoring of marine vegetation; mapping sea surface temperatures; seamount mapping using radar altimetry; and the contribution of remote sensing to a geographical information system for management of pearl oyster culture in French Polynesia.

The final session was a 'round table' to discuss future Pacific Island remote sensing requirements. This emphasised the need for serious evaluation of country needs, followed by the application of remotely sensed data where it could be useful, rather than the developer and vendor-driven implementation that has characterised some of the national-level projects presently under way.

For more information, or conference documentation, contact the conference organisers:

Lionel Loubersac, Station polynésienne de télédétection, B.P. 601, Papeete, French Polynesia: or Willy Bour, LATICAL, ORSTOM, B.P. A5, Noumea Cedex, New Caledonia.

INTERNATIONAL SOCIETY FOR REEF STUDIES MEETING

The Annual General Meeting of the International Society for Reef Studies (ISRS) was held in Noumea from 14 to 18 November 1990 and was scheduled to take advantage of the presence of participants in the Pix-Iles meeting, which was held directly following it. This allowed a somewhat larger participation, totalling about 50 people, than would normally have been expected.

The Society's routine business was conducted during the AGM proper on 16 November and included an amendment to the Society's constitution, election of office bearers, and financial business.

However, there were also four days on which participants made presentations on aspects of their research work, displayed posters, and undertook field expeditions. A number of the presentations concerned research carried out in Pacific Island countries and territories, including French Polynesia, New Caledonia and Vanuatu.

About a dozen of the participants were Pacific Island fisheries officers, or were closely associated with fisheries work in the region. These individuals took the lead in a 'round table' discussion on 'Fishing activities and natural resource exploitation in the South Pacific'.

The panel, which was co-chaired by Garry Preston and Paul Dalzell of the SPC Inshore Fisheries Research Project, aimed to identify those areas where research carried out by agencies and individuals outside the region could assist fisheries development and management in the Pacific Islands.

Two other round tables were also held: 'The South Pacific towards the year 2000: major environmental problems and the development of observation networks', which was chaired by Dr Bernard Salvat, and 'Coastal developments and shoreline modification: their consequences for the environment of lagoon ecosystems', which was chaired by Paul Holthus of the South Pacific Regional Environment Programme.

All the papers presented, as well as edited transcripts of the round table discussions, will be published in the conference proceedings in the near future. For conference documentation, or more information, write to the organiser:

Michel Ricard, c/o Université française du Pacifique, B.P. 4635, Papeete, French Polynesia.

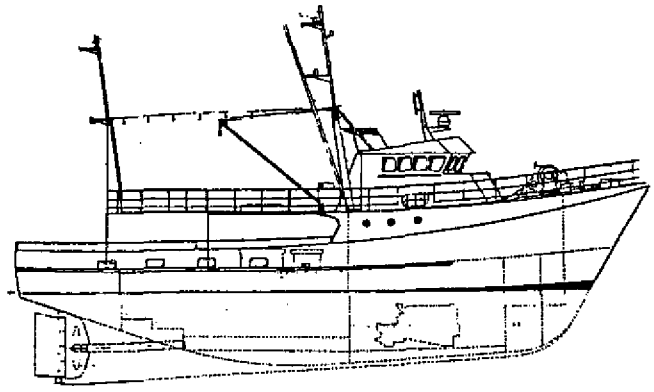
TWO NEW TUNA BOATS FOR FRENCH POLYNESIA

November 1990 saw the arrival in French Polynesia of two new combination troll/longline boats, valued at US$1.1 million each. The boats were constructed in France with government support, but are being bought and operated by local businessmen. The boats are expected to troll for albacore in the 40's between December and March each year, and spend the rest of the year trolling and monofilament longlining, mainly for yellowfin, in the Marquesas upwelling zone. French Polynesia plans to expand this fleet to 16 vessels over the next few years.

The French Polynesian Remote Sensing Station and ORSTOM plan to gather catch, effort, and sea-surface temperature data in a joint research project on this fishery, in particular to look at the relationship between fishing success and environmental variables.

Tahiti Nui and *Areuamanu* are the standard-bearers of an ambitious project to develop a complete tuna industry in Tahiti—including shipbuilding and repair, fishing, landing and processing.

Tuna caught will be for eventual export in frozen form to markets in Japan, the United States and Europe. Work created by this major project will offset high unemployment rates among Tahitians.



The two ships are equipped with a 90 cu m refrigerated hold to store tuna down to -25°C, plus twin 15 cu m brine tanks.

Each vessel will freeze the tuna in a two-tonne-a-day freezing tunnel. Tuna is taken over the stern of the vessels and put through either the freezing tunnel, in the centre of the partly-sheltered working deck, or into the box trap systems which are placed on each side forward.

Main dimensions of the two ships are:

— length overall:	25.0 m
— length of main deck:	22.2 m
— beam:	7.40 m
— depth:	3.87 m.

(Source: *Fishing News International*)

ASEAN STRESSES PROTECTION OF COASTAL RESOURCES

Policy makers of the six Association of Southeast Asian Nations (ASEAN) member states, representatives of media and international donor agencies have recently stressed the urgent need to protect and manage the region's deteriorating coastal resources.

In a resolution agreed upon during the first 'Policy Conference on Managing ASEAN's Coastal Resources for Sustainable Development', held recently in Baguio City, Philippines, the forum collectively stated the importance of focusing worldwide concern on the plight of Southeast Asia's coastal resources, and expressed its commitment to the integrated management and protection of these resources. International donor agencies, in turn, recognised the need to support coastal management programmes, while media representatives agreed to promote community awareness of issues.

Philippines Science and Technology Secretary, Ceferino Follosco, said that 70 per cent of ASEAN's population live in coastal areas and these areas are vital to the economies of developing countries. "The success of industries such as aquaculture, fisheries, tourism, shipping, and oil and natural gas production is inextricably linked to the skilful management of coastal resources', Secretary Follosco said.

However, studies show that these vital coastal resources are being depleted. Poverty, increased commercial activity, and population pressures have led to overexploitation. Fish catches are declining due to heavy fishing and the use of indiscriminate and destructive fishing

methods. Such methods, along with mining, logging and pollution, have damaged coral reefs and degraded the marine ecosystem, endangering marine animals. Mangrove forests, which are important nursery grounds for aquatic animals, are being cleared for human settlement and aquaculture, especially shrimp farming.

The conference came up with a ten-point resolution, now known as the Baguio Resolution on Coastal Resources Management, by:

— endorsing policies that promote sustainable development;

— encouraging integrated and comprehensive coastal resource management plans;

— strengthening the capabilities of government and non-government organisations responsible for managing coastal resources;

— relieving population pressures in coastal areas;

— enforcing regulations and schemes to promote sustainable uses of coastal resources;

— increasing awareness among coastal populations about their critical dependence on the continued productivity of coastal resources;

— promoting community-based participation in coastal areas;

— adopting policies and programmes to enable women to participate actively and contribute to the management of coastal resources;

— exploring ways for the public and private sectors to co-operate and benefit from efforts to sustain and develop coastal resources; and

— considering the implications of possible climate change and sea level rise.

The conference was organised by the International Center for Living Aquatic Resources Management (ICLARM) which, since 1986, has been co-ordinating the ASEAN/US Coastal Resources Management Project (CRMP), an international collaborative project financed by USAID to develop integrated coastal resources management plans in each of the six ASEAN countries.

(Source: *ICLARM Press Release)*

COLOURFUL POSTERS IDENTIFY FISH IN SIX LANGUAGES

There are more than 1,200 species of fish recorded in Pohnpei waters and catching them is a pleasant recreation for most Islanders and a profitable business for a few.

Two '*Commercial fishes of the Federated States of Micronesia*' posters which depict 95 of the most prominent fish have been produced and are on sale for US$10 the pair. The names of the fish are given in six languages—Pohnpeian, Chuukese, Yapese, Kosraean, Japanese and English. This, alone, contributes to the special interest of the posters.

The fish are presented in living colour and divided into categories by their habitats—shallow to deepwater bottomfish caught by landlines, rods and reels and traps; deepwater bottomfish caught by handlines and electric reels; reef fish, caught by nets, spears, hooks and lines and traps; and oceanic fish caught by trolling and sport fishing.

The posters can be purchased from the Science Dept, Community College of Micronesia, P.O. Box 159, Pohnpei FSM 96941.

(Source: *Pacific Magazine)*

BEST YEAR FOR HAWAII'S AQUACULTURE INDUSTRY

Hawaiian aquaculture experienced its best ever year in 1989, with total industry value increasing to US$ 21 million.

The state's 50 aquafarms produced over 450,000 kg of products with a value of US$ 6.8 million; research, training, and technology transfer activities added US$ 14 million. Hawaii raises a greater variety of both warm- and cold-water plant and animal seafood than perhaps any place in the U.S.

In 1989, farmers grew 35 species for pilot demonstration and commercial production, including freshwater prawns, marine shrimp, tilapia, catfish, carp, milkfish, various seaweeds, microalgae, oysters, clams, rainbow trout, abalone, salmon, lobster, mahimahi, sea urchin, sea cucumber, snails and pearl oysters.

The industry growth rate from 1986 to 1989 averaged 15 per cent per year, and all indications point to at least an 18 per cent climb for 1990.

(Source: *Ocean Science News*)

GIANT CLAM STEAKS, ANYONE?

Giant clam farms may provide meat and income for the South Pacific in the not too distant future. In the tropical reefs of Solomon Islands where giant clams thrive, the government is co-operating with scientists of the International Center for Living Aquatic Resources Management (ICLARM) to develop farming systems for growing giant clams, particularly *Tridacna gigas*, the largest species.

From its early microscopic stages of life, the clam settles in shallow waters and can grow to over 200 kg, needing only a small space, clean flowing sea-water, protection from predators during its juvenile phase and plenty of sunlight. Because the giant clam is phototrophic, i.e. it manufactures its own food through chemical processes generated by sunlight, it is self-feeding and needs no external food sources. In about six years, the clam reaches market size.

Most parts of the giant clam are edible, but poachers take only the adductor muscle, an expensive delicacy in Chinese cuisine and a mere 10 per cent of the animal's weight. In recent years, overfishing and deteriorating environmental conditions have diminished the stock of giant clams so much that they may be in danger of extinction.

At the Coastal Aquaculture Center, ICLARM's research station in Solomon Islands, scientists are experimenting to create an environment which will promote the giant clam's survival, growth and reproduction. The vulnerable larvae are raised in tanks; later the baby clams are transferred to wire-mesh cages in sheltered reef areas.

Several of these ocean nurseries are operated by villagers who keep the cages free of predators. So far, survival and growth rates have been encouraging and in a few years the clams will be placed in the open sea and later harvested for export.

The Center hopes to be able to supply baby clams to South Pacific nations to help in the development of giant clam farming.

New support this year from several donor agencies, primarily the British, Canadian and Australian governments, has allowed the Coastal Aquaculture Center to increase its research and development efforts.

(Source: ICLARM)

POLYSTYRENE PACKAGING AND THE ENVIRONMENT

The following is a summary of a report prepared by the New Zealand Trade Commissioner in San Francisco on polystyrene packaging, and its effects on the environment. There are two different types of polystyrene foam produced:

Extruded polystyrene, which uses CFCs to foam the material. This type of polystyrene is used to produce meat trays and hamburger packaging.

Expanded polystyrene, which is steam-expanded from individual beads. This method does not, and never has, used CFCs or HCFs in its manufacture. This material is used for electronics protection and in the production of vegetable, fruit, fish and other produce boxes.

This type of plastic can also be recycled. In Tokyo, the central fish market has for many years recovered the energy from ex-

panded polystyrene fish boxes by using them as feed stock for its boiler systems.

Before recycling of expanded polystyrene can commence, the various plastic resin types must be identified. So that this information is made readily available, the New Zealand and Australian Plastics Industry Association has recently promulgated a numbering system for plastic articles which identifies each specific resin type.

This system was first used in America and will be introduced within six months on all expanded polystyrene moulded products produced by two companies, RMAX and Barnes Plastics.

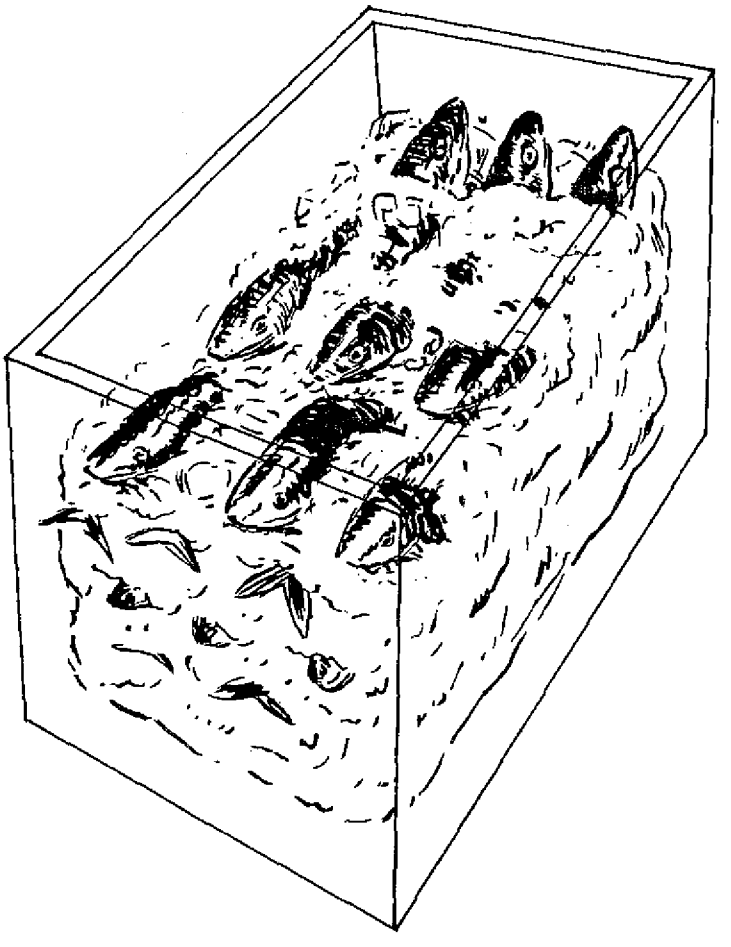
Products with a combination of materials are extremely difficult to recycle. Paper can be recycled, but waxed cartons cannot. Cardboard boxes can be recycled, but aluminium foil and laminated boxes cannot. Expanded polystyrene is not biodegradable.

Degrading materials in tips are a major source of methane — a greenhouse gas.

In larger tips, the combined leached chemicals from materials may seep into the water table, contaminating ground water supplies. Expanded polystyrene does not emit chemicals of any kind.

In conclusion, the Trade Commissioner found that expanded polystyrene packaging is a harmless and a recyclable product.

(Source: *Fishing Industry Board)*



PUTTING GOOD FISH ON THE TABLE

Two recent publications deal with the problems of quality fish production and processing

The food fishes,
by Dr M. Love

The fishing industry throughout the world has to cope with a number of unique difficulties, one of the most important being the natural variability of its raw material.

Dr Malcolm Love's book *The Food Fishes* describes in detail the chemical and biological variations of fish at the point of capture and explains also how these may affect the processing properties. The purpose of the book is to draw together, for the first time, a mass of hitherto unconnected material from widely differing sources. Extensive references add to the value of the text.

Dr Love, now retired from the Torry Research Station, Aberdeen, is one of the world's authorities on chemical biology of fish. By describing in detail the causes of variability in freshly-caught fish, he gives the reader a better understanding of raw materials and how processing activities, such as filleting and freezing, cause changes.

The book is divided into three parts. Part One considers the biological structure of fish flesh and how the life cycles of the various species can affect quality. In this section, the author describes both the physical structure and chemistry of fish muscle. Older fish differ in a number of respects from younger ones; maturation, spawning and ageing all affect fish quality.

Diet is an important consideration. Different foods can change the composition of the edible parts of the fish. Vitamins also originate largely from the diet. The book provides practical information on characteristics of primary importance to the consumer. Flavour, odour, texture, colour and the extent and nature of deterioration can all vary according to where the fish was caught. Awareness of particular flesh variations is an important part of quality control for people who handle fish commercially.

Freezing and cold-storage studies have been undertaken at Torry for many years. Deterioration of cold-stored fish can include the fading of salmonid pigments and oxidative rancidity of the lipids, which produces 'cold-store flavour'. Texture is also affected—the flesh toughens; however, this process occurs at different speeds in various fish species.

The final chapter considers how a range of environmental factors such as depth, temperature, oxygenation, crowding and water movements affect the chemistry of fish.

Pollution in the form of acid water or heavy metal contamination is raised as a particular problem, especially in fresh waters. A section on the effects of keeping fish at different temperatures will interest the culturist. The fact that fish infected with disease bacteria will voluntarily select a higher temperature zone than will uninfected fish offers possibilities in the combat of disease on fish farms.

The book will be of special interest to scientists who advise the industry and to official bodies concerned with the utilisation of fish as food.

Dr Love has used his many years of experience to produce a valuable contribution to the technology necessary to get fish products with a better and more uniform quality to the world's consumers.

Contact address: Farman Press, 50 Ferry Street, Isle of Dogs, London E149DT, UK.

(Source: *Fishing News International*)

Control of fish quality,
by Dr J.J. Connell

Many countries throughout the world have comprehensive systems of inspection and control to protect the customer against poor quality fish.

For motives of good commercial practice and profitability, the fish industries have also striven over the years to raise quality standards.

Furthermore, as consumer tastes move more to highly perishable fish products, careful attention is required by the seafood industry in preparation and storage.

Dr J.J. Connell, a former director of the Torry Research Station, Aberdeen, Scotland, has written an authoritative work on this subject titled *Control of fish quality*.

This textbook is written for fish technologists starting out in the field, industrial factory managers and people in the retail food trade who wish to learn more about handling fish.

The contents have world-wide application and include international quality standards as well as full details of the controls used in the European Community, Canada, India, the USA, Japan and other countries.

Control of Fish Quality is written in a straightforward informative manner. The opening chapter develops the basic question of what is fish quality. The second chapter deals with the intrinsic or natural qualities of various fishes, and species. Chapters 3, 4 and 5 discuss the various ways in which quality changes in fish and fish products, the factors that affect these changes and how they can brought under control.

Chapter 6 describes in detail methods for assessing quality. The remaining three chapters discuss the organisational and systematic means available to help provide the best and safest fish to the consumer at an acceptable price.

Methods of assessing quality and measuring the environmental factors that influence quality are explained.

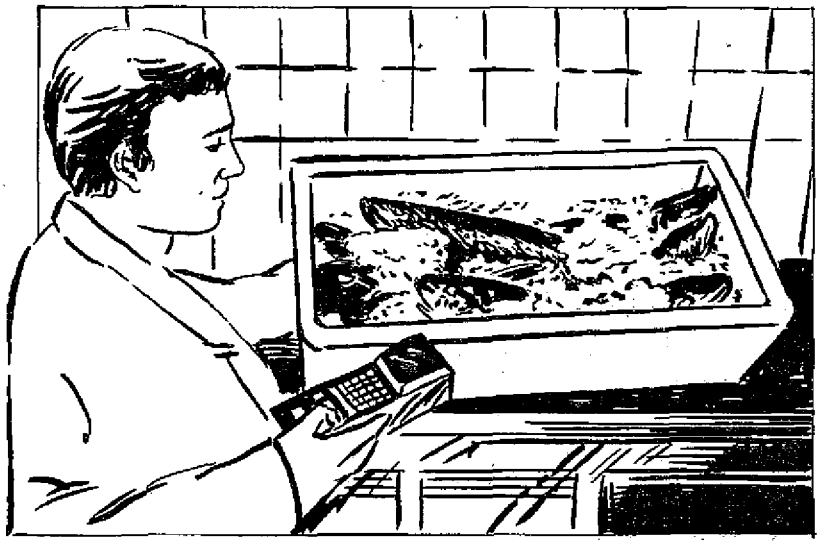
A great many methods have been proposed or tested for measuring fish quality but, for convenience, they can be divided into three groups, namely (1) sensory methods (sight and touch), (2) mechanical, instrumental and laboratory methods and (3) microbiological tests.

Statistical methods also form part of quality control. Food quality cannot be properly measured unless the correct number, size and kind of sample is selected. How many fish to test can often be worked out using statistical principles and using a properly designed sampling scheme.

Dr Connell's book, first written in 1976 but brought fully up to date in this revised edition, provides methods for official inspections, quality standards and Codes of Practice for many countries.

Contact address: Fishing News Books, Blackwell Scientific Publications Ltd., Osney Mead, Oxford, UK.

(Source: *Fishing News International*)



SURVEYING FAD DEPLOYMENT SITES AT RAROTONGA USING GLOBAL POSITIONING SYSTEM EQUIPMENT

by Aymeric Desurmont,
Masterfisherman,
Service territorial de la marine marchande et des pêches maritimes,
New Caledonia

Fish aggregation devices have been in use in the Cook Islands since 1980 and are recognised there as making an important contribution to local fishing efforts. A cost/benefit study on 1986 landing figures showed that with an average FAD unit costing around NZ$ 4,000 to deploy and each FAD producing average increased catch values in the order of NZ$12,500, returns of 312 per cent on outlay were realised (Sims,1988).

Few fishermen in the Cooks have any reservations about whether FADs increase small-scale fishing productivity and ease, and few would like to have to fish for the strong Rarotonga market without having FADs to target. But, in common with many other Pacific Island countries, the Cooks have suffered premature FAD losses. Although FAD survival rates have generally increased with growing experience and improved materials and rigging, the Cook Islands Ministry of Marine Resources (MMR) has been concerned for some time with improving its FAD programme personnel's ability to conduct accurate site surveys and to calculate catenary mooring systems precisely.

Following the major Pacific Islands FAD review undertaken by the South Pacific Commission Fisheries Programme during 1990 and the subsequent FAD workshop held during the 1990 Regional Technical Meeting on Fisheries, the Cook Islands Government, at the request of MMR, sought the technical assistance of SPC in upgrading its FAD survey, mooring calculation and deployment capability. In response, the Commission's Deep Sea Fisheries Development Project enlisted the co-operation of New Caledonia's Territorial Government in making the author available on secondment from his position as Master Fisherman with the Service territorial de la marine marchande et des pêches maritimes and co-ordinator of New Caledonia's FAD programme. The secondment agreement provided for the author to travel to Rarotonga for one month to work with the MMR FAD team, demonstrating the following FAD skills:

— Accurate site survey techniques using an echo-sounder;

— Navigation skills essential for site survey and plotting of selected sites;

— Mooring component calculation;

— Recommended rigging methods;

— Deployment techniques suited to local craft.

It is generally well accepted that FAD deployment sites should be surveyed as accurately as possible, not only to ensure an accurate depth reading, but to determine the degree of bottom slope, regularity, and absence of ledges or crevasses nearby. Due to the depth and forces acting on the anchor during its descent, it is impossible to predict the exact spot the anchor will land. Because of anchor deviation, it is best to choose a site with a wide breadth and gentle rope.

Even a casual observation of the rugged, eroded volcanic cones of Rarotonga Island suggests that these features may be mirrored underwater. It became apparent during this visit that this was indeed the case, and that inability to survey the bottom with precision had probably contributed to earlier FAD losses off the island. A good part of this visit, therefore, was devoted to training the local FAD team in a precise survey method utilising a reliable deep-water echo-sounder and a Global Positioning System (GPS) receiver/plotter for accurate navigation, site plotting and relocation. It is this aspect of the visit which is discussed in this article.

Survey vessel

The vessel made available for the survey work was a wooden launch of the TON-7 type (Fig. 1) designed by I. Gulbrandsen and built for MMR by a Tongan boatyard. The vessel had been modified to MMR request. The deck was raised slightly, the cabin extended, and an hydraulic line hauler and monofilament longline drum fitted to the working deck towards the stern. This extra weight on deck made the vessel quite tender. The first twelve days of the visit were mostly spent on preparing the vessel for sea after six months out of the

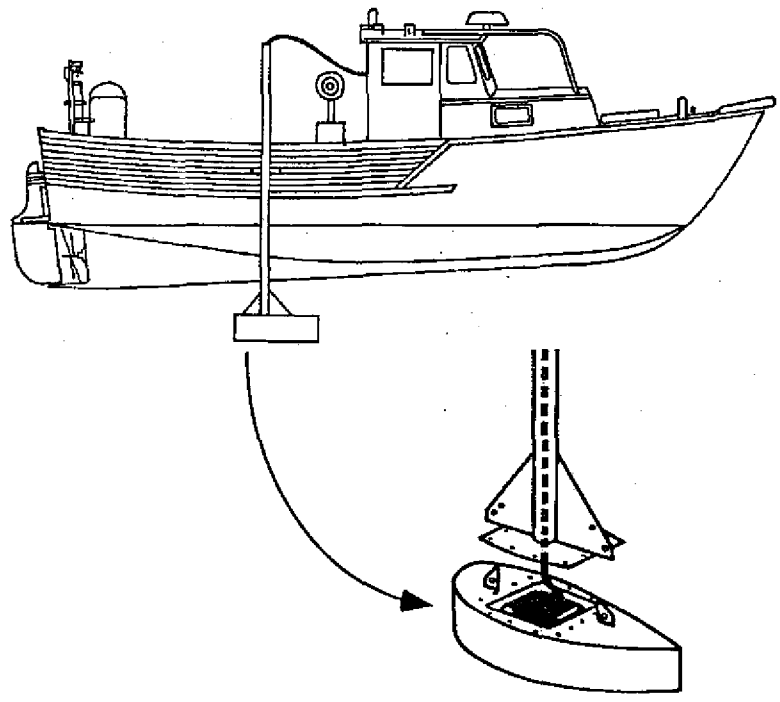


Figure 1: The TON-7 vessel used during the survey with detail of the transducer mounting

water, but fitted with her newly rebuilt 34 HD Yamaha diesel engine she worked well and served the purpose.

Electronic Equipment

The vessel was already equipped with:

— A VHF radio;

— An Autohelm electronic hand bearing compass;

— A SAT NAV unit and an SSB radio (not used during this survey).

Obtained especially for this survey and installed the day before the first survey trip was:

— A JRC, Model JLU 121 GPS receiver/plotter equipped with a CRT display. This GPS receiver utilises signals transmitted simultaneously from several satellites (from 3 to 5) to calculate position continuously (*see note below*), with an estimated error of less than 100 m. It took only a couple of hours to install on the boat and was giving a position within minutes of being activated.

The survey vessel was already equipped with a video echo-sounder, but it was not sufficiently powerful to obtain accurate readings at the 1,000 m+ depths required. Instead, the DSFD Project's Furuno FCV 362 colour video echo-sounder was taken to Rarotonga.

This unit, a 2 kw output power model, is equipped with both 50 khz and 28 khz transducers suited respectively to fish finding and bottom surveying at depth. A mounting frame for the transducer was fabricated in welded aluminium in New Caledonia, allowing the transducer to be fitted to the side of the survey vessel by clamping and lashing.

Preparing for the surveys

The aim was to survey four potential deployment zones, determine their suitability, and chart ideal anchoring positions accurately within the zones.

GPS positions in latitude and longitude are referenced to the World Geodetic System (WGS) 1984, and in plotting these positions on marine navigation charts, which are normally referenced to local or regional datums, it is necessary to apply corrections. In this case the chart used by MMR for FAD work was the Nearshore Bathymetry Chart of Rarotonga, Miscellaneous Series No. 56, published by the N.Z. DOI, which is referenced to a system known as International Spheroid 1924. So before plotting GPS positions on this chart, corrections had to be calculated. To determine the necessary corrections we contacted the Hydrographic Office of the Royal New Zealand Navy, which was able to give corrections only for standard British Admiralty (BA) navigation charts. However, by comparing the appropriate BA chart to the GPS position reading when at anchor in Rarotonga's main harbour and to the bathymetric chart used by MMR, we were able to calculate that we should plot GPS positions on the bathymetric chart with a correction of 24 seconds (0.4 minutes) of latitude northwards and 48 seconds (0.08 minutes) of longitude westwards.

The sites were selected by MMR with regard to their reputation as productive fishing areas, history of previous successful FAD deployments, and accessibility to the main boat harbours on the island.

At first it was planned that the survey would begin at the centre of a zone, distance from shore (2 miles) being the chief factor in identifying the zone's centre point. It was thought that by making soundings in a spiral pattern from that point, suitable deployment sites could be found. During the first survey attempt it soon became obvious that this approach would be inadequate; the steepness and irregularity of the bottom slope required a thorough survey of the entire selected zone to ensure identification of the optimum deployment site.

As a general rule, to ensure that the roll of the survey vessel does not affect the depth sounder readings unduly, it is recommended to take soundings while travelling perpendicular to the reef slope. So, for each of the areas we prepared charts on which the echo-sounding transects to be run were marked. The transects generally were planned as beginning in 600 m depth and extending for two miles seaward. To make the plotting of intermediate sounding positions simpler, it was decided that we would travel alongside the lines of latitude and longitude, as was done in the Ngatangiia zone , or at an approximately 45° angle to these lines (approximate because 1° of latitude does not have the same length as 1° of longitude at 21° South), as was done in the Black Rock, Arorangi (Figure 2) and Matavera zones (Figure 3).

Once the transect lines were drawn on the survey plan, we took their extremities as waypoints and entered the coordinates into the GPS unit. The GPS could then direct the vessel from waypoint to waypoint with great accuracy.

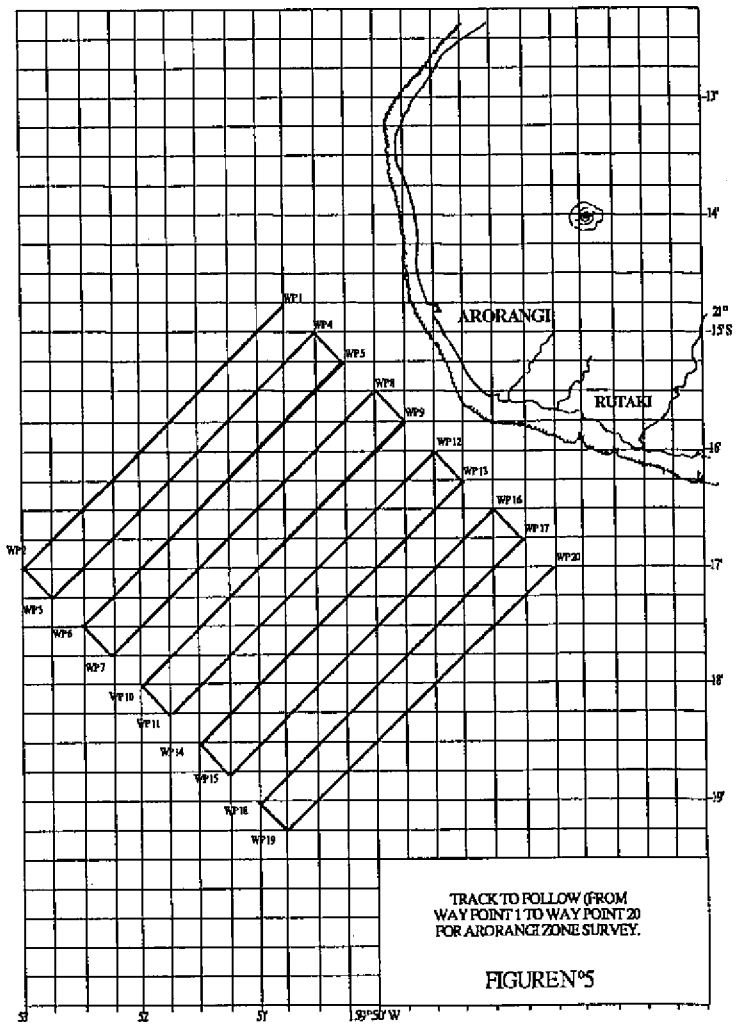


Figure 2: Echo-sounding transects in the Arorangi zone

A worksheet was also prepared for each zone on which we recorded all the planned sounding positions before going to sea. Depending on the zone and the precision required due to bottom features, this represented taking a sounding either every sixth or every third of a mile. For the largest survey zone, at Arorangi, this technique represented a transect track of more than 25 miles with about 150 soundings.

In the Black Rock zone, this sounding frequency was insufficient, because of indications of abrupt changes in bottom topography, and extra soundings were made. The extra soundings did reveal dramatic changes in bottom contours, emphasising the importance of precise surveying and precise positioning ability.

In the Matavera zone the sounding of the selected area revealed that a likely deployment site was indicated just beyond the zone boundary and, as a result, the survey was extended to include this area.

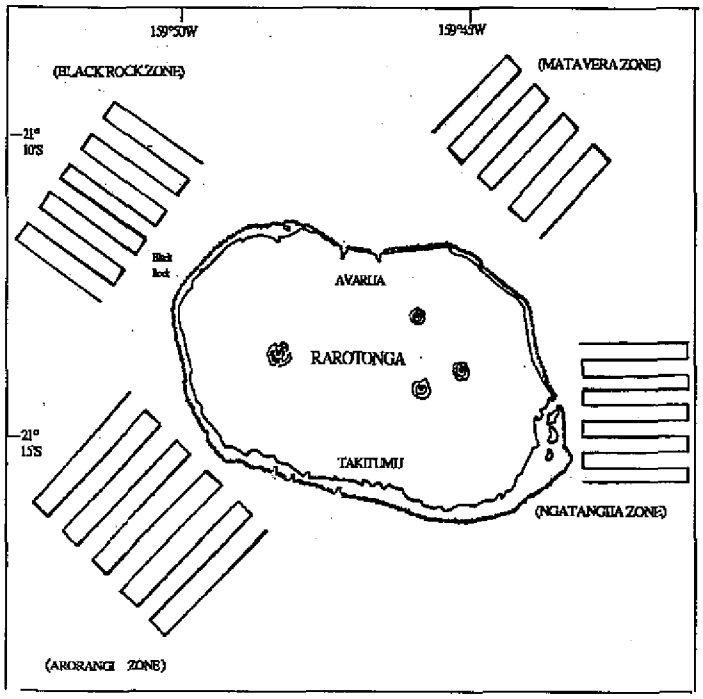


Figure 3: Areas surveyed

This preparatory survey planning can be summarised in five steps:

— Draw a 2-mile square on the chart which best covers the selected zone, with the edge of the square closest to land beginning at the 600 m contour.

— Draw parallel lines within the 2-mile square, spaced at one-quarter to one-third of a mile intervals, perpendicular to the natural bottom contour lines.

— Make the end of each parallel line a waypoint; note the coordinates of each of these points.

— Prepare a worksheet with provision for recording soundings at each required interval (one-sixth or one-third of a mile) along the transect lines.

— Enter all the waypoints into the GPS unit so that the track to follow will be displayed on the screen. All sounding points could be entered, but this is unnecessary as the GPS unit allows easy calculation of each sounding point as the vessel is under way.

Survey procedure

The boat left port on the morning of each survey day with a chart of the selected zone already prepared and marked with the transect lines, matching soundings worksheet, and the GPS unit operating with waypoints already entered. Once at the first waypoint the boat captain steered the vessel along the transect lines, guided by the GPS display, while the second member of the FAD team manipulated the GPS's cursor to get bearing and distance to the next waypoint and called for depth readouts as each sounding point along the transect was reached. The third member of the team operated the video echo-sounder and recorded depths at each sounding point.

Although this operation could quite easily be handled by two men, each of the FAD team was given a survey role in order to familiarise them all thoroughly with the procedure.

The streamlined aluminium side-mount specially constructed for the echo-sounder transducer allowed good soundings to be made while travelling at 6 knots. However, the engine of the survey vessel had recently been rebuilt and the captain preferred to run it at low speeds, so all surveying was conducted at speeds around 4 knots.

Once back in port with all positions and depths recorded on the worksheet and chart, we prepared to draw a contour map of the surveyed zone. The first step was to prepare a chart showing the lines of latitude and longitude for the surveyed zone. For the sake of convenience this was drawn to the same scale as the bathymetric chart generally used by the FAD team. The transect lines were then transferred to this chart and the depths at each sounding point recorded in place.

Because we wanted to draw contours at each 100 m increment it was nearly always necessary to interpolate the soundings from two points and draw the appropriate contour between them. This was done with great care, using the scale of the survey chart and the actual distances between sounding points. Thus, if one sounding was 935 m and the next 1015 m, the actual distance between the sounding points was one-third of a mile, and the gradient was assumed to be constant, we could calculate the increase in depth per millimetre on our scaled chart and arrive at the 1,000 m contour point.

This charting was relatively simple for the Matavera and Arorangi zones where the contour lines followed a natural and logical pattern. It was more difficult in the Black Rock zone where many bottom irregularities were present. It was decided to draw the contour maps keeping the positions' values given by the GPS, which meant that to match them with the bathymetric chart in use (in order to take bearings to shore, or for any other purpose), one would have to move them by 0.4° of latitude northwards and 0.08° of longitude westwards, e.g. 21°17'S and 159°50'W converted to 21°16.600'S and 159°50.080'W.

Although a little cumbersome, we chose to keep the GPS positions on the contour maps because they were prepared solely for the use of the MMR FAD team in locating FAD deployment sites. As the FAD team will certainly use its GPS for future FAD deployment work it will be more convenient for it to use contour maps with values matching the GPS.

Considerations in selection of anchoring sites

It is generally accepted, based on hydrodynamic principles and direct observation, that a concrete anchor block will, on release from a deployment vessel, tend to deviate from the vertical during descent to the bottom. The deeper the chosen site, the more deviation may be expected. Several factors probably influence the degree of deviation from a vertical fall, including: the shape of the block, the prevailing ocean current, and the drag of the mooring ropes and the raft at the surface. Because some deviation should be allowed for, careful consideration must be given to the area of 'safe ground' surveyed at the selected site and the point at which the block is released to 'aim' it at the chosen anchoring site.

By building the block as compactly as possible, and with a slightly larger base to give a low centre of gravity, the tendency of the anchor block to deviate during descent may be reduced. However, there is no way to eliminate this tendency entirely. It is generally accepted that when deploying a FAD by the recommended 'raft-first' method, with the mooring line paid out in a straight line between the raft and the deployment vessel, the drag of the mooring ropes and raft require that the vessel should pass over the anchoring site and continue on for one-third of the mooring length past the site before jettisoning the anchor.

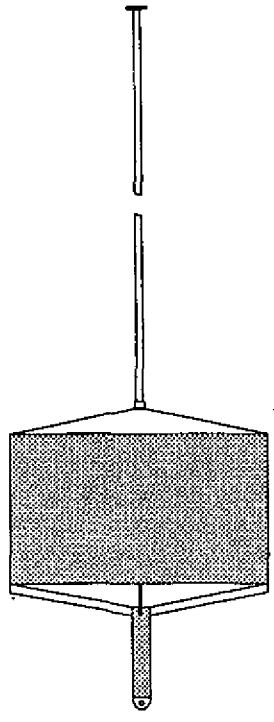
Care must be taken in regard to currents affecting the deployment position. This can be compensated for to some extent by taking bearings from the vessel to the raft during the paying out. If the raft is being carried sideways by the current, adjustments can be made to the vessel's course. *If current direction can* be determined before putting the raft in the water, it is best to steer the deployment vessel up stream of the drift of the buoy while paying out the mooring rope.

Of course, even when the anchor is released right on target there is margin for error.

Observations during previous deployments show that during a deployment in 1200 m with a 1 t block, the raft may move on the surface for up to 9 minutes, dragged by the weight of the descending block. Although the stretch and recoil of the mooring ropes account for some of this time, there is a significant period during which the block is under the influence of hydrodynamic forces, the drag of the mooring ropes, and currents in the upper water layer. The block may therefore deviate significantly from a direct vertical descent.

Therefore, when surveying to deploy a FAD in 1,200 m, the target zone where all depths are acceptable for the planned mooring (that is, within 10 % of the working site depth) must be as broad as possible.

It must be noted here that all survey preparation, the running of the surveys at sea, the drawing of the contour plans, and eventual site selection, were conducted with the full and active participation of the MMR FAD team, with the author taking the role of observer after each skill was mastered.



Cook Islands' FAD raft

Evaluation of equipment

Furuno FCV 362 echo-sounder

It is obvious that a reliable, deep-water capability echo-sounder is critical to accurate surveying of FAD deployment sites.

A unit such as the DSFD Project's Furuno FCV 362, with its 28 khz transducer in use, is quite adequate to the task of sounding depths in excess of 1,500 m, but in average conditions could not be expected to give reliable readings to the manufacturer's given range of 2,000 m.

The critical factor is output power. The FCV 362 produces a 2 kw signal and, while other models and makes are available which produce 3 kw signals and greater, it must be remembered that higher output power also requires increased input power. The FCV 362 was chosen for general FAD survey work because its power draw is about at the level that typical, medium-size fishing craft in the region can supply; this unit being purchased with the intention of using it widely in the region and necessarily on a wide range of fishing craft.

For this same reason the transducer mounting was designed not be a permanent fixture, but to be removable. It is likely that a fixed transducer mounting, i.e. fixed to a vessel's hull, would operate with greater efficiency. This unit cost US$ 4,280 in 1990, which, compared to the cost of a FAD lost through inaccurate depth survey, would seem a good investment. Of course a unit like this, which has dual frequency capability, has a wide range of fishing applications as well.

The FCV 362 has the complete 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; its colour video display was easy to read.

JRC JLU 121 GPS Receiver/Plotter

Although the navigation required for charting of FAD deployment sites can be achieved with complete accuracy by celestial navigation, or even by relying on coastal navigation with bearings to landmarks, the accuracy and ease of the Global Positioning System can make very precise bottom surveying relatively simple even for inexperienced navigators. The system has a high degree of reliability and accuracy and when conducting transect sounding surveys as we did, the ability to have steering directions from waypoint to waypoint proved invaluable. A day spent in training the MMR FAD team in the basic operation of the JRC JLU 121 unit was sufficient for them to use it effectively at sea.

This unit, which was purchased by the MMR in 1990 for around US$3,200, incorporates both a receiver and a plotter and has the capability to display digitised charts on the CRT screen. Thus the vessel's position is constantly indicated both in digital display of latitude and longitude as well as graphically on the plotting screen. A ball control allows for simple movement of a cursor on the screen.

Apart from the ship's own position the unit is able to give information on course made good, speed along route, speed toward destination, bearing and time to destination and so on. If the unit is not receiving adequate satellite signals an alarm notifies the operator. The corrections made between the GPS positions and the bathymetric chart used by MMR was a fairly simple process and was explained in detail to the FAD team. Recent publications of standard navigational charts typically include GPS correction figures. Because we moored the survey vessel in the same position each day we were able to check the reliability of the given GPS position; the greatest deviation noted was 0.07 miles.

Although some would argue that such sophisticated equipment is inappropriate in island fisheries activities, the experience in Rarotonga showed that with even minimal training, local personnel could make very good use of such equipment and conduct fairly complicated navigation exercises with great precision and reliability.

References

Sims, N. (1988). A cost-benefit analysis of FADs in the artisanal tuna fishery in Rarotonga. Background Paper 36, Workshop on Inshore Fishery Resources. South Pacific Commission, Noumea, New Caledonia.

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

THE VALUE OF NUTRITIONAL SURVEYS FOR FISHERIES WORKERS

by Paul Dalzell,
Inshore Fisheries Scientist,
SPC Fisheries Programme

In most Pacific countries a large proportion of the population lives on or near to the coast. Many of these people catch fish to feed themselves and to sell for cash income. A fundamental question for fisheries workers, both scientists and extension officers, is, 'what is the size of the catch ?'

Estimates of catch size are important since this is a direct indication of the scale of exploitation of fish stocks and the yield from a given fishing ground. Nearly all the fisheries in the South Pacific Islands are small-scale and artisanal in nature. (The term artisanal in the context of fishing refers to methods that require little or no mechanisation, as opposed to industrial fishing employing large vessels and sophisticated technology to catch fish.)

Fishing is usually carried out from the shore or close to the coast from locally built canoes or small dinghies. Most men and women living near the coast are potential fishermen and may devote some of their time to fishing, albeit only for subsistence purposes. In such circumstances it is very difficult to estimate the total catch from a given area without carrying out an extensive survey looking at different vessels and gears of a representative number of fishermen.

Estimates of commercial fisheries production may be relatively easy to determine. For example, in Papua New Guinea (PNG), most fish caught by artisanal fishermen is landed at Government fisheries stations. The amounts of fish sold to a station by each fisherman are entered in a receipt book and these form a permanent record of production. Thus we know that in PNG, commercial fisheries production from the coral reef areas of the country amounts to about 1,100 t/yr (Dalzell and Wright, 1986).

Much less is known about subsistence fisheries production in PNG. In their very detailed study of an artisanal reef fishery in the Tigak Islands of northern PNG, Wright and Richards (1985) recorded directly the weights of all fishes eaten over a 21-day period by Tigak Islanders and then extrapolated from this to the total population. This permitted an estimate of 12,443 kg for the total subsistence fish harvest by the Tigak Islanders.

In the absence of direct fish consumption observations, the fisheries scientist may be fortunate enough to have at his or her disposal a nutritional survey that gives frequency and amounts of different foods eaten by the population of a country or some part thereof. If the information is sufficient, then subsistence fisheries production can be calculated from these data in conjunction with the most recent census data which gives total population numbers. A very basic calculation for total subsistence production for PNG of 7,300 t/yr was made using this method by Frielink (1983) who used the 1980 national census in PNG to determine rural and urban coastal populations. He then calculated a daily fresh fish consumption of 50 g/day and 5 g/day for rural and urban populations respectively. The estimated production was acknowledged to be only a rough approximation requiring further work to improve the computation.

A better example is from a recent nutrition survey of the island of Niue carried out by the SPC Health Programme and the staff of the Niue Department of Agriculture. The survey recorded the frequency with which fish and other marine organisms were eaten by Niueans. This could be expressed as the percentage of the population eating seafoods at the three main meals a day, broken down into adults (15+ yrs), school children (5-14 yrs) and infants (<5 yrs). Direct observations on portion sizes were not made in the nutritional survey. Using anecdotal information from Niueans, Dalzell et al. (1990) assumed average fish portion sizes of 200 g for adults, 150 g for school children and 100 g for infants. When extrapolated to the entire population, this gave a daily total fish and seafood consumption on Niue of 252.8 kg or 92.3 t/yr, or an annual per capita consumption of 40.7 kg.

The foregoing illustrates the usefulness of nutritional data from the viewpoint of the fisheries worker. The three examples given here illustrate very rough gross estimates of fisheries production (Frielink 1983) and more accurate observations where relatively fine-tuned estimates can be made (Wright and Richards, 1983; Dalzell et al., 1990).

Nutritional surveys can have more use than their normally intended health purposes and it is hoped that this article will encourage fisheries workers in the Pacific to use such information, in conjunction with census data, for estimates of subsistence fisheries production. The first step should be to contact nutrition officers in national health departments to ascertain precisely what nutritional data has been collected, and then to impress upon them the usefulness of this type of information for fisheries when planning future work. The SPC Inshore Fisheries Research Project would be pleased to hear comments and suggestions from readers resulting from this article.

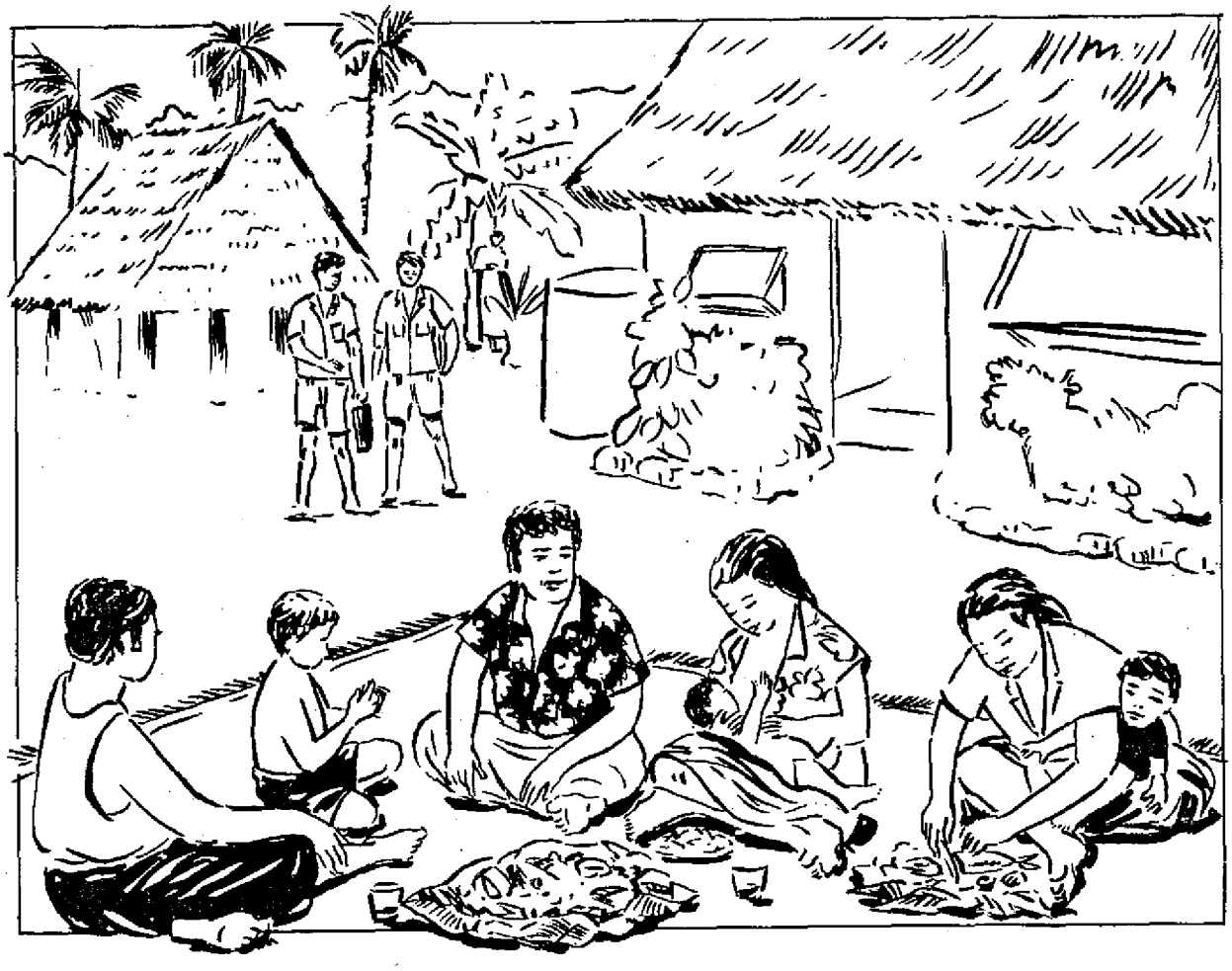
References

Dalzell, P. and A. Wright (1986). An assessment of the exploitation of coral reef resources in Papua New Guinea. First Asian Fisheries Forum, Asian Fisheries Society, Manila, 477—481.

Dalzell, P., S. Lindsay and H. Patiale (1990). Fisheries resource survey of the island of Niue. South Pacific Commission Fisheries Programme and FAO South Pacific Regional Aquaculture Development Programme, mimeo, pag. var.

Frielink, A.B. (1983). Coastal fisheries in Papua New Guinea, the current situation. Res. Dept. Primary Ind. (Papua New Guinea), 83/10, 33 pp.

Wright, A. and A.H. Richards. (1985). A multispecies fishery associated with coral reefs in the Tigak Islands, Papua New Guinea. *Asian Mar. Biol.* 2, 69—84.



A NEW FISHERIES COMPLEX FOR VANUATU

In the SPC Fisheries Newsletter *#54, Simon Maeva gave us a brief description of the new Fisheries Training Centre in Vanuatu. For this issue, Simon sent us a more detailed and illustrated article which appears below.*

by Simon Maeva,
Training Officer,
Fisheries Training Centre,
Vanuatu

Fisheries development in the small South Pacific Republic of Vanuatu received a big boost in 1990 with the completion of a new Fisheries Complex. The complex, which covers about two hectares, is sited on the sheltered Segond Channel of Espiritu Santo Island with the township of Luganville (Vanuatu's second town after the capital, Port Vila) about 2 kms away by road.

Funding for the building of the complex was provided by the European Community (EC) which has a large commitment to develop Vanuatu's inshore fisheries by supporting the Extension and Training Services of the Vanuatu Fisheries Department.

The new complex consists of the following sections:

— The Fisheries Department Administration offices for the northern area of Vanuatu;

— The Department Extension Service Headquarters for the northern area of Vanuatu and the extension office for Espiritu Santo itself;

— The Department workshop for the repair of outboards, small diesels, ice machines etc.;

— A waterfront development of wharf, jetty, slipway and 'boat park';

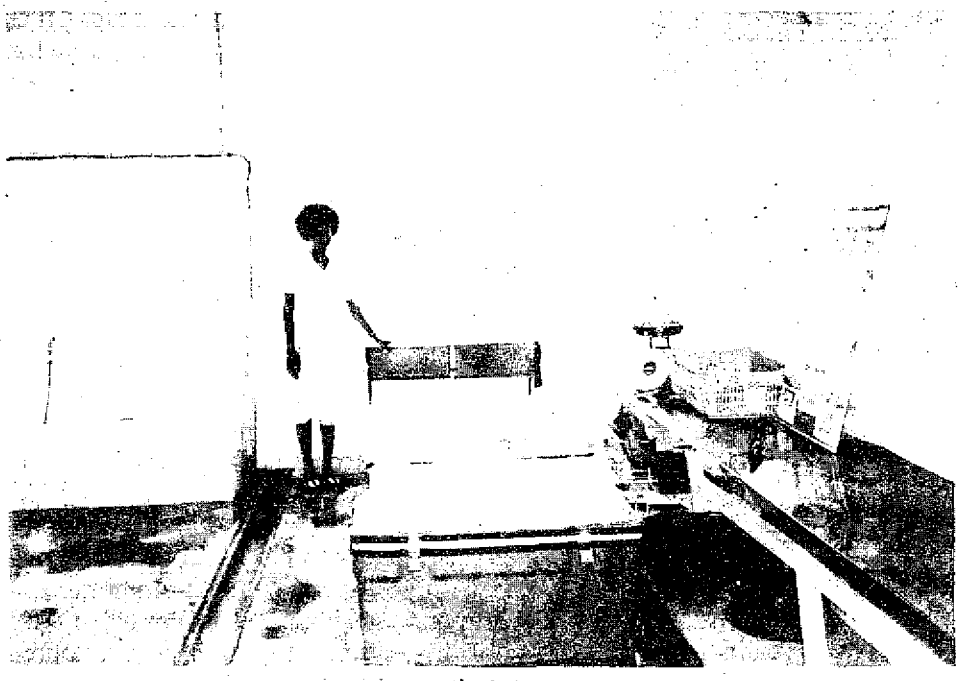
— The Fisheries Training Centre.

The Fisheries Training Centre covers about half the site and provides a classroom block of practical classroom, lecture room and a wet room for handling fresh fish (see photos).

Accommodation for up to sixteen trainees and three visiting tutors is found in two accommodation blocks. Courses are given to Ni-Vanuatu interested in taking up fishing as either a full-time or part-time occupation.

The Training Centre also caters for Extension Officer training. For new recruits to fishing, training is as much as possible of a practical nature and the Training Centre manages its own fleet of boats which will increase to four in early 1991.

Buildings of the Fisheries Training Centre



Wet room used for handling fresh fish

These boats range from a 10 m inboard diesel displacement vessel down to a 7 m outrigger canoe with outboard motor. Revenue from fish sales supports the running costs of the boats, including the skippers' wages and a small percentage for the trainees. In 1990 the Training Centre was the largest supplier of fish to Santo Fish Market, the Government-sponsored retail/wholesale outlet in Luganville, contributing some 9.5 t towards a total purchase of 72 t.

Trainees are encouraged to fish for deep water snappers, groupers and bream from 80 to 300 m depth (*Etelis* and *Pristipomoides* species form the bulk of the catch). These types of fish have a ready sale and are free of ciguatera poison-ing, a problem with some of the shallow-water fish.

Although experiments with various types of gear have been made over the years, the simple wooden FAO hand reel has so far proved the most appropriate technologically. It is cheap and easily repaired. Some boats using two of these reels have brought in catches of over 1000 kg in one month.

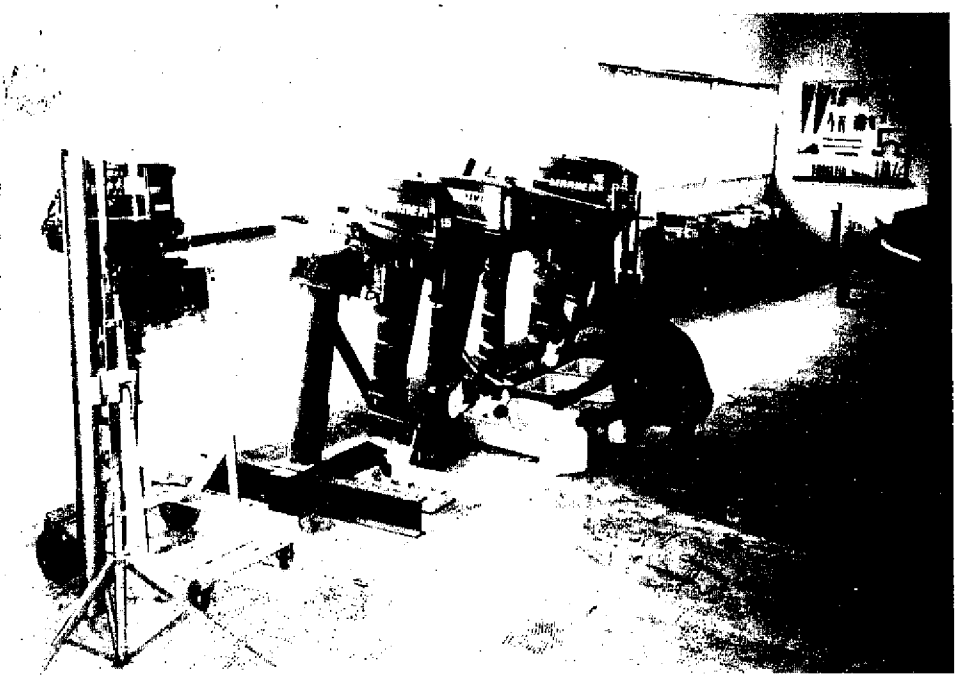
But as every fisherman knows, some months are better than others and an emphasis in training is to tell prospective fishermen to set aside money in the good months to provide for the bad ones.

The Fisheries Department Extension Service operates throughout Vanuatu, with centres in the Banks, Shepherds, Ambae, Malekula and Epi regions, as well as from offices on the main islands of Efate (on which Port Vila, the capital, is sited) and Espiritu Santo. EC involvement in the Extension Service has not only been concerned with construction and administration costs

Room used for meetings, lectures, video and slide showing

of three of the centres (Banks, Shepherds and Epi) but also with providing salaries for up to four expatriate advisers to work alongside Ni-Vanuatu Extension Officers for the first two years.

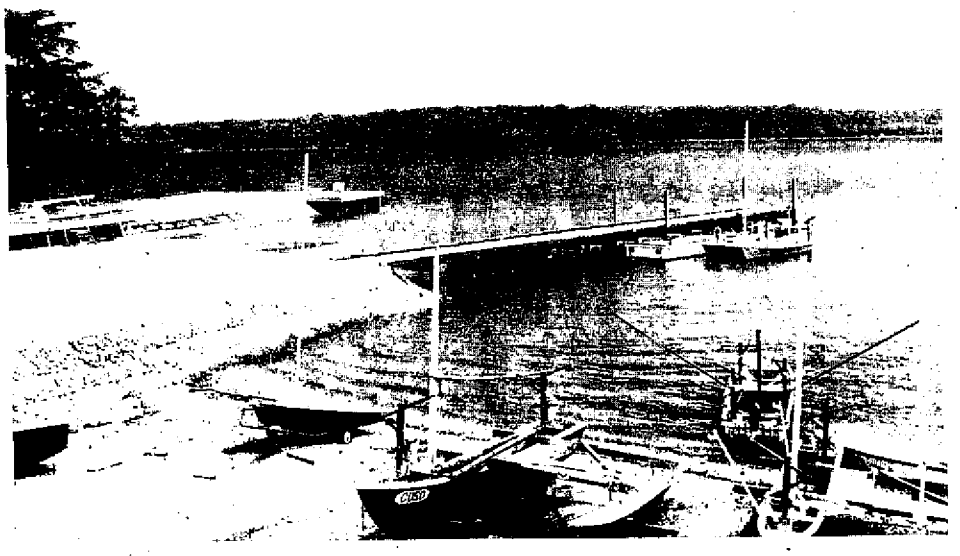
One interesting development in the last two years has been the 'Lease Boat Scheme'. Prospective fishermen are encouraged not to buy their own boat and engine at first, but to lease a complete unit (boat, engine, fishing reels, ice box, etc.) from the Fisheries Department on a percentage-of-catch basis. The book-keeping and management are done by the appropriate Extension Officer on behalf of the fisherman, who can concentrate on his fishing.



A trainee during a practical session on basic outboard engine repair and maintenance

Some individuals, after doing their training and leasing a boat, discover that fishing is not for them and they can't catch enough fish to make it pay. They are then asked to leave the scheme, or leave on their own decision.

The advantage of this is that there is no great financial loss for these individuals, which would have been the case if they had bought their own boat or taken out a big bank loan. On return of the leased boat and equipment, they are then available for someone else to try. On the other hand, some lease-boat operators are doing very well, earning well over Vanuatu's average wage and managing to put money aside eventually to buy their own boats and engines. The scheme is now operating from four Extension



View of the foreshore, showing the two wharfs and the beach where boats can be easily pulled ashore during cyclone season. Note the KIR-4 outrigger canoe (CUSO) undergoing painting.

Centres, with seven boats operating in Santo, four in Efate, two in Ambae and two in Malekula.

An important service for Vanuatu fishermen is the repair of engines (*see photo*) and the workshop at the new Fisheries Complex is never short of work. With four Ni-Vanuatu staff, EC support for the workshop is to provide an expatriate workshop manager. Workshop staff make regular visits to the Extension Centres on the outer islands to service ice machines, generators and other equipment too big to be sent back to Espiritu Santo.