SOUTH PACIFIC COMMISSION

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SPC ACTIVITIES

WORKSHOP ON PACIFIC INSHORE FISHERY RESOURCES

In March 1988, the South Pacific Commission (SPC) held a major workshop on Pacific Island Inshore Fishery Resources, which brought together over 100 fishery scientists and marine resource specialists from in and around the Pacific Islands region to discuss and exchange the most up-to-date information and experience on the management of tropical inshore fishery resources in the region. The workshop, the first of its kind to be organised by the Commission, was the inaugural activity of the newly-established SPC Inshore Fisheries Research Project, which aims to provide assistance to the small island countries of the region in assessing and managing their fisheries. It was made possible by generous direct funding support from the Governments of Australia, New Zealand and the United Kingdom, and from the Canadian International Center for Ocean Development, the Forum Fisheries Agency, and the FAO/UNDP Regional Fishery Support Programme. A large number of organisations, too numerous to list here, made substantial contributions by financing the attendance of their representatives, or by sponsoring the participation of resource specialists or Pacific Island scientists.

The two-week workshop was organised according to resource topics, with separate sessions covering most of the important fisheries of the region, including those for deep-water snappers, reef fish, beche-de-mer (sea cucumbers), trochus shell, pearl oysters, crabs, shrimps and lobster. For each topic, a selected specialist gave a keynote address which presented participants with a summary of the main biological and fishing characteristics of the resource in question. Following this, other participants gave brief summaries of aspects of their own research and management work, experiences, or problems. Questions and discussions followed and these allowed participants, particularly those representing Pacific Island government fisheries bodies, to share experiences and discuss many common fishery management problems.

Interspersed with the resource topics were theme sessions that enabled advances or new findings about resource assessment methodology to be explored. These sessions focused on areas such as survey techniques, the use of remote sensing to assess coastal resources, traditional systems of fishery management in the region, and coastal zone management.

The meeting finished with a half-day session which aimed to identify specific fishery research and management problems in the region, and areas where programmes such as the SPC Inshore Fisheries Research Project could make the biggest impact. The gathering and evaluation of statistical information on fisheries was identified as an area requiring attention, as was the conduct of baseline field surveys and the standardisation of survey methodology so that the changes resulting from fisheries development could be assessed by repeat sampling. Lack of usable taxonomic guides and difficulties in access to scientific literature and information in general were raised as important problems for many scientists working in remote parts of the region. Staff training, shortages of research funds, conflict between fishery scientists and political decision makers, and other broad perennial problems, by no means confined to the Pacific region, were also raised by many participants.

Overall, the meeting was a resounding success, in large part due to the enthusiasm of the hundred or so participants who attended. The long hours of the workshop were added to by the large number of extra-plenary sessions and specialist working groups that took place most evenings and on the mid-meeting weekend. The workshop has been a very effective launching pad for the SPC Inshore Fisheries Research Project. The challenge now is to retain the momentum generated by this unique gathering and to assist Pacific Island countries strengthen their own capacities to research and effectively manage their inshore fishery resources.

DEEP SEA FISHERIES DEVELOPMENT PROJECT NOTES

Republic of Palau

The Project's stay in Palau, supervised by Master Fisherman Lindsay Chapman, concluded on 28 May, after nearly six months of fishing trials around Koror, around Peleliu in the south and off the northern state of Ngaraard. Although the final report of this visit is still in preparation, some preliminary results are available:

Koror area

1 273 kg of fish were taken by droplining and trolling over 12 fishing trips, for catch rates of 2.0 kg/reel hour and 2.3 kg/line hour, respectively. Reef slopes along the east coast proved to be of more gradual gradient than those in the west, but produced fewer deep-water snappers (Etelinae). Where the reef-slope was steep, consistently strong currents running parallel to the coast made anchoring for deep-bottom fishing very difficult. A small sea-mount was located off the western reef which showed potential as a deep-bottom fishing ground.

The best troll catches were recorded over the steep drop-off along the western reef, with wahoo and barracuda predominating.

Southern area

The southern reefs have historically come under more fishing pressure than areas to the north. Of the three trips conducted in the south, two were at Luke's Bank, a large submerged reef lying between Angaur and Peleliu, and one off the south-west corner of Peleliu.

Luke's Bank was the most productive deep-bottom ground fished during the visit, producing a catch rate of 2.9 kg/reel hour. Deep-bottom fishing in this area was limited by strong tidal currents, which also affected the coast off Peleliu. Trolling results were low at 1.5 kg/line hour, possibly reflecting the relatively heavy troll-fishing pressure that this area is subject to.

Northern (Ngaraard)

Both the eastern and western reefs off Ngaraard State were fished. A total of 943.7 kg of fish was taken by bottom droplining and trolling over 7 trips. The droplining catch rates, at 3.1 kg/reel hour, were a good deal higher than those recorded around Koror and fish taken were generally of larger individual size. Reef slopes were of moderate gradient. A sea-mount reported to lie about 1.5 km off the east coast was located and fished at 120 m, and produced promising but inconclusive results, as Lindsay's log for that day indicates:

13 April, 1988 : Departed Koror at 08:30 hours and headed through the reef passage and north along the east coast. Trolled up to Ngaraard and started running back and forth parallel to the reef looking for a seamount that is known to local fishermen, but not charted. We found the spot without much difficulty, about 1.6 km off the reef. We anchored and started landing fish right away. Unfortunately this was short-lived, for after an hour the fish stopped biting. We persisted in the same spot until late afternoon and then moved into deeper water for the night. Pablo (the boat skipper) then landed the head of a large Etelis carbunculus *(short-tail red snapper), the rest being taken by sharks, and that was it except for a few small fish.*

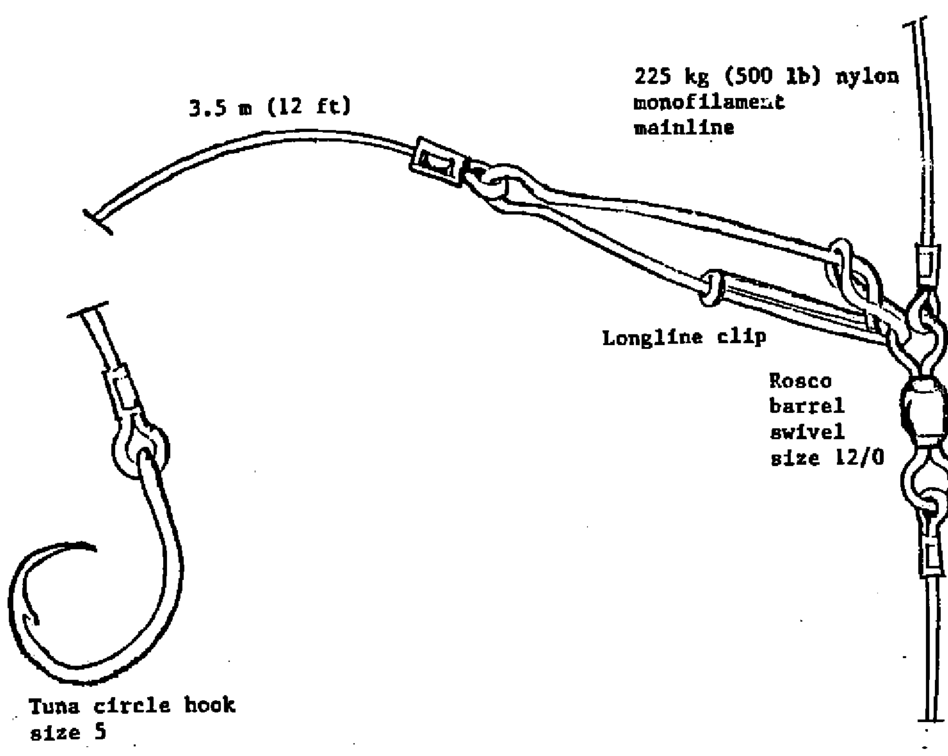
After dark all we caught were eels, and some oilfish and snake mackerels. We fished until 01:00 and then got some sleep. Started fishing again at 05:00 but landed only two good fish in one and a half hours and decided to head home. Landed a couple of barracuda trolling home. Arrived Koror 13:30.

During the trip, thirteen hours were spent engaged in droplining with three handreels, for an accumulated bottom fishing effort of thirty-nine reel hours. Forty-four fish were taken, with a combined weight of 103.9 kg, giving a catch rate per reel hour (cpue) of 2.7 kg. The most commonly captured species was the deep-water amberjack (*Seriola rivoliana*). Thirteen of the fish taken were of species which were locally unsaleable, including oilfish, snake mackerels, eels and sharks. Seven kilograms of frozen skipjack bait were used.

The troll catch, taken during eight hours of travelling between Koror and the sea-mount, with four lines trailed (giving a fishing effort of 32 line hours) amounted to nine fish with a combined weight of 32.3 kg — producing a catch rate of 1.0 kg line hour.

American Samoa

After losing vertical longlining gear to large tunas around Tutuila's FADs in late March, Master fisherman Archie Moana rigged new, heavier gear and after a spell of bad weather in early April set out to test the FADs again. The new longlines were made up from 225 m lengths of 225 kg test monofilament nylon broken at varying intervals (4 x 18 m sections from 54 m to 128 m and 8 x 1 m sections from 128 m to 225 m) with heavy duty Rosco barrel swivels (Size 12/0). Fourteen snoods were prepared for each longline, each rigged from a 3.5 m length of 180 kg test monofilament nylon fitted with a patent longline clip at one end and a Mustad tuna circle hook, or BKN hook, at the other. Snoods were attached to the mainline by snapping the longline clip through the eye of the swivels, as illustrated below.



Rigging arrangement to attach snoods to mainline

Archie first set these two new longlines around FAD 'B', baited with fresh atule (*Selar crumenophthalmus*). Over 6.5 hours fishing, including setting and hauling time, he and his crew captured nine yellowfin tunas and four bigeye tunas with a combined weight of 324.5 kg. The largest individual fish was a 63.5 kg yellowfin.

Later in April, Archie held a shore-side workshop for local fishermen to demonstrate vertical longline rigging, followed up with a practical session in longline setting conducted around one of the FADs.

During May and June, Archie continued with his bait fishing and vertical longlining trials and demonstrations and accompanied Office of Marine and Wildlife staff on a five-day training trip to the Manu'a group, and a seven-day exploratory bottom-fishing trip to Rose atoll. The Project's stay concluded on 13 June and a full report of the visit is presently in preparation.

Papua New Guinea

The Project's most recently recruited Master Fisherman, Paxton Wellington, is a Canadian who hails from Halifax, Nova Scotia. Paxton has an extensive background in Canadian and Alaskan fisheries, particularly in the bottom-longline fishery for halibut. His tropical fisheries experience includes four years in Vanuatu as a Master Fisherman with the Village Fisheries Development Project, including 12 months supervising the operations of the Espiritu Santo Fisheries Division.

Paxton's first SPC assignment is the supervision of the current DSFD Project visit to Papua New Guinea. The visit commenced on 31 March in response to a request to SPC by the Government of Papua New Guinea for assistance in promoting the development of deep-bottom fisheries in areas not covered during previous DSFD Project visits.

The first operational base was established at Oro Bay in Northern Province and 11 fishing and training trips were conducted in areas from Cape Ward Hunt to Tufi. A local canoe type, the 'Red Snapper' design, was used for all fishing, supported by a 10 m Fisheries Division vessel which was used for overnight accommodation at some fishing sites and to carry catches to Popondetta for landing.

Waters off Oro Bay are shallow and deep-bottom fishing grounds generally lie up to 40 km offshore. Paxton therefore concentrated on areas to the north and south of Oro Bay which are accessible to local fishermen. Working in company with National Fisheries Division counterpart officer, Mahara Aukik, and two extension officers from Oro Fishing Authority, Paxton demonstrated methods for locating fishing sites of suitable depth by sounding with weighted lines, and marking productive sites by taking bearings on landmarks, rather than the use of an echo-sounder which would be beyond the buying ability of most village fishermen. Catch rates recorded ranged from a low 2.3 kg/reel hour by bottom droplining, to a very poor 0.2 kg/line hour by trolling.

On 17 May the Project transferred to East New Britain Province where Paxton worked with four local fishing groups who operate 'Red Snapper' canoes. Fishing areas ranged from Urara Island and Reimers's Reef to Kurakabaul and Watom Island, Karavai Bay and Credner Island and, finally, Maputi. Tunas were scarce during this time and sardines were sometimes netted to use as bait. Apart from the rigging and use of deep-bottom fishing gear, Paxton also conducted informal training sessions in net-mending, and business aspects of small-scale fishing operations. The offshore areas fished, particularly the reef slopes around the offshore islands, proved to be more productive than the areas fished along the coast of the main island, New Britain.

Although the average catch rate recorded was only moderate at 3.0 kg/reel hour, Paxton believes that, with improved techniques and gear, local fishing groups could profitably develop a deep-bottom fishery in the area.

REGIONAL FISHERIES TRAINING PROJECT

Stage 1 Extension skills course held in Fiji

This four-week course was held from 11 April to 6 May 1988 in Suva and was the first step in an extensive training programme designed to equip regional fisheries extension officers with the communication and training skills which will enable them to become more effective in their roles and to initiate domestic training programmes in fisheries skills.

The course was structured to give the participants two weeks initial training in the development of their personal communication and extension skills; afterwards, under supervision, they developed syllabuses and materials for their own in-country courses. The participants also prepared a manual of extension and communication skills for Pacific Island extension officers to be used as an aid in the second stage of the course.

Stage 2 Extension skills course

The high level of enthusiasm and skill which characterised Stage 1 course participants has ensured the quality of the manual and other Stage 2 course materials prepared. It is now expected that all Stage 2 courses will be completed by the end of 1988 or early 1989.

The Stage 2 Fiji course is already completed. It was conducted by national trainers, with the support of one Queensland Department of Primary Industry tutor, at Suva, from 20 to 30 June 1988.

The schedule for the remaining Stage 2 courses is as follows:

FSM/Marshall Islands	August 1988
Kiribati, Tuvalu, Cook Islands	August 1988
Solomon Islands	November 1988
Papua New Guinea (Kavieng)	November 1988
Papua New Guinea (Port Moresby)	December 1988
Vanuatu	Early 1989

NEWS FROM IN AND AROUND THE REGION

NEW FISHING PORT FOR FIJI
(Source: *Fiji Times*)

A new F$10 million fishing port has been opened in Lautoka after two years' work. The port incorporates a 159 m long breakwater and a 120 m long piled finger jetty which, together, can accommodate up to 120 fishing boats.

The shore facilities include a two-storey administrative building which houses offices, a research laboratory, a radio room, and a workshop; three ice plants, capable of producing 50 tonnes of ice daily and a 20 tonne capacity storage facility. A rest room and canteen facilities for fishermen are also situated on the wharf, as well as a fuel dock and a mechanical slipway.

The port was funded by the Government of Japan through the Japan International Co-operation Agency (JICA) and has been designed to relieve Lautoka's Queen's wharf of all fishing boats, cutters and other small craft.

TUNA TREATY SIDETRACKED
(Source: *Pacific Islands Monthly*)

Pacific Island governments and the tuna industry have both suffered as a result of seemingly remote and unconnected matters, including New York City's practice of dumping sewage sludge in the Atlantic Ocean; a natural disaster killing oysters and clams elsewhere on America's Atlantic coast; and the arrival of foreign-built barges on the Mississippi River.

No United States Government funds in the form of tuna fishing fees can go to island governments, and no U.S. tunaboats can fish safely within island States' EEZs because of these complications. They all relate to the internal politics of the American Government — and have nothing to do either with tuna or the Pacific.

The Tuna Treaty, after much hard negotiating, was signed more than a year ago in Port Moresby; it has since been ratified by island governments, approved by a 89-0 vote in the U.S. Senate, and has President Reagan's signature. But no funds can be voted until enabling legislation has moved through both houses of Congress and therein lies the problem.

The tuna bill, which will allow the U.S. Government and the tuna industry to pay island nations about $US12 million a year for the next several years for tuna harvests, was introduced in both the Senate and House of Representatives. The bill itself has no enemies and is regarded as something that must be passed to meet the nation's international commitments, but those very qualities are delaying passage.

What often happens when a non-controversial piece of 'must' legislation appears is that it becomes, in the jargon of Capitol Hill, a 'Christmas tree'. Such a bill attracts extraneous ornaments — amendments dealing with other issues that probably could not be passed if they were not linked to a handy legislative vehicle.

When it came before the House of Representatives Committee on Merchant Marine and Fisheries, the bill was pounced on by a New Jersey Congressman, William Hughes, who decided it would be a fine vehicle for his own personal crusade — to prevent the City of New York dumping sewage sludge into the Atlantic Ocean off the shore of his State (and his district).

Hughes managed to graft his amendment on to the tuna bill, but the New York City delegation (defending their city's filthy practices) blocked the bill from consideration until May, when it was finally passed *sans* ornaments.

The bill has also attracted other, less controversial, amendments. One, backed by Committee Chairman Congressman Jones from North Carolina, called for a disaster relief programme to cope with red tide, a poisonous alga that kills oysters and clams off the coast of his district. The other sought to curb the use of foreign-built barges on America's inland waterways, notably the Mississippi River.

EYES ARE ON THE SEA
(Source: *Pacific Islands Monthly*)

The surveillance of their ocean zones presents a host of problems for the islands of the South Pacific. All countries and territories in the South Pacific declared exclusive economic zones (EEZs), fisheries zones or both between 1977 and 1984. The total area of the EEZs exceeds 30 million square kilometres and the area contributes at least 30 per cent of the world's tuna harvest each year. Around 80 per cent of the tuna taken in the region is caught by distant water fishing nation (DWFN) fleets.

With some exceptions, the development of national fisheries surveillance capabilities has not had a high priority, though interest in surveillance has grown in recent years with some highly publicised prosecutions of vessels fishing illegally. Papua New Guinea has established a surveillance centre in Port Moresby and the PNG Defence Force has four *Attack* Class patrol boats and six Nomad aircraft for surveillance tasking. PNG received a Pacific Patrol Boat (PPB) from Australia in May 1987 and has three more on order. The Solomon Islands have one patrol boat and will receive a PPB this month; Fiji has a surveillance centre at the naval base in Suva and surveillance is under the control of the Defence Force, which currently has five vessels. The Tongan Defence Services (TDS) operate two 12 m patrol boats whose normal mode of operation is to react to sightings, as they have limited range and sea-going qualities. The TDS has no air element, but the police have a small allocation of funds for hiring aircraft for surveillance purposes.

Tuvalu and Kiribati rely on surveillance flights by Royal Australian Air Force (RAAF) and Royal New Zealand Air Force (RNZAF) Orion P3 patrols. Vanuatu also relies on these flights and received a patrol boat in June 1987. The Cook Islands will receive a PPB from Australia in February, 1989: Western Samoa received its PPB in March this year. The Federated States of Micronesia use two chartered vessels; Palau, in a nice piece of irony, uses a converted Taiwanese fishing vessel and the Marshall Islands operate two patrol vessels.

Australia has taken a number of initiatives to assist South Pacific maritime surveillance. The PPB project gives participating countries a multi-purpose vessel for surveillance and enforcement, disaster relief, medical evacuation, search and rescue and police and VIP inter-island transport. The boats are built in Western Australia and the project includes a spares package to support the vessel for the two years after delivery; crew and base staff training by the RAN and the builders, Australian Shipbuilding Industries; and RAN advisers to assist in operating procedures. Officers have already been posted to the Solomon Islands, Vanuatu and Western Samoa.

Papua New Guinea has ordered four PPB patrol boats, the first of which was handed over in May, 1987. Vanuatu received its boat in June. Tuvalu and Kiribati are yet to decide if they want a PPB, while Tonga has declined.

The patrol boats should provide some measure of enforcement capability, but there has been much discussion in the Pacific about their costs. This point was made most recently by the Western Samoa Public Accounts Committee, in a report tabled in December 1987. Operating costs for each vessel (based on an annual usage rate of 1 200 hours), would be about A$ 100 000 a year, and crew salaries and provisions would add a further A$ 100 000 per vessel. Clearly, Australia would have to consider further aid to the island States to cover PPB running costs and future refits, or lack of finance could see the vessels lie idle for long periods.

The RAAF has increased surveillance patrols of the South Pacific from five to 10 a year since 1986. The current effort involves about 500 flying hours a year by P3 Orion aircraft. The Forum Fisheries Agency in the Solomon Islands has been working with the RAAF and the RNZAF to determine a new approach to surveillance flights — which have not, until recently, been successful for fisheries protection and vessel identification.

......MEANWHILE

The Solomon Islands Government is to hold talks with the United States over the reported discovery of two American tuna boats illegally fishing in the Solomons' exclusive economic zone. The boats were sighted from the air in March. The boats had been tracked by the newly opened maritime surveillance centre in Honiara, one of a number being established in the South Pacific under the Australian Defence Co-operation Programme. The Solomon Islands Police Commissioner, Mr Fred Soaki, said the American tuna boats had been photographed fishing less than 160 km from land.

Mr Soaki said the sightings had been referred to the Solomon Islands Department of Foreign Affairs, which would take up the matter with the United States Government. The seizure of another American tuna boat by Solomon Islands authorities several years ago resulted in the United States finalising a fishing agreement with South Pacific countries.

HERCULES LIFTS TROCHUS TO TUVALU
(Source: FAO/UNDP)

Following the successful transfer of 200 live trochus from Fiji to Funafuti by commercial air service (see *SPC Fisheries Newsletter* # 42), the FAO/UNDP Regional Fishery Support Programme recently completed a second transfer of 5 000 shells collected from Aitutaki in the Cook Islands. Aitutaki was chosen as the collection site largely because mature trochus are plentiful there — the stock having grown from an original transfer of 40 animals from Fiji in 1957.

Transport was a problem — most of the islands in Tuvalu have no landing strips and many do not even have harbours. Thanks to the New Zealand Government and its diplomatic missions in Suva and Rarotonga, a solution was found — the shells were airlifted to the islands by a military aircraft.

Five thousand trochus were collected by divers in Aitutaki, loaded onto a Royal New Zealand Air Force C-130 Hercules aircraft, and flown to Tuvalu. Boxes were parachuted into the remote Fakaofo, Nukulaelae and Nukufetau atolls and then the plane landed at Funafuti atoll (the only airstrip in the country) to off-load more trochus. At each location crews had been previously trained on how to seed the trochus on the reefs.

Because of the major expense of the operation, nothing could be left to chance. Explained Bob Gillett, the United Nations official responsible for the operation: 'It was like planning for a bank robbery, contingency plans had to be made for everything and we walked through the whole operation a number of times. The New Zealand Air Force crew was great in this sort of work.'

A similar trochus operation had been conducted for the Tokelau islands, north of Samoa, about two years ago. A survey conducted recently showed that the seeded trochus have been reproducing and offspring were detected.

FIJI'S PAFCO CANNERY WORKING TO CAPACITY
(Source: *Fiji Exporter*)

The demand for canned fish from four major importing countries is outstripping the supplying capacities in Fiji. Pacific Fishing Co. Ltd (PAFCO) is committed to huge orders from Japan, the United Kingdom, Canada and New Zealand and sold $F 30 million worth of canned fish in their last financial year which ended last March. 'We are hoping for similar if not better figures this year,' said the company's administration manager, Mitieli Balevanualala. But Mr Balevanualala said the inconsistent supply from fishing companies was an obstacle. 'We are doing all we can with the fish supply situation. We are trying to maintain the present work,' he said. 'But even if we had sufficient supply from our source we wouldn't be able to exceed the orders. There is no room for extra orders. We're utilising the maximum capacity of this cannery and this the best we can do. We have resisted new orders because we won't be able to meet them.'

PAFCO, whose controlling shares are held by the government, cans tuna, yellowfin and albacore supplied by Taiwanese, Japanese and local fishing vessels. Ika Corporation, a wholly-government owned company, supplies PAFCO with skipjack tuna. Ika general manager, George Reade, said they would increase the size of their fleet to nine vessels in three years. 'We are looking at six new boats and hopefully then we should be able to cater sufficiently for PAFCO's needs,' he said.

Ika was set up to supply PAFCO. Today Ika and some private boats contribute around 4 000 t a year to the cannery which needs at least 15 000 t of fish to continue full production. Private and overseas vessels also supply PAFCO. Said Reade: 'We have never been able to supply enough to PAFCO but with more vessels we may get close to their requirements.'

Ika vessels and a Japanese boat caught 2 280 t of fish from June last year to the end of April this year. Four other private boats fishing in Fiji waters supplied 803 t in the same period. Mr Reade said private foreign vessels were not committed: 'They have always been threatening that if the economy is not right they will pull out. This gives us more reasons to increase the Ika fleet.'

Meanwhile, the semi-government National Marketing Authority, which used to export fresh fish, has temporarily put a stop on overseas sales because of operational problems. NMA head Solomone Makasiale said his organisation was expected to be restructured soon and would resume overseas sales later this year. He said two overseas companies were interested in a joint venture with NMA in the export of fresh fish.

Trade and Commerce Minister Berenado Vunibobo sees a lot of potential in the export of fresh fish, beche-de-mer and other common foods. 'Some existing fishing companies have already begun moves to tap more fresh markets in Hawaii, Australia, New Zealand and Asia,' he said. 'However, this is an area which is largely untapped and foreign expertise and joint ventures would be welcome to develop the export of fresh fish. There does not seem to be any problem in the area of export of fresh produce. The onus is on the producers to look for markets to be able to export and to produce the standard and quality demanded. There is sufficient incentive for the producers since these foods can be exported duty-free and quota-free subject to obtaining a licence from the Ministry of Primary Industries. There is a French Produce Export Association which is co-ordinating with Fiji Trade and Investment Board to promote export of fresh produce. The Fiji Bureau of Statistics reported an earning of F$ 10 841 100 (1 870 091 kg) in the first quarter of 1988'.

Another fish canning company, Vo-ko Industries Limited, tried tapping markets in Australia, New Zealand and the United States but sales were 'not so promising'. Financial controller Abdul Hakik said the company's canned mackerel products faced stiff competition from Japan which was able to produce more at cheaper prices. 'But now with a depressed local market we are hoping to get back at some of our old sources and start competing on the outside scene,' Hakik said. A carton, containing 48 425-gram cans, costs $F 46.56. The company has the capacity to export five tonnes.

ICLARM'S SELECTIVE FISHERIES INFORMATION SERVICE
(Source: *NAGA*)

Thanks to support from the International Development Research Centre (IDRC) of Canada, ICLARM's special Information Service for researchers in its fields of expertise began again recently.

The Service has been reduced in activity since April 1987 when a previous IDRC-sponsored Selective Information Service project ended. Now the service is starting again. This time, however, there is a catch. ICLARM has been asked by IDRC to include a fee for services. The amounts are not great and if you have no funding support, ICLARM can exchange information. Details are given below.

ICLARM's Selective Fisheries Information Service is designed to provide in-depth information on research areas related to ICLARM's areas of expertise, in finfish aquaculture, especially of tilapias, carps and mullets, and integrated animal-fish farming; in resource management, especially in tropical multispecies fisheries; in small-scale or traditional fisheries; and in tropical coastal zone management. The service is multidisciplinary and includes aspects of fisheries and aquaculture.

ICLARM's information specialists are also able to help other institutions to develop their own information capability. Selective Information Service products include copies of important documents, lists of references to previous research and usually indications of other current research in the requested subject area. For frequently-requested and/or especially important topics, the Service undertakes a mini-review of the literature to highlight prominent researchers and institutions, point out any deficiencies in the coverage of the literature by the databases searched, and offers advice to new researchers in the field on the most useful articles and contacts.

The average cost of the Service for materials and postage per enquiry is about US$30, without accounting for time spent searching and preparing each report. Some form of payment, in cash or in kind, is requested from users to help the service become self-supporting. Here is the scale of fees.

- Requests from developed-country individual researchers and institutional enquirers, and consultants from all countries: US$ 20.00 plus materials and postage.

- Other enquirers: US$ 5.00 plus materials and postage. Cheques (from U.S.- based banks only) should be made out to ICLARM.

If the materials and postage cost more than $ 30.00 ICLARM will advise you of the likely cost in advance. If they cost less than $ 30.00 an invoice will accompany the package.

Or — you can exchange information. If you do not have a research grant or are in a country where foreign exchange is nearly impossible, you may exchange information. Send your enquiry together with some information that will help the Service, e.g.,

- reprints of scientific articles
- research reports
- a brief essay on the information available to you, or on your research and its relevance to national goals.
- photographs or slides of your research or fishing activities.

ICLARM might publish your essay or photographs in a future issue of *NAGA*, the ICLARM quarterly.

To use ICLARM's Selective Information Service send your research enquiry, being as specific as possible, to Selective Fisheries Information Service, c/- ICLARM, MC P.O. Box 1501, Makati, Metro Manila, Philippines.

BECHE-DE-MER TRADE ON THE INCREASE
(Source: Fiji Fisheries Division)

Fiji has seen a dramatic increase in exports of beche-de-mer for the first six months of the year. More than 25 companies throughout the country have reported exports totalling some 500 tonnes for the period, in comparison to 162 tonnes for the first half of 1987.

It is reported that a large portion of the trade has been **dri loli**, or blackfish, and that some traders have been dealing in undersize or poor quality dried product. The Fisheries Division is currently reviewing the situation and stricter size limits regulations may be formulated.

Meanwhile, Fiji's exports of vasua muscle (giant clam meat) between January and June have reached an all time high of 24 tonnes — representing an estimated harvest of 60 000 clams.

SHARK ATTACK
(Source: New Zealand Fishing Industry Board)

Three western Australian fishermen caught more than they bargained for when a 22 ft Mako shark, after being hooked on one of their lines, leapt into the boat ripping seats, fuel tank and fishing gear.

During the incident two of the fishermen were swept overboard, but managed to climb back in, and the boat was eventually brought in to the port of Bunbury with the shark still on board.

NEW DRIVE DEVELOPED
(Source: New Zealand Fishing Industry Board)

The Japanese Ministry of Transport and Foundation for the Shipping Advancement have for 23 years been paying Toshiba to develop a 'high speed dream ship', powered by a superconducting electromagnetic thruster.

A coil of niobium-titanium alloy is cooled with liquid helium to -260°C. Like a marine version of a magnetically levitated train, the dream ship propels itself by thrust developed from electromagnetic repulsion. When the coil flux and water current are at right angles to each other, a jet of water is pushed through a duct and this drives the ship forward.

Toshiba claims to have built a working prototype, two metres long, which drives a jet of seawater at two metres a second.

NEW DIRECTOR FOR NMFS SOUTHWEST FISHERIES CENTER LABORATORY
(Source: *Hawaii Star-Bulletin*)

George W. Boehlert has been named director of the Honolulu Laboratory of the Southwest Fisheries Center, National Marine Fisheries Service. He succeeds Richard S. Shomura, the laboratory director for 15 years. Shomura left the position in March to work on fishery-related projects at the University of Hawaii and will retire from federal service in August.

Mr Boehlert has been chief of the laboratory's insular resources investigation since 1983, leading research on physical and biological interactions in seamount ecosystems. He has written dozens of scientific publications.

The Honolulu Laboratory was established in 1949 as the Pacific Ocean Fishery Investigations and is located next to the University of Hawaii at Manoa. It employs about 90 scientists and support staff with research ranging from Hawaii to the U.S. territories and possessions and other Pacific islands. The scientists study the endangered Hawaiian monk seal and threatened green sea turtle as well as tuna, billfish, bottom fish, lobster and shrimp.

FISHERIES SCIENCE AND TECHNOLOGY

THE HEALING SEA
(Source: *Honolulu Star-Bulletin* and *Honolulu Advertiser*)

The modern discovery of palytoxin, one of the most poisonous compounds known, is a real-life detective story shrouded in a Hawaiian curse. The creature it's named after, *Palythoa toxica*, was tracked down as part of the quest for the algae responsible for a more common sea poison, ciguatera. In the early 1960s, the search prompted Philip Helfrich, director of the

Hawaii Institute of Marine Biology, to investigate an entry in Kukui and Elbert's Hawaiian-English dictionary under **limu**, the word for algae or moss.

The book referred to **limu-make-o-Hana** — the deadly seaweed of Hana. That matched references in David Malo's 1903 book, *Hawaiian antiquities*, and in notes by 1920s artist Katherine Livermore, on file at the Bishop Museum, to a poisonous organism living in a tidepool at the base of a 700-foot cliff at Mu'olea in the Hana district. According to legend, the pool is where natives disposed of the ashes of a vicious 'shark-man' they had killed. Apparently exempt from the off-limits rule were men called **hamohamo**, 'the smearers', who applied poison from the ashes to the tips of spears.

When Helfrich found the tidepool in the late 1961, he recalls he was repeatedly warned by local Hawaiians that the area was **kapu**. But a University of Hawaii (UH) team of zoologists went ahead and collected samples from the pool that December 30. Almost as they did so, fire broke out and destroyed the building housing their laboratory on Coconut Island.

Limu-make turned out to be not a seaweed but a rare soft coral, or zoanthid coelenterate. Pure palytoxin was isolated in 1963, but its chemical description wasn't completed until 1981, when UH chemistry professor Richard Moore mapped the atoms of the huge molecule using a technique called nuclear magnetic resonance. Over the years, the poison has been found in other species, but *Palythoa toxica* remains unique to the Maui tidepool, and is among the growing number of sea creatures that offer intriguing possibilities as sources of medicine.

Researchers in Honolulu hope to attach molecules of the poison known as palytoxin to lab-grown human antibodies as a 'magic bullet' against cancer. While at an early stage, the work with palytoxin is indicative of renewed interest by government and industry in potential cures from the sea. 'We see the sea as a source of many interesting and exotic compounds, some of which have exciting potential as drugs', says Steve Brauer of the Hawaii Biotechnology Group, which is working with palytoxin as part of a $990 000 federal small-business research grant. 'The process of culling them is a massive task and one which is just beginning.' One extract at an advanced stage of research is manoalide, named after the University of Hawaii at Manoa and derived from a sea sponge found at the Pacific island of Palau. Discovered in 1977 by Paul Scheuer of the University of Hawaii, it was demonstrated by University of California scientists to have potent pain-killing and inflammation-fighting properties. Allergab Pharmaceuticals, based in Irvine, California has an option to license the product commercially and is testing for toxic side-effects.

Other promising compounds are:

- **Didemnin B.** Isolated from tiny Caribbean sea squirts called tunicates, Didemnin B is the first wholly natural marine product to enter clinical trials with cancer patients as a potential anti-tumour agent. Pioneered by Kenneth Rinehart and colleagues at the University of Illinois at Urbana, Didemnins A and B also have been shown to inhibit oral and genital herpes, flu and fever viruses.

- **Dolastatin 10.** G. Robert Pettit and colleagues at Arizona State University painstakingly extracted this compound from an Indian Ocean sea hare, a shell-less mollusk not known to develop cancer. Supply problems have hampered research with the dolastatins and another group of compounds called bryostatins, discovered by Pettit in a barnacle-like 'false' coral that clings to ships and piers. Bryostatins have shown promise against leukaemia in mice and human ovarian cancer.

- **Pseudopterosins.** This class of anti-inflammatory compounds, developed by the University of California scientists working with manoalide, comes from the fernlike soft corals known as sea whips. The chemicals also have proved effective as painkillers in animal tests.

- **Punaglandins.** These natural extracts from a Hawaiian soft coral were found to be too toxic, but a similar synthetic version is undergoing clinical trials as an anti-tumour drug in Japan.

Often compounds that prove to be too poisonous for humans still represent a promising new chemical model. 'In many cases the natural product provides a good template, and then if undesirable side effects show, they can manipulate things pretty well and try to eliminate them,' says Scheuer, Professor Emeritus in chemistry, who helped identify punaglandins in 1982.

Until World War II, land plants provided the raw materials for nearly all pharmaceutical research. Some of the more effective drugs, such as aspirin and quinine from tree barks and morphine and codeine from opium poppies, have properties that were well known to ancient peoples. With the discovery of penicillin in 1928 from mould, lower forms of plants were recruited as a source of new medicines. Thanks to the easy accessibility of land plants and the process of fermentation, which allows large-scale production, research and development of land-based drugs moved quickly. But the terrestrial medicine cabinet now looks about as full as it's going to get. Tropical rain forests offer some promise, but are shrinking at an alarming rate. That leaves the ocean, home for an estimated 80 per cent of all life forms, most yet to be discovered.

Some of the most interesting discoveries have come from so-called 'sessile' sea creatures that attach themselves to rocks, hulls, piers or the seabed. These often have developed chemicals as a defence, in lieu of fins to swim away, against becoming lunch. Research into organic marine chemicals has been slow for a few reasons. First, only a small fraction of the ocean has been explored; second, even once identified as 'biologically active' in humans, many compounds can't easily be produced in quantities necessary for clinical testing, much less wholesale marketing.

One anti-cancer drug, Ara-C, was modelled after a substance isolated from a Caribbean sponge in the 1960s. Interest in marine pharmaceuticals ebbed in the late 1970s, but has been revived in the last five years or so, much of it building on university research funded by the U.S. Commerce Department's Sea Grant Program. In 1986, the National Cancer Institute jumped on the bandwagon, launching a large-scale programme to collect new specimens of marine life for screening as anti-tumour agents. The institute awarded contracts worth $3.6 million to SeaPharm Inc., a private research company based in Princeton, N.J., for the collection of 10,000 deep- and shallow-water specimens.

SeaPharm, the only U.S. company devoted exclusively to marine pharmaceutical research, has been working with the Harbor Branch Oceanographic Institution in Fort Pierce, Florida, to collect deep-water specimens using several technologies, including the Johnson-Sea-Link manned submersible. Since it began operations five years ago, SeaPharm has screened some 11,000 extracts for signs of activity against tumours, viruses and fungi and for effects on the immune system. The company has applied for more than 34 patents and hopes to begin tests by mid-1989 on humans of an anti-cancer compound from a South Pacific sponge.

Several University of Hawaii scientists today are working with federal research money on identifying new marine compounds. Blue-green algae, known to researchers as cyanobacteria and to swimmers as seaweed, may be as rich as land bacteria and fungi in their potential for drugs, says chemistry professor Richard Moore. Because collecting large amounts of blue-green algae in the ocean is difficult, Moore and associate researcher Gregory Patterson have grown and evaluated more than 900 strains in their laboratory since 1981, under grants from the National Science Foundation and the National Cancer Institute.

One compound, tubercidin, discovered elsewhere but found to be present in ocean algae, went to clinical trials as an anti-skin cancer agent, but was dropped because of high toxicity. A number of other new compounds were found, with some still under study as possible fungicides in agriculture. A chemical found in the blue-green algae that causes 'swimmer's itch' at Windward Oahu beaches is being studied by Moore as a key ingredient in the genesis of some tumours. The seaweed, *Lynghya majuscula*, contains a powerful irritant that acts as a 'tumour promoter', a compound that helps turn a DNA-damaged cell into cancer. 'The study of these compounds is important because they are tools by which you can study normal processes', says Moore. 'They aren't drugs, they aren't going to cure anything, but they do dramatic things to normal processes. By studying such irritants, scientists may be able to find ways to short-circuit the growth of tumours', says Moore.

In September 1986, under a five-year grant from the National Cancer Institute, Moore and Patterson began to grow another 1 000 strains of blue-green algae for tests against AIDS and 100 types of cancer. Reimar Bruening, an assistant professor of chemistry, has a proposal before the national Cancer Research Institute to study the feasibility of setting up coastal aquafarms to produce marine organisms that have shown potential as sources of medicines. While the verdict on palytoxin is still out, its potential as a cell-killer is well documented. Palytoxin inhibits the enzyme that breaks apart the body's biochemical energy packets, known as adenosine triphosphate or ATP. Without energy in the form of chemical ions, a cell simply grinds to a halt. Researchers at Hawaii Biotech hope to attach the palytoxin to lab-grown monoclonal antibodies that will attack specific cancer cells while leaving healthy tissue alone. But developing such an 'immunotoxin' is still a tricky business. 'You actually attach the toxin to the antibody, and then the theory is, when it gets to the cells, there is an enzymatic chewing-up of the antibody and the toxin is released to zap the cell,' says Moore, a consultant to Hawaii Biotech. 'The trick is attaching it to the antibody and hoping you get specific kill.'

But the path to approval and production of a drug for the market-place is a long and bumpy one. From current research, no marine pharmaceuticals are expected before the 1990s. 'I believe that there is a very large untapped resource of chemical entities from the ocean', says microbiologist Thomas Matthews of Syntex Corp. in Palo Alto, California. 'I also believe that they are going to play a major role in drugs in the future. Just exactly when we're going to see something come from these is a question of the amount of money and time that we put into it.'

MANNITOL AND CIGUATERA POISONING

(Source: *Marshall Islands Journal/ Honolulu Star-Bulletin/ Makai*)

The use of the drug mannitol to treat victims of ciguatera fish poisoning has recently received widespread, if not confused publicity in the Pacific region. The following articles, reprinted from regional publications, chart the progress of the mannitol saga — from the inadvertent discovery of its effect on ciguatera sufferers by a Marshall Islands doctor in 1983, to its popular acclaim as a 'wonder drug' and, finally, an informed assessment of its value as a ciguatera poisoning specific treatment by an eminent Hawaiian pathologist.

JAIN FIRST TO FIND FISH POISONING FIX (From the *Marshall Islands Journal*)

The Marshall Islands had the distinction of making medical history through a discovery of Dr Louis Jain. The Majuro hospital physician has found a cure for ciguatera fish poisoning. Jain cautions, however, that the apparent cure needs more study to avoid it being given in the wrong dosage.

Every year dozens of Marshallese — and thousands of people around the world — suffer the effects of fish poisoning. But nobody has ever come up with a treatment for fish poisoning until Jain's discovery in 1983, which, like many scientific 'firsts', came about quite by accident.

An emergency radio call from Jaluit Atoll, reporting that two patients were unconscious as a result of severe fish poisoning, brought Jain to the southern atoll on a medevac flight. The two men were in a coma, and had been that way for nearly three days. The severity of their condition was obvious from the stiffness of their arm and leg muscles. At the time, Jain thought they might be suffering from swelling of the brain as an allergic reaction to eating the long nose snapper fish. The two patients were loaded onto the plane on stretchers and just before take-off, Jain began intravenous injections of mannitol, a drug used to relieve brain swelling. The impact was startling. 'Within 10 to 15 minutes, just after takeoff, one of the patients woke up and began asking "where am I", and a few minutes later the other patient woke up also. The first man was sufficiently improved to get up and help the other patient into a wheel chair on arrival at Majuro', said Jain.

'Nobody would believe me that mannitol worked', said Jain about his discovery, which he began trying out on others who experienced severe fish poisoning symptoms. During 1986, another patient from Jaluit was brought into the hospital with fish poisoning. He was awake, but not able to move at all. Dr Neal Palafox was in charge of the patient and Jain suggested he try mannitol. He agreed, and five minutes after administering the drug, the patient stood up. Since then, Jain and Palafox have been administering the treatment on severe fish poisoning cases. 'So far I haven't seen any side effects. It has been used effectively on more than 50 patients, although only 20 cases have been documented', said Jain.

Palafox and Jain are working to set up clinical standards so that they can systematically study the results over a two to three year period. They want to run trials simultaneously on Majuro, Ebeye and Kwajalein. Jain has received a number of inquiries from doctors in other parts of the Pacific who have heard of the development. Both he and Palafox say that they use low dosages of the drug, which is very inexpensive and readily available in most countries. However, they urged health officials interested in the treatment to contact them before using it to avoid risking wrong dosages to patients.

Fish poisoning symptoms range from numbness of the lips and a reversal of temperature sensations (hot feels like ice, cold like heat) to more severe cases that may include diarrhoea and nausea, muscle pains and unconsciousness. Jain observed that three or four patients with severe fish poisoning had died here before the mannitol discovery in 1983. Health services reported that in 1986 there was an average of more than 10 cases a month of fish poisoning recorded in Majuro hospital alone — indicating that fish poisoning represents a serious national health problem.

Jain, Palafox and several other doctors have submitted an article relating the discovery to the *Journal of the American Medical Association* in hopes of bringing more interest in and research into the matter.

ANTIDOTE IS FOUND FOR FISH POISONING (From the *Honolulu Star-Bulletin*)

During the past two years, some 40 seafood eaters, who had been made seriously ill by a fish poison that is common in the Pacific, have been made well 'within minutes' by the use of an antidote discovered by University of Hawaii physicians.

Dr Neal Palafox, a graduate of the UH John A. Burn School of Medicine, now practising on the Marshallese island of Majuro, discovered that injections of the artificially produced sugar compound mannitol can permanently banish all effects of ciguatera poisoning. Ciguatera poisoning is also common in Florida and the Caribbean. UH medical school faculty member Dr Irwin Schatz, one of 11 authors of a paper on the use of the antidote, says that mannitol 'is inexpensive and available almost everywhere. It is commonly used to reduce brain swelling'.

Until the new treatment became available, people suffering from ciguatera often remained ill for 'two or three months', Schatz said. 'And if they contracted ciguatera a second time, the effects were worse than the first time. Injections of mannitol seem to make subsequent occurrences no worse than the first', he added. Although ciguatera is seldom fatal, its symptoms — which begin within 12 hours of eating tainted seafood — include numbness, vomiting and diarrhoea. In severe cases, those infected have become unconscious. Indeed, the discovery of the effectiveness of mannitol involved two such comatose patients. To reduce possible brain swelling, the two Marshallese — who had eaten fresh-caught red snapper — were given injections of mannitol by Dr Louis Jain who was attending them while they were on a medevac flight. Within 10 minutes, both were conscious, sitting up and talking and within 48 hours they had completely recovered.

Schatz says that although none of the patients treated so far were in Hawaii, 'We have no reason to doubt that the antidote will be just as effective here'.

CTX TREATMENT UNDER STUDY BY UH RESEARCHERS (From *Makai*)

Recent newspaper accounts touting the curative effects of the drug mannitol as an antidote for ciguatera (CTX) fish poisoning are being questioned by Dr Yoshitsugi Hokama, professor of pathology at the University of Hawaii. Ciguatera, a major concern in the rising U.S. consumption rate of seafood and in the fishing industries of endemic areas throughout the Pacific and the Caribbean, has been the focus of research by Hokama for a number of years. In a June interview, he said newspaper reports which called mannitol a 'miracle drug' and a 'complication-free antidote' for fish poisoning, were misleading and discussed the treatment's scientific report published this May in the *Journal of the American Medical Association* (JAMA).

Hokama, refuting the *Honolulu Advertiser* and *Honolulu Star-Bulletin* articles, stated that use of mannitol would be a useful treatment for an acute situation, but, until more studies are done, to suggest that it is an antidote is premature. According to Hokama, an antidote, by definition, would neutralise the ciguatoxin, but the misconception in terminology ignores the fact that the specific mechanism by which the drug acts is still unknown. Therefore, mannitol cannot be effectively termed an antidote. The *Advertiser* article, Hokama notes, also mistakenly states that the drug is injected when it is actually infused intravenously during treatment. Hokama points out that treatment by infusion of a mannitol solution should be carried out even though the mechanism of its action is yet unknown.

Authors of the original JAMA scientific article do not claim to have found a cure for ciguatera fish poisoning but instead report that the administration of mannitol shortens the neurologic and muscular dysfunction period in each patient infused. Hokama questions whether the mannitol itself is relieving symptoms or simply acting as a dilution of the ciguatoxin within the system, since the reason for the drug's apparent effectiveness remains unclear. A similar type of treatment was reported almost 25 years ago by Dr Raymond Bagnis, a physician with the Institut de recherches médicales Louis Malardé in French Polynesia who had treated patients suffering from CTX poisoning by infusing them with calcium gluconate. Structurally, this drug is very similar to mannitol and is presently one of the therapies recommended to local doctors treating cases of CTX poisoning.

Mannitol was first discovered to relieve symptoms of CTX poisoning in 1986 when administered to two comatose fishermen in the Marshall Islands diagnosed as suffering from cerebral oedema. Use of the drug is standard procedure when the brain accumulates fluid. Upon recovery, it was found that the men had eaten fish tainted with ciguatoxin. Hokama suggests that, since the major clinical symptoms of CTX poisoning are primarily gastrointestinal, involving vomiting and diarrhoea which cause dehydration, mannitol infusion may be merely rehydrating the patient. Again, the basic mechanism must be discovered before mannitol can be clearly claimed as an antidote.

The JAMA article reports speculation that the mechanism of action in mannitol indicates the possible absorption of ciguatoxin from the gastro-intestinal tract and that the ciguatoxin is thus displaced. Hokama theorises that the mannitol, which also functions as a diuretic, is not displacing ciguatoxin but rather is dispersing or diluting the ciguatoxin, thereby diminishing its activity. University of Hawaii researchers are presently conducting studies in this area.

According to Hokama, the most significant problem resulting from recent newspaper reports which claim mannitol as an antidote is the danger this type of misinformation poses to the public. Importers of fish from areas known to have high toxicity rates may feel freer to sell questionable fish on the open market now that an antidote to ciguatera is thought to be available. An example of this confusion was indicated by a fish importer from the Marshall Islands who commented to Hokama, 'Now that they have a cure I can bring those fish in and it doesn't matter if people get sick'. By all indications, this attitude ignores safety. Hokama warns that it does matter and that irresponsible behaviour should not be tolerated when dealing with the public's health.

The following article is reprinted, with slight modifications, from *Australian Fisheries*.

PRESENTING FISH FOR SALE ON THE JAPANESE MARKET

by

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Recent profitable exports of chilled fresh tuna from the Pacific to Japan have encouraged the export of non-tuna **sashimi**-grade fish such as Australian garfish, trevally and snapper. However, exporters have been disappointed at the low prices received for these fish, especially in the case of trevally. The reason that these exports have commanded only low prices is the condition in which the fish have been presented for sale, and not seasonal fluctuations in the market. It is imperative that producers, if they are to command top prices on Japanese markets, understand the expectations of Japanese fish traders.

Definition of terms

Traditionally, whenever quality permits, the Japanese consume almost any fish in its raw state. When the fish is served on its own the dish is called **sashimi**; when served with vinegared rice, it is called **sushi**. The most important aspect in determining the quality of the fish is its freshness.

Fishermen, wholesalers and retailers have all endeavoured to control the freshness of this raw **sashimi** fish for many years and several effective handling techniques have been developed. These include bleeding, ice slurry treatments and in particular a spiking treatment called **iki-jime**. In addition to brightness of skin colour and gills or clarity of the eyes, the Japanese use rigor mortis as the most significant criterion in determining the freshness of their fish (Figure 1).

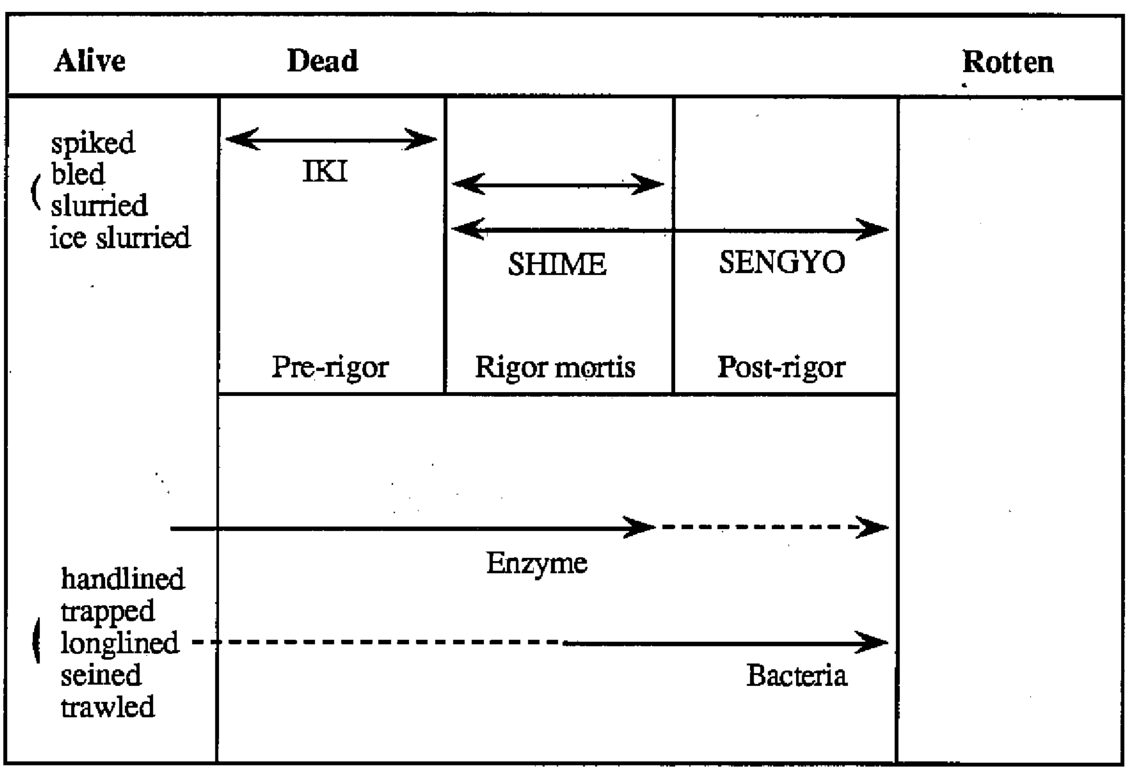

Figure 1. Changing of freshness according to rigor mortis

Live fish, which attract the highest price, are termed **katsugyo.** About 10 per cent of all fish sold at Tsukiji Market in Tokyo are live. The highest quality fresh fish are produced from live fish by the **iki-jime** method and are termed **iki** fish. **Iki** is a term reserved for fish which are determined to be still in the pre-rigor stage, in other words, the fish is brain-dead but muscle tissue is still alive with enzymic activities.

Most **katsugyo** sold in the Japanese markets are used in preparing the expensive pre-rigor quality **iki** fish with the **iki-jime** method.

A special form of **sashimi** called **arai** — wrinkled fillets produced by dipping in cold water — can be obtained only from **iki** fish.

Local Japanese fishermen who cannot supply live fish usually supply **iki** fish treated by **iki-jime.** However, the duration of the pre-rigor stage can be prolonged by **iki-jime** treatment for no more than 10 to 20 hours, depending on the species, and fishermen who cannot supply **iki** fish because of too distant fishing grounds are forced to supply rigor mortis stage **shime** fish.

Shime fish are those spiked with the **iki-jime** treatment but offered at market already in a stage of rigor mortis (see Figure 2). Fish which are spiked by the **iki-jime** method and immediately treated on board by ice slurry as well may have their rigor mortis prolonged for up to three to seven days.

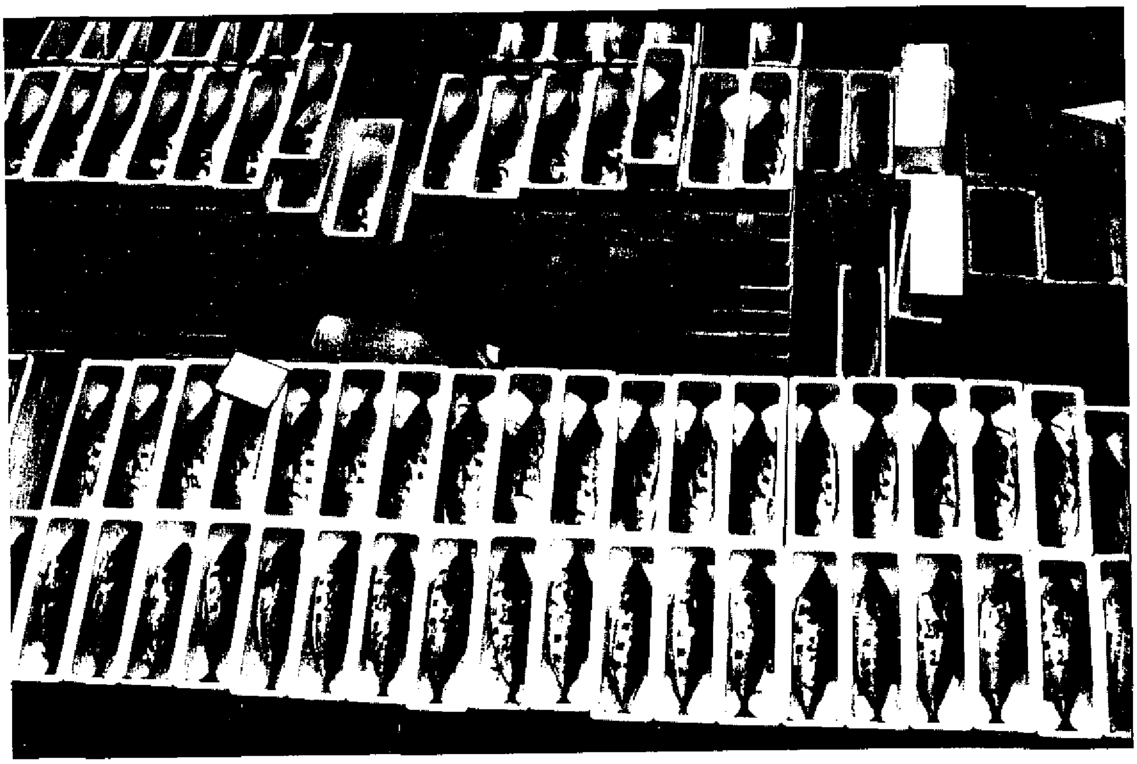

Figure 2. Rigor mortis shime kingfish (on ice) at auction at Tsukiji Market, Tokyo.

The quality of **shime** fish is considered to be second only to **iki** fish and these fish are also sold as **sashimi**-grade **iki-jime** fish. Fish smaller than 500 grams, such as yellowtail and slimy mackerel, are treated by ice slurries without being spiked or bled. In this case the treatment is called **kori-jime**, and the condition of the fish is still considered to be **sashimi**-grade.

It is common for **iki fish** to arrive at market in the stiff **shime** stage and consequently unable to command the best price. However, it should be realised that they are still **iki-jime** fish and therefore command a better price than those fish in which rigor mortis has set in but which have not been spiked, bled or slurried at the fishing grounds.

As the softened post-rigor muscle is different from the relaxed pre-rigor muscle common to **iki** fish and easily recognised, it is difficult for fish in the former condition to achieve good prices on the Japanese market. This was the Australian experience during the export trials of trevally from New South Wales.

Metabolism

The metabolism of fish is similar to that of other animals in that the oxidation of glycogen is used to produce heat or energy for the body and muscles, and energy for muscle contraction is gained from adenosine tryphosphate (ATP).

Fish metabolism is largely influenced by oxygen and the temperature of the environment. The air we breathe is about 18 per cent oxygen whereas sea water, on average, contains a mere 0.0006 per cent (six parts per million) of oxygen. Also, water is about 780 times more dense than air, making it heavy and difficult for fish to move through. Theoretically, a fish exposed to air can generate 780 times more power without water resistance. This means that 1/200 horsepower can be generated by a one kilogram fish regardless of size. A 200 kg tuna, for example, can generate one horsepower.

When fish are cruising in the water their body's biochemical metabolism is normal, with enough oxygen being supplied by blood circulation. Almost immediately after death, most enzymic activities are still functioning but, without oxygen being supplied by blood pumped from the heart, the heat producing glycogen ceases to recycle and accumulates as lactic acid (glycolysis). The ATP continues to break down, acting on the myosin and actin to produce actomyosin. This continuously contracts the muscles until all the ATP is used up, at which point rigor mortis results.

Maintaining the freshness of fish is simply a matter of preventing these enzymic activities and keeping as much as possible of the original amount of glycogen and ATP in the muscle by cooling, freezing, curing and cooking (which destroys enzymes) immediately on catching.

Spiking and bleeding

When fish are alive, most of the enzymes involved with the physiological functions are controlled by the nervous system. When landed, the fish struggles and undergoes enormous muscle contractions. Without oxygen available through the gills, the ATP is quickly used without being recycled, and the fish simply suffocates. Fish such as slimy mackerel, when left on deck struggling for only 10 minutes, use twice as much ATP within their muscles as do spiked **iki-jime** fish.

During the glycolysis process (when the glycogen turns to lactic acid) the muscles are marinated (Noguchi, 1967) and there is a rise in body temperature. This can be some 10 degrees Celsius in tuna and slimy mackerel, and even squid show a rise of between two and three degrees.

Spiked **iki-jime** fish, with damaged hindbrains, cannot respond to their changing environment or act autonomically to contract the muscles or maintain the right temperature. Consequently much of the original amount of ATP and glycogen within the muscle is restored and body temperature is kept lower.

As well as carrying oxygen and nutrients to muscles and organs, blood is also the agent for removing the waste produced in these areas. Bleeding is therefore an effective way of ridding the fish of wastes which spoil the quality of the meat, and also acts to prevent heating or to lower body temperature rapidly.

Fish generally first circulate blood to the gills, where it is oxygenated. It is then pumped directly to the body system by the heart (which consists of one ventricle and one auricle) with the help of the arterial bulb. Reasonable bleeding can therefore be obtained by cutting the artery anywhere, but the usual position is on the gills or the caudal peduncle (base of the tail). For tuna, both sides of the subcutaneous blood vessels (artery and vein) are cut near the pectoral fins.

The **iki-jime** method is used to destroy and/or isolate the nervous system from other organs. In particular, its object is to destroy the medulla oblongata, that part of the hindbrain which is responsible for most of the autonomic reactions (Figure 3).

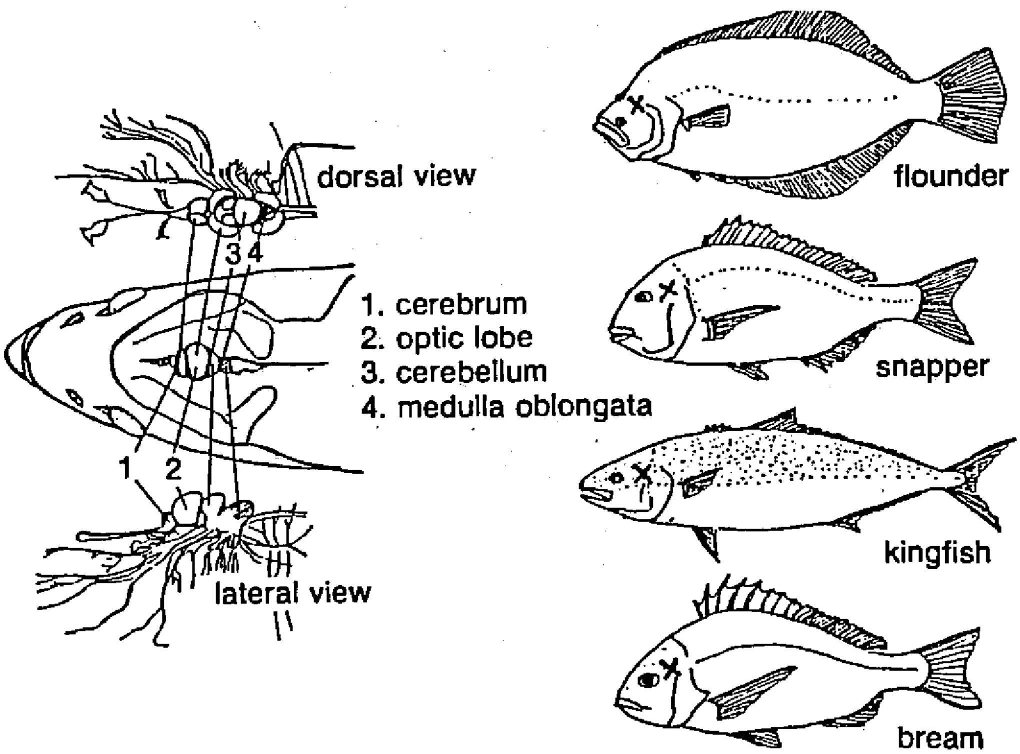

Figure 3. Position of medulla oblongata and spiking position

There are several methods for spiking the hindbrain or bleeding the pre-rigor **iki** or rigor mortis **shime** fish. In the case of **iki** fish such as trevally (but excepting snapper and some other fish), all live fish in the markets are cut or slit on their head with a heavy knife to isolate the hindbrain from the spinal cord.

As the spinal cord is also responsible for some autonomic reaction, fish over three kilograms are often killed by inserting wire down the spinal cord. Tuna longliners in New South Wales are presently using similar methods to destroy the spinal cord of large tuna (Figure 4). On certain fish, in addition to coring, the blood vessels on the cordal part are slit to facilitate bleeding.

Presentation is important in **shime** fish. Damage to the surface of the fish should be avoided if possible by spiking through the right side, using a sharp implement which will only show a small mark on the left side. In Japan, all fish are served with their head to the left and a spike mark will therefore be positioned underneath.

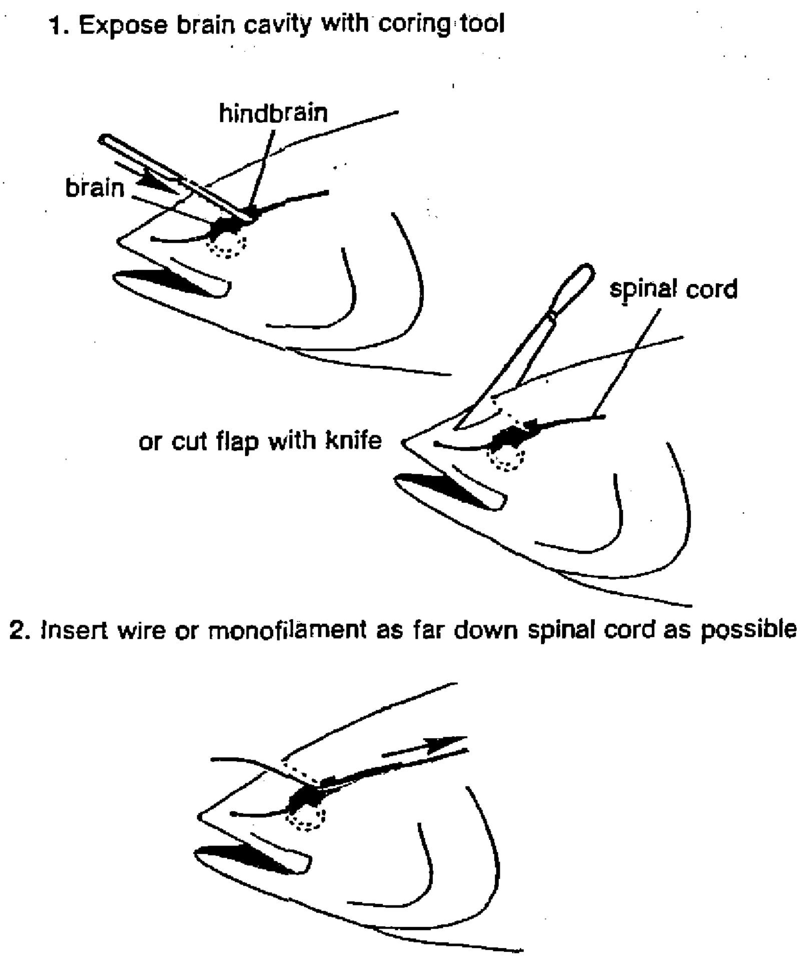

Figure 4. Method of coring and killing for sashimi tuna

Kingfish presented as **iki** fish usually have their heads half-severed and the spinal cord spiked by wire. They are bled by slitting near the base of the tail without ice. **Shime** kingfish, however, are spiked through the underside of the hindbrain, using a sharp knife, by opening the gillcover. They are bled at the same time by slitting the gills. In this way no mark shows on the outside. After ice slurry treatment, these fish are kept at all times in polystyrene boxes with ice.

The ice slurry

Under anaerobic conditions, ATP within the muscles ceases to recycle. When about two-thirds remain, rigor mortis sets in. Depending on the species, temperature and physical handling, this may take between 10 and 20 hours.

It is not clear if the wrinkling on **arai** fillets is caused by rigor mortis or some other muscle reaction by enzymes. But it is understood that no wrinkling effect is achieved if the fish is not fresh enough to retain more than two-thirds of the original ATP in the muscle. By lowering the temperature of brain-dead **iki-jime** fish, it is possible to slow down enzymic activity and maintain the ATP.

The setting-in of rigor mortis is faster if fish are treated in cold temperatures using either ice or ice slurries. To prolong the pre-rigor state, and achieve **arai** effects, the spiked **iki** fish are cooled by lowering their temperature in a slurry tank only five to six degrees below the normal living water temperature for that particular fish.

For **shime** fish, however, it is desirable that rigor mortis sets in fast and strong and lasts as long as possible. These fish are therefore treated by ice slurry immediately after spiking. Bleeding and ice slurrying are the most effective and fastest methods for chilling fresh fish for rigor mortis **shime** fish.

Depending on what fish are to be treated, and where, the ice slurry is made using either ice and sea water or fresh water with salts. In fact, using just fresh water for cooling and chilling is not ideal for presentation — regardless of the quality of the fish — as it causes leaching of the skin colour, clouding of the eyes and browning of the gills.

It is important to control the salinity of the slurry if fish are to be stored in it for a long time. Ideally, for most fish, storage time should be less than three hours. Japanese fishermen are generally prepared to achieve the right salinity and water temperature according to species by using a thermometer and specific gravity gauge to judge if extra salt and ice are necessary. For example, about half the salinity of sea water (1.8 %) is used for snapper, while a salinity similar to sea water (3.5 %) is used for squid.

Salts in an ice slurry bring down the freezing point, and sea water (with a salinity of around 3.5 %) will freeze at about minus 1.8 degrees Celsius. To avoid freezing the fish, the salinity of the slurry should therefore be carefully monitored.

Fishing methods and ATP

Spiking is effective only on live fish. However, it is not necessarily a successful treatment for fish which have been netted and are likely to have used up their ATP before spiking, and Japanese fishermen generally keep stressed and exhausted fish at rest in a set net or in an on-board circulating holding tank.

However, ATP recovery is largely dependent on the species and the original condition of the fish, and that may be influenced by season, type of migration, feed, size and age. Poorly fed, large or old fish rarely recover — they usually die, particularly when a high degree of glycolysis has developed and lactic acid becomes slow in being recycled.

It is vital for fishermen to select the best and most appropriate fishing methods in order to produce the best **iki-jime** fish. Handlines or droplines are the best catching methods. For some species, bottom longlining or trapping are reasonable methods. Seined and trawled fish, after a long haul, often show no signs of rigor mortis, having already used their ATP. They are definitely unsuited for **sashimi**-grade fish.

References

Huss, H.H. (1986). *Fresh fish quality and quality changes*. Manual prepared for FAO Training Program on Fish Technology and Quality Control.

Noguchi, E. (1967). *Harvesting fisheries*. (In Japanese.) Ed. by Association of Japanese Fisheries Resources.

Harvey, R. (1982). *A code of practice for air-freight chilled fish*. New Zealand Fishing Industry Board.

REPORT ON OPERATION OF FV KIMEJI, POHNPEI, FEDERATED STATES OF MICRONESIA 1983-1986

by

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Background

Upon arriving in the then-District of Pohnpei of the Trust Territory of the Pacific Islands from Yap in mid-1977, I was struck by the total reliance of the local fishery on gasoline-powered outboards and a few jet-drive gasoline-powered dories remaining from a previous fishery development project. In what appeared to be an ideal setting for smaller diesel-powered launches to fish outside the main barrier reef, there were none to be found. The reasons for the lack of such vessels became apparent, however, when I discovered an almost complete lack of facilities for maintaining or supporting such vessels. There was no fishery wharf, and no adequate mooring sites or other support facilities. Local fishermen operating from locally-built 'Mokil'-style planked outboard boats hauled their daily catch through knee-deep mud at the fishery co-operative and later unloaded their outboards by the same method. The boats were then skidded ashore on mangrove poles or strong bamboo.

Almost ten years later the situation has changed little, except that the Mokil-style boats have been replaced by fibreglass Yamaha or Otani outboard skiffs from Japan; the mud hole behind the fishery co-operative has been somewhat filled in, and the boats are dragged ashore each evening on scavenged galvanised pipes. The retail price of fish has escalated, going from an average of US$ 0.35 to US$ 0.50 per pound in 1977 to US$ 0.90 to US$ 1.10 per pound for skipjack and yellowfin tuna caught by these vessels and sold by either middle-men or the fishermen's own co-operative. These prices have continued to reflect the high cost of operating the outboard-powered boats, which have gone from 8 to 15 horsepower in the wooden skiffs of the mid-1970s to 35 and 40 horsepower in the fibreglass boats of the mid-1980s.

Without any viable alternative to present to either fishermen or politicians, at least two large-scale loan programmes conducted by the local government have focused on the provision of fibreglass skiffs and outboards, thus perpetuating and exacerbating the obvious problems brought about by a local fishery using solely outboard engines.

In late 1977, as District Fishery Officer, I set out to test the economics and practicality of a diesel-powered launch for fishing around Pohnpei and its two satellite atolls, Ant and Pakin. The Capital Improvement Project (CIP) plans at the time called for the necessary infrastructure for such vessels to be provided in 1979-80, according to the timetable in effect at the time. An expatriate boatbuilder setting up business in Pohnpei was commissioned to produce a fibreglass diesel-powered boat in Pohnpei which would have the following characteristics:

- semi-displacement hull;
- 26 to 28 ft in length;
- 6 to 8 plus knots speed;
- ice/fish capacity of 300-400 lbs;
- 20-30 hp diesel inboard, with hand-starting capability.

The vessel took almost a year to plan and build locally. It was launched shortly after I left the Marine Resources Department to take up a position with the newly created Micronesian Maritime Authority of the Federated States of Micronesia national government. The vessel was never utilised by my successors, and sat neglected, out of the water, for almost eight years.

It wasn't until 1982 that I was able to finance my own vessel of a similar type, with the same idea in mind: to test the practicality of operating an economical diesel-powered launch in the local fisheries. I noted that there was practically no deep outer-slope bottom fishing being done around Pohnpei at the time, and the troll-caught fish available locally were escalating in price as fishermen needed to cover expenses in their outboard-powered vessels. It was a combination of a failure of the Marine Resources Department to test my thesis, as well as a reluctance to pay the high prices for generally poor quality locally-caught fish, that prodded me to try it on my own. My work with the Maritime Authority involved extensive off-island travel, so my fishing activities were limited. I was able to fish only on weekends, and occasional off-days and holidays while in Pohnpei. This report is the result of such activity carried out over a four-year span, 1983-1986.

Setting

Pohnpei island is one of the eastern Caroline chain located at approximately 7° North, 158° East. It is a high island of volcanic origin, with a fringing reef and an extensive inner lagoon. The island is almost completely surrounded by mangrove forest, and extensive rainfall (400 inches per annum) in the interior of the island insures a flow of nutrients into the mangrove areas and lagoon.

Fishing activities were carried out with the assistance of an echo-sounder with a maximum depth of 300 fathoms. Use of this aid revealed a sloping dropoff on the windward (eastern) side and a more sheer drop on the lee (western) side which is more characteristic of an atoll than of other high islands in other parts of the Pacific. Throughout the four years of activity covered in this report I was unable to identify any pinnacles or seamounts connected to the outer reef system of the island. Two atolls, Ant and Pakin, lie to the west and northwest of Pohnpei. Ant is seven miles from Pohnpei at its closest point, while Pakin is 22 miles from the northern harbour entrance of Pohnpei island.

Only two surveys have been carried out on the outer slope in the past twelve years. Frank Cushing of Guam was employed by the Marine Resources Department during the first six months of 1977 (just prior to my arrival) to test deep water bottom fishing. Paul Mead of the South Pacific Commission (SPC) later spent two weeks on the island in 1984 as part of a village technology training course and conducted exploratory fishing. The SPC has never been requested to base its Deep Sea Fisheries Development Project on the island, perhaps reflecting the same lack of interest that prevented the vessel built in 1978 from undertaking exploratory fishing.

The result of Cushing's work was not encouraging. He spent most of his time in Pohnpei during the strong NE tradewind season, and explored the western reef more than the eastern portion. He reported an almost total lack of deepwater snappers such as *Etelis* common to other islands in the region, but mostly attributed this to his inability to fish the windward side.

Mead was on the island during the calmer summer months, but in the short time available was not able to get a good feel for the resources that a longer sojourn might have enabled. He utilised a small echo sounder in his work and also reported an absence of pinnacles or seamounts on the reef slope, with little or no success at fishing for deep water snappers at anything below 80 or 90 fathoms.

The Pohnpei State Economic Development Authority (EDA) commissioned a survey by a team from Hawaii to test the possibility of exporting fish from the outer slope in 1984. The one fisherman who remained behind for a 10-day survey was inexperienced in deep-bottom fishing techniques and spent most of his time night-fishing in shallow (30 to 40 fathoms) water. He left the island before the completion of the 10-day period, discouraged and disappointed. There was no follow-up to his work and EDA has not involved itself in deep-water resources since then.

Earlier, in a decision by the then-district government, the planned 'fishery complex' which had been identified for CIP funding in 1977 was scrapped, and the funds diverted to additional road paving planned for Kolonia. The only harbour improvement relevant to fishing in the subsequent eight years was the acquisition and placement of two 8 x 20 ft floating pontoon docks obtained through the 'goods and services' provided by the Japanese fishery access agreement. Marine Resources assisted me in this 'spare time' undertaking by allowing me to moor my boat at one of these floating docks, greatly facilitating the loading and offloading of supplies and fish.

Operations

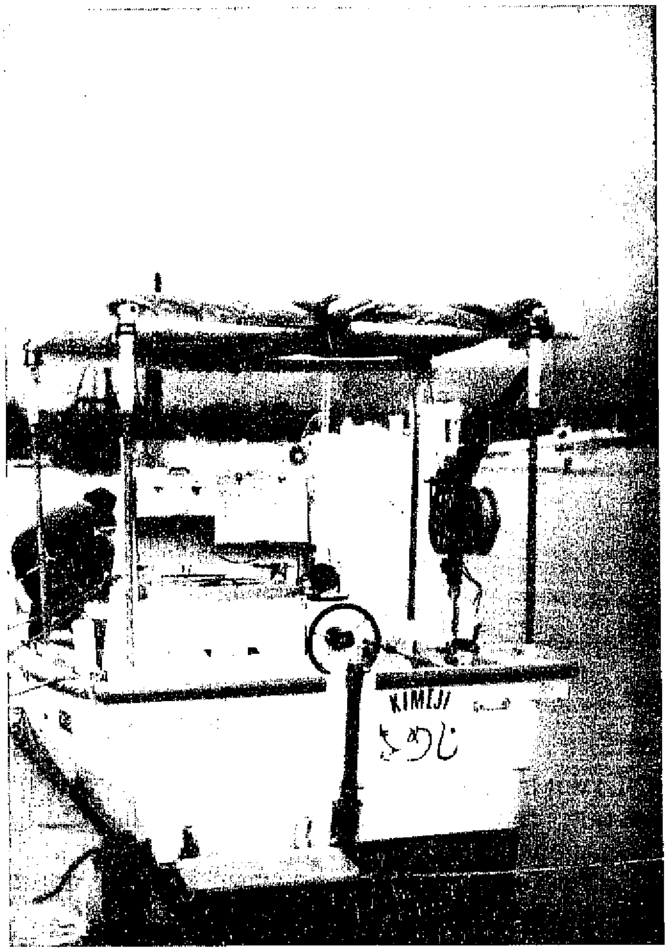
The size and type of vessel available to me was limited by my own personal finances. I found that Yamaha produces a suitable boat, designated model SPD-27, which is essentially an open launch powered by a 3-cylinder Yamaha diesel engine, that closely resembles the Yanmar model 3QM and which provides 7 knot speed at about one US gallon per hour at 1 900 rpm. The cost of the vessel and engine, equipped with controls, Morse cable-type steering in place of the standard tiller, a complete set of spares, gasket sets, spare injectors, hoses and belts, spare propeller and additional 12 V battery was just under US$ 13 000 (CIF, Pohnpei) in September, 1982. I added epoxy-saturated plywood decks and a console to house a VHF radio and echo-sounder, as well as a built-in fishbox with a capacity of 300 lbs. These, plus additional hardware, electronics, wiring, the installation of a separate 18 gallon stainless fuel tank and, eventually, purchase of a commercial electric bottom reel increased the total investment to about US$ 17 000.

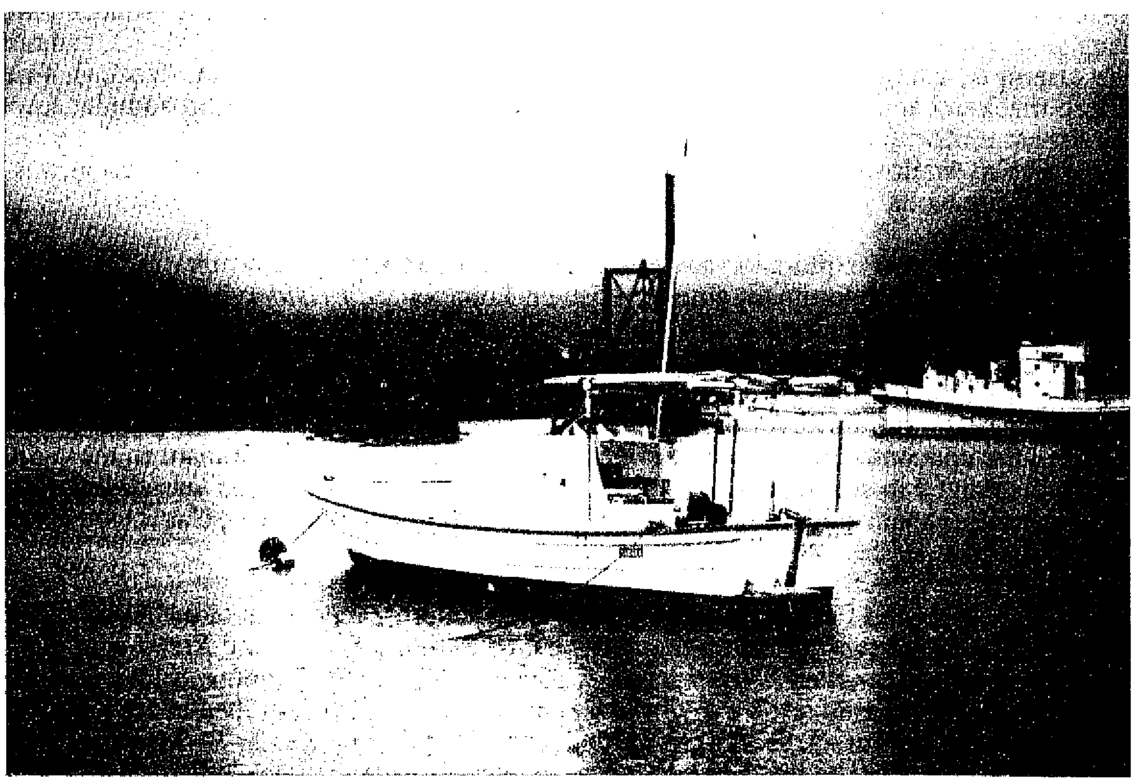
Because of other work commitments the boat was not completed and in the water until mid-1983. Five months of weekend and after-work fishing activity during the remainder of 1983 were followed by similar activity during eight months of 1984, ten months in 1985 and a final six months in 1986. This meant that several good, known fishing seasons were missed during the four-year period, as well as many summer months of good weather when more extensive explorations might have been carried out. One should thus not judge the results as those of fully investigative work, but simply as what it was: opportunistic fishing carried out as close to commercial conditions as possible under varying circumstances.

One hundred and twenty one trips, mostly lasting a day or less, were carried out over the four years. During the first eight months mostly trolling trips were undertaken, until the electric reel was installed later in 1984. The continued balance between trolling and bottom-fishing is a result of necessity; it takes a longer time to organise bottom fishing (bait, gear, etc.) than it does trolling. Since fishing was sometimes carried out after working hours, or at times when strong winds prohibited the vessel reaching the bottom fishing areas, trolling continued to be a technique employed. Trolling also produced most of the bait used in bottom fishing.

While results are not conclusive, I believe them to be indicative of what one could expect to find operating a similar vessel around Pohnpei on a more commercial basis. Most bottom fishing employed only one line, that of the electric reel (from Custom Marine Products in Tampa, Florida). On a few occasions a crewman accompanied me and utilised a Samoan-style manual reel common to the region. Trolling was carried out with only two lines, and I often fished alone or carried only one crewman to assist.

Table 1 lists the months of operation and number of trips taken during the four-year period. With the exception of a pronounced increase in the occurrence of wahoo (*Acanthocybium solandri*) and mahimahi (*Coryphaena hippurus*) during the months of December-March, there are no apparent 'seasons' for either pelagic or demersal fishing in Pohnpei. The main constraint to fishing activity is the weather, with the north east trades of November-May diminishing opportunities for bottom fishing on the eastern reef. Trips were almost without exception of one day duration.





Multi-purpose fishing boat *Kimeji*

Table 1. Number of trips (days)

Month	1983	1984	1985	1986	Total
January	-	4	6	-	10
February	-	7	4	5	16
March	-	2	2	3	7
April	-	1	4	6	11
May	-	4	-	4	8
June	2	-	-	-	2
July	7	-	1	-	8
August	7	1	8	7	23
September	4	7	4	9	24
October	-	3	1	-	4
November	2	-	4	-	6
December	-	-	2	-	2
Total					121

Techniques

Bottom fishing was carried out in much the same manner as described in various reports of the SPC bottom-fishing and outer reef programmes. Terminal gear consisted of reinforcing bar weights, trip swivels connected with Japanese longline leader wire and three circle hooks on monofilament leaders. Because almost all fishing was conducted during daylight hours, anchoring was usually not employed. I preferred to move up and down the reef, utilising the echo-sounder and currents to dictate spots where drops were made. After installation of the echo-sounder and electric reel in 1984 I spent several trips attempting to locate concentrations of deep snappers at the depths usually reported for these species elsewhere (140-200 fathoms). These attempts, using a variety of bait including skipjack (both fresh and frozen), frozen Japanese mackerel and frozen squid, yielded no results whatsoever. The echo-sounder recorded an almost uniformly smooth sloping bottom around Pohnpei island. Because of the abundance of fish at shallower depths at Pakin and Ant atolls, little deep-water exploration was attempted at those atolls.

After several months of exploration and experimentation, I settled for concentrating on the mid-depth species. Most predominant among those on Pohnpei are *Pristopomoides auricilla* and *P. zonatus*. Fishing with fresh or frozen skipjack as bait, at from 50 to 80 fathoms, will usually result in the capture of these two species only. An occasional *Pontinus macrocephalus* (a member of the scorpionfish family sometimes known as **hogo** in the Hawaiian bottom fishery) will be found, however capture of one of these usually means that one has drifted away from the concentration of *Pristopomoides*. The two species predominant in the catch at these depths ranged in size from one to three pounds. As a rule *P. zonatus* was slightly larger than *P. auricilla*. Details of the catch composition of bottom-fish as well as pelagics are given in Table 2.

At specific spots around Pohnpei island, namely Madelenihmw reef south of the Madelenihmw harbour entrance, and two places on the reef west of Palikir pass, several *Etelis* were caught while fishing for the smaller *Pristopomoides* species at 50 to 80 fathoms. Subsequent trips were made to those areas to test for *Etelis* at deeper depths, but never resulted in anything being caught below 90 fathoms. Several **opakapaka** (either *P. filamentosus* or *P. flavipinnis*) averaging over 15 lbs each were taken at two places, one on Pohnpei and one at Pakin. All of these were caught in 50-60 fathoms when fishing for the smaller *Pristopomoides*, and were usually captured when the catch included other species feeding at that depth, mostly carangid jacks, lethrinid snappers and an occasional *Aprion*.

Table 2. Species composition of catch

Species English name	Weight (lbs)	Number	Average weight (lbs)	% total weight	% total number
Trolled fish					
Acanthocybium solandri Wahoo	2723	203	13.4	23.68	10.02
Coryphaena hippurus Dolphinfish	470	47	10.0	4.09	2.32
Elegatis bipinnulatus Rainbow runner	86	19	4.5	0.75	0.94
Euthynnus affinis Kawa-kawa	40	9	4.4	0.35	0.44
Gymnosarda unicolor Dogtooth tuna	120	3	40.0	1.04	0.15
Katsuwonus pelamis Skipjack tuna	2293	421	5.4	19.94	20.79
Sphyraena sp Barracuda	639	97	6.6	5.56	4.79
Thunnus albacares Yellowfin tuna	1018	105	9.7	8.85	5.19
Bottom fish					
Aphareus rutilans Jobfish	83	9	9.2	0.72	0.44
Aprion virescens Grey jobfish	95	11	8.6	0.83	0.54
Caranx lugubris Black trevally	688	95	7.2	5.98	4.69
Caranx spp Trevally	75	31	2.4	0.65	1.53
Cheilinus undulatus Maori wrasse	54	3	18.0	0.47	0.15
Epinephelus spp Groupers	241	104	2.3	2.10	5.14
Etelis carbunculus Short tail red snapper	36	4	9.0	0.31	0.20
Etelis coruscans Longtail red snapper	59	4	14.7	0.51	0.20
Lethrinus spp Emperors	299	73	4.1	2.60	3.60
Lutjanus bohar Red seabass	178	22	8.1	1.55	1.09
Lutjanus gibbus Paddletail snapper	150	72	2.1	1.30	3.56
Lutjanus monostigma One-spot snapper	62	14	4.4	0.54	0.69
Paracaesio stonei Fusillier	19	12	1.6	0.17	0.59
Promicrops lanceolatus Giant grouper	175	1	175.0	1.52	0.05
Pontinus macrocephalus Red rock cod	179	77	2.3	1.56	3.80
Pristipomoides auricilla Gold-tailed jobfish	1031	388	2.6	8.97	19.16
Pristipomoides flavipinnis Yellow jobfish	92	9	10.2	0.80	0.44
Pristipomoides zonatus Banded flower snapper	475	174	2.7	4.13	8.59
Promethichthys prometheus Snake mackerel	4	1	4.9	0.03	0.05
Ruvettus pretiosus Oilfish	80	2	40.0	0.70	0.10
Seriola rivoliana Lunar-tail cod	36	15	4.4	0.31	0.74
Miscellaneous bony fishes	894				
Total	12394	2025			

During the tradewind season (December to May) bottom-fishing was usually done near the points or curves in the reef on the southwest and northwest corners of Pohnpei island. Since only one line was employed, I was able to utilise the vessel's forward movement to keep over the line and minimise drifting. Fishing at shallower depths of 50-70 fathoms, I found the fish to be moving (or the bite to be changing) with the movement of currents. As a rule the best bite was found downcurrent just past the curve or point on the reef.

Trolling was employed when travelling to and from Pakin or Ant atolls, and on days when gearing up for bottom-fishing would have been impractical (such as a short trip after work). Attempts were also made to troll around payaos (FADs) set near Pohnpei during 1984 and 1985 by the Pohnpei Marine Resources Department and Economic Development Authority. None of these payaos lasted more than a few months. Several were set too far from land to be accessible to the smaller boats on all but the calmest days. These were not monitored by local authorities and were soon lost. Those set within three miles of the reef were much more successful. Fishing around these closer payaos was carried out during the winter months when mahimahi and wahoo tend to be present in large numbers. The best day's catch at one payao during the 'wahoo season' resulted in a catch of 33 small wahoo averaging 10 lbs, and another 100 lbs of mahimahi, small skipjack and small yellowfin combined. During this same season (best usually in January/February) larger wahoo can be found near the reefs of Pohnpei, Ant and Pakin. Two such trips were made in February 1986, resulting in catches of 16 and 17 wahoo from 20 to 40 lbs each, per trip. When such fishing is undertaken, young coconut mid-rib (yellow) leaves are always tied on the lure to minimise damage to lure skirts.

The best trolling for wahoo is done with the echo-sounder tracking the bottom and undersea ridges, which at several points run perpendicular to the reef. When the correct spot, on one side or the other of such a ridge, is found, passes over that spot will yield the greatest number of strikes. Heavy, lead-head ruby-eye lures, or chrome jet-head lures of the largest sizes proved to be best for this type of trolling. The boat speed was kept above seven knots wherever possible; generally faster trolling speeds yielded more strikes on the lures. As a rule I did not set out on a trolling trip exclusively to capture yellowfin or skipjack. One of the biggest and most obvious disadvantages of operating part-time, as I did, is that one does not always know where to find feeding schools of skipjack and yellowfin. The local fishermen are spread out around the island and not always available to provide this kind of information; and even if found do not readily give it out. Recent years have seen a tremendous increase in the number of small outboard trolling vessels competing within schools. Crossed and tangled lines are becoming more commonplace, with the result that catches are hindered. Fishermen are almost always polite to one another in these situations, and assistance is rendered when required. However, the large number of small vessels following a school makes trolling at those times more difficult and in many cases less productive.

While the vessel was capable of catching all but the fastest-moving schools, the time spent generally did not warrant such chasing unless the fish were biting extremely well or happened to be heading towards more distant bottom fishing grounds anyway (such as Ant or Pakin atolls).

Ice was carried on all trips, usually 100 to 200 lbs per day depending upon availability and the duration of the trip contemplated. Since most ice produced in Kolonia by the Economic Development Authority is used by local retail stores to cool soft drinks and beer, the ice-making facilities (both the older machines and the new Japanese foreign aid-provided cold store) maintain business hours more suitable to a bank than a fish house. Because of the unavailability of ice on weekends, it often had to be purchased up to 48 hours in advance and held in coolers. The anticipated loss to melting meant that larger quantities had to be purchased, and resulted in increased ice costs.

The catch was placed in an ice-seawater slurry to which ice was added as subsequent catches were brought abroad and stored. Since times at sea usually did not exceed 12 to 14 hours, and since none of the catch was destined for commercial sale, handling was not done as carefully as one might on a commercially-operated vessel.

Total catch

Table 3. Catch during each month and per day's fishing (T= trolling, B= bottom-fishing)

Month		1983 Lbs	1983 Days	1984 Lbs	1984 Days	1985 Lbs	1985 Days	1986 Lbs	1986 Days	Total catch (lbs)	Total days	Average per day (lbs)
Jan	T	0		190		840		0		1030		
	B	0		15		263		0		278		
		0	0	**205**	4	**1103**	6	**0**	0	**1308**	**10**	**131**
Feb	T	0		448		228		876		1552		
	B	0		171		191		21		383		
		0	0	**619**	7	**419**	4	**897**	5	**1935**	**16**	**121**
Mar	T	0		0		74		331		405		
	B	0		196		118		80		394		
		0	0	**196**	2	**192**	2	**411**	3	**799**	**7**	**114**
Apr	T	0		23		85		67		175		
	B	0		100		243		345		688		
		0	0	**123**	1	**328**	4	**412**	6	**863**	**11**	**78**
May	T	0		32		0		227		259		
	B	0		248		0		82		330		
		0	0	**280**	4	**0**	0	**309**	4	**589**	**8**	**73**
Jun	T	310		0		0		0		310		
	B	0		0		0		0		0		
		310	2	**0**	0	**0**	0	**0**	0	**310**	**2**	**155**
Jul	T	445		0		30		0		475		
	B	73		0		82		0		155		
		518	7	**0**	0	**112**	1	**0**	0	**630**	**8**	**79**
Aug	T	482		25		180		104		791		
	B	36		77		468		528		1109		
		518	7	**102**	1	**648**	8	**632**	7	**1900**	**23**	**83**
Sept	T	85		280		449		264		1078		
	B	135		414		183		312		1044		
		220	4	**694**	7	**632**	4	**576**	9	**2122**	**24**	**88**
Oct	T	0		25		0		0		25		
	B	0		204		47		0		251		
		0	0	**229**	3	**47**	1	**0**	0	**276**	**4**	**69**
Nov	T	217		0		524		0		741		
	B	0		0		43		0		43		
		217	2	**0**	0	**567**	4	**0**	0	**784**	**6**	**131**
Dec	T	0		0		633		0		633		
	B	0		0		0		0		0		
		0	0	**0**	0	**633**	2	**0**	0	**633**	**2**	**316**
Total T		1539		1023		3043		1869		7474		
Total B		244		1425		1638		1368		4675		
Total		**1783**	**22**	**2448**	**29**	**4681**	**36**	**3237**	**34**	**12149**	**121**	
Catch/day		**81**		**84**		**130**		**95**		**100**		

Table 3 shows the catch during each month's fishing over the four-year period, irrespective of location. Catches are expressed in pounds as round weights. They were derived utilising several hand-held spring scales which eventually deteriorated and were replaced by eyeball estimates. On the few occasions when some of the catch was sold to assist students who participated in fishing as crew, these eyeball estimates were found to approximate closely the weights obtained from the scales utilised by fish buyers in Kolonia. Since mono leaders were always employed, no sharks were captured. Sharks were not desired in that they are not consumed as a rule in Pohnpei, and not at all by my family and the people to whom we gave away the catch. Even with the mono leaders, very few fish were lost to sharks during daytime fishing at any of the locations. Shark predation was greatest during the few times spent night fishing, particularly at Pakin atoll.

Catch and effort

Effort calculations have been made only for the bottom fishing activities during the period. Estimates of reel hours are not exact but have been computed by subtracting known transit times to fishing grounds from total hours of operation per day listed in the records. If at all, they are over-estimated , but in any case are probably within 10 per cent of the actual amount of effort expended. Since only one reel was utilised most of the time, the hours shown represent total effort. Where more than one reel was utilised, this has been compensated for in the data.

Total effort

The total effort shown was from 76 trips on which at least some bottom-fishing was attempted. 47 of these trips (62%) were undertaken off the reef surrounding Pohnpei; 21 trips (28%) were at Pakin and the remaining 8 (10%) were at Ant.

Despite the longer distances to both Ant and Pakin, the average amount of time spent bottom fishing per day was higher off both islands than off Pohnpei. This is partly because several half-day trips were undertaken off the Pohnpei reef, and because bottom fishing was often carried out in conjunction with trolling. The trips to both Ant and Pakin were usually made for the specific purpose of bottom fishing.

Pohnpei:	5.8 reel hrs/day's fishing
Ant	6.1 reel hrs/day's fishing
Pakin	7.1 reel hrs/day's fishing

Comparison of catch rates (weight/reel hour) of my bottom fishing results off Pohnpei and the two nearby atolls fall at the lower end of the range experienced by the SPC Deep Sea Fisheries Development Project in the other islands of the Federated States of Micronesia.

Table 4. Comparison of catch rates (weight/reel hour)

Island	Kg/reel-hour	Investigator
Yap	4.6	Mead (1978-79)
Kosrae	9.6	Mead (1979)
Truk	4.1	Taumaia (1980)
Pohnpei	4.0	McCoy
Pakin	5.5	McCoy
Ant	3.9	McCoy

Comparison of the information on the major deep-bottom species in Table 2 with the information contained in the reports of the Deep Sea Fisheries Development Project for other areas of the Federated States of Micronesia reveals some interesting though inconclusive information (Table 5).

Table 5. Catch of deep-bottom species

Species	Location	Average size (kg)	% catch by weight	% catch by numbers
P. auricilla	Ponape	1.1	23.3	29.2
	Truk	0.75	0.7	2.2
	Kosrae	1.4	3.9	9.4
	Yap	1.1	2.4	7.1
P. zonatus	Ponape	1.1	11.8	15.3
	Truk	1.1	2.6	5.4
	Kosrae	1.9	2.5	4.6
	Yap	1.4	3.4	7.9
P. filamentosus/ flavipinnis	Ponape	4.1	1.8	0.6
	Truk	3.2	2.8	2.0
	Kosrae	4.0	14.5	12.7
	Yap	2.3	2.2	3.2
E. coruscans/ oculatus	Ponape	6.7	1.3	0.2
	Truk	3.9	1.5	0.9
	Kosrae	9.5	5.5	2.0
	Yap	-	0	0
E. carbunculus	Ponape	4.1	0.8	0.2
	Truk	6.8	0.7	0.9
	Kosrae	3.0	0.2	0.3
	Yap	5.5	13.2	7.9

The predominance of *P. auricilla* and *P. zonatus* in the catch at Pohnpei is, I believe, proportionally far greater than that reported for these species from other countries in the SPC region. With the exception of those two species at Pohnpei, *P. filamentosus* from Kosrae, and perhaps *E. carbunculus* from Yap, there does not appear (at least from these reports) to be much opportunity to develop a deep-snapper bottom fishery in the FSM. Of course, all work was carried out under varying circumstances and the investigations were neither of a long duration nor continuous. Monitoring of current activity being undertaken commercially by the Yap State Fishing Authority may give information contrary to the findings of the report by Mead for Yap and Ngulu. However, for now one would have to say that on the basis of available information, a fishery based on these high value export species does not seem viable.

My own operations around Pohnpei lead me to believe that a bottom-set longline could increase the catch of *P. auricilla* and *P. zonatus* and perhaps make such a fishery commercially feasible. The depths fished did not result in any loss of gear due to snags, and it appeared from both the echo-sounder and feel of the line that such a bottom longline would not get caught or hung up on what is essentially a smooth bottom from 50 to 90 fathoms. If such a longline were employed in the daytime, the risk of losses to sharks would be lessened.

Thus, any viable commercial operation utilising a vessel such as mine would have to continue utilising both trolling and bottom-fishing techniques. Markets would probably have to be local, although some wahoo might be sent to Hawaii during the winter months. The following discussion on the commercial viability of a vessel such as *Kimeji* in Pohnpei assumes that catch composition would be similar to those reported here.

Expenses

Expenses to operate *Kimeji* for the four-year period were documented along with the catch information reported. Variable expenses included fuel, lube oil (calculated at 10% of fuel expenses), ice, and gear replacement. These were utilised to calculate the cost of production, exclusive of vessel amortisation, on a yearly basis as follows:

Table 6. Percentage of total expenses

	1983(%)	1984(%)	1985(%)	1986(%)	4-year total(%)
Fuel	63	65	65	58	63
Lube oil	6	7	7	6	7
Ice	12	18	19	28	19
Gear replacement	19	10	9	8	11

The local price for diesel fuel during the period ranged from a low of US$ 1.45/US gallon to US$ 1.65/US gallon. A commercial enterprise which operated more often than mine might have purchased fuel at a discount from Mobil at prices from US$ 1.15 to US$ 1.27 per US gallon when buying a minimum of 6 drums (300 gallons). Since this amount represented almost a year's supply for me, I did not bother to take advantage of this opportunity preferring to obtain fuel from a local gas station as required. Savings on bulk purchases of fuel would probably be offset by increased engine maintenance costs for a commercial vessel, however. During the four years I put in only about 1 100 hours on the engine and only replaced one impeller, two belts and numerous anti-corrosion zincs. Commercial operation would require overhauls of a more extensive nature, with resultant increased maintenance costs.

Like fuel, ice prices fluctuated during the period. Ice was always obtained from the Pohnpei Economic Development Authority, which offers no discounts to fishermen and since November 1985 charged US$ 0.05/lb. The lowest price ever charged was US$ 0.04/lb. Ice costs increased during 1986 and additional amounts were purchased to hold the catch for several days prior to consumption as an alternative to freezing.

Expenses of operation per pound of fish produced varied from a high of US$ 0.25/lb to a low of US$ 0.17/lb. The greatest opportunity for cost-cutting would be in reduced prices for ice. The current price of ice in Pohnpei does nothing to encourage its use, and it would be well worth government's efforts to give fishermen a discount. If ice prices were reduced and bulk fuel made available, a good estimate for a commercial operation would put expenses somewhere below the low end of the range experienced, perhaps at US$ 0.14 or US$ 0.15 per pound.

Table 7. Variable expenses per pound of fish produced

	1983	1984	1985	1986	4-year total
Variable exp.(US$)	437	577	832	832	2678
Total catch (lb)	1783	2488	5008	3237	12516
Cost/lb (US$)	0.24	0.23	0.17	0.25	0.22

Because of the different methods employed and the varying catch, I believe one of the most important pieces of economic information to come out of this work are the expenses/lb figures. These, coupled with catch per day and known fixed costs, should give a fairly accurate picture of the economic viability of a similar commercial operation. Different assumptions of course can be used, such as reduced variable expenses provided by cheaper ice and fuel, or increased catches which might be the result of more intensive commercial fishing effort per day, e.g. installation of a second reel for bottom fishing.

Since I rarely sold any of the catch (and any proceeds went to the crew) I do not have any solid information on local fish prices over the period on which to base a theoretical estimated income. However, occasional perusal of the local markets and discussions with local fishermen revealed that prices to fishermen for the bulk of species caught ranged from US$ 0.65 to US$ 0.85 per pound, depending upon species and season. Fish caught during the tradewind season, when the smaller outboards often cannot venture far from shore, would command higher prices than those caught in the summer when there is a glut on the local market. Figures from Table 3 show December-February as three of the top four months for catches, thus leading me to believe that landed prices at the higher range of the scale could be anticipated. At least one local hotel expressed an interest in purchasing the mid-depth bottom snappers (*P. auricilla* as well as *P. zonatus*) and indicated a price of US$ 1.00/lb for fish in the round delivered iced and fresh to its establishment. If an export market could be developed for the wahoo caught in the winter months, landed prices would certainly rise above the US$ 0.65 paid for that species locally during most of the year because of its relative undesirability on the local market.

The assumptions used in the following calculations are for the actual average catch over the 4-year period in this report. Fishing on a commercial basis could take place 160 days/year (4 trips per week x 40 weeks) now, and could be increased if facilities were improved to allow easier handling of gear and catch, acquisition of ice, and so forth.

A further assumption is that the fisherman obtaining a loan for this type of vessel would be one who already has equity in one of the many smaller fibreglass outboards on the island, and would finance about 80 per cent of the acquisition and start-up costs at current FSM Development Bank interest rates (9% in December 1986).

For a one-man operation averaging 103 lbs/day as in this report, earnings and expenses would be as follows:

Earnings per year (US$)	
160 days x 103 lbs/day = 16,480 lbs/yr x US$ 0.75/lb	12,360
Expenses (US$)	
Depreciation (for a US$ 13,000 vessel over 10 years excluding equipment)	1,300
Interest (80 per cent of total acquisition cost of US$ 17,000 over 8 years; figure shown is for first year only)	1,700
Variable expenses (US$ 0.15/lb for total catch)	2,472
Total expenses/year	5,472
Balance to owner (US$)	6,888

Of the several factors which could be varied to gain different income figures, one of the most reasonable would be the addition of one crewman and a second bottom-line. The second crewman would also probably tend to increase trolling catches as more fish could be pulled and a vessel of the size of *Kimeji* could become more efficient in its operation generally. If addition of the second crewman resulted in an increase in overall catch of 50 per cent, and if he were paid a quarter share of overall catch (as is assumed in several of the SPC calculations relating to economics of bottom fishing in the FSM), there could be little charge in net income to the owner, as shown below.

Earnings per year (US$)	
160 days x 150 lbs - 24,000 lbs/year x US 0.75/lb	18,000
Expenses (US$)	
Depreciation	1,300
Interest	1,700
Variable expenses	3,600
Crew share	4,500
Total expenses	11,100
Balance to owner (US$)	6,900

In the absence of any new catching technology, such as a bottom-set longline, I would favour continuing with the one-man operation from a standpoint of economic return to the owner/skipper.

Other considerations involved in having an additional crewman, such as reduction of work for the skipper, safety, companionship or fulfilment of social obligations might override the solely economic factors.

Conclusions

The vessel and engine proved themselves to be suitable for the purposes for which they were used. Little work was required on the engine other than regular maintenance, cleaning of filters, changing of belts and impellers, and so forth. The plywood decks built into the vessel and the resultant heavier load reduced its speed to about 8 knots. This still proved adequate for the fishing undertaken.

The vessel and operations undertaken with it proved to be economically viable under the 'semi-commercial' conditions experienced. Application of more commercial conditions coupled with year-round fishing should make the undertaking financially viable and provide a reasonable return to an owner/skipper. Paid crew should probably not be utilised unless new catching technologies are developed and employed which would result in increases in catch justifying additional crew expense.

On the basis of past work carried out by the SPC Deep Sea Fisheries Development Project in the FSM and my work in Pohnpei, I do not believe that such an extensive resource exists for deep bottom snappers as has been reported in Fiji, Tonga and elsewhere in the South Pacific. Extensive fishing trials should be conducted on the outer banks of FSM (particularly those between Truk and Yap) before any commercial enterprises are undertaken.

A possible reason for the lack of deep bottom snappers may be that they exist here in depths greater than in other parts of the Pacific. Practically no work has been attempted at depths in excess of 200 fathoms. Trials might be attempted at those depths, perhaps in conjunction with a bottom-set longline on an exploratory basis.