



Fisheries

Newsletter

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Editorial

Welcome to this issue of the *Fisheries Newsletter*. In this issue Bob Gillett et al., on page 32, raise the issue of the use of livelihood diversification for resource management in the Pacific Islands. It is now understood that inshore fisheries are overexploited in many areas of the Pacific and that securing alternative sources of income or food to relieve pressure on inshore marine resources is now critical.

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A pearl oyster (*Pteria penguin*) farmer in Vava'u, Tonga.



SECRETARIAT OF THE PACIFIC COMMUNITY

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■ REEF FISHERIES OBSERVATORY

Staff of the coastal component of the EU-funded Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROC-Fish/C) and the Coastal Fisheries Development Programme (CoFish) continued writing site reports as well as conducting specific survey work at the request of member governments. The programme lost two staff members due to a lack of funding. Ferral Lasi (Fig. 1), who worked with the programme for three years as a Reef Fisheries Officer (invertebrates), was an integral member of the inverte-

brate team who conducted survey work and training in nine of the 17 participating countries and territories. His input during the remainder of the project will be sorely missed. Ferral has moved back to the Solomon Islands, where he hopes to complete a second master's degree with a focus on fisheries economics. The PROCFish/C and CoFish staff wish Ferral all the best in his future endeavours.

Aliti Vunisea (Fig. 2) worked for three years with PROCFish/C as a Community Fisheries

Scientist. Aliti is no stranger to the region, and in this position she conducted survey work in seven of the 17 participating countries and territories. Although she will be greatly missed by the project team, Aliti will not be leaving SPC, as she has been recruited as the Human Development Programme Adviser for SPC's Pohnpei Office. The PROCFish/C and CoFish team wish Aliti well in her new position.



Figure 1 (left): Ferral Lasi, former Reef Fisheries Officer (invertebrates) with PROCFish/C.

Figure 2 (right): Aliti Vunisea, former Community Fisheries Scientist with PROCFish/C. Aliti now works as SPC's Human Development Programme Adviser in Pohnpei, Federated States of Micronesia.

Two staff recruited to work on country reports

Two staff have been hired on short-term contracts to work specifically on compiling and editing country reports. Céline Berre (Fig. 3) was hired on an eight-month contract to

compile individual site reports into a complete report, identify missing data, format and lay out the reports, and incorporate any editorial changes. Céline has developed

a style sheet and compiled and formatted reports for French Polynesia, Wallis and Futuna and Niue, which are now ready for editing. She has also worked to finalise the report for Nauru. We welcome Céline to the team and look forward to working with her in the coming months.



Figure 3 (left): Céline Barre will work with the programme for eight months compiling, formatting and laying out country reports.



Figure 4 (right): Sarah Langi will work with the programme for six months editing country reports and writing executive summaries.

We also welcome Sarah Langi who has been hired on a six-month contract to edit country reports, as well as write executive summaries for each report. Sarah began work on 1 June and is currently editing the reports for Vanuatu, Nauru and Tuvalu. The team looks forward to working with Sarah and providing input on and clarification of her queries as she edits.



Trochus and sea cucumber surveys around Epi Island, Vanuatu

Trochus and sea cucumber resource surveys were conducted in five sites around Epi Island in Vanuatu during April 2008 (Fig. 5). The government of Vanuatu requested assistance in training local officers in survey work. Epi Island is one of several known trochus shell production areas in the country, and is where community-based management systems regulate the area's trochus and sea cucumber fisheries. However, no resource assessments have ever been conducted around the island and no information is available on the status of these resources or on the socioeconomic aspect of communities and their relationship with reef resources. Despite the existence of traditional customary marine tenure systems, which are practiced by communities and reef owners around Vanuatu, commercial reef fisheries (e.g. trochus and sea cucumber) have disappeared from many reefs around the country.

This survey work is valuable to Vanuatu's Fisheries Department, which is interested in knowing the present status of marine resources and community management systems so that they can make informed management decisions at the national

level. In addition, local fisheries officers were trained in regional invertebrate survey techniques, which are being refined by the PROCFish/C and CoFish project. Staff from these projects will conduct similar trainings in other countries.

The PROCFish/C team consisted of Kalo Pakoa and Ferral Lasi, and Sompert Rena from Vanuatu Fisheries Department's Research and Aquaculture Section and Jason Raubani from the Coastal Fisheries Section. The socioeconomic component of the survey

was conducted by Vanuatu Fisheries Department staff Tony Taleo and John Mahit, with advice from the PROCFish/C socioeconomic, Mecki Kronen. Socioeconomic surveys were conducted two weeks prior to resource surveys. Funding for field surveys was provided both by PROCFish/C and an FAO-funded mini-project with Vanuatu's Fisheries Department.

REEF ENVIRONMENT

Epi Island has narrow fringing reef platforms (50–100 m wide) in



Figure 5 (top): Epi Island survey sites.

Figure 6 (bottom): This Epi Island reef, shallow and partly exposed at low tide (left), drops abruptly to five metres with no reef slope zone (right).

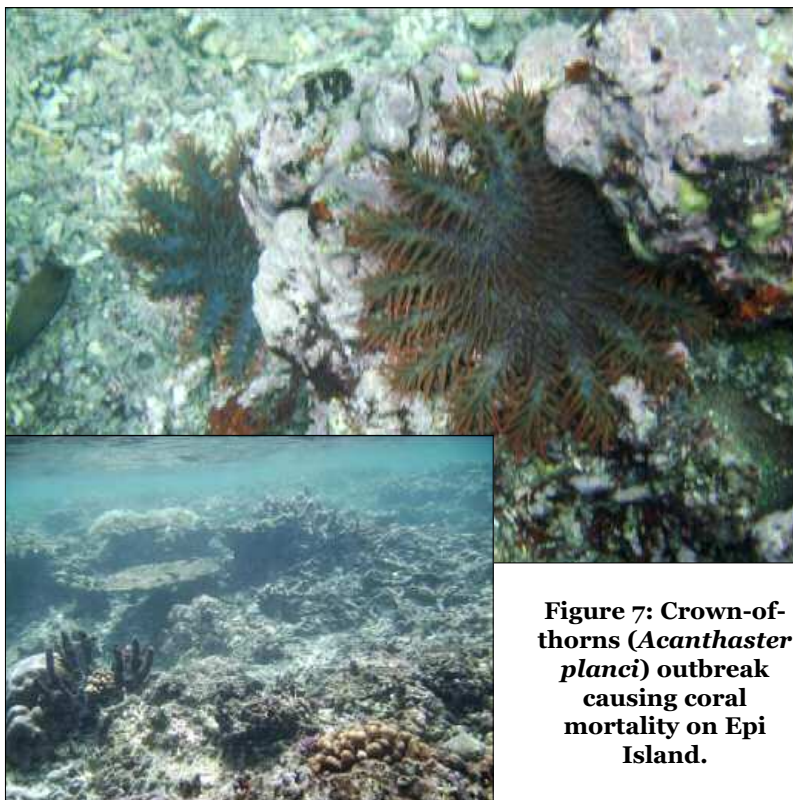


Figure 7: Crown-of-thorns (*Acanthaster planci*) outbreak causing coral mortality on Epi Island.



all the sites assessed (Fig. 6). These reef platforms drop off abruptly to around five meters (Fig. 6) to a mixed sand-rubble bottom, provide suitable habitat for trochus, which are collected by islanders walking the reefs at low tide or snorkelling in shallow water.

The general status of corals was poor at Lamén Bay, Ponkovo, Burumba and Mavelau (<20% coverage). A major crown-of-thorns (*Acanthaster planci*) starfish outbreak was recorded in these four sites (Fig. 7), with recent predation moving westward along the northern tip of Lamén Bay. Coral coverage was better (40–50% coverage) at Mapuna (NE) and the southern section of Mavelau (SW at Valesdir). River run-off from recent heavy rains contributed to sedimentation and poor visibility.

PRELIMINARY FINDINGS

Invertebrate diversity and abundance was generally low at all five sites. Only nine out of 18 commercial sea cucumber species were recorded. Two giant clams (*Tridacna maxima*, and *T. squamosa*) and three species of turban snails were also recorded. In addition to fishing impacts, unsuitable habitat also limits the numbers of this invertebrate species. Trochus numbers varied across the five sites. Ponkovo and Burumba had higher numbers due to the relatively effective traditional management systems enforced by both communities. Both small and larger shells were recorded (Fig. 8), and Burumba had relatively larger and older shells compared with Ponkovo, which had relatively young shells. On the whole, however, trochus resources in all five sites were depleted and present stocks are not sufficient for continued fishing. In addition, the

Figure 8: Larger adults and juvenile trochus present at all survey sites.

presence of juveniles at all sites is indicative that with sufficient time, the resource could recover. The nine sea cucumber species recorded occurred in very low densities. High-value black teatfish (*Holothuria nobilis*) and medium-value greenfish (*Stichopus chloronatus*) and *Actinopyga mauritiana* were present in moderate numbers. Apart from Lamen Bay — where the reef habitat is relatively well suited for sea cucumbers — the other sites had very few reef systems that were suitable for supporting a diversity of sea cucumber species.

COMMUNITY MEETING

In a debriefing meeting at the end of the surveys, chiefs and village elders from the five survey areas learned for the first time about the status of their trochus and sea cucumber fisheries.

Despite the communities' active traditional management systems (mainly through tabus), the poor status of these fisheries raised serious questions among the elders regarding the effectiveness of traditional management systems. Issues highlighted by chiefs and elders at the meeting included a weakening power to enforce tabus. Too many clans are enforcing too many parcels of reef, compared to the past when only the paramount chief enforced such laws. This has greatly diminished community solidarity, thus contributing to the loss of power of tabus. Also highlighted was the lack of national harvesting controls. Communities fish whenever they desire, and shell buyers buy year round. This has contributed significantly to the creation of many smaller clan-controlled reefs, thereby further weakening the *tabu* system.

Village elders stated that for their customary marine tenure systems to be effective, the national government needed to set harvesting seasons by province or by island.

FISHERIES STAFF TRAINING

Local trainees Jason Raubani (Fig. 9) and Sompert Rena enthusiastically participated in the survey training and have learned the skills needed to conduct a survey on their own. Both officers are involved in various resource assessment activities, including the Japan International Cooperation Agency (JICA) trochus and green snail seeding project, trochus transplantation, coral reef monitoring, aquarium fish and sea cucumber assessments. The skills they gained will be used to conduct similar standardised resource surveys in other areas of Vanuatu.



Figure 9: Local counterpart Jason Raubani conducting a survey.

Four sites in Tonga revisited for socioeconomic surveys

Socioeconomic and finfish resource surveys were initially conducted in six sites in Tonga in 2001/2002 (see Fig. 10) under the (then) DemEcoFish project. The survey was a pilot study under the European Union-

funded PROCFish/C programme. Because certain survey approaches have changed, four Tongan sites were revisited (Fig. 10). The Tongatapu socioeconomic surveys (conducted in April 2008) included 16 house-

holds in Ha'atafu and Manuka. Socioeconomic surveys on Ha'apai (conducted at the end of May 2008) included 20 households on Lofanga, and 27 households in Koulo. A summary of the 2008 socioeconomic

survey and a first comparison of results with the 2001/2002 survey are presented, using Lofanga as a case study. PROCFish/C staff Aliti Vunisea and Meeki Kronen conducted the surveys in Tongatapu and Ha'apai, respectively.

The programme thanks Tonga's Fisheries Department for its support and cooperation, and particularly acknowledges the following people: 'Ulunga Fa'anunu, Deputy Secretary for Fisheries; Siola Malimali, Fisheries Officer; Mele Makasini, Community Section; Martini Finau, Aquaculture Section; Poasi Fale Ngaluafu, Aquaculture Section; Fina Vili, Fisheries Officer Ha'apai; Fanueli Tongaonevai, staff of Ha'apai Fisheries; and all village chiefs and people of Manuka, Ha'atafu, Koulo and Lofanga for their patience and cooperation in answering all our questions.

Lofanga village is the sole community on Lofanga island in the Ha'apai group. The island is accessible only by boat, and a typical trip, weather permitting on a 4.5–6 m wooden skiff with a 30 hp outboard, takes between 1.5 and 2 hours from Pangai, the centre of the Ha'apai group (a distance of 20 km). Lofanga belongs to the crown prince Tupouto'a, who will be the crowned King of Tonga in August 2008. The crown prince also owns a small piece of land at Hihifo, a settlement attached to Pangai on Lifuka.

Lofanga has an area of about 1.4 km², and is mostly used for growing crops. Agricultural produce comprises the majority of goods transported and sold at the Pangai market. There are hardly any alternatives to fisheries for income generation. In fact, 70% of all households derive their primary income source from fisheries. This trend contrasts with the 2001/2002 situation, where hardly any households derived income exclusive-

ly from fisheries. Agricultural produce represented a very important source of income, and handicraft production complemented income in 2001/2002. Today, the market situation on Pangai has changed. Fuel prices for boat transport have increased, and the importance of agricultural production is more for subsistence matters rather than for income. Cash income is required to cover average annual household expenditures of USD 2,300, plus social and family obligations. Remittances from family members living overseas are important as they provide from USD 770 per year to 75% of all Lofangan households. The proportion of households benefiting from remittances was found to have almost doubled from the 2001/2002 survey.

Very little had changed regarding the (predominantly) non-commercial exchange of fish and invertebrates among community members. Fish for sale

mainly go to markets at Pangai and Ha'apai, with the occasional shipment to Tongatapu.

Results show that while 80–85% of all households consumed fish that they caught themselves (with 1–2 fishers per household), or that they were given, another 15–20% purchased fish. Invertebrates were not commercially purchased — in 85% of all cases they were caught by a household member, and in about 65% of all cases they were given by someone outside the household.

While the population has declined by about 14% since 2001/2002, total subsistence demand for fish has decreased even more. Today, it is estimated that Lofangans consume about 12 mt of fresh fish annually. Other food items, such as canned fish, have become increasingly more important in everyday nutrition. Lofangans consume an additional 21 kg of

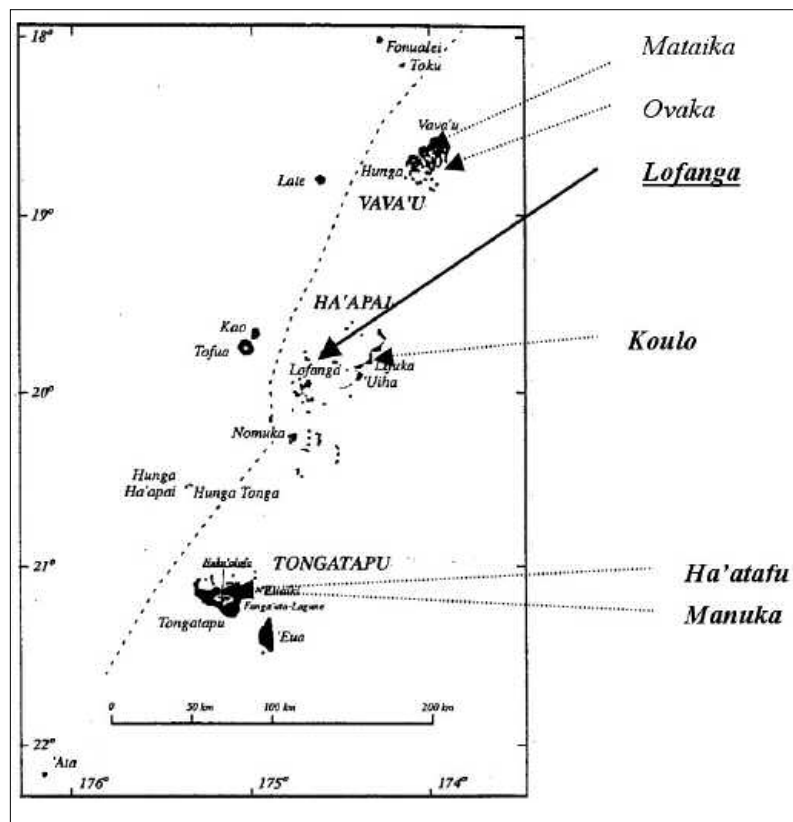


Figure 10: Location of DemEcoFish and PROCFish/C sites.

canned fish per capita annually, corresponding to a total of about 4 mt/year.

Women generally were not involved in finfishing, although the 2008 survey revealed that the women on Lofanga specialise in the collection of a few invertebrates. Octopus, for example, is not only a delicacy for home consumption, also it is also cleaned and hung in trees to dry (Fig. 11) for later sale on the mainland.

Lofanga's fishermen catch more fish for sale than they do for home consumption. In fact, the relationship is widening in favour of sale. The recent increase in oil and fuel prices may add to the necessity to compensate with bigger catches per trip.

Invertebrate collection is mainly done for home consumption, and is mostly done by women. Major species collected on reeftops are *elili* (*Turbo* spp.), *feke* (*Octopus* spp.), and giant clams. Dried octopus and giant clam meat are sold by women on Ha'apai for additional income. Men sometimes collect invertebrates such as lobsters or giant clams while spear diving for finfish.



Figure 11: Octopus drying on Lofanga Island.

Trochus surveys in Kosrae and Pohnpei, Federated States of Micronesia

Following an initial request from the Director of the Kosrae Island Resource Management Authority (KIRMA) in late 2007, the government of the Federated States of Micronesia (FSM) requested technical assistance from SPC to assess trochus stocks around Kosrae and Pohnpei, and to train local counterparts in survey methodologies. Two Co-Fish Reef Fishery Officers — Kalo Pakoa and Emmanuel Tardy — were assigned to this project, with fieldwork in Kosrae undertaken from 2–9 June, and in Pohnpei from 11–19 June. The primary goals of the mission

were to provide an initial assessment of trochus stocks, train the local team in PROCFish survey techniques, and provide advice for future management arrangements for trochus.

The CoFish team acknowledges and thanks the following people who assisted and/or worked with the team during the surveys. In Kosrae, Simpson Abraham, Director of KIRMA and the field team Steven Palik, Cornelius Nena, and Maxton Nithan, KIRMA; and Bruno Ned, Kosrae Department of Resources and Economic Affairs. In Pohnpei, Donald

David, Director of Pohnpei's Marine Development Division and Valentine Martin, Deputy Assistant Secretary, Marine Resource Units of the Department of Resources and Development; and the field team Dave Mathias and Scotty Malakai, Pohnpei Forestry and Marine Conservation Division; Pelson Moses, Pohnpei Marine Development Division; Allen Marcus, Chuuk Department of Marine Resources and Damasus Mailing, Yap Marine Resources Management Division. Thanks also to SPC's Northern Regional Office for assisting, especially Amena Yauvoli.

SURVEYS IN KOSRAE

Kosrae is a high mountainous island surrounded by coastal mangrove swamps and a fringing reef system. Reefs along the east and south coasts are narrow, but wide along the west and north coasts. The reef flat zone on the west and north is mostly exposed at low tide. The reefs all around the island are favourable for adult trochus (shallow outer reef). Large areas of back reef, especially on the northwest, north and east sides of the island, are favourable for the settlement of juveniles.

Trochus niloticus, or *takasangai* in Kosraean, was introduced to the island by the Japanese administration, perhaps from Pohnpei, around the late 1950s. It is not clear when the first harvest was made but harvests have occurred since the 1970s. Very little information is available about this resource in Kosrae. It is reported that a 10-year fishing closure was instituted around 1995/1996. In 2007, fishing was opened for a period of five days when a harvest of approximately 26 mt was made and sold for USD 78,255. The trochus fishery represents one of only a few income earning options for the island's 9,000 people. While there is a high local interest in the fishery, there is a lack of data on resource status. The results of this current assessment will constitute the baseline for reviewing regulations and future management decisions. A new management plan and harvest regulations will be developed based on the results of this assessment.

The survey covered a large amount of Kosrae's coastline, and comprised 49 stations of scuba and/or snorkel transects, consisting of 24 mother-of-pearl transects (timed swims), 18 reef front searches, 2 shallow water reef benthos transects, 4 reef front search walks as shown in Figure 12. In

addition, a single mother-of-pearl search was undertaken to locate trochus aggregations.

Trochus niloticus was present in moderate to large numbers around the island, with the highest densities recorded at the eastern reef of Lelu, Tafunsak in the north, and Okat and Walung in the west. In general, trochus were mainly found in deeper waters (5–10 m), and the stock

consisted predominantly of larger, older shells (>100 mm). For all survey sites, the full size range was found, including juveniles, which is promising for future recruitment. However, the majority of trochus were larger, older adults. Trochus were found to aggregate more in pockets of dead coral bottoms (Fig. 13) with epiphytic algal growth, rather than in areas of high live coral growth.



Figure 12 (top): Survey coverage (stars and squares) around Kosrae Island.

Figure 13 (bottom): *Trochus niloticus* in a crevice.

Other invertebrate species included eight commercially valuable sea cucumbers — dominated in numbers by greenfish, *Stichopus chloronotus*, and surf redfish, *Actinopyga mauritiana* — one giant clam (*Tridacna maxima*), one turban snail *Turbo argyrostomus* (kaweng), and a spider conch (*Lambis truncata*) (ful mula). *Tridacna gigas* is extinct from the island and old shells were observed from the dredged materials along the Lelu Harbour jetty. *Tridacna derasa* is being farmed for re-introduction purposes. Kosrae has a very healthy live coral cover with some areas reaching 80% coverage. However, crown-of-thorns (*Acanthaster planci*) outbreaks were detected in two pockets of reef at Tafunsak (north) and in the outer reefs at Walung (west) in 6–12 m depth.

A presentation of preliminary survey findings was made to the Governor of Kosrae, Robert Weilbacher, who was especially interested to know if another open season for trochus would be possible in the near future. The answer was “no answer just yet” until survey data have been analysed. Only then can advice on harvesting be provided. More importantly, the crown-of-thorns outbreak is

considered to be an urgent issue, and early clean-up work is recommended while their numbers are still manageable.

SURVEYS IN POHNPEI

A well developed reef system comprising mangrove forest, extensive fringing reefs, sea grass beds, lagoon and barrier reefs exist in Pohnpei. The lagoon encircling most parts of the island contains numerous patch reefs and some 15 passage breaks. An extensive barrier reef about 3 km offshore encircles much of the island. Trochus are found outside the barrier reef and reefs inside passes where suitable habitat exists.

Trochus niloticus was introduced to Pohnpei by the Japanese administration in 1939 from Palau. First harvests were transplanted to two of Pohnpei's outer islands, Sapwuafik and Mwoakiloa atolls. In 1958, 16 trochus sanctuaries were established around Pohnpei proper, and the first harvest of 65 mt was made in 1969. Afterwards, 18 harvests were made in Pohnpei proper between 1969 and 1994. Today, seven of the trochus sanctuaries are actively enforced, along with two recent

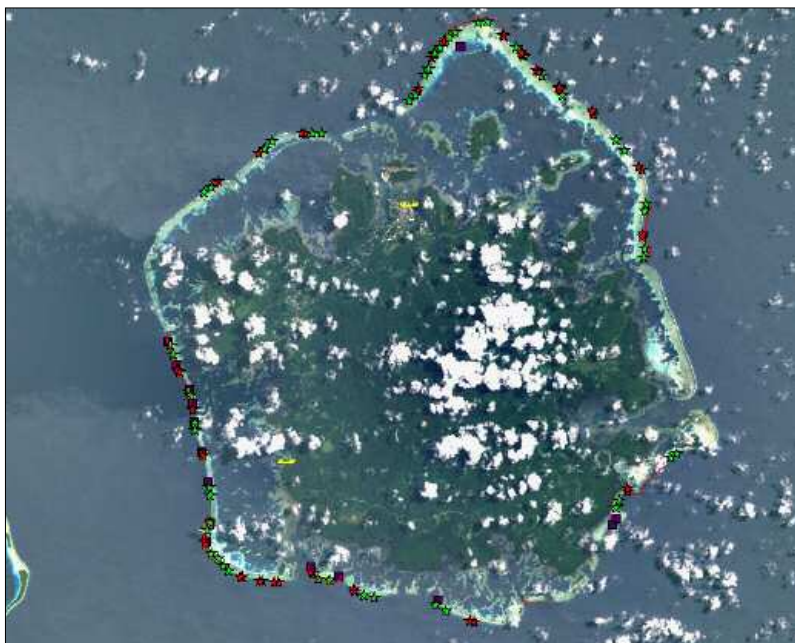
grouper spawning aggregation sites at Kehpara and Kepidau Pilen. Current trochus harvest control measures include a minimum basal shell width of 3 inches (7.6 cm) and a maximum size of 4 inches (10.2 cm), a shorter harvest season (six hours), and a harvestable quota based on assessment.

The recent re-structuring of Pohnpei's fisheries sector has resulted in the fisheries management section — the section traditionally in charge of trochus management — moved to the Department of Forestry and Marine Conservation. The new changes created confusion about the enforcement of existing harvest regulations, and because the Fisheries Department was not included in the new arrangements, poaching occurred within the sanctuaries, the open season was extended, no surveillance took place, and no catch monitoring was undertaken. According to the Chief of the Marine Development Division, some 200 mt of shell may have been collected in the 2004 season. The quota allocated was 100 mt. The current resource assessment survey is essential to providing an accurate picture of trochus numbers for management purposes. Last year's harvest (2007) of 18 short tons was made at Sapwuafik Atoll, one of Pohnpei's outer islands, and sold to a local buyer at USD1.65 a pound (\$3.64/kg) of cleaned shell (i.e. no meat).

In total, 63 stations of scuba and/or snorkel transects were made, consisting of 26 mother-of-pearl transects (timed swims), 22 reef front searches, and 15 shallow water reef benthos transects (see Fig. 14). The data collected are sufficient for providing an overview of the resource status.

Trochus were found at all survey stations at 0–10 m depth.

Figure 14: Survey coverage for Pohnpei.



High aggregations were common all around the island, with regular higher densities in the west and south. A range of sizes was recorded, but in most cases the majority of shells were large (>10 cm) and old. Abundance inside existing sanctuaries does not seem to be much different than found outside the sanctuaries. The relatively high trochus abundance at Pohnpei is an indication of good management efforts since the 2004 harvest.

In addition, five sea cucumber species were present with *Stichopus chloronotus* and *Actinopyga mauritiana* being the most commonly found on the barrier reef. The elongated giant clam (*Tridacna maxima*) was the only giant clam recorded but was found in very low numbers. Other gastropods commonly found included *Turbo argyrostomus*, *Tectus pyramis*, *Dendropoma maxima*, and various species of Cypraeidae, Conidae, and Turbinellidae.

Pohnpei is facing a long-term outbreak of the crown-of-thorn starfish (*Acanthaster planci*) (Fig. 15), which is abundant from the northern tip of the barrier reef, all the way down to the southwest reef at Black Coral Island Sanctuary. Relatively fewer numbers were recorded on south and east facing reefs, but live corals in these areas were not abundant. High numbers of remaining dead coral heads (Fig. 16) at 5–11 m depth, suggest that this outbreak may have occurred several years ago.

Pohnpei is planning a trochus survey for one of its outer islands in July and will be using the new surveying techniques during that survey. Basic survey tools (2 slates and 1 Chainman, a string measure tool) have been provided to the Pohnpei team to assist them with this work.

Preliminary results of the trochus survey were presented at the governor's office. As in Kosrae, a serious concern is whether fishing will remain possible. The team maintained that only proper data analysis will provide the answer. Shell buyers from Fiji and Vietnam, who were visiting FSM in search of raw shell, were also present at the meeting, as well as

the manager of SPC's Northern Regional Office, Amena Yauvoli. Crown-of-thorns was reported to be an urgent problem in Pohnpei, and clean-up action was recommended.



Figure 15 (top): A crown-of-thorns starfish feeding on corals is an all too common site in Pohnpei.

Figure 16 (bottom): Dead coral reef in Pohnpei.

First sub-regional underwater visual census (UVC) finfish workshop

The first sub-regional underwater visual census (UVC) finfish workshop was held in Noumea from 16–25 June. Participants included William Saladrau and Tarisi Toroca Shaw from Fiji; Delvin Thoma and Jake Debaio from Nauru; and Peter Rex Lausu and Rosalie Masu from the Solomon Islands. Céline Barré from SPC, and a local fisheries scientist, Matthieu Junker, also attended. Four workshops in total will be held.

In PROCFish/C and CoFish projects, training in underwater visual census techniques has been conducted during all in-country fieldwork. However, today, a large number of staff trained in these methodologies have changed activities or positions. Therefore, to ensure local capacity at the country level, this series of workshops has been organised. The objective of these courses is to equip fisheries departments and associate agencies with the tools to undertake underwater assessments and monitoring of finfish resources on their own. A two-person team per country will be trained so that necessary repeated assessments of fish stocks and habitat conditions can be carried out to ensure the sound management of artisanal fisheries.

The first two days of the workshop in Noumea were devoted to theoretical and practical classroom exercises. The following six days were spent on underwater trainings using different methods for identifying fish at

the species level, as well as estimating their size and distance from the observer. Trainees dove once or twice a day, practicing the different techniques (Fig. 17). They then spent time discussing their data with the instructor. The dives took place in the shallow waters of intermediate lagoonal reefs off Noumea and nearby areas. Several practice dives focused on describing

habitat and on evaluating (quantitatively and qualitatively) the different parameters used to describe environmental conditions. The last day of training was used to explain how the database software is used and to give participants a chance to practice using its different functions: data record and quality check analysis.

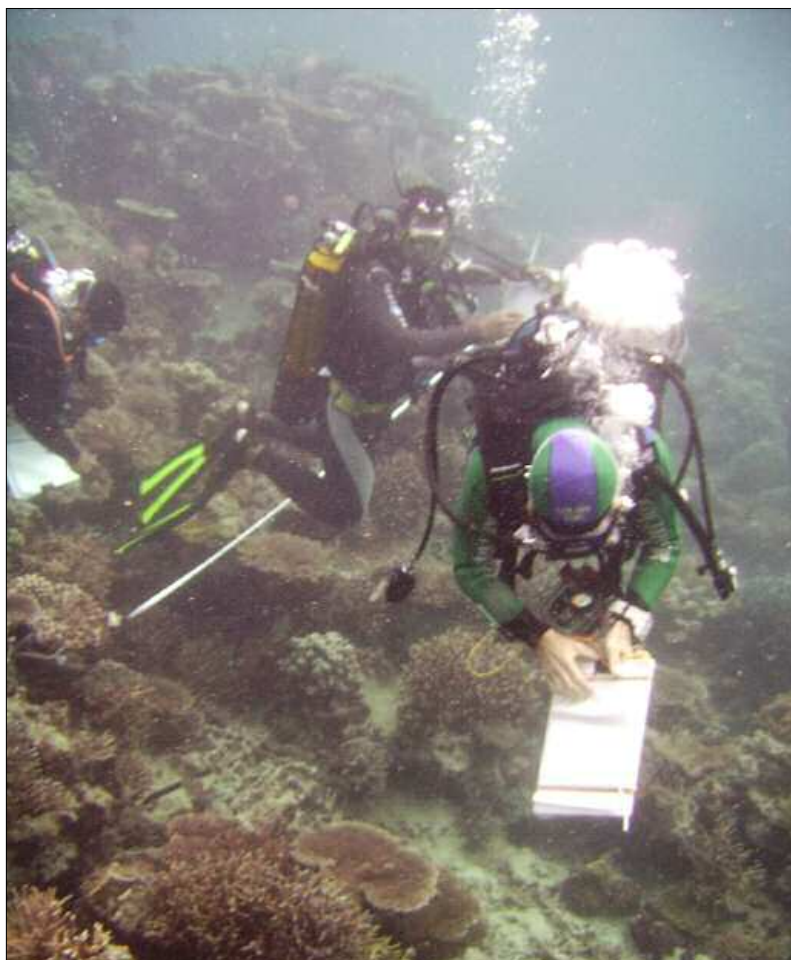
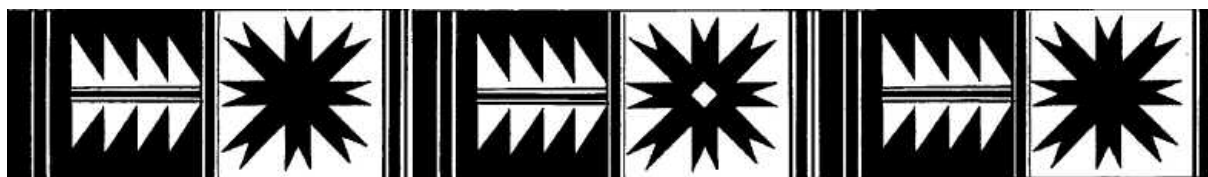


Figure 17: Training dive during workshop.



Regional workshop on the economics of marine protected areas

The PROCFish/C Reef Fisheries Information Manager, Franck Magron, attended a workshop on the economics of marine protected areas (MPAs). The workshop was held in Suva, Fiji from 26–30 May 2008 and was organised by the Coral Reef Initiative for the Pacific (CRISP), the International Union for Conservation of Nature (IUCN), and the

Secretariat of the Pacific Regional Environment Programme (SPREP).

This workshop brought together economists and practitioners of marine managed areas (MMAs) from various non-governmental organisations and CROP (Council of Regional Organisations in the Pacific) agencies. These groups discussed the best economic

instruments to use (e.g. cost-benefit analyses, multi-criteria analyses, business plans) for establishing and managing MMAs. The workshop was the first step in a continuing process to assess the economics of MPAs and determine future collaborations that could assist in this area.



COASTAL FISHERIES MANAGEMENT SECTION

Apia Policy endorsed by ministers

The Pacific Islands Regional Coastal Fisheries Management Policy and Strategic Actions — also known as the Apia Policy — was given the green light for its implementation by fisheries ministers during the Annual Ministerial Forum Fisheries Committee meeting in Koror, Palau.

The policy was developed in response to a directive from the Pacific Islands Forum Leaders under an amendment made to the Pacific Plan for Strengthening Regional Cooperation and Integration (Pacific Plan) at their meeting in Tonga in 2007.

The policy accommodates the Vava'u Declaration on Pacific

Fisheries Resources, which places high priority on “the development and management of coastal/inshore fisheries and aquaculture to support food security, sustainable livelihoods and economic growth for current and future generations of Pacific people”.

The policy is the first regional mechanism developed to harmonise national policies and activities that address the long-term sustainability of coastal fisheries resources and maintenance of healthy marine ecosystems. It provides guiding principles for strategic action at national and regional levels to address the problems and challenges encountered by Pacific Islands countries and territories (PICTs) in managing their coastal fisheries.

Strategic actions identified under the policy include the provision of technical assistance to PICTs to translate the international instruments and guidelines into harmonised policy directions that can be incorporated into national plans, national legislation, national economic development

strategies, fisheries sector plans, environmental management plans for implementation at the local or national level. This technical assistance takes into consideration changes that may have occurred over time within coastal fisheries management. It also identifies and addresses external and internal or endogenous factors (e.g. type of government structure, political history, national laws and regulations, influence of traditional authorities, and institutions such as customary and traditional rights within PICTs, that affect the policy formulation process).

The policy was developed and endorsed by the Special Session of Heads of Fisheries held in Apia in February 2008, and will guide SPC's technical assistance to PICTs from 2008–2013.

SPC acknowledges financial assistance from the Commonwealth Secretariat and the Government of Iceland towards the development of this policy.



Assistance with fisheries management ordinances in the Marshall Islands

In 2001, SPC assisted with the development of a community-based fisheries management (CBFM) programme for the Marshall Islands Marine Resources Authority (MIMRA). MIMRA, under its CBFM programme, has worked with five atolls (Mejatto, Likiep, Arno, Majuro and Ailuk) in developing community fisheries management plans that regulate the management and development of fisheries resources at the respective atolls.

One of the obligations by the local government councils — which have worked under the CBFM programme — was to develop fisheries management ordinances to legally bind management measures developed as integral parts of their fisheries management plans.

Of the five atolls that have worked with MIMRA's CBFM programme, none has yet approved a fisheries management ordinance. The difficulty encountered by the local government councils in establishing fisheries management ordinances was the lack of legal expertise to assist with the development of ordinances translated into legal formats.

MIMRA requested SPC's Coastal Fisheries Management Section to assist with developing ordinances into legal frameworks where they will be recognised in accordance with the relevant legislations.

Gerald Zackios, a local attorney, was contracted as the legal consultant with the assignment while

staff from SPC's Coastal Fisheries Management Section provided coastal fisheries expertise. The assignment involved consultations with mayors from the various atolls, NGO representatives, relevant government authorities, and MIMRA personnel.

The assignments concluded with two fisheries management ordinances for two atolls, and a template that will facilitate the development of future ordinances by other government councils.



Sea cucumber management plan for Yap

SPC's Coastal Fisheries Programme has both management (<http://www.spc.int/coast-fish/Sections/Community/index.html>) and research sections (<http://www.spc.int/coast-fish/Sections/reef/index.htm>) to assist Pacific Island countries and territories in developing and implementing sound coastal fisheries management policies. In June 2008, Etuati Ropeti (SPC Coastal Fisheries Management Officer) and Kim Friedman (Senior Reef Fisheries Scientist-invertebrates) visited Yap in the Federated States of Micronesia to assist with the development of a management plan for Yap's rapidly expanding sea cucumber fishery.

The main aim was to:

- collate the available information on the history of Yap's sea cucumber fishery;
- conduct a large number of consultations to inform

resource custodians and other stakeholders in Yap of current options for managing their sea cucumber resources and related habitats;

- assist authorities in developing a legal framework for recognising management undertakings for the sea cucumber fishery. This was accomplished by studying existing legislation and working with the current Attorney General to facilitate the promulgation of regulations that enable enforcement of the Management Plan under the Yap State Marine Resources Management Division (MRMD); and
- formulate a workable management plan (that includes the concerns of a wide range of stakeholders), for the administration of Yap's sea cucumber fishery.

The sea cucumber management plan was developed in response to a request by the Yap State MRMD for technical assistance from SPC's Coastal Fisheries Programme. SPC facilitated the process through wide consultations with resource custodians and industry stakeholders (including relevant data collected from in-water surveys of Yap and neighbouring states). Onsite scientific advice and relevant information on the fishery was provided so that all parties could make informed management decisions.

The purpose of this work is to guide the exploitation, harvest, processing and export of Yap's sea cucumber resources. In the absence of any substantive technical information or scientific assessment, the purpose of the management plan is to impose sensible and locally relevant principles of a precautionary approach for the exploitation of

the sea cucumber fishery in order to achieve its goal as articulated by stakeholders.

The management plan's general vision is to "Have community and government cooperation, to sustain harvests and optimise incomes, whilst maintaining reef and local coastal environments".

This led to the management plan's ultimate goal, which is to "To promote economic improvement for peoples of Yap whilst maintaining sustainable harvest and stock levels."

Like most other small island states, Yap has limited land and potential for agricultural development, although it possesses oceans rich in marine life and valuable fisheries resources, including sea cucumbers. Although sea cucumber species are not traditionally harvested as a protein source by Yapese communities, the fishery has been impacted by fishing due to the high value of dried sea cucumber (*beche-de-mer*) by the expanding Asian market. Easy access and quick cash on hand, the sea cucumber fishery has become one of the more important income sources for some coastal communities.

Given the potential benefits for all communities, and the likelihood of a fishery collapse if harvest rates continue without a management framework, a more fair and precautionary approach became a necessity to mitigate current unsustainable exploitation. A moratorium on fishing was placed on the growing fishery in late 2007 to give authorities time to develop a sound management platform. The fishery is planned to reopen using the new management framework in 2008.

The management plan provides the framework for the state authority to guide the exploitation and sea cucumber harvest-

ing in Yap. The recommended management actions require a joint effort and close collaboration between government, resource owners, communities and agents in order to ensure the sustainable use of sea cucumbers, and to optimise economic returns for everyone.

Management undertakings presented were identified through discussions held with the Governor of Yap State, Hon Sebastian L. Anefal; Lieutenant Governor, Hon Anthony M. Tareg; Director of the Department of Resources and Development, Michael Gaan; resource owners; government officials; and stakeholder consultations during a two-day workshop conducted at the small business centre training room 17–18 July 2008, and other field work carried out during assignments in Yap.

This assignment would not have been possible without the kind assistance and support of the Governor, Lt Governor and MRMD staff. The support of the Director of the Department of Resources and Development, Michael Gaan, needs special mention, as does the invaluable assistance and guidance of the Chief of MRMD, Andy Tafleichig, whose critical assistance was much appreciated during the interviews, workshop and consultations. Special thanks also go to all stakeholders, resource owners, community representatives and the marine products agents who shared their vision and provided valuable information during the consultations.

Few problems were encountered, except that information available on the history of the fishery was scant, and stakeholders needed to assimilate a large amount of industry and scientific information in order to progress with formulating the plan. The most critical issue now is to ensure that the man-

agement plan is legally recognised under the authority of Yap State's MRMD. This will need the State Code to legally recognise MRMD as the appropriate power for promulgating the relevant policies and management plans for facilitate fisheries management in the state.

The draft management plan is now undergoing its last set of changes, as communities and stakeholders get another chance to look over the document and make comments and suggestions. In early August, this plan will have been professionally edited, and then printed for distribution in Yap.

SPC will continue to assist in distributing the management plan while also assisting in developing capacity, where possible, with the required actions listed in the management process. Of critical importance in this regard will be the ongoing assistance in training local counterparts in sea cucumber assessment and monitoring survey techniques.

A further publication highlighting the building blocks used in formulating this plan is planned for inclusion in an upcoming edition of the SPC *Beche-de-mer* (sea cucumber) Information Bulletin (<http://www.spc.int/coast-fish/News/BDM/bdm.htm>).



■ NEARSHORE FISHERIES DEVELOPMENT AND TRAINING SECTION

Fourth SPC Sea Safety Bulletin published

The fourth edition of the SPC *Sea Safety* Special Interest Group bulletin has been published. This bulletin is prepared by the Nearshore Fisheries Development and Training Section and produced with financial assistance from France through the French Pacific Fund.

It has been more than a year since the last issue of the *Sea Safety* was printed and distributed. Many of you have undoubtedly been waiting patiently for news of sea safety in the Pacific. We are also waiting for contributions from you, the readers. In the last issue, the editor, Hugh

Walton, urged "group" members and readers to "sharpen their pencils or sit down at their keyboards and send in safety-related stories and articles". Unfortunately, not much material was sent to Mr Walton's desk. And just who are the group members that he was referring to? As it turns out, we are way too few. The group consists largely of the editor and a few contributors, including the staff of SPC's Coastal Fisheries Programme, the very ones who produce the *Sea Safety* bulletin.

The wish of having sea safety-related news and stories pouring

in from around the Pacific and elsewhere never came to fruition. Even so, we are producing a fourth issue of the bulletin – with new aspirations and a new approach. The staff of SPC's Nearshore Fisheries Development and Training Section will take over editorial functions and will also remain the root of the sea safety awareness group and continue to be the main contributors, at least for now. For the most part, the reports on SPC activities, safety features, training activities, technology and safety, resource materials, and accident and incident reports will come from our small group. We will still rely on others for news from other places. Since we are, in a sense, reviving the bulletin after a brief hiatus, we ask you to be patient when examining our efforts, just as we have been patient waiting for your stories. And we still urge you to sharpen your pencils...

In this bulletin, readers will enjoy a story on sea safety in the Cook Islands, and an article on tricks of the trade. Also included under the "Resource Materials" section, is a report called "Surfing the Net for sea safety", which has links to many interesting sites. Maritime New Zealand has also kindly allowed us to use some of their materials in this issue. You will find excerpts from their Radio Handbook for Coastal Vessels, tips about boating safety, and a simple guide to making radio distress calls. Thanks to Maritime New Zealand for sharing this vital information in the interest of safety at sea for all.



Fiji School of Maritime and Fisheries Studies: Training attachment in Nelson, New Zealand

BACKGROUND

The Fiji Institute of Technology's School of Maritime and Fisheries Studies (SMFS), along with the Fiji Marine Board, offers Standards of Training, Certification and Watchkeeping (STCW)-approved programmes to train Able Seamen, which include Nautical Science Officers, Deck Hands, Ship Marine Engineering and Shipbuilding/Ship Designers. In addition, the school has a fisheries department, and so serves as one of the maritime training institutes in the region that also offers fisheries related programmes.

Recently, the SPC Nearshore Fisheries Development and Training Section has been strengthening the working relationship between SMFS, SPC, and the Nelson Marlborough Institute of Technology (NMIT)/New Zealand School of Fisheries in Nelson (NZSoF) by facilitating SMFS tutor attachment to NMIT/NZSoF. The NZSoF organised a special attachment to upgrade the knowledge and skills of the SMFS Fishing Instructor, Josese Rakuita, on food safety and fish handling. The attachment was partially sponsored by SPC through its Coastal Fisheries Programme.

JOSESE'S REPORT

A formal agreement has been reached between the Fiji Institute of

Technology (FIT) and SPC Fisheries Training Department to co-share financial assistance for a training attachment at Nelson Marlborough Institute of Technology under the New Zealand School of Fisheries. the training needs identified included a lack of knowledge and skills to deliver the existing training curriculum of seafood handling provided under the Diploma in Applied Fisheries Technology Training Program for the FIT fisheries training section at SMFS.

The four weeks of training (from 19 May to 1 June at Nelson) was a learning experience in all aspect of seafood handling and packaging, and advance deckhand fisheries. I benefited from the training in many ways and gained enormous knowledge in New Zealand's legislative requirements for the management of seafood products and gained various knowledge and skills needed for planning and equipment use, in order to keep up abreast with new seafood technology and international markets of seafood products.

The training also provided me with the knowledge and skills to 1) manage and deliver components of the seafood training programme for students wishing to complete the Diploma in Applied Fisheries Technology at FIT in Fiji; and 2) conduct training to fishing industry employees in Fiji.

The training provided information on the requirements of the EU and USA and other international market, the background and skills to

train deck hands and safety of life at sea in a fishing vessel operation, which will be of great help in classroom teaching at FIT under the Deck Watch Rating and Basic Fishing programme. It also provided the necessary knowledge in adult training and classroom management.

I was fortunate because my accommodation and meals were well arranged by Mr Alec Woods.

The training attachment at NMIT, New Zealand School Of Fisheries was a fruitful learning experience for me as it broadened my existing knowledge and skills in the areas of Management of Quality Seafood Production and Legislative requirements of International Markets, which will help those interested students attending training at SMFS and current employees in Fiji's fisheries industry.

I would like to take this opportunity to thank the following people who assisted in making this training attachment a successful one: Mr Terri Luciani, SPC Fisheries Training Adviser Noumea New Caledonia, Mr Alec Woods, NMIT Nelson New Zealand; Mr Ganeshua Chand, FIT Director; Captain Tevita Robanakadavu, Head of the Fiji Institute of Technology's School of Maritime and Fisheries Studies; and Mr John Rafoi, Manager Human Resources at FIT.

Josese Rakuita
Instructor, School of Maritime and Fisheries Studies (FIT)



First competent authority training held in Nelson, New Zealand

Recent inspections by the Food and Veterinary Office of the European Union (EU) in Papua New Guinea and Fiji, highlighted a lack of understanding of EU sanitary requirements in government and industry in those

countries, as well as a need for further training of inspectors. Technical support provided to Niue in early 2007 also identified training and mentoring needs in that country.

In response to these needs, SPC provided a short training course in New Zealand for inspectors from the competent authorities of interested countries in early April this year. The Development of Tuna Fisheries in the Pacific-ACP

countries (DevFish) project will then provide short-term consultancy services for in-country follow up, training and mentoring to the competent authority inspectors in each country.

The training course was fully funded by DEVFISH, a regional project funded by the EU under the EDF9 programme, and implemented by the Pacific Islands Forum Fisheries Agency (FFA) and SPC.

The course coordinator was Alec Woods from the New Zealand School of Fisheries/Nelson Marlborough Institute of Technology. Consultancy services were required from a seafood quality specialist with extensive experience and knowledge of EU regulatory requirements. Cushla Hogarth, from Solutions in Seafood (NZ), was contracted for this purpose. Ten participants from four Pacific Island countries successfully completed this programme.

EXTRACT FROM CUSHLA'S REPORT

Background

In recent years, several Pacific Island nations have determined there is a need to increase revenue through the export of seafood products to international destinations. With this comes the need to meet importing countries' requirements. A fundamental need in this area is for the exporting nation to have a competent authority, staffed by personnel who are competent in inspections of premises and overall management of a system that assures importing countries of the safety and wholesomeness of the products they are importing.

Coupled with this, some Pacific Island nations were subject to visits from EU officials last year with a particular focus on the export of seafood products to the EU. The official reports identified a number of significant issues that placed

the exporting nations at risk of being removed from the EU list of nations approved to export seafood products to the EU.

A collaborative arrangement between the NZ School of Fisheries and Solutions in Seafood was successful in securing funding for a two-week training assignment in New Zealand for up to 10 personnel from competent authorities (or related government departments) from Fiji, Samoa, Papua New Guinea and Niue.

This report summarises the content of the programme, and issues arising that will need to be followed up in-country by Ian Watson from Watson Consulting as part of the follow up programme.

Content

Participants experienced learned theory, and made offsite visits as part of their two-week programme.

The programme's content included: EU legislation, compliance of existing country legislation versus EU legislation, national control plans, registration of premises and certification, auditing premises against seafood safety legislative requirements, non-compliance and corrective actions, overseas competent authority discussion, product testing and laboratories, inventory and traceability, vessel hygiene and handling, and a visit to a seafood processing facility.

Programme overview

All 10 participants showed a keen interest in developing their skills as competent authority personnel and participated fully in the training programme.

On completion of each training section, participants were asked to report back on issues in their respective countries, and this information was used to prepare a final programme report on actions needing to be addressed on return to home countries.

Programme evaluations showed the following:

- Overall satisfaction in the training programme with all participants scoring 3 out of 5 or higher (average or better),
- A request for a similar refresher training for competent authority personnel,
- A request for lengthening future programmes to allow for more consolidation of learning and more practical, hands-on learning.

Issues arising and priorities for follow up

While participants each country presented their findings from the two-week programme, a summary of priority actions is given below.

General

The programme facilitator recognised that there was a range of abilities and experiences as competent authority personnel within the participants. This posed a difficulty in how to pitch the course content. While some participants were just beginning to understand their role (and needed more theoretical understanding), others were much more advanced and would have benefited from more hands-on practical experience.

In addition, the separation of training responsibilities in New Zealand (provided through a collaborative effort between the NZ School of Fisheries and Solutions in Seafood Limited) from that in-country (to be offered by Ian Watson of Watson Consulting) needs careful future consideration as it leads to potential duplication of work and a lack of continuity for competent authority participants. Several participants commented on the lack of continuity and raised concern over potential issues on their return to their home countries.



■ AQUACULTURE SECTION

New SPC Freshwater Aquaculture Officer appointed

SPC's Aquaculture Section recently hired a new Freshwater Aquaculture Officer, Dr Tim Pickering. Tim worked previously as a lecturer in aquaculture at the University of the South Pacific (USP) in Fiji.

Tim took up the post in June 2008, and follows in the giant footsteps of tilapia and prawn expert Satya Nandlal, who departed SPC late last year for

new challenges in Australia. Tim's background encompasses both freshwater and marine aquaculture commodities in Pacific Island countries.

He has been involved in diverse projects that include seaweed, marine shrimp, sponges, sea cucumber, eels, live rock, marine ornamental fish and corals. Much of his recent work, however, has been in helping to

establish and manage a freshwater prawn and tilapia farm as a commercial joint-venture between USP and the private sector in Fiji. Along with Marine Aquaculture Officer Antoine Teitelbaum and Aquaculture Adviser Ben Ponia, Tim's arrival brings the strength of SPC's Aquaculture Section's back up to three."



Dr Tim Pickering, SPC's new Freshwater Aquaculture Officer

Fourth Fisheries Ministerial Conference held in Palau

In an unprecedented move, aquaculture was included as an agenda item on the Forum Fisheries Committee Officials Ministerial Conference. This forum traditionally focusses on tuna fisheries and provides guidance for the Pacific Islands Forum Fisheries Agency based in Solomon Islands. But given the interconnectivity and importance of coastal fisheries and aquaculture, it was decided to include agenda items from these sectors in the meeting.

A "State of Coastal Fisheries and Aquaculture" report was

drafted and delivered by SPC staff at the conference.

The aquaculture agenda item focussed on delivering the regional aquaculture strategy — the SPC Aquaculture Action Plan 2007 — which was recently completed. The inclusion of aquatic biosecurity in the aquaculture strategy was a "talking point" that raised considerable interest among participants.

The regional strategy was warmly received by officials and endorsed by ministerial

representatives attending the conference.

The Fourth FFC Fisheries Ministerial Conference was held in Palau from 19–20 May, and was attended by SPC's Aquaculture Adviser.



Aquaculture updates from Palau

While attending the FFC Fisheries Ministerial Conference in Palau, SPC's Aquaculture Adviser, Ben Ponia, took the opportunity to make some site visits and meet with people involved in aquaculture and coastal fisheries, including:

- Ngatpang State milkfish farm project. Located about an hour's drive from Koror the farm receives up

to 2.4 million fingerlings per year from Taiwan. Seventy-five per cent are farmed for live bait and the remainder are left to grow larger to be sold as food fish. Staff involved in the project have recently received training in fish de-boning techniques, which makes the product much more marketable. The project is largely funded by Ngatpang State, with techni-

cal advice and labour provided by Philippine expatriate staff.

- Local fish outlets in Koror: PMCI Fish Market and Happy Fish Market. We discussed reef fisheries, processing, marketing issues, etc with the owners and staff.
- Palau Mariculture Demonstration Centre (PMDC), operated by Palau's Bureau of Marine Resources. The PMDC continues to produce large quantities of giant clams in its hatchery. The most common species is *Tridacna derasa*, which are provided to villages for community grow-out schemes. The PMDC fish hatchery is also active with a large batch of hatchery-reared tiger groupers and rabbitfish juveniles in production. Other fish species, such as Napoleon wrasse and coral trout, are being conditioned for future spawning. The fish hatchery manager, Percy Rechelluul, is collaborating with various private businesses and state projects (including the Ngatpang milkfish farm) to provide rabbitfish for cage culture trials. The PMDC also hopes to produce milkfish fry from its hatchery in the future.
- Accompanied by Bureau of Marine Resources staff, the Aquaculture Adviser viewed some PMDC sites where rabbitfish cage culture trials were being conducted. This included the Rip Tide Restaurant, which has two cages, each holding 2,000 fish that are five months old; the Airai company farm,



Figure 1 (top): Palau PMDC fish hatchery.

Figure 2 (bottom): Rabbitfish breeders at the PMDC hatchery.

which has six cages, each with more than 2,000 fish; Neco Marine Ltd, which has a small trial cage with rabbitfish and milkfish. This company plans to build its own

rabbitfish hatchery for a large fish farm.

- SPC's Aquaculture Adviser and other senior SPC staff assisted the Bureau of Marine

Resources in an intensive one-day workshop to draft a new Coastal Fisheries and Aquaculture National Development Plan.



Regional aquaculture status report presented to FFC Fisheries Officials and Ministers meeting

Copies of the SPC Aquaculture Action Plan 2007 were given to ministers and senior government officials at the FFC Fisheries Ministerial Meeting in Palau in April 2008. Also presented, was the Regional Status Report on Coastal Fisheries and Aquaculture (drafted by SPC aquaculture staff).

The SPC Aquaculture Plan 2007 provides a snapshot of the region's substantial and diverse aquaculture sector. It provides a forward looking perspective on the important role that aquaculture can play in meeting the challenges of population growth and global changes. It is a regional strategy that provides SPC's member countries with guidance on how the burgeoning aquaculture sector can be tailored to the needs and values of the Pacific community.

Highlights of the aquaculture status report include the following key points:

1. Aquaculture is the world's fastest growing food sector. It provides almost 50% of the world's food fish. With a plateau in sustainable wild fisheries harvest, the sector has been identified as a key option to make up the shortfall in food security and livelihoods.

2. Aquaculture is also expanding rapidly in the Pacific. SPC estimates that the average annual production is USD210 million dollars. The

volume of production is 4,600 metric tonnes of bulk marketed product (e.g. shrimp and seaweed) and 250,000 pieces of individual-

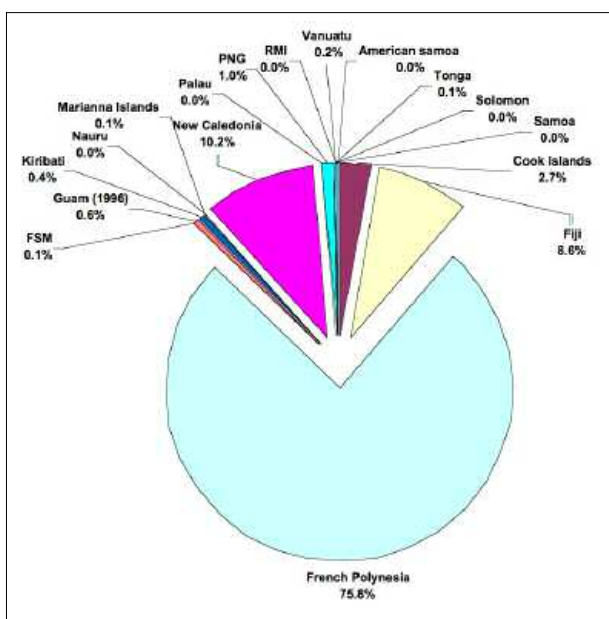
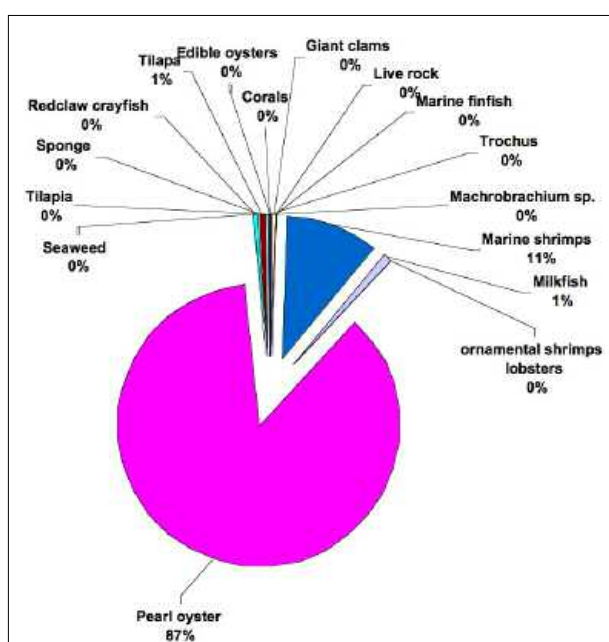


Figure 3 (top): Annual value of aquaculture commodities produced in the Pacific.

Figure 4 (bottom): Annual value of aquaculture production in the Pacific per country.

ly sold product (e.g. giant clam and corals). Up to 25,000 people may be directly involved in the aquaculture sector.

3. In the Pacific, from atoll archipelagos to mountainous highland regions, aquaculture is diverse and involves farming inland freshwater

and marine species. Exports are dominated by black pearls from French Polynesia and marine shrimp from New Caledonia. Production for domestic consumption is also increasing. For example, it is estimated that there are at least 10,000 fish farms (such as for tilapia) in Papua New Guinea. Other key

aquaculture commodities include freshwater prawns, marine ornamental species (e.g. giant clams, corals, live rock), and kappaphycus seaweed. Emerging commodities also include sea cucumbers, mud crabs and marine finfish (as highlighted in the Aquaculture Action Plan).



Workshop on preventing biological invasions

International guidelines for the responsible trade of live aquatic animals, which could be ecologically invasive if they are released into the wild, are not properly addressed institutionally within the various UN agencies. In this arena the pet trade, live bait and aquaculture industry are some of the key risk sectors.

Under its mandate for invasive alien species, the subsidiary body on scientific advice (SBSTA-13) for the Convention on Biological Diversity (CBD) recommended that the CBD secretariat convene an expert workshop to advise the 9th Meeting of the Conference of Parties (COP-9) on best practices for minimising the risks associated with the introduction and trade of live aquatic animals.

To tackle this initiative, the CBD partnered with the Global Invasive Species Program (GISP), the IUCN's Invasive Species Specialist Group, and the University of Notre Dame (USA) in organising a workshop. About 40 participants, including SPC's Aquaculture Adviser, were invited and sponsored to attend the workshop, which was held from 9–11 April 2008 at the University of Notre Dame Campus.

The workshop had three main sessions:

- **Current science and economics on risk assessment for**

animal species in international trade. This session was moderated by scientists and was interesting because of the apparent gulf between the quantitative "pre-screening" techniques proposed by ecologists and the qualitative judgments that decision-makers realistically operate under. One of the outputs from the workshop was a draft of key principles involved in pre-import screening, or import risk analysis as it is more commonly referred to by primary development sectors.

- **The international legal and institutional context for risk assessment of animal species in international trade.** There are clear gaps in the international instruments governing the trade and movement of live aquatic animals that are potentially invasive. Some related issues are covered under other instruments. For example, endangered species come under the Convention on International Trade in Endangered Species (CITES), plants are covered by the International Plant Protection Convention (IPPC), and pathogens under the World Trade Organization (WTO) by standards set by the World Animal Health Organization (OIE).

- **Current national practices and available tools for risk assessment in international**

trade. During this session, various countries and regions shared their experiences with "pre-screening" potentially invasive species. There is a contrast between countries such as the USA, Australia and Israel, which have accumulated good biodiversity databases and judicial/litigation processes, and some South American countries that have a vast and largely unreported biodiversity and a rapid pace of economic development.

The dichotomy of the invasive concept between aquaculturist and ecologist was noted by SPC. "Invasive" attributes, while negatively viewed by naturalists, are looked favourably upon by farmers.

The SPC regional experience presented to the workshop was that "pre-screening" controls were best incorporated into holistic approaches such as "aquatic biosecurity" because of the limited capacity available in the region to deal with the range of risk factors excluding invasiveness (for example, pathogen risk). However, ensuring the use of responsible practices requires cooperation between all stakeholders from the ground level upwards. Among the UN agencies, especially the CBD, FAO and OIE, a similar cooperative framework must be established.



Dr Dale Hamilton engaged as SPC aquatic biosecurity consultant

Aquatic biosecurity is recognised as a major challenge to ensuring responsible aquaculture and fisheries development and trade in the Pacific region. Implementation of the regional aquatic biosecurity programme will require a new regional initiative involving fisheries, environment, quarantine, veterinarian and public health departments.

The region faces a variety of challenges in this area. Some current examples include:

- A trade embargo imposed by Australia on shrimp imports from countries that have IHNV virus. This embargo affects shrimp producers in the region such as Fiji and New Caledonia.
- The increasing numbers of Pacific Islands that are importing live, genetically improved tilapia fingerlings from Asia

have requested advice on quarantine protocols.

- The European Commission has recently imposed new regulations on imports of live aquatic animals into the European region and has advised that exporting countries will need to become members of the World Animal Health Organisation (OIE) and have competent national authorities to issue health certificates. This will directly impact the marine ornamental sector in the region, which currently provides livelihoods to some 800 households and exports of USD15 million dollars per annum.

Various forums have tasked SPC (as the lead CROP agency) to take initiative in this area.

Dr Hamilton, who is the former Vanuatu chief veterinarian and quarantine officer, has been

engaged as a short-term consultant to advise SPC on aquatic biosecurity matters. Some of the key activities he will be involved in include:

- Providing urgent advice to member countries on meeting the new European Commission regulations affecting the trade of live aquatic (ornamental) exports;
- Assisting with the drafting of a new SPC policy brief on aquatic biosecurity;
- Assisting in the review and final drafting of the regional aquatic biosecurity framework developed at the SPC regional aquatic biosecurity meeting (held in October 2006);
- Providing desktop advice on aquatic biosecurity issues (e.g. quarantine, disease) as they arise.



Hatchery production and restocking of sandfish in community-managed fishing rights areas (qoliqoli), Fiji Islands

Sea cucumbers are valuable but severely depleted fisheries throughout Pacific Island countries and territories (PICTs), and Fiji is no exception. In Fiji, dairo (or sandfish, *Holothuria scabra*) is an important sea cucumber species that also forms part of the Fijian traditional diet, so it contributes to food security in addition to being a lucrative export commodity. In the last 20 years, fishing pressure — stemming from export demand — has resulted in declines in size and abundance of individuals of this accessible shallow-water species.

Sandfish hatchery technology has been developed in New Caledonia and in Australia through research supported by the Australian Centre for International Agricultural Research

(ACIAR) and the WorldFish Center. Techniques to spawn sandfish and rear larvae up to juvenile size (>3g) are now relatively straightforward, and can be transferred to other PICTs. On-growing juvenile sandfish to larger sizes in tanks is not feasible however, because feed and space quickly becoming limiting factors. Release into large ponds or into the coastal environment is necessary for growing juveniles to commercial size.

The major research question yet to be convincingly answered is whether post-release survival of sandfish, and growth to harvestable size, are sufficient to justify the cost of breeding and rearing juveniles in captivity. Pilot studies by the WorldFish Center and other agencies

demonstrate that sandfish restocking results are very unpredictable, and the benefits are uncertain. More releases of larger numbers of juveniles, with rigorous post-release monitoring, are necessary to provide baseline growth and survival information. Field experiments will then be needed to further refine release protocols and habitat selection criteria to obtain the best results.

The ACIAR project “Development of aquaculture-based livelihoods in the Pacific Islands region and tropical Australia” — led by James Cook University with project partners SPC, WorldFish Center and University of the South Pacific — funds aquaculture research “mini-projects”. These are small, tar-

geted research interventions to address bottlenecks or constraints to sustainable aquaculture development.

The mini-project “Culture of juvenile sandfish, *Holothuria scabra*, for re-stocking and sea ranching trials in Fiji” was launched in May of this year. A stakeholder’s consultation was held with country partners Fiji Ministry of Primary Industries (Department of Fisheries), Hunter Pearls, and the Fiji Locally Managed Marine Area Network (FLMMA), to define objectives and protocols for a juvenile sandfish re-stocking and sea ranching project in Cakaudrove Province on Vanua Levu.

This mini-project will transfer sandfish hatchery technology to Fiji, then will scale-up and extend earlier re-stocking research on post-release survival and growth. Some preliminary work will also be done to determine possible management frameworks for large-scale sandfish re-stocking and sea ranching that will meet the future needs of stakeholders.

The term “sea ranching” here means a “put, grow and take” operation, whereby owners harvest released sandfish from a

lease or property rights area (e.g. qoliqoli) as a commercial operation. “Re-stocking” means to restore breeders in a depleted fishery by releasing sandfish into a restricted area and protecting them as a future spawning population. This latter activity is best combined with community-based marine resources management tools such as marine protected areas (MPAs).

Following the launch of this mini-project, the next task is to identify suitable environments and communities for re-stocking trials. Collaboration with Fiji’s Department of Fisheries and with selected communities in Cakaudrove Province is ongoing, and is aimed at finding the best possible juvenile release sites to increase the chances of success. WorldFish Center research has shown that seagrass beds comprising ribbon-like seagrasses on sandy-muddy substrates and growing at a depth of not less than 20 cm at low tide, are the most suitable.

Surveys must also be done to determine the most reliable sources of adult sandfish to use as broodstock for the hatchery production of juveniles, which will take place at the Hunter Pearls hatchery at Savusavu

from November 2008–February 2009. During this hatchery phase, staff of Fiji’s Department of Fisheries and Hunter Pearls will be trained in sandfish breeding and larval rearing techniques.

Afterwards, sandfish will be released and monitored to track their progress. Rigorous sampling and statistical techniques are necessary to make sense of the high variability inherent in this type of survey data. An ACIAR-USP masters scholarship has been awarded to a Fijian student to lead the survey work. Access and management arrangements for this research and monitoring phase will be made with a custodian community at each site because, as the sandfish grow in size and value, security will become an issue. For example, communities who already delineate and enforce an MPA in their fishing rights area will be preferred for this research.

There are conflicting views about whether re-stocking or sea ranching sandfish can actually be successful. It is only through open, transparent and research-based approaches that stakeholders can gain the information they need to plan for the long-term health of the region’s sandfish resources. The Fiji sandfish mini-project is intended to be the next step along this path.

(Contribution: Tim Pickering, Secretariat of the Pacific Community, Noumea, New Caledonia and Cathy Hair, James Cook University, Townsville, Australia)



Dairo (sandfish) cooked the Fijian way: stuffed with corned beef and onions, cooked in *lolo* (coconut cream), served with *nama* (seagrapes, *Caulerpa racemosa*), and topped with *kora* (fermented coconut) and *tavioka* (cassava).

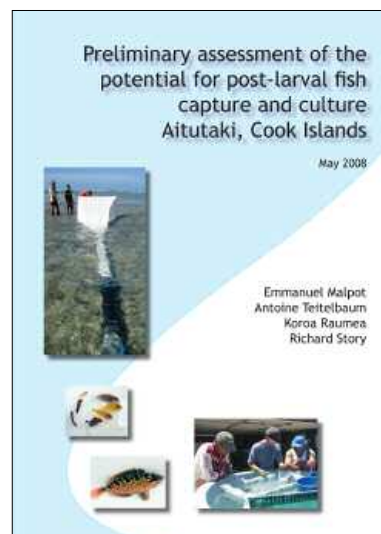
Report now available on the preliminary assessment of the potential for post-larval fish capture and culture Aitutaki, Cook Islands

This study was supported financially by the French Pacific Fund. It was based on a technology transfer of the post larval fish capture and culture from French Polynesia to the Cook Islands. These techniques have been developed thoroughly experimented by French Polynesian private operators and by the countries fisheries department (SPE).

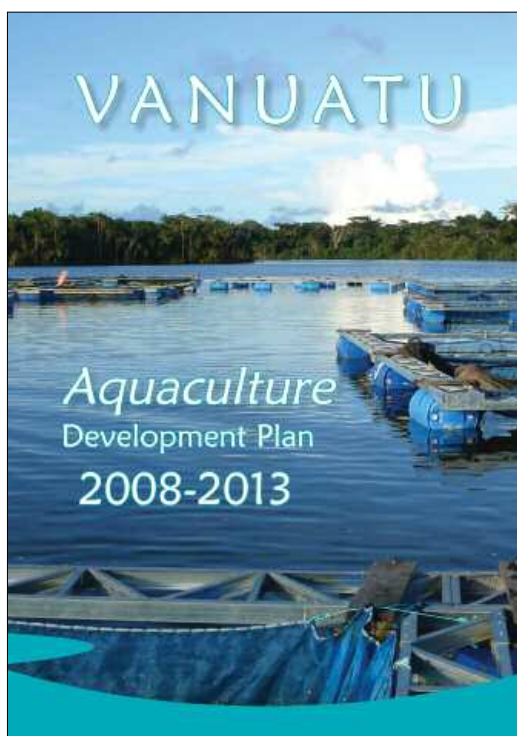
For this project, a consultant from Aquanesia, French Polynesia (emmanuel.malpot@mail.pf) was hired to assist Cook Island

fisheries department to install the sampling equipment, analyze data and raise marine fish and crustacean post larvae. The report contains an analysis of the potential for development of this technique in Aitutaki, Cook Islands.

As part of this project, Cook Island fisheries officials were sent to Borabora at the Bora EcoFish farm (boraecofish@mail.pf) to gain training in post larval capture and culture techniques.



Vanuatu Aquaculture Development Plan 2008–2013 available



The Vanuatu Aquaculture Development Plan is now available. The plan was produced by Vanuatu's Department of Fisheries, with financial and technical assistance provided by SPC. Appreciation is extended to other government agencies, NGOs and private sector companies in Vanuatu who contributed to the formulation of this document during a national planning workshop and follow-up consultations.

Vanuatu holds many promises for the development of both marine and fresh water aquaculture. And so, this plan comes at a perfect time and will be presented to aquaculture stakeholders in the next quarter, during the launching of Vanuatu's aquaculture association.

This five-year plan will hopefully assist Vanuatu in working towards quality and sustainability while at the same time developing its aquaculture.

Both the plan and the Cook Islands post-larval fish culture report will soon be online at: www.spc.int/aquaculture. Copies can also be obtained from SPC's Aquaculture Section: marieangeh@spc.int



Seventh symposium on diseases in Asian aquaculture

The seventh Symposium on Diseases in Asian Aquaculture (DAA VII) took place from 22 to 26 June 2008 in Taipei, Taiwan (<http://homepage.ntu.edu.tw/~daaseven/index1.htm>).

This symposium is principally a forum for scientists and students from the Asia-Pacific region specialising in the health of aquatic animals. The Fish Health Section of the Asian

Fisheries Society holds this event every three years. The group was established in May 1989 for the purpose of producing technical materials on the health of aquatic animals.

DAA VII was convened to bring together participants from around the world to discuss their work and develop new strategies for promoting aquatic animal health in Asia.

The theme of the 2008 Symposium was "Communication, cooperation and coordination: Key issues in aquatic animal health management".

The four-day event comprised some 12 oral presentation sessions focused on aquatic animal health and addressed the following specific topics:

- Global perspectives in managing aquatic animal health
- Emerging issues in aquatic animal health management
- Epidemiology, detection and diagnosis of pathogens in fish, shellfish, molluscs and their environment
- Biosecurity and containment in aquaculture systems
- Recent developments in genomics and bioinformatics: implications for aquatic animal diseases
- Immunology/Disease resistance/Host-pathogen interaction
- Microbiology of aquatic animal pathogens and antimicrobial peptides
- Shrimp health and diseases
- Mollusc health and diseases
- Finfish health and diseases
- Pathogen risk analysis, probiotics, therapeutics
- Aquatic animal health management; International trade and risk.

Each session was introduced by an address on the current status of each area by a world specialist and followed by presentations from scientists, students, farmers and others.

A poster session was organised on Day 3 with nearly 200 posters on display for the duration of the symposium.

With funding from SPC's Aquaculture Section, the Fisheries Service of French Polynesia was able to take part in the symposium and present a poster entitled: "Diseases of *Platax orbicularis* (Ephippidae) and *Polydactylus sexfilis* (Polynemidae), two fishes farmed in French Polynesia". Oral presentations were highly instructive and reported on the latest developments and progress in the diagnosis and detection of diseases observed in the aquaculture environment. Each session was an opportunity to exchange ideas with eminent specialists such as:

- Dr Brian Jones: Principal Pathologist with the Western Australia Fisheries and Aquaculture Department who had been previously met in Tahiti during exchanges on the Tahiti pearl oyster health watch network and in connection with some of his work on fish. A training session at his laboratory in Perth (Western Australia) is planned for next year.
- Dr Teruo Miyazaki: Professor of Fish Pathology at the University of Mie (Japan), a fish histopathology specialist who was also promoting his latest book entitled "Coloured atlas of fish histopathology" (volumes 1&2 ed. Dr Teruo Miyazaki). This book will be very helpful for diagnosis using histological techniques.

- Dr C.V. Mohan: Professor of Fish Pathology, in charge of training by the Network of Aquaculture Centers in Asia-Pacific (NACA) on histological techniques (Master Class), the most recent of which took place on 12 November 2007 in Bangkok, Thailand (see website: <http://www.enaca.org>).

- Dr Ingo Ernst: Scientist with the Aquatic Animal Health Unit of the Australian Department of Agriculture, Fisheries and Forestry (DAFF). Dr Ernst provided advice on how to solve ectoparasitosis problems in French Polynesia's *Paraha peue* cage farming ventures.

This is not an exhaustive list of the various exchanges initiated during the symposium. For reference, the mission report will be passed on to SPC's Aquaculture Section. French Polynesia's fisheries service wishes, through this article, to warmly thank the various people who assisted during these very enlightening meetings. Events such as this are essential for acquiring new knowledge and contributing to the sustainable development of French Polynesia's aquaculture.

Contribution by Georges Remoissenet, Fisheries Service, Papeete, Tahiti, French Polynesia (georges.remoissenet@peche.gov.pf)



■ A WATERY GOLDMINE FOR "BIOTECH"

From fish in polar seas to bacteria in hydrothermal springs, some sea creatures live in conditions that make it hard for us to believe their survival is possible. Their resistance under exceptional conditions, such as high salinity or extreme temperatures, or their ability to produce toxic substances, is intriguing researchers from Marine Genomics¹, a network of European excellence. Slowly but surely, biotechnology researchers are taking an interest in these astonishing natural phenomena, which can provide us with numerous benefits, from new medicines for cancer and revolutionary antibiotics to biodegradable plastics.

"Certain organisms survive in extreme depths, with little or no oxygen, or resisting extreme temperatures," notes Mike Thorndyke, leader of the Evolution, Development and Diversity node within the Marine Genomics network. "How do these creatures manage under such conditions? How do they cope with the dramatic depths, temperatures and pressure? We are trying to find out, as their metabolisms could offer discoveries that would be of use to everyone, including in the field of human health. The enzymes of these organisms are of more interest than those usually used; for example, we could use them in very saline solutions and in extreme temperatures."

EXTREMOPHILES

Take the case of fish swimming in the polar seas. Why don't they freeze? Thirty years of relentless research has finally revealed the secret of their resistance to the icy waters. A team of Canadian biologists has demonstrated that "anti-freeze" proteins, 10 times more active than those previously known, fix to ice crystals to

stop them growing; a property that could be very useful in the field of medicine, in particular for organ storage or for cryosurgery, a technique that consists of destroying tumour cells by freezing them.

Or consider the bacterium *Desulfotalea*, which is resistant to cold because it grows in sub-zero temperatures on the seabed. By using the enzymes of this bacterium instead of their mesophilic counterparts (which can only grow at moderate temperatures), industries involving food processing or washing processes could save significant amounts of energy.

At the other end of the spectrum, the bacterium *Pyrococcus abyssi* lives in hot marine springs and maintains an optimal enzymic activity at temperatures of 80–110°C. The biochemical nature of its enzymes could be a key tool in technologies in the future to recombine DNA. Certain enzymes have already been put to commercial use: the DNA polymerase I, isolated from the thermophile bacterium *Thermus aquaticus* works in polymerase chain reactions (PCRs) to manufacture huge numbers of genes for *in vitro* research.

The list of marine products useful in biotechnology is growing steadily and includes a range of proteins, lipids and "cazymes", enzymes capable of converting complex carbohydrates to produce green fuel. Other bacteria are involved in the breakdown of polymers, a process that scientists at Ifremer, the French Research Institute for Exploitation of the Sea, are using to produce entirely biodegradable plastic. "Finding micro-organisms capable of resisting very high temperatures, or surviving

in extreme conditions, should lead to revolutionary industrial applications," explains Philippe Gouletquer, National Coordinator of Marine and Coastal Biodiversity at Ifremer. "That's why biodiversity is fundamental to biotechnology."

CHEMICAL WARFARE

It is not only the habitats of some marine organisms that have led them to acquire valuable qualities, but also the way in which they spend their time. These "couch potatoes" of the deep combine a sedentary lifestyle with a soft body, necessitating a chemical means of defence from predators. They have, therefore, evolved the ability to synthesise toxic compounds, or to obtain them from marine micro-organisms.

Particularly powerful, since they need to be effective in water, and as diverse as the microscopic flora and fauna that produce them, these natural products are of great interest to scientists. They provide a huge reservoir of substances that could be used, for example, to develop new treatments for infectious diseases or cancer. Over 16,000 new compounds of this type have been isolated from organisms such as sponges, ascidians and seaweeds.

GENETIC DIVERSITY

In Europe, the Marine Genomics network is helping to discover new metabolites. "We sequence DNA fragments to measure genetic diversity in different sites along European coasts, but also elsewhere, like in the Antarctic. It's important to allow us to study extremophiles, those organisms living in extreme conditions," explains Thorndyke.

¹ Financed by the Commission with 10 million Euros over four and a half years

The network is constructing large databases that support research into biotechnology, such as the development of antibiotics from DNA fragments, the creation of micro-conductor chips, and the mass production in bioreactors of rare marine bioproducts, such as growth hormones.

Director of the Center for Marine Biotechnology and Biomedicine in San Diego (USA), William Fennical is among the pioneers discovering new anticancerous molecules in the sea. Having left the invertebrate field to turn to micro-organisms, Fennical and his team discovered numerous actinomycete species in the benthic deep, despite the common belief that there were none in the sea. In 2003, these researchers demonstrated that *Salinos-*

poramide A, a compound isolated from one of these actinomycetes, was able to bind to a tumour and inhibit its growth. It is now in clinical trials for multiple myeloma, a cancer of the blood.

A RESEARCH ODYSSEY

"Despite these promising applications, research related to the vast potential of marine organ-

isms and the seas is greatly lacking. The seas offer riches that we need to take advantage of before they disappear," underlines Thorndyke. The pharmaceutical industry lacks interest in this type of research, particularly because of legal uncertainty and a problem of availability. It is difficult to apply traditional methods of testing and development for a compound produced in

Culinary classics with a twist

Some 20% of protein in the human diet comes from the oceans. The health benefits of seafood have already been well-established and the future looks even more promising. Gene technology should open the way to new food products: containing high levels of unsaturated fatty acids and fish protein, they will help to reduce the risks linked to certain chronic diseases. Moreover, many organisms contain enzymes of particular use in the food industry. Amino-peptides found in tuna reduce the bitterness in certain foods, while proteases from fish eliminate the skins of cuttlefish, squid, and the membranes surrounding the egg pouches of fish, helping in the preparation of salmon caviar.

Medicines fished from the seas

***Ecteinascidia turbinate*:** This sea squirt from the Caribbean and the Mediterranean makes an anti-cancer compound, Yondelis (PharmaMar).

Actinomycetes: With its active ingredient extracted from the actinomycete bacterium *Micromonospora marina*, the anti-tumour drug Thicoroline is under development by PharmaMar.

***Bugula neritina*:** This cosmopolitan marine bryozoan lives in symbiosis with a bacterium able to secrete an active bio-molecule, bryostatin. This acts as a deterrent to predator fish, but is also known for having properties that work against cancer of the kidney and the pancreas, and non-Hodgkin's leukemia, melanomas and lymphomas. It is currently in clinical trials.

Cyanobacteria: Scytonemin is a yellow-green ultraviolet sunscreen pigment present in this aquatic blue-green algae and may be used to develop inhibitors for use as anti-proliferative and anti-inflammatory drugs.

***Aplidium albicans*:** This invertebrate has enabled the company PharmaMar to isolate a marine anti-cancer agent, Aplidin, currently in its trial phase.

Sharks: Sharks are particularly unaffected by cancer, largely because of squalamine, a molecule present in the liver. This could be used to fight against certain brain tumours.

Japanese sponge: KRN 7000 is not a natural product but it consists of a series of compounds extracted from a Japanese sponge, *Agelas mauritianus*. Tested on mice, it has been proven to work against tumours, particularly colon cancer.

***Conus magus*:** This cone snail paralyses its prey using a poison-tipped barb. The poison is a painkiller many times more potent than morphine and is now on the market as Prialt.

Nemerte worm: GST 21 is the first molecule of marine origin that has been tested for the treatment of Alzheimer's.

***Marthasterias glacialis*:** The Roscovotone molecule has been extracted from this spiny starfish by Dr Laurent Meijer from the National Centre for Scientific Research (CNRS) in Roscoff, France. By blocking cancerous cells without affecting healthy ones, it is a potential chemical weapon against cancer.

tiny quantities by a sponge that lives hundreds of metres down. But, thanks to a few sea enthusiasts, the “biotech” odyssey is running its course. For the last 20 years, the biotechnology company PharmaMar (Spain) has been investigating potential anti-cancer properties of marine products discovered by academics as well as by its own explorers. Some 40,000 organisms and marine products likely to offer therapeutic potential have already been recorded by the Spanish company, and six of these are in clinical trials.

In the future, researchers will find it easier to experiment on hard-to-reach abyssal creatures. They will be able to grow useful substances in the laboratory, since they do not always come from the marine organisms but from associated bacteria. Another option is to isolate the gene responsible for synthesising the compound and “grafting” it onto an organism that is easier to handle. Either way, these developments cannot take place without investments, both private and public. As part of this, the European Commis-

sion’s Green Paper on maritime policy suggests the creation of “Blue Investment Funds”.

Source: Research*eu, the magazine of the European research area, Special Issue, December 2007
<http://ec.europa.eu/research/research-eu>



■ OPTIMISING FISHERIES BENEFITS IN THE PACIFIC ISLANDS: MAJOR ISSUES AND CONSTRAINTS

This report has been produced to inform the World Bank management and other interested donors of the status and issues of the fisheries sector in the Pacific Islands region. It identifies key constraints and past mitigating actions, and examines the potential future role of the World Bank in the Pacific Islands fisheries sector.

TUNA FISHERIES IN THE PACIFIC

The Pacific Islands region and the wider western and central Pacific Ocean is the most important tuna fishing area in the world, estimated to be worth about USD3 billion in 2007. At present, the main benefits from tuna fisheries include license fees, direct employment in fishing activities, spin-offs from locally based fishing fleets and processing facilities, and modest local taxes. All Pacific Island countries receive fees for foreign fishing activities in their waters. In some countries, access fees form a very large portion of government revenue, up to one-third for some countries in some years.

One of the major issues regarding tuna fisheries in the region is the relative benefits of receiving access fees vs. pursuing domestic industry development. An estimated 1.4 million metric tonnes of tuna have been taken annually from the waters of Pacific Island countries in recent years, although less than

one-quarter of the catch is made by vessels based in this region. Consensus is growing that improved management could enhance the percentage of value added per metric tonne of landed tuna.

The same is true of Pacific Island countries’ participation in existing tuna processing and marketing activities. The tuna industry is currently undergoing structural changes. Tuna harvesting, processing and marketing is being affected by a variety of factors, including rapidly rising energy prices and changes in major world markets as a result of major exchange rate movements, differences in relative income growth and changing consumer demand patterns. These features are likely to affect the distribution of benefits from the region’s tuna resources.

CONSTRAINTS TO FISHERIES DEVELOPMENT

Many of the constraints to fisheries development can be divid-

ed into two categories: (a) governance, and (b) small countries and/or industries struggling with powerful countries and powerful economic interests. The measures suggested for their mitigation are mostly conventional, and are similar to approaches that have been attempted (with varying degrees of success) in recent history, although suggestions for a different approach are also made.

Some of the major constraints to tuna fisheries development in the region include poor national fisheries institutions, corruption within the fisheries sector, lack of skilled fishery managers, lack of regional solidarity, poor government policies for tuna industry development, weak governance in the inshore fisheries sub-sector, and market access issues.

Poor national level fisheries institutions

Government fisheries agencies are far less effective now than they were two decades ago. Some reasons for this are insti-

tutional structures that result in low accountability to stakeholders, corruption, poorly trained staff, and budgetary processes that favor staffing levels over activities. Many of the present difficulties in the fisheries sector can be traced directly to ineffective fisheries departments and low levels of professionalism. Recommended mitigating actions to address this issue include:

- Consolidating experiences from the many institutional enhancement projects that have been carried out in the region, and linking these efforts to ongoing governance programs in and outside the sector at national and regional levels;
- Enhancing the ability of fishery stakeholders to influence fisheries department policies and activities and to promote accountability;
- Enhancing the skills of fishery managers; and
- Creating evaluation and oversight mechanisms to assure greater adherence to policies and legislation (e.g. bringing the results of governance improvement work and evaluations to the attention of stakeholders, high-level authorities, and the general public).

Corruption in fisheries

In recent years there has been a noticeable rise in fisheries-related corruption in the region. Corruption is a major issue in fisheries governance, and many of the actions identified for improving fisheries institutions also apply to decreasing corruption. Recommended mitigating actions to address this issue include:

- Identifying simple generic measures for deterring corruption specific to the fisheries sector;

- Estimating and publicizing the cost to the national and regional economy of corrupt activity in the fisheries sector; and
- Establishing links between national and international anti-corruption activities and those at the fisheries level.

Lack of skilled fishery managers

In many of the smaller Pacific Island countries, fishery agencies do not have staff with the skills needed to effectively manage fisheries. Also, the regional university does not recognize the large and growing need for fisheries managers. Recommended mitigating actions to address this issue include:

- Creating an awareness and reviewing the curriculum of the University of the South Pacific and other regional institutions, in conjunction with a survey of demand from government fishery agencies; and
- Arranging a program to finance fisheries management students and mid-career managers.

Regional solidarity in fisheries

Pacific Island countries can only effectively deal with more powerful countries and economic interests through regional solidarity. In previous decades, the region was noted for its solidarity in fisheries matters, especially in dealing with distant water fishing nations (DWFNs). For various reasons, however, this solidarity has decreased. Recommended mitigating actions to address this issue include:

- Assessing the economic and political costs of eroding regional solidarity in fish-

eries, giving examples of where it has occurred, and how it may be avoided in the future;

- Encouraging the concept of accountability in regional agreements, including pre-agreed mechanisms for dealing with noncompliance; and
- Developing a regional sector management strategy that enables the resource poorest country to equitably benefit from regional tuna resources by enhancing regional benefits across the board.

Government policies for tuna industry development

It is generally recognized in the region that the major role of government in promoting tuna industry development should be improving fisheries management policies. This concept, however, has not been fully implemented in most countries. Recommended mitigating actions to address this issue include:

- Carrying out national reviews of private sector investment conditions that focus on the fisheries sector, using both investment and fisheries expertise;
- Exploring potential benefits of improved resource and sector management, assessing multiple scenarios of resource and fleet management, and improvements in the framework for private investment; and
- Developing a group of donors that would jointly support a rational private sector investment program, possibly in conjunction with the negotiation and implementation of future fisheries agreements and adjustments of the resource management system.

Weak governance in the inshore fisheries subsector

Fisheries departments, fisheries officers, and communities need to take more responsibility for marine resources. A related matter concerns village food supplies. Although the security of village marine food resources is arguably the greatest issue with respect to inshore fisheries in the region, there is some danger that its importance may be obscured by the quest for greater economic development. Recommended mitigating actions to address this issue include:

- Promoting policies or management plans against which the actions of fishery departments with regards to inshore fisheries can be measured;
- Subjecting inshore development schemes to objective economic scrutiny by enhancing the ability of regional organizations to provide economic advice on small-scale fisheries; and
- Enhancing the skills of fishery managers.

Market access

Access to the world's lucrative tuna markets is often constrained by food safety issues, the requirements of trade agreements, and logistical considerations. Papua New Guinea is the only country in the region that is compliant with European Union food sanitation requirements. Some of the most important logistical considerations in market access concern inadequate airports and airline policies. Many countries do not have adequate size airports for economical air-freighting and most airlines that service the region are likely to introduce aircraft that have less air cargo capacity. Recommended mitigating actions to address this issue include:

- Promoting more effective national fisheries institutions in order to seriously address the blockages created by the sanitary requirements; and
- Following up on a 2000 study that suggested regional cooperation in air freighting of fish.

All of the mitigation measures identified above are in many respects conventional, and are similar to approaches that have been attempted — sometimes with mediocre results — in the last two decades. This lack of success indicates that a fundamental change of strategy is required to improve regional benefits from fisheries. Some new approaches may circumvent traditional institutional and political constraints and/or may actively aim to address them. Such new approaches include using modern financial instruments, and more active multi-lateral donor participation in fishing sector management. Based on the information and analysis presented in this report, The World Bank's involvement in fisheries in the Pacific Islands region should focus on:

- Enhancing the effectiveness of their governance;
- Assessing the status and financial feasibility of the main fisheries, and their potential restructuring; and
- Enhancing Pacific Island countries' share of future domestic income (value added) from tuna fisheries.

A summary of World Bank interventions that could lead to more benefits to Pacific Island countries is provided below. The interventions are prioritized according to the magnitude of likely benefits to countries, and whether the intervention is currently being addressed:

- Reduce corruption in fisheries;
- Improve poor national fisheries institutions;
- Enhance skills of fishery managers;
- Encourage countries to "take advantage of their advantage" in dealing with DWFN;
- Increase country participation in the tuna industry;
- Improve impact of fisheries studies;
- Improve government policies for tuna industry development;
- Improve regional solidarity in fisheries;
- Improve the effectiveness of the Western and Central Pacific Fisheries Commission;
- Strengthen governance in the inshore fisheries subsector;
- Improve effectiveness of monitoring, control, and surveillance through economic analysis;
- More active multi-lateral donor participation in fishing sector management;
- Improve market access; and
- Specific studies that may cover a broader (economic and/or political) area than existing analysis.

Source: Summary of Gillett R. and van Santen G. 2008. Optimizing Fisheries Benefits in the Pacific Islands: Major Issues and Constraints. The World Bank. 62 p. [Full report is available online at www.worldbank.org/eaprrural]



■ PRESS RELEASE

Freshwater prawn farming is a topic of the moment in global aquaculture. According to the latest statistics (FAO Fishstat Plus 2008), farmed production of all species of *Macrobrachium* reached nearly 444,000 mt in 2006, with a value exceeding USD 1.76 billion.

Macrobrachium: the culture of freshwater prawns is a new book by Michael New, C.M. Nair,

M.N. Kutty, K.R. Salin and M.C. Nandeesh, published by Macmillan India Ltd in 2008 (www.macmillanindia.com).

This book, modestly priced at USD 25 plus postage and packaging, is available from Dr C. Mohanakumaran Nair (naircm@hotmail.com). While the book highlights current practices in the freshwater prawn

farming sector in India, it also contains information on the current situation in some of the other major producing countries. It is valuable as a reference volume and practical manual for all concerned with freshwater prawns, especially academicians, farmers, policy makers and investors.



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LIVELIHOOD DIVERSIFICATION AS A MARINE RESOURCE MANAGEMENT TOOL IN THE PACIFIC ISLANDS: LESSONS LEARNED

BACKGROUND

Inshore fisheries are overexploited in many areas of the Pacific Islands. A variety of management interventions, both traditional and introduced, have been used in attempts to reduce fishing effort. This paper focuses on how successful the use of livelihood diversification — securing alternative or supplementary sources of income or food to that obtained from inshore fishing — has been in relieving fishing pressure on inshore marine resources of the Pacific Islands region.

This study was supported by the WorldFish Center and the Secretariat of the Pacific Community (SPC) as part of an attempt to consolidate the wealth of experience gained over the years in marine resource development and management in the Pacific Islands region. From a historical perspective, failed initiatives have often been repeated without knowledge of previous work and, conversely, successes can go unrecognised. By consolidating the lessons of the past, scarce development and management resources may be more productively employed in the future. Although an examination of this topic of livelihood diversification is timely, other related areas deserve to be analysed from a lesson learned perspective. These include what has

*Robert Gillett¹,
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Hugh Govan⁴,
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Michelle Lam⁶*

been learned from decades of experience in areas such as the promotion of aquaculture, turtle conservation efforts, capacity enhancement of government fishery agencies, and many others.

With respect to livelihood diversification, a number of terms require clarification. “Livelihood diversification” is often equated to “alternative income generation”, but the latter is less inclusive of subsistence activities, something that is quite important in Pacific Island fisheries. The term “supplemental livelihoods” acknowledges the fact that the promoted activity is not likely to completely replace the existing practice. From a practical perspective, however, these three terms are often used interchangeably in the Pacific Islands.

Although livelihood diversification has long been promoted for marine resource management in the region, the results of specific initiatives are poorly documented. This lack of documentation, however, does not negate the need for, or the validity of, an examination of the subject. Out

of necessity, this study relies heavily on the observations of key individuals. The emphasis is on past experience, rather than what may seem intuitively appealing or what appears to hold promise for the future. The time frame considered is about three decades — approximately the limit of what has occurred within the memory of senior individuals presently working in the fisheries sector.

Preliminary research consisted of two components. The first was assembling the available literature on livelihood diversification (as it transpired, this was largely limited to proposals for interventions), and discussions with 22 individuals who have promoted livelihood diversification, either as a marine resource management tool or for terrestrial conservation purposes in the Pacific Islands. That information collection phase was followed by the convening of a meeting of six fisheries specialists from regional/international organisations, NGOs, and the private sector which have a combined total of 125 years of working experience in the region. During that consultation, the major issues in the use of livelihood diversification as a management tool were identified, and in subsequent discussions of successes and/or failures and associated considerations, a number of lessons emerged. Those are reported in this paper.

It should be stressed that the importance of livelihood diversification is much broader than just fishery management. Its potential for general community development, although great, is however not the subject of this paper. Here, the analysis is

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focussed on using livelihood diversification for marine resource management. Fisheries managers in the Pacific Islands have several mechanisms at their disposal to reduce fishing pressure, but the choice of the appropriate one is often not clear. Because livelihood diversification has been for so many years mentioned, promoted, and used as a means for reducing this pressure, it is thought that the specific topic of its effectiveness as a fisheries management tool deserves attention — and is the subject of this paper.

LIVELIHOOD DIVERSIFICATION AS A MARINE RESOURCE MANAGEMENT TOOL

Livelihood diversification has been promoted as a tool for marine resource management in the Pacific Islands for at least 30 years. In this period, there have been two main categories of attempts: 1) promotion of an alternative that in itself is supposed to result in less inshore fishing, and 2) as a mitigation measure — something used when another management intervention, such as a ban on fishing, produces a temporary hardship in the form of less seafood or less income from fishing.

Four main types of alternative activities have been promoted in the region to reduce fishing pressure as alternatives to inshore fishing. These categories are:

- **Aquaculture.** There is a long history in the region of promoting the culture of marine organisms, often partly justified by the fact that such activity will reduce the amount of inshore fishing. The Samoa Fisheries Division Annual Report (Fisheries Division 2000) states, “Objectively, aquaculture and mariculture have been observed to be one of the options in

alleviating pressure on over-exploited inshore reef and lagoon fisheries’. In reviewing aquaculture in the region, Tanaka (1999) asserts, “In many countries national fishing regulations are coming into force to stop over-fishing... Without, however, offering alternative sources of income generation to villagers such co-management would not be maintained in the long-term. Aquaculture development in the coastal areas seems the best alternative for this purpose.”

- **Fish aggregation devices.** The placement of anchored rafts (FADs) in offshore areas to improve tuna fishing, as well as other attempts to promote small-scale tuna fishing, have often been justified by the fact that they may relieve fishing pressure from nearby inshore areas. The following rationale is given in a FAD manual for the region: “In many coastal areas, growing populations and the need to increase fishing production have led to overfishing of inshore and reef resources. If fishermen who normally fish inshore are able to catch more fish and earn better incomes by changing to FAD-based tuna fishing, the fishing on inshore resources will be reduced” (Anderson and Gates 1996).
- **Deep reef slope fishing.** The promotion of fishing for snappers and other large bottomfish on outer reef slopes and seamounts has been undertaken in many Pacific Island countries in the context of transferring fishing effort farther offshore to more lightly exploited resources. A major focus of development agencies such as SPC was to encourage Pacific Island enterprises to move away from reef and

lagoon fishing, with its limited commercial development potential, to unexploited fisheries such as deepwater snapper (Adams and Chapman 2004)

- **Alternatives outside the fishing sector.** Activities that have been actively promoted to reduce inshore fishing pressure have included tourism (especially ecotourism), livestock raising, surfing, handicraft production, and adding value to harvested seafood. Huber and McGregor (2002) state that in relationship to establishing marine protected areas (MPAs), ecotourism is the most common alternative activity.

Although the above mechanisms are commonly employed in the Pacific Islands, data on the frequency of their use are almost non-existent. Some indication of prevalence is given by the World Bank (2000), which reviewed coastal resource management at 31 sites in seven Pacific Island countries. The study showed that income-generating programmes introduced for the explicit purpose of alleviating pressure on coastal resources were found at 18 sites (58% of all study sites). They included aquaculture (10 sites), FAD tuna fishing (10 sites), and deep slope fishing (10 sites), with some sites having more than one activity. Tourism, farming, handicraft production, and infrastructure work were also found at various sites, but in general, these had been introduced as development activities in their own right, rather than as a coastal resource management strategy.

In addition to serving as a tool for marine resource management, livelihood diversification has often been used in the Pacific Islands region for environmental purposes, especially biodiversity conservation.

Although the environmental objectives can be quite different (e.g. support of conservation area institutions and/or infrastructure), some of the lessons learned are quite relevant to the fisheries sector. It should be noted that in the region, livelihood diversification efforts that deal with the environment appear to have been better documented and evaluated than those for fishery efforts.

Outside the Pacific Islands, livelihood diversification has often been used for the management of marine resource as well as for other purposes. A literature search indicates that much of the marine experience has occurred in Asia, especially Indonesia and the Philippines, and has commonly involved seaweed farming and tourism. However, the present paper focuses primarily on the Pacific Islands experience.

THE SUCCESS OF USING LIVELIHOOD DIVERSIFICATION AS A MANAGEMENT TOOL

Requirements for success

The success of using livelihood diversification as a management tool needs to be carefully defined. For the "tool" to be considered successful it must satisfy several conditions: 1) results in activities that produce supplementary income and/or food; 2) the extra income and/or food actually decreases fishing pressure; 3) does not result in broader environmental damage; and 4) is considered to be worthwhile enough by the target fishers to be continued. Another requirement for the tool to be successful is that it must have been originally intended as a resource management measure. After all, a huge tuna cannery could satisfy the above three conditions, but because such a facility is not normally planned as an inshore fisheries management measure,

it could hardly be considered a success in that context. From the preceding, it can be seen that for livelihood diversification to be considered a successful management tool, the requirements are somewhat demanding.

The reality

In reviewing marine resource management in the Pacific Islands over the last 30 years, it is difficult to identify cases where the use of livelihood diversification as an inshore management tool could be considered clearly successful. This contention is based only to a limited degree on analysis of documented experiences, although reports on the promotion of livelihood diversification are scarce, and those evaluating success are almost non-existent. The sentiment of the poor record of livelihood diversification is based mostly on the assertions of knowledgeable individuals — 22 people who have attempted to use livelihood diversification as a management tool or have observed the results of its use.

The experience

Formal evaluation of the success of livelihood diversification as an inshore management tool in the region appears to be limited to two studies:

- In 1998, the World Bank studied coastal resource management, including alternative income generation (AIG) at 31 sites. In terms of the perceived impacts that AIG has had on reducing the extraction of coastal resources at the 18 study sites where AIG has been attempted, the results were somewhat disappointing. Residents did not believe that any of the aquaculture efforts were having a substantial impact, and the effects of FAD fishing and bottom fishing were only marginally better.

- Chapman et al. (2005) studied the effects of fish aggregation devices (FADs), including measuring their usefulness as inshore management tools. It was concluded that the success of FADs as a management tool was difficult to determine. This was due to the fact that at all locations, marine protected areas were already in place and local communities and fishermen had already changed their activities to account for this.

All of the 22 knowledgeable individuals interviewed during this study could cite numerous failures of the use livelihood diversification, but examples where it was clearly successful in reducing fishing effort were not offered. Some individuals did indicate that there are some important considerations associated with this performance record. These include:

- Even in modern developed countries, most small businesses fail, so a generally poor record of livelihood diversification in mostly rural coastal communities in the Pacific Islands region cannot be taken as proof that the livelihood diversification concept will not work.
- Some of the attempts to use livelihood diversification to reduce inshore fishing pressure not only failed to do so, but actually increased the pressure. Those that are associated with the provision of boats or boat building, or the establishment of commercial market outlets, appear prone to this risk.
- Some positive examples were cited, such as reduced fishing pressure on the reef off some resorts, but (as per success criteria mentioned above) those sources of livelihood diversification were often not primarily intended to be management tools.

The usual case is where an external agency (e.g. government fisheries agency, NGO) decides to provide some assistance to a community to commence a livelihood diversification activity (e.g. boat for off-shore fishing, materials for fish culture). This is often an outright grant (e.g. cash or goods) or something that inherently subsidises the concerned activity (e.g. free marketing service). Many such attempts are initially successful, but as expectations are unfulfilled, as business complexities set in, or as subsidies cease, either the community or external agency loses enthusiasm and the livelihood diversification activity winds down.

It may be useful to identify some specific examples of the various types of unsuccessful uses of livelihood diversification for marine resource management.

Activity ceased with termination of subsidy. In Samoa, attempts to encourage fishing outside the reef by introducing medium-sized, low-cost boats were initially successful (King and Fa'asili 1998), but when the subsidy for vessel purchase expired, other groups did not pursue the activity (Etupati Ropeti, SPC Coastal Fisheries Management Officer, pers. comm.).

Overly optimistic donor with multiple goals. In a relatively remote part of the Solomon Islands (one of the region's less-developed countries), an NGO promoted deep reef slope fishing for livelihood diversification. Project documentation stated that the activity would 1) be a successful business, 2) have a positive effect on the coastal resource management situation, 3) be gender sensitive, 4) have participation from three ethnically and culturally different communities, and 5) produce equitable benefits in those com-

munities (Gillett 1999). The intervention, however, was not successful in any of the five categories (Michelle Lam, pers. comm.).

Involvement of communities in marketing complexities. One of the stated objectives of a project aimed at producing dried tuna jerky in Tuvalu was to relieve pressure on overexploited reef and lagoon resources. A component of the project involved sending tuna jerky to overseas markets. No sustained export of this product has occurred due to the fact that individuals or associations on outer islands do not have the requisite entrepreneurial attitudes, business skills or ability to cope with complex export arrangements (FFA 2005).

No relief of fishing pressure from the activity. In Palau, culturing a wide variety of marine organisms (e.g. giant clams, milkfish, sponges, seaweeds, pearls, oysters) has been promoted over the years. One of the justifications for aquaculture was to relieve pressure on inshore reef resources (Chapman 2004). A survey in 1999 stated that the residents of six coastal communities in Palau perceived little, if any, reduction in coastal fishing because of aquaculture efforts (World Bank 2000).

Activity producing opposite effect. The Fiji Fisheries Department Annual Report for 2002 (Fisheries Department 2003) states that the provision of subsidised boats and fishing gear for tuna fishing around FADs was intended to "promote off-shore fishing relieving pressure on inshore fisheries". In 2003 this scheme "assisted 31 small-scale tuna fishers through providing fishing gears, safe affordable and recommended outboard engines and punts, under the small-scale subsidy scheme of a total sum of F\$332,999" (Fisheries Department 2004). A

study of inshore spearfishing in Fiji (Gillett and Moy 2006) gives information on the success of that scheme: "Commercial spearfishing is depleting fishery resources in areas which may be quite important for village food supplies" and that, at the most important commercial spearfishing landing site in Fiji, "almost all the fibreglass skiffs presently involved in spearfishing were originally obtained through the small-scale tuna fishing subsidy scheme of the Fisheries Department".

Successful, but not promoted as a measure to reduce fishing pressure. The small "Mystery Island" off the coast of Aneityum in Vanuatu receives occasional calls by cruise ships. Tourist expenditures ashore have resulted in less inshore marine harvesting and have been an incentive to establish a marine protected area (Hugh Govan, pers. comm.). Although a favourable marine resource management situation has resulted, the Mystery Island project was not intended for resource management purposes, and therefore cannot be considered a successful management "tool".

Other types of difficulties encountered in the use of livelihood diversification for marine resource management include naïve attitudes towards marketing ("produce something wonderful and it will be purchased"), communities receiving business advice from individuals and/or agencies that do not have the requisite experience, and soaring expectations on the part of target communities of the benefits that may result from the activity in question.

In reviewing the above, many of the difficulties fall into two categories:

- *Overly simplistic views of how individuals and communities react to opportunities and con-*

straints. There is the assumption that extra cash or food will remove fishing pressure, but the actual situation of what motivates and discourages individuals and communities is far more complex.

- *The difficulties faced by traditional Pacific Island communities in operating commercial businesses.* Crocombe (2001) reviews indigenous business development in the Pacific Islands over the last century. He concludes that the business failure rate is very high and the proportion of all business in the region handled by indigenous people is shrinking, observations that do not bode well for the usual targets of livelihood diversification: Pacific Islanders inexperienced in business, often in isolated communities.

Elements of success

It is relatively easy to cite examples of livelihood diversification failure. A more challenging, but potentially more productive exercise, is to identify success in livelihood diversification initiatives and the associated positive elements. Several apparently successful examples have not been subjected to close examination and have not yet been in place for long enough to withstand the test of time. Nevertheless, the ones that have been identified during this study are:

- About three years ago in Fiji a major coral-exporting entrepreneur began leasing reefs from coastal communities for the growing of 'live rock'. Communities receive payment and there is a perception of less inshore fishing in those communities. (W. Aalbersberg and E. Lovell, personal communication);
- Seaweed culture appears to be commercially successful in

places in Kiribati and the Solomon Islands, and there is some indication that seaweed farmers fish less, including fishing in inshore areas. (Garry Preston, Gillett, Preston and Associates, pers. comm.);

- The government of French Polynesia has installed a series of FADs, and one of the stated objectives of the programme is to encourage the "poti marara" vessels to fish away from inshore areas, which appears to be occurring at present (Terri Luciani, SPC Fisheries Training Adviser, pers. comm).

The first two examples above reinforce ideas received from individuals familiar with the use of livelihood diversification for terrestrial biodiversity conservation in the region. One of these is that the business model employed should involve a tight relationship with an empathetic business partner, rather than communities attempting to do marketing on their own. The first example demonstrates the advantage of communities obtaining passive benefits from their marine assets, rather than immersing in the complex business world. The third example is reliant on an inherent subsidy, a feature discussed later in this report.

In the above examples there is also the suggestion that the activity promoted in "successful" livelihood diversification tends to produce modest, rather than spectacular, amounts of alternative income or food.

EMERGING TOPICS AND IMPORTANT ISSUES

An examination of some issues associated with the use of livelihood diversification as a marine resource management tool may help explain the poor success record, or conversely, such scrutiny may suggest where improvements should be made.

What can an outside livelihood diversification intervention do for a community, that the community cannot do for itself?

The essential input of an external agency into the livelihood diversification process has most often consisted of identifying business or product opportunities, providing marketing support, giving subsidies, supplying technical assistance, and performing the role of an "honest broker" between the community and a business. When the assistance is disaggregated to this level, some of the weaknesses become apparent. An important point is that much of the assistance is provided by officers of government fisheries departments and environmental NGOs. These people often do not have the depth of experience required for effective identification and critical evaluation of opportunities; those types of agencies characteristically do not embody or foster such skills. Providing marketing support is an important area of assistance by external agencies, but because commercial opportunities are rarely static, marketing support is an ongoing need. However, fisheries departments and NGOs are simply not set up to provide such assistance in perpetuity. The same could be said for livelihood diversification activities that require long-term subsidies. On the other hand, agencies that focus on performing the role of "honest broker" between communities and commercial businesses seem to enjoy a higher degree of success. This appears to be the case for seaweed farming in Solomon Islands and live rock culture in Fiji. The reason could be that the type of agencies that promote livelihood diversification are reasonably capable of performing the vital role of moderating expectations and performance between communities and businesses.

The good, bad and ugly of subsidies in livelihood diversification. Many of the interventions of external agencies are outright grants or something that inherently subsidizes the concerned activity, such as free marketing services. Ideally, the subsidies would:

- 1) Only be required to catalyse a process that would subsequently become feasible or stand-alone (e.g., boatbuilding where it is promoted for livelihood diversification), or
- 2) Demonstrate something that, once observed by the target audience, would be adopted (aquaculture in most places where it is promoted for livelihood diversification), or
- 3) Be provided by a donor with substantial financial resources and ability to provide a very long-term commitment. (see box text below)

The reality is that most livelihood diversification projects that were intended to be “kick started” with a subsidy (#1 and

#2 above), have been discontinued when the subsidy was withdrawn. Reasons for this could include elevated financial expectations, the fact that obtaining the subsidy becomes the primary reason for involvement in the livelihood diversification activity (getting a free boat), a feeling of being disadvantaged or cheated in starting an activity without a subsidy when others previously have had one, and a lack of a clear exit strategy. Livelihood diversification projects that involve long-term subsidies suffer from the lack of donors with such generosity. The box text below describes one project apparently predicated on perpetual support that was not forthcoming.

Getting over the “fisheries management hump”. There is often mention in the Pacific Islands of the needs associated with the temporary impacts of fisheries management initiatives. King and Fa’asili (1998) describe this situation and indicate that alternative seafood and income sources are needed to compensate for short-term

losses of income or fish when establishing marine protected areas (MPAs) and other management schemes until the protected stocks recover to higher levels of abundance or productivity and can be exploited again. There are many considerations associated with both the existence and magnitude of such a “fisheries management hump”, many of which relate to what position on the catch curve an exploited fishing area is located (Tim Adams, SPC Director, Marine Resources Division, pers. comm.). The prevailing hypothesis upon which many of the region’s MPAs are based is that short-term losses will be compensated by long-term production gains. Assuming this to be true, an important point should be made: the few positive examples of livelihood diversification as a management tool, both in marine and terrestrial areas, suggest that achieving success takes a considerable amount of time, while the need for overcoming management-induced hardship is immediate. The incompatibility of the two time frames could

Reliance on long-term subsidies*

In 1997, an environmental NGO decided to proceed with the construction and operation of a rural fishing centre (RFC) in Waghena, a village close to the Arnavon Islands Marine Conservation Area (AMCA) in the Solomon Islands. The RFC was established with the support of the NGO, and was modelled on those being promoted at the time by the European Union's Rural Fishing Enterprise Project. The difference in this case was that the RFC had the express goal of providing income opportunities that would allow local residents to forego harvesting threatened species from the AMCA. These species included hawksbill turtles, megapodes, and sedentary marine resources such as pearl shell, trochus and beche-de-mer. As well as establishing the RFC, the NGO had already supported the establishment of community-based management (CBM) arrangements for the AMCA, and the two initiatives were seen as being inter-linked. In addition to providing alternative income for the resource users of the area, it was hoped that profits produced by the RFC could support the cost of community patrols and other CBM activities. Unfortunately, the technical and economic feasibility of the RFC was dubious from the start. An independent pre-project assessment advised that the RFC would not be financially sustainable as designed without a permanent subsidy from the NGO (Preston 1996). The local representative of the NGO at the time stated that the organisation would indeed be willing to provide a subsidy in perpetuity in order to achieve its conservation goals in the area, but this was apparently a personal view and not the NGO's official position. The RFC ceased to operate after several years of subsidised operation, and there is little evidence to indicate that the activities of the centre contributed anything to conserving the marine resources of the AMCA.

* See Leisher et al. 2007 and van Beukering et al. 2007 for an alternative interpretation of community assessment of the value and effectiveness of the Arnavon Islands Marine Conservation Area.

therefore explain at least some of the difficulties of using livelihood diversification as a management mitigation measure.

Business skills. It is common knowledge that the general level of business skills in rural Pacific Island communities is quite low; this is understandable given the largely subsistence nature of the economy over much of the region and the egalitarian qualities of many of the cultures. In this context, in the promotion of livelihood diversification that depends on business skills, there is no “magic solution”, but rather the road to success must start by the development of basic financial literacy. This is a long and complex process that could easily overwhelm an initiative focussing on the fairly narrow subject of using livelihood diversification as a marine resource management tool. Accordingly, this could be another explanation for the high failure rate of such projects. Conversely, it could also be a factor in the success of those projects that remove village-level participants from business complexities, such as arrangements for passive leasing of lagoons for aquaculture or having an “honest broker” for interfacing with commercial firms.

Village selection. The process of selecting sites for livelihood diversification for resource management seems to have a considerable effect on subsequent success. In many programmes, sites have been selected due to a need that is perceived important by outside agencies (e.g. high biodiversity value, or the protection of aggregations of threatened species) or after “selling” the project to residents, while in others (e.g. the PNG Coastal Fisheries Management and Development Project and the AusAID/Samoa Fisheries Project) villages were made aware of management efforts, including livelihood diversification activities, and could apply to be part of the

project. The latter method, although not the most common, seems to be more successful at identifying communities with a real interest in resource management, rather than those whose primary interests are the fringe benefits.

Other items on the agenda.

Some supposed uses of livelihood diversification as a management tool are simply not genuine, and were never really intended to relieve pressure on inshore resources. Included in this category are measures to temporarily mollify vocal communities when harsh measures are put into place (e.g. a livelihood diversification project to muffle dissent after a total ban on a particular species), words inserted into a proposal to a donor to add extra appeal (often for aquaculture projects: “...in addition, it will relieve pressure...”), and as justification for distributing goods prior to an election (e.g. materials conceivably related to seaweed farming). In the extreme, several of the allegations of corruption associated with fisheries in the region have involved fiddling with items related to supposed livelihood diversification (e.g. free or subsidised boats and engines), hence a sinister incentive for formulating or accepting such programmes. All of these dubious uses have detracted from the performance record of livelihood diversification as a management tool.

LESSONS LEARNED IN THE PACIFIC ISLANDS

In the use of livelihood diversification for resource management in the Pacific Islands region, past experience points to some important overall conclusions. These include:

- Agencies promoting livelihood diversification that focus on performing the role of “honest broker” between communities and commercial interests seem to be the most successful.

- Businesses are generally better than fisheries departments or NGOs at identifying and/or developing opportunities, but often have difficulties in spreading benefits and in community relations, hence the need for somebody to smooth the interface between business and community.
- It seems to be more effective for an agency to identify and work with an empathetic businessman than to attempt to drag communities into the complexities of the business world.
- The rare livelihood diversification initiative that is successful requires a long time to achieve profitability and the eventual profits are characteristically modest rather than spectacular.
- Although most subsidies are intended to only catalyse a livelihood diversification activity, their withdrawal most often leads the demise of the concerned activity. The effective subsidy exit strategy is rare.
- Expectations of the target community often grow to unrealistic levels, leading to disenchantment when such benefits are not attained.
- Boats and boatbuilding activities for livelihood diversification often “backfire” and results in even greater inshore fishing pressure.
- Most livelihood diversification interventions have not been properly evaluated to determine their effectiveness at reducing fishing pressure as intended, but this aspect should be essential.
- In reviewing past failed livelihood diversification initiatives, there appears to have been a lack of consider-

ation given to other management measures to reach the desired objective.

Perhaps the most important lesson learned about livelihood diversification in the Pacific Islands is that its performance has not been to the level where it can be considered an effective resource management tool. In many cases, livelihood diversification could even be a distraction that deters communities from gaining an awareness of the need for, and benefits of, more effective forms of marine resource management.

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SUPPORT FOR THE TONGAN HALF-PEARL INDUSTRY

In May 2008, SPC's Aquaculture Officer visited Tonga to provide assistance to two projects aimed at stimulating the small-scale, half-pearl (mabe) industry in Tonga's Vava'u group.

A pearl shell carving training workshop was organised by SPC in Vava'u and involved local craftsmen and women who wished to improve their pearl shell and mabe handicrafts production. Tokerau Jim, a master carver from Rarotonga, Cook Islands, was contracted by SPC to deliver the highest possible quality, hands-on training.

Following the workshop, a hatchery rearing session of winged pearl oyster (*Pteria penguin*) was undertaken in Tongatapu at the Sopa Mariculture Center. This was conducted

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as part of an Australian Centre for International Agricultural Research (ACIAR)-funded project for which James Cook University (JCU) in Townsville, Australia is the commissioned organisation and Professor Paul Southgate is the Project Leader. Technical assistance for the hatchery work was provided by Andrew Beer and Paul Southgate, and SPC's Aquaculture Officer, Antoine Teitelbaum. The spat produced by the end of this run will be used to supply Vava'u pearl farmers and, thus, increase the supply of raw material of pearl shells and mabe. The spat will also be used in experi-

ments to refine culture and mabe production methods.

HISTORY OF PEARL FARMING IN TONGA

Cultured pearls in the Pacific are dominated by the black pearl, which is produced from the black-lip pearl oyster, *Pinctada margaritifera*. In Tonga, pearl oyster culture began in the early 1960s. In 1975, an experimental venture was set up by the Tongan government. Broodstock of the winged pearl oyster, *Pteria penguin*, was imported from Japan for initial culture trials. The FAO South Pacific Aquaculture Development Project (SPADP) provided assistance in 1989 in carrying out stock assessment, spat collection surveys, and grafting techniques.

Commercial feasibility of pearl farming in Tonga was initiated in 1993. Japanese specialists estimated that an area of approximately 850 ha in the Vava'u island group could be farmed for half-pearl production, supporting an annual production of around 750,000 pearls, with approximately 30% of these being first-grade. Assuming a value of USD30 each for first-grade half-pearls, potential annual revenue from an area of 850 ha was estimated to be around USD7.5 million (Finau 2005).

Tonga is in a relatively unique position to diversify the range of pearl products because Vava'u has winged pearl oysters from which half-pearl (mabe) can be produced. One of the advantages of producing half-pearls is the lower capital and technological investment required and the value-added opportunities through jewellery and handicrafts. Already there is a small but thriving niche



***Pteria penguin* broodstock.**

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market to sell mabe pearls to tourists in Vava'u.

TRANSFERRING CARVING TECHNOLOGIES FROM RAROTONGA TO VAVA'U

SPC's Aquaculture Section targets livelihood opportunities. Mabe pearls and carved shell products are one of the lucrative opportunities supporting sustainable and profitable small-scale and rural development, especially in areas where tourism is developing.

In June 2006, SPC's Aquaculture Section, together with JCU, organised a similar carving workshop in Kiribati to introduce the basics of those techniques (Teitelbaum 2007). That carving workshop was a more advanced course and had two major goals: 1) to provide an overview of the fundamentals involved in pearl jewellery and handicrafts (tools and craftsmanship, jewellery and handicraft design, pearl handicraft preparation and setting and marketing techniques), and 2) pay particular attention to the domestic market opportunities and local cultural carving and handicraft traditions in Vava'u.

Tokerau Jim (www.tokeraujim.com), the master carver hired for this exercise, runs a successful business in the Cook Islands. For the occasion, he brought in some specific tools that he uses in his workshop in Rarotonga. The Taurus ring saw¹ and the Foreman hand drill² were the most noticeable technological improvements that were brought to Vava'u. Traditionally, carvers used hand grinders and hacksaws for producing their crafts, taking over 30 minutes to produce shapes out of a shell. A ring saw can produce a shape in less than one minute. Further-



Top: Tokerau Jim explaining the use of the carving tools.

Bottom: Vava'u carver training with new tools.

¹ Available for purchase at the Stained Glass Web Mart www.glassmart.com

² Available for purchase at Mountain Heritage www.mhcrafters.com



more, the Foredom hand drill (with an rpm rate of over 45,000 compared with 30–33,000 for standard hand drills) allows carvers to be a lot more precise in their motifs and carvings.

Over this three-day event, trainees learned how to handle the new tools and how to produce better quality products with a true finished luster. Drawing and cutting shapes, designing pendants, earrings or whole shell art was demonstrated. Half-pearls (mabe) were also used for the carving exercises. Tokerau Jim demonstrated how to best use each shell to reveal its best colour and true nature. Thanks to Tokerau Jim, trainees also learned how to incorporate traditional Tongan motifs in the carvings, making those products uniquely Tongan.

One of the bottlenecks of handicraft production is the lack of supply of mabes and pearl shells. How can handicraft and mabe production be improved given the current state of farming in Vava'u?

THE NEED FOR SPAT

Until recently, pearl farmers from Vava'u (regrouped under the Pearl Grower Association – PGA) have only been growing a limited number of shells using natural spat collection. The poor recruitment of spat has resulted in the harvesting of adult oysters from the wild, which has further impacted recruitment and natural spat fall of *Pteria penguin* in Vava'u is now extremely limited.

ACIAR is funding a 2.5-year research project (FIS/2006/172), focusing on the development of

Top: Display of products from the workshop.

Bottom: Andrew beer holding a broodstock *Pteria penguin* during spawning (female).



appropriate hatchery culture techniques for *Pteria penguin* and the use of hatchery-propagated oysters for pearl production. This project involves collaboration with SPC and ties in with SPC's Aquaculture Action Plan.

Further development of the pearl industry in Tonga is hindered by a lack of knowledge of culture requirements of *Pteria penguin* and methods for optimising pearl production from this species. For example, only one preliminary study has reported on hatchery or nursery culture of *Pteria penguin* (Beer 1999) and, while limited information is available relating to half-pearl production from the related *Pteria sterna* (Ruiz-Rubio et al. 2006), similar information is not yet available for *Pteria penguin*. Research is required to optimise culture methodology and pearl production from *Pteria penguin* as a basis for sustainable industry development. This ACIAR project will address the following major points:

- Hatchery culture of *Pteria penguin* and optimisation of hatchery culture techniques;
- Nursery culture and grow-out, optimising culture techniques;
- Half-pearl production and aspects effecting pearl quality (position, location, time);
- Investigation of round pearl production from *Pteria penguin*;
- Training Tonga Fisheries Department staff in culture methods and pearl production; and
- Training farmers and members of PGA.

Top: Hatchery setup.

Bottom: Broodstock in induction tank.

Production of high quality half-pearl from *Pteria penguin* in Tonga has been clearly demonstrated and existing pearl farming expertise in Tonga provides considerable opportunity for this project to have immediate impact.

A SUCCESSFUL SPAWNING AT SOPU MARICULTURE FACILITIES

In May 2008, the hatchery at SOPU was upgraded by Tonga Fisheries Department aquaculture staff, and assisted by Andrew Beer and Antoine Teitelbaum. Several tanks were cleaned and prepared for larval rearing. A filtered water system was rigged and a spawning set up (including heat shock set up)

was put into place. All hatchery equipment needed for spawning and larval rearing were recovered or purchased, while a first batch of 30 adult *Pteria penguin* broodstock were air freighted from Vava'u.

The first batch of oysters was successfully induced to spawn, and larvae were put in incubation. A second batch of 30 broodstock was induced to spawn several days later and these produced more than satisfactory numbers of eggs, allowing us to fully stock all available hatchery tanks. The extra spawn was placed in outside raceways and those were fertilised using agricultural fertilis-



er, in the hopes of producing a natural bloom of microalgae.

The temperature requirement of most pearl oysters is between 26°C and 29°C for larval rearing (Ellis et al. 2005). During the run, the water was as low as 20°C over night in the hatchery and so a heat exchange system was put into place and aquarium heaters were also used, allowing water temperatures to be maintained between 26°C and 30°C.

A large proportion of the microalgae required as larval food was provided as a commercially available algal concentrate obtained from Reed Mariculture in the USA. The species used were *Pavlova* sp. and T-ISO. The encouraging results indicate that algal concentrates may be of considerable benefit to hatcheries in the region by reducing the requirement to culture live micro-algae for larval pearl oyster culture. This would simplify hatchery production and reduce the need for specialised culture facilities and technical capacity.

More than 500,000 eyed larvae were placed into settlement tanks. When sample spat collectors from these tanks were

inspected two weeks later, large numbers of spat were observed. Spat collectors were transferred to an ocean-based longline and spat will be harvested from them in September 2008.

Both the spawning and larval rearing run of *Pteria penguin* and the shell carving workshop complemented each other in the sense that they assisted in increasing the supply of spat, which is in high demand in Vava'u and which ultimately improves the end products of the Tongan carved shell and mabe industry. In the near future, this sustainable activity should gain in popularity and provide more alternative livelihood options to Tonga's rural populations.

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Vavau hosts many good sites for pearl farming.



PRACTICAL SAFETY AND FISHING COURSE FOR PACIFIC ISLAND FISHERIES OFFICERS

In October, SPC's Fisheries Development Officer, William Sokimi, assisted the Vanuatu Maritime College in coordinating the Practical Safety and Fishing Course for Pacific Islands Fisheries Officers. The course provided hands-on training in fishing operations that use several sustainable fishing methods commonly used on small craft in the Pacific Islands region. Fishing operations were conducted according to safe operational plans (SOPs) that ensured crew safety onboard and promoted environmental awareness. The course also explored economically viable fishing practices that may be conducive to a specific local situation.

Course topic areas included tuna catching methods such as small-scale pelagic horizontal and vertical longlining; mid-water jigging and mid-water handlining fishing; deep-bottom fishing; basic navigation and seamanship; vessel operations and management; vessel and crew safety; onboard handling and preservation of catch for meeting export standards; information on bycatch mitigation; and small scale bait fishing gear and methods.

At the end of the course, fishermen were expected to return to their respective jobs in the region and use the knowledge they gained during the course to assist fishing communities and enterprises in developing sustainable and profitable fishing operations.

Course participants included Ben Buga, Solomon Islands Fisheries

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Officer; Elko-Joe Agir, Nauru Aquaculture and Coastal Fisheries Officer; Erbai Yukiwo, Palau Fisheries Extension Fisheries Officer; John Oswyn, PNG National Fisheries College Commercial Fisheries Team Leader; Pomat Nelson PNG Manus Provincial Administration Post Harvest Officer; Martin Finau, Tonga Department of Fisheries Officer; Pesamino Tufele, Wallis and Futuna Fisheries Officer; Morgan Magatogia, Niue Department of Fisheries Officer; Tanuvasa Toetu Pesaleli Samoa Fisheries Division Extension Fisheries Officer/Skipper/ Engineer; and Tiavare Henry, Cook Islands private sector commercial fisherman.

COURSE ACTIVITIES

The first week focussed on safety courses, beginning with a two-day class on sea survival techniques, followed by a one-day class on fire fighting, and a two-day workshop on first aid. These short courses were well received by participants because with the exception of two participants, none had any previous formal training in sea survival techniques, fire fighting or first aid.

Week two focussed on deep-bottom fishing activities, week three on vertical longlining and week four on horizontal longlining. Each Monday from week two to week four was set aside to construct fishing gear specific to the fishing operation for that week. At the end of the day, the gear was placed on the vessels, and from Tuesday to Friday practical fishing activities were conducted according to the assigned fishing method for that week.

The FV *Etelis* and the FV *Em Nao* (Figs. 1 and 2) carried out the operations for deep-bottom fishing, vertical longlining, trolling, and mid-water jigging. The FV *Evolan* (Fig. 3) was used for horizontal longlining because it is equipped with a hydraulic line hauler and has



Figure 1: FV *Etelis*.

sufficient deck space to carry out this operation effectively.

SEA SURVIVAL, FIRE FIGHTING AND FIRST AID COURSES

Onboard fishing operations was the main thrust of the Practical Safety and Fishing Course; therefore, it was important that participants fully understand the basic concepts of dealing with emergencies at sea before departing on fishing trips. Participants were required to undergo training in sea survival techniques (Fig. 4), fire fighting (Fig. 5) and basic first aid (Fig. 6). These short courses also gave participants an insight into the basic qualifications required by seafarers for admission to work on commercial fishing vessels. This insight will assist fisheries officers in dealing with offshore fishing personnel during the course of their duties.

During the progression of each course, assessments were carried out to ensure that participants grasped the concepts and lessons they were taught. Participants who did not understand any part of the lessons were re-briefed until they understood. At the end of each course, a final assessment was conducted to ensure that participants retained the information given during the lessons. At the end of the week, each participant qualified for a Safety Certificate and was eligible to be onboard during the practical fishing trips.

SAFETY AWARENESS BRIEFING: SAFE OPERATIONAL PLANS

Another main of the course was to stress the importance of



Figure 2 (top): FV *Em Nao*.

Figure 3 (middle): FV *Evolan*.

**Figure 4 (bottom):
Participants engaging in sea
survival techniques.**



implementing safe operational plans (SOPs) (Fig. 7). SOPs reduce the chances of mishaps at sea and, in the event that a mishap does occur, crew members will have a better chance of survival than if an SOP had not been implemented.

During the course, an SOP and fishing gear checklist was filled out every morning before departure. It was signed by the skipper and handed over to the college's shore duty officer for the day. The 10 participants were divided into two SOP groups. Before departure, the SOP group for the day had to ensure that every item on the checklist was accounted for and that the vessels were ready for the practical fishing operations. Upon return from the fishing trip the SOP group for the day carried out the final fish processing duties, ensuring that at the end of the operation, all the fish were properly gilled, gutted and iced according to the preferences of the fish buyers.



The second SOP group was responsible for tidying up the vessel and stowing away the fishing gear in readiness for the next fishing trip. This group also refuelled the vessel and prepared it for the next fishing trip, as they would be the SOP group the next morning.



An important point that was stressed to participants was that the SOP for any vessel is unique to that vessel alone. This is because each vessel has a different layout and positioning of gear and so the requirements for each vessel are slightly different.

Figure 5 (top): Dealing with an onboard fire.

Figure 6 (middle): Practicing first aid on a dummy.

Figure 7 (bottom): Pomat Powayai of PNG carrying out an SOP check.

PRACTICAL FISHING ACTIVITIES

A PowerPoint presentation was given to brief participants on the course structure and the type of fishing methods that would be carried out. Fishing gear was constructed during the afternoons of the first week, after the safety classes.

The fishing methods taught during the course were deep-bottom fishing (Fig. 8), trolling (Fig. 9), FAD/mid-water jigging using the chum bag method and jigging rods, vertical longlining, horizontal longlining, and bouke-ami lift net bait fishing.

While most participants were familiar with some of the fishing methods, only several of them had any real opportunity to go out on fishing trips. The deep-bottom fishing method was known to most, probably because it is an extension of the shallower bottom-fishing methods. However, vertical longlining, horizontal longlining, mid-water chum-bait fishing and bouke-ami baiting method were new to most participants.

Although some participants knew about the "drop stone" method, none had actually tried it, so the modern variation of this method (using a chum bag), was not known to most of them (Figs. 10 and 11).

Participants were given the opportunity to participate in each fishing method and to make recommendations for

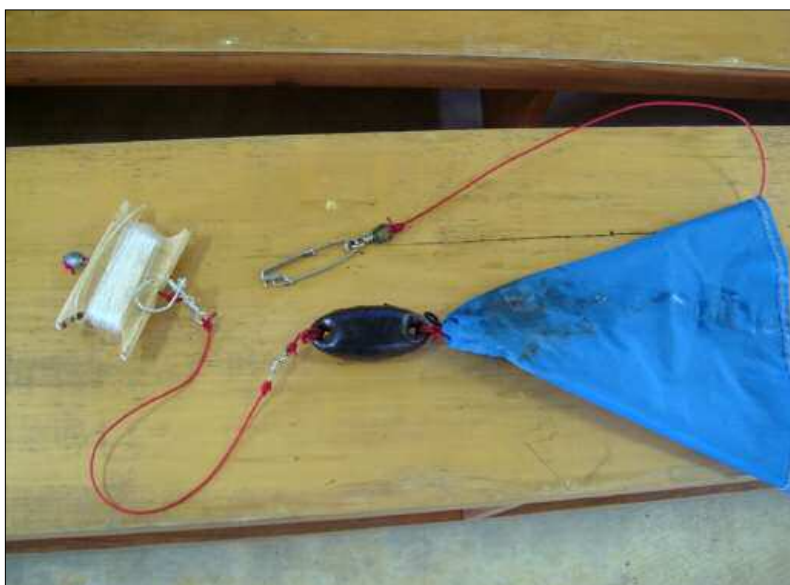


Figure 8 (top): Morgan Magatogia of Niue trying his hand at deep-bottom snapper fishing.

Figure 9 (middle): Mahi mahi and yellowfin tuna caught while trolling at the FAD.

Figure 10 (bottom): Chum bag gear used for mid-water fishing.

improving fishing operations or suggest modifications to the fishing gear to suit their personal preferences.

CATCH RECORDS

Catch records were kept every day by the SOP group. Participants were briefed on the importance of maintaining catch records in logbooks, and on listing information on fish species, number caught, weight, length, fishing area, fishing time, method used, number of hooks used, and tide level.

Trolling at the FAD produced good results. The fish caught were predominantly skipjack tuna (*Katsuwonus pelamis*), followed by juvenile yellowfin tuna (*Thunnus albacares*), mahi mahi (*Coryphaena hippurus*), mackerel tuna (*Euthynnus affinis*), rainbow runner (*Elagatis bipinnulata*), great barracuda (*Sphyrna barracuda*) and wahoo (*Acanthocybium solandri*).

During the deep-bottom fishing sessions (Fig. 12), 108 fish were caught with a total whole weight of 389.6 kg (see Table 1 below).

Vertical longlining was the main fishing method during week three. The total catch of 101 fish, weighing 351.6 k (see Table 2 for details).

Horizontal longlining was the main method used during week four. The catch from this fishing method included a total of four sets conducted in two consecutive days, two sets per day. The catch totalled 12 fish weighing 108.7 kg (see Table 3 below).

During the three weeks of practical fishing, 221 fish were caught, weighing a total of 849.9 kg.

Table 1: Deep-bottom fishing results

Common name	Scientific name	No. of individuals	Combined weight (kg)
Ruby snapper	<i>Etelis carbunculus</i>	55	262.9
Grouper	<i>Epinephalus morrhu</i>	3	3.5
Mahi mahi	<i>Coryphaena hippurus</i>	2	10.2
Dogtooth tuna	<i>Gymnosarda unicolor</i>	1	16.7
Rainbow runner	<i>Elagatis bipinnulatus</i>	3	3
Blue-lined flower snapper	<i>Pristipomoides amoenus</i>	7	3
Longtail red snapper	<i>Etelis coruscans</i>	7	23
Yellowfintuna	<i>Thunnus albacares</i>	3	8.6
Mackerel tuna	<i>Euthynnus affinis</i>	1	1.2
Amberjack	<i>Seriola rivoliana</i>	5	24.4
Green jobfish	<i>Aprion virescens</i>	1	1.3
Rosy jobfish	<i>Pristipomoides filamentosus</i>	14	19.4
Large-eye bream	<i>Wattsia mossambica</i>	5	11.4
Great trevally	<i>Caranx ignobilis</i>	1	1
Total		108	389.6

Table 2: Vertical longlining results

Common name	Scientific name	No. of individuals	Combined weight (kg)
Yellowfintuna	<i>Thunnus albacares</i>	28	198.6
Skipjack tuna	<i>Katsuwonus pelamis</i>	64	107.2
Mahi mahi	<i>Coryphaena hippurus</i>	7	43.1
Rainbow runner	<i>Elagatis bipinnulatus</i>	1	1.2
Mackerel tuna	<i>Euthynnus affinis</i>	1	1.5
Total		101	351.6

Table 3: Horizontal longlining results

Common name	Scientific name	No. of individuals	Combined weight (kg)
Yellowfintuna	<i>Thunnus albacares</i>	4	88
Great barracuda	<i>Sphyraena barracuda</i>	1	1.5
Ruby snapper	<i>Etelis carbunculus</i>	1	7.5
Longtail red snapper	<i>Etelis coruscans</i>	1	4.5
Grouper	<i>Epinephalus</i> sp.	2	5.6
Large-eye bream	<i>Wattsia mossambica</i>	1	0.8
Blue-lined flower snapper	<i>Pristipomoides amoenus</i>	2	0.8
Total		12	108.7

FISH AGGREGATING DEVICE

A fish aggregating device (FAD) was deployed 2 nm southwest of Malo Island in 530 m depth by Nare Wolu, masterfisherman with the Vanuatu Maritime College. The FAD had been in the water one month before the course started and several schools of fish were in the vicinity during the course.

Schools of skipjack schools included individual fish weighing between 1 kg and 6 kg while a school of juvenile yellowfin tuna included fish ranging from 8 kg to 15kg. The deeper yellowfin tuna in the area ranged from 18–50 kg, and several of these were caught using the chum bait fishing method.

PROCESSING THE CATCH

Several onboard demonstrations were carried out to demonstrate the recommended methods for onboard handling of fish for the fish markets according to the buyer's preference. The bulk of the catch was retained on ice for processing at the college's fish processing room where the participants could participate as a group to gill, gut, clean and ice the fish and also record the species and weight of each fish caught.

The participants were briefed on the different methods in which deepbottom fish and pelagic fish are processed and the reasons for processing them this way.



Figure 11: Yellowfin tuna caught using the mid-water chum bait method.

MARKETING

Arrangements for marketing the catches were made by the college's office administration

manager, Norman Davies. Actual marketing was undertaken by Kelvin Talo, the college's senior catering instructor. Fish were sold to local stores,

restaurants, motels and also to college staff



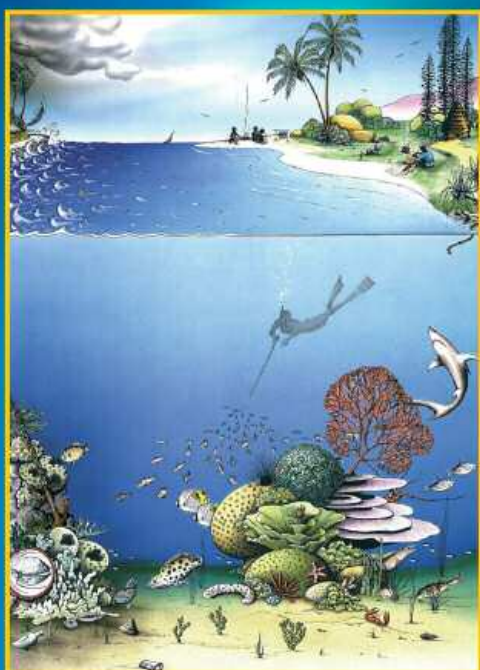
Figure 12: Deep-bottom fishing.

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