Fisheries Newsletter

Number 127 (October – December 2008) *ISSN 0248-076X*

Editorial

Welcome to issue 127 of the Fisheries Newsletter. This issue features an article by Johann Bell et al. in which the authors discuss how household income and expenditure surveys can be modified to help government monitor, amongst other things, how much fish is being consumed in rural and urban areas, and how many households use fish for subsistence.

On a more personal note, this will be the last Fisheries Newsletter I will produce. I will leave SPC in June 2009 after more than 20 years of service. My colleague Aymeric Desurmont (AymericD@spc.int) will be in charge of producing the newsletter, which will now be published three times a year instead of four. Thank you for your interest, support, contributions and comments during all these years. Merci!

Jean-Paul Gaudechoux
Fisheries Information Adviser (JeanpaulG@spc.int)

Three-month-old aquacultured *Siganus argenteus*

in This Issue

SECRETARIAT OF THE PACIFIC COMMUNITY
Prepared by the Information Section of the Marine Resources Division and printed with financial assistance from France.

REEF FISHERIES OBSERVATORY

Staff of the coastal component of the European Union funded Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C) and the Coastal Fisheries Development Programme (CoFish) continued to compile and edit country reports as well as conduct some follow-up finfish surveys in Tonga. In addition, analysis of the PROCFish/C regional dataset continued with the assistance of Auckland UniServices Limited, the group contracted by the project to provide statistical assistance.

Update on the compilation, finalisation and publishing of country reports

During the fourth quarter, Ms Sarah Langi and Ms Celine Barre made good progress with compiling and editing country reports. The first three reports (Vanuatu, Nauru and Tuvalu) were published in the third quarter. Final drafts of reports for French Polynesia, Wallis and Futuna, Niue, Samoa, Kiribati, and Papua New Guinea (PNG) were sent to the respective countries for comment and clearance, and the reports for New Caledonia and Solomon Islands are nearing completion. Following clearance of the Wallis and Futuna report in English, the full report is now being translated into French. As reports are published they are placed on the PROCFish/C Web portal on the country specific pages as public domain documents.

Analysis of regional dataset

Associate Professor Brian McArdle of the University of Auckland made his second visit to Noumea in November to provide statistical assistance to project staff who are analysing the regional dataset. Good progress was made in drawing linkages between the different disciplines, with data analysis based on current finfish and invertebrate resources and user status, complemented by habitat and socioeconomic data. Tailor-made queries provide access to data as desired, and analysis is based on a range of statistical procedures including descriptive, linear analytic and multivariate methods.

The simplified diagram (Figure 1 on page 3) shows the steps that have already been taken. First results have been summarised and were presented at the PROCFish/C Advisory Committee meeting held in early February 2009.

Finfish resource assessments in Tonga

The last finfish surveys for the PROCFish/C project were done in September/October 2008 at four villages in the Kingdom of Tonga (Manuka and Haatafu on the island of Tongatapu, and Lofanga and Koulo in the Haapai group), repeating assessments previously done in 2001/2002, but following the adopted methodology for PROCFish/C finfish surveys. A total of 50 transects were sampled, and more than half of the transects were carried out at the same locations as those sampled during the 2001/2002 PROCFish visit, providing a unique chance to compare changes over time. The PROCFish/C survey team was made up of Pierre Boblin, Silvia Pinca and Enelio Liufao from Wallis, and was assisted by Sione Vailala Matoto, Secretary for Fisheries; Ulunga Faanunu, Deputy Secretary for Fisheries; and Sioli Malimali, Mele Makasini, and Vea Kava, Fisheries Officers.

Tongatapu

Tongatapu is a coral atoll with mean coordinates of 21°10′ South and 175°10′ West, and a lagoon that has the unusual feature of opening to the north, which gives it the shape of a crescent and should classify it in the pseudo lagoon category (Figure 2). The sites do not have any clearly defined fishing areas and the inhabitants practice 'open access' fishing. The fishing surface area is about 10 nautical miles wide and 20 nautical miles long, and fish traps are used in some locations (Figure 3). There were three different habitats to survey, i.e. coastal, outer and back reefs, but there was a total lack of intermediate reefs due to the lack of a lagoon. Therefore, the sampling plan called for 18 transects by village, six per habitat.

The state of resources in this reef complex is very poor and the zone has been seriously impacted.

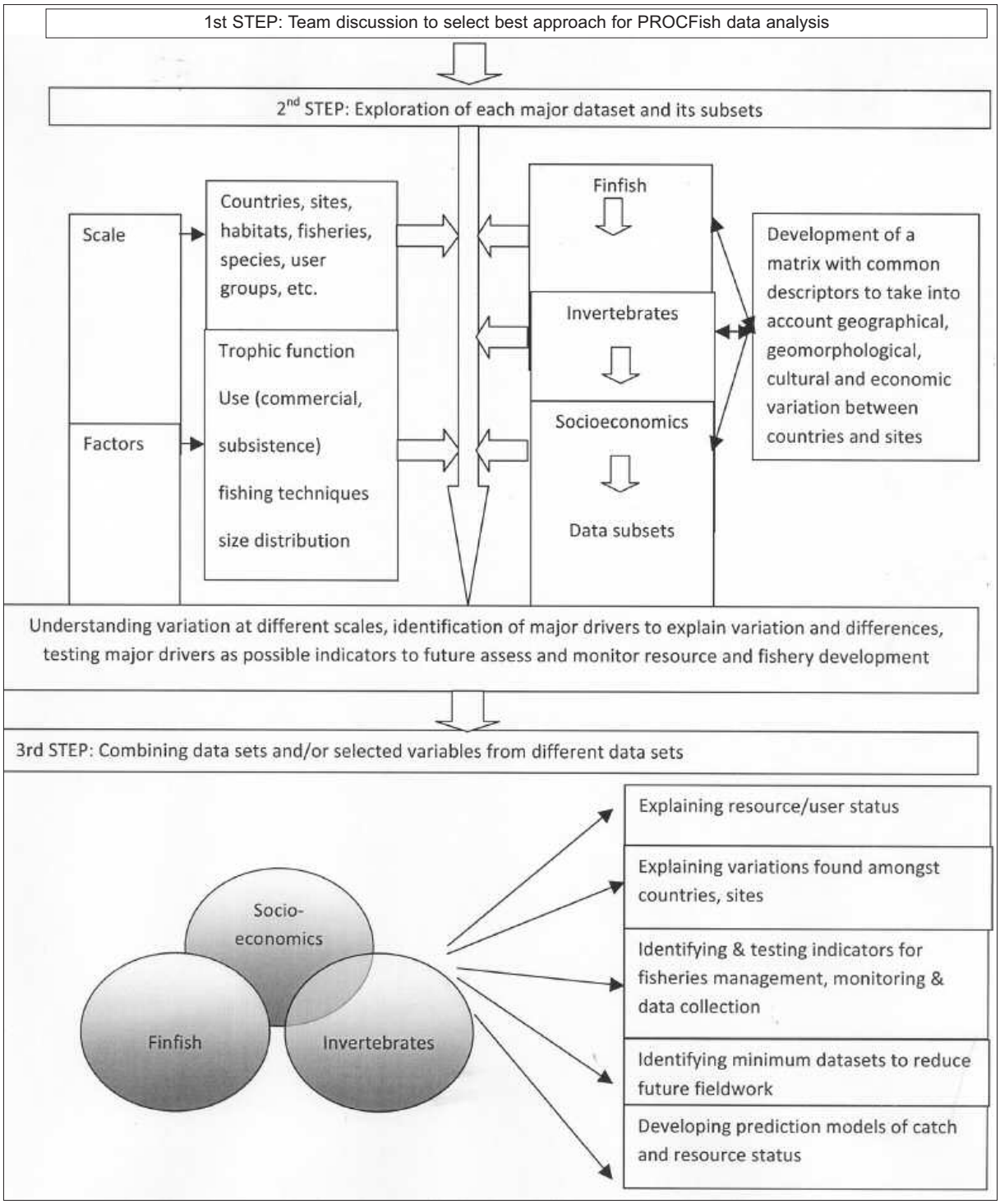


Figure 1: Steps taken in analysis of regional dataset

Densities were so low it was difficult to quantify them and the observed sizes were particularly small; most of the fish counted were post-juveniles, if not actual juveniles. The rare adult-sized fish had an immediate flight response and did not return. The observations of those fish were made by divers at a distance — often more than 10 meters; the response of the fish therefore confirms excessive spearfishing. The already low biodiversity risks becoming even poorer in the future if fishing pressure is not reduced. Divers also noted a total absence of apex predators. Density and biomass of fish were dominated by the herbivorous Acanthuridae and Scaridae. The most important species in terms of biomass and density were small-sized species of those two families, such as: *Ctenochaetus striatus*, *Zebrasoma scopas*, and *Chlorurus sordidus*. Biomass of other families was extremely low. Mean sizes of major families were particularly

small: Balistidae, Labridae, Lethrinidae, Lutjanidae, Scaridae and Siganidae displayed mean size below 50 per cent of the maximum values, indicating the effect of heavy fishing.

The Atata Island reserve was recently created and two transects were done windward and leeward of this zone. It was interesting to note that the reaction of fish there was completely different from the reaction of fish in the other sectors; observation distances there were shorter and there was almost no flight reaction. This proves that fishers respect the restrictions in this reserve and that such areas are needed.

Overall, the western village in Tongatapu, Manuka, appeared much poorer than the eastern village of Haatafu, in terms of diversity of species, density of commercial fish, average size and size ratio of fish as well as biomass. Both back and outer reefs were particularly poor, with the lowest density, biomass and diversity of fish among all the sites surveyed. Live coral cover was also very poor in the outer reefs.

The Haapai group

The Haapai island group is located at the mean coordinates 19°4′ South and 174°25′ West. It comprises a multitude of small coral atolls often bordered by motu, coral islands, and volcanic islands, one of which still shows signs of reduced activity in the form of fumaroles (Tofua Island). The volcanic island of Lofanga, located in the southwest of the island group at the coordinates 19°49.2′ South and 174°33.3′ West, is a slightly elevated piece of land (maximum altitude 15 meters), which has no lagoon and is inhabited by a community of about 300 people. The village is only accessible by sea from the west or south-eastern coast. It is about 1 nautical mile long by 0.5 nautical miles wide. The fishing area, excluding the island itself, includes, to the north and northwest, the lagoon reef complexes of Hakau Houaulu (3 x 0.8 nautical miles, the motu of Niniva included) and Hakau Lahi (2.6 x

Figure 2 (top): Map of sampling sites in Tongatapu

Figure 3 (middle): Fish trap in Tongatapu

Figure 4 (bottom): Sampling sites in the Haapai group

1 nautical miles, the motus of Nukupule and Meama included). Southeast of Lofanga, fishers also use the reefs on the small islands of Makauata and Luangahu, along with about a dozen other reef microstructures, each no more than 200 meters in diameter. Figure 4 shows the survey sites.

At Lofanga village there are only two types of reef habitat: outer reefs and back reefs. This fishing area is not exclusive, although logically it is preferred by the local community as it is closer and has more fish. There are no fishing reserves; however, there does seem to be an overall willingness to create a protected area, and this came through at the fishing group meeting on the island.

The status of the resources is mediocre, and the fish have an instantaneous flight reflex at certain sites, only returning much later and always keeping a great distance. Densities were average and sizes were below normal. There were some good-sized fish, but they were very rare. As to the number of species, this was relative to the distance from the centre of biodiversity — that is to say rather poor, and also poorer than countries to the East of Tonga. The existence of *Siganus niger*, endemic to Tonga, was confirmed. Big predators were rare, particularly sharks and Epinephelidae.

Koulo is a village located at the northern end of the coral island of Lifuka at the mean coordinates of 19°46′ South and 174°20′ West. In the eastern part, a barrier reef exposed to the prevailing winds is not accessible by sea, and the northern part of the island is linked to the island of Foa by backfill and a road. The fishing system is open access, which is why all of the western part of Lifuka and the southern part of Foa were sampled. There are only two types of habitat at this site, i.e. outer and back reefs. We were not able to categorise the reef structures along the island as coastal since there was no terrigenous effect due to the lack of rivers and mangroves.

Our initial impressions were quite clear from the first dives and only grew stronger with time. Fish swam away very quickly and the biggest ones kept a good distance. Densities were very low and sizes were small, particularly in the southern part of Lifuka; this was true for all the species. In the northern part of the site, i.e. the southern part of Foa, we were able to note an appreciable difference: numbers were higher and specimen sizes larger. But the impact was still high at this site and the general status of resources was very poor. The level of biodiversity was similar to the level at the other two sites. Here again, we observed the local *Siganus niger*. No sharks or large predators were recorded.

GIS/RS conference

The yearly Geographic Information Systems and Remote Sensing (GIS/RS) Pacific Users Conference was held at the University of the South Pacific (USP) in Suva, Fiji Islands, from 2 to 5 December 2008. It brought together practitioners from Pacific Island countries and territories (PICTs) and Council of Regional Organisations in the Pacific (CROP) agencies as well as representatives from GIS/RS software and services companies and global positioning system (GPS) equipment companies.

During the workshop we presented the use of open source software OpenLayers to build Web-based GIS applications and provided many examples and code snippets. This technology allows the display of geographic information on top of existing base layers provided by

Figure 5: Position of PROCFish/C survey stations

Web map servers (WMS), Google Maps, Virtual Earth or raster images (Figure 5).

OpenLayers is used within the PROCFish/C portal to deliver GIS/RS products to fisheries officers, in particular compressed Landsat images of reef areas for direct use in MapInfo (Figure 6). Participants expressed their interest in this software as it is a free alternative to commercial systems, and is sufficient when the need is limited to map display and basic interaction.

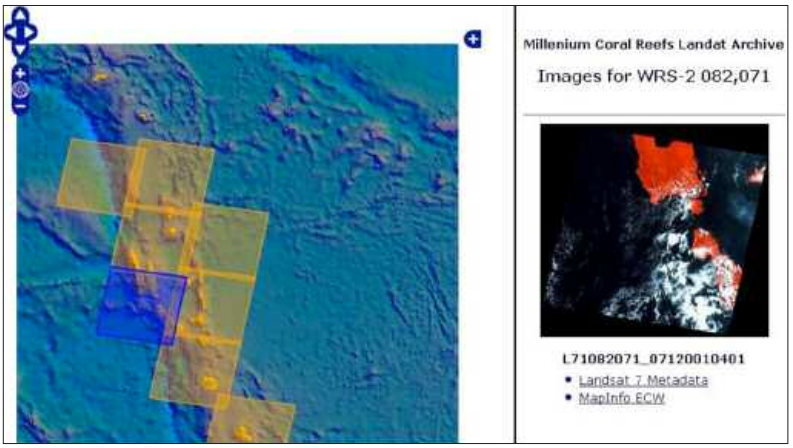


Figure 6: Landsat image footprints showing what images are available

Annual science day in Noumea

The annual science day organised by the non-governmental organisation (NGO) Symbiose was once again hosted at the Secretariat of the Pacific Community (SPC) compound. For the event, the PROCFish/C invertebrate team and the Information Section organised a stand to familiarise the public with marine invertebrate identification. A 140-litre aquarium was installed, holding about 35 different species of gastropods, bivalves, crustaceans, sea cucumbers and other echinoderms collected around Noumea during the two weeks preceding the event.

Using the SPC poster 'Marine Invertebrates of the Pacific Islands' (Figure 7), which describes 55 of the most commonly used invertebrate species of the region, children and adults had to identify the species presented in the aquarium. It was a real challenge for those without a trained eye. The winners were rewarded with SPC pens, lanyards and invertebrates posters. The playful aspect of the game and the many species unknown to most visitors created a craze around the aquarium, making the day a real success.

Figure 7: Marine Invertebrates of the Pacific Islands poster

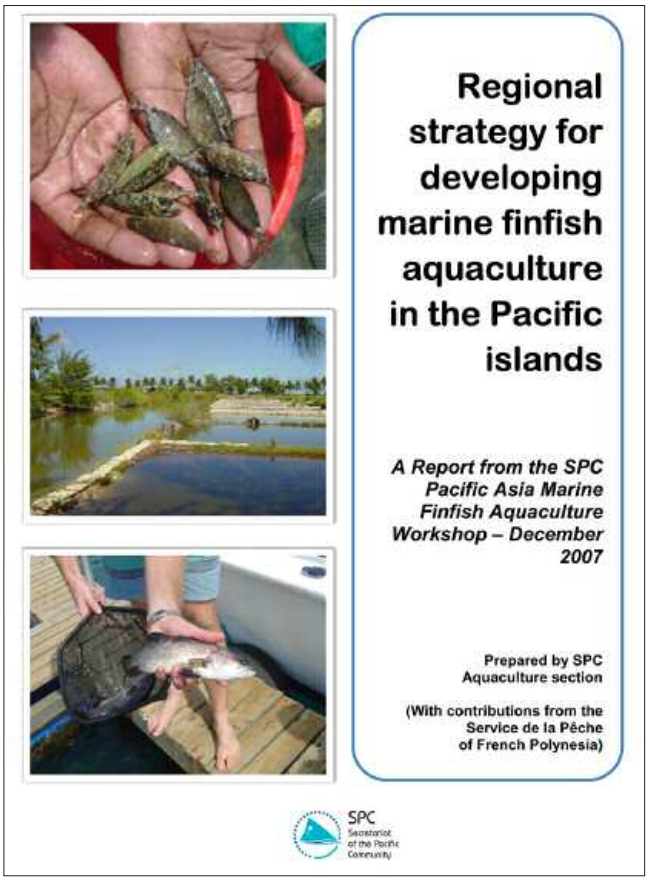
AQUACULTURE SECTION

SPC Aquaculture Section publication: Regional strategy for developing marine finfish aquaculture in the Pacific Islands

In December 2007, the SPC Aquaculture Section hosted the Pacific-Asia Marine Fish Technical Workshop. Representatives from French Polynesia, New Caledonia, Marshall Islands, Palau, PNG and Solomon Islands were invited to participate. Regional organisations from Australia, the Pacific and Asia (Institut français de recherche pour l'exploitation de la mer [IFREMER]; Network of Aquaculture Centres Asia-Pacific; USP; Queensland Department of Primary Industries and Fisheries - Northern Fisheries Centre; The WorldFish Center; and the Australian Department of Agriculture, Fisheries and Forestry) also attended. Private sector investors for the region were represented as well, with Good Fortune Bay Fisheries (from Australia and Marshall Islands) and AQUALAGON (from New Caledonia) also in attendance.

This workshop was a technical consultation between marine fish aquaculture experts and SPC member PICTs that are active in marine fish aquaculture. Its goal was to provide SPC with advice on the most feasible options for marine fish aquaculture and identify a regional framework for collaboration to address priority research and development needs in the Pacific.

A technical report is now available from the SPC Aquaculture Section. This report will be posted online soon. Please contact Antoine Teitelbaum for a copy of the report at AntoineT@spc.int.



A regional consultation to support the marine ornamental industry

SPC has been assisting the region to develop management and monitoring regimes to ensure the long-term sustainability of the marine ornamental trade whilst promoting best eco-friendly industry practices to ensure maximum benefits from these resources.

As part of this effort, the Aquaculture Section and the Live Reef Fisheries Section of SPC and the Secretariat of the Pacific Regional Environment Programme (SPREP) hosted a subregional workshop in Noumea, New Caledonia, in early December 2008 on the marine aquarium trade. The workshop was a technical consultation between private stakeholders, public stakeholders and specialists from this industry in the Pacific to examine current and new issues in the trade and to identify national and regional initiatives that will ensure the long-term sustainability of this important, yet relatively unknown industry.

The workshop objectives were to:

- Assess the global and regional trends of the industry in terms of markets and production systems;
- Investigate criteria for commercial viability at both community and company levels;
- Assess requirements and issues related to international agreements for export, such as compliance with the Convention on International Trade in Endangered Species (CITES) and the recent World Organisation for Animal Health (OIE) veterinarian requirements;
- Determine the role of certification programmes;
- Evaluate resource assessment techniques to ensure sustainability of wild fisheries;
- Identify further opportunities for aquaculture;
- Determine base requirements for national management plans; and
- Identify priorities for research, development and training.

Major exporting countries such as Fiji Islands, Marshall Islands, Kiribati, Vanuatu, Tonga and Solomon Islands were represented, while other countries that have marginal or developing trade in ornamentals, such as Cook Islands, French Polynesia, New Caledonia and PNG, were also present and actively participated in the various sessions. Representatives from Queensland's Department of Primary Industries and Fisheries presented the Queensland Great Barrier Reef approach to managing this industry, which is currently being implemented.

Private sector representatives who are highly regarded in the trade, such as Tony Nahacky from Fiji Islands, discussed the good practices of their companies and stressed issues such as the safety of the collectors, quality of the product and sustainability of the collection practices. Walt Smith from Walt Smith International presented his rock and coral farming projects, amongst other things, to the delight of smaller entrepreneurs from Vanuatu, Kiribati and Tonga who benefited greatly from those presentations. Tekinaiti Kaiteie from Moving Colors, a Kiritimati-based exporter, represented the Kiritimati Petfish Association and shared his experience and concerns about operating a business and shipping live animals from such a remote part of the world. The lack of support from NGOs and government agencies

Flame angels (*Centropyge loriculus*) at an exporters' facility

was also stressed and ways to improve this were discussed.

Representatives from NGOs, other independent organisations and USP actively participated in all sessions on topics such as aquaculture development, trade barriers, CITES, and sustainability of practices. Participants from the Marine Environmental Research Institute of Ponhpei, USP's Institute of Marine Resources (IMR), and the WorldFish Center in Solomon Islands all contributed their knowledge and experience to help improve this important industry in the Pacific.

Two field trips were organised by SPC. The participants visited the newly refurbished Aquarium des Lagons on Noumea's Anse Vata beach, where they were able to observe species from New Caledonia found in habitats ranging from the rivers to the outer reef. Some rare species were spotted by the more experienced fish watchers, while the 50 kg maori wrasse remained a favourite. A second field trip took over 20 participants for a snorkelling trip to the reef where ornamental trade enthusiasts and fish experts could see for themselves the fantastic New Caledonian marine life.

At the end of the workshop, an interactive CD with all the PowerPoint presentations was produced and distributed to participants. A technical report

Top: Kalmet Kaltabang from Vanuatu and Jeff Kinch from SPREP at the SPC workshop

Middle: Cultured corals (here *Acropora* spp.) are increasingly in demand on the global market

Bottom: Loading aquarium fish onto an air freighter for export on Kiritimati Island, Kiribati

is currently being prepared and will be available online soon.

Emerging issues and challenges

A few key issues emerged from this workshop and form the basis of the work that will need to be pursued in the future.

Aquaculture – an alternative source of products

Aquaculture is providing the market with an increasing range of cultured products. For example, giant clam farming has increased since the first trials in the 1980s; in 2007 over 75,000 cultured clams were exported from the Pacific. Cultured corals and cultured live rocks are also being successfully marketed to environmentally conscious aquarists. As the culture of these products expands in the Pacific, alternative employment is being created for people in rural areas. Culture of fish such as the highly sought after clownfish is also increasing worldwide, and the Pacific seems to have good opportunities for development in this area.

Air transportation – a continuing saga

The aquarium trade has a symbiotic relationship with the airline industry. Live fishes and corals surviving on a limited oxygen supply must be shipped quickly to their destination, and the trade therefore depends on airlines to get its products to market. At the same time, the flow of outgoing airfreight cargo provides a steady stream of business, helping these international flight routes stay afloat. In Tonga for example, the ban on live-rock harvest caused a drop in airfreight cargo and reputedly contributed to the demise of one of the international flight connections.

Certification for a 'Pacific' product — a label for Pacific exemplary practices

Certification of best practices for the marine aquarium industry was deemed a high priority by both government and private-sector stakeholders at the Noumea workshop. Eco-labeling can add value to consumer products, or at least help maintain market share. The industry stakeholders, however, stressed a need to avoid past experiences with burdensome over-documentation and to apply certification in areas where operators already have strong commercial incentives to do well. The SPC-based Coral Reef Initiative in the South Pacific (CRISP) has announced an intention to carry out a feasibility study in 2009 to identify possible models for certification and eco-labeling in the marine aquarium trade, and to seek the one that is most appropriate for the industry in the Pacific.

International compliance

Today's global market has made compliance and reporting increasingly stringent and complex. As aquarium products move from one country to another they must comply with the powerful CITES, which aims to ensure that international trade is not affecting global biodiversity. Lately, the Pacific has been affected by temporary bans that have been imposed on some species. A factor in these bans has been poor coordination between environment departments, which typically issue CITES permits, and fisheries departments, which are responsible for the industry.

Biosecurity is an issue of increasing importance. Recently the European Commission (EC) imposed a requirement for all live aquatic imports to be accompanied by disease certification and for the exporting countries to also be members of OIE. The Pacific has become an unintentional victim of this new requirement. Most, if not all, of the countries affected by this ruling lack the institutional and funding capacity to accommodate these measures. Fortunately, there are some conciliatory gestures from EC indicating that a regional approach coordinated by SPC may provide a temporary respite. However, this really only serves to raise a flag that increasingly stringent biosecurity measures in the trade are right around the corner.

What lies ahead?

With growing interest in the aquarium trade from Pacific countries, the trade is expected to continue to grow in the region. SPC will continue to coordinate efforts and provide the technical support and assistance required by PICTs to develop and manage this industry in a sustainable way. A 'Pacific' label that indicates high quality eco-friendly products that promote sustainability is an idea worthy of exploration by Pacific Island nations. And as for international trade measures, they have the capacity to either become a barrier for the Pacific marine aquarium trade or to assist the trade in keeping a clean image.

For further information please contact Being Yeeting, SPC Senior Fisheries Scientist (Live Reef Fisheries), email: BeingY@spc.int, or Antoine Teitelbaum, SPC Aquaculture Officer (Aquaculture Section), email: AntoineT@spc.int

Building capacity for Solomon Islands in freshwater aquaculture

(By James Ngwaerobo, Aquaculture Officer, Solomon Islands Ministry of Fisheries and Marine Resources)

With the increasing pressure on capture fisheries, freshwater aquaculture has potential to develop among PICTs. SPC and USP are taking a lead to assist the development of tilapia and freshwater prawn farming among the PICTs.

The Aquaculture Development Plan for Solomon Islands, recently developed by the Solomon Islands Ministry of Fisheries and Marine Resources (MFMR) in collaboration with SPC, listed freshwater aquaculture (tilapia and prawn) as a priority. To further strengthen the Solomon Islands Freshwater and Brackish Programme, MFMR requested that SPC provide training to enable MFMR to build capacity to implement its programme. A three-week training and work attachment was conducted by SPC and USP in collaboration with the Aquaculture Unit of Dairy Farms (Fiji) Ltd. (DFF), and the Naduruloulou Research Station (NRS) of the Fiji Islands Department of Fisheries. As a member of MFMR staff based in the newly established Aquaculture Division, I was able to attend this training.

Freshwater and brackish water aquaculture has been established for more than two decades in Fiji Islands, so aquaculture infrastructure like feed mills, hatchery and culture technology, supporting institutions and personnel are comparatively well developed. This has created a foundation for training so that other PICTs can learn from experiences in Fiji. Nile tilapia and *Macrobrachium rosenbergii* prawn hatchery and grow-out practices are in operation, including one large commercial prawn farm at Navua and a number of smaller extensive and semi-intensive tilapia and prawn farms in other parts of Fiji. There is a large freshwater aquaculture centre and prawn hatchery operated by the Fiji Islands Department of Fisheries at NRS in Tailevu, which is responsible for overseeing the development of this sector among rural communities. The establishment of a second, commercially oriented prawn hatchery by USP's IMR, and IMR's partnership with DFF to operate the Navua prawn farm, have further consolidated freshwater aquaculture in Fiji.

The training

The training covered a wide range of practices in tilapia and prawn hatchery operation, husbandry and grow-out. This involved fieldwork, hands-on work experience, and lectures on tilapia and prawn biology. The training was conducted at the DFF Navua prawn farm, the IMR-USP hatchery in Suva, and NRS in Tailevu. Vanuatu Fisheries staff member Glen Alo was the first person sponsored by SPC to complete this training (in September 2008) and I was the second (in November 2008).

The Fiji freshwater aquaculture sector includes polyculture, integrated agriculture-aquaculture farming (tilapia and ducks) and monoculture of both tilapia and prawn. The different farming methods have been proven to work well and are suitable for PICTs. The main commercial species are Nile tilapia and rosenbergii prawn; grass carp (*Ctenopharyngodon idella*), big head carp (*Aristichthys nobilis*), silver carp (*Hypophthalmichthys molitrix*), puntius (*Puntius gonionotus*), gold fish and fancy carp (*koi*) are also raised.

Grow-out — tilapia and prawn

Two weeks of attachment and training was spent on the pond cycle developed for prawn pond management: preparation and maintenance of ponds, application of lime and fertiliser, filling of ponds, stocking with prawns, feeding, daily maintenance, pond sampling, and record keeping. Also covered were feed preparation (ingredients and equipment), harvesting, and packaging of prawns. Field visits were made

Prawn feeding, USP hatchery

Grass carp harvesting, Naduruloulou

to a number of other farms to observe the different types of farming (monoculture, polyculture, and integrated farming). These topics were covered both at DFF, which focuses on prawn grow-out, and at NRS, which maintains broodstock for tilapia and prawn and produces juveniles for pond stocking.

Hatchery — tilapia and prawn

NRS operates hatcheries for both tilapia and prawn. These are 'master hatcheries', responsible nationally for maintenance and dissemination of the best possible broodstock for these species. I spent time here going through the steps for broodstock management and tilapia fingerling production for pond stocking.

Prawn hatchery — green-water technique

One week was spent in the IMR hatchery at USP for training on a green-water technique for prawn larval culture. This method is an alternative to the clear-water culture technique usually practiced in Fiji Islands, and was learned under the guidance of Japan International Cooperation Agency (JICA) Senior Volunteer Tomohiro Imamura and the IMR hatchery team. Training covered all aspects of hatchery larval husbandry: water quality management, prawn larval development, and daily feeding.

Implications for Solomon Islands

Solomon Islands is preparing for the establishment of a freshwater and brackish aquaculture sector under its Aquaculture Development Plan 2009–2014. This training in Fiji Islands has contributed to:

- Capacity building on skills and knowledge in best practices for farming and hatchery practices under Pacific Islands conditions;
- Our knowledge about the pond cycle for prawns;
- Developing MFMR's capacity to conduct its own experiments in Solomon Islands;
- MFMR's ability to conduct an import risk assessment on the viability of importing Nile tilapia *Oreochromis niloticus* as a better option for aquaculture than the Mozambique tilapia *O. mossambicus* already long established in Solomon Islands; and
- Capability of MFMR Aquaculture Section staff to carry out training for its provincial officers.

The training will help strengthen the work force and will contribute to current MFMR efforts to develop tilapia and prawn farming as an alternative livelihood under the Community-Based Fisheries Management Programme. This aims to improve food security for the increasing population as well as reduce the stress on our natural fish stocks.

COASTAL FISHERIES MANAGEMENT SECTION

Subregional workshop on ecosystem approaches to management of coastal fisheries in PICTs

17–21 November 2008 Nadi, Fiji Islands

Through joint efforts by SPC, the United Nations Food and Agriculture Organization (FAO) and The Nature Conservancy (TNC), a subregional workshop on ecosystem approaches to coastal fisheries management in the Pacific Islands was held in Nadi, Fiji Islands. The main objective of the workshop was to provide an opportunity to further discuss, at a regional level, the concept and practice of the ecosystem approach to fisheries (EAF) and to consider the way forward in implementing EAF in PICTs. The workshop targeted decision-makers, Heads of Fisheries Administration and Heads of Environment Administration. It also built on other regional efforts toward implementing EAF management, such as those by the Forum Fisheries Agency (FFA) for the management of the region's tuna resources.

The workshop concluded with the following recommendations to achieve better fisheries management outcomes.

- Regional and international agencies should provide the resources needed to progress with the application of EAF in the region, in particular for:
  - generating background reports, developing appropriate legislation, data collection and monitoring systems, establishing committees, etc.;
  - completion of EAF pilot and case studies;
  - capacity building for agency staff and stakeholders;
  - formal and 'on the job' training exercises on various EAF-related processes relevant to PICTs; and
  - assisting with extension of, or the development of, overall country plans for coastal fisheries and other related planning processes.

- A short document should be generated that outlines how the different approaches all fit together. This should first focus on the SPC-generated community-based processes and the FAO-generated processes.

- New and improved tools/mechanisms should be developed to assist PICTs to determine how to link the various levels of management — community, provincial, national, regional — as part of the process for the formulation of an EAF management tool box.

- The current management plans and activities should be extended/adapted to include any missing EAF components to form part of general guidelines for the implementation of EAF.

- Regional workshops should be conducted that:
  - share experiences in applying EAF using the various methods and principles; and
  - detail the use of specific tools (e.g. risk analysis, community-based consultation) rather than try and cover all the EAF-related methods at once.

- A regional EAF network should be established, which

Participants at the EAF management workshop

may include the establishment of an EAF interest group operating in a manner similar to other interest groups established under SPC's Coastal Fisheries Programme (CFP).

- Processes should be harmonised among institutions (e.g. fisheries and environment agencies plus others).

The workshop was attended by 38 participants from 12 PICTs including representatives from a range of national, regional and international inter-governmental organisations (IGOs) and NGOs, including SPC, FFA, SPREP, TNC, JICA, and FAO. A similar workshop for the Northern Pacific was held in Guam in March 2009.

Technical assistance to Tonga Department of Fisheries

The Coastal Fisheries Management Adviser visited Tonga to offer advice on Tonga's Community-Based Fisheries Management Programme (CBFMP). The visit was requested by the Government of Tonga through a project proposal to SPC to assess the present development of its CBFMP and to provide advice as to how the programme may proceed after the termination of the Australian Agency for International Development (AusAID)-funded Tonga Fisheries Project (TFP)

Tonga's CBFMP

The establishment of Tonga's CBFMP came under the fourth component of the TFP and has been operated as a major part of the Community and Outer Islands Development and Advisory Section (CDAS) of the Department of Fisheries. The TFP's main objective was to contribute to the economic development and social well-being of the people of Tonga through sustainable development and management of living marine resources, with attention to remote and disadvantaged communities. To achieve this goal the TFP focussed on capacity building in the Department of Fisheries, assistance to small-scale fisheries, developing an environment that enables industrial fisheries to increase export income and enhancing sustainable community-based management of inshore resources.

The CBFMP approach is for CDAS to work closely with coastal communities to develop community coastal management plans (CCMP) which obligate communities that own the plans to take action to conserve and manage their special management areas (SMA). The Minister of Agriculture & Food, Forests and Fisheries under the Fisheries Act of 2002 is empowered to declare SMAs for conservation and management of fisheries resources by coastal communities. To manage these SMAs, the Department of Fisheries was tasked under CBFMP with promoting working relationships with coastal communities to manage the SMAs.

The CDAS has so far worked with six coastal communities (three in Haapai, one in Vavau and two in Tongatapu) on the development of their CCMPs. The CCMPs of the Haapai group were developed under AusAID assistance and the ones for Vavau and Tongatapu were developed by the CDAS on its own. The CCMPs for the Haapai communities have been completed and are being implemented. The CCMPs for the Vavau and Tongatapu communities are nearing completion.

The assignment

With direction from the Department of Fisheries, the assignment was carried out under the following terms of reference. The plan of work was structured to obtain as much information as possible in order to present a reasonable assessment of the work done under CBFMP.

- Hold discussions with the Department of Fisheries and the Ministry of Agriculture & Food, Forests and Fisheries (MAFFF) to receive views on CBFMP.
- Hold discussions with coastal communities that have worked under CBFMP to hear their opinions.
- Meet with other government agencies and NGOs that may have interests similar to those of CBFMP.
- Take into account views presented in various reports relevant to CBFMP and formulate an independent opinion.
- Based on the results of the meetings and discussions described above, assess the CBFM programme and provide advice on how it should progress.
- Identify ways that SPC could help with future improvement of CBFMP including suggestions regarding external funding sources that may be of assistance in implementing CBFMP in Tonga.

Recommendations

At the conclusion of the assignment, a draft report was presented to the Department of Fisheries. The report's recommendations included a national workshop to seek more opinions on the legality of restricting the harvest of SMA fishing to communities responsible for the SMAs, capacity building for programme staff, legislation review, programme activities to support participating communities, and partnership with SPC in developing project proposals and national workshops for the implementation of EAF management.

The integration of EAF management into CBFMP will be an important activity of the programme in the near future. This will be jointly organised by SPC and the Department of Fisheries through a national workshop with SPC providing resources. SPC is also committed to assisting the development of CBFMP in Tonga through: 1) development of an EAF management model, 2) production of awareness materials, 3) development of the first community-based EAF management model, and 4) timely reviews of the programme when needed.

Developing Yap's sea cucumber regulations

One of the major activities during this period was to assist the Marine Resources Management Division (MRMD) in the State of Yap, Federated States of Micronesia, in developing regulations for the sea cucumber fishery. The harvesting of sea cucumbers in the State of Yap has been an important activity, especially in outer-island communities, as it provides significant income. Over recent years, harvesting and export of the animals has greatly increased.

By law, customary marine tenure in Yap allows resource and reef owners full authority to own and harvest the resources of their respective marine areas. Because of the way the law is structured, MRMD cannot limit the harvest of the animals. The only strategy for the state government to control exploitation of the resource was to apply restrictions on the size and volume of products to be exported. Therefore, the state government placed a moratorium on the export of sea cucumber until regulations to control and monitor exports are ready. SPC was asked to assist with the development of those regulations.

The draft regulations have been submitted to the Attorney General's Office and the legislative authority for public hearing and gazetting.

NEARSHORE FISHERIES DEVELOPMENT AND TRAINING SECTION

During September and October 2008 Fisheries Development Officer (FDO) Steve Beverly assisted the Vanuatu Maritime College (VMC) in Santo, Vanuatu, with the practical fishing modules for a course called Sea Safety and Fishing for Pacific Island Fisheries Officers. Following the course at VMC Steve left for Nelson, New Zealand, to participate in the Fourth Regional Course for Managers of Medium-to-Large Size Fisheries Enterprises at the New Zealand School of Fisheries (25 to 29 October).

The course at VMC was conducted over a four-week period by VMC staff with assistance from the FDO. There were 11 students in the course, each from a different PICT. The students were:

- Nonu Tuisamoa from American Samoa;
- Joe Kaukura from Cook Islands;
- Alvin Sinem from Yap;
- Nena William from Kosrae, Federated States of Micronesia;
- Semiti Korovavala from Fiji Islands;
- Iareta Awerika from Kiribati;
- Lee Polin from Marshall Islands;
- Jeb Bop from Nauru;
- Ben Logai from PNG;
- Solomona Tufuga from Samoa; and
- Maani Petaia from Tuvalu.

The first week of the course was dedicated to introductory material including an overview of fishing methods, sea safety and survival (Figure 1), safe operational plans (SOPs), fire fighting, first aid, seamanship, knots and splicing, chartwork and navigation, and boat handling.

The boat handling included pre-departure checklists, starting and stopping the motors, leaving a dock, and returning to a dock. The two vessels used for this exercise, F/V *Emm Nau* (Figure 2) and F/V *Etelis* (Figure 3), were used during previous courses for fisheries officers at VMC (see *Fisheries Newsletter #125*) and were used for all fish aggregating device (FAD) fishing and deep bottom fishing exercises during the 2008 course. A third boat, F/V *Island Flyer* (Figure 4), was used for horizontal longline fishing. *Island Flyer* is a private boat that was chartered just for the course, while *Emm Nau* and *Etelis* belong to VMC.

The second week of the course was devoted to fishing around FADs — trolling, vertical longline and handline fishing. The first day of the week was spent making up gear and preparing *Emm Nau* and *Etelis* for an early departure on the following day. Under the FDO's supervision, students prepared vertical longlines (VLLs), branchlines for the VLLs, several lures for trolling, palu ahi rigs, jigging spreaders, and scatter-bait rigs. At the beginning of each day of fishing two students were assigned to be captain for the day, one for each of the two boats. Their first task was to fill out an SOP. Next they checked that all fishing gear, bait, ice, and food were loaded on the boats before starting the motors and getting underway for the fishing area. Figure 5 shows the vessel track for *Etelis* going to the FAD and

Figure 1 (top). Students practising abandon ship drill during the sea safety module.

Figure 2 (middle). F/V *Emm Nau* rigged for trolling and deep bottom fishing.

Figure 3 (bottom). F/V *Etelis* fishing at the VMC FAD.

returning to the school during first two days of fishing. This track was made by an ArgoNet small boat tracking system. Fishing was generally quite good; the boats landed 50–100 kg of combined yellowfin tuna, skipjack tuna, and rainbow runner each day. Some of the fish was retained by the school's kitchen while some was frozen to be used for bait.

At the completion of each day's fishing the designated captains filled out catch logs and profit and loss forms. The sales figures in the profit and loss statements were nominal estimates based on local fish prices and no real money changed hands during 'fish sales'.

The second week of the course was devoted to horizontal longline fishing. The owner/operator of *Island Flyer*, Geoff Brenton, brought his boat across the channel to the college from his place on Aore Island. *Island Flyer* is an 8 m fiberglass catamaran with twin 200 HP Mercury outboards, equipped with a homemade hydraulic longline reel that is powered by a portable petrol powered hydraulic system. This was not ideal for longline fishing but served the purpose as a training platform. The students rigged floats and floatlines and made up monofilament branchlines in a branchline bin that they made from a large plastic drum. For the next three days, longline trips were made in the same vicinity as the FAD so that the students could fish the FAD

Figure 4. F/V *Island Flyer* with homemade longline reel.

Figure 5. ArgoNet track of two trips to the VMC FAD.

Figure 6. Golden snapper caught on *Etelis*.

during the longline soak in order to catch bait for the following day's fishing. The FAD was productive but the longline fishing was not. However, the boat and the gear served well for technical instruction in setting and hauling a longline.

On the last day of the third week, the students made up deep bottom fishing gear and loaded *Etelis* and *Emm Nau* with drop lines and rigs for snapper fishing, which took place most of the fourth week. Three bottom fish trips were made in all. The best fishing of the course took place just northeast of VMC off a small island off the east side of Santos (Aesi Island), in about 200 m of water. *Etelis* dropped anchor and *Emm Nau* tied up on the stern of *Etelis*. Both boats caught several golden snapper (*Pristipomoides multidens* — Figure 6).

On the final day of fishing the weather deteriorated and the students were suffering from fatigue. The boats came back early with few fish. In the evening VMC hosted the participants and instructors at a fish dinner that was followed by a presentation of Safety Certificates and Fisheries Extension Officer Certificates. Mark Gooderham (Figure 7), the new CEO at VMC, congratulated each student for a job well done as he passed out the certificates. Steve left for New Zealand the same day.

On Monday Steve accompanied participants in the Fourth Regional Course for Managers

Figure 7. Captain Mark Gooderham, CEO of VMC.

Figure 8. Fish on display in the retail section of the Auckland Fish Market.

Figure 9. Harvesting salmon in Pelorus Sound, New Zealand.

of Medium-to-Large Size Fisheries Enterprises (Nelson School of Fisheries) on a field trip to Pelorus Sound where they visited a salmon farm (Figure 9) and a mussel farm. The course participants got to see salmon being harvested but were not able to see the mussel harvest. On the following day, Steve gave a presentation to the course on improving profitability in domestic longline fisheries.

FAO Expert Consultation on Best Practices for Safety at Sea in the Fisheries Sector

FAO organised an Expert Consultation on Best Practices for Safety at Sea in the Fisheries Sector (10–13 November 2008) as a response to a recommendation made at the 27th session of the FAO Committee on Fisheries (COFI) in March 2007. A large number of members expressed concern about the safety at sea of fishing vessels, especially small-scale fishing vessels. FAO was urged to continue collaboration with the International Maritime Organization (IMO) and it was suggested that FAO should develop guidelines on best practices for safety at sea and that COFI should consider developing an International Plan of Action (IPOA) on the subject.

There were nine experts invited to the consultation and four resource persons. The SPC Nearshore Fisheries Development and Training Adviser attended as a resource person, along with Dr Yugraj Yadava (Director, Bay of Bengal Programme [BOBP]), Brandt Wagner (Senior Maritime Specialist, International Labour Organization [ILO]) and Hiroyuki Yamada (Marine Technology Section, IMO). Experts participated in their personal capacity and came from a range of countries including Iceland, Japan, Oman, Philippines, South Africa, Sweden, Canada and Venezuela. Most had a professional background in maritime safety and few had fisheries-specific experience. The FAO Technical Secretariat consisted of Jeremy Turner (Chief of FAO Fishing Technology Service) and Ari Gudmudsson (Fishery Industry Officer — Vessels, Fishing Technology Service).

The expected outcome of the Expert Consultation was a report, including:

(i) a draft outline for guidelines on best practices for safety at sea in the fisheries sector, together with recommendations regarding their scope, special needs of developing countries, and any special considerations and goals; and

(ii) appropriate next steps that might be taken following the completion of the Expert Consultation.

Participants were informed that the draft outline resulting from the consultation will be developed by FAO, with inputs from the consultation participants, into the Guidelines on Best Practices for Safety at Sea in the Fisheries Sector. These guidelines will be published as part of the FAO Technical Guidelines for Responsible Fisheries series, i.e. as a subset of the Code of Conduct for Responsible Fisheries.

The principle objective of the guidelines should be the improved safety and health of those working in the fisheries sector through the development of national strategies. This objective should be achieved through the use of a set of readily understood guidelines. It was emphasised that the guidelines should take a holistic approach to ensure that all factors having an influence on safety are comprehensively covered, and that awareness-raising on safety issues should be accorded a high priority.

The consultation agreed on an outline for the development of guidelines on best practices based on a series of four interlinked pillars. In each of these pillars, three layers of guidance would be provided: a first layer directed at policy level; a second layer setting out more detailed procedures and checklists; and a third layer providing detailed working instructions, case studies and reference material. During the four days of the meeting the four pillars were 'built' as follows:

Under the first pillar a baseline assessment of safety issues will be carried out through data collection and analysis of accidents within the fisheries sector in order to identify and provide the necessary information to permit an understanding of problems where they exist. In addition, the results of the analysis will provide benchmarks in support of monitoring and evaluation units.

The second pillar will consist of an inventory or baseline survey giving a comprehensive overview of all aspects of a national fisheries sector, in particular the human resources engaged in the sector, as well as available aquatic resources, technology and supporting services. Such an inventory will be useful in drawing attention to the diversity of fisheries, which range from subsistence fisheries to industrial fleets.

Within the third pillar, the information provided under pillars 1 and 2 will be analysed in detail

in order to identify safety problems and their causes. This information will then be used to develop corresponding solutions and measures for their mitigation and prevention.

The fourth pillar will then concentrate on the implementation and promotion of the strategy. This would include how to advocate, manage and influence change and evaluate progress.

It was stressed by the Expert Consultation that as guiding principles, the guidelines should recognise the need to adopt a participatory approach through consultation with stakeholders and the creation of a broad-based empowerment structure to ensure ownership of the process by the ultimate beneficiaries: the fishers and their families. It was further highlighted that the guidelines should recognise the need for regional and subregional cooperation in promoting safety at sea, especially in small-scale fisheries. It was also stressed that whereas the guidelines should have a global perspective, the intent is for action at national and local levels. All stakeholders should therefore hold a clear and shared vision of the objectives. It was further emphasised that to ensure a participatory approach the language used in the guidelines should be as simple and non-bureaucratic as possible and that the document itself should be user friendly, taking into consideration the relatively wide target audience and application of the guidelines at the national and local levels. It was noted that the guidelines would be of particular value to those individuals or groups who champion the cause of improving safety in fisheries.

The review of the legal framework related to fishing vessel safety should be participatory (including all stakeholders — governmental and non-governmental — who have an interest or may be affected by decisions on the matter) and interdisciplinary (lawyers and technical experts should participate in the exercise).

Recommendations on improving legislation on fishing vessel safety need to be flexible and to a certain degree general, so as to be useful to different countries with different legal frameworks and traditions. Special attention should be given to the development and implementation of appropriate and enforceable legislation for small vessels, including the carriage of safety equipment and training requirements. A model law may, therefore, not be the ideal instrument; rather, elements of solid legislation on fishing vessel safety may be identified, and certain options for their inclusion in a specific legal framework may be formulated to provide some guidance to countries. In addition to playing a 'command and control' role, legislation may be a significant tool in providing incentives, addressing training and education issues, and creating the basis for permanent institutional cooperation.

Following the presentation to the experts of a paper titled 'International Commercial Fishing Management Regime Safety Study: Synthesis of Case Reports', the Expert Consultation thoroughly discussed the relationship between fisheries management and safety at sea. The synthesis document, which describes a global study recently undertaken by FAO and the US National Institute for Occupational Safety and Health (NIOSH), concludes that fisheries managers should acknowledge the indirect and direct effects of fisheries resource management measures on the safety of fishing operations and that they should consider safety as part of their goals. The consultation reviewed the recommendations made in the synthesis document and noted that it contained some very valuable observations. Based on the discussion, the recommendations in the synthesis document will be modified to address the following issues:

- Every fishery management decision affects safety.
- The title of the chapter on recommendations will be changed to 'Recommendations to move forward' since the chapter will now contain advice not only to fisheries managers, but also safety professionals and others.
- Reference will be made to the relevance of fishermen's safety within the ecosystem approach to fisheries.
- The report will recommend that fisheries managers and safety professionals work together and engage on issues of mutual concern.

The Expert Consultation considered the possible needs of developing countries to implement guidelines on best practices in the fisheries sector. It recognised that many developing countries have special needs that extend beyond simply translating the best practices into national languages and that this is certainly the case within the artisanal and small-scale fisheries sectors. It was anticipated by the consultation that assistance may be required to remove constraints to the development and implementation of a safety policy, and also to promote participation in regional and subregional activities related to safety at sea. In addition, possible issues were identified that may require technical and legal assistance, data collection and analysis, capacity building, scientific cooperation and the training of trainers and extension workers. Furthermore, it was noted that there would be a need to clarify how such assistance could be made available

through, for example, technical cooperation programmes and regional cooperation. The consultation recommended that special attention be given to the availability and affordability of safety equipment and servicing facilities, noting that such availability and affordability could influence promulgation of regulations.

The Expert Consultation concluded its work with the identification of a series of appropriate next steps in the development of the FAO Guidelines on Best Practices for Safety in the Fisheries Sector. Five recommendations were made to that effect:

1. The Expert Consultation, noting the recommendation contained in the report of the 27th session of the COFI that '...FAO should develop guidelines on best practices for safety at sea', recommended that the FAO secretariat should now proceed with the development of the guidelines on the basis of the outline and general guidance developed by the Expert Consultation. The experts expressed their willingness to be involved in the work, either in the development or review of draft texts. The consultation noted the advantages of drawing on the expertise available within the ILO and IMO secretariats and recommended that FAO strive to ensure coherence with IMO and ILO instruments, codes and guidance (including joint FAO/ILO/IMO publications) and integration with ongoing and related work by IMO and ILO.

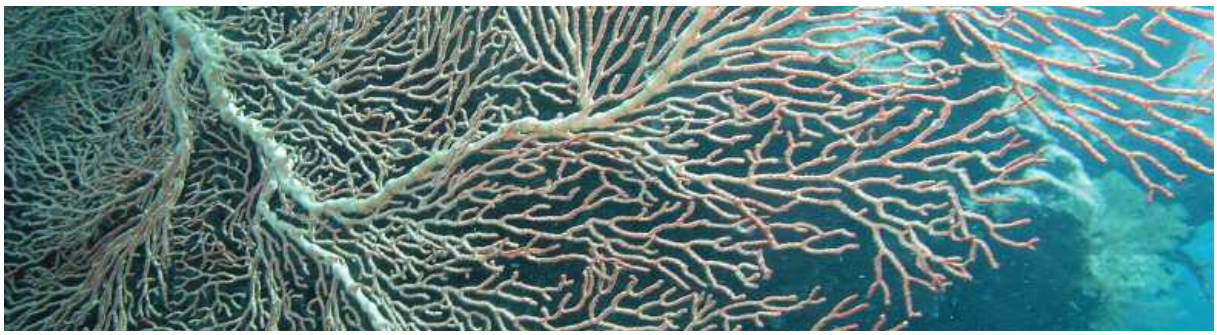
2. The Expert Consultation noted with interest the quality of the findings of recent FAO regional workshops on safety at sea and suggested that their outcome be reflected in the guidelines[1].

3. Following extensive discussion on the draft executive summary of the 'International Commercial Fishing Management Regime Safety Study: Synthesis of Case Reports', the Expert Consultation recommended that FAO should freely distribute the templates used in the development of the case studies to countries wishing to carry out a case study on their own fisheries. Agreeing with the report's main finding that fisheries management has indirect and direct effects on fishing safety, the consultation also recommended that FAO should undertake further research into impacts of fisheries management on safety, for the purpose of developing training materials that could lead to an improved and shared understanding between fisheries managers and safety professionals on issues of mutual concern.

4. Considering the socio-economic and environmental elements of safety at sea, the consultation recommended that FAO and regional fisheries management organisations undertake to promote safety at sea as part of the ecosystem approach to fisheries.

5. The experts, aware that the guidelines constitute only voluntary guidance, considered and sought ways and means to ensure that they would lead to the development of national fisheries safety strategies. As a means of according additional authority to the guidelines, the consultation strongly recommended the development of an IPOA on safety in the fisheries sector, of which the guidelines would be an integral component.

- BOBP/FAO Workshop in Chennai, India, October 2001;
- FAO TCP/RLA/0069 Regional Project in the Caribbean Region, 2000–2001;
- FAO/SPC Regional Expert Consultation in Suva, Fiji Islands, February 2004;
- FAO/South West Indian Ocean Fisheries Commission (SWIOFC) Regional Workshop in the South West Indian Ocean, Moroni, Comoros, December 2006;
- FAO Regional Workshop in Latin America and the Caribbean in Paita, Peru, July 2007



Community Based Fisheries Diversification in Small Island States
10-14 November 2008

Introduction

SPC was asked by the Japan International Cooperative Agency (JICA) to collaborate in training Pacific Island fisheries officers in the practical fishing component of the JICA course on Community Based Fisheries Diversification in Small Island States. In November 2008, SPC Fisheries Development Officer (FDO), William Sokimi, began working with the JICA course coordinator, Hideyuki Tanaka, to implement a workshop on FAD fishing methods.

The workshop was attended by eight officers from around the region, with one representative each from Fiji (Tekata Toaisi), Marshall Islands (Candice Guavis), Samoa (Ferron Fruean), Solomon Islands (Lionel Luda), Tonga (Sione Mailau) and Vanuatu (Graham Nimoho), and two from Papua New Guinea (Ephraim Ridley and Peter Logomina). They were joined by 10 local fishermen from the Suva/Nausori corridor (Tagaloa Tane, Toma Ratujese, Adrian Panapasa, Aisake Biu, Saimoni Ratukadreu, Uraia Rabakele, Semi T Molidegei, Taniela Gonerara, Robert Garnett and Sam Zinck).

The workshop covered seven focus areas:

- Situation of FAD fisheries in the Pacific region.
- Methods of monitoring and evaluating FAD fisheries.
- Small craft safe operational plans (SOPs) and safe boat handling principles.
- Common fishing methods used at and around FADs.
- Construction of FAD fishing gear.
- Practical FAD fishing exercises using the gear and methods outlined during the course.
- Review of fishing trips and catch results.

Methods and fishing gear used during the practical fishing excursions

1. Trolling with single and double lures per mainline (Figs 1 and 2).

2. Jigging with weighted rod and feather lure (Figs 3 and 4).

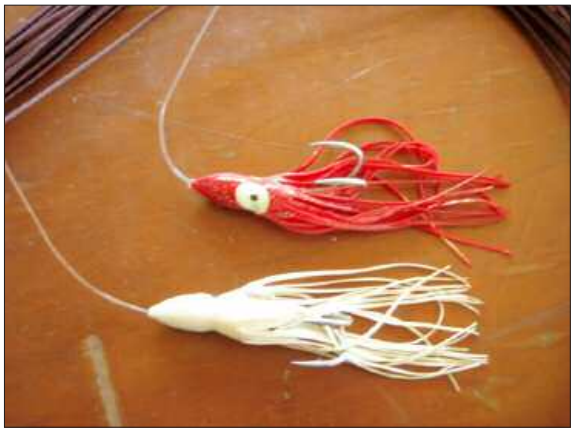


Figure 1 (top left): Double trolling squid lures
Figure 2 (top right): Rapala lure for single trolling
Figure 3 (bottom left): Jigging rod with feather lure
Figure 4 (bottom right): Feather lure and straw lure used with jigging rod

3. Fishing for yellowfin tuna and large pelagic fish using the chum bag method – an advanced application of the drop stone method (Fig. 5).

4. Bait jigging using artificial lures (Figs 6 and 7).

Practical fishing exercises

Four boats were used during the practical fishing trips with the course participants and JICA coordinator rotating between the different vessels over the three fishing days.

All fishing operations centred around a subsurface FAD that was deployed in November 2007 off Nukubuco sandbank. The fishing trips were conducted during flat calm seas with a low breeze on all three days. The calm seas allowed the boats to drift slowly, providing ideal conditions for jigging and chum bait fishing.

Trolling using double and single lures, jigging with rod and sinker and the chum bag method all produced good results. There was no opportunity to practise live bait jigging as there was no suitable focal point. This was one of the disadvantages of having to fish the subsurface FAD without an echo sounder or surface position marker.

To avoid mayhem when fish were caught, each boat was equipped with three lines when trolling and one chum bag and one jigging rod with feather lure when mid-water fishing.

Catches

Good catches were made, mainly due to the input of two experienced local fishermen, Tagaloa Tane and Sam Zinck, who quickly grasped the concepts being demonstrated. The fishing methods were not in fact very different from the old drop stone methods that they previously used but were more refined and quicker to employ.

After each trip, the fish were counted (Fig. 8), measured, and shared amongst the participants and boat crew. A debriefing exercise was then carried out to assess the activities for the day and plan the next day's fishing activity.

The total fishing time over the three days was 14.5 hours, dur-

Figure 5: Chum bag used for catching yellowfin tuna
Figure 6: Straw lures used for jigging bait
Figure 7: Feather lure used for jigging bait
Figure 8: Part of the catch

ing which 70 fish were caught with a total weight of around 576 kg (43 yellowfin tuna weighing around 510.5 kg; 26 skipjack tuna weighing around 60.0 kg; and one 5 kg mahimahi). Weights were estimated by matching the fork lengths for each fish against a length/weight chart (Fig. 9).

Trolling accounted for 46 fish of which 15 were caught on Rapala lures and 31 on squid skirt lures. Twelve trolling hooks were used between the three boats; i.e. 4 hooks per boat; one lure each on single lines and one mainline with double lures. Therefore, the CPUE for trolling was 3.8 fish per hook.

The chum bag method caught 14 yellowfin tuna (Figs 10 and 11), with only one chum bag being used per boat. The CPUE for the chum bag method was 4.7 fish.

Feather and rod jigging caught 10 fish – 9 yellowfin tuna and 1 mahimahi. Three jigging rods with feather lures were used between the three boats (one per boat) so the CPUE for this method was 3.3 fish.

- Day 1 – 14 yellowfin tuna (78.5 kg) and 9 skipjack tuna (30.5 kg)
- Day 2 – 14 yellowfin tuna (216 kg) and 17 skipjack tuna (29.5 kg)
- Day 3 – 15 yellowfin tuna (216 kg) and 1 mahimahi (5 kg)

Debriefing and presentation of certificates

The course closed with a final debriefing session and presentation of Certificates of Participation to the local fishermen who took part. Parcels of fishing gear were also presented to the fishermen as a token of appreciation from JICA for their cooperation during the workshop.

Figure 9 (top left): Measuring the fork length

Figure 10 (top right): Casting the prepared chum bag

Figure 11 (right): Tuna caught with the chum bag method

FAD construction and deployment in Wallis Island
3–15 December 2008

In the first two weeks of December 2008, SPC Fisheries Development Officer, William Sokimi, provided technical assistance to SARP (Service des Affaires Rurales et de la Peche) in Wallis and Futuna to construct and deploy three FADs around Wallis Island and two in Futuna. The Wallis Island FADs were deployed during the visit and plans were made to deploy the two Futuna ones in early 2009.

The FAD gear was purchased from New Zealand with part of the mooring rope and joining components ordered being lighter than the SPC recommended design.

Constructing the FADs

A major aim of this programme was to train four SARP staff in planning, constructing and deploying FADs. Three FADs were constructed and ready for deployment within three days while two more had been constructed by the end of the second week after the deployment of the first three.

The three Wallis Island FADs were designed to be deployed in depths of 700 m, 800 m and 1000 m, while the two Futuna FADs were designed for depths of 850 and 1200 m. Except for differences in mooring length and the positioning of the supplementary buoyancy floats, all the FADs were constructed similarly. The buoyancy of the flotation section was around 245 kg while the buoyancy in the middle mooring section varied with the different mooring lengths of the polypropylene rope. The flotation section included seven 30G-2 pressure floats and 15 purse seine floats strung along a 20 m x 24 mm nylon rope. The middle mooring consisted of a 20 mm polypropylene lead core rope spliced to a 16 mm polypropylene Danline rope. Since the depths for all five FADs differed, the supplementary buoyancy float was strategically positioned in each mooring to prevent the rope in the catenary curve from tangling with the float while at the same time being within the safe depth rating for the float.

Anchor system
The anchor system consisted of two grapnel anchors constructed from a 1.5 m length of 76 mm galvanised pipe and two 6 m lengths of 25 mm rebar rods doubled up at the centre then pushed through the galvanised pipe (Fig. 2).

The combined weight of the two grapnel anchors plus 20 m of 16 mm chain was around 160 kg. Ideally, it would be preferable to have at least three times the buoyancy lift for the anchor system so the anchor system should have been around 700 kg plus. However, since it was impossible to carry this weight on the deployment vessel, several old engine blocks were included in the anchor system to bring the weight to around 350 to 400 kg (Fig. 3).

Selection of sites and FAD deployment

All FAD sites were selected from charts compiled by the French Navy in 1997. These sur-

Figure 1 (top): FV *Hakula* which was used for deploying the FADs

Figure 2 (middle): Grapnel anchors

Figure 3 (bottom): Old engine blocks used in mooring system

veys produced accurate Bathymetric charts that were much more detailed than working off the results of 81 waypoints in a 2′ latitude x 2′ longitude survey area.

The Wallis Island FADs were loaded and deployed individually for safety reasons. Flags were connected to the FADs when the deployment sites were revisited five days later to confirm the FAD settling positions

All the FADs were deployed using the 'U' formation, where the flotation section was released first then the vessel angled up current towards the shallower depths while paying out approximately half the mooring length before turning around, landward/downwind side, and returning towards the flotation section. Once all the rope had been paid out, the depth and position were checked again before the anchors were released. This deployment method tends to put less strain on the mooring rope as the anchor makes its way to the bottom. All the anchor chains were hung over the side before the anchors were released to ensure that once they were let go, nothing was attached to the vessel.

Wallis Island fishermen should now be able to reap the benefits of the FADs.

Tuvalu Fishermen's Association facilitates capacity training

Sustainable, dynamic 'self help' capacity is the vision of the Tuvalu National Fishermen's Association (TNAF). As part of achieving this vision, the association facilitated training on outboard motor maintenance and small fisheries business management for members in Vaitupu in April 2008.

The training reflected one of TNAF's priorities – to help its members become self-reliant in sustaining their small fishing operations. With the cost of parts increasing, the importance of regularly servicing their outboard motors was noted as crucial – most outboard motors on Vaitupu are never serviced after purchase. The training was conducted by Ioapo Lapo, who is a Japanese-trained Yamaha motor mechanic and also the licensed dealer for Yamaha outboard motor parts in Funafuti. Under his guidance, participants undertook hands-on servicing of operational motors using basic parts as well as identifying and fixing problems in motors that had been broken down for some time.

The training, the first of its type on the island, was well received by all the fishermen, who said that it was easier and faster to learn through practical lessons rather than theory. At the end of the training, it was stressed that fishermen need basic skills in maintaining and repairing their outboard motors to minimise engine breakdowns early in their operation and ensure their safety at sea.

The practical training was complemented by training in small fisheries business management, which was presented by the association's executive officer, Mrs Fa'aui Telii, who is a certified ILO trainer. She focused on maintaining records for small fishing operations to determine if a profit was being made and stressed the need to differentiate between business and personal finances.

Both training sessions targeted registered TNAF members. A number of active fishermen have not yet registered as members but were very much interested in the training, which was the first carried out under TNAF's work plan. Similar training is planned for the other islands when funding support is secured.

Shell carving

In another initiative, the association organised a training workshop on making shell jewellery for its members in Funafuti in August 2008. The workshop was facilitated by Francis Sylva Wairiu. Francis, a Solomon Islander from Guadalcanal, makes seashell jewellery as a home-based business in Honiara. He was identified by the Solomon Islands Small Business Enterprise Centre (SBEC) and accepted the training consultancy through SPC/DevFish.

Tthe workshop focused on practical lessons, with training on using specialist tools such as a 'dremel' cutting tool and grinders. The trainees were guided through the procedures of identifying appropriate shells, cleaning and preparing them for cutting, drawing designs on the shells and cutting them out, and then sanding and smoothing out the cut shapes. The cut shapes are polished with 'rouge dialux' to reveal the lustre of the shell.

By the end of the training, participants had made simple shapes for pendants, earrings and necklaces. They were amazed at the natural shell patterns revealed through cutting simple cross sections of shells and acknowledged that the training had shown them the potential monetary value of the plentiful seashells lying on the beaches.

The main aim of the training was to identify an opportunity for association members and their spouses/family to earn additional revenue, especially during non-fishing periods. There were about 20 trainees –15 female and 5 male including two youths.

TNAF is the umbrella association of all the fishers' associations in Tuvalu and was formally established in 2006. Its main function is to represent fishers' interests with the national government and development partners. TNAF secured assistance from SPC, through the DEVFISH project, to fund the position of executive officer.

GLOBAL STUDY OF SHRIMP FISHERIES

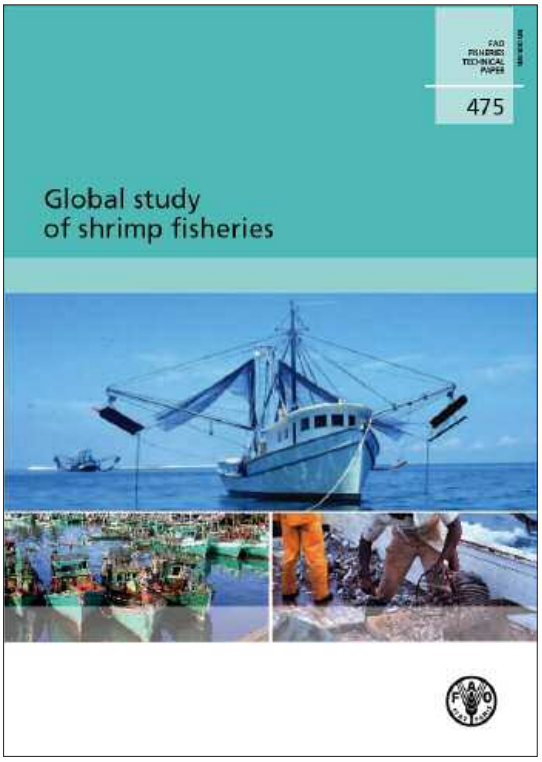
A global study was carried out on the development and present status of shrimp fisheries, with a focus on direct and indirect social, economic and environmental impacts. The study report reviews the current situation, problems and issues, as well as the solutions found and trade-offs made. Important topics relating to shrimp fisheries were examined in 10 countries representative of geographic regions, together with their various shrimp fishing conditions – Australia, Cambodia, Indonesia, Kuwait, Madagascar, Mexico, Nigeria, Norway, Trinidad and Tobago and the United States of America. The results of the country reviews were combined with specialised studies on important aspects of shrimp fisheries to produce the major findings of the overall study.

The world shrimp catch is about 3.4 million tonnes per year, with Asia to the fore of the industry. World production of shrimp, both captured and farmed, is about 6 million tonnes, of which about 60 per cent enters the world market. Shrimp is now the most important internationally traded fishery commodity in terms of value. In many tropical developing countries, it is the most valuable fishery export and also a significant employer. However, the economic importance of the shrimp fishery needs to be reconciled with considerable concern about its environmental impacts.

The report covers the development of shrimp fishing; structure of shrimp fisheries; target species; catch/effort; economic contributions; trade; bycatch; fuel; biological aspects; impacts on the physical environment; impacts of large-scale shrimp fishing on small-scale fisheries; management; enforcement; research; data reporting; and the impacts of shrimp farming on shrimp fishing.

A major conclusion of the study is that there are mechanisms, instruments and models to effectively mitigate many of the difficulties associated with shrimp fishing, based on taking a precautionary and ecosystem approach. The inference is that, with appropriate implementation capacity, shrimp fishing, including shrimp trawling, is indeed manageable. In many countries, however, weak agencies dealing with fisheries, lack of political will and inadequate legal foundations cause failures in shrimp fishery management. The report makes specific recommendations in a few key areas such as the management of small-scale shrimp fisheries, capacity reduction and access to the fishery.

(Source: Bob Gillett; FAO Fisheries Technical Paper. No. 475. Rome, FAO. 2008. 331 p.)



COCONUT OIL AS AN ALTERNATIVE FUEL – PROGRESS IN FISHERIES RELATED APPLICATIONS
Lessons learned from a pilot project

Hugh Walton
Acting Principal
National Fisheries College
Kavieng
Papua New Guinea

Introduction

In November 2006, the Board of the Papua New Guinea National Fisheries Authority approved funding for the National Fisheries College to investigate the potential use of coconut oil as an alternative fuel for the fisheries sector. Working in partnership with a Kavieng based fisheries and seafood processing company, Emirau Marine Products (EMP), the research project set out to establish a small coconut oil processing facility and then to test the oil in a variety of engines and working environments.

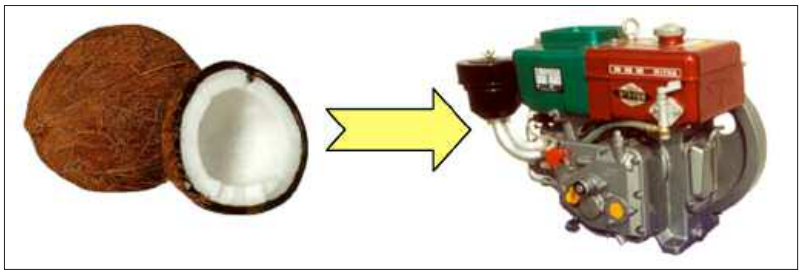
In the context of fishing vessel operations, the challenge was to determine whether coconut oil could be produced and processed as a cost-effective alternative to diesel. For coastal communities, the wider challenge was to document potential use of coconut oil as a community fuel source. EMP is the major buyer of bêche de mer in New Ireland Province. With concerns about the status of the resource, the company believed it might be possible to divert a degree of community fishing effort from bêche de mer to copra production, especially if the price of copra could be increased from the then 30 toea per kilogram to a level where community interest in copra production could be sustained.

The project was prompted by the dramatic increase in the cost of diesel and petrol in 2006 and 2007 and the negative impact on the fisheries sector, most notably the domestic tuna long-line fishery. In PNG, the main fleet operators had ceased fishing operations and tied up their vessels.

Project components

The main components of the project are to:

- establish an oil production facility
- monitor oil production and operational costs
- examine and test options for engine operations using coconut oil
- examine oil filtering and processing options
- review community-level oil production potential and operational applications
- look at options for bi (co)-product development and use
- assess operational economics and commercial viability



Overview of project progress

By June 2007, the project was in full-scale oil production with two operational oil presses, two press filters, 20,000 litres of holding tanks and a single copra shredding machine. With a staff of six, the project was able to process around 1200 kg of copra per day producing 700–800 litres of coconut oil. The raw oil was pumped through a series of three settling tanks and then returned through the screen filters ready for use.

In the following months, the project produced around 140,000 litres of coconut oil which has been tested and used in various machinery and equipment with a mixture of success and failure. Considerable effort was put into oil filtering and processing options as it was initially found that a basic filtering process was insufficient to prevent filter and injector blockages in standard engines (for example, a Toyota Hilux). The project declined to adopt the accepted practice of using a coconut oil and kerosene mix to avoid fuel blockages and instead focused on improving filtration and oil processing methodologies and on considering options for engine conversion systems to allow for more efficient utilisation of coconut oil fuel.

It should be noted that the project primarily used kiln dried copra which leaves a carbon residue in the oil that needs to be eliminated before it can be used as a fuel. This problem did

not occur when high-quality sun or heat dried copra with no carbon residue was used.

With the assistance of two small grants from the EU DEVFISH Project, specialist technical advice and assistance was obtained to procure several simple engine conversion systems from Australia. For smaller engines, these systems contained a small electric in-line heater that is fitted to the fuel line to pre-heat the oil. For larger engines, the system comprises a heat exchanger to pre-heat the oil prior to injection and two additional filters to ensure that the oil is filtered to 5 microns.

After considerable experimentation, the project consolidated a process to produce fat-free fuel. This process involves carefully mixing raw oil with a small volume of water and caustic soda which is stirred into the oil until it is completely mixed. Once left to settle, the fatty acids within the oil separate and coagulate in the bottom of the tank and the remaining oil is poured off, heated and the finely filtered.

Tests of the fat-free fuel show that it burns better than raw oil and eliminates injector blocking issues. However, it should also be noted that the fine-filtering process is fundamental to ensuring fuel quality and lack of filtering will invariably result in fuel filter blockages.

Coconut oil fuel has been tested in a range of engine applications with the most complex being a 450 hp turbo charged Cummins, the largest being a 30-year-old Nigata, and the simplest being the Chinese-built 6.6 hp Jiang Dong. The project continues to produce and utilise coconut oil fuel in several applications. It is currently intended that the project will be developed into a commercial enterprise, which will mean that NFA will withdraw from operations and hand over the reins to the private sector.

Lessons learned to date

Establishment of an oil production facility

- Establishment costs were higher than anticipated due to the electrical demand of the oil presses and copra cutter;
- The operation of an oil processing facility requires a high level of hands-on engineering management and regular maintenance;

Monitor development and oil production costs

- Over the life of the project, the price of copra has reflected the volatility of the fuel oil market. When the project began, the local purchase price was 30 toea per kilogram. This rose steadily to K 1.00 where it stabilised for a time, then jumped as high as K 1.40 only to gradually decrease in the latter part of 2008 to 60–70 toea.
- Assuming a K 1.00 per kilo buy price, the basic operational economic parameters are as follows:
  - Daily processing of 1200 kg = K 1200.00
  - 1200 kg produces around 800 litres of oil
  - 10% volume loss for fat reduction process gives 720 litres finished fuel
  - Costs:
    Labor (6 persons @ 8 hours = K 160.00
    Electricity (approx) = K 45.00
    Operational overhead= K 200.00
    Total production cost = K 1605.00
    720 Litres @ K 1605.00 = K 2.22 per litre
- With the effective utlisation of process waste products, the cost of fuel production could be further reduced as follows:
  - The copra waste can be reconstituted to a fine mix with reprocessing through the copra crusher to produce around 400 kg per day of copra powder, which can potentially be sold as stock feed for

Heat exchanger and filter system

around 20 toea per kg. This provides around K 80.00 per day of cost offset.
- The waste fatty acids can easily be packaged as a form of industrial hand soap with potential production of 5 kg per day to contribute an additional K 50.00 per day of cost offset.
- In this scenario, the daily production cost is reduced to K 1475.00 and the cost of production is reduced to K 2.04 per litre.

- Given cost factors such as depreciation and equipment replacement and the fluctuation of copra prices, the likely production cost of coconut oil fuel is between K 2.30 – K 2.50 per litre.

Examine and test options for engine operations using coconut oil

Small engines

- Various small diesel engines can run successfully on straight filtered raw coconut oil and these engines have a wide range of potential applications.
- Small coconut oil driven engines can be successfully used on small boats, although a high degree of engineering management is required;
- Coconut oil powered engines are potentially much cheaper to operate than normal outboard engines but do not produce high speeds.

Larger engines

- Coconut oil can be successfully used with larger engines. The project has tested processed and non-

Summary operational data

- Twin Jiang Dong 6.6 hp water cooled engines
- 1 litre of coconut oil per engine per hour
- 10–15 litres of water per engine per hour
- 1000–1400 kg carrying capacity
- 4–5 nautical miles for K 6.00 (assumes K 3.00 per litre)

Summary operational data

- 22 hp vertical shaft air cooled engine fitted to a normal 70 hp outboard
- 13 knots top speed
- 5–6 litres of processed coconut oil fuel per hour
- Around K 18 per 12–13 nautical miles

Top: The coco-cat

Bottom: The Sunsette Rigby 22

Summary operational data

- 450 hp Agasaka main engine
- Over 100,000 litres raw filtered coconut oil in 18 months of operation
- Assuming a coconut oil fuel cost of K 3.00 per litre and given diesel prices ranging from K 3.30 to K 4.70 per litre during the operational period, the potential cost saving is significant

The Elfride – two years on raw coconut oil

processed coconut oil on various engine types including the Toyota Hilux, a Toyota 5-ton truck, a rotary injected turbo-charged Cummins genset and a 30-year-old 450 hp Nigata.

- The Toyota and Cummins engines operate better on processed coconut oil fuel but the large injectors of the Agasaka will manage raw non-processed oil.
- Generally, a high level of engine monitoring and maintenance is required, especially if the coconut oil has not been adequately filtered.
- With a potential retail price of K 3.00 per litre, the coconut oil fuel can provide quite significant savings in the cost of engine operation. The 5-ton Toyota truck has been tested with 10,000 litres of processed coconut oil fuel during a period when the diesel fuel price ranged from K 3.70 to K 4.70 per litre.

Examine oil filtering and processing options

- The standard manual filters are effective to perhaps 20–25 microns, but filtering to 5 microns is required for successful engine operation.
- For commercial operations, a centrifugal or fine bag filter system is recommended.
- The project achieved improved engine reliability and performance with the fat-free fuel process.

Review community level oil production potential level and operational applications

- There are several options for small-scale, low cost, local level coconut oil production with potential volumes of 12–20 litres of oil per day, although there are no clear examples of committed local level small-scale coconut oil production in New Ireland.
- With the small coconut oil powered engines, it is possi-

A 5 micron bag filter system

ble to develop local level electricity generation based on using coconut oil fuel, although again there are currently no operational examples of this technology.

- The processed coconut oil fuel burns successfully in lamps and stoves and could provide a viable alternative to kerosene lamps and cookers in rural areas.

- There are a number of current initiatives in support of the further development of small-scale coconut oil production and there is a substantial and accessible information network documenting coconut oil and fuel production in local and commercial contexts.

Look at options for bi (co)-product development and use

- Waste copra can be reprocessed into a sand-like powder and bagged up for sale as animal feed.

- Copra waste makes a very good low cost base for feed pellet production and, given access to a steady supply of fish meal and other key ingredients, there is potential for feed meal production to be developed as an additional component of coconut oil production.

- The waste fatty acid compounds from the coconut oil fuel production process can be used as a hand-wash for removing oil, grease and dirt.

Assess operational economics and commercial viability

- Over the project, the price of copra has varied dramatically. At less than 60–70 toea per kg, copra processing is not really commercially worthwhile. However, with prices in excess of K 1.00 per kilo, copra production has enjoyed an upsurge during the project period.

- The project has established that, if diesel prices remain above K 3.50 per litre, there is potential for commercially viable production and use of coconut oil fuel.

Coconut oil hand press in operation

IMPORTANCE OF HOUSEHOLD INCOME AND EXPENDITURE SURVEYS AND CENSUSES FOR MANAGEMENT OF COASTAL AND FRESHWATER FISHERIES

Johann Bell[1], Phil Bright[1], Bob Gillett[2], Greg Keeble[1], Mecki Kronen[1], Kelvin Passfield[3], and Chris Ryan[1]

INTRODUCTION

'Development and implementation of national and regional conservation and management measures for the sustainable use of fisheries resources' is a priority of the Pacific Plan. It was reiterated in the Vava'au Declaration on Pacific Fisheries Resources, the Special Theme of the 5th Pacific Conference on the 'Future of Pacific Fisheries', and at the 4th Annual Forum Fisheries Committee Ministerial Meeting.

SPC and FFA are assisting Pacific Island countries and territories (PICTs) to develop and implement plans to improve the assessment and sustainable management of their oceanic, coastal and freshwater fisheries resources and aquaculture. Particular emphasis is being placed on:

- maximizing the contribution of tuna to economic growth by increasing the involvement of PICTs in the catching, processing and trading subsectors of the industry, rather than focusing mainly on optimising access revenues (see www.ffa.int/devfish for details);
- planning the use of fish for food security to provide for the future welfare of the region's rapidly growing populations (SPC 2008, Bell et al. 2009); and
- optimising the number of livelihoods that can be sustained by fisheries and aquaculture (SPC 2007a,b).

Export data provide good information for assessing the effectiveness of management measures aimed at maximising the economic benefits from tuna and the contribution of aquaculture products and coastal fisheries commodities (such as bêche-de-mer and trochus) to livelihoods. But there is currently little or no reliable information on the volume of fish[4] used for subsistence for most PICTs (Gillett 2009). The same is true for harvests of fish from coastal and freshwater areas sold at local markets.

There is an urgent need to redress this problem. Large increases in the supply of fish are needed to provide food security in the near future (Fig. 1). Governments need to know whether the recommended management measures and policies they implement to provide access to this fish are working effectively. Depending on the country or territory, such measures include storing and distributing low-value tuna landed by industrial fleets; sustaining the productivity of coastal reef fisheries resources; installing low-cost, inshore fish aggregating devices (FADs) to provide better access to tuna for coastal subsistence fisheries; development of fisheries for small pelagic fish; and expansion of pond aquaculture (SPC 2008, Bell et al. 2009).

This paper outlines how household income and expenditure surveys (HIES) and censuses can be modified relatively easily to provide governments with a powerful tool to monitor: i) how much fish is being consumed in rural and urban areas; ii) how much of this fish is derived from subsistence fishing, gifts, or purchased from local markets; iii) how much income is being earned from the sale of fish on local markets; iv) how many households use fish for subsistence, and/or depend on the sale of fish to contribute to their livelihood; and v) what proportions of these benefits come from oceanic, coastal and freshwater fisheries resources and aquaculture.

ADVANTAGES OF HIES AND CENSUSES

While there are limits to the information that can be derived from HIES and censuses, these tools give fisheries departments the opportunity to collect basic information on production of coastal and freshwater fisheries that would otherwise be expensive to collect through targeted surveys.

The advantages of using HIES to assess fisheries production are that they are usually conducted every 5 years and are a high priority for both governments and

[1] Secretariat of the Pacific Community, Noumea, New Caledonia
[2] Gillett, Preston and Associates, Suva, Fiji
[3] International Union for Conservation of Nature, Suva, Fiji
[4] Fish is used here in the broad sense to include finfish and invertebrates

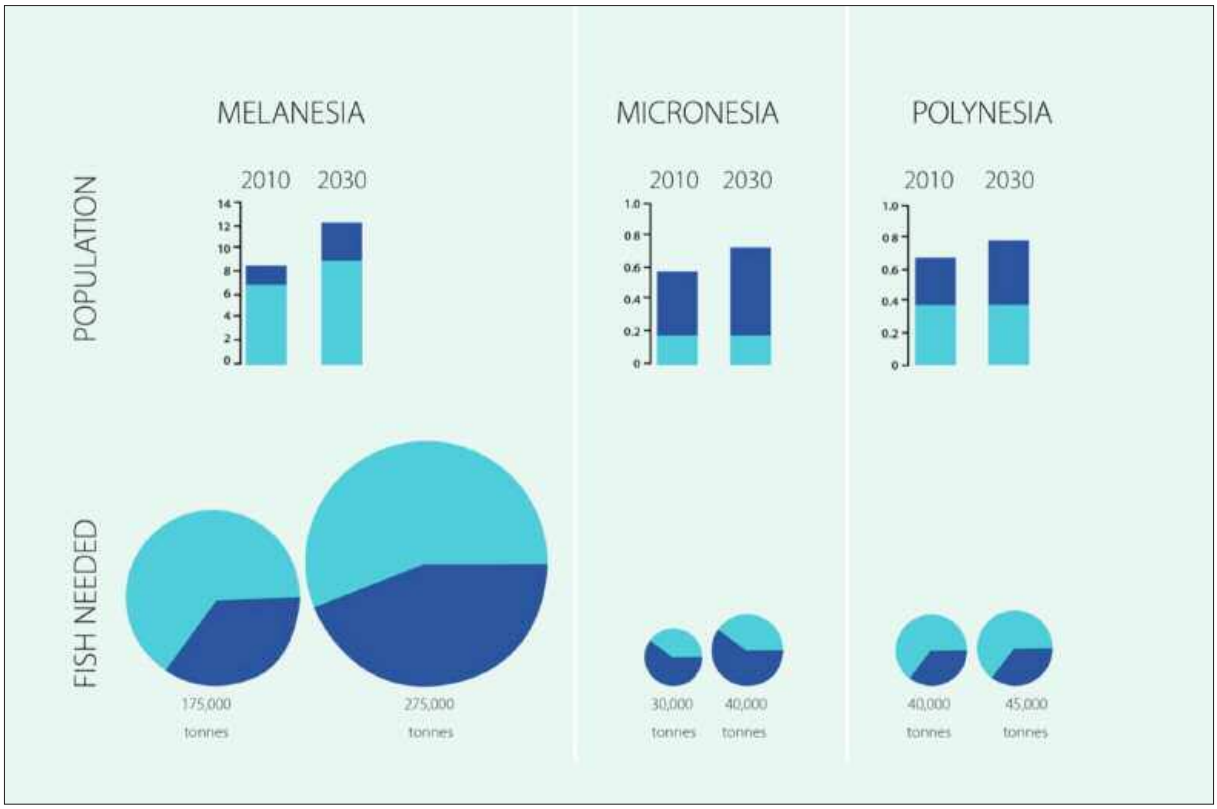


Figure 1. Forecasts of population growth and amount of fish needed for food in rural (light grey) and urban (dark grey) areas of the Pacific - Source: Bell (2007)

donors – they are used to adjust the Consumer Price Index, quantify poverty and hardship, and analyse the nutritional status of households. For larger PICTs, up to 5% of households are covered nationally by HIES. In smaller PICTs, up to 30% of households are surveyed. In both cases, extrapolations to the national level are considered to be reliable.

Well-designed HIES, appropriately supervised by national statistics offices, can be expected to deliver sound estimates of local fish consumption, household expenditure on fish, and household income derived from fish, in both rural and urban areas.

The great strength of censuses is that they provide information for all citizens every 5 or 10 years, depending on the PICT involved. If they are modified to include basic questions about participation in fishing and associated activities, they have the potential to measure the percentage of households involved in subsistence fishing, and in other types of fishing to derive income. Another advantage of using censuses is that they lend themselves to analysis using geographic information systems (GIS). This allows policy-makers to see the spatial distribution of fishing activities for subsistence and livelihoods.

Prerequisites for HIES and CENSUSES for use in fisheries management

Although information of much use to fisheries managers can be obtained from HIES and censuses, modification of these tools needs to be done carefully to minimise the number and cost of additional questions.

Identifying the objectives of collecting the information is the essential first step. In most cases, these objectives will centre around:

i) obtaining estimates of coastal and freshwater fisheries production where they do not exist already; and

ii) evaluating the success of management interventions and policies, such as those designed to improve regular access to fish for food security, or to assist fishing communities to adapt to climate change.

Clearly, senior staff from national fisheries departments and national statistics agencies need to consult on how best to modify HIES and censuses for the purpose of fisheries management. In particular, they need to identify the best trade-off between the additional work involved for enumerators and the information to be gained. As a guide, modification should be limited to 3–5 new questions.

Information required

HIES

To assist management of fisheries, HIES should be modified to collect information in ways that are simple to understand and that make it easy to quantify, for each household, the fish caught for subsistence, purchased at local markets, sold, received as gifts and given as gifts[5]. These data can then be used to estimate total fish consumption, total fish catch, the number of households engaged in subsistence and market-based fishing, and the average income earned by selling fish on domestic markets.

Fish consumed and caught by households should be disaggregated into the lowest number of categories that enable fisheries managers to:

i) evaluate the relative contributions of the main fisheries resources to subsistence fishing/aquaculture, and activities aimed at generating income; and

ii) assess the total fish production from the key coastal and freshwater fisheries management sectors and aquaculture.

A provisional list of the fish categories that could be used in modified HIES by a broad range of PICTs is shown in Table 1. In general, the number of fish categories used for HIES diaries and questionnaires should be limited to 8–10. The list should cover the major commodities used by households but could also include individual species where they are a regular and important part of the diet and need specific management.

Although the most frequent application of HIES for fisheries will be to estimate coastal and freshwater fish production, the fish categories chosen should also measure consumption of:

i) tuna and other offshore fisheries resources (to evaluate policies to improve access to these resources); and

ii) imported fresh and frozen fish (to evaluate the need/potential for replacement of imports. Note, however, that records of imports of seafood for the tourism industry will also be needed to do this).

It will also be important to obtain robust estimates of:

i) the consumption of fresh meat, poultry and tinned meat to quantify the contribution of fish to total intake of animal protein, and

ii) the consumption of both locally produced and imported canned fish to ascertain the relative contribution of fresh fish and canned fish to the diet.

Censuses

For censuses, questions need to be constructed to measure the number of people and households deriving subsistence and income from oceanic, coastal, freshwater and fisheries, aquaculture and fish processing on a self-employed and employed basis. Once again, the questions used should be kept to the minimum needed to obtain the basic patterns of engagement in fishing.

Care is needed to:

i) phrase fisheries questions for censuses in an identical way to those in HIES;

ii) separate fishing and aquaculture activities from agriculture activities; and

iii) define terms such as 'subsistence' and 'employment'. In particular, statisticians should recognize that employment in fishing is not limited to jobs with fishing companies – in most countries there are large numbers of small-scale fishers selling fish for income.

Estimating total production from small-scale fisheries using HIES

In PICTs where there is no export of coastal fish, robust estimates of

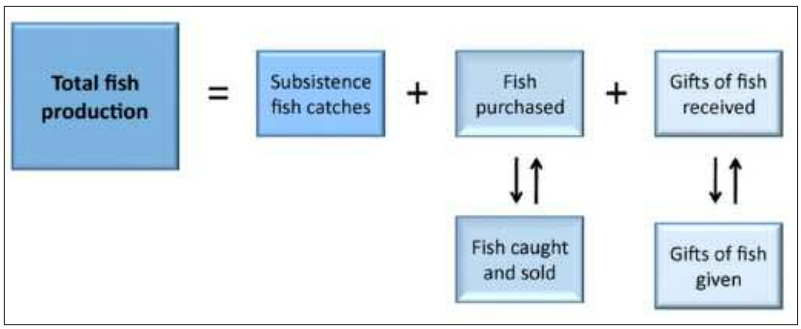


Figure 2. Principal sources of information from HIES that can be used to estimate total national production of coastal (or freshwater) fisheries in countries and territories where such fish are not exported.

Note that the total amount of fish sold can often, but not always (see text), be used to verify the total amount of fish purchased, and the total amount of fish given as gifts can be used to verify the total amount of fish received as gifts.

[5] Gifts includes fish taken overseas by the household to give to relatives

national fish consumption can provide a good proxy for production from coastal fisheries (Fig. 2). However, care is needed to deduct any purchased fish consumed that is derived from imports of fresh or frozen coastal fish species. Also, in PICTs that have a large tourism industry, the amount of fish sold by households is likely to exceed the amount of fish purchased by households. In such cases, the amount of fish sold should be used in preference to the amount of fish purchased to estimate production over and above that recorded for subsistence and gifts.

In PICTS where commercial companies export coastal food fish, the quantities involved will need to be obtained from national export records and added to the categories described in Figure 2 to estimate total coastal fisheries production. The volume of exports can be verified by comparing it with the volume of imports recorded by the receiving country.

HIES will be of most value to fisheries managers when they quantify the total weight of fish harvested – total weight is the most common metric for reporting fisheries production. Accurate measurements of total fish weight derived from HIES will enable managers to identify changes in per capita fish supply, and changes in total production from each of the main resources used to provide access to fish.

Caution is needed, however, in interpreting any changes over time in total production of coastal and freshwater fisheries derived from HIES. Changes in production may not always represent changes in the status of the stock. For example, improved access to tuna may induce coastal communities to rely more heavily on offshore resources for food and reduce catches of reef fish. To interpret whether changes in coastal fish production derived from HIES are due to changes in the rate of exploitation, fisheries managers will also need to rely on other indicators of the status of coastal resources, such as changes in the relative abundance and size of key species.

Methods to improve the accuracy of HIES

In past HIES, total weight of whole fish consumed has often been calculated by dividing the amount spent to purchase fish by the average price per kilogram. Errors have occurred when the average purchase price was not recorded at the time and had to be estimated later. In the case of subsistence catch, households were asked to estimate:

i) the price they would have paid if they had bought the fish at a local market, or

ii) the weight of their catch, without providing them with the equipment or a reasonable guide for doing so.

The accuracy of information on fish acquisition and sales can be improved in future HIES by changing the recording methods as follows:

1. Arranging for a fisheries specialist to provide training for all enumerators in attributing fish to the main

Category	Market price (unit)	Caught by household		Purchased		Sold		Gift received		Gift given	
		Value ($)	Wt (kg)	Value ($)	Wt (kg)	Value ($)	Wt (kg)	Value ($)	Wt (kg)	Value ($)	Wt (kg)
1. Tuna											
2. Other offshore fish											
3. Reef fish											
4. Other inshore fish											
5. Shellfish (invertebrates)											
6. Freshwater fish											
7. Aquaculture fish											
8. Imported fresh/frozen tuna											
9. Imported fresh/frozen reef fish											

Table 1. A summary of the recommended information on fisheries to be collected from HIES, showing the main categories of resources used for subsistence, purchased and sold, and received and given as gifts.
(1,2: Offshore resources; 3,4,5: Coastal resources; 6: Freshwater resources; 7: Aquaculture; 8,9: Imports (outside management areas))

categories prior to implementing a HIES.

2. Estimating the total weight of fish caught by the household for subsistence or received as a gift. To enable households to do this, enumerators will need to provide them with charts that can be used to estimate the weight of fish of different sizes in each category. Where possible, enumerators should be equipped with scales and visit each household every day during the HIES period to help measure the fish and 'ground truth' that the fish are allocated to the correct category. A simple, inexpensive hand-held spring scale and a plastic bag for holding the fish is all that is required.

3. For fish purchased at local markets, the total purchase price, and the price per unit (kg, lb, string of fish, etc.) should be recorded, together with the total weight (or number of units) as described above. Similarly, for fish sold by the household, the total price and total weight (or units) should be recorded (Table 1).

4. The fish categories selected by a PICT could be preprinted on the pages of a diary as an aid for households in recording what fish they caught, purchased, sold, received as gifts and gave as gifts (Table 1). Diaries could also include images of the main categories of fish (with examples of the main species in each category) to minimise the risk of errors in filling out the diary.

5. When data from HIES are converted to totals for fish categories, and consolidated to document patterns for rural and urban areas, confidence limits should be calculated to provide a measure of evaluating the significance of any changes in total fish weight over time.

Careful application of these methods is essential. Otherwise, the benefits of modifying HIES will not be realised – poorly supervised HIES will produce data of little value. National statistics agencies, and the donors that support them, may wish to consider incentives for the implementation of well-designed HIES, e.g., bonus payments when all fieldwork is performed thoroughly.

Conclusion

Fisheries management agencies throughout the Pacific currently have poor information on the amount of fish caught for subsistence or livelihoods (local sales) from coastal and freshwater areas. This poses a major problem because managers have little idea about whether these resources, which play a vital role in national food security and maintaining livelihoods in rural areas, are being harvested within sustainable bounds. Government decision-makers also have no idea of the value of subsistence and small-scale commercial fisheries to the national economy.

Well-conducted HIESs and censuses promise to provide basic information on the composition, quantity and estimated value of these harvests, and the number of households involved in different forms of fishing and aquaculture, on a regular basis. This information can then be used to evaluate the success of management measures and policies to improve regular access to fish for food security and income earning opportunities. It can also be used to inform decision-makers responsible for evaluating the cost benefits of coastal and watershed developments that may have a negative impact on coastal fisheries resources.

Senior staff from national fisheries departments and national statistics agencies need to consult on what modifications should be made to future HIES and censuses to collect the basic information required in ways that minimise the work involved.

Considering that a large number of HIES or censuses are planned for the Pacific over the next three years (Haberkorn 2008), and that many PICTs do not have the resources to support targeted fisheries surveys, the modification of HIESs and censuses to serve fisheries management should be given urgent consideration.

Acknowledgements

We thank Alexandre Ailloud, Lindsay Chapman, Matthew Chigiyal, Gerald Haberkorn, Tim Lawson, Tim Pickering, Ben Ponia, Chris Ramofafia, Etuati Ropeti, Arsene Stein and Leilua Taulealo for the useful discussions that helped to develop these ideas.

References

Bell, J. (2007). Fish – cornerstone of future food security? Pacific Islands Business October 2007: 44.

Bell, J.D., M. Kronen, A. Vunisea, W. J. Nash, G. Keeble, A. Demmke, S. Pontifex and S. Andréfouët (2009). Planning the use of fish for food security in the Pacific. Marine Policy 33: 64-76.

Gillett, R. (2009). The contribution of fisheries to the economies of Pacific Island countries and territories. Pacific Studies Series. Asian Development Bank, World Bank, AusAID, FFA, SPC (in press).

Haberkorn, G. (2008). 2000-2008 Census and household surveys. Statistics and Demography Programme, Secretariat of the Pacific Community, Noumea.

SPC (2007a). The future of Pacific fisheries – planning and managing for economic growth, food security and sustainable livelihoods. 5th Conference of the Pacific Community, Apia, Samoa, 12-13 November 2007.

SPC (2007b). SPC Aquaculture Action Plan 2007. Secretariat of the Pacific Community, Noumea, New Caledonia.

SPC (2008). Fish and food security. Policy Brief 1/2008, Secretariat of the Pacific Community, Noumea, New Caledonia.

© Copyright Secretariat of the Pacific Community, 2009

All rights for commercial / for profit reproduction or translation, in any form, reserved. SPC authorises the partial reproduction or translation of this material for scientific, educational or research purposes, provided that SPC and the source document are properly acknowledged. Permission to reproduce the document and/or translate in whole or in part, in any form, whether for commercial / for profit or non-profit purposes, must be requested in writing. Original SPC artwork may not be altered or separately published without permission.

Original text: English

Secretariat of the Pacific Community, Marine Resources Division, Information Section,
BP D5, 98848 Noumea Cedex, New Caledonia
Telephone: +687 262000; Fax: +687 263818; cfpinfo@spc.int; http://www.spc.int/coastfish

RABBITFISH: A CANDIDATE FOR AQUACULTURE IN THE PACIFIC?

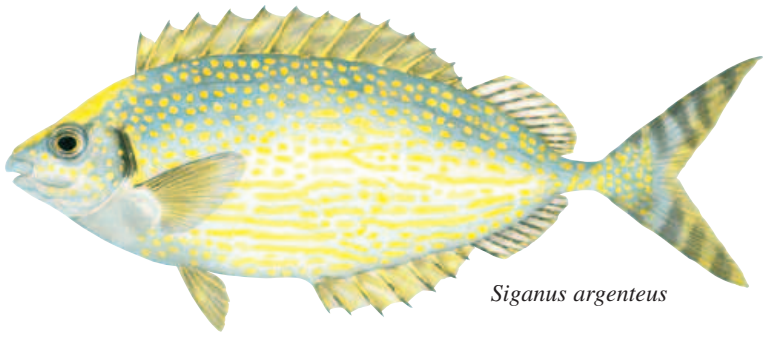
Antoine Teitelbaum[1], Tap Prior[2], Frank Legarrec[3], Cletus Oengpepa[4], and Patrick Mesia[5]

Worldwide, rabbitfish species have long been identified as appropriate candidates for aquaculture in developing areas of Asia. For example, *Siganus canaliculatus*, *S. guttatus*, *S. virgatus*, *S. spinus*, *S. punctatus*, *S. fuscescens* and *S. javus* in Malaysia and Philippines (Pacoli 1983; Von Wersternhagen and Rosenthal, 1976) and Indonesia, *S. canaliculatus* on the east coast of Africa (Bwathondi, 1982), *S. rivulatus* in the Middle East and Mediterranean region (Cagiltay 2003) and finally *S. randalli*, *S. lineatus* and *S. fuscescens* in the Pacific region (Brown et al. 1994; Rechellul pers. comm., Legarrec pers. comm.).

Rabbitfish aquaculture is fairly well understood and documented. More importantly, this group is very abundant during its recruitment periods, making it easy to catch in the shallows and thus keeping down the costs of acquiring fingerlings.

Several species of rabbitfish (mostly *S. argenteus*, *S. fuscescens*, *S. spinus* and *S. lineatus* – Fishbase, 2008) recruit into shallow seagrass beds and mangrove areas when they are about 60 days old and show strong aggregating behaviour. This phenomenon has been observed in Solomon Islands, generally in the summer months (October–February) (C. Oengpepa pers. comm). In Guam, they have been observed to recruit in high numbers in April (Tsuda and Bryan, 1973). In the Philippines, recruitment peaks were observed in February, March and April during new moon periods (Lam, 1974). A high recruitment event was observed in Fiji (Pickering pers. comm.) in December 2007. Usually, the juvenile fish recruit as a bait ball on shallow seagrass, mangrove areas or reef flats. They can be collected by push nets, cast nets, seine nets, lift nets, etc.

Excellent efforts have been made throughout the region to develop rabbitfish hatchery protocols, e.g. by the Bureau of Marine Resources in Palau for *S. fuscescens* and by Aqualagon, a New Caledonia based company for *S. lineatus* (SPC 2009). This hatchery development shows high promise for servicing niche export markets and local markets where the species has high value. However, most rural or peri-urban areas of the Pacific are best to tap into the large bait balls formed by rabbitfish when they recruit to develop a low tech, low investment type of aquaculture whether in floating cages, pens or ponds.



Siganus argenteus

REVIEW OF RABBITFISH FARMING INITIATIVES THROUGHOUT THE REGION

SOLOMON ISLANDS: Assessing local feed types for grow out of *S. argenteus*

With contributions from Cletus Oengpepa (WorldFish Center) and Patrick Mesia (MFMR)

In Solomon Islands, ACIAR recently funded a project called 'Cage culture of rabbitfish (Siganids) with emphasis on locally available diets'. The project is one of the ACIAR-funded aquaculture mini-projects that are currently being jointly implemented by James Cook University, SPC, The University of the South Pacific and the WorldFish Center together with in-country counterparts (Fisheries Services and the private sector in some cases). The three aims of this project are to (i) culture wild caught rabbitfish fingerlings in a simple cage farming system using proven commercial diets; (ii) identify locally available sources of ingredients that can be used for fish mariculture, develop simple diets and compare growth and survival of rabbitfish using these diets; and (iii) evaluate future options for

[1] Aquaculture Officer (Marine), Secretariat of the Pacific Community, Noumea, New Caledonia, AntoineT@spc.int
[2] President, TGA, Rarotonga, Cook Islands, pryor@tangaroaci.co.ck
[3] Manager, Aqualagon, New Caledonia, legarrec@canl.nc
[4] Station Manager, WorldFish Center, Nusa Tupe, Western Province, Solomon Islands, c.oengpepa@cgiar.org
[5] Fisheries Officer, Ministry of Fisheries and Marine Resources, Honiara, Solomon Islands, patrick_mesia@hotmail.com

marine finfish mariculture to address some of the emerging food security issues in the Pacific.

The WorldFish Center, Ministry of Fisheries and Marine Resources and the SPC Aquaculture Section are involved in trials which began in October 2008 at the WorldFish Center station in Nusa Tupe, Western Province. So far, a few hundred *S. argenteus* fingerlings have been collected from seagrass beds and placed in floating sea cages.

A batch of these are being fed with a commercial imported aquafeed to assess the maximum growth potential of the species under Solomon Islands conditions, while the others are being fed on locally made feed. The local feed is made of by-products that are cheap and easily found throughout Solomon Islands – fish meal from the Noro based tuna plant and copra meal. To make the feed, sago palm starch is being used a binder.

Survival has so far been excellent but growth has been better with the fish fed commercial diets. The trials will continue until all fish are brought in at commercial size. We expect to be running more feeding trials with a wider range of locally available ingredients.

Rabbitfish is highly regarded in Solomon Islands and some areas such as North Malaita have high populations, great farming spots and good rabbitfish recruitment patterns. We hope to be able to demonstrate the cheapest way to farm these

Top: Small scale experimental floating farm in Solomon Islands

Middle: Kurukuru (WorldFish staff) feeding the rabbitfish

Bottom: Monthly sampling of rabbitfish growth in Solomon Islands

fish and the MFMR wishes to transfer these farming /feeding techniques to places such as Lao lagoon in the near future.

New Caledonia: Hatchery development for a lucrative 'Picot Rayé' (*S. lineatus*) market

By Franck Legarrec (Aqualagon)

The 'picot' is the favourite fish of New Caledonians. It reaches USD 14–18 per kg and its current production (fishing only) is around 50 t per year. Research on picot started in 2003 in collaboration with the *Laboratoire d'Etudes des Ressources Vivantes et de l'Environnement Marin* (LERVEM) at the University of New Caledonia. In 2004, the project was awarded a prize in a French technological innovation contest run by ANVAR. A pilot-scale hatchery was installed to demonstrate technical feasibility.

During the initial phases of the research, broodstock was routinely secured and a good understanding of their maturation was developed. A complete picot life cycle was achieved repeatedly during the initial trials and specific requirements for live phytoplankton and zooplankton during larval rearing were developed. Cage trials proved that picot reached commercial size (300 g) in less than a year.

In 2009, a commercial hatchery and commercial farm will be established in southern New Caledonia with a total production capacity of 100 t per year. Aqualagon is expecting to produce 30 t per year from 2010 onwards. Focusing on the local market, Aqualagon is hoping to diversify its production by (i) selling fingerlings to other farmers, (ii) developing the restaurant/wholesaler market for picot, and (iii) possibly exporting.

Cook Islands: Making the best of large recruitments of *S. argenteus* in Rarotonga: Pond farming of rabbitfish

By Tap Pryor (Titikaveka Growers Association)*

Each January in Rarotonga, rabbitfish (*Siganus argenteus* or *morava*) run in thick schools close to the beaches. Surrounded by a net, they form what looks like a huge, black medicine ball, indeed called a 'bait ball'. Predator fish lurk in slightly deeper water, looking for the carelessly wandering mini-school and racing in like wolves after caribou. The fingerlings are so abundant they seem uncountable, perhaps best quantified by the local term 'heaps'.

Top: *S. lineatus* broodstock in New Caledonia

Bottom: Releasing freshly caught *S. argenteus* fry at TGA's land based pond facilities

* Titikaveka Growers Association (TGA) is an NGO promoting organic agriculture and inland aquafarming in Cook Islands in close association with the Ministries of Agriculture and Marine Resource Management.

Titikaveka Growers Association (TGA) developed and operates a demonstration aquafarm on Rarotonga. Amongst its facilities are two lined ponds holding 600,000 litres of seawater each with a salinity of 22–25 ppt or roughly 61–69% of the salinity of ocean water.

The seawater is pumped in from the nearby lagoon just once to fill the ponds after which it is recirculated internally through large (22 x 2 x 1 m), oyster-loaded biofilters at 600 lpm. TGA maintains a dense, marine phytoplankton culture in the ponds. At present, we have over 150,000 oysters in inventory and add about 50,000 per month from a hatchery in Tasmania, Shellfish Culture Ltd. Grow-out requires 8 months from seed to market, so the peak load will be about 400,000 oysters from 2 cm to 10 cm.

Phytoplankton culturing on the demonstration aquafarm is normally assisted by a polyculture of milkfish, but as one pond had been recently filled, it contained no fish in January. To compensate, TGA's Chairman, Teava Iro, decided to recruit some rabbitfish and easily transferred about 5,000 fingerlings by simply bucketing them from the bait ball into containers and rushing them by truck three km to the pond. They lived.

Alerted to the apparent success of the small trial, Secretary of Marine Resources, Ian Bertram, organized a second operation two weeks later from the opposite side of the island near Avatiu Harbour. Equipped with a battery-powered aerator and several tanks, MMR staff were able to transfer an additional 30,000 or so to the same pond with only a handful of losses. These too continue to thrive.

For the month that we have had them in stock, we have been feeding a chicken mash (16.5% protein) twice daily, which they scoop up eagerly. Presumably, they supplement this by grazing surface algae and zooplankton. We note in Antoine's paper that other Siganid species – all omnivores – have successfully been fed a wide range of diets, including everything from tapioca leaves and seaweed to chopped fish and fish meal pellets. We intend to try many of these. The recommended ration in the tropics is 5–7% of bodyweight, a huge amount of food whenever most of ours reach a marketable 250 grams.

We also note that Siganids are pervasive throughout the region. Who can say how well TGA's trial will turn out by January 2010! However, if these fish continue to survive and grow and if we can learn how best to feed them, we will try to acquire more fingerlings. At 50 fish/cu^3, we will carry bio-loads of 12.5 kg/cu^3 when marketable, an achievable target even when doubled by the oyster load. With the benefit of biofilters and/or packages of bacteria and enzymes (probiotics) to maintain water quality, we may end up with a second demonstration of some possible use to the region.

Transporting *S. argenteus* on the back of a truck in Cook Islands

References

Brown, J.W., Chirichetti., P., Crisostomo, D. 1994. A cage culture trial of *Siganus randalli* on Guam. Asian Fisheries Science. Metro ManilaVol. 7, no. 1, pp. 53-56.

Bwathondi, P.O.J. 1982. Preliminary investigations on rabbitfish, *Siganus canalicullatus*, cultivation in Tanzania. Aquaculture. Vol. 27, no. 3, pp. 205-210.

Cagiltay, F. 2003. Culture of the rabbitfish (*Siganus luridus* Rueppell, 1828). Su urunleri dergisi/Journal of Fisheries and Aquatic Sciences. Vol. 20, no. 1-2, pp. 257-261.

Fish Base, 2008 www.fishbase.org

Lam, T.J.1974. Siganids: their biology and mariculture potential. Aquaculture (3) 325-354.

Pacoli, M.E. 1983. The farming of siganid in the Philippines. Fish Today. Vol. 5, no. 2, pp. 50-52.

Tsuda, R.T. and Bryan, P.G. 1973. Food preferences of juvenile *Siganus rostratus* and *S. spinus* in Guam, Copeia (3) 604-606.

Von Wersternhagen, H. and Rosenthal H. (1976) Some aspects of the suitability of various Philippine siganid species for mariculture. Aquaculture (9).

Siganus punctatus