Fisheries Newsletter

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Editorial

In this issue of the Fisheries Newsletter, readers will find reports on the activities conducted by the various sections of the Marine Resources Division, in particular the Fisheries Development Section. Our two Masterfishermen kept very busy. William Sokimi conducted a training course in Tonga on the Ministry of Fisheries training vessel, the F/V Takua. As for Steve Beverly, he worked with New Caledonia's Marine Trades Training School on monofilament longline fishing. Longlining is becoming more developed in New Caledonia and so training in fishing techniques is in great demand. You can learn more by reading the in-depth article Steve has written on new developments in this fishery in New Caledonia.

Among this quarter's "high points", we should mention the Training Section's new safety-at-sea initiative, a report on the activities of the DemEcoFish Project and an article by Bob Gillett on the fisheries sector's contribution to the economies of Pacific Island countries.

I hope this summary has whetted your appetite and so I'll let you dive into this issue. As always, your comments on its contents are greatly appreciated.

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Mecki Kronen

Cast netting in Tonga

in This Issue

SECRETARIAT OF THE PACIFIC COMMUNITY
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FISHERIES DEVELOPMENT SECTION

In early October, Fisheries Development Officer, William Sokimi, completed a training and assessment project in Tonga, which was conducted on the Tonga Ministry of Fisheries' training vessel, FTV *Takuo*. An assessment of both the fishing operation and shore-based management was also completed. Several areas were identified where improvements could be made to shore-based management, especially regarding forward planning for slipping and unloading in other countries. These improvements were discussed with Fisheries staff.

Quotes for the provision of materials for the fish aggregating device (FAD) research project in Niue and the Cook Islands were received by Fisheries Development Adviser, Lindsay Chapman, in late October. The successful quote was from Gourock New Zealand, with an order placed for the materials including sea freight to the two project locations already passed.

Fisheries Development Officer Steve Beverly worked with l'Ecole des Métiers de la Mer (EMM) in New Caledonia in late October. During 2001 EMM started a new training module for monofilament longline fishing. The purpose of the module was to offer training endorsements to existing French ticketed captains who were seeking employment in one of the many new longline companies that have started operating in New Caledonia (see feature article).

The domestic fishery was growing rapidly and there were not enough qualified longline skippers to fill all of the vacancies in the industry. French law precludes foreign operators from operating fishing vessels in a French territory so the growth of the fleet and the development of the domestic fishery depended on this training. SPC was requested to give assistance in the practical portion of the module.

Steve provided both classroom materials covering a wide range of subjects pertaining to fisheries in the Pacific, as well as instruction in longline fishing, utilising Marine Marchande's 12 m aluminium catamaran, F/V *Dar Mad*. Captain Lucky Fogliano and First Mate Silivelio Famoetau (Velio) provided valuable assistance to the training as did EMM's Fishing Master Laurent Braud. The six trainee captains were : Bill Brown, Stephane Clain, Jean-Louis Corouge, Christian Cugola, Franck Gnai, and Wilfrid Salua (Fig. 1).

Six day-trips to an area just offshore of Passe de Dumbéa were made on F/V *Dar Mad* over a three-week period, with three trainees going out on each trip. Training was given in the basic parameters of setting and hauling the longline. These included: deciding where to fish, deck set-up for setting the line, course during setting, boat speed during setting, line setter speed, number of hooks in a basket, baiting hooks properly and attaching the snap to the mainline (Fig. 2), safety while setting, record keeping, radio buoy and radio direction finder function, retrieving the line (Fig. 3), securing the line to the reel, unsnapping branchlines, coiling branchlines, pulling floats, coiling floatlines, safety during hauling, boat operating during hauling, and retrieving a broken line. In addition, proper fish handling and preservation techniques, fish cutting exercises, and fishing gear fabrication were incorporated into the training.

During the six longline trips, 46 saleable fish were caught on 1500 hooks, including several large sashimi-grade bigeye tuna (Fig. 4). The overall catch rate for the three-weeks' effort was 3 fish per 100 hooks or 73 kg per 100 hooks, which is above average for the Pacific region. The module was completed in early December and some trainees have already started working with local companies as longline skippers.

At the end of October, Lindsay travelled to Fiji Islands for three

Steve Beverly

Figure 1: Steve and the six trainee captains in front of EMM

weeks to provide input to the development of the Fiji National Tuna Development and Management Plan. This was a collaborative project with the Forum Fisheries Agency assisting the Fiji Fisheries Division in drafting the plan.

Lindsay provided input in the areas of development options, especially for small-scale tuna fishing operations, training needs and infrastructure requirements. During earlier discussions, it was decided that the medium-scale tuna longline fishery was fully developed, so this fishery was not covered in the development options component of the study.

There were 22 companies involved in tuna longlining, with approximately 90 tuna longliners in Fiji Islands, of which around 80 were actually fishing. Companies were expecting another 28 vessels to arrive by mid-2002.

In mid-November 2001, there were roughly 1237 people working on tuna longline vessels, and 68 per cent of those were Fijian. Among skippers and engineers, Fijians accounted for only around 35 per cent, suggesting training was needed in order to increase the numbers of qualified Fijian skippers and engineers.

Other identified training needs included sea safety certification for all crew, training of fisheries staff in fisheries management and other related fields, and the use of one of the Fisheries Division's extension vessels for training in conjunction the Maritime Training School (MTS). The need for a dedicated fisheries training school, as part of the MTS was also identified.

In terms of infrastructure, congestion at wharves and a shortage of wharf space, a lack of

From top to bottom

Figure 2: Setting the line
Figure 3: Hauling the line
***Figure 4: Gaffing and boating a bigeye tuna on F/V* Dar Mad**

[Photos: Steve Beverly]

slipping facilities, and a shortage of suitable land close to the water were all noted.

Suggestions were provided on ways to address these needs, in Suva, Lami and Lautoka. Availability of airfreight space was another restricting factor for the tuna fishery.

At the end of the fieldwork, Lindsay presented his findings to the project Steering Committee. The findings were discussed within the committee and several suggestions or clarification of points were presented by industry members. A final draft report was provided to the Steering Committee in late November for their consideration; the project coordinator will incorporate relevant parts of the report in the plan itself.

William undertook site survey work as part of the FAD research project in Cook Islands in early November. Seven potential sites in Rarotonga and five in Aitutaki had been identified during prior discussions between local fishermen, the Ministry of Marine Resources staff and SPC staff.

In both locations, the method of conducting the site surveys was the same. First, the survey pattern was established for each site, taking into consideration the direction of the wind and swell. The survey pattern was either in an east–west or north–south direction.

Waypoints were logged into a GPS to establish the sequence for each survey. Surveys were conducted on the windward or weather side of the island first, whenever possible, leaving the leeward surveys until last, or doing these when it was too rough on the windward side. For each survey, 81 waypoints were entered into the GPS. This covered the nine legs of the survey, which covered an area or square of 2 nm by 2 nm, with each leg at a 0.25 nm distance to the last.

Weather conditions in Cook Islands were reasonable, allowing all site surveys to be completed on schedule. The information was keyed into an Excel computer programme to plot the bottom topography.

William began conducting site surveys in Niue in late November. It was necessary to launch the hired 7.5 m aluminium catamaran off the wharf each morning (Fig. 5), and retrieve it each evening in the same way (Fig. 6).

Rough weather in Niue meant site surveys took longer to complete than originally planned. Over the course of 10 days, William completed all seven surveys.

Lindsay joined William in Niue in December to undertake an initial community survey, as part of the FAD research project. The community survey gathered information on current fishing activities of households in selected villages. The same survey will be done in 12 and 24 months with the same households. At the end of the project, surveys will be compared to see if there has been a change in

Lindsay Chapman

Figure 5: Launching the project vessel in Niue

Lindsay Chapman

Figure 6: Retrieving the project vessel at the end of a survey session

fishing practice as a result of FAD deployment around the country.

The community surveys were conducted in eight villages around the island, and a total of 150 households were interviewed. Between 42 and 100 per cent of the households were covered in the eight selected villages. Many of the interviews were conducted in Niuean, by fisheries staff, Ms Desiree Tukutama and Mr Jayjay Talagi, who assisted Lindsay in the survey work. This data will be analysed.

TRAINING SECTION

Thirteen trainers of women gathered in New Zealand

A regional course funded by New Zealand was run at the Nelson School of Fisheries from 19 November to 7 December 2001. Designed for people who teach fisheries subjects to women at the grass-roots level, the course attracted thirteen participants from 11 countries and territories, including two male fisheries officers. Many of the participants were highly qualified, making it a challenge for the School of Fisheries to keep topics interesting, while still emphasising the need to focus in-country training at a basic level. The course included three major themes: a one-week block, emphasising communication and teaching skills; seven days on seafood technologies; and a three-day seafood business management workshop, which concluded the programme. Participants also developed resource materials, which they will use when organising in-country workshops.

All participants came with a background in training at the community level, and returned home with an enhanced knowledge of adult teaching techniques and seafood technologies. The course sessions on small business management and fisheries conservation and management will enable the trainers to run wide-ranging workshops for the benefit of communities in their own countries. The SPC Community Fisheries and Training Sections are keen to keep in touch with the trainers, and will remain available to further assist them with their training projects.

Top: *Trainee presenting a farewell gift to NZ School of Fisheries Head Alec Woods*

Right: *Lara Manarangi-Trott (Cook Islands) and Charlene Funaki (Niue) at course closing dinner hosted by NZ School of Fisheries*

[Photos: Michel Blanc]

New materials on vessel safety

A series of new resource materials has been produced as a follow-up to recommendations made at the 6th meeting of the Association of Pacific Island Maritime Training Institutions and Maritime Authorities (APIMTIMA) in March 2001.

The materials developed by the section are intended to promote the use of Safety Management Systems (SMS) by fishing companies in the region. SMS is an active and documented process aimed at reducing the risk of accidents for the crew, the ship and the environment.

Each SMS includes a series of written procedures and records and regular inspections by the authority monitoring the system.

In December, the following materials were distributed to fishing companies, fisheries administrations, and maritime authorities:

- Two information leaflets on SMSs;
- A model SMS for a medium-size longliner; and
- A Safe Operational Plan for small commercial vessels

If you have not yet received the above materials, please contact the Fisheries Training Section at michelbl@spc.int. The model SMS and Safe Operational Plan can be downloaded from the section's website:

http://www.spc.int/coastfish/Sections/training/Training%20material/Training_material_Order.htm

A manual on the co-management of commercial fisheries resources

Following the successful example of commercial fisheries co-management in Samoa, a strategy for the promotion of co-management principles has been developed. This includes the wide distribution of a manual, written by the Samoa Commercial Fisheries Adviser (and former SPC masterfisherman), Peter Watt. The manual is available in both French and English.

In brief

- Following successful workshops in Vanuatu and Tonga, Fisheries Training Section staff are continuing to promote seaweed farming among coastal communities in the region. Using remaining funds from a Taiwan-funded project, the section is developing a video that will promote seaweed farming as a small income earning activity without going into technical details. USP is in the process of filming a technical training video in Fiji Islands, and SPC and the USP videos should complement each other, providing useful resource materials for future workshops.
- Funding has been secured for the 23rd SPC/Nelson Fisheries Officers course, which began on 21 January 2002 at the School of Fisheries. The main donors (New Zealand and the Commonwealth Secretariat) have requested that SPC undertake a review of the course and past participants. It is envisaged the review will be carried out by a consultant and will include visits to several countries that have benefited from the course. Funding of future courses will depend on the review's fundings.

REEF FISHERIES ASSESSMENT AND MANAGEMENT SECTION

The DemEcoFish project is making progress

The MacArthur Foundation-funded DemEcoFish project began with the recruitment of a social scientist in mid-October 2001.

Staff from SPC's Coastal Fisheries Programme, the French Research Institute (IRD), visitors from the University of Newcastle (UK), Agricultural School Rennes (France), and International Marinelife Alliance (IMA) closely cooperated with personnel of the Tonga Ministry of Fisheries headquarters and Ha'apai office to successfully implement the project's pilot research study.

This first survey targeted the two villages and their fishing grounds, namely Koulo and Lofanga in the Ha'apai group of Tonga. The survey took place from the end of November to mid-December last year.

DemEcoFish utilises an interdisciplinary approach, combining socio-economic, ecological and fisheries research. The overall objective is to find indicators, or proxies, to determine fishing pressure, and thus status of reefs (and lagoons) in the South Pacific.

The expected output from data collected from twelve sites, six each in Tonga and Fiji Islands, should allow analysis and understanding of relationships between socio-economic, ecological and fisheries parameters and their combined effects on fishing pressure and marine resource abundance (reef and lagoon) in the South Pacific region. The comparison of sites in Tonga and Fiji Islands will enable the study to examine variations and differences regarding cultural, socio-economic, demographic, geomorphological, and ecological factors.

To achieve the project's objectives, the methodological approaches adopted by all three disciplines involved must be both appropriate and effective. Accordingly, the pilot project sought to test the proposed socio-economic, ecological and fish underwater census methods under field conditions. The pilot project's research methodologies will be further tailored if necessary to ensure they meet the project's special requirements.

The socio-economic surveys of both Ha'apai village communities, Koulo and Lofanga, included: a population census; consumption and extraction of reef fish and seafood at the household, individual and fishermen levels; and marketing and management issues. It was demonstrated that co-operation with local extension and field officers is essential, in particular to organise meetings, and for communication using the local language.

Information on preference and techniques used at fishing grounds was collected from both communites. This information was used to lay out underwater fish and ecological censuses. Over 11 days, the dive teams performed 97 and 34 Underwater Visual Censuses (UVC) of commercial and total species, respectively, mainly using 50 m transect measure-

Mecki Kronen

Fusi Koulo reef gleaning

ments. Weather permitting, both exposed and protected reef sides were covered, mainly including fringing and intermediate reefs. In addition to fish counting, data on habitat structure was collected. Another survey was conducted in the Vava'u island group of Tonga, targeting two village communities and their fishing grounds, from the end of February to the end of March 2002.

Mecki Kronen

Sale of feke (octopus) at Nuku'alofa market

THE CONTRIBUTION OF FISHERIES TO THE ECONOMIES OF PACIFIC ISLAND COUNTRIES

In early 2001 the Asian Development Bank (ADB) expressed growing concern that the importance of fisheries to Pacific Island economies is not fully appreciated by the countries of the region nor by the donor community. In discussions with the Forum Fisheries Agency (FFA) and the Secretariat of the Pacific Community (SPC), ADB developed a concept for a project that would improve the accuracy of estimating the contribution of fisheries to national economies. At a later stage the World Bank agreed to participate in this joint activity.

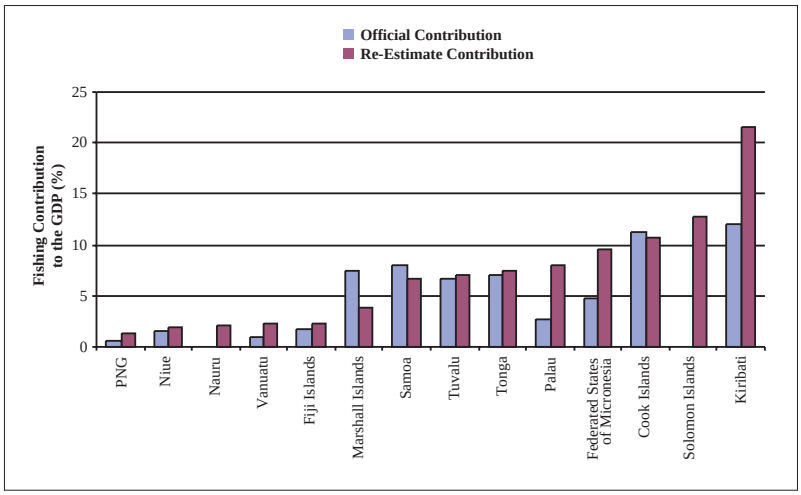
The project initially focussed on the fisheries contribution to gross domestic product (GDP), including identifying this contribution, examining the methods used by national authorities in the calculation, commenting on the validity of these methods, and producing an independent estimation of the fisheries component of GDP for each Pacific Island country.

Information was also compiled on specific economic benefits of fisheries, including contributions to employment, exports, government revenue and nutrition. The study's report indicates the official contribution and re-estimated contribution of fishing to GDP in Pacific Island countries (see figure on the left).

The report also made estimates of the volumes and values of catches in each Pacific Island country. Estimates of the value of the catches in four categories are given in the table below. Information is also given for each Pacific Island country on the fisheries contribution to government income, exports, employment and nutrition. The report will printed by ADB in April/May and be available from ADB as:

> Gillett, R. and C. Lightfoot (2002). The Contribution of Fisheries to the Economies of Pacific Island Countries. Asian Development Bank, World Bank, Forum Fisheries Agency, Secretariat of the Pacific Community.

(Source: Gillett, Preston and Associates)



	Subsistence fishing (USD)	Coastal commercial fishing (USD)	Offshore locally based (USD)	Offshore foreign based (USD)	**Total (USD)**
Fed. States of Micronesia	10,000,000	14,500,000	12,495,000	144,000,000	180,995,000
Papua New Guinea	20,227,167	21,394,119	44,344,173	75,073,907	161,039,366
Kiribati	7,890,322	6,309,677	0	132,258,065	146,458,064
Solomon Islands	8,061,016	1,901,573	69,242,058	826,771	80,031,418
Fiji Islands	24,675,061	15,231,519	25,639,724	554,935	66,101,239
Marshall Islands	3,836,000	973,000	0	50,000,000	54,809,000
Tuvalu	931,097	283,871	0	38,000,000	39,214,968
Nauru	331,774	1,117,742	249,677	36,774,194	38,473,387
Samoa	7,142,999	6,582,647	9,840,376	99,236	23,665,258
Tonga	3,992,122	10,855,633	3,676,379	103,789	18,627,923
Palau	2,500,000	2,595,000	12,500,000	270,000	17,865,000
Cook Islands	1,164,268	10,319,644	396,909	407,494	12,288,315
Vanuatu	3,974,587	681,801	0	253,087	4,909,475
Niue	167,041	50,804	0	4,234	222,079
Total (USD)	94,893,454	92,797,030	178,384,296	478,625,712	**844,700,492**

BULL MARKET IN BLUEFIN TUNA AQUACULTURE

You might think you are hearing the soundtrack to an old cowboy movie or have just awakened in the heart of cattle country at roundup time, but that line could be a new slogan for a tuna industry starting to find its own home on the range.

Around the world, fishermen facing declining quotas for high-quality bluefin tuna are discovering that one way to maximise the return on their reduced catch is to add value to it, only in a novel way: catch 'em live and fatten 'em up.

That's what Australian tuna fishermen have done in a big way. Concerned over the sustainability of the species, fisheries managers and the industry established quotas in 1984 to limit the tonnage of fish caught to 14,500 metric tonnes. That was reduced to 6,250 mt in 1988 and 5,265 mt in 1989. These days, things are different. The wild-catch tonnage caught has stabilised at that set in 1989, and a Convention for the Conservation of Southern Bluefin Tuna has been established by Australia, New Zealand and Japan.

Fish from the Down Under combo of wild catch and aquaculture are sold exclusively in the high-value Japanese sashimi market with prices averaging USD 1,200 per fish. By adding value through tuna farming, operators increased the value of their catch from USD 12.5 million to USD 252 million in 2000.

The notion of capturing bullion tuna and holding them for the market has been around for a quarter of a century. It started in St Margaret's Bay, Nova Scotia, in 1976 but stopped a few years later when the giant Atlantic bluefin tuna altered their migration path. Since then, various forms of bluefin aquaculture have been developed, the best known in Port Lincoln, Australia, but with operations spread around the world in Croatia, Malta, Morocco, Spain, Portugal, Japan and Mexico.

In almost all the cases, proponents of the tuna-growing industry have been commercial fishermen and vessel owners. Roger Hillhause, co-owner and pilot for the 150-foot tuna seiner *Connie Jean*, has been working with Mariculture Norte in Ensenada on the Baja Peninsula in Mexico. His partner in the boat, Leonard Engrande, is a stockholder in the company. Hillhause says the aquaculture business has been slow getting off the ground, but all the pieces of the puzzle are starting to come together, from the Mexican boats and fishermen catching sardines for the tuna feed to the equipment.

"Mariculture Norte has really established a nice plant now" says. "There are 10 big holding pens plus three or four towing pens, that follow us around. It is all done fresh. They slaughter them in the morning and cool them off, and by the next day or so they are in Japan." (The Ensenada operation has a marketing advantage over numerous other tuna-penning locations because of its proximity to the Los Angeles airport with its 19 flights a day directly to Tokyo.)

More international operations are getting started on the Mexican side of the border. "An Australian company is opening a new one in the Coronado Islands, and there are several other permits in the making," Hillhause says.

Speaking at the 19th Annual Fisheries Week of the Azores last year, Professor François Doumenge, director of the Oceanographic Museum in Monaco, reported that farmed bluefin production had increased exponentially from 4,130 mt in 1997 to 17,750 mt in 1999. (The numbers are in dispute. Last December, Fish Information & Services (FIS) reported that farmed tuna production was likely to exceed 14,000 mt in 2000.) Doumenge, an authority on bluefin aquaculture and economic development, has been researching tuna since the early 1960s and estimates that in the future, 80% of the world's bluefin could come from aquaculture. "What we see now is the start of the phenomenon," he said. "Tuna aquaculture is up and running at prices that are profitable. In the next two years, tuna aquaculture will develop."

Rich Ruais, executive director of the East Coast Tuna Association, cites two benefits of catching wild tuna and pen rearing them before slaughter: controlling the fat content in the fish through feeding, and then using quicker killing methods than are possible in wild fisheries. "It makes a much more valuable product. When you use a purse seine, a product is only worth so much. When you draw the seine net up and the fish die violently, they build up lactic acid. If you make the transfer to a cage and use a better method of killing the fish, like the Spanish do with a spear gun where the fish

is killed and shocked and in minutes the fish is in a slurry ice, you've got a prime product."

Fishermen around the world may be participating in bluefin aquaculture, but it is not likely to be permitted in the United States, says Ruais. "It looks very bleak, unfortunately, for U.S. fishermen. We have a regulatory process that presents formidable obstacles." He cites various branches of the National Marine Fisheries Service, the Endangered Species Act, and state and local regulations combining into too thick a morass for anyone without the deepest of pockets to wade through. "I would say most fish groups find our government hostile to modern developments like this, whereas in other countries like Spain, Croatia, Morocco, and others they are more sympathetic and pro-industry than in the U.S.," he says. "I would wish someone well in trying, but they better be prepared for a tremendous battle and a very expensive one."

Tuna farming is a moot issue for West Coast fishermen, even if permits were possible. Hillhause doubts that enough bluefin come far enough north off California to make penning practical in U.S. waters.

Rex Ito at Prime Time Seafood says the Australian production is meeting a market space in Japan for a high-grade bluefin for the supermarket trade. Keeping the fish in the pens until they are at their prime is the ticket to getting high prices, he says. "You're trying to get peak colour and fat content. When the pen is ready to harvest, it is like a ripe fruit, the fish at a perfect point in their development."

The Australian bluefin is mostly going to Japan frozen, Ito reports. "Instead of going to fresh, they super-freeze them. The value is almost the same as fresh once you take out the shipping costs and ups and downs of the market," he says.

Ito says it is the reliability of supply and consistency of quality that make farmed bluefin popular, but it is bound for supermarkets and will never replace free-range bluefin in the very top echelon of the market. "The true connoisseurs still prefer a wild fish, as they prefer a wild salmon. The muscle and meat structure is not the same from a pen 50 feet across compared to thousands of miles of ocean. Consumers complain about the meat structure and say the fat doesn't taste right."

The wild bluefin still gets the top price, too, he points out. "When a farmed Australian is going for 3,000 yen per kilo, in the same day a fancy wild bluefin from the East Coast or Spain with good fat will go for 6,000 or 7,000 yen per kilo," he says. "It is just a different product; it is not in the same size class, and it is also natural."

Whether tuna farming will serve as a model for farming other species, such as black cod and halibut, remains to be seen; but fishermen in many fleets have a definite success story to ponder as they contemplate the future of their industry.

(Source: Pacific Fishing, August 2001)

LONGLINE MORATORIUM, LARGE VESSEL AREA CLOSURE PROPOSED FOR AMERICAN SAMOA

The Western Pacific Fishery Management Council in October voted to recommend that the National Marine Fisheries Service (NMFS) implement emergency regulations to stop new entry of U.S. longline vessels over 50 feet in length from fishing in American Samoa.

Under the proposed regulations, longline vessels that do not hold a longline permit and have not documented a catch prior to 25 October 2001, would not be able to fish in the U.S. Exclusive Economic Zone (EEZ) around American Samoa. This moratorium would remain in effect until a limited entry program is implemented.

Henry Sesepasara, fisherman and advisor on American Samoan culture, emphasised the need for this action due to the American Samoa community's cultural dependence on fish. This constant demand has been met through a fleet of 30-foot, open-decked catamarans, known as alia. A rapidly expanding fleet of longline vessels larger than 50 feet in length now threatens the local supply.

This large-vessel segment of the longline fleet has grown from only three vessels in 2001 to more than 22 large vessels today. More are expected to join this segment of the fleet in the near future.

Compared to the small alia, these large longline vessels have much greater fishing power: two to three times the number of hooks, longer longlines, longer fishing time per set and greater holding capacity.

As a consequence of the rapid expansion, the potential fishing

effort around American Samoa has increased from less than 500,000 hooks during the first quarter of 2001 to 1.8 million hooks during the third quarter of the year. Because the EEZ around American Samoa is relatively small and surrounded on all sides by foreign EEZs, this expansion could deplete the local availability of tuna stocks.

The proposed moratorium would be an additional safeguard beyond the area closure for large pelagic vessels (i.e., larger than 50 feet overall) proposed by the Council at its June 2000 meeting. Specifically, the Council recommended closing the area approximately 50 nautical miles around the islands of American Samoa to large vessels fishing for pelagic management unit species.

(Source: Pacific Islands Fishery News, Winter 2002)

SUSTAINABLE WAY TO HARVEST SHARKS

Lovers of sharks and shark-fin soup can both relax. Economists have worked out a sustainable way to fish the species, and it should appease both conservationists and soup connoisseurs.

Thanks to the burgeoning Far Eastern trade in fins for soup, sharks are one of the most valuable food items in the world, says Quentin Fong of the University of Alaska in Fairbanks. Demand in the Hong Kong market, which handles some 3000 tonnes of fins a year, is so great that the best fins sell for more than USD 400. They provide the much-prized noodle-like cartilage that thickens and flavours Chinese soups.

But because sharks are slow to mature and only produce a few offspring at a time, their populations are vulnerable to overfishing. Many are slaughtered for their fins alone, long before they reach reproductive age. For instance, most sharks caught off the shores of West Africa are younger than two years. Conservationists say that the fin trade is threatening the survival of some species, and that the sharks should be allowed to grow up and reproduce before being caught.

Now help is at hand from an unlikely source: economists. Fong has combined ecological and market data on sharks and demand for their fins to create a single "bioeconomic" model for the shark trade.

Optimum solution

Because Chinese chefs will pay more for the long strands of cartilage in larger fins, Fong says that fishermen could maximise profits by allowing sharks to reach adulthood before they are caught. In economic terms, if the sharks are left for longer than that they become an increasingly wasted asset. But if caught any younger, they will not fetch such a good price.

Fong's analysis concentrates on the blacktip shark (*Carcharhinus limbatus*), one of the most widely harvested species. It grows to about 2 metres in length and is, according to the World Conservation Union, highly vulnerable to overfishing.

The economically optimum solution for the blacktip is to allow them to mature to around 10 years old. This is only early middle age for the blacktip, which could expect to live to around 20 years, but it is getting on for twice the age at which it starts to reproduce.

It all sounds good in theory, but there are few effective controls on shark fishing anywhere in the world. So the lure of an instant return—plus the fear that if the small sharks are thrown back somebody else will catch them—means sensible economics usually goes out of the window. The solution is for countries to start enforcing a tough fisheries management policy, says Fong. That might mean setting a minimum size for sharks that can be caught for their fins, for instance.

(Source: New Scientist.com, 30/01/2002)

INDO-PACIFIC SOFT CORALS AND SEA FANS

Soft corals and sea fans (Cnidaria: Octocorallia) are found in almost all marine habitats from equatorial to polar regions, and from the intertidal to the abyss, with the Indo-Pacific tropical shallow water reefs as their centre of diversity.

About 85 genera belonging to 22 families have so far been recorded in the warm shallow waters of Australia, where they repre-

sent an important component both of the reef and inter-reefal seabed fauna. The number of octocoral species presently can not even be approximated, because like so many other tropical marine phyla, an unknown proportion of species awaits taxonomic description or revision.

Soft corals and sea fans comprise a wide range of taxa with drastically different ecological characteristics. They are animals, yet like plants they are inescapably subject to the physical environment in which they settled as larvae. Thus the abundances of many taxa are subject to relatively strong control by their physical and abiotic environment. Some kinds of disturbance, such as prawn trawling or cyclones, probably affect a majority of shallow-water species, whereas taxa vary widely in their sensitivity and tolerance ranges to sedimentation, freshwater and nutrient run-off. Some of the more long-lived species are presently being investigated as potential bio-indicators for changes in nutrient and sediment levels in coastal waters. Some taxa produce bio-active substances for protection against predation and fouling, which have attracted the attention of biochemists in the quest to find new pharmacologically valuable substances.

Despite their conspicuous nature, abundance and potential economic benefits, very little is known about their biology and ecology. For example, it was discovered only about five years ago that the diet of soft corals, unlike that of their carnivorous hard coral relatives, consists of phytoplankton and other microscopic particles suspended in the water column (Fabricius et al. 1995). However, many soft corals, like the hard corals, contain symbiotic algae (zooxanthellae) in their tissue, and thus also bleach and die when sea temperature rises one or two degrees above normal summer maxima.

Katharina Fabricius, a coral reef ecologist at the Australian Institute of Marine Science, and Phil Alderslade, Curator for Cnidarians at the Northern Territory Museum in Darwin, have now completed the first comprehensive guide to shallow-water reef-inhabiting octocorals. The readers targeted are people involved in research, monitoring and management of coral reefs, as well as tourist divers, seawater aquarium owners and other interested lay people. The book presents plates of underwater photographs of genera, together with sclerite drawings, and a page of easy-to-understand descriptions and remarks on their ecology and distribution. The focus is on species of the Australian Great Barrier Reef and surrounding soft bottom habitats. However, as many of the genera have a very wide distribution, the guide is also of use in the Indo-Pacific including Japan and all over the tropical East African coast and Red Sea.

Soft Corals and Sea Fans. A comprehensive Guide to the Tropical Shallow-Water Genera of the Central-West Pacific, the Indian Ocean and the Red Sea. K. Fabricius and P. Alderslade. 272 pages. Price is AUD 66.00 (including GST) plus AUD 9.00 postage within Australia.

Available from AIMS Bookshop,

phone: +61 (0)7 47534409,
fax: +61 (0)7 47716138 or
email: bookshop@aims.gov.au

(Source: Waves, the Marine and Coastal Community Network, Vol. 8, Number 2, Spring 2001)

NEW DEVELOPMENTS IN NEW CALEDONIA'S LONGLINE FISHERY

by Steve Beverly,
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New Caledonia has been a sleeping giant in terms of domestic longline fisheries development. In 1983 there was only one registered domestic longliner, which landed about 60 tonnes of fish. By 1999 the fleet had grown to 13 vessels with annual landings of about 1800 tonnes of tuna and other species.

Unlike in some Pacific Island countries and territories, the exploitable resource and the available support infrastructure in New Caledonia have been underutilised. The total landed catch of all longline species could possibly be increased to 10,000 tonnes annually without overexploiting the resource. In fact, in 1962, the Japanese longline fleet landed over 11,000 tonnes of all species fishing from forty boats in the vicinity of New Caledonia.

New Caledonia has an EEZ of 1,740,000 km^2, which borders the EEZs of Australia, Solomon Islands, and Vanuatu (Fig. 1). The EEZ also borders large areas of international waters to the southeast and southwest. The total land area of New Caledonia is 19,103 km^2 and the estimated population at mid-year 2000 was 212,700 inhabitants.

Development of a domestic longline fishery geared to exporting fresh fish is dependent on the development of a tourist industry with regular flights going to Japan and elsewhere. The most important component of infrastructure for the commercial longline fishery in the Pacific, aside from wharves and harbours, is availability of air cargo space so that fresh fish can be delivered to the main markets — Japan, USA, and Europe.

New Caledonia has well developed wharves and harbours and has a developing tourist industry, several flights weekly to Japan (five to Tokyo and two to Osaka) typically with about sixty tonnes of available cargo space.

By the end of 2001, this component of local infrastructure was underutilised by the fishing industry. So far, fish stocks and air cargo space have not limited domestic longline development in New Caledonia. Up until now, there just hasn't been much development.

In contrast to New Caledonia, Fiji Islands and Australia to the west both have well-developed longline fisheries. Fiji Islands, which started modestly in the early 1990s with only a handful of boats landing less than 100 tonnes, now has a fleet of over 100 boats landing approximately 10,000 tonnes annually of tuna and other species. Most of the Fiji's catch is destined for Japanese and US markets and the canneries in Fiji Islands and American Samoa. Fiji Islands registered boats have started branching out by fishing under access agreements in Vanuatu's EEZ.

The longline fishery in eastern Australia has had a similar history of rapid growth. Prior to 1995 the eastern Australian longline fleet consisted of a few boats catching around 30 tonnes annually. Today the fleet fishing out of Mooloolaba in Queensland has over 125 boats and lands over 2000 tonnes of broadbill swordfish annually, most of which goes to US markets. The Mooloolaba longliners fish for broadbill swordfish in Australian and international waters bordering New Caledonia's EEZ. Recent trends in New Caledonia are showing that the domestic longline fishery may be on the

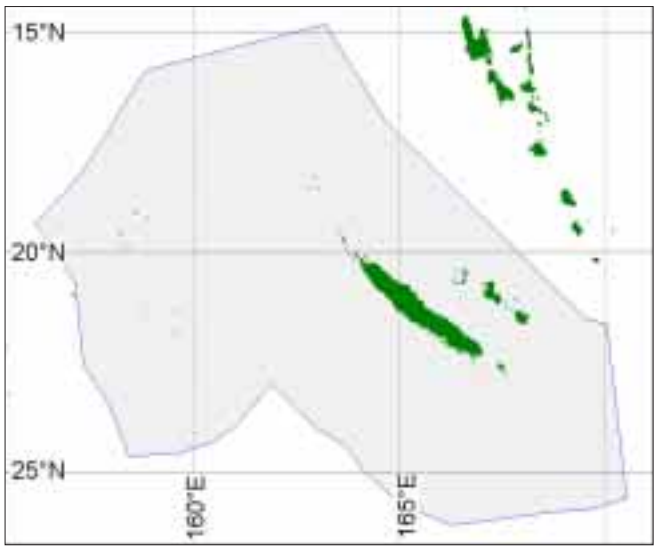

Figure 1: New Caledonia's EEZ

verge of a rapid growth cycle similar to what happened in Fiji Islands and eastern Australia.

The 13 New Caledonian boats fishing during 1999 in New Caledonia all belonged to the same company, Navimon, based in Noumea. During 2001, Navimon sold one of their vessels and another was lost on the reef, reducing their fleet to 11 vessels. Navimon was the only company in New Caledonia during the late 1990s since two predecessors, Megu Caledonia and Toho Caledonia, finished operations.

Four new companies, however, started up during 2001 and more are in the planning stages. By the end of 2001 the fleet had grown to 18 vessels. The domestic longline fleet in New Caledonia could number up to 40 vessels by the end of 2002 and the total landed catch, including tunas and broadbill swordfish, could be around 6000 tonnes. The potential annual catch of all longline species could be 10,000 tonnes or more.

The four new longline companies include:

- Albacore, with one boat delivered in 2001 and another two coming in 2002;
- Pêcheries de Nouvelle-Calédonie, with six boats in 2001, ten boats by early 2002, and a processing plant at Koumac completed in 2001;
- Pescana, with eight boats planned for 2002 and a processing plant at Quai de Pêche in Noumea completed at the beginning of 2002; and
- Sodefish, with one boat built in Fiji Islands for early 2002 delivery and a processing plant at Quai de Pêche completed in 2001.

The New Caledonian company, Albacore, ordered a brand new longliner built in Tasmania, Australia by Allan Barnett Fishing Co, capable of freezing albacore on board for the canneries as well as storing fresh sashimi grade bigeye and yellowfin tuna for the Japanese market.

F/V *Yellowfin* (Figs. 2 and 3) is the first of three steel 20 m longliners that Albacore will have operating by the end of 2002. F/V *Yellowfin* began fishing in late 2001 and so far, according to Captain Soane Mataila, the results have been promising. F/V *Yellowfin* is 20 m LOA, 7 m beam, and 3 m draft. It has three RSW holds with 5 tonnes each capacity, a two tonne blast freezer, a thirty tonne holding freezer, and two, two-tonne bait freezers. The main engine is a 470 HP Caterpillar 3406.

Figures 2 and 3: F/V* Yellowfin *[Photos: Steve Beverly]

Another new longline fishing company in New Caledonia had its origins in Tahiti. The president of the company, Claude Favy, also began his career in longline fishing in Tahiti. Claude and his partner, Mr Michel Friederich, were hydraulic engineers working on a hydro-electric project in Tahiti. Part of the project involved importing very large steel pipes from France. Claude and Michel figured out a way to make the pipes in Tahiti and saved millions of CFP on freight alone. With the money gained from that venture, they bought an entire fleet of longliners from a company that was having financial troubles, and organised Compagnie des Clippers du Pacifique Sud. By the late 1990s, there were too many boats fishing in Tahiti, so they decided to move the fleet to New Caledonia. The first boats arrived in Koumac, Northern Province, in March 2001. After that they began arriving two at a time from a New Zealand shipyard, Q-West Boat Builders in Wanganui, that was commissioned to stretch them from 16 m to 19 m and do complete re-fits.

Figure 4 (top): F/V* Karaavha 8 *leaving for a fishing trip
Figure 5 (bottom): Unloading fish from F/V* Karaavha 3 *at Koumac

[Photos: Steve Beverly]

The new company is called Pêcheries de Nouvelle-Calédonie (PNC). PNC is a joint venture between Claude and Michel, Sofinor (the nickel mining group in Northern Province), and the government of the Northern Province in New Caledonia. *Karaavha 10*, one of the first two PNC boats to arrive in 2001, is unique in that it is constructed of fibreglass and fitted with a Lindgren-Pitman (USA) longline system. All of the other *Karaavhas* (Figs. 4 and 5) are aluminium of the same design and fitted with Bopp (France) longline reels and line setters.

Each boat is capable of setting up to 2000 hooks per day and eight sets per trip. The fish holds will carry up to ten tonnes of iced fish. PNC has a ten-ton-a-day flake ice machine on the wharf and each boat will soon have its own on-board ice machine.

Besides the fleet of longliners, PNC operates a processing plant adjacent to Pandop Marina in Koumac (Fig. 6), where the fleet is based. PNC also has a small processing plant at Quai des Scientifiques (Scientists' Wharf) in Noumea for local sales and distribution. The plant at Pandop was completed during 2001. It is well appointed and has been HACCP certified but is still awaiting EU approval for exporting products to EU countries. The plant has a receiving and

chilling room, cutting room, packing room, and cold storage for packed fish cartons, as well as ample office space to administer and manage the fleet and plant. All incoming fish are either hung on a steel rack (Fig. 7) or packed in ice on pallets in the chill room (0ºC) until their fate is decided. Albacore are finned and cleaned before being packed in ice.

They are later trucked to Noumea where they are frozen and containerised for shipment to one of the canneries in Pago Pago. Sashimi bigeye and yellowfin are weighed and graded before being packed in wet-lock cartons for shipment to the Japanese market, or are iced if packing is to occur the following day. Byproduct species such as opah, mahi mahi, and wahoo can be cut at the plant in Koumac or shipped to PNC's other facility in Noumea, where they are processed for the local market. All fish are trucked to Noumea in refrigerated trucks using a private transport company. The advantage of being located in Koumac is that the fleet is closer to some of the better fishing areas. The disadvantage is that the processing plant is four hours away by road from Tontouta International Airport, the link to the Japanese market.

Pescana is another new joint venture company operating in New Caledonia, but this time with a foreign interest. The partners are a long established fishing company from New Zealand, Sun Fish, and a New Caledonia shipping company, Sofrana, who have joined forces as Pescana. Pescana has a new processing plant in Nouville (Fig. 8), situated beside Navimon's processing plant. According to the Director, Mr Bernard Nazaire, Pescana's plan is to have a fleet of at least eight longliners operating sometime in 2002. Pescana also plans to

Figure 6 (top): Part of Pêcheries de Nouvelle-Calédonie's fleet in Koumac
Figure 7 (middle): Processing albacore tuna at Pêcheries de Nouvelle-Calédonie's plant in Koumac
Figure 8 (bottom): Pescana's new processing plant at Quai de Pêche, Nouville

[Photos: Steve Beverly]

process fish for other independent operators.

Pescana's plant in Nouville is state-of-the-art for fresh fish processing plants. All fish will be delivered from the boats docked at Quai de Pêche in insulated boxes in a slurry. After weighing and grading, the fish will either be processed as fresh export fish and packed into wet-lock cartons or will be further processed for the local market.

Pescana has engaged a professional fish grader from Australia, Mr John Streets. John was trained in Japan and will pass his knowledge of fish grading on to a local counterpart over the next three years. The packing room features a gel ice machine (Fig. 9) capable of producing thousands of 1 kg packs of gel ice per day, sealed in leak-proof polyethylene pouches.

The plant will comply with all HACCP and EU standards for export packing houses. In addition, Pescana has installed a 25-ton a day flake ice machine (Fig. 10) that has an auger delivery system capable of delivering ice directly to the fish holds of the longliners. This is a first for Noumea. Pescana will not only supply ice to their own fleet but will be marketing ice to other fishing boats.

In August 2001 SPC's Fisheries Development Officer, Steve Beverly, visited Alloy Fabricators boat building yard in Lami, Fiji, along with the owner of Sodefish and the captain of the new boat being built for Sodefish (see SPC *Fisheries Newsletter* #98).

The boat, F/V *Warren* (Figs. 11 and 12), is now completed and was recently ferried to Noumea. Owner Pita Mourin and Captain Stephane Gil reported that the trip over from Fiji was a real test of the boat. They encountered winds of 45 knots and eight-metre seas during most of the five-day voyage. According to Pita and Stephane, F/V *Warren* performed very well.

F/V *Warren*, which was named after its designer, Warren Ellcot, of Tahiti, is 18.78 metres long with a beam of 5.8 metres and a draft of 2.2 metres. It is powered by a Cummins 380 HP diesel engine. The wheelhouse electronics include a MaxSea system that is operated by a PC.

The software package includes a plotter with chart cards showing bathymetric data in 3D and a receiver that can download weather and oceanographic information. The fishing gear

Figure 9 (top): Pescana's gel ice machine
Figure 10 (bottom): Pescana's 25-ton-a-day flake ice machine

[Photos: Steve Beverly]

***Figures 11 and 12: F/V* Warren**

[Photos: Steve Beverly]

consists of a Smart Reel and line setter made in Fiji by Seamech Hydraulics. All fish will be chilled in a refrigerated slurry box on deck before being packed in ice in the fish hold.

Even though the Warren is Pita Mourin's fist venture into longline fishing, he is not new to fishing in New Caledonia. He has a 12 metre bottom longliner, F/V Thalassa, that has been one of the most successful snapper boats fishing out of Noumea. He and his wife, Maggy Maillet, market all of their snapper and other species from a stall at the local fish market at Port Moselle in Noumea. They also have a new processing plant located at Quai de Pêche that is HACCP and EU certified so they will soon be exporting fresh and value added fish to foreign markets. Pita's future plans include ordering more boats similar to Warren, but longer by four or five metres.

More boats are on the way and it will be very interesting to see how longline fishing develops in New Caledonia during 2002. All of the new players will be building on experiences learned from the pioneers and they should do well. The resource and the infrastructure are there. The only thing missing is qualified captains and engineers to man the growing fleet but this problem is being addressed by l'Ecole des Métiers de la Mer. The development of longline fishing in New Caledonia will bring with it not only investment and foreign earnings but jobs for locals as more people are trained and gain experience. The future looks bright for domestic longline fishing in New Caledonia.

COURSE ON ALTERNATIVE APPROACHES TO FISHERIES MANAGEMENT: THE RELEVANCE OF CO-MANAGEMENT

by Peter Van der Heijden, International Agricultural Centre, Wageningen, The Netherlands

Introduction

Fishers and professional staff working in fisheries management and development face intractable problems such as declining fish stocks in coastal and inland waters, deteriorating aquatic habitats, declining standards of living among many resource users, enduring conflicts between stakeholders and reductions in government budgets and staff.

The usual approaches to fisheries management—based on centrally made decisions regarding regulations, and attempts to enforce these regulations by local authorities—often have limited effectiveness in resolving these issues. There is an ongoing search for alternative approaches to fisheries management. The co-management approach, which seeks the collaboration of resource users, government and other stakeholders in one management framework, could be a suitable option in some situations.

In co-operation with Wageningen University, the International Agricultural Centre will organise the third international training course 'Alternative approaches to fisheries management; the relevance of co-management' in October 2002. This seven-week course will be aimed at staff of fisheries departments, and development, educational and research institutes working in fisheries management and towards development of fishing communities. The course will give participants the chance to reflect on current and traditional fisheries management approaches, and learn about new approaches to fisheries management. Special attention will be given to co-management, and its advantages and disadvantages, preconditions and consequences for institutions and communities. Attention will be given to both social and fisheries science aspects of fisheries management.

Course focus

The training course focuses on managing the exploitation of wild aquatic resources, especially fish, shrimp and shellfish stocks found in lakes, reservoirs, rivers, coastal areas and the sea. One of the primary tasks of fisheries management is to balance the pressure resulting from the exploitation of fish stocks and other components of the marine ecosystem with the limited capacity of natural populations to compensate for losses due to harvesting.

Information about fish and fisheries is crucial for management. The use of indirect methods and complicated scientific models to assess the size and nature of the fish population is necessary due to the "hidden" nature of the resource. The conclusions from scientific research on natural fish populations have a certain margin of error and uncertainty and can cause heated debates between the concerned parties. Information about the size, characteristics, and catch/effort are essential but data collection systems are often expensive. The information needs for resource management, methods of collecting information from stakeholders, and the quality of various types and sources of information are important topics in this training course.

Experience has shown that centrally made regulations and plans to manage fisheries are only seldom successfully implemented and enforced at the lowest levels, especially in countries with large fisheries sectors and limited budgets for fisheries. Decentralisation and a greater role for the resource users in design, implementation and enforcement are often recommended as a way forward.

The course will assess the characteristics of various approaches to management and link the success or failure of these to the characteristics of the fisheries and stakeholders. The conditions for successful involvement of resource users in fisheries management (co-management) are studied. The consequences of choosing a co-management approach, and the steps to be taken when a more participatory way of management is opted for, will be highlighted.

Training methods

This interactive course is based on actual work situations. Participants present the fisheries management situations in which they work; these then underlie course activities. There are also lectures, small workshops, role-playing activities, excursions and individual work sessions. Case studies are used

as models to illustrate the effects and impacts of different management approaches and practices. Short excursions and fieldwork in a rural community are used to acquaint participants with the concepts of participatory appraisal and planning. Case materials are used as an introduction to real-life management practices in the Netherlands.

Using new insights and information, participants work on individual and group assignments. These activities lead to the formulation of individual action plans for the various organisations represented. Typically, these address modes of operation, strategies, policy and organisational structure.

The training course is organised in cooperation with the Fisheries Section of the Fish Culture and Fisheries Group of Wageningen University and the Law and Governance Group of Wageningen University. The programme is composed of four parts.

Part 1: Fisheries management: views, objectives and approaches

In the first module the focus will be on the various disciplines involved in fisheries management, on the various views, objectives and approaches of the people working in fisheries management. The characteristics of various fisheries systems will be discussed, and course participants will present the main issues and problems affecting their work.

Some of the topics in this part include:

- the perspectives of the biologist, the economist and the social scientist on fisheries management;

NEW OCEAN RESOURCES MANAGEMENT COURSE FOR REGIONAL FISHERIES PERSONNEL CLOSE TO FINALISATION

Under the auspices of the United Nations Division for Ocean Affairs and the Law of the Sea (UN/DOALOS), the University of the South Pacific (USP) and the South Pacific Regional Environment Programme (SPREP), through the International Waters Programme (IWP), have been working with the Fisheries Department of the Food and Agriculture Organization (FAO) to produce a new short course that focuses on ocean resources management, principally the Code of Conduct for Responsible Fisheries. The first course will be held at USP in Suva in June 2002.

The first course, which has been developed under the Train-Sea-Coast initiative of the Global Environment Programme, will train up to 20 participants from the region. The principal target group for the course is middle-level managers working in the fisheries administrations of Pacific Island states. A small number of places are also reserved for representatives from NGOs and the private sector.

Staff from USP, FAO and SPREP and other experts will serve as resource personnel for the course with advisory input from the Forum Fisheries Agency (FFA) and SPC. The course outline is:

Module 1: Management Advice
Module 2: Management Polices, Strategies and Plans
Module 3: Managing Legal Issues
Module 4: Stakeholder Roles
Module 5: Regulation and Monitoring
Module 6: Administrative Functions — Management of a Fisheries Administration

The final planning session for the course is scheduled for early March. Once arrangements are finalised, FFA member countries will be approached to nominate participants for the first delivery in June. Additional information on this programme is available from Drew Wright, Project Manager, International Waters Programme at SPREP (DrewW@sprep.org.ws) or Michel Blanc, Fisheries Training Adviser at SPC (Michelbl@spc.int).

The Train-Sea-Coast (TSC) Programme was launched in 1993. It is the primary instrument through which UN/DOALOS aims to strengthen the existing capabilities of qualified training and educational institutions — such as USP — with responsibilities for capacity building in the field of coastal and ocean management. Other courses that have been developed through the TSC Programme include: management of marine protected areas; the role of women fishers within coastal communities; marine pollution control; Law of the Sea and ocean policies; integrated coastal zone management; exchange and inter-relationships between the river basins, coastal lagoons and adjacent marine areas; identification of coastal and marine sensitive areas; nutrient pollution from agriculture; and approaches to conflict management in ocean and coastal management.

- fisheries systems and characteristics: the problem of scale;
- the main issues and problems affecting participants' work; and
- approaches to fisheries management.

Part 2: Information — a crucial component of fisheries management

In this part, the focus will be on assessing what information is needed for fisheries management, and how this information can be collected, analysed, presented and distributed. It will also examine the value of various kinds of information present among stakeholders.

Some of the topics that will be discussed include:

- socio-economic and catch/effort information needs;
- variance and uncertainty in fisheries outcome; and
- information management and flow.

Part 3: Tools for fisheries management

This part will focus on various tools and methods for the management of various fisheries systems. The tools deal with the collection of various types of information, the protection of vital components of the aquatic ecosystem, management of conflicts, and the effects of activities and developments taking place outside the fisheries sector.

Some of the topics to be discussed include:

- conflict management;
- protected and closed areas;
- fisheries management as an element of integrated area management;
- stakeholders analysis; and
- rapid rural appraisal.

Part 4: Fisheries co-management

In this part, various cases of fisheries co-management will be presented and analysed, and questions related to these cases will be discussed. 'Under what social and ecological/physical conditions does fisheries co-management have the highest chance of succeeding?' 'What can be done to improve these conditions?' 'How can a process aimed at increasing fishers' participation in management be started and implemented?'

Some of the topics discussed in this part include:

- fisheries co-management: conditions, case studies from different regions and from different types of fisheries;
- consequences of adopting a co-management approach for the government, fishers and other stakeholders; and
- capacity building for fisheries management.

More information on the course and application forms can be obtained from:

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CLAM HARVESTING, THE CONVENTION ON THE INTERNATIONAL TRADE IN ENDANGERED SPECIES (CITES) AND CONSERVATION IN MILNE BAY PROVINCE, PAPUA NEW GUINEA

by Jeff Kinch,
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Introduction

Milne Bay Province (MBP) lies at the far eastern tip of Papua New Guinea (PNG) and is dominated geographically by its marine environment. MBP's maritime area is roughly 110,000 square kilometres and contains some 13,000 square kilometres of coral reefs, or an estimated 32% of the national total of reef area (Munro 1989; Dalzell and Wright 1986). MBP has a shoreline of 2120 kilometres with over 600 islands, atolls and reefs scattered throughout (Omeri 1991).

MBP has an extensive barrier reef system that runs along the southeastern coast and extends eastwards into the Coral Sea where it forms a discontinuous series of easterly-trending reefs (Sullivan 1991; Loeffler 1977; Manser 1973). At its eastern extremity, this reef system surrounds the Louisiade Archipelago, continues northwest to the D'Entrecasteaux Islands, and loops around the Trobriand Islands. These reef systems are said to be in close proximity to what is regarded as the epicentre of marine species diversity, containing some of the most biologically diverse and pristine coral reefs, mangrove forests, and seagrass beds left in the world (Allen and Swainston 1993; Beehler 1994; Piddington et al. 1997). This biodiversity may be disproportionately high due to the complexity and internal connectivity of the above reef systems, and relatively low levels of terrestrial influence.


Jeff Kinch

The bulk of MBP's approximately 200,000 inhabitants live near the seashore, on both the islands and the mainland. Communities in MBP are culturally similar. Most are predominantly matrilineal, so that clan membership, territorial rights, and inheritance are determined through the female line. The people are mostly subsistence and artisanal fishers who sell marine resources to exporters and rely mainly on fishing and subsistence agriculture for their food security and community livelihoods. Average annual income per household has been estimated at USD 130 (Kinch 2001; Mitchell et al. 2001). The impact and pressure exerted on marine resources such as beche-de-mer, shark and giant clams is likely to increase in the future given MBP's burgeoning population (currently growing at 2.5% per annum), the increasing desire for cash, and the decline in traditional income sources such as copra.

Previous research on giant clam stocks

Giant clams are classified in the order Cardiacea and the family Tridacnidae (Munro, 1993). Of the eight species of giant clams, seven species occur in MBP, including *Tridacna gigas*, *T. derasa*, *T. squamosa*, *T. maxima*, *T. crocea*, *Hippopus hippopus* and *H. porcellanus*.

Prior to commercial harvesting, Chesher (1980) reported unfished areas of the Longman/Kosmann Reef having concentrations of *T. gigas* at 9/ha. An earlier survey on Siata reef near Nuakata Island, by Tarnasky (1980), described the density of *T. gigas* at 10/ha. The research described by Chesher (1980) reported that the overall density for all species of giant clams, prior to commercial exploitation, was 39/ha.

In 1996 a combined South Pacific Commission (SPC) and PNG National Fisheries Authority (NFA) stock assessment was carried out in the Engineer and Conflict Groups. Throughout the survey area *H. hippopus* was the most abundant at 20.1/ha, followed by *T. maxima* at 17.9/ha, *T. crocea* at 11.9/ha, *T. squamosa* at 5.8/ha, *T. derasa* at 5.3/ha, *T. gigas* at 0.4/ha and finally *H. porcellanus* at 0.3/ha.

From extrapolation of this data it was suggested by Ledua et al. (1996) that approximately 98% of the stock of *T. gigas* throughout the MBP had been wiped out since the early 1980s. Stock density of all species was estimated to be down by 82.35% of the original population while the current standing stock of giant clams represented 17.65% of the original population. The overall density of all species

was estimated to be only 0.5 per hectare (Ledua et al. 1996).

In the 2000 Marine Rapid Appraisal Program (RAP) conducted by Conservation International (CI), six species were recorded from 39 sites throughout MBP. Densities of Tridacnids were sparse at most sites; occasionally, however, isolated patches with higher population densities were encountered with the vast majority of Tridacnids recorded at depths of 0–9 meters. The most commonly observed species were *T. maxima* (69.2%), *T. squamosa* (56.4%), and *T. crocea* (41%). *T. gigas* accounted for only 3.5% of the total giant clam count (Allen et al. in press). Most Tridacnid species were small, and few large individuals were encountered. The general impression gained from this survey is that stocks of these animals are lower than is considered normal.

Given the importance of giant clams to the people of MBP, a more thorough and comprehensive assessment of Tridacnid stocks is required. A stock assessment and biogeographical survey (SABS) is now under development between CI, the NFA, and the Commonwealth Science and Industry Research Organisation with financial assistance from the Australian Centre for International Agricultural Research. This SABS is specifically planned for beche-de-mer but will also include giant clams and other sedentary species and will provide information for future management of all these species (Kinch et al. 2001; CSIRO 2001).

Biology and stock decline

A feature of giant clam biology is stocks become non-sustaining when densities fall below certain undefined levels. This is because of their mode of spawning (see Lucas 1988). Giant clams maximise fertilisation success by spawning in synchrony in response to current-borne pheromones. Giant clam eggs contain, or are associated with, a chemical that induces spawning in conspecific clams, which detect the spawning inducer. The second clam releases sperm and the eggs are then fertilised. However, if there are no conspecific clams downstream, the eggs are unfertilised. Giant clams are, therefore, highly vulnerable to stock depletion.

Also, if adults are removed over a large area, planktonic larvae might not settle out as readily as in a normal area. This means fewer smaller clams than normal, which means existing predators consume a larger percentage of those clams that do settle out. Predators of intermediate sized clams also exert heavier pressure on their prey as numbers become reduced and result in very few clams reaching maturity in a fished area. Govan (1992) lists 45 species of known predators and metazoan parasites. Predators include balistid fish, octopods, xanthid crabs and muricid gastropods.

If a reef is entirely depleted of giant clams, re-population will depend entirely on this planktonic larvae brought in from other reefs by prevailing currents. If the reef is isolated or the current direction is unfavourable, the re-establishment of a stock could take hundreds of years (Munro 1993). Even in dense natural populations of giant clams, recruitment is very sporadic (Adams et al. 1988; Pearson and Munro 1991).

Harvesting methods

Fishing methods for giant clams are exceedingly simple due to their shallow distribution, conspicuousness and sedentary habit. In MBP small clams are collected opportunistically during reef gleaning activities, while larger ones are collected by free diving. The flesh is excised from the shells by slipping a knife or sharpened wooden stick along the inner surface of the shell to cut one end of the adductor muscle. Sticks are also used to pry *T. maxima* from the reef. Giant clams located in deeper water are hauled to the surface using ropes and chains, which are lowered to the open shell. Once at a depth where divers can get to them or brought to the surface, the mantle and muscle is excised from the shell, which is is then dropped back into the sea. Previously, a local fishing company aided village divers in harvesting giant clams by towing canoes to harvesting sites and by using their boats and dories to winch giant clams to the surface.

Hookah gear (compressed airline-supplied diving) has also been used in MBP during the last decade. A local entrepreneur from the Engineer Group with business links to a local fishing company previously used the hookah gear to relocate giant clams to a 'ranch' located near his home island (see Ledua et al. 1996).

Jeff Kinch

Harvesting* T. gigas *at the Long/Kosmann Reef

Poachers and illegal buyers

Roe (1961) documented pearling fleets in Junet near Sudest Island in February 1888. These boats were mostly crewed by Filipinos, Malays, and South Sea Islanders and it is highly probable due to the nationality of the crewmen, that giant clams were harvested; particularly since this fleet later left for Woodlark Island because the seabeds at Junet had been overharvested. In the early 1920s several incidents of poaching were beginning to occur. Zimmer (1922–23), a District Officer, writes about Japanese fishing boats poaching giant clams in the lagoon at Brooker Islands.

The peak period for illegal entry by foreign fishermen was between 1967 and 1981, which saw sightings and arrests of numerous long-range Taiwanese fishing vessels (Bartlett 1975; Potter 1975; Standing 1975). This activity reached its peak in the mid-1970s then subsided in the face of depleted stocks, strong international pressures and improved surveillance of reef areas (see Dawson and Philipson 1989; Lucas 1994).

These Taiwanese fishermen came regularly. Rather than reporting the presence of these vessels to the government, some islanders openly traded with them and in so doing, only encouraged them to become bolder in their operation. In one instance Sabarl and Panawina villagers accused Brooker and Motorina peoples of trading with Taiwanese vessels (Standing 1975). People accepted the arrival of the Taiwanese because they brought rice, tobacco and other commodities. The islanders now blame these same Taiwanese fishermen for depleted giant clam stocks.

In 1996, there were reports of illegal Asian buyers at Losuia in the Trobriand Islands. These buyers purchased more than one tonne in 1996 which was subsequently smuggled to Port Moresby and shipped to overseas destinations mixed with other seafood exports (Lokani nd).

Commercial harvesting of giant clams

Commercial fisheries for giant clams developed in MBP in the wake of the reduction of Taiwanese activities and in response to the sustained demand. Export of giant clams from MBP commenced in 1983 (Lokani and Ada 1998), through the influence of the International Food and Agricultural Development (IFAD) which funded Milne Bay Fisheries Authority (MBFA) fisheries development project (Munro 1989). MBFA grew out of fisheries extension activities of the Department of Primary Industries in the 1960s. In 1976 the project, which attracted aid from New Zealand, was taken over by IFAD and the Milne Bay Fisheries Station and subsequently set up at Samarai in 1980. The MBFA operated processing facilities, and maintained major collection centres at Vakuta and Esa'ala in the north, and Brooker and Tagula in the south. The project ended in 1990 due to high staff wage costs, breakdowns in the organisational structure, absenteeism, and the misappropriation of funds (ANZDEC 1995).

Other problems encountered during the project's lifespan included a lack of protection and policing by the government in the areas of illegal fishing and poaching, and considerable opposition from villagers over the clam fishery (Maurice Pratley and Associates 1989).

In 1989, a giant clam biologist, working with the International Centre for Living Aquatic Resources Management (ICLARM), visited the Samarai-based MBFA's processing facility and analysed the purchasing records held there. His analysis showed that a total of 85.7 metric tonnes of adductor muscle (equivalent to over 750 tonnes of total flesh) were purchased between January 1983 and May 1988 (Munro 1989).

The purchase and export of giant clam was stopped in May 1988 by a ruling from the Department of Environment and Conservation (DEC) when PNG became a signatory of the Convention on Trade in Endangered Species (CITES). The ban on exporting giant clams was lifted in 1995 by the Minister for Environment and Conservation on the understanding that there was a management plan in place. A Milne Bay Province Giant Clam Fishery Management Plan was drawn up by the NFA but was never gazetted due to inter-agency rivalry and outside political pressure, and so was never put in place.

In 1995 the DEC set an annual quota of 35 metric tonnes of giant clam muscle. The basis or reasoning for this figure is not known. Within the first six months of the ban being lifted, a local fishing company exported approximately 18 metric tonnes of adductor muscle from MBP (Ledua et al. 1996). This company was started in 1994 and was formally part of a larger parent company. By acquiring assets, boats, staff, the management and the fish trading business of the previous MBFA operation, it is now the largest fishing company in MBP.

During the 1983–1988 MBFA period, the majority of giant clams harvested from MBP

came from the Calvados Chain and the Tagula area; but during the mid-1990s, a review by the SPC-NFA team found only 180 kg of giant clam muscle in the Tagula area, suggesting that stocks had not yet recovered from the previous MBFA period (Ledua et al. 1996). Also, during the 1983–1988 period, the Trobriands contributed 4676 kg of giant clam muscle, but only 94.5 kg were purchased from this area in 1995–1996.

During the first four months of 1996, a local fishing company purchased 14.32 metric tonnes of giant clam muscle (approximately 29,000 individuals) with 70% of this catch (9.76 metric tonnes) coming from the Sudest, Sabarl and Grass Islands.

Throughout 1998 and 1999, a local fishing company purchased giant clams from the Calvados Chain, Junet (Kinch 1999, 2000, 2001), and the Lusancay reefs in the D'Entrecastaux Group (Mitchell 2000). In 1998, 4651 kg of giant clam muscle were purchased from the Calvados Chain area (Kinch 1999).

For many people in remote areas, the only source of cash is from local fishing companies through their buying programmes. Unfortunately, this often leads to the not-too-judicious harvesting of marine resources. A local fishing company has been criticised by several government officers in the past over their operations (see Sailoia 1996; Merpe 1996). This criticism was partly leveled at the purchase of clam shells from villagers in preparation for export in 1997, when a local fishing company exported 16 tonnes of shell. Piles of giant clam shell can still be found stacked around Alotau, awaiting export.

During 1998 and 1999, the author was based at Brooker Island in the Calvados Chain researching his anthropology PhD on marine resource management. The community at Brooker is largely dependent on the marine environment as they only produce around 50% of their own subsistence requirements from agriculture.

They are avid sailors and major marine resource exploiters. From July 1998–June 1999, the Brooker community earned 67,000 kina from the sale of various marine resources, and this accounted for approximately 90% of all income. Of this 67,000 kina, beche-de-mer contributed 49.3% to the total; trochus, 19%; crayfish, 13.1%; fish, 10.8%; giant clams, 6.7% (or 4514 kina), and the remainder came from shark fin and black lip pearl oyster (Kinch 1999).

At this time, a local fishing company purchased two sizes of giant clam muscle based on weight. Under 400 grams earned 6 kina, and over 400 grams earned 10 kina. The prized muscle accounts for about 10% of the clam's soft tissue weight and 1 to 2% of the total weight in the large *T. gigas* and *T. derasa* (Lucas 1994). From January to the end of September 1999, a local fishing company purchased 697 kg of giant clam muscles, mostly *T. gigas* and *T. derasa*, from Brooker people. This was broken down into 551 kg (or 1970 individual clams) of under 400 grams, earning 3306 kina and 146 kg (or 170 individual clams) of over 400 grams earning 1460 kina (Kinch 1999).

Jeff Kinch

Piles of* T. gigas *shells stacked around Alotau awaiting export

From 5 January to 1 May 1999, the author recorded 81 fishing expeditions where giant clams were harvested. The majority of giant clams recorded from these expeditions were harvested from the Long/Kossmann reef area. This is the same area where Chesher did his stock assessment work in the 1980s.

At the time, Brooker people were supplying crayfish and giant clam adductor muscle to a local fishing company, while harvesting smaller giant clams (mostly *H. hippopus*) for trade and subsistence, and beche-de-mer for later sale. During these recorded expeditions, Brooker people harvested 788 unidentified giant clams (most were *H. hippopus*), 161 *H. hippopus*, 53 *T. gigas* and 188 other *Tridacna* spp.

This amounted to 1190 giant clams with a combined mantle and muscle weight of 968.6 kg. The most commonly harvested species were *H. hippopus* and *T. derasa*. Of all the *T. gigas* that were harvested, almost a third were not full-grown adults.

The Brooker Islanders' catch per unit of effort (CPUE) for giant clams per trip (note that trips also included looking for other sedentary species) was 11.95 kg per trip (including mantle). Individual CPUE ranged from 1–56kg/trip (including mantle). In contrast, the research conducted by the SPC-NFA team on the local fishing company purchasing records estimated the CPUE from 53 trips around Sudest, Sabarl and Grass Islands at 18.66 kg per trip (strictly muscle) (Ledua et al. 1996).

***A multi-species catch by Brooker people aboard a local fishing vessel at the Long/Kosman Reef. On the floor you can see the white mantles of several* T. gigas**

[Photo: Jeff Kinch]

Seventy kg of giant clam adductor muscle (*Tridacna *spp.) on board a local fishing vessel. This catch was later discarded because it had perished

[Photo: Jeff Kinch]

Individual CPUE ranged from 1–688kg/trip (strictly muscle). The prices at this time ranged from 2–5 kina/kg.

Giant clams do not withstand sustained commercial fishing pressure and the perception among villagers is now one of reduced numbers of giant clams and other marine resources, notably beche-de-mer. For example, 75% of Brooker people now notice a decline in giant clam stocks (Kinch 1999). Using research from the Great Barrier Reef it was deduced by Ledua et al. (1996) that the natural recruitment rate for giant clams in MBP would be 9341 animals per year for *T. gigas* and 274,000 for *T. derasa*. The level of harvesting that has been reported above implies that the level of harvesting to supply MBFA and a present local fishing company is and was not sustainable.

Ledua et al. (1996) noted that the density of giant clams from the SPC-NFA research was so low that it alone warranted a total ban on the harvesting of giant clam species. It was also recommended back in 1980 that commercial fishing for giant clams should not be part of the MBFA Coastal Zone Development Program, but the farming of giant clams was recommended instead (Chesher 1980).

Exports

Internationally, giant clams are commercially utilised in a number of ways. They are marketed as aquarium specimens, sashimi, seafood, shells and shell craft. The major international trade is largely in giant clam adductor muscle and shells (Wells et al. 1983) and this is what MBP has focussed on in the past. Chinese gastronomes regard the adductor muscle tissue from giant clams as a highly prized delicacy with aphrodisiac properties (Lucas 1988). The level of exploitation is induced by the lucrative prices paid by Asian markets and there is a direct link between the threats to PNG's marine resources and the proximity of these affluent and growing markets.

According to Sant (1995) PNG exported 68 tonnes of giant clam muscle during the years 1982–1987. This figure is not accurate as 85 tonnes were exported from MBP alone during the years 1983–1988. As mentioned above, the export of giant clams from MBP commenced in 1983 (Lokani and Ada 1998; Munro 1989). The purchase and export of clam muscle was then stopped in May 1988 and reinstituted in 1995 (Ledua et al. 1996). The export of giant clams was again

Milne Bay Giant Clam Export Figures: 1983–2000

Year	Species	Details	Quantity (Kg)
~1983	*Tridacna* spp	Giant clam adductor muscle	5500
~1984	*Tridacna* spp	Giant clam adductor muscle	1000
~1985	*Tridacna* spp	Giant clam adductor muscle	6000
~1986	*Tridacna* spp	Giant clam adductor muscle	34,500
~1987	*Tridacna* spp	Giant clam adductor muscle	28,500
~1988	*Tridacna* spp	Giant clam adductor muscle	10,000
1989–1994	**Moratorium in place with PNG signing the CITES agreement; lifted in 1995**		
*1995	*Tridacna* spp	Giant clam adductor muscle	1000 (†18,000)
*1996	*Tridacna* spp	Giant clam adductor muscle	14,005 (†14,320)
*1997	*Tridacna* spp	Giant clam adductor muscle	10,650
*1997	*Tridacna* spp	Unprocessed giant clam shell	16,000
*1998	*Tridacna* spp	Giant clam adductor muscle	13,560
*1999	*Tridacna* spp	Giant clam adductor muscle	8900
2000–Present	**Trade stopped due to alleged infringement of the CITES regulations**		

~Munro 1989

* National Fisheries Authority Marine Exports Records. (Note: records are not complete for 1995 and 1996. Figures for 1995 and 1996 are thought to be lower than the actual figure, as there had been illegal buying of giant clam muscles, which were being transferred to Port Moresby (Lokani nd)

† Ledua *et al.* 1996.

stopped in 2000 when it was found that a local fishing company was not complying with permit regulations under CITES.

Giant clam exports have been the third most important export in terms of weight and value from the export fisheries sector in MBP (Lokani nd) and previously contributed a significant amount to the income of rural fishermen. During the 1990s, clam shells were exported to Australia and clam muscles were exported to Singapore.

Recent issues

The issue over the commercial harvest of giant clams in MBP came to the fore in early 1999 when twelve giant clams were removed from a five-star dive site at Wong's Reef near Tewalla Island in the D'Entrecasteaux Group. It was alleged that the giant clams and the dive site were destroyed by villagers selling giant clam muscle to a local fishing company (Halstead 1999; Eastern Star 2000a, b).

In early 2000, the Executive Manager for Fisheries Management and Industry Support of NFA, stated that a local fishing company in MBP did not have a licence to purchase or to export clam products. In correspondence between dive-boat operators and the management of the local fishing company in question, the director of the fishing company wrote:

> *Five years ago after lengthy negotiations with the Department of Environment and Conservation and the Minister, we implemented a management plan for the sustainable harvest of clam shells in the Samarai-Misima-Sudest area. Kiriwina and Goodenough areas were not included in the plan, because we could not guarantee the integrity of the plan in that area (Critten 1999).*
>
> *There has never been a prosecution because the Government Authorities are well aware that [our fishing company] request for purchasing of giant clams was channelled to proper authorities concern and was given approval with a Milne Bay Province Giant Clam Fishery Management Plan from the National Fisheries Authority in 1996. All [our fishing company's] export were inspected and approved by National Environment and Conservation with CITES certificate (permit to export) and all export documents to IRC were always clearly marked Giant Clam with the word Scallop in bracket, as requested by the overseas buyers as this product is only recognised by this name in their market (Critten 2000).*

As noted above, the Milne Bay Province Giant Clam Fishery Management Plan was never put in place because it had never been gazetted. Greenpeace's Country Director later stated in several press statements that the export of the giant clams by the local fishing company was a breach of law with officials from the Office of Environment and Conservation (OEC, DEC had been downgraded in 2000) and the NFA turning a blind eye to it.

He also claimed that misdescription of an export commodity was a serious offence under Customs regulations. The Greenpeace director believed that weak administration, conflicts between national and provincial agencies, and corruption combined with very close links between business, government and politicians in MBP was the root cause of lack of enforcement of OEC, NFA and CITES regulations (The Independent 2000; Eastern Star 2000a).

The OEC Senior Enforcement Officer later confirmed that under CITES arrangements, giant clams could be commercially exported from a ranch or farm and the local fishing company had authority to harvest and export clam meat on the understanding that the clams were coming from a farm. The OEC has now issued a ban on clam exports under CITES after learning that a local fishing company was allegedly exporting clam meat from the wild (Timothy 2000; also see Israel 2000). An investigation by the Principal Inspections Officer at NFA concluded the following in his report:

> *From my findings and assessments of the harvesting and exporting of giant clam meat by [a local fishing company], I have come to the conclusion that Environment and Conservation issued a clearance to [a local fishing company] by mistake. Environment and Conservation issued the clearance on the understanding that [the local fishing company] had a giant clam farm, from which the meat could be harvested and exported.*
>
> *Some points to note with regard to the export of the clam muscle. Clam muscle has always been referred in the documents as scallop and noted as farm reared. I had raised this matter with [a local fishing company] that it was misleading information about the product. . . I now suspect that the company was trying to conceal the fact that the product was giant clam muscle harvested from the wild which would be a breach of CITES requirements (Timothy 2000).*

CITES

In PNG, the Fauna Act has no provisions for the international trade in protected fauna but relies on the Customs Act, which stipulates that the export of any fauna without a permit is

an offence. PNG, however, is also party to CITES, which restricts the trade in endangered species. Under the International Trade (Fauna and Flora) Act, CITES species exported without a permit are prohibited exports and the whole family of giant clam species has been listed on CITES Appendix II since 1985, which requires permits for international commercial trade (Sant 1995).

A species may be listed under Appendix II of CITES when it is deemed to be threatened with extinction if international commercial trade is not regulated. This does not prohibit trade, but allows for the monitoring of trade under a permit system.

Each party to CITES is required to designate one or more "management authorities" to be responsible for administering the convention and one or more "scientific authorities" to advise on scientific and technical issues, including assessments of the threat that may be posed to species by international trade.

Parties must establish legislation that prohibits international trade in specimens in violation of the convention, penalises such trade, and allows for confiscation of specimens illegally traded or possessed (Armstrong and Crawford 2000).

In classifying species and determining whether the populations are robust enough to be traded internationally, the scientific authority determines, through scientific procedure (like the SPC-NFA stock assessment in 1996 and the proposed SABS), whether international trade will jeopardise the survival of the species (Armstrong and Crawford 2000).

Because of the listing of giant clams under CITES, the OEC (formerly DEC) assumed responsibility for its regulation, which caused confusion at NFA because it has jurisdiction over the export of fresh marine resources and was the agency responsible for management.

Conservation and management measures

In order to ensure the sustainability of all marine resources including giant clams in MBP, effective management strategies must be implemented.

However, before this can happen, basic scientific data assessing the stocks of animals must be gathered. The before-mentioned SABS will help alleviate this information gap.

Several approaches to assisting the recovery of overfished giant clam populations have been proposed. These include the establishment of Marine Protected Areas (MPAs), concentrating the remaining adult clams so their reproduction can be facilitated by proximity for fertilisations of gametes; and seeding cultured giant clams of sufficient size or in sufficient numbers into the field to produce adult populations (Lucas 1994; Tisdell 1992).

The imposition of a ban on further fishing, or strict harvesting quotas, to be harvested in a single short season, coupled with size restrictions, also offers prospects for management.

Quotas could be determined for individual areas on the basis of stock appraisals. Such a system could also encourage individuals or communities to develop clam gardens, in which undersized clams could be grown out to a saleable or minimal harvestable size.

Owing to the low natural mortality rates of giant clams, the largest yields will be obtained by taking giant clams at relatively large sizes. Thus, it would also be possible to stipulate minimum sizes of giant clam adductor muscles and corresponding shell lengths and body weights for each species as the value of adductor muscle increases with increasing size (Munro 1993). Chesher (1980) offered size limits for the commercial harvest of giant clam. He recommended that *T. gigas* should only be collected when they were between 45 and 65 cm in width, and *T. derasa* at 30 to 55 cm in width.

The objectives outlined in the ungazetted Milne Bay Province Giant Clam Fishery Management Plan were to manage the

Giant Clams Size/Age Ratio for PNG

Species	Shell length in cm by age in years									
	1	2	3	4	5	6	8	10	15	20
*Tridacna gigas**	4.8	13.97	22.02	29.09	35.29	40.74	49.73	56.66	67.82	73.64
*Tridacna gigas**	4.8	12.73	20	26.67	32.78	38.38	48.22	56.49	71.84	81.77
Tridacna squamosa	4.75	9.16	12.99	16.32	19.22	21.74	-	-	-	-
Tridacna maxima	2.08	5.09	7.78	10.19	12.34	14.27	-	-	-	-
Hippopus hippopus	5.04	11.75	17.17	21.55	25.09	27.95	-	-	-	-

**T. gigas* recorded from two different parts of PNG (Munro 1993)

wild population of giant clams and to maintain the fishery at an economically sustainable level. Fishing restrictions under the ungazetted plan stated that fishing for giant clams was to be restricted to free diving (i.e. no hookah or scuba). Mechanical fishing methods, such as ropes with hooks, were also not to be used and all fishing was to be carried out from small boats with a maximum of 40 hp outboard (National Fisheries Authority 1996).

Marketing restrictions under the ungazetted plan stated that giant clam products should meet all CITES conditions of export with all exports to be inspected and certified by a CITES inspector. All adductor muscles destined for export should be declared as adductor muscles; and all giant clams products destined for export should be declared as raised from a farm or harvested from the wild (National Fisheries Author-ity 1996).

Recommendations from the SPC-NFA study in 1996 also called for a ban on all underwater breathing devices. Export companies were also to be discouraged from just purchasing the adductor muscle but rather encouraged to purchase the mantle and the shell as well.

They also called for the establishment of a recording system and for a giant clam hatchery for re-seeding and farming with further study done on actual habitat areas (Ledua et al. 1996). They also proposed either banning harvesting for five years or setting the total allowable catch (TAC) at five metric tonnes, which was the same TAC to have been set under the ungazetted plan (National Fisheries Authority 1996). SPC, after review of the SPC-NFA data, suggested that due to the longevity and erratic recruitment of giant clams, it would be best to have a one-month "pulse-fishing" season every 7–10 years.

The establishment of MPAs or refuges for giant clams and other threatened species is an obvious course of action, which can be advocated for all areas where stocks are depleted (Braley 1994; Munro 1993; Lucas 1994; Mitchell et al. 2001). The Milne Bay Community-Based Coastal and Marine Conservation Program (CMCP) is currently being augmented between multiple partners, including CI, the United Nations Development Program (UNDP), the Global Environment Facility (GEF) and all levels of provincial and national governments.

The CMCP will establish Community-Based Marine Management and Conservation Areas in high biodiversity locations for which community-based resource management (CBRM) is socially and economically feasible. The use of CBRM is deemed instrumental in the success of conservation and management initiatives of marine resources.

These CBRM efforts will be complemented and supported by appropriate marine resource use policy changes covering all of MBP, and targeting institutional capacity building of the Local Level Governments and Ward Development Committees.

These local government and community level measures will hopefully lead to the recovery and long-term sustainability of currently over-harvested species (such as giant clams), and will help ensure that other marine species will not be over-exploited as markets develop or local human populations increase.
Restocking appropriate reef environments with cultured giant clams is the most direct method of population enhancement. Village people have already been doing this to a certain extent, but they have done so for subsistence reasons, rather than conservation or management purposes. People collect juveniles or sub-adults and place them in a secret location or on the foreshore reefs outside their houses and harvest them for consumption later (Mclean 1978; Kinch 1999).

Because giant clams have larval stages typical of bivalves, they can be hatchery-reared using methods that have been developed for other commercial bivalves (oysters and scallops). Giant clams can be cultured in the shallow subtidal zone, on and off the bottom in the intertidal zone, and in floating structures. By virtue of their symbiotic relationship with a species or species group of dinoflagellate algae, giant clams are the world's only self-feeding farm animals (Munro 1993).

Crawford et al. (1988) recognised four phases in the culture of giant clams: the hatchery phase where larvae are reared from eggs in tanks; the nursery phase where juveniles are reared in onshore tanks from metamorphosis (0.2 mm shell length) to about nine months of age and 20+ mm shell length ("seed" clams); the ocean-nursery phase where juvenile clams are further raised in protective containers in the sea to a shell length of 200+ mm; and finally the grow-out phase where giant clams are left to grow out to harvestable size (see also Calumpong 1992; Braley 1992; Usher and Munro 1988; PCAMRD 1990).

Clam farming requires high capital outlays by village standards, and so there are social and economic risks involved. Its establishment at the village level in MBP requires support

from NFA, CMCP and other international agencies.

Hazards include exposure to storms (Calumpong and Solis-Duran 1993) and mortality from parasites and predators (Govan 1992). In well-sited ocean nurseries most giant clam mortality is due to these predators and parasites and considerable effort on the part of villagers is needed to ensure adequate levels of survival for giant clam spats.

Considerable research has been carried out in Solomon Islands in improving survival rates of giant clams in village farms (Bell 1999; Hambrey and Gervis 1993). Lucas (1994) and Tisdell et al. (1994) also suggest that large quantities of new product are needed to test potential markets, and large quantities must then be available to supply the markets, but there is high financial risk in producing large quantities without established marketing agreements. This is not a real issue in MBP as it is one of the last areas within the Coral Triangle with adequate reefs, and the previous volume of exports indicates readily available markets.

Commercial farming of giant clams is currently not practised in MBP though as mentioned above there was previously a clam "ranch" owned by a local entrepreneur in the Engineer Group. The practice employed was to obtain giant clams using hookah gear from surrounding reefs and place them at his patch. This "ranch" is no longer in operation, having sold off all giant clams to the local fishing company several years ago.

This practice does not equate to farming because it is entails relocating wild stock to a central location and selling it off. As noted earlier, stocks of giant clams in the Engineer Group are now depleted (Ledua et al. 1996).

Presently, there is a proposal under negotiation to build a clam hatchery at Nivani Island in the Deboyne Islands. The owners of this company also own the freehold title on this island and plan to set up a breeding and grow-out facility for giant clams. When the clams are at a size for translocation they will be distributed or sold to villagers around the area with instructions on how to care for them. After a period of three years the company will purchase the clams back from the villagers, while selling out more. A hatchery for gold lip pearl shell has also been proposed by Coral Sea Mari-Culture, and this could also be utilised for rearing giant clam spats.

Conclusion

Local extinctions of giant clams and the general low stocks in MBP are a reflection of previous unsustainable practices from commercial utilisation, poaching and subsistence harvesting. Once populations are reduced below a certain level, even subsistence fishing may be sufficient to keep giant clams below recruitment levels. Thus, there is an urgent need to develop a means to conserve and restore giant clam populations in MBP.

The prospect of culturing giant clams could be considered for MBP, although exploitation pressure must be regulated and balanced to allow giant clams to maintain their stability and regenerative capacity. The most appropriate management for giant clams and other marine resources would be to encourage CBRM control over reefs. This would form a cost-effective means of managing a resource, by which local communities enforce management regimes. This is the aim of the UNDP/GEF-sponsored Coastal and Marine Conservation Programme. The information obtained from the forthcoming SABS will also assist local communities in designing appropriate management areas and strategies.

Hatcheries in MBP could provide alternative income earning opportunities for small island communities in suitable ecological locations, reduce pressure from overfishing and unsustainable harvests of other marine products, and add value and provide incentives to keep reef systems and associated nearshore environments intact.

The cost-benefit that could be realised by local communities through the ocean grow-out of juveniles produced in hatcheries appears to be an option worth pursuing. This would of course need to be subsumed under CBRM regimes.

Finally, the Milne Bay Province Giant Clam Fishery Management Plan needs to be reviewed by NFA, and special attention needs to be given to addressing the capacity-building needs of the National Departments of the OEC and the NFA. There is a need for amelioration of conflict and confusion between the fisheries and environmental legislation, and for improved monitoring, recording, and reporting through the use of CITES trade mechanisms.

Export of giant clams could then possibly be restarted once community-based and managed farms were in place, as MBP has previously specialised in the export of adductor muscle as a food product to the Asian region and these markets are still readily available.

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Jean-Paul Gaudechoux

Tridacna derasa

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Tridacna derasa

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