



# Fisheries

## Newsletter

Number 120 (January – March 2007)

## Editorial

Welcome to this issue of the *Fisheries Newsletter*. We present a very interesting article on the ISO 22000 Certification. This new standard specifies requirements for a food safety management system in which an organisation in the food handling chain needs to demonstrate its ability to control food safety hazards to ensure that food is safe at the time of human consumption.

Franck Magron, following on an article published in *Fisheries Newsletter* #117, describes sources of information for shallow water bathymetry and how these sources can be used to produce bathymetric maps for coastal fisheries management purposes.

Jean-Paul Gaudechoux  
Fisheries Information Adviser  
jeanpaulg@spc.int



## in This Issue

---

SPC Activities Page 2

News from in and around the region  
Page 28

Coral uses and perspectives on  
sustainable development in Solomon  
Islands  
*Antoine Teitelbaum* Page 35

ISO 22000 Standard: A food safety  
management system  
*Vincent Talbot* Page 40

Shallow water bathymetry  
*Franck Magron* Page 44

---

**Farmed *Acropora* in Leitongo Village, Solomon Islands. The international ornamental coral market is demanding more cultured corals because they adapt better to aquarium conditions. Also, farming corals is seen as an eco-friendly practice, compared with the wild harvesting of corals**



SECRETARIAT OF THE PACIFIC COMMUNITY

Prepared by the Information Section of the Marine Resources Division and printed with financial assistance from France.

## ■ REEF FISHERIES OBSERVATORY

Staff of the coastal component of the EU-funded Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C) and the Coastal Fisheries Development Programme (CoFish) began fieldwork in the Cook Islands, with two sites surveyed in the first quarter. In addition, the Live Reef Fisheries Trade Specialist was involved in several projects, including fieldwork in Kiribati, a global IUCN grouper meeting, and training of an attachment from Tuvalu.

### Fieldwork and surveys in the Cook Islands

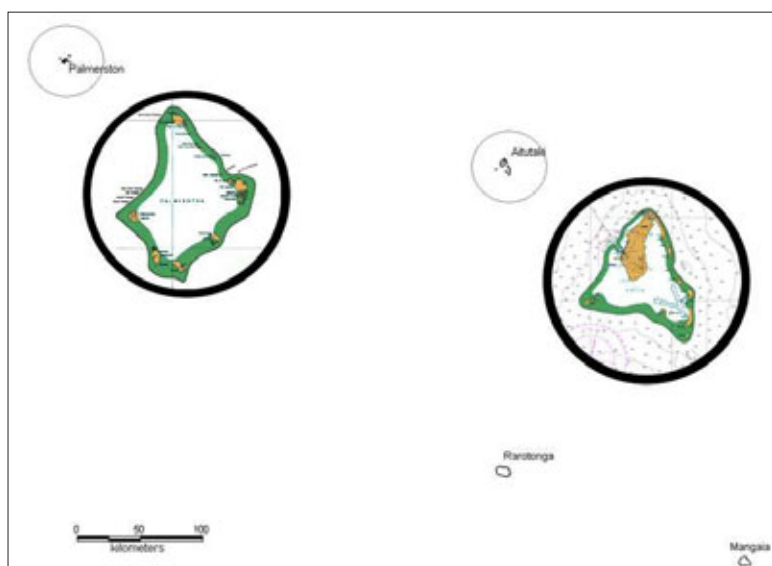
Finfish, invertebrate and socio-economic surveys were conducted in two locations in the Cook Islands (Palmerston and Aitutaki atolls, Fig. 1) during February 2007. The PROCFish/C and CoFish team consisted of Kim Friedman and Kalo Pakoa (invertebrates), Silvia Pinca and Pierre Boblin (finfish), and Mecki Kronen (socioeconomics). The PROCFish/C and CoFish team acknowledges and thanks the following people who assisted and/or worked with the team at one or both locations: Ian Bertram, Secretary for Fisheries; Kori Koroa, Head of Coastal Fisheries Section; counterparts from the Cook Islands Ministry of Marine Resources, Richard Story, Ngatamaroa Makikiriti, Nooroa Roi, Ngametua Atingakau, Dorothy Solomona; boat operators and guides, Mataio Mareko (aka Captain Nemo), John Noovao, and Bill Marsters; Jo Akroyd, Cook Islands Marine Resource Institutional Strengthening Project; and the elders, community members, and fishers from the two survey sites.

#### Aitutaki

Aitutaki Atoll comprises a high island (16.3 km<sup>2</sup> in area), a shallow lagoon (75 km<sup>2</sup> in area to approximately 10 m depth), and a typical atoll barrier reef formation with reef islets or 'motus', the majority of which lie to the east

and south. Aitutaki's shallow lagoon (Fig. 2) is closed off by the barrier reef, except for one cut through the passage in the west, and two shallow passages in the east and northwest. Circulation inside the lagoon is slow, and coastal waters around the mainland suffer heavy rates of sedi-

mentation. Reefs in the lagoon were predominantly dead and fragile, and often covered by epiphytes and silt. Coral conditions improved with distance from the mainland, especially towards the southwest. On the barrier reef top and drop-off, reef conditions were generally good.



**Figure 1: The two survey sites: Palmerston and Aitutaki atolls in the southern Cook Islands.**

**Figure 2: Aitutaki invertebrate survey coverage, with survey stations noted.**

Invertebrate surveys were conducted in many locations around the reef and lagoon (Fig. 2). Preliminary results revealed that the elongate clam, *Tridacna maxima* was the most common giant clam, although *T. squamosa* was present, but rare. *T. maxima* stocks have been largely overfished, with dead shell piles evident on most 'open' reefs. Also noted in the reserve were large sized, healthy *Tridacna gigas*, *T. derasa* and *Hippopus hippopus* (translocated species). These present an excellent resource for Cook Islanders, as large sized *T. gigas* and *T. derasa* are becoming rare around the Pacific.

The commercial topshell 'trochus' (*Trochus niloticus*) fishery was the invertebrate highlight on Aitutaki. Trochus are harvested only when there are sufficient numbers on the reefs to ensure the quota can be reached sustainably, and har-

vests are valuable enough to warrant fishing. The last harvest was in 2001, and the current survey suggests that the trochus stock density (Fig. 3) is sufficient to allow fishing.

The density of urchins (*Echinothrix diadema*) was very high in some areas, especially on the reef platforms. Infaunal species were of little importance in the Aitutaki system due to limited habitat, although the Pacific asaphis (*Asaphis violascens*) was present. Aitutaki's beche-de-mer resource was unusual: although habitat conditions looked very suitable, the full complement of species expected for a high island lagoon system (such as Aitutaki) was not present. The three most commercially valuable species were *Actinopyga mauritiana*, *Stichopus chloronotus* and *Holothuria atra*, which according to local knowledge, have not been harvested for many years. Deeper

water species, such as prickly redfish (*Thelenota ananas*) were recorded, but at low densities. Other species such as *Stichopus horrens* (collected for subsistence use) were recorded in very low numbers. *Holothuria leucospilota* (edible gonads are consumed) was present in moderate to high densities. Brown sandfish (*Bohadschia vitensis*) was absent, and only a single tigerfish, *B. argus*, was recorded. In addition, high-value black teatfish, *H. nobilis*, were also absent from records.

Finfish surveys are normally conducted at six locations in each of four reef types: outer reef, back reef, coastal reef and intermediate (lagoon) reef. However, a total lack of reefs along the coast and the murky water conditions within Aitutaki Atoll in the eastern lagoon area imposed a limit to the assessment of the coastal reef. Therefore, 18 dive locations in the outer, back and lagoon habitats were assessed with the following preliminary results.

**Outer reefs:** In general, fish density was high but diversity was very low. Most fish hid in pools in very shallow water and could not be reached due to the surf. There were fair numbers of large carangids (e.g. *Caranx melampygus* and *C. ignobilis*), *Chanos chanos*, *Scomberoides lysan*, and few average-sized *Cheilinus undulatus* (Fig. 4). Very high concentrations of *Cephalopholis argus* (ciguatera), and *Melichthys niger* and *M. vidua* were sighted. Parrotfish were the most abundant fish, with *Chlorurus frontalis* the main species.

Surgeonfish were represented by many *Ctenochaetus striatus*, as well as some species of *Acanthurus*. Very few *Acanthurus lineatus* and a few large schools of small *A. triostegus* were observed. *A. achilles* were rare. Higher level carnivores were frequent, such as *Lethrinus atkinsoni*. The fish were not wary of divers, most probably because carnivores are not targeted



**Figure 3 (above): Large broodstock shells in abundance (sizes 110 mm +) in parts of Aitutaki**



**Figure 4 (left): Napoleon wrasse on the outer reef of Aitutaki.**



because of problems with ciguatera, especially *Caranx argus*, *Lethrinus xanthurus*, *C. melampygus*, *C. ignobilis*, *Lutjanus fulvus* and *L. monostigma*. There was also a total absence of sharks and only one turtle was seen at the surface by the west pass.

**Intermediate reefs:** These were very rare in the lagoon and located in very shallow murky waters (Fig. 5). The eastern reefs were not sampled due to very low visibility. Hard substrate was mainly found in the southwestern part of the atoll, where elongated thin reef structures were found.

**Back reefs:** The east side of the atoll has no back reef, which is

only present on the west and south sides of the atoll. This habitat is represented by a mix of dead coral rock and pockets of sand and rubble, inhabited by many small surgeonfish, and a few other fish assemblages.

Socioeconomic surveys on Aitutaki covered 30 households, including 129 people (~7% of the total number of 435 households and current population of 1871). Household interviews focused on the collection of general demographic, socioeconomic and seafood consumption data. In addition, individual interviews

**Figure 5: *Acropora* coral in the lagoon.**



were conducted with finfish fishers (26: 22 men, 4 women) and invertebrate fishers (22: 13 men, 9 women). The most important socioeconomic parameters are presented in Table 1 for both Aitutaki and Palmerston atolls.

Survey data for Aitutaki suggest that the community is less

**Table 1: Fishery demographics, income and seafood consumption patterns on Aitutaki and Palmerston atolls**

		<b>Aitutaki</b> (n=30 HH)	<b>Palmerston</b> (n=10 HH)
<b>Demography</b>	% of HH involved in reef fisheries	80	90
	Nb fisher per HH	1.93 (±0.53)	2.40 (±0.52)
	of which % finfisher men	25.9	16.7
	of which % finfisher women	5.2	0
	of which % invertebrate fishermen	0	0
	of which % invertebrate fisherwomen	6.9	0
	of which % finfish and invertebrate fishermen	39.7	33.3
<b>Income</b>	of which % finfish and invertebrate fisherwomen	22.4	50
	% HH with fisheries as 1st income	6.7	40
	% HH with fisheries as 2nd income	23.3	0
	% HH with agriculture as 1st income	16.7	0
	% HH with agriculture as 2nd income	6.7	0
	% HH with salary as 1st income	56.7	50
	% HH with salary as 2nd income	13.3	20
<b>Consumption</b>	% HH with other source as 1st income	33.3	20
	% HH with other source as 2nd income	10	30
	Expenditure USD/year/HH	5,239.13 (±788.81)	7,784.32 (±1,502.36)
	Remittance USD/year/HH *	1,068.09 (±584.44)	826.36 (n/a)
	Quantity fresh fish consumed (kg/capita/year)	57.71 (±7.31)	111.52 (±26.48)
	Frequency fresh fish consumed (time/week)	3.35 (±0.33)	5.30 (±0.42)
	Quantity fresh invertebrate consumed (kg/capita/year)	2.52 (±0.90)	4.25 (±3.70)
	Frequency fresh invertebrate consumed (time/week)	0.25 (±0.10)	0.30 (±0.25)
	Quantity canned fish consumed (kg/capita/year)	20.37 (±5.24)	0.00 (±0.00)
	Frequency canned fish consumed (time/week)	1.64 (±0.37)	0.00 (±0.00)
	% HH eat fresh fish	100	100
	% HH eat invertebrates	63.3	70
	% HH eat canned fish	73.3	0
	% HH eat fresh fish they catch	73.3	90
	% HH eat fresh fish they buy	36.7	0
	% HH eat fresh fish they are given	66.7	100
	% HH eat fresh invertebrates they catch	63.3	60
	% HH eat fresh invertebrates they buy	6.7	0
	% HH eat fresh invertebrates they are given	6.7	20

\* average sum for households that receive remittances

dependent on fisheries than it may have traditionally been. The traditional dependency is evident from moderate to high per capita fresh fish consumption.

However, people also consumed canned fish at a significant rate, suggesting a change in lifestyle from fresh fish to processed fish, and a higher availability of cash, which helps to substitute subsistence fishing activities with purchased meals. A comparison of the current 2007 results with those reported by Adams et al. (1996)<sup>1</sup> in 1996, reveals that: 1) Aitutaki's total population has decreased from 2300 to 1800, 2) the average household size has also decreased (from 7 to 4 people), and 3) the frequency and quantity of fresh fish has decreased from 4.7 to 3.3 meals/week, and 100 to 58 kg/per capita/year. In addition, salaries are the most important source of income, whereas only 7% of households rely on fishing as a primary source of income, and 23% of households with a complementary secondary source of income. One reason for the suggested lifestyle change may be tourism, which brings at least 10 times as many visitors to Aitutaki per year as there are residents.

### Palmerston

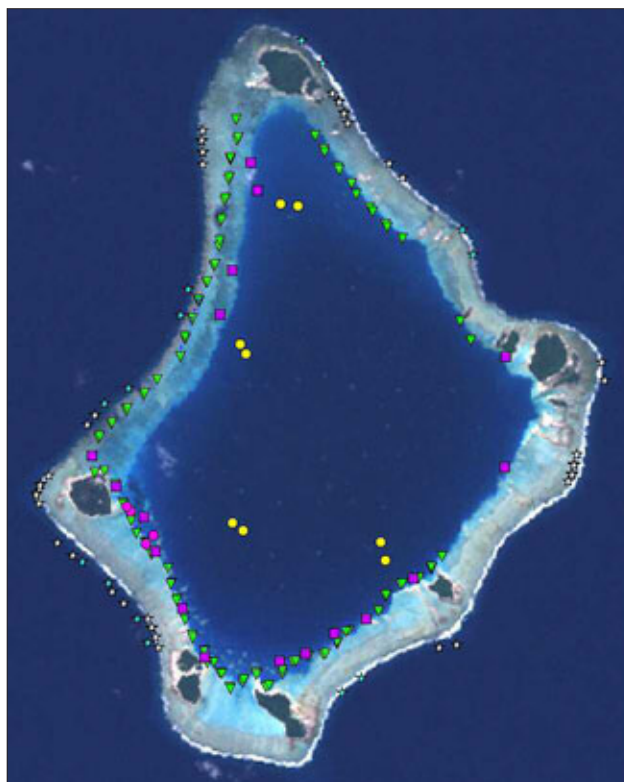
Palmerston Atoll has an extensive lagoon area (51 km<sup>2</sup>) that is 32% smaller than Aitutaki's, but is much deeper. There were six islets (or motus) on the barrier reef whose total land area was less than 2 km<sup>2</sup> (Fig. 6). The lagoon is closed off by the barrier reef except for one very shallow reef crossing (in the west, and with a depth of 2 m) and a second shallow cut, traversable at high tide, in the northeast. Circulation inside the lagoon was minimal, with the main water exchange occurring over the reef. Patch reefs were common

throughout the lagoon, often reaching up from a fine sediment benthos of 20–30 m (total inshore reef area was approx 10.2 km<sup>2</sup>).

Invertebrate surveys were conducted in many locations around the reef and lagoon (Fig. 6). Preliminary results revealed that *Tridacna maxima* was the most common giant clam species, and *T. squamosa* was present, but rare. Many dead shell piles were evident on most suitable reefs, indicating that the resource was being overfished. Small numbers of good sized adults are still present to ensure the flow of recruitment in the lagoon, but they are widely spaced and attention is required to ensure sustainability of the existing stock. The bulk of the female population is found in the larger sized clams (clams are protandric in their development), and therefore some stocks need to be protected in areas of medium

to high density. There was some mantle bleaching of clams in the lagoon (a similar reaction to coral bleaching), and no clams were found at depth on pinnacle patches, indicating that these habitats are affected by episodic periods of poor water quality.

Movements of trochus (*Trochus niloticus*) to Palmerston have been recorded for 1973, 1981, and 1982 (> 3000 shells transported), with just a single 1.5 tonne harvest in 1997 of poor quality shells. There is currently a moratorium on trochus harvesting, and there is some anecdotal evidence that the presence of trochus is limiting the return of giant clam stocks. Palmerston's outer reef (approximately 34.4 km lineal measure) was extensive, but most shells were recorded in the lagoon and near the 'draining' passages in the east and north of the lagoon. The cur-



**Figure 6: Palmerston Atoll invertebrate survey coverage, with survey stations noted**

<sup>1</sup> Adams T.J.H., Bertram I., Dalzell P., Koroa M., Matoto S., Ngu J., Terekia O. and Tuara P. 1996. Aitutaki Lagoon Fishery, Fisheries Resources Survey and Management Plan, SPC, Noumea, New Caledonia.

rent survey suggests that trochus stocks are patchy and, within the best aggregations, occurring at low density. The outer reefs are a good habitat (high topography and complexity) for adults, but the low production of juveniles in the lagoon means less export of shells to these reefs.

The density of urchins (*Echinothrix diadema*) was not as high as on Aitutaki. In fact, the community at Palmerston is clearing out some of these urchins (dumping them on the beaches). Infaunal species were of more importance in the Palmerston system due to the available habitat, but Pacific asaphis (*Asaphis violascens*) was the main target, and this species does not lend itself to surveying as it is found in the stony benthos. Anecdotal records show lobster abundance to be low to moderate.

Palmerston's beche-de-mer resource consisted of slightly more species than Aitutaki's. The sea cucumber resource comprised mainly *Stichopus chloronotus*, although *Holothuria atra*, *Actinopyga mauritiana* and several specimens of *Bohadschia argus* were also recorded. In addition, black teatfish, *Holothuria nobilis* and a single specimen of white teatfish, *Holothuria fuscogilva* were also recorded. Other species such as *Stichopus horrens* and *Holothuria leucospilota* were also present, although brown sandfish (*Bohadschia vitiensis*) was absent. There was undoubtedly an opportunity to fish small amounts of greenfish (*S. chloronotus*), which were ubiquitous in the lagoon and recorded in high densities. Surf redfish (*A. mauritiana*) also has limited potential.

Like Aitutaki, Palmerston's finfish surveys were restricted to the outer reef, back reef and intermediate reef, as the coastal

reef area was all but missing, due to the atoll's particular topography and the total lack of terrigenous influence from the small motus. The following preliminary results are drawn from the 18 dive locations surveyed across three habitats.

**Outer reefs:** The eastern side of the atoll was not sampled due to poor weather conditions. In the northwest and northeast areas, high densities and large sizes of *Hipposcarus longiceps* (Fig. 7), *Chlorurus microrhinos*, *C. frontalis*, *Scarus altipinnis* and *Lethrinus xanthochilus* also formed large schools, and some of the sizes observed were quite exceptional. Since fish were not scared by the presence of divers, it can be assumed that spearfishing is not practiced. Large *Plectropomus laevis* were found everywhere due to the fact that they were ciguatoxic and therefore not caught by fishers. The abundance of apex predators (especially *Carcharhinus amblyrhynchos* and *Triaenodon obesus*) was fairly good, but not exceptional.

During the sampling period, the water at the northern tip of the atoll was very milky, probably because of spawn, and the fish were actively mating (especially surgeonfish and parrotfish, Fig. 8). Abundant small sized and juvenile fish, especially *Scarus sor-*

*didus*, were recorded on the flat outer reef area, but many large sized fish were found on the shallower coastward part of the reef. Poorer fish fauna of smaller size was recorded at the southeast sites. Several sharks, both *Triaenodon obesus* and *Carcharhinus amblyrhynchos*, along with one turtle, were sighted in these areas.

**Intermediate reefs:** The inside of the atoll is dominated by a sandy floor dispersed with several small columnar-shaped pinnacles and small patch reefs that displayed fairly good coral coverage and fish biomass. Two pinnacle dives in the northwest area of the atoll displayed high numbers of good-sized *Scarus altipinnis*, *Hipposcarus longiceps*, *Cephalopholis argus* and *Lethrinus monostigma*. A site located on a patch reef directly in front of the main island had fairly good coral cover and diverse fish biomass, with one Napoleon wrasse and a large school of rabbitfish.

**Back reef:** This habitat in the south and southeast had small coral patches composed of micro-atolls, which act as natural fish traps. This area is about 3.5 nautical miles long and has been seriously impacted, being located very close to the inhabited island. The northern lagoon sector is much richer although the fish, especially the dominant *H.*

**Figure 7: *Hipposcarus longiceps* and *Chlorurus microrhinos* in Palmerston's western outer reefs.**







*longiceps*, escape at the approach of boats and divers. The back reefs are very poor in corals and very poor in fish, except for a very high concentration of juvenile *Ctenochaetus striatus* (Fig. 9) found in the thousands on the southwest back reefs. Abundant numbers of trevallies (*Caranx melampygus*) were feeding and grey reef sharks hovered around the area. Rays were found feeding on the sandy bottom around the reef structures (Fig. 10).

On Palmerston, the current total population of 56 people, and all 10 households, were surveyed. Household interviews focused on the collection of general demographic, socioeconomic and seafood consumption data. In addition, individual interviews were conducted with all 24 finfish fishers and 20 invertebrate fishers (12 women, 8 men). A fish management meeting was also conducted with the Palmerston community. A comparison of the most important socioeconomic parameters of both island populations is presented in Table 1.

The Palmerston community is greatly dependent on its reef and lagoon resources due to the limited alternatives to earn income on this isolated atoll, as well as the limited agricultural potential. This fact shows in a calculated per capita consumption of ~110 kg/year, which is much higher than the figure stipulated by Preston et al. (1995)<sup>2</sup> of ~70 kg/year.

**Figure 8 (top): *Chlorurus microrhinos* in mating display on Palmerston's outer reefs.**

**Figure 9 (middle): High concentration of juvenile surgeonfish.**

**Figure 10 (bottom): Blue fin trevallies (*Caranx melampygus*) and rays around back reef coral patch.**

<sup>2</sup> Preston G.L., Lewis A.D., Sims N., Bertram I., Howard N., Maluofenua S., Marsters B., Passfield K., Tearii T., Viala F., Wright D. and Yeeting B. 1985. The marine resources of Palmerston Island, Cook Islands (1988). SPC, Noumea, New Caledonia.

Living costs on Palmerston are high because all goods are imported by boat from Rarotonga, and all perishable food items require freezing facilities. However, Palmerston has experienced some modernization as seen in nutritional, educational, income and lifestyle changes. Comparing data reported in the 1988 survey

(Preston et al. 1995) and the CoFish 2007 survey reveals that 1) the population has decreased from 140 (end of 1980s/beginning 1990s) to 66 (in 1996) and 56 (in 2007); and 2) the total number of motorized boats has decreased, from a reported 24 boats (and 35 outboard engines) in 1988, to 15 boats surveyed in 2007 (9 motor-

ized, 6 non-motorized). In addition there has been a slight reduction in the volume of fish exported, from a reported 80% in 1988, to an estimated 75% in 2007. There has also been a reduction in the quantity of open water fish catches (~70% in 1988) in favour of mainly parrotfish (2007).



## The Live Reef Fisheries Trade Initiative

*The Live Reef Fisheries Trade (LRFT) Initiative, a part of the Reef Fisheries Observatory, is a project currently funded by the MacArthur Foundation, AusAID and the Taiwanese government. The Initiative provides technical assistance and advice to Pacific Island countries and territories in managing their live reef fisheries and addresses other problems and issues relating to these fisheries in order to ensure their ecological and economical sustainability over the long term.*

### MacArthur Foundation approves further funding support for SPC's LRFT Initiative

In March 2007, the MacArthur Foundation Board of Directors approved the extension of the grant in support of the LRFT Initiative, with USD 350,000 being provided over the next three years. The grant will allow SPC to continue to provide the needed assistance to its member countries and territories in addressing issues and problems relating to the conservation and sustainable management of their live reef fisheries.

SPC is very thankful for this continuing support from the MacArthur Foundation and looks forward to a further fruitful three years working together in partnership with the Foundation.

### Moving forward with the Kiritimati Island bonefish management plan

The Kiritimati Island bonefish fishery is a very important tourist-based catch and release sport fishery for Kiribati, with an estimated net worth of about USD 2.5 million annually. Because of concerns raised by

local bonefish guides and hoteliers on Kiritimati — in anticipation of potential problems from uncontrolled fishing efforts — the Kiribati government in 2002 requested SPC to assist in developing a management plan for the fishery. Due to a lack of information about the fishery, SPC initiated some scientific research and field experiments, which were conducted in 2003 and 2004. Most of this fieldwork went well, although some very important field experiments were vandalized towards the final stages of the survey, and so were not completed. Financial resources were short then, and the research was suspended until further funding could be found to complete the work. By 2006, with still no funds secured, the Kiribati government decided to look into internal funding options and again requested SPC's assistance.

A one-week trip was made by the Live Reef Fisheries Specialist, Being Yeeting, in January 2007 to discuss a strategy for moving forward with the Ministry of Fisheries and Marine Resources Development (MFMRD). During the visit — and after consulting with MFMRD and several other government departments that have an interest in the bonefish

fishery in Kiritimati — a six-month plan of action was drafted and presented to MFMRD. The plan consists of seeking funding as well as undertaking activities necessary to develop a Kiritimati bonefish management plan up to the actual completion and submission of the plan to the government.

The plan of action was implemented on 1 March 2007, and thus far, it is on schedule. Achievements to date, which are part of the action plan, include:

1. The completion and submission of a funding proposal to government. This has resulted in funds now being available to cover all activities, including the cost of technical assistance from SPC.
2. The completion and submission of a Cabinet paper to the Kiribati government for the endorsement of the management plan and related regulations to be developed.
3. The establishment of a Bonefish Task Force within the government that would provide governmental support and coordination of efforts and contributions of the different government



stakeholders. The Task Force is headed by the Ministry of Fisheries and comprises representatives from the Ministry of Environment, Ministry of Tourism, Ministry of the Line and Phoenix Group and the Attorney General's office.

4. The first consultation workshop with Kiribati Island stakeholders was held in mid-March. The workshop provided the opportunity to present some of the biological findings from the bonefish research to date, discuss management issues and concerns, and facilitate the development of a bonefish management framework by the stakeholders using the Ecosystems Approach to Fisheries Management. The workshop was a great success with strong positive support from the public. A workshop report has been finalized and distributed to the Kiribati government and workshop participants at the end of April 2007.
5. The next steps include an attachment training of a Kiribati fisheries officer at SPC to learn how to process biological samples (e.g. otoliths, gonads), and learn how to process and analyse data. The attachment will also be involved in writing up the draft bonefish management plan and regulations to take back to Kiribati at the end of the training. Both the plan and the regulations will be given to government and public stakeholders for finalizing before submission to the government for endorsement and implementation.

### Red listing of grouper species

The red listing of fish species is done through a process developed by the International Union for the Conservation of Nature

and Natural Resources (IUCN) to check on the status of exploited fish species. IUCN uses its widely understood system to assess and classify species according to their respective level of risk of global extinction. Critically endangered species ultimately become red listed by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which provides some protection for trade in signatory countries.

From 7–11 February 2007, the LRFT Specialist attended an IUCN workshop at the University of Hong Kong on the red listing of groupers. The workshop was attended by a number of well-known grouper researchers from around the world. Participants brought their own databases and references from the region they work in. The SPC PROCFish/C data, and data from previous SPC technical reports, were shared at the workshop, and together with data from the French Institute of Research and Development (IRD) provided by Michel Kulbicki, it was possible to complete an assessment of grouper species in the Pacific.

At the end of the workshop, the status of more than 100 grouper species was assessed. Twenty grouper species were classified as being threatened, meaning that these species needed urgent management measures to reduce their overexploitation levels in order for them to avoid becoming globally extinct. Most of these threatened species are not from the Pacific Islands region. Two species from the Pacific that are being targeted by the Live Reef Food Fish Trade, *Plectropomus areolatus* and *P. laevis*, were listed as vulnerable and therefore are in need of management, especially the known fishing practice of targeting their spawning aggregations.

The workshop was very useful in understanding the whole IUCN red listing process and in gaining an understanding of the status of groupers globally, and specifically, in the Pacific region. An information paper describing the IUCN red listing process will be circulated to SPC member countries in the near future. Also, a press release of the recent IUCN workshop held in Hong Kong can be viewed on the IUCN website:

[http://www.iucn.org/en/news/archive/2007/03/6\\_coral\\_reefs.htm](http://www.iucn.org/en/news/archive/2007/03/6_coral_reefs.htm)

### CITES update

The next meeting of the parties to CITES will be in June 2007, and the following marine species are being considered:

- Proposed for Appendix II listing: two species of spiny lobsters (Brazil population only); European eel; red coral; spiny dogfish (*Squalus acanthias*); Porbeagle shark (*Lamna nasus*); and an endemic Indonesian species of cardinal fish.
- Proposed for Appendix I listing: all species of sawfish.

The proposed listings under CITES should have no affect on Pacific Island countries and territories. Also on the agenda for future consideration are sea cucumbers, toothfish, some other shark species, and seahorses.

There is now a memorandum of agreement between FAO and the CITES Secretariat, where FAO will provide scientific opinion and advice on all proposed CITES listings of marine species. In this regard, FAO has begun a worldwide review of sea cucumbers, covering the biology, fisheries and stock status. This will form the basis for any scientific advice provided to CITES on sea cucumbers, in the event they are proposed for listing under the convention.

Also to be discussed at the upcoming CITES meeting is the trade in giant clams, especially for the aquarium trade. CITES is concerned that some species being traded are not second generation cultured, and it appears that giant clam exports from some countries in the Pacific are under question.

#### **Closer working relationships between SPC and SCRFA**

In February 2007, the LRFT Specialist met with the Director of the Society for the Conservation of Reef Fish Aggregations (SCRFA, website: <http://www.scrfa.org>) to finalize and sign a memorandum of understanding (MOU) between SPC (through the LRFT Initiative) and SCRFA that the two organisations have been developing and discussing over the last year. In the past, SPC has worked closely with SCRFA informally, for the benefit and interest of SPC member countries. The MOU will allow a closer formal working partnership between the two organisations, so that they can assess reef fish spawning aggregations and establish management and monitoring programmes in Pacific Island countries that will ensure the sustainability of reef

fisheries in the region. There are no funding commitments tied to this MOU, but it is hoped that funding proposals will be developed for future work activities.

#### **Tuvalu looks into the marine aquarium trade**

In March 2007, Mr. Tupulanga Poulasi, fisheries officer from Tuvalu's Fisheries Department, undertook a three-week attachment training under the LRFT Initiative Attachment Training programme. Attachment training is part of a regular capacity building programme for Pacific Island countries to build local expertise within fisheries departments so that they can conduct resource surveys and analyse and interpret survey results of their live reef fisheries for management and sustainable development purposes.

This attachment training for Tuvalu is a follow-up to in-country training on field survey methodology, and a survey of the marine aquarium trade resources of Funafuti, undertaken in 2005 at the request of the Tuvalu Fisheries Department. This survey looked at the potential of Tuvalu's marine resources

for the marine aquarium trade. Unfortunately Tuvalu had to defer this part of the attachment to a later date, due to local staffing shortages.

The aim of the attachment training was to learn how to clean, enter and analyze the Funafuti survey data using RFID, a database and query programme developed by the Reef Fisheries Observatory. The fisheries officer also had the chance to interpret survey results and to write a technical report under the guidance of the LRFT Specialist. The report discussed the current status of the potential marine aquarium trade resources, the available species and stock estimates (with recommendations on how much should be considered for exploitation), and what management setups and logistical factors should be considered before starting up operations. The technical report aimed to provide the status of the resource without trying to promote or negate the possibilities of a marine aquarium trade for Tuvalu. The first draft of the technical report was completed by the end of the attachment. The report has been finalized by mid-April, and submitted to the Tuvalu government for consideration.



## **■ AQUACULTURE SECTION**

### **Impacts of Policy and Institutional Environment on ACIAR Research in the South Pacific, USP Campus, Suva, 6-7 March 2007**

According to the Centre for International Economics (CIE), policy and institutional settings are a major influence on the uptake, effectiveness and, therefore, the impact of research projects in the Pacific. This was the premise adopted by CIE when it was commissioned by the Australian Centre for International Agricultural Research (ACIAR) to review the impact of policy and institutions on its research projects in the Pacific.

To explore this issue further the CIE organised a regional workshop, involving approximately 20 representatives from industry, academia, NGOs, regional agencies and ACIAR. Country participants included Fiji, Samoa, Solomon Islands, Papua New Guinea and Tonga. The workshop was co-hosted by the University of the South Pacific (USP) Pacific Institute of Advanced Studies in Development and Governance, and was

held from 6-7 March at the USP Suva campus. SPC's Aquaculture Adviser also participated.

Policy may negatively influence the incentives of producers to undertake the investments generated by research. Distortions can also lead to situations where new production techniques may have counter intuitive and sometimes counter productive effects. Formal and informal institutions may reduce returns to invest-

ment in new technologies. A lack of managing risk may deter smallholders from becoming specialised and moving out of subsistence production.

The workshop observed that project selection and design are critical stages that often fail to take into account the questions of commercial viability and the link between commercial involvement and adoption. Some of the issues poorly addressed at this stage include:

- Market and risk analysis;
  - Consultation with the private sector;
  - Analysis of incentives facing quasi-subsistence farmers;
  - Recognition of incentives driving researchers (e.g. the emphasis on producing publications); and
  - Contractual arrangements with private sector collaborators.
- Other important policy/institutional factors include:
- The security of property rights/tenure: Incorporating customary fishing rights; land tenure and its impact on mobilising land for investment or use as security for loans;
  - Government funding and its approach to research and extension activities: Donor dependence often deters government from funding or contributing to ongoing research and development; inadequate priority often given for spending in the agriculture/fisheries sector; inherent weakness in government extension services;
  - Issues of trust and methods of engagement lead to inappropriate contractual arrangements and enforcement: This impedes the scope for enterprises to be formally involved in growing/distribution/marketing and for input to provide credit and technology;
  - Weakness of national biosecurity agencies makes it difficult to comply with requirements for export markets;
  - Input costs may be unreasonably high. Especially concerning fertilizers and pesticides for agriculture. This may be the result of high internal costs (taxes) or that the perceived cost/benefits by farmers of technological gains are too low or uncertain;
  - Insufficient institutional capacity to absorb and utilise policy analysis (i.e. a lack of analytical tools for policy making);
  - Limited capacity to enforce legislation;
  - Poor governance influencing the targeted beneficiaries and consistency of application of regulations and taxation; and
  - Government marketing agencies may erode incentives for private sector activities.



## SPC Aquaculture Section assists with aquaculture environmental impact assessments in the Federated States of Micronesia and Cook Islands

### Coral farming in Kosrae, Federated States of Micronesia

In January 2007, SPC's Aquaculture Section commissioned Mr Steve Lindsay (Australia) as a short-term consultant to prepare an environmental impact assessment (EIA) for a coral farm on Kosrae. The farming proponent is Mr Martin Selch, a German entrepreneur who has formed a local company called Micronesian Management and Marketing Enterprises (MMME). MMME proposes to culture and export marine ornamental species, including hard and soft corals, from its base in Kosrae.

The main environmental risk reported by Mr Lindsay's assessment was the required removal of first generation coral fragments to initiate the farm. However, the conclusion drawn from the report supported, in principle, the business plan proposed by MMME. The EIA was submitted to Kosrae's Environmental Protection Agency, and a farming permit has been approved.

The EIA report produced by Mr Lindsay has been designed to provide a template for SPC to assist other commercial coral operations within the Pacific.

### Finfish and edible oyster farm in Rarotonga, Cook Islands

During the first quarter of 2007, SPC also provided advice to the Cook Islands National Environment Service to assess the environmental impacts for a proposed aquaculture operation on the main island of Rarotonga. The aquaculture operation is a joint project between Ecoculture Ltd, a local company headed by Mr Tap Pryor, and the Titikaveka Growers Association (TGA), a local association of agricultural growers.

The project will consist of fish ponds and oyster raceways. The



site already has a hydroponic farm. The species to be farmed include edible oysters, milkfish, Nile tilapia, and possibly prawns. The system is designed to use the fish farm's by-products for the growth of the oysters and the prawns. The raceways will serve as biofilters due to the microbial activity, the filter feeding of the oysters. Detritus feeding by the shrimp will help recycle nutrients. Pilot trials involving milkfish resulted in rapid growth rates. Small trials with local *Macrobrachium* lar were also carried out.

A comprehensive EIS was provided. One concern that was addressed was the impact of the project on the water table lens. The project has drilled its own wells to source water and has put in place safeguards for the proper discharge of wastewater. The EIA has also documented the risks and management practices to prevent negative impacts associated with the introduction of aquatic species that are alien to the Cook Islands. It is hoped that this document can serve as a model for enterprises considering similar projects.

After a process of technical reviews and public consultations, the National Environment Service issued Ecoculture and TGA a permit to proceed with farming. The company has since started importing Nile tilapia from the Philippines.



**Top: Coral fragments being grown by MMME in Kosrae, Federated States of Micronesia**

**Middle: Fish ponds for Rarotonga project**

**Bottom: Mr Tap Pryor next to some trial shrimp ponds for his Rarotonga project.**



## Fiji: Update on Dairy Farms Fiji's *Macrobrachium* shrimp farm and J. Hunter Ltd's Pearl Farm

While in Fiji recently, the Aquaculture Adviser took the opportunity to visit a shrimp farm in Navua and a black-pearl farm in Savusavu.

### DDF prawn farm, Navua

I accompanied Dr Tim Pickering (Aquaculture Lecturer, University of the South Pacific – USP) to the Dairy Farm Fiji (DDF) Aquaculture Unit, located at the former Viti-corp Ltd farm, which the company has leased from the Fiji Islands Government. *Macrobrachium* and tilapia had been farmed there previously, and so DFF inherited the existing ponds and infrastructure. Improvements were undertaken, however, to upgrade pond surfaces, dykes and slopes.

DDF prawn farm operates through a unique relationship between private sector and academia (i.e. USP). Under the current arrangement, USP — through its Institute of Marine Resources (IMR) — provides technical advice and labour to the farm on a cost-recovery basis. The School of Marine Studies (SMS) Seawater Laboratory at USP (Laucala campus) breeds and rears post-larvae (PL) ready for pond stocking. Avinash Singh (IMR) is project manager.

This is a useful case-study of technology transfer for the Pacific Islands region, as it is a successful demonstration of one mechanism for transferring scientific research and development to industry application. Early projections for the business model were derived from the economic models (available on the SPC Aquaculture portal website); it was interesting to see this model being applied in a real life

situation. The model continues to be useful for fine-tuning the whole operation; for example, by inputting real farm data to make decisions about the optimum size of prawns for harvesting, or the best stock density for prawns.

DDF has already completed several harvest cycles. The operation is well into the learning curve, and from this experience the commercial aspects of prawn farming are beginning to be understood. So far DFF has exceeded its harvest expectations (compared with the initial economic modelling), largely by increasing stocking densities. One of the 0.3-ha ponds was harvested the week prior to my visit, had yielded approximately 600 kg of prawns at 38 g/individual, after a six-month grow-out.

During my visit, I also noted some positive indications of the marketing demand for prawns. For example, DFF had just com-

pleted building a retail shop, called 'The Prawn Shop', which that week had sold 250 kg of prawns (at FJD25/kg) without any advertising. This consisted of sales made to people driving by who saw the sign and stopped. The product is marketed as 'Fiji Blue Prawn'.

According to Kevin Blake, CEO of DFF, the company is a small portfolio of two of New Zealand's eminent entrepreneurs (Bruce Pulman and Paul Boocock). The primary business of the parent operation in Fiji (Highway Stabilizers Ltd) is road works, bridge construction and other road projects. The Viti-Corp lease for the DFF prawn farm was added as an 'industry good' project, intended to raise the company profile.

Since DFF is generating a quick cash turnover, there is potential for commercial expansion. Currently there are 24 grow-out ponds and there are plans to



**The newly constructed Prawn Shop where DFF farm raised *Macrobrachium* prawns are sold. From left to right: Tim Pickering (USP), Avinash Singh (IMR), and Ben Ponia (SPC)**



build another 20 after the rainy season. To take the industry good concept another step further, and to make a wider impact at the community level, the DFF farm is keen to explore a satellite-farming concept. This would involve post-larval prawns being supplied from DFF hatchery extension services to village ponds. After a short grow-out period, these prawns would be marketed through the company chain: a soft version of the Fijian Goodman Fielder Crest Chicken contract grow-out model.

### **J. Hunter Pearl Farm, Savusavu**

The J. Hunter Pearl label is quickly becoming an exclusive, high quality product line for Fijian pearls. The farm's success is the result of attention to a number of critical factors, such as good business acumen, marketing, and consultation with local communities.

Under the managerial direction of Justin Hunter, the farm at

Savusavu has approximately 500,000 oysters under cultivation. The pearl harvests several million Fijian dollars (gross) per annum. Upon arrival I viewed several crops that had just been harvested. The pearls display the usual spectacular array of colour that Fiji pearls are becoming renown for. Amongst this crop were some dark 'chocolate' coloured pearls. The quality of the pearls is probably due, in part, to the expertise of the Japanese technicians employed by the farm. These technicians also provide seeding services for other pearl farmers in the surrounding area. The J. Hunter operation is also expanding to a second location.

The pearl farm operates its own hatchery, and routine spawning operations were underway during my visit. The Fiji oysters appear to have a high fecundity and large sized eggs, which could be related to the nutrient-

rich water quality environment of Savusavu Bay. While the hatchery is not large by commercial standards, it still has scope for expansion and could accommodate other species. The farm also employs a USP graduate as its biologist to carry out ecological baseline studies, particularly water quality monitoring and carrying out basic pearl grow-out experiments.

The pearl farm provides direct benefits through avenues such as employment (of all genders and a range of ages), but also indirectly through the business that the high investment pearl farming enterprise generates. The farm also pays a dividend from its profits to the local village. For example, it has provided funds for a community hall, which also serves as emergency shelter in case of a cyclone. In addition, the farm sponsors an education scholarship for young students from the vil-



**J. Hunter Pearl harvest, showing the different shades of Fiji pearls**



lage. Those interesting in knowing more about the farm's operations can visit their website ([www.pearlsfiji.com](http://www.pearlsfiji.com)).

At the farm we also discussed the possibility of carrying out

some mabe pearl seeding trials. The J. Hunter Pearl Farm has thousands of reject oysters that could be used for experiments. It would be particularly interesting if the geographical scope for this experiment could be

standardised and extended throughout the Pacific and other countries.



## Publications update

### Joint SPC and USP farming and hatchery techniques manual produced for freshwater prawns (*Macrobrachium rosenbergii*)

Two practical manuals on freshwater prawns (*Macrobrachium rosenbergii*), resulting from collaborative work between USP and SPC, have been recently published. Mr Satya Nandlal (SPC Aquaculture Officer) and Dr Timothy Pickering (USP Aquaculture Lecturer) have jointly contributed to the publication. These manuals use the same format for the popular tilapia hatchery and tilapia grow-out manuals produced in 2004 by the same authors.

The first manual is dedicated to hatchery operations (Volume I), and the second manual (Volume II) concentrates on pond grow-out.

The entire *Macrobrachium* prawn industry relies entirely on the availability of post-larvae. To face the needs of this young but growing industry in the Pacific, more hatchery and best practices are encouraged at the regional level. The hatchery manual is targeted fisheries department, NGOs, and the private sector that wish to improve or expand their techniques in setting up or running a freshwater prawn hatchery. The manual covers topics including hatchery techniques (broodstock, larvae, and feeding), system design, water quality management and more.

The grow-out manual aims at assisting small-scale commercial

farmers, as the freshwater prawn market is expanding quickly. This manual covers topics such as pond management, water quality management, harvesting and marketing.

Both volumes are well-illustrated and user-friendly documents, well initiated and very descriptive. They will greatly contribute to improve freshwater prawn hatchery and grow-out techniques in the Pacific region.

The manuals are available on the SPC aquaculture portal website:

[http://www.spc.int/aquaculture/site/publications/pub\\_search.asp](http://www.spc.int/aquaculture/site/publications/pub_search.asp)

Printed copies are also available for a charge. If you wish to find out more information about this publication the please contact:

Dr Tim Pickering, Marine Studies Program, University of the South Pacific, Private Bag, Suva, Fiji Islands. Email: [pickering\\_t@usp.ac.fj](mailto:pickering_t@usp.ac.fj), or

Satya Nandlal, SPC Aquaculture Officer, BP D5, 98848 Noumea, New Caledonia. Email: [SatyaN@spc.int](mailto:SatyaN@spc.int)

### SPC Pearl Oyster Information Bulletin revived

After two and half years of absence, the 17th issue of the SPC Special Interest Group Bulletin on Pearl

Oysters has been released. Professor Paul Southgate from James Cook University (Australia) has replaced Mr Neil Sims as the principal editor of this publication. The bulletin continues to be produced by SPC, with financial assistance from Australia, France and New Zealand. Although the bulletin will maintain the same general format, it will include minor changes, such as the publication of longer research type articles. It will also be seeking regular updates from major research groups and country statements.

The first issue includes an abstract of pearl oyster work presented during the World Aquaculture Society (WAS) conferences in Hawaii (2004) and Bali (2005). The issue also



includes news from the industry and a report on the SPC regional pearl meeting (Fiji, December 2005) as well as articles on the progress of pearling in the Pacific region: Cook Islands and Pohnpei, and in Tanzania, East Africa.

The *Pearl Oyster Bulletin* will aim at being published twice yearly and will mostly comprise research articles, reports from research groups or from the industry, as well as reports from member countries.

The *Pearl Oyster Bulletin* is available on SPC's website:

<http://www.spc.int/coastfish/news/POIB/17/index.htm>

Printed copies are mailed free of charge. The editorial board welcomes any contribution to the Bulletin. If you wish to contribute, join our mailing list or find out more information about this publication. Please contact:

Prof Paul Southgate, School of Marine Biology and Aquaculture, James Cook University, Townsville, 4811 Queensland, Australia, Email: paul.southgate@jcu.edu.au, or

Ben Ponia, SPC Aquaculture Adviser, BP D5, 98848 Noumea, New Caledonia. Email: benp@spc.int



## ■ NEARSHORE FISHERIES DEVELOPMENT AND TRAINING SECTION

### SPC assistance to New Caledonia-based tuna longline fishing company

Fisheries Development Officers Steve Beverly and William Sokimi began a medium-term project assisting a New Caledonia-based longline fishing company, Navimon, during the first quarter of 2007. The project began in February and will continue into June 2007, or until most of the company's eight boats and captains have had a chance to benefit from SPC's assistance. A Fisheries Development Officer will accompany the captain and crew of each boat on a regular longline fishing trip to observe standard operating practices with the view of offering recommendations for changes that could increase catch and fish quality and, thus, profitability of the operation.

Navimon has a fleet of eight longline boats (Fig. 1) that were built in either France or French Polynesia. All of the boats have the same general particulars and all have practically the same complement of gear, electronics and safety appliances. What follows are lists detailing boat particulars, fishing gear, wheelhouse electronics, and safety appliances on Navimon's boats.

#### Particulars

- Built by Chantiers Piriou, Concarneau, France 1999
- Steel stern house longliner
- LOA – 20.7 m
- LWL – 18.75 m
- Beam – 6.9 m
- Molded depth – 3.6 m
- Draft – 2.6 m
- Fuel capacity – 24 m<sup>3</sup>
- FW capacity – 12 m<sup>3</sup>
- Main fish hold (ice, 0°C) – 55 m<sup>3</sup>
- Freezer capacity (-20°C) – 20 m<sup>3</sup>
- Main engine – 450 CV
- Crew complement – 7

#### Fishing gear

- Lindgren-Pitman longline reel with 35 nm of 3.5 mm monofilament mainline.
- LS-4 line setter with 100 cm circumference drive wheel. This makes line speed easy to calculate: RPM/31 = speed in kt.
- Floats are 36 cm hard plastic longline floats.
- Floatlines are attached to floats – 12 m long, 6.4 mm black tarred line.
- Branchlines are 18 m of 2.0 mm monofilament with 3.6 Japan tuna hook w/ring

(90%) or 16/0 tuna circle hook (10%). There are no swivels except on the snaps. 10% have 30 cm of SS wire leader with eye-to-eye connection. There are approximately 1980 brachlines.

- There are 4 Sel Call radio buoys.

#### Wheelhouse electronics

- Furuno FCV-291 echo sounder
- Furuno FR-7062 radar
- Furuno FAP-300 autopilot
- Furuno GP-1810 GPS plotter
- Furuno GPS-WAAS GPS
- Furuno FM-8500 VHF radio
- Furuno FM-3510 VHF radio
- Furuno FS-1862-15 SSB radio
- Furuno FAX-207 Weather Fax Receiver
- Linemaster longline controller
- PC with MaxSea plotter software
- CapSat transceiver TT-3022-D VMS system
- Thrane and Thrane INMARSAT system
- Taiyo ADDF-TD-L1100 radio direction finder
- Sel Call SVC-STI buoy caller
- SST monitor

### Safety appliances

- Two liferafts with Hammerbolts
- Lifering with light (on wheelhouse bulkhead)
- Lifering (on main deck)
- EPIRB with Hammerbolt (on wheelhouse roof)
- Radar transponder
- SMDSS radios
- Flares, rockets
- Life jackets

On each boat there are fire extinguishers in every compartment, including the engine room, wheelhouse, galley, and crews' quarters. There is an automatic CO<sub>2</sub> system in the engine room, and there is a fire alarm monitor panel in the engine room. All compartments have an alarm.

The work plan devised for this project was to have Steve or William participate in a standard longline trip of about 15 days on each boat, during which the longline would be set and hauled 8 to 10 times. Their task is to observe normal fishing practices and then offer suggestions on possible ways for improving operations. At the conclusion of each trip, a debriefing session with SPC, Navimon's management, and the captain of the boat in question, will be held at Navimon headquarters. At the conclusion of the entire project a comprehensive report will be provided, detailing the findings and recommendations of the Nearshore Fisheries Development and Training Section. Observations regarding the following categories were made and noted.

- Boat
- Fishing equipment and gear
- Searching for fish
- Fishing operations
- Fish handling
- Catch and effort
- Captain and crew
- Ecosystem approach to fishing
- Other issues (miscellaneous)

Among other techniques, the captains were introduced to the use of remote sensing charts for finding likely fishing areas. Charts for New Caledonia's EEZ, showing sea surface height (SSH), sea surface temperature (SST), and current speed and direction, can be downloaded free from the Naval Laboratory Ocean Modelling (NLOM 32 Degree Page) website from the USA ([http://www7320.nrlssc.navy.mil/global\\_nlom32/nou.html](http://www7320.nrlssc.navy.mil/global_nlom32/nou.html)).

Temperature depth recorders (TDRs) were used to monitor depths of sets during all fishing operations. Depth reached by the deepest hooks in a basket is important to know when targeting different species. For example, bigeye tuna (*Thunnus obesus*) are usually found in much deeper water than are yellowfin tuna (*T. albacares*), while albacore tuna (*T. alalunga*) are found somewhere between the other two.

Most longline fishermen have learned some techniques for getting their line to sink to a certain depth but most times there is considerable guesswork and without the use of TDRs it is difficult, if not impossible, to know

the actual depth. Even when careful calculations based on line setter speed and boat speed are carried out, the actual depth is not really known. Another important factor is to have some way of determining the speed of the line being deployed from the line setter.

Not only will the distance between hooks be known but, in correlation with boat speed, line setter speed will determine the estimated depth that the line will settle at, notwithstanding environmental conditions. Often hand-held tachometers are used or the manual method of gathering the line to determine distance between hooks can also be used. Now, however, many line setters have a gauge to show line speed, or the speed can be read in the wheelhouse using equipment such as a Linemaster line controller, which works through a sensor attached to the line setter, which is calibrated to read the rotation speed of the line setter drive wheel.

Environmental conditions such as currents cause the line to settle at depths that don't correspond to calculations. Navimon's captains were shown techniques to



**Figure 1: Navimon fleet at Fisherman's Wharf in Nouville, New Caledonia.**



calculate theoretical depth. One method uses a hand-held tachometer to find the speed of the line setter drive wheel, and then calculates the speed of the line being thrown by the line setter if the vessel isn't equipped with a Linemaster line controller. Dividing this speed into the boat's speed gives a figure called the sagging ratio, or SR. Knowing the SR and the number of hooks in a basket allows the captain to calculate the depth of the deepest hooks in a basket.

At the end of March 2007, three trips had been made by William and Steve. In February Steve made a trip on F/V *Katia*, and in March he made a trip on F/V *Keitre*. William made a trip in April on F/V *Lanasera*. The results of those trips are briefly described as follows.

F/V *Katia* made eight sets fishing to the west of La Grande Terre (the big island of New Caledonia). A total of 349 saleable fish (mostly albacore) with an estimated weight of 6,050 kg were caught on 16,470 hooks. The catch per unit of effort (CPUE) for this trip was 2.1 fish per 100 hooks or 37 kg per 100 hooks. Calculated depth for the parameters used on all sets was 315 m. Actual depths according to TDR data, however, ranged from 175–185 m. This depth range also corresponds closely to where albacore tuna are found and this was the main species being sought on this trip.

F/V *Keitre* made seven sets fishing on the east coast of La Grande Terre and around the Loyalty Islands of Ouvéa and Lifou. A total of 12,700 hooks were set during the seven sets (average set was about 1800 hooks), catching 219 fish with an estimated weight of 3,850 kg. The CPUE for this trip was 1.72 fish per 100 hooks or 30.3 kg per 100 hooks. Calculated depth for the deepest hooks on F/V

*Keitre*'s sets was 330 m but actual depths based on TDRs ranged from 200–240 m. Yellowfin tuna and wahoo (*Acanthocybium solandri*) were caught on the hooks nearest the floats, while albacore tuna were caught on hooks 5 to 12 and bigeye tuna were caught on hooks 12 to 15. The boat was targeting a mixed fish species because the boat planned to unload at the new fresh processing facility (La Pêcheries de Lifou) on Lifou. The range of depths was suitable for mixed target species.

F/V *Lanasera* made 12 sets. Two sets were made northwest of New Caledonia while the other 10 sets were done on the east coast of La Grande Terre and northwest of the Loyalty Islands. A total of 22,800 hooks were deployed averaging 1900 hooks per set. The total catch was 233 fish with an estimated weight of 4804 kg. The estimated CPUE for this trip was 1.02 fish per 100 hooks or 21 kg per 100 hooks. Using the skipper's normal setting parameters, the calculated depth for the deepest hooks was 297 m. The range of depths actually reached, as determined by TDR data for the normal sets, was 165–224 m. The calculated depth for the deeper setting parameters using 340 RPM on the line setter was 443 m. The actual settling depth for the deepest hook on these sets ranged from 445–646 m.

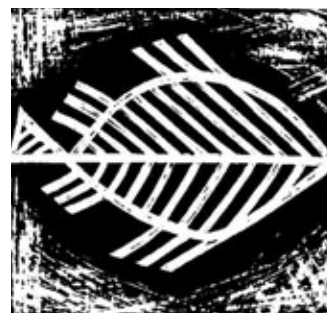
The overall catch on F/V *Lanasera* comprised 38.7% albacore tuna, 34.9% yellowfin tuna, 7.2% bigeye tuna, 9.8% mahi mahi (*Coryphaena hippurus*), 4.3% wahoo, 2.6% blue marlin (*Makaira nigricans*), 1.7% opah (*Lampris guttatus*), 0.4% swordfish (*Xiphias gladius*), and 0.4% sailfish (*Istiophorus platypterus*).

On all trips the captains were given advice on searching for fish using remote sensing data and other more traditional methods, such as following the

2000 m and 3000 m depth contours on the navigation charts, talking to other boat captains, watching for birds, and monitoring temperature on the wheelhouse SST monitor (i.e. searching for thermal fronts). Crews were also given advice on ways to improve fish handling and icing. When all trips have been completed in June, William and Steve will write a comprehensive report detailing all recommendations so that the Navimon fleet can improve their profitability.

In March, Steve conducted a sashimi tuna-handling workshop for captains and crew of Pêcheries de Nouvelle-Calédonie (PNC) in the Northern Province of New Caledonia (Fig. 2). PNC has a fleet of eight aluminium longliners that operate out of Pandop Harbour in Koumac (Fig. 3).

All of their fish is processed at Pêcheries du Nord's processing facility at Pandop Harbour. Fish are graded as either A grade or B grade soon after being unloaded from the boats. Captains and crews are paid based on fish grade. An A grade fish earns more for the boat than does a B grade or a reject fish. This fact was impressed on the captains and crew as they learned the fine points of fish handling to ensure that they land more A grade fish and, thus, get more in their pay packets. Copies of SPC's manual, On-board handling of sashimi grade tuna, were given to each workshop participant.





**Figure 2 (left): Fish handling workshop at Pandop Harbour.**



**Figure 3 (right): One of PNC's longline boats, F/V Karaavha 8, at Pandop Harbour.**

### Minimising sea turtle mortality from interactions from longline fishing gear

A project, sponsored by the US NOAA Fisheries' Pacific Islands Regional Office in Honolulu (PIRO), was undertaken in New Caledonia during March 2007 to heighten awareness of appropriate measures to take in order to minimize sea turtle mortality from interactions with longline fishing gear. The project included the development of turtle bycatch awareness and instructional materials, followed by a series of workshops, including one at SPC that included participation from the staff of the SPC Nearshore Fisheries Development and Training Section and that of New Caledonia's Marine Marchande<sup>1</sup>. Additional workshops were undertaken with captains and crews of the New Caledonia tuna longline fishing industry in the tuna longline ports at Noumea and Koumac.

The project's activities in New Caledonia are part of a greater effort by PIRO to heighten awareness of sea turtle bycatch mitigation, and to introduce mortality reduction techniques to several countries with domestic-based longline fish-

eries in the Western and Central Pacific Ocean. Similar PIRO-supported projects have been undertaken in Indonesia and several Pacific Island countries, including Papua New Guinea, Federated States of Micronesia, Marshall Islands, and Palau. Although basic elements addressing turtle bycatch are similar for each country, the projects have been developed to address the specific needs of the country concerned. For example, in some countries longline activities are undertaken by foreign fleets so awareness materials need to target the activities of those vessels and should be produced in the relevant languages. In New Caledonia, longlining is undertaken by purely domestic companies using national crews, which affords more ongoing contact with the crews, and creates opportunities for follow-up activities.

The project in New Caledonia was undertaken by Kona, Hawaii-based fisheries consultant Mike A. McCoy of Gillett, Preston and Associates. He was assisted by the staff of the

Nearshore Fisheries Development and Training Section and that of Marine Marchande, which coordinated the project's contacts with the fishing industry.

Initial impetus for the project came from several directions. During 2003–2004 NOAA fisheries scientists undertook activities in Papua New Guinea to track the migrations of leatherback sea turtles, *Dermochelys coriacea*, through satellite telemetry. Since migratory tracks from several leatherback turtles transiting the New Caledonia exclusive economic zone (EEZ) indicated the cessation of transmissions from ocean areas to the north and east of the main island, it was considered important that longline fishing operators in New Caledonia be made aware of these tagging activities and migratory patterns. The project also offered an opportunity to collect any anecdotal information on sea turtle interactions, in particular those with leatherbacks.

A second reason to highlight turtle bycatch mortality mitiga-

<sup>1</sup> The Service de la Marine Marchande et des Pêches: the government fisheries management agency in charge of commercial fisheries in New Caledonia.

tion was to encourage New Caledonia to increase its efforts at placing onboard fishery observers on its domestic tuna longline fleet. Observers can play an important role in raising awareness of means to reduce potential sea turtle mortality if interactions with sea turtles occur with longline fishing gear. Observers are also a critical component in the collection of data on fishery interactions with sea turtles.

The project was given additional momentum when fishery regulations regarding sea turtles were promulgated at the provincial level in New Caledonia during 2006. These regulations prohibit the capture of turtles by residents of New Caledonia within provincial (i.e. lagoon and nearshore) waters except when prior approval for cultural use has been obtained. Subsequently, new regulations addressing sea turtles that are

captured incidentally by commercial fishing vessels in national waters are being formulated and are expected to be promulgated by the New Caledonia government in the near future. The project was thus timely in highlighting possible responses at sea to sea turtle interaction with fishing gear, and sensitizing the industry to the overall subject.

The major objectives of the project were to:

- 1) heighten awareness of sea turtle interactions with fishing gear by familiarizing commercial fishing operators in New Caledonia and fishery observers and staff of Marine Marchande with techniques of handling sea turtles caught incidentally by fishing operations,
- 2) provide appropriate equipment and instructions to the

fishing industry on how to address specific sea turtle interactions with commercial fishing gear,

- 3) collect baseline data on interactions between sea turtles and tuna fish gear in New Caledonia,
- 4) integrate appropriate topics on sea turtle interactions with commercial fishing into ongoing work programmes of Marine Marchande and the SPC Training Section, and
- 5) enhance cooperation among the different government and non-governmental organisations involved in fisheries management and turtle conservation, locally and regionally.

The project directed its activities towards the following primary target audiences:

- Fishery observers and relevant staff of Marine Marchande;
- Operators and crew of domestic-based longline vessels in New Caledonia;
- Staff of L'École Des Métiers de la Mer, a tertiary training institution in Noumea that provides instruction in marine-related occupations including commercial fishing;
- Staff of the three provincial government departments in charge of inshore natural resources management and development; and
- Certain staff of the SPC Marine Resources Division who are active in support and analyses of pelagic fisheries in the WCPO.



**A Navimon crew member practices the turtle dehooking technique**



In addition to the above, two locally based environmental non-governmental organisations active in turtle conservation activities in New Caledonia — Worldwide Fund for Nature, New Caledonia (WWF) and the Association pour la Sauvegarde de la Nature Neo-Calédonienne — were advised of the project's activities and given a briefing at its conclusion. The Director of the Noumea Aquarium also participated in the briefing as the aquarium is currently undertaking several turtle projects, including placement of satellite transmitters and subsequent tracking of turtles in New Caledonia.

Workshops with the fishing industry resulted in the gathering of anecdotal information that suggests a low level of interactions between sea turtles and tuna longlining in New Caledonia. From discussions with captains and crews, it appears that when turtles are caught incidentally by longline operations, it occurs mainly with loggerheads (*Caretta caretta*). In only one instance did a captain acknowledge catching (entangling) a leatherback during fishing operations. Some captains mentioned catching four to five turtles over a multi-year span. One captain said he caught three turtles during 2006, but most captains indicated that interactions were rare.

The project successfully attained its objectives, due in great part to the cooperation and participation of the New Caledonia longline fishing industry. This project can serve as a foundation on which future turtle bycatch awareness activities can be undertaken by Marine Marchande at the national level, and by the SPC Training Section through training institutions at the regional level.

Some near-instant gratification was received by the project when Charles Cueurapuru, an observer with Marine Marchande was at sea on the Noumea-based F/V *Sidina* following attendance at one of the workshops. During his voyage, the vessel encountered a small (37 cm carapace length) green turtle

entangled in fishing gear. The turtle appeared very weak, so the observer and crew used skills described in the workshops to bring the turtle onboard, untangle the line, and resuscitate it. They raised its hind quarters, covered the turtle with a wet towel, and periodically checked if had regained consciousness. According to the observer, after about two hours, the turtle did regain consciousness and began moving its flippers. At the conclusion of the haul the skipper stopped the vessel and the turtle was returned to the water where it quickly swam away. Charles notes that this was the first turtle he has encountered in six years of observing on longliners in New Caledonia.



*Caretta caretta*

## Fisheries Development Officer visits Port Moresby, PNG to look at the domestic longline fishery and to deploy FADs

Fisheries Development Officer (FDO), Steve Beverly, spent two months in PNG recently, first looking at the domestic longline fishery in order to advise on improvements to increase profitability and sustainability; and, second, to rig and deploy six FADs for artisanal and sports fishermen.

### PNG's domestic longline fishery

The objectives of the longline portion of the FDO's visit to PNG were to:

- meet with longline fishery operators to identify and
- document current fishing and catch handling practices;
- undertake fishing trips to observe current fishing techniques and onboard handling methods to determine possible improvements; and
- observe unloading of catch and immediate post-dis-

charge handling and processing practices to determine possible improvements that could be made at that stage of the product handling chain.

Three longline companies were looked at: Sanko Bussan PNG, Fare Well Investment, and

Latitude 8. Between them they operate a fleet of around 30 tuna longliners. In addition, Sanko Bussan PNG operates a processing plant that grades and packs fresh fish for export and produces value-added tuna products for export. Fare Well Investment does its own grading and marketing but uses Sanko Bussan PNG for all processing and packing. Latitude 8 has a processing plant that grades and packs all Latitude 8 tuna for export.

These three companies had been experiencing losses and were having difficulties operating profitably due to a number of factors, including rising fuel and airfreight costs, decreasing market value for export fish, and decreasing catch rates. Several boats were looked at in this brief study, including boats from each company. Off-loading and processing was also viewed from all three companies.

However, the FDO went only on one fishing trip and that was with a Latitude 8 boat. A number of problems were identified with the vessel and this information has been passed on in a formal report. None of the problems related to fishing practices. It turns out that catch rates have started to improve in PNG. On the trip that the FDO made in October the boat set a total of 16,000 hooks during a 14-day fishing trip averaging 2000 hooks per set and catching 181 saleable fish weighing 5850 kg. The nominal CPUE was 1.13 fish per 100 hooks or 36.5 kg per 100 hooks. The catch was dominated by large yellowfin tuna (> 40 kg). Fish handling, off-load-

ing, grading, processing, and packing were all carried out according to industry norms. In spite of this relatively good catch of mostly high-grade tuna that was handled and processed very well, the trip resulted in a net loss for the company.

The reasons outlined above (high fuel costs, etc.) contributed to the loss from this trip, but another contributing factor was the boat itself. Older second-hand Asian boats can be bargains but the best option is to re-power them before putting them into service. Vessels over

20 years old have large large engines that use a lot of fuel (these boats were made at a time when fuel costs were half of what they are today). Re-powering with a more fuel-efficient engine would have made this boat more viable. The general condition of the boat also contributed to the loss. Only one of several refrigerated sea water (RSW) fish holds was operational. The boat had to return to port after only eight sets when the one hold was full. If all of the holds were working, then 14–16 sets could be made in a single trip, cutting back on



**Top: Fare Well Investment's F/V *Crystal 102* at the Main Wharf in Port Moresby.**

**Bottom: Frozen tuna quarter loins at Sanko Bussan's processing plant.**

operating expenses. Most of the other boats viewed by the FDO were in top condition, including Fare Well Investment's F/V *Crystal 102* (Fig. 1).

Airfreight availability and cost have always been a problem for PNG longline fisheries. The cost of air freighting fresh tuna to foreign markets is often equal to half the total revenue from fish sales, and cargo space is often hard to find. One way to avoid the dependency on airfreight is to produce frozen value-added products that can be exported by sea freight. One option to be

considered is producing value-added products onboard vessels. In order to do this, however, new vessels would be needed for the fishery. Value adding is already being done on shore in PNG, with fish produced by the domestic longline fleet. Sanko Bussan PNG was producing a variety of products, including frozen tuna quarter loins (Fig. 2) and frozen wahoo steaks that were being exported to markets in the European Union.

The fish are coming back to PNG's southern waters, but operating costs will probably continue

to rise. Older Asian boats in the domestic fleet probably won't survive but the better boats have a good chance of meeting the challenge if they continue with the trend of moving away from the dependency on airfreight. Frozen value-added products are likely to replace fresh frozen exports in the coming years in the domestic longline fishery in PNG. Any acquisitions of new boats should steer towards fuel-efficient boats capable of staying at sea for months and of producing frozen value-added products onboard.



## DEVFISH Project update

*The Development of Tuna Fisheries in the Pacific ACP Countries (DEVFISH) Project has been progressing through its planned activities in the second year of this four-year project.*

### Work with private sector/associations

One of the project's components is to assist beneficiary countries in improving their national policies for and national institutional arrangements with private sector tuna fishery development. This is done by providing support aimed at strengthening national consultative processes and national representation of private interests involved in tuna fisheries policies and development.

This process involves identification of appropriate private sector interest groups through consultations with the national fisheries authorities.

In instances where there was no formalized establishment of such interest groups and desire was registered, support was provided through:

- Constitution /articles of association guides

- Registration fee to appropriate government office
- Provision of templates for business /work plan development

Since the commencement of the project, seven countries have requested project support and this has been provided or is in the process of being provided.

The second phase of the project's assistance in this component — especially designed for newly established associations — is developing and expanding individual business and/or work plans so that they include links to relevant national and regional support programmes and schemes.

The project's profiling survey of associations, done through questionnaires given at various industry workshops, supports the findings of a previous FFA/SPC-sponsored study (Walton, H. 2001. National Fisheries Association Study. A report prepared for the Forum Secretariat and the Forum Fisheries Agency), which found that one factor recognised to have caused the downfall and lack of effectiveness of associations is their

reliance on voluntary input, which compromises the individuals' own business aspirations and takes time and effort away from their own work.

To build capacity at the association level to undertake and pursue these initiatives and interests, the project is supporting association staff for a trial period of 6–12-months. One of their primary responsibilities, in addition to administrative tasks and following up on outstanding association business, is pursuing opportunities to secure funding for sustaining positions and funding other identified activities after the DEVFISH sponsorship lapses.

DEVFISH is liaising with potential regional programmes and schemes to build support for DEVFISH's objectives. One potential area currently under discussion as this article goes to press is facilitation of support staff capacity development in proposal write-up and identification of a potential list of support schemes available through regional agencies.

To date the project has sponsored support staff in five asso-



ciations that have requested such assistance; a few more have expressed interest, and are in discussions with the project officer to finalize prerequisite requirements before support is provided.

Assistance provided within this component also includes support to facilitate a dialogue

between private sector interests and the government.

There are a few other forms of association support that the DEVFISH project is providing to tuna fishing associations in Pacific-ACP countries.

The project has limited funds available for small projects in

each of the participating countries, which can be accessed by a national coordinating committee.

Detail reports and work program/activities of the DEVFISH project can be viewed on [www.ffa.int/DEVFISH](http://www.ffa.int/DEVFISH).



## ■ FISHERIES MANAGEMENT SECTION

### Coastal Fisheries Management Programme in the Solomon Islands

*(This contribution is dedicated to Ms Ethel Sigimanu – former Permanent Secretary for the Ministry of Fisheries and Marine Resources)*

In an effort to manage the country's coastal fisheries resources, the Solomon Islands Ministry of Fisheries and Marine Resources (MFMR) has developed and implemented a community-based fisheries management programme (CBFMP) with assistance from SPC's Coastal Fisheries Management Section.

A model CBFMP was developed by SPC staff and approved of by MFMR as an approach for developing community fisheries management plans. The model takes into account the Solomon Islands' cultural complexity and traditional systems, its various forms of governance (community, provincial and national), and systems of tenure and resource ownership.

In recognition of the importance of managing coastal fisheries, the Koilovalu community, through their village Chief Mr Godfrey Tivahorua and Chairman Mr John Liva, requested MFMR's assistance in developing and establishing a fisheries management programme for their community. MFMR responded with the development of a CBFMP for the village and neighbouring

communities. The fisheries management plan will obligate communities to take actions to manage their fishery resources and marine environment, and obligates MFMR to provide technical services that support community actions.

#### Koilovalu community

Koilovalu village is situated along the southern coast of Small Ngella (Ngella Pile) in the Florida Islands, Central Islands Province. The village gets its name from **koilo**, a native plant (known scientifically as

*Callophyllum* spp.) and **vala** meaning 'across' in the native dialect. The village's population is around 400: 150 adult men and women, and the remaining being children and youth. Those that migrated to live and work in Honiara or other provinces are estimated to be in the range of 50–100 people.

The majority of people in the community are actively involved in fishing. The main fishing methods used by men are hook-and-line, drop-lining, trolling, and spearfishing, while women are more involved in



**The CBFMP team on their way back to Honiara: Carlos Haikau (front), and from left to right Peter Rex, Lionel Luda, John Leqata.**

collecting shellfish on reefs and mangrove areas, and hook-and-line fishing in coastal areas. Children are mostly involved in gillnet fishing and handlining.

The community is quite dependent on fishing for income and daily subsistence needs.

### Community workshops

Community workshops were held in Koilovala from 14–17 February 2007. The workshops were officially open by the Minister for Fisheries, Central Province Honourable Robert Kande. In his opening address, the minister highlighted the importance of looking after community fisheries resources, the importance of stakeholder participation in the decision-making process and participating in provincial efforts to develop the province as a whole. He also gave assurance of the current adminis-

tration's commitment to sustainably manage the use of these resources for future generations.

The workshops, which were facilitated by MFMR staff, identified key problems and how the community was affected by these problems, identified the causes and possible solutions to the problems, actions to be taken to resolve these problems, and suggestions for who was responsible for implementing these actions. Representatives from the neighbouring communities of Vunuha, Ghumba, Siarana and Burungia also attended the workshop, expressing their interest and support for the programme.

### The management plan

Information gathered from the community workshops were compiled by programme staff and used to formulate a commu-

nity fisheries management plan. The plan highlights some of the key problems identified by the community, and covers a range of actions to be undertaken by both the community and MFMR.

Before any undertakings are implemented, the draft plan must first be approved by MFMR and the community.

### Final word

The establishment of a national CBFMP for the Solomon Islands is seen as an important initiative that supports the government's aim of providing greater food security for everyone, especially people living on the outer islands and in rural areas.

The CBFMP approach acknowledges that local communities are the prime instigators of attitude change, and that communities need to understand that it

### Rural communities lead resource management

**A new programme has been established by the Ministry of Fisheries and Marine Resources to enable community participation in sustaining their fisheries and marine resources. The programme is called 'community-based fisheries management' and will be facilitated by a team of five officers from the Ministry of Fisheries and the Secretariat of the Pacific Community (SPC).**

Ministry of Fisheries Permanent Secretary Ethel Sigimanu told Solomon Star that as resource owners and users, communities have to participate in the programme. 'It is the communities who will use the resources therefore, the Ministry sees that it is their responsibility to use and look after their resources wisely.'

'We took this approach because our capacity is very small to ensure that marine resources are preserved and are used in a sustainable way,' Mrs Sigimanu said. The programme involves workshops and awareness among communities on how to identify problems in relation to the use of fisheries and marine resources.

Mrs Sigimanu said these awareness programmes would help communities identify problems they have encountered in relation to their resources and seek solutions to those problems. The community-based fisheries management programme was the Ministry's initiative since last year. The permanent secretary said Koilovala Village in Small Gela is the first community to adopt this programme.

'This is an ongoing programme that will cover all provinces but for the start, only one community from each province will be selected upon their interest,' Mrs Sigimanu said.

This means, communities will have to identify their problems and then request the team to include them in their programme. SPC's participation in the programme is to provide technical support. SPC's Coastal Fisheries Management Officer Etuati Ropeti, who is also the technical adviser of the programme, said when the programme was initiated, a preliminary study was also conducted to identify the needs for the programme.

'Today we are actually providing advice and implementation is on the ground,' Ropeti said.

*Excerpts from the Solomon Star Newspaper 21 February 2007 (reprinted with permission)*

is they who must take responsibility for looking after their fishery resources and marine environment.

Changes in community attitudes can be facilitated with MFMR as the lead agency, along with international and local non-governmental organisations (NGOs). These agencies can support awareness programmes and the development of fishery resource management schemes to properly manage the inshore fish stocks of the Solomon Islands.

Awareness programmes play a crucial role in the development of a CBFMP. Such awareness

programmes increase local communities' understanding of the marine environment, the current status of coastal fisheries resources, and problems associated with the marine environment.

The CBFMP, which has now been implemented in Koilovala, will no doubt benefit the community for many years ahead.

#### Acknowledgements

The work in Koilovala would not have been possible without the support of the Permanent Secretary Ms Ethel Sigimanu and the staff of MFMR. Support from the premier and ministers

of the Central Province government also needs special mention.

The hard work of the CBFMP team, Carlos Haikau, John Leqata, Peter Rex and Lionel Luda are very much appreciated. Keep up the good work!

Special thanks go to the Chief, Chairman and people of Koilovala who have shared their vision and taken the initiative in ensuring that their coastal fisheries resources will be well looked after for now and future generations.



#### Dynamite and chlorine causes scarcity in marine resources

**Dynamite and chlorine have been identified as the main cause of fish and marine resources scarcity in Ngella, Central Islands Province. Koilovala villagers revealed this during the first community-based fisheries management workshop held at their village last week.**

**The management workshop was an initiative of the Ministry of Fisheries supported by the Secretariat of the Pacific Community (SPC). Speaking to Solomon Star yesterday SPC's Coastal Fisheries Management Officer, Etuati Ropeti, said villagers only realised the effects of dynamite and chlorine on their marine resources after comparing the resources they have now to what they used to have.**

**Mr Ropeti said there are other contributing factors such as population growth and pollution. However, villagers felt that dynamite and chlorine were the main causes for their declining marine resources. 'People have been practising these for so long and today more and more people from outside are using these methods in their waters every now and then.'**

**'Some of the villagers have learnt from these techniques and are now practising them as well,' Mr Ropeti said, reiterating what the villagers have raised during the workshop. Therefore, he said having realised these problems, the villagers are now working with the police to put a stop to these destructive methods of fishing.**

**'It is encouraging to see that the communities have realized one of the major causes to unsustainable harvest of fish and marine resources and are willing to work together with the police to protect their environment,' Mr Ropeti said.**

**He said the Koilovala villagers have also agreed to set up their community by-laws to ban the use of dynamite and chlorine in their waters. They also requested the Ministry of Fisheries to provide awareness programmes against these destructive methods of fishing. Ministry of Fisheries and Marine Resources Permanent Secretary Ethel Sigimanu said people have turned to such fishing methods because of commercial gain.**

**'The pressure from school fees and other needs could be one of the pressures that gave rise to such unsustainable harvesting,' Mrs Sigimanu said.**

**Therefore, she said her ministry is encouraging communities to give suggestions on how to resolve these issues on dangerous fishing methods through the community-based fisheries management programme. Mr Ropeti said this management plan would spell out the responsibility of not only the communities but also the government. But he said the overall objective of the programme is for the community to take ownership of the management.**

*Excerpts from the Solomon Star Newspaper 21 February 2007 (reprinted with permission)*



## Developing a coastal fisheries legislation for Kiribati

In the last two years, FAO undertook a project that provides assistance in establishing coastal fisheries legislations in Micronesian countries. Kiribati was one of the countries involved. SPC's Coastal Fisheries Management Section was asked to provide expertise to the project.

SPC's Coastal Fisheries Management Adviser, Ueta Faasili, and a legal consultant, drafted coastal fisheries legislation for Kiribati, provided a template for community fisheries by-laws, and ran a one-day workshop for relevant and

interested ministries and stakeholders in order to provide guidance on how the legislation may proceed.

The assignment concluded with drafts of:

- Cabinet submission for the Ministry of Fisheries and Marine Resources;
- An interim by-laws process to be used by the island councils, Fisheries Division and other important stakeholders in developing fisheries by-laws; and

- A by-law template to be used during the formulation of fisheries by-laws.

Recommendations were also put through to the Ministry of Fisheries and Marine Resources Development as a guide in developing its legislation.



---

© Copyright Secretariat of the Pacific Community, 2007

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

Original text: English

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

## ■ THE FISHING CAPACITY OF LONGLINE AND POLE-AND-LINE FLEETS IN THE WESTERN AND CENTRAL PACIFIC OCEAN

The control of fishing capacity continues to be one of the most significant challenges facing national fishery managers and administrators, as well as the various tuna regional fisheries management organisations (RFMOs) around the globe. In some fora, the level of analysis that has been undertaken to develop capacity controls is relatively involved and complete. In others, data are not yet available from all the required sources for quantitative assessment of national and regional capacities of the relevant fishing fleets. Highly migratory species (HMS) fisheries in the western and central Pacific Ocean (WCPO) fall into the latter category. This study complements a 2003 report on purse seine capacity in the WCPO. To date there have been no published reports documenting the num-

ber, much less the fishing capacity, of longline or pole-and-line fleets in the WCPO.

To augment that previous study on the fishing capacity of the longline and pole-and-line fleets, the consultancy firm Gillett, Preston and Associates (GPA) was contracted in June 2006 by the US National Marine Fisheries Service Pacific Islands Regional Office to review the fishing capacity of these two fleets. Work on the review began in early July 2006 and was completed four months later.

The difficulties of measuring fishing capacity should not be under-estimated. In a review of global longline fishing capacity, Miyake<sup>1</sup> states it is 'very hard to define and furthermore, almost impossible to quantify at present'. Because the survey was an

initial attempt to estimate a fairly elusive subject in the WCPFC area, a relatively simple input measure of capacity is used: the number of vessels in the various fleets. More specifically, capacity is defined as the number of vessels having at least some participation in tuna longline or tuna pole-and-line fishing in the WCPFC area in 2005.

The results of the study were presented in Apia in December 2006 at the annual meeting of the Western and Central Pacific Fisheries Commission. The following are the main findings of the study.

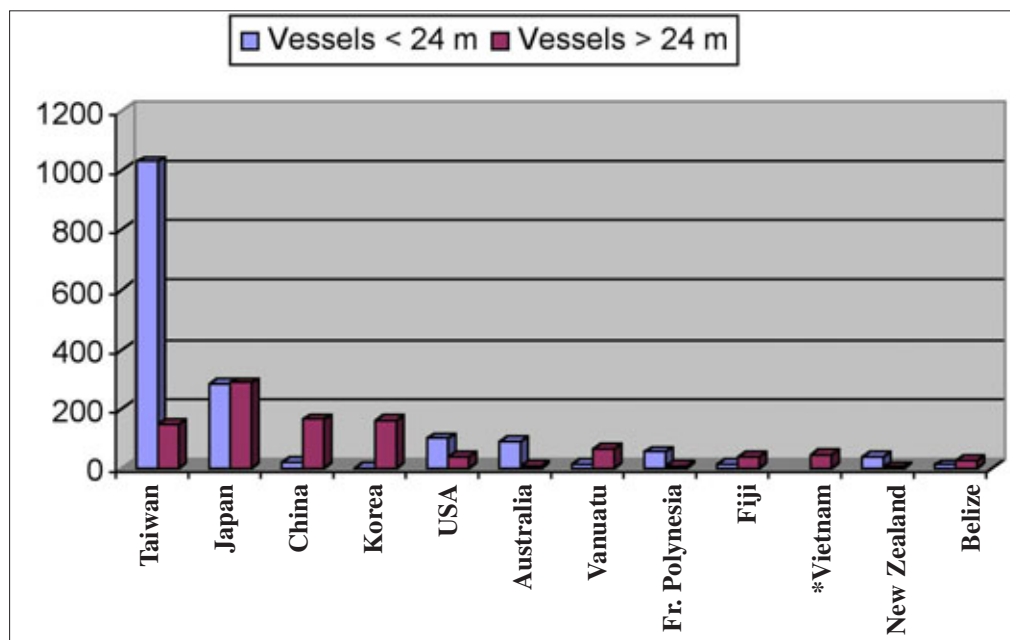
<b>Major constraint</b>	The lack of detailed vessel information from Japan and Taiwan was the study's greatest constraint to obtaining an accurate assessment of fishing capacity in the region.
<b>Fleet activity</b>	According to data collected during this study, the longline and pole-and-line vessels of at least 29 nations were active in the WCPFC area in 2005. The largest longline fleets were those of Japan and Taiwan. The largest pole-and-line fleets were those of Japan and Indonesia.
<b>Estimate of the number of longline vessels</b>	Taking the national longline fleets for which the study's database has good coverage (25 countries, 1,021 vessels) and adding to it the estimates from other sources for the vessels of Japan, Taiwan, Indonesia, and Vietnam (3493 vessels) results in the study's best estimate of the number of longliners 14 meters and above: 4514 vessels.
<b>Estimate of the number of pole-and-line vessels</b>	Taking the national pole-and-line fleets for which the study's database has good coverage (7 countries, 138 vessels) and adding to it the estimates from other sources for the vessels of Japan (215 vessels) results in the study's best estimate of the number of pole-and-line 14 meters and above: 353 vessels.
<b>Limitations and gaps of the databases</b>	Numerous limitations and gaps in data must be acknowledged. Vessel size, transliteration of the Chinese language into Taiwanese, and the Pacific Islands Forum Fisheries Agency's Regional Register are particularly important and require special attention.
<b>Improving the estimates of vessel numbers</b>	Estimates of vessel numbers could be improved considerably by obtaining the full cooperation of Japan and Taiwan, gaining a greater understanding of longliners based in Indonesia and Vietnam, and altering the WCPFC vessel reporting requirements.
<b>Obtaining an output-oriented estimate of fishing capacity</b>	Going beyond fleet sizes to obtain an output-oriented estimate of fishing capacity (potential annual catch) appears possible. More information on vessel characteristics and catch rates are required, but this could be obtained, or at least estimated, through a combination of available data and fleet experience.

<sup>1</sup> Miyake, P. 2004. A review of the fishing capacity of the longline fleets of the world. p. 157–170. In: Bayliff W.H., de Leiva Moreno J.I. and Majkowski J. (eds). Management of tuna fishing capacity: Conservation and socio-economics. Second meeting of the Technical Advisory Committee, FAO Fisheries Proceedings Number 2, Rome.

The number of longline and pole-and-line vessels estimated by the study are shown in the figures below.

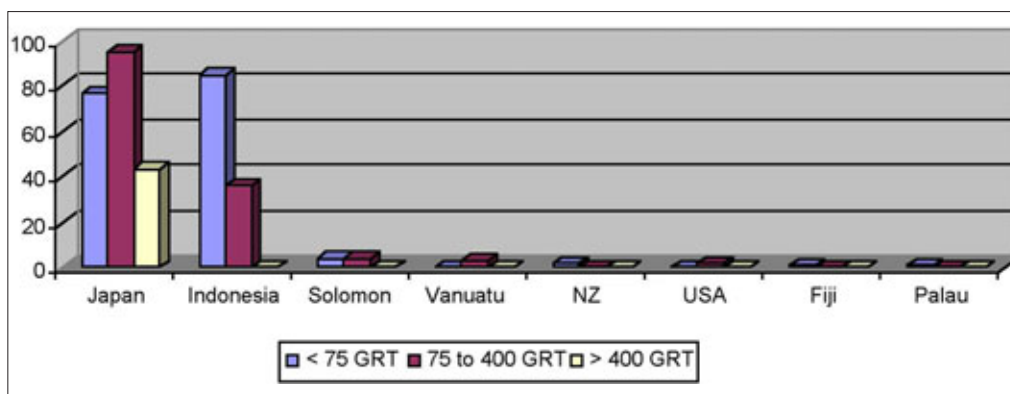
A copy of the full study in electronic form is available from Gillett, Preston and Associates (gillett@connect.com.fj)

(Source: Gillett R. and McCoy M.A. November 2006. Gillett, Preston and Associates)



#### Major WCPFC area longline fleets

(\* As many or most of the small longline vessels in Vietnam operate only part time, only the large Vietnamese longliners are shown here)



#### Pole-and-line vessels over 14 meters

## ■ SPEARFISHING IN THE PACIFIC ISLANDS: CAN IT BE MANAGED?

Spearfishing is growing in importance in the Pacific Islands. It was almost insignificant in the region prior to the introduction of diving goggles in the middle of the twentieth century. Now the fishing method is one of the

major components of inshore fishing in the Pacific Islands. Spearfishing is also a major contributor to what is arguably the greatest fishery problem in the Pacific Islands: excess inshore fishing effort and associated

resource declines. On the positive side, spearfishing produces much of the local marine food available to Pacific Islanders.

A recent SPC/FAO study reviewed spearfishing in select-



ed Pacific Island countries. The report of the study identified the important species caught, ascertained the major difficulties caused by spearfishing,

explored interventions to mitigate the problems, and considered the assistance likely to be required by Pacific Island countries in the management of their spearfisheries.

The major spearfishing issues in the five countries of the study were identified as:

<b>Important spearfishing issues in Fiji</b>	<p>Commercial spearfisheries depleting fishery resources in areas that may be quite important for village food supplies.</p> <p>The low priority given to enforcing legislation related to spearfishing.</p> <p>The exclusion of 'spearing' from commercial fishing activities that require a license, and the exclusion of 'spearing' by outsiders from activities that can be regulated by traditional authorities under the Fisheries Act.</p> <p>The difficulty of collecting evidence required for a successful prosecution of fishing with scuba gear.</p> <p>The difficulty of villagers enforcing rules on fisheries activities that mainly occur at</p> <p>The incompatibility of marine-oriented tourism and spearfishing, or at least commercial spearfishing.</p> <p>The health risks of scuba to untrained divers.</p> <p>The use of large 'fish collection vessels' in conjunction with spearfishing.</p> <p>The targeting of fish spawning aggregations by spearfishers.</p>
<b>Important issues in Tonga</b>	<p>In Tonga's open-access regime there is some concern that nothing practical can be done about the excessive fishing effort, a major element of which is spearfishing.</p> <p>There are very few controls on spearfishing, and very lax enforcement of ones that do exist.</p> <p>Although the use of scuba for spearfishing appears to be contained, there is some worry that the situation may change if the beche-de-mer fishery and associated scuba use re-commence.</p> <p>It is difficult or impractical to collect the evidence required for a successful prosecution of using scuba for spearfishing.</p> <p>Some individuals are concerned about the long-term impacts of visits by industrial-scale spearfishing operations to Tonga's isolated reef areas.</p> <p>Spearfishing inside the fish fences for fish, which other people considered have already been 'caught' is growing.</p>
<b>Important issues in Samoa</b>	<p>Balancing the need to protect Samoa's inshore fisheries from the deleterious effects of spearfishing with the political directive to allow the existing group of spearfishers to continue.</p> <p>Reconciling the village by-laws (which may ban scuba spearfishing) with the national level de-facto permission granted to a group of scuba spearfishers.</p> <p>The difficulty of reducing fishing effort from a variety of inshore fishing techniques, the most important of which is spearfishing.</p> <p>Whether the export of inshore fisheries resources (an important component of which is the catch from spearfishing), is justified.</p>
<b>Important issues in Tuvalu</b>	<p>There is sometimes conflict between spearfishing and other gear; the contention that spearing reduces the amount of fish available for line fishing.</p> <p>The complexity of reducing Funafuti inshore fishing effort</p> <p>The concept that there are limits to inshore fisheries production is new to many Tuvaluans.</p> <p>The perception by some government officials that any controls placed on inshore fishing (including spearfishing) by the Fisheries Department could be thought by the general public as being contradictory to the Fisheries Department's development efforts.</p> <p>The increased algal growth in the lagoon area around the populated centre of Funafuti could be, at least partially, as a result of the removal of herbivorous fish by spearfishing.</p>
<b>Important issues in the Solomon Islands</b>	<p>Fishing is an important component of inshore fishing effort and, even in areas away from the urban centres, there is the perception that inshore resource are declining due to fishing pressure.</p> <p>Night-time spearfishing with flashlights is having a major impact on parrotfish and spawning aggregations of groupers.</p> <p>There is considerable concern about coral damage while spearfishing.</p> <p>At least some fisheries officers feel that spearfishing is wasteful because of the damage to fish flesh and because a spear hole results in faster bacterial decomposition.</p>

The 10 most important spearfishing difficulties from the five country visits, a review of the literature, and discussions with fishers appear to be:

- The contribution of spearfishing to inshore over-fishing
- The use of scuba in spearfishing
- Night spearfishing
- Industrial spearfishing
- Negative interaction with line fishing
- Poaching and difficulties of surveillance
- Devastation of certain species
- Devastation of spawning aggregations
- Incompatibility of spearfishing with marine tourism
- Increased algal growth due to the removal of herbivores.

The table on page 32 summarizes these difficulties and lists some successes and failures in their mitigation.

The SPC/FAO study indicates that spearfishing is important in

Pacific Island inshore fishing. The visits to five countries during the present study show that there are very large differences between countries, and between locations within a single country, in the level and type of spearfishing activities. A common feature in each area is that spearfishing is a major contributor to inshore over-fishing. In all but the most traditional places there are difficulties with enforcing spearfishing management measures.

A few generalisations on spearfishing management can be made:

- For several reasons, a complete and effective ban on scuba spearfishing and effective enforcement is the single most important spearfishing management measure. Expressed in crude terms, 'If a country does nothing else right in spearfishing management, ban the use of scuba'.
- Spearfishing effort must be managed along with other forms of inshore fishing. Attempts at restricting just spearfishing are not likely to be successful, as fishing effort may be easily transferred to other small-scale fishing methods.

- In the management of inshore fisheries, including that of spearfishing, only a few measures are likely to be successfully implemented at the national level. Most interventions must be formulated, initiated, and enforced at the local level, preferably with some assistance from the national level.

In the management of Pacific Island inshore fisheries, no single measure is likely to be effective in addressing all the present and future concerns at a particular site. The relative success of the various possible interventions is likely to change over time as conditions evolve. It therefore seems that an effective community-level strategy would be to have a marine protected area along with other interventions such as limits on commercial species, seasonal bans, and prohibition of night spearfishing ('MPA plus').

A full copy of the report of the SPC/FAO spearfishing study is available on the FAO website:

<http://www.fao.org/docrep/009/a0774e/a0774e00.htm>



## Spearfishing difficulties and considerations of mitigation measures

Spearfishing Difficulties	Considerations	What has not worked at addressing issue; What may have been over-looked	What has enjoyed at least some success at addressing issue
<b>Spearfishing is a major contributor to inshore over-fishing</b>	Excess inshore fishing effort and associated resource declines are arguably the greatest fishery problem in the region  The problem of inshore over-fishing is complex and there are no easy solutions	National level legislation by itself  Management interventions dealing with spearfishing alone are unlikely to be effective at addressing inshore over-fishing  All attempts at controlling effort in open access situations	Spearfishing must be treated as one of many fishing methods that contribute to the problem.  Providing information/assistance/encouragement to communities for them to address issue
<b>Use of scuba</b>	Reduces fish populations to low levels  Diminishes/eliminates reserves for fish in deep water  Inevitable use of scuba gear by unqualified and/or careless people and accompanying injury and death	Simply banning the use of scuba for spearfishing or all fishing, because of difficulties of obtaining evidence for court prosecution Research on the issue is no guarantee that a ban on scuba will follow (Guam)	Banning at the national level the possession of scuba and fishing gear in same boat or car  Awareness raising: In rural areas, social pressure to avoid what is considered an unsustainable practice seems more effective than government regulations Using dive tourism operators to promote/enforce bans
<b>Night spearfishing</b>	Reduces fish populations to low levels	Attempts to legislate on the national level	Bans at the community level
<b>Industrial spearfishing</b>	Past or present operations in Fiji, Tonga, Solomons, and Northern Marianas use large vessels and many divers  Sequential devastation of fish populations to the detriment of adjacent villages under the guise of development	Assuming that cash provided to villages adequately compensates for resource depletion	Providing information to national authorities on experiences in these operations (e.g. southern Lau in late 1980s)
<b>Negative interaction with hook/line fishing</b>	Traditional fishers often feel that spearing reduces the amount of fish available for line fishing, either by reducing the abundance of fish or by making them wary of all fishing gear.  Although could be dismissed as not being important, it appears to be perceived to be a significant issue in many traditional areas	Ignoring the generational aspect to the spear/line conflict - old men, who mostly fish with lines, disapproving of spearfishing, mostly done by much younger males.	Communities banning spearfishing in certain areas (e.g. inside lagoon)
<b>Poaching and difficulties of surveillance</b>	Because spearfishing occurs at underwater and often at night, enforcement of any management rules can be difficult and expensive.	Suggestions that national governments should provide boats and fuel to communities for policing usually do not come to fruition, nor do they seem sustainable	Sensitisation of communities by outside partners as to the value of their coastal resources and the harm done to the resources by poachers.  Sanctions on both boat owners and on spearfishers
<b>Devastating certain species</b>	The humphead parrotfish ( <i>Bolbometopon muricatum</i> ) and the humphead wrasse ( <i>Cheilinus undulatus</i> ) seem to be especially unfortunate as they are both high value species and inherently not very resilient to fishing pressure	National level legislation banning commercialisation of certain species without significant follow up is not effective even in a capital city	Local-level bans on night spearfishing  An externally funded marketing project refusing to buy these species
<b>Devastating spawning aggregations</b>	The large numbers of fish taken at some spawning aggregations give the impression that the species is abundant. This can hide the less obvious possibility that, for some species, one or a few large aggregations may represent all the adults in a population (Y. Sadovy, per.com., November 2005).	National level legislation by itself	Creation of an awareness at both the fisheries officer and the community levels of the importance of spawning aggregations and associated protection  Community involvement in establishing marine protected areas that encompass spawning aggregations
<b>Incompatibility of spearfishing and marine tourism</b>	Spearfishing, whether traditional or modern, catch many of the same fish that are most visible/valued by tourist divers Even at sustainable levels of fishing effort, spearfishing can have considerable effects on tourism prospects	Attempting to 'win a war with a village'	Community involvement in establishing marine protected areas that are close to resorts An economically powerful tourism industry leading initiatives to ban spearfishing entirely, or commercial spearfishing, or by non-residents (some Caribbean and Indian Ocean countries).
<b>Increased algal growth with the removal of herbivores</b>	The removal of scarids, acanthurids, and siganids by spearfishing is thought to result in increased abundance of algae	An increase of ciguatera-producing organisms could possibly result	Some Funafuti, Tuvalu spearfishers report an increase in siganids at some distance from a large MPA



## ■ URGENT BAN TO PROTECT 7 SPECIES

An emergency five-month suspension of all bottomfishing in the main Hawaiian Islands resulted from new research that seven species of bottomfish are being overfished and that immediate steps are needed to protect them.

The closure, which will start in six weeks, needs to be enacted by US National Oceanic and Atmospheric Administration Fisheries Service and the state Department of Land and Natural Resources, but both agencies have indicated they are prepared to do so.

The new closed season, which is to be established in both state and federal waters around all the main Hawaiian Islands, will be in place 1 May–30 September. The closed season replaces a previous plan to close federal waters only at Penguin Banks of Moloka'i and Middle Bank, between Kaua'i and Nihoa.

The more aggressive regulation is because the newest fisheries data suggest bottomfish stocks are more threatened than scientists had realized, said Ed Ebisui, a member of the Western Pacific Regional Fishery Management Council.

Prized Hawaiian eating fish — the **onaga**, **'ehu**, **gindai**, **'opaka-paka**, **kalekale**, **lehi** and **hapu'upu'u** — are covered by the closed season. The closure will mean the only Hawaiian bottomfish on local markets during those months will be from the Northwestern Hawaiian Islands, which federal regulators say is not being overfished.

The closure will affect his business, but something clearly needed to be done to protect the fishery, said Brooks Takenaka of United Fishing Agency, which operates a fish auction in Honolulu.

'It's all of our collective responsibility to realize what is happening. We've got to be careful of the utilization of our resources,' he said. But he also said he hopes regulators keep open minds and continue looking at data to find ways to manage the fishery that least affects the community and the fishing industry.

'I'm getting calls from fishermen and wholesalers that weren't aware of this. For the full-time commercial fishing guys, this is a knock. They can't just go and do other types of fishing. It takes different equipment. And it's not like they can just go somewhere else,' Takenaka said.

He said some fish will continue coming in from the Northwestern Hawaiian Islands until a fishing ban takes place in four years within the Papahānaumokuākea National Marine Monument. And local consumers will also find more fish coming in from the Indian Ocean and the South Pacific — generally from areas not carefully managed to protect resources, he said.

'People are going to be eating fish from someone else's backyard,' he said.

The Western Pacific Regional Fishery Management Council responded with the closed season after receiving NOAA Fisheries' latest estimate, based on fishery data through 2005, that says local bottomfish stocks are at risk unless the take is reduced by 24 percent.

Federal waters beyond three miles and out to 200 miles from shore are covered by the new ban. The state is committed to enacting a nearly identical closed season as well, said Alton Miyasaka, an aquatic biologist with the state Division of Aquatic Resources. But he said

the state has not yet laid out a timetable for getting the new closed season rules enacted.

'Our hope is to manage it together. We're all pulling together,' Ebisui said.

During the first year of the closed season, NOAA Fisheries and state fisheries officials will be aggressively gathering data, and trying to expand the information they now collect about the fishery. Within the next year, they expect to establish a fishery managed like some Alaskan and West Coast fisheries, in which a total allowable annual catch is established and daily catches are monitored. When Hawai'i anglers have caught the total allowable catch, the season immediately closes until the following year.

One problem: Commercial anglers report their catch, but recreational fishing boats don't have to.

Recreational bottomfishers by the start of the 2008 season will be required to report their catch daily, as will commercial anglers. Both would also be required to provide detailed locations on where they catch their bottomfish. One benefit for recreational anglers is that bag limits will be removed.

'This year's five-month closure is kind of a buffer. We still don't have a handle on the recreational take,' Ebisui said.

Source: Honolulu Advertiser, 20 March 2007  
<http://www.honoluluadvertiser.com>

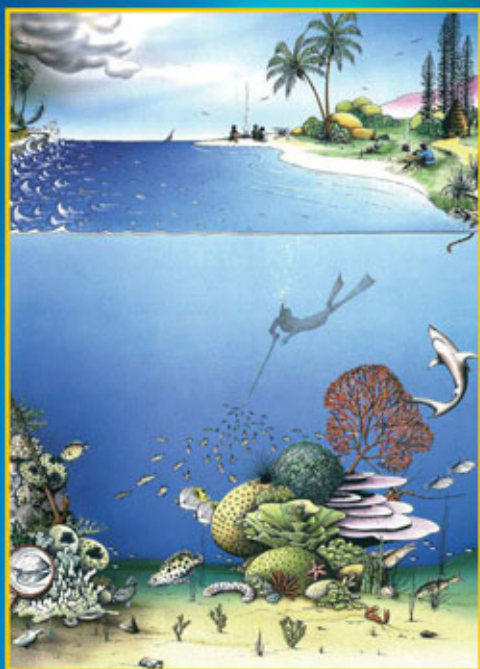


# Ciguatera and related biotoxins workshop

**Noumea, New Caledonia, 27-31 October 2008**

A workshop on the latest developments in ciguatera research,  
covering environmental influences, causative organisms, and  
socio-economic and medical aspects

## FIRST CALL - TENTATIVE PROGRAMME



- Toxins producing *Gambierdiscus* spp.
- Environmental influences
- Structure and chemistry of ciguatoxins
- Clinical treatment and folk remedies
- Toxicology and mechanisms of action
- Ciguateric fish species
- Socio-economic impacts
- Collection and use of clinical and epidemiological data
- Risk assessment and management

CONTACTS: [ciguatera@noumea.ird.nc](mailto:ciguatera@noumea.ird.nc)





# CORAL USES AND PERSPECTIVES ON SUSTAINABLE DEVELOPMENT IN SOLOMON ISLANDS

During a recent visit to Solomon Islands, staff from SPC's Aquaculture Section and the Solomon Islands Ministry of Fisheries and Marine Resources (MFMR) visited the Western and the Central Provinces and gathered information on the wild harvesting and farming of corals.

## TRADITIONAL AND MODERN CORAL USE IN SOLOMON ISLANDS

For many years, the wild collection of corals has brought substantial income to rural communities in many provinces in Solomon Islands. Wild coral harvesting caters to three main markets:

1. Local trade (as a source of lime for chewing with betelnut);
2. Curio trade (dead corals)
3. Marine aquarium trade (live corals)

## Lime production

In Solomon Islands, chewing betelnut is a long-standing and common tradition. Calcium carbonate is the active ingredient of lime and forms the basis of the skeletal structure of staghorn corals (*Acropora* spp.), which are harvested on the reef.

All Solomon Islanders, especially those who chew betelnut, are familiar with lime. **Daka** or leaf, lime and betelnut are all essential ingredients in betelnut chewing because without one of these, the desired taste cannot be achieved. Betelnut chewing is part of Solomon Islands traditional culture and enhances socialization among people.

*Antoine Teitelbaum*  
*Aquaculture Officer*  
*SPC, Noumea*  
*New Caledonia*  
*(AntoineT@spc.int)*

However, today many people do not chew betelnut due to religious restrictions (Seventh-Day Adventists and evangelical churches).

Lime production is as follows.

- Corals are harvested from their habitat using light crow-bars or other tools. Harvesting duration depends on the amount of coral required. In some provinces, coastal communities gather great amounts of coral in the waters near their villages. This coral is then stockpiled.

- All harvested corals are then sun-dried for over 10 days. After drying, the corals appear bleached because the live tissue has died.
- The bleached corals are burned on a fire. Dried mangrove wood is the best fuel to use because they burn slowly, and produce good heat. The wood is stacked as when making a **motu** (traditional oven).
- The corals are burned until they turn into ashes (lime). The lime is collected and stored in coconut woven baskets or bamboo stalks. These are then stored in the warmest part of the kitchen above the fireplace.

- The lime is now ready to be stored in various types and sizes of bottles to be sold to betelnut consumers. It is important that lime is stored in airtight containers to avoid humidity.

Lime is sold in local markets through the barter system. The price for lime ranges from



Staghorn corals used for the production of lime.



SBD1.00 to SBD10.00 depending on the quantity sold. Lime is not an export commodity in Solomon Islands, therefore the Ministry of Fisheries has no data on its production.

#### Bleached corals for the curio trade

In Solomon Islands, the use of corals for the curio trade began in 1984. It was then stopped by the government in 1994 but restarted again in 2003. According to MFMR's data, 20,000 pieces were exported in 2004 (Lal and Kinch, 2005)<sup>1</sup>.

This activity is a substantial source of cash for coastal communities. *Acropora* spp., *Pocillopora* spp., *Turbinaria* spp., *Helipora* spp., and *Seriatopora* spp. are harvested on reefs (especially in Central and the Guadalcanal provinces) then sun dried and bleached. These are shipped by sea, in containers, to the USA where they are sold as curios.

#### Harvesting corals for the ornamental trade

Corals harvested for export for the ornamental trade generate the highest incomes. Most of this activity takes place around the Nggela group in Central Province. Inhabitants of Buenavista, Sandfly and Nggela islands have been collecting corals since the mid-1990s. In 1996, 175,000 pieces of live coral were exported for the ornamental trade.

Villagers often operate in groups under an informal cooperative, harvesting live corals as a cash income mostly on a part-time basis. Of the 200 people involved in the collection of marine ornamentals in Solomon Islands, it is estimated that 25% are focusing on the collection of coral fragments.

Around 70 species of corals are harvested for the ornamental trade. The most popular orders requested by Honiara-based exporters to village fishers are

for the following genera: *Euphyllia* spp., *Acropora* spp., *Montipora* spp., *Sarcophyton* spp., *Sinularia* spp., *Ricordia* spp., and *Fungia* spp.

During a recent trip to Central Province, staff from SPC and MFMR met with a group of coral fishers from Leitongo village in the Sandfly Islands. Henry Kaoni, chief of the collectors, outlined his practices and shared his concerns with the team. For 13 years, fishers from Leitongo have been harvesting corals that are mainly sold to Solomon Islands Marine Export (SIME) in Honiara. Over 2000 pieces of corals can be sold each week. Each piece sells for between SBD2 and SBD2.5. Coral fishers are becoming increasingly worried that coral resource in their surrounding waters seem to be suffering by this activity, and while the cost of living has increased, the price of corals has remained the same.

Later, the SPC/MFMR team met with a group of collectors in a mangrove stand. This area had a very diverse population of hard coral species. Although freshwater runoff has caused mortality in the surface layers, healthy coral colonies were observed in the deeper parts of the mangrove. Collectors use a dugout canoe as the collection vessel and take turns diving. The group harvests corals with a screw driver or chisel. Coral fragments are then placed in a plastic basket on top of a layer of mangrove leaves. On the day of the visit, the SPC/MFMR team observed a harvest of *Lobophyllia* spp., *Euphyllia* spp., *Ricordia* spp., and *Merulina* spp.

Back at the village, the corals are placed underwater in surrounding areas, to ease the acclimatization of the freshly harvested



Wild caught coral in the Nggela.

<sup>1</sup> Lal P. and Kinch J. 2005. Financial assessment of the marine trade of corals in Solomon Islands. Report prepared for the Foundation of the Peoples of the South Pacific International, Suva, Fiji; South Pacific Regional Environment Programme, Apia, Samoa; Department of Fisheries and Marine Resources and Forestry and Environment and Conservation, Ministry of Natural Resources, the Solomon Islands Government, Honiara, Solomon Islands. C-SPODP II. 32 p.

colonies. The day before they are exported, the corals are taken to Honiara (1–1.5 hours by boat) and placed at SIME's facilities. Coral colonies are sorted, graded and placed in the raceways of SIME's re-circulating system. On the day of export, the corals are bagged with oxygen, boxed, and sent to the airport.

#### WHAT IS THE FUTURE OF FARMED CORALS?

The sustainability of the wild caught coral trade is questionable. In the late 1990s, the first trials of coral aquaculture started in Marau Sound in Guadalcanal Province. Of the 30 farmers that were trained and equipped for that purpose, only a few individuals adopted the technology and produced farmed coral fragments. Between 2000 and 2004, farmed corals accounted for only a small fraction (on average 1.6%)

of the total amount of corals exported from the Solomon Islands (see table below).

The financial assessment produced by Lal and Kinch in 2005 demonstrated that coral culture in Solomon Islands can only be a viable source of income if the following criteria are met.

- Culture operation are developed on a large scale;
- Transport costs to Honiara are shared with those from other activities;
- Transport of coral fragments to Honiara are made at least once a month;
- Villagers fetch better prices for their production.

Since 2004, the number of farmed corals appears to be increasing at an exponential rate. Official export statistics

show an increase from 600 pieces in 2004 to 1600 in 2005, and more than 7000 pieces in 2006. These figures are from the production of 1 farmer in Central Province, 8 farmers in the Marau Sound area, and 6 farmers in Western Province.

The international ornamental coral market is demanding more cultured corals because they adapt better to aquarium conditions and they are regular in sizes, colours and shapes for a given species. Furthermore, farming corals is seen as an 'eco-friendly' practice, compared with the wild harvesting of corals.

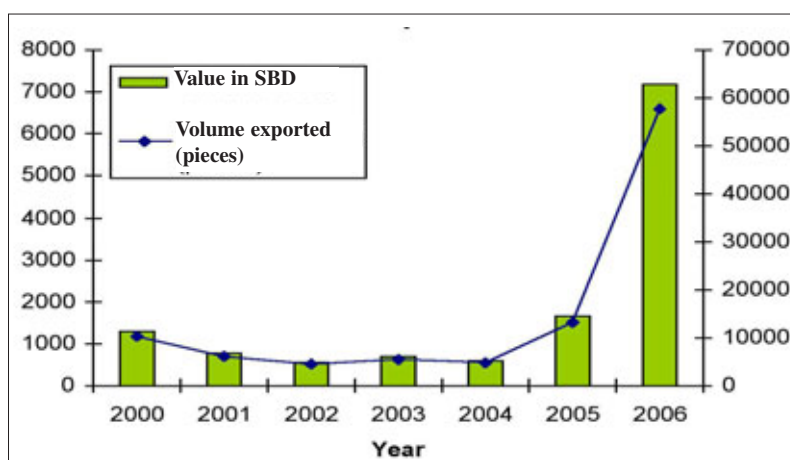
Unfortunately, in Solomon Islands, coral farming is limited by the following factors.

- The demand for wild caught corals is still high and they are cheaper products for exporters;
- Only a few species of corals can be cultured (fast growing ones); a larger number of wild caught species can be obtained;
- There are only two shipments of live stock per week. Most available airfreight space is already used by aquarium fish and wild caught corals;
- Villagers often find it difficult to access basic materials for culture (wire, cement, plastic moulds).

After further discussions with coral fishers, it appears that catching wild corals is not as profitable as it used to be. Prices are low and collection sites are far away because some nearby areas have been overfished. Culturing areas close to villages makes this activity very attractive. Further more, farmed corals fetch higher prices than wild caught corals: farmed

#### Number of farmed corals vs number of wild corals exported from Solomon Islands since 2000

Year	No. of farmed corals (pieces)	No. of wild corals (pieces)	Percentage of farmed vs wild
2000	1299	51,417	2.46%
2001	766	33,250	2.25%
2002	567	40,750	1.37%
2003	686	51,627	1.31%
2004	439	71,017	0.61%



Export of farmed corals (in pieces) from the Solomon Islands since 2000.





**Lagoon house used for farming activities in Sandfly island.**

corals are currently marketed at SBD8 per piece.

Not all coral species can be farmed. Some have slow growth rates, and others do not adapt to farming conditions. However, for those that can be easily farmed, it makes sense that cultured fragment should slowly replace wild caught for a given species, for both soft and hard corals. For example, *Acropora* spp., *Montipora* spp., *Sarcophyton* spp., and *Sinularia* spp. are very easy to farm and have fast growth rates.

#### COULD STOCK MANAGEMENT, LABELS AND REGULATIONS HELP DEVELOP THE CORAL AQUACULTURE INDUSTRY?

The WorldFish Center and the Marine Aquarium Council (MAC) are currently working together in drafting a 'Mariculture Area Management Plan', with financial assistance from the New Zealand Agency for International Development (NZAID). Management plans are established within local communities that are involved in the aquaculture of clams and corals within Western Province. The goal is to obtain MAC certi-

fication of the products. For example, villagers are taught to commercialize third generation corals only, and good practices for fragmenting and handling are demonstrated. Recently, three workshops, on corals, giant clams and post larval capture and culture techniques, were carried by the WorldFish Center at the Nusa Tupe field station in Western Province.

Obtaining MAC certification will help Solomon Islands products by adding value and will help farmed marine ornamental

products in gaining recognition on the global ornamental trade.

So far, regulations on coral harvesting in Solomon Island are basic (see boxed text below). However, a license is required for exporting corals overseas. The introduction of quotas on wild caught fragments would help in promoting farming activities.

#### WHAT WILL MFMR DO?

Although the global ornamental market is growing, MFMR understands that harvesting and culturing of corals can only be a source of income for a limited number of coastal communities.

However, MFMR wishes to regulate the wild caught harvesting while promoting farming activities. The following actions will be MFMR's priority as part of the national aquaculture development plan.

- Assist the private sector in developing in a sustainable way (i.e. promoting and supporting farming);
- Encourage competition by providing a limited number of licenses;

### CORALS & CORAL SAND

- Except under the written permit granted by the Under Secretary of Fisheries;
    - a) It is illegal to take or collect dead or live coral or coralsand from any designated area.
    - b) It is illegal to use machines for the extraction of coral gravel and coral sand.
- "a" shall not apply to the:
- i) taking or collecting of lime coral for the sole purpose of producing by traditional method limes for consumption with betel nut.
  - ii) clearing of a passageway through any reef area, provided that such clearing has been duly authorised by appropriate authorities

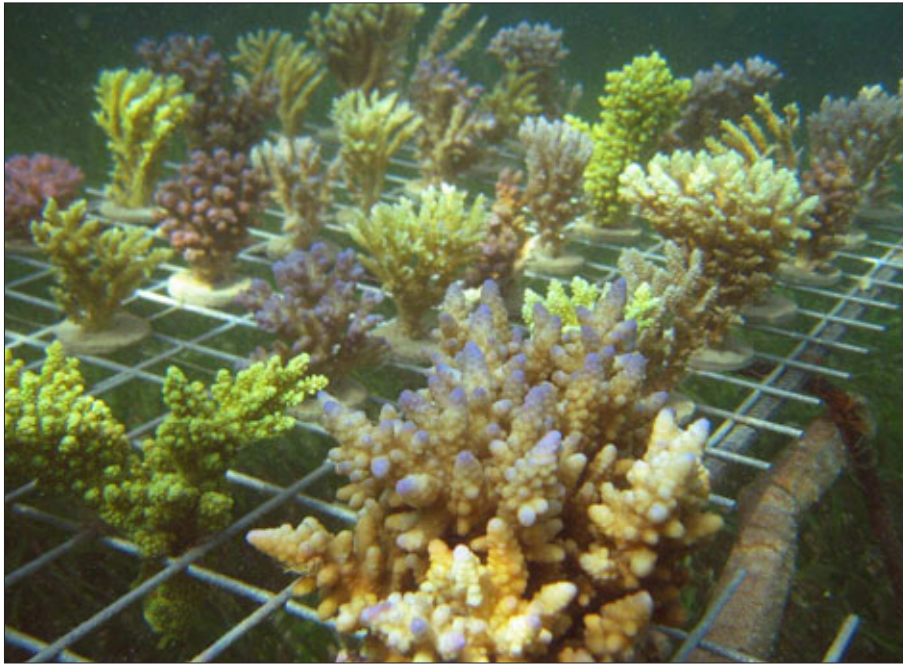
**Penalty: for both offence: \$100 fine or 3 months imprisonment or both such fine and imprisonment.**



- Assess how many households will benefit from farming activities and support accordingly;
  - Develop a strategy that will progressively replace wild caught corals by farmed corals (for fast growing species);
  - Train provincial fisheries assistants in coral farming techniques; they in turn will be able to train villagers.
- For further reading, see the report of the Foundation of the Peoples of the South Pacific, International (FSPI), 'Financial assessment of the marine trade

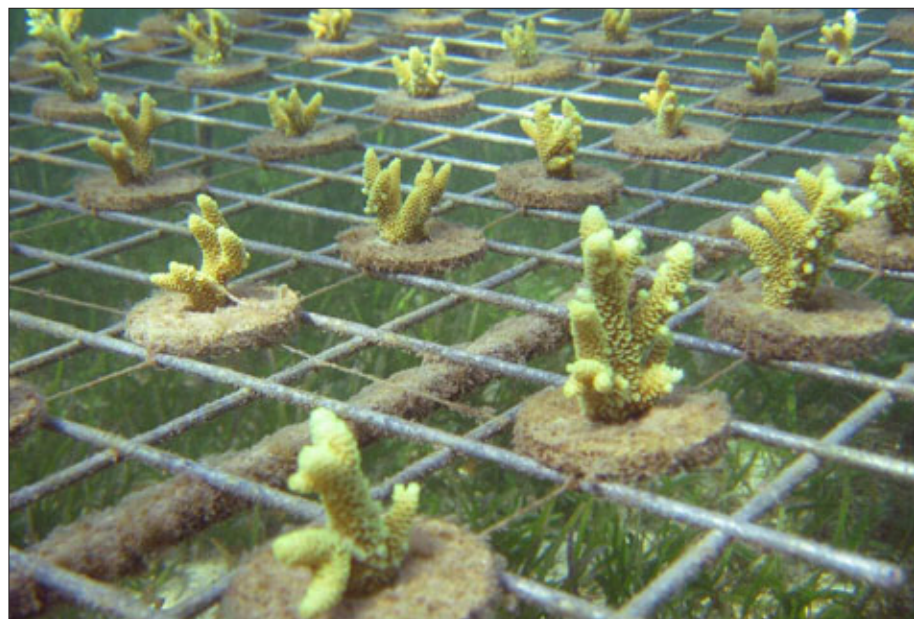
of corals in Solomon Islands', written by Lal and Kinch, 2005.

[http://www.fspi.org.fj/program/coastal/research\\_and\\_development\\_reports.htm](http://www.fspi.org.fj/program/coastal/research_and_development_reports.htm)



**Mother colonies used for producing coral cuttings.**

**Culture of *Acropora* fragments.**



# ISO 22000 STANDARD: A FOOD SAFETY MANAGEMENT SYSTEM

The Quality Institute is a New Caledonia-based company that brings together quality, hygiene, safety and environmental consultants. A leader in the International Organization of Standardization (ISO) procedures, the Institute assisted the first New Caledonian companies in getting their ISO 22000 certification.

ISO 22000 certification allows companies in the food industry to show that they are capable of providing customers with safe products. But what exactly does this new certification guarantee? What type of company is it for? Why do companies decide to commit themselves to the procedure?

## WHAT IS THE REASON FOR ISO 22000?

At the time when a major credibility crisis is affecting the food sector and overwhelming public opinion, gaining control of food safety has become a vital issue. A lack of hygiene can have negative consequences in terms of both public health and economics.

Given this, initiatives have been undertaken in many countries to formulate more or less voluntary rules. But the vast increase in the number of private reference systems based on the Hazard Analysis Critical Control Point (HACCP) method led to a certain amount of confusion among the various groups in the food industry. In September 2005, after three years of work, ISO published a universal reference framework (i.e. the ISO 22000 standard), which was the result of a consensus between 45 countries.

**Vincent Talbot**  
**Institut de la Qualité**  
**Noumea**  
**New Caledonia**  
**([iqtalbot@lagoon.nc](mailto:iqtalbot@lagoon.nc))**

This standard meets a two-part need to:

1. improve safety for all food sector stakeholders, and
2. harmonise existing food safety methods through a internationally recognised reference system.

**Hedelab, Belgium, states:** *'For us, the ISO 22000 is designed to allow — whatever the country or product involved — harmonised implementation of the HACCP method, recognised by experts as the best tool currently available to guarantee food safety for consumers. Since the large increase in the numbers and types of food crises, certain countries and even certain food industries and companies have created their own safety standards. As a result, there are more than 20 different sets of standards. Through the international consensus that led to its development, the ISO22000 certification is destined to become the reference in international food safety.'*

## What added value does ISO 22000s provide?

- requires the creation of a complete food safety management system;
- provides an international dimension;
- allows a smaller number of more harmonised standards;
- imposes structured and targeted communications;
- subjects all control measures to hazard analysis;
- meets food industry expectations;
- fills the gap between ISO 9001 and HACCP;
- suitable for all types of business since it imposes results and not resources ;
- is based on a system approach, not a product approach;
- proposes clear, easily audited requirements;
- provides a reference base for the food chain as a whole;
- focuses on mastering the essentials;
- provides an auditing (and not inspection) standard composed of clear requirements;
- allows third-party certification;
- makes resource savings possible by reducing the number of redundant audits; and
- can serve as a reference base for national legislation

Just over a year has passed since ISO 22000 was issued, but already more than 50 countries have adopted it.

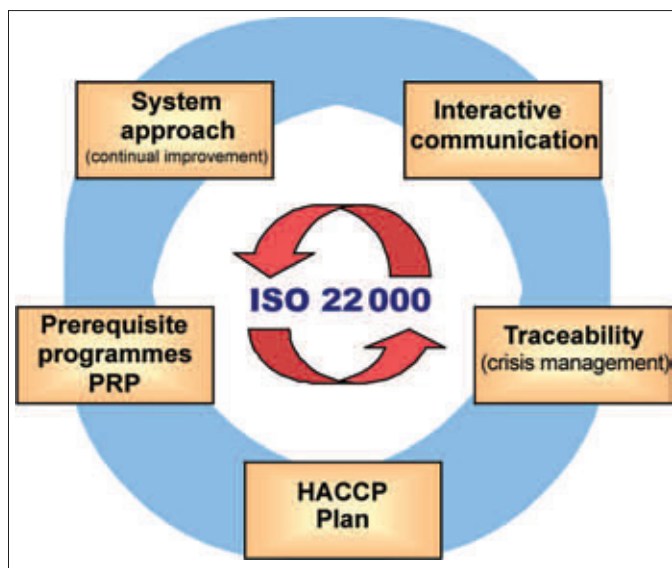
## WHO IS THE ISO 22000 MEANT FOR?

The ISO 22000 certification is for all food sector companies (producers, processors, distributors) as well as all related industries, such as packaging, transport, animal feed, cleaning and disinfecting, equipment production, etc.

This standard implements a common vocabulary and improves communications between everyone involved in the food industry.

### KEY FEATURES OF THE ISO 22000 STANDARD

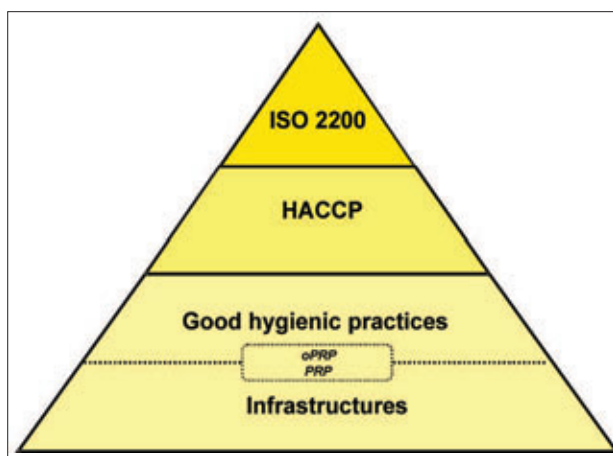
The ISO 22000 standard is a management system standard that sets requirements for results without setting requirements for resources. The HACCP system is based on organisation and is guided by a policy and objectives with clearly defined responsibilities, allotted resources, and control over how objectives are met. This organisation is designed to ensure continual improvement in food safety. This standard sets out specific requirements for the five areas shown in the figure at right.



### WHAT DOES ISO 22000 BRING TO THE HACCP METHOD?

#### PRP, operational PRP, CCP and validation

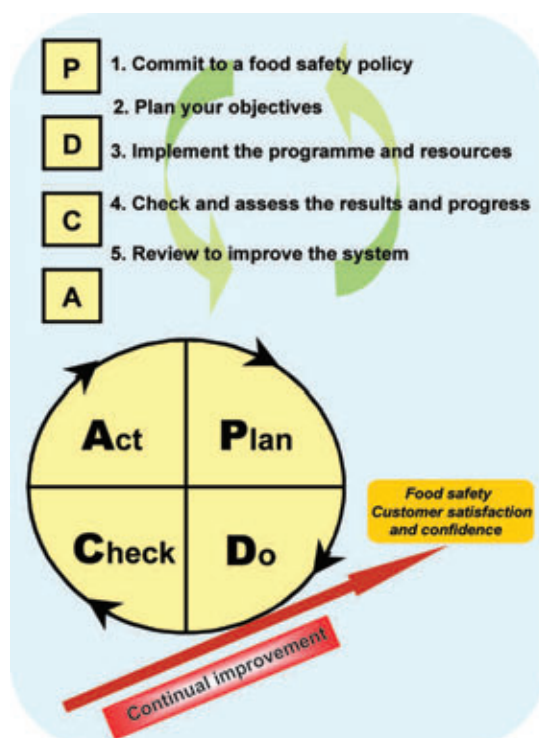
ISO 22000 has made it possible to fill in, in a targeted manner, certain gaps that hindered proper understanding and use of the HACCP method, in particular, by introducing prerequisite programmes (PRP), and operational PRP (oPRP). The standard makes it possible to prioritise control measures based on criteria linked to the probability of the occurrence of a certain type of hazard and its severity. In addition, ISO 22000 requires that control measures associated with oPRP and critical control points be validated before they are implemented.



#### System components

ISO 22000 has also set up, around the HACCP method, all the system and organisational components, based on the principle of continual improvement that made ISO 9001 such a success.

In fact, once companies have met the challenge of setting up an HACCP the first year, they then face a new challenge —





keeping it operational over the coming years, something that ISO 22000's 'PDCA: Plan-Do-Check-Act' system approach makes possible. By providing system components (procedures, audit, indicators, operating reports, management reviews, steering committees, etc.), this standard contributes to efforts to structure and improve management. These measures allow companies to avoid fixed HACCP systems and move towards systems that constantly adapt to the situation and to food safety needs.

As the first New Caledonia company to receive ISO 22000 certification reports: 'Our system really became dynamic and involves our staff a great deal more.'

#### Communication between participants in the food industry

The requirement for communication about potential hazards, both upstream and downstream depending on the needs, is a new and major asset of ISO 22000, one that will promote the development of an integrated sector culture and approach. In the seafood sector, for example, processors will not only have to have good communications with fishers, packaging suppliers and transporters but will also have to prove that they fully master the requirements that they have set with these participants in the food chain.

For in-house communications, emphasis is placed on providing the ISO 22000 team with timely information on any changes that could affect food safety. A lack of communication in this area can have a significant impact as has been demonstrated by recent cases of food poisoning caused by changes in maintenance or in raw materials or packaging without the ISO 22000 team's prior approval.

#### ISO 22000: A PASSPORT FOR EXPORTING?

By selecting an ISO 22000 certification, you are adopting an internationally recognised system. Whatever the country, you will share a common language with your customers, suppliers and competent health services. Also, from a health point of view, the ISO 22000 standard has a great potential to partially fill the gap between rich importing countries and developing countries that want to export.

In the seafood sector, Thailand was one of the first countries to benefit from the development of processed product exports by adopting an effective and internationally recognised food safety programme.

ISO 22000 is also a good way to reassure consumers who are increasingly wary about the food they buy. Certified companies demonstrate their food manufacturing professionalism by guaranteeing better study of and communication about related hazards.

#### WHY DO COMPANIES COMMIT THEMSELVES TO AN ISO 22000 APPROACH?

Mainly because some exporting companies want to adopt a common language to facilitate exchanges. Other companies because they want their hazard analysis and control techniques to be consolidated, validated

and recognised by an outside agency. And other companies commit to an ISO 22000 approach in order to complete their ISO 9001, ISO 14001, HACCP plans through the implementation of an integrated system.

In all cases, everyone recognises the interest of the standard's managerial dimension in moving their current fixed HACCP plans towards a well-adapted dynamic system that strongly involves staff and is constantly improving.

In the end, ISO 22000 combines a series of advantages, involving quality management, external and in-house communications, designating responsibility, implementing crisis management, continual improvement, good health practices and differentiating between PRP, oPRP and CCP.

To find out about ISO 22000, visit the following websites:

[www.codexalimentarius.net](http://www.codexalimentarius.net)

[www.iso.org](http://www.iso.org)

[www.institut-qualite.nc](http://www.institut-qualite.nc)



**Goodman Fielder New Caledonia, first company in the South Pacific to be certified for ISO 22000 in December 2006 by the Bureau Veritas Certification:** *'We were already certified for ISO 9001 but we knew that our existing HACCP plan needed to be revised, optimised and included in a dynamic approach to continual improvement. With strong support from management, this approach allowed us to gain the full participation of production staff and federate all our departments and teams. Today, our ISO 22000 certification demonstrates our efficiency in food safety control, increases our customers' confidence on the local market and allows us to develop an export market.'*

Vincent Talbot, a free-lance consultant from the Institut de la Qualité in New Caledonia, was invited by the SPC Nearshore Fisheries Development and Training Section (NFDTS) to develop a tailor-made course for staff from various local institutions dealing with or interested in seafood safety issues including HACCP principles and the new ISO 22000 standard. Overall, the course was designed to enable participants to gain a good understanding of the new ISO 22000 standard and its implications. This involves quality management, external and in-house communications, designating responsibility, implementing crisis management, continual improvement, good health practices and differentiating between prerequisite programs (PRP), operational prerequisite programs (OPRP) and Critical Control Points (CCP).

The one-day course was held at SPC in Noumea, on Monday 08 February 2007. Post-course feedback from the trainer and the 10 participants – covering 7 government administrations and organisations (including SPC) — was very positive, particularly with regards to the training methodology and resource materials. At the end, participants left with a greater understanding of ISO 22000 standards but many felt that this very intensive course should preferably be delivered in two days.



**Participants of the one-day course held at SPC**

# SHALLOW WATER BATHYMETRY

A previous article in the SPC Fisheries Newsletter (# 117) described how ocean bottoms are largely unexplored, and that the available Pacific Ocean bathymetric maps are a mixture of localized oceanic surveys and satellite altimetry, with a resolution ranging from 30 seconds (~1 km at equator) to 5 minutes.

While these maps are quite useful for the management of pelagic fishes and seamounts, they are generally unsuitable for nearshore and reef fisheries management, for which, higher resolution maps are necessary. This article describes other sources of information for shallow water bathymetry, and how these can be used to produce bathymetric maps for coastal fisheries management purposes.

## NAUTICAL CHARTS

Hydrographers and cartographers have produced nautical charts for the Pacific Islands region for centuries, and some of the charts available today are updated versions of 19th century original ones.

Nautical charts are generally available for the whole Pacific, but scale varies depending on the area. Because nautical charts have been created for navigational purposes, they emphasise hazards such as reefs, focusing on avoidance more than on the exact mapping of reefs. Nautical charts are generally quite detailed for approaches to harbours and passes, with additional detailed plans for these areas of interest.

Figure 1 shows that the bathymetry in the NZ945 chart for Penrhyn is much more detailed around Taruia Passage and

**Franck Magron**  
**Reef Fisheries Information**  
**Manager**  
**Secretariat of the Pacific**  
**Community**  
**([FranckM@spc.int](mailto:FranckM@spc.int))**

Gudgeon Bay, than in the rest of the lagoon and the passage is even more detailed because of its importance for navigators.

## Importation of nautical charts in a GIS

For use within geographic information system (GIS) software, charts can be scanned and geo-referenced (raster image), or they can be digitized (on screen or with a digitizing board) and stored as points, contour lines and polygons. Spatial queries are possible with digitized charts, while raster images are generally used as backdrop.

Nautical charts have been digitized on a large scale by US federal agencies such as the National Oceanic and Atmospheric Administration (NOAA), the National Geospatial-intelligence Agency (NGA), and the National Imagery and Mapping Agency (NIMA), but these products are generally not released to the public for copyright reasons, apart for US waters. Some private companies have also digitized charts to incorporate them in GPS plotters but these are generally encrypted and in a format incompatible with GIS software.

The projection and datum used to produce the chart must be known in order to geo-reference or digitize a chart, which is sometimes not the case for older charts for which adjustments for plotting GPS positions cannot be determined.

In conclusion, nautical charts are most often not readily available in vector format and often lack detailed bathymetry for reef areas and areas outside frequently used shipping lanes.

## HYDROGRAPHIC SURVEYS OF COASTAL WATERS

Depths between 30 m and 200 m are beyond remote sensing techniques (visible light is quickly absorbed and water is opaque to radar frequencies) and predicted bathymetry, using satellite altimetry, is not reliable for shallow water. Therefore, sonar and lead line remain the ways of measuring depths in the 30-200 m range.

A typical survey is done with a medium size boat equipped with a single-beam or multi-beam sonar that records depths regularly (every 20 m; see Fig. 2) along the boat path (parallel transects). Very shallow areas (e.g. patch reefs or flat reefs) are generally not covered because they cannot be safely explored by the survey boat; therefore, holes in the dataset often correspond to shallow reefs.

Hydrographic surveys provide very accurate depth information, and additional data can be collected with additional sensors at the same time (e.g. acoustic signatures can be used to map bottom types). These types of surveys are done routinely by the South Pacific Applied Geoscience Commission (SOPAC) for ACP countries, and NOAA's National Ocean Service for US territories.

An alternative method consists of digitizing individual soundings on nautical charts. This is a tedious process, but can make up for a lack of available sonar information for an area.

## Use of hydrographic survey soundings

Each sounding point is stored as an XYZ position (geographic position and depth), and the dense set



of sounding points is interpolated to produce a depth map (with isobaths at 5 m, 10 m, 20 m, 30 m), and determine the corresponding surfaces as in Figure 3.

It is noticeable on this figure that there are differences between what can be seen on the satellite image and with the isobaths, mostly due to the shallow areas excluded from the survey. The area circled in red for example is wrongly classified as a 20–30 m area while it is obviously much shallower. The actual error varies depending on the interpolation method and the pattern of data gaps.

It is possible to set a maximum distance between interpolated points and leave holes as unknown, or unclassified areas. Figure 4 correspond to the same location as Figure 3 but no interpolation has been done for data gaps (in white). As a result, the area for which depth can be retrieved is about 50% of the previous one, and the proportion of 10–20 m surface areas compared with deeper areas has changed dramatically because shallow reefs are mostly unclassified.

Because of these differences and depending on the processing of data, it is important when using isobaths or depth grids to determine how they have been produced (interpolation method and location of sounding points) and to compare the interpolated grid with available charts and satellite images.

#### BATHYMETRY OF VERY SHALLOW AREAS USING REMOTE SENSING

Pacific reef fisheries focus on depths between 0 m and 20 m, for which detailed bathymetry is often out of the scope of sonar surveys (reef areas dangerous for navigation). Yet these very shallow waters are not totally opaque to visible light and both passive and active remote sensing can be used to determine bathymetry.

#### Light detection and ranging (LiDAR)

A LiDAR is an active remote sensing equipment that uses time delay between a laser pulse and its reflected signal by the target to determine the distance of the latter. The SHOALS-1000 (Scanning Hydrographic Operational Airborne LiDAR Survey) system in particular uses a blue-green laser and can measure depths up to 60 m over a 200 m swath width, a vertical accuracy of 15 cm and a distance of 8 m between sounding points (Wozencraft 2001). The SHOALS system is mounted on a Twin Otter aircraft and operated by the Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX).

This technique is complementary to the traditional sonar surveys and can be used to map very shallow waters and surf zones. It can also map the topography of the nearshore (beaches and dunes). LiDAR data is currently freely available from the NOAA website for US coastlines.

Unfortunately, the cost of airborne operations restricts its use for specific areas, and it is very unlikely that LiDAR data will be available in the near future for remote islands. According to the JALBTCX website, SHOALS surveys will be conducted in Majuro, Kwajalein, Kosrae, Pohnpei, Chuuk and Yap in addition to US territories.

#### Multispectral and hyperspectral images

This method is based on the optical properties of the water column: light absorption is exponential with depth and varies with wavelength (wavelengths corresponding to red colour are absorbed twice as fast as blue ones, see Fig. 5). Compared with LiDAR, which uses laser pulses to illuminate the scene, passive remote sens-

ing simply measures the sunlight reflected by the sea floor.

The difference between multi- and hyperspectral data is the number of sensors and their sensitivity a predefined range of wavelengths: Landsat and IKONOS satellites for example have four sensors (bands) for visible and near infrared spectrum, while the Compact Airborne Spectrographic Imager (CASI) can discriminate between 288 spectral bands.

The accuracy of depth as determined through passive remote sensing is far less than what can be achieved using sonar or LiDAR. The method often requires some kind of area specific calibration, using ground truth data and atmospheric correction to normalize the data. The advantage of this method is that it can use available images, and satellite images have a very large footprint compared with airborne and ship surveys, which are more localized.

Passive remote sensing can be used for depths up to 30 m, depending on water turbidity and atmospheric conditions. Numerous papers have been published on the use of satellite images for shallow water bathymetry (Ishiguro et al. 2001; Stumpf and Holderied 2003; Provost et al. 2004) and it is still an active research topic as there is still room for improvement. The main problem being that not only the water column absorbs light but also the atmosphere, particles in suspension in water and the sea floor itself, depending on substrate type. The resultant signal contains the depth information, but is mixed with the other components.

Fortunately for fisheries management purposes, depth does not need to be known within a 15 cm accuracy. A rough mapping of depth classes (for example 0–5 m, 5–10 m, 10–15 m,

15–20 m, and 20 m+) is probably sufficient and can be obtained quite easily by using a ratio of blue and green bands if some soundings at various depths are available for the area and can be used to calibrate the image (Figure 6).

This method has been used to produce rough depth maps of Tonga's reefs, using available relatively cloud free Landsat images and sounding points from nautical charts.

### CONCLUSION

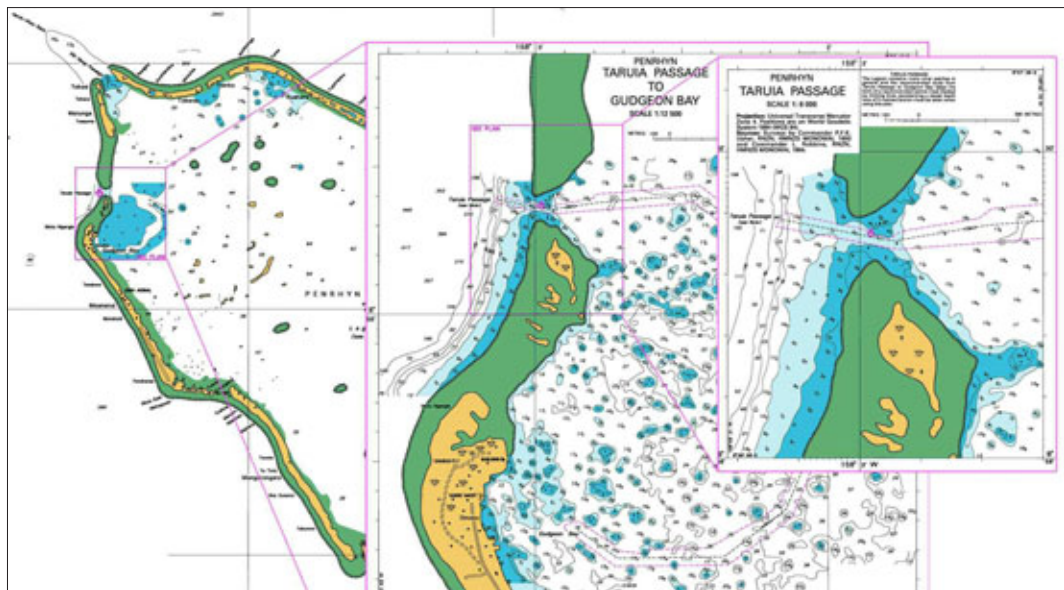
Sonar surveys have limitations in term of coverage of very shallow waters and are well complemented by LiDAR surveys but the operational costs of these types of surveys limit their use to specific areas. Passive remote sensing can provide a cheaper alternative but at the expense of accuracy and more robust methods, and models are still sought by researchers for improvement of current mapping.

When using a bathymetric map for coastal waters it is important to know how it was produced, for which purpose, and its limitations in order to determine if the map is suitable for the particular intended use.

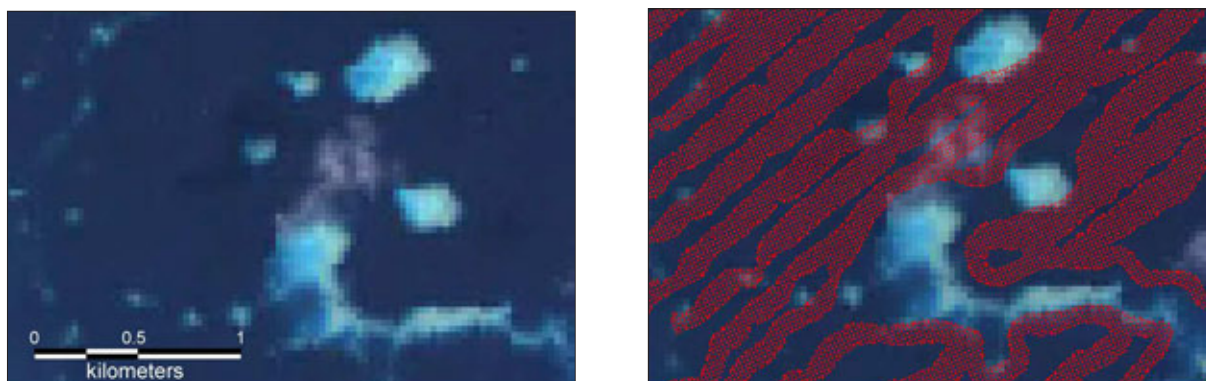
### REFERENCES

- Ishiguro E., Tatsuno K., Kawakatsu, M., Hirayama S., Washid, D.A., Kongo S., Shimada K., Higashi M., Habano A., Azuma T., Kikukawa H., Moriyama M., Taifileichig A., Peckalibe P., Sulog T., Liyeg F., Kanemasu E.T. 2001. Studies on the evaluation of water depth around seashore and the land classification in Yap Islands using satellite data. p. 77–85. In: The Progress Report of the 1999 Survey of the Research Project Social Homeostasis of Small Islands in an Island-Zone. (paper no. 34, part I, sec. 2, report 2).
- Provost J.-N., Collet C. and Rostaing P. 2004. Hierarchical Markovian segmentation of multispectral images for the reconstruction of water depth maps. *Computer Vision and Image Understanding* 93(2): 155–174.  
*doi:10.1016/j.cviu.2003.07.004*
- Shifrin K. S., *Physical Optics of Ocean Water*, American Institute of Physics, New York, (1988).
- Stumpf R.P. and Holderied K. 2003. Determination of water depth with high-resolution satellite imagery over variable bottom types. *Limnological Oceanography* 48:7–556.
- Wozencraft J.M. 2001. The coastal zone revealed through SHOALS LIDAR data, *Proceedings, Hydro '01*, Norfolk, Virginia, USA.

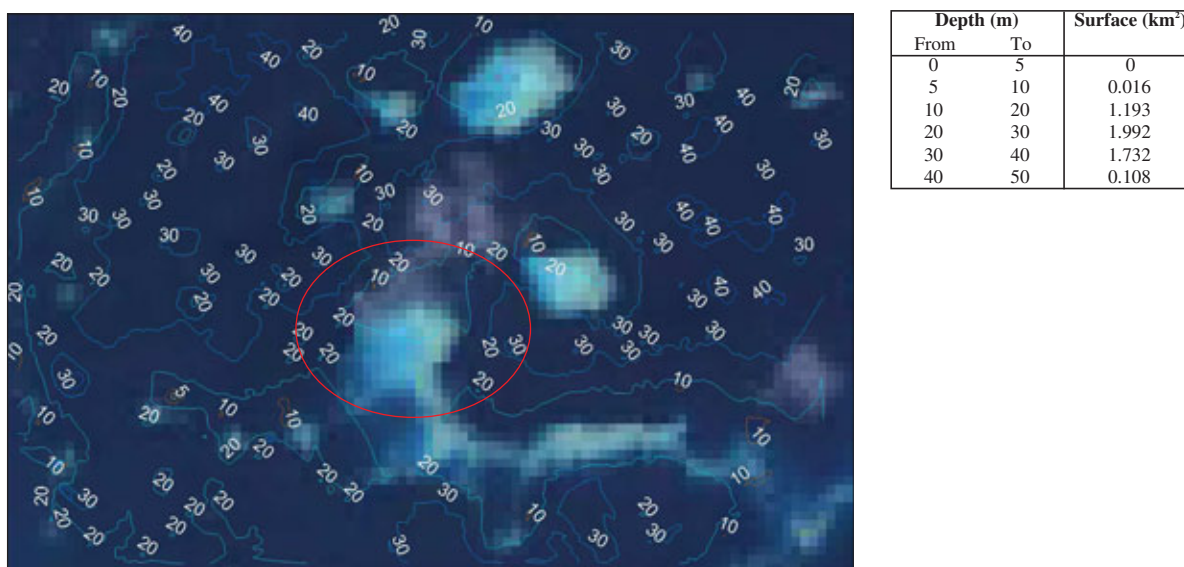




**Figure 1: Increasing level of details around passes and harbours for navigational purposes (from NZ 945 chart)**



**Figure 2: Sounding points of a typical sonar survey (in red) over a Landsat image**



**Figure 3: Isobaths produced after interpolation of XYZ data (triangulation)**



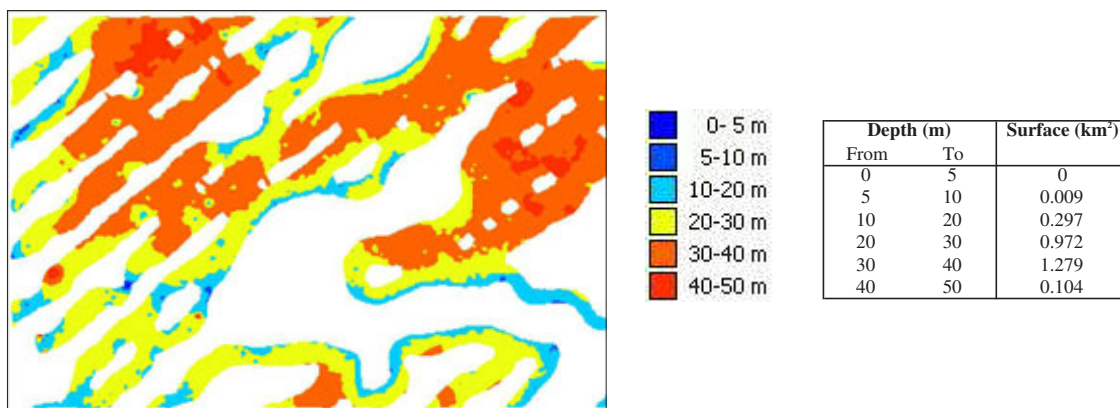


Figure 4: Depth classes with interpolation limited to a maximum distance of 50 m

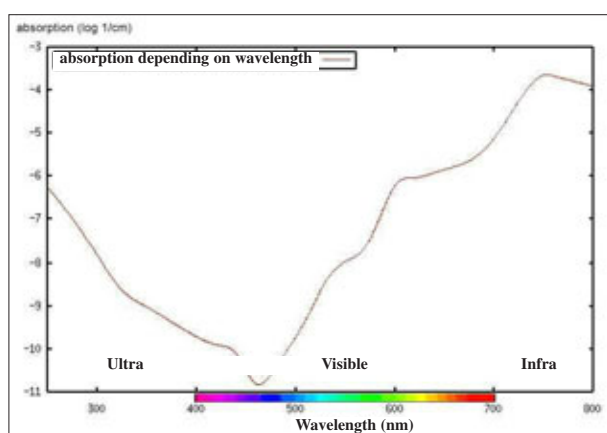


Figure 5 Absorption according to wavelength  
(as per data from Shifrin 1988)

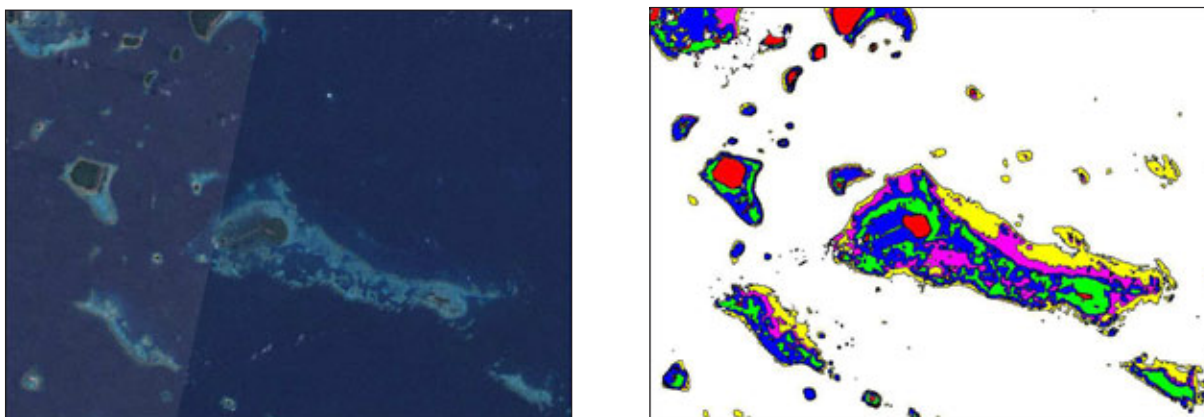


Figure 6: Satellite image (Landsat 7) and corresponding depth classes