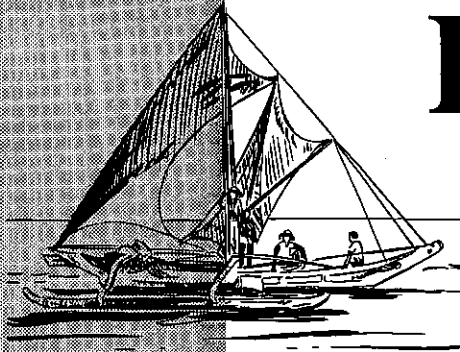


FISHERIES

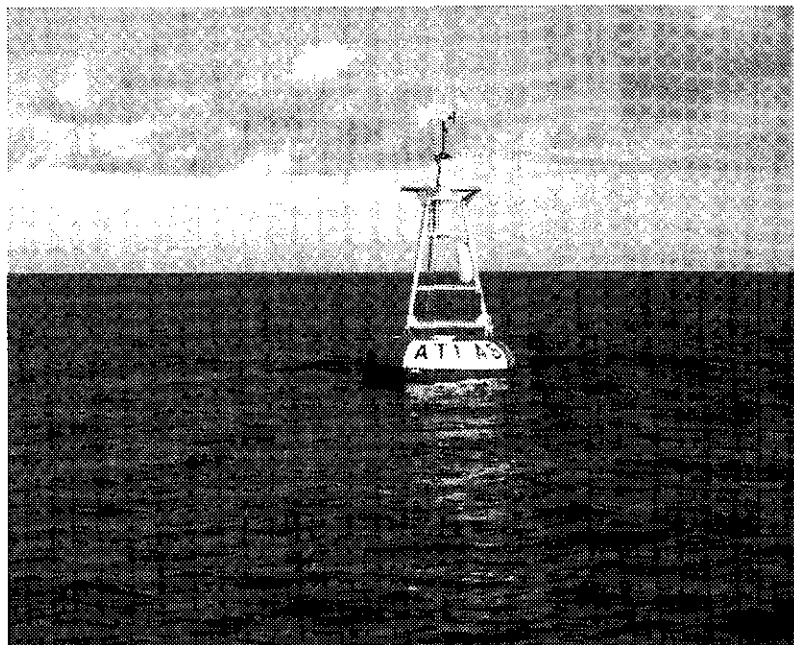
Newsletter



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Moored buoys are used to better understand and predict El Niño events. The surface instruments are located on the tower of the buoy.



South Pacific Commission
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■ RESOURCE ASSESSMENT SECTION

SPC/FFA Workshop follow-up

The first week of July was occupied with the second half of the SPC/FFA Workshop on the Management of Pacific Inshore Fisheries Resources. This meeting was covered in detail in the *SPC Fisheries Newsletter* #73. It was convened for a two-week period and was attended by over a 100 participants who tabled over 100 original papers.

Much of the Resource Assessment Section's recent activities has been focused on the timely publication of the outputs from the meeting, namely a collection of the background and country papers, a narrative report on the Workshop and a volume on the management of Pacific coastal fisheries based on the keynote papers presented at the meeting.

The collection of background and country papers will comprise two volumes with minimal editing and formatting and will be produced as part of the Integrated Coastal Fisheries Management Project (ICFMAP)

Technical Document Series (formerly the Inshore Fisheries Research Project Technical Document Series). It will run to between 1,300 and 1,400 pages and went to the printers at the end of September.

Although the papers forming this collection are not being edited into a single format, a considerable amount of work has been required to make sure that all the drafts are legible and suitable for printing. The Workshop narrative is also expected to be published later this year, while the authors of the various keynote papers have been contacted to review their contributions following the Workshop and to re-submit them for publication before the end of the year.

During the Workshop, a special session was convened with representatives of six of the Commission's member countries, which had requested assistance from ICFMAP in the development of fisheries management

plans for specific fisheries resources.

Following the meeting, the timing and implementation of these six sub-projects have been discussed with the respective fisheries departments and the first of these, at Aitutaki in the Cook Islands, is scheduled for November this year. The field assignments in each of the sub-projects will require in-country visits by all of the ICFMAP staff and, in some instances, the Women's Fisheries Development Officer.

Also included will be two Fisheries Research Associates who were recruited to ICFMAP during August and who will take up their posts in October. The Research Associate positions are one-year attachment positions to ICFMAP designed to give Pacific Island fisheries scientists a chance to improve their skills and knowledge by participation in all aspects of project work. 

Fishery Resource Adviser attends Third Australasian Fisheries Managers Conference

The Third Australasian Fisheries Manager's Conference was held on Rottnest Island, Australia, from 2 to 4 August 1995.

The Conference proper was prefaced by a one-day workshop on the management of Australian recreational fisheries. The workshop was memorable because one tends to forget, working in the Pacific Islands, that, in Australia, four million people fish at least once per year, so a large proportion of the Australian population will spend large amounts of

money to throw fish back into the water (up to 60,000 t a year). It was also interesting to look at the plethora of rules applied to familiar resources like mud-crab in the different states. Bag limits, size limits, closed seasons, gear restrictions, bans on berried females, licences, etc., are all entrenched in the legislation, and the most common request from the recreational lobby seems to be for easily-understood pamphlets on what the rules pertaining to different species in different areas actually are.

It was instructive to observe the increasingly important role played by unpaid, spare-time, volunteers in recreational fishery management, particularly in patrolling local fishing areas to provide information to fishermen on fishing techniques and regulations. Fisheries law enforcement in Australia now consists as much of public education as of trying to arrest people for illegal fishing, and the 'Law Enforcement Section' has become the 'Compliance Section' in most fisheries departments.

Keynote address

At the Conference, Carl Walters (Professor at the Fisheries Centre of the University of British Columbia) was the keynote speaker and gave an excellent talk. His brief was to be thought-provoking, and he succeeded, to the extent that many participants sat there stunned. I make no apology for paraphrasing parts of the presentation here . . .

Professor Walters first became familiar with the region when he ran a computer stock assessment course with Ray Hilborn in Australia in 1983. At that time, everyone was optimistic about the potential of these new computerised stock assessment methods to solve all the problems of tropical fisheries.

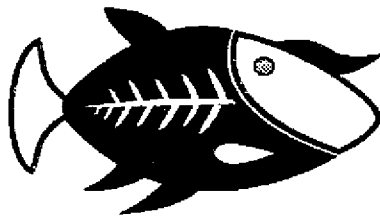
During the follow-up courses in 1986 and 1988, though, he started to worry about the applicability of these methods, and by the 1990s he became completely disillusioned. He says now that the science of stock assessment has taken a complete turn. Most recent papers point out that fisheries scientists don't really know what they are doing, and that a lot of scientific advice is not just imprecise, but actively misleading. There are enormous changes going on in fisheries science now and these have considerable implications for management.

Walters warns that fisheries managers should beware of output controls that depend on accurate stock assessment. There have been a lot of moves towards quota systems on the premise that if you can control the catch, everything else is automatically under control. Nobody has stopped to ask if it will work, and it all depends on

stock assessment. Walters is not aware of any fishery where a sustainable quota can be truthfully said to be assessable to within an accuracy of 40 per cent. In fact, most quotas ought to be radically reduced.

He gave several examples of fisheries where resource estimates with wide confidence limits have resulted in quotas being set at the upper end of the range, for political expediency.

Also, many of the high-tech stock assessment methods used recently produce upwardly-biased estimates. This is often a fundamental property of data that result from harvest information and is not necessarily the fault of the method.



The problem is that most fisheries managers can't do stock assessment and so they have to trust scientists. Carl Walters says that they shouldn't!

He points out that the northern cod fishery is the most heavily assessed fishery in the world, and that the recent northern cod collapse is probably the second largest fishery disaster in the world. 35,000 people are out of work, and the billions of dollars allocated for subsidies have now run out — all because of a blunder in stock assessment that wasn't uncovered in time. Just think about the potential for error in fisheries that we know much less about!

Admittedly the problem was not entirely the fault of scientists. The scientific community

was divided about cod. Aerial surveys actually showed that the stock was still low, but managers wanted to believe the more optimistic model.

Another problem is that fisheries managers always try to find compromise solutions between commercial and non-commercial interests. But Walters points out that 'you can't compromise with conservation'.

For example, stock assessment of the chinook fishery in North America actually predicted the decline successfully, but management was a series of compromise measures to avoid potential conflict, and the fishery suffered. Walters stresses that managers must take harder decisions. He points out that Mother Nature does not sit at the negotiating table and she will not compromise.

Fishermen are good at pointing to everyone else when their fishery gets into trouble, but never blame themselves. Carl Walters calls this the 'Shiva Syndrome'. Overfishing is almost never blamed unless the overfishing is by another section of the fishing community, and fingers are pointed variously at habitat changes, pollution and government policy.

In most declining fisheries, the only answer is to reduce fishing. Walters reckons that hatcheries are a management 'techno-fix' that doesn't really work. He isn't aware of any proven successes over the long term, and says that they tend to exaggerate the problem by keeping effort up.

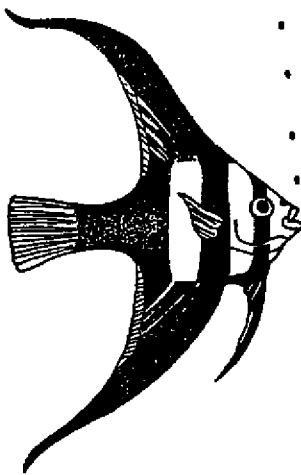
He predicts that over the next 20 years, if things continue along the present track, we will lose most of the large open-sea resources, especially those de-

pendent on international action (which is even less effective than national management).

Walters pointed out that most of us work for public agencies, but we tend to forget that we are in charge of long-term sustainability of a publicly-owned resource. We must remember who *owns* the fish, no matter who *pays* for management.

He reckons that the 'user pays, user says' concept is the most destructive form of fisheries management this century. He also pointed out that fishing rights are not necessarily resource *ownership* rights. Since the resource is actually publicly owned, it implies the public right to regulate. The fisheries manager's client is the public, not industry.

Fisheries management should collect costs from the industries that use public resources, but it industry shouldn't then be able to tell the public how to manage its resources. We should make resource managers into managers, not arbitrators. The first responsibility is to maintain fish for the future, but many managers are afraid to recommend the hard options to politicians.



How can you do sustainable management if you can't do accurate stock assessment? Walters says that the emerging consensus is that the safest way to manage stocks in the face of uncertainty is the old approach of the *fixed exploitation strategy* — to take some percentage of the stock every year, with the percentage fixed at a certain proportion of the natural mortality.

The first time this approach was legislated was in Alaska in the late 19th century, where a maximum of 50 per cent of the standing stock of sockeye could be harvested, and we are now going back to that because it has worked so well. A fixed-harvest strategy allows you to 'track' close to the optimum harvest all the time. It doesn't require biomass information.

So how do you make sure that you get, say, 30 per cent of the fish when you don't even know for sure how big the stock is? You manage the risk of capture via *input controls*.

One way, for example, is simply to close 70 per cent of the fishing grounds to fishing. Why are sockeye fisheries the only sustainable fisheries in the United States and Canada? It's because the management philosophy was to close all of the migratory range of the species and to open only a few small 'windows' to take a controlled percentage. Professor Walters predicts that this is probably going to become the dominant approach to fisheries management over the next few years.

Other presentations

Many more interesting presentations followed during the next three days, and these will be published by the Fisheries De-

partment of Western Australia in the near future. It is clear that fisheries management in Australia has become a very different animal from fisheries management in the Pacific Islands over the last 30 years.

For a start, *cost recovery* has become an automatic watchword for Australian fisheries departments. Revenue to manage fisheries is obtained from the fisheries themselves through licence fees or other levies. This would obviously be a difficult concept to transfer to most Pacific Island fisheries at this stage of development, since subsistence fisheries, by definition, do not generate cash from which to take a levy.

However, given the state of the rest of the world's fisheries, it is clear that Pacific Island fisheries departments should not feel embarrassed about recovering the costs of management from any fully commercial fisheries under their control (provided, of course, that central government allows the revenue thus generated to be turned back into actually defraying fisheries management expenses).

There was an interesting paper on resource-sharing, from Paul McLeod, Dean of Economics and Commerce at the University of Western Australia — interesting because it confirmed some of the prejudices I have always had about the application of market economics theory to fisheries.

One point that Professor McLeod made was that markets do not work unless property rights are clearly defined, and market-dependent solutions to fisheries management problems cannot be advocated without very careful thought.

He says that you should not just accept the typical economist's knee-jerk response to a problem by 'letting the market sort it out'. Most fisheries property ownership systems do not form markets as traditionally understood by economists anyway. In many cases, there just aren't enough players in the system to cover all the assumptions behind market theory.

Another interesting point that came out of his talk is that *security* for natural resource-users such as fishermen lies not in holding a long-term licence, but in the effectiveness of the management plan. There is no point at all in holding a long-term licence or quota if the resource is rooted (highly technical term used by Australian fisheries managers, meaning 'over-fished'), and participating fishermen should thus have a very strong vested interest in seeing the best management plans possible.

There was a very lucid explanation of the development of Maori fishing rights in New Zealand over the last few years, by Mandy Cassidy, followed by presentations on Australian Aboriginal fishing issues.

A brief description of Pacific Island reef fisheries management was presented by the SPC representative at the end of the Conference.

Fisheries Management Society of Australasia

During the course of the Conference there was an evening session to discuss a recommendation (arising out of last year's workshop) to form a Fisheries Management Society of Australasia (FMSA), separate from the Australian Society of Fish Biology (ASFB). The issue of whether or not to form a special interest group under ASFB was discussed at some length, but it was decided that a separate

society would be best at this stage, with the possibility of amalgamation later under an umbrella heading such as 'Australasian Fisheries Society'

SPC was proposed to be one of the founder institutional members of the FMSA when it is incorporated, representing the interests of the Pacific Islands region. Rosemary Lea, Senior Fisheries Management Officer of the Northern Territories Fisheries Department, is the Chairperson-elect. The society will arrange the fourth Australasian Fisheries Managers' Conference, probably as a special session during the World Fisheries Congress next August. There will be a newsletter for the society and the possibility of starting up a journal of Australasian fisheries management will be discussed. SPC will publish more information in the *Fisheries Newsletter* as it arises, including details of how individuals may become members. 

Biology and Geology of Coral Reefs: European meeting of the International Society for Reef Studies and the British Ecological Society

This meeting, held at the University of Newcastle, UK, from 5 to 9 September, was an opportunity for researchers on coral reefs from all over the world to present and discuss their work (including a substantial fishy component).

SPC Coastal Fisheries Programme staff rarely attend international scientific meetings, so this was also an opportunity for the Resource Assessment and Management Section to find out about the latest trends in coral reef research in other regions. It was thus of great value to our own work of transferring fisheries stock assessment and management technology to the Pacific Islands.

We also presented a paper to the meeting describing Pacific Islands coral reef fisheries, so it is to be hoped that some attention was drawn to the most appropriate subjects for externally-sponsored research in this region.

Judging by the amount of interest in collaborative research opportunities (and even a number of enquiries about jobs), there is still plenty of interest by scientists in the Pacific Islands, even if grant-providers have turned their attention elsewhere.

However, this was a scientific meeting, not an international development meeting, thus there was no opportunity to

match good intentions with the money to actually implement new Pacific projects.

This was a very condensed meeting, with two sessions running concurrently: one on the biological aspects and one broadly on the physical aspects of coral reefs.

As with any scientific meeting of less than monumental scope (you will need to attend the 1996 International Coral Reef Symposium in Panama for a more complete coverage), presentations could not cover the whole range of the subject matter, but were rather a series of bites taken here and there, many of them providing

insights that could not be obtained from the literature. Even so, there was a noticeable clustering of interest around certain narrow areas within the broad session headings of the meeting.

For example, testing the efficacy of marine reserves and protected areas for sustaining nearby fisheries was the major topic within the 'Management-related issues on coral reefs' session; and investigating the toxicity of *Palythoa* took up the entire session on the 'Role of toxins in the coral reef environment'.

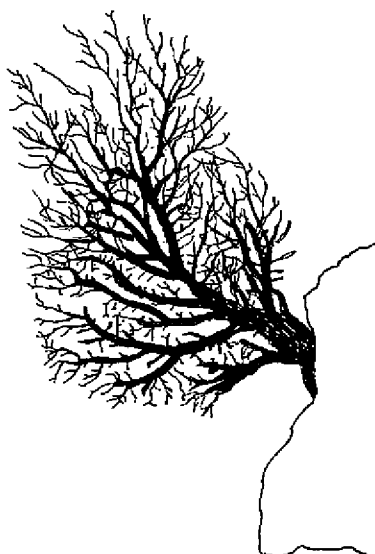
Noticeable by their scarcity were broad-ranging review papers or critical attempts to survey the state of knowledge in particular topics.

However, this again seems to be a characteristic of meetings of research scientists, which tend to confine themselves to what is considered to be new and noteworthy, since each scientist presumably knows the background of his own field so well. Perhaps the meetings themselves provide the material for synthesists to go away and review a topic.

However, some broader synthesis papers might make certain topics more accessible to specialists in other fields, so that more insight could be gained into their own work. New ideas are one of the most valuable things to come out of meetings.

One exception to this rule was an excellent 'Review of remote sensing for the assessment and management of tropical coastal resources' by E. P. Green, P. J. Mumby, A. J. Edwards and C. D. Clark. The senior author is at the Centre for Tropical Coastal Management Studies at the

University of Newcastle (Newcastle-upon-Tyne, NE1 7RU, UK). Although this was presented as a poster rather than verbally, there was enough material there to suggest that this will be essential reading for all who have anything to do with satellite and airborne imagery in coastal marine applications, particularly those who have to make decisions about what technology to use in various circumstances and to assess whether the technology is actually up to the job. The review will apparently be published in the Autumn edition of the journal *Coastal Management*.



Robert Ginsburg and Sue Wells used the meeting to publicise the International Year of the Reef that has been declared for 1996/7. The exact dates were not given and the sponsoring body(s) were not announced, but this will apparently be a major effort to assess the condition of reefs worldwide, to document patterns of degradation and seek their causes, to educate users and the public on the value of reefs, and to assist in the development of their recovery and promote their sustainable management. It will be complementary to the Interna-

tional Coral Reef Initiative (for which SPREP is organising a Pacific regional workshop at the end of November 1995) and other national, regional or international programmes.

Stefano Aliani (Stazione Oceanografica, CNR, Forte Santa Teresa, 1-19036 Pozzuolo di Lerici (SP), Italy) has been developing and testing methods of describing reef and coral status that do not require organisms to be identified to the species level, and can thus both be carried out more easily where access to taxonomic expertise is limited, and can enable reefs to be compared in different geographical areas where the species are different.

Such 'non-taxonomic descriptor' methods could be very useful for Pacific Island fisheries departments that have to carry out environmental impact assessments, or look at the effects of coral harvesting or other damage.

There was the usual debate over the significance of coral bleaching events. There was an interesting video from Australia (shown by Emre Turak of AIMS), showing bleaching of coral occurring after a flood plume, taking an unusual direction, brought large amounts of silt and freshwater onto reefs.

Most of the corals had recovered within two months, although some corals, particularly in the scleractinian families Pocilloporidae and Agariicidae and the hydrozoan *Millepora* (fire coral) showed some mortality.

Such unusual flooding events occur every decade or so in this area and obviously have a selective effect on the local reef community composition, which must have adapted accordingly.

Another presentation suggested that at least some coral bleaching is caused by bacteria, although the putative pathogen has not even been isolated yet.

Several papers dealt with producing artificial reef structures through electrolytic carbonate accretion *in situ*. This basically involves running a current through steel mesh underwater, which precipitates limestone onto the mesh (up to 1 in radius in 2 weeks – about 1 kg of accretion costs in 1 kilowatt-hour).

The usual question was asked: 'Why don't you just use concrete blocks instead of going to all this trouble?' The answer is that it is more cost-effective than cement blocks, particularly in remote-island situations, and there seems to be much better colonisation and higher growth rates from encrusting corals and sponges.

Nick Polunin and Simon Jennings discussed some of the work they have done in Fiji over the past couple of years. Simon looked at a series of different fishing grounds covering a wide range of fishing effort and analysed the fish community composition in relation to the amount of fishing going on.

They found that there was not much correlation between the intensity of fishing and the biomass of different species. In other words, the effects of fishing are hardly discernible in these six fishing grounds.

There was a special discussion group on reef-fisheries research collaboration later in the meeting, to discuss the possibilities of working together on several research initiatives of topical importance. Three issues were put forward:

1. *Recruitment of reef fishery organisms in the Pacific region*, presented by René Galzin, Université de Perpignan, France. Recent work at the Australian Institute for Marine Studies (AIMS), reported at the SPC/FFA Workshop on In-shore Fisheries Management by Dave Williams, suggests that long-distance transport of larvae may be important in certain areas ('sinks') of Australia for the replenishment of reef organisms.

On the other hand, work in French Polynesia has suggested that recruitment around isolated oceanic islands depends on local sources of larvae. René proposed a study to resolve this question, involving collaboration between Australian and French (including New Caledonian and French Polynesian) scientists.

There is an opportunity for other interested scientists in the Pacific Islands to collaborate in this study, which will be of great relevance to the management of Pacific Island reef fisheries.

2. *The effects of fishing on reef communities and ecosystems*, presented by Nick Polunin of the University of Newcastle, UK. Fishing can be considered a research tool, and we can learn a lot about ecosystems by observing how they respond to disturbances.

Nick's research group has already done some work on this in the Pacific (Fiji), and will be continuing to look at the effect of fishing on ecosystems in other parts of the world in future.

The newly-validated technique of using otolith weights for the ageing of tropical fish holds

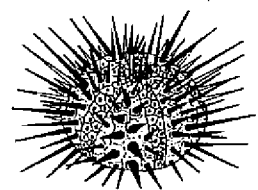
considerable promise for elucidating fish community age-structure and Nick would be interested to hear from anyone working in this field.

3. *The utility of marine fishery reserves*, presented by John Munro, of ICLARM. Many people are worried that reserves are being promoted as the ultimate, and in many cases the only, management tool for maintaining sustainable tropical reef fisheries.

There is much action in the Philippines, where large areas of reef (up to 10%) are being set aside, but where no reduction in the total number of fishermen is possible (since the fishery is the 'resource of last resort' for the landless poor in the Philippines, unlike some other areas).

It is likely that this will put increased pressure on the remaining fishable areas and, for some fisheries that are just teetering on the brink of collapse, may push them over the edge. If there is no 'spillover effect' where fish from the reserves replenish the surrounding areas, it is possible that the net loss to the ecosystem may be much greater than if the reserve areas had not been taken out of the fishery.

John suggests that this type of question needs to be investigated as a matter of some urgency, and will be carrying out some work of his own in the Caribbean. Again, this is very much the kind of question that would benefit from international collaboration.



■ POST-HARVEST SECTION

Regional Workshop on Handling, Quality Assessment and Grading of Sashimi Tuna

Sixteen participants from all over the Pacific and Southeast Asia descended on Chuuk, Federated States of Micronesia in late August to attend a workshop designed to improve skills in handling, quality assessment and grading of longlined sashimi tuna.

The workshop was organised by the SPC Coastal Fisheries Programme and funded under the Canada-South Pacific Ocean Development Program (CSPDP).

The background to this initiative stems from the need to develop and improve in-country skills in an area that is often the domain of specialists from outside the region. Quality assessment and, in particular, grading, are very often carried out by graders from Japan, Tai-

wan or Hawaii. These skills are slowly being developed in the Pacific, especially in countries such as Fiji and the Federated States of Micronesia that have had tuna longlining and exporting operations for a number of years.

Other countries are just starting up their longlining ventures and need the skills to ensure that the tuna being exported overseas will be sent to the correct market, where it can be sold for the best possible prices.

Ten countries were represented at the workshop — all with a flourishing longlining industry or with plans already in place to establish such an industry over the next twelve months. The Pacific was represented by the Cook Islands, Federated States of Micronesia, Fiji, French

Polynesia, Kiribati, Papua New Guinea, Tonga and Western Samoa. From the ASEAN region, a participant each from Indonesia and Thailand funded their own attendance.

The teaching was carried out by three tutors: Kunji (Ken) Harada, Quality Control Officer at the Sydney Fish Market, took care of the tuna quality assessment and grading sessions; Steve Beverly, Masterfisherman, taught and demonstrated the on-board handling and processing techniques; and Steve Roberts, SPC Post-harvest Fisheries Adviser and workshop coordinator, taught more general topics on sashimi tuna markets, new quality assurance procedures that will affect all fish exporters from the Pacific, and appropriate facilities for packing and exporting tuna.



Tuna cut in half to show where the fish should be spiked

The full list of topics covered during the six-day workshop included:

- ☛ overview of the world/Pacific sashimi tuna trade with the main markets,
- ☛ biology of tunas and physical characteristics of tuna flesh with respect to eating quality,
- ☛ overview of factors affecting the quality of tuna,
- ☛ causes of flesh deterioration in tuna,
- ☛ principles of chilling,
- ☛ procedures for quality assessment and grading of sashimi tuna,
- ☛ grading of sashimi tuna (practicals),
- ☛ on-board handling of sashimi tuna,
- ☛ on-shore handling of sashimi tuna,
- ☛ design features of a good packing plant,
- ☛ packing for export,
- ☛ regulations and documentation requirements affecting the export of tuna, and
- ☛ introduction to modern quality management procedures (HACCP, QMP, etc.).

Ken Harada's inputs provided a valuable insight into what it is that takes place in the flesh of tunas and can make such a big difference to the quality of the fish when it is caught, landed, processed and stored. The biochemical changes that take place at the cellular level not

only affect the texture and colour of the flesh, but also the flavour of the meat.

Furthermore, Harada explained that there are factors associated with the condition and biological make-up of *each tuna* that cannot be changed by how the fish is treated after it is caught. These factors are intrinsic and are similar to variations between individuals in any biological systems.

While it may be impossible to improve the quality of tuna that are intrinsically defective, it is

comparatively easy to turn good-quality, potentially valuable tunas into fish that will bring poor returns.

The beneficial effects of the various on-board handling steps on the quality of the flesh were described in detail, and again linked to the biochemical changes in the flesh, the physical changes to muscle structure, and the colour and visual appeal of the meat.

Such procedures include careful handling at all stages, brain killing and destroying the spi-



Steve Beverly demonstrates how to spike the fish

nal cord, bleeding, gilling/gutting, and finally efficient chilling — all have a beneficial effect on the tuna flesh.

Many of these points were further highlighted during practical demonstrations. Harada was able to show the variations in quality and grade between a number of tunas and provide a cause-and-effect explanation for tunas with defects.

As a bonus, Harada expertly showed how a tuna loin is cut up for sale in restaurants and sushi bars in Japan. This was quickly followed by the contented murmurs of raw fish sampling.

Steve Beverly provided details of the practicalities of handling and processing tuna on the fishing-boat, starting the moment the tuna is caught. The range of tools and materials needed for these steps were shown and simulated demonstrations carried out on some landed tuna.

His many years of longlining experience enabled Steve to show the most efficient ways of stunning, bleeding, spiking the tuna's brain, destroying the spinal cord by running a piece of monofilament line down the spinal canal, the different ways of gilling and gutting the tuna, and finally, how best to lower the temperature of the fish as quickly as possible to preserve the quality of the flesh.

One of Steve Roberts' more onerous tasks was to explain a new quality assurance procedure that is being introduced by the United States Food and Drug Administration and at some stage in the very near future, will affect all fish exporters selling fish to the US.

This includes sashimi tuna packers who sell medium-quality tuna and bycatches to the US market. The quality assurance system is called Hazard Analysis Critical Control Point (HACCP) [see article by Vance McEachern in the last issue of *Fisheries Newsletter* and one by James Movick in this issue].

This is scheduled to become law in early 1996. The new system will mean modification to packing plants and extra procedures for the exporter.

It was explained that, although the initial effect would be painful, in the long term there would be benefits associated with being able to provide better guarantees of quality; holding a competitive edge should be easier.


Participants were relieved to learn that Japan has not (as yet) indicated that it will introduce similar quality assurance procedures.

The workshop's organisers were very fortunate that the workshop participants were a sympathetic and patient group who understood that there are unpredictable 'highs' and equally unpredictable 'lows' in any fishing activity. This was certainly the case in Chuuk during the week of the workshop, which coincided with a period of very poor catches.

Only one vessel deposited its catch of 1.5 mt of fish at the Chuuk Fresh Tuna Inc. landing while the workshop was running. The unusual lack of tuna curtailed the number of practical sessions that were planned and limited the grading skills demonstrations and practice that each participant could experience.

Despite this serious impediment, the workshop did achieve many of its objectives. A review of the workshop conducted on the last day established that the participants had benefited from the week's diverse instructional activities.

The workshop on the handling, quality assessment and grading of sashimi tuna has been a very popular activity, as shown by the number of countries and individuals applying for the limited number of workshop places. The Commission feels that further similar workshops should be run again, possibly as two sub-regional workshops. Anyone interested in participating in such a workshop should send an expression of interest to the Fisheries Programme at SPC.

Finally, the Coastal Fisheries Programme extends its expression to: the Canadian Government and Canadian Ocean Resource Associates Inc. for agreeing to fund this workshop as the final, closing activity of one of the Coastal Fisheries Programme's sub-projects on post-harvest fisheries training; the Sydney Fish Market Pty Ltd, which made a valuable contribution by providing the services of Mr Kunji Harada free of charge; the Government of the Federated States of Micronesia (FSM) and Chuuk State, for responding positively to the Commission's request to host the workshop in their country; the FSM National Fisheries Corporation for providing invaluable logistical assistance; and National Fisheries Corporation (Chuuk), together with Chuuk Fresh Tuna Inc., for helping with the day-to-day running and organisation throughout the six-day workshop. 

■ CAPTURE SECTION

New Masterfisherman to be appointed

In September the Commission released notice of a vacancy for a Masterfisherman within the Capture Section.

In response to the nature of requests for assistance now regularly received by the Section, the

notice specified that, apart from a wide experience of Pacific Island fisheries and a professional sea-going qualification, the appointee will have thorough knowledge of tuna longlining techniques and the handling skills required to produce

sashimi-quality fish, and of fish aggregation device theory and practice. It is expected that the new Masterfisherman will take up the post before the end of 1995.



Maui meeting re-affirms Pacific Islands' determination to develop a tuna fishery

Some 140 representatives from 20 countries gathered recently in Maui, Hawaii under the sponsorship of the Maui Pacific Center to jointly develop strategies that would see 25 per cent of the region's tuna fishery in the hands of Pacific Islanders within the next decade.

The common theme of the keynote speakers, who included such luminaries as Hawaii's Senator Daniel Inouye, Ratu Sir Kamisese Mara, Sir Michael Somare, and Canada's Minister of Fisheries Brian Tobin, as well as fisheries managers and representatives of Pacific Island fishing enterprises, was that Pacific nations can and should take control of the harvesting of their tuna resources to ensure their sustainability.

Most delegates to the conference believed that domesticating the Pacific tuna fishery was best left to the private sector, but that the success of these enterprises depended on governments adopting policies to foster private development and co-operating regionally to protect tuna resources.

Delegates from both Fiji and Papua New Guinea pointed out that private investment increased once governments had established clear, fixed guide-

lines for participation in their tuna fisheries.

These sentiments were echoed by economists from the World Bank and Asian Development Bank. Entering the fresh-chilled tuna longline fishery was generally seen as the best opportunity for Pacific Islanders to benefit more directly from their tuna resources.

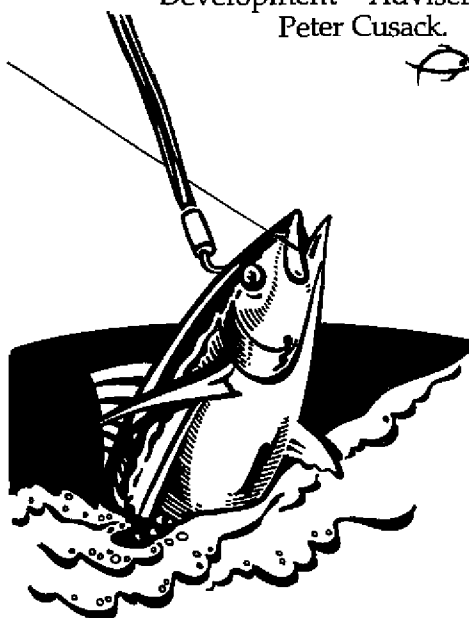
It was suggested that countries presently hosting foreign longline fleets under access agreements might adopt a 5 for 1 ratio, cancelling 5 foreign licences when one new domestic vessel is commissioned. Successful operators attending the conference pointed out that a cautious and calculated approach to entering this fishery was still of the utmost importance.

Careful assessment of the resource and of shipping and marketing opportunities was vital, they said. They also emphasised the relative simplicity of the required support infrastructure and strongly advised against major investment in elaborate, and unnecessary, landing and packing plants.

The successful operators made it clear that the best safeguard for avoiding costly mistakes in the selection of vessels and gear was to secure genuine expertise.

The conference outcomes will be provided to each Pacific Island government and the Maui Pacific Center is likely to convene a further conference in 1996 to review progress.

The Capture Section's UNDP-sponsored Offshore Fisheries Development Project provides advice and assistance in the development of domestic tuna fisheries; enquiries should be addressed to SPC's Fisheries Development Adviser, Peter Cusack.



■ TRAINING SECTION

New Fisheries Training Officer on board

In May, the position of Fisheries Training Officer (FTO) became vacant after Michel Blanc was appointed Fisheries Education and Training Adviser to replace Hugh Walton. The recruitment process for the FTO post immediately started and, in July, a screening committee selected Magnus Bergstrom from amongst seven applicants.

Magnus has a Bachelor of Science degree in Marine Biology and Fisheries, and relevant fisheries training experience in Africa (designing of staff development training for the Angola Maritime and Fisheries College) and in India and Bangladesh through the FAO (lecturing and training of fisherfolks in Bangladesh).

His recent assignment (1993–1995) at the Micronesian Maritime and Fisheries Authority (MMFA), Yap, FSM is also very relevant to the work carried out by the Fisheries Training Section.

As director of the MMFA, Magnus was coordinating all maritime and fisheries training programmes for FSM. Since 1993, Magnus has been in contact with the Training Section through direct correspondence and has shown a keen interest in some of the Section's activities (Pacific Island fishing deck-hand certification, HRD planning, safety-at-sea training ...).

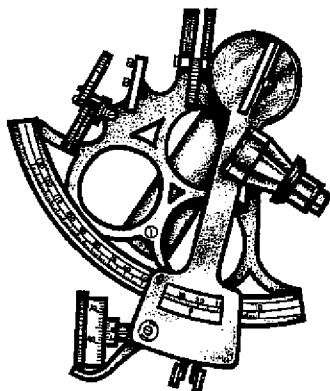
The new FTO will be in office early in November and staffing levels in the Section will then be back to normal. Magnus' working experience in FSM will be an asset for the strengthening of the Section's links with Micronesian countries.

Magnus is 44, comes from Sweden and is married with two children.



Regional workshop advertised

As fisheries in the Pacific move from subsistence to small-scale commercial operations, the skills needed by boat operators change. While fishing skills continue to be the most important, many small-scale fishing enterprises have failed because the operators lacked an understanding of the financial aspects of business practice.



In response to expressed concerns on the matter and to a recommendation of the 25th Regional Technical Meeting on Fisheries that the Fisheries Training Section should implement organisational and enterprise management training, funding has been obtained from UNDP to operate two regional workshops on the management of fishing enterprises.

The first workshop was advertised in August through SPC Savingram no. 39. The training programme will be of ten days' duration and will deal with skills relevant to small-boat operators. In order to obtain the greatest coverage, the workshop will be run on 'train-the-trainer' principles. Participants will acquire financial skills that will assist them to advise small-boat operators on financial matters.

They will also develop the structure and materials to run their own short, in-country workshops. These materials will be printed and made available regionally. In this manner it is expected that the greatest possible spread of information and training will be obtained.

The workshop will be held at a Pacific Island venue to be decided shortly. It will be run during the last two weeks of March 1996.

Interested and motivated fisheries extension officers are most welcome to apply through their fisheries department. The closing date for receipt of completed nomination forms and official endorsement is 15 December 1995.



Nelson course review and options

The 16th annual SPC/Nelson course finished on 27 July in Noumea, with participants able to view the new Commission Headquarters and learn first-hand of the broader work programmes before flying off home after six months on the course.

The programme of the Nelson module was little changed from the previous year's course. As usual, the practical module proved a great success.

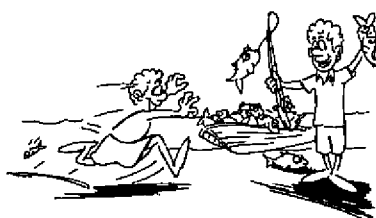
Since its inception in 1983, the practical programme has evolved into a comprehensive hands-on experience with the operation of a small fishing centre and experience given in the areas of vessel operations and supply; fish catching, handling and marketing; record-keeping; and financial management.

For the second year in a row, the module was hosted by the Northern Province of New Caledonia, at Touho, an area renowned for its snapper and Spanish-mackerel fishing grounds.

The SPC/Nelson Polytechnic Pacific Island Fisheries Officers Training Course has been run each year since 1979.

In response to suggestions from countries and to recommendations made at the Regional Technical Meeting on Fisheries (RTMF), the course content has been continually altered to keep it responsive to country needs and to changing circumstances.

This year, the course has been subject to additional review by the Commission and a comprehensive survey of previous course participants and fisheries departments has been carried out. The survey com-



menced in April 1995. Letters were sent to each Chief Fisheries Officer (CFO) of the region, along with individual questionnaires to be given or mailed to each participant of that country or territory who had attended the course since 1979. It is hoped that the questionnaires have reached most of the 173 course participants.

By August 1995, replies had been received from 52 participants, which gives a reply rate of 30 per cent. The results obtained in this survey have been very useful in underlining several areas where the course could be improved for the benefit of on-going participants.

An analysis of the results suggests that the following changes should be made to improve the course:

- ☛ 'Boat construction and repair' should be dropped or reduced to basic essentials;
- ☛ 'Diesel engine maintenance' should be dropped;
- ☛ The time spent on 'Welding' should be examined, with the purpose of determining if it can be reduced;
- ☛ The 35 hours spent on 'Fibre-glassing' should be reduced to 28 hours;
- ☛ The time gained from dropping the above subjects should be divided between those subjects that, according to students, need

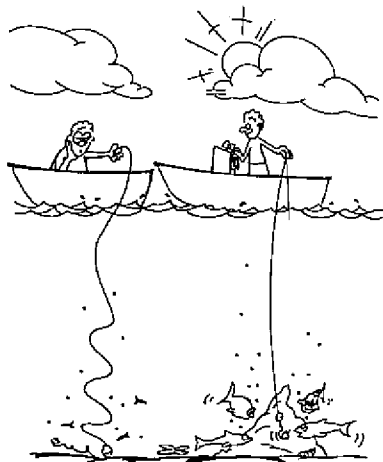
more time, i.e. 'Electronic fish-finders and GPS', 'Computer studies', 'Fishing technology' and possibly others;

- ☛ The course outline should be adjusted to reflect these changes; and
- ☛ If the course is to be ongoing, past 1996, Nelson Polytechnic should issue a Certificate of Achievement approved by the appropriate authorities.

A report on the survey was forwarded to the New Zealand School of Fisheries, Nelson Polytechnic, with a view to implementing the above recommendations for the 1996 course.

The report was also circulated to the course sponsors (Government of New Zealand, Commonwealth Secretariat and Commonwealth Foundation).

Although the Commission is now in a position to confirm that the course will again be offered in 1996, its funding is becoming more and more difficult to secure.



As a consequence, the Training Section is exploring options for the continuation of fisheries technical training in the region. In June, as part of the course review, the Manager of the Commission's Fisheries Programme and the Fisheries Education and Training Adviser went to the Nelson Polytechnic to meet the 1995 course students and their tutors.


Discussions with the School of Fisheries staff suggested that one longer-term option for upgrading the course would be to integrate it into an appropriate course being offered by the School to the New Zealand fishing industry.

Elective subjects dealing with aspects of Pacific Island fisheries would be included in the course to make it relevant to the needs of the Pacific region.

One of the advantages of this suggested change would be that successful course participants would be issued a recognised Certificate of Achievement as opposed to the current Certificate of Attendance.

Also, SPC would not need to seek sufficient funding each year for a minimum of ten students to attend the Pacific Islands Fisheries Officers Training Course.

These suggested changes, as well as the results of the questionnaire survey, will be presented to SPC member countries at the 1996 Regional Technical Meeting on Fisheries (RTMF) in Noumea.

In the meantime, the Section and the New Zealand School of Fisheries will prepare the 17th course by adjusting the course outline to reflect the survey results. The course will start on 12 February 1996. 

ASEAN/PINs cooperation in fisheries education and training

In May, the Manager of the Commission's Fisheries Programme and the Fisheries Education and Training Adviser went to Manila, Philippines, to attend a two-day workshop entitled *Human Resource Development Planning and Information Networking: Cooperation and Coordination in Fisheries Education and Training*.


The main purpose of this workshop was to explore means of coordinating donor-supported fisheries education and training programmes in the Pacific Is-

land region with those in South-East Asia.

Although Asian countries offer many courses and programmes which are not available in the Pacific region (especially in the areas of post-harvest and aquaculture), access to these programmes for Pacific Island fisheries personnel is constrained by the absence of appropriate funding mechanisms.

In this regard, a set of recommendations was addressed to the donor community. Section

staff coordinated Pacific Island inputs to the workshop and presented a paper on human resource development planning in the Pacific Island fisheries sector.

The workshop was sponsored by the Canadian International Development Agency and the Government of France and was organised under the auspices of the Asia-Pacific Economic Cooperation Fisheries Working Group and the Pacific Economic Cooperation Council. 

■ OCEANIC FISHERIES PROGRAMME

Eighth meeting of the Standing Committee on Tuna and Billfish

The Eighth Meeting of the Standing Committee on Tuna and Billfish (SCTB8) was held from 16 to 18 August 1995 at SPC headquarters in Noumea, New Caledonia. Participants came from American Samoa, Australia, Cook Islands, Fiji, French Polynesia, Indonesia, Japan, Korea, New Caledonia,

Solomon Islands, Taiwan, Tonga, United States of America, the Food and Agriculture Organization of the United Nations, the Forum Fisheries Agency and the Indo-Pacific Tuna Programme.

The agenda included an overview of western Pacific tuna

fisheries; a review of the Oceanic Fisheries Programme (OFF) work programme for 1994-95 and work plan for 1995-96; the financial and staffing status of the OFF; prioritisation of OFF activities; regional and international developments affecting the OFF; and reports by other organisations.

During the overview of western Pacific tuna fisheries, the participants gave reports on tuna fishing activities in their home countries or territories.

This was the first meeting of the Standing Committee at which country reports were given in a systematic manner. They proved to be a valuable source of information for OFP staff and the other participants.

Highlights of the review of the OFP work programme included presentations by staff recruited in early 1995 under the South Pacific Regional Tuna Resource Assessment and Monitoring Project (SPRTRAMP).

Mr Peter Sharples, Port Sampling and Observer Supervisor, reported on the status of port sampling programmes supported by the OFP and the implementation of OFP scientific observer coverage with three observers recruited under SPRTRAMP.

Dr Patrick Lehodey, Senior Fisheries Scientist, discussed his work on the environmental determinants of tuna fishery production in the western equatorial Pacific.

Dr Michel Bertignac talked about work he is doing for a joint effort by the OFP, the Uni-

versity of Queensland and the Forum Fisheries Agency to develop a management model incorporating both biological and economic components; Dr Bertignac's multi-species model for western and central Pacific tuna incorporates age structure and movement, with harvesting by multiple gear types.


A sub-committee was established at the Seventh Meeting of the Standing Committee on Tuna and Billfish, which was held in Koror, Palau, from 5 to 6 August 1994, to prioritise OFP activities in the event that budgetary restrictions required reductions in the OFP work programme.

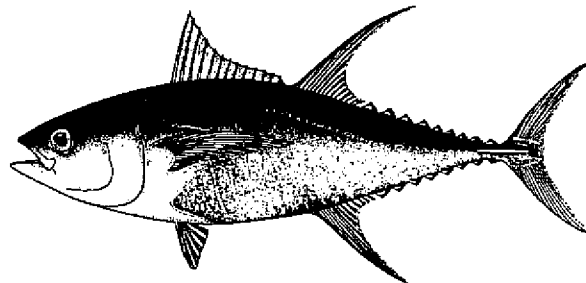
OFP activities were categorised into three priority levels. Four activities were identified as top-level activities; these were:

- (1) maintenance of the catch-and-effort database;
- (2) provision of scientific advice on the status of stocks on a regular basis;
- (3) development of integrated models for stock assessment of tuna species; and
- (4) maintenance of collaborative links with regional and international organisations involved in oceanic and tuna fisheries matters.

The impact on the OFP of a number of regional and international developments was discussed; these included the Multilateral High-Level Conference on South Pacific Tuna Fisheries held in Honiara, Solomon Islands from 5 to 9 December 1994; the South Pacific Organisations Coordinating Committee (SPOCC) Review of Institutional Arrangements in the Marine Sector; the United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks; and the establishment of the Interim Scientific Committee on North Pacific Tuna and Tuna-Like Species.

Under this agenda item, the representative of the Fisheries Agency of Japan presented three possible options for alternative institutional arrangements for tuna data collection and dissemination, and for tuna research in the South Pacific.

SCTB8 was immediately followed by the Fifth Meeting of the Western Pacific Yellowfin Research Group (WPYR5), from 21 to 23 August 1995. WPYR5 was different from previous WPYR meetings in that it also touched on matters related to bigeye and skipjack. 



■ MAHIMAHI CULTURE GOES COMMERCIAL

Mahimahi is Hawaiian for 'strong-strong'. One of the most sought-after fish in the sea, it is prized for both its fighting spirit and its reputation as a premium-quality table fish. Identified as an outstanding candidate species for commercial farming, it will probably revolutionise marine aquaculture. It is the first aquatic species that is effectively pre-adapted to a production line cultivation system, thereby allowing the development of aquaculture as a true agribusiness.

The ongoing decline of the wild-capture fishery and restrictions imposed on it, together with excellent prices, will lead to a rapid increase in the production of premium-quality farmed marine fish. Mahimahi has been identified as one of these species.

Seafood Business (January/February 1993) cites an opinion that 'within a few years, mahimahi will be a pre-eminent aquaculture species in tropical and warm-water environments'. The attributes of the species support predictions that it will become one of the most important fish in the evolution of the aquaculture industry.

The market outlook for farmed mahimahi is good. Australian, US and European markets for the species are growing and the availability of farmed fish is likely to increase. There is also excellent potential for farmed mahimahi in other countries in the Asian-Pacific region.

The Australian Cooperative Research Centre for Aquaculture Ltd has estimated that within 10 years, 2,000 t of mahimahi, with a market value of A\$ 20 million, could be pro-

duced by aquaculture on the east coast of Australia each year. West coast mahimahi production is harder to estimate, but will probably exceed 1,000 t per annum, with a market value of A\$ 10 million. These production estimates were based on supply of the domestic market alone.

Biotechnical attributes

Mahimahi is an epipelagic marine finfish that occurs worldwide in tropical, subtropical and warm temperate regions. Other common names for mahimahi include dolphinfish, dolphin, dorado and dorade coryphaene. It is one of the world's most famous game fishes and is noted for its excellence as a food fish.

The biological attributes that make mahimahi one of the most exciting species for large-scale, commercial farming in the world today, are its unique spawning capability, exceptional growth rate and efficient food conversion ratio (FCR).

Adult fish can spawn naturally once every 48 hours, throughout the year, without the need for hormonal or other chemical treatments. Each female can produce over 250,000 eggs on each spawning occasion. In terms of growth rate, mahimahi can grow from an egg to more than 10 kg within 12 months. Under intensive culture, it can

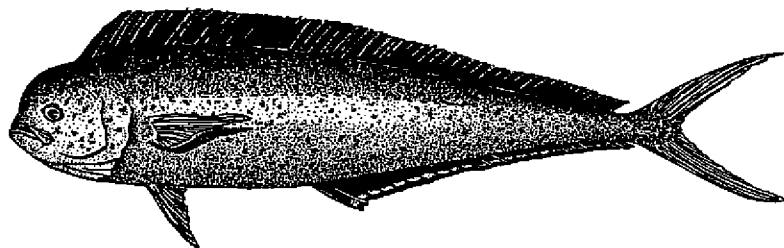
attain approximate weights of 2.5 kg within six months, 4.5–5.0 kg within eight months and 8.0–8.5 kg within 10 months. The mahimahi has a very efficient FCR (average 1.2:1), which translates directly to increased profitability.

Mahimahi has many attributes that are compatible with the requirements of modern agribusiness. Its superior growth rate means that fish can be supplied to the market in a relatively short time, allowing improved cash flows and reduced risks. Other species of marine fish can take 12–18 months to grow to 300–500 g and have less efficient FCR.

Broodstock hatchery and nursery facilities for mahimahi are comparatively small because they are used throughout the year. This feature allows significant cost reductions.

By contrast, other species of farmed fish generally only spawn once each year and hatcheries need expensive, sophisticated, controlled environment broodstock facilities to extend, or provide additional, spawnings. These other species also require relatively more hatchery and nursery space and equipment than mahimahi does.

For mahimahi, the estimated production rate (that is, the amount of fish produced per



Mahimahi (*Coryphaena hippurus*)

unit of water volume per year) is about 200 kg/m³/yr. The equivalent rate for other species of farmed fish is around 50 kg/m³/yr. Farmed mahimahi also have a high fillet percentage (average 50–60%). The flesh is high in quality and has superior flavour, texture and appearance.

Commercial farm designed

Mariculture Development Pty Ltd., an Australian company, possesses commercial mahimahi aquaculture technology. The company was formed with the objective of building a commercial mahimahi farming industry both in Australia and overseas.

The research and development phases have now been completed, with commercial-scale production envisaged within the next 12 months.

The company has designed an intensive, land-based tank farm capable of producing 200 t of fish per annum. Production can be increased as required by building additional modules. The farm adopts a strong environmentally-oriented approach and makes provision to treat the water before it is discharged.

The cultivation process is characterised by a series of production runs, each commencing at predetermined intervals. Each

production run begins with the stocking of fertilised eggs and ends with the harvesting of market-sized fish. Larviculture tanks are stocked periodically.

After the hatchery stage, each cohort of fish is transferred to the nursery, where weaning is completed. The fish are then graded and transferred to the grow-out facilities.

After the grow-out period the fish are harvested at weekly intervals (or more frequently, accordingly to market requirements) and processed. One of the strengths of the technology and the commercial farm design is that they can be transferred to a suitable site in any location around the world.

Future opportunities

Mahimahi is the first species being targeted by Mariculture Development Pty Ltd, due to the fish's outstanding commercial potential worldwide and because it is ready for immediate commercial development.

The technology is, however, broadly applicable to other highly attractive aquaculture candidates. Future species diversification offers significant potential in the longer term.

Mariculture Development Pty Ltd believes that mahimahi is one of the species that will com-

prise a significant proportion of global, cultured marine finfish production in the future. The company is presently in the process of establishing at least one commercial mahimahi farm.

Several suitable sites on the west, east and south coasts of Australia and overseas are presently being considered. The sites are being evaluated according to specific criteria, which consider ecological, biological, economic and social factors. The company has adopted a market-oriented approach in its site selection process, by favouring sites that are closer to major markets.

To date, most interest in investment in this development has come from overseas, particularly from Asian companies. Mariculture Development Pty Ltd considers that the future opportunities for expansion will include a range of offshore developments of vertically-integrated finfish production facilities.

With this in mind, investors are being sought with a common long-term understanding of the industry sector, complementary business connections and an adequate capital base.

(Source: *Infofish International* 4/95)



■ TWENTY PER CENT OF THE WORLD'S FISHERIES ARE DISCARDED

In a landmark study of the annual quantity of incidental organisms discarded during fishing operations, a new estimate of 27 million tonnes world-wide has been made.

Results of the study by D.A. Alverson, M.H. Freeberg, J.G. Pope and J.A. Murawski for Natural Resources Consultants of

Seattle, were presented at the Conference on Fisheries Management: Global Trends, held in Seattle, USA, from 14 to 16 June 1994.

The authors examined over 800 papers containing quantitative and qualitative information to characterise the nature and scope of regional and global incidental catch

and discard problems. Mortalities associated with discarding practices were also reviewed. Following are excerpts from their paper.

The authors provided a provisional estimate of global discards in commercial fisheries of 27.0 million t, with a range of 17.9 to 39.5 million t. The region

with the highest discard estimate is the Northwest Pacific. Shrimp trawl fisheries, particularly for tropical species, were found to generate more discards than any other fishery type and account for just over one-third of the global total. On a weight-per-weight basis, 14 of the highest 20 discard ratios were associated with shrimp trawls.

The fisheries associated with the twenty highest numbers-based ratios represented a variety of shrimp trawl, pot, fish trawl, and longline fishery gear types. At the opposite end of the scale, fish trawl, seine, and high-seas driftnet fisheries accounted for the majority of the gear types in the authors' list of the 10 lowest discard ratios.

Although the data are tremendously variable, four major gear groups stand out. Shrimp trawls are alone at the top of the list, while relatively low levels are recorded for pelagic trawls, purse seines targeting on menhaden, sardines and anchoveta, and some of the high-seas driftnet fisheries.

Between these two extremes lie two other groups. The first of these is comprised of bottom trawls, unspecified trawls, longline gear, and the majority of the pot fisheries. The final group fits between the very low ratios of the pelagic trawl group and the moderate ratios of the aforementioned bottom trawl/pot/line assemblage.

Fisheries in this last group include the Japanese high seas driftnet fisheries, Danish seines and purse seines for capelin.

The authors note that in most instances there are inadequate data to determine the biological, ecological, economic or socio-

cultural impact of discards. Nevertheless, data do suggest that survival of most discarded species is low, declines in some non-target species have been significant, overfishing often involves a significant by-catch component, and shifts in species dominance and the occupation of certain ecological niches have been in part due to discarding.

The extent to which discarding alone and not the fishing process as a whole is responsible for these shifts is, however, unclear.

Economic losses tied to the act of discarding and objectives of monitoring or preventing discards presently run into billions of dollars. Such losses include those associated with discards of species of commercial value to other fisheries, discards of

non-legal individuals (for reasons of sex, size or management policy), and indirect costs related to discarding of non-target species of little commercial value.

Included in the bundle of monitoring and prevention costs are by-catch-related marine fisheries management expenditures, fishing opportunity lost due to premature target fishery closures following the attainment of by-catch ceilings, observer ceilings, observer costs, enforcement expenses, modifications to fishing behaviour, and increases in sorting and handling times.

Voluntary by-catch reduction measures are unlikely to be successful if they are not in the short-term economic interest of the affected fisher. A variety of

Annual discard weight by major region as estimated by the authors

Area	Discard weight (t)
Northwest Pacific	9,131,752
Northeast Atlantic	3,671,346
West Central Pacific	2,776,726
Southeast Pacific	2,601,640
West Central Atlantic	1,600,897
West Indian Ocean	1,471,274
Northeast Pacific	924,783
Southwest Atlantic	802,884
East Indian Ocean	802,189
East Central Pacific	767,444
Northwest Atlantic	685,949
East Central Atlantic	594,232
Mediterranean and Black Sea	564,613
Southwest Pacific	293,394
Southeast Atlantic	277,730
Atlantic Antarctic	35,119
Indian Ocean Antarctic	10,018
Pacific Antarctic	109
Total	27,012,099

techniques to reduce discard levels have been attempted by managers, engineers, and scientists. These have included traditional net selectivity approaches, the development of fishing gear taking advantage of differential species behaviour, and time/area fishing restrictions.

These methodologies have worked with varying degrees of success, depending on the species being managed and the willingness of industry to work together for positive solutions.

Emerging ideas include effort reduction, incentive programmes, and individual transferable quotas that move the responsibility for by-catch reduction to the individual vessel

level. The authors feel that major gains against the global by-catch problem are likely to occur as such shifts towards individual responsibility take place.

Progress may be impeded, however, because observer programmes, an uncommon characteristic of today's fisheries, are necessary for an adequate audit of progress toward by-catch goals. For many fisheries suffering from growth overfishing, a reduction in effort may be the most straightforward means of reducing by-catch and improving fisheries conservation and management.

Because the solution to global discard problems will vary between fisheries and regions, a

clear understanding of the nature and scope of specific fishery problems should precede the introduction of management and other measures.

Quick solutions to the by-catch problem are unlikely. Instead, a concerted national and international effort that will take money and time is necessary. A critical component of such action will be the reduction in effort levels from today's excessive amounts to quantities which will avoid conservation and ecological problems and will efficiently harvest the sea's resources.

(Source: NAGA, January 1995)



■ UNITED STATES STARTS TO MONITOR FISHING VESSELS

The Government of the United States has recently installed satellite monitoring systems on the fishing vessels of two Asian companies caught fishing illegally in US waters, according to US and Japanese officials.

Rather than risk losing their ships to confiscation by the US courts, the fishing companies have agreed to have devices installed on their vessels that allow the US Government to monitor them wherever they go in the world, officials said.

The system uses a transponder (installed on a fishing vessel) that periodically sends a signal to a satellite. The signal is then relayed to a US government station in Hawaii that identifies the ship's location within 100 metres. It is used to help determine if fishing vessels are operating illegally.

The first case in which the transponders were mandated on foreign vessels involved a Korean

fishing company, which had 17 devices installed after its ships were caught fishing illegally in 1994, according to Guam-based Assistant US Attorney Mikel Schwab.

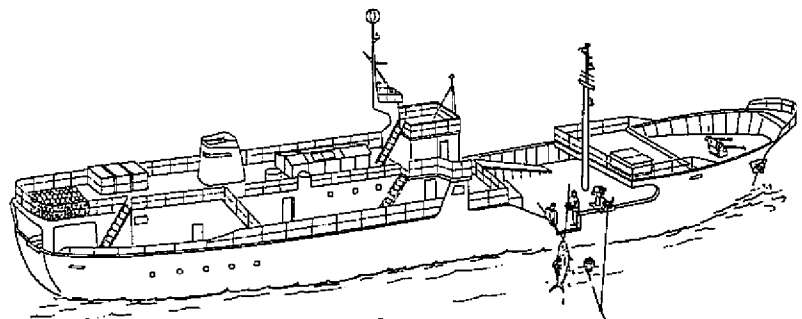
Questions raised

The leading Japanese daily newspaper *Asahi Shimbun* asked why the United States would impose the installation of transponders which are 'not permitted by Japanese Radio Law,' if the transponders only operate near US exclusive economic zones and if the 'actions will affect all other Japanese tuna boats from now on'.

US officials did not respond to these questions, but the Guam US Attorney's office did say the transponders transmit tracking signals regardless of location.

Japanese fishing company officials have also expressed concern about giving their ships' exact positions worldwide to US officials, said Paul Ortiz of the National Oceanic and Atmospheric Administration in Long Beach, California.

'I know that certain fishery associations feel that providing that type of information to someone like the United States government, they feel perhaps



that information can too easily get to the US fishing fleet and give them competitive advantage', he said.

'We have told them that this information is used solely for enforcement purposes and is kept confidential', Ortiz said.

Hawaii and some Pacific nations already require fishing vessels in their waters to use the devices, and he said the trans-

ponders only give a location. They cannot verify if a ship is actually fishing.

Schwab said as more ships are outfitted with the devices—both voluntarily and otherwise—the fishermen who are forced to fish legally will report those they see operating outside the law.

'The requirement for transponders in lieu of forfeiture of

a vessel and its catch has advantages for both the government of the United States and vessel owner', he said. 'Transponders guarantee future compliance and prevent mistaken violations. The transponders are preventive rather than punitive.'

(Source: *Pacific Daily News*, 1 August 1995)



■ PNG CLOSES DOOR ON FOREIGN FISHING FLEETS

PNG's Minister for Fisheries and Marine Resources, Mr Titus Philemon, supported by the PNG Fisheries Council, has decided to end a 40-year-old practice of licensing foreign long-liners to fish in PNG's 200-mile exclusive economic and fisheries zone.

Mr Maurice Brownjohn, Chairman of the Fishing Industry Association, said the new stance taken by the Government has boosted the morale of the domestic fishing industry.

This was indicated, he said, by its commitment to invest between K7 million (about US\$ 5.17 million) and K9 million (about US\$ 6.65 million) in boats and infrastructure this

year. Studies were already showing that domestic fishing boats will bring more benefits to the country than foreign vessels had done.



These will include an increase in the foreign reserves for Papua New Guinea from the fishing industry alone, and the creation of jobs for local people.

It has been demonstrated, he said, that one local boat alone can generate more export revenue in a year than was collected by the State in combined licence and access fees for the 129 foreign boats licensed by PNG in 1994. It is also expected that about 2,500 people will be employed in the early stages of the new venture.

(Source: *The South Sea Digest*, 11 August 1995)



■ OCEAN LIFE REVOLVES AROUND LONG-TERM CYCLES

Ocean productivity is often driven by long-range cyclical events that we don't readily understand and can't reasonably hope to control, according to several recent studies.

Jeff Polovina, chief of ecosystem and environmental investigation for the National Marine Fisheries Service in Honolulu, noted, for example, a marked decline in fishery production at French Frigate Shoals in the

northwestern Hawaiian Islands. The drop has occurred over the last 15 years. It is believed to be responsible for the decline in the number of Hawaiian monk seals at this collection of shallow reefs and sandbars, 400 miles west of Kauai. There's less food for them, so many of the newborn seals are starving.

It would be easy to attribute the decline to recent fishing pressures or other man-induced

problems, but it's more likely the result of a long-term change in ocean productivity in the region.

Polovina said his research suggests lower productivity may be the norm at the shoals, but that there are cyclical spikes that allow production of fish, lobsters and other species to bloom, and as a result, allow the populations of predator species such as seals and seabirds to

increase temporarily. Such a spike occurred at the shoals in the late 1970s and the early 1980s.

The dynamics of these cycles aren't well understood, but Polovina figures, based on historical data, that the cycle lasts about 60 years. That means that since production of food was high in about 1980, it won't be as high again until about the year 2040.

In a related study, Polovina found that if migratory fish don't show up in their normal numbers, it might not be the result of local conditions at all. He studied the migration of Pacific bluefin tuna, a popular species in Japan, but one that's not much fished by Hawaii commercial anglers.

California fleets that target the bluefin have complained in recent years that the numbers of the big tuna have been down.

Polovina said evidence suggests that it's an abundance of food in the western Pacific that's keeping them on that side of the ocean.

'These fish are going to go where the food is most available. Normally, they spawn in a restricted area off Japan, and go all the way across the Pacific (passing a few hundred miles north of Hawaii) to California. The speculation is that it's a foraging migration.

'The recent declines in California may be due to an enormous increase in sardine availability in the western Pacific. But now it looks like that sardine population is going down', meaning the tuna could reappear in the Eastern Pacific as they look for food, he said.

The sardine populations have been high since about 1977, when the Japanese sardines became unusually abundant.

That's part of a cycle too, and with them declining, it's likely that some other species will increase to take up the slack, he said.

But Polovina said that with wide-ranging open-ocean species, vast cyclical changes, involving the related issues of ocean currents, nutrient availability and global climate, may have the greatest impact on populations.

Human activities, notably fishing pressure, can affect fishery stocks, of course. 'High fishing pressure can keep a species from recovering as quickly as it might, or it can accelerate the decline' of a species being affected by cyclical patterns, he said.

(Source: *The Honolulu Advertiser*, 3 September 1995)



■ TAIWAN'S LONGLINERS TO OPERATE IN SOLOMON ISLANDS

A Taiwanese fishing company, Ting Hong Oceanic Enterprise, began catching tuna in Solomon Islands waters in September, using 19 longline fishing vessels.

The company, whose application for longline operations was approved by the Foreign Investment Board in 1994, has been allocated a quota of 4,000 t a year and could operate up to 100 boats to catch tuna for the lucrative sashimi market in Japan.

But company spokesman Mike Chien says that, in the long term, whether the company operates 100 boats will depend very much on a charter agreement with the Guandong Provincial Fisheries Company of mainland China, which owns all its fishing vessels.

Nineteen of the Ting Hong Oceanic Enterprise's fishing boats have arrived in Honiara and 81 more are expected to arrive later. Ting Hong Oceanic

Enterprise has similar operations in the Marshall Islands, Yap, Palau and the Federated States of Micronesia.

In Solomon Islands, the company will have a shore-based facility for packing the catches before they are flown to Japan by the company's own Boeing 727 jet aircraft.

(Source: *Solomon Times*, 11 August 1995)



■ FISHING TREATY WINS UNANIMOUS APPROVAL

More than two years of negotiations paid off recently with the unanimous approval of a global treaty that will bring strict conservation standards and strong

enforcement to the management of fisheries on the high seas.

The treaty is the first international agreement to commit nations to a philosophy of erring on the side of caution when scientific data on fish stocks are

uncertain. It also gives nations the power to board and inspect fishing vessels on the high seas that are suspected of illegal fishing — a measure that caused much wrangling until the final hours of the UN conference in New York.


I am genuinely, happily surprised at the substance of this convention', said Canadian Fisheries Minister Brian Tobin. The treaty is even stronger than a bilateral agreement reached last spring by Canada and the European Union, which has already drastically reduced ille-

gal fishing in the North Atlantic, he said.

Not everyone is as upbeat about the new treaty. Greenpeace, for example, has denounced it as 'too weak to save plummeting fish stocks' because it does not require nations to reduce the size of their fishing fleets or use environmentally safe fishing gear.

However, Greenpeace fisheries experts Matthew Gianni and Michael Hagler admit privately that they are pleased with many parts of the treaty.

The next step in the treaty's approval process is scheduled for December, when the UN General Assembly will vote on its adoption. After that formality, it will be open for signing by UN member nations. The treaty will not have the force of law until at least 30 nations have formally ratified it. In the meantime, some nations have indicated that they may be willing to abide by the treaty's provisions before it is ratified.

(Source: *New Scientist*, 12 August 1995) 

■ HEART DISEASE AND FISH

There is much evidence to suggest that eating fish protects against coronary heart disease. This is attributed to the omega-3 or n-3 polyunsaturated fatty acids contained in seafoods.

These fatty acids reduce serum triglyceride levels but do not lower LDL cholesterol levels. They affect prostaglandin synthesis and have minor effects on the inhibition of platelet aggregation and prolongation of bleeding time, but to a lesser degree than aspirin.

Eating fish does not convey universal protection from coronary heart disease; myocardial infarction is low in Japan and high in eastern Finland, although both people eat large amounts of fish. The Eskimo have low rates of coronary disease but their diet and lifestyle are different; they eat seal and whale, and most die before reaching middle age.

However epidemiological work suggests that mortality from heart disease is less when fish is eaten than when none is eaten at all.

A recent study utilising the US Health Professional Follow-up Study gives a fuller picture. This prospective study, beginning in 1986, gathered detailed information about dietary intake and subsequent end points of death and morbidity from coronary heart disease.


There was no significant association between dietary intake of n-3 acids or fish intake and the risk of coronary disease. The risk of death from coronary disease was reduced by some fish intake compared with no fish intake at all.

However, substantially increasing fish intake did not confer any additional protection from death from coronary disease.

It may not just be a question of fish intake alone, as the high fish-takers often reported high cholesterol levels or a family history of heart disease. They were health-conscious, smoked less, were more active, consumed more fibre and chicken regularly, and less red meat and less saturated fatty acids.

If these factors were allowed for, increasing n-3 fatty acids still conferred extra protection against coronary disease.

Prudently there should be a fish intake of one or two servings a week, but increasing the intake in men free of coronary disease confers no extra protection against subsequent coronary heart disease. The study gives no support for the overall use of fish oil capsules which provide n-3 fatty acids in larger amounts than usual.

(Source: *New Zealand Medical Journal*, 28 June 1995) 



■ NOAA STUDIES SWORDFISH AND TUNA BEHAVIOUR

The National Marine Fisheries Service investigated the movements and habitat of pelagic swordfish and tuna during a National Oceanic and Atmospheric Administration (NOAA) research cruise off the island of Hawaii.

During the 6–21 August 1995 cruise, fisheries service researchers attempted to catch and track broadbill swordfish and large yellowfin tuna, to collect depth and position information. The scientist hoped to track each fish for at least two to five days to gather data about any movements through the island chain and to find areas where fish linger.

This was the second attempt by fisheries service researchers, who developed the tracking

techniques some 25 years ago in Hawaii, to track broadbill swordfish and large (over 150 lb [\approx 68 kg]) yellowfin tuna. Earlier research focused on smaller tuna and marlin. The scientists collaborated with Pacific Ocean Research Foundation and Stanford University scientists who have been conducting satellite tracking experiments on blue marlin off the island of Hawaii.

Researchers aboard the NOAA ship *Townsend Cromwell* set and retrieved longline hooks at night for swordfish and during daylight for tuna. Any vigorous fish that was caught was outfitted with an ultrasonic transmitter and released to be tracked by three team members aboard the 56-ft commercial fishing vessel *Hana Like*.

This vessel was chartered by NOAA to allow the scientists to receive better signals from the attached transmitters. Scientists aboard the *Townsend Cromwell* collected data on the habitat of the tracked fish, including sea temperatures at depth and surface, salinity, dissolved oxygen, current profiles, and an estimate of plankton biomass.

The movement and habitat information will add to scientific knowledge about swordfish and tuna, fish caught by both commercial and recreational fishermen in Hawaii.

(Source: *West Hawaii Today*, 11 August 1995)



■ TROPICAL AQUACULTURE TRAINING PROGRAMME ORGANISED BY THE CENTRAL QUEENSLAND UNIVERSITY

The Central Queensland University (CQU) has designed, constructed and is operating the Mariculture Research & Training Centre (MRTC). The MRTC is a fully operational 'model' saltwater prawn/shrimp farm used primarily for training in the farm management principles and practices of tropical aquaculture.

The CQU will organise an Aquaculture Training Workshop and Tour from 24 November to 1 December 1995.

This workshop is designed to give participants a broad-spectrum exposure to a wide variety of aquaculture facilities with an industry-perspective training programme.

Workshop participants will receive the latest industry information on tropical aquaculture in Queensland. The training programme will be conducted in a University lecture theatre by various speakers, and also at the Mariculture Research and Training Centre. The main theme for this section of the programme is on pond grow-out for aquaculture species. A practical 'hands-on' approach is given in the training programme in order to deepen students' understanding of course information.

Topics include: biology and reproduction, site selection and farm design, business aspects of project, water quality management, stocking and growth monitoring, harvesting and pond preparation.

The aquaculture tour programme includes government centres plus private farms and hatcheries, some of which are mentioned below:

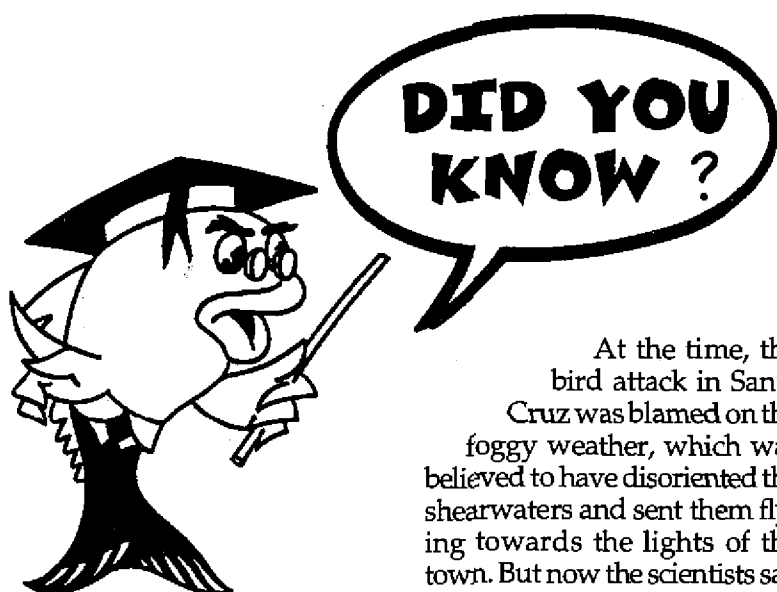
Prawn/shrimp hatchery and grow-out farms, redclaw crayfish farms, silver perch hatchery and grow-out farms, barramundi hatchery, aquarium fish hatchery, crocodile farm.

For more details on this workshop, please contact:

Mrs Maxy Barron
Central Queensland University
Rockhampton M.C. QLD 4702
Australia

Phone: 61 79 309892
Fax: 61 79 309209





Hitch's birds deranged by dodgy anchovies

A bizarre attack by crazed seabirds that helped Alfred Hitchcock to shape his horror classic, *The Birds*, could have been caused by poison from a marine alga, say researchers in California. More than 30 years after the strange event, the scientists from the University of California at Santa Cruz have found that the alga and its toxin show up with alarming regularity in the waters off the coast of California.

In 1961, a small seaside town near Santa Cruz was bombarded by hordes of sooty shearwaters. The crazed birds pecked people, smashed into houses and cars, broke windows and staggered around vomiting pieces of anchovy over local lawns.

Hitchcock apparently called the local newspaper to ask for copies of articles covering the event, saying that he wished to use them as 'research materials'. Two years later, *The Birds* — originally a short story by Daphne du Maurier — reached the cinemas.

At the time, the bird attack in Santa Cruz was blamed on the foggy weather, which was believed to have disoriented the shearwaters and sent them flying towards the lights of the town. But now the scientists say a marine neurotoxin called domoic acid could have caused their strange behaviour.

'This could very well explain what was reported in the papers, although we can't prove it', says David Garrison, a biologist at Santa Cruz. 'The birds definitely showed some sort of neurological damage — confusion, disorientation, inability to function.'

Domoic acid is produced by a marine alga called *Pseudo-nitzschia australis*, which inhabits the waters of Monterey Bay as well as many other waters around the world.

In large enough amounts, the toxin can cause brain damage and even death. Birds — and even people — can succumb to the poison if they eat fish or other marine animals that have eaten the alga.

In 1987, for instance, more than 100 people living on Prince Edward Island in Canada, fell ill after eating mussels contaminated with domoic acid. Four died.

And in 1991, hundreds of dead pelicans and cormorants were washed up on the beaches near Santa Cruz after feasting on tainted anchovies in Monterey Bay. That same year, people in Oregon and Washington State were poisoned by domoic acid in razor clams.

Although such outbreaks are few and far between, Garrison and his graduate student Peter Walz have discovered that there are twice-yearly blooms of the alga in Monterey Bay, each lasting several weeks. Other scientists in the team have found traces of domoic acid in a range of marine animals.

The scientists do not know why outbreaks of domoic poisoning are so rare when the alga and its toxin are found so regularly in Monterey Bay.

Nor do they know if long-term exposure to small amounts of the toxin could be bad for health. And while commercially harvested shellfish in California are monitored for domoic acid contamination, the researchers warn that people who gather their own seafood might be at risk.

'There really needs to be some careful work to document exactly where domoic acid is going in the marine food web and how long it is retained by different organisms', says Garrison.

(Source: *New Scientist*, 22 July 1995)



■ BOOK REVIEW: FISHING FOR ANSWERS — WOMEN AND FISHERIES IN THE PACIFIC ISLANDS

Fishing for answers — women and fisheries in the Pacific Islands, edited by Elizabeth Mathews, is reviewed by Patricia Tuara, SPC Women's Fisheries Development Officer.

The literature detailing the participation of women in fisheries within the region has continued to grow since the 1980s.

However, the articles produced tend to be scattered throughout the island countries. *Fishing for answers — women and fisheries in the Pacific Islands* is possibly one of the first books written which is a compilation of articles from around the region, documenting the experiences of women in the fisheries sector.

At 177 pages, the book is a compilation of thirteen case studies, which can be divided into two topic areas.

The first five studies focus on the fishing, collecting and processing activities carried out at the subsistence level by women in fishing communities.

In contrast, the remaining eight studies explore the effects of modernisation and development on women's fishing activities, and the need for sustainable use of resources. The studies are written by a cross-section of people which includes students, teachers, fisheries department personnel and researchers.

The diverse experience of the writers is evident in the range of topics they discuss, which cover such areas as the fishing techniques of Kiribati women, the collective efforts of women in the Papua New Guinea Women in Fisheries Project, the employment conditions of Solomon Islands women in a commercial fish cannery, and the

relationship between food security, women and tuna in Fiji.

The annotated Pacific-specific women-in-fisheries bibliography provided at the end of the book is a useful outline of reference documents.


Fishing for answers — women and fisheries in the Pacific Islands is a book that will appeal to a wide audience, but in particular those who are interested in the significant role played by Pacific women in the fisheries sector.

The book is published by the Women and Fisheries Network, a group of individuals interested in advancing women's development in the fisheries sector.

Editing of the articles in the book was carried out by Elizabeth Mathews, who became a

member of the Women and Fisheries Network while she was a United States Fulbright fellow at the University of the South Pacific.

Elizabeth has written articles based on her research work in the region and is best known for her documented research on women's fisheries activities in Palau.

The book can be purchased for US\$ 10.00 inclusive of postage. Orders can be placed with the Women and Fisheries Network, contact Milika Naqasima, SPAS, Univ. of the South Pacific, P.O. Box 1168, Suva, Fiji, phone (679) 313900 Ext 2559 or fax (679) 302548. 



TONGA'S AQUACULTURE RESEARCH AND DEVELOPMENT PROJECT

Background

The Kingdom of Tonga traditionally depends heavily on marine fisheries resources for the people's food supply.

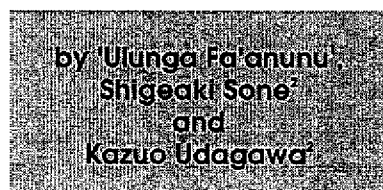
Fisheries of the Kingdom can be classified into three categories: small-scale inshore fisheries conducted in and around the coral reefs, subsistence fisheries conducted on the reef flats, and export-oriented modern fisheries operated in the 700,000 km² exclusive economic zone.

The small-scale inshore fisheries, which include diving, net, fish-fence and hook-and-line fishery, are most important in connection with food supply. The pressure on marine resources by inshore fisheries has been increased with the recent advance of the market economy and improvement of fishing gear.

As a result, resources such as mullet, giant clam and sea cucumber have shown signs of decline, and lobster has shown reductions in average size.

As fish resources around coral reefs and shellfish resources on the reef flats are vulnerable to the intensification of fishing pressure, proper fisheries management measures (including aquaculture) should be taken for the sustainable development of the Tonga fisheries.

In 1978, the Fisheries Research Center was established, through



the Japanese Government's grant aid scheme, to promote research on the development of Tongan fisheries.

However, the centre was severely damaged by a cyclone in 1982 and its research activities were hindered by the damage.

The Sixth Five-Year Development Plan (1991–1996) stressed the importance of aquaculture development and strengthening of scientific and technical support of the Ministry of Fisheries for fisheries development.

The Government of Tonga requested technical cooperation from the Japanese Government to strengthen the research capability of the Ministry of Fisheries in the fields of aquaculture and fisheries management.

The request included three items of technical cooperation:

- ☞ culture of fish such as mullet (fish culture);
- ☞ seedling production and resource enhancement of shellfish (shellfish culture); and
- ☞ survey and management of inshore fisheries resources (resource survey and management).

In response to the request, the Japan International Cooperation Agency (JICA) conducted a series of preliminary surveys to collect baseline data on fisheries in Tonga.

JICA and Tonga's Ministry of Fisheries started the five-year Aquaculture Research and Development Project on 2 October 1991. JICA sent a chief adviser, a fish culture expert, a shellfish expert, a resource management expert, and a project coordinator on a long-term basis. The Tongan Ministry of Fisheries allocated counterpart researchers to each of the three fields.

The following article will describe the progress of the project during the three first years, the present situation and the work to be done before the projects ends.

General

Repair and construction of facilities

For the implementation of the project, it was necessary to repair facilities damaged by the cyclone and to construct some new facilities. This was completed by November 1992.

Short-term experts from Japan

The project invited short-term experts to provide technical guidance on all aspects of the project, from resource surveys to video tape-making for resource conservation campaigns.



1. Ministry of Fisheries, P.O. Box 871, Nuku'alofa, Tonga

2. Japan International Cooperation Agency (JICA), c/o Ministry of Fisheries, P.O. Box 2480, Nuku'alofa, Tonga

Training of counterpart personnel in Japan

The project sent Tongan counterpart personnel to Japan for training in general fish culture techniques and observation of fisheries management systems. The fish-culture expert and a Tongan counterpart were also sent to Australia under JICA's technology exchange scheme.

Provision of equipment and materials

JICA provided the project with a vehicle, laboratory equipment, aquaculture materials, boats, office and audio-visual equipment, an aquarium, etc.

Publication of research bulletin

The project has started to publish *Fisheries Research Bulletin of Tonga*. The purposes of this publication are:

- ☛ to prevent loss of the results of project activities by scattering;
- ☛ to encourage the Tonga staff to do research; and
- ☛ to publicise the activities of the project in the countries of South Pacific and other regions.

The first two volumes of the bulletin were published in 1994.

In the future, the project will work to implement the following tasks:

- ☛ invite short-term experts from Japan to conduct follow-up surveys;
- ☛ continue sending Tongan counterpart personnel to Japan for training;

☛ request JICA to provide more equipment and materials within the limits of budgetary appropriation;

☛ publish one to two volumes of *Fisheries Research Bulletin of Tonga* every year; exchange information with fisheries organisations in the South Pacific; and

☛ organise an international seminar on marine aquaculture and resource management

Fish culture

Experiment on mullet pen culture

The experiment covers most aspects of pen culture, including: collection of mullet fry (mostly *Liza macrolepis*); choice of suitable sites; and construction of several pens, including a 100 m x 100 m pen with a wooden walkway connecting the pen to the land.

After two bad years due to damage caused to the pond by a cyclone, three experiments are ongoing:

☛ culture of mullet in a wide size range together with rabbit fish, with feeding;

☛ culture of small mullet, without feeding; and

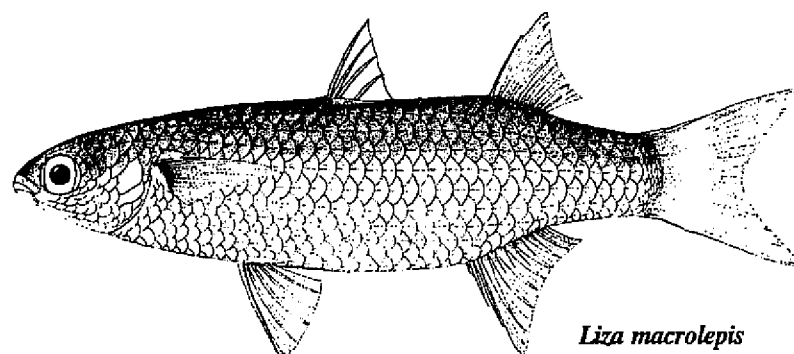
☛ culture of small mullet, with feeding.

The team is monitoring the growth of the fish by monthly sampling.

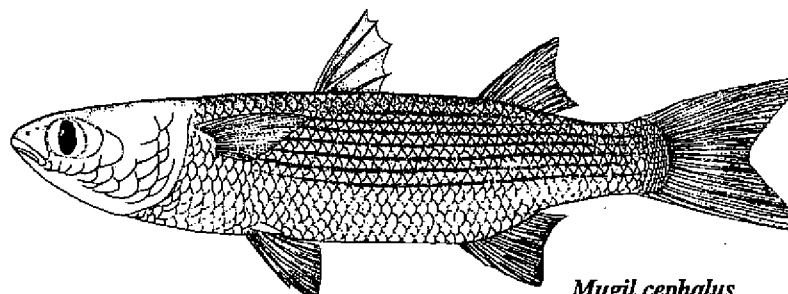
In the future the fish culture team will continue the pen culture of mullet and determine the possibility of growing *Liza macrolepis* fry 3-4 cm to 100 g within one year. It will also examine the possible production by mixed pen culture of mullet of different size groups and rabbit fish. Those mullet which have grown over 100 g will be sold at the fish market to provide economic data on mullet culture.

Survey of mullet stocked in Lake Ano, Vava'u Island

The Ministry of Fisheries released 9,000 fry of *Mugil cephalus* into Lake Ano, Vava'u



Liza macrolepis



Mugil cephalus

Island, in July 1990 with assistance from FAO. The fish culture team received two specimens of mullet caught in the lake in August 1993.

Those mullets were females of 31–34 cm and 500–800 g with developed ovaries. This indicated that the released mullet were growing well in the lake.

However, further information was necessary to estimate the lake's carrying capacity of mullet stock.

After conducting an environmental survey in the lake in October 1993, the team released 200 fry of *Liza macrolepis*, and a small number of *Valamugil seheli* fry, collected in the surf area of the island during the survey.

The study of the mullet in Lake Ano will be continued. Growth and seasonal change in gonadal maturity of the mullet will be determined by the study.

Study on supplemental feed for mullet pen culture

The fish culture team conducted a feeding experiment to study the feed values of locally produced cassava, squash and beer brewery residue using fibre-reinforced-plastic tanks.

The results indicated that growth of the fish was poor when they were given those local products mixed at 50 per cent with formula feed for carp imported from Japan. The reason for the poor growth was the low protein content of the local products.

Another experiment showed that the growth of the fish was enhanced when fish were given feed containing copra. Formula feeds for chicken and pig were inexpensive, but found to be poor in feed value for mullet. Utilisation of *Eucheuma* (a seaweed) extract as a binder for feed was found to be unrealistic because it was hard to mix the extract evenly with feed ingredients.

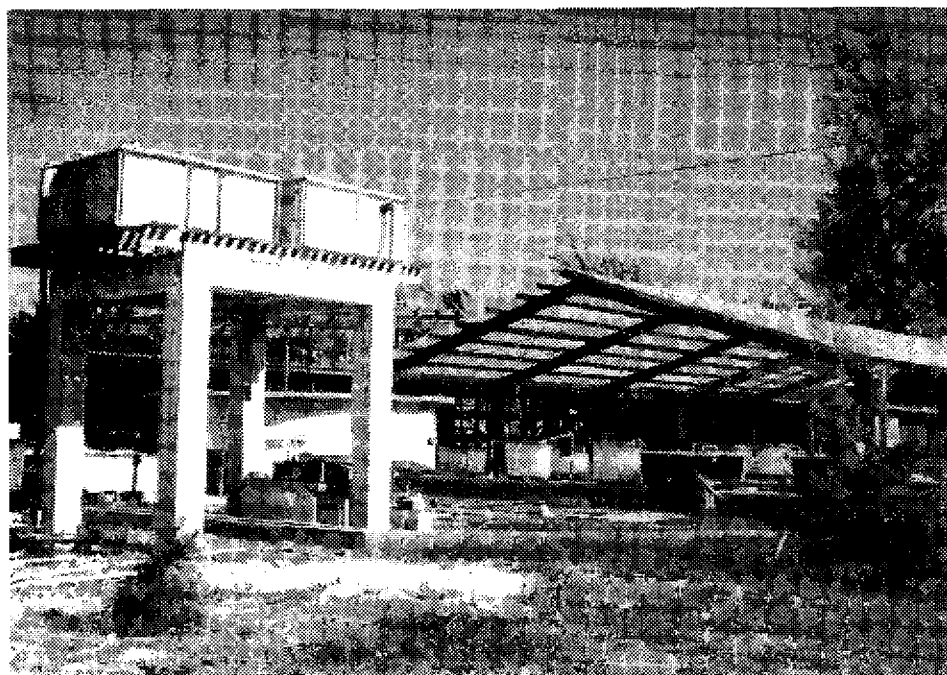
Future activities will include the establishment of a formula for supplemental feed for mullet pen culture. The cost of the formula feed should be lower than T\$ 0.5/kg.

Study on the life cycle and availability of natural fry of mullet

Unlike *L. macrolepis*, there has been little information on the time, location and quantity of appearance in the surf zone of *Mugil cephalus* fry.

Three surveys are ongoing to collect more information about *Mugil cephalus*:

- ☛ interview survey of fishermen to clarify the migration and spawning ground;
- ☛ sampling survey at the fish market to clarify the spawning season; and
- ☛ fry collection survey along the surf zone of Tongatapu Island to clarify the season and quantity of fry appearance in the surf zone.



Aquaculture facilities at the Fisheries Research Centre

From the data collected so far, it can be said that the spawning season of the fish occurs in June and July, and fry smaller than 2 cm appear in the surf zone in August and September.

The examination of the gut contents of *M. cephalus* fry made under the guidance of Dr Ohno showed that the fry drastically change their food items from small animals to detritus at 2 cm. This information is useful to establish rearing techniques for *M. cephalus* fry.

Shellfish culture

Baseline data collection

The shellfish culture team collected information on natural environmental conditions, economically important species, present situation of shellfish fisheries and level of seed production technique of Tongan staff.

Seedling production and intermediate culture of giant clam

The team chose *Tridacna derasa* as its target species for seed production and ocean culture.

The aim of the ocean culture is not to create an exploitable resource of giant clam through release of huge quantities of seedling clams, but to sustain the reproducing population and thus enhance the giant clam resource.

Therefore, the team did not aim at large-scale seedling production. The team induced spawning using stimulation by temperature shock combined with gonad suspension treatment.

Herbivorous gastropods were used for clearing seaweeds that grew on and around the young shells, hindering their growth. The team produced 70,000 young clams of 5 mm in 1992 (spawned in 1991) and 20,000 young clams in 1993 (spawned in 1992).

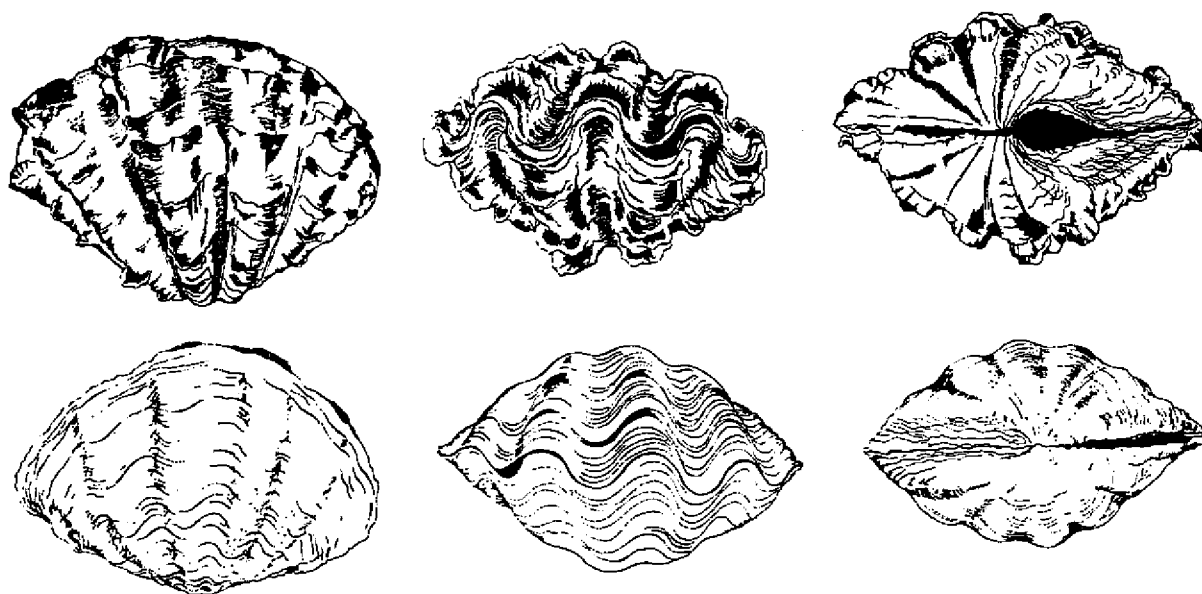
The reason for the decrease in 1993 was the loss of a large number of larvae due to the leakage of the tanks. The young clams were placed on concrete plates and reared in raceway tanks until they attained 2 cm, and they were stocked in the ocean nurseries for further growing.

By establishing this technique, it became possible to stock all shells in the ocean nurseries within one year after the eggs had been taken. The shellfish culture team produced about 50,000 shells of 5 mm in 1994. These shells were cultured to 2 cm in the raceway tanks and then stocked in Sopu ocean nursery.

In the future, the shellfish culture team will establish standardised procedures to produce 50,000 seedling giant clams of 2 cm and will estimate the production costs. A manual will be prepared on giant clam seedling production. Small *T. derasa* and *T. squamosa* will be shipped to the Japanese aquarium fish market on an experimental basis.

Giant clam culture in ocean nurseries

Three ocean nurseries were established at Sopu, Kolonga and Atata Island. Follow-up surveys were conducted to determine the growth and survival rate of *T. derasa*. It was found that their survival rate could be raised by protecting them from



Lateral, dorsal and ventral views of the shell valves of *T. squamosa* (top) and *T. derasa* (bottom)

predators with a plastic net during a short period just after the stocking. Shells produced in 1992 (spawned in 1991) had grown to 9.5 cm and those produced in 1993 (spawned in 1992) to 5.5 cm by September 1994.

Survival rate of the shells was almost 100 per cent except for a period just after the stocking. The project sent 1,000 small giant clams to Ha'apai Island upon the request from the Ministry of Fisheries.

The giant clams stocked in the ocean nurseries will be monitored regularly for growth, survival rate, gonadal maturation and predators. The team will establish standardised procedures to maintain the survival rate of the shells above 70 per cent during the first 12 months after stocking.

A manual will be prepared on the giant clam ocean culture. Three-and-a-half-year old *T. gigas* will be sold in the domestic market on an experimental basis.

Seedling production and culture of giant clam other than T. derasa

The shellfish culture team conducted seedling production of *T. squamosa* and *T. tevoroa* successfully. *T. tevoroa* was found to be a fast-growing species, though production of seedlings in large quantity was difficult.

T. squamosa was found to be not suitable for seedling production since it is hard to handle (due to its scutes on the shells), weakly adapted to change in environmental conditions and slow in growth.

The shellfish culture team will examine the technical possibility of seedling production of

trochus, green snail and other shellfish.

Experimental transplantation of trochus and green snail

More than 1,000 trochus were imported from Fiji and released off Vainiliku, Fudave Island and Euaiki Island, after an experiment on spawning induction and the tagging of 100 specimens.

More than 400 green snails were imported from Vanuatu and Japan in three different shipments. After an experiment on spawning induction, most were released off Euaiki Island, while some were kept in the Sopa ocean nursery to be used in seed production experiments.

Field survey

A series of surveys was conducted to locate suitable sites for ocean nurseries of giant clams and suitable sites for transplantation of trochus and green snail. The results showed that Atata Island and Fukave Island were suitable for ocean nurseries of giant clams.

Fukave Island, Euaiki Island, Ualunga Lalo and Vaini Liku were found to be suitable for transplantation of trochus and green snail. Ocean nurseries were established at Atata and Kolonga.

Survey on spawning cycle of shells

The shellfish culture team conducted monthly sampling of *Tridacna maxima* (Kukukuku), *Grafrarium* spp. (To'o), *Anadara* spp. (Kaloa'a), and *Turbo setosus* ('Elili) from the fish market.

Size and gonad maturation condition of the samples were examined to clarify seasonal

changes in gonadal maturation, spawning season, minimum maturation size, sex ratio and size of sex inversion.

Market research for giant clam

The shellfish culture team is conducting market research to examine the possibility of selling *T. gigas* in the domestic market and *T. derasa* and *T. squamosa* in the Japanese aquarium fish market.

Resource survey and management

Baseline data collection

The resource management team collected meteorological data, aerial photographs and information on fisheries in Tonga. It carried out a survey of the present situation of fisheries in Tongatapu, Ha'apai and Vava'u Island groups.

It has already completed the report on Tongatapu. Two JOCV members are now preparing the report on Ha'apai and Vava'u.

Stock survey

The resource management team conducted surveys on the giant clam and the lobster fisheries. A release-and-recapture experiment, using tagged ark clams, provided information on the growth rates of these animal. A study on sea cucumbers, in collaboration with an American Peace Corps volunteer, was stopped due to the depletion of stock caused by over-fishing.

Surveys on growth rates and spawning season for lobsters will continue in the future, and a manual of stock survey and resource management will be produced. The resource management team will examine the

economic viability of giant clam ocean culture in co-operation with the shellfish survey team. It will also formulate appropriate management policies for the giant clam and lobster resources.

Fish landing survey

Fish and shellfish landing surveys were carried out daily at Vuna Wharf and Faua fish markets. Interviews with fishermen gave information on their life-style and on the amount of the catch which did not pass through the fish markets. The results of these surveys will be published in *Inshore Fisheries Statistics of Tonga*.

Campaign for marine resource conservation

The resource management team organised a trochus releasing ceremony which was held in the presence of His Royal Highness Prince Lavaka and publicised nationwide through newspapers and TV.

The team prepared a video tape to enhance the people's awareness of the need of marine resource conservation. The tape also introduces the activities of the project and the Ministry of Fisheries.

It was televised every day for several weeks. The team prepared posters and booklets on

fisheries regulations, and, with these teaching aids, visited 26 schools to give lectures to more than 9,000 students. A poster competition was successfully held on the occasion of the national agriculture show on September 1994. More than 300 posters were entered in the competition by students. An award ceremony was held at the Ministry of Fisheries on 30 September 1994.

A poster or visual identification guide of shellfish in Tonga will be produced for use in a conservation campaign. The team will also make video tapes of giant clam, trochus, green snail and lobster for the same purpose.



Fisheries staff in front of the Ministry of Fisheries building

THE IMPLEMENTATION OF QUALITY CONTROL IN A PACIFIC ISLAND FISH PROCESSING COMPANY

This article is extracted from the background paper which was presented at the SPC/FFA Workshop on the Management of South Pacific Inshore Fisheries, held at SPC headquarters in Noumea, New Caledonia, from 26 June to 7 July 1995.



Introduction

Pohnpei Fisheries Corporation (PFC) is a modern fish processing company located in Pohnpei, Federated States of Micronesia, in the Western Central Pacific.

PFC is owned by the Government of the State of Pohnpei, but operates as a commercial enterprise under its own independent Board and management. The company was established in 1992 to operate a modern fish processing plant built in 1991 by a Danish refrigeration and food processing company, Sabroe Industries.

PFC's business—adding value to the Micronesian fishery

PFC is in the business of adding value to the fisheries re-

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sources of Pohnpei State and the Federated States of Micronesia.

PFC adds value to the Micronesian fishery by processing the fish into high-quality fresh, frozen and dried/smoked products, primarily for export sale. These fetch a higher average per unit value than whole fish exports, and create employment and production expenditure which generate additional income for the local economy.

In addition, PFC adds value to the Micronesian fishery by selling ice and other supplies and services to foreign longline boats based in Pohnpei. By providing these services PFC creates additional jobs, generates substantial profits which are retained in Pohnpei instead of being repatriated by a foreign company, and enables Pohnpei State to retain discretionary control over fishing transshipment in our ports so that we are not beholden to one or only a few specific foreign companies.

Plant equipment and facilities

The fish processing plant utilises high-quality mechanised processing lines and various mechanical and electrical cutting, freezing, smoking and

vacuum packaging equipment. The original processing plant was built on a complete turn-key basis by the Danish engineering company, Sabroe. The plant was initially designed primarily to process deep-bottom snappers into block frozen fillet packs. Most of the processing and freezing equipment is of European manufacture and designed to handle small 6–7 lb (2.7 – 3.2 kg) fish.

Micronesian governments have been sensitive to the need for high standards in processing facilities, primarily as a result of the FSM's close association with and administration by the United States.

The Pohnpei State Government had therefore stipulated that the plant be built to Danish food industry standards, which were thought to be more restrictive even than those of the US. We are not certain that this standard was in fact maintained, as we soon noticed some clear, although thankfully only minor, deficiencies.

Initial strategic decisions on business direction

Even during the construction of the facility in 1990–91 it was realised by the State Government that the resource of deep-bottom snappers is very limited in Pohnpei. Consequently, before the facility came into operation, the project was reappraised and three fundamental strategic decisions were taken:

1. That the fish processing plant should be run as a strictly commercial entity, completely outside the government administrative system and political control;

2. That production would be focused on the abundant tuna and other pelagic resources of the FSM;
3. That PFC would pursue a market lead strategy, emphasising high-quality, highly sanitary, value-added products.

Implementation of the strategy

The establishment of the commercial company

Pohnpei Fisheries Corporation was established by law in November 1992, and began to be organised in January 1993. Recruitment was initially very slow as we sought to build the organisation with a great deal of training for the initial supervisory staff. In addition, it took time to establish raw material procurement arrangements with the foreign fishing boats.

Production of tuna and pelagic product forms

PFC now specialises in processing of tuna, especially yellowfin (kihada) (about 70% of total tuna processed) and bigeye (mebachi) (about 3%) which are processed into loins and other value-added forms for either fresh or frozen export. In addition to tuna, the plant has access to resources of skipjack tuna (kasuo), marlin (kajiki) and shark (especially blacktip shark).

Since June 1994, monthly average raw tuna processed has been about 240,000 lb (≈ 109 t). Current product forms produced or in active development are:

- loins/fillets fresh or frozen, ranging from 5 to 12 lb (2.3 to 5.4 kg), with an average of about 8 lb (3.6 kg) per loin;

- steaks or other controlled portion sizes cut into steaks in either fresh or frozen state, ranging from 2 to 12 oz (57 to 340 g) when cut by automatic portion control cutter;
- small loin portions and cubed/diced meat from the end portions of loins;
- smoked/dried and jerky tuna products prepared using various flavoured marinades.

The change in product focus has necessitated some technical changes in the plant and we have recently added other US-manufactured refrigeration and processing equipment specifically suited to this type of product. The recent upgrading of the facility is also intended to ensure that it conforms with US Food & Drug Administration (US FDA) standards.

National food inspection

Processing of food products for sale or export from the Federated States of Micronesia is regulated by the Department of Health Services of the National Government in accordance with the National Food Safety Act.

This law was enacted in accordance with current WHO/FAO Codex Alimentarius standards. PFC has been duly inspected and certified to operate by the Department. In addition to setting various food safety standards for the fish processing plant facilities and operations, this law also requires specific certification of all container lots of refrigerated cargo.



Results to date

PFC was organised in 1993 and is presently still in its initial commercial growth stage. The company began export production in July 1994 but was severely constrained by deficiencies in the refrigeration design and processing capability which made it difficult to cope with the larger tuna and pelagic species now processed. It also suffered from an insufficient supply of raw fish as a result of unsatisfactory procurement arrangements.

In our first year of operation, 1993, PFC had only very limited production of 21,242 lb (9,644 kg), primarily of fresh and frozen tuna, and ended the year with a substantial operating loss. In 1994 fiscal year, PFC total production increased substantially from July, and gross sales were US\$ 1,434,835. We ended the year on 30 September 1994, with a small net profit. Projected gross sales for 1995 are US\$ 4,000,000 and a year-end net operating profit is projected.

Proposed marketing strategy

After looking at the possibility of producing suitable products for either the US or Japanese markets, it was decided to focus on the US initially, with frozen loin production. This was to take into account the learning curve that we would need to take our staff along. The Japanese market is also felt to be too subjective and rigorous, with institutional constraints that we did not want to be hampered by at the outset.

Major market

In line with this it was decided that the major market for PFC products would be the United States frozen tuna steak market.

While fresh/frozen sales as a whole have remained relatively constant in the U.S. over the past eight years, demand for tuna, especially yellowfin tuna, has increased, with more and more restaurants featuring this product on their established menus.

It was decided that after an initial period of basic loin production PFC would emphasise high-quality production of value-added products such as portion-cut steaks, utilising new improved freezing and packaging technology and close inter-dependent marketing relationships with specific buyers to ensure a high-quality, customer-tailored product. That phase was due to begin in August 1995.

This strategy puts PFC in a position to take advantage of changing needs and preferences in the United States market, where there is growing acceptance of high-quality frozen fish in preference to fresh fish, a preference for more convenient portion-cut product forms, increasingly high food safety and quality requirements (both regulatory and on the part of consumers), and a willingness to pay a premium for products offering these value characteristics.

In assessing the US market we noted both the increasing regulatory trend toward more effective and restrictive food safety procedures and standards, and the increasing demand on the part of consumers for safe, healthy and socially responsible foods and processes.

The new US Food and Drug Administration regulations require companies selling fish products in the United States to introduce a variant of total quality management which is re-

ferred to by its acronym, HACCPs, short for Hazards Analysis Critical Control Points System.

Adoption of a HACCPs-based production system requires identification of the critical points in the production process at which there is the best chance of serious degradation in the quality or safety of the product.

Each processing plant develops a HACCPs plan unique to its own physical situation and process flows. It then establishes clear surveillance and monitoring mechanisms focused on these critical points. The US FDA regulations set quite restrictive standards on many aspects of permissible plant construction and operation and product standard, but the principle of HACCPs is infused into the entire regulatory approach.

US food regulations have been evolving for a number of years now, and finally came to a head for the seafood industry in 1994 with the adoption of the new US FDA regulations based upon HACCPs and the new US Nutritional Food Labelling Act, which seeks verity and standardisation in consumer product representations. After February 1996, by law/regulation all fish sold in the United States will have to conform with these new regulations and their system of quality control.



PFC will introduce a corporation-wide HACCPs control system in accordance with US Food and Drug Administration standards by 30 September 1995.

Competition

US prices of frozen loin product are increasingly affected by the growing supply of relatively low-priced, lower-quality product from other countries. Competition in the frozen tuna loin category comes from Singapore, Taiwan, Indonesia and Latin America.

A number of other Pacific Island entities are already also engaged in this industry and more are expected to enter soon. It is realised that many of our competitors have access to more fish at lower prices and have lower labour and transportation costs.

PFC's competitive advantage must therefore come from delivering a higher-quality product. In that regard we are fortunate that, with our location, we begin with very good-quality, fresh, raw tuna. That fresh fish is caught in some of the most pollution-free waters in the world, thus enhancing our quality and food-safe image. The Pacific Island imagery that is used in the marketing promotion adds to the exotic and high-quality image.

Our vision

From this initial appraisal of our objective situation and the key strategies we had decided to adopt, we drew up the following vision of our company:

The Vision that we have for our company is that PFC will become an integrated, value-added fisheries company engaged in fishing,

transshipment and processing, which is run by Pohnpeians and which is internationally competitive and renowned.

By 1998 PFC will be a highly visible company, known as the highest-quality and best-value fresh frozen and value-added tuna company in the United States market-place specifically, but with the capability to supply such products to the highest expectation of any market-place in the world as a result of our attainment of the highest internationally-recognised quality manufacturing standards.

In attaining this vision PFC will be environmentally sensitive, practise the highest possible quality and food safety standards, and expand the human resource skills of its people to cope with the modern, commercially competitive, world while retaining our cultural identity and pride.

We push this vision with our staff at every opportunity and in every manner possible, for we must be able to provide them with clear guidelines and a central organising focus on quality.

How to get product quality?

Using external standards as an agent for internal changes

Clearly the adoption of a quality production system would require us to tackle the issue of quality in all aspects of our operation.

Conformity with HACCPs under the US FDA regulations requires that the work force be trained, disciplined and efficient. The work force must know why it is doing something, not just how to do something.

We soon realised that the need to meet US FDA standards and to adopt a HACCPs programme in our plant was not so much a challenge and a problem, but rather a fantastic opportunity to justify the broader social and production changes that we needed to have anyway in order to run a competitive, efficient business.

The fact that we had to conform to outside standards has made it easier for us to enforce certain internal rules and standards which might otherwise have been resisted. It has made it easier to stand up to various pressures and the tendency for political intervention, by giving us an objective, technical, externally imposed norm and rationale. Political, community and personal resistance to some of our changes could be stifled easily by pointing to our need to meet these irreducible and unavoidable external requirements.

Concern with overall corporate quality: adopting the goal and structure of Total Quality Management

At that point we decided to go the entire way, to set the goal and to begin the process toward a Total Quality Management system embracing all aspects of our operation, both product- and service-oriented. This again puts into a formal structure the social and management changes that we feel are necessary to run an efficient business.

I tend to view HACCPs as a subset of a TQM approach, albeit focused most closely on the production of a product. But the point cannot be stressed too heavily that, particularly in an Island culture, with little experience in efficient modern business, it is necessary to take a

broader approach to focus the entire organisation on quality production and service.

Implementation of TQM requires management commitment, empowered employees and continuous improvement. Development of procedures and monitoring mechanisms is critical. These allow not only improved products, but also improved management and lower costs, as more information is obtained and distributed within the company on a faster basis.

The Total Quality Management business strategy is readily adaptable to the food industry. The highly changing business environment in which the food industry operates, and especially the need for continuous change and improvement, establishes a need for some systematic process. TQM should also be focused on the firm as a producer of value for one purpose alone: satisfaction of the customer.

Staffing issues

PFC presently employs 78 regular employees, of whom 75 are Pohnpeian and 3 are expatriate. With future expansion, 20 additional Pohnpeian employees are expected to be hired before the end of 1995.

Recruitment and training

All staff are given appropriate training, emphasising sanitation, hygiene and food safety rules, prior to or at the beginning of their employment. This usually lasts for two weeks and is based upon a company manual that was put together by our initial Production Manager and subsequently revised after our initial training experiences.

Continuous training and professional upgrading of all staff are carried out by in-house training and reinforcement, academic study and vocational study by correspondence. Staff are given increasing exposure to the international market-place and to other processors and engineering operations through field trips and attachments. PFC is committed to ensuring that each and every employee receives at least two weeks of new skill training each year. In addition, training reinforcement of old skills is carried from time to time.

Empowerment

PFC management continually emphasises, verbally and through practical work assignments, that we want our staff not only to know how to carry out a task, but also to understand why it is done, what the implications are and what the options may be. An empowered, knowledgeable and thinking work-force is critical to the success of a quality control and excellence programme. It is also a more productive and motivated work-force.

Staff meetings are held regularly to ensure distribution of information about our progress or any major problems. Small team meetings are held between supervisors and their teams to review any problems or successes which they have had.

Quality control in a manufacturing environment requires delegation of responsibility to the line workers themselves. We give any worker the right to reject any fish which he feels has not been handled properly or is not of good quality. This requires management to place trust in our workers.

We never openly second-guess their decisions but will quietly review their actions. We have found that very soon the skill of our staff in picking out bad fish and quality has become quite impressive.

Outside support

Outside contractors are brought in for short periods to address specific technical problems or needs. To date PFC has brought in a smoked products consultant, HACCPs/quality control consultant, refrigeration and plant construction experts and consulted widely with various experts from regional and international agencies.

Strategic alliances

PFC has also sought to form close relationships within the industry as a means to achieve market penetration, acquire additional technical expertise, obtain technology and access innovative research and development at lower costs and risk. We have entered into various technology transfer agreements and joint marketing arrangements which give us access to new technology and technical expertise.

Joint marketing agreement

Joint marketing agreements with established companies are particularly attractive in that they will produce revenues, credibility, and market presence rather quickly. This gives PFC the opportunity to establish its name in the market through co-branding, by piggy-backing on an established system.

Through joint marketing arrangements we use the expert personnel of these companies to assist us in the establishment of

our own HACCPs programme, which, while meeting our needs, most importantly is what the customer himself expects and wants. Complete integration into our customer's own HACCPs programme is considered to be the ideal situation for us.

Technology transfer philosophy

PFC is very conscious of the need for expert, experienced management and technical expertise. At the same time PFC has searched for management technology transfer techniques that have the best chance of success in our Pohnpeian situation.

What seems to work is a process which involves bringing in outside expertise for specific areas and needs, but only after the local staff and management have had an opportunity to tackle the problems themselves and come up with their own methods and solutions.

The Pohnpeian staff are encouraged to develop systems and products on their own, and to try these for a time before outsiders are brought in.

Learning trials are encouraged and mistakes are never reprimanded so long as there is a conscious learning process involved.

When the outside experts are finally brought in, therefore, there is a certain amount of acquired knowledge and practical experience, upon which it is easier to build with more expert and complex knowledge.

This way of working seems to be effective as a means to ensure maximum learning and absorption of technical input.

Food safety programme

PFC is currently having discussions with the FSM Department of Health Services and New Zealand authorities on the provision of additional expert food technologists and lab technicians to staff PFC's laboratory and assist in both PFC and FSM food inspection and HACCP establishment until Micronesians are trained.

As its goal, PFC has set May 1996 as the date for implementing its fish safety and quality inspection and audit system, working with the FSM Department of Health Services and the New Zealand Ministry of Agriculture and Fisheries.

ISO 9002

Internationally, a TQM approach to management and manufacturing is codified in the ISO 9000 standards which have been established by the International Standards Organisation, an international agency comprised of the national standards and quality control authorities of the major industrial states.

Specifically, the ISO 9002 standard is most relevant to a food processing/manufacturing organisation such as PFC. Products produced for the European Community market will generally be considered of suitably high standard if they are produced by a company which has

been certified to comply with ISO 9000 standards. PFC aims to be certified to ISO 9002 standard by 31 December 1997.

Application of US FDA/HACCP regulations to fishing boats

In the future, it is expected that the US FDA will require HACCP-based programmes of fish quality control to be applied from the fishing-boat level, from the time of capture of the fish.

Enforcement of this will probably be the responsibility of the processor. PFC will need to develop suitable programmes of fish handling training and control for all boats from which it receives fish.

This can only be achieved through the promulgation of regulations by the FSM Government, as a condition of fishing in the FSM.

Conclusion

This paper tries to explain how we came to put quality and food safety as the central issues and organising theme of our company. Market forces dictate this approach, and its application gives us a critical competitive advantage.

In applying a quality control system in a social and cultural situation which has different

standards and tolerances, it was considered necessary to set about creating a new corporate culture that applies inside the company premises.

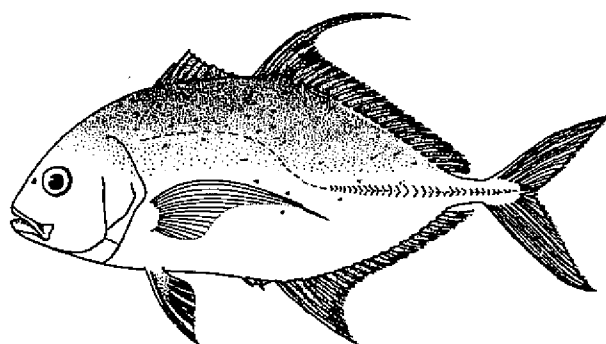
We do, however, continue to draw upon our traditional cultural system to construct appropriate work incentives and organisational arrangements that will work for our people.

We set very clear, high goals and objectives and we continually emphasise these goals and our vision. We talk of it continually.

We take every opportunity to reinforce and emphasise the new culture. We empower and motivate our employees. They reward us with productivity and loyalty which clearly sets us apart.

As anyone who visits our plant will see, we are nowhere near where we want to be in terms of employee performance and consistency, but we are better than when we started two years ago, and we have already produced what is considered to be the highest-quality frozen tuna loin in the US market-place.

We emphasise the positive aspects and we are confident that we will achieve the goals that we have set for ourselves.



MOORED BUOYS USED FOR EL NIÑO PREDICTION

Since the early 17th century, mariners have noted the presence of an unusually cold current moving north towards the equator off the coast of Peru during most of the year, causing typically cool and dry conditions near the coast.

Early Spanish chronicles also noted the occasional appearance of heavy rains and floods in the coastal regions of Peru, which indicated an oceanographic environment quite different from that caused by the usual cold Peru current.

Modern measurements have shown that the latter conditions occur when the cold waters off Peru are overrun by a warm,

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south-flowing current in the winter months.

This warm ocean current that typically appears near Christmas and lasts a few months was called 'El Niño' by Spanish fishermen.

The appearance of this current is regular, although the degree of warming is variable. At irregular intervals (typically three to seven years), the warming is exceptional and persistent, rais-

ing the sea-surface temperature by more than three degrees Celsius and lasting for six to eighteen months.

The term El Niño is now used mainly to describe these abnormally warm events.

El Niño events are accompanied by unusual and often catastrophic weather events around the globe. The large scale ocean-atmosphere interaction causing warming events across the Pacific is termed ENSO (El Niño Southern Oscillation).

As an ENSO event begins, warm waters of the western tropical Pacific shift eastward due to a weakening of the easterly trade winds. An example of this basin-scale surface temperature warming in late 1994 can be seen in Figure 1. Migration of warm water from west to east disrupts the large-scale atmospheric circulation pat-

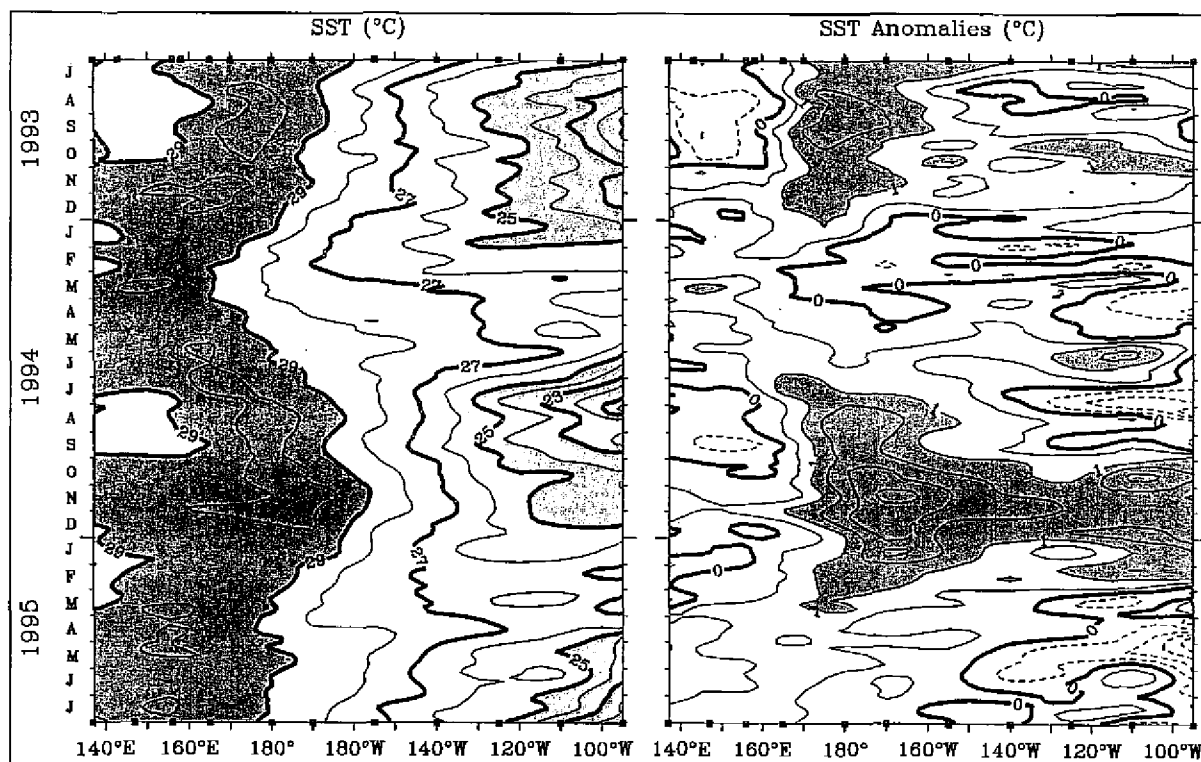


Figure 1: Sea surface temperature and anomalies along the equator from 135°E to 95°W, July 1993–July 1995, as measured from the TAO buoys

terms, resulting in global changes on land and at sea.

During ENSO events there are often drought conditions in northern Australia, Indonesia, and the Philippines and excessive rain in the island states of the central tropical Pacific and along the west coast of South America. These events affect non-tropical regions as well.

For example, the north-eastern United States and Canada and the Pacific North-west tend to be warmer than normal; and it is rainier than normal in the states bordering the Gulf of Mexico. In California, ENSO can be associated with either excessively wet or excessively dry winters. ENSO events also disrupt the marine ecology of the tropical Pacific and the Pacific coastal regions of the Americas.

The warm water is not as rich in nutrients as the usual cool water and does not support marine life. The amount and distribution of commercially valuable fish stocks is affected. Though it originates in the tropical Pacific, the consequences of ENSO are felt on a global scale.

The Tropical Atmosphere Ocean (TAO) array of buoys was developed in order to better describe, understand and predict ENSO events. The array is part of a multinational research programme sponsored by the governments of France, Japan, Korea, Taiwan and the United States. The array consists of nearly 70 buoys, moored with steel cable, spanning the equatorial Pacific between the Galapagos Islands and New Guinea (see Figures 2 and 3).

The buoys are separated by approximately 900 nautical miles in the east-west direction, and about 150 nautical miles in the north-south direction. Actual buoy positions are listed periodically in the *Notice to Mariners* publication.

Each buoy measures surface wind, air temperature, humidity, sea-surface temperature, and subsurface temperatures down to 500 m. A few buoys also measure ocean currents, rainfall and solar radiation. Environmental data and buoy positions are transmitted via satellite and received daily at the TAO Project Office.

Data are also transmitted in real-time over the Global Telecommunications System (GTS) to operational weather centres around the world, where they are incorporated into numerical

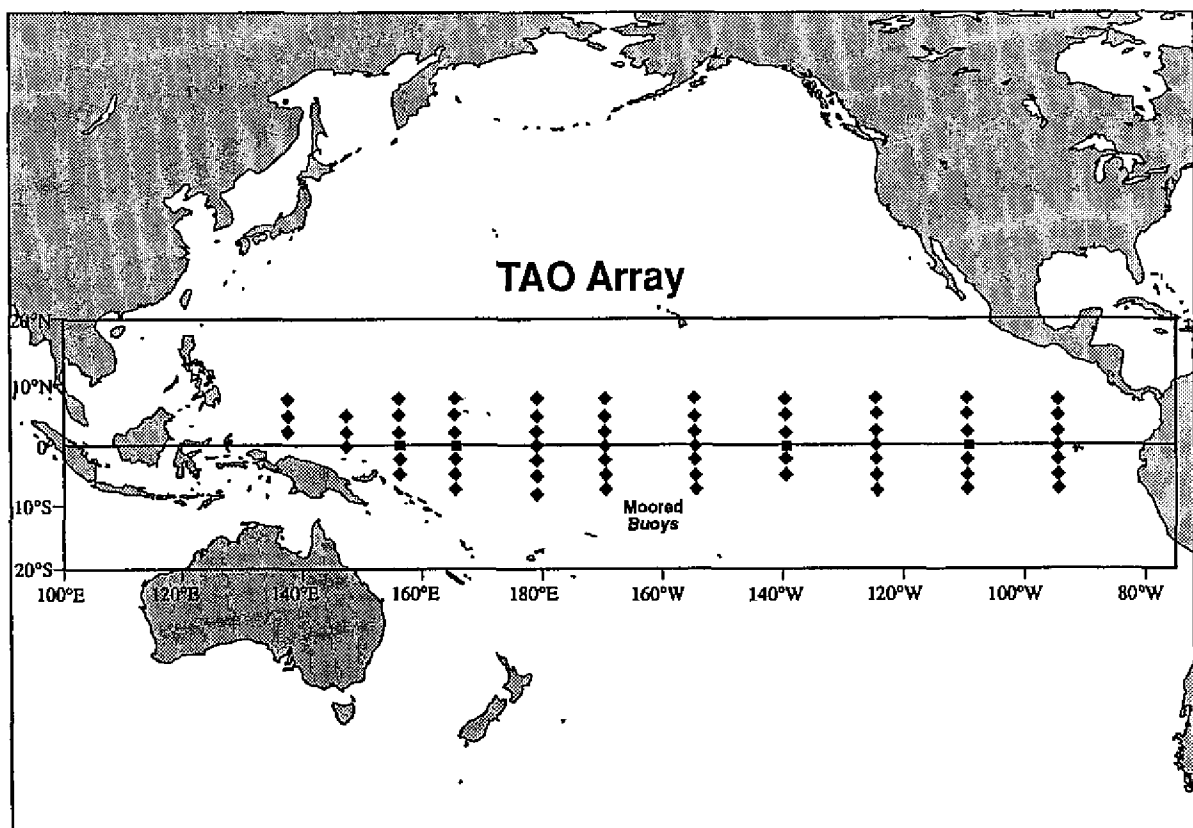


Figure 2: Locations of the buoys in the TAO array

weather and climate forecasting models. The data can also be downloaded directly by scientists and other interested parties via Internet.

The TAO Array provides critical real-time data from the equatorial Pacific region where there are few islands or ships providing weather information. These data are used by several weather centres to produce charts of sea-surface temperature and storm forecasts which are distributed to the maritime community via radiofax broadcasts. Wind and ocean current data from the buoys have also been used by nations in the western Pacific to help locate missing or overdue vessels.

The ability to anticipate future El Niño events and other disruptions in the world's climate benefits not only maritime communities, but all peoples of the world. By steering clear of these moorings, you can help us to learn more about these events and improve the prediction of them in the future.

For further information, please contact the TAO Project Office at:

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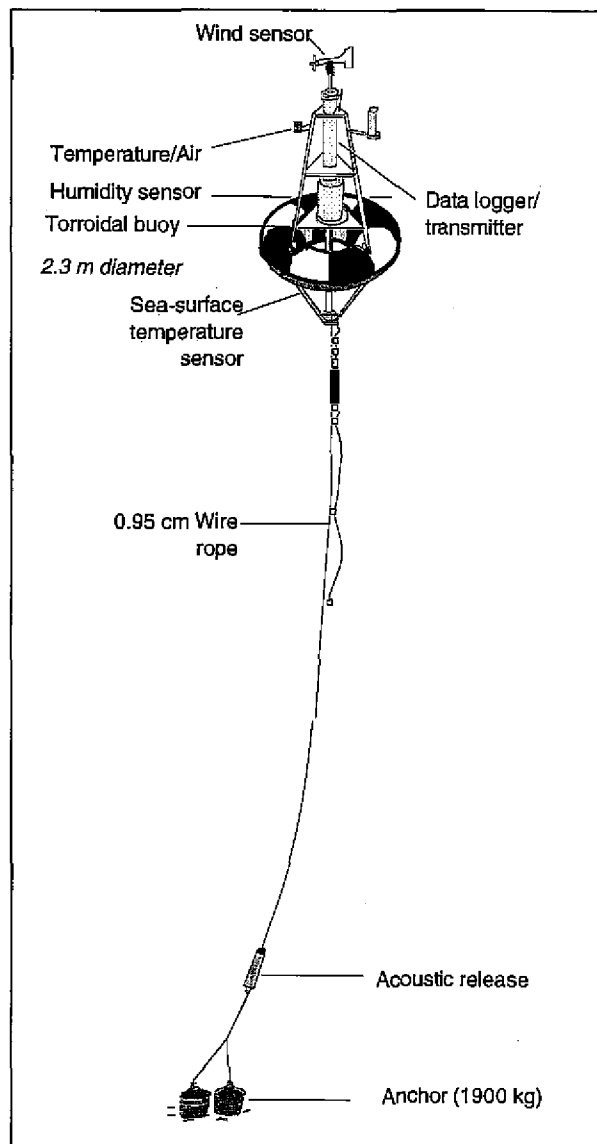


Figure 3: Schematic drawing of a TAO buoy. Each buoy measures and transmits surface and sub-surface data. The moorings are securely anchored in place.

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