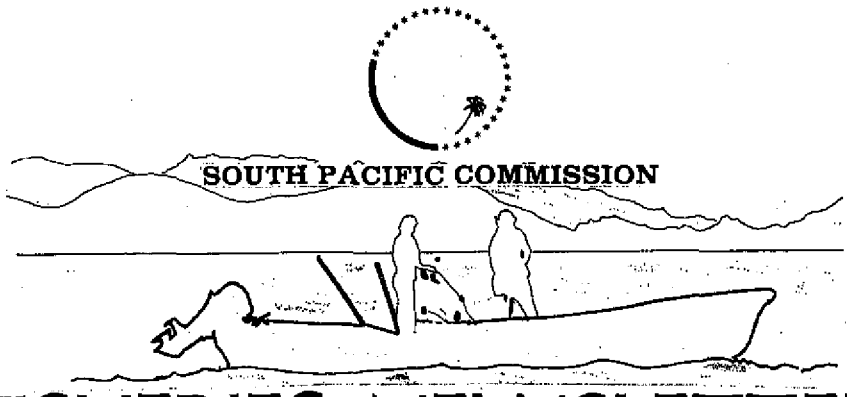

FISHERIES NEWSLETTER

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Contents

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SPC ACTIVITIES

SECOND REFRIGERATION COURSE CONCLUDES

The second SPC/FAO/UNDP Regional Refrigeration Training Course, which started on 8 June 1986 (see SPC Fisheries Newsletter 37, p3) was formally closed on October 17 by SPC Fisheries Adviser Bernard Smith, The course, which ran for 19 weeks, was directed by Senior Tutor Michael Vincent, and aimed to give the 16 participants a thorough grounding in the theory and mechanical skills necessary to enable them to effectively run, maintain, and repair the refrigeration equipment normally associated with a small fish processing plant.

The breakdown of topics during the course was as follows:

Subject area	Lecture/ Demonstration hours	Workshop/ Practical hours	Total hours
1) Basic refrigeration	60	60	120
2) Electrical	60	100	160
3) Diesel maintenance and repair	10	30	40
4) Welding - gas and arc	20	40	60
5) Refrigeration and maintenance service and troubleshooting	80	140	220
6) Refrigeration unit and facility construction	10	30	40
7) Product storage and quality control	40		40
8) Evaluation	40		40

The course tutors noted that the level of achievement was higher than on the first course, held in 1985 also in Rarotonga. All but 3 of the participants passed the final examination for the International Labour Organisation trade certificate, conducted independently by the ILO Trade Testing Centre in Rarotonga.

A third refrigeration course is now being planned, to focus mainly on the melanesian sub-region. The course will probably be held in Papua New Guinea at a time and venue to be decided shortly.

COURSE IN FISHING METHODS AND EXTENSION SKILLS

Following a comprehensive discussion of regional training needs, the 17th SPC Regional Technical Meeting on Fisheries (held in August 1985) identified communication skills and fishing operations as two of the twelve priority target areas to be addressed by the SPC Regional Fisheries Training Project. Since that time, several countries have requested assistance to upgrade the technical fishing skills of staff involved in fisherman training programmes.

In response to these identified priorities the Commission recently designed and ran a 6-week regional course in "Catching Methods and Extension Skills". This was an integrated course to provide advanced training in specified fish catching methods together with instruction in personal communication skills and professional teaching and demonstration techniques. The course was designed for the many Pacific Island fisheries extension officers who are actively

engaged in assisting fishermen improve the effectiveness of their everyday fishing operations, and in demonstrating new fishing methods.

The course, held in Fiji from 29 September to 6 November 1986, was attended by 12 participants - four from Fiji and 8 from other countries of the region - all of whom are actively engaged in assisting fishermen to improve the effectiveness of their everyday fishing operations, and in demonstrating new fishing methods. The course was based at the Fisheries Divisions training centre in Lami, but much time was spent at sea and in the field on practical fishing and extension exercises.

The first part of the course, lasting four weeks, was supervised by SPC Fisheries Training Officer Alastair Robertson, SPC Master Fisherman Lindsay Chapman, and consultant Tongan Fisheries Officer Naita Manu, and was devoted to intensive at-sea training in four fishing methods.

a) deep bottom fishing using handreels
b) trolling around fish aggregation devices
c) vertical longlining (demonstration only)
d) circle gill netting for pelagic lagoon species.

The training was conducted using two 28-foot plywood monohulls and one 28-foot aluminium 'alia' catamaran, as well as several local-style flat-bottomed punts for the gill-netting work. Fishing trips lasted between one day and two weeks, and during the period the trainees became proficient in the main fishing methods to the point where they could effectively demonstrate them to fishermen.

Boat handling, general seamanship and related subjects were also covered during this period, and reinforced in classroom sessions ashore. These included:

a) Boat steering and manoeuvring
b) Safe loading
c) Correct loading and storage
d) Correct method of mooring boat to wharf or other boat
e) Use of knots both for fishing and general purposes
f) Use of mariner's compass
g) Use of the chart for safe navigation and selection of fishing spots
i) Safety at sea
j) Keeping catch records
k) Fish identification
l) Anchoring - deep and shallow methods
m) Echo-sounder use, care and simple maintenance
n) Correct fish handling procedures
o) Icebox design

The second part of the course, which lasted two weeks, was supervised by consultant Mr Brian Trendell, a specialist in extension training from the Queensland Department of Primary Industry. The classroom sessions made use of a variety of teaching and discussion techniques, including decision-making and role-playing games and discussion sessions, to emphasise the importance of inter-personal communication skills. In addition, some technical subjects, such as basic accounting and record keeping, were also addressed. The full list of subjects covered during this period was as follows:

Inter-personal skills:

a) Public speaking
b) How to prepare for a meeting (e.g. have a written question sheet, research the subject to be discussed, have hand-out materials, have some suggestions ready, etc.)
c) How to talk to fishermen to obtain maximum response,
d) How to take notes of meetings and write reports
e) How to arrange meetings so they run smoothly and achieve results - observing local protocol
f) How to prepare and use demonstration equipment
g) How to give a methods demonstration
h) How to explain government policy to fishermen in a way they understand

Technical skills

a) How to keep financial records and use money
b) How to organise a simple store and use simple stock control and records
c) How to manage an ice plant
d) Economics.

Some practical exercises in communication and extension work were carried out during this period and proved very valuable. One involved a real attempt to introduce a new concept to a local fishing community. After discussing the best way to go about the exercise, a group of four students were elected by the class to make initial contact with a community of inshore gill-net fishermen on a tributary of the Rewa river. The fishermen, none of whom had experience of ocean fishing, were invited on a one-day fishing trip to a nearby FAD, where basic surface trolling techniques were demonstrated. The exercise finished with a discussion, in one of the fishermen's homes, about the methods demonstrated and the potential of the techniques for the fishermen concerned. The exercise overall was very successful, and gave the trainees a real insight into the importance of adequate preparation, effective communication and technical ability in conducting what are effectively non-formal adult education activities.

EIGHTH NELSON COURSE ANNOUNCED

The SPC/Nelson Polytechnic Pacific Islands Fisheries Officer Training Course was initiated in 1979 in response to a request from island governments for additional training opportunities for Pacific Island fishermen and extension workers. The course was designed to provide selected Pacific Islanders with extensive practical training in a variety of fisheries skills and related technical knowledge. To date, seven very successful training courses have been carried out in collaboration with Nelson Polytechnic, New Zealand. During the 1979 - 1986 period, 81 Pacific Islanders from 17 countries and territories in the region have undergone training in Nelson.

The objectives of the course are to train selected Pacific Island fisheries officers or fishermen in the practical fisheries skills required to operate a small fish-receiving station or extension centre in a remote location. The training offered covers a wide range of skills and knowledge of value to a fisherman or a fisheries extension officer responsible for providing support facilities and advisory services to local fishermen. Such centres are often

located in remote areas with limited communications, and the success or failure of the venture will depend largely on the enterprise and abilities of the staff concerned.

In response to continued demand for this type of training, the eighth such course has been scheduled and was formally announced in SPC savingram #47/86. The 18-week core course will be held at the Nelson Polytechnic, Nelson, New Zealand, from Monday 9 February 1987 to Friday 12 June 1987. This will be followed by a five-week practical fishing course at a Pacific Island venue, from Monday 15 June 1987 to Friday 17 July 1987.

The New Zealand Government has again generously agreed to provide major funding for the 1987 course, with significant additional funding contributed by the Commonwealth Foundation, the South Pacific Commission, and the FAO/UNDP Regional Fisheries Development Programme. The Commonwealth Secretariat, which has funded previous courses, is presently conducting an evaluation of the course with a view to on-going funding.

DEEP SEA FISHERIES DEVELOPMENT PROJECT NOTES

--Tokelau

Master Fisherman Pale Taumaia concluded his 3-month assignment to Tokelau on December 22nd, one month later than expected due to a forced trip home to Western Samoa for personal reasons earlier in the assignment.

The main purpose of this visit was to demonstrate to Tokelauan fishermen the vertical longline fishing technique that has been under development by the DSFD Project for the past two years or so. Since this is a method of harvesting the deeper-swimming tunas around FADs, most fishing was carried out from the Island of Nukunonu, the only one of Tokelau's three islands to possess a FAD at the start of the visit. A second FAD was installed near Alofi in August after the Project visit commenced, and in October Pale transferred to continue his programme there. Unfortunately a shortage of fuel on Alofi limited the amount of fishing that could be carried out.

Fishing results were generally good, although the conservative Tokelauan fishermen working with the project only partially acknowledged the usefulness of this method to them. Vertical longlining, which is carried out using a wooden handreel, is a direct alternative to the traditional Tokelauan technique of handlining for tunas. Most fishermen preferred their own technique, mainly because it is active (the fishermen feel the fish bite, strike, and play the fish to the surface) rather than passive (in vertical longlining the lines are usually left to "fish themselves" for a given period of time, after which any catch is hauled in). Only when the local fishermen's hands were cut and blistered from the fishing lines would they use the wooden handreels for fishing. The fact that the vertical longline out-performed the traditional fishing style was not a great inducement to most fishermen, since local custom dictates that large catches have to be handed over for sharing out among the community.

The fishing demonstrations allowed evaluation of a number of differed bait types used on the vertical longline. During 14 fishing trips, Pale was able to do several shots each using 4 types of bait - ulihega (Decapterus sp), garfish, flying fish and cut skipjack. Ulihega was by far the best bait, with garfish and flying fish equal second. Cut skipjack did not catch a single fish. The bait trials reflected the Tokelauan fishermen's own bait preferences for tuna handlining. However when deep-bottom fishing, which was carried out as a secondary activity during the visit, cut skipjack still out-performed other bait types by a long way.

--Cook Islands

Master Fisherman Lindsay Chapman's assignment to the Cook Islands ran from 17 November 1985 to 29 July 1986. (See SPC Fisheries Newsletter 37, p4). Following the conclusion of the SPC Catching Methods and Extension Skills Course (see article p2 this issue), Lindsay returned to Rarotonga for a 6-week visit in November/December 1986 to undertake some follow-up activities to the earlier assignment.

The purpose of the visit was to help improve the operation of the Fish Trading Programme operated by the Cook Islands Ministry for Outer Island Affairs. Under this programme, the Ministry purchases fish from the outer islands of Manihiki, Penrhyn and Palmerston, ships them back into Rarotonga on its own vessel, the MV Ravakai, and resells them via its wholesale/retail outlet on Rarotonga, sometimes after processing and/or freezing the fish. At the time Lindsay's visit started, the operation had been losing money for a while. Lindsay's task was to indentify problem areas and recommend improvements in Fish Trading's processing and marketing operations, and its general management, as well as provide basic training in fish handling and processing methods to Fish Trading's Rarotonga staff.

(Photo: L.B. Chapman)

Packing parrotfish fillets in Fish Trading's processing room

During the assignment, Lindsay was able to identify several problem areas, which included:

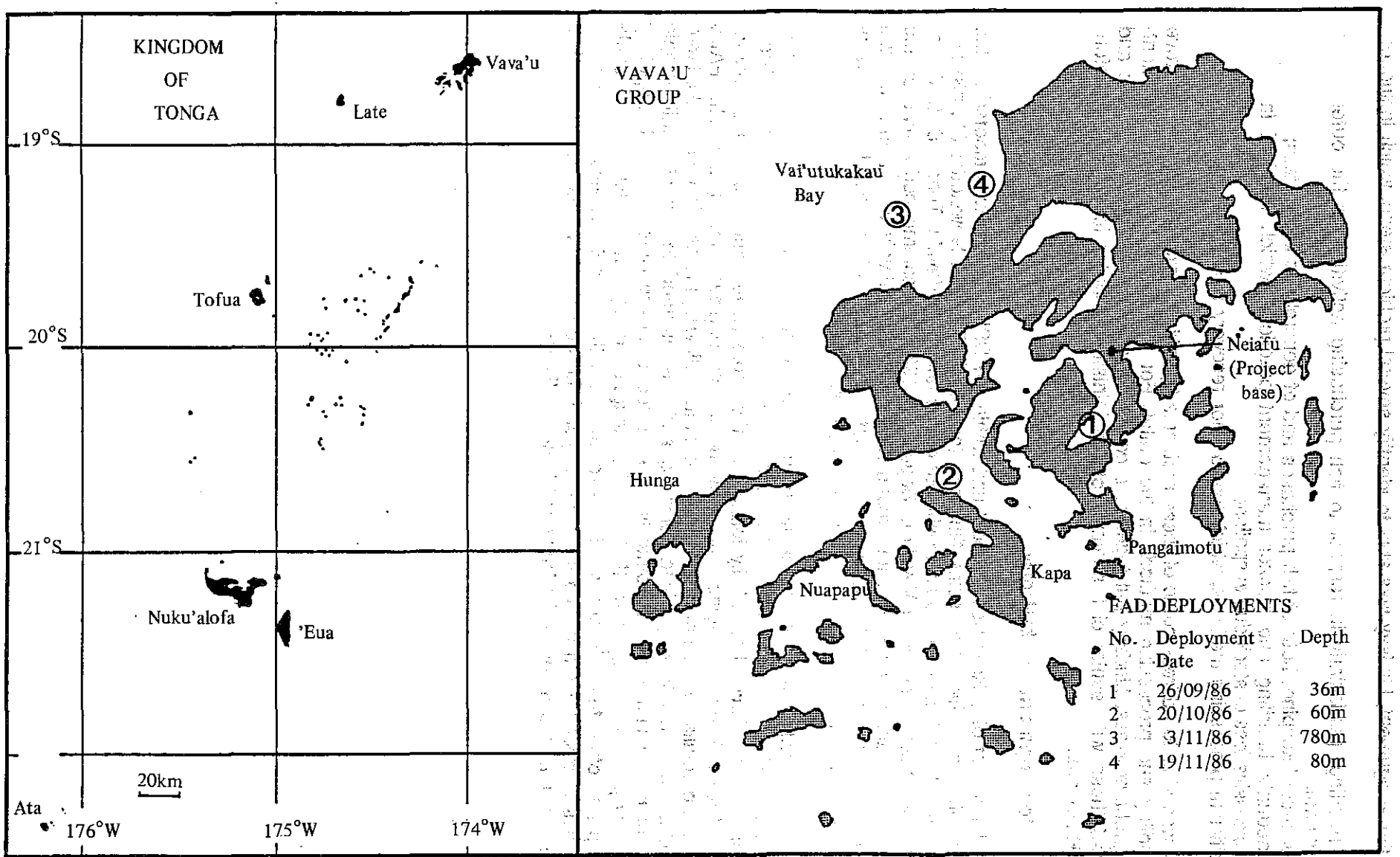
-Overstaffing, particularly in respect to fish purchasing activities on the outer islands;
-Poor record-keeping, both of fish purchases and of general financial details;
-Inadequate handling and freezer management practices, which resulted in excessive loss of stock due to spoilage;
-Inefficient processing methods, which led to poor recovery rates.

Lindsay was able to address some of these problems by taking immediate steps to improve fish handling and processing methods in the outlet. For the financial and manangement-related problem areas, Lindsay put together a comprehensive set of recommendations and discussed these with senior civil servants of the Ministry of Outer Island Affairs before leaving Rarotonga.

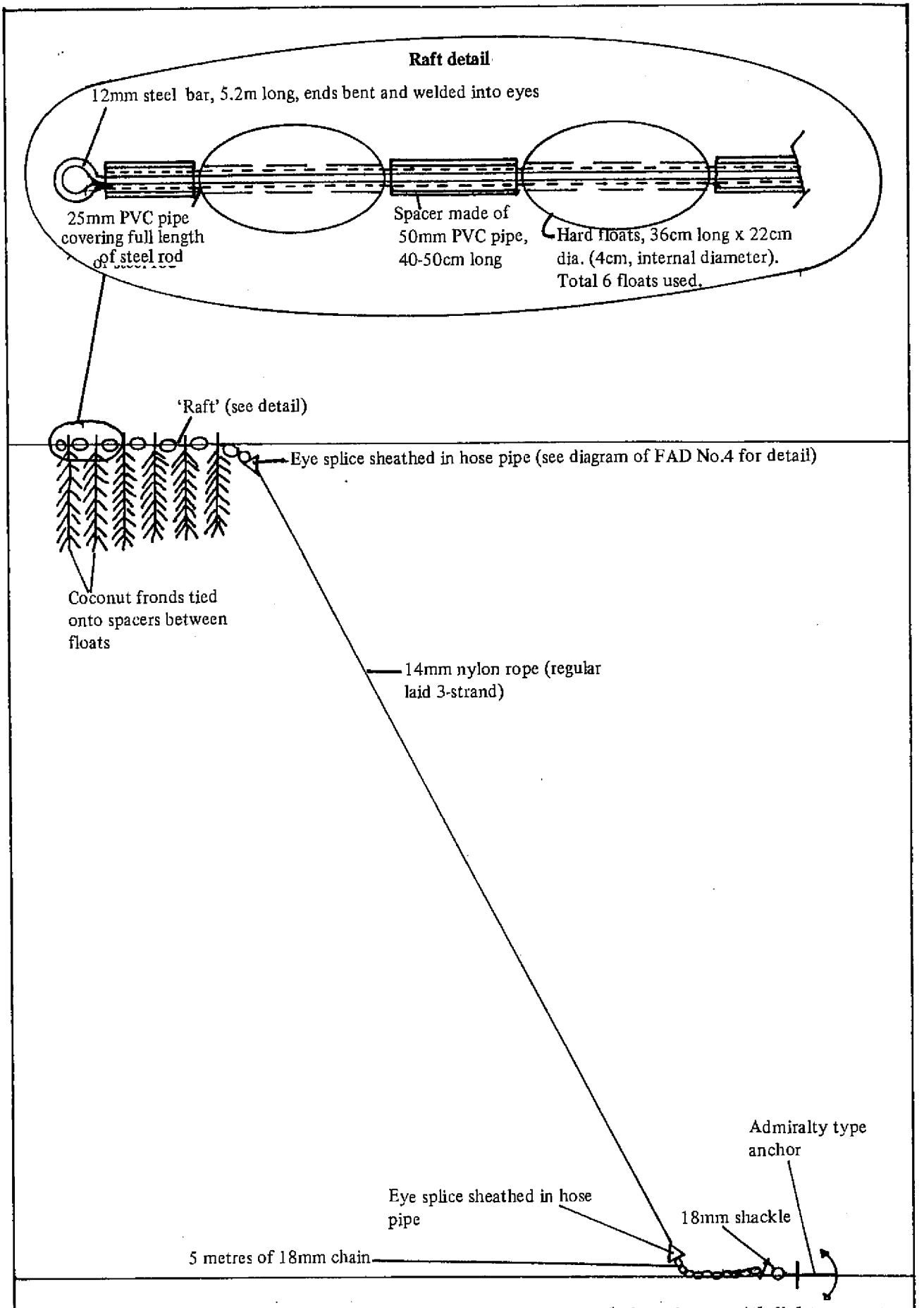
--Gear Development Sub-Project

The establishment of a Gear Development unit within the DSFD Project was mooted by the Fisheries Officers of the region some time ago (see SPC Fisheries Newsletter 35, p3) and has now been formalised with the establishment of this activity in Vava'u, Tonga. SPC Master Fisherman Paul Mead moved to Vava'u in September 1986 and commenced setting up the project, which is scheduled to last for around 2 years. This relatively long time-frame will allow gear development work to proceed uninterrupted by the need to change location every few months, which has been a major obstacle in the past.

Paul's initial activities have been mainly preparatory so far. He has set up a properly organised gear store and a workshop, cleaned and fixed up the project vessel Vete (a 26-foot fibreglass Yamaha fishing boat kindly loaned for the Project's full-time use by the Tongan Fisheries Division) and its engine, and constructed and deployed four FADs. The FADs locations, and details on each of them, are shown in the following pages. Two are in sheltered inlets within the main Vava'u island complex, and are intended to attract small pelagic species for bait fishing trials. The other two are in deeper ocean waters, and will hopefully draw in larger oceanic species that will be caught during deep-trolling, small-scale longlining and other trials. In addition to these activities, the project will also be focussing on methods of deep-bottom fishing in depths beyond the 300-400m normally considered to be the maximum feasible depth for 'standard' handreel fishing

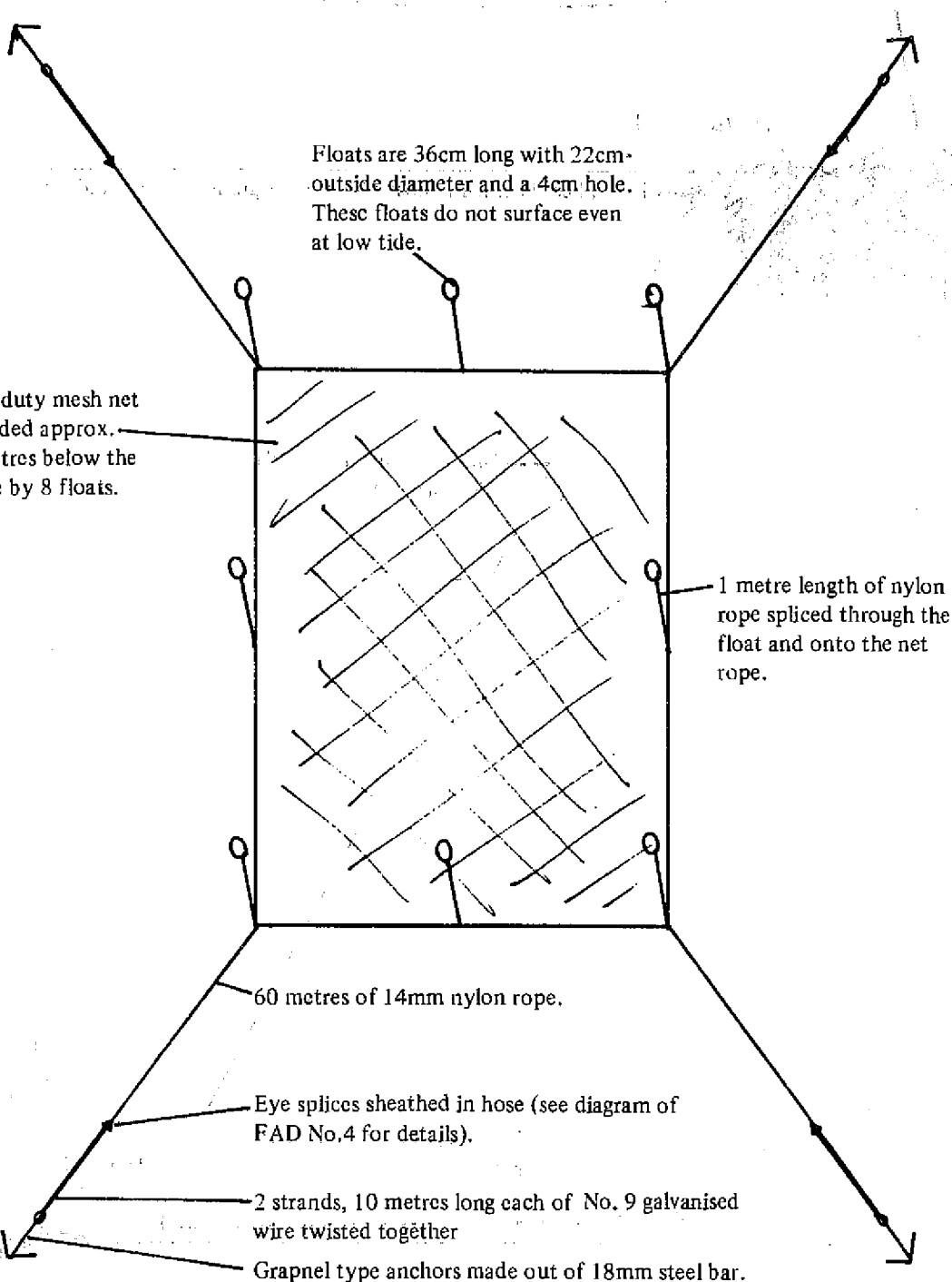


Locations of SPC Gear Development Sub-project base and FAD deployments in Vava'u, Tonga.

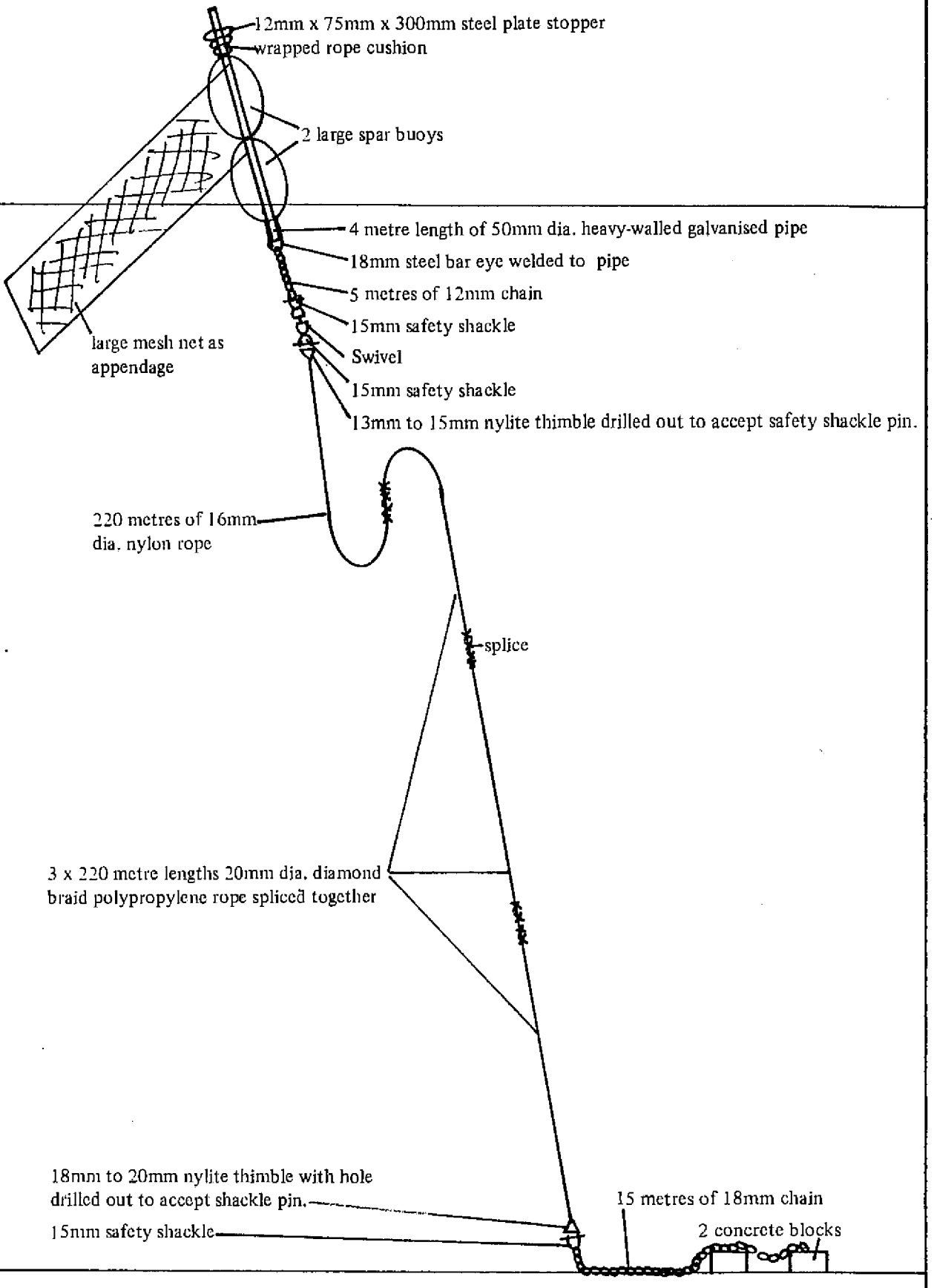


FAD No. 1: Deployed in a depth of 36m on a sand bottom, in a sheltered area with light current and no swell.

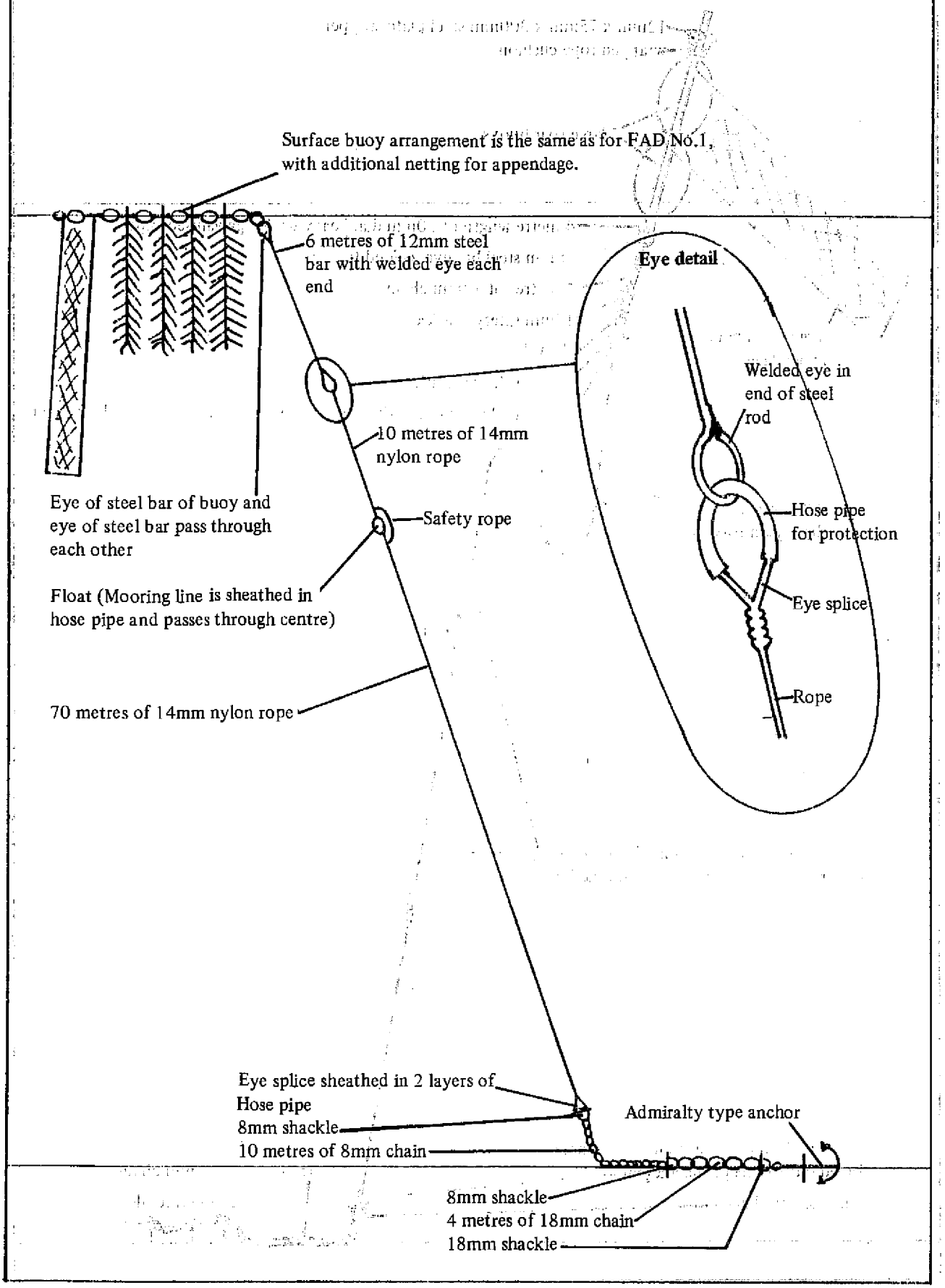
FAD No. 2: Subsurface FAD deployed in 80-90 metres. FAD is moored on a steep drop off with strong currents and slight swells and is designed for sea weed attachment.



FAD No. 3: Deep water FAD deployed in Vaiutukakau Bay in a depth of approximately 780 metres.



FAD No. 4: Deployed in approximately 80 metres on the edge of a 30-40 metre shelf which extends approximately 400 to 500 metres off shore. FAD is moored on a hard bottom of rock and coral and is in a sheltered area with light current.

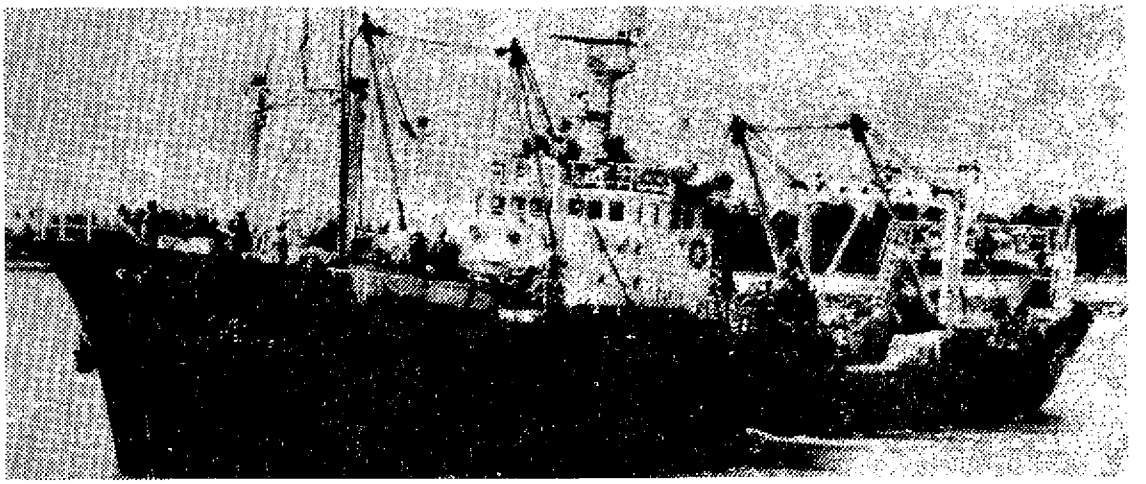


NEWS FROM IN AND AROUND THE REGION

KOREAN TRAWLER OPERATES IN TONGA

(Source: Tonga Chronicle/SPC).

The Taha Noa Taha, first fishing vessel of Ma'alata Fisheries (Tonga) Ltd, steamed into Nuku'alofa on Thursday August 15 1986, and started fishing shortly afterwards. The vessel is a stern trawler, specialised for deep-sea pelagic trawling, and in Tonga is engaged in prospecting on a commercial basis the extensive seamount area to the west of the Tonga ridge.



(Photo: 'Tonga Chronicle')

The Taha Noa Taha on arrival in Nuku'alofa

Although the vessels presence is allowing the exploitation of presently under-utilised resources, local fisheries officials have expressed concern that the joint-venture arrangement under which the boat is operating has enabled the owners to sidestep the normal licensing conditions applied to a foreign fishing vessel. The boat is locally licensed and entitled to fish as a Tongan vessel rather than a foreign one. Although the deep-trawling method being used is thought to target on schools of pelagic armourhead (Pentaceros richardsoni) associated with deep-water seamounts, there is growing suspicion that a large part of the catch is actually deep water snappers (genera Etelis and Pristipomoides) which are also the target species for Tonga's rapidly expanding fleet of truly local small fishing boats. So far, Tongan fisheries officers have been denied access to examine the catch composition, which is all being frozen on board and exported from Tonga.

GIANT CLAM MARICULTURE.

(Source : Clamlines)

The International Giant Clam Mariculture Project has started to release an informal, occasional newsletter called "Clamlines" which aims to keep interested parties informed as to progress with the project. The newsletter is available to research workers and others with a bona fide interest in the project from ICLARM South Pacific Office. P.O. Box 1531, Townsville, Queensland 4810, Australia. Editor Dr John Munro requests that contributions (in the form of informative detailed and frank reports of ongoing work related to giant clams - and not 'press releases') also be sent to him at that address.

The first issue (November 1986) of Clamlines opened with the following summary of the projects aims, structure and activities.

THE INTERNATIONAL GIANT CLAM MARICULTURE PROJECT.

Objectives:

To create a foundation of scientific knowledge which will enable giant clams to be raised in sufficient numbers in hatcheries to make reef restocking or extensive mariculture feasible.To reverse the trend of the larger species towards extinction. To develop a new industry in the equatorial Indo-Pacific based upon the extensive cultivation of an esteemed traditional food resource, which will provide increased food supplies and exportable products. To ultimately create mariculture systems for the only phototrophic (and thus self-feeding) potential farm animal known.

Principal Co-operating Institutions:

International Center for Living Aquatic Resources Management (ICLARM)
James Cook University of North Queensland (JCUNQ).

Other Co-operating institutions:

Fisheries Research Branch, Department of Primary Industry, Brisbane,Queensland [DPIQ];
University of Papua New Guinea, Port Moresby (UPNG);
Silliman University, Oumaguete City, Philippines (SU);
Marine Sciences Institute, University of the Philippines, Quezon City (UP) ;
Fisheries Division, Ministry of Agriculture and Fisheries, Suva,Fiji (MAFF);
Fisheries Department, Ministry of Natural Resources, Honiara, Solomon Islands (MNR);
Tropical Development and Research Institute, Overseas Development Administration, London, England (TDRI);
University of Newcastle-upon-Tyne (UNT);
Micronesian Mariculture Demonstration Centre, Koror, Republic of Palau (MMDC).

How it works and who funds what:

The two major components of this project operate independently in that funding for the principal scientific work coordinated by JCUNQ is channeled directly from the Australian Centre for International Agricultural Research (ACIAR) to JCUNQ and then to four of the cooperating agencies (UPNG, UP, SU, MAFF). ICLARM has no financial involvement with JCUNQ or ACIAR but Dr John Munro serves as joint coordinator, with Dr John Lucas of JCUNQ, of the ACIAR-funded activities. Dr John Copland of ACIAR is responsible for the overall progress of the ACIAR-funded activities. The ACIAR funding will amount to about A$900,000 over the three years from July 1984.

The other co-operating institutions (DPIQ, TDRI, MMDC, UNT) generate their own research funds but exchange information and cooperate with the other institutions in a unified effort to attain the Project objectives.

ICLARM's work in the Solomon Islands is a collaborative effort between ICLARM and the MNR Fisheries Department in which the MNR contributes the services of a graduate Fisheries

Officer, loans the Project various items of equipment and provides an office and support services for ICLARM's giant clam hatchery manager. Funding currently available for the work in the Solomon Islands derives from grants from United Kingdom Overseas Development Administration,the Australia and Pacific Science Foundation and the L.B. and M.J. Skaggs Foundation, supplemented by ICLARM core funding. The External Aid Division of the New Zealand Foreign Affairs Department supported part of the preparatory work leading to ICLARM's involvement in the Solomon Islands.

Other ICLARM work on stock assessment and economic studies and further work on project development is supported from core funds, largely derived from the Australian Development Assistance Bureau's regular contribution to ICLARM's core budget.

Synopsis of results to date:

All species of giant clams have now been spawned by at least one of the participating groups and the use of serotonin for spawning induction has been refined to the point that successful induction is the norm (but certainly not the rule). Gonad biopsy techniques are sufficiently advanced that non-ripe clams and clams that are likely respond to induction can be readily identified.

Larval rearing methods have been advanced to the point that successful rearing through this phase is no longer a problem; but the crunch still comes at metamorphosis and the problem of mass mortality at this point is still a major obstacle to high intensity production of spat. Optimising settlement conditions through the use of a mullite/epoxy substratum seems likely to pave the way to better survival in the early nursery stages. There seems to be lots of scope for improving survival and growth in the land-based nursery stage.

A major advance has been the discovery that, in terms of growth and survival under Australian conditions, the lower inter-tidal zone is the most favourable area for the ocean nursery phases of Tridacna gigas. This has important implications for the economics of clam farming because the ocean nursery phase is highly labour intensive. For example, the MMDC Tridacna derasa nursery in Palau is in water 4-5 m deep and many hundreds of man-hours of underwater work are needed each year for the maintenance of a relatively small nursery. If the nurseries can be located in the intertidal zone the work load could be dramatically reduced and the output of juvenile clams/man/year correspondingly increased.

Field methods for survey and population estimates have been refined by the ICLARM, Fiji and UP groups and growth and mortality rates derived for species in several areas. A small suite of computer programs for analysis of growth and mortality estimates has been assembled and a comprehensive insight into the magnitude and variability of the parameters of growth, mortality and recruitment is emerging.

These estimates are now permitting site specific production curves to be calculated and will also lead the way to the formulation of scientifically-based recommendations concerning the exploitation and management of wild stocks and an evaluation of the feasibility of restocking depleted reefs with hatchery-reared juvenile clams.

Acquisition of information on economic factors, utilisation of clam products, possible market outlets, product development and social aspects are the main concern of several participating groups and some useful work has also been sponsored by the Forum Fisheries Agency.

PROGRESS WITH AUSTRALIAN-PACIFIC PATROL BOAT PROJECT

(Source: Tuvalu Echoes/AMC).

The Pacific Patrol Boat Project, formally announced at the South Pacific Forum Meeting in August 1983, is an undertaking by Australia, in conjunction with several South Pacific countries, to develop and deploy patrol vessels to meet the needs of regional states in monitoring their 200 mile exclusive economic zones, enforcing fisheries, customs, quarantine and other legislation, and providing search and rescue capabilities and inter-island communication.

Last year, Australian Shipbuilding Industries in Western Australia won the contract to build 12 of the vessels which will be provided to selected Pacific Island states as part of a comprehensive aid package which also includes large elements of training, initial vessel operation costs, and in some cases support from operational advisors. The 12 vessels are due to be delivered in the next three years, four each for Papua New Guinea and Fiji and one each for Vanuatu, Solomon Islands, Western Samoa, and Cook Islands. An additional vessel is also being considered for Tuvalu, provided that the two governments can reach agreement on a formula for sharing the maintenance, repair and running costs of the boat when Australian Defence Department officials visit Funafuti in January 1987. The project, which is being managed by the Royal Australian Navy (RAN), is worth about A$60 million.

As part of the package, the Australian Maritime College (AMC) has just completed what will be the first of a series of courses for officers who will be future operators of the patrol vessels. The course, run in co-operation with the RAN, covered a variety of topics including customs, fisheries surveillance, marine law and the law of the sea. AMC expect to run a further two such courses a year until the Patrol Boat Project is completed.

REFRIGERATION FOR DEVELOPMENT

(Source : IIR/SPC).

The International Institute of Refrigeration (IIR) is undertaking a large-scale information campaign to promote awareness of refrigeration technology and its application in improving the quality of life, particularly in developing countries. The campaign, entitled 'Refrigeration for Development', is organised in three phases:

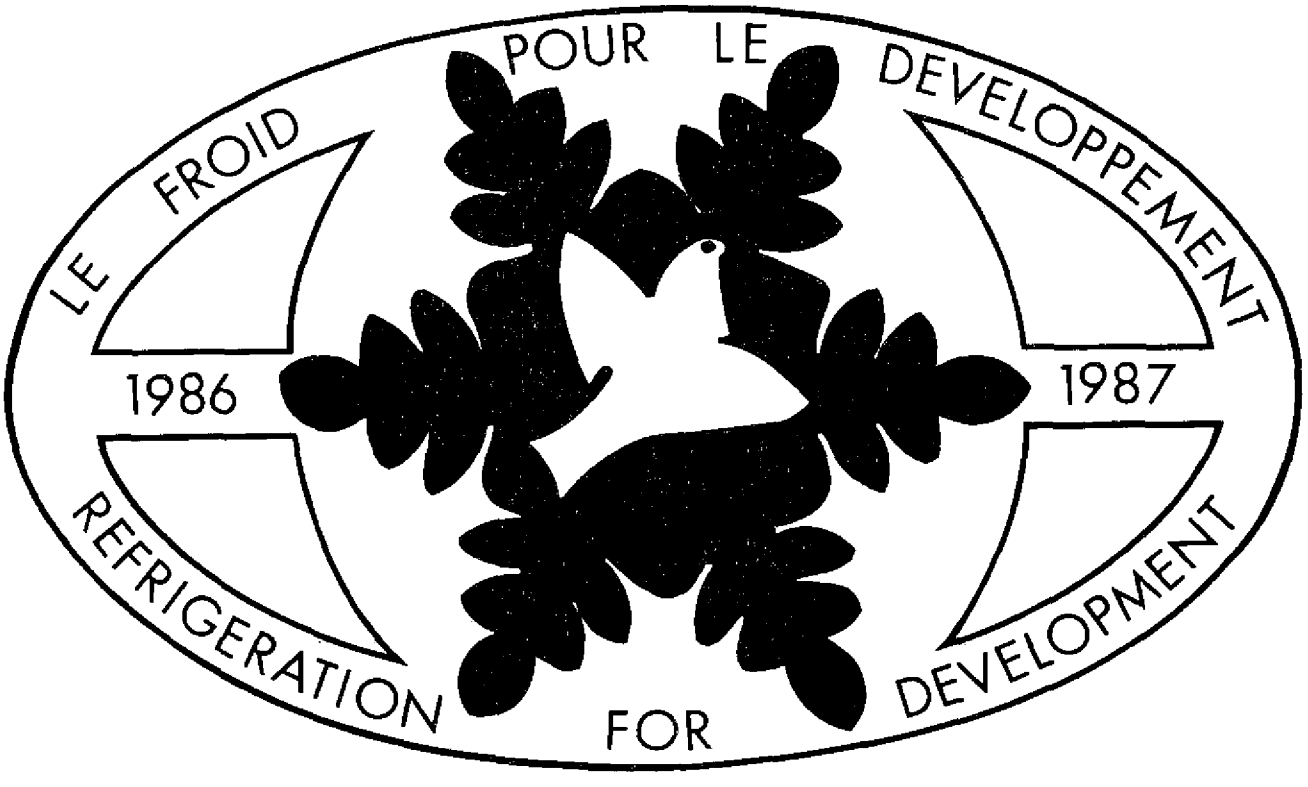
1) A world conference, held in Paris from June 18-20, 1986, which brought together representatives of countries and the media to highlight refrigeration problems and solutions, especially in the third world.

2) An information-gathering and disseminating cycle, lasting about a year, during which IIR is undertaking a survey among national, international and professional organisations to obtain information about their refrigeration-related activities, events, problems and solutions. The IIR is gathering information via surveys and correspondence, and reporting its findings in the IIR Bulletin, from where it is diffused further by the technical press.

3) The 17th International Congress of Refrigeration, to be held in Vienna from August 24-29 1987, during which there will be a sum-up of the operation and an analysis of the results obtained, followed by conclusions and recommendations which will be passed on to national and international authorities.

Refrigeration is of fundamental importance to fisheries development in the Pacific Islands region, and almost all activities aimed at increasing local fisheries production ultimately depend on refrigeration equipment for ice-production, freezing or cold storage. The

Importance of refrigeration has been emphasised recently in the work of SPC's Coastal Fisheries Section. In 1984 the Commission carried out a survey of refrigeration equipment and installations in use in the small-scale fisheries sector in the region. The report of the survey (SPC Technical Paper No 188, Refrigeration for Small-Scale Fisheries in Pacific Island Countries, by G.L. Preston and M.A. Vincent) documented a number of common and major refrigeration problem areas, many of which occurred at the planning stage, and outlined approaches to minimise them. Subsequently, in 1985, the Commission jointly (with FAO/UNDP) ran a 20-week course in refrigeration equipment maintenance and repair (see SPC Fisheries Newsletter No 32 p 2) for engineers and technicians working on fisheries-related plants. The course was repeated, but at a slightly more basic level, in 1986 (see article p2 this issue), and will probably be run a third time starting late in 1987. Meanwhile, refrigeration engineer Mike Vincent, who acted as senior tutor for both the courses already completed, is presently carrying out consultative work in Pacific Island countries. His short-term assignments include in-country training programmes, advice on plant design to meet future refrigeration requirements, and straightforward troubleshooting to help keep running the refrigeration plant on which national fisheries development activities depend.



The campaign logo

The growing interest in refrigeration technology among national fisheries programmes reflects an increasing awareness of the importance of the technology to successful fisheries development in the region. The IIR campaign comes at a time when many countries are seeking information on technological advances and solutions to refrigeration problems. Equally,many countries have important experience which could contribute to the future development of refrigeration in fisheries and elsewhere.

The IIR, which is a bilingual (English/French) organisation, is keen to exchange and disseminate all such relevant information. For further details contact:

International Institute of Refrigeration,
177 Boulevard Malesherbes,
F-75017,
Paris, France.

AQUACULTURE CONFERENCES

(Source: Brigham Young University/European Aquaculture Society).

The Third International Conference on Warm Water Aquaculture will be held at the Brigham Young University, Hawaii, from 11-14 August 1987. The meeting will focus on the future of both crustacean and finfish culture and will expose participants to recent technology, practical experience and information from scientists, technicians, farmers and support industries.

As part of the conference, a complete publication of proceedings will be issued. Previous conference proceedings have provided over five hundred pages of information on the state of both crustacean and finfish aquaculture.

The organisers are keen to contact potential participants or individuals who would like to submit papers to the conference. For more information contact:

Robert Winget,
Co-chairman,
Warm Water Aquaculture Conference,
Brigham Young University,
Laie,
Hawaii, 96762.

The European Aquaculture Society (formerly the European Mariculture Society) has announced another international aquaculture conference and exhibition, Aquaculture Europe '87, which will be held in Amsterdam from 2-5 June 1987. During the conference, general sessions will focus on: site selection; water quality problems and solutions; fisheries and the enhancement of natural production; sea-ranching; new developments in culture technologies; and the economics of processing, marketing, and distribution of farmed products. Other more generalised sessions will consist of experience papers on molluscs, crustaceans, fish and seaweeds, with emphasis on feeding and nutrition, disease prevention and treatment, reproduction, breeding and on-growing, aquaculture equipment and technology, and other items of general interest.

More information on the conference can be obtained from:

European Aquaculture Society,
Prinses Elisabethlaan,
69, B-8401,
Bredene, Belgium.

COURSES IN FISHERIES DATA ANALYSIS AND ECONOMICS

(Source: OSU)

Two short courses in "Fisheries Data Management Using Microcomputers" and "Fisheries Economics" will be run in the second half of 1987 at Oregon State University (OSU) in the US. The data management course is jointly offered by OSU and the Consortium for International Fisheries and Aquaculture Development (CIFAD). The economics course is offered by OSU, CIFAD and the International Institute of Fisheries Economics and Trade (IIFET).

a) Fisheries Data Management Using Microcomputers

The data management course runs in two complementary sessions from 22 June to 10 July, and 13 to 31 July, 1987. The training programme is specifically designed for fisheries and aquaculture managers and researchers with responsibilities for the collection, management and analysis of fisheries information.

The first session is entitled 'Introduction to Computers and the Design of Fisheries Data Bases', and the topics covered include microcomputers, software, the design and operation of fisheries and aquaculture data bases, the MS-DOS operating system, the LOTUS 123 spreadsheet programme, and the dBase III+ data base programme. Participants will use IBM microcomputers or compatibles to analyse data using appropriate software. Participants are encouraged to bring data from their own countries for discussion and analysis during the session.

The second session, entitled 'Analysis of Fisheries Data', requires familiarity with the LOTUS 123 and dBase III+ programmes. Topics covered include: the practical aspects of fish population dynamics, with emphasis on length-frequency analysis and the use of the ELEFAN suite of programmes; and stock assessment using data collected through a variety of methods - catch-per-unit-effort studies, tagging operations, examination of climatic and oceanographic conditions, examination of stomach contents and reproductive condition, and others. Again participants may bring along data from their own countries for analysis.

b) Fisheries Economics

The second course runs from 17 - 18 September 1987. This is an intensive training programme for middle and upper level administrators with responsibility for fisheries and aquaculture management and development. It is also suitable for teaching staff at educational establishments offering fisheries economics courses or units, and for private sector individuals. The programme covers : Fisheries Supply (production relationships, cost and return relationships, business management procedures, financial analysis); Aquaculture (production and cost relationships, market considerations); Demand for Fish and Fish Products (theory and applications of consumer behaviour, role of marketing in determination of demand); Markets for Fishery Products (market structure, pricing, distribution of fishery products, internal exchange rates, international trade barriers); Public Policy (management, development); and Research (basic economic research methods, identification of research needs). The course information will be presented primarily through lectures and written material, but participants will also explore issues in fisheries management, develop and analyse business plans in fisheries and aquaculture, and review problems in fisheries development and seafood marketing.

Both courses will be conducted in English. For further information contact:

CIFAD Training Programmes,
Office of International Agriculture,
Oregon State University,
Corvallis, Oregon 97331, USA.

FISHERIES MANAGEMENT TRAINING PROGRAMME AT ICMRD

(Source : University of Rhode Island)

The University of Rhode Islands International Centre for Marine Resource Development (ICMRD) is offering in mid-1987 a training programme for senior and middle-level administrative personnel involved in training, education, planning and development of fisheries activities. The programme consists of three short courses, which will be held at the University's main campus in Kingston, Rhode Island. The courses are :

a) Information from the Harvest Sector (18 May - 12 June 1987)

This workshop is primarily for those individuals in developing countries who are responsible for providing information used in making policy decisions affecting small-scale fisheries. It will prepare participants to design and execute data collection programmes used to generate information concerning the resource and harvesting sector of the fishery. The first part will focus on identification of a minimum set of biological, economic, and socio-cultural information necessary for policy decisions. The second part will focus on appropriate data collection methods for obtaining the needed information. The third part will deal with methods for the conversion of data into information that can be used for policy recommendations.

b) Microcomputer Application in Fisheries (15-26 June 1987)

This two-week course will introduce the use of microcomputers in analysing data from the fisheries sector. The revolution in microcomputer technology has made computer hardware and software readily available at reasonable prices worldwide. Microcomputers now allow the manipulation of large amounts of data into useful information on which to base development programme plans and management decisions. For developing countries, this represents an opportunity for more cost-effective fisheries management. Data collected through techniques learned in the course 'Information from the Harvest Sector' can be utilised to prepare economic analysis and to perform appropriate statistical analyses for decision making purposes. The course will focus on the application of widely accepted microcomputer software for the transformation of data from the fisheries sector into useful information for managers.

c) Minimising Post-Harvest Losses (29 June - 24 July 1987 1975)

This workshop will examine the causes of post-harvest losses and the methods for minimising them in a small-scale fishery system. Losses ranging from 20 to 40 per cent are frequently observed. Basic causes for these losses include improper handling, contamination, and poor methods and practices for preservation, transportation, and marketing. Evaluation and adaptation of improved methods to prevent these losses will be the main topic of this course.

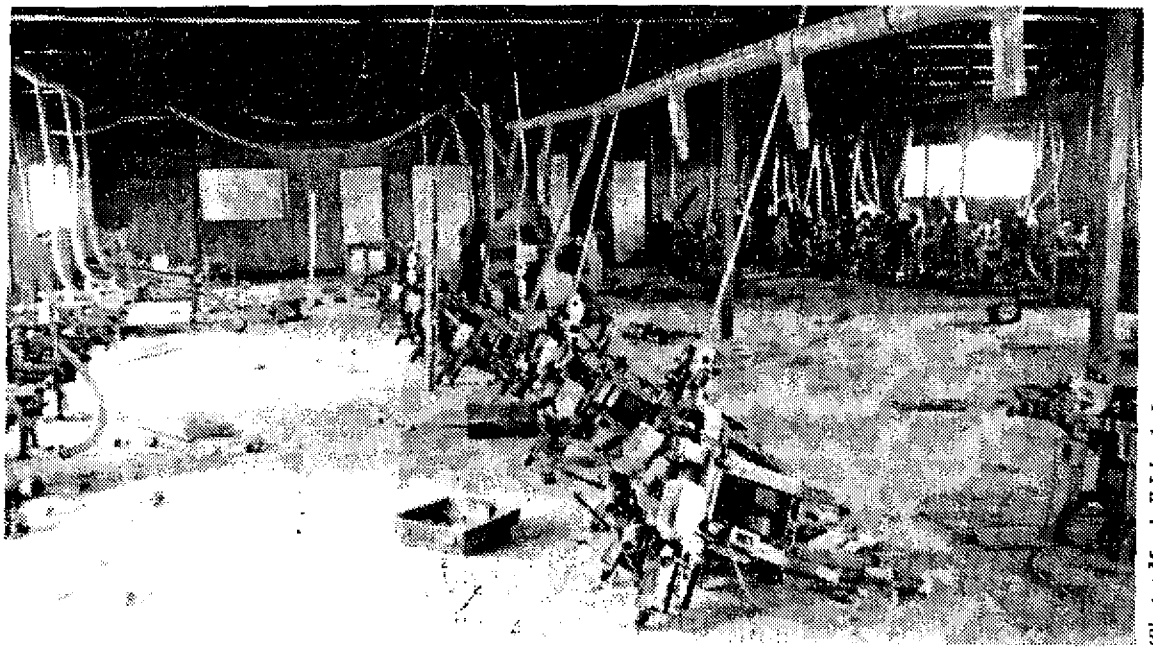
Although the courses are related in content, it is not necessary to attend all three sessions. However, it is recommended that participants enrolling in Microcomputer Applications in Fisheries also attend Information from the Harvest Sector.

The deadline for submission of applications is February 9, 1987. Enrolment is limited to 30 persons, with a minimum of 10 enrolments needed for a course to be offered. For further information write to:

George Aelion,
Training Coordinator,
ICMRD,
126 Woodward Hall,
University of Rhode Island,
Kingston,
RI 02881, USA.

MARSHALL ISLANDS BUTTON FACTORY VANDALISED

(Source : Marshall Islands Journal).



(Photo: Marshall Islands Journal)

Majuro's ex-trochus button factory

The trochus button factory in Long Island, Majuro looks like it has been hit by a cyclone. Vandals of the 'Killer Snake' gang have completely destroyed the windows and are working on the inside now. Eighty jobs for Majuro people and a trochus processing industry are now gone, possibly for good.

RESEARCH FACILITIES AVAILABLE AT LIZARD ISLAND

(Source: Lizard Island Research Station)

The Lizard Island Research Station is a facility of the Australian Museum and is dedicated to supporting research into all aspects of the biology, geology, hydrology, history and conservation of the Great Barrier Reef. Scientists, their assistants, and research students from universities or teaching institutions worldwide are invited to use its extensive facilities to undertake bona fide research activities.

The facilities include one 14-metre research vessel, 7 small boats, scuba tanks and free air for diving, aquaria, wet and dry laboratories, and a darkroom. The island has its own electrical power system and fresh water is supplied from a well and from catchment tanks. Self contained accommodation is available for up to 14 visitors in several small bungalows.

Lizard Island Research Station is a non-profit organisation and is not directly supported by any government funding. For more detailed information, current rates and booking forms, write to:

The Director,
Lizard Island Research Station,
PMB 37,
Cairns,
Qld 4870, Australia.

FIJI TRIES TO IMPROVE FISH SALES: THE FISH TRADERS VIEWPOINT.....
(Source : Islands Business/ John Richardson)

Fresh fish for everybody. The idea that there isn't sounds absurd in a country like Fiji, with more than three hundred islands. But for many families fresh fish is a luxury they can't afford.

David Rosa took over as general manager of the National Marketing Authority's fish collection and marketing operation in April 1986 with that aim in mind. Already, the ex-British Army sergeant-major's spearhead into the Northern Division has brought about a quantum leap in fish gathering. Rosa believes there's enough fish around to satisfy the local market with plenty left over for a healthy export operation. Rosa's aim eventually is to bring in up to 50 tonnes of fish a month from small fishermen - 25 tonnes for the local market and the rest for export. "The fish is there, the market is there, and Fiji has the resources to cancel out any need for imported fish", he says. "Fish is a highly-nutritious food. I would like to see fresh fish for everybody. I don't want frozen fish. We are importing unnecessary, poor quality, poor grade, un-nutritious fish. From New Zealand we get snapper heads, from Australia we get grey mullet and all sorts of rubbish. They catch it in larger quantities so they can sell it cheaper."

Gearing up to wipe out the need for imports means very organised collections and good communications coupled with education. Rosa has travelled to the Northern Division to explain to villagers the necessity of keeping their fish in top quality. He's also explained the value of fish to local communities. "For a tonne of copra they will get around $230, $220 at the moment. It takes them the best part of a week to prepare and dry. They can make much better money catching much less than a tonne of fish."

Before Rosa took over NMA had no organised fish collecting procedure as such, he says, "except that if they heard there was fish in Taveuni for instance they would jump on the ferry and go buy it. But it's unpredictable. Sometimes they got there and there was only 100 kilos. That doesn't even pay for the fuel. The only consistent supply at that time was Labasa."

The NMA's fish depot at Lami is the headquarters of the organisation's fish drive. The depot has a 60-tonne cold storage facility and serves as a retail outfit. So far Rosa has concentrated on the Northern Division, setting up a "cold chain" all the way from the moment a fish is caught right up to the point where a consumer buys it. And he's linked his effort closely to the Ministry of Primary Industries' Fisheries Division activities. "Ice plants are

run by the Fisheries Division. They have them in Labasa, Nabouwalu, Savusavu and Taveuni. Now, that should cover the whole of the Northern Division. We follow very closely behind, so all those places have our NMA set-up."

Ice-boxes are being placed at strategic points around the coast. "The local fishermen buy the ice - it's not free. We insist now that when they go out fishing they take ice with them. We're trying to introduce the cold chain. If they don't ice their fish, we won't buy it. They can sell it to somebody else. Simple as that. Fishermen are also being instructed on the correct method of placing fish on ice, to keep it fresh and at the same time not damage the flesh."

Once the fish goes into the ice boxes, it's the property of the NMA. Much of it is shipped down to Viti Levu for the Suva market. But, says Rosa "when the fishermen sell their fish to the NMA in the Northern Division, the NMA staff are quite at liberty to re-sell it locally. In fact, I insist on that so that we don't get accused of pinching natural resources from that area. The excess fish is brought over to urban areas because that's where the market is."

Rosa knows he can rely on Labasa, where most of the fishermen are Indians. They're highly motivated because they know there's a good return from fish. He also knows he has to come to terms with what he calls the "Fijian factor". That's why he believes plenty of ice boxes to act as pick-up points for NMA officers are necessary to ensure a good, constant supply. If a Fijian village has a death or a wedding or any other big occasion, the fishermen are likely to stop fishing while it's on. His idea of plenty of ice-boxes means they can do that and the in-flow of fish won't be hindered because other villages will be supplying.

Rosa's first objective is to get the Northern Division fully in gear The advantage of the Northern Division, apart from good fishing grounds, is that the area is served by the roll-on-roll-off ferry link with Viti Levu. Apart from fish, Rosa is looking at seafood such as mud crabs - plentiful on the Bua coast. "They are very much sought after in the urban areas. We have tried to increase our supply from there, telling the local women to go out and get us crabs. For ten kilos of crabs they can get $30 in their hand. At the moment we are getting mainly reef fish, and we also have fishermen who are going deep sea fishing, trying to get us snapper".

One of those deep-water snapper, opakapaka (Pristipomoides spp.) is prized for the export market. "We are beginning to think about exporting our excess fish. It really depends on the rate of expansion, or the rate of development that the Ministry of Primary Industries Fisheries Division wishes to go." Opakapaka is being exported to Hawaii and it's fetching good prices. They're a little depressed at present but, says Rosa, opakapaka can bring up to $20-25 a kilo on the highly-discerning Honolulu market. "The cost of opakapaka is a little too expensive for the local market at the moment. But there are people who come in looking for it who have tried it. Once they have eaten opakapaka they're hooked on it".

Supplies of opakapaka vary. It's a problem Rosa is trying to surmount on fish collections in general. "With opakapaka it depends on the fishermen.This week we're not going to export because the fishermen won't go out because of bad weather. We're trying to encourage more fishermen to go into high-value fish for the overseas market as well as the local market. The hotel industry is a good market, but they want a regular, consistent supply. Unfortunately we haven't enough people going for this type of fish. We only have four fishermen on our books here who we can expect opakapaka from."

Rosa's contention is that good, fresh fish should be within the range of everyone in the country. And if the NMA reaches its target, fresh fish prices can be reduced without reducing payment to the people who catch it.

He'd like to see an NMA fish retail outlet in Suva, where the mass of the consumers are. Rosa spent the final years of his army career preparing for the day he was pensioned off. He studied management. and had a good look at the way fish is bought and sold in Britain.

He agrees with the irony that any small town fishmonger in the UK has much more of a choice of fish than major stores in Fiji. Billingsgate Fish Market in London is one of the largest in the world. Rosa's been there. "To be quite honest what I would like is to see our small operation as a mini-Billingsgate. We receive fish from all corners of Fiji and sell it out, and by ten o'clock in the morning we're closed. I'm looking at that idea."

.....AND THE FISHERMAN'S
(Source : Islands Business)

The ocean's full of it: fine quality nutritious meat. The trouble is that for a return of 50 or 60 cents a kilo, it is not worth bringing in. "Some days we are dumping a tonne of shark," complains Fiji commercial fisherman, Graeme Southwick. "Shark's a highly-priced fish on the Australian market. I was shark fishing for seven years, and the stuff we have here is compatible with what they've got."

There's no discernible market for shark meat in Fiji. Southwick sells occasionally to a couple of processors, who prepare it for sale in fast food outlets, served up usually with chips or taro.

But there's hardly any shark fishing going on in Fiji. "In fact any shark we catch is a by-product of our other activities" says Southwick, whose company Wasawasa Fisheries Ltd runs a vessel fishing mainly for deep-water snapper. "The type we are catching are deep-water shark. We're pulling them out of about 200 fathoms. They're only about a metre to a metre and a half long, a really excellent size for fish and chip shops. But the best you get offered locally is around 50-60 cents a kilo. For that price it is not worth putting them in your freezer. They just take up ice and space. By the time you've cleaned them it's not worth bringing them in." So the ice and the storage space is used for snapper, which brings around $4-$5 a kilo. "Nobody has really put any effort into shark fishing because of the market situation here," he adds. There's also the fact that, to many Fijians, shark is regarded as a totem, although Fijian fishermen who catch shark have no problems about eating it. "I haven't run into many Fijians who won't eat it. Rotumans eat it, and they eat it in Kiribati and other Pacific Islands."

Southwick has recently been investigating the US market, where a shark steak is beginning to replace T-bone steak as a macho-type meal. Even so prices in the United States are still low. "We saw the stuff retailing up there for about $US4 a kilo. Shark steaks. The latest prices I saw in Australia were $3.80 a kilo. That was to fishermen."

Southwick has been given a grant to investigate the marketing potential of certain shark species he's catching. One of the by-products is squalene, extracted from the liver, which is expensive and is used in the cosmetics industry. (See SPC Fisheries Newsletter#30)

There's a certain way of handling shark if the meat is to be any good at all for eating. "The important thing is that the shark has to be alive when it's caught. It's no good catching them in nets because they die. They should be alive and preferably kicking, and then the head has to be cut off and they have to be gutted and bled immediately." The still-pumping heart gets rid of all the blood, and a chemical called urea which sharks have in their bodies to help with buoyancy. If the urea soaks into the flesh it turns into ammonia and the meat is ruined. After butchering, the shark should then be soaked in a wash tank, in flowing seawater, for around an hour. After that the meat is odour-free.

Could shark take off in Fiji? "Not unless somebody really pushes it. Not unless somebody's prepared to put a bit of effort into marketing it, and we aren't in a position to do it at the moment," says Southwick.

In fact, at the moment he isn't in a position to do much at all. Wasawasa's main business is snapper, top quality, well handled fish which Southwick hasn't sold on the local market for the last two years because he can't get the price he needs to stay in business. "We've spent this last year developing the catching side and we've increased the daily catch from 50 kilos to about 500-600 kilos. The trouble is the market can't absorb that amount of fish. The increased catch has sent the price down through the floor, and it's uneconomical for us to fish for snapper even on the Honolulu market. We don't sell fish locally because the price is too low. On the main market for this fish, Japan, you are talking about $US14 a kilo. In Fiji you can get $2 a kilo. It costs us a couple of dollars a kilo to get the stuff to Japan, so nobody in their right mind is going to sell it on the local market."

He has mixed feelings about the Honolulu market, often pushed among South Pacific nations as a prime area for selling export fish. "One of the problems has been the myth of super-high prices coming out of Honolulu. It's worth $20 a kilo there once or twice a year. But the Honolulu market is extremely small, and you can get $15 a kilo one day and $1.50 the next day if a big catch comes in like ours, and it's happened to me. Just recently we sent up eight tonnes in two weeks, and the market collapsed. The Honolulu market can't take it."

It costs Southwick's fishing company $1,500 a day to keep its 70-foot boat fishing. To sell snapper locally, and make a bit of profit, he says he needs $4 a kilo. The National Marketing Authority is gearing up its local fishing effort (see preceding article) by encouraging small fishermen. It can get snapper from them cheaper than it can from a large-scale operation like Wasawasa. "They've already told us they can't pay that kind of price for big quantities of fish. The small guys are catching 100 kilos a week. We're catching 600 kilos a day".

Even the hotel industry in Fiji doesn't pay the price Southwick needs. "The hotel market here's a big joke. For example, one of the big hotels buys 40 kilos a week from the NMA... all the hotels in Fiji don't buy a tonne a week." The hotels, he says, want top quality fish, but they don't want to pay more than $3 a kilo. "If we could sell every hotel 50 kilos a day we could keep them all going, one boat. But they don't want to pay the price."

He doesn't agree with the hotel industry complaints that regular supplies of fish aren't attainable. "We can get fish to them regularly, but they say they can go and buy it from the villagers down the road. So we say, 'Go and buy it down the road, but don't come complaining to us when the villagers don't go fishing.' Then they say the supply's inconsistent. They can get consistent supply, and extremely good quality, but they are not prepared to pay. The cost of fishing is an international cost. It's not a local cost, except for the wages. The equipment, the fuel is governed by overseas prices. There's a crisis situation at the moment because of what's happening with snapper. Right now we aren't fishing because the Honolulu market can't accept the amount of fish we need to be viable, but we're investigating US mainland markets, which appear to be stable and can cope with that volume."

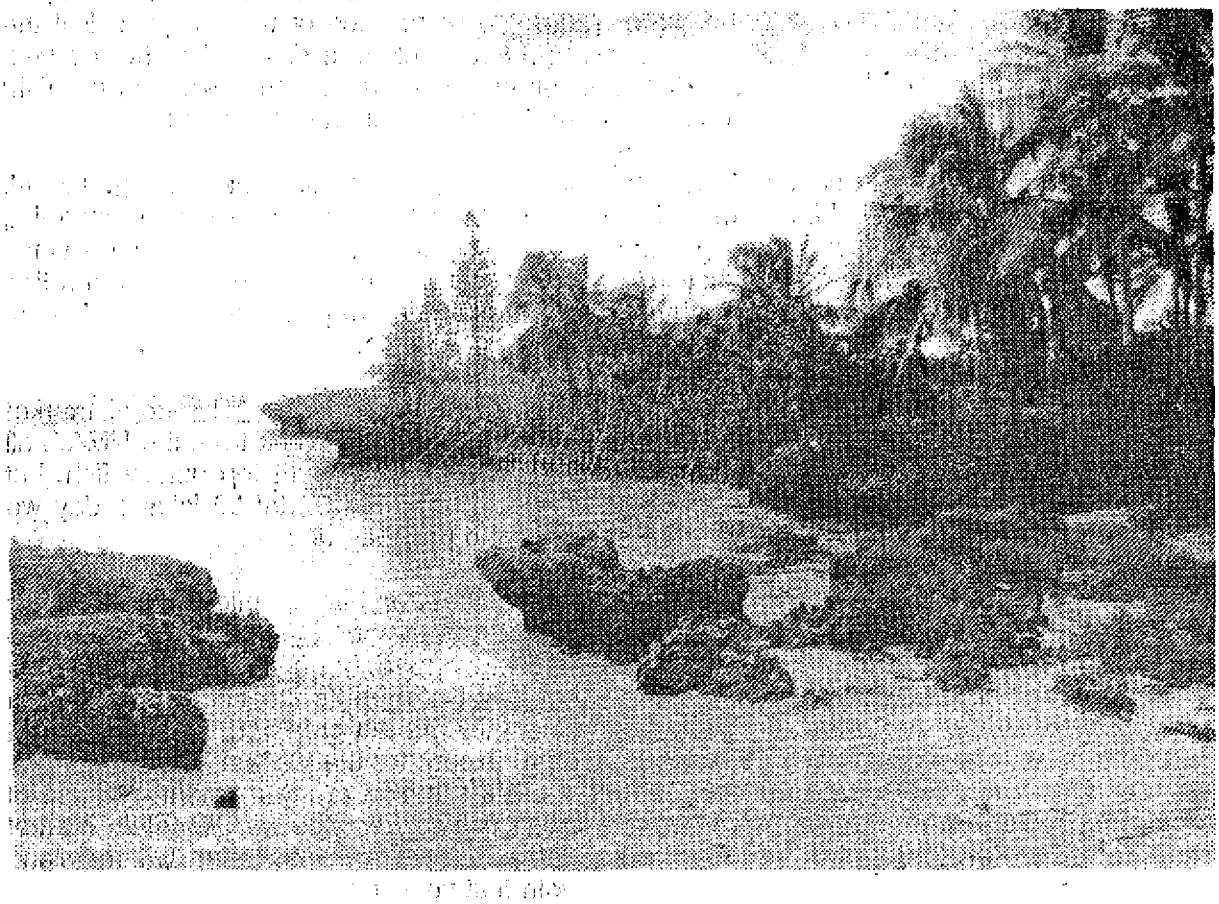
RETURN TO TURTLE RANCHING IN NEW CALEDONIA

(Source : Le Journal de Nouvelle-Caledonie/ SPC)

On the island of Lifou, New Caledonia, as in many other part of the Pacific, turtles are the exclusive property of the chiefly families. Only certain high-ranking individuals have the right to authorise others to catch or eat turtles. Any ordinary fisherman catching a turtle in his nets or by any other means is required to present it to the chief, and anyone eating turtle meat without chiefly permission will, it is believed, suffer a variety of serious illnesses.

In areas where traditional customs are still strong, therefore, there is an established mechanism, which assists modern attempts to promote turtle conservation. Nevertheless, turtles are an important facet of cultural life and are used as food on important ceremonial occasions. In many parts of Melanesia, there is a tradition of turtle ranching, whereby captured turtles are kept, fed, and fattened up until they are eaten as part of a ceremony or festive occasion.

This tradition is declining, but last year the Mou clan on Lifou decided to re-establish the practice as part of an overall attempt to raise awareness of culture and tradition among the local population. The clan cleaned up and renovated their traditional ranching area, a small sheltered cove on a sandy bay, and rebuilt the wooden lattice fence which prevents the turtles from escaping. The ranch used to exist on the same spot, but was destroyed by a storm in 1956 and was never repaired.



(Photo: Le Journal de la Nouvelle-Calédonie)

The turtle enclosure rebuilt by Lifou's Mou clan

The ranch seldom contains more than six or seven turtles, which accumulate as they are occasionally caught by local fishermen. Once inside the pen, the turtles are fed on leaves, fruit, vegetables and waste fish by a member of the clan whose hereditary duty is the care of the ranch. Nevertheless, he is unable to authorise the use or killing of the turtles, this being the right of the chief.

If the numbers of turtles in the ranch become depleted, a special turtle fishing expedition is made to re-stock it. All the men of the clan participate in the expedition, which takes place at night using a large mesh net about 20 metres long. The net is held in the water by 2 or 3 men, while the rest carry out a 'fish drive' to chase any turtles toward the net. Most fish, except the very biggest, will not be retained, but turtles, because of their shape, cannot pass through. When a turtle strikes the net, he is quickly grabbed by one of the fishermen and rolled over in the meshes so that he becomes well and truly trapped. Then, when two or three fishermen come around, he is removed from the net and hoisted into a boat or onto shore from where he is ultimately taken to the ranch. This fishing method can yield 5 or 6 turtles in a night, enough to restock the ranch.

(Photo: Le Journal de la Nouvelle-Calédonie)

Heaving aboard a large turtle

While most conservationists feel that any turtle hunting whatsoever is too much, there is a lot to be said for maintaining this traditional practice within its proper cultural framework. Carried out according to traditional means and customary restrictions, the utilisation of turtles helps maintain cultural and social patterns which have evolved over very many generations, and reinforces the fisherman's respect for resource conservation by tying it to values with which he readily identifies. The alternative, a complete moratorium on turtle hunting, is usually unenforceable and leads to the demise of the cultural side of turtle use while encouraging illicit hunting of turtles for casual or commercial purposes using modern, efficient methods of capture.

FISHERIES SCIENCE AND TECHNOLOGY

'BURN' CAUSES PROBLEMS IN HAWAII'S TUNA INDUSTRY

(Source : University of Hawaii)

A 'Commercial Fishing Workshop', sponsored in Hilo, Hawaii by the University of Hawaii Sea Grant Extension Programme, focussed on the damage that 'burnt' tuna, and poor quality fish in general, may be doing to Hawaii's tuna industry. 'Burn' in tuna is thought to be caused by the buildup of lactic acid combined with rising body temperatures in a hooked fish as it fights on the line. Enzymes from the tissue or from bacteria may also contribute to the subsequent deterioration of the muscle tissue. However, Dr Robert Nakamura, who is researching the problem, expressed his view at the workshop that control of the 'burn' problem lies in better handling of the fish after it is captured.

"Although our information is mostly anecdotal, we keep hearing reports from the mainland market that Hawaii fish are of low quality" said Nakamura. "They get some of our worst fish. I have heard horror stories like 19 of 20 fish in a shipment being rejected because of flesh burn. If Hawaii fish develop a reputation for being of poor quality, the market will more and more look to other suppliers."

Nakamura has concluded that tuna 'burning' occurs after the fish has died. He said that microscopic examination of muscle tissue from burnt tuna clearly indicates that burn does not occur until at least a few hours after the fish has been landed.

Burnt tuna flesh appears pale and watery, has a sour or off taste, and is worth much less than good quality flesh. About 23 per cent of the tuna caught by handlining (ika-shibi) burn, compared with less than 5 per cent of those caught by longlining and 50 per cent of those caught by sport trolling.

The researchers have found a number of factors that may predispose fish to burn. In all size ranges, female ahi burn more often than do males. Also, larger ahi burn more often than do smaller ones.

When a fish is caught seems to be correlated with burn, too. In the nighttime ika-shibi fishery, for example, a yellowfin caught at 8 p.m. is less likely to burn than one caught at 2 or 4 a.m. "I have a hard time believing that fish caught in the early morning are different from those caught at 8 p.m.," said Nakamura. "Therefore, the higher incidence of burn in late-caught fish is due to differences in handling."

From data collected during observations of ika-shibi fishermen on the island of Hawaii, it was found that the earlier a fish was caught, the lower its body temperature would be by the time it was off-loaded at the pier. "The rate of burn is directly related to the amount of time the fish has been in the chill box," said Nakamura. "We think this time relationship with burn is a management problem, not a physical one. We think that cooling the fish to its core as rapidly as possible is the most important step to take to reduce, if not completely prevent, burn. We have found that slowly cooled tuna have a greater chance of burning than rapidly cooled tuna."

Bleeding, gilling, gutting, and properly icing the fish within 20 to 30 minutes of capture are among the most important steps a fisherman can take not only to reduce burn but also to maintain good quality flesh.

To help fishermen develop better skills, Nakamura and his team are compiling a handbook of fish handling techniques that will be published later this year as a UH Sea Grant Extension

report. In addition, a group of associated research workers will be publishing three short technical bulletins on fresh versus frozen fish, the economic rationale for quality fish handling, and marketing for fishermen. These extension publications are expected to be available later this year also.

CONSUMER ACCEPTABILITY OF SHARK

(Source: Consumer Acceptability of Shark by J. Welsford, J.L. Sumner, R.R. Pyne and J.M. Lyle. In "Spoilage of Tropical Fish and Product Development", FAO Fisheries Report No 317 Supplement, 1985, pp 414-417.)

Of the approximately 17,000 tonnes of whole shark presently harvested from Australian waters only some 10,000 t are landed in Australia for domestic consumption; major species are Mustelus antarcticus (gummy shark) and Galeorhinus australis (school shark), typically taken from the colder, southern waters. Approximately 90% of these ultimately enter the Victorian market. However, estimates indicate an additional tropical shark resource of approximately 10,000 t, comprising mainly Carcharhinus spp.(black-finned school sharks), Rhizoprionodon spp. (milk sharks) and Sphyrna spp. (hammerheads) which could be harvested annually from Australian waters.

The question has been asked - would the warm-water species of shark prove acceptable to the Victorian consumer? For several reasons the prognosis has been considered unfavourable. One of these is a perception by Victorian buyers that consumers would consider warm-water shark as inferior to the colder southern species, in turn affecting demand and prices.

To test the preferences of Melbourne consumers for warm- and cold-water sharks, a series of taste panel evaluations were carried out by the Food Technology Unit, Royal Melbourne Institute of Technology, during 1983. As well, the project examined the physical and chemical characteristics of sharks to assess any intrinsic differences which might affect eating quality.
Consumer acceptance of 12 species of shark from Northern Territory waters was assessed by comparison with well accepted cold-water species, Mustelus antarcticus (gummy shark) and Galeorhinus australis (school shark). Evaluation was carried out by (1) sensory evaluation through taste panel tests and (2) objective evaluation through examination of chemical properties (hypoxanthine content, pH and moisture content) and physical properties (colour and texture).

Taste panelists were able (70% of tastings) to distinguish between warm- and cold-water species, but the difference was rated "slight-moderate" and no preference emerged for either warm-or cold-water shark. That is, about 50% of preferences were given to each species group.

Cold-water species were significantly whiter, smoother and moister in texture and had a blander flavour compared with the warm-water species which emerged as yellow-grey, having a firmer meaty texture and stronger flavour. These differences in colour, texture and moisture were confirmed in objective evaluation tests.

Only one warm-water species, Carcharhinus cautus (mangrove shark) was found to have poor consumer acceptability because when cooked it had a dry, rubbery texture and the flesh was darkly coloured.

The indications from this study are that there are intrinsic differences,warm-water species presented as more meaty, tangy compared with the whiter, softer, blander cold-water shark but both groups were equally acceptable to consumers.

ABSTRACTS

THE BIOLOGY AND CULTURE OF TROPICAL OYSTERS by C.L. Angell, 1986 42pp.

Oysters with potential for aquaculture are found throughout the tropics and sub-tropics, but few species have been cultured, and those in only a few tropical countries. This monograph reviews the biology, ecology and culture techniques, both experimental and commercial, used in the tropics; describes the problems associated with tropical oyster farming; and points out research needs to develop further this form of aquaculture. Three oyster genera are discussed in the review: Ostrea, Crassostrea and Saccostrea. The advantages and disadvantages of various species of each genus with regard to aquaculture are described.

Contact address: ICLARM, MC P.O. Box 1501, Makati, Metro Manila, Philippines.

THE US TUNA MARKET: A PACIFIC ISLAND PERSPECTIVE by D.M. King, 1986

The US accounts for one-third of the world tuna market and over half of the world market for canned tuna and dominates international trade in cannery-quality tuna. Whether Pacific Island nations choose to deal directly with the US in the development of tuna fisheries or choose to work more closely with other nations, the financial performance and economic impact of their tuna-related ventures will be influenced by changes in the US market.

The US tuna market is primarily a market for canned product, but specialty markets for other kinds of raw, frozen and processed tuna products are growing. For high-volume tuna producers, the canned market is still the only reasonable option, but markets for specialty tuna products which are too small to attract the major US tuna companies may offer a niche where small producers can penetrate the US market. It is important to understand, however, that US consumers prefer meat to fish and although the traditional canned tuna product is popular, attempts to market other kinds of processed tuna products have always failed.

Arranging for the distribution and marketing of tuna products in the US is as important as developing efficient harvesting and processing operations. The major US food companies operate elaborate marketing/ distribution networks and are in a position to buy raw and processed tuna products from many different sources. Any investments in tuna development that are oriented toward the US market should be viewed from the perspective of a complete production/ distribution system and the investor should know where his operation fits into that system.

Most individual Pacific Island nations are not in a position to develop a competitive national tuna industry or command enough market power to deal effectively with the major tuna companies or have any significant impact on the international tuna trade. On a regional basis, however, Pacific Island nations control 40 per cent of the global tuna supply which is a large enough share to make a major impact on all world markets. If Pacific Island nations view the large US market from a regional rather than a national perspective, they can develop strategies that will give them more market control and allow them to negotiate more effectively with the large US tuna companies. Dealing collectively will also allow island nations to take advantage of economies of scale by centralising information gathering, surveillance and enforcement, marketing functions, etc. Large US food companies have developed their strength in the tuna industry by centralising control over tuna production/ distribution systems; to compete or negotiate with them successfully, Pacific Island nations will need to do the same.

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IS INTERNATIONAL MANAGEMENT OF TUNA NECESSARY?

by

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Abstract

Movements of skipjack and yellowfin tuna are reassessed and it is shown that long distance movements are the exception rather than the rule for these species and that for countries with large economic zones, stocks may be considered resident. Under current economic conditions, unregulated fisheries will not overexploit skipjack tuna and will not seriously overexploit yellowfin. International cooperation in regulating harvests is probably not required for these two species, particularly where economic zones are large. However, international cooperation in research and collection of catch statistics is necessary since it will be quite difficult for an individual country to evaluate trends in the fishery.

Introduction

The proposition that international cooperation is required for the effective utilization of the tuna resources of the world has become almost universally accepted.[1] The fact that individual fish have been recovered thousands of miles from the place they were tagged has caused most tuna species to be classified as "highly migratory" thus investing them with a unique status in international fisheries. The United Nations Convention on the Law of the Sea, now recognised as common practice by major fishing nations, provides coastal states with the authority and responsibility to manage all fisheries resources within the exclusive economic zone (EEZ), but specifically mentions highly migratory species as requiring international cooperation.[2] Lack of complete agreement over the extent to which coastal

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1 See Joseph, International arrangements for the management of tuna, a world resource in Rothschild (ed). World Fisheries Policy - multidisciplinary views. University of Washington Press, 1972. Joseph, Scientific management of the world stocks of tunas, billfishes and related species. J. Fisheries Research Board of Canada 30, 1973. Joseph, The management of highly migratory species: some important concepts. Marine Policy, October 1977. Joseph, International Tuna Management Revisited, Chapter 6 in Rothschild (ed) World Fisheries Policy; Joseph and Greenough, International management of tuna, porpoise and billfish, University of Washington Press, Seattle, 1979, 253 pp; Kearney, The Law of the Sea and regional fisheries policy, Ocean Development and International Law Journal, 1978, pp 249-286; Van Dyke and Heftel, Tuna Management in the Pacific: An analysis of the South Pacific Forum Fisheries Agency, University of Hawaii Law Review, 1981, pp 1-65; King, International management of highly migratory species, Marine Policy, Vol. 3 No. 8, October 1979, pp 264-277.

2 The Law of the Sea, United Nations Convention on the Law of the Sea, 1983, the United Nations. Annex 1 gives a list of highly migratory species.

states may exercise authority over highly migratory species within EEZs has caused some serious problems on both sides of the Pacific.[3]

There is no consensus on the most desirable institutional structure for international cooperation in tuna research and management. Organisational models range from the Inter-American Tropical Tuna Commission (IATTC), which has at various times imposed catch quotas, to the Tuna and Billfish Assessment Programme of the South Pacific Commission (SPC), which conducts scientific research on the state of the stocks and harvests but has no management responsibility. Within the biological, economic and legal literature cited above, the inevitable necessity of international catch regulation is not questioned. Implicit in virtually every paper is the assumption that since tuna are highly migratory, serious overexploitation will result unless there is international regulation of harvests.

At the political level, there is no general agreement that international control of harvest is required. Not all nations have agreed to participate in the existing international agencies. Most Latin American nations have withdrawn from IATTC, and their own fishermen are essentially unregulated in their own waters. The U.S. does not recognise national sovereignty over tuna within the EEZ of coastal states, and U.S. fishing boats continue to fish in the EEZ of some countries of the western Pacific without authorisation of the coastal state.

Proponents of international regulation need only reiterate the sad history of the North Sea and Norwegian spring spawning herring stocks, where international disputes prevented effective control and enormously valuable stocks were harvested to commercially insignificant numbers, to make a case for the necessity for international control.

The need for international regulation of harvests rests on two necessary assumptions. The first is that movements of fish are large in relation to the EEZ of the nations concerned, so that harvests that occur in one country or in international waters will significantly affect harvests in other countries. The second assumption is that an unregulated fishery must inevitably overexploit the resource. The reason for the disastrous history of the North Sea and Norwegian herring is that it was economically profitable for an individual vessel to keep fishing even when the stock abundance was very small, as low as 1% of the original biomass. If an unregulated fishery will not overexploit the stock, then there is no pressing need for regulation. If movements of fish are small in relation to the economic zone of a country, then the country can effectively regulate its own fishery.

Are skipjack and yellowfin highly migratory?

The term "highly migratory" has been so widely used in legal writings that any biological meaning it originally carried has become not only obscure but possibly irrelevant. In fact, the term has become almost a synonym for tuna, a development which hides the wide range of migratory behaviour between tuna species. Nevertheless the migratory properties of the principal commercial tuna species merits examination to determine how these properties might be best exploited by management strategies.

There are over a dozen species of tuna captured in commercial fisheries around the world and all show long distance movements. Table 1 summarizes the estimated total global tuna catch. Skipjack and yellowfin constitute approximately 70% of the total catch by all gears, and constitute over 90% of the purse seine catch, the fishing gear considered to be most seriously in need of regulation.

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3 Tsamenyi, B.M. The South Pacific states, the USA and sovereignty over highly migratory species, Marine Policy, January 1986, pp 29-42.

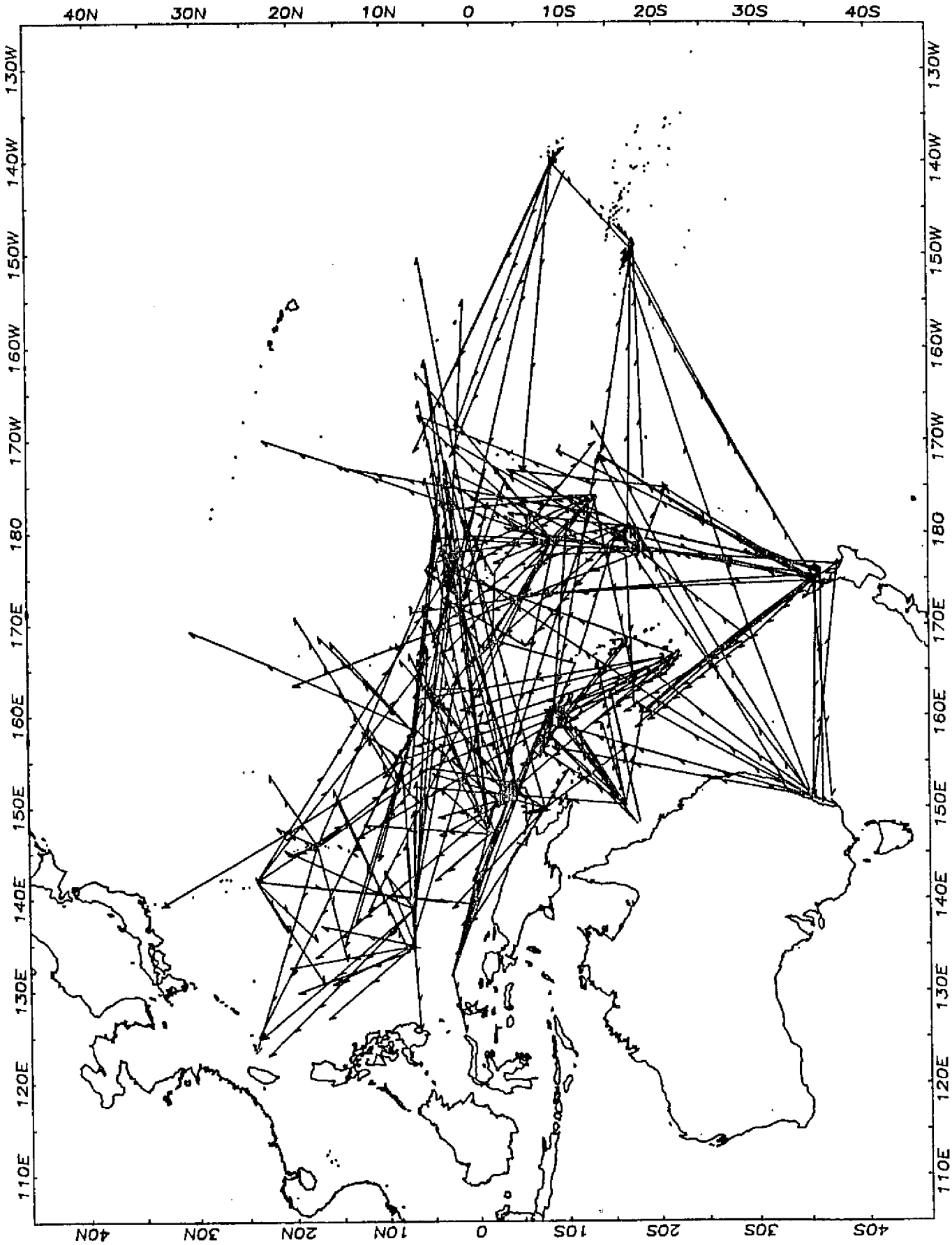

Figure 1: Straight line representations of movements of skipjack tagged by the Skipjack Programme and subsequently recovered. Data are selected so that no more than two tag movements are shown between any 10 degree square, which has the effect of representing almost all long distance movement and few short distance movements.

Table 1.1980 world landings of tuna. All numbers in thousands of metric tonnes.
Source :FAO Fisheries Statistics Yearbook.

Species	Landings	Per cent
Skipjack	771	42
Yellowfin	520	28
Bigeye	198	11
Albacore	180	10
Frigate	137	7
Kawakawa	45	2
Total	1851	100

Large numbers of skipjack and yellowfin have been tagged and recaptured in the eastern Pacific by the IATTC, in the western Pacific by the SPC, and in the Atlantic by ICCAT. Figure 1 shows sample long distance movements of marked skipjack from the SPC study. This graph has appeared in over 30 SPC publications, emphasizing the highly migratory nature of skipjack. Figure 2 shows a frequency distribution of the distance moved from the same study. Most fish moved relatively short distances, and the long distance movements of Figure 1 are a minor proportion of the total tags recovered. About 85% of skipjack tag recoveries in the SPC study occurred in the country of release. Figure 1 may be considered typical of the tendency of scientific reports of tuna migration studies to show graphs that overemphasize long distance movement and underemphasize localized movement.

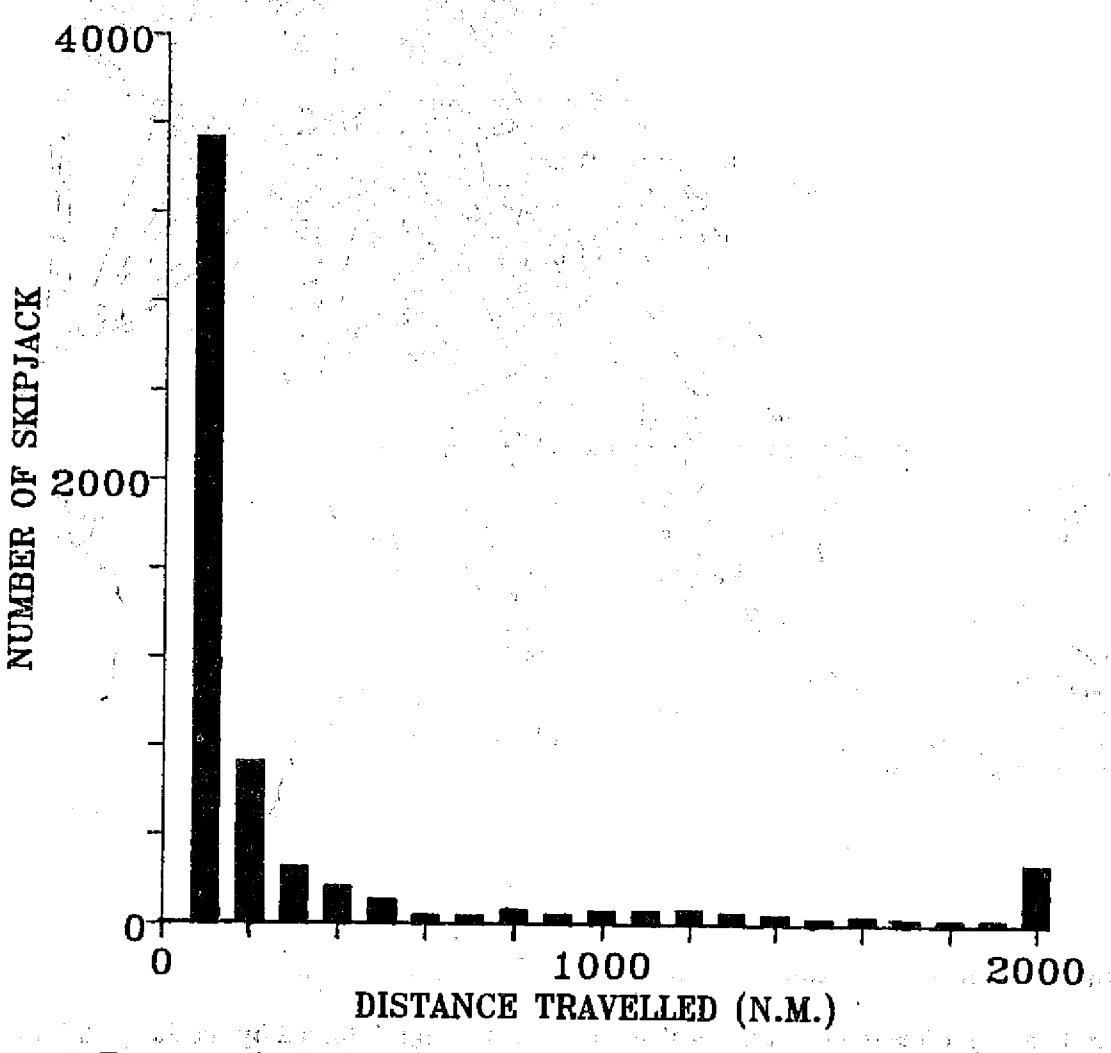

Figure 2: Frequency distribution of distance travelled by skipjack recovered by the Skipjack Programme. Almost all fish were recovered very close to the source of tagging.

Figure 3 shows a graph of average distance moved in relation to time at large for yellowfin tuna tagged and recaptured in the eastern Atlantic.[4] The monthly movement rate is rather small, and there is an obvious annual movement, thought to be associated with annual cycles in water temperature. Figure 4 shows tag movement data from yellowfin tagging in the eastern Pacific by IATTC[5], where again tagged fish moved very little.

The long distance movements of some tagged tuna are of great biological interest and understandably dominate the perspective of many biologists. The SPC tuna scientists continue to use the illustration emphasizing long distance movement despite the small average distance moved shown in Figure 2. The IATTC produced a glossy book with illustrations and life history descriptions of the major tuna species with the title "Tuna and billfish, fish without a country"[6]. The biological emphasis on long distance movement can probably be ascribed both to its exciting nature and the fact that most tuna biologists work for international agencies preoccupied by the international nature of tuna stocks.

Although individual fish occasionally move long distance, this behaviour appears to be exceptional for skipjack and yellowfin. Low rates of movement may be the norm. An important tuna management concern is whether adjacent fisheries, whether in adjacent countries or in a single country using different gear types, adversely affect one another. The extent to which movements of tuna cause such interactions obviously depends on the sizes of the EEZs. If an EEZ is very large, then most tuna will be resident; if the EEZ is very small, most will move between countries.

Table 2. EEZ size and radius of an equivalent circle for some large countries in the Pacific Ocean

Country	Sea area within EEZ (square km)	Equivalent radius (kilometres)
Cook Islands	1830000	763
Fiji	1290000	641
French Polynesia	5030000	1265
Kiribati	3550000	1063
Mexico	2851000	953
Nauru	320000	319
Solomon Islands	1340000	653
Tonga	700000	472
Tuvalu	900000	535
U.S. Trust Territories	6200000	1405
Vanuatu	680000	465
Western Samoa	120000	195

4 Cayre, Le Hir and Pianet, Marquage et migrations des albacores dans la region de Pointe Noire, Office de la recherche scientifique et technique outre-mer, Documents scientifiques de centre de Pointe-Noire Nouvelle Serie No. 37. 1974

5 Schaefer, Chatwin and Broadhead, Tagging and recovery of tropical tunas, 1955-1959, Inter-American Tropical Tuna Commission Bulletin V No. 5, pp 343-452.

6 Joseph, Klawe and Murphy, Tuna and Billfish -- fish without a country, Inter-American Tropical Tuna Commission, La Jolla, California.

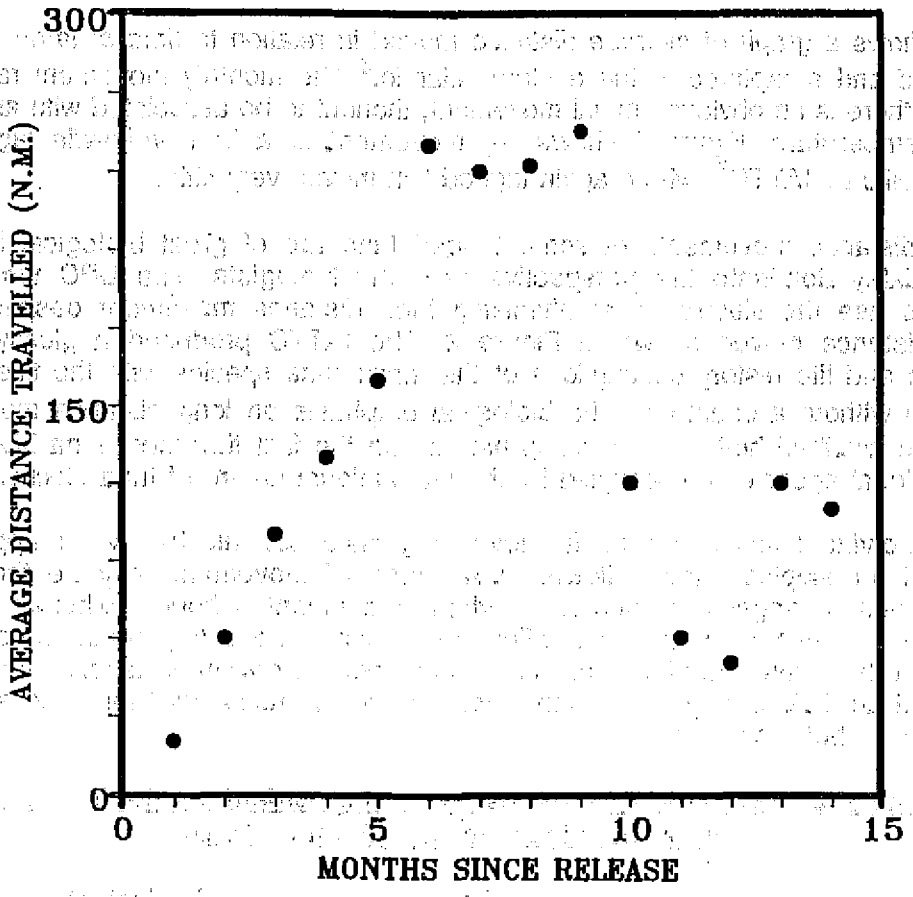

Figure 3: Average distance travelled vs months since release for yellowfin tuna tagged in the eastern Atlantic.

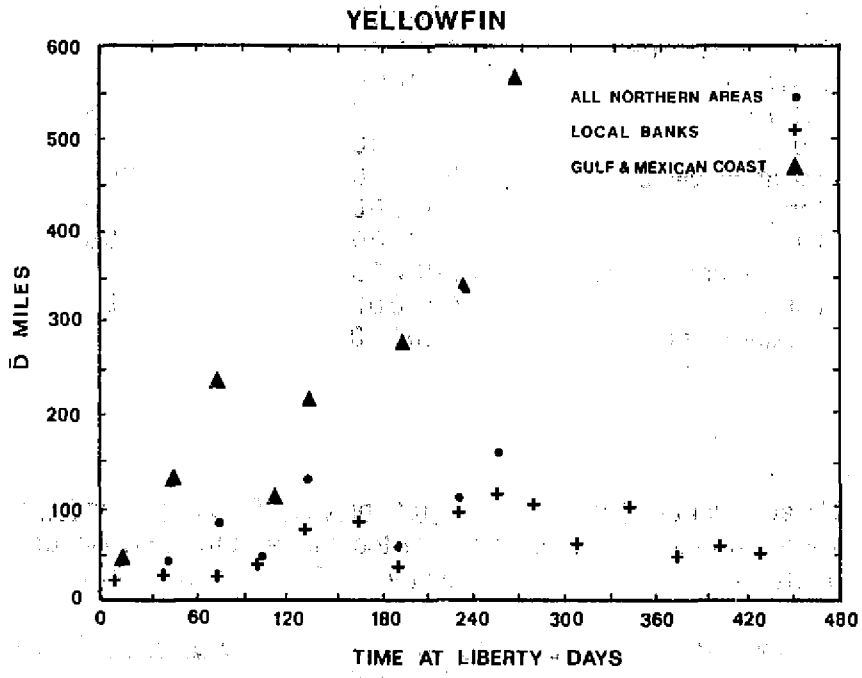

Figure 4: Average distance travelled vs time since tagging for yellowfin tuna tagged in the eastern Pacific.

Table 2 lists some of the countries of the world where tuna fishing takes place giving the size of their EEZ in square km. and the diameter of a circle having the equivalent area. For the larger countries, the types of yellowfin movements shown in Figures 3 and 4 could easily take place within the EEZ of the country. The fact that 85% of skipjack tags were recovered in the country of tagging in the SPC study is also undoubtedly due to the large economic zone of many of the countries. The qualitative differences between these large EEZs, and the very small EEZs of most central American and West African countries may explain the traditional perspective of skipjack and yellowfin rapidly moving between EEZs.

In a more quantitative analysis, Hilborn[7] presented two models of interaction between tuna fisheries in different countries and showed that with economic zones of more than 1,000,000 sq km there is likely to be almost no interaction between skipjack fisheries, and only modest interaction between yellowfin fisheries. There are great differences in EEZ area between countries, and we can easily imagine that the largest countries could manage their own skipjack and yellowfin resources with little concern for outside harvest rates, while small countries could be swamped by the fishing policies of their neighbours.

Other factors, in addition to EEZ size and movement rate, will also constrain the capacity of a coastal state to manage tuna fisheries within its EEZ. Mortality rate and recruitment of young fish to the fishery are expected to be important as well.

The two previously discussed factors, EEZ size and movement rate, combine to produce a monthly emigration rate. If the natural mortality is high relative to the emigration rate, then what goes on in one area will be of little consequence elsewhere. However, if mortality is low relative to emigration, then external events will be more important.

Tuna are though to have extremely high mortality rates. The generally used figure for yellow-fin is 6% per month[8]; for skipjack within the SPC area the corresponding figure is 17% per month. These high mortality rates reinforce the possibility that countries with large EEZs may be little affected by their neighbours' fishing policies.

Recruitment of individuals to the fishery is the result of the combined biological processes of reproduction, growth and immigration. If recruitment takes place within a country, then there is a trade off between emigration from the country and natural mortality rates. If recruitment does not take place inside a country's EEZ, then that country is dependent upon the countries that do have recruitment to maintain its stocks. The distribution of spawning is not well known for either skipjack or yellowfin tuna, but the distribution of larvae is a useful guide to identify regions where recruitment occurs. Studies of the larval distribution of skipjack and yellowfin[9] show that recruitment seems to take place widely across the

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7 Hilborn, Spatial models of tuna dynamics in the western Pacific. "Proceedings of the Second U.S.-Australia conference on renewable resource management", Lecture Notes in Biomathematics, Springer Verlag.

8 Lenarz and Zweifel, A theoretical examination of some aspects of interaction between longline and surface fisheries for yellowfin tuna, *Thunnus albacares*, Fisheries Bulletin 76: 807-825,1979

9 Far Seas Fisheries Research Laboratory, Average Distribution of Larvae of Oceanic Species of Scombroid Fishes, 1958-1981, Shimizu, 424, Japan, S Series No. 12, March 1985.

tropical oceans of the world. Thus most countries can be thought of having their own stock in terms of recruitment. The major exception is the relative absence of skipjack larvae in the eastern Pacific.

We cannot easily classify tuna into highly migratory and not highly migratory groups. There is an enormous difference between the migratory behaviour of bluefin and albacore tuna at the most migratory end of the scale and that of yellowfin and skipjack at the less migratory end. A definition of "highly migratory" apparently used during the Law of the Sea conferences[10] states "highly migratory species, which are creatures that are believed to undertake extensive migrations, and that carry individuals through many coastal zones as well as the high seas throughout their life." This definition is unlikely to apply to skipjack and yellowfin in the western Pacific, although we can imagine dozens of major commercial species for which it would apply. Simply stated, skipjack and yellowfin are much less migratory than many other commercially important non-tuna species. Thus there appears to be little biological justification for inclusion or rejection of highly migratory species in the current Law of the Sea.

It is more fruitful to ask if the movement rate is high relative to the size of the EEZ of the Country and to the natural mortality rate. In the western Pacific, Papua New Guinea, the Solomon Islands, the Federated States of Micronesia, Kiribati and French Polynesia all have very large EEZs. Most other western Pacific and Indian Ocean countries also have large EEZs. while the tropical countries of West Africa and Central and South America have much smaller EEZs. From the perspective of movement rates, the stocks in larger countries could almost certainly be considered resident, while the stocks in the smaller countries could not. For the small countries international cooperation in regulation of catch would obviously be much more important should such regulations be required.

Will unregulated tuna fishing overexploit the resource?

For countries where movement rates are high relative to EEZ size, international regulation of catch is only important if overexploitation will take place in the absence of such regulation. The stock size toward which an unregulated fishery will tend is often called the "bioeconomic equilibrium", a concept that recognises that the equilibrium stock size is governed by both the biology of the stock and the economics of the fishery.

The collapse of many of the world's fisheries, including the North Sea and Norwegian herring, the Peruvian anchoveta, and many groundfish stocks prior to extended jurisdiction is directly attributable to a low bioeconomic equilibrium stock size. In these fisheries, vessels could still meet operating expenses even when stock size was very low.[11]

The bioeconomic equilibrium stock size for tuna is not particularly well known, although of all the major tuna fisheries in the world only the southern bluefin fishery by Japan and Australia and the Atlantic bluefin fishery have prompted enough concern that serious harvest restrictions are in place. It is felt that the decline in catch rates from the early 1970s to the early 1980s in the eastern Pacific yellowfin fishery may have been due to overfishing, but the bioeconomic equilibrium was apparently not terribly low, because effort dropped and catch rates increased without catch regulation.

The experience in the Philippines tuna fishery is a useful illustration of the sensitivity of this conclusion to specific fishing conditions and fleet characteristics. This fishery, based on the use of payaos or fish aggregation devices (FADs), is one tuna fishery that may have seen

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10 Joseph 1977, Ibid.

11 Clark, Bioeconomics of the Ocean. Bioscience 31(3), March 1981 pp 231-237.

serious overexploitation and where intense local fishing pressure induced a drastic decline in average size of fish.[12] This experience demonstrates that a specialised fishing method and highly developed local fleet, without the economic structure of the large purse seine vessels, is perhaps capable of overexploiting tuna stocks. However, at the moment only the Philippines have a fishing fleet with such capability.

In summary, at today's prices and fishing technology there does not seem to be any need for smaller countries to worry about a large foreign fleet marauding along the edges of its 200-mile zone, depleting adjacent tuna stocks. The only existing technology that seems economically capable of potentially depleting tuna stocks is the small scale shore based fishery depending on FADs, such as occurs in the Philippines, which does not operate on the high seas. Changes in prices of technology could easily make inshore tuna fisheries more attractive, and prompt the need for regulation within a country. Furthermore, if prices were considerably higher, high-seas purse seine fishing for yellowfin and possibly even for skipjack could pose the threat of overexploitation in some locations.

Biology, international law and national fisheries policies

Tuna have been given special status in the Law of the Sea as highly migratory, a distinction they share with billfish, some marine mammals and sharks. Although regulation of harvests of highly migratory species is given to coastal nations under the Law of the Sea, the convention also encourages international cooperation in harvest regulation. U.S. law, under the Fisheries Conservation and Management Act of 1976, does not recognise coastal state jurisdiction over tuna. The joint House-Senate conference committee[13] states that "Since there is no justification for coastal nation jurisdiction over such species, this section declares them subject to management pursuant to international fishing agreements established for that purpose." Highly migratory species are defined in the act as "species of tuna which, in the course of their life cycle, spawn and migrate over great distances in waters of the ocean."

A realistic appraisal of the movement rates of different tuna species could well lead to re-evaluation of the highly migratory nature of yellowfin and skipjack. The spirit of the law is clear, and the low movement rates combined with the large EEZs of many countries suggest a somewhat different interpretation.

One must recognise, however, that this section of the U.S. law is not based exclusively on biology, since billfish, also classified in the Law of the Sea as highly migratory, are considered subject to national jurisdiction. This exclusion was made in response to U.S. sports fishing interests who wished to exclude longline fisheries from the areas near U.S. sport fishing centres. While the exemption of billfish from the U.S. law makes it clear that there is no biological basis for U.S. tuna policy, it remains official policy that tuna require international management, and highly migratory skipjack and yellowfin are often cited for special consideration. Perhaps reconsideration of the movements of skipjack and yellowfin, combined with the decline of the domestic US tuna industry, may lead to an official change in U.S. policy.

Conclusions

There are many reasons cited for international cooperation in tuna management and such cooperation is most successful where the reasons have a sound foundation in economics,

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12 Floyd, Development of the Philippine tuna industry. Pacific Islands Development Program, East-West Centre, Honolulu, Hawaii Report. February 1986.

13 Anon. Fishery Conservation and Management Act of 1976. Report of the Committee of Conference on H.R. 200, U.S. Government Printing Office, Washington, 1976.

politics or biology. We have attempted to make a case that many countries of the world are capable of managing skipjack and yellowfin tuna stocks without recourse to international catch regulations. There are examples where international management regimes for regulating yellowfin catches have broken down, such as in the eastern Pacific. To the litany of political causes for these breakdowns we would add some biological causes as well. There is clearly no compelling biological reason to impose international management regimes for all so-called "highly migratory" species in general nor for yellowfin and skipjack in particular.

International cooperation is required however, for the study of tuna dynamics. No individual country will be able to devote the resources required to conduct tagging studies on the scale of those conducted by IATTC, SPC and ICCAT. Without such international cooperation, we would know very little about tuna. Furthermore, for any country to learn about the biology and optimal management of tuna, it will need to know what has happened elsewhere in the world. Most fisheries management techniques involve trying to see a trend from noisy data. Data available to any individual country will contain little information and noise will obscure trends. However, when data are combined on a regional scale, trends will become clearer and significant changes will be detected sooner. All countries will profit by sharing and combining systematic analysis of data. The current structures of the IATTC, SPC and ICCAT are well matched to these problems.

In the above section, we have made a case that under current conditions, international catch regulations for skipjack and yellowfin are probably not required, and almost certainly not for countries with large EEZs. There are a number of reasons, however, why individual nations may need to assess and manage their tuna resources.

First, many countries are permitting substantial industrial scale fishing within their EEZ, and need to know the magnitude of the yield that can be taken, and the impact that industrial scale fishing will have on domestic artisanal and subsistence fisheries. To answer these questions substantial tagging and comparative analysis of catch statistics between countries will be required.

Secondly, the Philippine experience, combined with the increasing use of fish aggregating devices around the world, suggests that many countries may develop local fisheries capable of potentially overexploiting their own stocks. International cooperation in the analysis of such data will be essential if countries are to learn by each other's experience.

Finally, although the current bioeconomic equilibrium appears to pose little threat to skipjack and yellowfin, a substantial change in price or major technological innovation could change this situation dramatically. A well established catch monitoring system, both in domestic and international waters, is necessary to detect overexploitation before it becomes severe and the costs of recovery become excessive. Every effort should be made to ensure that data collection, monitoring and research programmes are in place now to monitor these fisheries as they develop.

In conclusion, the traditional assumption that tuna are highly migratory and what goes on in one country strongly affects its neighbouring countries is probably not true for skipjack and yellowfin tuna in countries with large EEZs. Furthermore, the current economic structure of large scale tuna fishing does not lend itself to overexploitation of yellowfin and skipjack tuna. International catch limitation is probably not required in most of the world for these two species. International cooperation in data collection and analysis is essential if individual countries are to use their tuna resources wisely.