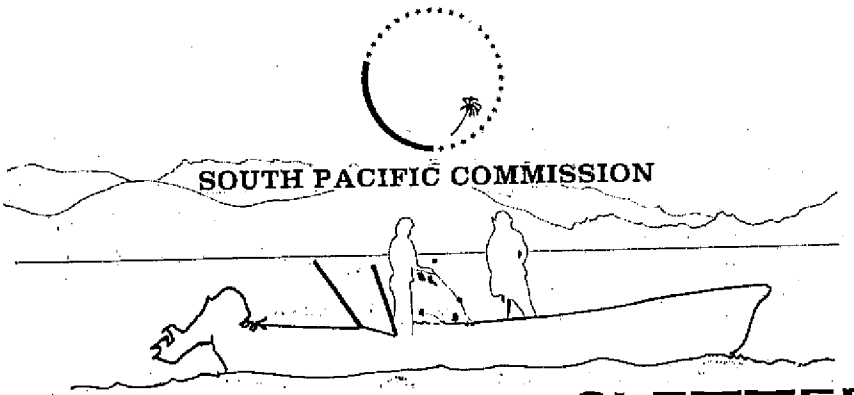

FISHERIES NEWSLETTER

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SPC ACTIVITIES

DEEP SEA FISHERIES DEVELOPMENT PROJECT NOTES

Truk — Federated States of Micronesia

Following the completion of the DFSD Project's stay in Palau, on 23 May 1988, SPC Master-fisherman Lindsay Chapman transferred directly to Truk State in the Federated States of Micronesia (FSM), arriving there on 24 May.

The purpose of this assignment was, at the request of the Truk State Government, to conduct a fishing survey by bottom-droplining to assess the deep-water snapper resources along Truk's outer reef-slope, to train government fisheries officers and local fishermen in deep-bottom dropline fishing techniques, and to examine the economic potential for the establishment of a small-scale deep-bottom fishery.

The project base was established at Moen Island, the administrative centre and one of the largest of the 15 islands and more than 80 islets which form Truk lagoon. Lindsay worked with the Truk Marine Resources Division, fishing from its 11 m fibreglass vessel *Esinou*, and by the end of September had completed 22 fishing trips, 18 around Truk lagoon's outer reef-slope, and four at the Hall Islands group to the north.

Lindsay's logsheets and catch records to date indicate that the suitability of Truk's outer reef-slope for deep-bottom droplining varies considerably from area to area: the western reef has a generally very steep outer-slope, was difficult to fish, and catches were low in comparison to other areas; the southern reef varied in outer-slope gradient as did catches, it was noticeable that productivity declined markedly with repeated fishing of any one spot; the eastern reef has a moderate outer slope and, despite this area being generally exposed to the weather, produced consistently better catches than other areas.

Big dogtooth caught in Ruo-Hall Group — Truk State

Catches recorded during the four trips made around Ruo Island in the Hall group were higher than those recorded around Truk lagoon to date, though the few trips conducted there and the fact that catches were taken from virtually unexploited stocks preclude any realistic assessment of the area's potential.

During the remainder of his stay, Lindsay plans to continue his droplining survey, extending his fishing to the areas of Truk's reef not yet fished.

Papua New Guinea

Masterfisherman Paxton Wellington, on his first DSFD Project assignment in Papua New Guinea (see SPC Fisheries Newsletter # 45), travelled from Rabaul to Kavieng in New Ireland Province on 3 July 1988 to demonstrate deep-bottom dropline fishing to staff and students at the National Fisheries College located there.

Paxton spent the first week at Kavieng, building FAO/Western Samoa-design wooden handreels and refurbishing and outfitting the College's fishing boat. He then arranged shoreside workshops and training sessions during which students were shown the essentials of rigging deep-bottom fishing gear, and discussed the locating of deep-bottom fishing grounds and fishing techniques.

From mid-July Paxton conducted 20 fishing trips with first-year students, during which practical instruction was given in all aspects of bottom-droplining, trolling and catch handling. The Project visit to Papua New Guinea concluded on 23 September 1988 and the full report of the stay is presently in preparation.

SPC Gear Development Project evaluation of Alvey reels for artisanal fishermen

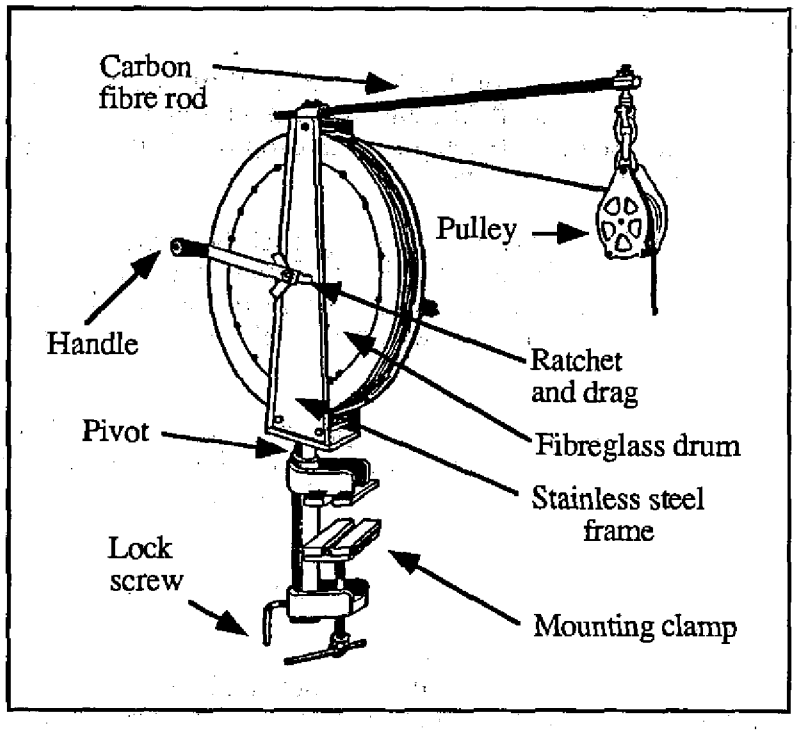
From the first assignment of the DSFD Project (in American Samoa in March 1978), there has always been an element of gear development in the practical work of the Project. The first 'official' work on gear development was undertaken on the DSFD visit to Tonga in 1980/81. Since that time simple small-scale gear development work has been an important part of the Project's work. The 1982 SPC Regional Technical Meeting on Fisheries recommended that there be 'greater emphasis on gear development', and the 1985 meeting recommended that the DSFD Project be restructured so that one of the masterfishermen be assigned full-time to the development of new and innovative fishing gear and fishing methods.

Since the 1982 recommendation the DSFD Project has devoted considerable time to different trolling techniques and gear, with one of the main objectives being the improvement of existing techniques by the adaptation of more efficient gear used successfully in other areas of the Pacific. Exceptionally versatile and effective for several fishing methods, but especially for trolling, are heavy duty reels manufactured in Australia by Charles Alvey and Son. The three basic models, listed in ascending order of size, are the Reefmaster, Reef Queen and the Reef King. Models which have been used by the DSFD Project are the Reefmaster and Reef King.

The first Alvey reel used, a galvanized Reefmaster, was supplied to the Project by Robert Kearney, then the Co-ordinator of the SPC Tuna and Billfish Assessment Programme, in May 1982, for use in gear development work. Because of what appeared to be a simple reliable breaking system, the SPC masterfisherman thought it might have potential as a trolling reel. It was not considered a promising bottom fishing reel as, due to the small inside diameter of the spool, the hauling rate was considerably less than that of the FAO-Samoan handreels being used by the DSFD Project for deep bottom fishing.

The main emphasis of the 1982-83 visit of the DSFD Project to Niue was on gear development, including sub-surface trolling. As part of this work a limited number of trolling trips were carried out using the Alvey Reefmaster rigged with approximately 80 m of 80 kg test single

strand stainless wire backed by 200 m of 130 kg test monofilament nylon. Due to its relative small size and ease of attachment, a swivelling 'G' clamp, the Reefmaster proved to be an effective trolling reel. To clear the trolling line from the stern of the boat and aid in line recovery, a short hardwood arm with attached nylon pulley was bolted on to the top of the reel frame. This arrangement worked well and the Reefmaster rigged as described was used with some success in the DSFD 1983 visit to the Cook Islands. Photos of the reel with comments and suggestions by the masterfisherman were sent to the SPC Fisheries Adviser who relayed them to the manufacturers.



Alvey Reef-King reel

In the 1984-85 DSFD visit to Fiji the Reefmaster was used for surface and sub-surface trolling in gear development-oriented work. During this Project the masterfisherman received from SPC one of Alvey's newly developed Reef King model reels which was used successfully for deep bottom fishing, surface trolling, sub-surface trolling and deep trolling. The substantially stronger frame of the Reef King was constructed of heavy stainless steel instead of galvanized steel, the outside diameter of the fibreglass spool was 460 mm instead of 280 mm as on the Reefmaster, and it was fitted with a fibreglass rod and attached nylon pulley mounted in a bracket on top of the reel frame.

Both the Reefmaster and the Reef King were used extensively for surface and subsurface trolling during the six month 1985-86 DSFD visit to Tonga. In Tonga both reels were usually rigged with 80—100 m of 49 strand 1.2 mm diameter stainless steel cable backed by 300 m of 150 kg 'Super Toto' braided line on the Reef King and 300 m of 50 kg 'Super Toto' on the Reefmaster. Since September 1986 until the present time (April 1988) these two reels have been used continuously in gear development work, mainly for subsurface and deep trolling mostly around the Vava'u area of Tonga.

That the Reefmaster and Reef King are effective and versatile trolling reels is indicated by the length of time they have had heavy use with no major repairs, by the number of species caught (over 25) and by the extreme size range of fish landed. Catches include fish as large as 50 kg yellowfin, sailfish to 76 kg, blue marlin to 85 kg, and shark mackerel as small as 0.25 kg. Although the size of fish hooked is sometimes determined by the size of the lure, it is not always true that large lure = large fish, small lure = small fish. Probably a more accurate statement would be that more large fish are **landed** on large lures. Most big lures do catch only

big fish, as small fish do not usually strike the larger lures, and because large lures are usually rigged with heavy trace and hooks and are trolled on heavy line. Both large and small fish hit smaller lures, but as the lures are usually rigged with lighter trace and hooks and trolled from fixed lines or handlines, the larger fish are lost, mainly because the fishermen are not able to give to the initial strike and run when a large fish hits.

What would appear to be a simple solution is to rig smaller lures on heavier trace and hooks and troll them off heavier line. However it is fairly widespread knowledge among fishermen in the region that a small lure rigged with heavy trace does not usually receive as many strikes or hookups as the same lure on lighter terminal rigging.

Large fish are landed on lures rigged with light trace and hooks on sporting gear due to the give of the rod and an efficient adjustable braking system. One of the main advantages of a heavy-duty Alvey reel for commercial or part time trolling is that they do have an adjustable drag or braking system which, when set properly, is capable of giving to the initial violent strike and run of large fish without exerting too much strain on the terminal gear. Due to the Alvey reel's braking system smaller lures rigged on lighter more effective terminal gear can be used successfully to land a greater size range of fish.

Characteristics that make the Alvey reel effective are:

- robust construction (mostly solid stainless steel and fibreglass)
- easy to transport, to attach and detach from the boat
- relatively compact and quick easy to store
- requires a minimum of maintenance, basically just rinsing with fresh water and a drop of oil or spray applied to moving parts
- safe and easy to use
- extremely versatile, can be used for numerous fishing methods including:
  - most methods of trolling
  - most methods of bottom fishing, from shallow water to depths exceeding 400 m
  - as effective backing for palu-ahi and ika-shibi lines

Alvey reels are economically priced when purchased directly from the manufacturers. They cost approximately three to four times more than a good hardwood FAO-Samoan handreel but less than a heavy sport fishing reel.

REGIONAL FISHERIES TRAINING PROJECT

SPC/Nelson Polytechnic Pacific Islands Fisheries Officers training course

The ninth SPC/Nelson course was held between 8 February and 15 July 1988. The course commenced with an eighteen week section at Nelson, where the participants studied a comprehensive range of subjects relevant to the practical work of a fisheries extension officer. This was followed by a five week practical fishing module at Koror, Palau.

The Nelson section followed the usual course outline, with the inclusion for the first time of basic tuition in micro-computers. Palau was a very effective venue for the practical training and allowed many of the trainees to study and practise fishing methods which they had not been exposed to in their own countries. As well as standard trolling, and various other line-fishing methods, the students were able to see or participate in mariculture activities, pole-and-line fishing, catching and holding live-bait, green-stick trolling, and surface longlining for yellowfin. SPC is grateful to the Government of the Republic of Belau and especially the Chief and staff of the Marine Resources Division for their well-organised logistical and personal support, which ensured the success of this section of the course.

Twelve fisheries officers attended, from the following countries: American Samoa (1), Cook Islands (1), Fiji (1), Federated States of Micronesia (1), Kiribati (1), Papua New Guinea (2), Solomon Islands (1), Tuvalu (1), Vanuatu (1), and Western Samoa (1).

INSHORE FISHERIES RESEARCH PROJECT

Fishery Resource Survey of Palmerston atoll, Cook Islands

Palmerston atoll in the Cook Islands is one of the major sources of fish supply to the national capital, Rarotonga. Although it is sparsely populated (66 inhabitants at the time of the survey), the island's skilled fishermen have developed a level of 'industrialisation' in the capture and processing of reef fish, especially parrot fishes, to the point where there are real grounds for concern about the future of the parrot fish resource. In response to perceptions of declines in both catch rates and the average size of the parrot fish caught, the Palmerston Island council imposed a temporary ban on parrot fish exports from the atoll, and sought the advice of the Cook Islands Ministry of Marine Resources (MMR) on ways in which the fishery might be restored to its former level. MMR in turn requested the assistance of the SPC Inshore Fisheries Research Project (IFRP) in the conduct of a field survey to gather baseline information on the status of Palmerston's parrot fish stocks, and stocks of other marine resources, and in the formulation of management advice.

Cook Islands Fisheries Officer Ned Howard with part of the catch from parrot fish survey fishing

The survey was carried out for two weeks in September 1988 as a joint exercise between MMR, IFRP, and the Forum Fisheries Agency (FFA), which contributed to funding the survey. Funding for the vessel charter necessary to get the 12-man team to and from Palmerston was contributed by the FAO/UNDP South Pacific Regional Fisheries Support Programme (RFSP). Because of its nature, every effort was made to involve field assistants

from other atoll countries, to whom the survey was of considerable relevance. The final survey team consisted of the IFRP Senior Scientist, an SPC consultant, the FFA Research Coordinator, 6 Cook Islands Fisheries Officers, and Fisheries Officers from Tuvalu, Fiji and Kiribati.

The survey allowed the collection of baseline information on the parrot fish fishery and on other resources, including trochus, pearl shell, giant clams, lobsters, and other finfish, as well as assessment of the status of the parrot fish fishery. In discussion with local fishermen and island officials, management guidelines were developed, and these were formally presented to, and discussed with, the Island Council on the day the survey team departed Palmerston. The most important recommendations concerned improved collection of statistics on fish exports from Palmerston, establishment of a permanent reserve in which fishing is prohibited, and either a continuation of the present ban for a further two years, or imposition of an annual quota of 10 t/year for 5 years. It was gratifying to see that the Council concurred with the team's recommended approach, to the point that new regulations governing the fishery came into effect the same day. A draft report was compiled on the team's return to Rarotonga, and a second meeting with MMR officials was held prior to the team's departure. The primary 'clients' of the project, the island council and MMR, were thus provided with the information they requested within a week of the survey's completion.

The draft report has been upgraded to a joint IFRP/FFA technical report and is pending publication. The process will probably take some time because of the need to obtain inputs from 12 team members in 7 different countries, and to integrate what began as three quite distinct documents — a description of the parrot fish fishery, a parrot fish management plan, and a description of fisheries for other species.

It is likely that a follow-up survey will need to be carried out 18 months to 2 years after this survey, to ascertain the effectiveness of recommended management measures. The IFRP has indicated its willingness to provide further support if required.

20TH REGIONAL TECHNICAL MEETING ON FISHERIES

The 1988 RTMF, held in Noumea from 1-5 August, was attended by 60 delegates from 25 SPC member countries and 9 international or other organisations. The meeting was chaired by Dr Meryl Williams, the Australian representative. The purpose of the meeting, as always, was to present the work of the SPC's fisheries programmes for regional review, to provide an update on the major issues facing fisheries development in the Pacific, and to facilitate the interchange of information and ideas among the region's fisheries managers.

The first item on the agenda was the restructuring of SPC's Fisheries Programmes, which had been carried out in response to a recommendation from the previous year's RTMF (see SPC Fisheries Newsletter #42). The revised structure put forward by the SPC Secretariat proposed the integration of the Coastal Fisheries Programme and the Tuna and Billfish Assessment Programme into a single entity, the Fisheries Programme, under the direction of a single overall co-ordinator. The new structure was designed to encourage greater interaction between the two sectors, as well as to streamline the administrative hierarchy and increase the ability of the programme to react quickly to country requests for specific projects, especially in the field. The proposed structure was endorsed by the meeting, which recommended its approval by the 27th South Pacific Conference, the Commission's decision-making body.

There followed a review, which took up two days of the meeting, of the activities of each of the Fisheries Programme's component projects over the past year. The **Fisheries Training Project** was described and an outline given of the major training courses and workshops run. These included the 9th SPC/ Nelson Polytechnic Pacific Island Fisheries Officers Course (22 weeks), a 2-week FAD construction and deployment workshop, the Third Regional Refrigeration Course (18 weeks), and a comprehensive training programme in extension skills, which involved a series of regional and national level courses, of 2-4 weeks each. The activities

Fish Handling and Processing Project were outlined, with descriptions of country assignments undertaken in Cook Islands, Palau, Kiribati, Guam and Tuvalu. An overview of the work of the **Deep Sea Fisheries Development Project** was given, following which each of the project's three Masterfishermen presented a more detailed description of his own activities, often using slides to illustrate aspects of fishing operations, gear, or general working conditions. DSFD Project activities were undertaken in Tonga, Palau, Federated States of Micronesia (2 assignments), Papua New Guinea and American Samoa. An outline was given of the work of the newly-established **Inshore Fisheries Research Project**, whose major activity had been the Workshop on Pacific Island Inshore Fishery Resources. This was discussed in more detail later in the meeting. The activities of the **Fisheries Statistics Project** were described, and SPC policy on the confidentiality of data submitted by member countries discussed in detail. A presentation was made on the collaborative ORSTOM/SPC **Tuna Environment Study**, which relates oceanographic conditions to tuna distribution in the region. The **Tuna and Billfish Research Project** was described, and the results presented of tagging studies carried out in Kiribati, as a precursor to larger scale studies in the Solomon Islands, and in the Western Pacific as a whole. Assessment and monitoring of levels of exploitation of stocks of commercially important tuna and billfish species, and the interactions between fisheries based on these stocks, were also discussed at length. The Programme's **Information Services** were discussed and delegates informed on progress with the production of publications, and on activities related to the inter-organisational Pacific Islands Marine Resource Information System (PIMRIS), which is a joint activity of SPC, the Forum Fisheries Agency (FFA), the University of the South Pacific (USP), and the Committee for Joint Prospecting of Offshore Resources in the South Pacific (CCOP/SOPAC).

The next agenda item was the report of the first meeting of the Standing Committee on Tuna and Billfish, whose establishment had been proposed at the previous year's RTMF. As well as providing technical advice on tuna exploitation, management and research to the RTMF, the Committee also provides an important opportunity for distant water fishing nations (DWFNs) operating in the Pacific to co-operate in the scientific work of the TBAP, and thus encourages the contribution of data to the regional tuna database by these nations. The RTMF recognised that there remain important gaps in the database and this poses fundamental problems for tuna research and management. The meeting therefore recommended that scientists or other DWFN representatives be encouraged to attend future meetings of the Committee, and that SPC formally request its member countries to encourage DWFN co-operation in the Committee during access and license fee negotiations, and at other opportunities.

A joint SPC/FFA initiative to provide computer training to fisheries workers was the next item to be discussed. Several options for the content and scheduling of a series of linked training courses and workshops were considered and the meeting ultimately recommended that the programme be carried out by the organisations involved as soon as possible.

The meeting then turned its attention to a proposal for a regional trial purse seining programme, which would assess the feasibility of this type of fishing using smaller vessels and in a wider range of fishing zones and conditions than is presently the case. The proposal for a four-stage project (I - preparatory study; II - detailed project definition; III - final project implementation and operation; IV - project evaluation), to run over five years and co-ordinated through SPC, had already been approved in principle by the SPC Committee of Representatives of Governments and Administrations (CRGA) subject to the technical scrutiny of the RTMF. The CRGA had empowered the Secretariat to proceed with phase I, the report of which was tabled at this meeting. Funding had also been identified for phase II if the project was approved by this meeting and, ultimately, the South Pacific Conference. After having carefully considered the proposal and the phase I report, the meeting unanimously endorsed CRGA approval of the project and recommended early implementation of the phase II activity.

As is the practice each year, a one-day workshop was held on an issue of topical interest in Pacific Island fisheries development. The subject of this year's workshop was fish poisoning and seafood toxicity. It focused extensively on the fish consumption and marketing, and public health, implications of ciguatera poisoning. Much interest was shown in recent advances in the

detection of ciguatoxicity in fish samples, and participants had the opportunity to observe the newly developed 'poke-stick' test from the University of Hawaii, as well as a slide show illustrating the better established mosquito bioassay used by the Institut des recherches médicales Louis Malardé in French Polynesia. The workshop concluded with the formulation of several recommendations: that the poke-stick test be evaluated by appropriate laboratories in the region; that the SPC Fisheries and health programmes collaborate in the production of a concise manual to aid clinical diagnosis of ciguatera cases; and that the Commission increase its encouragement and support to national programmes to improve the diagnosis and formal notification of instances of fish poisoning.

The next item was a detailed account of the Workshop on Pacific Inshore Fishery Resources, already referred to briefly under the review of SPC Fisheries programme activities. The major issues raised by the workshop regarding inshore fisheries research and management were outlined. These included in particular the difficulties in reducing effort in over-exploited fisheries (which warrants a cautious approach to fisheries development) and the fundamental conflict between 'modern' views of fisheries management, which are based on western views of fishery resources as common property, and traditional systems of marine tenure in the Pacific. As a result of the workshop, the future work programme of the Inshore Fisheries Research Project is now more clearly defined, and this was discussed in detail by the meeting.

A proposal for establishing a regional post-harvest fisheries laboratory, as a joint activity between the SPC Fish Handling and Processing Project and the USP Institute of Marine Resources, was then presented. The function of such a laboratory would be to allow applied research and training in appropriate areas of post-harvest fishery technology, including product storage trials, microbiological evaluation, product development, packaging technology, improved processing and storage methods, quality assessment and assurance, and investigation of new products or by-products. Much of this work is a necessary precursor to the development of value-added products, especially for the export market, and many countries represented at the meeting strongly supported the concept of the project. However, the meeting agreed that the proposal needed further development, specifically in determining appropriate inter-organisational arrangements, and recommended the formation of a small committee to undertake this task.

The meeting then considered a proposal for a joint investigation by the SPC Inshore Fisheries Research Project (IFRP) and the FAO South Pacific Regional Aquaculture Development Project (SPRADP) into the potential of reef ranching or reseeding in the tropical Pacific. There is considerable interest in reef ranching and reseeding, both as a means of improving fishery yields of selected species and as a means of managing heavily fished resources, but little hard information on the successes or failures of trials carried out elsewhere. This present proposal involved two phases aimed at improving the availability of information on this topic: firstly, a collaborative literature review of worldwide experience with restocking programmes for marine resources: and secondly, if appropriate, one or more field trials in collaboration with interested member governments. The field trials, which would involve one or more controlled juvenile releases, would be heavily monitored by the IFRP, with the SPRADP taking responsibility for all aquaculture-related elements. The meeting expressed its support for the proposal, which would not require additional funding support since it could be carried out using the operational funds of both projects, and recommended its implementation.

The meeting finished with short presentations of the work done by other organisations involved in fisheries development in the region. The Western Samoan representative described the successful results of testing of diesel-powered outboard motors in his country. The representatives of the International Center for Living Aquatic Resource Management, the FAO/UNDP Regional Fisheries Support Programme, the Japanese Overseas Fishery Cooperation Foundation, the Queensland Department of Primary Industries, the USP Institute of Marine Resources, and the Forum Fisheries Agency all briefly described the recent activities of their organisations and answered questions from the floor.

A number of other technical issues, not recorded here, arose during the meeting, which once again provided a forum for frank and open discussion on a wide range of topics of common interest to the fisheries bodies of the region. The technical guidance received will ensure that SPC's fisheries activities continue to be tuned to the needs and aspirations of its Pacific Island member countries.

NEWS FROM IN AND AROUND THE REGION

FOUR AUSTRALIAN BOATS TO FISH IN THE WEST OF PNG

(Source: *The Times of PNG*)

Four Australian-based trawlers have started prawn fishing in PNG's Western Province as of August 1988. At a brief ceremony in Daru to officially announce this, Premier Norbert Makmop said foreign investment in his province was welcome but must comply with the policies of the National and Provincial Governments. He said his province lacked investment capital and required assistance from foreign companies in fishing, forestry and agriculture.

The four trawlers, owned by Specialist Seafoods Company based in Townsville, arrived in Daru after the National Government issued them licences to fish exclusively for prawns in Western Province waters. The catch will be sold to Specialist Seafoods in Townsville through the freezer and wholesale division of Proves, a company based in Port Moresby.

This is an interim arrangement, under which the company is given up to six months to operate. The Chairman of Specialist Seafoods, Bill Hughes, said if their operations within these six months prove viable, they will consider renewing the licence.

At the moment the four vessels are captained by Australians, but will eventually be taken over by nationals. Capable Papua New Guineans will be recruited to understudy then replace the four Australians, Mr Hughes said.

POHNPEI SHELL EXPORTS

(Source: *Pacific Magazine*)

The second largest shell export from Pohnpei is handicrafts made locally by artisans of Kapingamarangi. There is no shortage of materials. The largest export, however, is trochus shells sold to local and Japanese interests for the manufacture of quality buttons and jewellery and there definitely is a shortage. Twelve thousand shells were originally planted on Pohnpei's reefs in 1937 by the Japanese Government, and they multiplied during World War II when they were possibly the only Japanese targets missed by American bombs on Pohnpei. In recent years, however, the shells have been gathered commercially with such enthusiasm that the legal collecting season has been continually shortened. This year the open season was only three days in length, 19-21 July from 5 a.m. to 6 p.m. Only live trochus were accepted by the buyers so that undersized shells could be returned to the sea for another year. This move by the Government also discouraged harvesting and storing trochus shells before the beginning of the season.

TECHNICAL ASSISTANCE FOR FISHERIES

(Source: *Pacific Magazine*)

A consortium of Pacific Island nations will receive more than US$12 million annually from the tuna industry and in U.S. assistance with the signing of the South Pacific Tuna Act. The Act gives U.S. tuna fishermen access to more than 10 million square miles of fishing waters in the South Pacific. The fishermen will buy licences to operate in the waters and the tuna industry has guaranteed the island nations a minimum payment of $250,000 annually in technical assistance for fisheries. 'In the past, American tuna boats have been arrested by several South Pacific nations for fishing in sovereign exclusive economic zones (EEZs) without proper licenses,' said Ben Blaz, Guam's delegate to the US Congress. 'There was growing resentment over these "jolly roger" tactics of the American boats and the refusal to recognise national jurisdiction over the EEZ's tuna and the refusal to purchase licenses to fish in the disputed waters, which is their major natural resource and primary producer of foreign exchange for the struggling, largely land-poor island nations', Blaz said.

SYMPOSIUM ON REMOTE SENSING OF THE COASTAL ZONE

This symposium, held as part of the Australian Expo 88 Scientific Conference Series, ran from 7-9 September 1988. Participants were mainly from agencies in Australia and South-East Asia, but with some inputs from U.S. and European scientists.

The symposium focused on the application of remote sensing technology to the problems of coastal zone development and management. The common perception of remote sensing is increasingly becoming centred on the use of satellite images such as those obtained from LANDSAT or SPOT. However, many presentations at the symposium illustrated the usefulness of less well-known technologies, including medium and high resolution imaging spectrometers, side-looking airborne radar, laser airborne depth sounders, advanced very high resolution radar, and visible light and infra-red aerial photography. Digital images can be obtained from all these sources and more, and manipulated to reveal often very detailed information about study sites that may range from a small area to one covering thousands of square kilometres.

The uses to which these technologies can be put are varied and of interest to a wide range of potential users in all areas of coastal zone development and management, including resource assessment and environmental monitoring. The various participants presented papers illustrating some of the applications: mapping of seagrass beds and the distributions of other aquatic plants, water quality monitoring, observing the movement of effluent plumes, shallow-water marine resource exploration and assessment, measurement of reef areas, determination of coastal water depths, and even identifying wetland mosquito breeding areas.

The applications of remote sensing for tropical fisheries purposes in the Pacific Islands have yet to be demonstrated. However there seems to be potential in a number of areas, especially in monitoring coastal zone developments that may affect fisheries production, and in carrying out basic resource surveys and assessments in remote areas that are costly to survey by traditional means.

CANADA GIVES MONEY FOR REGIONAL PROJECTS

(Source: *Fiji Times*)

The Canadian Government is giving $C10 million over five years in aid for a regional ocean development project. The $10 million contribution will come from the Canadian International Development Agency(CIDA). The International Center for Ocean Development (ICOD), a

crown corporation based in Halifax, will manage the project. ICOD will work with four regional partner institutions: SPEC; CCOP/SOPAC; the South Pacific Forum Fisheries Agency (FFA); and USP.

The Canadian ambassador, Mr Douglas Small, who is based in Wellington, signed an agreement in Suva on August 1988 with the heads of three regional organisations involved in ocean resource development and management. Mr Small signed the agreement (called the Canada-South Pacific Ocean Development Project) on behalf of Monique Landry, Minister for External Relations and International Development, with Mr Henry Naisali, Director of the South Pacific Bureau for Economic Co-operation (SPEC); Mr Jioji Kotobalavu, Director of the Committee for the Coordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas (CCOP/SOPAC); and Mr Geoffrey Caston, Vice-Chancellor of the University of the South Pacific (USP). The agreement was signed at SPEC headquarters. Earlier this month, Canada signed the memorandum with the FFA in Honiara, Solomon Islands.

'The project will help promote regional development by strengthening support for the major regional institutions engaged in ocean resource development and management in the area,' Mr Small said. 'The Island Nations of the South Pacific have an excellent record of achieving their development goals through co-operative regional action. We feel that Canada is particularly well-suited to assist in this process in the sector of ocean development and management.'

Canada's new development assistance strategy, 'Sharing Our Future', announced in March 1988, emphasises strengthening the ability of people and institutions in developing countries to solve their own problems in harmony with the natural environment. 'Many of the people of the island nations of the Pacific are dependent on the sea for their livelihood, but per capita income is low and development difficult, mainly because the population is spread over a large area. The Canadian contribution will support projects in the inshore and offshore mineral exploration and management, marine transportation, marine policy, and the protection and preservation of the marine environment', Mr Small said.

Canada has provided assistance to the South Pacific region since the early 1970s. In 1971 CIDA contributed $750,000 for a research vessel and marine science equipment for a tropical fisheries training project, and in 1978-81, $8 million for the construction of the Institute of Marine Resources. ICOD has committed $4 million to over 30 ocean management projects since 1985, with a further $6 million to be spent over the next five years.

Canada has also supported development in the South Pacific by using funds from the Canadian High Commissions in Australia and New Zealand for a variety of grassroots projects, and through participation in international multilateral agencies such as the United Nations Development Programme and the Commonwealth Fund for Technical Cooperation. Canadian non-governmental organisations, with CIDA backing, have been working in the area for many years. CUSO is the largest, with nearly 100 Canadian advisers in Papua New Guinea, Vanuatu and the Solomon Islands.

6TH INTERNATIONAL CORAL REEF SYMPOSIUM

The 6th International Coral Reef Symposium was held in Townsville, in Queensland, Australia, from 8-12 August 1988. It provided a collaborative forum for the discussion of three major areas of coral reef research: the biological and physical bases of present day reef systems, the imperatives and methods of management practices, and the historical perspective of reef environments provided by geological studies.

The scientific programme was developed to encompass twenty-two mini-symposia covering a number of topics in the fields of biology, geology and reef management. These included such diverse subjects as recruitment processes, herbivory and predation, *Acanthaster* biology,

human and environmental impacts on reefs, and the emerging importance of research methodologies such as remote sensing.

633 participants from 49 countries were registered at the Symposium, including scientists from several Pacific Island countries (Cook Islands, Federated States of Micronesia, Fiji, French Polynesia Guam, New Caledonia, Papua New Guinea and the Solomon Islands). A total of 360 oral presentations were made, 21 of which were status reviews, and a further 164 posters were presented. The contributions are presently being edited and will appear as conference proceedings.

USP COUNCIL BACKS MARINE AFFAIRS TEACHING AND RESEARCH

(Source: *Tonga Chronicle*)

A marine affairs teaching and research development plan was recently endorsed by the Council of the University of the South Pacific in Suva, Fiji.

The plan, which is anticipated to be highly decentralised, includes:

- development of degree programmes in marine-related studies, with new courses in oceanography, fisheries economics, and marine geology;
- expansion of short courses and non-degree offerings in all aspects of marine affairs;
- encouragement of research by both students and staff.

Although funding for the plan has yet to be found, the university has already established the post of Co-ordinator of Marine Studies, combining it with the directorship of the Institute of Marine Resources. It has also established a co-ordinating committee to develop the programmes. The committee will include university scientists and representatives of regional agencies. The committee will absorb the work of the IMR Programme Review Group and the Ocean Resource Management Programme Working Group.

U.S. PRECIOUS CORAL RESOURCE MANAGEMENT

(Source: *Pacific Daily News*)

The precious corals that are the gems of the sea grow slowly and in deep water. They choose places with firm bottoms on which they anchor themselves, and where strong currents flow around their branches. The pink, gold and bamboo corals live a long time, reproduce slowly and are found in colonies with members of many ages. Dragging a dredge net repeatedly through a colony can seriously damage it, and it takes many years, decades, for such a colony to regain its former size.

The history of precious coral collecting shows repeatedly that after discovery, colonies have been fished until the corals were depleted, said Richard Grigg, of the University of Hawaii's Oceanography Department, in the environmental assessment for proposed new regulations for precious coral harvesting. Among Pacific areas with United States control, precious corals have been found in six spots around the Hawaiian Islands, off Palmyra island, and may also exist around other island groups. Of all known colonies, only the one off Makapuu, Oahu has been accurately surveyed, and it is the largest colony known among U.S. possessions.

Fisheries officials fear that a resource about which so little is known, and which is so sensitive to overharvesting, needs protection and management. The Western Pacific Regional Fishery Management Council has proposed an amendment to its Precious Corals Fishery Management Plan for the Western Pacific Region.

To better protect the coral colonies and establish guidelines that will allow coral harvesting without overharvesting, the amendment would expand the corals plan. It would include those United States possessions in the Pacific where precious corals are likely to be found. These are the 200-mile exclusive economic zones around Wake Island, Johnston Atoll, Kingman Reef, Palmyra, Jarvis Island and Howland and Baker Islands. All these waters together would be considered a single exploratory area. Management would be extended to all species, whether now known or not, of the precious pink coral genus, *Corrallium*. At least one new species has been found in the 1980s, and others may later be found, and under the existing plan, they would not be covered. The pink and red *Corrallium* corals are the most valuable part of the precious coral industry.

To promote coral fishing and to gather information about now undiscovered coral beds, the amendment would establish a programme of experimental fishing permits for areas where such corals are suspected but not known to exist. While there is an annual harvest limit of 2 200 pounds (1 000 kg) for all corals in each exploratory area, the experimental permits would allow larger takes to help justify the financial risks to boats that go looking. The quotas could be changed once an estimate of the size of colonies is developed.

The new amendment could be in place by mid-August, following approvals by the National Marine Fisheries Service and the Secretary of Commerce. The exploratory areas, in addition to the new one cited above, are waters around Guam, around American Samoa, and in the Hawaiian Archipelago outside the known coral beds.

U.S. experts are anxious to re-establish a presence in coral harvesting, and to gather better information on the resources. Today, there is no American coral harvesting underway since Maui Divers of Hawaii shut down its submersible harvesting programme a few years ago. Most Pacific precious coral is collected by Japanese and Taiwanese firms. Most of the coral seems to come from waters far west of Hawaii, with much harvested from the Emperor Seamounts. But U.S. officials are aware there's also plenty of poaching of corals within U.S. waters. 'The foreigners are out there poaching, and they're selling our coral back to us', said Kitty Simonds, executive director of the Western Pacific Fishery Management Council.

Justin Rutka, Council staff economist, said that one of the best potential coral beds in U.S. waters may lie on the Hancock Seamount, beyond Midway and Kure. American officials think it's a good one, because poachers have been extremely active there, particularly in the late 1970s and early 1980s.

HATCHERY HELP

(Source: *Pacific Daily News*)

Many people feel that aquaculture has a promising future on Guam because of its climate, the availability of land for ponds, ample water and a large market. Unfortunately, the reality is not there. Few farmers have been able to produce prawns, shrimp or fish with any degree of profit.

Now Guam is getting some help from the Oceanic Institute, along with Federal funding. The Guam Aquaculture Development and Training Center hatchery in Mangilao resumed operations in mid-August 1988. It was built a number of years ago by a Chinese businessman at considerable expense, and acquired by the Government of Guam as a tax lien.

The Center will be used to supply local farmers with prawn postlarvae and will be operated on an experimental basis at first, hopefully developing to be a commercial, private venture eventually.

TONGA COAST PATROL INSTALLED

(Source: *Tonga Chronicle*)

The Jean Hamilton Foundation for Marine Safety announced the installation of the Friendly Islands Voluntary Coast Patrol on 4 July in honor of the 70th birthday of His Majesty King Taufa'ahau Tupou IV. The patrol, with a core of 12 including professional people, will serve all users of the sea from its base on Fafa Island.

In addition to installing the patrol, the foundation aims to improve marine safety by:

- importing and retailing at cost marine safety equipment such as emergency radio beepers, strobe lights, flares, and life jackets;
- establishing bases to receive emergency signals;
- arranging a central radio base station equipped with UHF and CB equipment;
- purchasing or leasing heavy-weather search-and-rescue boats equipped with satellite navigation equipment;
- posting safety notices at strategic points, particularly near major hotels and on island resorts;
- setting up a safety-training programme, including swimming classes and training on behavior at sea for school children.

To raise funds the Foundation is seeking overseas sponsors for the first annual Off-shore Power-boat Race, scheduled for December 28 1988. The race will include several classes, including local 15-footers and an open free-style event.

Mr Bernt Eisgruber of Fafa Island Resort, who helped to create the Foundation, said that the proposed race would be used also to stimulate more awareness of safety at sea and would likely develop into a major tourist attraction. He added that it would be a most appropriate fund-raiser, since Miss Hamilton 'loved power boating'. In support of the coast patrol, Fafa Island Resort has already ordered UHF and CB equipment for its four boats including a 20ft rescue barge, which will also be used for the patrol. This week the resort management also ordered construction of a speed-boat.

Meanwhile, Mr Frank Cooper of Canberra, Australia, who is holidaying at the resort, has agreed to provide his boat, the *FJ* to the patrol at no cost until the speedboat is ready. The *FJ*, a completely rigged game-fishing boat will be used to raise money for the patrol through fishing and pleasure trips around Tongatapu.

The resort's motorised sailboat, *Kurti*, intended as the other ship of a patrol fleet, has been fitted with a new mast and sail. In addition, a more powerful diesel engine has been purchased for it and a long-range diesel and water tanks are to be installed. The craft has been described as a stable, fast and economic displacement yacht, with cruising speeds up to 10 knots.

The foundation, a non-profit organisation was inaugurated last month by Her Royal Highness Princess Salote Mafile'o Pilolevu Tuita, and by Mr Eisgruber and his wife Gabi in memory of Miss Jean Hamilton, 23, of Engadine, Sydney Australia who vanished at sea near Fafa Island on May 25 while surf-skiing.

TUNA TREATY MILESTONE IN PNG

(Source: *Pacific Magazine*)

In June, in Port Moresby, Papua New Guinea, the United States Ambassador Everett Bierman deposited his country's instrument of ratification for the South Pacific tuna treaty. The ceremony was simple but significant, because with the deposition of the U.S. instrument, the treaty took effect.

The ceremony, at Papua New Guinea's Parliament House, was witnessed by the Prime Minister, the Hon. Paias Wingti, flanked by his ministers, heads of government departments and the country's diplomatic corps. The South Pacific Forum Fisheries Agency's deputy director, Dr David Doulman and Transform Aqorau, legal officer for Solomon Islands' Ministry of Foreign Affairs, were present at the ceremony and represented the South Pacific parties to the treaty.

The ceremony took place in Port Moresby because Papua New Guinea is depository for the treaty. Fifteen South Pacific countries have signed the treaty, while 12 have completed their respective ratification processes. The remaining three South Pacific countries that have signed the treaty, but which have not yet ratified it, are expected to do so shortly.

Speaking at the ceremony, Bierman said that the treaty's entry into force represented the beginning of a new era in co-operation between the United States and the South Pacific countries in the area of fisheries and fisheries development. He went on to say that the treaty would give U.S. fishermen access to one of the world's richest fishing grounds. Bierman reiterated that the United States looked forward to close and friendly relations with the peoples of the South Pacific. At a press conference after the ceremony he indicated that the United States would certainly wish to extend the treaty after it expires in 1993.

Dr Doulman said that many commentators had been sceptical that the United States and South Pacific countries could conclude a fisheries treaty. However, he said that the sceptics had been proved wrong. He added that the treaty represented international co-operation and understanding in a real and practical way.

Papua New Guinea's Minister for Fisheries and Marine Resources, the Hon. Thomas Negints, accepted the U.S. instrument of ratification from the U.S. Ambassador. In accepting the instrument from the Ambassador, Negints said that the United States had shown its genuine commitment to the South Pacific by making the treaty a reality. He added that the treaty should foster closer ties between the United States and the countries of the South Pacific. In doing so, the United States recognised the sovereign rights of south Pacific countries over their fisheries resources.

Under the provisions of the treaty, U.S. industry and government will pay a total of $60 million over five years. Most of the revenue will be divided among the South Pacific countries on the basis of where the fish are caught. There is likely to be a disproportionate share of revenue going to a small number of south Pacific countries. This is largely because of the distribution of tuna resources throughout the region and the distribution of fishing effort. Technical co-operation provided by U.S. industry will be aimed at providing South Pacific countries with ways and means to strengthen and expand their commercial fisheries undertakings. Each year the countries will notify the United States of the type of technical co-operation needed.

In addition, the U.S. Government has major responsibilities under the treaty with respect to controlling and monitoring the activities of its previously undisciplined and buccaneering purse seine fleet. Significantly, the treaty incorporates Law of the Sea language. Most of the South Pacific have signed the Law of the Sea Convention, but the United States has not. However, this does not affect the South Pacific treaty in any way.

Negotiations for the treaty started in late 1984 following the seizure of the U.S. purse seine vessel, *Jeanette Diana*, for illegal fishing in Solomon Islands' Exclusive Economic Zone. The negotiations were at times bitter and stormy, especially in the early rounds when the American Tunaboat Association played an influential role. The negotiations took ten rounds and two years to complete. The treaty was signed in Port Moresby in February 1987.

The Solomon Island-based South Pacific Forum Fisheries Agency will administer the treaty on behalf of its member countries. Barerei Onorio, former chief fisheries officer in Kiribati, has been appointed to the agency to handle administrative tasks associated with the treaty. He was closely associated with the negotiation of the treaty and has been involved with the U.S. purse seine fleet for a number of years.

The Forum Fisheries Agency has already issued licenses to a large number of the purse seine fleet. These licences will be effective for one year. Under the terms of the treaty the South Pacific countries will place observers on board selected vessels to check vessel operations and catch reporting. These observers have wide ranging powers and responsibilities under the treaty. All observers have had specialised training and most are experienced fisheries and surveillance officers from South Pacific countries.

While the treaty's entry into force was welcomed generally throughout the South Pacific, the parliamentary opposition in Papua New Guinea called on the Government to withdraw from the treaty. The opposition described the treaty as a 'rip-off' by the United States rather than gainful economic co-operation. However, the opposition's criticism of the treaty appeared to be politically motivated and not based on a comprehensive understanding of the treaty's provisions and benefits.

Following the Port Moresby ceremony, Papua New Guinea's Prime Minister issued a press statement concerning the treaty's entry into force. He said that the treaty represented a historic milestone in relations between South Pacific countries and the United States.

As a result of the tuna treaty entering into force and the recognition by the United States of the South Pacific countries' sovereignty over their tuna resources, it is likely that increasing pressure will come from American Samoa, Guam and the Marianas for the United States to formally exert jurisdiction over its tuna resources. While the Federated States of Micronesia, the Marshall Islands and Palau derive significant amounts of revenue each year from distant-water tuna fishermen, the neighboring U.S. territories miss out because of the non-recognition by the United States of coastal state sovereignty over tuna stocks.

NEW CENTRE OF OCEAN INFORMATION TO OPEN SOON

(Source: *Fiji Times*)

The South Pacific island states are co-operating to set up a regional ocean-related information system. The Pacific Islands Marine Resources Information system (PIMRIS) will create a network of information centres in Suva, Honiara and Noumea.

PIMRIS recently received a boost with the signing of a $368,000 agreement between the University of the South Pacific and Canada's International Centre for Ocean Development (ICOD). This will help create a regional co-ordination unit to link the Pacific Information Centre at USP with three other regional agencies: the South Pacific Forum Fisheries Agency (FFA); the South Pacific Commission (SPC); and the Committee for the Coordination of Joint Prospecting in South Pacific Offshore Areas (CCOP/SOPAC).

USP Pro-Vice Chancellor, Dr Subramaniam Pillay, called the agreement a milestone in the development of a systematic ocean management approach. 'Our researchers and decision makers will soon gain instant access to vital marine information related to fisheries and offshore

minerals. Managing this kind of information is a major step in managing the resources themselves', Dr Pillay said.

The August 22 agreement with USP is part of a new $1.8 million ICOD aid package to the South Pacific region. The package includes a $120,000 scholarship programme enabling four Palauan students to get a Tropical Fisheries Diploma at USP. In all, the Canadian donor agency has committed $10 million in technical help, training and information programmes to the South Pacific region over five years. ICOD will also act as an implementing agency for an additional $10 million aid on behalf of the Canadian International Development Agency (CIDA). As a result of increased activity, ICOD and CIDA will open a regional office in Suva later this year.

MARLIN SINKS BOAT

(Source: *Pacific Daily News*)

A Guam man was missing and feared drowned at sea after a hooked marlin sank his fishing boat off Tarague beach. The man, together with a companion, hooked the marlin from their 7 m boat about 3 km offshore, but while trying to boat it the marlin rammed and holed the boat, which quickly filled with water and sank.

After clinging to the boat's fishbox the men abandoned it in fear that sharks would be attracted. They then attempted to swim to shore, but heavy rainstorm and wind separated them. One of the fishermen was picked up by the Coast Guard during the night but a search of the waters nearby and of adjacent beaches showed no sign of his companion.

NEW ZEALAND GOVERNMENT ANNOUNCES MAORI FISHING AGREEMENT

(Source: *New Zealand Government*)

The New Zealand Government said in September that it had reached an historic agreement with the native Maori people to return half of the country's offshore fishing resources to Maori control over 20 years.

Prime Minister David Lange said the Government would return 2.5 per cent of the fishing quota to Maori control each year. Wellington will also provide financial help for the Maoris for fishing vessels and other facilities needed to take an immediate role in the New Zealand fishing industry.

Mr Lange said legislation cementing the agreement with Maori negotiators would be introduced in Parliament immediately. It will include a clause limiting any further Maori fishing claims for the next 20 years. He gave no final figure for the cost but earlier estimates put the Maori share of the fishing resources after 20 years at $A 643.50 million. The agreement is the first to give legal force to the 148 year-old Treaty of Waitangi, which promised the Maoris ownership and control of their forests, lands and fisheries.

The quota allocation of 2.5 per cent a year will allow Maoris to catch 16,000 tonnes of wetfish increasing by the same amount for the next 20 years. The fishing industry has vowed to fight the proposal and is considering court action. Maoris label opponents of the deal racist and claim hysteria is causing a nationwide backlash against them.

The fisheries talks began early this year after the New Zealand Maori Council successfully took the government to court to prevent it handing Crown land — granted to it by Maori tribes — to government-owned groups. After the landmark decision, negotiations began on claims for compensation for large areas of the country. Local courts have also ruled that the Maoris' traditional rights to fish over-rode laws and regulations on coastal fishing.

DETAINEES PAY THEIR WAY
(Source: *Pacific Daily News*)

Following the arrest and conviction of 25 Indonesian fishermen for illegal trochus fishing in Palau (see *SPC Fisheries Newsletter* # 44) the Indonesian Government is reported to have asked Palau to repatriate the detainees at Palau's expense.

'The Government of Palau is not that rich to be able to do that', according to Bureau of Public Safety Director, Kaoro Brell. Instead, says Brell, the fishermen, who have been assigned family sponsors in Palau, will each have US$50 per month credited to an account in the Palau Supreme Court for the work they do for their sponsors. The Indonesians will also receive US$10 per months to buy articles such as cigarettes. Once they have accumulated sufficient credit for their airfares they will be sent home.

PURSE SEINERS FOR SOLOMONS
(Source: *Fiji Times*)

Solomon Islands recently took delivery of two Australian-built purse seiners which will join the national pole-and-line fleet in tuna catching in the nation's 1.3 million square km exclusive economic zone.

The 57 m, 500 tonne *Solomon Premier* and *Solomon Chieftain*, which together cost some A$30 million to build, are sophisticated vessels equipped with the latest fishing technology, including 'bird radar' capable of locating seabirds which pinpoint tuna schools. On its first set, made just before reaching Honiara, the *Solomon Premier* took 40 tonnes of fish. Each vessel has a carrying capacity of 520 to 530 tonnes of frozen fish and a freezing capacity of about 80 tonnes/24 hours.

VANUATU RESTRICTS COCONUT CRAB TRADE
(Source: *South Seas Digest*)

Vanuatu Fisheries Department has placed a three-month ban on the sale of coconut crabs from the northern Torres Islands, following a report requested by the Torres Islands' council and funded by the Australian Centre for International Agricultural Research, which found that the stocks there were threatened by over-exploitation.

During the period of the ban fisheries authorities will develop management guidelines to regulate the trade, which last year saw up to one tonne of crabs shipped to Port Vila restaurants weekly.

HAWAIIAN RESEARCHERS TRACK MARLIN
(Source: *West Hawaii Today*)

National Marine Fisheries Service (NMFS) scientists working with the Pacific Gamefish Research Foundation managed to tag three marlin with ultrasonic transmitters and track the fish over several days in Hawaiian waters during September.

The research project is similar to other sonic-tagging programmes sponsored by NMFS (see *SPC Fisheries Newsletter* # 43) which attempt to gain an understanding of billfish behaviour and movement. Once tagged the fish are released and followed by a research vessel, the

researchers being able to read the marlins' position and depth from on-board monitoring equipment.

The three Hawaiian fish all tended to head offshore into deeper water after release. They swam at speeds between 1.5 and 2 knots and at depths ranging from the surface down to 180 m. The marlin swam deeper during daylight hours, usually between 45 m and 60 m, but stayed within 12 m of the surface at night.

OCEAN RESOURCES AND MANAGEMENT SCHOLARSHIP AVAILABLE

(Source: International Centre for Ocean Development [ICOD]

The Canadian development agency ICOD each year offers scholarships for selected candidates to attend training courses in ocean resources development and management. Candidates from developing South Pacific countries are eligible for selection so long as they are nominated by the government or institutions in their country of origin.

Up to twenty scholarships each year are awarded for candidates to attend a one-year graduate diploma programme in Marine Affairs. Ten scholarships are available for study in English at Dalhousie University and ten for study in French at the Université du Québec at Rimouski.

Up to twenty other scholarships are granted each year for study at the Master's level in marine-related fields at Canadian universities. Further scholarships enable students to attend the World Maritime University in Sweden and the regional universities of the West Indies, South Pacific and Papua New Guinea. ICOD also offers a limited number of awards for participation in the International Ocean Institute's ten-week training programme in the 'Conservation and Management of Marine Resources: The Exclusive Economic Zone.'

Governments wishing to obtain further information on eligibility, academic requirements and application deadlines may contact ICOD's Training Division. Governments and individuals seeking further information about marine-related training in Canada will find ICOD's recent publication, *Directory of Marine Training in Canada*, useful. The new directory includes details of programmes, courses and associated research specialisations of 72 Canadian universities, colleges, technical schools and government departments. Requests for copies of the directory should be addressed to the Information Division, 5670 Spring Garden Road, 9th Floor, Halifax, Nova Scotia, Canada B3J 1H6. Telephone: (904) 426-1512. Telex: 019-21670 ICODHFX.

MARSHALLS BUY TUNA BOAT

(Source: *Pacific Daily News*)

The Republic of the Marshall Islands recently brought its first tuna purse-seiner with the help of a US$3.6 million loan through the U.S. National Marine Fisheries Service.

The vessel, formerly owned by the Starkist Tuna company, is now being outfitted in a Singapore shipyard. After the installation of new navigation equipment, and extra deep net and new booms, the fishing boat is expected to be in operation by November, 1989.

The Marshall Islands is looking to recruit six or seven Marshallese fishermen to work aboard the boat which, although it will have Majuro as its home port, will spend most of its time fishing elsewhere in the Pacific.

The Marshall Islands Government has a contract with Starkist guaranteeing that company's purchase of the seiner's catch — this was part of the sale agreement. The Project is a government joint venture with U.S. tuna fisherman Fermin Ferrera, who gained notoriety last

year when his fishing boat was impounded by the Government of Kiribati and later sold back to him for US$1 million.

Meanwhile, the Marshall Islands Marine Resources Authority (MIMRA) has announced that the Marshall Islands earned more than US$ 900 000 during the last fishing year through its treaty with Japanese tuna-fishing companies. The fishing year, which ended April 30, 1988 brought the Marshalls about US$ 800 000 in fees and US$ 105 000 in goods and services from Japan, said Steve Muller, Director of the MIMRA. The earnings have been nearly the same for the past three years, according to MIMRA figures.

A total of 266 trips to the Marshalls were made by a combination of 151 longline and pole-and-line boats during the period. The longline vessels catch mostly yellowfin (45% of their catch) and bigeye tuna (40%). Smaller amounts of albacore, blue marlin and sharks are also caught. Pole-and-line boats catch mostly skipjack tuna which is used mainly for **katsuobushi** (steamed and dried fish) and canning.

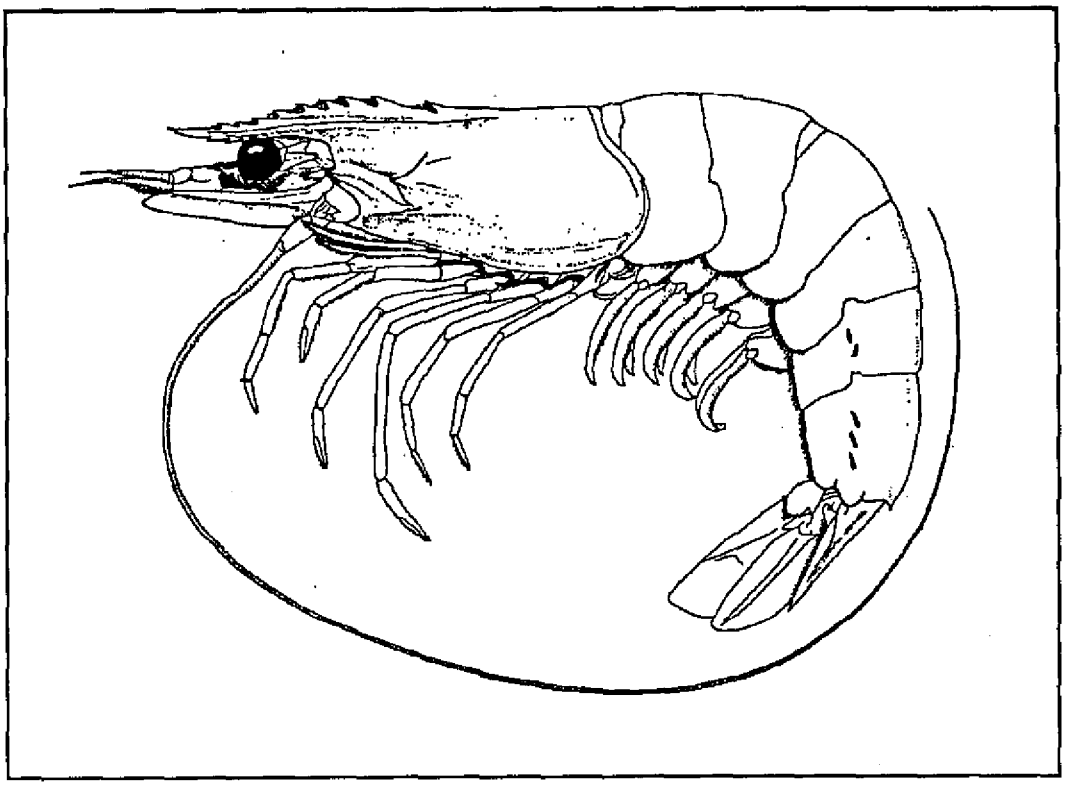
According to the treaty, the price that Japanese fishermen pay for fish is based on a formula involving initial access fees and the landed catch value at the time of sale. Prices in the four Japanese ports where the fish is unloaded vary from month to month. The Marshalls' payment is roughly four per cent of the landed catch value.

According to MIMRA figures, the 1987 calendar year was the best of the last three for fishing. Japanese fishermen hauled in 4,881 tonnes compared with 3,300 tonnes in 1986 and 3,681 in 1985.

IS IT A PRAWN OR A SHRIMP ?

(Source: *NZ FIB Newsletter*)

At the 1967 World Conference on the biology and culture of shrimps and prawns held in Mexico City, it was agreed that the term 'prawn' will be reserved for freshwater creatures only, while their marine/brackish water relatives will all be called 'shrimps'.



FISHERIES SCIENCE AND TECHNOLOGY

OUTBOARD MARINE JET
(Source: *Australian Fisheries*)

An outboard marine jet for boating in shallow waters has been released on the Australian market by Outboard Jets Australia.

The Outboard Jet is designed to replace the stock gearcase on all major brands of outboard engines. Manufactured from stainless steel and aluminium with a baked enamel finish, the Outboard Jet is available in small, medium and large versions to suit Mercury, Mariner, Johnson, Evinrude, Yamaha, Suzuki, Chrysler and Force outboard engines of 25 hp and larger. The conversion of conventional outboard engines takes approximately two hours.

The jet picks up water through a grate. The impeller then pumps the stream of water out through the discharge nozzle. The stock outboard exhaust system, which is retained, expels exhaust gases and cooling water through the centre of the jet stream.

For further information contact Outboard Jets Australia, 45 Seventh Street, Mildura, Vic 3500; telephone (050) 22 1155 or (050) 22 1435.

INFRARED SYSTEM PROVIDES NEW VIEWS OF THE OCEAN
(Source: *Makai*)

Production of high-resolution thermal maps of ocean and coastal resources from an airplane-borne infrared (IR) scanning system is the goal of a research project funded in part by the University of Hawaii Sea Grant College Program. The project is being conducted by researcher George Curtis of the university's Joint Institute for Marine and Atmospheric Research (JIMAR) and Narendra Saxena, a marine geodesy specialist with the UH Department of Civil Engineering.

Maps and images of surface water temperature can be used in a variety of marine-related studies, such as ocean currents, freshwater seeps, ocean discharge from installations like Ocean Thermal Energy Conversion (OTEC) and large aquaculture farms, and marine and land resources.

The scanner, an HRB-454 system on loan from NASA Ames Research Center, was originally designed for use in a U-2 aircraft at altitudes of up to 90 000 feet. The scanner has been adapted for use in a smaller, lower altitude Piper Aztec aircraft. Operated out of Kona on the island of Hawaii, the twin-engine aircraft is contracted by UH for a variety of oceanographic research.

An infrared (IR) scanner produces images by measuring the heat emitted from the earth's surface in the form of longwave radiation. This contrasts with conventional photography, which records the light reflected off a surface. The scanning mechanism allows for continuous swath readings along a flight track. With a scan angle of 60 degrees, this means the scanner covers a 3 600 foot swath at a flying height of 3 000 feet.

The readings from the IR sensor are recorded in two forms: on black-and-white film or magnetic tape. To produce the film image, the sensor first converts the detected heat into an electrical signal. This signal is then used to trigger a glow tube which exposes light pixel-by-pixel onto a spool of 70 mm film in synchrony with the scanning mechanism.

The signal is also changed and fed into a tape recorder for recording in analogue form. Variations in temperature detected by the sensor are transformed into variations in the signal

level, which are then fed to the tape recorder. The data on the tape are later digitised with a computer; this greatly enhances the ability to quantify and display the data using computer graphics.

Because clouds can block the heat emissions from the earth's surface, the ability of the Piper Aztec to fly underneath cloud cover offers a definite advantage over satellite-borne systems. This is particularly true in areas where clouds are often prevalent — areas like Hawaii and other Pacific Islands, as well as the coastal regions of continents. In addition, flying at a lower altitude produces much greater resolution, both in area and in temperature differentiation, than with a satellite system. The HRB scanner is designed for a minimum flying height of 3 000 feet and can differentiate areas 3 feet apart from this altitude. Its temperature resolution is better than 0.5 degree C.

Such high resolution can help locate seepage of groundwater into the ocean. Groundwater is an important and valuable resource in islands like Hawaii, which are composed of porous volcanic rock. Seepage detection can aid hydrologists in locating appropriate well sites to tap the fresh water before it is lost to the sea.

Initial tests of the Piper-installed scanning system during flights in May 1984 over the Kona coast on the island of Hawaii demonstrated this capability. An infrared scanning image of Honokohau Small Boat Harbor, a site with known freshwater springs, clearly revealed the presence of groundwater seepage into the ocean. The cooler temperature of the groundwater showed up in lighter tones than the warmer surrounding ocean water on the photograph; its pattern of mixing and dispersal in the ocean was well defined.

The data obtained from an infrared scanning system can be useful to several governmental agencies as well as to the private sector, says Curtis. These include the Hawaii Department of Land and Natural Resources, U.S. Environmental Protection Agency, U.S. Geological Survey, UH Water Resources Research Center, and resort developers.

The impact of cold water discharge into the environment from OTEC is one possible application of the system. According to Curtis, little evaluation has been done of diffusion of this cold water effluent, its modes of sinking, and its effects on the required warm water and the environment in general. These may be related to factors such as near-surface thermal structure, currents, and wind. Analysis of such effects would be advisable, he says, in light of probable further OTEC experimentation. The IR scanner can show any surface effects of such an operating system in near-real time.

The system can also be employed by private industry to detect water stress in crops, particularly sugar cane. Infrared photographs of the crops can reveal a lack of water in plant leaves well before such stress is evident to field observers. This early detection could lead to timely treatment and result in increased crop yields.

Other uses for the scanner include locating and monitoring the gyre off the west coast of Hawaii island, an ocean circulation phenomenon with direct implications to the fishing industry. The system can aid in mapping mixing zones of waters discharged into the ocean from large aquacultural farms. Locating small craft and possibly persons in the water at night are other potential applications of the system. On land, it can be help detect and locate hot spots in solid waste landfills.

QUEENSLAND MUD CRAB BREEDING EXPERIMENTS

(Source: QDPI Fisheries Research Branch/Tady Hoshino)

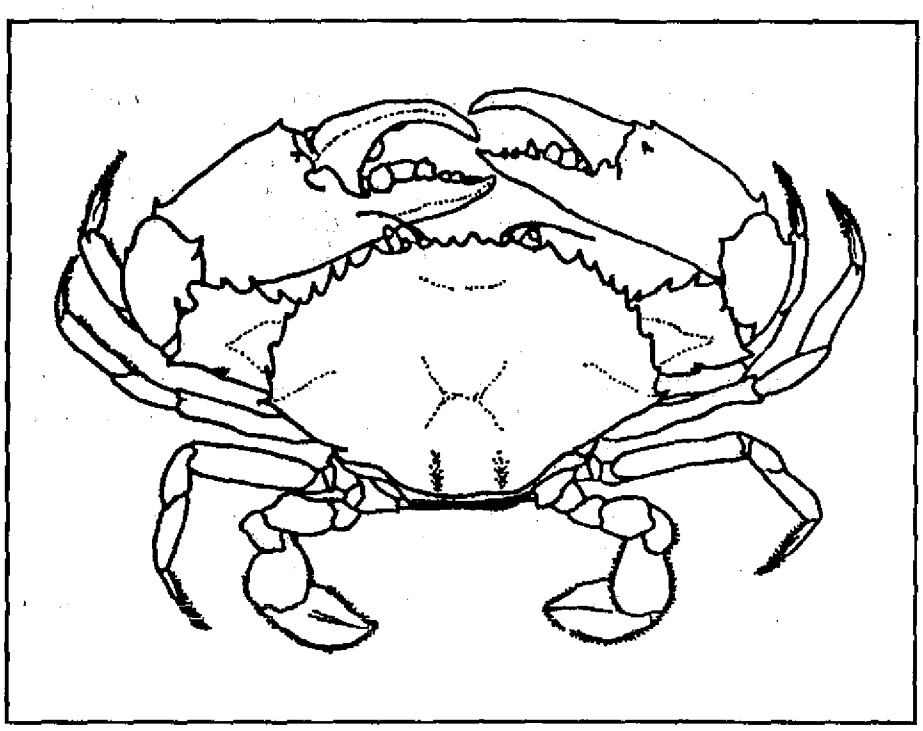
In response to reported decreases in catches of mud crabs (*Scylla serrata*) by both recreational and commercial fishermen, the Fisheries Research Branch of the Queensland Department of Primary Industries has been investigating the possibility of producing crabs by artificial rearing.

The Recreational Fishing Enhancement Programme has provided support for the artificial production of mud crabs and has looked into the feasibility of large-scale production.

As part of the experiment, a total of 36 female crabs were captured for breeding from areas around Brisbane during December 1987 to March 1988. On arrival at the laboratory the crabs' eyestalks were removed: this affects the crabs' hormone production and induces spawning. Some crabs were placed in individual 750 litre tanks while others were held in groups of 3-5 in 5-tonne tanks. On February 25 about 1.5 million larvae hatched from one of the crabs.

One hundred thousand larvae were transferred to a 5-tonne tank for the larval rearing experiment. Larval rearing was by the community culture method, in which newly hatched larvae are added to rearing water (organic suspension water) in which a mixture of potential feed organisms has been cultured. The advantage of this method is that it provides a wide variety of nutritional sources for early larval stages, in addition to the usual diet of rotifers and brine shrimp nauplii.

Four days after starting the experiment, severe mortality occured in the tank due to a sudden climatic temperature change. Nevertheless on 27 March, a small number of juvenile crabs, measuring less than 1 cm across, were harvested. The result of the trials showed that the use of the community culture method has potential for the development of larval rearing of mud crabs. Although the maintenance of organic suspension water was difficult due to the unstable weather, a modified method in the culture of *Chlorella* species and diatoms produced healthy larval development through to the crab stage. The moderate success achieved with this first rearing attempt suggests potential for further work, particularly if experiments can be conducted over the full period of natural spawning.



The mud crab (*Scylla serrata*)

ABSTRACTS

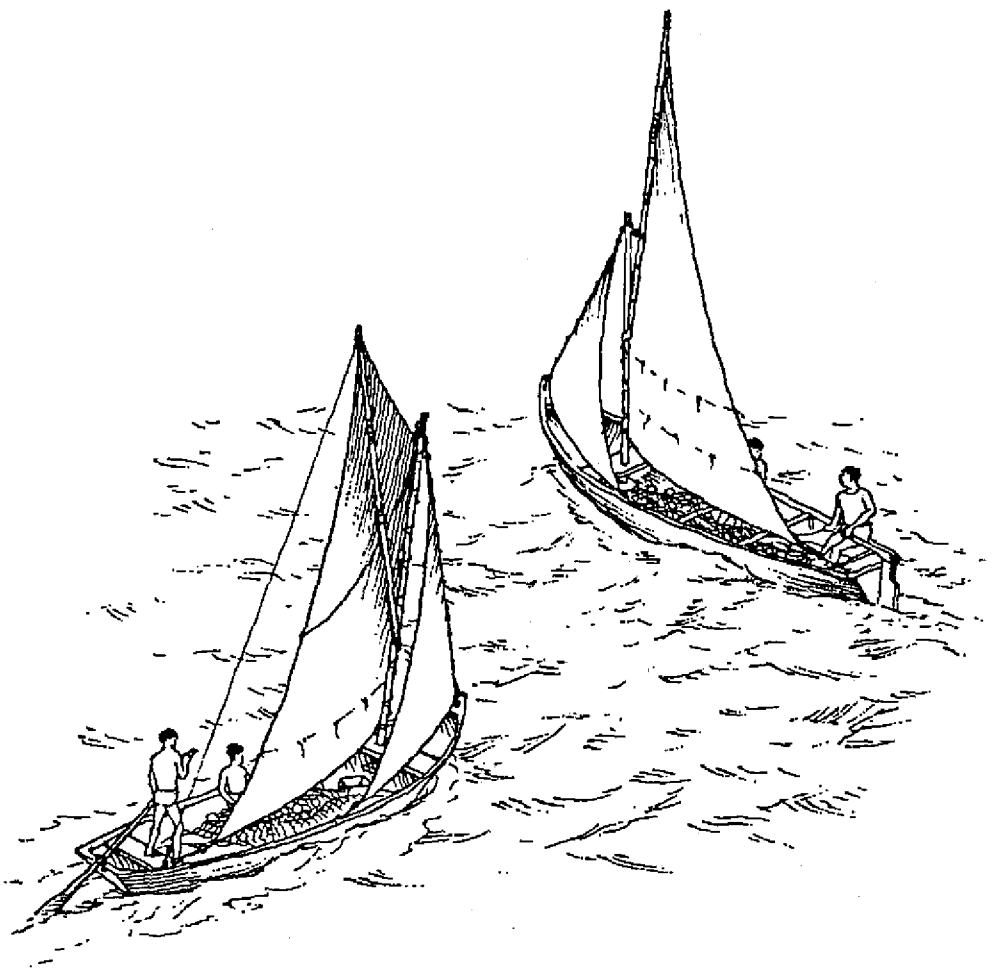
SAILS AS AN AID TO FISHING, by the staff of MacAlaster Elliot and Partners Ltd

This book has been produced to help Fisheries Officers, community leaders and fisheries co-operatives introduce auxiliary sail to small-scale fisheries in developing countries, using simple techniques with locally-available materials.

It is divided into two sections. The first section contains all the information needed to make a decision as to whether or not auxiliary sails can be used to improved the effectiveness of a particular fishery, taking into account local factors which will vary from region to region. It gives guidance on assessing the economics of a fuel-based fishery, and shows the likely advantages, savings and cost-effectiveness of auxiliary sail. Taking existing boats and fishing methods, it explains in non-technical terms the principles, design and economics of sailing rigs, and how to construct and install them.

The second section of the book describes in detail five different sailing rigs, one or more of which should be suitable in any particular fishery. Having examined local conditions, existing boats and fishing methods, the reader will be able to choose and design a sailing system from the simple rules and tabular information provided. The terms used throughout are basic and the layout is pictorial and easy to follow. The book does not attempt to give in-depth instruction on sailing techniques, but has enough information to allow sailing rigs to be installed and tested safely in sheltered waters.

Contact address: British Development Division in the Pacific, Private Mail Bag, Suva, Fiji.



The following article is reprinted, with slight modifications, from *Laboratory Leaflet N°60 — Lowestoft — 1987*

THE SCIENTIFIC ESSENTIALS OF FISHERIES MANAGEMENT AND REGULATIONS

by

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1. STOCK DISTRIBUTION

All fish undergo some seasonal movements in relation to water conditions, or, for example, when migrating to and from spawning grounds. A few individual fish may 'take off' over very long distances but the majority, especially demersal fish, do not move far (over tens rather than hundreds of miles). As a result, they become associated with particular areas which can be grouped to identify self-contained stocks. Pelagic fish tend to move further, with seasonal movements following water temperature changes, but even they can be associated with particular divisions of water. The continued existence of each of these stock units depends on the number of fish caught being replaced by young fish bred into the same area and stock unit.

2. AIMS OF MANAGEMENT

At the broadest, international, level the aims of fisheries management include maintaining the overall stability of the 'Industry' with agreed shares for each of the participating countries. At the more practical level which seeks to relate the catching industry to its raw material (the fish). the aim is to **maintain** a catch as large as possible from each stock at a catch rate which is profitable to the fishermen.

The catch rate (that is the number of tonnes of fish caught per hour or per day) determines the balance between costs and earnings and itself depends on the abundance of the stock. Thus, because the abundance of the stock goes down as the level of fishing goes up, there is a balance that has to be struck. History shows that, left to its own devices, a fishery will expand and catch rates decline until there is no profit margin left. This forces the 'Industry' either to contract, or to seek financial support from its Government. In many cases, this is accelerated by a fall in catches and if fishing is maintained at too high a level, the stock may suffer the severe collapse already seen in the herring fisheries in the 1970s. The aim is to manage the stocks at a level which maintains both the catches and a profitable catch rate, based on the biological potential of the resources concerned.

3. BIOLOGICAL BACKGROUND FOR MANAGEMENT

Each stock is made up of year classes (the young of each annual spawning). As each year class gets older the numbers of fish are reduced by death from natural causes and from fishing, but the survivors get bigger. Details differ between stocks but the total weight (biomass) of a year class has a characteristic maximum at some optimum age (Figure 1).

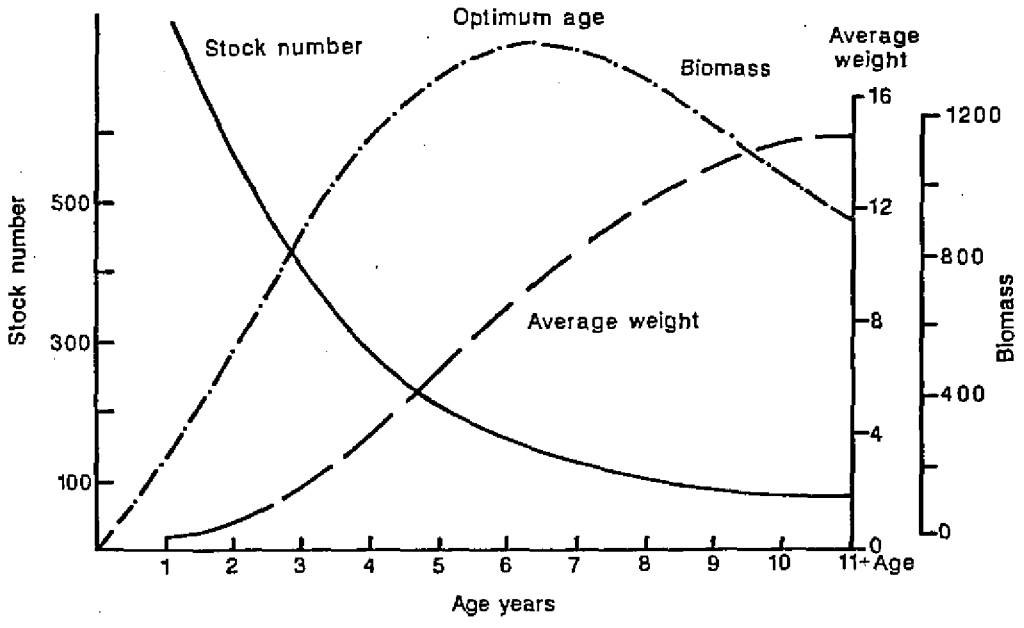

Figure 1. The relationship between the growth in weight of individual fish of a stock and the change in number and weight of a year class as it grows older.

The maximum catch would be achieved by catching all fish of a year class at the optimum age. But it is not possible to catch every fish, and because year classes mix together fishing gears catch more than one age group of a stock. The nearest equivalent to catching all of the fish in one age group is to manipulate the fishing to keep the average age at which fish are captured near to the optimum age. This can be achieved by balancing the age at which fish are caught against the percentage caught each year (Figures 2a and 2b).

When fishing effort is low (Figure 2a) fish survive in the fishery for several years and the average age of capture can be close to the optimum (i.e. satisfactory) even if the age at first capture is low. If the age at first capture is too high, the average age of fish caught is too high, fish are wasted and the stock is under-exploited.

With high fishing effort (Figure 2b), the fish are removed very soon after they arrive in the fishery. If they are caught when they are small very few reach the optimum age and fish are wasted. Satisfactory exploitation requires capture to be delayed until the fish have grown to a reasonable size.

In a well-managed fishery the age or length at which fish start being caught is matched to the level of fishing (fishing mortality), so they advance together towards the optimum giving the maximum sustainable yield (MSY) per young fish (recruits) entering the fishery (MSYR) (Figure 3).

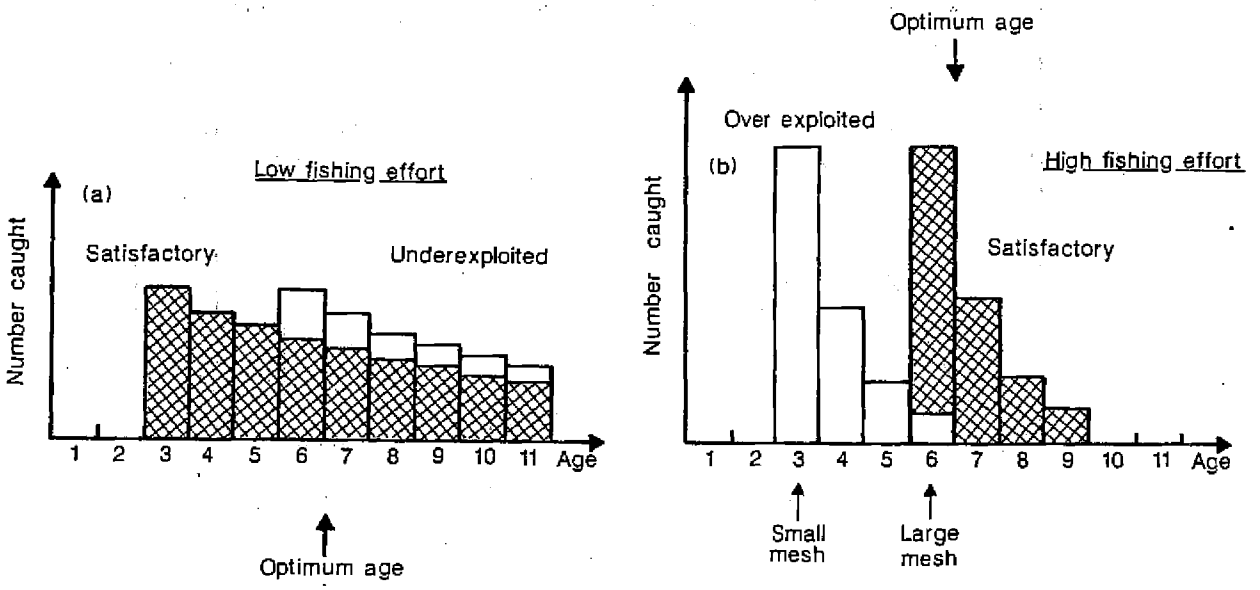

Figure 2. Examples of the age composition of a stock under different combinations of fishing rate and age at first capture, as determined by mesh size: (a) with low fishing effort; (b) with high fishing effort. Cross-hatching identifies the more satisfactory exploitation pattern for the given level of exploitation.

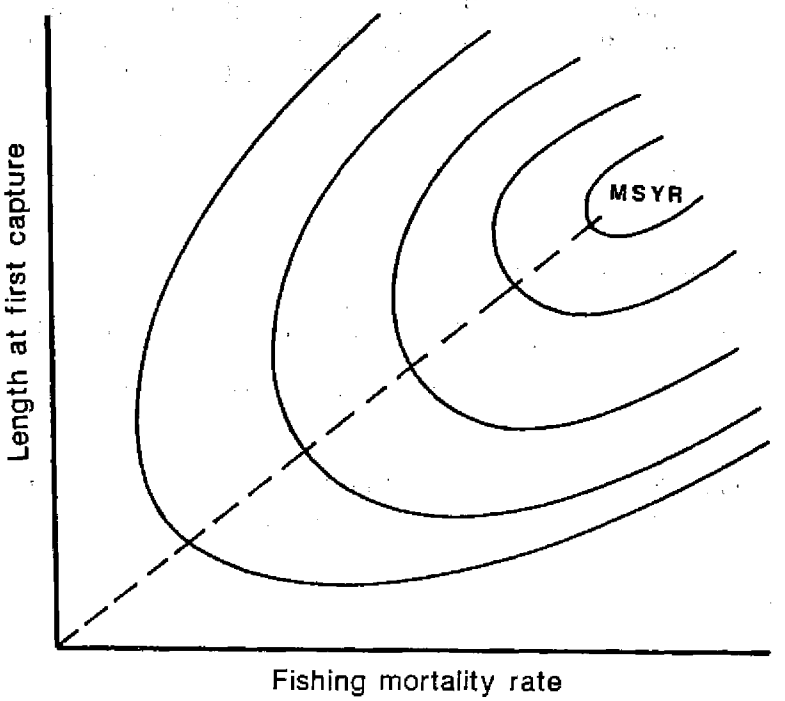

Figure 3. A more general theoretical relationship between length at first capture and fishing mortality rate. Each line represents a constant catch level and the levels increase towards maximum sustainable yield per recruit (MSYR).

4. TOOLS OF MANAGEMENT

There are two main tools used to manage fisheries at the international level. These are total allowable catches (TACs), which limit the amount of fishing (i.e. the percentage of the stock caught each year) and technical measures (closed areas and seasons, mesh size, minimum size of fish), which influence the type of fishing and 'tune' the age and size of fish caught. At the national level, in some countries at least, these are augmented by additional catch controls to ensure a fair share-out of catch within the national fleet, and vessel licensing to provide control of fishing capacity where this is necessary.

4.1 TACs

TACs are being applied to a large number of stocks as a basis for negotiating shares of the resources between countries and to achieve a given percentage harvest of the stock each year. They are based on an annual analysis of the size of each stock, to determine the numbers left from the previous year's fishing and the numbers of new fish just growing to a catchable size.

The immediate environment and longer-term changes in the climate both affect the numbers of new, young fish (year classes), so there is a natural variation in stock size as well as from changes caused by fishing. If the stock size changes, then so do the catch rates. So, if the level of fishing is managed to take the same percentage of the stock catch each year, then the catch will vary from year to year as the stock size changes. Fishermen, fish processors and the market would prefer a constant TAC, but even if that approach were adopted the stock and catch rates would still vary. In years of high stock the fishery would have to be closed early (Figure 4).

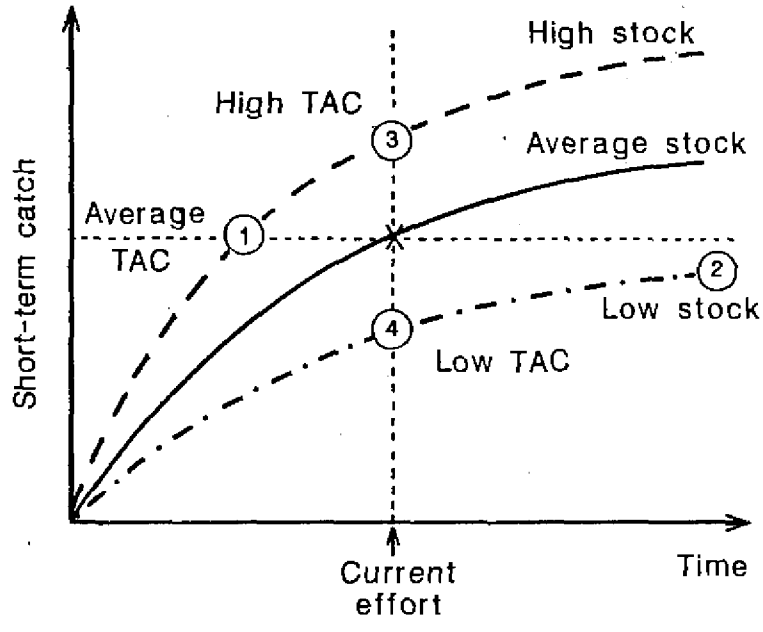

Figure 4. Representation of the effect of variations in stock size (year classes) on the TAC and length of fishing season: if TACs were based on an average catch level and kept constant from year to year, in years of high stock the TAC would be reached and the fishery closed early (1); in years of low stock the TAC might not be reached at all (2); if TACs are set to take a constant percentage of the stock and keep the fleet fishing the whole year, then in years when the stock is high the TAC must be increased (3); and vice versa (4).

Conversely, in years of low stock there would have to be a rapid and expensive injection of extra fishing effort or the TAC would not be reached. Constant TACs would have the added

risk of causing severe damage if they were set too high for any length of time, and if the TAC were set on the low side to avoid that risk, then the managers would be wasting fish and potential earnings. Negotiated TACs generally place more emphasis on a fixed percentage harvest to maintain fleet utilisation levels whilst at the same time reducing, as far as possible, the year to year fluctuation in catch.

4.2 Technical measures: closed areas and seasons

The use of technical measures depends on the type of fishery. The options are closed areas and seasons, the control of mesh size (or some other characteristic of the fishing gear) and the minimum size of the fish.

The usefulness of closed areas and seasons depends on the nature of the problem. They can be especially helpful in preventing a fishery from concentrating on a particular age of size class which needs to be protected. These may be very small fish on a nursery ground, or fish congregating to spawn which would be disrupted and dispersed by intensive fishing activity. Closed areas and seasons are less helpful if the problem is control of the overall level of exploitation, because instead of reducing fishing they invariably lead to its diversion to another area where the problem will be perpetuated. Certainly, it is true that whatever their value the specific fishing grounds are often difficult to define, because fish distributions move a little from year to year, and they are especially difficult (expensive) to enforce.

4.3. Technical measures: mesh regulation and minimum size

4.3.1 Rationale for mesh regulation

Mesh regulation depends on the 'mechanical' selection of different sizes, and therefore ages, of fish by the gear being used. A small-meshed purse-seine catches virtually everything that it encloses and is unselective. At the other extreme, drift-nets catch only the fish which are just the right size to get stuck in the meshes, so individual drift-nets are highly selective. Longlines have selectivities determined by the size of hook. For trawls and seines, it is possible to relate the selectivities of different fish species to different mesh sizes.

Figure 5 shows the selectivity of haddock using a 70 mm cod-end mesh. Each dot represents the percentage of the length group retained in the cod-end. A 'selection curve' is drawn through these points.

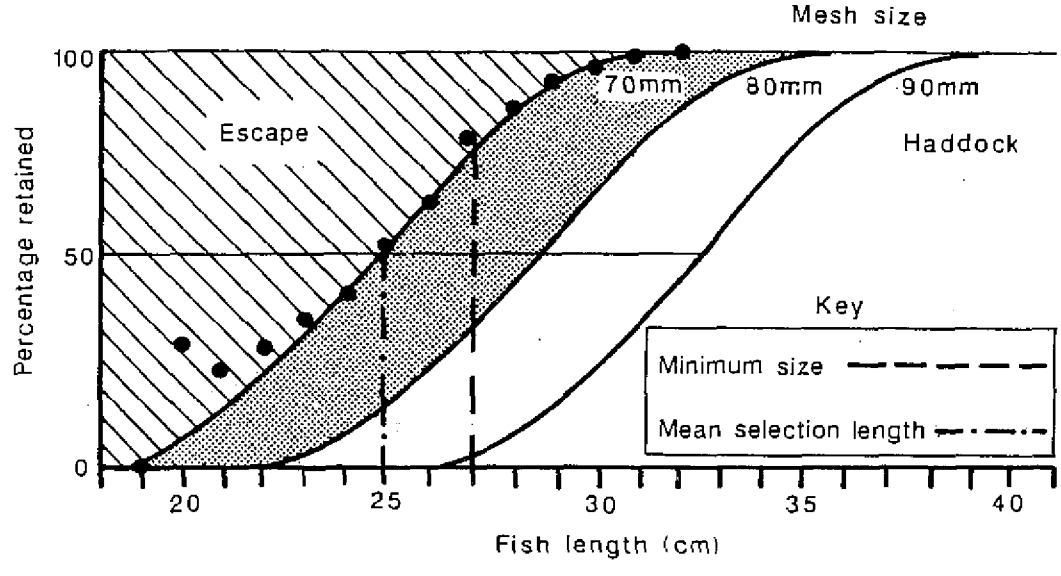

Figure 5. Mesh selection for North Sea haddock for three different mesh sizes

The areas above the 70 mm cod-end mesh curve describe the numbers of fish which escape through the cod-end; those below are caught and retained. The size of fish at which half are retained and half are released is called the 'mean selection length' (in this case 25 cm). The stippled area between the curves for the 70 and 80 mm mesh sizes represents additional numbers of small fish, released by the 80 mm mesh compared to the 70 mm mesh, which would be available to be captured later at a larger size. The minimum size (MS) is related to the mean selection length but, inevitably, some fish which are smaller than the MS are caught and must therefore be discarded (usually dead). The mesh size regulates the size and therefore the age at which fish start being caught. This age is related to the level of fishing. In general, as fishing increases the mesh size needs to be increased.

4.3.2 Application of mesh regulation

Mesh regulation can be applied to many types of net but for some species it is either unnecessary or it does not work. Fish which are quite small when adult do not benefit by careful manipulation of the age at first capture. On the other hand, shoaling pelagic species are caught in such large quantities that they blind the meshes of either trawls or purse seines, so even though it might be useful, selection is not very effective. In these instances, even though a mesh size may be prescribed, more reliance is placed on the broad protection of a minimum size limit to prevent deliberate fishing on the juveniles of a species.

Minimum sizes are there to support the mesh size and are not necessarily closely related to the maturity of the fish. Without the minimum size there would be continual pressure to reduce mesh size because, in the short term, there are always relatively more small fish available for capture with a smaller mesh.

Depending on market characteristics, fishermen find a strong incentive to try to catch more small fish, if only to increase their scope for selection of better sized fish. This can lead either to the smaller mesh or various attachments to nets to reduce the effective mesh size.

4.3.3 Gains and losses of mesh regulation

Increase of the mesh size has both short- and long-term effects. In the short term, there is always some reduction in catches because most of the smallest fish are released, also including a few that might be above the minimum landing size. The effect may be small if the fishermen have been discarding a lot of small fish anyway, but it will be large if they have been using undersized nets. The fish that escape from the larger mesh will remain in the fishery and grow to be caught at a larger size (Figure 6a). The delayed capture will also lead to a useful increase in the stock size in the sea, thereby improving the spawning stock and future catch rates (Figure 6b).

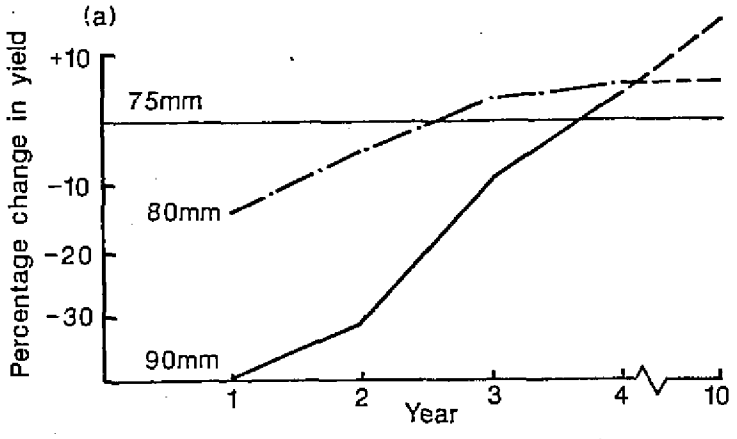

Figure 6a. North Sea sole. Percentage change in yield with time following changes in mesh size from 75 to 80 or 90 mm.

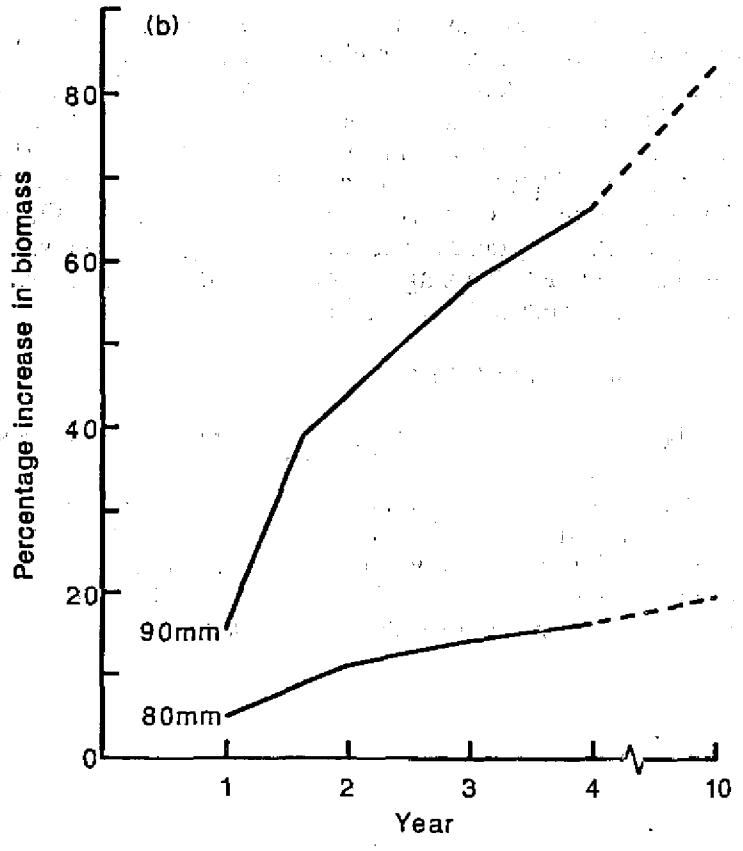

Figure 6b. North Sea sole. Percentage change in weight of stock (biomass) following changes in mesh size from 75 to 80 or 90 mm.

In reality, each species requires a different mesh size. Fishermen can direct their fishing to one species or another by choice of ground, time of fishing, rig of gear, etc., but inevitably they will catch a mixture of species at any one time, or even fish for different species at separate times during the same trip. Clearly, it is not practicable to enforce a different mesh size for each component of the mixed fishery, so the mesh size chosen for the regulation has to be a compromise. In some cases there are different short-term losses and long-term gains for different species, which bear more or less heavily on different countries and different fleet sectors within a country, depending on their special interest or area of fishing. It is not possible to provide practicable and separate regulations for each special interest. The mesh size is negotiated as being that which gives the best result for most participants.

In extreme cases, a fishery has to be carried out with a small mesh to catch a particular, small species but it cannot then avoid catching the young of another species which should be fished with a larger mesh, which will affect the potential catches of that other fishery. But an increase in mesh size to meet the requirements of the larger species would allow all of the smaller species to escape. Managers, therefore, must decide on the balance of interest between the two fisheries and regulate in the interest of one at the cost of the other. This may be achieved through by-catch regulations which are intended to control the amount of one species that can be caught in a fishery directed towards another.

4.3.4 Long-term effects of mesh regulation.

Excessive fishing effort at any mesh size not only reduces potential catches and catch rates (profitability), but may in the long term reduce stock sizes to the point where the stock can no longer reproduce satisfactorily, causing it to collapse. This is much less likely to happen when

the age of first exploitation is delayed until after the age at which the fish become sexually mature, by using a large mesh. A large mesh not only offers increased potential yields, but also reduces the likelihood of stock collapse, and leaves a larger mature stock as a buffer against occasional bad years (Figure 7).

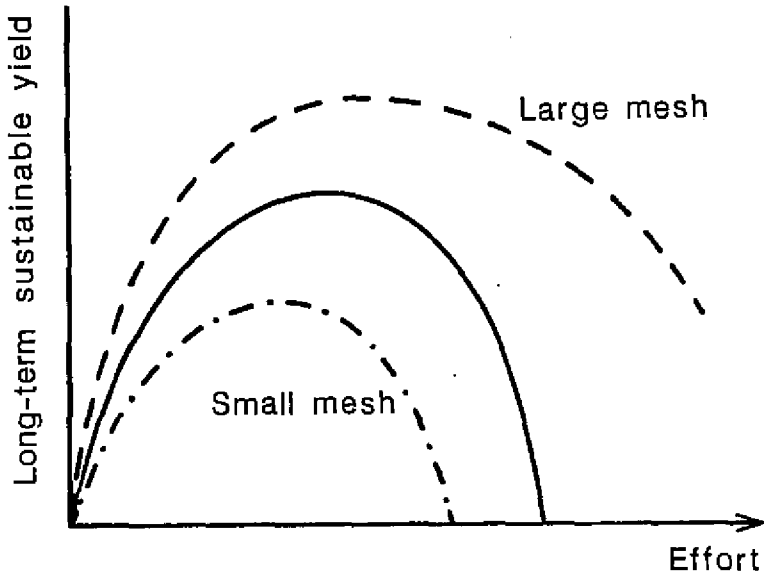

Figure 7. The effect of mesh size on long-term sustainable yield and permissible levels of fishing effort.

5. REFERENCES

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YELLOW-TAIL TRAPPING IN NEW SOUTH WALES

by

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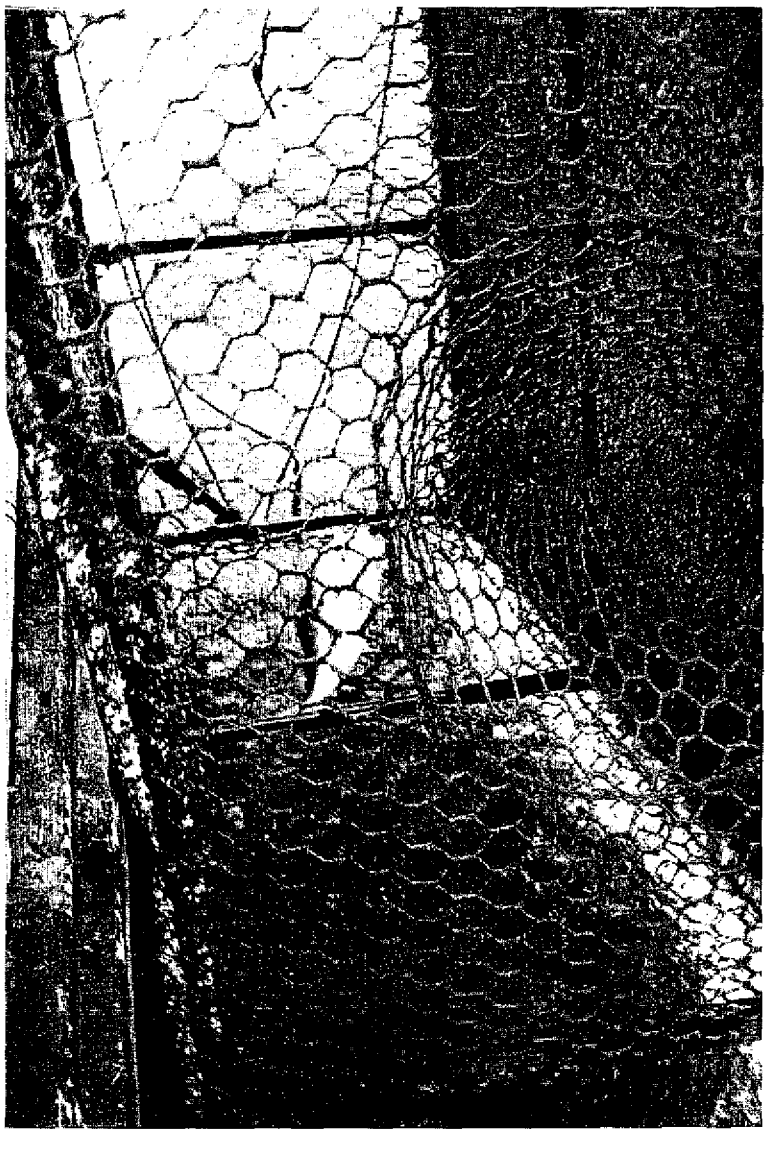
There was a fisherman from Italy who soon became known as the best yellow-tail fisherman in the Sydney area. He would consistently bring in over 100 kg a day, even when other fishermen were getting nothing. This went on for several years until someone finally caught him hauling his fish trap. The top of his trap was disguised with seaweed to avoid detection. He would only take enough fish out to make a good days catch, leaving the rest for the next day.

Today there are quite a few fishermen using this method in the Sydney area and as far as is known, this is the only area in Australia where this trap is in use. The trap works on the same principle as a FAD. No bait is used.



Detail of fishing end of trap

The fish are attracted to the trap by the shade that is provided by the plastic cover attached to the top. There have been some very spectacular catches, with 200-300 kg per trap not uncommon when the fish are running. Although the catch is very species-specific (yellow-tail, rainbow runner, mahi mahi), it could have some application in the Pacific region. Below is a description of the trap and the method for rigging.

TRAP CONSTRUCTION

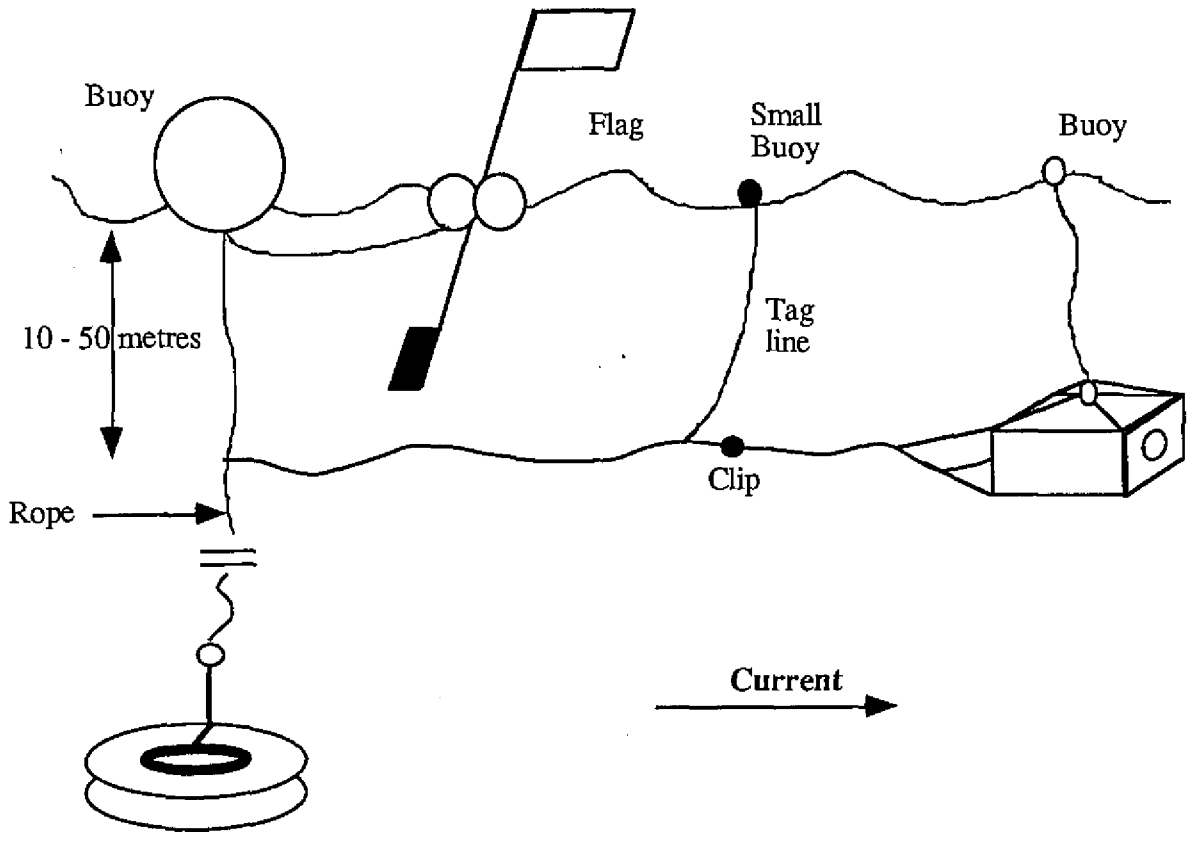
The trap consists of a very simply constructed wooden framework, covered with chicken wire. A large door is made in the side of the trap for removal of fish. There is one fishing head in the rear of the trap. This opening must face aft as the fish tend to only swim up current. Openings at the sides and front have been tried, but it was found that the trap then did not work at all.

The top of the trap is covered with a very fine mesh plastic screen to provide shade. People have tried to cover the sides, either partially or completely, but again this made the trap cease to work. Two to four bricks are wired to the bottom for weight.

RIGGING

Two rope bridles are attached to the trap, one to the top for the small buoy to keep the trap afloat at the desired depth, and another at the front for attachment to the main anchor line. It is very important to rig the bridles so the trap hangs straight in the water. If the trap is slanted even a small amount, the current will tend to make it move either up or down in the water, depending on which way it is hanging.

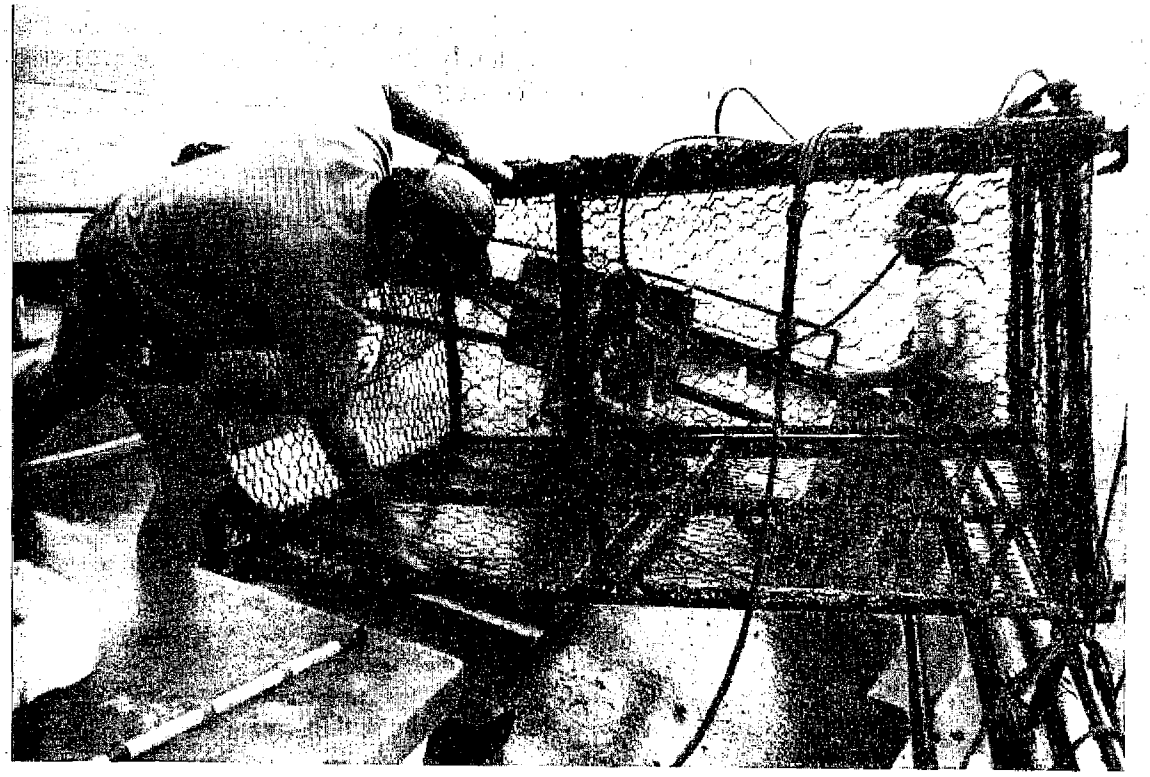
The buoy to float the trap must be only just large enough to keep it afloat, so as to minimise movement from wave action. It may be necessary to increase the size of the buoy as growth accumulates on the trap. The length of rope from the trap to the buoy must be exactly the same as the length of the rope on the main anchor line, so that the trap hangs straight in the water.



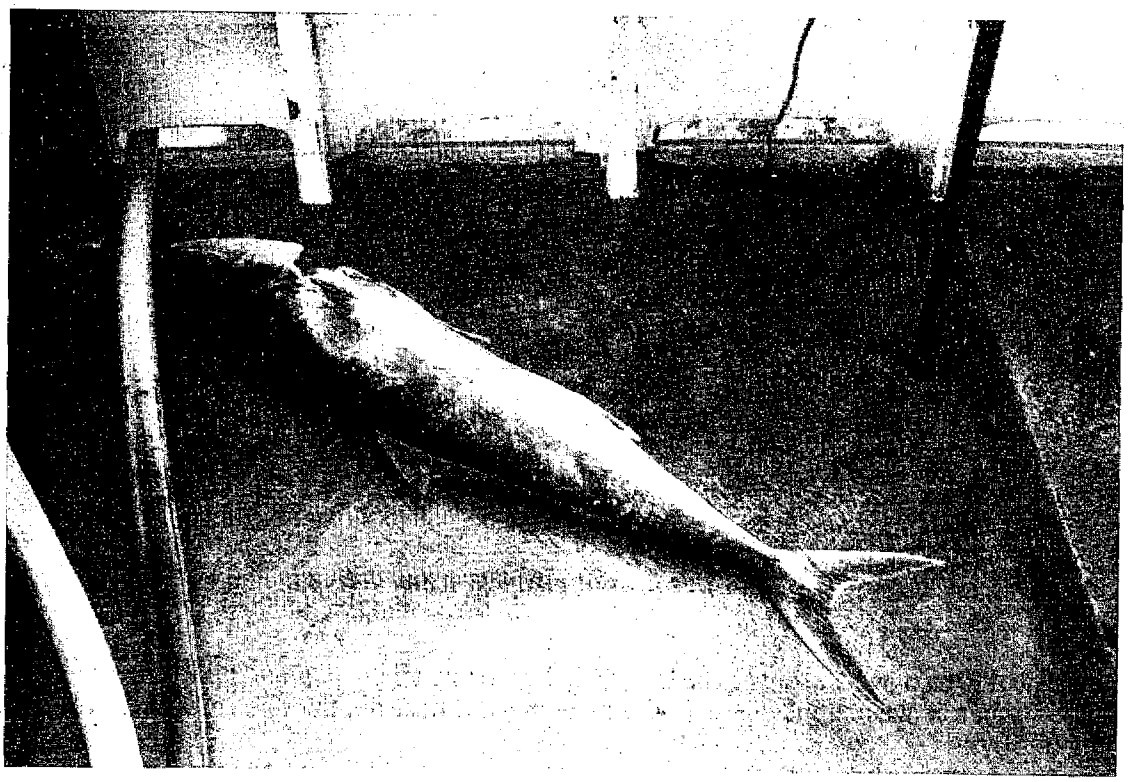
Trap mooring system

Originally the trap was used at the surface, but from trials it was found that catch rates increased when it was submerged, 10-20 m being the best depth. The trap is effective up to depths of 50 m.

The trap observed was 2 x 1.5 x 1 m, to meet the legal size limit of traps in the coastal waters of New South Wales. The fishermen feel that the bigger the trap, the better it fishes, so the size of the boat is the only constraint for the size of the trap.



Cleaning some of the growth off the trap



Yellow-tail

TRANSPLANTATION AND MARINE RANCHING/FARMING OF INSHORE RESOURCES ON CORAL REEFS

by

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INTRODUCTION

Coral reef resources are important for subsistence and artisanal fisheries in tropical seas. While urbanisation and the cash economy are developing, inshore resources have been over-exploited for quick cash returns at many localities. This is because of the ease of fishing and collecting these often conspicuous and sluggish organisms, and because of their slow growth and maturation rates, despite high fecundities. Wide-spread poaching has also contributed to declines and local extinctions of certain resources such as giant clams.

Numerous attempts to initiate commercial aquaculture have been unsuccessful in the Pacific islands, with rare exceptions. Uwate and Kunatuba (1983) reviewed this and suggested caution in future development in this area, indicating many constraints and disadvantages related which apply to the Pacific Islands. They suggested several ways to increase the likelihood of aquaculture successes, rather than simply disregarding any further attempts based on the poor record in the past, as they believed that commercial aquaculture might nevertheless be a means for economic stability and growth for the Pacific Islands.

In order to improve exploitation of renewable resources from coral reefs, options other than commercial aquaculture should also be explored. Inshore resources of the reefs are represented by many groups of organisms which demonstrate different life history and recruitment strategies. Individual resources may be limited in stock sizes and are very vulnerable to over-exploitation at each locality, so that careful schedules should be formulated to exploit various species which may be harvested and managed according to the nature of their recruitment and growth patterns.

Some inshore fisheries may be better managed by enhancement of wild stocks that are limited by depletion of brood stocks, high juvenile mortality, area-specific recruitment due to current patterns, and so forth. This may be achieved by reseeding programmes using hatchery-produced juveniles, and providing suitable grow-out habitats for the juveniles to survive at higher rates than otherwise.

It is important that the resources should be carefully managed, based on sound knowledge of each organism. Research should be directed to fill gaps in resource biology for the tropical species in general, as indicated by the series of sessions during the SPC Workshop on Inshore Fishery Resources, held in Noumea in March 1988.

MEANINGFUL APPLICATIONS OF CORAL REEF RANCHING/FARMING

Transplantation

Although a great many coral reef organisms are distributed throughout the scattered oceanic islands, certain resource species are limited to the continental islands within the Indo-West Pacific faunal region. This may be related to the abilities and chances of larvae and juveniles to be dispersed by means of oceanic currents and/or rafting on flotsam. Important species of larger archaeogastropods such as trochus and green snail are restricted in their ranges, probably because of their short larval life span of only a few days.

Transplantation of trochus was attempted by Japanese fisheries authorities before World War II, and has been very successful in many Micronesian islands where the species did not occur before. This has been followed by transplantation to various South Pacific islands in the 1950s, and again in recent years, including secondary transplants within island groups after the successes of the original transplants (e.g. Gillett, 1986).

Giant clams have been promoted for transplantation in recent years, after seedling production was established for distribution at the Micronesian Mariculture Demonstration Centre (MMDC) in Palau, and the Orpheus Island Research Station of James Cook University in Queensland, Australia. While this was developing, criticisms were raised regarding transplantation of reef animals such as the above, because unwanted organisms such as pathogens and parasites might be unduly transported along with the target species.

If the transported broodstocks were maintained in the facilities based on land, and juveniles produced there were released with careful quarantine, then the problem associated with direct transplanting of adults might be avoided. Furthermore, such seedling production would provide opportunities to implement effective grow-out programmes. Therefore, basic ranching/farming facilities for seedling production are essential for successful transplantation of target species such as green snail.

Reseeding of over-exploited stocks

Accessible resources of reefs are prone to over-exploitation, and resource species with slow growth rates and short larval lives will recover very slowly or not at all, if brood-stocks have been over-fished. This situation may prevail along the coasts of heavily populated or urban areas, even though the habitats might remain in good condition for producing such resources. Reef ranching/farming of sessile or sedentary organisms would help restore fisheries for over-exploited species in such areas. This applies also to depleted stocks which have been subject to poaching. Attempts to reseed giant clam stocks are being made in Yap and other Micronesian islands (Price, 1988).

Enhancing stocks in recruitment-limited habitats and areas

Natural recruitment may be limited to certain areas by currents which carry pelagic larvae, and then by the nature of habitats for the settled juveniles to grow and survive. For species with short pelagic larval life, dispersal of larvae may be erratic depending on the variable wind and current conditions, resulting in spatial and temporal fluctuations in larval settlement. In some cases, coastal topographies may tend to dictate nearshore currents, so that eddies might be formed to hold larvae in specific areas.

Thus, there would be both good and poor juvenile habitats of variable degree. One site may be good for larvae to settle but poor for their survival, and vice versa. If we could identify specific habitat requirements for larval settlement and juvenile grow-out, and if particular habitats might be found as being good for juvenile growth, but recruitment-limited, then artificial seeding of

the area using hatchery-produced juveniles would become a means to enhance the fishery through ranching.

PROBLEM AREAS TO BE SOLVED FOR SUCCESSFUL CORAL REEF RANCHING/FARMING

In marine ranching/farming, it is easy to achieve high survival rates in the larval stages of many species if they develop lecithotrophically as trochus and green snail do. The most vulnerable early juveniles may be protected inside land-based tanks supplied with running sea water: such systems are well-established for abalones and turban snails in Japan. Tens of millions of juvenile abalones are produced each year in government and non-government hatcheries and are released into fishing grounds by many fisheries co-operatives throughout Japan.

The grow-out habitats for juveniles may consist of shelters and feeding surfaces combined in proximity, so that they survive and grow to large sizes which are less vulnerable to predation. However, natural mortality in the juvenile stages of many species is poorly understood. Also lacking is information on the 'escape-sizes' or turning points in the size-specific mortality rates of earlier juveniles.

As juveniles grow, feeding rates increase rapidly and land-based tanks may no longer be large enough for holding very large numbers of herbivorous juveniles. Then, it would be necessary to determine optimum strategies for transfer of growing juveniles from tanks to the sea. For example, juveniles that are too large for tanks may be still too small to be released directly into the natural habitat. If such is the case, artificial grow-out habitats may be designed and deployed in the sea. Research efforts to develop such habitats for tropical species are necessary, because tropical marine communities contain a variety of potential predators at every size range. Caging the artificial habitats may exclude larger predators but there might be many others that can penetrate inside the cages (e.g., Perron *et al.*, 1985).

Caging also excludes herbivorous fishes and other competitors which would graze algae on the feeding grounds inside the grow-out systems for herbivorous gastropod resources. It is important to determine the productivity of such encrusting algae on the feeding surfaces in the system, so that carrying capacities of the target species can be estimated. Supplementary algal food may be cultivated elsewhere, and added to the system to increase its capacity.

It may be appropriate to develop polyculture systems rather than monospecific cultivation during the grow-out phase, as has already been tried by MMDC for giant clam and trochus. Specific predators would be controlled by introduction of selective predators to the caged system. In short, research efforts to find optimum culture systems are necessary in order to design maintenance-free grow-out habitats for each resource.

It may be worthwhile to try spat-collecting in the field, if spat-falls can be predicted for particular species. Spawning activity in trochus is influenced by lunar periodicity (Heslinga and Hillman, 1981). Green snail may behave similarly but this should be studied for confirmation. Because the larvae of trochus and green snail are likely to metamorphose in response to contact with coralline algae or GABA (like those of abalones: Morse *et al.*, 1979), spat-collectors for the snails may be tested using substrates whose surfaces are encrusted with coralline algae. It is also noted that abalone larvae settle on the substrates whose algal surfaces have been grazed by larger juveniles in hatcheries. Mucus or some other agent may attract the larvae to settle.

It should be stressed that a great deal of basic research must be carried out for a better understanding of larval and juvenile ecology in general. Local and small-scale oceanography in relation to larval dispersal and settlement is another area which deserves attention.

POTENTIAL RESOURCE ORGANISMS FOR CORAL REEF RANCHING/FARMING

Molluscs

Giant clams have already been demonstrated as ideal animals for farming on the reefs (Heslinga and Fitt, 1987). Some other bivalve genera, such as *Modiolus, Anadara, Fragum, Pinctada, Gelonia* etc., as well as oysters, may also be considered. Very little study has been carried out on the basic ecology of these bivalves, except for *Pinctada* species. Research on reproductive biology and growth rates should be carried out prior to consideration of their farming.

The bivalve *Fragum* would grow on photosynthetates produced by its symbiontic zooxanthellae, as does *Tridacna*. If the clam grew fast enough and could be bred easily, *Fragum* farming might become feasible, perhaps for local consumption. Shells of this genus are used for necklaces in Polynesia.

Among gastropod species, green snail and trochus are the main targets for reef ranching (Yamaguchi, 1988), but other smaller archaeogastropods could also be enlisted. There are many trochids, turbinids and small abalones which are favored as food for subsistence from the reefs. *Tectus pyramis, Turbo setosus, Turbo argyrostomus, Haliotis ovina* and *Haliotis asinina* are such examples. They are all widely distributed and may be abundant locally.

Species of *Strombus* and *Lambis* in the family Strombidae should be included as potential ranching/farming resources. In the Caribbean, the queen conch *Strombus gigas* is cultivated for farming (Buehler, 1988).

Some gastropods which are sought after as specimen shells may also be cultivated for shell trade. Archaeogastropods are easier for farming, so that species such as *Turbo petholatus*, the cat's eye, may be suitable for this.

Larger carnivorous gastropods, such as triton trumpets and helmet shells are difficult to cultivate even if egg capsules were laid in captivity, because their larvae are likely to live very long pelagic lives, perhaps for several months.

Crustaceans

Edible crustaceans are in general active and predatory animals. The larvae of crabs, lobsters and prawns are relatively easy to obtain because they are usually carried by females after being spawned. However, farming of crustaceans is subject to the problems of providing animal food for larvae and juveniles.

Juveniles of penaeid prawns and swimming crabs are raised in large numbers of marine ranching operations in Japan. If the technology could be transferred from Japanese hatchery operations to those in the Pacific Islands, crustaceans might be considered for intensive farming rather than reef ranching in the future. Most oceanic reef habitats are not suitable for releasing crustacean seedlings because of low carrying capacities and the presence of abundant predators. On the other hand, mangrove crabs may be good animals for ranching, with habitat and food enhancements for their juvenile habitat.

Tropical lobsters are out of the question because their very long pelagic life span would practically preclude larval rearing. However, lobsters could perhaps be farmed if juveniles were found to settle on artificial collectors in sufficient numbers. Juvenile lobsters may be attracted to settle by the presence of nonspecific adults. Another possibility is to deploy artificial reefs to provide shelters which may be used by juvenile lobsters. It is not known whether the survival of juvenile lobsters would be improved by such habitat enhancement.

Echinoderms

Many holothurians and an echinoid (*Tripneustes gratilla*) are used as food in the tropical Pacific. The latter has been identified as one of the reef ranching species in Okinawa and is being cultivated. Its larval life span is three to four weeks, typical for planktotrophic larvae in echinoderms. Algal food must be prepared (unless artificial food for such larvae becomes available), and maintaining algal culture may constitute a significant constraint in the Pacific Islands where there are not enough trained experts in this. Sophisticated facilities for algal culture may be difficult to establish and maintain in the tropical islands.

Rearing larval holothurians may require similar facilities and techniques to those needed for the echinoid. It may be desirable to explore possibility of mass production of juveniles of commercially important holothurians for ranching, and to determine whether the growth rates of holothurians are increased by nutrient enhancement or organic enrichment in their habitats.

Sponges

Sponge farming was planned and tested by Japanese fishery researchers in Okinawa and Micronesian islands before World War II. In theory, sponge culture is simple, but there has been no record of successful operation as a viable business. Because products from this farming would be exclusively for export, it may be important to identify marketing outlets before commercial production.

Seaweeds

Tropical seaweeds of commercial importance, both for food and for agar or carrageenan production, are *Gracilaria, Polycavernosa, Eucheuma* and *Caulerpa* (Nelson, 1988). All these are successfully cultivated at various localities in Taiwan, the Philippines and Okinawa. In Okinawa, a few additional seaweed species, i.e. *Cladosiphon okamuranus* and *Monostroma nitidum,* are more important for commercial cultivation as food.

Agarophytes are very good food for juvenile and adult green snails, so that they may be cultivated to supply food for the snail ranching. Very successful pond farming of small abalones depends on food supply from cultivated *Gracilaria* in Taiwan (Chen, 1984).

CONCLUSION

There is not enough information available for many of the potential ranching/farming species on the reefs to allow the formulation of more practical, rather than conceptual, plans for implementation. However, many of the above-mentioned resources are probably amenable for low-techology and small scale operations in the Pacific Islands. Basic facilities such as land-based holding tanks for brood-stocks and raceway tanks with running seawater systems for rearing small juveniles are the minimum requirements to be maintained at hatcheries. Once these basic facilities are established, personnel should be allocated not only for daily production of seedlings of established species, but also for research to develop potential species for ranching/farming systems.

It may not be possible for the initial phase of ranching/farming programmes to be cost-effective in the sense of business, i.e. by investing capital to run hatcheries for commercial gain after harvests, because of the slow growth rates of the majority of species concerned. Government-run or subsidised hatchery stations could be established to supply seedlings at production costs, while fishery co-operatives might be established for management of reef resources (in the case of ranching). Farming operations might be run by private enterprise along with co-operatives. Reef ranching should in any case be regarded primarily as a means for managing inshore resources.

Basic research should be carried out to solve the problems outlined in the previous sections but this is beyond the scope of small local hatcheries. Therefore, existing research institutions should be encouraged and provided with financial support to enable them to undertake projects in this field. The Japanese Government should be persuaded to establish a research centre for this purpose at a strategic location, in order to provide facilities for both research and training, as the basis for aid programmes in fisheries. Such an institute could be established in association with the existing aquaculture laboratories in Okinawa, because most of the important tropical species found in the Pacific Islands and also in the South-East Asia are distributed in the Ryukyus.

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