Fisheries Newsletter

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Editorial

Welcome to this issue of the *Fisheries Newsletter*. This issue features a new bycatch mitigation technique tested by the longline industry to avoid shallow water bycatch species and improve catch rates for bigeye tuna. The protection of endangered and threatened species is taken seriously by the Pacific Island longline fishery, and SPC has decided to adopt a proactive approach to address this problem.

As usual, the practical fishing component of the 2004 Nelson Polytechnic Fisheries Officer Training Course was run in New Caledonia in June and July. This year, trainees had two weeks of exposure to SPC's fisheries programmes and projects, and four weeks of practical fishing experience. You will find more information on this course on page 3.

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The F/V *Blue Moves* was one of the vessels used for the new deep setting fishing trials. This new technique was designed to avoid shallow water bycatch species and improve catch rates for bigeye tuna.

in This Issue

SECRETARIAT OF THE PACIFIC COMMUNITY
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FISHERIES DEVELOPMENT SECTION

Deep setting techniques for tuna longlining

Fisheries Development Officer, Steve Beverly, spent two months in Mooloolaba, Queensland, Australia, testing a new deep setting technique designed to mitigate bycatch (especially of sea turtles), and to enhance the catch of target species (especially bigeye tuna). (See page 20 of this Newsletter for a feature article on this project and the results.)

Technical assistance to Tuvalu

Fisheries Development Officer, William Sokimi, worked in Tuvalu earlier this year, assisting the National Fisheries Corporation of Tuvalu (NaFICOT) in preparing two of their tuna longline vessels for an upcoming development project to catch tuna for the sashimi markets in Japan and the US. As part of the development strategies to capitalise on commercial offshore fishing and tuna longline operations for the sashimi markets, NaFICOT accepted two second-hand vessels (Fig. 1) that were offered by the Korean government as aid assistance to Pacific Island countries. The vessels had previously served seven and eleven years in Korea's fishing industry and were originally pelagic gillnet vessels.

Prior to William's arrival, cosmetic restoration work was carried out on the two vessels in Busan, Korea before delivery to Tuvalu. However, en route to Tuvalu, several deficiencies were discovered. The vessels were diverted to Japan in order to avoid the brunt of a storm as well as to be upgraded. The main mast of the larger vessel (F/V *Taivalu*, 29 m) toppled during the storm; it was found that the cause was faulty deck welds on the base plate that had rusted all the way round (even though the plate was securely bolted to the fibreglass deck). The smaller vessel (F/V *Papuku*, 24 m) developed engine trouble and had to be towed part of the way to Japan.

In Japan, the F/V *Taivalu*'s mast's base was strengthened and the mast welded back on. Minor work was carried out on upgrading the generators of both vessels. The main engine on the F/V *Papuku* was stripped to the engine bed and rebuilt. General work was done on both vessels to improve their appearance. The restoration work in Japan lasted for a month before the vessels were cleared to continue on to Tuvalu. No improvements or alterations were made to the deck layout in preparation for tuna longline operations. NaFICOT management preferred to have this done in Tuvalu or Fiji to match the configurations of the longline reel produced by Seamech in Fiji.

Once the vessels were in Tuvalu, William conducted a full survey of each and made recommendations on further work to be done. These recommendations were sent to the General Manager of NaFICOT. The survey recommended much work to be done, although much of it will be minor, inexpensive jobs that can be done in Tuvalu. To start, the timber mountings for a gillnet cage (Fig. 2) were removed from F/V *Taivalu* so that the deck was clear (Fig. 3) for future mounting of the monofilament longline system and fishing gear.

A general awareness workshop on handling sashimi grade tuna and tuna longline operations was conducted during the time William was in Tuvalu. NaFICOT provided four yellowfin tuna for the workshop, and William demonstrated the different steps in handling tuna for the sashimi market. The workshop was very

Figure 1: The two Korean vessels provided under aid

successful and 45 fishermen participated. The fishermen requested more information on tuna longline fishing methods and operations, and so meetings were organised for the next two days in which longline fishing methods were touched on and fishing gears for the operations were constructed (Fig. 4).

Figure 2 (top left): Timber mounting for gillnet cage on F/V *Taivalu*

Figure 3 (top right): Front deck of F/V *Taivalu* cleared

Figure 4 (bottom right): Workshop participants constructing tuna longline gear.

Community surveys in the Cook Islands

Fisheries Development Adviser, Lindsay Chapman, conducted the third and final community survey in Rarotonga and Aitutaki. The surveys were part of the FAD research project undertaken by the section in Niue and the Cook Islands. Nearly 470 households had to be located (222 on Rarotonga and 247 on Aitutaki), which was quite difficult in cases where families had moved to another village, were on holidays away from home, or had even left the country. On Rarotonga, 185 households were located and a family member from each was interviewed. On Aitutaki, 208 households were located and a family member interviewed. The data will be analysed in the coming months.

In addition to the community surveys, Lindsay worked with the Fisheries Department on the catch and effort logbooks. Each fisherman providing data was given an identifying number so there would be no confusion with data from each provider. This was necessary as several fishermen used the same vessel at different times.

Field component of the SPC/Nelson Polytechnic fisheries officers training course

Steve and William spent the month of June assisting with the SPC/Nelson Polytechnic Fisheries Officers Training Course. For the second time the Field Component of the course (formerly referred to as the Practical Fishing Module) was held in Koumac in New Caledonia's Northern Province (see *Fisheries Newsletters* #94 and #101).

The Field Component was organised by Fisheries Training Specialist, Teriihauroa Luciani, who was assisted by William Aruhane, a tutor from the Fisheries Section of the Solomon

Islands School of Marine and Fisheries Studies. Ten fisheries officers from nine Pacific Island countries and territories were included in the group: Willie Kokopu from Solomon Islands, Michael Forsyth from Samoa, Jay Jay Talagi from Niue, Koliniasi Hafoka from Tonga, Elia Henry from American Samoa, Antoine Maloune from New Caledonia, Peter Momgo from Papua New Guinea, Maika Uluinakabou from Fiji, and Tekamaeu Karaiti Bureita and Tetioma Ukenio from Kiribati.

The group came to New Caledonia after spending five months in Nelson, New Zealand at the Nelson Marlborough Institute of Technology. Part of the Field Component was spent in Noumea at SPC headquaters, working with staff members from the Oceanic Fisheries Programme, the Reef Fisheries Observatory, Aquaculture, and the Coastal Fisheries Management Section. The group spent the bulk of their time in Koumac fishing on F/V *Dar Mad* (Fig. 5) and F/V *Max* (Fig. 6), and learning how to scuba dive. The scuba instructor was Stephane Guilbert, who also coordinated logistics, accommodations, and meals in Koumac. The work activities in Noumea and the scuba diving lessons were added to the Field Component as a result of recommendations given after the SPC/Nelson Polytech course was reviewed in 2003.

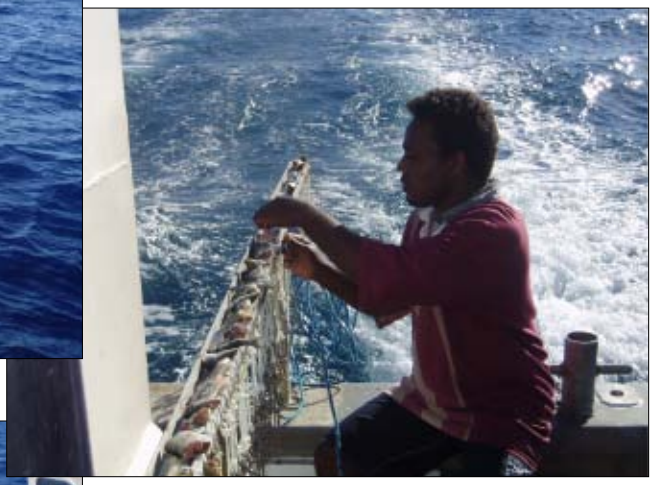
Steve acted as fishing master on F/V *Dar Mad*, assisting Captain Lucky Fogliani and First Mate, Velio Famoetau. William Sokimi acted as fishing master on F/V *Max*, assisting Captains Bill Brown and Charles Poithily. William Aruhane, who was attached to the Field Component as an associate tutor, also acted as fishing master from time to time. Each day, depending on the weather, the two boats left Pandop Harbour in Koumac with four or five trainees to carry out fishing trials, including trolling around the FAD that F/V *Dar Mad* deployed on the first day of the Field Component. The fisheries officers learned new skills and added to old ones, including:

- preparing the vessels for fishing trips;
- choosing a fishing area by inspecting local charts;
- demonstrating the correct method of mounting and adjusting a Samoan hand reel;
- constructing bottom-fishing grapnels, sinkers, and gaffs;
- checking safety equipment prior to fishing trips;
- analyzing costs of running a small-scale fishing vessel;
- keeping accurate records (logbooks) of catch;
- navigating safely to and from the fishing grounds;
- processing catch to local and export standards (Fig. 7), and
- preparing fishing gear (Fig. 8).

After four weeks of fishing on the two boats they understood the principles of catching fish by the following methods: trolling with lures, deep bottom fishing with hand reels (Fig. 9), bottom longlining (Figs. 10 and 11), vertical longlining, and pelagic longlining. A smaller group accompanied Stephane each day for classroom diving lessons and for open water scuba diving. To earn a basic certificate in scuba diving each participant had to accomplish four dives plus attend the briefings.

Figure 5 (left): F/V *Dar Mad*

Figure 6 (right): F/V *Max*



Fishing was not as good as it had been during the 2002 Fishing Module held in Koumac, and the weather was not great. In spite of this, the Fishing Component was very successful, and some nice fish were caught, largely because of the efforts of all involved and because Koumac is a near perfect venue.

From top to bottom, left to right

Figure 7: Antoine learning to cut an opah for the local market
Figure 8: Tetioma, Tekamaeu, and Peter preparing fishing gear at the workshop
Figure 9: Tetioma, Willie, Bill Brown, Maika, and William bottom fishing on F/V *Max*
Figure 10: Willie loading the bait rack for bottom longlining on F/V *Dar Mad*
Figure 11: Willie, Jay Jay, and Maika preparing to haul in the bottom longline while Velio looks on

FAD research project update

The FAD research project ended in June as the application to extend this project was declined by New Zealand. An extension until December 2004 was granted to allow the completion of the community surveys, analysis of data, final report write-up, and the writing and publishing of a manual on FAD mooring designs.

At the end of June there were two project FADs on station off Rarotonga from 5 deployments (one after 27 months and the other after 12.5 months), two project FADs off Aitutaki from 4 deployments (one after 26.5 months and the other after 12.5 months), and two project FADs off Niue from 10 deployments (one after 28 months and the other after 2 months). Four of the FAD losses off Niue were attributed to cyclone Heta.

FAD maintenance has been as regular as possible. In June, Lindsay accompanied the Fisheries Department staff on a maintenance run where FADs were checked off Rarotonga. One project FAD had a new flagpole arrangement attached to the buoy system (Fig. 12) while the other project FAD could not be checked as there were five boats tied up to it (Fig. 13), mid-water fishing with handlines and vertical longlines. FAD maintenance off Niue has been difficult due to the damage caused by cyclone Heta and the unavailability of the Public Works launch, which is needed to do the job properly.

Several fishermen continue to provide consistent catch and effort data for the project in Rarotonga. In Niue, the number of fishermen providing data has increased, although, fishing has been limited by no readily available crane to lift boats in and out of the water. It is hoped that the logbook system will continue after the conclusion of the project; the Fisheries Departments are encouraging fishermen to complete their logbooks.

Figure 12 (far left): Shallow-water FAD buoy design with new flagpole arrangement

Figure 13 (left): Boats tied up at the Matavera FAD, all mid-water fishing for tuna

TRAINING SECTION

2004 Nelson Training Course

This year's SPC/Nelson Polytechnic Fisheries Officers Training Course started at the New Zealand School of Fisheries on Monday 26 January. Ten trainees from nine countries attended the course. The practical fishing component was run in New Caledonia and the topics were broad in scope and made full use of SPC's fisheries programmes and other institutions in New Caledonia.

Trainees had two weeks of exposure to SPC's fisheries programmes and projects, and four weeks of practical fishing experience (longlining, bottom fishing, trolling, catch processing and marketing). Fishing operations were run in Koumac, in the Northern Province of New Caledonia, from 7 June to 2 July. As in recent years, this practical training was coordinated by the staff of SPC's Fisheries Training Section with technical and teaching inputs from Steve Beverly and William Sokimi (SPC's Fisheries Development Section), staff from the local fisheries department, and the captains and fishing masters of F/V *Dar Mad*. Articles about the 2004 practical fishing module can be found in this issue. In addition, courses on basic scuba training and safe diving practice awareness were added to the field component.

A training attachment was organised for William Aruhane, the new fishing instructor of the school of marine and fisheries studies in Solomon Islands. The purpose of the attachment was to familiarise the fishing instructor with small-scale fishing techniques used in the

South Pacific. William was attached to the Field Component as an associate tutor and also acted as fishing master from time to time.

The 2004 course ended on Friday, 9 July, in New Caledonia, where students completed practical fishing component of the course. During the 24-week programme, our trainees gained sound experience and skills that they will undoubtedly pass on to fisher-folks in their home countries.

The SPC Fisheries Training Section wishes good luck to the 2004 students. We also thank all the institutions and individuals involved in both the Nelson and practical fishing modules. From SPC's point of view, Koumac proved to be an ideal venue for the best group of trainees in many years. Let's hope the donor community will continue to see the benefits of such a great training course.

PROCFish/C presents its work to the Nelson students

In the first week of July, Nelson Training course students spent three days working closely with staff from SPC's PROCFish Coastal project. Formal presentations on the methodology of resource data were made in the training room, where participants learnt the various methods and tools used to census fish, invertebrates and habitats.

Adopting an interactive approach, Mecki Kronen moderated a session of brainstorming discussions on the rationale (why?), framework (what?), user group (for whom?), methods (how?) and endpoints of designing, implementing and analyzing socioeconomic fisheries surveys. Case studies from the DemEcoFish and PROCFish/C socioeconomic fisheries manual project were used to demonstrate the need to determine minimum data set required and the most efficient methodological approach. Each participant was provided with a ficticious data-set in socioeconomic fisheries questionnaire survey format.

The socioeconomic session was particularly appreciated by those participants who are or will be involved in the design or implementation of fisheries surveys. It is likely that some participants will be counterparts of PROCFish/C's future socioeconomic field studies.

An introduction to relational databases and database design was given by Franck Magron, who gave practical exercises using MS Access and a module specifically developed for hands-on training in entering, processing, and retrieval of the ficticious socioeconomic datasets.

These exercises were aimed at providing participants with a better understanding of how databases are structured and why, and how they can be used conjointly with spreadsheets for data analysis.

A final session was devoted to using MapInfo to display and query data.

A hands-on training exercise on survey techniques used to census finfish and invertebrates was demonstrated at Ilot Canard, a small island not far offshore from Noumea. In the field, participants were split into groups and taken through routines of surveying and recording fish, invertebrates and habitats.

The Niue participant expressed his excitement in being exposed to field survey techniques, emphasizing the importance of being skilled in hands-on techniques, when help is sought from Fisheries Officers to devise or assist in survey work. Samasoni Sauni and Pierre Boblin helped with the demonstrations for finfish census, while Kim Friedman worked on invertebrate training.

In brief

- With funding assistance from the Commonwealth Secretariat, the section is undertaking a needs assessment for the implementation of business planning and management training in the Solomon Islands and Vanuatu. This follows the successful introduction of the Start and Improve Your Fisheries Business (SIYFB) training programme in Papua New Guinea. The training programme consists of two courses focussing on business awareness, planning and management. Using the

ILO Global SIYB programme training materials, indigenous knowledge of PNG coastal fishing communities as well as technical and socioeconomic information on PNG's fisheries sector, the SIYFB programme was jointly developed by the National Fisheries College (NFC) and the small Business Development Corporation (SBDC) of Papua New Guinea, and delivered to a total of 183 trainees in seven coastal provinces. The overall intention of the current project is to give detailed consideration to the possible application of the PNG training model to the Solomon Islands and Vanuatu in a joint initiative between the Commonwealth Secretariat, SPC and NFC. More on this project in the next issue.

- The "turtle-friendly fishing boat" stickers have been printed and widely distributed in the region. Available in both English and French, the stickers are the Training Section's latest addition to its awareness campaign on the bycatch issue in tuna longlining. The resource materials now include guidelines for safely releasing hooked turtles (available as a poster, a sticker, or a laminated card), the marine turtles identification cards, and the recently released manual on protected marine species. The next item will be shark identification cards, which should be printed and distributed by the end of 2004. It is now up to the national training institutions to introduce a module on "protected marine species" into their courses for local fishermen. In addition, fisheries administrations have a key role to play in disseminating SPC awareness materials to their fishing industry. Last, but not least, observer programmes can use the materials as part of their training and at-sea activities. Those interested in the above materials should contact Training Section staff.

- The Section is facilitating a series of individual training attachments. A number of fishing vessel engineers and skippers from Nauru and the Solomon Islands will soon sit for mandatory certificates in Fiji (Nauru) and Honiara. Limited funds are still available from the section should a company or a fisheries administration wish to train one of their staff locally or overseas. The section will facilitate the attachment on a cost-sharing basis, provided the desired training is identified as a priority.

- Niue Fisheries has recently approached the Training Section to receive assistance in setting up a competent authority aimed at monitoring the quality and export of local seafoods. The first major fish processing operation on the island will start its operations soon, making the development of a competent authority a priority.

- As a follow up to recent small vessel safety initiatives, the section is facilitating a session on this issue at the Heads of Fisheries meeting (30 August – 03 September). The desired output of the session is an indication of support for a possible FAO/SPC small vessel safety project, and the identification of national commitment and likely drivers. More on sea safety in the next issue!

- Section staff recently assisted the Vanuatu Maritime College (VMC) in developing its website. In the initial phase of this project, website design was discussed and agreed on. Then, using the information and pictures provided by VMC, the website was built up. Currently, and until the college finds a local host server, the website is accessible via the SPC homepage:

http://www.spc.int/coastfish/Sections/training/institutions/VMC/index.htm)

Other fisheries training institutions wishing to receive assistance in the area of website development should contact section staff.

AQUACULTURE SECTION

15th NACA Governing Council Meeting

SPC's Aquaculture Adviser, Ben Ponia, participated in the Aquaculture Development Seminar and 15th Governing Council meeting for the Network of Aquaculture Centres Asia-Pacific (NACA) held in Sri Lanka from 20-25 April 2004.

The aquaculture seminar was largely focussed on Sri Lanka with lessons applicable to the Asia-Pacific region.

A major topic of the seminar was reviving the local Sri Lankan prawn industry, which is struggling to cope with diseases and mismanagement practices. Subsequent speakers from countries such as India and Vietnam presented case studies that proved rural and poor farmers made profits when they applied simple best management practices. These same principles are applicable to the Pacific.

The ornamental trade is a substantial export earner in Sri Lanka. But as is the case in many Asia-Pacific countries, institutional support by government to the private sector is lacking. The marketing chain in the industry between supplier and consumer is evolving with fewer middleman and a dynamic demand-supply process. With advances in fish breeding technology, a highly priced market for colourful and unusual species is building momentum, and some of the freshwater species in the Pacific, particularly Melanesia, could be candidates for export. The major market is the EU followed by the US, Japan, and eastern European countries that recently joined the EU, and which vie for opportunities to supply major markets in countries such as France and Germany. The Pacific needs to stay abreast of these developments.

One of the initiatives presented to the Governing Council meeting was a status report on aquaculture in the Asia-Pacific region. The document, "Emerging Trends and Experiences in Asia-Pacific: 2003" has a chapter on the Pacific written by SPC staff. Although the scale of aquaculture in the Pacific is miniscule compared with Asia (the farm gate value of prawns alone is worth USD7 billion dollars), the region has a relatively diverse sector.

The main objective of the Governing Council meeting was to review NACA activities for 2004 and approve the work plan for 2004-2005. NACA continues to build on its strong programme of poverty alleviation, in particular through the Support To Regional Aquatic Resources Management (STREAM) project. The animal health programme, dealing with disease and movements of stocks, will continue to be of importance and relevance to the Pacific region. The newly revamped NACA website http://www.enaca.org has a vast collection of freely available information materials and a discussion bulletin for raising queries. There will be a slight refocussing of the organisation to address aquaculture marketing support, a timely and wise move.

Fiji aquaculture study tour

In June 2004, SPC organised a study tour of Fiji's aquaculture sector for Mr Barney Smith (ACIAR), Dr Yves Harache (IFREMER) and Dr Gupta Mogadushu (WorldFish Center). Also present were Mr Filomone Mate, senior officer with the Ministry of Fisheries and Forestry, and SPC staff members Ben Ponia and Satya Nandlal.

SPC/USP Tilapia and Freshwater Shrimp Aquaculture Training Workshop

Upon arrival in Fiji, participants gathered at Nanduruloulou Aquaculture Research Station. Nanduruloulou staff hosted a farewell function for the regional trainees of the aquaculture training workshop, who were completing their last day of station work.

The next day included the final lectures for the regional training workshop. Dr Gupta, who has vast experience in tilapia aquaculture and genetics, gave a lecture, outlining why a broodstock maintenance programme was necessary for ensuring that best genetic stocks are propagated. His talk laid the seeds for the concept of Nanduruloulou Station serving as a central broostock facility for Fiji and possibly the Pacific region. In the final session, participants formed a panel to comment on the presentations of workshop participants who were outlining their future research projects and to assess future priorities for development.

Public Seminar on Aquaculture, USP lecture room

A public seminar on aquaculture was organised by the Ministry of Agriculture, Fisheries and Forestry (MAFF), USP and SPC at the USP campus. The main speakers were Dr Gupta on tilapia aquaculture in Asia, and Dr Yves Harache on the rapidly expanding prawn industry in New Caledonia. Other presenters included Ben Ponia (SPC), who gave an overview of aquaculture in the Pacific, and Satya Nandlal (SPC), who gave a presentation on freshwater shrimp farming. Dr Tim Pickering reviewed aquaculture activities at USP, and Professor Leon Zann gave an introductory lecture. About 100 persons attended the seminar, and despite the late finish (9:30 pm), most were present at a cocktail reception afterwards.

The next morning, there were visits to municipical markets to look at the diverse variety of fish (both wild caught and farmed) sold in Fiji.

Suva

Navua Prawns, Navua: The Navua prawn farm has four earthen ponds, about 0.8 ha each. According to owner Jim Tilbury, the farm has mostly concentrated on *Penaeus monodon*. The farm has produced up to 7 mt/ha. The domestic demand for product had been quite good, however, freak flooding had ruined the crop and the business was now looking at refinancing to recuperate the financial losses incurred. In the past, the post larvae for the farm had been supplied by a hatchery in Australia, but now Jim was waiting on the fisheries hatchery in Galoa to provide seed stock.

Gulf Seafoods, Navua: This is a relatively new operation that is farming *L. stylirostris* prawns. The farm has four large circular ponds, lined, each about 0.3 ha. In addition, there are 10 raceways in a greenhouse, each with a 10 tonne capacity. Another 25 growout ponds, 0.8 ha each, and a hatchery are under construction. The farm is serviced by a sophisticated aeration and water delivery system. Post larvae are being provided from a hatchery in Brunei. An import risk analysis for the introduction of post larvae has been commissioned by SPC for the Fiji government. Despite some initial problems, the farm has had a relatively successful first harvest, yielding 7.5 mt/ha and 5 mt/ha from two of the harvested ponds. Farm owner Peter Blake hopes to tap into an export market in the Middle East.

Government prawn hatchery, Galoa: The Galoa hatchery is spawning local *P. monodon* stocks. The hatchery is well equipped with pond and hatchery infrastructure. However, at the time of the visit, it was facing difficulties with broodstock collection and maturation and an unusually early spawning season resulted in no post larvae being produced.

Montfort Boys Town Technical College, Suva: Montfort College is probably one of the best model demonstrations for integrated aquaculture in the Pacific. The fish ponds have integrated a variety of livestock and crops, including duck, cattle, sheep and taro. The Genetically Improved Farmed Tilapia (GIFT) tilapia are the main species farmed, and ponds were fully stocked during the practical sessions of the SPC/USP training workshop. The USP Institute of Marine Resources had also been allocated several ponds to rear *Macrobrachium* shrimp.

Time was running short, but a quick visit was made to a village (*Mataqali*) farm. The village ponds were raising high valued *Macrobrachium rosenbergii* shrimp. The enterprise had been able to recuperate the funds borrowed for construction and start-up quite quickly. However the long-term sustainability of the operation will require the village to work out a profit-sharing system that will equally benefit the farmers putting in the work, and various stakeholders with ownership (such as landowners).

Prawn growout ponds at Gulf Seafood farm in Navua

Integrated aquaculture-agriculture at Montfort Boys Town

Nanduruloulou Aquaculture Research Station: A tour of the aquaculture facilities at Nanduruloulou was made to follow up on the training workshop recommendations. The feed mill equipment was inspected for the possibility of instigating some feed formulation research, in conjunction with Papua New Guinea. Potential siting of quarantine facilities was reviewed, which will be essential if Nanduruloulou Station is to introduce new genetic lines of shrimp or tilapia. Following the training workshop, staff had restocked the ponds with new tilapia fingerlings and *Macrobrachium*. Nanduruloulou Station has excellent facilities for freshwater aquaculture research and training and has the potential to be a regional centre of excellence.

A visit was also paid to Abdul Sadat who is one of the success stories from assistance provided by Nanduruloulou Station. Sadat is a tilapia farmer who experimented with stocking densities and was now harvesting up to 7 mt/ha of fish from his ponds. He had just finished building a large house that had been paid for entirely from his tilapia sales.

The next day participants flew to Savusavu on Vanua Levu island where some interesting developments are underway.

Savusavu

Montfort Boys College, Savusavu: The Montfort College in Savusavu has a large number of ponds set up for fish farming. As a follow up from the training workshop an agreement had been reached for Fisheries extension officers on Savusavu to work at the college and revive the tilapia hatchery. This hatchery will be a distribution point for farmers in the locality. Some of the college ponds had been dug too deep and could not be fully drained, which caused a problem because there was variation in fish sizes and uncontrolled breeding. A possible solution is to conduct monosex culture. Institutions such as Montfort could benefit from a simple fish farming booklet targeting school level children.

Marine Finfish Aquaculture, Savusavu: The concept of farming marine finfish is no longer a novelty in the Pacific. The operation on Savusavu was set up by Chris O'Keefe who recently moved from Australia where he farmed barramundi and mangrove jack. A series of circular fibreglass tanks are used for rearing and conditioning broodstock. A shipping container has been refurbished as an algal laboratory. The mass algal culture is conducted outdoors using bag culture. The farm intends to focus farming mainly on local mangrove jack (*Lutjanus argentimaculatus*) but

Mangrove jack broodstock at Marine Finfish Aquaculture, Savusavu

will also raise some coral trout. The large fish broodstock held in captivity appear well conditioned and have already produced several successful spawnings. According to Chris, the Savusavu location offers an abundance of fish broodstock, good sites for offshore cage culture and a great lifestyle. His intention is to export his product for the Asian live fish trade and some of the excess freight space could be supplemented by wild caught fish.

Savusavu Fisheries Department, pearl project: SPC Aquaculture staff met with Mr Tevita Taumaipeau, the head of the government pearl farm. According to Tevita, there is still considerable interest in pearl farming, and the recent spat collection data indicate an opportunity for further expansion and the possibility of villages becoming involved in spat supply. The government station currently has three trainee farmers who were on six-month attachments, getting practical experience in farming. Using the recently developed pearl farming economic modelling software, we reviewed various options for pearl farming in Fiji. We concluded that it was probably not financially viable for small pearl farms to operate, and we noted the need to concentrate on niche inputs (i.e. spat collection, juvenile growout or farm maintenance).

J. Hunter Pearls farm, Savusavu Bay: This is the largest black pearl farm in Fiji; it seeded 35,000 oysters in February 2004. Justin Hunter displayed some of the pearls from recent harvests. On display was an impressive line of high quality of pearls of regular shapes, large sizes and high lustre. There was some variation in colour in the darker tones, which is typical pearls from eastern Polynesia (French Polynesia and Cook Islands). The layout of the pearl farm and seeding shed was well designed and good farming practices were evident. Particular effort was being made to share the farm benefits with the neighbouring community and villages. For instance, company dividends are put towards a village education scholarship fund. The farm provides employment opportunities, and women in particular are involved in spat collection activities. Considerable progress has been made since the farm began four years ago, and a hatchery to accommodate further expansion is being considered. Attention is also being paid to marketing, with the development of a website (www.pearlsfiji.com), glossy brochures, and onsite value-added jewellery setting. In Fiji, J. Hunter pearls are being exclusively marketed through the Prouds department store chain, and recent travellers through Nadi airport may have noticed the pearl booth on display.

After the return to Suva, meetings were held to discuss follow-up projects.

Outcomes

From the study tour it was evident that the freshwater pond aquaculture sector was lacking a strategic direction and good statistics for planning. Subsequently, the CEO for MAFF requested SPC and ACIAR to assist in a pond census and the development of a strategic plan. These outputs will enable government to consolidate its recent pond construction activities and ensure that a proper

Blacklip pearl oysters being farmed at J. Hunter Pearls farm in Savusavu.

allocation of resources is made for the future expansion of the industry. The pond census and strategic plan was completed by mid August in time for budget considerations.

Follow-up meetings were also held with the USP Institute of Marine Resources and there are a number of ongoing projects that will help strengthen cooperation and sharing of information in the region. One positive outcome was that the French Embassy in Suva agreed to fund a scheme whereby French researchers from IFREMER station in New Caledonia will deliver an annual lecture on an aquaculture topic at USP.

Fiji's own cultured black pearls from the J. Hunter Pearls farm

Feasibility study on the potential for farming Macrobrachium rosenbergii in Papua New Guinea

Under the auspices of Secretariat of the Pacific Community (SPC), a feasibility study on the potential for farming giant freshwater prawns (*Macrobrachium rosenbergii*) in Western Province (WP), Papua New Guinea (PNG) was undertaken by SPC's Aquaculture Officer in February and March 2004. Additional objectives of the study were to suggest the feasibility of completely domesticating the Fly River strain of M. *rosenbergii* for aquaculture and to assess the suitability of pre-selected sites for hatchery establishment and farming in the Middle Fly River area. The study was extended for a week to observe fish farming practices and fingerling production at Goroka, Aiyura Fisheries Station, Yonki Fisheries Station, Arap and East New Britain so that SPC could learn about the problems experienced, and therefore be in line with the regional training for the extension officers in aquaculture held on 10 May 2004 in Suva, Fiji.

A series of findings and recommendations is compiled on the basis of my field visits and from the interactions with the villagers in Middle Fly River, Obo Fishing Company staff, fisher persons, the National Fisheries Authority (NFA), Ok Tedi Mining Limited (OTML) staff, and others at Aiyura Fisheries Station, Yonki Fisheries Station, Arap and East New Britain.

Physical parameters such as temperature, water quality and quantity, topography, and soil type indicated that conditions are suitable for subsistence and semi-commercial level prawn production. The abundance of land, labour and resources gives Tabubil and the Middle Fly Region some advantage in prawn production compared with other regions of PNG. However, a lack of aquaculture tradition, and technical expertise, data on prawn and fish markets, and a lack of adequate capital and pond input resources are critical impediments for

development in WP. It is essential to have at least a general knowledge of WP in order to understand and formulate workable solutions to some of the current problems. The report, therefore, incorporates references to the general geography of the area in order to place climate and fisheries in the proper context.

The starting point for any attempt at aquaculture development in WP must be the recognition of certain elements distinctive to the area. WP is the biggest province in PNG with a relatively large land area, river systems, and a small population. Only a very small per cent (possibly 0.5% or less) of the total cultivable land is presently farmed. Transportation is a major constraint to marketing and, thus, increasing productivity and volume of (any commodity) are issues that need to be dealt with. In order to attract funding to promote investment in prawn culture, NFA, OTML, and sponsoring agencies of this consultancy will have to provide all possible incentives, particularly since it is a new concept. The type of incentives may include those that entice villagers to include prawn and other fish farming (e.g. barramundi, tilapia, and local species such as Sooty grunter). There are a number of problems that NFA and OTML may face and these are referred in various sections of this report. To facilitate the development of prawn culture, NFA and OTML are urged to create a general "climate" favourable to the development of either small - or medium - scale prawn farms. This is needed since the profitability has never been demonstrated and villagers/farmers/investors have alternative possibilities of investment that may offer greater returns.

There are no prawn farms in operation and as such, the report does not include aspects of prawn farming because it does not exist. However, a summary on prawn growout and other detailed aspects will be appended in the technical report series that will be prepared in addition to this report. The contents of this report may only serve as a general guidline and should be taken as suggestions or observations intended to assist those interested in identifying their own criteria and options for actions, as well as partners for collaboration, in support of prawn culture development in WP.

Driti Women's Tilapia Project
(Bua, Fiji Islands)

Satya Nandlal, SPC's Aquaculture Officer, visited the Driti Women's Tilapia Project with Filimone Mate, Principal Aquaculture Officer, and Maleli Dawai, Fisheries Extension Officer, Ministry of Fisheries and Forests, Bua, as part of the Fiji Aquaculture Census Survey for the Fisheries Department.

Following on from an article that appeared in *Fisheries Newsletter #107* (October /December 2003), below is a brief account of the farm and progress made to date.

The farm was improved through assistance from SPC, USP and the Fiji Fisheries Department and now consists of six ponds.

Progress and principal accomplishments

Objective 1. Enhance food security for the village

Driti Women have:

- served as a good role model in producing tilapia fish and prawns for their village. They have played their part in repairing the inlets and outlets of all ponds including improvements to the water supply for the ponds. The farm has been maintained very well, it looks clean and the lower portion of the farm fenced to keep out animals. Tilapia fry production, stocking, harvesting and sales are now being carried out routinely by members of the group;
- made the best possible use of the funding support from

Pond details	Pond 1	Pond 2	Pond 3	Pond 4	Pond 5	Pond 6
Length(m)	26	23	24	17	15	37
Width (m)	14	20	14	13	12	9
Area (m^2)	364	460	336	221	180	333
Water depth–inlet side (cm)*	50	-	50	55	50	40
Water depth–outlet side (cm)*	80	-	75	60	60	80
Inlet size (mm)	75	50	50	50	50	50
Outlet size (mm)	100	100	75	100	100	100

* Water depth taken on 24 June at 12.55 pm; pond 2 was harvested and thus empty on this day

SPC for the improvement and management of the project;

- assisted in making awareness of the benefits of eating fish or having fish in their diets to their nearby villages; and

- assisted with the planning, promotion and implementation of tilapia dishes for sales and during various meetings and workshops in nearby villages.

Objective 2. Provide a source of cash income through fish sales and fry sales

Driti women have:

- made a gross sales of tilapia and prawns close to FJD 6947 since October 2003 (see table below for details);

- purchased a total of 4200 shares in Unit Trust of Fiji at $0.57 per unit amounting to FJD 2394;

- purchased a brush cutter by contributing one-third (FJD 216) of the total costs towards the total cost of FJD 650 to Bua District Administration;

- paid in advance a total FJD 750 for feed to Crest Feed Mill Limited. The feed will be delivered or taken to the village as when the need arises;

- cash in hand of over FJD 1000;

- provided the Fisheries Department with information relevant to the group's efforts to develop cost of production budgets and expected revenues for the production of table-sized tilapia and prawns. They do not like to raise fish to four months as recommended, but instead, prefer to allow the fish to reach table-size, which allows each family member to have one whole fish during meals; and

- demonstrated that the demand for tilapia and prawns in nearby villages cannot be met by existing ponds alone. The project was designed to meet needs of Driti village and is serving that purpose.

Objective 3: Provide a source of tilapia fry for their farm and other farms in Bua.

Thus far, the project has produced fry and stocked all ponds, and have supplied excess tilapia fry to stock the Driti Creek.

Future plans include:

- The completion of cement tanks construction for holding fish before sales. Supplies of tilapia need to be of the highest quality and available on a continuous basis in order to have a competitive advantage to tinned fish and other sources of meat in the village. SPC urges members to purge fish in order to remove "off" flavors of tilapia to ensure a standard quality and the availability of a consistent product at all times.

- The group is requesting the development of educational materials from SPC, USP and the Fisheries Department, including feeding charts for individual ponds and integrated farming systems, and pictures of all local fish and crustaceans in the nearby river.

- Access to inorganic fertilizer to enhance pond production (with assistance with from the Fisheries Department).

- Have requested for assistance for a workshop specifically on record keeping and development of their business skills.

- The group wishes to access information and assistance from Fisheries Department on live tilapia sales in Bua. They need assistance to identify resources required and training to implement this exercise. This would allow members to market tilapia and prawns directly to nearby villages, at least on a small-scale, and thus promote the consumption and farming of tilapia in other villages as well. They would also be able to meet the needs of fingerlings from the current production from their ponds for other ponds in the area.

- The present set of records for fish stocking, harvest and sales, including financial records needs improvement.

Pond No.	No. fish stocked	Stocking Density (fish/m²)	Rearing days	No. fish harvest	Average wt. (g)	Total wt. (kg)	Total income FJD	Feed cost FJD	Gross profit	Food Conversions
1	1,600		24/4/04	1,450 (91%)	149	216	648			
2	2,000		24/4/04	1,331 (67%)	149	197.8	593.4			
3 prawns	1,000			901	27	24.8	248			
4*	1119	5	112	1107 (98.9%)	183.7	203.4	704.3	288.5	415.8	1.89:1
2*	2,150	8	102	2,010 (93%)	135.5	272.4	953.4	362	590.6	2.1:1
1*	2,100	8	112	2008 (95.6%)	123.8	248.7	870.45	362.8	507.65	2.3:1
3*	1,980			1,708		229.1	801.85			

The group would like a workshop to train members on record-keeping as well as business aspects of tilapia farming.

- The Driti Women's Tilapia Project is the only active project in Bua. The group wants other women's groups to be established or activated in the province, such as the Banikea Women's Tilapia Project.

Project impacts

- The results achieved to date provide strong evidence that village women can raise tilapia and market them efficiently, even in a distant rural setting. It is recommended that similar types of projects be revived or formed in other districts.

- Driti villagers are eating tilapia fish raised in their ponds. They are not relying on other protein sources, such as tinned fish or beef from the village stores.

- Several government departments are now a taking a keen interest in the success of the project. Several government ministers, including Fiji's cabinet, have visited the project.

SPC, USP, Fiji's Fisheries Department, and the Ministry of Women have developed and promoted the Driti Women's Tilapia Project through an

Top: Four of the six ponds with village in the background

Middle: Newly-built cement tanks (funding from Fiji Government) for multiple use" purging the fish before sales, holding broodstock, fingerlings for sale, etc .

Bottom: Water catchment dam

organised training programme in October 2003. This resulted in increased public awareness of successful tilapia farming, and the potential for tilapia/prawn aquaculture as a viable agricultural enterprise in the district. Furthermore, successful technology transfer to enhance current and future production methodologies for tilapia and prawn will depend on regular hands-on training, follow-up field visits, and improved lines of communication between government fisheries officers and group members.

The village visit offered an opportunity to analyse the contribution of women to village income generation through tilapia farming, and to explore ways to raise the visibility of women in aquaculture. Traditionally, Driti women have worked mostly in subsistence vegetable gardens and taking care of household activities, but it is important to note that women can contribute in different ways to the survival and welfare of a village. There is today, an acknowledgment that most Driti women are working at the fish farm directly and they are interested in sharing their experiences and learning more about the economics of fish farming. The Fisheries Department is urged to continue their assistance to this group.

Another trend in the village is a renewed interest in women having more control over village activities. Fijian women have traditionally been very community-minded and they are now using their energies and skills to look at survival strategies for their village. This will give them more control in running village businesses. In Bua, where there are plenty of resources (land and water for agriculture), there would be year round work for everyone, and women could provide for their families in a meaningful way as they have been doing for ages.

There is a need to acknowledge the contribution of women and to accept them as legitimate contributors to village welfare. During the short visit, women identified their strengths. They have the ability to manage and listen to their families and communities and understand their needs. They are confident organisers of village activities, and have courage and a sense of reality. They also take pride in the fish farm because they know that the income from the farm could assist them in providing resources for various church and village activities. The women have learned the hard way how to work together for their village, and are beginning to express their views more and more forcefully. Despite members having to manage the fish farm on a weekly basis, it has become an important economic activity that the village is very proud of. The money generated from the farm is spent very carefully. This is the first time a group involved in tilapia farming has purchased shares as part of its investment plan.

2004 AFA/SPC PACIFIC ISLAND FISHING TRAINEESHIP

Grant Carnie
Australian Fishery Academy

Funding originally allocated for the deferred 2003 SPC Fisheries Officer's programme has been freed up, thus enabling the Australian Fisheries Academy (AFA) to run a third AFA/SPC Traineeship for promising young fishers from Pacific Island nations. The format was the same as the first two successful programmes, though slightly shorter and with two less trainees because of the reduction in funds. The participants for the third programme came from Papua New Guinea, Kiribati, Tuvalu, and, for the first time, the Cook Islands. Contrary to the first two programmes in which industry sector representation was diversified, the 2004 trainees were all from longline fisheries, reflecting the dominance of that fishing methodology in domestic Pacific Island commercial fisheries.

The first trainee to arrive was Marakia Karakaua from Kiribati who, although AFA staff didn't know it, had been placed on an earlier flight in Brisbane and so arrived in Adelaide four hours ahead of schedule. After some initial panic when he wasn't at the airport at the expected time, and thoughts of a lost Pacific Islander somewhere in Adelaide, a city far bigger than anything he would have previously experienced, staff were able to track him down and discover he had been "rescued" by a family with connections to the Gilbert Islands and was enjoying a family barbecue in the Adelaide Hills! The family adopted Marakia during his stay in Adelaide and showed him some wonderful South Australian hospitality.

Thankfully the rest of the trainees arrived without any unexpected events and they all soon happily moved into their Adelaide accommodation at the nearby Fort Largs Police Academy. There was an induction on the first day to allow the trainees to settle in, get used to the Australian winter weather and be briefed on the programme for the coming eight weeks. The scheduled two weeks of training at the Port Adelaide campus began as usual with Sea Safety and Senior First Aid training to prepare the trainees for their seagoing work experience. The rest of the time was spent developing navigational skills using the Academy's wheelhouse simulator. AFA staff set the trainees various simulated voyages around the islands of Port Lincoln and let them test their skills in preparing, undertaking and navigating a trip safely.

Each programme has included a visit to a sporting event while in Adelaide and now that the football season was underway it seemed a good idea to introduce the trainees to the wonderful game of Australian Rules football. They were lucky, because what was promising to be one of the games of the season, Port Adelaide versus Collingwood (a team from Melbourne), was to be played while they were in Adelaide. Collingwood had surprisingly knocked Port Adelaide (known as "the Power") out of the 2003 finals and went on to lose the grand finalists to the Brisbane Lions, so emotions were sure to be high. Seats were secured for the match, played on a Sunday at Adelaide's famous AAMI Stadium. Trainees were told that the chief executive of AFA was a "one-eyed" Power supporter, so any cheering for Collingwood would be severely frowned upon and the rules of the game explained! The end result was that the Power won, the chief executive was ecstatic, and the trainees surely went away knowing that Aussie Rules is a far superior game to rugby!

The programme moved to the Port Lincoln campus at the beginning of May, taking the trainees by road to their new home so they could see some of the South Australian scenery and the beginning of the outback, which is such a contrast to their own tropical islands. They were again accommodated on the waterfront in the marina complex, where they were able to watch at close quarters the movements of the local fishing fleet. AFA and SPC believe this interaction with Australia's largest and most diverse fishing fleet is a vital part of the traineeship programme and allows the trainees to be right in the middle of some of the busiest and most successful fisheries in the country.

The Port Lincoln part of the programme began with a look at local fishing vessels, processing factories and aquaculture farms. The advantage of Port Lincoln as a magnificent seafood industry training centre was again highlighted, with trainees able to see at first hand a broad spectrum of fishing, aquaculture and seafood processing methods. This two-week section of the programme consisted of training in vessel handling, fishing techniques, electronic fish finding, seafood handling and fisheries management including environmental issues, now such a critical aspect of all fisheries-related training. AFA staff were able to use the newly developed SPC training resources for protected marine species as part of

Top left: Trainees Marakia Karakaua (Kiribati), "Pa" Pokina (Cook Islands), Simon Salesa (Tuvalu), Kepera Ovau (PNG) and Tara Une (Cook Islands) relaxing on board the Australian Fisheries Academy training vessel, MV *Tucana*.

Top right: Kepera Ovau (PNG) plotting a course aboard the Australian Fisheries Academy training vessel, MV *Tucana*.

Bottom left: Tara Une (Cook Islands) at the helm of the Australian Fisheries Academy training vessel, MV *Tucana*.

Bottom right: Simon Salesa (Tuvalu) and Marakia Karakaua (Kiribati) on board their host longliner in Mooloolaba before departing for seagoing work experience.

the programme and reported very favourably on the professionalism, relevance and usefulness of the material.

A graduation barbecue for the trainees was held on the boardwalk at the Marina Hotel on 20 May, where the graduates celebrated the end of the campus-based component of the 2004 programme with AFA staff and local fishers, and were presented with an AFA/SPC Pacific Island Fisher's certificate as well as Sea Safety, First Aid and Navigation Workshop certificates of completion.

The trainees were then ready to join their Australian fishing vessels which, as always, are selected to represent a similar fishery to the one they fish in at home. Because all the trainees this time worked in longline fisheries, Mooloolaba on Queensland's east coast was the chosen port for work experience. The longline fleet here work very much to moon phases so the programme was timed so that the trainees arrived in Mooloolaba just before the fleet put to sea again. Rusty Strickland, who had been working in Papua New Guinea for four years on the AusAID-funded National Fisheries College Strengthening Project, was now based near Mooloolaba and joined the AFA team as mentor and liaison person for the trainees while they undertook their work experience.

The third traineeship has again been a great success with trainees doing well in their training at the AFA campuses and so further developing their skills as commercial fishers. The experience they gained through working in the Australian fishing industry and seeing first-hand how Australian vessels operate will be of great benefit to the fishing industry in their own countries. As with the first two groups of trainees, they were enthusiastic and committed, and they demonstrated a great desire to learn new skills. The feedback from the host employers in Mooloolaba was excellent, and they repeated the thoughts of AFA staff that the trainees represented their countries admirably, applied themselves well to their tasks and would be welcome back at any time.

NEW DEEP SETTING TECHNIQUE TESTED IN MOOLOOLABA, AUSTRALIA

Steve Beverly, Fisheries Development Officer, SPC & Elton Robinson, SeaNet

A new technique for setting tuna and swordfish longlines that was designed to avoid shallow water bycatch species and improve catch rates for bigeye tuna has been tested. SPC's Fisheries Development Officer, Steve Beverly, with the help of the Australian Fisheries Management Authority (AFMA), SeaNet (www.oceanwatch.org.au), and two longline fishing companies operating out of Mooloolaba in Queensland, Australia, were behind the experiment.

The objectives of the project – which took place during March, April, and May 2004 – were to perfect the new deep setting technique so that it could be duplicated by any longline boat, and to test it alongside normal setting practices to see if catch rates changed. To be feasible, the new technique had to either improve or not change catch rates for the main target species, bigeye tuna and broadbill swordfish.

The vessels used for the fishing trials were Southern Moves' vessel, F/V *Blue Moves* (Fig. 1), and Cafferel Tuna's vessel, F/V *Diamax* (Fig. 2). The project could not have been completed without the generous support of the fishing fleet. F/V *Blue Moves* and F/V *Diamax* are part of the Mooloolaba fleet that fishes in Australia's Eastern Tuna and Billfish Fishery, which is managed by AFMA. AFMA provided funding for the project under their Eastern Tuna and Billfish Management Advising Committee – Initiated Research Fund. SeaNet provided logistical support and liaison with local operators. Two trips were made, one on each boat. All bugs were worked out of the setting technique on F/V *Blue Moves* so that data could be collected on the trip on F/V *Diamax*. Temperature and depth recorders, or TDRs, were used on all project baskets and on some normal baskets for comparison.

Figure 1 (top): F/V *Blue Moves*
Figure 2 (bottom): F/V *Diamax*

Background

Pelagic longlining targets tuna and billfish species but also catches other species that may or may not be marketable. Target species include bigeye tuna (*Thunnus obesus*), yellowfin tuna (*T. albacares*), albacore tuna

(*T. alulunga*), broadbill swordfish (*Xiphias gladius*), and striped marlin (*Tetrapterus audax*). There are two groups of non-target species caught by longliners: byproduct and bycatch. Byproduct species include those that are not targeted but are retained because they have commercial value. These include species such as mahi mahi, or dolphin fish (*Coryphaena hippurus*), wahoo (*Acanthocybium solandri*), opah, or moonfish (*Lampris guttatus*), and some billfish and shark species among many others.

Bycatch species are those non-target species that are discarded because they either have no commercial value or because they are endangered and are protected by international law. Discarded bycatch species that have no commercial value include species such as lancetfish (*Alepisaurus* spp), snake mackerel (*Gempylus serpens*), pelagic rays (*Dasyatis violacea*), some sharks, and undersized tunas and billfish, among many others. Discarded bycatch species that are endangered and are protected by international law include sea turtles, sea birds, marine mammals, some shark species and, in some areas, billfish.

There are seven species of sea turtles worldwide: loggerhead (*Caretta caretta*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), olive ridley (*Lepidochelys olivacea*), flatback (*Natator depressus*), leatherback (*Dermochelys coriacea*) and the Kemp's ridley (*Lepidochelys kempii*), which only occurs in the Gulf of Mexico and the northwest Atlantic.

SPC's Oceanic Fisheries Programme reviewed turtle bycatch in the western and central Pacific Ocean tuna fisheries for the South Pacific Regional Environmental Programme's (SPREP) Regional Marine Turtle Conservation Programme. The review stated that incidental catches of sea turtles in the longline fishery occur when turtles encounter baited hooks or when they get entangled in mainlines or floatlines. When mortality occurs it is typically due to drowning. If turtles are hauled just after getting hooked or entangled they usually survive. Observer reports show that tropical areas have more turtle encounters and that depth of set appears to be the most important factor. Analysis of data suggests that bait and time of set do not have as much of an effect as depth of set. Estimates from observer data show that turtle encounters on shallow sets are 10 times higher than on deep sets, and that when there are turtle encounters on deep sets they are almost always on the shallowest hooks in the set. "This suggests that there is probably a critical depth range of hooks where most marine turtle encounters would be expected to occur in the western tropical Pacific longline fishery" (SPC 2001).

A Hawaii study of turtle dive-depth distribution revealed that loggerheads spend most of their time in depths shallower than 100 m, and that even though olive ridleys dove deeper than loggerheads, only about 10 per cent of their time was spent deeper than 100 m (Polovina et al. 2003). The report concluded that incidental catches of turtles should be substantially reduced with the elimination of shallow longline sets. If the new deep setting technique could land all hooks below 100 m and still fish effectively, then it could be a solution to the turtle bycatch issue as the surface down to 100 metres seems to be the critical depth range of most sea turtles. (See *Fisheries Newsletter # 93* for a discussion of the turtle bycatch issue in the Hawaiian longline fishery).

Pelagic longlines can be set to fish at a variety of depths from near surface waters to depths down to 400 and 500 m, depending on target species. Even deep-set lines, however, have a high percentage of their hooks – the ones nearest the floats – fishing in shallow water. Since the 1970s, longline fishing has evolved, and much more has been learned about the vertical distribution of main target species, relationships of catches to thermocline depth and other environmental factors, and actual depths and shapes of longline sets. The introduction of monofilament longline systems using mechanised line setters, or shooters, has allowed fishermen to increase and to control the depth of set by throwing line out at a rate faster than the speed of the vessel. But, without the use of TDRs, it is difficult to know for sure the actual depth achieved because of environmental factors. One thing has not changed, however. The basic shape of the longline has always been a catenary type curve – the shape taken by a chain or cable suspended between two points and acted upon by gravity. Even with deep sets a substantial portion of the branchlines in the catenary curve remain at shallow depths.

Generally, longline gear fishing deeper in the water column is more effective in targeting bigeye tuna, probably due to the preference of bigeye tuna for 10-15°C water (Hampton et al. 1998). Prior to 1974, though, virtually all longliners operating in the Pacific set their hooks in shallow depths. Deep setting was introduced around the latter part of 1974 and was quickly adopted by most vessels targeting bigeye tuna in equatorial Pacific waters. Gear with more than 10 branchlines per basket was considered to be deep gear. A basket with 6 branchlines was assumed to fish at 170 m, while a basket with 13 branchlines was assumed to fish at 300 m (Fig. 3). Bigeye catch rates were better on deep sets and catch

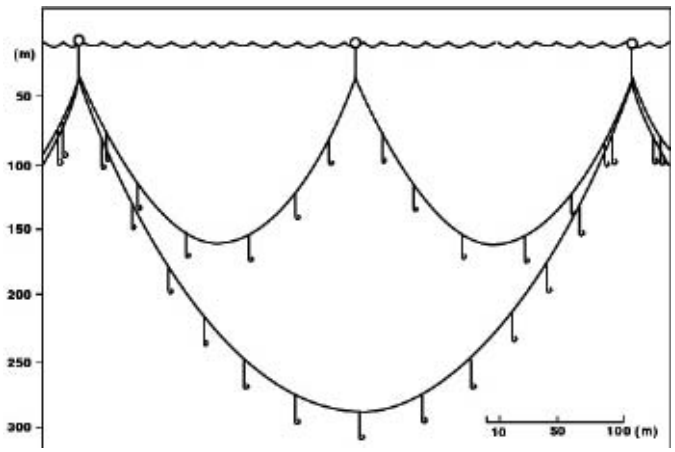


Figure 3: Catenary curves of regular longlines with 6 branchlines and with 13 branchlines per basket (Suzuki and Warashina 1977).

rates for all other species decreased with deep sets.

Since the advent of deep setting, however, some fleets have reverted back to shallow setting. Shallow sets are made during a two-week period – one week before and one week after a full moon. The sets are generally made at night and target bigeye tuna. Longliners targeting broadbill swordfish use roughly the same strategy – shallow night sets using squid bait and lightsticks and fishing around a full moon. The longline fleet operating in the Eastern Tuna and Billfish Fishery in Australia has, for the most part, adopted this technique.

New deep setting technique

A need was seen to develop a method that would take advantage of the habits of turtles and bigeye tuna by avoiding one while targeting the other. The problem was how to set and haul a pelagic longline that fished only in water below 100 m. At the same time, the method had to be easily adaptable by longline fishermen. The initial concept for the project was first presented at SCTB16 in Mooloolaba in 2003 (see *Fisheries Newsletter # 106*).

For the new deep setting technique, normal floatlines were used in pairs separated by a blank section of mainline with no baited branchlines for a distance of 50 m. The section of mainline that holds the baited branchlines was suspended directly under these floats and was weighted down at each end by a 3 kg lead weight attached to the mainline by a standard snap (Fig. 4). The distance between the floats and the lead weights was the target depth for the shallowest hooks in the basket – 100 metres. Therefore, portions of the mainline acted as supplemental floatlines. These portions of the mainline being used as supplemental floatlines were hauled the same as the rest of the mainline. All parameters, such as target depth of shallowest hooks, were simple to change and the only new gear needed was lead weights with lines and snaps, additional floats and floatlines, and additional mainline. All other fishing gear remained the same as the boats normally used.

The experimental longline was set as follows: The line setting timer was set so that every beep corresponded to 50 m of line. Then, a float with normal floatline was attached to the mainline and thrown overboard as the boat was underway. The mainline was ejected by the line setter at a rate slightly faster than the speed of the boat. After 50 m of line was paid out, a second float was deployed. Then 100 m of mainline was paid out in the same manner. This section of mainline acted as a supplemental floatline. The length

Figure 4: Three kilogram lead weight with swivel snap

of this section was metered using the line-setting timer. One beep of the line setting timer equalled 50 m, so there was one beep between the two paired floats and two beeps between the second float and the first lead weight. After the first weight was deployed, baited branchlines were attached to the mainline in the normal fashion. After 12 to 20 branchlines (one basket) were deployed, a second lead weight was attached to the mainline. The second lead weight was attached at the beep normally used to signify a float (i.e. the end of that basket). A float was attached after two more beeps and a second float on the next beep and the whole process was then repeated.

The sagging rate – the ratio between the distance the boat travelled for one basket and the length of line paid out for one basket – needed to be pre-determined. The sagging rate calculation for the weighted deep sets was similar to sagging rate calculations for a normal longline set except that the expected shape of the line from float to float was rectangular rather than a simple curve. Sagging rate was based on: target depth of the shallowest hook, distance between hooks, distance between the paired floats, and basket size. Sagging rate was easy to calculate but was different for each target depth of shallowest hook and for different basket sizes.

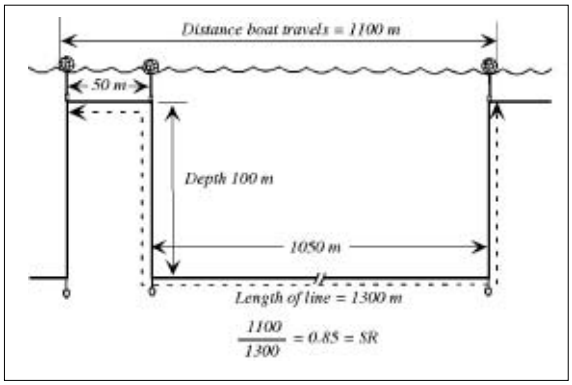


Figure 5: Calculating sagging rate for one basket using the deep setting technique

Total distance travelled by the boat for each basket was equal to total length of line paid out minus twice the depth. Total line paid out for each basket was equal to the length of line in the basket (the portion with branchlines attached) plus twice the depth, plus the distance between the two floats at the end of the basket. The ratio of these two numbers, length of line paid out and distance travelled by the boat, gave the sagging rate. For example, if the target depth of the shallowest hook was 100 m and there were 20 hooks in a basket with 50 m intervals between hooks, then the boat travelled 1050 m + 50 m = 1100 m. The length of line paid out was 1100 m + 2 x depth, or 1300 m. Therefore, the sagging rate equalled 1100 m/1300 m, or 0.85 (Fig. 5).

Once the sagging rate had been calculated, it could be used to adjust boat speed and line setter speed. In the above example, if line setter speed was 10 kt then boat speed was set at 8.5 kt – in order to eject ample line to get the line to settle as planned. Theoretically, if all parameters were followed, there shouldn't have been much sag in the fishing part of the line. It should have taken on a roughly rectangular shape with the fishing portion of the line lying parallel to the surface (as in the schematic diagram in Fig. 5). During trials, however, it was found that some sag still occurred between the lead weights. Therefore, the line actually fished at a variety of depths, but all below the target depth of the shallowest hook. The sag was probably caused by the weight of individual branchlines.

Standard longline snaps weigh 45 grams, and hooks weigh 15 grams each. These two components alone would add 1.2 kg to a 20-hook basket. If necessary, more sag could have been put into the fishing portion of the line by decreasing boat speed or by increasing the number of hooks in a basket, as with normal setting, and conversely, sag could have been reduced by increasing boat speed.

Fishing trials

Trip narrative: F/V Blue Moves

On 29 March, F/V *Blue Moves* got underway from Mooloolaba at 1715 hours, heading south. Between 30 March and 6 April, seven sets were made in coastal waters along the continental shelf around 29° S and 154° E. Each set consisted of 1000 hooks baited with *Illex* spp. squid with a light stick on every other branchline. Sets were made generally just on or after sunset and hauls were made the following day starting in the morning.

Fishing was generally terrible. A total of 7000 hooks yielded only 51 saleable fish (not counting numerous *Escolar* spp. that were retained but are of low value). The catch consisted of 14 yellowfin tuna, 2 bigeye tuna, 27 mahi mahi, 3 swordfish, and 5 albacore weighing approximately 1.5 metric tonnes.

Unfortunately, poor catches like this had been typical for the Mooloolaba fleet for the previous six months (see *Fisheries Newsletter # 108*).

On a more positive note, the new deep setting technique worked fine. Project baskets were set on three of the seven sets, two using the line setter and one without using the line setter. The boat's normal technique was to not use the line setter, but instead do a typical

swordfish type set (shallow night set around the full moon using squid and lightsticks). Baskets had 12 hooks each. During the project sets, basket size was kept at 12 hooks but the setting sequence was changed for the deep set baskets. TDRs (Fig. 6) were attached at both ends and at the middle of each basket to monitor set depth, and were set to record every 10 minutes. TDRs were also put on some normal baskets for comparison.

Project results were generally good. Actual depths corresponded to target depths for the shallowest hooks of about 100 m on the sets using the line setter. The gear was somewhat cumbersome to set at first but hauling went without difficulty. In fact, the line came up very easily as it was made taut by the weights.

Results from the set using lead weights but no line setter showed that lead weights have almost no effect on sinking the mainline if there is no sag put into the line. The line initially sank to 45 m but came back up to normal depth of 25 m with the stretch and spring back of the line. Therefore, the deep setting technique did not work without using a line setter.

The trip on F/V *Blue Moves* was considered to be a shakedown cruise to work out any bugs in the deep setting technique. Some modifications were made to the gear after the first set. The lines on the lead weights were shortened to 0.5 m and the lines on the TDRs were shortened as well.

This made the setting sequence much easier on the third set. It was determined that 50 m between floats was sufficient to avoid tangles with the portions of mainline acting as floatline. Also, the technique of using the line setting timer to regulate depth was initiated.

Figure 6: Star-Oddi TDR (www.Star-Oddi.com)

Trip narrative: F/V Diamax

On 21 April, F/V *Diamax* got underway from Mooloolaba, heading northwest. After three days of travel, two sets were made around 18° S and 155° E without much luck. A decision was made to head south after the poor fishing in the north. A temperature break was identified using the on-board real-time altimetric charts from MaxSea (www.maxsea.com). The remaining five sets were carried out around 23° S and 156° E fishing between the 24°C and 25°C surface isotherms. Fishing improved a great deal so no further movements were made other than slight adjustments. On each set, 400 hooks in 20 hook baskets were set using lead weights while 600 hooks were set using normal gear configurations in 10 or 20 hook baskets. TDRs were put on both types of baskets. It was decided to keep the target depth of the shallowest hook at 100 m, knowing that the sag would place the middle of the baskets deeper. Sagging rate for the set was 0.85. Figure 7 is a schematic

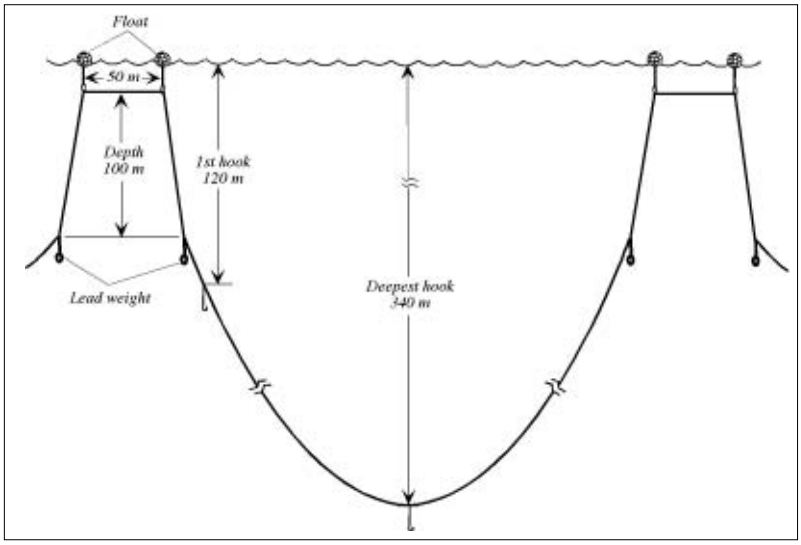


Figure 7: Diagram showing configuration of weighted gear with 20 hooks per basket and target depth for shallowest hook of 100 m using a sagging rate of 0.85.

of the theoretical shape of that basket.

A large swordfish (Fig. 8) was caught on the same set. Fortunately, there was a TDR attached adjacent to the branchline that was taken by the swordfish. The depth was 130 m and bite time was 17h15 for a daytime swordfish bite. The spike in the line was caused by the swordfish swimming away from the line, causing it to rise. The swordfish presumably died at midnight when the depth line went flat.

Several bigeye tuna (Fig. 9) were caught on the weighted gear. TDR data often showed spikes indicating depth and time of bite.

Fishing effort and catch on F/V Diamax

In the sets using project gear configurations, 6000 hooks were set, 2420 with lead weights and 3580 without lead weights. A total of 69 fish of the five main target species were caught (bigeye, yellowfin, albacore, swordfish, and striped marlin). The project gear caught 31 target species fish, weighing 1184 kg on 2420 hooks, giving nominal CPUEs of 1.3 fish per 100 hooks and 49 kg/100 hooks. The normal gear caught 38 target species fish, weighing 1452 kg on 3520 hooks, giving nominal CPUEs of 1.08 fish per 100 hooks and 41 kg/100 hooks. These CPUEs were based on average fish weights. Bigeye tuna, averaged 37.6 kg gilled and gutted (G&G). By observation, fish caught on the deeper weighted gear were generally bigger than fish caught on the shallower gear. This included a 90 kg (G&G) bigeye tuna and a 188 kg headed and gutted (H&G) broadbill swordfish. Project gear outfished the normal gear by about 17 per cent.

Figure 8 (top): Crew of F/V *Diamax* with 200 kg swordfish caught on a deep day set using the new deep setting technique.

Figure 9 (bottom): One hundred kg bigeye tuna caught with the new deep setting technique.

Further manipulation of the catch figures shows CPUEs for normal gear for bigeye tuna of 0.56 fish /100 hooks and 21 kg/100 hooks, while CPUEs for project gear for bigeye tuna were 0.95 fish /100 hooks and 36 kg/100 hooks. Therefore, project gear outfished normal gear for the main target species by 42 per cent. For swordfish, the normal gear had CPUEs of 0.3 fish/100 hooks and 17 kg/100 hooks. For the project gear swordfish CPUEs were 0.25 fish/100 hooks and 14 kg/100 hooks – about the same as with the normal gear. All of the swordfish caught on the project gear were caught at depths greater than 100 m and many were caught during daylight hours.

Discussion and conclusions

Most of the original design parameters of the deep setting technique were retained but others were changed, most during the trip on F/V *Blue Moves*, but some on F/V *Diamax*. It was found that 3 kg lead weights were sufficient to sink the fishing portion of the line down to the target depth of the shallowest hook. Lines for attaching the lead weights to the mainline only need to be about 0.5 metres long, and one standard longline snap was enough to keep the lead weights in place. Originally, the lines were 4 m long and had two snaps to keep them from sliding on the mainline. These proved to be too cumbersome, especially during setting. Floatline lengths of 10 m were sufficient and, in any case, had little effect on target depth of shallowest hooks, other than adding to the overall depth achieved by a small amount. Fifty metres was enough for the distance between the two floats at each end of a basket to keep the longer portions of mainline being used as supplemental floatline from tangling. These lines became entangled only once and that was when a large swordfish was hooked on the first hook in a basket and pulled the lines together. Two sizes of hard plastic longline floats were used during the trials – 300 mm floats with 14.5 kg buoyancy, and 360 mm floats with 20 kg buoyancy. The 300 mm floats proved to be sufficient to support the 3 kg lead weights and the longline. The setting timer proved to be very useful in regulating the distance between floats and lead weights (i.e. the target depth of the shallowest hook). The original expectation of the entire basket of branchlines fishing at or near the same depth was unrealistic and, in fact, was not realised. The fishing portion of the line suspended between the two lead weights hung in a sagging shape, similar to the sag normally encountered in longline fishing. This worked out to be advantageous as a range of depths could be fished, all below the target depth of the shallowest hook. In other words, nothing changed in the way the line fished except that everything was displaced 100 m downwards.

All original project objectives were met. The technique was perfected and proved to work almost flawlessly. Experienced longline fishermen should have little or no trouble adapting to the technique. Target depths were achieved so that all hooks fished below the mixed layer where bycatch encounters normally occur. The technique was simple enough so that it could be duplicated on almost any longline vessel using a monofilament system with a reel and line setter. Finally, target species CPUEs on F/V *Diamax*, compared with the normal portion of the sets, were enhanced or unchanged, depending on species and, although one short trip was not statistically significant, it may be considered to be indicative.

There were some drawbacks to the technique, however. More gear was needed to conduct the deep setting technique – additional floats and floatlines, lead weights with line and snaps, and more mainline. For a boat setting 1000 hooks in 20 hook baskets this would cost around AUD 4000. It could be cheaper if less expensive weights were used. More time was needed to set and haul the weighted gear. For example, if the target depth for the shallowest hooks was 100 m then 50 seconds more setting time was needed for each basket (providing that 10 seconds equalled 50 m of line being ejected from the line setter). A similar increase in time was needed for hauling. For a line totalling 1000 hooks with 20 hooks per basket, this would add 105 minutes to time spent on deck. Lastly, fewer yellowfin tuna and byproduct species were caught on the deep-set gear. Byproduct species add significantly to a longline vessel's revenue, but species such as mahi mahi, tend to bite during the haul so catch rates for these fish wouldn't be affected.

Results from the F/V *Diamax* were encouraging but were only indicative of the new deep setting technique's possibilities. No turtles were caught, but this was expected. Turtle encounters in the longline fishery are infrequent. What was shown, however, was that all hooks in a longline can be set in the zone outside of where turtle encounters normally occur. By inference, no turtles would have been caught unless they struck baits as the line was being set or hauled, or if they became entangled in floatlines. The same can be said for other shallow water bycatch species. The slight increase in nominal target species CPUEs using the deep setting technique as compared with normal setting during the trip on F/V *Diamax* was also only indicative of what might hap-

pen in the longer term. More work needs to be done to prove the efficacy of this new technique and to show that it can significantly mitigate encounters with turtles and other bycatch species while, at the same time, significantly increase the nominal CPUE of deep water target species, especially bigeye tuna. Work also needs to be done to ascertain if the deep setting technique will prove to be feasible for deep day swordfish sets. The 200 kg swordfish caught at 130 m at 1700 hours on F/V Diamax was astounding but was also only indicative.

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REGIONAL TRAINING WORKSHOP IN TILAPIA AND FRESHWATER SHRIMP AQUACULTURE

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Background and purpose

A short-term training course on tilapia and freshwater shrimp farming was held in Suva, Fiji from 10–28 May 2004. The training course was a collaborative effort by the Secretariat of the Pacific Community's Aquaculture Section, the University of the South Pacific's Marine Studies Program, and Fiji's Ministry of Agriculture, Fisheries and Forestry. Satya Nandlal, SPC's Aquaculture Officer, was the lead trainer for the workshop.

The workshop was initiated when regional aquaculture officers expressed a need for in-depth training of tilapia hatchery operations and pond growout aspects. SPC staff reported a lack of basic skills and knowledge of tilapia fry production as a major problem confronting freshwater aquaculture centres in the region. A lack of fry affects the production aspects of tilapia as well, which in turn affects the livelihood of the thousands of poor farmers involved in aquaculture in the region (e.g. in Papua New Guinea and Fiji). In addition, aquaculture officers in several member countries (e.g. Vanuatu and Fiji) had already acquired skills in freshwater prawn hatchery operations and had requested training in pond growout of prawns.

One of the major problems in producing tilapia fry stock has been the lack of skills for good management of broodstock, and the identification of maturity conditions of breeders. Furthermore, culturing sufficient quantities of tilapia and prawns in ponds (i.e. with good growth rates, less mortality, good feed conversion ratios etc.), remains a difficulty in many countries. Although the technologies for spawning tilapia – using various methods and pond growout – are established, their application is not widely known in the Pacific region. There is a need to disseminate information about these technologies.

The idea of ensuring an adequate supply of trained staff and, thereby, sustaining aquaculture is shared both by SPC and its training partner, the University of the South Pacific.

The aims of the three-week training course were to:

- provide trainees with theoretical information and hands-on training in various aspects of tilapia fry production, broodstock management and identification of maturity conditions, pond/tank/hapa hatchery methods and preparation, stocking, feeding, fertilization, sampling, harvesting, transportation and marketing;
- provide trainees with theory and hands-on training in tilapia and shrimp pond site selection, mechanical and manual pond construction, pond preparation, stocking, sampling, feeding, fertilizing, harvesting, transporting and marketing; and
- identify pressing issues within the region and provide an opportunity to discuss collaborative projects.

USP's Marine Studies Program hosted the training course using its lecture room facilities and the Naduruloulou Aquaculture Station. Monfort Boystown Fish Farm provided its facilities for practical work.

Twenty-three aquaculture officers with varying levels of responsibility, attended the course. Countries represented included: American Samoa, Fiji Islands, Papua New Guinea, Palau, Samoa, Solomon Islands and Vanuatu. In these countries, tilapia and prawn farming are developing, and in some cases have already developed, into small enterprises.

Lectures and field exercises/ demonstrations

To acquaint participants with principles and techniques of tilapia hatchery operation, lectures on tilapia and prawn pond growout, the specific topics covered during the training included:

Tilapia hatchery operation

- General aspects of tilapia fry production in the Pacific
- Biological characteristics of tilapia
- Broodstock management, feeding, conditioning and selection
- Hatchery methods
  - open pond
  - hapa
  - tank
- Selection and stocking of broodfish

- Spawning/maturity condition of females and males
  - Size of broodfish
  - Fry collection method for each of the above hatchery methods
  - Timing of fry collection
  - Procedure for counting
  - Broodfish replacement and rotation strategies

Pond growout of tilapia and prawn

- Present state of tilapia and prawn/shrimp production in the Pacific
- Systems of production/culture technique
- Choice of species and biophysical requirements
- Biological, social and legal considerations, marketing and economics
- Site selection and culture systems: instruction in determining the adequacy of water supply, suitable soils and slope for pond construction, food and fertilizers.
- Farm design and pond construction: demonstration of how to vary the depth of soil removal for adequate bottom slope to facilitate complete drainage, how to build a diversion canal, how to build adequate height, width and slope of bunds/pond wall.
- Water management.
- Pond preparation and filling: how to properly clean and dry ponds, demonstrating lime and pesticide application, regulation of pond water supply.
- Application of fertilizer and lime. Pond fertilization: value of applying fertilizer and lime to a pond, the application (how, when, where and rates) of adding fertilizer and lime to a pond, judging if fertility is sufficient, or if fertilizer is required (and if so, in what quantity and types of fertilizers).
- Stocking: optimum stocking densities, fingerling quality and optimum sizes, identifying characteristics of stunted fish, supply sources of fingerlings and post larvae.
- Pond management: feeds, feeding and sampling, including the importance of supplemental feeding, feed formulation, ingredients or feeds available and their costs, value of higher protein feeds, mixing of ingredients and percent of constituents in food to increase quality and feed schedules. Time of day to feed and amounts of feed according to estimated or actual growth rates of fish or prawns.
- Harvesting: determining optimum harvesting times and methods, netting/seining techniques, draining and pick-up of remaining fish and prawns.
- Transportation of live fish and prawns, including sorting, grading, packing, storage and preservation.
- Marketing/off flavours: the importance of keeping fish in clean water 12 hours prior to sales or cooking.
- Disease control and basic quarantine procedures.
- Tilapia/shrimp business plan and economic modeling, including prawn sales in markets.
- Tilapia/shrimp extension method: how to work with farmers.

Practical work

Following the lecture and classroom activities, participants were divided into groups where they undertook practical work on hatchery operations and growout. Practicals included: preparation of tanks, hapas and ponds for tilapia breeding at Naduruloulou and Monfort, identifying maturity conditions of males and females, selection of "ready to spawn" breeders, and stocking the three hatchery systems. Thereafter, participants prepared feed and fertilizer rations and provided guidelines for feeding and maintenance of the different systems. Fry collection and harvesting techniques were demonstrated 12–20 days after stocking.

The practicals on growout included: site selection, manual pond construction at Naduruloulou, pond preparation (cleaning, liming, and application of derris root, repair of pond walls, inlets and outlets). Participants seined, counted, weighed, and packed tilapia fingerlings and post larvae into oxygenated plastic bags and transported them to farms to be stocked into ponds. The acclimatization procedure was demonstrated and thereafter, tilapia were released into ponds. Feeding rations and fertilizer requirements were calculated, including total feed requirements for the whole cycle. Participants identified the various types of feed at Naduruloulou, and calculated the required crude protein levels for feed formulation at the different stages of tilapia and prawn feeding. Production tilapia grower mix, fry mix and pellets were formulated and prepared using the machines at Naduruloulou Station.

Participants also sampled tilapia and prawns using cast nets. In addition, tilapia and prawns were seined, transported live via truck (prawns in ice boxes) to

Naduruloulou for purging overnight, and then transported to Nausori market the following day for marketing. Participants carried marketing and then calculated the costs/economics involved in tilapia/prawn farming. The cash was returned to the farmer.

Field trips

Participants visited Kimble's tilapia farms at Navua, Waila fish farm and Rokoraite fish and prawn farm. Briefings on farm activities were made by Satya Nandlal. Participants harvested tilapia from Waila farm and prawns from Rokoraite farm as part of their exercise in harvesting, transporting and marketing of fish and prawns. Naduruloulou and Monfort sites were used throughout the training period for performing all other practical aspects of the training.

Study Experience Reports

A report based on the knowledge gained to solve a specific problem in participants' country was prepared and presented by each participant on the last day of training. Visiting aquaculture delegates, Mr Barney Smith of ACIAR-Australia, Dr M.V. Gupta of the WorldFish Center, Dr Yves Harache of Ifremer Noumea, and Mr Ben Ponia of SPC attended this session and provided comments. This report was also reviewed by the instructor.

Discussion

Participants were encouraged to discuss the training course topics with the instructor and among themselves after each lecture or practical exercise/demonstration.

At the end of the course, certificates of attendance were given to participants by Barney Smith, Dr M.V. Gupta and Dr Yves Harache.

Training highlights

1. Trainees successfully performed tilapia spawning using the three hatchery methods at both training venues: Naduruloulou Aquaculture Station and Monfort fish farm.

2. Trainees manually constructed a pond at Naduruloulou Station.

3. Trainees seined, cleaned, graded, packed and sold prawns and tilapia as part of the practical exercise.

4. Trainees formulated and prepared tilapia fry mix, grower mix and tilapia pellet diet using machines at Naduruloulou.

5. Aquaculture delegates, Mr Barney Smith of ACIAR-Australia, Dr M.V. Gupta of the Worldfish Center, Dr Yves Harache of Ifremer Noumea, and Mr Ben Ponia of SPC presented their views on future developments of tilapia and prawn aquaculture in the region.

Training course evaluation

At the end of the training, participants answered several questions, which were used to evaluate the course.

1. What did you like about this workshop?

2. What did you not like about this workshop?

3. How could this workshop be improved?

4. Any other comments?

For question 1, responses included: "having practicals to accompany the theory was a good idea", "the training was a good learning experience", "learning in the "Pacific way"", "the contents of the workshop really met my needs in area of freshwater aquaculture" "easy to communicate with tutors", "hands-on training for every aspect are done practically", "time well utilized", "very informative" "workshop was well organized", "know my fish-meet my needs-play with them-in return they will give me the answer to my questions".

For question 2, participants responded by saying: "the workshop is too short", "practical sessions should be full-day sessions", "lecturing is very fast", "proper aids were hard to find, computers, etc.", "the level of teaching materials … was very helpful for some of participants..but some lagged behind contributed to delays", "the program was too tight and there was no room to breath", "always running against time", "coming late at night", "very intensive", "lecture room was a bit crowded", "lunch breaks were too short", "had to start early 7.00 and finish 6-7 pm".

In response to question 3, participants said: "increase workshop durations", "more time given", "handouts prepared before class", "more time to practicals", "3 weeks is not good enough for me as I like learn more-make it 3 months", "the lecture venue should be closer to the field", "another follow up…at least 6 weeks", "include visits to highland farms", "no work done on weekends", "give enough time to rest", "minimum requirement for participation (e.g. diploma and experience)", "teach based on same topic".

For question 4, participants said: "workshop equipped me with new informations", "it helped me a lot to see where I could solve some problems", "this is the best aquaculture training I have ever participated in", "better if participants stay together",. request for follow up training", "very valuable training",

"another separate training should be done on farm development aspects", "no comments but it was a wonderful sessions that have already offered to us by Mr. Satya, thank you", "thank the organizers, "future training.. consider equal number of female participant or male", "cage culture of tilapia should be considered in future training", "more allowance be given", and "thank you very much".

In general, the course was evaluated as "just right" by the majority of participants. The instructors were also satisfied with the outcomes of this training and felt that refresher training would be essential for all participants, although there may be a greater need for some than for others. Research and training institutions could develop facilities for such short-term refresher courses for various categories of personnel in order to upgrade their knowledge and skills, with reference to major advances in technology.

Conclusion

A shortage of fingerlings and poor production of tilapia and prawns have been major problems confronting freshwater aquaculture centres in certain Pacific Island countries. It is anticipated that training would enhance the sustainability of tilapia and prawn farming, and would maintain the momentum of the development achieved thus far. Course instructors believe that the economic and social factors relating directly to the fish farmer, his family, and his community must be understood and considered fully by extension officers, if the full effects of this training are to be realised. In particular, there is a need to document cases showing the strength and weaknesses of fish farmers and to establish a framework for generating more effective and creative interactions between farmers and extension officers in the region. It is anticipated that participants will maintain contact with instructors and that instructors would, in turn, be able to advise on specific technical issues.

Acknowledgement

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Top: Fiji's Minister of Agriculture, Fisheries and Forestry Hon. Konisi Yabaki at the opening of the workshop

Right: Break time

1. **Trainees preparing tanks for tilapia breeding at Naduruloulou**
2. **Trainee Peter Minimulu of PNG leading by example in preparing a pond for prawn stocking**
3. **Trainees Sompert and Glen from Vanuatu with a "catch".**
4. **Trainees in full-swing at pond construction assignment**
5. **Trainees harvesting prawns at Rokoraite farm**
6. **Sorting, grading and weighing prawns.**