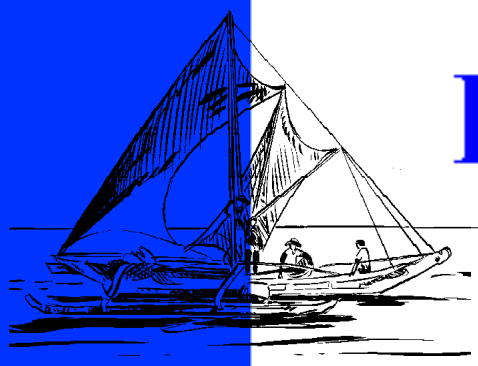


FISHERIES Newsletter

NUMBER 76
JANUARY — MARCH 1996

IN THIS ISSUE

During the field survey of the Aitutaki lagoon, fish traps were deployed to catch fish for tagging

South Pacific Commission
Prepared by the Fisheries Programme Information Section
Printed with financial assistance from the Government of France

TWENTY-SIXTH REGIONAL TECHNICAL MEETING ON FISHERIES

The South Pacific Commission's Regional Technical Meeting on Fisheries provides the only opportunity for senior fisheries officers from all member countries and territories to meet and discuss technical aspects of fisheries development and, through the exchange of experience, ideas and information, to identify mutual needs and problems which can best be met by a regional approach.

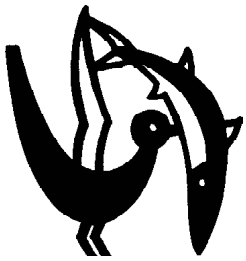
The meeting assists the work of the Commission's Fisheries Programme by reviewing and commenting on existing or proposed activities, formulating new initiatives where required, and making recommendations for consideration by the SPC Committee of Representatives of Governments and Administrations and, if appropriate, approval by the South Pacific Conference.

The Thirty-second South Pacific Conference (Fiji, 1992) gave approval for this meeting to be held biennially.

As a result of this regular process of review and discussion, the work of the SPC Fisheries Programme is able to retain its relevance to the evolving needs of Pacific Island countries and territories. The guidance provided over the years by succes-

Draft Agenda: 25th SPC Regional Technical Meeting on Fisheries

Monday 5 August	– Opening formalities – Fisheries Programme Manager's report – **Technical session #1:** Western Pacific Tuna Fishery overview stock status – **Technical session #2** : South Pacific Regional Tuna Resource Assessment and Monitoring Project (SPRTRAMP)—Progress report
Tuesday 6 August	– Oceanic Fisheries Programme—Overview – **Technical session #3** : Report of the Sixth Meeting of the South Pacific Albacore Research Group – **Technical session #4** : Hazard analysis and critical control point (HACCP)—regional implications
Wednesday 7 August	– Coastal Fisheries Programme—Overview – **Technical session #5** : Integrated Coastal Fisheries Management Project—progress report – **Technical session #6** : Use of live milkfish as longline fishing bait, and selection of longline fishing vessels
Thursday 8 August	– Coastal Fisheries Programme—Overview (continued) – Statements by other organisations – South Pacific Regional Aquaculture Programme: proposal for future regional arrangements in aquaculture – Report on ACIAR Pearl Oyster Project – Offshore Fisheries Development Project Tripartite Review
Friday 9 August	– Institutional Review in the Marine Sector—discussion/update – Future arrangements for the Regional Technical Meeting on Fisheries – Other business – Adoption of the report – Close of meeting



sive Regional Technical Meetings on Fisheries has been an essential element in developing the wide range of activities that are undertaken by the Fisheries Programme, which is now the South Pacific Commission's largest single programme.

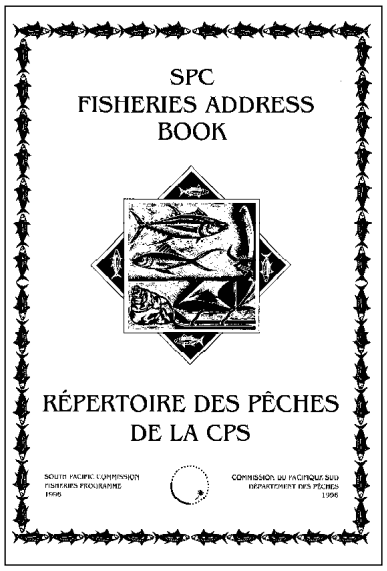
The 26th SPC Regional Technical Meeting on Fisheries will be held at SPC headquarters in Noumea, New Caledonia, from 5 August to 9 August 1996. A draft agenda for the meeting, subject to modification, is shown on page 2.

INFORMATION SECTION

SPC 1996 Fisheries Address Book

Our readers will remember that the FAO/UNDP Regional Fisheries Support Programme (FAO RFSP) used to publish annually the well-known 'Addresses useful to Pacific Islands fisheries personnel'. This publication was very appreciated in the region.

In 1992, the FAO RFSP ceased its activities and the South Pacific Commission decided to carry on publication of the address book. The 1996 edition is now ready and has been distributed widely in the region. In addition to more than 1,000 addresses covering 49 countries and territories, basic fisheries statistics, Exclusive Economic Zone areas and a map are included for each Pacific Island country or territory.



Copies of the Fisheries Address Book can be obtained by writing to the Fisheries Information Section, South Pacific Commission, B.P. D5, 98848 Noumea Cedex, New Caledonia. Please note that this year, due to increasing mailing costs, there will be a charge of US$ 25.00 per copy for packing and postage. We trust this document will remain popular and we are always open to suggestions for making it even more useful.

Henry Yule leaves the Commission

Henry Yule, Fisheries Information and Training Associate with SPC for the past year, left the Commission in early March 1996.

During his attachment with the Information and Training Sections, Henry gained useful experience. He will be putting his new skills to good use at the National Fisheries Authority in Papua New Guinea.

In particular, he will certainly take initiatives that will assist the development of the Papua New Guinea fisheries sector, such as production of a newsletter on national fisheries issues and coordination of the preparation of national and regional training activities.

Henry's secondment was funded by the French Government, which has recently reiterated its interest in funding this position for another year. The position is to be filled by a Pacific Islander from the Ministry/Department of Fisheries, or from a department involved in producing or using fisheries information, in one of the Island countries and territories of the region.

Appointment will be by secondment, for one year only. An SPC Savingram announcing the position has been issued. Its duties and reponsibilities associated are listed below:

- Maintain full familiarity with and active participation in the full range of activities being undertaken by the Information and Training Sections of the SPC Coastal Fisheries Programme;
- Gather, edit and collate materials for inclusion in the *Fisheries Education and Training Information Bulletin*, and assume responsibility for all aspects of the Bulletin's timely production on a bi-annual basis;

- Prepare teaching resource materials for use during fisheries training workshops and group teaching activities run by the Commission;
- Assist as required with the production of the SPC *Fisheries Newsletter* and other Information Bulletins;
- Assist with the management of the Information and Training Sections' databases;
- Assist with the development and management of an internal system to store and retrieve information on training issues, activities and opportunities in the region;
- In liaison with the SPC Library and other staff of the Fisheries Programme, respond to requests for information from Pacific Island governments, training institutions and individuals.

Applications should be addressed to the Secretary-General, South Pacific Commission, B.P. D5, 98848 Noumea Cedex, New Caledonia, and reach him no later than 15 May 1996.

Henry Yule (Fisheries Information and Training Associate) and Jean-Paul Gaudechoux (Fisheries Information Adviser) working on the design of the SPC *Fisheries Newsletter*

First issue of a new Special Interest Group Bulletin on Live Reef Fish Exports

In *Fisheries Newsletter* #73, we mentioned that the Information Section would establish a new Special Interest Group on Live Reef Fish. This issue was raised by the participants in the FFA/SPC Workshop on Management of South Pacific Inshore Fisheries, which was held in Noumea last year.

Dr Bob Johannes, well known to the readers of the *Fisheries Newsletter*, has agreed to be the technical co-ordinator of this new group (at least for the section concerning living marine resources for human consumption).

We are currently looking for a coordinator for the aquarium fish section and we are sure that there is a keen and willing editor just waiting for the opportunity to take the reins and work with us. If you think you can help, please contact the Information Section.

The first issue of *Live Reef Fish* has been printed and distrib-

uted widely in the region. It covers various subjects and areas of interests such as the regional workshop on the live reef food-fish trade in Asia and the Western Pacific, the aquarium fishery in the Cook Islands, the management of Palau's aquarium life fishery, and the environmental, economic and social implications of the fishery for live coral reef food-fish in Asia and the Western Pacific.

Contributions for the second issue of this Information Bulletin are sought, including: statistics on the trade, including quantities of live fish exported or imported by various countries; description of efforts to run the trade on an environmentally sustainable basis; management measures; forthcoming conferences, workshops and other events; and copies of reports and newspaper articles.

First issue of a new Special Interest Group Bulletin on FADs

The first issue of the SPC *FAD Bulletin* came out of the printery at the end of March. If we consider the wide distribution of a questionnaire to future SIG members in August 1995 as the starting point of the operation, the whole process took almost nine months . . .

This first issue is organised in three main sections:

- The first section presents original contributions on general matters. François Conand and Emmanuel Tessier lead off with an article on the FAD programme of La Réunion Island in the Indian Ocean. Then Keniichi Kikutani explains the way fishermen have set up and run their own FAD programme through their cooperative on the Japanese Island of Okunoshima. It is interesting to note that, in both cases, FADs have created an important new source of income for artisanal fishermen and, in both cases also, fishermen themselves have taken up the management of the FAD programme.
- The second section is dedicated to the technical side of FADs, including FAD design and construction, and fishing techniques. Peter Cusack, SPC's Fisheries Development Adviser, presents the two FAD systems recommended in the handbook: *Rigging deep-water FAD moorings* (1996). Knowing how critical design and construction are for the success

FISHERIES PROGRAMME
INFORMATION SECTION

The Nature Conservancy

LIVE REEF FISH

The Live Reef Fish Export and Aquarium Trade

Number 1 — March 1996

INFORMATION BULLETIN

Group Co-ordinator: Bob Johannes, 8 Tyndall Court, Bonnet Hill, Tasmania 7053, Australia. [Phone: 61 02 298064. Fax: 61 02 298066, E-mail: bobjoh@iccc.net.au] — Printed with financial assistance from the Government of France

Editorial

Welcome to the new Special Interest Group (SIG) on the live reef-fish (export and aquarium) trade. This SIG will operate as a network of individuals working in, doing research on, or otherwise concerned about the live reef-fish trade, and will encourage the sharing of ideas, experience and information.

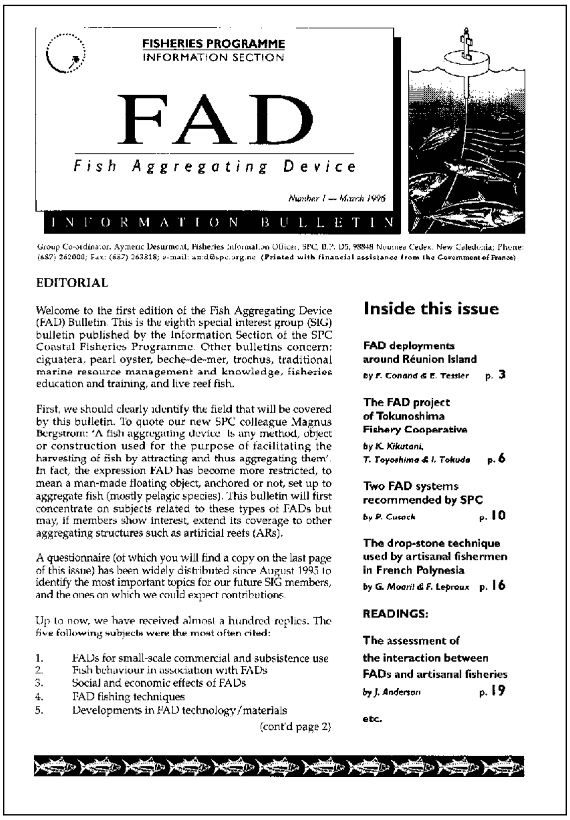
Good news for those of you who are in the front line in the war against the excesses of the live reef food fish (or simply 'the') trade. Recent media coverage shows clearly that the world is now taking the fast-spreading environmental damage being done by the trade very seriously. There have been long front-page stories in *The New York Times* and the *International Herald Tribune*, as well as major stories in many other newspapers in the US, Australia and South-East Asia.

CNN television did two long news stories (broadcast to 210 countries!). A two-page feature article came out in the *New Scientist*. Voice of America will very likely have broadcast a story on the subject by the time you read this. *Time Magazine* is carrying out a major investigation of the issue, using several reporters. Much additional media coverage is due in the next few months.

The group coordinators of the SIG are Bob Johannes (for live reef fish—see address above) and Larry Sharron (for reef aquarium fish—Coral Reef Research Foundation, P.O. Box 1713, Koror, Palau 96940, Fax: (680) 488 2305).

Our principal focus is on SPC member countries and territories, but persons with an active interest in these subjects in any part of the world are encouraged to join this special interest group, submit information to the bulletin and receive the bulletin free. Since the live reef food-fish trade in the Pacific is inextricably linked with East Asia, and the marine aquarium trade is also very significant in the latter region, people from East Asia with an active interest in the subject are especially encouraged to participate. (cont'd page 2)

Inside this issue



FISHERIES PROGRAMME
INFORMATION SECTION

FAD

Fish Aggregating Device

Number 1 — March 1996

INFORMATION BULLETIN

Group Co-ordinator: Aymeric Desurmont, Fisheries Information Officer, SPC, B.P. D5, 98848 Noumea Cedex, New Caledonia; Phone: (687) 262000; Fax: (687) 263818; e-mail: amd@spc.org.nc (Printed with financial assistance from the Government of France)

EDITORIAL

Welcome to the first edition of the Fish Aggregating Device (FAD) Bulletin. This is the eighth special interest group (SIG) bulletin published by the Information Section of the SPC Coastal Fisheries Programme. Other bulletins concern: ciguatera, pearl oyster, beche-de-mer, trochus, traditional marine resource management and knowledge, fisheries education and training, and live reef fish.

First, we should clearly identify the field that will be covered by this bulletin. To quote our new SPC colleague Magnus Bergstrom: 'A fish aggregating device is any method, object or construction used for the purpose of facilitating the harvesting of fish by attracting and thus aggregating them'. In fact, the expression FAD has become more restricted, to mean a man-made floating object, anchored or not, set up to aggregate fish (mostly pelagic species). This bulletin will first concentrate on subjects related to these types of FADs but may, if members show interest, extend its coverage to other aggregating structures such as artificial reefs (ARs).

A questionnaire (of which you will find a copy on the last page of this issue) has been widely distributed since August 1995 to identify the most important topics for our future SIG members, and the ones on which we could expect contributions.

Up to now, we have received almost a hundred replies. The five following subjects were the most often cited:

1. FADs for small-scale commercial and subsistence use
2. Fish behaviour in association with FADs
3. Social and economic effects of FADs
4. FAD fishing techniques
5. Developments in FAD technology/materials

(cont'd page 2)

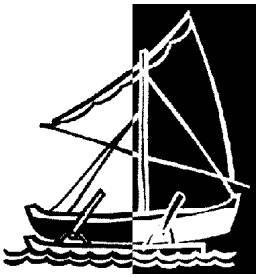
Inside this issue

of a FAD programme, we hope that the comparison of the different designs will offer enough information and provoke sufficient debate to create the 'perfect FAD' ('the one that cost almost nothing and lasts forever'). Frédéric Leproux presents the latest developments in the ancestral 'dropstone' fishing technique that is commonly used around FADs by artisanal fishermen of French Polynesia.

- The last section is reserved for abstracts and reviews. For the first issue, a wide spectrum of subjects related to FADs is presented to give an idea of the richness of the subject.

As for every publication of SPC's Fisheries Information Section, a French version of this bulletin will be published soon. Thus, it provides a unique (and free!) opportunity for contributors to reach new readers and increase their sphere of influence . . .

Readers interested in receiving a copy are invited to contact: Aymeric Desurmont, Fisheries Information Officer, B.P. D5, 98848 Noumea, New Caledonia (Fax: 687 263818 or E-mail: amd@spc.org.nc).



RESOURCE ASSESSMENT SECTION

Second ICFMaP national sub-project completed

The ICFMaP team spent five weeks in Fiji during February and March conducting field work for the second national sub-project, which was concerned with determining the effectiveness of a five-year gillnet ban along the Macuata Coast of Vanua Levu.

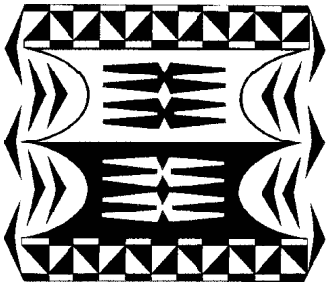
This area is a very rich fishing ground, comprising a large barrier reef lagoon that extends along the entire northern coast of Vanua Levu. Many rivers and streams drain into the lagoon, which also has abundant coral reefs and mangrove forests.

The barrier reef system is known as the Great Sea Reef. It runs from northern Vanua Levu in an almost unbroken chain, south to the Yasawa Islands off the western coast of Viti Levu.

For many years the commercial fishermen from both Vanua Levu and Viti Levu fished within the lagoon with gillnets, landing catches into the main town Labasa, or taking fish back to Suva. In 1989, concern over the level of commercial fishing and the effect that this was having on local subsistence fisheries led to the local chiefs exercising their traditional authority and declaring a ban on commercial gillnet fishing.

This ban on gillnet fishing was imposed in 1990, and commercial fishermen then switched from gillnet fishing to handline fishing along the Great Sea Reef. In the five years following the ban, there have been encouraging signs that the lagoon fish stocks have recovered.

Consequently, advice was sought from Fiji's Fisheries Division by the local chiefs and the Macuata Provincial Goverment on whether the ban should be lifted or left in place.



Fiji's Fisheries Division requested the assistance of the South Pacific Commission in answering this question, with the result that the ICFMaP team conducted a series of field observations in the Macuata area between February and March this year.

The ICFMaP team comprised Inshore Fisheries Scientist, P. Dalzell and Fisheries Research Associates Sione Matoto and Esaroma Ledua.

The team was joined later by the Senior Inshore Fisheries Scientist, Tim Adams, who also spent time in Fiji to finalise some work on the analysis of a satellite image of Aitutaki at SOPAC. This was related to the previous ICFMaP field assignment in the Cook Islands during November 1995.

The main activities for the ICFMaP team were:

1. to conduct a series of gillnet fishing trials in the various traditional fishing grounds of the Macuata area to obtain baseline information on catch rates and catch composition;

2. to conduct creel surveys and interviews with villagers in the Macuata area to obtain information on subsistence fishing methods and catch rates, and to obtain opinions on whether the villagers would like the ban to stay in place or be lifted;

3. to summarise any historical data on commercial gillnet fishing in the Macuata area;

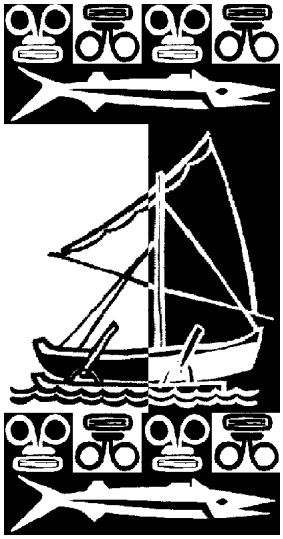
4. to describe the present commercial handline fishery in the Labasa–Macuata area and summarise catch–effort and economic data from commercial fishing by collecting data from landing sites and fish dealers;

5. to draft a preliminary summary of the results of the field work and, based on these, recommend future management strategies for the Macuata fishing grounds.

Gillnet fishing was conducted from the Fiji Fisheries Division vessel *Gonedau* at four different sites in the Macuata area (Macuata, Sasi, Mali and Labasa) between Monday and Thursday each week over a four-week period. Fishing was conducted around the clock, with the nets being set at high tide and retrieved at low tide six hours later.

This meant that it was usually possible to make between six and seven different sets during the three days each week when gillnet fishing was carried out and to compare day versus night catches. Three different mesh sizes (2 in, 3 in & 4 in *[1 in = 2.54 cm]*) were used to obtain information on mesh selectivity. After each set the catches were sorted to species, and length and weight of each individual specimen were recorded. Ancillary information on water temperature and salinity was also collected, to provide a salinity profile from the coast out to the Great Sea Reef.

After returning to Labasa every Thursday, some of the ICFMaP team would spend time in the various villages during Friday and Saturday, collecting information on subsistence fishing. Other team members spent time in Labasa collecting information from the commercial handline fishery and entering the various data sets into computer files.



Most commercial fishing is conducted from 28 foot (8.4 m) diesel powered launches, with a crew of 2–3 fishermen. These vessels depart from Labasa, usually on a Monday and return within 7–8 days, depending on fishing conditions. Catch records from these vessels were obtained during the period the ICFMaP team was in Labasa, as well as some smaller data sets for fishermen handlining from dinghies and a group of spear fishermen from Mali Island. Records were collected at landing sites, retail stores and the Labasa market.

Interviews were also conducted with commercial fishing operators to obtain information on details of fishing methods and costs of fishing and to solicit opinions on whether the gillnet ban should remain in force.

Most people were in favour of maintaining the gillnet ban. They felt a return to gillnet fishing would probably lead to another ban in a few years' time when nearshore stocks were once again depleted. The commercial fishermen have made the change to line fishing and are unwilling to go to the expense of re-equipping their vessels for gillnet fishing if the future is likely to be uncertain.

The commercial fishermen sell a lot of their catch locally in Labasa and surrounding towns, but two operators in Labasa also send fish by road and ferry to Suva, where it is sold to stores, roadside vendors, hotels and restaurants. The scale of these operations was quite interesting and suggested possible models for fisheries development elsewhere in the Pacific.

During the final week of the assignment, the ICFMaP team fished within the Labasa estuary, an area where commercial gillnet fishing is not banned. This was done to make some comparison with fishing on the Mali, Sasa and Macuata fishing grounds, where the ban is in place. Subsistence gillnetting is still permitted in these areas, subject to permission from the chiefs, but is only employed to generate large volumes of fish for village feasts and is conducted infrequently.

Following the end of the field work, the ICFMaP team assembled to review a summary report of the findings and recommendations arising from these

activities. This was then presented to the staff of the Fisheries Division office in Labasa for their comments, and was later carried by Mr Ledua to Suva to present to the Division's Director of Fisheries and Principal Fisheries Officer.

The main recommendation arising from this assignment was that the commercial gillnet ban should remain in place. The villagers in the Macuata area reported noticeable improvements in subsistence fishing following the ban and commercial fishermen are unlikely to switch back to commercial gillnet fishing, having successfully adapted to handline fishing on the Great Sea Reef.

The ICFMaP team will draft a detailed technical report in the near future which will contain summaries of all the data collected during this assignment and the various recommendations pertaining to subsistence and commercial fishing in the Macuata area.

Publication of Workshop Proceedings

The South Pacific Commission and Forum Fisheries Agency convened a Workshop on the Management of South Pacific Inshore Fisheries between 26 June and 7 July 1995.

Over one hundred papers, including country statements, background papers and keynote addresses, were presented during the two-week meeting.

The Workshop was the first major forum to address the management of inshore fisheries in the tropical insular Pacific and complemented the Commission's previous workshop, held in 1988, on the biology and assessment of the region's coastal fisheries resources. The 18 country statements and 76 background papers from the Management Workshop have now been published in two 70-page volumes, with all papers in their original language and a translation where this was available.

To facilitate timely publication, these proceedings were published as 'manuscript collections'; that is, the papers were simply collated and published in the form they were presented to the meeting. The two volumes are published as Integrated Coastal Fisheries Management Project Technical Documents Nos. 11 and 12 and can be obtained from the Distribution Assistant at the South Pacific Commission.

The two volumes are available for no cost, but postal charges are as follows: special airmail rate (Europe only), 4000 cfp, surface mail (rest of world excluding Europe), 2000 CFP. Normal airmail postage rates are available on request, but are likely to exceed 7500 CFP.

Payment for the proceedings should be by international money order or bank cheque in Pacific francs (CFP) or US dollars. The exchange rate is approximately 100 CFP= US$ 1.00. A further volume from the workshop is in preparation; it will contain the meeting narrative and the invited keynote addresses.

CAPTURE SECTION

Stephen Beverly joins SPC as Masterfisherman

Before taking up the position of Masterfisherman with the South Pacific Commission in March 1996, Steve Beverly was involved in the commercial tuna fishing industry in Hawaii and Fiji, and in Guam as a skipper and fishing master of a tuna longline boat for a year.

Steve is not new to the Commission, as he has undertaken consultancies for the Coastal Fisheries Programme in the past, particularly in the area of tuna capture fisheries development, FAD technology, and training activities in these areas.

Before turning to commercial tuna fishing, Steve taught biology, oceanography and physical science at intermediate and secondary-school level in various schools in Honolulu, Hawaii.

Steve has a Bachelor of Science degree in Zoology, a Master's ticket to command offshore fishing vessels, and a secondary school teaching certificate. He has brought with him extensive experience in commercial fishing, tuna development, and commercial fishing vessel operation and management.

Steve, who is from Hawaii, will be working with the Commission's Coastal Fisheries Programme for a contract period of three years.

Tuna longline assistance for FSM

The National Fishing Corporation (NFC) of the Federated States of Micronesia recently reiterated its request for assignment of an experienced tuna longline skipper to assist in improving the catching performance of two vessels in the national fleet. These vessels are equipped with US monofilament longline gear and have consistently failed to match the catching capacity of the rest of the NFC fleet.

The Capture Section initially responded to the request through a visit by the Fisheries Development Adviser, in February 1996.

Following this visit, the Section's newly recruited Masterfisherman, Steve Beverly, was assigned to work with NFC in March 1996 for two months initially, to accommodate this request.

Steve's work will focus on providing hands-on training to the crew on the use and operation of LP gear system, with particular emphasis on fishing gear construction, vessel and equipment operation and layout, setting and hauling procedures and seamanship, and also including any other aspects of commercial tuna longlining operations.

Tuna longline attachment training for two FSM nationals

To further support and promote the initiation and development of a viable domestic tuna longlining fishing industry in FSM, the Capture Section, in response to a request from FSM's Micronesian Longline Fishing Company (MLFC) was also able to arrange and make funding available under the Offshore Fisheries Development Project for a training attachment of two FSM nationals in Hawaii.

The training attachment focused initially on an introductory course to tuna longlining operation, after which the trainees were employed on Hawaiian commercial tuna longline fleets for six months. The course was conducted as a commercial venture by Ocean Producers International.

The purpose of the training attachment was to enable FSM nationals to acquire the relevant practical experience in a commercial tuna longlining operation, in order to be able to man domestic tuna longline fishing boats within the national fleet.

Milkfish farming takes on a new life

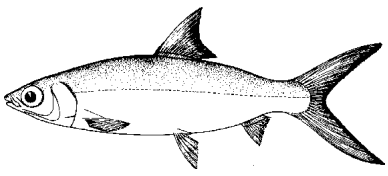
Farming milkfish to provide longline bait seems to be booming in Guam. As reported in the article by Bill Fitzgerald which appears on page 24 of this issue, possible earnings of US$8.5 million/year are projected for the industry from the growth and supply of 20 million pieces/year of live milkfish to the longliners calling at Guam for offloading and re-supply.

Two large farms are currently operating, both of which import pigmented fry (about 1 month old and 2 cm long) from Taiwan, and grow out the fish to 15 cm over 45–90 days on pelletised feed. When bait are to be transported to vessels, they are loaded into canvas bins (about 1 m^3) on a flatbed truck fitted with an aeration system using compressed air flowing from a bottle.

About 2,000 fish are loaded into each bin. At the dock the fish are pumped into the vessel's forward hold using a canvas hose of about 200 mm diameter; although they go from 18 ppt salinity to straight seawater without any acclimatisation, losses are reported as less than one per cent. In use as baitfish the fish are hooked under the dorsal fin, and are reported to survive for long periods.

Meanwhile Guam's Aquaculture Development and Training Center (GADTC) has reared milkfish broodstock that are now eight years old. These are expected to spawn this (northern) summer. The hatchery presently has the physical capacity to produce one million fry/year and is working towards expanding its capacity to five million fry/year. GADTC's aim is to produce and supply fry to local farmers.

The rapid growth of milkfish farming on Guam follows reports that Taiwanese longliners using live milkfish achieve CPUE rates three to five times



higher than those achieved with frozen bait. While there are as yet few hard catch data available to back this statement, it is clear that Taiwanese vessel operators are now reluctant to use agents in Guam who are not able to supply live bait.

If the reports of the effectiveness of live milkfish can be verified, this development has important implications both for current Pacific-based transshippers elsewhere and for established and emerging domestic longline operations. The advantages of establishing live bait farms might include: improved catch rates; foreign exchange savings on imported bait; reliability of supply for domestic fleets; increased or sustained levels of longliner port calls for transshippers; and the potential for local entrepreneurs going into milkfish aquaculture to generate substantial revenues.

The Capture Section is currently gathering more information on live bait use. Methods used include collaborating with the SPC Oceanic Fisheries observer programme and monitoring the recent trials with live milkfish bait in the Hawaii longline fishery.

TRAINING SECTION

Safety-at-sea campaign update

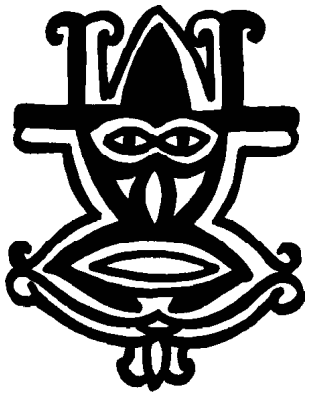
The first phase of the safety-at-sea campaign material production is near completion. Due to the extensive and very positive response from the region, it is hoped that funds can be identified for a second phase of this very important work. The SPC Fisheries Training Section has received a large number of letters expressing appreciation for the campaign materials.

The response from competent people in the region is of great value to our work. The Training Section in return will try to respond appropriately. For our continued efforts in the area of safety at sea, ideas and proposals relating to deeply-felt needs in this area are warmly welcomed.

The English version of the last two videos in the safety series should by now have reached all users on our mailing list. If you have not received copies but would like to use them in education, training or extension, please feel free to write to us. The two last films distributed are:

Better safe than sorry: a video that relates the story of two fishermen who are close friends. These fishers have completely opposed approaches to safety at sea – one, Jone, always plays it safe when at sea; the other, Rambo, is careless. The story is pure fiction, but many Pacific Islands artisanal fishermen could recognise themselves in one of the two main characters—and possibly more in Rambo than in Jone!

Survival at sea—A Kiribati tale: tells the true story of three i-Kiribati fishermen who drifted for seven months on a small fishing boat between Kiribati and Western Samoa. One died at sea but two survived. This story provides the manager of SPC's Fisheries Programme with the opportunity to discuss the issue of safety at sea for small-boat operators.



The French versions of these two films are expected to be ready during the second quarter of 1996.

The Fisheries Programme training video collection now contains the following 10 titles:

1. *An icy tale: chilling fish on board*,
2. *A chilling story: handling fish in the processing plant*,
3. *Trolling fish with natural bait*,
4. *Bottomfishing with hydraulics*,
5. *On-board handling of sashimi-grade tuna*,
6. *Air-freighting of chilled fish*,
7. *A visit to the fish market*,
8. *Once upon a fish stall*,
9. *Better safe than sorry*,
10. *Survival at sea: a Kiribati tale*.

Anyone interested in obtaining copies of the materials produced or in assisting with in-country promotion of safety-at-sea issues should contact SPC's Fisheries Training Section.

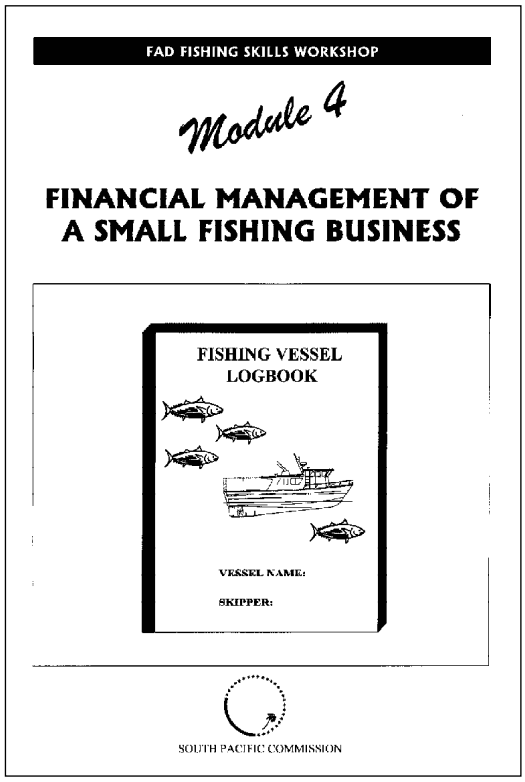
Regional workshop on business management for trainers of small-boat operators

A regional workshop on small fishing business management was organised by the Fisheries Training Section at the Vanuatu Fisheries Training Centre in Santo from 18 to 26 March. The workshop was attended by 14 fisheries officers from 11 Pacific Island countries and territories namely Fiji, Kiribati, Niue, Palau, Papua New Guinea (3 trainees), Solomon Islands, Tonga (2 trainees), Tuvalu, Vanuatu, Western Samoa, and the Federated States of Micronesia.

The purpose of the workshop was to equip the participants with the necessary skills and resource materials to develop and implement their in-country training programme on business management for small-boat operators.

To achieve this, the workshop was operated in a participatory manner, with learning outcomes being achieved through small-group discussions, role plays and daily learning reviews. The following topics were covered during the first part of the workshop: basic arithmetic, financial management of small-fishing business (accounting and banking principles, boat operation costs, feasibility studies, record-keeping, use of a spreadsheet for commercial fishing operations), as well as extension and communication skills (role of the extension officer, how to get ideas accepted, one-to-one communication).

The second part of the workshop focused on the development of resource materials, with the SPC fishing log-book and teaching manual being reviewed and appraised by the participants.



On the last day of the workshop, the trainees drafted an in-country training programme which, for most of them, will consist of a series of short courses targeting small-scale fishers or fisheries extension officers. The course materials (fishing log-book, teaching manual and spreadsheet) will shortly be finalised and printed by SPC before their distribution to the workshop participants and to all fisheries departments and training institutions in the region.

The Fisheries Training Section will also be in a position to financially support the in-country follow-up programmes through the provision of small grants. It is expected that most of the in-country programmes will have been implemented by the end of 1996.

The Fisheries Training Section is grateful to the staff of the Vanuatu Fisheries Training Centre for their friendly co-operation and for the provision of their superb facilities, to the workshop tutors, Chris Turner (School of Business and Accounting, Nelson Polytechnic) and Captain Alastair Robertson (New Zealand School of Fisheries, Nelson Polytechnic) for their valuable input, to the well known ex-FETA and commercial fisherman, and of course to the donors, the United Nations Development Programme (UNDP) for the overall funding of the workshop and the Commonwealth Secretariat and the German Fund for Technical Cooperation (GTZ) for the funding of three participants.

OCEANIC FISHERIES PROGRAMME

Sixth meeting of the South Pacific Albacore Research group

The sixth meeting of the South Pacific Albacore Research (SPAR) group was held in Rarotonga (Cook Islands) from 6 to 8 March 1996. It was attended by scientists from American Samoa, Australia, Cook Islands, Fiji, French Polynesia, Japan, Niue, Solomon Islands, Taiwan, Tonga, United States of America, Western Samoa, and the Forum Fisheries Agency.

The Oceanic Fisheries Programme (OFP) of the South Pacific Commission acted as secretariat. The meeting was chaired by Mr Albert Caton of the Australian Bureau of Resource Sciences.

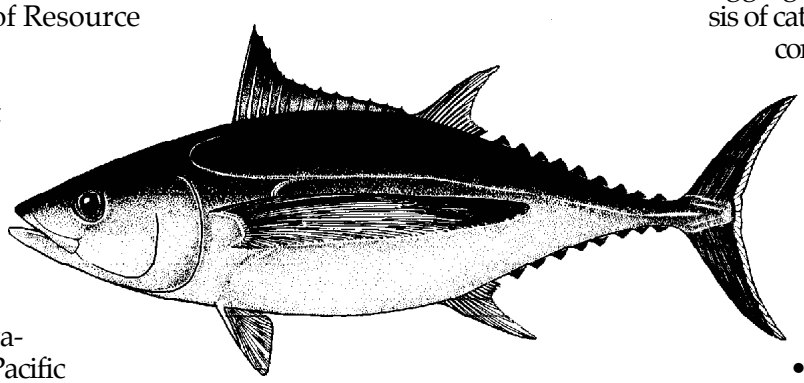
The meeting first reviewed the fisheries, the availability of fisheries data, and recent research. It then addressed the status of the south Pacific albacore stock and future research priorities. The following statement concerning the status of the South Pacific albacore stock was adopted by the meeting.

Fishery outlook

The record-high catch of South Pacific albacore (52,000 mt) occurred in 1989. Of this catch, about 20,000 mt was taken by the driftnet fleet. Since the moratorium on driftnet fishing, the total catch has declined to about 30,000 mt per year. For the last three years for which data are available (1992–1994), the total annual catch was steady at 32,000–34,000 mt. Over these three years, the annual longline catch has been constant at about 27,000 mt. The performance of the New Zealand and the Sub-Tropical Convergence Zone (STCZ) troll fisheries has been variable.

Over the next few years, longline catches are likely to be stable. The Taiwanese catch may decrease somewhat if the albacore price drops and more of these vessels switch to yellowfin and bigeye targeting.

On the other hand, continued development of domestic, small-scale longline fleets in Pacific Island countries may see some compensatory increases in catch from this source. The troll fishery in the STCZ is likely to react to the poor 1995/96 season with fewer American vessels participating in 1996/97.



However, more Canadian trollers may join the three Canadian vessels that participated in 1995/96. The New Zealand troll fishery has recorded above-average catches for the past two seasons, which may encourage some increase in effort next season.

Overall, no major changes are forecast for the fishery over the next few years, and the outlook is for reasonably stable catches at about the current level, barring a major change in the economic climate or catch rates.

Indicators of stock condition

The meeting considered a range of information potentially useful for evaluating stock condition. The information is in several categories: nominal and standardised catch per unit of effort (CPUE) time series, analysis of tagging data, and analysis of catch, effort and size composition data using the SPARCLE (South Pacific Albacore Research Catch-at-Length Estimator) model.

- The Taiwanese fleet is the longline fleet that has most consistently targeted albacore over the period of the fishery, although there has been some recent shifting to yellowfin and bigeye targeting by some vessels. The CPUE of this fleet therefore remains the most useful indicator of stock condition. Taiwanese longline CPUE declined during the late 1960s and early 1970s. Since then, nominal and standardised time series show no clear trend, but considerable inter-annual variability. The lowest CPUEs were recorded during 1989–1991; they recovered to higher levels in 1992–1994.

- The Japanese longline fleet targeted albacore in the 1960s, but have targeted yellowfin and bigeye since the early 1970s. Nevertheless, the albacore CPUE in recent years (mid-1980s on) should be a useful indicator, as targeting practices during this period have not changed to any degree. Albacore CPUE by Japanese longliners shows a strong increase from 1991 to 1994, particularly in the tropical area of the fishery.

- The American troll fishery targets albacore seasonally in the STCZ. CPUE has shown considerable variation. CPUE declined from 1986/87 to 1992/93, before recovering to a high level in 1994/95. While no data are yet available, CPUE for the 1995/96 season is believed to be low. The interpretation of troll fishery CPUE is confounded by the limited distribution of the fishery in relation to the stock and the strong influence of environmental conditions on the availability of fish.

- Tagging experiments carried out in the STCZ, New Zealand coastal waters and the Tasman Sea have resulted in low tag recoveries (less than one per cent of releases), with most recoveries made by longliners. On face value, the data are suggestive of low surface fishery exploitation in relation to the longline fishery. Attrition model analysis can provide estimates of mortality rates, assuming that the tagged fish are representative of the population. Such an analysis of the longline returns suggests a total mortality rate of 0.4–0.6 yr-1. The estimated exploitation rate depends on the assumed level of tag reporting (and survival from other forms of tag loss); the rate ranges from about 0.02 (70 per cent reporting) to 0.13 (10 per cent reporting).

- The length-based age-structured analysis using the SPARCLE model provides considerable new information on the condition of the stock. As questions remain regarding some aspects of data quality and further work on the model is planned, the model results should be considered preliminary. The results indicate that recent average exploitation rates are in the range 4–8 per cent. They are thus consistent with the range of likely exploitation rates estimated from tagging data. Total mortality estimates are also reasonably consistent with those obtained from tagging data. The recruitment time series shows considerable variation (possibly linked with environmental conditions), but little indication of a long-term trend. Variations in total biomass appear to have been largely driven by recruitment, with little observable impact on the fisheries. At current levels of fishing, there is unlikely to be an observable impact on the surface fishery by the longline fishery.

Condition of the stock

Total catches of South Pacific albacore have been stable over the past several years, although the success of the troll fishery in the STCZ has been variable. Longline CPUE has been stable or increasing in recent years, and there is no evidence from these data that the current levels of fishing are adversely affecting the stock. Nor is there any indication that the driftnet catches of the late 1980s and early 1990s have had a significant impact on the stock or on the longline fishery.

Analyses of tagging data and a length-based age-structured model provide reasonably consistent estimates of growth and mortality rates, which confirm that albacore are slow- growing and long-lived relative to the tropical tunas. The fisheries potential of albacore is therefore more restricted by comparison with these species.

The tagging and age-structured models also provide a preliminary indication that the current exploitation rate is relatively low, probably less than 10 per cent per year. This provides further evidence that the current level of fishing can be sustained.

Age and growth of tunas

On the occasion of the SPAR meeting, tag recovery data from albacore were used in an analysis of growth, movement and mortality (Ref.: 6th SPAR Workshop, W.P. 3; Bertignac, Lehodey & Hampton).

In the past, growth rates of south Pacific albacore have been estimated from caudal vertebrae, otolith increments and length frequency. While there is a correspondence between growth rates estimated using caudal vertebrae and length frequency (in the hypothesis of annual cohorts), the analysis of daily growth increment counts on otoliths provides conflicting results. The present analysis supports the view that the growth

rate proposed from increment counts of otoliths is too high by an order of 2. Furthermore, the estimates of the growth parameters, L and K, are consistent with the estimates obtained from length-frequency analysis.

A biological technician will join the SPRTRAMP programme in April. With this new staff member, the OFP will be able to carry out laboratory work on the growth of tuna species (initially yellowfin and bigeye).

Tuna oceanography

Today, we can take advantage of the increasing reliability and availability of oceanographic data to analyse the relationship between the distribution of tuna and the oceanic environment. Such a study is in progress for the skipjack fisheries in the Pacific Ocean.

In addition to the use of the parameters (temperature, thermocline, oxygen) generally taken into account in this type of study, a general transport model based on the advection-diffusion equation was developed to investigate the hypothesis that redistribution by general oceanic circulation results in concentration zones of tuna forage.

The first runs of the model showed interesting zones of convergence in the two major surface fishing zones of the tropical Pacific (west and east) exploited by purse seiners. The preliminary results of the model were presented to a seminar organised by the Pelagic Fisheries Research Program of the University of Hawaii, 28–30 November 1995.

So far, the model has used monthly climatological series of data (i.e., data of several years averaged by month) and has been limited to 20°N–20°S. To increase the coverage of this area and to analyse the interannual variability, particularly the influence of ENSO (El Niño Southern Oscillation) events, on the dynamic of the fisheries, actual time series of data generated by general oceanic circulation models are sought.

The algorithm of the model has been improved so that it can take account of these long series of monthly data, as well as the sea surface temperature, the depth of the thermocline and the depth of an oxygen limit value.

BARRAMUNDI FRY FARMING

Introduction

In 1984, the Pacific Oceanological Centre (COP) (IFREMER, Tahiti) started a research programme on tropical sea-fish farming. After testing a number of local and imported species, an imported one, the barramundi: *Lates calcarifer* (Aquacop et al., 1990; 1991) was chosen. This species occurs in South-East Asia and northern Australia, where there is a fishery and a farming industry.

After nine years of research, the biological and physiological knowledge required to develop farming techniques suited both to the species and to island and lagoon environments is now available in a report on farming methods and in a technical and economic study of the industry as a whole (Pierson et al., 1994).

Depending on the needs which arise within any particular project, fry production can be carried out either intensively or semi-intensively in a hatchery or under extensive conditions.

In the former case, the larvae are raised under controlled conditions (temperature, light, salinity, food, preventive treatment, etc.). This method requires major capital investment and specialised labour, inducing high running costs.

The extensive technique used in the USA for the red drum (*Sciaenops ocellatta*), for example, or in Australia for *Lates calcarifer* relies upon natural production of plankton in fertilized earth-walled ponds. Since this system requires neither a hatchery, nor a unit to produce live prey, capital investment and running costs are relatively low.

On the other hand, this type of farm cannot be reliably duplicated, because it is basically dependent on weather conditions, a factor over which control cannot be exercised.

When the demand for fry is low, this technique makes it possible to develop a small-scale fish production activity, at low cost. This was the choice made in Tahiti by the *Société d'Aquaculture du Pacifique* (Aquacop) which has an aquacultural venture covering approximately 10 ha, producing freshwater prawns (*Macrobrachium rosenbergii*) and saltwater prawns (*Penaeus stylirostris*).

Since it wishes to diversify, this company has introduced *Lates calcarifer* farming on a small scale (objective: 20 t per year) in order to test both the required techniques and the market. After some trials carried out at IFREMER/COP, the technique was transferred to Aquapac.

Larval breeding

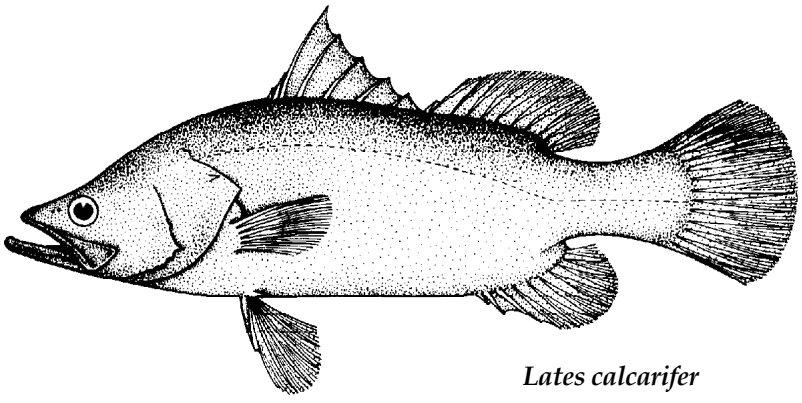
The pond

Farming takes place in an earth-walled pond, 1 to 1.5 m deep, filled with seawater. The pond should be between 1,000 and 1,500 m^2 in area. Its drainage system should be fitted with a water-filtering system in order to be able to empty the pond without losing the fry. The bottom of the pond should slope sufficiently for rapid water drainage at the end of the emptying process. A concrete channel or a simple ditch for fish concentration purposes will make it easier to harvest fry.

Plankton production

After emptying the pond, it should be filled with seawater pumped through a 500 μ filter to avoid the introduction of predators. The pond should be filled eight to nine days before the larvae are introduced. It should be fertilized from the outset in order to encourage the phytoplankton bloom which will provide the zooplankton's source of nutrition. Organic (fish food) or mineral (NPK agricultural) fertilizer may be used. Fertilization is to be continued throughout the farming cycle.

An inoculum from a pond where a bloom has already developed may help start the initial production of phyto- and zooplankton. The weather conditions are the most important single factor; sunlight is necessary for the phytoplankton, comprising chiefly chlorellae and diatoms, to develop. The zooplankton is primarily formed of rotifers and copepods.



Lates calcarifer

Larval breeding

The pond is seeded with *L. calcarifer* larvae 48 hours after hatching, at a density of 100 larvae per litre. The larvae must gradually be acclimatised to the physical and chemical parameters of the ponds (temperature, salinity, pH) during the transfer.

Two-day-old larvae have an open mouth and a functional digestive system and are mobile. They will therefore be able to feed as soon as they are released in the pond and will seek the areas which are most favourable to their development (shade, still water, optimum temperature, etc.).

During grow-out, daily temperature, salinity and pH measurements make it possible to maintain the most favourable conditions for the plankton to thrive. Should these parameters vary significantly, partial replacement of the water can prevent a shrinkage in the phytoplankton community. In the event of heavy rain, it may be necessary to stir up the water in the pond, in order to avoid stratification between fresh and salt water.

Harvesting the fry

Harvesting takes place approximately three weeks after seeding. The pond is emptied and the fry are harvested in the concentrator , using a scoopnet.

The rate of survival is very variable. During various trials carried out at COP, it ranged from 3 to 15 per cent, basically depending on weather conditions.

Aquapac has achieved survival rates of between 20 and 50 per cent with subsequent batches. The average weight of a three-week old fry is 250 mg, with, however, a relatively wide range of sizes, which encourages cannibalism. Earth-pond rearing should not therefore be a prolonged process. After harvesting, the fry should be sorted into size groups in order to reduce the risk of cannibalism during the nursery phase.

The average weight of fry is significantly higher than that obtained in hatcheries with intensive or semi-intensive rearing methods. This makes it possible to wean the young fish very rapidly, with a low mortality rate, and to considerably reduce the length of the nursery period, with the juveniles being placed in a grow-out cage 60 days after hatching.

Conclusion

This method of producing fry has a number of advantages:

- capital investment and labour requirements are small;
- it does not require intensive production of phytoplankton and live prey;
- it makes it possible to produce completely disease-free fish;
- the fry produced are, at an identical age, larger and heavier than those produced by intensive rearing and the production cycle is reduced by three to four weeks;
- it requires very little energy.

All these advantages make it possible to substantially reduce the cost of rearing fry and obtain a ready supply, making cage grow-out trials and market testing possible without incurring excessive financial risk.

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(Source: J.L Martin, IFREMER)

PORT LINCOLN TUNA OPERATOR BRINGS HOME A RECORD A$ MILLION CASH

Last year, Hagen Stehr bought a Japanese-built fish cage, possibly the largest in the world, after it had failed to attract a buyer for three years. 'The Russians were supposed to buy it', he said. 'But it was a one-off cage, and very expensive, and they didn't have the money. Then it was offered to a couple of other countries without success.

'I became aware that it was available, made a deal with the Japanese, and got it for a reasonable price, not knowing if it was going to work. Everyone else thought it was too big', he said, 'but I took a gamble'.

The first phase of the operation was to locate the fishing grounds. Some 30 km off Eucla, at the head of the Great Australian Bight, spotter planes reported up to a hundred schools of 30 to 100 t in one day, suggesting that southern bluefin numbers this year could be the best in decades. On Boxing Day, *Angelica S*, a 40-tonne trawler with a 12-man crew and Marcus Stehr at the wheel, left Port Lincoln for Eucla, towing the enormous octagonal cage, some 80 m across and 40 m deep.

Angelica S caught up to 1,000 tuna a day (using pole and line), at around 18 kg on average, releasing them into the cage. Then began a harrowing two weeks towing what Hagen described as the 'monstrous' cage, containing about 150 t of fish, some 800 km from the head of the Great Australian Bight to Port Lincoln.

It was a dangerous and complex operation, with logistic problems as well as those posed by sharks and some truly terrible weather, with Hagen, on shore, keeping in close contact with his son on the boat.

'The fish go into a pattern in the cage. When you stop, they have to change their behaviour and swim another way. They swim in circles, you see. While the cage is going forward they swim in a certain way; when it stops they have to swim differently.

And if there is a weather change, or if you enter a strong current, they could freak out. It's a very delicate operation'. The caged tuna were fed about 40 t of pilchards on the long tow home. When they are fed, Hagen said, the water 'just erupts; it's like piranha in the Amazon'.

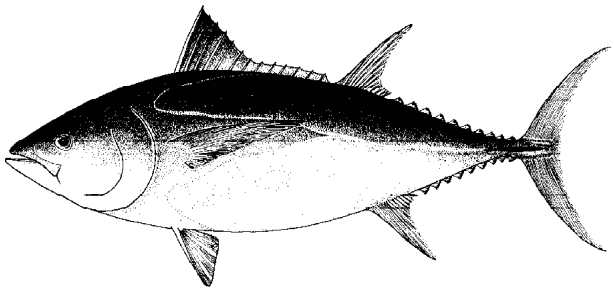
The young tuna have now been transferred to two pontoon cages near Boston Island, to be fed and fattened for four or five months, when they will be ready to be sold on the lucrative Japanese market at A$45,000 to A$50,000 a tonne.

Hagen Stehr justifiably believes that the success of this complex operation is a significant step forward for the tuna farming industry which, he says is still 'in a very steep learning curve'.

His successful gamble was so important because 'it was the biggest catch ever towed into Port Lincoln; the cage was so big and we had such bad weather'.

Tuna farming in Port Lincoln has had a meteoric rise since the first farm was established four years ago. Seven tonnes were produced in the first year; this year exports are expected to reach around 3,000 t. Almost to a thousand people are now involved in the industry. With five major companies and a lot of small one-farm operators who produce 20–30 t, there are now around 50 tuna farms in Boston Bay.

(Source: *Professional Fisherman*, March 1996)



HOUSING FOR 100,000 CLAMS COMPLETED IN MARSHALL ISLANDS

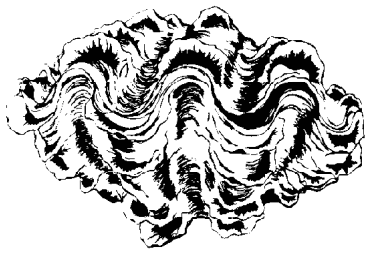
The new clam facility situated at the Robert Reimers Long Island site has been completed and is ready for housing up to 100,000 clams a year at saleable size.

Reimers began its diversification into the 'clam business' ten years ago with the food market in mind. The *Tridacna gigas* giant clam, however, takes seven years to mature to a size which yields the prized adductor muscle. After much time, the research teams at Reimers discovered that the aquarium trade is a much

more lucrative business, with some species of clam selling from US$ 25 to US$ 100 each in stores all over the world. Until now, clams have been a very rare commodity, with supply limited to a very few sources.

The giant clams are bred and reared for four months (they have 40:1 chance of survival at this stage), then harvested and transported to the Long Island facility, where they grow to export size. (Here they have a 7:1 chance of survival.)

The clams' development is dependent on space, waterflow and sunlight, all of which are monitored by biologists Dave Anderson and Bill Bridgeland. The clams live in sea-water tanks which pump water directly from the ocean.



Because the clam grow by a process of photosynthesis, the shade-cloth covering the tanks only cuts out 50 per cent of the sunlight. *T. maxima* and *T. squamosa* are the predominant varieties being bred.

It has taken a long time to find an appropriate market and product, but according to Peter Gigante, General Manager for RRE, 'There are export opportunities here in the Marshalls if time and funding are available, but above all it requires persistent research experimentation and creative will-power'.

Reimers will sell its clams via trade magazines and other methods. They will sell directly to consumers in addition to distributors and retail shops, thereby ensuring high manufacturing volume by influencing prices at the retail level.

Eventually, different size ranges of clam will be available for sale, as those not sold in any one year will grow larger. Research into how to breed the more popular blue and green clams could prove fruitful. Reimers also plan to export coral; this too depends on appropriate research.

(Source: *The Marshall Islands Journal*, 9 February 1996)

AUSTRALIA–PALAU AGREEMENT ON SURVEILLANCE COOPERATION

On 21 November 1995 President Nakamura met with the Australian Defense Delegation to execute a Memorandum of Understanding (MOU) between the two governments. The MOU recorded the understandings reached between the Government of Australia and the Government of Palau concerning Palau's participation in the Pacific Patrol Boat Project as part of surveillance cooperation with Australia.

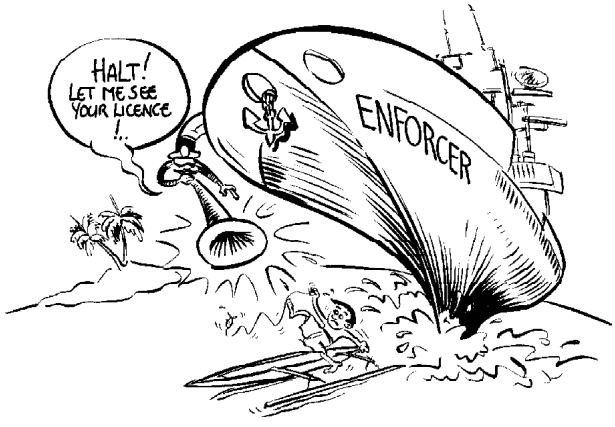
Under the MOU, the Government of Australia will provide one vessel to Palau, to be handed over on 25 May 1996. Australia will also provide advisers for an initial period of two years and more in the future as may be agreeable to both governments. They will advise the Republic on the introduction into service of its vessel and the establishment of facilities, a surveillance system, operational procedures and a maintenance system.

Under the MOU, and prior to delivery of the vessel, the Government of Palau will be responsible for the establishment of surveillance and management systems required for the effective operation of the vessel.

In addition, the government of Australia will arrange, and in fact is currently conducting, appropriate training in Australia for the vessel's crew and staff nominated for the Government of Palau.

Australia's Pacific Patrol Boat Project has benefited other Pacific nations, including Cook Islands, Federated States of Micro-nesia, Fiji, Marshall Islands, Kiribati, Papua New Guinea, Solomon Islands, Tonga, Tuvalu, Vanuatu and Western Samoa.

(Source: *Palau Gazette*, 30/11/95)



WORLD CONGRESS ON COASTAL AND MARINE TOURISM TO BE HELD IN HONOLULU

The 1996 World Congress on Coastal and Marine Tourism will be held in Honolulu, Hawaii from 19 to 22 June 1996.

Coastal and marine-resources-based activities continue to be a major growth sector in international tourism. In 1990, the first Congress on Coastal and Marine Tourism (CMT 90) set out to examine the opportunities and challenges posed by this emerging sector of the industry.

CMT 90 brought together more than 250 participants from 31 nations and territories to consider the nature of tourism in coastal zones. Business and government representatives, community leaders and scientists agreed that successful, sustainable tourism must carefully integrate planning and development. Collaboration among communities, resource managers, industry, education, and non-profit organisations is also necessary.

Plenary, discussion and workshop sessions will be offered at the 1996 Congress. Some sessions will be jointly presented with the partially concurrent Pacific Congress on Marine Science and Technology (PACON96).

For more information, contact Dr Jan Auyang, CMT96, c/o Oregon Sea Grant, Oregon State University, 500 Admin. Services, Corvallis, OR 97331-2131, USA. [Phone 541 7375130, Fax: 541 7372392; Internet: auyongj@ccmail.orst.edu]

FIFTH INDO-PACIFIC FISH CONFERENCE—FIRST CIRCULAR

The Fifth Indo-Pacific Fish Conference will be organised by the *Institut français de recherche scientifique pour le développement en coopération* (ORSTOM). The exact dates will be specified in the second circular. However it is likely to take place during the last week of October 1997 at the ORSTOM Centre in Noumea, New Caledonia.

As with the first four Indo-Pacific Fish Conferences (Sydney, Tokyo, Wellington and Bangkok), the main topics of the Fifth Conference will cover all aspects of the systematics, evolution, biogeography, biology, ecology and genetics of both freshwater and marine Indo-Pacific fishes. In addition a number of workshops will be organised on specific themes (e.g. biodiversity, databases) and on other fields of science related to fish (e.g. parasitology, ethnology). The aim is to promote fruitful discussions between scientists dealing with all aspects of Indo-Pacific fishes. For any enquiry concerning the Fifth Indo-Pacific Fish Conference, please contact:

Bernard Seret, Antenne ORSTOM, Muséum National d'Histoire Naturelle, Laboratoire d'Ichtyologie générale et appliquée, 43 rue Cuvier, 75231 Paris Cedex 05, France. [Phone: 33 1 40793738, Fax: 33 1 40793771, E-mail: seret@mnhn.fr]

TROCHUS HATCHERY AND NUTRITION WORKSHOP

The Trochus Hatchery and Nutrition Project in the Northern Territory University (NTU) will organise a two-day workshop from 6 to 7 June 1996. This project is funded by the Targeted Institution Links Program (TILP) of the Department of Employment, Education and Training (DEET), Canberra, Australia.

This workshop will aim to disseminate to the public the research results of the TILP/DEET-funded research project 'Cooperative research into the biology of the topshell *Trochus niloticus*, from northern Australia and eastern Indonesia'.

Some of the topics that will be presented during the workshop are: a review on the progress and achievements of the trochus hatchery and nutritional project; a review of the trochus fisheries in Western Australia, Vanuatu and eastern Indonesia; development of the NTU trochus hatchery and the growth rate of juvenile trochus maintained in a closed recirculating system supplied with bore water; induced spawning of trochus with artificial stimulus; preliminary studies on the gonadal cycle of trochus from the King Sound, Western Australia; hatchery production and growth of juveniles in eastern Indonesia.

For more information, please contact: Convention Catalysts Int., G.P.O. Box 2541, Darwin, NT 0801, Australia. [Phone: 61 89 811875, Fax: 61 89 411639, E-mail: leec@darwin.ntu.edu.au]

Why cholera blooms in the Spring

One of the mysteries surrounding the spread of killer intestinal diseases such as cholera may have been solved: the bacteria responsible hitch a ride on marine plankton, and as the plankton multiply, so do the pathogens. In the next few years, both populations are likely to explode in heavily populated coastal areas as a result of global warming and increasing sewage pollution of the sea.

The link between disease bacteria and plankton is mentioned as one possible impact of global warming on disease this week in the *Journal of the American Medical Association*.

Paul Epstein of Harvard Medical School, one of the report's authors, explains that researchers wondered 30 years ago if there was some link between cholera and plankton that might explain why the disease flared up in spring and autumn in Bangladesh. Microscopic marine algae also multiply, or 'bloom', then.

The idea was dismissed when researchers could not find the *Vibrio* bacteria that cause cholera when they cultured algae. But recently, Rita Colwell of the Maryland Biotechnology Institute treated marine plankton with antibodies that bind specifically to *Vibrio*, linked to fluorescent dyes. 'They lit up', says Epstein. Not only *Vibrio*, but other disease bacteria, including *Pseudomonas* and *Escherichia coli*, have now been found clinging to phytoplankton and zooplankton.

'They didn't find it before because when the algae aren't growing, the bacteria shrivel 150-fold to a dormant state.' The dormant bacteria failed to 'wake up' in the culture. But they do revive, says Epstein, when particular temperature conditions and nutrients cause plankton to bloom.

'We think this explains the cholera outbreak in Peru', he says. After being absent in the Americas for more than a century, cholera boke out in Peru in January 1991. The same strain of *Vibrio* is responsible for the wave of cholera that has been slowly crossing Asia since 1961. 'But in Peru it appeared near Lima, then 400 kilometres north two days later, then 800 kilometres south two days after that', says Epstein.

'The usual vectors of cholera, such as human travellers, could not explain why it occurred so far apart in such a short time.' He thinks an Asian ship infected the local plankton with *Vibrio* at several ports when it dumped ballast water. 'A little bilgewater in the sea is not enough to explain the outbreak', says Epstein.

'But we think the *Vibrio* were amplified by the rich algal bloom that year that spread along the coast.' In 1991, the periodic climatic phenomenon called El Niño warmed Peruvian coastal waters, causing larger blooms than usual.

People probably became ill after eating contaminated fish. The disease struck poor neighbourhoods first, partly because of poor sanitation, but also because poor people eat fish caught close to the shore, in the thick of the bloom, while the rich eat more expensive fish caught offshore.

Cholera also increases in Bangladesh in El Niño years, when coastal waters are warmer and plankton blooms are bigger, says Epstein.

Colwell says an outbreak of cholera in Sebastopol in 1993 coincided with an algal bloom in the Black Sea, and *Vibrio* bacteria were found on the suits of divers who became ill.

Epstein thinks satellite monitoring of algal blooms would help to predict outbreaks of waterborne diseases. No scanners sensitive to algal colours have flown on remote-sensing satellites since 1986. But two are planned this year: a German detector aboard an Indian satellite, and an American scanner aboard a satellite called Seawifs.

(Source: *New Scientist*, 20 January 1996)

PRELIMINARY SURVEY FOR FISHERY MANAGEMENT PLAN FOR AITUTAKI LAGOON (COOK ISLANDS)

by Sione V. Matoto, Integrated Fisheries Management Associate SPC, New Caledonia

Aitutaki is situated about 225 km north of Rarotonga, the capital of the Cook Islands, with a land mass of 1991 ha and a population of approximately 3,000.

Its geological structure is unusual in that it is an island which is partly volcanic and a coral atoll. Its lagoon is generally shallow (2–15m), and is considered one of the most attractive places in the Pacific.

The island is the second most heavily-populated area of the Cook Islands and supports an increasing tourist industry. The major transport in and out of Aitutaki is provided by Air Rarotonga, which operates two Twin Otters (20 seats), servicing three flights daily to Rarotonga and other islands, and a container ship arriving at Aitutaki monthly.

The increasing level of exploitation of fisheries resources in Aitutaki Lagoon has caused great concern to the people of the island in recent years. The experience of fishermen suggested that fisheries resources in the lagoon are declining. The depletion of food fish and giant clam (**pa'ua**) stocks in recent years was thought to be caused by the fact that they are easy to catch in such a shallow lagoon.

Consequently, the Aitutaki Island Council approached the Ministry of Marine Resources (MMR) for assistance regarding the fisheries resources.

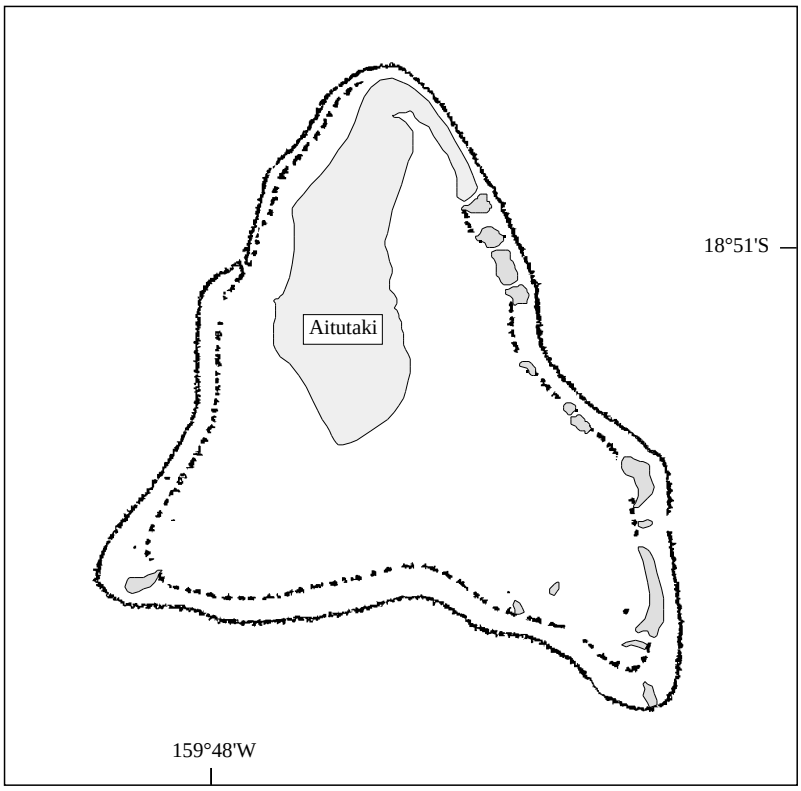
The Ministry of Marine Resources requested SPC's Integrated Coastal Fisheries Management Project (ICFMaP) to conduct a field survey to find out the status of fisheries resources, establish monitoring programmes and develop a management plan for Aitutaki Lagoon.

The Aitutaki Lagoon fishery management plan project was intended to be used as a pilot example for other islands of the Cooks. The legislative framework to support such plans was already in place, but this would be the first time that a fisheries plan under the Marine Resources Act had been drafted and executed.

The preliminary survey was carried out jointly by the Ministry of Marine Resources, the Marine Research Station in Aitutaki, and SPC's Integrated Coastal Fisheries Management Project.

The aim was to produce an integrated reef and lagoon fisheries management plan for Aitutaki lagoon fisheries, to be submitted to Cabinet by the Aitutaki Island Council and Ministry of Marine Resources, for legislation as a bylaw under the 1989 Marine Act.

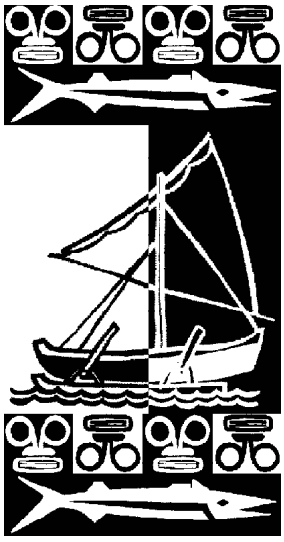
Household surveys, deployment of fish traps, an underwater visual census (UVC) and controlled fishing exercises were



Map of Aitutaki

carried out at Aitutaki to discover the following information:

- What fish are eaten/used for subsistence/sale/export (what kind, what quantity and when?
- What (roughly) is the available biomass of these important fish?
- What is the history of fish and fishing, and what changes in human population and fish usage are likely to occur in the future?
- How are fisheries currently managed? What mechanisms, powers and resources are available?
- What is the aim of management? What hardships or tradeoffs is the Council prepared to make in promoting sustainable subsistence fishing, tourism and/or commercial fishing; and
- What is the prospect of improving sustainability through indirect strategies (e.g. post-harvest development, mariculture, marine parks)?



Besides the main objectives, senior staff of the Ministry of Marine Resources expressed their concern regarding the decision made by the Aitutaki Island Council to open the trochus harvest season on 7 November 1995 for four days.

The Island Council had allowed 26 tons of trochus to be harvested rather than the 9 tons which were recommended by the MMR after the last trochus survey.

The ICFMaP team consisted of Dr Tim Adams (Fisheries Resources Adviser), Paul Dalzell (Inshore Fisheries Scientist), Sione Matoto (Integrated Fisheries Management Associate) and Patricia Tuara (Women's Fisheries Development Officer), who was working in the Cook Islands on a separate assignment. The project was conducted in collaboration with the staff of the MMR Marine Research Station in Aitutaki: Ian Bertram, Onio Terekia, John Ngu, Metusela Koroa and Joshua Mitchell.

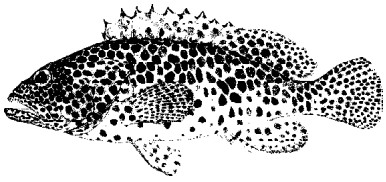
To identify fisheries utilisation within Aitutaki Lagoon, household surveys were carried out in pairs, i.e. a local person was partnered with one of the SPC team. The target number of households to be interviewed was 100.

Interviews were conducted with approximately 15 households each from seven villages (Amuri, Vaipae, Tautu, Nikaupara, Reureu, Arutanga and Urea), over a two-day period. By the end of the survey, 101 households had been interviewed.

Fish traps were deployed to catch fish for tagging so that fish migration within the lagoon could be monitored. Each trap was baited with two tinned fish (mackerel in oil) and deployed close to a patch of reefs or a coral head. Four traps were placed near a clam nursery at Maina and three near Moturakau and Tautu.

After nine days, the traps were pulled up; for ten traps, only five fish were caught. All traps were rebaited, now using frozen fish, and lowered back to the same location.

Although very few fish were caught by traps, many were caught using a rod and line at various sites in the lagoon. Overall, 53 fish were tagged and released, with a majority of the catch being *Epinephelus merra*.



Three sites were selected to carry out the underwater visual census (UVC) exercise. Transects were set out near the clam nursery at Maina and Moturakau, each 50 m x 5 m, covering an area of 250 m^2. The survey team worked in pairs throughout the UVC exercise–three pairs counted seven major families of fish (snapper, grouper, emperor, parrot, surgeon, butterfly, and goatfish), while the remaining surveyors took a count of invertebrates and coral. Finfish were counted six times at each transect and sessile invertebrates once.

The controlled fishing exercise was carried out by spear-fishing on a reasonable-sized patch of reefs located close to the clam nursery near Maina. A boundary was marked within which three people had been spear-fishing in four consecutive sessions within a two-day period.

After each fishing session of 1.5-2 hours, the total fish catch was weighed, sorted according to species, and individually measured (fork length) and weighed. The results of this exercise determined the fishable standing stock for the lagoon by measuring the decline in catch per unit of effort.

The collaborative effort between the ICFMaP and MMR staff contributed significantly to the success of the field survey in Aitutaki. All activities were completed according to plan and the information required for the Aitutaki lagoon management plan was obtained.

A draft report has been completed. Ongoing monitoring activity is currently being conducted by MMR staff. The ICFMaP team is working toward the completion of the final report, which will include a statistical analysis of the data collected from all activities.

The management plan for Aitutaki Lagoon is to be completed by the end of 1996 during a return visit of the SPC-ICFMaP team.

Fisheries Research Officer John Ngu (centre) demonstrates his prowess at catching groupers for tagging

POTENTIAL FOR AQUACULTURE OF BAIT IN GUAM

This article is extracted from a report prepared by Bill Fitzgerald, former Chief Planner with the Department of Commerce, Guam)

by Bill Fitzgerald

INTRODUCTION

Tuna longline vessels prefer to use live milkfish as bait because it is significantly more effective than other baits. Milkfish have been shown to give a catch rate three to five times more effective than dead bait (Bartram, personal communication, 1994).

In addition, the milkfish is the preferred live bait, since it tolerates handling and long-term holding in bait wells. Milkfish bait tolerate the depths at which the longlines are set and usually remain alive even when the longline is retrieved.

This significantly better effectiveness of milkfish translates into a substantial economic benefit to the vessel. The improved catch rate means that either the catch per trip is increased or trips can be shortened to reach the same catch target. For example, a line deployed with 1,000 hooks using conventional bait such as squid could result in a catch of 30 tuna with an average value of US$200/fish.

The use of live milkfish as bait could increase the catch to 90–150 tuna for the same deployment. This represents an additional value of US$12,000-24,000 per set which would more than cover the entire cost (approximately US$4,000) for live milkfish bait for the entire trip (representing multiple sets).

Traditionally, Taiwan vessels departing Taiwan for fishing grounds in the Western Pacific would load enough live milkfish bait for approximately two fishing trips. Thereafter, the less effective dead bait would be used. To avoid the down time in fishing required for travel to Taiwan to purchase bait (one week's travel time and two weeks in port to load) the longliners now prefer to purchase the bait on Guam.

A Guam-based corporation entered into an exclusive contract agreement with a Taiwanese longline fleet to provide bait, starting in March 1995. A 3–5 year contract was offered by the Taiwanese company. The corporation has obtained a lease on a 14 acre site to establish a milkfish farm.

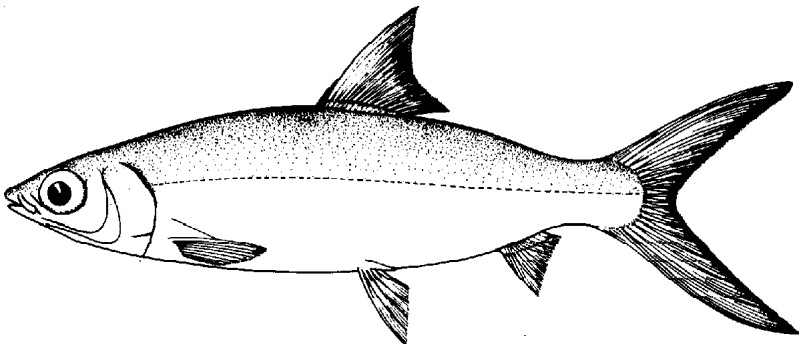
A prefabricated concrete pond design was adapted. The scheduled first delivery date of bait to the fleet was March 1995. It was possible that a bait carrier vessel from the Philippines might be used to meet this first delivery obligation, to allow time for the farm construction and initial operation.

One of the current largest aquaculture farms on Guam has entered into an agreement with one of the tuna transshipment agents to produce milkfish for bait. The farm started the transition in production at the beginning of 1995. This will represent 35 acres of ponds for the tuna bait market.

All the transshipping agents are trying to make arrangements to provide live milkfish bait to the tuna longline vessels they service, in order to remain competitive with other agents that have secured a source.

These companies are looking at bringing in juveniles, which would be held for a short period before distribution to the vessels. They are also considering developing aquaculture farms on Guam to produce the bait.

The largest longline fleet in the region, Ting Hong, has also expressed interest in establishing a bait aquaculture farm on Guam to supply its vessels.



The milkfish, *Chanos chanos*

Market

A Taiwan fishing company wants to purchase juvenile milkfish (approx. 6 in long) as live bait. It requires 8,000–10,000 pieces/vessel/trip. Each vessel makes 2–3 trips/month. The number of vessels the company intends to have based in Guam ranges from 30 to 200, depending on the season. Table 1 shows the vessel schedule. The cost of live milkfish bait in Taiwan is 14.8 cents/piece during the low season and 37 cents/piece during the peak season.

However, the price is reported to reach 50 cents/piece or higher in Taiwan (Kuo & Hwang, personal communication, October 1994). There are about 6 pieces/lb [*1 lb = 0.454 kg*]; therefore, the price by weight is US$0.89–2.22 per lb. A premium price could be expected to be paid for bait in Guam, since obtaining bait there would save 3-4 weeks' fishing time plus ships' operation expenses. The fishing time saved also represents additional revenue from the potential catch. The annual demand, based on the average number of monthly port calls, is 1.9 million pieces/month or 22,800,000 pieces/yr. At a price of US$2.22/lb this would be worth US$8,436,000/year.

Production

A substantial commitment of pond area and resources will be required to produce the quantity needed for the tuna longline fishery. Table 2 presents different scenarios.

Basic culture parameters obtained from Taiwan

- Culture area needed: approximately 1–1.5 ha/1,000,000 pieces/year;
- Stocking density: 150,000–300,000/ha (15–30/m^2);
- Growth rate at given stocking densities: from 2 cm fry to 15 cm takes 45–90 days;

Table 1: Tuna fleet monthly bait demand

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total	Monthly average
Vessels based in Guam	30	30	30	50	100	150	150	150	200	100	100	50	1,140	95
Port calls	60	60	60	100	200	300	300	300	400	200	200	100	2,280	190
Approx. bait demand (1,000 pieces)	600	600	600	1,000	2,000	3,000	3,000	3,000	4,000	2,000	2,000	1,000	22,800	1,900

Table 2: Production scenarios

Quantity needed (pieces/year)	Stocking density (pieces/km^2)	Survival (%)	Harvests per year	Area needed (hectares)
20,000,000	20	80	4	31.25
20,000,000	40	80	4	15.63
20,000,000	60	80	4	10.42
20,000,000	80	80	4	8.81
20,000,000	100	80	4	6.25
20,000,000	120	80	4	5.21
20,000,000	150	80	4	4.17
20,000,000	200	80	4	3.13
25,000,000	20	80	4	39.06
25,000,000	40	80	4	19.53
25,000,000	60	80	4	13.02
25,000,000	80	80	4	9.77
25,000,000	100	80	4	7.81
25,000,000	120	80	4	6.51

- Can you slow the growth down for off-season stocking? Yes;
- Survival: 80–95%;
- Price: (reported to be US$.035/fry but in large numbers US$.005/fry in the Philippines); US$400/10,000 pieces in Taiwan;
- Are fry available in quantity needed? Yes
- Months available: May–October.

Tuna transshipment industry

The foreign longline fishery on Guam grew at a rapid pace from 5–8 vessels in late 1986. At the end of 1993, 270 individual vessels made more than 1,000 port calls to the island. The number of port calls increased in 1994 to 236 vessels, with 687 port calls for just the first seven months of 1994. Port call data back to 1990 are available from the Department of Commerce. In 1993, for the first time, more port calls were made by Taiwanese vessels (569) than by Japanese vessels (399) (Table 3).

The longline vessels, which range in size from 19 to 59 tons, reportedly fish mainly in the waters of the Federated States of Micronesia (FSM), with a growing percentage in international waters. The catch is offloaded on Guam for air-transshipment to Japan for the sashimi markets, with the exception of the portion of the catch that does not meet the quality requirements. This portion of the catch is termed rejected fish.

Tuna rejected for the sashimi market is presently handled in three main ways: purchased by a reefer vessel, which stores the tuna for pickup by a mother vessel for the Korean tuna market; frozen for container transshipment to canneries; or processed by a private Guam-based entrepreneur into jerky, loins and other value-added products. The Department of Commerce's figures show that since 1991, roughly 13 per cent of the tuna off-loaded is rejected for transshipment to the sashimi market.

The longline transshipment fishery on Guam consists mainly of Japanese and Taiwanese vessels. The vessels call at the Guam Commercial Port, where the catch is contracted to agents who handle the dockside off-loading, inspection, weighing, boxing and shipping of the fish. Seven agents currently handle this activity. The role of the vessel agent is to organise and/or facilitate procedures involving: port entry/departure; customs and immigration; fuel, water and ship's chandlery; payments for port call services; and distribution of rest and recreation money.

Numerous other primary and secondary support services have evolved as a direct result of the growth and changes in the longline tuna transshipment industry. The culture of bait fish is one that has significant potential to expand the aquaculture industry and add to the economy as a whole.

The longline catch consists mainly of yellowfin and bigeye tuna. An estimated three to five per cent of the total catch consists of billfish (mostly marlin). Billfish have now been included in the shipments to Japan. Prior to this market change, they were either sold locally or discarded. The price for transshipped fish varies according to the quality. The air freight cost to Japan is about US$1.25/kg. The primary destination of the transshipped tuna is Narita, since refrigerated trucking is available to all parts of Japan. Other market distribution areas in Japan are Osaka and Nagoya. In addition to Japan, there are some small marketing opportunities for fresh tuna in Hawaii and the US mainland.

In 1993, 7,104 t of fish were offloaded from longline vessels and transshipped from Guam, as shown in Table 4. Of this amount, 52 per cent was bigeye tuna, and 44 per cent was yellowfin. This reflects a 32 per cent increase over the 1992 transshipment total of 5,390 t. These totals, however are still well below the 1989 peak-year estimate of 15,000 t.

Table 3: Potential bait demand/value based on port calls

Year	Port calls	Vessels based in Guam	Potential bait demand*	Potential value (US$)**
1986	195	N/A	1,950,000	975,000
1987	207	N/A	2,070,000	1,035,000
1988	728	N/A	7,280,000	3,640,000
1989	1,055	N/A	10,550,000	5,275,000
1990	1,450	328	14,500,000	7,250,000
1991	1,078	233	10,078,000	5,036,000
1992	846	224	8,460,000	4,230,000
1993	1,089	270	10,089,000	5,044,500
1994	1,509	348	15,090,000	7,545,000

* based on 10,000 pieces/trip

** based on US$ 0.50/piece

The fluctuations in the Guam-based longline tuna industry after 1990 reflect growing pressure from the Federated States of Micronesia (FSM) which ties the issue of fishing permits for in its waters to off-loading the catch at its ports. The support and air cargo infrastructure has improved in the 1990s in FSM. This has resulted in a decrease in the number of vessels transshipping from Guam, as shown by the decline in port calls from 1,450 in 1990 to 846 in 1992 (the lowest point).

Prior to 1991, most foreign longline vessels licensed to fish in the EEZ of the FSM off-loaded their catches in ports other than those in the FSM and thus negated the possibilities for collecting relevant data. Recently, the Micronesian Maritime Authority (MMA) has shifted the licensing priorities to encourage the basing of foreign longliners in FSM ports. As a result, the number of longline vessels now off-loading their catches in FSM ports has increased dramatically. In 1992, a total of 670 port calls was made in the FSM, while in 1993, the number of port calls made more than doubled, with 1,432 landings recorded for the year. This coincides with the decline in the number of port calls made to Guam during this time period.

However, Guam has a number of competitive advantages over the other ports of the region. These include lower fuel cost, along with better and greater services available (e.g., rest and recreation facilities, medical services, provisioning, equipment repair, ship repair, etc.).

The addition of baitfish availability would add a very significant competitive advantage that should draw additional vessels to base in Guam. Furthermore, bilateral negotiations are underway between Guam and FSM to change the restrictive FSM fisheries policy regarding port off-loading. If these fail, it is likely that the US Department of Interior will intervene to relieve this constraint.

Table 4: Annual longline transshipment volume, 1986 – 1994 (metric tonnes)

Year	Total transshipment	% change from previous year
1986	5,364	–
1987	3,116	–42
1988	6,772	+117
1989	15,000	+122
1990	12,729	–15
1991	9,587	–25
1992	5,391	–43
1993	7,104	+32
1994	8,962	+26

Totals for 1989 and 1992 are estimates.

Benefits

Baitfish production expands the potential economic opportunities for the development of the aquaculture industry. It further diversifies the market opportunities. It also provides benefits to the Guam-based tuna transshipment industry. The availability of a cost-effective source of baitfish on Guam provides a significant competitive advantage to the Guam tuna transshipment industry. Similarly, the successful culture of baitfish on Guam should stimulate expanded demand, with additional fleets sourcing bait in Guam.

Taiwanese vessels usually spend 8–9 months in the fishing grounds before returning home to Taiwan. Vessels returning to the fishing grounds would probably bring live milkfish bait with them that would be adequate for 1–2 months of fishing. This would reduce the overall bait demand for that portion of the vessel's total fishing months.

Conclusion

The information available suggests that the most likely production scenario would require approximately 20–25 ha of ponds to produce 20 million pieces of bait per year. These could be new ponds, existing ponds converted to bait production or a combination of the two. However, it is recommended that the bait production capacity be phased so not to produce an over-supply. In addition, the new ponds should be of a design that could easily be used for the culture of other commercial aquaculture products if the bait demand declined.

THE DEVELOPMENT OF SMALL-SCALE FISHERIES FOR BOTTOMFISH IN AMERICAN SAMOA (1961–1987)

This article has been written by David Itano, former Fisheries Research Scientist with the Oceanic Fisheries Programme of the South Pacific Commission. Due to its length, only part of the article will be presented in this issue. The second part, together with the bibliography, will be published in Fisheries Newsletter *#77.*

by David G. Itano,
Hawaii Institute of Marine Biology
Kaneohe, Hawaii

Introduction

General

American Samoa consists of five high, volcanic islands and two atolls. The population centres are located on Tutuila and Aunu'u. They lie approximately 95 km to the west of Ofu, Olosega and Ta'u, which comprise the Manu'a Island group. Swain's and Rose Atoll are 280 and 360 km to the north and east of Tutuila respectively (see map on page 30). The country maintains a semi-independent status while enjoying the benefits of full territorial status of the United States.

The domestic commercial fisheries of American Samoa have evolved over the past 25 years through the efforts of several fisheries development and training programmes. These have included boat-building projects, low-interest boat-loan incentives, FAD programmes and training in small craft navigation, marine electronics and outboard engine repair. Specific training and surveys with fishing techniques have included deep-water bottomfishing (Mead, 1978; Moana, 1988), skipjack live-bait pole-and-line fishing (Rodman, 1973; Bryan 1978), bouke ami lift-netting (Tuna Programme, 1984), lobster trapping (Chambers & Nunes, 1975), live-bait assisted trolling (Bryan & Lambert, 1979), ika shibi fishing, palu ahi hand-lining (Crook, 1985), PVC pipe bottomfish longlining (Makaiwi, 1984), deep-water shrimp trapping, dead-bait trolling, vertical longlining and flying-fish netting (Moana, 1988). This list is far from complete.

Some of these techniques were readily accepted by local fishermen but most were quickly forgotten. Training in bottom-fishing and the introduction of manually-operated bottomfish handreels have gained the widest acceptance with the local fleet. The handreels were also quickly utilised in the pelagic troll fishery for skipjack and yellowfin tuna.

The promotion of domestic bottomfishing in American Samoa has been so successful that some of the local bottomfish grounds have become significantly depleted. Some of these fishery development programmes were active for periods of time adequate to note declines in catch vs effort and location and decreases in mean size of harvested fish.

As previously stated, American Samoa has experienced several fishery development programmes in the last quarter century. Many of these are identical to development programmes already in progress or proposed for other Pacific Island countries and territories.

This paper will attempt to recount the early development of the domestic bottomfishery in American Samoa as it relates to the development of sustained, economically viable artisanal fisheries. It is hoped that other countries of the region will find this exercise useful in planning the rational development and management of their domestic fisheries*.

Background

A visit in 1961 by John C. Marr, director of the Hawaii Area, Bureau of Commercial Fisheries (Marr, 1961), resulted in the following recommendations to increase local fishery production:

- fresh-water ponds for tilapia culture;
- salt-water ponds for mullet culture or rearing;
- nearshore fishing by trolling, handlines, set lines, lobster traps, tangle nets and fish traps;

* The Department of Marine and Wildlife Resources is currently conducting bottomfish assessment projects and studies on the biology of bottomfish species exploited in the Territory, to better manage these resources.

- tuna longlining and general tuna fishing development;
- pole-and-line tuna fishing;
- sport-fishing and charter-fishing industry development; and
- aquarium fish trade.

This article examines the development of the American Samoa commercial/artisanal fishery as it relates to the exploitation of bottomfish taken by hook and line.

FIRST-GENERATION FISHERY DEVELOPMENT

Initial status

At the time of Marr's visit to American Samoa, there were no local commercial fishing vessels or sport-fishing craft in the entire Territory. The concept of fishing to produce a marketable product for monetary gain is incompatible with traditional Samoan cultural values.

In a somewhat paradoxical sense, the erosion of other traditional values and the acceptance of a cash economy based on government jobs and tuna cannery employment resulted in a steadily decreasing level of traditional, subsistence fishing.

Cultural deterioration also led to the loss of a rich heritage of oceanic seafaring among the Samoan people. Marr estimated that there were only about 10 traditional outrigger canoes (**paopao**) regularly fishing around the main island of Tutuila.

Most fishing and seafood gathering activities in Samoa concentrate on shallow reef-flat areas between the outer fringing reef and the shoreline (Hill, 1977; Wass 1980a). Dependence on imported protein and the local sale of inexpensive frozen fish from the canneries further discouraged the start of a domestic fishing industry.

In 1961 alone, approximately 100 short tons of frozen fish (mostly wahoo) caught incidentally by the foreign longline fleet based on the Pago Pago canneries was sold locally at cost or slight profit for US$ 0.12/lb (Marr, 1961) [1 lb = 0.454 kg]. This inexpensive source of fish remains a serious constraint on domestic fisheries development to this day.

The Marr report recommended the establishment of a government agency at the departmental level to guide and assist fisheries development, with priority given to the introduction of a suitable small craft for near-shore fisheries. The vessel Marr recommended would be outboard-driven, easily built and maintained, 4.9–7.0 m long and capable of utilising troll, hand-line, trap, gillnet, surround net, night lighting and longlining gear.

At the same time, he cautioned that training and appropriate technology were essential and that Samoan fishermen must be willing to resume and pursue a rigorous seafaring life for the fisheries development to succeed.

Bottomfish surveys–*Tautai A'e*

The Office of Marine Resources (OMR) was created by executive order of the Governor of American Samoa during the 1960s to deal with all fisheries-related matters, which included addressing the recommendations of the Marr report.

The major objectives of the office at this time were fisheries development, marine resource identification and resource assessment.

OMR bottomfish surveys from 1967 to 1970 on the 10 m fibreglass vessel, *Tautai A'e*, indicated potential for a small-scale bottomfishery based in Pago Pago (Ralston, 1978).

A total of 125 bottomfish survey trips was made, and the catch results from 104 bottomfishing trips between September 1967 and March 1969 produced 14,411 kg of bottomfish for an average of 138.6 kg/trip at a mean rate of 3.5 kg/line-hour. Survey effort concentrated on shallow shelf areas around Tutuila Island to a depth of 55 m, resulting in a catch dominated by shallow-water emperors and snappers.

It was reported that 23.3 per cent of the catch was *Lethrinus miniatus*, 19.2 per cent *Lutjanus gibbus*, and that there was a large percentage of *L. bohar*, which were not included in Ralston's analysis as they are often ciguatoxic in Samoa and are not marketed.

The remainder of the catch was composed of *Lutjanus kasmira*, *Cephalopholis* spp., *Ephinephelus* spp. and the dogtooth tuna, *Gymnosarda unicolor*.

The best fishing areas for these species were on the relatively broad shelf areas around Tutuila near Aunu'u Island, Cape Taputapu and Cape Matatula (Figure 1). Catch rates in these areas ranged from 4.1 to 4.9 kg/line-hour. There were some indications that catch rates fell during the period of the surveys, although it is not certain if the cause was fishing pressure or seasonal variation in catchability.

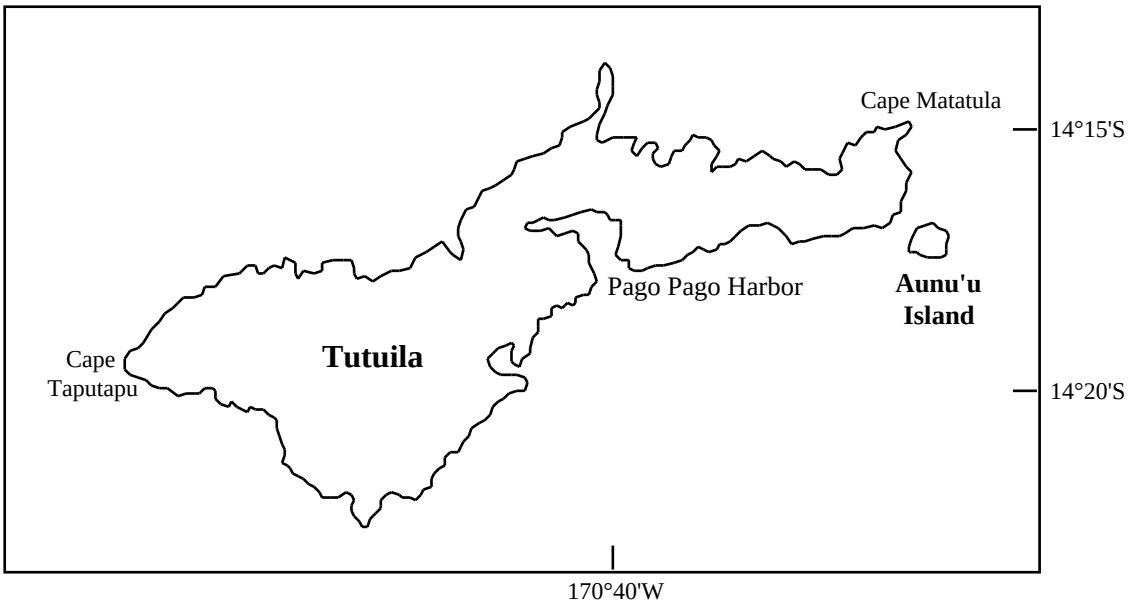


Figure 1: Shallow water bottomfish grounds surveyed by the Tautai A'e

However, it is likely that the drop in catch rate was a real consequence of the vessel fishing down virgin stocks of bottomfish.

Dory Project

In February 1972, the OMR Small Boat Project, funded by the American Samoa Office of Economic Opportunity (OEO), launched the first small-scale, commercial fishing vessel for American Samoa (Wass, 1973). The OMR developed a boat-building facility that eventually produced 23 vessels over a three-year period (Wass, 1975).

The vessels were patterned after the Oregon Dory, popular in the US Pacific north-west, designed for beach launching and used in the salmon troll and shallow-water groundfish fisheries. The Small Boat Project is commonly referred to as the Dory Project due to the choice of vessel design. The plywood hulls were 7.3 m long with a 2.4 m beam and small cuddy cabin forward. The early dories were supplied with petrol-driven engines and inboard/outboard (I/O) propeller drive units. Six other dories were equipped with I/O jet drives in an attempt to avoid problems of propeller damage on shallow coral reefs during beach landings (Pedro, pers. comm.).

The jet drives were soon abandoned; later dories were equipped with 70 hp diesel engines with I/O propeller units (Hume & Eginton, 1976). A few dories were equipped with true inboard shaft and cutlass drives, but the I/O units were preferred (Yamasaki, pers comm.). The flat bottoms of some of the dories were removed and replaced with modified V hulls in response to complaints concerning the rough handling (Pedro, pers. comm.).

Completed dories were made available to local residents interested in commercial fishing on the understanding that the cost of materials and construction costs would be paid back to the government. The repayment and a low rate of interest would be generated from fish sales and re-enter an OEO revolving fund. Very little of the money was ever repaid.

Fishing captains were asked to report catches to the OMR on standardised trip report forms that contained information on area fished, fishing method, number of fishermen, number of hooks, weight of catch (total) and number and weight of predominant species (Wass, 1973). According to OMR records, 70 per cent of the dories engaged in some bottomfishing activities.

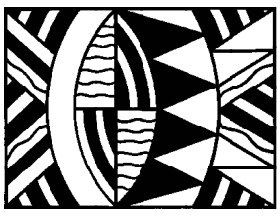
Almost all of the bottomfishing was conducted at night, and most of the fishing trips lasted for only a single night. Dories averaged three to four fishermen per trip. Most of the bottomfishing was conducted in relatively shallow waters, between 55 and 146 m. Fishing effort concentrated on the shallow shelf areas around Tutuila Island that had already been surveyed by the *Tautai A'e*. No mechanical means of line retrieval was employed, meaning that all bottomfishing and trolling was conducted with simple handlines kept in baskets or loose in the bottom of the dories.

The shallow fishing grounds and handlines produced a predictable catch of shallow- to mid-depth snappers, emperors and groupers. In 1974–1975, Dory Project vessel landings by weight included *Lutjanus kasmira* (30.9%), *Lethrinus* spp. (22.8%), *Lutjanus gibbus* (16.2%) and *Pristipomoides* spp. (9.5%). The remaining 9.5 per cent of the catch was a mixture of other snappers, groupers and jacks (Wass, 1975).

A wide range of mechanical problems beset several dory owners and many of the dories were out of service for extended periods of time while engines or drive units were changed or replaced. After the first few years, the lack of routine maintenance took a heavy toll on many of the dories. Some eventually became unserviceable and some were out of service due to repossession for failure to pay the vessel loans.

However, a few very dedicated and conscientious fishermen maintained their craft in a rough but serviceable condition into the 1980s (Mead, 1978). Figure 2 charts the progress of Dory Project boat-building efforts. It shows the number of vessels fishing every year in Tutuila and Manu'a and the number that were inactive, lost at sea or sold to Western Samoa.

The number of inactive vessels for 1978–1980 was not known at the time of preparation of this article. Vessels that were inactive generally had mechanical problems or were changing engine types.



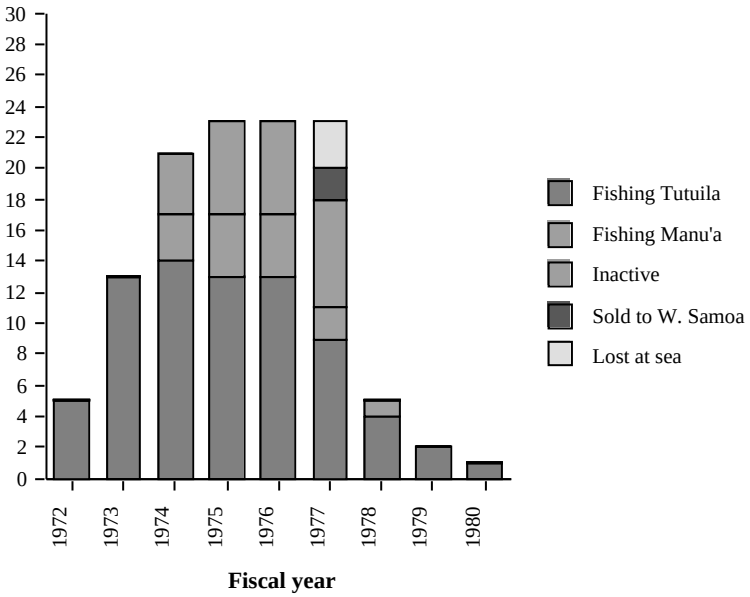


Figure 2: OMR Dory Project vessels, 1972–1980

VISTA fisheries development project

In the early 1970s, a group of around 20 Americans with fisheries training or expertise came to American Samoa as volunteer fisheries advisers to the OMR with the Volunteers in Service to America (VISTA) programme (Yamasaki, pers. comm.).

A diversity of backgrounds and skills was represented in the group, who ranged from university students to commercial fishermen from the US mainland and Hawaii. Several of the volunteers were attached to various aspects of the Dory Project or the OMR boat-building facility.

SPC Outer Reef Artisanal Fisheries Project (ORAFP)—Western Samoa, 1975

A five-member team from the South Pacific Commission ORAFP visited Western Samoa for seven months in 1975 to survey and assess bottomfish resources, assess the feasibility of commercial fisheries development and train local fishermen to use new gear and fishing techniques. The project concentrated on surveying bottomfish grounds and providing training in outer reef slope bottomfishing using electric and manually operated reels (Hume & Eginton, 1976).

A variety of vessels was used during the visit, including two Pago Pago-built Oregon dories. The significant aspect of this visit was the use of hand and electric reels for bottomfishing in Samoa; this was possibly the first time Samoan fishermen had been trained and given the opportunity to use anything other than handlines for bottom-fishing operations.

SPC Deep Sea Fisheries Development Project—American Samoa 1978

Three years later, the SPC Deep Sea Fisheries Development (DSFD) Project sent its masterfisherman Paul Mead to American Samoa. He remained in American Samoa from 28 March to 2 July 1978, with the objectives of introducing new fishing gear and methods to improve

bottomfishing efficiency, and encouraging the exploitation of unexploited outer reef slopes deeper than 120 m. The dory project had begun six years prior to Mead's visit and four dories were still in operation around Tutuila Island during this period.

When Mead first came to the Territory, local bottomfishing concentrated on the shallow-water snapper/emperor/grouper complex. Bottomfishing was conducted at night using handlines, with no mechanical means of retrieving the line.

Mead used two privately-owned dories for his bottomfishing surveys and equipped them with FAO-designed, Western Samoan-type wooden handreels, each filled with 500 m of 113 kg monofilament line.

Ground tackle consisted of 350–730 m of polypropylene line, and a short section of 10 mm chain attached to a simple 12 mm steel grapnel hook anchor (Mead, 1978). A portable depth sounder was also used to assist in the location of suitable anchoring and fishing areas.

Instead of fishing on the shallow shelf areas around Tutuila, Mead concentrated on deeper areas by anchoring on the edge of the outer reef slope, and playing out anchor line to reach the desired depth.

The use of this technique with wooden hand-reels was soon adopted by the American Samoan dory fleet. It opened up entirely new fishing grounds and brought the deep-water, high-value snappers under exploitation. The FAO-designed handreels were also quickly adopted for trolling operations, significantly increasing dory CPUE.

This project was the first to document the harvest in American Samoa of commercial quantities of high-value bottomfish, such as *Etelis coruscans*, *E. carbunculus*, *Aphareus rutilans* and *Pristipomoides* spp.

Lethrinids made up a large part of the catch by number, but the eteline snappers represented over 50 per cent of the catch by weight . . . *To be continued.*

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South Pacific Commission, B.P. D5, 98848 Noumea Cedex, New Caledonia
Telephone: (687) 262000 - Telex: 3139NM SOPACOM - Fax: (687) 263818