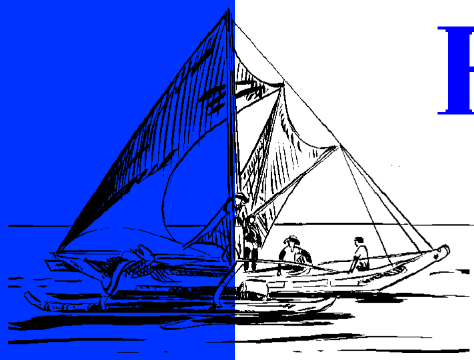

FISHERIES

Newsletter

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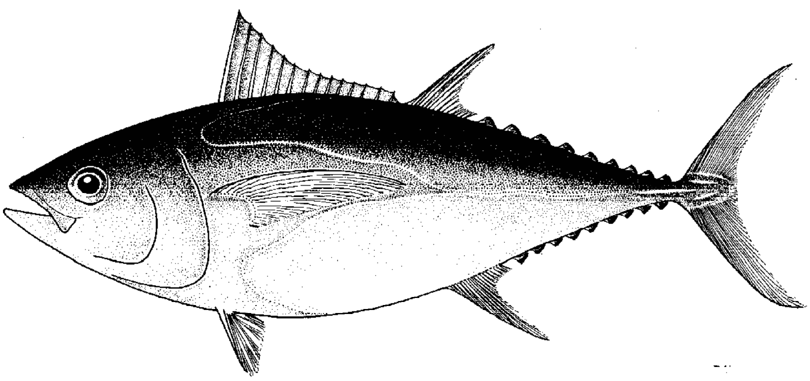
IN THIS ISSUE



Bigeye tuna (*Thunnus obesus*) is one of the main species targetted by longline vessels

South Pacific Commission
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RESOURCE ASSESSMENT SECTION

Fisheries management and marine conservation start to find common ground: A report on the World Conservation Congress

The SPC Coastal Fisheries Resource Adviser, Dr Tim Adams, attended the first World Conservation Congress in Montreal, Canada, in October 1996, at the invitation of the World Conservation Union (IUCN), to take part in a two-day Fisheries panel discussion under the Marine and Coastal Workshop of the Congress.

This was a large meeting, the triennial meeting of the IUCN governing body, and was attended by several thousand people overall.

There were a lot of workshops going on simultaneously, and the fisheries panel discussion over two days did not attract many participants. Indeed, at times, there were more presenters than participants in the room.

This low participation may also have been due to the generally low profile that marine issues have historically taken in the environmental calendar compared to terrestrial issues.

However, things are changing. Like environmental organisations everywhere, IUCN is starting to pay more attention to marine ecosystems, and there will be more and more interest by environmental organisations in fisheries issues as time goes on.

Over the past couple of years there has grown a general public perception that fisheries science and/or fisheries management has 'failed', ignoring the rôle that unwise political decisions, taken in the face of good advice, have played. There are likely to be a lot of wheels reinvented over the next few years if this trend runs its course, and if dialogue between environmental and fisheries institutions does not occur.

But the very fact that IUCN included a fisheries session within the World Conservation Congress was a welcome sign that the need for dialogue is recognised. Sustainability of fisheries is not a recent invention, although broad public support for it is, and fisheries specialists have a lot to contribute alongside the new popular support for the development of more effective marine management systems.

The purpose of the Fisheries theme in the Congress was to provide some guidance to IUCN's Marine and Coastal Programme over the next three years. In addressing this work programme, the Fisheries group was complemented by concurrent themes on Marine Protected Areas, Integrated Coastal Area Management and International Marine Law.

At the end of two days discussion, these four groups addressed the plenary Marine and Coastal Workshop with their conclusions, the idea being that the IUCN Marine and Coastal Programme would take these recommendations and weave the priorities into a coherent work programme for the next three years.

The IUCN Marine and Coastal Programme is run by Magnus Ngoile and Paul Holthus (lately of SPREP and The Nature Conservancy in Hawaii).

The fisheries theme was keynoted by Dr Meryl Williams, director of the International Center for Living Aquatic Resources Management (ICLARM), who spoke on 'Conservation and fisheries: A roadmap for the new era'. Fisheries theme speakers were:

- Dr Scott Parsons (Dept of Fisheries & Oceans, Canada): Opening remarks;
- Dr Angel Alcala (Commission on Higher Education, Philippines): The roles of community-based fisheries management and marine protected areas in coastal fisheries;
- Dr Mike Sissenwine (National Marine Fisheries Service, USA): The concept of fisheries ecosystem management: Current approaches and future research needs;
- Dr Michael Sutton (Worldwide Fund for Nature [WWF]): Influencing fisheries conservation: an international NGO perspective;
- Dr Jake Rice (Dept of Fisheries & Oceans, Canada): Future challenges for fisheries resource assessment in the aid of fisheries management;

- ☞ Dr Cornelia Nauen (Directorate-General for Development, European Commission): New approaches to development cooperation in capture and culture fisheries; and

- ☞ Dr Tim Adams (South Pacific Commission): Coastal fisheries and development issues for small islands.

The job of the SPC representative was to focus attention on small islands as a 'cross-cutting' issue. Although this was a small session, the scarcity of argumentative voices arguably provided a little more freedom in coming up with a coherent set of issues to guide the future IUCN work-programme.

When diverted by participants questions, discussion became confined to a narrow set of topical issues, and the discussion often had to be channelled back onto the bigger picture. There was actually material here for several full days of discussion.

For example, much of the discussion in the fisheries theme on the first day centred on the recent red-listing of certain fishes, with the panel expressing considerable doubt about the wisdom of basing the criteria for red-listing purely on percentage declines in population numbers over time, given the notorious variability of aquatic ecosystems. Relative species abundances can change dramatically over time even without human intervention.

Some participants were not happy with this criticism since IUCN has apparently spent five years considering different options and trying to make the red-listing criteria more rigorous. Unfortunately, they didn't appear to consider the option of having any fisheries specialists on the criterion development panel.

The fisheries group stressed to plenary that their reservations were not based on a wish to open up exploitation on red-listed species, but that the ease with which the scientific credibility of the criteria could be undermined might cast doubt on the whole red-listing process.

The other major side-issue the fisheries panel discussed was the Unilever/WWF initiative to form the Marine Stewardship Council (MSC), and thereby to provide a voluntary environmental labelling scheme for products of fisheries certified to be sustainable. Again, the main issue here was the criteria by which 'sustainability' would be assessed, and the panel's frank assessment that this would be almost impossible to carry out fairly, given our current lack of knowledge about the status of many fisheries, let alone assessing what is sustainable.

WWF reckoned that this would be developed from an initial empirical basis, and that a series of workshops and panels would be held over the next three years to develop criteria and indicators. But one worry raised by the panel was that the lack of knowledge about smaller-scale fisheries would mitigate against small-scale fisheries and developing country fisheries being certified, and thus against them obtaining premium prices in first-world markets.

Another worry was that most of the fishery export products coming from the South Pacific that are in need of (or amenable to) consumer-driven restraints on exploitation are sold in Chinese-speaking countries, and the meeting felt that the green consumer movement is not yet a major market factor in most of these areas.

The eventual review of each fishery under the scheme for sustainability would be carried out by independent assessment agencies under the ægis of the MSC, and not by governments or producers.

WWF sees this as using market leverage to actually advance fisheries management measures. It would not be imposed from above by government, but would be a positive incentive to buy fish only from certified sustainable fisheries, in order to obtain a premium price from the 'green consumer'. SPC will be talking to the WWF about the possibility of holding a technical meeting to consider the potential and pitfalls of such a scheme in the Pacific Islands region.

The final list of issues flagged by the fisheries group for the IUCN Marine and Coastal Programme to consider in its future work included the following:

- ☞ Supporting the ecosystem management approach; but the need was raised for some guidance, and fishery specialist input, to the new Ecosystem Management Council. It was also felt that there was a need to clarify terms so everyone knows what is being talked about. IUCN would have a rôle in coordinating this, and also in 'scientific quality control'. The fisheries group noted that a lot of marine ecosystem models are descriptive only, and tools are also needed for prediction;

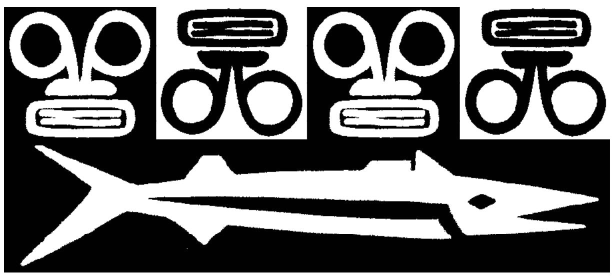
- ☞ There was a recommendation on marine protected areas (MPAs), giving strong general support to setting up MPAs, but warning that they need to be considered in the socio-cultural context, and are only one in a range of potential fisheries or coastal area management tools available. There was a worry that they might be considered a panacea for all overfishing problems and soak up a disproportionate amount of small-country budgets.

It was noticeable that the MPA working group had been thinking mostly in First World terms (e.g. the session leader talked about commercial and sport fisheries, but ignored subsistence), and it was also noticeable that 'sustaining fisheries' has become a major justification for setting up new MPAs, even though there has been little real proof offered yet that MPAs would be any better than other management measures in sustaining nearby fisheries.

The panel predicted that this would become an increasing source of potential 'overlap' between environmental and fisheries agencies in future. One thing is clear though. MPAs are good at focussing public attention on issues. The basic gist of the fisheries panel's recommendation to IUCN was that MPAs needed to be established quickly, bearing in mind the precautionary principle, but that a critical 'learning process' had to be built in;

- ☞ Encouraging FAO and IUCN (and indeed, all fisheries and environment agencies) to get together and talk more;
- ☞ Emphasising the importance of the human element in small-scale fisheries. From the technocrat's point of view this could be sold as 'using people's interest as a door into management'. IUCN could also help in the definition of the carrying capacity of the fisheries environment, around the more specific stock assessments carried out by fisheries specialists;
- ☞ The important rôle that the IUCN Commission on Education has to play, especially in addressing the need for school marine-related curriculum development and development of teaching resources in small-island countries; and
- ☞ One of the workshop recommendations advised IUCN to play a part in 'legitimising stakeholders'. It wasn't exactly clear what this meant, but it seemed to refer either to the need to get more people around the table when talking about fisheries problems, not just fishermen & fisheries departments, and/or to the need to help local people feel that THEY own the projects, not just the implementing agency.

Dr Williams finished off the fisheries workshop presentation to plenary by reiterating her keynote point, that we are now in a third stage of global fisheries development, where the precautionary principle holds sway, and that the very fact that IUCN had invited a bunch of fisheries 'types' to its triennial planning meeting was an illustration of this 'paradigm shift'.



Coastal Fisheries Resource Assessment and Management Section update

The section provides several services to member countries, as well as maintaining an 'overview' of the status of coastal fishery resources in the region.

However, the chief activity, in collaboration with the Coastal Fisheries Post-Harvest Section, is the implementation of the United Kingdom ODA-funded Integrated Coastal Fisheries Management Project (ICFMaP) during the period 1995–97. Previous ICFMaP subprojects are briefly described in previous SPC *Fisheries Newsletters*, but a series of in-depth field reports will be listed in the newsletter for public release in the third quarter of 1997.

Subprojects have been carried out, or are under way, in Cook

Islands, Fiji, Tonga and Papua New Guinea, and one remaining sub-project is arranged in Tokelau, which it is hoped to implement in the second quarter of 1997.

ICFMaP was set up to assist SPC island member fisheries departments to develop management measures or plans for specific high-priority or 'problem' fisheries (including the integration of economic efficiencies or alternatives), as well as to promote coastal fisheries management awareness in the region.

The first year of the project (September 1994 to August 1995) concentrated on regional issues, drawing together as much information on existing fisheries management measures and coastal fishery resource status as possible, and organising a major international workshop on inshore fisheries management.

The activity during the second two years of the project (September 1995 to August 1997) concentrates on specific in-country case-studies. These were identified and arranged by agreement with those member countries that submitted requests for ICFMaP collaborative assistance in 1995, but the project retains a certain flexibility to undertake some additional work, provided that requests fall within the guidelines for implementation.

The Resource Assessment and Management Section, of course, also continues to service ad-hoc relevant requests for information or advice that do not involve staff travel or large amounts of time. As well as answering questions within our own area of expertise in coastal fishery resource assessment and management (and, increasingly, aquaculture), we endeavour to put people in touch with possible sources of advice in other countries and institutions. We are also available if any member country fisheries department needs an opinion on the results of any work carried out either by their own staff or by outside consultants, even if only to double-check calculations.

In short, unlike many specialised institutions, we are not completely wrapped up in our own work but we try to help member countries wherever possible. Informal queries are welcomed.

Unfortunately, (we would probably be extremely popular otherwise) we do not have any funds for awarding grants. We do the work rather than paying consultants, and we try to get involved only in national activities which need a bit of assistance or experienced advice rather than carrying out 'stand-alone' activities.

In addition to the usual methods of communication with SPC, of which Peacesat probably has the best cost/speed ratio, we now do a lot of business via email. If you have email, try reaching us on tja@spc.org.nc or esaroma@spc.org.nc (or sfr@spc.org.nc for post-harvest issues).

Unfortunately, SPC has not yet been able to get a good enough line to run its own World-Wide Web server, but we are gradually converting and adding reports and publications to the internal network.

When full Internet facilities finally arrive, we will be able to immediately launch a library of electronic publications about Pacific Island inshore fisheries resource and management issues onto the World-Wide Web.

The main news from the section this quarter is the resignation and departure of Paul Dalzell, SPC Inshore Fisheries Scientist. Paul has joined the Western Pacific Region Fisheries Management Council in Hawaii (WPRFMC)—the statutory body that is responsible for the management of the EEZs of Hawaii and US Pacific Island territories.

Paul's departure was reluctant since he enjoyed his work at SPC, but when you are on short-term contract you have to take your employment chances when you can. At the time of Paul's departure there were only nine months left to run on the ICFMaP project which pays the salary of the Inshore Fisheries Scientist, with no commitment for renewal, whilst the WPRFMC job is not limited by short-term project funding.

Paul's expertise in the stock assessment of reef fishes and small pelagics, not to mention his prolific written output, will be sorely missed, and our best wishes go with him and his wife, Nellie. With less than a year left to run on the project it is not feasible to recruit a new person to the IFS post.

Instead, with the agreement of the Fiji Fisheries Division, the current ICFMaP secondment officer Esaroma Ledua will stay on with ICFMaP until the end of the project in August 1997.

The ICFMaP project was reviewed by the United Kingdom Overseas Development Administration in December. This physical review occurs approximately once a year, and measures the progress of the project towards its milestones, and against the logical framework that was drawn up at the start of the project.

The review is also an opportunity for the project supervisors to amend the framework according to changing circumstances. Although the South Pacific Commission is more interested in seeing how its work fits in with the changing needs expressed by member countries, and thus how member countries view the project, adherence to the original logical framework is more important to the donor. Much of the review thus consisted of trying to reconcile these two sets of occasionally disparate expectations.

Although the results of the review are not officially known, the most likely future path for ICFMaP is to use the savings generated by the reduction in staffing over the next year to extend a small component of the project beyond the official closing date of August 1997.

Substantial extension of this activity under the current donor is unlikely, since the UK aid strategy for the future in the region has been focussed to concentrate on assistance in education and governance.

Fisheries, like some other major sectors, is likely to suffer. At the same time, global environmental organisations and donors are starting to pay more attention to the need for better management of small-scale and reef fisheries, and marine resource inventories.

Since this is exactly the kind of work that has been carried out by the SPC Resource Assessment and Management Section for the past five years, we hope that duplication will not occur and that future support for the section will start coming in from this direction as well as from 'traditional' fisheries sources.

One of the main conclusions of the regional 'overview' component of the ICFMaP project is that, unlike the gloomy perceptions about the state of fisheries and fisheries management in the rest of the world, the Pacific Islands have considerable cause for optimism about their coastal fisheries.

Of course, there are high profile problems, some of which are severe, but these are mainly confined to export fisheries and a few densely-populated islands—the very areas where western values and the cash economy is strongest. In comparison to the rest of the world, Pacific Island domestic food fisheries are spread over a very wide range of species and are still mainly non-commercial.

The few rigorous studies that have been done suggest that they are sustainable at current levels of exploitation. Of course, fishing, and the regulation of fishing, has been a major part of Pacific Island societies for hundreds of years (thousands, in Melanesia).

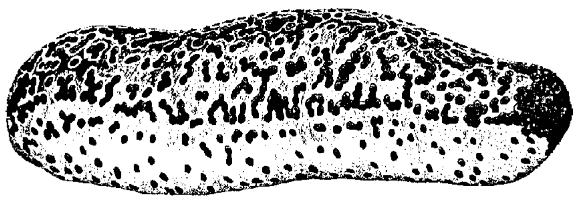
The Pacific Islands thus have a lot to teach the rest of the world. But the world will not learn those lessons unless a great deal more effort is put into the study of Pacific Island fisheries and fishing societies, and unless the changing trend away from short-term, fly-by-night ventures and towards longer-term local sustainability is assisted to completion.

ICFMaP Milne Bay fieldwork

In October the Resource Assessment Section assisted the National Fisheries Authority of Papua New Guinea in carrying out some field investigations towards the management of beche-de-mer and giant clams in Milne Bay Province.

The rapid resource appraisal was carried out under the leadership of Paul Lokani of the PNG NFA with support from Milne Bay Provincial Fisheries Office, and with the assistance and expert advice of SPC ICFMaP officers Esaroma Ledua and Sione Vailala Matoto. The work was mainly based aboard a PNG Provincial Fisheries extension vessel. Beche-de-mer and giant clam abundance and biodiversity were assessed by underwater visual census over 100 m transects at 63 sites.

Obviously there is little hope of accomplishing a statistically rigorous appraisal of patchily-distributed organisms over a vast area within the four weeks



available for this fieldwork, but the three scientists between them have many years of experience of appraising similar resources in several Pacific Island countries and the fieldwork provides an expert opinion on the state of resources. This, coupled with analysis of historical information, will enable Papua New Guinea to make a decision on the type of management measures necessary to best maintain these highly valuable organisms.

At the time of writing, the data from this fieldwork has not been completely analysed, but indications are that the original population of *Tridacna gigas*—the largest giant clam and the main target for poachers and commercial export—has been reduced by at least 80 per cent in the province.

This estimate is based on the ratio of dead shells to live shells seen during the survey, so it cannot be said over exactly what timescale this level of exploitation has occurred. However, even if this is over a decade, it is still an extremely high rate of poaching or exploitation for an organism which is long-lived, of a low natural mortality, and subject to frequent recruitment failures.

The study will also attempt to estimate overall giant clam abundance, but this is likely to have a very large statistical uncertainty compared to relative estimates of mortality. Once baselines are normalised, mortality estimates can also be checked by comparing the current abundance of live animals to abundance in surveys carried out previously.

In terms of biodiversity, Milne Bay Province has 7 of the 8 recognised species of giant clam present in its waters, with the most abundant being *T. maxima*. The only species not present, *Tridacna tevoroa*, has so far only been found in eastern Fiji and Tonga, on the eastern limit of the range of the larger giant clams.

The results of this work, and of the parallel study on beche-de-mer, will be reported in the next quarterly fisheries newsletter. During the first quarter of 1997, ICFMaP will complete the work of assisting the Cook Islands Ministry of Marine Resources and the Aitutaki Island Council to develop a Management Plan for the Aitutaki Lagoon fishery that was legally designated under the 1989 Fisheries Act.

Further analysis of data from other subprojects will occur, and be brought into publishable form, and preparation will begin for the Tokelau lagoon fishery management subproject.

■ TRAINING SECTION

Second regional workshop on sashimi tuna

The first regional workshop on the handling, quality assessment and grading of sashimi tuna was held in Chuuk, Federated States of Micronesia in August 1995, and was followed by two in-country workshops in Papua New Guinea in December 1995 and French Polynesia in May 1996. These two-day workshops were conducted by Ken Harada, Sydney Fish Market's Quality Control Officer, with teaching inputs from Section staff.

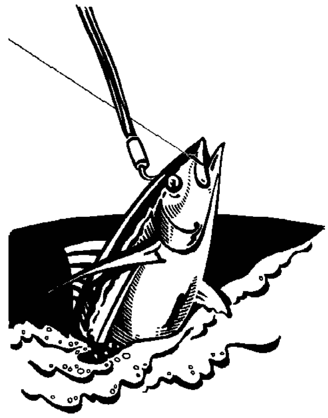
As a consequence of the development of domestic tuna longline operations in the region, there is an increasing training need in the area of tuna handling and grading, and, following the request of some member countries, the SPC Coastal Fisheries Programme will organise a second regional workshop on sashimi tuna in 1997. It is likely that the one-week workshop will be held in Tonga, and the tentative dates are 19–23 or 26–30 May.

The workshop will be jointly prepared and implemented by the Post-harvest and Training Sections with Section staff selecting participants and making arrangements for tutors, travels and general logistics.

It is also possible that SPC Masterfisherman Steve Beverly will be present for the workshop and will assist with some of the lectures and practicals. Ken Harada will again be the main workshop tutor and his director, Mr Graham Crouch, will give a presentation on the tuna marketing opportunities in Australia.

The workshop lectures will comprise an introduction to the

Japanese sashimi markets, tuna biology and physiology, on-board tuna handling, quality assessment, on-shore handling and packing. 'Hands-on' demonstrations of tuna handling and grading will also be carried out. Some of the resource materials (video and manual on the on-board handling of sashimi-grade tunas) that have been produced by the Section will be used for this workshop.



Funding for the second regional workshop will be provided by UNDP under the SPC-FFA Regional Fishery Support National Capacity Building project. In addition, a funding proposal of US$ 35,000 for additional activities in this area was approved by the Government of Taiwan/ROC in December 1996.

New video soon

A video focusing on the management skills required to successfully operate a small fishing business will be filmed in Fiji in February this year. This programme will complement the Section's resource materials produced to assist with in-country training initiatives in the area of small business management.

These materials, which include the SPC fishing logbook, a spreadsheet and a teaching manual, had been reviewed and finalised by the participants to a regional 'train-the-trainer' workshop in Santo, Vanuatu, in March 1996. Subsequently distributed to all fisheries administrations and training institutions in the region, the materials have been used in a series of national workshops in Niue, Solomon Islands, Papua New Guinea and Tuvalu.

The video script, written by ex-FETA and next FTO, Alastair Robertson, tells the story of Pauli, a typical Pacific Island fisherman who believes more in his fishing skills than in record keeping.

The problems start with a letter from the bank informing Pauli and his wife Mere that their boat will be repossessed if the outstanding loan repayments are not received within a week!

Fortunately, Pauli's friend, Luka, is a fisherman who has attended some training courses on the management of small fishing businesses. Luka will explain Pauli and Mere how to properly keep financial and trip records with the SPC logbook. He will also stress the importance of these records and their use and will give some advise on how to fish 'smarter'.

The video will be filmed and edited by the SPC Regional Media Centre in Suva. It should be completed and ready for distribution around mid-1997.

■ CAPTURE SECTION

Update of country assignment—ice fish correctly

The New Caledonian country assignment, being conducted by the Section's Masterfisherman, Steve Beverly, concluded in late December. Steve's work with the local tuna longline company, Navimon, had him undertake trips on three of the company's five vessels. The fishing side of Steve's work was reviewed in detail in the last edition of this newsletter, and will not be covered again here.

Steve has been able to provide positive feedback to the skippers and crew of the vessels, as well as the shore management, on areas of the fishing gear and technique that could be improved. Some of these improvements, such as using longer floatlines to get the gear fishing deeper, and using a sea surface temperature indicator, were tried on one vessel with better catch rates being achieved. It is not possible to draw any definite conclusions from this one trial, however, the results were very encouraging.

The other main area that Steve was able to assist in, was improving the on-board handling of the catch, primarily the icing and storage of the catch. On all of the vessels, Steve found that insufficient ice was available for icing the fish if there were good catches. This was due to limited ice being loaded on the vessel

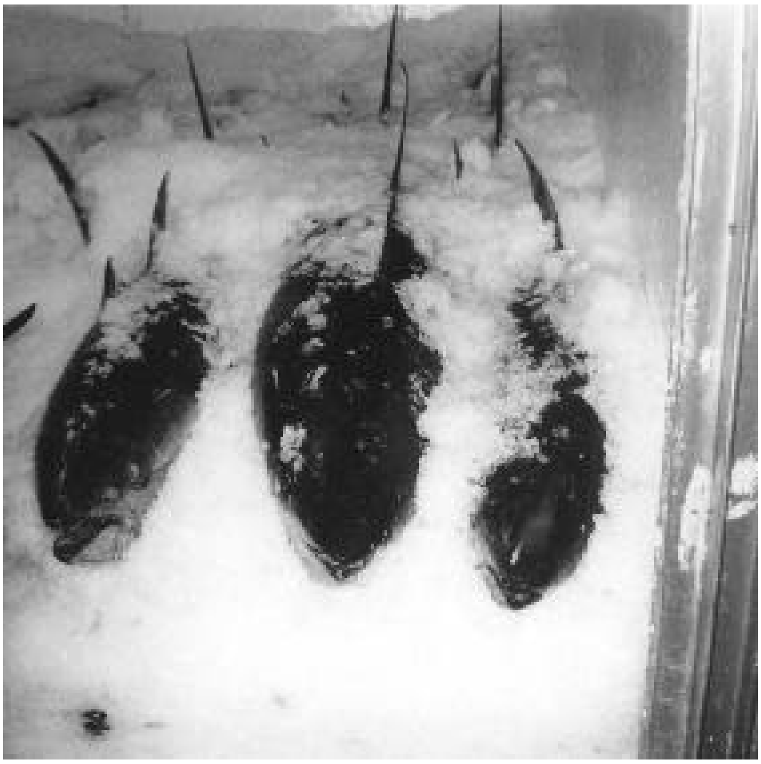


Figure 1: Icing fish in a vertical position with belly down (note that fish are not touching each other)

(the cost of ice was equivalent to US$ 200 per tonne), and the limited capacity of the on-board desalination plant that provided fresh water for the on-board ice machine. On two trips, this combination resulted in lost fishing time due to ice shortages.

When sufficient ice was available, Steve demonstrated the correct method of icing sashimi grade tunas. This process starts with a good layer of soft ice of sufficient depth to last for the duration of the trip (about 20 to 25 cm). The fish should be iced in a vertical position, belly down and back up (Figure 1).

It is acceptable for the heads and tails to touch but the bodies of fish should be kept separate—a finger's width space should be left between fish, and between fish and the walls of the hold or bin boards.

On the day after icing, fish should be re-iced (Figure 2) by removing all air pockets or 'igloos' (Figure 3) from around the body of the fish. As many as three or four layers of fish can be packed in this way, with the layer of ice between layers of fish needing only to be four to six cm thick.

On following days, any heads or bodies showing through the ice should be covered again. The ice used should always be chopped and smashed until it is 'soft'—lumpy ice will dent the fish. Ice can be chopped with a shovel and then smashed to smaller pieces by stamping on it. For larger fish some ice should be put into the gill cavity as well.

Figure 2: Re-icing fish after one day to remove air pockets

One technique for icing large fish is to lay them first on their sides on the starting layer. Next some soft ice is shovelled onto the fish but not enough to cover them completely.

Then the fish are turned to the vertical position by twisting the tails until the fish have turned upright. As this is done ice will fall under the fish and support them long enough to allow them to be covered completely. This technique works best if several fish are iced at one time in a row.

In preparing the fish for icing, care is needed to ensure that all blood is rinsed from fish before they are placed into the fish-hold. It is easy to hold the fish up by the tail with the head down so that blood and rinse water can be drained onto the deck prior to placing the fish into the fish-hold.

The fish-hold and the ice should be kept as clean as possible. Lastly, when fish are removed from the ice at off-loading, water should be sprayed on the ice only and not directly onto the fish.

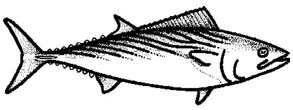


Figure 3: Air pockets formed around fish during the first day of icing

In between trips on the Navimon vessels, Steve went to the Cook Islands for one week to work with the Ministry for Marine Resources to develop a proposal to assist local tuna longline operators. A summary of this trip is covered in a separate article in this newsletter, 'New life for old gear in Cook Islands'.

Review of constraints to develop and expand the domestic tuna longline fishery in Tonga

The Fisheries Development Adviser, Lindsay Chapman, spent three weeks in Tonga conducting a review of the constraints on the development and expansion of a domestic tuna longline fishery in Tonga.

Lindsay held meetings with staff from the Ministry of Fisheries, local fishermen and processors, and officers from other government departments that were involved in different aspects of fish exports, training, or ports and services.

Based on the information collected at these meetings, 22 issues were identified as constraining the development of a tuna longline fishery (or other export-focused fisheries).

The issues identified were wide-ranging and included:

- the process and costs associated with the issue of export licences (issued for one consignment of fish only);
- the lack of knowledge on the tuna resource in Tongan waters;

- the most suitable vessel for tuna longlining in Tonga;
- the manning, safety and training requirements for the fishing industry;
- the role of the Ministry of Fisheries in development work;
- the potential conflict of interest of some staff in the Ministry of Fisheries;
- the need for local operators, including the Ministry of Fisheries, to work together and not compete;
- the availability of wharf space, airfreight space and bait for tuna operators;
- the handling of product by airline staff when exporting;
- the standards for processing plants to meet HACCP (hazard analysis of critical control points);
- the potential for, and types of, foreign investment;
- the support industries needed to keep a fishing fleet operational; and
- the need to be able to operate seven days a week if weather conditions and flight schedules require.

A draft report of the findings was presented to a public meeting and was well received. Participants at the meeting asked questions and sought clarifications regarding some of the 38 recommendations in the draft report.

The Secretary for Fisheries, 'Akau'ola, also stated that the draft report would be very useful for his Ministry as it identified and pulled together all of the constraints into one document.

He said that this draft report complemented the economic work recently undertaken by the Forum Fisheries Agency, and that all of this would guide the Ministry of Fisheries' approach towards encouraging the development and expansion of the domestic tuna longline industry in Tonga.

Another part of Lindsay's review consisted of a trip onboard one of the local tuna longline vessels, F/V *Capricorn II*, to identify areas that could be improved and assess the requirements for a longer-term country visit by the Commission's Masterfisherman.

Several problems were identified by Lindsay as constraining the potential of the operation. The most important of these was the limited below-deck ice-hold space (1.5 tonnes of fish maximum with ice) which meant that ice-chests needed to be carried on deck to store enough fish to make fishing operations viable.

This greatly affected the fishing operation, especially during line hauling and the cleaning of the catch, as large areas of the deck space were used for storing ice-chests.

On this trip, over 2 t of fish were caught during three sets of the 650-hook longline. Catch rates were excellent, however, problems were encountered with icing of the catch (the trip had to be cut short), and with the hydraulic system (which affected the operation of the line thrower and the mainline reel).

A report of this trip was compiled, highlighting many areas that could be improved and recommendations on possible solutions, and presented to the vessel owner as well as being incorporated in the draft report presented to the public meeting.

The Section has also made progress on several reports on technical assistance to member countries and territories. The first, 'Tuna fisheries development assistance, East New Britain, Papua New Guinea', should be published in the first quarter of 1997.

New life for old gear in the Cook Islands

On a recent visit to Rarotonga, Cook Islands (27 October to 2 November) SPC Masterfisherman Steve Beverly saw two things that were very encouraging.

One was an old Ministry of Marine Resources vessel that has been restored to better-than-new condition, and the other is a new improvement on the old FAO Samoan Handreel.

The purpose of the Masterfisherman's visit, however, was to liaise with MMR Secretary, Ray Newnham, and Colin Brown, formerly of MMR and FFA, to come up with a proposal for a future SPC Capture Section assignment to Cook Islands. The Capture Section attachment will take place in early 1997 and will involve technical assistance to the fledgling longline industry in Cook Islands. The main longline operator in Rarotonga is Lucky Matapuku. Lucky has a 16-metre vessel and is in a joint venture with Sealords of

New Zealand, operating a packing house and exporting tuna to Japan and other markets.

The project will also assist artisanal and FAD fisherman and work on upgrading the FAD skills of MMR Fisheries Officers. SPC's Fisheries Development Adviser and Masterfisherman will share the workload, and at the end of the project they will conduct a workshop on fishing vessels, including maintenance and management; fish handling, processing, and marketing; and post-harvest (value-added products).

It was while working on the first draft proposal for the project that the Masterfisherman had a chance to see the refurbished Ton-7 vessel and the new improved Cook Islands' version of the FAO Samoan Hand Reel.

Brent Fisher, a Cook Islands resident originally from New Zealand, is a very enterprising sort of person. By trade he is an electrician, but an interest in fishing saw him enrolled in an FAO boat-building course some years back. As a result of the skills he learned on the course he built an FAO-designed fishing outrigger canoe.

The canoe has been the main vessel in Brent's fishing charter business, Fishing Tours (Rarotonga). Brent takes up to four or five anglers at a time on around-the-island trolling trips, catching mahi mahi, skipjack tuna, and the occasional yellowfin tuna.

The canoe is powered by a four-stroke outboard and, according to Brent, is very seaworthy. Brent wanted to expand his business, however, and move into a larger vessel and also into the more lucrative commercial fishing for bottom snappers and export tuna. The problem was finding a suitable and affordable vessel.

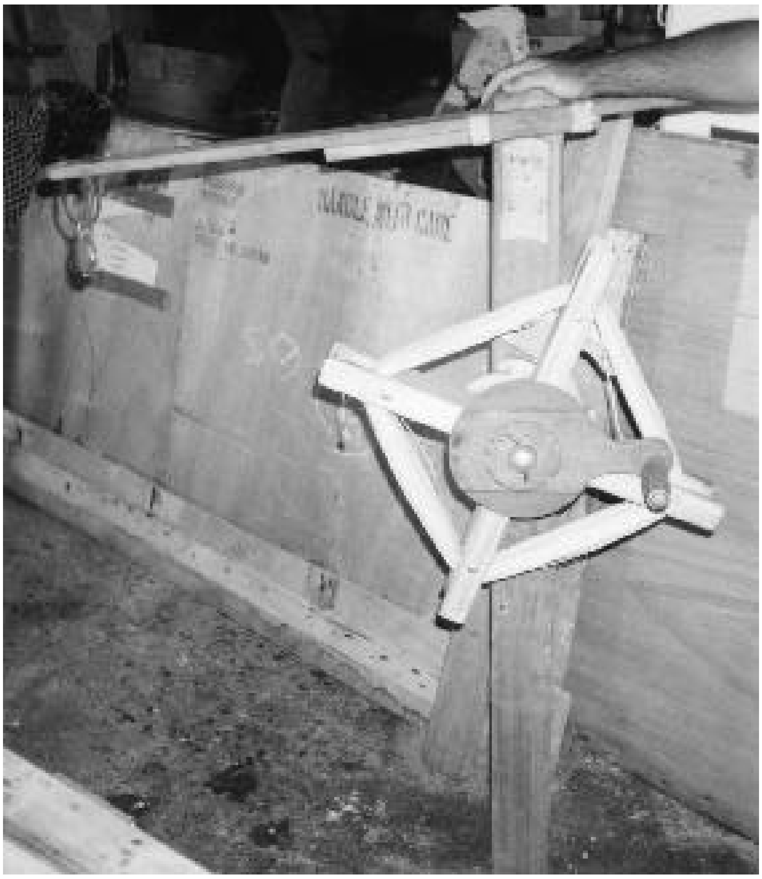
Several years ago, MMR had an FAO Ton-7 (8.8-metre diesel) built in Tonga for use as a fisheries survey vessel. The boat was quite successful during the first few years of operation but later suffered from lack of use and ended up on the hard.

It was here that Brent first saw her. It probably wasn't love at first sight but Brent could see the potential—if a little bit of tender loving care was applied. The vessel was auctioned off by MMR and Brent submitted the winning bid. At the time the boat was not operational and had several rotten timbers and broken bits and pieces.

Today the newly painted and re-named *Peka-Anne* sits proudly in Avatiu Harbour with all systems operational, including a four-mile longline reel and a hydraulic hauler for bottom longline gear.

Brent reckons he got a real bargain but he has had to put several thousand dollars into *Peka-Anne* and lots of time and labour. In addition to replacing all of the bad wood Brent fabricated a new canopy over the back deck and extended the wheelhouse, which now has all new perspex windows.

On the last day of his visit, the Masterfisherman accompanied Brent and his crewman, Chris Mussell, on a shake-down cruise to test the longline gear. Brent will be one of the fisherman that SPC will be assisting in 1997.



The modified FAO/Samoan handreel

On this short five-hour trip in October, the plan was only to demonstrate setting and hauling techniques. To make the process more realistic, bait was used, but nobody expected to catch any fish as the line was only going to soak for an hour or so.

To everyone's surprise, a 22 kg albacore tuna was landed with a set of just 40 hooks. The line was set just two miles north of Avatiu Harbour. Brent will qualify to fish inside of the six-mile limit as *Peka-Anne* is less than ten metres in length. If this first venture into small-scale longline fishing is any indication, the new lease of life given to *Peka-Anne* should prove to be quite successful for Brent Fisher. He certainly has the right surname for the job.

Josh Mitchell, MMR Surveillance Officer, took the Masterfisherman on a tour of all of MMR's facilities and introduced him to the staff. One of the staff, MMR Fisheries Officer William Powell, is something of an inventor. In fact, he is affectionately referred to by some as 'Gyro Gearloose'.

When the Masterfisherman went to William's shop he saw the reason for this nickname. William is a prolific tinkerer. At his shop he had, among other things, an electric coconut scraper of his own design for which he now has about twenty orders. Production of the coconut scrapers was progressing slowly, so William made his own electric hacksaw for cutting the steel grater from a large piece of a second-hand steel shaft. Cutting the first one or two by hand was a time-consuming and very laborious task.

William's electric hacksaw, which is made from an old motor, hand-made wooden pulleys and levers, and a regular hand-held hacksaw, has changed all that.

William took a similar approach when it came to making standard FAO-designed Samoan handreels for bottom fishing. He looked at a standard reel and thought to himself, 'I can make that better'. And he did!

William has added a free-spool feature to the reel so that line can be played out faster. But more importantly, he has added a brake and a ratchet so that his reels operate much the same way as a commercial made reel.

The ratchet is made from wood and the brake mechanism is made from a pipe flange (see photos). The parts are available almost anywhere, it just took some innovation to come up with the design.

William has plenty of orders for his newly-designed reel, and if it proves to be successful in Rarotonga then it might take off throughout the region.

The Masterfisherman is eager to return to Rarotonga to see how Brent is doing with *Peka-Anne* and to find out the results from bottom fishing trials with the new hand reels.

William Powell shows part of his modified FAO/Samoan handreel

WESTERN PACIFIC REGIONAL FISHERY MANAGEMENT COUNCIL (91ST MEETING)

The 91st Western Pacific Regional Fishery Management Council meeting was convened between 19 and 21 November 1996 in Honolulu. The meeting marked the 20th anniversary of the establishment of the Western Pacific Council, which along with seven other Fishery Councils manages fisheries within the US Exclusive Economic Zone (EEZ, from 3 to 200 n.mi. offshore).

The Magnuson Fishery Conservation and Management Act of 1976 established US jurisdiction over fisheries in federal EEZ waters and created the eight regional councils to oversee fisheries in their respective areas.

The Western Pacific Council is the policy-making organisation for the management of fisheries in the EEZ and adjacent waters around American Samoa, Guam, Hawaii, the Northern Marianas and several other smaller islands and atolls.

The total area of ocean under the Western Pacific Council's jurisdiction amounts to 1.5 million sq. miles and represents about half of all US EEZ waters (see figure).

Sixteen Council members represent the fishing community and government agencies of the region. Half of the members are designated territorial, state, and federal officials with fishery management responsibilities. The others are appointed by the US Secretary of Commerce to represent commercial and recreational fishing interests.

The present Council Chairman is Mr James Cook from Hawaii, a commercial fisherman and partner in Pacific Ocean Producers, a commercial fishing gear supplier. Vice-Chairs are Mr Paul Bordallo (Chairman of the Guam Economic Development Authority), Mr William Paty (Mark A. Robinson Trust, Hawaii), Mr Arnold Palacios (Director of CNMI Division of Fish & Wildlife) and Dr Paul Stevenson (South Pacific Resources Inc (BHP), American Samoa).

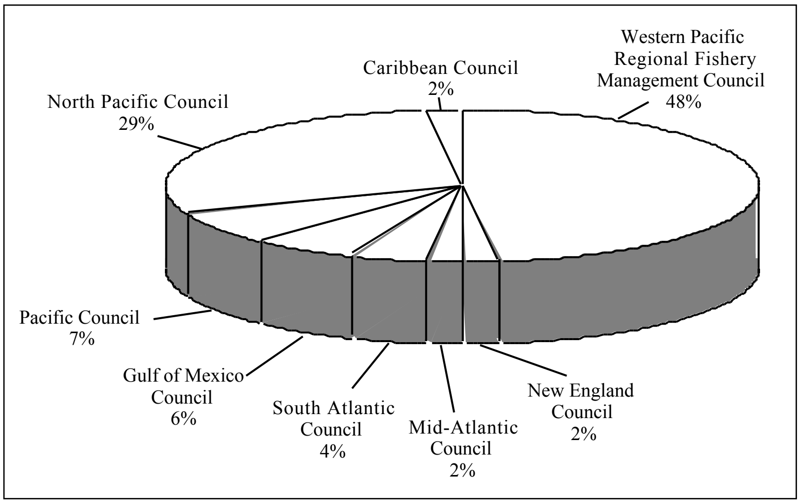
Apart from being the 20th anniversary of the Council, the 91st meeting was also jointly convened with the Marine Advisory Committee (MAFAC) to the Secretary of Commerce. MAFAC members come predominantly from the private sector and advise the National Marine Fisheries Service (NMFS) on their work programmes.

Some of the issues discussed during the 91st Council included possible high-grading (selective discarding of lower-value animals) in the North Western Hawaiian Islands (NWHI) lobster fishery, resource interaction allocation problems in the Hawaiian domestic pelagic fisheries at the Cross Seamount, bycatch of turtles and albatross and incidental catches of sharks in the Hawaiian longline fishery, management of the bottomfish fishery in the NWHI, and traditional harvesting of turtles by native peoples in the Councils area of jurisdiction.

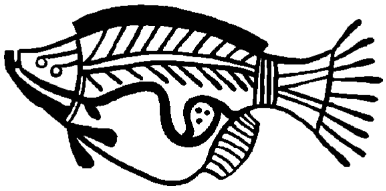
These and other issues will be addressed over the next few months by Council staff working with the various fisheries agencies within the Western Pacific region and progress will be reported at the 92nd Council meeting in April.

The Council also reviewed the reauthorised Magnuson-Stevens Fishery Conservation and Management Act of 1996 which was signed into law on 11 October 1996. Provisions of particular interest to the Council include:

☞ allowing foreign fishing within the 200-mile EEZs of American Samoa, Guam



The different jurisdictions covering the US EEZ [total: 3,252,600 sq. nautical miles]



and CNMI at the request of the Governor, in which access fees would be turned over to the island government for marine conservation in those areas;

- establishing a Western Pacific Community Development Program to provide opportunities for communities of indigenous residents in the Council area to increase their share of the economic benefit;

- funding for indigenous communities to develop fishing conservation management and enforcement plans and projects.

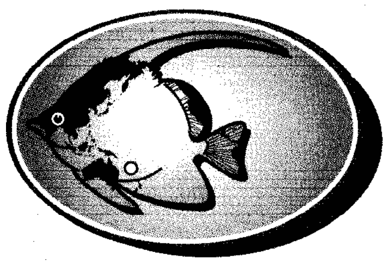
(Source: Paul Dalzell, WPRFMC)

FIFTH INDO-PACIFIC FISH CONFERENCE

The Fifth Indo-Pacific Fish Conference will be held in Noumea (New Caledonia) from 3 to 8 November 1997. Hosts will be ORSTOM and SPC (South Pacific Commission), with the sponsorship of the SFI (French Society of Ichthyology). Proceedings will be published in the journal *Cybium*.

There will be two major themes: biodiversity and biology–ecology. For the first theme, three sessions are planned, one on systematics, one on the conservation of fishes and a third on the uses of biodiversity in fisheries.

For the second theme three sessions are planned: one on reproduction, growth and physiology; a second one on population and community ecology; and a third on applied and evolutionary genetics.



Eight workshops have been designated for the following subjects: parasitology, human culture and fish in the Pacific, databases, perspectives in ichthyology, collection management, fish behaviour, ichthyotoxicity, and elasmobranchs as biological models.

A number of other workshops may take place, for instance on fish reserves. Poster sessions will also be available. A second circular will be sent in December 1996 and a last circular in April 1997.

To receive more information or to register, please contact:

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MARINE BENTHIC HABITATS & THEIR LIVING RESOURCES

A conference on Marine Benthic Habitats and Their Living Resources (Monitoring, Management and Application to Pacific Island Countries) is planned for 10 to 16 November 1997 in Nouméa, New Caledonia. The primary goals of the conference are to:

1. bring together geologists and biologists studying the relationship between marine geology and living marine resources, including marine biodiversity and fisheries; and
2. provide a synthesis of the *in situ* technology available to study and monitor the benthic submarine environment. The ultimate goal is technology transfer to Pacific Island nations.

At the 1996 SOPAC (South Pacific Applied Geoscience Commission) meeting, it was strongly recommended by the island nations that a habitat conference be organised in the region.

IFREMER [French Institute of Research for Ocean Development], ORSTOM [French Institute of Scientific Research for Cooperative Development] and the South Pacific Commission, have agreed to host the conference in Noumea. The conference is under the joint sponsorship of SOPAC and the IOC (Intergovernmental Oceanographic Commission), specifically its regional subsidiary body IOC/WESTPAC.

The two main subjects related to marine habitats are fisheries and biodiversity. It is well known that many fisheries around the world are declining.

Thus, studies aimed at understanding the importance of fishery habitats are important for management purposes, especially if harvest refugia can be established to help replenish certain living resources. Pacific Rim countries may need assistance in investigating their fishery habitats to develop sustainable resource use.

In addition, biodiversity is a subject of international concern. Because human activities have deleteriously affected both terrestrial and marine habitats, there is concern that the diversity of species occupying these habitats will decline, perhaps even leading to extinction of some species.

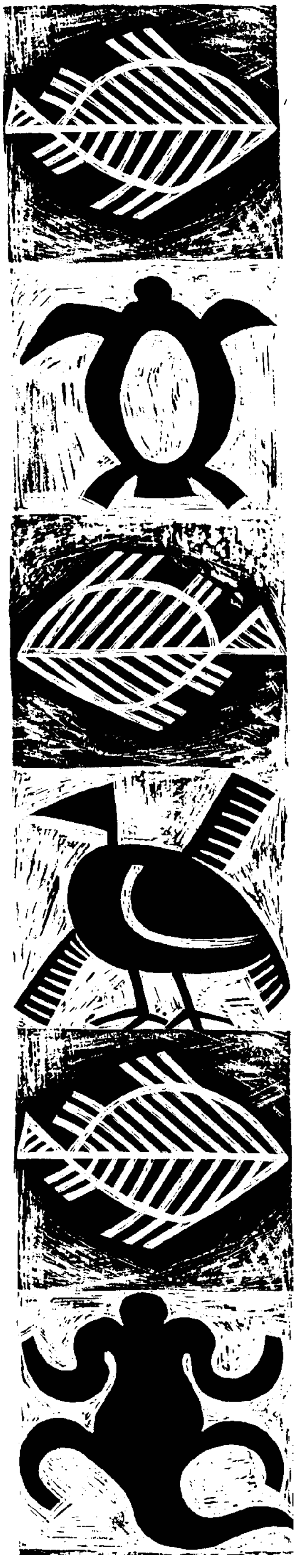
Much pioneering work on marine habitats and their role in hosting myriads of species, some of which support fisheries, has been done in the United States, the United Kingdom, France, Canada, Australia and New Zealand. However, such research has just begun in the South Pacific.

For example, since 1991, New Caledonia has been carrying out an EEZ (Exclusive Economic Zone) survey program, ZoNeCo, aimed at evaluating its potential marine resources using swath mapping surveys, physical oceanographic measurements and exploratory fishing.

The main objectives of the conference will be to:

1. inform participants of present-day methodologies to study marine habitats, fisheries and biodiversity;

2. interpret case histories relative to South Pacific interests, demonstrating how these techniques have been applied to marine habitats (bays, lagoons, coral reefs, shelf and slope environments, seamounts and ridges);



3. identify crucial habitats and resources;

4. propose a training component, especially for South Pacific nationals, on such techniques as ROVs (Remotely Operated Vehicles), submersibles, acoustic surveys, GIS (Geographic Information Systems), GPS (Global Positioning Systems), etc., with the idea of developing these further in future sessions; and

5. establish the parameters for habitat monitoring systems to assist in management and sustainability of resources, giving consideration to the implementation of the Global Ocean Observing System (GOOS) in the region.

Below is a list of the topics that will be covered in the Conference:

Focuses

1. Lagoons and bays;
2. Shallow reefs;
3. Deep reefs;
4. Shelf and slope;
5. Seamounts and ridges; and
6. Deep-sea trenches and canyons.

Technology and methodology to assess habitats and resources

1. Geophysical techniques (subbottom profiling, bathymetry, side scan sonar, etc.);

2. Direct observations (snorkelling, SCUBA (Self-Con-

tained Underwater Breathing Apparatus), DOVs (Diver Operated Vehicles), Manned submersibles, etc.);

3. Remote sensing (ROVs, satellite images such as the SPOT HRV, aerial photography, etc.);
4. Optical imaging;
5. Hydro-acoustics;
6. Destructive sampling (trawls, cores, dredges, etc.); and
7. Physical oceanographic and water quality measurement tools (currents, salinity, temperature, oxygen, nutrients, chlorophyll, etc.).

MANAGEMENT AND CONSERVATION OF HABITATS AND RESOURCES

1. Characterisation and quantification of habitats;
2. Life history studies of dominant, habitat-specific organisms;
3. Use of habitats by organisms (food, shelter, movements, etc.);
4. Sustainability of resources;
5. Effects of natural and anthropogenic impacts (extraction, noxious species, harmful algal blooms, sedimentation, erosion, predator outbreaks, etc.);
6. Harvest refugia; and
7. Social, political, and economic considerations.

INTERPRETATION AND ANALYTICAL TECHNIQUES

1. Geographical Information Systems (GIS);
2. Computer interfacing and analysis;
3. Mathematical modelling;
4. Visualisation techniques;
5. Environmental impact analyses; and
6. Global Ocean Observing System (GOOS).

For more details on this conference, please contact:

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AQUACULTURE WITHOUT CAGES OR NETS

In order to offset the depletion of inshore resources, the *Hydro-M Environnement* Company, with its headquarters in Toulouse (France), is proposing a scheme inspired by a Japanese model to culture fish without using cages.

The artificially-bred fish are released near man-made reefs formed from boat wrecks on which an ecosystem becomes established. In order to ensure that the fingerlings stay near their new home, they are conditioned for three months in the hatchery by means of the systematic transmission of a low- or medium-frequency sound signal at feeding time.

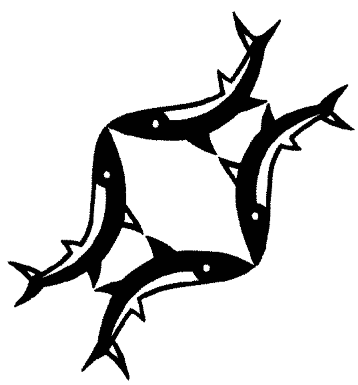
When they are released as adults and hear the signal again, they associate it with a reward and so stay near the sound source. All that needs to be done is to moor buoys emitting the same signal in the rearing area, and distribute a bit of food once a week in order to maintain the reflex.

In comparison to traditional aquaculture, all the costs related to cages, and most for feed, are eliminated. The flesh of fish raised in the open water is also higher in quality.

In order to assess the economic viability of this project, *Hydro-M Environnement* is preparing a test of this method using bass (*Dicentrarchus labrax*) for Autumn 1996 in collaboration with Thomson, the Spanish Oceanographic Institute and the Italian Naval Automation Institute.

However, the approval of local fishing agencies and the Maritime Affairs Agency still has to be obtained. The site selected is a 1600 sq. n.mi. bay south of Arcachon which opens onto the gulf of Gascony in the Atlantic Ocean—a natural passage for fish, which could become an area of high productivity.

(Source: *La Recherche* 287, May 1996)



NEW ZEALAND TO PUSH OUT LIMITS

New Zealand is getting set to dramatically increase its 200-mile Exclusive Economic Zone. It has started on a NZ$ 40 million seabed survey in the oceans surrounding the country in order to claim potential lucrative marine, oil and mineral resources well beyond the present EEZ.

The project, expected to take six years, began with an exploration in waters to the north and west of the country in 1996. Surveys should ultimately be used to increase New Zealand's jurisdiction to the outer limits of its continental shelf.

Outer limits of the zone could nudge—perhaps even overlap—Australian and Pacific Island nation boundaries.

(Source: *Fishing News International*)

SEAWEED EXPORTS ARE BECOMING IMPORTANT IN KIRIBATI

Seaweed cultivation is now Kiribati's fourth largest income earner after copra, sea cucumbers and ornamental fish. A report by New Zealand's Ministry of Foreign Affairs and Trade said that seaweed farming has been established on nine of Kiribati's outer islands.

New Zealand has invested nearly US$ 950,000 on the project and helped set up the Atoll Seaweed Company, which coordinates the buying and exporting.

This industry already has transformed the economy of some islands. On Tabuaeran (Fanning) Island, income from seaweed has displaced copra to become the single biggest earner, while it is close to rivalling copra on Kiritimati (Christmas) Island where there are now 137 registered seaweed producers.

Seaweed is used to manufacture carrageenan, which is used in food, cosmetics and pharmaceuticals. World demand for the variety produced in Kiribati is about 80,000 t. Production in 1995 was 705 t, a 78 per cent increase over 1994. It was expected that more than 1,000 t would be harvested in 1996.

Farmers receive 32 cents US per kg for dried seaweed, which is consolidated on Tarawa and shipped in containers to Denmark. The Kiribati government has a five-year contract with a Danish company for all the seaweed the country can produce. Exports earnings in 1994 were US$ 5.9 million.

The method of farming is to tie cuttings of fresh seaweed to culture ropes that lie off the seabed on a structure of ropes and posts. The ropes are harvested after five to seven weeks. Farm sizes vary, the largest ones managing more than 4,000 individual plants. New Zealand's funding for fiscal year 1996–1997 will go into a seaweed press, truck, scales, pallet lifter and for building warehouse.

(Source: *Pacific Magazine*)

FISHING AND FARMING COMBINE IN AUSTRALIA

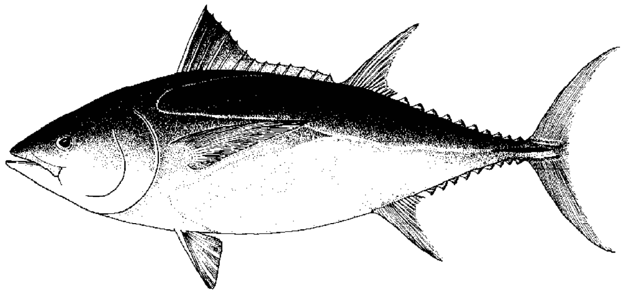
Australian boats are towing tuna for fattening worth around US$ 2.8 million when they pull back cages from the fishing grounds to ongrowing sites in Boston Bay, a few miles from Port Lincoln (see *SPC Fisheries Newsletter* #76)

Purse seiners of between 110 and 120 ft (33.5 and 36.5 m) operate with chum, feed and tow boats in the fishing-to-farming operation which can last from December to March each year.

Schools of Southern bluefin tuna are spotted from the air and pilots direct catchers to tuna of a suitable size for ongrowing. They do not target big or small fish. Purse seiners are mainly seeking Southern bluefin schools of only 30 to 50 t to maintain quality and, generally, two or three shots are made to stock each cage. A chum boat works to keep the fish near the surface so that the seine can be set easily. Catches are then transferred from the net into the cage via gates.

The purse seines of 700 to 800 m long by 80 fathoms deep (146 m) are not dried up after pursuing, but the cage is towed into position to meet the net which is left to drift. Pursers cannot use side thrusters during their operations as they could damage the cage netting.

Between two and four divers are sent down into the seine and tuna are guided out through a net gate and into the cage through a transfer gate without being touched.



Then the netting forming the gate in the purse seine is clipped back into position on rings and the cage gate is closed. Often tuna do not even break the surface while in the seine and the net-to-cage transfer operation can be completed in just 25 minutes. Cage-maker Graeme Johnson outlines 'that the important thing is to feed the tuna as soon as the gate is closed. Then they are a little more settled for the tow.'

Obviously, with such a valuable cargo, a careful watch has to be kept on both the condition of the tuna and the towing cage. Any weak tuna are spotted and harvested by divers who enter the cage daily as it is being hauled for home at between 1.5 to 2 knots—often through heavy seas. Divers also inspect the cage for damage during this often tedious towing time.

And towing lines are necessarily long so that the propeller wash does not disturb caged tuna. Tows can last 400 km and 14 days, according to the season and ground. Mortality when towing seems to be very low as tuna are 'tough' fish, although they need careful handling.

Originally, the industry at Port Lincoln used Japanese cages. Then experiments were made with cages made out of flexible medium density polyethylene piping with a compressed foam core. Cages are delivered to the operating area in kits and the pipes are welded together on site.

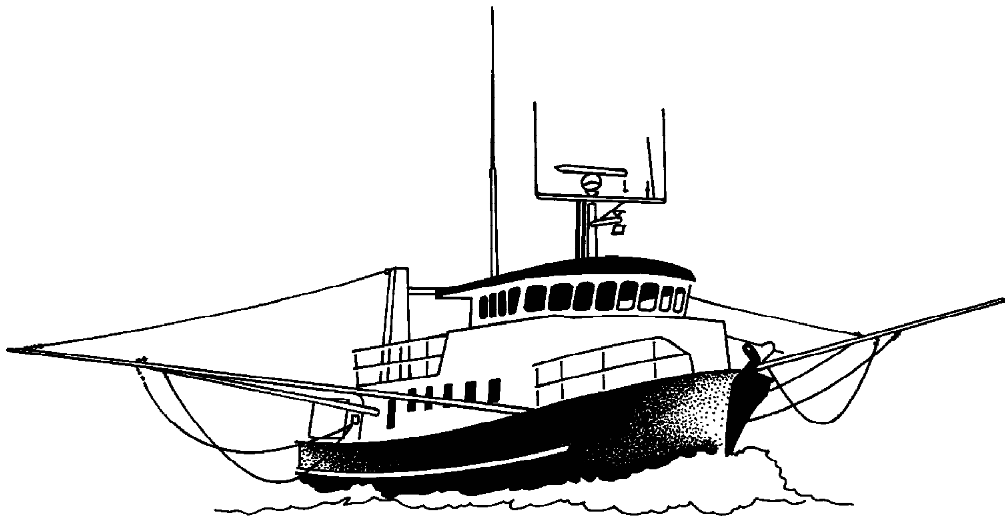
It takes several days to assemble the cage, a 160 m circumference model including towing equipment costing about US$ 140,000.

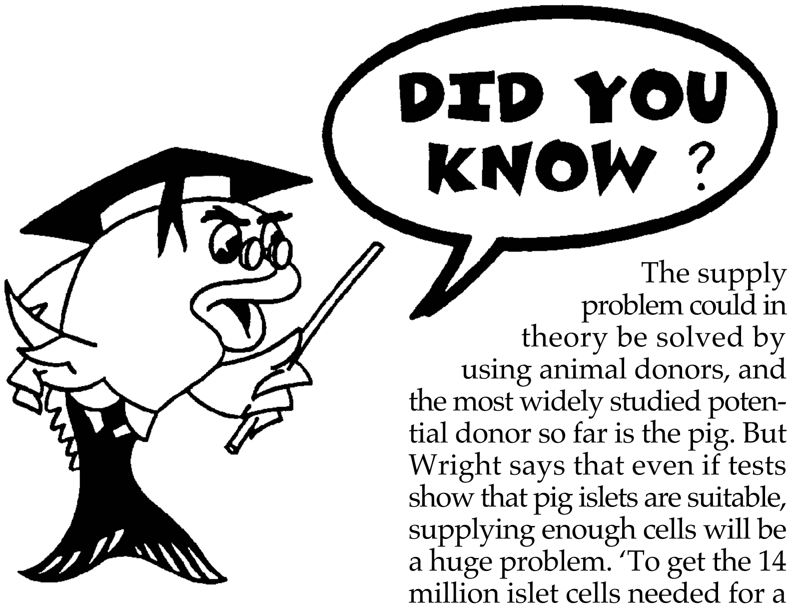
The early cages were hexagonal, but they are now a long hexagonal shape. According to Graeme Johnson 'they look like a boat and travel like a boat'. Flume tanks test were carried out to perfect the design and some 27 km of twine goes into the construction of the cage net just to hang the ropes.

Six-inch stretch mesh (15.2 cm) is used as 8-inch mesh (20.3 cm) damaged the faces of tuna which swam into the netting. The tow rope is eight-plait of 64 mm diameter specified to withstand the 7.5 t drag at 1.5 knots towing speed.

'We use all floating rope. We started with steel ropes, but they sank,' says Graeme Johnson. Vessels of between 600 and 800 hp are needed for towing as they are operating through six-metre seas with three-metre high waves on top. Often, they are prawn boats filling in between seasons.

(Source: *Fishing News International)*





Doctors farm fish for insulin

Fish guts may seem an unlikely source of organ transplants for humans, but Canadian scientists are trying to turn genetically engineered fish into donors for the cells in the pancreas that could cure childhood diabetes. If the approach is a success, the scaly organ donors could mean an end to daily injections for millions of children.

When a healthy person eats sugar, cells in the islets of Langerhans secrete the hormone insulin. Insulin allows tissue such as muscle to take up the sugar. But in the most serious form of diabetes, which begins in childhood, the islets are destroyed and patients survive on daily injections of insulin. But injections cannot mimic the finely tuned response of normal islets to blood sugar and fluctuating levels of sugar and insulin eventually damage diabetic's eyes, hearts, nerves and kidneys. It takes three human pancreas to supply enough islets for one transplant. There are fewer than 10,000 pancreas donors in North America each year, and 3 million diabetics.

The supply problem could in theory be solved by using animal donors, and the most widely studied potential donor so far is the pig. But Wright says that even if tests show that pig islets are suitable, supplying enough cells will be a huge problem. 'To get the 14 million islet cells needed for a human transplant, you need ten pigs. To treat 10 000 diabetics a year, you need a million pigs,' he says. The animals would have to be reared in sterile conditions, for two years. If each pig is given four square metres of space, that equates to 200 pig houses of 20 000 square metres, to treat just 10 000 people. 'The costs would be astronomical,' says Wright.

Enter the tilapia, a freshwater fish widely farmed in the tropics. Unlike pigs, fish can be raised cheaply at high density in small spaces. Tilapia could also solve some of the other major problems with the cross-species transplantation. The first of these is finding a way to stop the patient's immune system attacking the animal tissue without resorting to immunosuppressant drugs.

Scientists have previously transplanted rat and mouse islets between the two species without using drugs by encapsulating the islets in gel. Wright's team uses gels derived from seaweed, called alginates. Their pores let sugar and oxygen in and insulin out, but exclude the cells and large molecules of the immune system.

In theory, encapsulated islets could be given to young diabetics with little or no immunosuppression, says Wright, but blood vessels cannot grow into the capsules, and many transplanted cells suffocate.

Tilapia live in warm ponds with low levels of oxygen, so their cells need only one-fifth of the oxygen that human cells need. So they should survive encapsulation.

The other big bonus with tilapia is that the fish have two pancreases, one for digestive enzymes and the other solely for insulin. Because one pancreas is basically an agglomeration of islets, it is much easier to isolate the cells from other tissue. For human or pig islets the extraction process costs A$ 3000, which is 90 per cent of the cost of human transplants.

Wright's team has transplanted fish islets into mice and rats, where they successfully produced insulin in response to changing blood sugar levels. But there is still one big obstacle. Fish insulin works poorly because it differs from the human hormone by 17 amino acids. Pig insulin is only one amino acid different.

Wright's colleague Bill Pohajdak has cloned and modified the tilapia insulin gene to produce human insulin and the team is now injecting the gene into tilapia eggs. Wright says that previous experience with genetically modified fish suggests that with enough injecting and screening, some of the animals will express the human gene in sperm or eggs. The team then hopes to breed a stable line of fish that produce only human insulin.

(Source: *New Scientist*)

■ ICFMaP PUBLISHES REVIEW OF COASTAL FISHERIES IN THE SOUTH PACIFIC

A major review of coastal fisheries in the South Pacific region was published in October in *Oceanography and Marine Biology: an Annual Review* (Vol. 34, 395–531, 1996).

This article was initially prepared as a draft by Paul Dalzell and Tim Adams for the SPC–FFA Workshop on the Management of South Pacific Inshore Fisheries, convened in Noumea in June–July 1995.

The draft was revised with further input from Dr Nicholas Polunin of the Centre for Tropical Coastal Management Studies (CTCMS) of the University of Newcastle upon Tyne in England.

Like ICFMaP, the CTCMS has also been a recipient of funding from the British Overseas Development Administration, and Dr Polunin and co-workers have conducted extensive research on fisheries in the Pacific Islands and elsewhere in the tropics.

The review, entitled Coastal Fisheries of the Pacific Islands, covers most forms of fishing and harvesting activities in the coastal zone and is broadly divided by the following resource categories: reef fish, deep slope fish, large and small pelagics, estuarine fish, echinoderms, molluscs and crustaceans.

The authors describe the fishing methods employed for these different resources, present information on catch rates and catch composition, summarise research on the biology and stock assessment and the socio-economic aspects of each fishery.

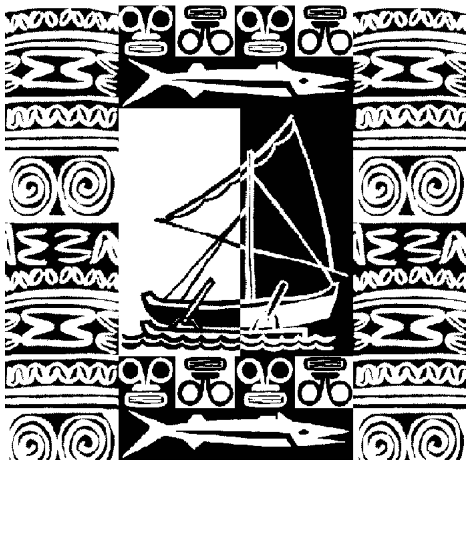
Following these descriptions and summaries estimates are given of the total fish and invertebrate harvest from the coastal zones of the Pacific Islands. The authors finish by pointing to directions for future research and suggesting how future social, economic and political events will have an impact on Pacific coastal zone fisheries.

This review complements Nearshore Marine Resources of the South Pacific, a volume of mainly biological profiles on the various coastal fisheries resources of the Pacific published in 1993 by the Forum Fisheries Agency. In this latest review, greater emphasis is given to the descriptions of the fisheries, rather than the biology of the target species.

However, the literature of Pacific Island stock assessment and fisheries biology is summarised in considerable detail. The article has allowed the authors to bring to the attention of the fisheries science community in the region and beyond the extensive volume of 'grey' literature on coastal fisheries in the South Pacific, as well as the more conventional published reports and scientific papers.

Reprints of this review will be distributed to fisheries administrations in all the SPC member countries.

(Source: Paul Dalzell, WPRFMC)



NOTES ON LONGLINE VESSEL PARAMETERS FOR PACIFIC ISLAND COUNTRIES

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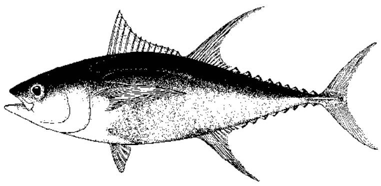
Longline fishing vessels come in a range of sizes, have different deck layouts, are made from either steel, aluminium, fibreglass or wood, and are equipped with a variety of machinery and fishing gear.

Choosing a suitable vessel, either new or second-hand, presents a plethora of problems to anyone interested in entering into commercial tuna longline fishing. Costly mistakes can be made when selecting a vessel. The wrong choice can mean failure just as the right choice can increase the chances for a successful venture.

Furthermore, the 'right' boat in one fishery may not be the most suitable boat in another area. Local sea conditions and resource availability, technical expertise of prospective crew members, and land-based infrastructure should also be considered as they all have a bearing on suitability of a vessel.

The whole idea of fishing is to make money. If the cost of a vessel is so great that no return can be made on the investment, then the 'best' boat may not be the most *suitable* boat.



VESSEL SIZE AND RANGE

Tuna longline trips (for chilled tuna) can last anywhere from one to three weeks. After three weeks the first caught fish will start to spoil and will be of little value.

However, for safety purposes a vessel should have the capability to steam for about four weeks without refuelling. Typically, a vessel has to steam for several days to get to the fishing grounds, fish for about ten sets, and then return to port.

Tuna are highly migratory, so during any one trip vessel movements of one or two days duration may have to be made to follow the fish, and even after each set smaller movements are usually made to adjust for currents and drift.

In areas where commercial longline fishing is just starting and the resource is very abundant, the above may not necessarily be true, but following the first few 'gold rush' seasons the resource will start to feel the pressure of fishing and vessels will have to range further and further from home ports to catch full loads. It may be all right to start out with a 'mini' longliner (15 m [50 ft], or less) but in the long run it would prove to be *unsuitable* as it could not adapt to a changing situation.

When considering vessel size and other parameters, both suitability and *versatility* need to be considered. A versatile vessel could adapt to other fisheries like albacore trolling in the southeast Pacific, and would have a higher resale value if it was adaptable to fish in areas where the EEZ is bigger and longline vessels need to have a longer range.

A vessel of 18 to 23 m (60 to 75 ft) length overall and of 50 to 80 gross registered tonnes (GRT) with a fuel capacity that would allow it to steam for four weeks without refuelling would probably be suitable in most situations and versatile enough to adapt to changes.

A suitable 20 m (66 ft) longline vessel would be equipped with a main engine of probably not more than 300 or 400 horsepower (220 to 300 kW) and a generator with an output of about 25 to 30 kW. A vessel so powered could probably be expected to burn about 900 litres (250 US gallons) of fuel per 24 hours of operation.

Therefore it would need to have a fuel capacity of at least 25,000 litres or 25 t* (7,000 US gallons). At 10 knots (maximum speed necessary for a longliner) this would give it an operating range of over 6,000 nautical miles (11,000 km).

These are only the very basic parameters, however, and there are several more things to consider. The next most important size parameter of a longline vessel is fish hold capacity (assuming beam and depth correspond to length, i.e., a 20 m [66 foot] vessel with a beam of about 5 m [16.5 feet] and a depth of about 2.5 m [8.25 feet]).

* Actually one tonne of fuel is not equal to one tonne of tank volume. Fuel is less dense than water so one tonne of fuel might have a volume of 1100 litres or so. The specific gravity of fuel depends upon its temperature so this number varies considerably. For this report, however, one tonne of fuel will be considered to occupy approximately one tonne of tank volume.

If a vessel is capable of making at least ten sets of 1,500 hooks during a trip it would expect, on average, to catch about 7.5 t of all species of fish (target species and by-catch). This is based on a rough Pacific average CPUE of 0.5 kg/hook (50 kg/100 hooks) for tuna longline vessels.

Obviously, fewer fish will be caught on some trips and during some times of the year, and more fish will be caught during other trips, particularly during the peak fishing seasons. As much as 15 t of fish could be caught on ten sets during one trip.

Therefore, for a longline vessel to be both suitable and versatile it should be capable of carrying up to 15 t of chilled tuna and by-catch. The actual size of the fish hold(s) depends largely on the type of chilling system used. Refrigerated sea water (RSW) systems and slurry systems need about 2 t (1 t = 1 m^3) of hold space to chill one tonne of fish while 'ice' boats need anywhere from 3 to 5 t of fish hold space to chill one tonne of fish (depending on the configuration of the fish hold).

Hold space is also needed to store ample bait for ten sets—about 1.5 to 2 t. If live bait is used then holds need to be adaptable to holding circulating sea water.

Other less obvious but equally important parameters include fresh water holding capacity and crew complement. A vessel that stays at sea for up to four weeks should be able to hold sufficient fresh water for four weeks with a reserve.

A typical crew complement for a tuna longliner would be in the range of four to eight people, including captain (in some operations the captain serves as engineer and fish master). Each man on a fishing vessel would be expected to consume about 25 litres (6.5 US gallons) of fresh water per day. For a crew of six (average) this would add up to over 4000 litres, or 4 t (1200 US gallons) for a four-week time period (three weeks plus one week's reserve).

The trend throughout the region is for longline vessels to be required to take along a scientific or compliance observer on certain trips. Ample berthing and fresh water capacity needs to be considered for such contingencies. A suitable and versatile long-line vessel should have a crew complement of six to eight persons and should have a freshwater capacity of at least 700 litres (200 US gallons) per person. In lieu of a 4 t fresh water tank, a vessel could be outfitted with a desalinator capable of producing sufficient volumes of fresh water.

HULL MATERIAL

Although there are a few good wooden boats in service in the longline fishery, most vessels are either steel, fibreglass, or aluminium. Each of these three materials has its advantages and disadvantages, and the choice is largely a matter of preference. However, a case can be stated for each.

Steel vessels are probably the most versatile as they are relatively easy to fabricate and repair. Steel is also very forgiving to captains who make navigation errors and miss the pass through the reef. Steel is malleable and tends to dent or bend rather than crack or break as a result of collisions. At sea repairs and gear adjustments can be done if a welding machine and oxyacetylene set are part of the boat's tools and machinery. Most shipyards are set up to work with steel and steel is relatively inexpensive and available almost everywhere. On the other hand, steel rusts and steel boats need constant upkeep to prevent them from rusting away.

Fibreglass vessels come as fibre-glassed plywood, fibreglass reinforced plastic (FRP, GRP), or fibreglassed foam (composites, foam sandwich, etc.) or a combination of these materials. The main advantage to fibreglass is that it is relatively maintenance free. There is no chipping and painting, no rust, no corrosion.

Fibreglass is also fairly easy to work with and small repairs and modifications can be done easily with materials that are available in most places (resin, catalyst, and glass cloth or mat).

Fibreglass is also compatible with almost any other material—steel, aluminium, brass, wood, silicon, rubber, etc.). The main disadvantages to fibreglass are that it is flammable, that it cracks, and that it can have a tendency to absorb water (osmosis). Osmosis occurs particularly when poor workmanship is involved in laying up the fibreglass or when foam-fibreglass composites are made without using pressure.

Under these conditions fibreglass and composites (fibreglass and foam) can become porous. Water soaks through the fibreglass and into the foam. Aside from that, if a fibreglass vessel collides with another vessel or with the reef, major hull damage can occur—the hull can be holed quite easily compared to steel.

The worst case, however, would be a fire on a fibreglass vessel.

Once resin and foam (in the presence of fuel oil, hydraulic oil and motor oil) are ignited it is very difficult to put out the flames. Burning resin and polyurethane foam (as in foam sandwich vessels) give off toxic fumes that can be lethal. Steel and aluminium, on the other hand, do not burn, although there can be fires on board steel or aluminium vessels.

Aluminium has two main advantages as a hull material. One, it is light weight and thus an aluminium vessel is more fuel efficient than a similar sized steel vessel. Two, aluminium, like fibreglass, is relatively maintenance free.

Aluminium, although it corrodes under certain conditions, does not rust. There is no chipping or painting to be done, and often aluminium vessels are not painted at all above the water line. An annual wash down with phosphoric acid is all that is usually needed.

There are two main disadvantages to aluminium vessels, however. One, marine grade aluminium, unlike steel, is not very malleable and tends to crack under extreme stress, as during an encounter with the reef or another vessel. Two, aluminium is difficult to work with and expensive as compared to steel.

A special welding machine is needed, along with a highly-trained welder, to work with aluminium. Most small shipyards and slipways do not work with aluminium so major repairs or modifications could be very costly.

Aluminium plate is also not available in most places. Furthermore, aluminium does not get along very well with other metals. If stainless steel fittings are used on an aluminium vessel, for instance, care must be taken to isolate the two metals from each other with rubber or silicon. If they are not isolated and in the presence of sea water, electrolysis will take place and the aluminium will corrode away and be reduced to a white powder.

Lastly, aluminium is a very good conductor of heat which means that heat can be easily transferred from machinery to crew's quarters or the fish hold. In the tropics, aluminium decks can get quite hot. This not only causes discomfort to the crew but can affect quality of fish landed on the deck.

All in all, steel is probably the preferred material for a longline vessel unless the vessel will be operating in a very remote locality with a crew that may not keep up on regular hull maintenance. In that case, fibreglass, because of its ease of maintenance, would be the preferred hull material. It may be wise on fibreglass vessels to have more than the necessary minimum number of fire fighting devices.

Hull configuration

The best hull for longline fishing is a deep displacement type hull with a single (hard) chine. Planing or semi-planing hulls or hulls with round or multiple chines should be avoided. These type of vessels are more suited to coastal (near shore) fisheries, such as the Australian west coast cray fishery. It is also good to have a skeg with a foot plate and pintle bearing for the rudder rather than shaft struts and a free-standing rudder.

A smooth, uninterrupted line from stem to rudder is the ideal as there should be few places for the mainline to get caught on during hauling of the longline. Keel coolers and transducers should be on the port side if possible and all zinc anodes should be mounted so that they will not snag the mainline. Bilge keels (roller chocks) should be avoided.

The other main consideration is where to put the wheelhouse. Most Asian longline vessels have stern houses. There are several advantages to having a stern house. One, the vessel operator has a clear view of all deck operations, including machinery, during hauling. He can clearly see the mainline coming up, and he can monitor all crew activities as well, including fish handling and chilling procedures.

Two, all fish holds are forward of the engine room and shaft tunnel on a stern-house vessel. This allows more room for hold space and also reduces the transfer of heat from machinery to fish hold. It is easier to make the fish hold water tight if there is no shaft tunnel running through it. Another advantage to having the machinery behind the holds is that access to the shaft packing gland (stuffing box) is usually via the engine room, where it can be easily viewed and repaired as necessary. On a forward-house vessel it is often very difficult to gain access to the packing gland (to tighten the gland or add packing) while at sea fishing.

The shaft tunnel on a forward-house vessel is usually under the main fish hold and the packing gland may be buried under layers of fish and ice, which would make monitoring and repairing difficult. This could be critical during an emergency.

Lastly, a short tail shaft as on a stern-house vessel is less expensive than a long shaft as on a forward-house vessel. Often, on forward-house vessels, two shafts are necessary: an intermediate shaft that runs from the gear box coupling to just forward of the packing gland; and a tail shaft that exits to the propeller. Additional bearings (*Babbit* bearings) are usually fitted along the way to support this extra weight. A long shaft would add considerable cost to a vessel as compared to a short shaft.

There are many forward wheelhouse vessels in longline fisheries in the Pacific, however. Most of these started out as something else, like shrimp draggers (prawn trawlers) or net boats, in which case a forward house might be advantageous.

The main advantage for a forward house to longline fishing is that the crew is out of the weather. Forward-house vessels are also probably better during setting operations, as the line can run unobstructed from reel or baskets to the stern, where baiting takes place.

Many operators of forward-house longline vessels have added an outside station on the back deck, usually on the after-bulkhead of the house, where the operator can both drive the vessel and control the hauling of the mainline and the removal of branchlines simultaneously. (Hauling is usually done from the starboard side so that the vessel operator can have a clear view of the so called 'danger zone' which is the area around his vessel from dead ahead to 11 1/4 degrees aft of the beam on the starboard side, or nine points off the starboard bow. International Rules prohibit one vessel from crossing the port bow of another vessel).

FISH HOLD(S) AND CHILLING SYSTEM

There are several options for fish-hold configuration and chilling systems. Fresh-chilled sashimi-grade tuna can be produced by icing the fish in layers of crushed or flake (or shell) ice, by immersing the fish in a slurry made up of crushed ice and sea water, or by immersing the fish in refrigerated sea water (RSW) or a mix of sea water and fresh water.

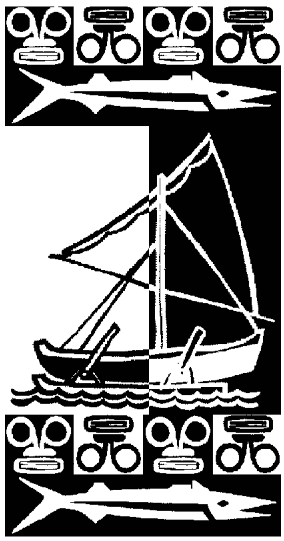
The common goal of all these systems is to reduce the body temperature of the fish to 0°C (32°F) and to keep the fish at or near this temperature for the duration of the fishing trip.

Each system has its advantages and disadvantages and the choice of system has a direct bearing on the type of fish hold(s) a vessel would have and the type of refrigeration machinery necessary to support the function of the fish hold(s). The availability of land-based infrastructure and market demands also play a role in choice of chilling systems.

Icing fish has several advantages over RSW and slurry systems. One, the product is usually better than fish that have been chilled in a liquid system. Properly-iced fish do not come into contact with other fish or with the structure of the fish hold. There is little skin damage to iced fish as compared to fish chilled in a liquid.

Damage can occur, however, if ice is not broken up into very fine pieces or if the starting layer of ice is not of sufficient depth. Iced fish will also keep longer than fish stored in a liquid system. Iced fish (tuna) can be kept as long as three weeks and still be marketable as export-grade fish. RSW or slurry fish start to bleach out (soak-up water) after one to two weeks.

Furthermore, iced fish require only one large fish hold that is usually divided into separate bins with removable boards. RSW and slurry systems require that the vessel have several fish holds up to a maximum size of about 2 t each. If the holds are too large the fish will move around, especially in rough weather, and become damaged.



Ice boats, if there is sufficient ice available from a shore facility, do not need an on-board refrigeration system. This is also true of slurry systems but not true of RSW systems. Ice boats or slurry boats could have an on-board flake ice machine or the holds could be refrigerated as a supplement to the ice in the holds, but this is not always necessary. RSW boats, by contrast, are wholly dependent on on-board machinery (generator and refrigeration system).

The main advantage that RSW and slurry systems have over icing is that they are less labour intensive. Digging graves in the ice is hard work and requires a certain degree of skill and usually has to be done twice for each day's catch—once for pre-chilling in a slaughter bin and again the following day in one of the main bins in the fish hold. RSW and slurry fish are merely dropped into the tank after cleaning (bleeding, gilling and gutting, bagging). Some vessels use a combination of slurry for pre-chilling and ice for storing fish.

However, this requires that the vessel have at least two tanks, or holds. Multiple tank systems have the advantage, however, that since there are several tanks on the vessel as opposed to one main fish hold, at least one of these tanks can be used for live bait storage; or in the case of RSW boats, supplementary fresh water or fuel supply.

One disadvantage to RSW systems is that temperature variations are more likely to occur than with ice or slurry systems. Another disadvantage to both RSW and slurry systems is that fish must be bagged in either plastic body bags or mutton cloth (gauze) tubes to prevent skin damage. This adds to the operating expenses.

Notwithstanding the preferences of the captain, fish master, crew, and fish buyers, the selection of a chilling system is mostly dependent on available infrastructure. If there is sufficient shore-side ice available, then icing would probably be the best choice.

Second to this would be a slurry system. Neither of these systems depend on on-board machinery (except for pumps to remove melt water). If there is no shore-side ice available, or if it is too expensive or the supply is unreliable, then some sort of on-board refrigeration system would be necessary. This could be an on-board flake ice machine for icing or for a slurry system, or an RSW system.

The main disadvantages to having on-board refrigeration systems are that initial capital costs are higher and product quality is wholly dependent on keeping on-board machinery operational. Consider the following scenario:

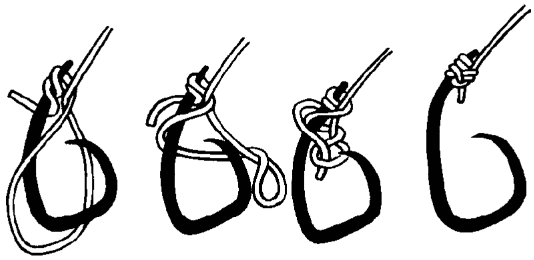
> *A company has a choice of five ice boats supported by a shore-side, five tonne/day flake-ice machine or five RSW boats and no shore-side ice facility. Which should they choose? The ice boats would require that only one piece of refrigeration machinery be looked after as opposed to five pieces of machinery. Furthermore, the ice machine would be on land where it could be monitored 24 hours a day by one qualified technician. The choice of RSW boats would require that the company have five qualified technicians and each of the very expensive machines would be subjected to a harsh environment far away from parts stores and support infrastructure.*

Capital expenditure for five ice boats would be substantially less than for five RSW boats—only one fish hold as opposed to several on each vessel, and no refrigeration system needed. However, ice boats with no refrigeration system are wholly dependent on a reliable and affordable shore-side ice supply.

With every system of chilling fish it is important to have well-insulated fish holds. Fish holds should have at least 5 inches (13 cm) of polyurethane foam insulation. This may have to be thicker on a bulkhead shared with the engine room or a machinery space. Hatches should also be well-insulated and on some vessels additional *plugs* are necessary (insulated hatch cover that fits underneath the deck hatch).

Machinery

If a longline vessel is going to be equipped with some sort of **refrigeration system** there are several options to choose from. Ice machines can make either sea water ice, fresh water ice, or both. If a fresh water ice machine is selected (fresh water ice is better as it doesn't freeze the fish) then the vessel would probably also need a water maker,



or desalinator. It takes a tonne of water to make a tonne of ice. A one tonne per day ice machine would soon use up all of the ship's supply of fresh water if the vessel did not have a desalinator. Flake ice machines usually use R-22 refrigerant (Freon).

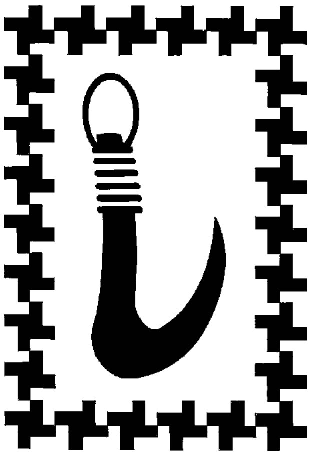
Sea water in RSW systems can be cooled by chillers with the evaporators in a remote chiller tank away from the fish holds or it can be cooled by having the evaporators installed in the fish holds either as coils or as plates. Temperature is controlled by thermostatic expansion valves.

Most RSW vessels use R-22 refrigerant (R-12 refrigerant is being phased out world-wide to be replaced by A-134) and R-502 is very expensive. R-717, ammonia, is usually only used on freezer vessels). The compressor for either an ice machine or an RSW system can be run from an electric motor, a belt drive from the main engine, or a hydraulic motor.

The most important piece of machinery on a fishing vessel, however, is the **main engine**. There are a multitude of brands, configurations, horsepower, and types to choose from. The most important considerations are initial cost, fuel efficiency, dependability, and availability of parts and service.

It is not necessary to have two main engines on a longliner, nor is it necessary to have an engine rated at over 400 horsepower (A general formula to use is three horsepower for every tonne of displacement—one horsepower equals approximately 0.75 Kw).

High-powered vessels capable of speeds in excess of 20 knots are more suited to coastal fisheries where trip duration is relatively short, i.e., one-to-three days. Generally speaking, four stroke six cylinder in-line naturally or turbo-aspirated diesel engines are preferable to eight or twelve cylinder supercharged V8 or V12 engines; popular name brand engines and gear boxes with local distributors or agents are more suitable than exotic brands; dry exhaust systems are more suitable than wet exhaust systems; electric starters are more trouble-free than air or hydraulic starters; and simple, unsophisticated engine setups are preferable to 'high tech' systems with lots of 'bells and whistles'.



Engine start and stop buttons should be on the engine, or at least in the engine room, and not in the wheelhouse or on the flybridge. This necessitates at least two trips into the engine room daily and hopefully would mean that sump oil levels, engine coolant levels, gear box oil, and bilge water levels would be checked.

Cable controls (e.g. **Morse Cables**), for engine throttle and marine gear shifting are preferable to electronic or hydraulic controls as they are easier to maintain or replace. Good engine choices would be **Caterpillar** (USA), **Gardner** (UK), **Yanmar** (Japan) or **Baudouin** (France). **Twin Disc** is probably the most popular marine gear box.

However, there are many other good brands of marine diesel engines and marine gear boxes. One important consideration is availability of parts and service. Before an engine and gear box are selected it would be good to try to identify sources for spares like fuel and oil filters, injectors, starter motors and alternators, and rebuild kits for pumps and cylinder heads. If these basic items cannot be accessed then it may be best to find a more suitable engine for which parts and service are readily available.

One very important piece of machinery, especially in the tropics, is an engine room **exhaust fan**. Ambient engine room temperatures can become quite hot during hauling of the longline gear when the main engine may be operating at peak RPM and the hydraulic pump operating at peak output.

Exhaust fans should be mounted somewhere near the exhaust stack so that hot air is expelled while cool air is being drawn in from a vent somewhere in the forward end of the engine room. An on-off switch for the exhaust fan should be mounted in the wheelhouse so the fan can be switched off in case of fire.

Propellers should be fixed pitch, not variable pitched—and nozzles are not necessary. Shaft packing glands should be the simple, water-cooled-type using Teflon or graphite-type packing and not oil-filled, although grease fittings on shaft glands are probably a good idea.

Another important piece of machinery on a longline vessel is the **hydraulic system**. The most suitable hydraulic system is one that is the most depend-able. Care should be taken so that the output of the hydraulic pump matches the minimum ratings of the hydraulic motors on the reel and line setter (indicated by **pressure**—in pounds per square inch, *PSI*; *Bars*, atmospheres; or *Kilopascals*, 0.01 atmosphere; and **capacity** in *GPM*—gallons per minute or litres per minute).

A typical hydraulic system for operating a longline reel might be rated at 1500 PSI and 10 GPM. A hydraulic pump that runs from a power take off (*PTO*) on the main engine is probably the best choice. Electrically-powered hydraulic systems are fine until there are problems with the generator set. Consider the following scenario:

> A *vessel has all of its gear in the water and then experiences a generator breakdown. If the main engine is still operational then the vessel would be capable of returning to port, even if the fishing trip had to be cut short. If the vessel has a hydraulic system that runs off of the main engine then there would be no trouble in recovering the gear. However, if the hydraulic system is electrically powered, the entire set of fishing gear could be lost as the vessel would not be capable of hauling the fishing gear.*

Ideally, a vessel would have a backup system to cover such situations. Additionally, a hydraulic system that operates a longline system should have some sort of built in heat exchanger, either sea-water or keel cooled. Hydraulic line haulers and reels work under a fairly heavy load for eight to twelve hours during hauling. Hydraulic fluid can become quite hot and if it is not cooled, damage can occur to motor and pump seals in the system.

Wheelhouse electronics

The following electronic appliances are either basic necessities for longline fishing, or are highly recommended. Although it is possible to operate without all of them, each has a function that makes navigation safer or fishing more productive or both:

Global Positioning System (GPS) receiver: Gives exact position in latitude and longitude at intervals of every second—accurate to within about 30 m. A GPS navigator is essential for both longline fishing and general navigation.

Colour plotter: this can be separate from the GPS or can have a built-in GPS receiver. A plotter gives more detailed information about the longline set. The plotter actually draws a picture (plot) of how the line was set and how it was hauled.

A comparison of the two gives the captain important information about set and drift (current direction and speed) and the presence of eddies or convergences. Events like fish catches can be entered on the plotter easily by pushing the 'event' button. Geographical features like reefs can also be entered onto the plotter.

Radar: essential for navigation, especially in areas where there are abundant reefs or where there may be other vessels. If fishing is done within radar range of shore, radar can be used to plot positions of longline set. A thirty-six mile range radar should be sufficient for a longline vessel.

Autopilot: autopilot is not essential but it is highly recommended as during setting it relieves one man from steering the vessel. Often this man is needed on deck to help with the set or to bury fish. An autopilot also gives a much straighter set than hand-steering would. Some autopilots can also be used during hauling.

Single side band (SSB), or high frequency (HF) radio: an HF radio is essential for communication both for general navigation (ship-to-ship and ship-to-shore) and for fishing. Longline vessels can share catch and fish location information with each other, and can relay catch data and ETA (estimated time of arrival) to agent or manager on shore. With an export fishery depending on air links to Japan and other international markets, good communications are critical.

VHF radio: short-range radio communication is essential for communications with harbour authorities, agents, and with other vessels in crossing situations to avoid collisions.

Colour sounder: a sounder is important for navigation, especially in strange waters when entering harbours or going through passes in outer reefs. Another function of a sounder that is important in longline fishing is its ability to 'find' fish. In fact, sounders are often called 'fish finders'. This is not so important for locating schools of tuna but for locating bait that tuna may be feeding on. Some sounders have the capability of reading the depth of the thermocline, thought to be an optimum place for deeper-water tunas (bigeye). Some sounders are equipped with sea-surface temperature sensors and are able to display this information graphically on a time line.

Sea surface temperature (SST) monitor: SST data is important information for longline fishing, both for tunas and for broadbill swordfish. Fish are often found on either side of a 'temperature break' or an area where temperature drops or rises rapidly in a short distance. Temperature breaks are thought to accumulate bait as bait schools move from cooler water into warmer water or vice-versa. These accumulations of bait attract schools of larger fish like tuna or broadbill.

Radio direction finder (RDF) and radio buoys: this is not an essential item as longliners operated throughout the world for years using only lights and coloured flags on bamboo poles to locate their lines.

However, using radio buoys and RDFs makes life a lot easier for the fisherman as he gets to rest between setting and hauling. Radio buoys are also useful when the mainline parts during hauling. If a buoy cannot be located after a break in the line then the vessel can always steam to the next radio buoy.

Usually several radio buoys are attached to the mainline, at intervals and at either end. RDFs can also be useful as navigation aids. A Taiyo Model TD-L1100 (the most popular model RDF) is capable of tuning to land-based airport beacon transmitters and to AM radio stations. This information could tell the captain which way to go to return to port in the event all other systems failed. More sophisticated RDFs allow for eavesdropping on other vessel's positions, thus gaining information about location of other fishing vessels and hopefully fish schools.

Weather fax receiver: weather information is faxed worldwide on a number of frequencies. The information comes as a weather map and is much more detailed than reports given on HF radio or Inmarsat-C systems. Also available on some frequencies are remote-sensing data like sea-surface temperature maps. A weather fax is an essential item on any longline vessel operating in the cyclone belt.

Inmarsat-C: satellite communication between vessels and also ship-to-shore is possible in a fax mode with Inmarsat-C (Inmarsat-A has voice communication capabilities but is too expensive for longline operations). In Hawaii Inmarsat-C systems are mandatory on all longline vessels as GPS position data of each vessel in the fleet is monitored to insure compliance with fisheries regulations.

As an aside, the fleet has been able to use the Inmarsat-C system to greatly improve communications with the added benefit that all communications are secure. No one can eavesdrop on a fax transmission so two boats can share confidential fishing information with each other.

Bathythermograph: a bathythermograph is an instrument that enables the vessel's crew to measure the depth of the thermocline. The thermocline is that place in the water column where sea water temperature changes abruptly and is generally thought to be an optimal depth for targeting bigeye tunas. There are available on the market, portable-disposable bathythermographs that are affordable as well. A bathythermograph is probably an optional instrument.

PC or personal computer: computers are becoming more and more desirable on fishing vessels. A PC is necessary for Inmarsat-C two-way communications using software like **Galaxy**; and software is available with charts for course plotting, for monitoring weather, and for getting real-time satellite oceanographic data like sea-surface temperatures.

Furuno (Japan) is probably the most popular maker of marine electronics for longline fishing vessels. However, there are several other good brands to choose from including: **Raytheon** (USA), **JRC** (Japan Radio Corporation), **Koden** (Japan), **SEA** (Stephens Engineering Systems, USA), **Icom** (Japan), **Taiyo** (Japan) to name but a few.

Fishing gear

There are two main types of longline gear—traditional, or **basket gear**, and compact, or **monofilament gear**—with many combinations and variations in between. Basket gear refers to the original gear as developed by Japanese fishermen decades ago. It derives its name from the fact that the mainline (tarred *Kuralon* or polyvinyl alcohol, and/or tarred *Tetron* or polyester) was stored in baskets.

Typically traditional gear is hauled by a hydraulically, electrically, or mechanically (shaft driven) line hauler and the branchlines are coiled by hand. The sections of mainline are either coiled into some type of basket or tub or are tied up into a bundle, and then stowed in a cage or in bins.

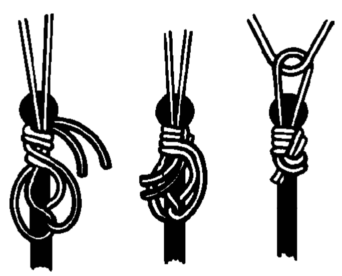
Branchlines are usually left connected to the mainline and are placed on top of each successive coil of mainline. Branchlines are made from tarred *Kuralon*, a sekiyama or middle wire, a leaded swivel, and a galvanised trace, or leader, with hook. Refinements to this system include the use of electric coilers for coiling branchlines and hydraulic line coilers (line arranger) for arranging the mainline in a large bin. This type of system is referred to as an 'automatic' system and is very popular especially with the Okinawan fleet. Branchlines are usually separated from the mainline on automatic gear, then coiled and stowed in separate baskets.

The line is usually set with a line setter, or shooter. This gives the crew better control over depth of the mainline. With traditional basket gear the mainline is hand thrown over the stern as the vessel steams ahead. Depth of set in this case is variable. The most popular manufacturer of traditional basket gear fishing machinery is **Izui Iron Works** (Japan).

Both traditional basket gear and more modern automatic basket gear are excellent fishing systems. However, both basket gear systems have two definite disadvantages:

- One, the systems are very expensive. New automatic basket gear systems cost, on average, about 25 per cent more than what a monofilament reel fishing system would cost with equal setting capabilities.

- Two, the systems are very labour intensive and require a higher degree of skill than is required for monofilament systems. Hand-coiling branchlines, or even coiling with an automatic coiler and stowing in baskets, is much more difficult than coiling branchlines into a tub as is done with monofilament systems. Making up the gear is also much more time consuming than making up monofilament gear. Typically it takes a crewman several seasons before he is proficient with basket gear, while monofilament gear can be mastered after only a few trips.



Some vessels, particularly Taiwanese, use a combination of the two systems—monofilament mainline is hauled using a basket-gear-type hauler. Usually on these systems branchlines are still coiled by hand or with automatic coilers. Mainline is usually stored in large plastic or bamboo baskets.

Another system that is somewhere in between basket gear and monofilament reel gear is the Japanese **Magu-reel** made by Izui Iron Works. The Magu-reel is a cassette-type monofilament system. That is, the mainline is stored on not one, but several small reels, or cassettes.

The line is hauled with a hydraulic line hauler much the same as is used with basket gear. There is a separate hydraulic machine called a line winder that spools the mainline onto the reels after it has been pulled aboard by the hauler. The branchlines are removed from the mainline and are coiled either by hand or with an electric branchline coiler. Magu-reel systems use line setters and fish very well.

However, they are much more expensive than single reel monofilament systems. The only advantage is that the Magu-reel hauler takes up little room on deck. However, the reels (usually about 10 or 12) need to be stowed somewhere and moved forward and aft on a daily basis. Both the Magu-reel systems and the automatic basket gear systems require three pieces of hydraulic machinery and one or two electric branchline coilers, while basket gear requires only one piece of hydraulic machinery and monofilament reel systems require only one or two. Branchline coilers can be used with monofilament reel systems but they are not a necessary piece of equipment.

Probably the most popular system in established and newly-developing Pacific Island longline fisheries is the compact, or monofilament longline system that uses one large reel to store and haul the monofilament mainline.

The system was developed on the east coast of USA about 15 years ago (**Lindgren-Pitman**) but now there are systems being made in Australia, Europe, and Fiji (**Leahy Engineering** in Australia, **Bopp** in France and **Seamech** in Fiji). The system is composed of a large hydraulically-operated reel made of steel or aluminium that can contain as much as 68 nautical miles (125 km) of nylon monofilament—depending on the diameter of the line and the size of the reel. Lindgren-Pitman has recently come out with a two-reel system that is capable of holding over 100 nautical miles (185 km) of line.

The line is set from the stern of the vessel, usually with the aid of a line setter (shooter) although it can be set without a shooter. If the line is set without a shooter—this is called 'towing' the line—then the length of mainline set is equal to the distance that the vessel travels and the baited branchlines do not reach into very deep water.

With a shooter the depth of the set can be increased, as the length of mainline paid out is greater than the distance travelled by the vessel. Depths of 100 fathoms (200 m) or more can be reached. This is important when deep-swimming tunas (bigeye) are being targeted. As the line is paid out over the stern during setting, baited branchlines are attached at intervals usually controlled by an audible signal from a setting timer.

The number of branchlines set between floats is called a 'basket' and can vary from 5 or 6 to as many as 30 or 40. Length of floatlines can vary from 5 fathoms (10 m) to as much as 30 fathoms (60 m). A typical or average tuna longline set would have floatlines of 15 fathoms (30 m) and 20 branchlines of 5 to 6 fathoms (10 to 12 m) in each basket. Radio buoys would be attached at either end and at intervals in between.

The monofilament nylon (polyamide) mainline can range from 3.0 mm to 4.5 mm in diameter. The branchlines (snoods, gangions) can be made from 1.8 mm to 2.1 mm diameter monofilament, 3.0 mm tarred Kuralon, 3.0 mm tarred red polyester, or a combination.

Branchlines can also have swivels (barrel, bullet, or leaded) and wire traces. Hooks can be Japan tuna hooks with or without rings, big-game hooks, or circle (rotating) hooks. Connections are usually made with crimps or swages, but sometimes knots are used. Connected ends are protected from chafing with aimata, thimbles, green springs, or plastic tubes.

The line is hauled usually from the starboard side of the vessel and stored directly back onto the reel. Branchlines are removed as the line is moving and coiled into branchline bins or tubs. Floatlines are also detached and floats and floatlines are stowed somewhere on deck.

Monofilament reel systems have three main advantages over other longline systems:

- One, the initial cost is substantially less than for Japanese basket gear systems. A complete tuna longline system with a monofilament reel for a medium-sized vessel (16 to 18 m) would cost about US$ 60,000, while an automatic basket gear or Magu-reel system would be about 25 per cent more.
- Two, monofilament reel systems are simpler than other systems. It is easier for an operator and crew to learn how to master a monofilament system and it is easier for the captain or engineer to maintain as well. Making up the gear for a monofilament system is relatively simple and can be learned in a short time.
- Three, fishing effort can be increased, at least as compared with most other systems, when monofilament systems are used.

Arguably, the automatic basket gear systems, as used by most Okinawan vessels, are as efficient as monofilament systems, but monofilament systems are markedly more efficient than traditional basket gear or Taiwanese basket gear systems. Cost, simplicity, and efficiency make monofilament reel systems the best choice for Pacific Island longline fisheries.

Vessel costs

The main idea of commercial tuna longline fishing is to make money. If a good return cannot be made from the initial investment then fishing efforts are probably a waste of time and resources (fish and money). Money in the bank, with adjustments for inflation, can probably be expected to earn at least 5 per cent annually. If a fishing venture does not give investors a return of at least 5 per cent in the long run then it is probably not worth the effort. In order to optimise the chances of getting a good return several things need to be considered: there are probably ceilings on vessel effort, catch, and market performance; expenses—variable, fixed, and marketing—are probably going to be greater than expected; and Murphy's law was written by a fisherman: 'If something can go wrong, it will go wrong'. One other thing: financial projections, especially in the longline fishing industry, are fiction. Proposed profit-loss scenarios rarely correspond even remotely to reality after the fact. The following oversimplified financial scenario is offered as an example of what might be expected:

A medium-sized longline vessel with gear cost US$ 500,000. It makes 1.5 trips per month of 10 sets each setting 1,500 hooks each day of fishing. An average of 5 t of fish are caught each trip (90 t annually). The market value of this catch averages US$ 10,000/t. Annual gross receipts are, therefore, US$ 900,000. Marketing expenses in an export fishery are about 50 per cent of gross receipts so there is a net back to the company of US$ 450,000. Variable costs, or operating expenses (expenses shared by the boat and the crew) are deducted from this net. Variable expenses (fuel, bait, ice, food, etc.) are in the range of US$ 10,000/trip or US$ 180,000 annually (not counting salaries and wages). This leaves another net of US$ 270,000. This amount is then *divided between the boat and the crew, usually in a 50/50 ratio unless the crew are paid on a base wage with bonuses. The crew share is thus US$ 135,000 (for a crew of six this would amount to annual wages of US$ 38,571 for the captain and US$ 19,285 for each of the deckhands). The balance is the boat share—US$ 135,000. All fixed costs have to be paid out of this amount. Fixed costs are based on mortgage, interest, depreciation, hull insurance, maintenance reserve, license fees, wharf charges, etc. Without going into all the details, fixed costs could be expected to be in the range of 20 per cent of the original investment, or US$ 100,000 annually. This leaves a final net back to the operation of US$ 35,000, or 7 per cent. Slightly better than what the original investment would make if the money was just left in the bank and everyone stayed home.*

This oversimplified picture does not take into account the spin-off benefits that this boat would produce: some of the money earned is foreign export money, so the local economy would benefit and the vessel would help to create employment both in the fishery and in local goods and services. With more fine tuning and better luck the net return might be expected to grow over time to a higher figure.

If more than US$ 500,000 is invested in the vessel initially will the returns be higher? Probably not. At higher levels of investment fixed costs become too high in relation to gross receipts. A diminishing set of returns is the result. On the other hand, if initial investment can be kept low, as with the purchase of a second-hand vessel, the profit-loss picture might look brighter.

In the case of second-hand vessels a substantial risk is added to an already very risky venture so a high degree of caution should be used. Vessels that have gone bankrupt once should probably be avoided (there are usually good reasons why they go bankrupt).

Vessels that are offered on tender after being seized for illegal activities can be real bargains, on the other hand. Other ways to improve the profit-loss picture are to seek 'soft' loans usually offered through development banks or international assistance organisations; or to make an outright purchase, in which case the vessel could be 'self insured', saving the company five or six per cent annually of capital costs.

Average annual Hawaii-based domestic longline vessel characteristics [1 pound = 0.454 kg]

	Mean
Vessel length (ft)	69
Gross tons	94
Total horsepower	457
Purchase price (US$ 1,000)	267
Additional investment (US$ 1,000)	106
Value of electronics (US$ 1,000)	34
Number of trips in 1993	10.8
Travel days per trip	9.6
Fishing days (sets)/trip	10.6
Total pounds sold per trip	18,021

Average annual Hawaii-based domestic longline vessel economic information

	Annual mean (x US$ 1,000)	Range (x US$ 1,000)	Median (x US$ 1,000)
Revenue	504	58–1,153	481
Variable costs	377	40–831	361
Fixed costs	100	31–239	98
Net return	27	(219)–253	28
Add back non-cash depreciation charge	12	3–36	11
Cash return	40	(205)–262	38

The tables showing average profit-loss from 95 Hawaii-based longline vessels for the year 1993 are extracted from: Hamilton, M, R. Curtis & M. Travis. 1996. Cost-Earnings Study of the Hawaii-Based Domestic Longline Fleet. Joint Institute for Marine and Atmospheric Research.

Other considerations

Other things to consider are what type of survey is necessary and what type of registry is required. Depending on local rules and/or requirements of lenders and insurance companies, a vessel may have to be under a particular survey such as those proscribed by American Bureau of Shipping (USA), Uniform Shipping Laws (Australia), or Bureau Veritas (French).

Flag of registry is equally important. After a vessel is purchased and imported into a country it may have to undergo a new survey and be re-flagged. This can be quite expensive, and so should be looked into beforehand so costly mistakes can be avoided.

Lastly, aside from suitability and versatility, *simplicity* is also something to be sought in a longline fishing vessel. Some wise business manager years ago came up with this appropriate acronym to describe a universal management approach to most situations: the 'KISS Principle' or 'Keep It Simple, Stupid'.

The more complicated a longline vessel and its systems are, the more likely it is to experience costly breakdowns. An example of this is hydraulic leader carts for winding in and stowing branchlines and floatlines. The job of pulling in floaters and floatlines can be done by hand, and it is on most longline vessels.

Some vessels use hydraulically-operated reels, called leader carts, to wind in branchlines or float lines and floats. Hydraulic leader carts add a needless complication to an already fairly complex piece of machinery, and more problems as well: one more hydraulic motor to break, one more set of hoses and fittings to wear out and be replaced, one more thing to paint and grease.

This is not to mention the additional initial expense and the room they take up on deck. There are countless other examples of bits and pieces that could be avoided or simplified on a fishing vessel including engine room layout, machinery, deck layout, fishing gear configuration and components, pumping systems, alarm systems, etc.

The Masterfisherman's ideal longline vessel

The ideal longline vessel for fishing in Pacific Island countries would be 21 m length over all by 6.5 m beam and 3.6 m depth. It would be made from steel and have a single hard chine, a stern wheelhouse, and a raised bow (see appendix A for general arrangements).

The main engine would be a **Caterpillar 3406** with a **Twin Disc** gearbox, electric starter, keel cooler, and dry exhaust. It would have a thirty kW generator set with a name brand like **Onan** or **Northern lights**. The fuel tank capacity would be 25,000 litres and the fresh water capacity would be 4,000 litres. Crew complement would be eight men.

The fish hold would be a single 40–50 t hold for icing fish (fifteen tonne chilled-fish capacity). It would be separated into several compartments with aluminium or wooden bin boards. One bin could serve as a freezer room for bait storage. There would be a hydraulic boom for offloading fish.

The wheelhouse would be equipped with mostly **Furuno** electronics including 36 n.mi. radar, SSB radio, VHF radio, GPS with colour plotter, echo sounder with sea surface temperature monitor, and a weather facsimile receiver.

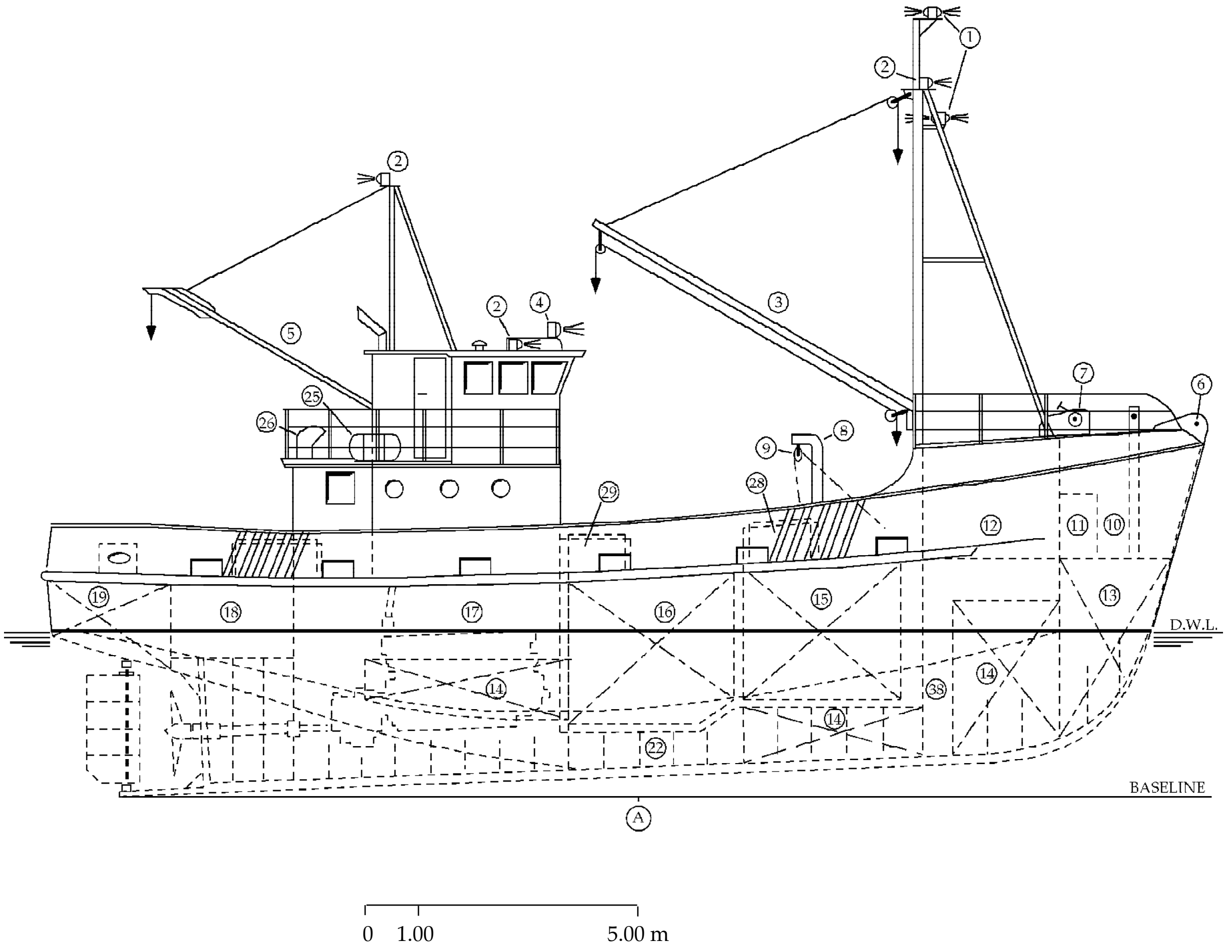
It would also have an auto pilot and a **Taiyo** Model TD1100 radio direction finder. Optional gear would be an **Inmarsat-C** transceiver, a PC or personal computer (486 with **Windows 95**), and a bathythermograph.

Fishing gear would consist of a **Lindgren-Pitman** Super Spool and LS-4 line setter. Hydraulics for the fishing gear would run off of a belt-driven power-take-off from the main engine and would run through a heat exchanger. The LP reel would have 50 n.mi. of 3.6 mm monofilament mainline. There would be 4 branchline tubs each holding 440 branchlines (10 m long).

The branchlines would be made from tarred red polyester 3.0 mm line with 45 g leaded swivels and one metre of stainless steel wire leader ending in a **Mustad** 3.6 stainless steel tuna hook with ring. Other gear would include at least four radio buoys, about one hundred 360 mm plastic floats, about 10 strobe lights, gaffs, grapples, spikes, etc. and spare parts for everything.

Last but probably most important is **safety equipment**. The ideal vessel would be equipped with an eight-man life raft, two or three life rings with strobe lights, a 406 EPIRB (emergency position indicating radio beacon), a well stocked medical kit, ample fire extinguishers, emergency signal devices (hand-held flares, rocket flares, and smoke signals), and a separate battery for the HF radio located outside the engine room. Expiration dates on all safety equipment would be current.

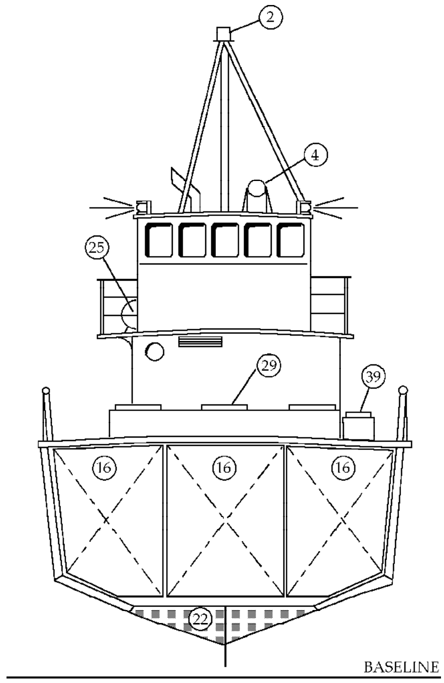
General arrangements of an ideal mid-sized steel longline vessel. Adapted from: Eyres, D. J. 1984. Fishing boat designs: 4. Small steel fishing boats. FAO Fish. Tech. Pap. (239): 33p.



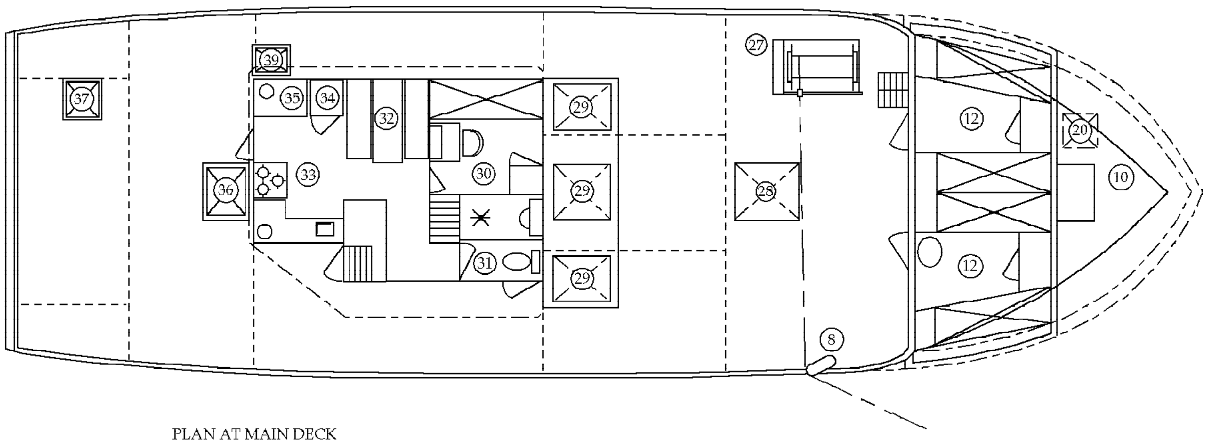
Main particulars

Length over all	21.00	m
Length water line	19.90	m
Beam (max) moulded	6.50	m
Depth (moulded)	3.60	m
Draft at D.W.L.	3.00	m
Hold capacity	30.00	m^3
CSW tank capacity	39.00	m^3
Fuel oil	22,500	l
Fresh water	5,500	l
Main engine	300	hp

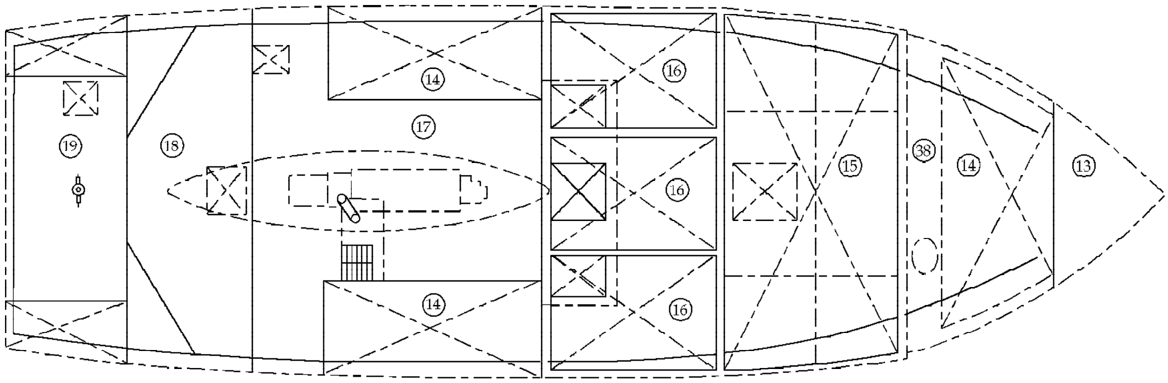
21.00 m steel fishing boat		
GENERAL ARRANGEMENT II		
Scale: as shown	Boat no.	Drwg no.
Drawn: GB	SB2	1 & 2
Rome, 1983		



SECTION 'A' (looking aft)



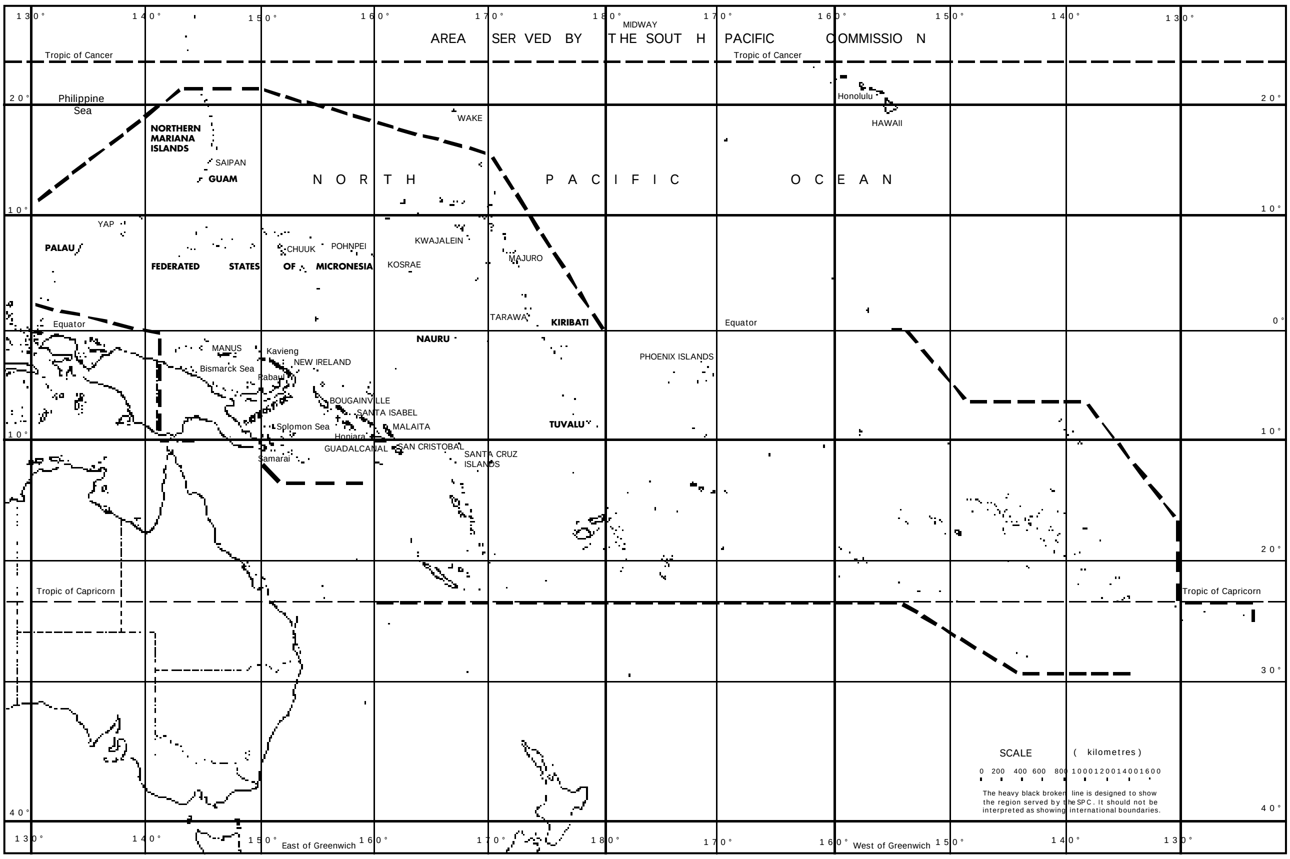
PLAN AT MAIN DECK



PLAN BELOW MAIN DECK

0 1.00 5.00 m

1. Fishing lights
2. Navigation lights
3. 6.50 m boom, 1000kg SWL
4. Search light
5. 4.25 m boom
6. Anchor roller
7. Windlass
8. Mainline davit
9. Mainline block
10. Fore peak stowage
11. Anchor chain stowage
12. Accomodation (8 berths)
13. Salt water ballast
14. Fuel oil tanks
15. Fish hold, 30 m^3
16. 3 C.S.W. tanks, 13 m^3 each
17. Engine room
18. Gear stowage
19. Steering gear and fresh water tanks
20. Access to fore peak
21. Wheelhouse
22. Concrete ballast
23. Chart table
24. Deck store
25. Inflatable liferaft, 10 man
26. Supply vents to engine room
27. Line hauler
28. Hatch to insulated hold
29. Hatches to C.S.W. tanks
30. 2 berth cabin
31. W.C. and shower
32. Galley
33. Mess table and seating
34. Refrigerator
35. Locker
36. Hatch to gear store
37. Hatch to steering gear
38. Sonar space
39. Emergency exit from engine room


AREA SERVED BY THE SOUTH PACIFIC COMMISSION
NORTH PACIFIC OCEAN
Tropic of Cancer
Philippine Sea
NORTHERN MARIANA ISLANDS
SAIPAN
GUAM
WAKE
MIDWAY
Honolulu
HAWAII
YAP
PALAU
CHUUK
POHNPEI
KOSRAE
KWAJALEIN
MAJURO
FEDERATED STATES OF MICRONESIA
TARAWA
KIRIBATI
Equator
NAURU
MANUS
Bismarck Sea
Kavieng
NEW IRELAND
Rabaul
BOUGAINVILLE
SANTA ISABEL
MALAITA
Solomon Sea
Honiara
GUADALCANAL
SAN CRISTOBAL
Samarai
SANTA CRUZ ISLANDS
PHOENIX ISLANDS
TUVALU
Tropic of Capricorn
East of Greenwich
West of Greenwich
SCALE (kilometres)
0 200 400 600 800 1000 1200 1400 1600
The heavy black broken line is designed to show the region served by the SPC. It should not be interpreted as showing international boundaries.