



# Fisheries

## Newsletter

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## Editorial

Welcome to the last issue of the Fisheries Newsletter for 2002. Readers will find, as usual, reports on the activities of the various sections of SPC's Marine Resources Division. Among this quarter's highlights, was the Regional Workshop on the Management of the Live Reef Fish Trade in the Pacific. This workshop was held at the University of the South Pacific, Suva, Fiji Islands, in September 2002 and was part of the regional technical assistance project (RETA) funded by the Asian Development Bank. This workshop provided Pacific Island fisheries policy-makers and managers with the opportunity to share and learn from each other's experiences. This workshop was very important in identifying priorities for future assistance, policy development and capacity building in the region.

As always, your comments on and contributions to the Fisheries Newsletter are welcome.

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*Young fisher from Lakeba village,  
Vanua Levu, Fiji islands  
[Photo: Mecki Kronen]*



SECRETARIAT OF THE PACIFIC COMMUNITY

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# SPC ACTIVITIES

## ■ FISHERIES DEVELOPMENT SECTION

During the last quarter of 2002, SPC Fisheries Development Officer, William Sokimi attended four short courses at the Fiji School of Maritime Studies. The mandatory courses were for compliance with the International Maritime Organization's Standards of Training, Certification and Watchkeeping for seafarers (STCW 95), which are required by all ship's Masters, Mates and Engineers as part of qualifications upgrading occurring worldwide. To upgrade his skippers qualification, William was required to take first aid at sea, advanced fire fighting, occupational health and safety, and proficiency in sea craft operations.

### Small-scale tuna longline development project – Marshall Islands

In the Marshall Islands, William liaised with staff of the Marshall Islands Marine Resources Authority (MIMRA) on preparations for a small-scale tuna longline development project to begin in early 2003. William provided input to the repair and refitting strategies for the fisheries training vessel, FTV *Wa – Bal*, and initiated measures for procuring fishing gear for the project.

The management of the vessel has changed hands several times, over the last three years, resulting in deterioration of the vessel. Strong westerly winds and inadequate sheltering facilities also contributed to the vessel's run-down state. A considerable amount of work was done before the vessel could be taken on offshore fishing trips. This included work to damaged portions of the hull, deck and superstructure; repainting the vessel; upgrading the engine room, including servicing the main engines, pumps and hydraulics; upgrading the electrical and battery charging systems; repairing and modifying the plumbing system; and



*FTV Wa – Bal before the refit and repair had commenced*  
[Photo: Lindsay Chapman]

installing of additional sea survival equipment. Several alterations and additions were recommended for inclusion in the restoration work so that the vessel could effectively perform tuna longline fishing and other offshore fishing methods. The Robert Reimers Company was contracted by MIMRA to execute the restoration of the vessel following a tender process.

William also compiled a list of fishing gear needed for performing several offshore fishing methods, including horizontal longline, vertical longline, deep-water bottom fishing, ika-shibi and palu-ahi fishing.

Preparations for the small-scale tuna development project in 2003 are fully underway.



### Cetacean Interactions Workshop – Samoa

In mid-November, William joined Deirdre Brogan of SPC's Statistics and Monitoring Section in a cetacean interactions workshop in Apia. The workshop addressed problems associated with cetacean interactions with commercial longline fisheries in the

South Pacific region, and depredation by cetaceans of fish caught with longline gear. This workshop was instigated following complaints from around the region and a recent request from Samoa to address the situation and find mitigating factors

to deal with it. The workshop was convened under the auspices of the South Pacific Regional Environment Programme's Marine Mammal Conservation Programme. Industry representatives, fishers, biologists, scientists, fisheries managers, region-

al intergovernmental representatives and non-governmental organisations attended the workshop.

The depredation by cetaceans of longline-caught fish was not fully addressed in earlier years when foreign distant water fleets fished the region. However, with domestic fleets in place, attention is drawn to depredation levels, which are resulting in conflicts between tuna longline operators and cetaceans.

Global interactions between fishermen and cetaceans were previously recorded and attempts were made to address the situation. This is evident in nations with developed gill net, purse seine, trawl, and trap fisheries.

However, less attention was given to depredation levels in longline fisheries. In general, global interactions between fishermen and cetaceans are increasing and most often (especially in tuna longlining) these interactions are more detrimental to the fishing industry than to cetacean populations. The dissenting attitude of some fishermen towards cetaceans may lead to drastic retaliatory measures that will further complicate relations.

The objectives of the workshop were to:

accurately define the scope of the interactions of cetaceans and hooked fish on longline gear, and review the evidence available in the South Pacific region;

evaluate interactions and determine when and how they occur;

identify the species involved and the nature of the interactions;

determine the actions taken by fishermen to deal with the problem and appraise the implications for cetacean populations;

determine the common characteristics among the various fisheries;

suggest potential mitigation strategies;

identify areas of research that are critical to evaluating/solving the problems;

develop a research programme to investigate cetacean (especially toothed whale) behaviour around pelagic longline vessels and practically test various mitigation strategies; and

establish a mechanism to facilitate ongoing communication among participants.

Workshop participants spent the first day brainstorming about the various issues to be addressed, and later divided into two groups to come up with suggestions to address key points raised during workshop discussions. One group discussed mitigation measures, while the other concentrated on assessing other issues that were raised.

The mitigation group put forward several proposals for consideration:

reducing vessel and gear noise levels;

avoiding "hotspots" (i.e. areas where cetaceans are frequently seen);

alternating fishing season patterns;

changing fishing patterns and gear;

changing setting and hauling times;

verifying visually, or by other means, that an area is clear of cetaceans before engaging in a fishing operation;

encouraging communication between fishermen about cetacean interactions;

laying out false fishing gear to direct cetaceans away from 'true' fishing gear and fishing ground; and

encouraging scientists and observers to partake in fishing trips to obtain accurate data and assessments.

Participants in the assessment group concluded that priority should be given to collecting accurate data from logbook recordings, research cruises, port sampling or any other means that provides accurate information. The group also stated that there is a need to standardise the methods used to measure the depredation of fish caught by cetaceans and other predators (e.g. sharks, squid) on tuna longlines. Other problem areas included:

the current lack of data, which prevent accurate assumptions from being made;

the difficulty in attributing all depredation to a predator category;

empty hooks may or may not be due to depredation;

depredation may be a result of multiple predators;

indirect interference, such as scaring target species and depredation of bait, is difficult to assess;

data collection should focus on population status and dynamics, cetacean reaction to acoustic devices, migratory patterns and diurnal movements; and

determining the effectiveness of increased numbers of observers, and training fishermen.

During the final stages of the workshop the two groups formulated a draft report on outcomes; the workshop coordinator and two volunteers were requested to produce the full report.



### Survey of two fishing vessels – Korea

In December, the Nauru Fisheries and Marine Resources Authority (NFMRA) requested that William Sokimi assist them in surveying two fishing vessels in Korea. These vessels were part of the Korean government's aid assistance to Pacific Island countries. Nauru was offered 10 vessels as part of the package. Because of Nauru's limited harbour space, the government decided that only two long-line vessels and one squid jigging vessel would be required in consideration of accepting the offer. These vessels had to be constructed of fibreglass (FRP) and be no more than 40 GRT and less than 18 metres long. The vessels were also required to have a refrigerated seawater system or ice holds.

The Korean Ministry of Maritime Affairs and Fisheries provided two vessels for inspection.

The operational status of the engines and electronics could not be established during the survey. The main engines and engine rooms on both vessels needed repainting and restoration, and loose wiring needed to be sorted and secured. As no maintenance records were produced for the main engines, their service records could not be examined. The electronic equipment in the wheelhouse of both vessels showed signs of rust, sliding doors (main entrance) on both vessels were not watertight, most of the metal fittings needed to be replaced, fish holds needed to be repaired and tested, and the status of the refrigeration system needed to be established. The vessels had no fishing gear on them.

In general, the condition of these vessels at the time of

inspection was typical of vessels that have not been operational for 6 to 12 months. Costly restoration work would need to be done on the vessels before they were seaworthy enough to make the delivery voyage to Nauru, or to conduct fishing expeditions in Nauru's EEZ.

Even if the vessels were finally restored, they would require expensive maintenance programmes to keep them operational, and the present infrastructure on Nauru could not support such upkeep. While there is a temptation to procure free vessels, these are second-hand and have been worked excessively in the fishing trade. The decision to take responsibility of these vessels and the arrangements for procuring them was solely the prerogative of NFMRA.



*Some of the vessels being given away by South Korea  
[Photo: William Sokimi]*

## Fishing skills workshop – Palau

Fisheries Development Officer, Steve Beverly, conducted two fishing skills workshops in Palau, in conjunction with the Bureau of Marine Resources (BMR) and the Palau Visitors Authority (PVA). The two workshops, FAD Fishing Skills and Horizontal Longline Fishing Skills, followed a Tuna Handling and Grading Workshop conducted by SPC's Training Adviser, Michel Blanc. Seventeen fishermen, tour boat operators, dive boat operators, and educators participated in the workshops, which were held at BMR headquarters in Koror and onboard BMR's fisheries training vessel, *FV Elechil*.

A week was spent preparing fishing gear, consulting with BMR and PVA staff, and preparing *FV Elechil*. During this time, Michel Blanc conducted two, one-day workshops on on-board tuna handling and grading. Most of the participants in Michel's workshops were also in the fishing workshops.

The FAD fishing workshop was held the following week. The first day consisted of lectures on FADs, fish habitat, FAD fishing techniques, and sea safety. The sea safety lecture included demonstrating the sea safety grab bag, which contains an EPIRB, VHF radio, first-aid kit, fishing kit, and inflatable life jacket. During the afternoon, fishing gear was assembled, modified, and loaded onto *FV Elechil*. Gear included four complete vertical longlines with 15 branchlines each, five palu-ahi rigs, two bags of stones for drop-stone fishing, handlines, and trolling lines and lures.

**Top: *FV Elechil* at the wharf**  
**Bottom: Fishing gear being made up and loaded on *FV Elechil***

[Photos: Steve Beverly]

*FV Elechil* came equipped with a hydraulic vertical longline hauler with multiple detachable reels. Additionally, two wooden FAO Samoan handreels were mounted on the boat for demonstration purposes. These were loaded with palu-ahi rigs.

During the remainder of the two-week period, six fishing trips were made — five to a FAD and one to the outer reef slope on the west side of Koror. The FAD, located in about 2000 metres of water, was privately owned and had been deployed

by a local pole-and-line fishing company. During each trip, four vertical longlines (VLL) were set around the FAD. Bait consisted of local opelu, imported opelu or imported squid. Trolling, palu-ahi, drop-stone, single-hook drift line, and hand-line techniques were used while the VLLs soaked. Usually, five or six trainees went on each trip, along with the captain, Pablo Siangdeldeb and Steve.

A horizontal longline workshop was also held. Two days were spent on lectures, viewing a





videotape on longline fishing, and a practical session on making up longline fishing gear. FV *Elechil* came equipped with a longline reel and monofilament gear, which were modified. Branchlines were shortened from 32 m to 15 m and new floatlines were made from tarred polyester line.

Four longline trips were made, all on the east side of Koror, three to six miles offshore with sets running in a northeast/southwest direction parallel to the coast. Three to six participants went along. On each trip, 240 branchlines baited with muro aji (opelu), sardines, or squid were set at 0600 and hauled at 1300 hours. Lines were set with either 20 or 15 hooks in a basket. A flag buoy was attached to the mainline every mile. Finished sets were six to seven miles long.



Only one tuna (about 20 kg) was caught during the four longline trips. Other fish included a 40 kg sailfish, a big-scaled pomfret, several thresher sharks, a blue shark, and several mahi mahi. Locals blamed the poor fishing on El Niño. Locally based foreign longliners working out of Palau were experiencing a bad season as well. Normally, the good tuna fishing season in Palau is between April and August.



One objective of the horizontal longline workshop was to demonstrate to sport fishermen, tour boat operators, and dive boat operators — who often

**Top:** *Hauling a vertical longline*

**Middle:** *Skipper of FV Elechil, Pablo Siangdeldeb*

**Bottom:** *Cleaning a yellowfin tuna taken on the vertical longline*

*[Photos: Steve Beverly]*

perceive longline fishing as an activity that ruins their livelihood — that it is, in fact, envi-

ronmentally friendly. No turtles, sea birds, or under-sized marlins were caught.

During a joint BMR and PVA jointly held a barbeque at BMR headquarters, certificates were handed out.



*Left: Hauling the horizontal longline*



*Right: Certificates awarded at the end of the workshops*

[Photos: Steve Beverly]

## Second International Fishers Forum – Hawaii

The Second International Fishers Forum on solving the incidental capture of seabirds and sea turtles in longline fisheries was held in Hawaii in November, and hosted by the Western Pacific Regional Fisheries Management Council. The objectives of the meeting were to:

- increase the awareness of the interaction problem;

- promote the development of practical and effective management and mitigation measures;

- foster an exchange and dissemination of information on mitigation measures and the development of coordinated approaches to test new measures; and

- promote the development and implementation of col-

laborative mitigation research studies by scientists, fishermen, resource managers, and other interested parties.

Several days were spent in breakout sessions. In the turtle mitigation and research group, several presenters gave the results of their work. One group from The Azores, reported they had 237 turtle interactions in over 93 sets of a longline (shallow sets for swordfish). They tested different hooks and hook shapes to see if one resulted in reduced bycatch. The same interactions occurred with each hook type, although using the "J" hook resulted in over 50 per cent throat hookings, while the circle hook resulted in only 10 per cent throat hookings. Turtles were usually hooked in the lower jaw, with circle hooks.

Other researchers looked at turtle interactions and the position of the branchline with respect to the float (depth of hook set – swordfish set). Little difference was detected, although there was a higher catch rate during daylight hours. The main conclusions of this breakout group were the need for more information on turtle biology, the need for funding effective gear modification, a need by industry to know how big the longline catch of turtles is and the per cent mortality, and the need for more funding for gear research.

The breakout group on data identified issues regarding lack of trust, lack of commitment, privacy, and who had access and use of data. Some of the outcomes included the use of standard logbooks (internationally), for both catch and effort

and research-type data collection, the collection of necessary data, and adequate training and education for those collecting or

providing the data. Trust-building was a big issue, and it was agreed that industry needed to be involved in all aspects,

including the use of the data. Data ownership was also discussed, but with no clear decisions made.



## National Tuna Development and Management Plan – Kiribati

SPC Fisheries Development Adviser, Lindsay Chapman travelled to Kiribati to assist in the development of a national tuna development and management plan. This collaborative project was arranged by the Forum Fisheries Agency (FFA) in partnership with the Kiribati government. A Canadian consultant, Peter Flewwelling, was hired to coordinate the process. Staff from several regional organisations provided input in their areas of expertise. A steering committee was organised with

representatives from different stakeholder groups.

Lindsay gave advice on development options, and constraints, especially for small-scale and medium-scale tuna fishing operations. Other areas that were covered were training needs and infrastructure requirements. Domestic tuna fishing operations would likely focus on Christmas Island and Tarawa. Overall, the situation in Kiribati is unique, as there is limited infrastructure (especial-

ly Christmas Island), limited land for development (on both islands), limited fresh water and power availability (both locations), limited flights (one per week to Christmas Island), limited freight capacity (both locations) and high freight costs (especially from Tarawa). All of these factors hinder future development, although the government of Kiribati is keen to address these limitations so that domestic development of tuna resources can occur.



## ■ AQUACULTURE SECTION

### National aquaculture profile for the Federated States of Micronesia

Steve Lindsay was recently hired as an SPC consultant to prepare a national aquaculture profile for the Federated States of Micronesia. The profile provides detailed information on the history of aquaculture development over the past decade.

Constraints and development issues are discussed. According

to the report, the sector will benefit from improvements in coordination among the four states (Kosrae, Pohnpei, Chuuk and Yap). Selected commodities have potential but require private sector investment confidence and supporting legislation from government. Mr Lindsay's work was managed under the direction of the

Department of Economic Affairs who requested SPC's assistance for a strategic review of the aquaculture sector for national planning purposes.



### First national seaweed training workshop — Solomon Islands

#### Introduction

Seaweed farming requires low capital inputs and simple technology. It is a prospective cash crop for rural coastal communities and has proved to be a viable alternative to traditional export products, such as copra.

Given these attributes, the 1st SPC Aquaculture Meeting in November 2002 identified seaweed as one of the high priority

commodities for the Pacific region. Solomon Islands is one of the countries that could potentially be a major producer of seaweed.

#### **Seaweed farming developments in Solomon Islands**

Seaweed farming trials in Solomon Islands began in 1989 through the British Overseas Development Agency (ODA).

Experimental trials were established at Vona Vona lagoon and Rarumana village. The initial results were promising, with 10 metric tonnes produced. However, after the Coastal Biological Company ceased its operations in 1991 the project had to be terminated.

In 1999 the Solomon Islands fisheries department began to revive interest in seaweed farming, but this was disrupted by

the ethnic crisis. By 2002 the European Union funded Rural Fishing Enterprise Project (RFEP) became involved. The RFEP manager, Rory Stewart, previously worked in seaweed farming in Kiribati. The RFEP and the Solomons fisheries department established pilot farms in Langalanga, Malaita Province, and in Rarumana, Western Province.

The successful establishment of trial farms in Langalanga and Rarumana caused widespread interest at local and national levels. SPC was approached to assist the Solomon Islands government with a national workshop that would provide the relevant training to extend seaweed farming to all provinces. Planning and logistics were coordinated through an organising committee comprising Mr Alex Meloty, fisheries department, Mr Rory Stewart, RFEP, and Mr Ben Ponia, SPC aquaculture programme. Funding for the workshop was provided by SPC and RFEP.

### **Arrangements for the seaweed workshop**

Mr Ledua Esaroma was the workshop trainer. He was one of the main proponents behind the rejuvenation of seaweed farming in Fiji Islands and is the agent for FMC BioPolymer, the sole buyer of seaweed in Fiji.

Mr Kamati Kautu from the Kiribati fisheries department was also recruited as a resource person for the workshop. Kamati has first-hand knowledge of the seaweed farming industry in Kiribati through his duties as a seaweed extension officer.

The core trainees for the workshop were fisheries officers from the Solomon Islands national fisheries department and the provincial fisheries

The seaweed, *Kappaphycus* sp., is commonly known in the industry as *euचेमा* or *cottoni*. Farms are made up of lines strung between stakes in shallow reef areas, or on floating rafts and longlines in deeper lagoon areas. Seaweed cuttings are simply tied and left to grow until harvest six weeks later. Seedstock is obtained from a small portion of the harvest retained.

Unlike many of the region's fisheries products, the export market demand for seaweed is guaranteed. The carrageen from the sun-dried seaweed extract is used in a wide variety of food and pharmaceutical products. World production, mostly from Southeast Asia, is about 150,000 dry tonnes.

In the Pacific, seaweed farming is well established in Kiribati, with production around 1000 dry tonnes per annum, and has been re-established in Fiji Islands, with annual production peaking at 700 dry tonnes. Around 1500 rural households are engaged in farming, providing cash-in-hand to meet basic financial obligations such as school fees, church donations and communal activities.

departments. While most were novices in seaweed farming there were a few relatively experienced participants who had been involved in the recent phase of pilot farms or through training sponsored under the FAO South Pacific Aquaculture Development Program several years ago.

Ms Jane Bagita, an observer from the Milne Bay fisheries department in Papua New Guinea, was also invited. Papua New Guinea has tremendous potential for seaweed farming and the Solomons workshop was a good opportunity for Jane to assess the applicability of seaweed farming for her country and perhaps champion its cause in the future.

Rarumana Island, where the fieldwork occurred, is a 40-minute boat ride from Gizo, capital of the Western Province. Numerous seaweed plots were established in a back-reef area about two kilometres away from the village, covering an area stretching maybe a half kilometre. It was estimated that there were about 6000 lines in total. Since the activity had

started (about four months earlier) the farms had harvested about 3.6 tonnes of dry product (about 30 tonnes wet weight). About two tonnes were produced by a single person. The enthusiasm of the village host as well the scenic setting of Rarumana lagoon was a great working environment.

### **Conclusion**

By the end of the workshop, participants had been guided through all aspects of seaweed farming, including methods for site selection, farming materials selection, preparation of farming materials, setting up test plots, predator identification and control, harvesting and drying, moisture testing, storage, marketing, farm management, farm modelling and monitoring.

This trip also assisted in formulating national targets for the industry. The aim is to produce 80 dry tonnes per month and the involvement of 500 families within a four-year time span. The current phase of expanding seaweed production will also lead to the first export of a con-

tainer load, possibly within the next six months. FMC BioPolymer, one of the main buyers of seaweed, is negotiating with the Solomon Islands government to buy the seaweed at a set price until the country reaches a certain tonnage, after which the producers can bargain on prices.

The roles of SPC and the European Union RFEP were discussed during post-workshop meetings, to ensure that follow-on

support was provided. The two agencies have resources to provide much of the necessary technical and funding assistance for the initial growth stages until seaweed farming reaches a critical mass where private sector-led development can be sustained. The European Union has committed funding for seaweed developments until December 2003. There are positive signals that after this, it will fund a five-year project, similar to the assistance that was pro-

vided to establish the industry in Kiribati.

On a regional level, seaweed development in Solomon Islands is an important step towards the regional target of at least 10,000 tonnes per annum. This quantity is required to justify a regional processing plant that will provide value adding opportunities to improve the profitability for farmers.



## ■ REEF FISHERIES OBSERVATORY

### The DemEcoFish Project: Completion of fieldwork

The MacArthur-funded DemEcoFish project has nearly completed all its socioeconomic field surveys. As planned, a total of six sites (communities) located in three major regions of Tonga and Fiji were researched. The three Tongan regions and six villages, including fishing grounds are: Koulo and Lofanga in the Ha'apai Island Group, Mataika and Ovaka in Va'vau, and Ha'atafu and Manuka on Tongatapu. In Fiji Islands, the villages of Nukunuku and Nasaqalau on Lakemba Island of the Lau Group, Dromuna and Muaivuso on Viti Levu, and Lakeba and Nakawaqa on Vanua Levu were targeted by the survey.

Each survey began with a village meeting for information and for gaining an overview of the role that marine resources play in the selected community. These meetings were also used to learn about the community's fishing grounds, and to perform a participatory based survey — using ranking and scoring tools — on fishing and marine consumption issues by gender and age groups.

Data collected in each village comprised household census

and household consumption surveys (targeting all households within the selected community); individual fishing and consumption surveys (targeting about 20–25% of all men and women over 15 years of age); fishing and marketing surveys (targeting all fishers who mainly fish with boat transport and with a strong commercial interest), complemented by a boat owner survey (motorised and non-motorised), and a marketing survey (targeting agents, middleman, shop owners, etc.).

In addition, participatory ranking and scoring tools were used to address older primary school students in the selected communities. This survey allowed an insight into fishing activities and strategies of children aged ~12 years, and gender related fishing education.

The socioeconomic surveys were jointly conducted by the Community Fisheries Scientist from SPC's Reef Fisheries Observatory, and staff members from the Tongan and Fijian Ministries of Fisheries. Complementary team members from the University of the South Pacific and other national

authorities joined the survey teams.

Efforts are underway to start the data management and processing part of the research project. Discussions and efforts are ongoing as to how best use and modify the results obtained from this project for the EU-funded ProcFish/C project. Plans are also underway to address the dissemination of results. The design of technical and scientific publications using the results from field data collected is in progress.



## ■ WORLD FISH CENTER (formerly ICLARM)

### First sea cucumbers produced in New Caledonia

After a long period of development, the WorldFish Center/SPC project on restocking sea cucumbers is in full swing. Following a short teething period at the hatchery at Saint Vincent, north of Noumea, the project team produced the first batches of juvenile sandfish (*Holothuria scabra*), a highly valued sea cucumber species. These are the first of their kind to be reared in New Caledonia; the largest of which are now over 20 mm in length and growing quickly! Through multilateral funding, a new greenhouse hatchery was built to accommodate the aquaculture systems for the project.



*The hatchery at Saint Vincent, New Caledonia*  
[Photo: WorldFish Center]

The early larval stages have proved difficult to maintain in the conditions at the site. But the latest batch of these, well over 5000 sandfish juveniles a few millimeters long, has been successfully reared and transferred to raceway tanks for growing to a larger size. In a couple of months, they will be used in the first experiments to determine how to release them for restocking depleted sea

cucumber fisheries for Pacific and Southeast Asian communities. Others will be used in trials to see if they can be grown in co-culture with shrimp, which are the primary aquaculture interest in New Caledonia.

A component of the project, to reveal the genetic structure of sandfish, is now being finalized — with interesting results. The allozyme electrophoresis analy-

ses indicate that most of the nine selected sub-populations of sandfish interbreed. But two sub-populations near Noumea appear more isolated and with different genetic compositions. The results are allowing the design of responsible designs for the experiments, in order to protect the genetic diversity of this topical species.



*Left: Juvenile sandfish, 2 mm in length; Right: Juvenile sandfish, 15 mm in length*  
[Photos: WorldFish Center]

## ■ PAPUA NEW GUINEA: TWO NEW FISHERIES PROJECTS UNDERWAY

### ***ADB approves USD 5.7 million for coastal fisheries project***

The Asian Development Bank (ADB) has approved a loan of USD 5.7 million to Papua New Guinea (PNG) for a Coastal Fisheries Management and Development Project, which aims to improve the management of the country's valuable coastal fisheries resources, especially in overfished areas. The project will also create income-earning opportunities for fishermen by providing links to established commercial fishing centres, and will strengthen provincial fisheries offices by training fisheries officers to better manage fisheries resources at the provincial level.

About 30,000 coastal households, whose livelihoods depend on fisheries, will benefit directly from this project.

Phase 1 of the project began in 2000, in which extensive research and consultations were made throughout the country with stakeholders such as fishery participants, representatives of the public and the private sector, resource users and owners, and non-governmental organisations. During this process, the provinces of Milne Bay, Morobe, New Ireland and Western were identified as the target provinces for the project.

These provinces possess either one or all of the following: a supporting infrastructure, a relative abundance of fish resources, potential for increased value from small-scale fisheries, and proximity to commercial fishery centres.

The project also include the construction of: a tuna longlining wharf in Lae, a small boat jetty

in Daru, a small boat jetty and a transit house in Alotau, and a mariculture facility on Nago Island, Kavieng.

### ***Rural coastal fisheries project kicks off in PNG***

The implementation phase of the new Rural Coastal Fisheries Development Project has began with the arrival of the Project Team Leader, Mr Sean Marriott, in Port Moresby in October 2002.

This follows on from the signing of the financing agreement last year between the then Prime Minister, Sir Mekere Morauta and the EU Delegate, Mr Anthony Crasner.

The project is intended to run for five years and has a budget of six million euros. It has identified seven project sites throughout the country: Alotau, Buka, Daru, Kavieng, Lae, Madang and Port Moresby.

Mr Marriot said the project would support small-scale fishing enterprises. Its objective is to improve the welfare of the rural coastal population through a greater participation in harvesting and marketing of their marine resources.

"Apart from infrastructure developments, the big idea of this project is to promote development through private sector initiatives. A line of credit, backed up by an initial loan scheme, will be established through banks and private companies to enable small fishing enterprises and fishing groups to purchase boats, fishing gear, ice plants and other equipment. The private enterprise ethos will be reinforced through training and help in preparing investment proposals so that,

from the start, this project will act as a credit guarantor to communities who do not have access to capital — and not simply as a source of handouts.

"Running alongside the credit schemes will be help for communities with depleted resources to acquire the resource management skills that will help them develop and recover those resources so that they can realise the full benefit of sustainably managed assets. Fishing groups will also be given the skills to enable them to manage their business and resources effectively and profitably.

"This departure from the traditional fisheries project delivery vehicle offers an exciting and challenging approach to development in a sector which has often frustrated effective progress and the Rural Coastal Fisheries Development Project aims to change all that," Mr Marriot said.

(Source: Fishing Line, bi-monthly newsletter of the National Fisheries Authority, Issue No. 11, September–October 2002)



## ■ MARINE RESOURCE SURVEY AND ASSESSMENT OF JALUIT ATOLL, REPUBLIC OF THE MARSHALL ISLANDS

### Background

The Jaluit Atoll Marine Conservation Area (JAMCA) was established in 1999, after preliminary studies in 1998. The JAMCA was developed through the combined efforts of the Jaluit Atoll Development Association, the Jaluit Atoll Local Government Council, the Jaluit Community and the national Environment Protection Authority (EPA). Donor support and assistance was received from the South Pacific Regional Environment Programme (SPREP) through its South Pacific Biodiversity Conservation Programme (SPBCP); a Conservation Area Supporting Officer (CASO) has recently been appointed to manage and develop the program. This position is based on Jaluit Atoll.

The goals of the JAMCA are to develop and implement:

- a sustainable marine resource management plan,
- a sustainable terrestrial management plan,
- community-based management structures,
- alternative income generating activities,
- public awareness, training and education programs, and
- measures to strengthen the capacity of the community to effectively manage a conservation area.

The JAMCA project will first develop an adaptive marine resource management program that has access to reliable, baseline biological information on the marine ecosystem and

species-specific population data. This information will provide the basis for the formulation of a robust monitoring program and a resource management plan. The goal of this marine evaluation report is to provide baseline biological information. The marine resource management program must monitor changes in resource levels and be able to respond decisively with management decisions that are practical and acceptable to all stakeholders and resource users. The marine resource survey objectives were to:

- assess and estimate species stocks for the below listed selected species as baselines for planning and future monitoring,

- map the general distribution of populations (or major population clusters) of giant clams, trochus and blacklip pearl oysters within the lagoon,

- generate any other biophysical information on the marine resources of Jaluit that would be important in the formulation of a management plan for the lagoon.

The selected species were: giant clams (*Tridacna gigas*, *T. maxima*, *T. squamosa*, *Hippopus hippopus*), trochus (*Trochus niloticus*), blacklip pearl oyster (*Pinctada margaritifera*), groupers (*Epinephelus microdon*, *E. maculatus*), and rainbow runner (*Elagatis bipinnulatus*).

### Executive summary

Visual resource survey methods (manta tows, timed swims and line transects) were used to evaluate the marine resources of Jaluit Atoll. A total of 231 tows (199 lagoon, 32 ocean side) cov-

ering 80 hectares were conducted during the evaluation. Data collected for each tow included: water depth, tow width, tow length, total number of trochus, clams, pearl oysters, fish, sea cucumbers, per cent coral cover, per cent cloud cover, wind conditions, and latitude and longitude coordinates.

Marine biodiversity is high at Jaluit Atoll. Invertebrate and vertebrate species diversity and stock abundances were also high, with reproduction and recruitment occurring. Reef passes and ocean-side reefs had higher species diversity than lagoon reefs. No evidence of destructive fishing methods was found. Nine mangrove forests were found within the atoll, all of which are unique and require further scientific study.

Four areas of the Jaluit lagoon are recommended for designation as marine reserves (north western section of the lagoon and the three main water passes). The selection criteria determining these reserve locations included species diversity, species abundance, accessibility and uniqueness. The dimensions and precise location of the four suggested marine reserves are flexible and must be determined through discussions with all stakeholders. All reserve areas should include the reef flat down to the 100-meter mark outside the lagoon. All organisms located within this area should be protected.

A community-based questionnaire was used to assess the intensity of giant clam, pearl oyster and trochus utilisation, and social attitudes towards conservation.

In addition, the questionnaire was used as a training exercise for the newly appointed CASO officer. Giant clams and trochus are staple food items within the atoll and are consumed either weekly or on a monthly basis. The majority of respondents collect these animals themselves, however some bartering and cash purchasing occurs. Over 80 per cent of respondents indicated that these animals are becoming scarce; respondents stated they would welcome and support a conservation program.

All respondents were aware of national regulations pertaining to the collection and sale of trochus, although they were unaware of pearl oyster regulations. A traditional marine management system called "MO" has been used to protect both marine and terrestrial resources in the past and may be a useful tool for all marine management plans for this atoll.

Population stock abundances of Epinephelinae fish (*Epinephelus polyphkadion*, *E. maculatus*, *Plectropomus laevis*, *P. oligacanthus* and *Variola louti*) and the rainbow runner (*Elagatis bipinnulatus*) are high and the current level of subsistence harvesting appears not to be detrimental to these fish populations. No commercial activities currently target these fish; however, management protocols should be introduced for all species of fish utilised for commercial purposes. These protocols could include limits on size, gender, space and location, and should include protection programs for breeding purposes. The collection of biological information (fork length, weight and gonad index) must continue to provide evidence of the annual reproductive cycle, the minimum size of maturity for each gender, and population structures over an annual period for each species. Such data are imperative for the

development of specific management protocols. Clarification of the location and timing of grouper reproductive aggregation sites must be determined and included in the management plan.

Population stock abundances differ for each species of giant clam. *T. maxima* are the most abundant species and high numbers were located throughout the lagoon. Current subsistence harvesting of this animal has caused localized population declines on some reefs, especially those close to inhabited islands and popular fishing grounds. Population numbers of *T. squamosa* and *H. hippopus* were low and these clams urgently need to be conserved through an appropriate management plan. No specimens of *T. gigas* nor, the introduced *T. derasa* were located. It is suggested that both species are extinct from this atoll.

Blacklip pearl oysters (*Pinctada margaritifera*), both mature and juvenile shells, were located within the lagoon. Population numbers varied. Pearl oysters have little if any subsistence value within this atoll and therefore fishing pressure on natural populations is all but absent. However, this oyster is utilised for black pearl production and there is keen interest in developing an industry. A management plan needs to be developed for the commercial exploitation of this species. The removal of live oyster stocks from this lagoon, which has occurred in the past, should be prohibited. The collection of oysters for their shell (button and handicraft trade) at the commercial level should be tightly regulated, if not prohibited.

Stock populations of *Trochus niloticus* on Jaluit Atoll are low. This is a direct result of recent commercial harvesting. It is

clearly evident that trochus stocks need to be conserved immediately before further depletion of this species occurs. A total ban on the commercial exploitation of this species should be considered and maintained until such time that trochus stocks have significantly recovered to allow sustainable harvesting to recommence. Restrictions should also be considered for all subsistence activities. These restrictions could include: size restrictions, reef restrictions (reserves), closed seasons and bans.

Eleven species of sea cucumber were found (*Holothuria atra*, *H. nobilis*, *H. horrens*, *H. edulis*, *H. fuscopunctata*, *Actinopyga mauritiana*, *Bohadschia argus*, *B. marmorata*, *Stichopus variegatus*, *Thelenota ananas*, *T. anax*) on Jaluit's reefs. Population abundances are high for all species except for the commercial species currently harvested. Stocks of *H. nobilis*, *H. fuscopunctata*, *B. marmorata*, *S. variegatus*, and *T. ananas* are low to very low within the lagoon as a direct result of current commercial harvesting. Stock populations of these animals below 20 meters depth are unknown.

Management protocols need to be developed and implemented to preserve the existing stocks of commercial sea cucumbers to allow recruitment and sustainable commercial harvesting. Suggested protocols to consider are: bans on the collection of certain species, bans on collection locations, size limits, season limits and closures.

The crown of thorns starfish, *Acanthaster planci*, was found in very low numbers on Jaluit and are not considered a threat to the reefs at this time.

Two species of tropical lobsters were found in Jaluit, *Panulirus penicillatus* and *P. versicolor*. The former was more abundant.

Anecdotal information indicated that *P. longipes fermoristriga* is also present, but was not seen during the survey. Thirty specimens of *P. penicillatus* were examined; over 50 per cent of female lobsters were either carrying eggs or had signs of recent release of eggs, clearly indicating that this species is reproductively active during the summer months. Only one immature specimen of *P. versicolor* was located during the survey. Additional information is required to provide evidence of this species' reproductive cycle. The current subsistence harvesting of *P. penicillatus* and *P. versicolor* on Jaluit Atoll appears not to be detrimental to populations on the reefs, and therefore, no immediate management action needs to be implemented. Management protocols must be developed and implemented if and when commercial harvesting of these species occurs.

A number of recommendations, based on the results of this study, are discussed for each organism. An overall monitoring program must be implemented. The monitoring program has been designed to provide baseline scientific information on the life histories of these animals and their abundance. Information gained from this program is essential for the development of appropriate management plans. The designation and policing of the recommended marine reserves should be undertaken immediately. Management plans must be developed for all future commercial fishing and harvesting of marine resources.

### **Recommendations**

Jaluit Atoll's marine resources require management. Without an adaptive, useable management plan, stock populations of marine organisms will be over exploited.

The priority activity should be the collection of basic life history data on the organisms discussed in this paper. Data (biological and morphological) must be collected on a monthly basis over an annual period for each organism. The biological information obtained for each individual species is imperative to the development of a suitable management plan. Data must include: date of sample, location of sample, sex and maturity of animal, body length (fork length, carapace length), total weight, reproductive condition, and gonad index.

In addition, marine resource stock surveys (as undertaken in this evaluation) should be repeated, at least on an annual basis, to provide information on the population structure and abundance of marine organisms within the lagoon.

Data collection should be undertaken at intervals of three months on the four existing giant clam monitoring transect sites. Additional transect sites, including coral monitoring sites, must be developed in the suggested marine reserve areas once the reserves have been developed.

The four marine reserves recommended should have boundaries identified and passed into legislation as swiftly as possible; all marine life in these reserves should be preserved and protected.

The suggested community-based fisheries questionnaire should be used to assess the patterns of exploitation of fisheries resources, the main methods of fishing and the most common species caught.

The above activities should form part of the CASO offi-

cers' work plan. The CASO officer should provide marine education and awareness training programs for the community on all aspects of coral reef management, and conduct regular community meetings to discuss the management program.

A marine evaluation program is required to determine the spawning aggregation sites of the dominant Epinephelinae fish species. The timing of this program will be determined from the CASO monthly examination of fish gonads.

A resource evaluation is required to determine the existence, abundance, and location and population size of mangrove crab and coconut crab populations within the atoll. This evaluation should also provide information to assist in the development of a management plan for each species.

Immediate conservation measures should be implemented to prevent further exploitation of trochus and commercial sea cucumber stocks. A total ban on all commercial harvesting of trochus should be considered. Regulations should be introduced to decrease the fishing pressure on the existing stocks of commercially valuable sea cucumbers.



All new commercial marine harvesting activities should be prohibited until such time that sufficient biological information has been collected to develop correct management protocols.

The artificial culture of pearl oysters for the pearling industry should be considered.

(Prepared for the Marine Management and Conservation Area Project, RMI, funded by SPREP and prepared by Stephen Lindsay, Micronesian Aquaculture and Marine Consultant Services: slindsay@mail.fm)



## ■ MARINE RESOURCE SURVEY OF LENGER ISLAND, POHNPEI STATE, FEDERATED STATES OF MICRONESIA

### Background

The Conservation Society of Pohnpei (CSP) is a recently established, non-governmental organisation that has taken on the responsibility of promoting and developing sustainable management and conservation programs for natural resources within Pohnpei State. The development of a marine conservation area and management plan for Lenger Island is one of CSP's current programs. The goals of the Lenger Island conservation program is to develop and implement:

- a sustainable marine resource management plan,
- a sustainable terrestrial management plan,
- community-based management structures,
- alternative income generating activities,
- public awareness, training and education programs, and
- measures to strengthen the capacity of the community to effectively manage a conservation area.

The Lenger Island Marine Conservation project will first develop an adaptive marine resource management program that has access to reliable baseline biological information on the condition of the marine

ecosystem and to species specific population data. This information will provide the basis for the formulation of a robust monitoring program and a resource management plan. The marine resource management program must monitor changes in resource levels and be able to respond decisively with management decisions that are practical and acceptable to all stakeholders and resource users.

The goals of this marine evaluation report are to provide this baseline biological information in order for the marine management plan to be implemented. The marine resource survey objectives were to:

- assess and estimate selected species stocks as baselines for planning and future monitoring,
- design undertake and a reef monitoring program that can be continued by CSP and local stakeholders over time,
- identify any rare endemic species that should be protected,
- identify any fish aggregating sites,
- provide information and advice to assist CSP in developing a marine conservation program that can be maintained over an extended period of time,

generate any other biophysical information on the marine resources that would be important to the formulation of a management plan,

undertake a training and information exchange program for CSP staff and local stakeholders on all relevant marine evaluation techniques and management, and

provide a written report on all findings at the completion of the contract.

The New Zealand Agency for International Development — through a PIE grant — funded the resource assessment survey. The Conservation Society of Pohnpei (CSP) administered the funding for this survey.

### Executive summary

Visual resource survey methods (manta tows, timed swims, line intercept transect and line transects) were used to evaluate the marine resources of Lenger Island. A total of 57 tows covering 20 hectares were conducted during the evaluation. Data collected for each tow included: water depth, tow width, tow length, total number of sponges, clams, pearl oysters, fish, sea cucumbers, per cent coral cover, per cent cloud cover, wind conditions, and latitude and longitude coordinates.

Marine biodiversity is high and the coral reef surrounding Lenger Island is healthy. Invertebrate and vertebrate species diversity and stock abundances were high, with reproduction and recruitment occurring. No evidence of destructive fishing methods was found; however, reefs are being damaged by anchors. An anchor awareness and mooring buoy project should be introduced. Mangrove forests and mangrove crabs are located within the reserve and require further scientific study.

The entire fringing reef surrounding Lenger and Sapwtik islands should be made into a marine reserve, and within this reserve, all activities should be regulated, such that certain activities are prohibited, while others are allowed. Closed reefs should be included. The marine reserve should include the reef flat down to the 30-meter mark. All organisms located within this area should be protected.

The effects of sedimentation on coral reefs should be investigated. A program should be developed to provide scientific data for determining sedimentation levels on the coral community within the marine reserve. Furthermore, a sedimentation study should be considered and implemented to evaluate sediment levels resulting from marine sand mining.

Population stock abundances of all fish evaluated during the survey were low. The majority of fish were immature juveniles and all fish were cautious around humans in the water. Overexploitation of fish stocks has occurred and marine closure reserves should be developed. The collection of biological information (fork length, weight and gonad index) should be developed to provide evidence of the annual reproductive cycle, the minimum size

of maturity for each gender, and population structures over an annual period for each species. Such data are imperative for the development of specific management protocols. Clarification of the location and timing of grouper reproductive aggregation sites must be determined and included in the management plan.

Low population stock abundances were recorded for two species of giant clams, *T. maxima* and *H. hippopus*. *T. maxima* are the most abundant species while *H. hippopus* were present in very low numbers of. No specimens of *T. squamosa*, *T. derasa* or *T. gigas* were located. Conservation measures for the remaining populations of clams should be introduced.

Blacklip pearl oysters (*Pinctada margaritifera*) were found, although population numbers were low. Pearl oysters have little if any subsistence value and therefore fishing pressure on natural populations is all but absent.

High stock populations of the commercial Pohnpei wool sponge, *Hippospongia* sp. were located. It is recommended that community-based sponge farming be initiated once the marine reserves have been developed and community interest is present.

Fifteen species of sea cucumber were observed (*Holothuria atra*, *H. nobilis*, *H. horrens*, *H. edulis*, *H. fuscopunctata*, *H. flavomaculata*, *Bohadschia argus*, *B. marmorata*, *B. graeffei*, *Stichopus variegatus*, *S. chloronotus*, *Thelenota ananas*, *Stichopus* sp. *Actinopyga palauensis*, *A. miliaris*). Stock populations of the commercially important species (*H. nobilis*, *H. fuscopunctata*, *B. marmorata*, *S. variegatus*, *T. ananas*) were found in relatively high numbers, and their population density indicates that past commercial harvesting has

not greatly reduced population stocks, at least on the surveyed reefs. It should be noted that the majority of commercially important species favour habitats not found on the inshore islands of Pohnpei.

The crown of thorns starfish, *Acanthaster planci*, was found in low numbers, and is not currently considered a threat to the reefs at this time.

One individual lobster, *Panulirus versicolor* was found during the survey. Lobster populations within the marine reserve are very low and management protocols need to be developed to preserve existing stocks.

A number of recommendations, based on the results of this study, are discussed for each organism. An overall monitoring program should be implemented. The monitoring program has been designed to provide baseline scientific information on the life histories of these animals and their abundance. Information gained from this program is essential for the development of appropriate management plans. The designation and policing of the recommended marine reserve and activities should be undertaken immediately. Management plans must be developed for all future commercial fishing and harvesting of marine resources.

### Recommendations

Lenger Island's marine resources require management. Without an adaptive, useable management plan, stock populations of marine organisms will be further exploited. The recommendations presented below have wider implications for Pohnpei Island and should be adapted to develop additional marine conservation areas. This is not a definitive list and additional priority areas should be developed.

Lenger Island's entire fringing reef should be designated a marine reserve. Within the reserve certain activities should be prohibited. It is recommended that certain reef areas be closed to all fishing and harvesting activities for a period of time (at least three years) to allow populations of all marine organisms to mature and breed.

The priority activity should be a public awareness program to provide information about non-destructive methods of anchoring boats on reefs. A mooring buoy project should be undertaken to reduce the use of individual anchors.

The collection of basic life history data on specific marine organisms should be undertaken. Biological information obtained on individual species is imperative to the development of a suitable long-term marine management plan.

Marine resource stock surveys (as undertaken in this evaluation) should be repeated, at least on an annual basis, to provide information on the population structure and abundance of marine organisms within the lagoon.

Data collection should be undertaken at intervals of three months on the three existing fish monitoring transect sites. Additional sites should be considered once the marine reserve has been developed; these sites should compare closed reefs with exploited reefs.

Twice-yearly data should be collected on per cent coral cover at the two permanent coral monitoring sites. Additional transect sites, including coral monitoring sites, must be developed once the reserves have been designated.

The suggested community-based fisheries questionnaire should be used to assess the patterns of exploitation of fisheries resources, the main methods of fishing and the most common species caught.

CSP should provide continued marine education and awareness training programs for the community on all aspects of coral reef management, and conduct regular community-based meetings to discuss the management programme.

A marine evaluation study is required to determine the spawning aggregation sites of the dominant Epinephelinae fish species.

A resource evaluation is required to determine the existence, abundance, location and population size of the mangrove crab population. This evaluation should also provide information to assist in the development of a management plan for the species.

All new commercial marine harvesting activities should be prohibited until such time that sufficient biological information has been collected to develop correct management protocols.

The artificial culture of sponges should be considered.

(Prepared for the Conservation Society of Pohnpei, CSP. Willy Kostka (csp@mail.fm); Prepared by Stephen Lindsay, Micronesian Aquaculture and Marine Consultant Services: slindsay@mail.fm)



## ■ FATIGUE AND FISHING CREWS

*Time and again, fatigue has been a major factor in marine incidents.*

Sleep is a basic human need and a lack of adequate sleep may lead to fatigue. Fatigue may be described as a reduction in physical and/or mental capability as a result of physical or mental exertion that has the potential to impair most abili-

ties including strength, speed, reaction time, coordination and decision-making.

Fatigue may be acute or chronic. Acute fatigue can occur in a matter of hours, as a result of excessive and sustained mental or physical activity, and may be cured by an adequate period of rest or sleep. Chronic fatigue is

experienced when the normal period of rest or sleep is insufficient to restore an individual's working performance to its usual level. Chronic fatigue is subtle and usually develops over a period of time. Individuals suffering from chronic fatigue perform below their personal best and are often unaware that their performance has been sig-

nificantly degraded. In the worst cases, chronic fatigue can cause an individual to momentarily sleep at work, while sitting or standing, for what is known as a "micro-sleep".

In practice, what this means is that fatigue not only results in being tired or feeling sleepy. It means that a person's performance is below, often well below, what is normal and that people are not as alert as they think they may be. People may not even recognise that they are suffering from fatigue. Signs and symptoms of fatigue include forgetfulness, avoiding tasks, poor communication, poor decision-making and fixation on a single task.

### **Measures to prevent fatigue**

The STCW (Standards of Training, Certification and Watchkeeping for Seafarers) Convention requires administrations to take measures to prevent fatigue, by prescribing hours of rest for seafarers; however, this convention does not apply to fishing vessels.

The International Labor Organization Convention, No. 180, on Seafarer's Hours of Work and the Manning of Ships, for every seagoing ship ordinarily engaged in commercial maritime operations, states that to the extent practicable, "the competent authority shall apply the provisions of this Convention to commercial maritime fishing". The convention contains provisions to limit the maximum number of hours of work of a seafarer in a week. It also prescribes the minimum hours of rest in each week.

### **A dangerous profession**

According to a report from the United Nations Food and Agriculture Organization, the fatality rate among fishermen in Australia is 143 per 100,000, compared with the national average of 8.1 per 100,000 for other occupations.

The report notes that one of the major dangers in the fishing industry is fatigue, and that fishing boats tend to be understaffed to maximise profits.

### **Keeping a proper lookout**

The International Regulations for Preventing Collisions at Sea, 1972, as amended, in Rule 5, states:

*Every vessel shall at all times maintain a proper lookout by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and the risk of collision.*

In addition to ships being required to maintain a proper lookout, skippers of fishing vessels must also ensure that a proper lookout is maintained at all times. The danger of insufficient manning levels is that this can lead to crew fatigue and hence to an ineffective lookout, or none at all.

(Source: Australian Transport Safety Bureau, Safety Bulletin 04, <http://www.atsb.gov.au>)



#### **Remedial measures**

Fishing vessel owners and operators are urged to review the issues of manning and fatigue on their vessels. They are also urged to take remedial measures to prevent fatigue such as:

Scheduling watches;

Considering sleep needs when making decisions on crew numbers;

Avoiding under-manning;

Using a team approach where possible to prevent a single person's fatigue from impeding safety;

Not letting other activities intrude on rest and sleep; and

Ensuring that both the skippers and crews have the opportunity for adequate levels of rest.



## ■ CONSERVING ECOLOGICAL INTEGRITY OF MARINE RESERVES: "NO TAKE" IS NOT NECESSARILY "FULLY PROTECTED"

A troubling trend has emerged in recent years among many marine protected area (MPA) scientists, planners, and advocates: namely, the interchanging use of the terms "fully protected" and "no-take". Such usage suggests that extractive use *per se* is the only resource-use issue relevant to the protection of marine resources within marine reserves. The logical outcome of such a paradigm is that managers/planners are led to believe that simply making these areas off-limits to fishing might adequately protect the ecological integrity of such areas.

Such a view, however, is inconsistent with best-available science and common sense. Today, many biologists concur that on a worldwide basis, the greatest threat to wildlife, biodiversity, and ecosystem health is the widespread degradation, loss and fragmentation of natural habitats (Ehrlich and Wilson 1991; Soule 1991). While "extractive use" may frequently contribute to habitat degradation in marine ecosystems, it is far from the only factor or form of resource use involved.

It has been well documented, for example, that unregulated numbers and/or activities of recreational divers and snorkelers can cause substantial damage to sensitive marine habitats. Such problems become evident even at levels of diving intensity far less than those presently experienced at many popular dive sites (CIDE 1997). Coral reefs are particularly sensitive to diver damage, with documented impacts typically including reduction of live coral cover, reduced abundance and diversity of corals and other benthic invertebrates, and

increased turbidity and sedimentation at reef sites (Hawkins and Roberts 1992, 1993; Chiappone and Sullivan 1996; Harriot et al. 1997; CIDE 1997; Roberts and Hawkins 2000; Jensen 2001). Problematic impacts from unregulated recreational diving have also been documented on temperate rocky-reef habitats in both the Mediterranean (Zabala 1997; Badalamente et al. 2000) and in California kelp forests (Schaeffer et al. 1999).

Similarly, feeding and other forms of harassment of marine wildlife have been shown to cause ecological disruption in the forms of altered behavior and/or unnatural distribution/abundance patterns in sharks (Burgess 1998), reef fishes (Perrine 1989; Quinn and Kojis 1990; Cole 1994; Hawaii DLNR 1993, 1999) and marine mammals (NOAA 1994). Marine mammals have been most thoroughly studied with regard to the impacts of inappropriate human interactions (feeding, touching, etc.). Here, the problems documented were of sufficient concern (NOAA 1994) that such activities are now classified as a form of "take" and prohibited under provisions of the U.S. Marine Mammal Protection Act.

Despite such well-documented problems, the referenced activities remain unregulated at most so-called "fully protected" marine reserves. While the long-term impacts of chronic overfishing on reef communities are not to be taken lightly, neither should substantive documented "non-consumptive" impacts. In fact, given the problems documented from the referred activities within some established marine reserves,

one could argue credibly that the latter should be of at least equal concern as the former in the development of management schemes designed to "fully protect" the long-term ecological integrity (or fisheries) of sensitive tropical and temperate reef habitats.

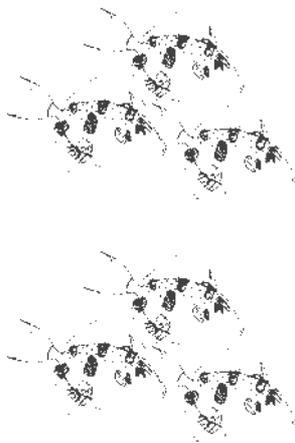
Roberts and Hawkins (2000) pointed out the need to regulate diving intensity on coral reefs, suggesting that a sizable portion (10–20%) of reef areas in "fully protected" marine reserves be completely closed to scuba diving. Badalamente et al. (2000) reported that newly established marine reserves in the Mediterranean quickly became magnets for increased dive tourism, and the resulting impacts on benthic communities and disturbance of reef fish assemblages (through rampant fish feeding) forced authorities to either ban divers completely, or strictly regulate their numbers in some areas. A focused study of the impacts of recreational diving impacts on kelp forests of central California (Schaeffer and Foster 1998) led authors to conclude that, "Marine reserves not based upon empirical data and allowing unmonitored levels of diving can be counterproductive to the conservation ideals they are supposedly based upon." Davis and Tisdell (1995) reached a similar conclusion: "The environment of heavily used dive sites... may be impacted by scuba diving and these impacts may conflict with conservation goals."

These lessons and admonitions should not remain unheeded. In an era of ecosystem-level approaches to conservation and management, it must be acknowledged that extractive

use is but one of any number of ways in which the ecological integrity of marine ecosystems may be compromised by human impacts. Even when fisheries protection/restoration is the primary goal in establishing a marine reserve, it should be recognized that protecting the integrity of supporting habitats and biological assemblages is as necessary to that goal as the regulation of extractive use. Full protection for MPAs designed to conserve biodiversity, protect wildlife, and/ or maintain natural ecosystem attributes must go beyond the simple concept of no-take. Regulatory schemes designed to provide "full protection" for sensitive marine ecosystems should invoke the precautionary principle as the management standard, and thereby encompass, to the degree practical, protections from the full spectrum of all known and readily controlled negative human impacts.

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## ■ SECOND INTERNATIONAL FISHERS FORUM

The Second International Fishers Forum was hosted by the Western Pacific Regional Fishery Management Council in Honolulu, Hawaii, from 19 to 22 November 2002. Forum participants resolved to reduce the number of seabirds and sea turtles accidentally caught by longline fishing gear, and approved a resolution that:

requests the Western Pacific Regional Fishery Management Council to present the findings of this Forum at the next Session of the Committee of Fisheries of the Food and Agriculture Organization (FAO);

encourages FAO to work with relevant international organizations to develop guidelines leading to an international plan of action for the reduction of sea turtle bycatch from marine fisheries throughout the world's oceans;

invites the Convention on Migratory Species to consider the forum's findings in pursuing conservation measures to protect marine turtles and seabirds;

urges FAO and other organizations to collaborate in carrying out the International Plan of Action to reduce incidental catches of seabirds in longline fisheries.

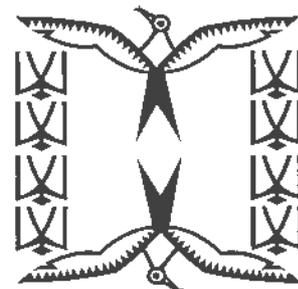
This resolution was approved after four days of intensive deliberations on a wide range of topics by more than 200 participants from 28 countries and 14 US states. Issues included proposed and existing methods to protect seabirds and sea turtles; data collection; education and outreach; obstacles to progress; international agreements; incentives for fishermen, and the use of models in developing management options. Participants included a diverse mix of longline fishermen, fishery managers, fishing gear manufacturers and technicians, fishery biologists, and representatives from non-governmental environmental organisations.

The conference also showcased equipment and methods that are being used to protect seabirds and sea turtles. Some participants were introduced to the de-hooking device that fishing vessels are using successfully in the North Atlantic to safely release sea turtles that are snagged on longline fishhooks. Also on display was a weighted fishing line that sinks the hooks to a level below the reach of seabirds. This method is being tested with success in the New Zealand area and in the North Pacific.

The forum concluded with fishermen and scientists making personal commitments to help

reduce fishery interactions. Manuel Duenas, President of the Guam Fishermen's Cooperative Association, said "We are committed to making the emerging longline fishery in Guam a model for other longline fisheries. To make this goal a reality, a team of scientists, researchers and fishermen agreed to review all aspects of the fishery, from data collection to the use of new and emerging mitigation methods. We all signed an agreement here at the conference to serve as members of an advisory panel."

Another initiative scheduled to start next month is a worldwide competition among fishermen to develop mitigation measures that successfully reduce the incidental catch of seabirds and sea turtles by longline fishing gear. "Through this innovative initiative, fishers will help to develop more seabird-friendly fishing methods," noted Carles Carboneras from SEO/Birdlife, a Birdlife International partner organization in Spain. "As a



result of the huge communication effort associated with this competition, fishers' level of information and awareness of the problem of seabird bycatch will be significantly raised." The next forum will likely convene

in 2004, with the aim of securing participation from all longline fishing nations and fishermen, and ensuring that the commitments made at this forum are successfully carried out.

For more information contact the Council by phone: (808) 522-8220; fax: (808) 522-8226; email: [info.wpcouncil@noaa.gov](mailto:info.wpcouncil@noaa.gov) or log on to [www.wpcouncil.org](http://www.wpcouncil.org)



## ■ NET CLOSING ON CORAL REEF BOMBERS

Coastguards will soon be hot on the trail of fishermen who are illegally blasting many coral reefs to rubble as they use bombs to increase their catch.

Blast fishing is a problem in many places throughout Southeast Asia and along Africa's east coast. Although it is illegal, efforts to stop it are hampered by poor detection rates.

"Blast fishing is often known to occur in a region through sporadic arrests and anecdotal observations, yet the scale of the problem is often not appreciated as most blasts go undetected," says George Woodman, who works on the listening project led by the marine sensors group at the Hong Kong University of Science and Technology.

One problem that has hampered the development of a detection system for underwater explosions is the cacophony produced by the claw-clicking "pistol" shrimp that live on reefs. Pistol shrimp near the detection system can generate

short-range shock waves that are bigger than the signal from a distant bomb. But now the Hong Kong team has solved the problem.

The researchers use underwater microphones, or hydrophones, to pick up the noise from blasts. The detection range for each hydrophone is around 30 kilometres and the team has developed software to calculate the direction of a blast from the slight time difference between the noise reaching each of three hydrophones. Two such sets of hydrophones could be used to triangulate the position of an explosion to within 30 metres over a 10-kilometre range.

Woodman and his team first had to make sure they could reliably recognise the sound generated by home-made bombs in the shallow waters where reef-smashing fishermen operate. They set off controlled explosions using bombs made from a mix of fertiliser and fuel oil using sandy areas of the seabed to minimise ecological impact.

Their system distinguishes the noise of an underwater explosion from that of the shrimps' clicking by recognising differences in the energy of the sound produced. An explosion contains more energy overall and lasts longer than the clicks. In contrast, the noise from an outboard motor is more prolonged, but its peak signal is smaller. Their system will be described in a future issue of *Marine Pollution Bulletin*.

The team has already tested one of their hydrophones in a survey for the Sabah Parks Authority in Tunku Abdul Rahman National Park, off Kota Kinabalu in Sabah, Malaysia.

"Over a 10-day stretch we picked up 15 blasts using one listening station (hydrophone) and we are very confident we can determine the direction of the blasts to within about 0.2 degrees," says Woodman. They now hope to mount a trial with three hydrophones.

(Source: Michelle Knott, [NewScientist.com](http://NewScientist.com), 13 January 2003)

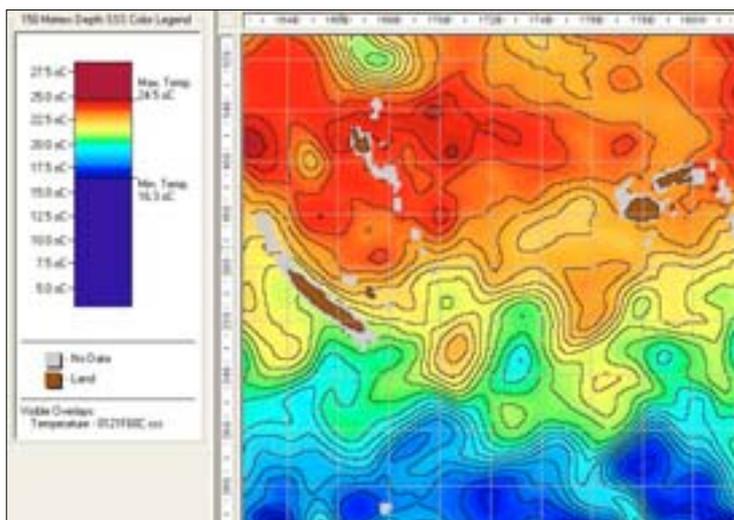


## ■ ORBIMAGE ADDS NEW SUB-SURFACE TEMPERATURE INFORMATION TO FISHING SERVICE PRODUCTS

Orbital Imaging Corporation (ORBIMAGE) announced the launch of a new feature related to its world renowned SeaStarSM Fisheries Information Service. Sub-Surface Temperature

Information is now available to all subscribers of ORBIMAGE's SeaStarSM Service as an additional component to support the analysis of probable fishing grounds. ORBIMAGE's SeaStarSM

Service is used to support fishing operations for tuna and swordfish as well as other surface dwelling fish such as mackerel, sardines, anchovy and herring.



The new Sub-Surface Temperature Information feature is offered at two depths, 50 metres and 150 metres, and is available worldwide. This new information will further assist long liners and purse seiners to identify the best regions for locating tuna and other species when used in conjunction with other surface information already provided with ORBIMAGE's SeaStarSM Service, such as plankton concentrations (derived from ORBIMAGE's OrbView-2 "SeaWiFS" satellite), surface currents, sea surface temperatures, sea surface height and weather information. These information layers are sent as data files by email to each fishing vessel where they are viewed and analyzed in the form of maps using ORBIMAGE's OrbMap TM software.

Sub-Surface Temperature information is determined by modeling the sub-surface thermal changes that would cause the satellite-observed changes in sea surface temperature and sea surface height. The predicted temperature distributions are calibrated with in-situ observations and historical records, as well as iterative techniques that help increase their accuracy.

"Our satellite-derived oceanographic information has already greatly enhanced the fisherman's ability to interpret surface patterns to find fish," says Greg Hammann, Director of Product Development, "but the Sub-Surface Temperature Information helps to interpret ocean patterns beneath the surface that will improve catches even further by

showing vertical patterns that affect fish distribution."

"Our subscribers to the SeaStar Service are very excited to receive this leading edge information product," adds Chris Wilson, Director of Sales and Marketing. "The feedback we receive from the boat captains is that they believe it is an important, and even critical, component to their fishing operations."

ORBIMAGE is a global provider of Earth imagery products and services, and currently operates the OrbView-2 ocean and land multispectral imaging satellite (launched in 1997), and a worldwide integrated image receiving, processing and distribution network. Currently under development, ORBIMAGE's OrbView-3 satellite will offer one-metre panchromatic and four-meter multispectral digital imagery, and is planned for launch in 2002. ORBIMAGE offers the SeaStarSM Fisheries Information Service, which provides oceanographic maps derived from OrbView-2 satellite imagery of the world's oceans to commercial fishing customers worldwide.

(Source: ORBIMAGE  
<http://www.orbimage.com>)



## ■ NEW SHIP AIDS ISLE'S RESEARCH ROLE

Hawaii has a strategic role in the US mission to explore and develop ocean resources, says the administrator of the National Oceanic and Atmospheric Administration.

NOAA now pumps about USD 70 million a year into the state for a wide array of fisheries, ocean and atmospheric programs, retired Navy Vice Adm.

Conrad Lautenbacher Jr. said in an interview. "Hawaii obviously is critical for NOAA, being a strategic location in the middle of the Pacific."

"The addition of the vessel *Oscar Elton Sette* to NOAA's Hawaii fleet dramatically increases capabilities for fisheries and coral reef research and mapping," he said.

The *Sette*, a former Navy ship converted for fisheries and oceanographic research at a cost of USD 12.4 million, was commissioned in January 2003 in Honolulu. It is named for the Honolulu Fishery Laboratory's first director, who pioneered in fisheries science.

Lautenbacher said the *Sette*, which replaces the "venerable"

*Townsend Cromwell*, will begin work immediately in Hawaii and other Pacific waters. It will conduct fishery surveys, physical and chemical oceanography, coral reef research and marine mammal projects.

"NOAA performs the foundation for our economic security, and the ship we are bringing on line... is an essential piece of that," Lautenbacher said.

He stressed the importance of a national fleet to survey and explore the oceans for the health and economy of Hawaii and the country, pointing out, "We know more about the backside of the moon".

Commercial fishery landings in the United States total about USD 3.3 billion, with Hawaii's landings of 30 million pounds a year worth USD 60 million, he said. [1 pound=0.454 kg]

"If we could get assets to restore our fisheries to reasonable levels, we could increase that harvest by USD 1.4 billion," he said. "Here is enormous potential for

us to improve our economic value from the sea with more research and survey work. This ship (the *Sette*) represents part of that effort."

Another Navy ship is being converted and refurbished by NOAA, which hopes to obtain funding to operate it in Hawaii in 2004 to 2005, Lautenbacher said.

He is also "looking for a more permanent place to nest these ships and have a safe harbor for them" at either Navy piers or Snug Harbor, which he now uses when space is available. University of Hawaii marine operations are based at Snug Harbor.

Lautenbacher said a number of issues are pending here, such as the need for experiments by the fishing fleet "to make longline fishing more environmentally friendly."

"Now the court is holding us up from doing some experiments. It's not a very satisfactory situation," he said.

NOAA's USD 70 million investment in Hawaii's economy includes about USD 22 million distributed in grants to various organizations, Lautenbacher said.

Among recipients are the Sea Grant College Program, Hawaii Undersea Research Laboratory and the Joint Institute for Marine and Atmospheric Research, all at the University of Hawaii.

NOAA employs about 261 people in its Hawaii operations, including the National Weather Service, National Marine Fisheries Service, Hawaii Coastal Zone Management Program, National Water Level Observation Network, Humpback Whale National Marine Sanctuary, Richard H. Hagemeyer Pacific Tsunami Warning Center, and Mauna Loa Observatory Climate Monitoring and Diagnostic Laboratory.

(Source: Honolulu Star Bulletin, 24 January 2003)



**The NOAA RV Oscar Elton Sette**  
[Photo: NOAA]

# REGIONAL WORKSHOP ON THE MANAGEMENT OF THE LIVE REEF FISH TRADE IN THE PACIFIC

## **Background and introduction**

As part of the regional technical assistance project (RETA) funded by the Asian Development Bank (ADB), a regional workshop was held at the University of the South Pacific Laucala campus in Suva, Fiji Islands, from 16 to 20 September 2002.

Of the 50 participants, half were from the Pacific region, representing 11 SPC member countries that have LRFT operations (either for food fish or aquariums). Scientists and economists from academic and research institutions as well as non-governmental organisations were present, as were representatives from the LRFT industry. Mr. Thomas Gloerfelt-Tarp represented the Asian Development Bank.

*by Being M. Yeeting,  
Senior Fisheries Scientist (LRFT)  
SPC, Noumea,  
New Caledonia*

The workshop provided Pacific Island fisheries policy-makers and managers with the opportunity to share and learn from each other's experience (successes and failures) in developing and managing the trade, and to identify priorities for future technical assistance, policy development, and capacity building in the region.

## **The workshop**

The workshop was organised and coordinated by SPC's Live Reef Fish Trade specialist, Being Yeeting, with assistance from USP's Training Coordinator, Seremaia Tuqiri and his staff. Ms Sholto Faktaufon, from the

Fiji office of International Marinelife Alliance (IMA), provided secretarial support for the meeting.

The meeting comprised 11 different sessions focusing on key issues of the LRFT. Each session had an appointed facilitator. The sessions and their subject matter included:

Session I: Opening/ Introduction

Session II: Overview of the Live Reef Fish Trade (LRFT) in the Pacific

Session III: Pacific Island countries' LRFT experiences

Session IV: Overviews of relevant LRFT initiatives

Session V: The Australian experience

Session VI: Key scientific concerns

Session VII: Key management concerns



*Participants in the regional workshop  
[Photo: USP]*

Session VIII: Marketing concerns, certification and best practices

Session IX: Mariculture: A potential solution?

Session X: Pulling together experiences and lessons presented

Session XI: Wrapping up discussions and putting outputs together

### Workshop sessions

Opening speeches were made by Thomas Gloerfelt-Tarp (ADB Project Officer) and Dr Jimmie Rodgers (SPC's Senior Deputy Director-General). Also, as part of the opening ceremony, a memorial dedication, followed by a moment of silence, was made by Dr Jimmie Rodgers in honor of the late Dr Bob Johannes and his work in the Pacific region in fisheries.

A LRFT video produced by SPC as part of its awareness materials, was viewed as an introduction to some of the important issues to be discussed during the meeting.

The second session consisted of presentations that gave a regional and global overview of the LRFT, both aquarium and food fish. Current trends in the value of the trade and some of the issues that would affect the future of the trade in the Pacific were discussed.

Presentations on the status of the LRFT in individual countries and the current problems and issues of developing and managing the LRFT were presented in the third session. This was an important workshop session because the information provided would be very useful in directing SPC's future efforts in ensuring that appropriate assistance is given to its member countries.

The fourth session covered different initiatives (aims, approaches and results and outputs) in the Pacific that have attempted to deal with aspects of the LRFT. The initiatives presented included:

ADB-funded SPC Pacific Regional LRFT Initiative, which involved collaboration with non-governmental

organisations, particularly The Nature Conservancy (TNC) and the International Marinelife Alliance (IMA);

TNC LRFT work in PNG and Solomon Islands;

Australian Centre for International Agricultural Research (ACIAR) funded Solomon Islands LRFT project; and

ACIAR/Queensland Department for Primary Industries/ ICLARM capture and culture of coral reef fish project.

Representatives from Australia gave presentations describing their experience with the LRFT. Australia provides at least 90 per cent by volume of the LRFT (food fish) exported to Hong Kong from the Pacific. It is acknowledged as probably the only well-managed and seemingly sustainable LRFT operation in the region. Although the Australian LRFT situation is very different from that of small Pacific Island countries, there were important lessons to learn from their experience.

LRFT issues in the Pacific are often lumped together making it difficult to understand and rectify problems. The workshop therefore made an attempt to separate these issues into three specific groups. The first of these, Session VI, dealt with key scientific concerns, Session VII dealt with key management concerns, and Session VIII dealt with marketing concerns, including certification and best practices. Experts in these areas helped clarify issues, especially their implications to the future sustainability of the LRFT.

Session IX discussed the culture of fish for both the live food fish and aquarium fish trades. Grouper aquaculture has had success in Asia, where most of the research has been conduct-



*Being Yeeting (left) and Tom Graham (right) organising one of the sessions*  
[Photo: Jean-Paul Gaudechoux]

ed, so it was important to hear Asia's experience and discuss the feasibility of introducing such activities into Pacific Island countries.

The final two workshop sessions summarised outputs, especially the recommendations and priority areas for future action. These are listed below.

There is a strong need for community awareness, especially for rural communities.

A good socioeconomic evaluation of the LRFT is required, which looks at cost-benefits, opportunity costs as well as alternatives.

There is a strong need to build the technical capacity and ability of local personnel to conduct reliable data collection and assessment of the resources with the most suitable methods.

Underwater visual census (UVC) is a useful tool for making quick resource assessments.

Some countries are using trial fisheries to evaluate the feasibility of the industry.

Transportation of live fish from source locations to the market is a common problem for Pacific countries. Sea transport is wasteful because of high mortality rates, while opportunities to transport by air are limited for most countries.

The environmental risks associated with transporting water (with fish) from one country to another seems to have been neglected and should be addressed.

Ciguatera fish poisoning is an important issue that countries need to consider when developing their live reef food fish industries.

There is a great need to develop or improve the management infrastructure in most countries.

The real costs of management, including the costs of monitoring and enforcement should be borne by the industry.

An observer programme for LRF fishing and transport vessels should be developed, similar to the observer programme used for the region's foreign tuna fisheries.

The exploitation of rare and vulnerable species such as the humphead wrasse is not sustainable and should be banned.

Cyanide fishing is not as important an issue in the Pacific, as compared to the targeting of spawning aggregations, which can quickly lead to depletion of fish stocks and should be discouraged.

Given the fast-growing economy of China, the demand for live food fish is likely to increase.

Information on wholesale prices of live reef fish is an important need of local governments and communities. Such information can be maintained in a centralised database, such as the one being developed by SPC.

Certification and best practice standards may improve the quality of LRF products and reduce the waste associated with high mortality rates, but the implications of such schemes for local suppliers in Pacific countries are not known.

Mariculture of grouper species for the live food fish trade is not an option for Pacific countries because of the highly competitive sources in Asia. It could, however, be an option for the trade in marine ornamental species, especially using semi-aquaculture-based aquarium operations that collect larvae from the wild for grow-out.

The Australian live reef food fish industry is very different from those in Pacific



**Sompert Gerava from the Vanuatu Department of Fisheries**  
[Photo: Jean-Paul Gaudechoux]

Island countries and therefore what works for Australia might not work in the Pacific.

### **Countries' specific concerns and needs**

There is a need for information and programmes to improve public awareness on all aspects of the LRF trades. Questions and recommendations included:

How do we make politicians and decision-makers more sympathetic to the reality of the LRFT and the need to properly manage it?

What should a country do when approached by a LRF operator?

Compile case studies from the Pacific to determine the pros and cons of having a LRFT and to review lessons learned not only in this trade but also in other industries, such as forestry and tuna fisheries.

Targeted and appropriate awareness materials that communities can comprehend easily should be developed in local languages.

Country specific guidelines for management should be formulated.

Fact sheets on aggregations and the effects of the LRFT on them should be produced and included in the TNC/IMA/SPC awareness package.

Regularly updated information on ciguatera fish poisoning and outbreaks should be provided.

Countries need to have a clear and transparent processes for investors wanting to start LRF operations. Countries should also proactively advise LRF operators, possibly through the Hong Kong Chamber of Seafood

Merchants, of their requirements. SPC could take on the task of developing a standard Pacific requirement, rather than each country doing so individually.

Information linkages between supply countries and Hong Kong is needed, as is a cross-checking mechanism involving reliable partners such as the Hong Kong government, the Hong Kong Chamber of Seafood Merchants and IMA-Hong Kong. The Hong Kong government has already agreed to provide any information required by supply governments.

Market prices can be made available to countries on a timely basis through SPC, with the help of IMA-Hong Kong. Possible media include SPC's website and SPC's Live Reef Fish Information Bulletin. The issue of information confidentiality should be considered.

There is a need for a "rough rules of thumb" to be developed, which would provide steps to making quick precautionary decisions based on the limited information available whether new LRFT operations should be allowed or not.

SPC should prepare a package containing management guidelines and recommendations for government (fisheries departments) for Pacific Island countries.

Coordination among government departments should be strengthened and fisheries departments should become more involved as new LRF operations emerge.

Assistance should be given to Pacific Islands in developing and putting in place

management structures necessary for addressing the LRF trades.

There is a lack of capacity and resources, both human and financial, in fisheries departments, especially at the provincial and state levels.

Countries should consider and explore potential management options such as:

Using and building on traditional/customary management approaches to address the LRFT.

Using marine protected areas, aggregation site closures, and seasonal closures of LRF fisheries during spawning seasons.

Enforcement priorities should be clearly defined at the national, provincial, state and community levels.

Enforcement is a political issue and money is needed to ensure that enforcement will be effective. Options for meeting the costs of management from external funds should be considered; for example, should there be mechanisms to transfer the costs of management to the industry?

Enforcement of some controls is more expensive than others. The relative cost-effectiveness of various management options needs to be considered; controls on fish exports, are relatively inexpensive to administer and enforce.

Where fisheries management capacity is limited, partnership or co-management arrangements that involve NGOs, communities, and other government jurisdictions should be considered.

There is a need to consider the development of vessel observer programmes for LRF fisheries.

Public awareness of regulations is needed in addition to active enforcement in order to ensure compliance.

The capacity of regional organisations such as SPC is limited. Strengthening effective regional partnerships with NGOs and other regional and international organisations should be considered.

SPC's LRFT and Aquaculture Programmes work together on related matters. SPC should, however, maintain strong links with organisations and initiatives in Southeast Asia, such as the Network of Aquaculture Centers in Asia-Pacific (NACA).

The potential for gardening coral for aquaria should be examined.

The outputs indicate a number of priority areas of concern. Awareness at all levels of government (both at the political and technical levels), communities, operators and investors is a top priority. Information needs, which are closely linked to awareness, are another priority. Possibly the most important priority for managing the LRFT is capacity building.

Efforts and activities to address these priorities have already begun. Such activities include the production of a handbook of fishery management guidelines for the live food fish trade, the production of a package of LRFT awareness-raising materials for communities, the production of a handbook about ciguatera fish poisoning, the development of a regional database for the LRFT, a compilation of case studies of operations in the Pacific and various capacity building activities.

### **Acknowledgements**

SPC expresses gratitude to its partners, TNC and IMA, for their contributions to this very successful meeting. Many thanks are also given to the resource people and country participants for their presentations and active involvement in the discussions, to USP's Marine Studies Program for providing the venue and logistical support, and last but not least, to ADB for providing funding which made this workshop possible.



*The French territories were represented as well: Dr Cedrik Lo from French Polynesia (left) and Alex Ruben from New Caledonia (right)  
[Photo: Jean-Paul Gaudechoux]*

# COMMUNITY-BASED FISHERIES MANAGEMENT PROGRAM IN AMERICAN SAMOA

## Abstract

As the population in American Samoa has expanded, the demand for fishery resources has similarly increased. Fisherfolk have used effective but often destructive fishing methods, including the use of bleaching agents, dynamite, and avaniukini (a local plant-derived poison). In addition, outside fishermen, who were often reported to be from other Pacific Islands, have entered village reefs and used bleaching agents. There have also been various reports of fishing nets, which are left on the reef, eventually trapping and killing many marine species. From these identified problems and recommendations from village communities, which were obtained through carefully designed surveys, came the need to establish a program to improve fishing and marine resources in villages.

The Community-based Fisheries Management Project assists villages in managing and conserving their inshore fishery resources by a voluntary scheme of co-management with the territory, which enhances ownership and stewardship by the village community. The project's aim is to improve fishing and sustainable development of marine resources in participating villages as well as the territory. For this, the identification of village sites to establish traditionally oriented management regimes is featured in conjunction with well-developed village fisheries management plans. In addition, monitoring and regular reef checks by village communities and fisheries staff are conducted.

by Fatima S. Sauafea-Ainu'u  
Department of Marine and  
Wildlife Resources,  
American Samoa

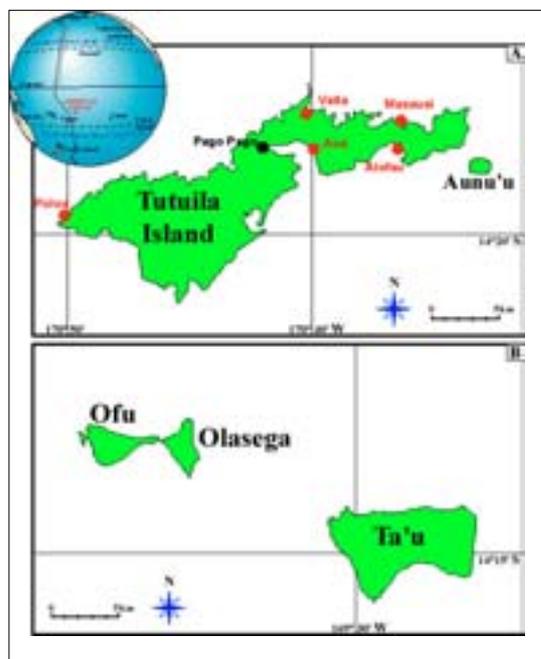
## Introduction

American Samoa is the only US territory south of the equator. It consists of five rugged, highly eroded volcanic islands and two coral atolls. It comprises the main island of Tutuila, Aunu'u, the Manu'a islands of Ofu, Olosega, and Tau, Swains Island, and the uninhabited Rose Atoll. The land area of the territory is about 76.7 square miles with a population of approximately 63,000 (census 2000). Tuna fishing and canning are the major industries, and

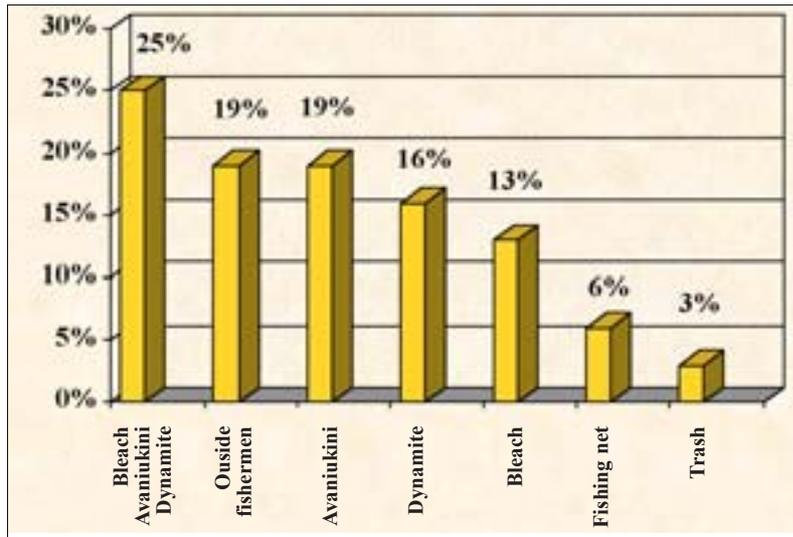
many native Samoans practice subsistence fishing and farming.

The population in American Samoa is rapidly increasing, which places increasing pressure on its marine environment. Fish and shellfish catches have declined in the lagoons and inshore reefs of American Samoa for many years. Reasons for this decline include probable overexploitation, the use of destructive fishing methods such as dynamite, bleach, a traditional plant-derived poison (avaniukini), and environmental disturbances. Other harmful activities include the destruction of nursery areas such as mangroves, by road construction and land reclamation. In addition, poor land management has resulted in erosion and siltation of lagoons.

The extent of the problem was determined through a carefully designed survey conducted by the Department of Marine and Wildlife Resources (DMWR) in



American Samoa (A: Tutuila Island; B: Manu'a Islands)



*Fishing methods that damage village reefs*

11 selected villages. Participating villages were randomly selected based on their geographical locations on the main island of Tutuila and the Manu'a islands. The survey was implemented in both Samoan and English. Its purpose was to determine fishing problems and recommendations as well as input from communities on ways to improve fishing in their village.

Fishing in American Samoa, either on the reef or in the open ocean, can be accomplished using careful and discrete fishing practices. However, a high percentage of respondents were of the opinion that the use of destructive fishing methods such as dynamite, bleach, and plant-derived poison were used in their waters. In addition, outside fishermen from other villages come and used destructive fishing methods. There have also been various reports of fishing nets, which are left on the reef, eventually trapping and killing many marine species.

The survey report, along with previous studies by the department on the territory's reef area, justifies the need to include communities in improving the sustainable development of

resources. The Community-based Fisheries Management Program was implemented in 2001. At present, there are five villages in the program, four with established marine protected areas and Fisheries Management Plans (Poloa, Alofa'u, Vatia and Aua) and one which is in the process of drafting its Fisheries Management Plan (Masausi).

#### **Co-management of the resources at the village level**

The Community-based Fisheries Management Program exists to assist villages in managing and conserving their inshore fishery resources by a voluntary scheme of co-management with the government. The program's goal is to enhance ownership and stewardship of the marine resources by the village community. The program aims to improve fishing and sustainable development of marine resources in the villages.

For this, identification of village sites to establish marine reserves or marine protected areas (MPAs) is featured. In addition, restocking of giant clams in MPAs, as part of DMWR's assistance in the program, enhances

the development of good fisheries practice and management approaches.

The Community-based Fisheries Management Program was adopted from a similar program in Samoa under the Fisheries Office. Although the two Samoas practice the same tradition and culture, the differences in lifestyles and economies impact the way in which the programs are implemented. Thus, the program development process is essentially the same with a few exceptions to meet the system and regulations organized in American Samoa.

#### **Extension process of the program**

The first step in the process is to conduct an initial contact with a village's chiefs to set a date for a first meeting with the village council. The program's cultural officer, who is a representative from the Office of Samoan Affairs, makes contact with the village mayor and leaders for the arrangement of a meeting with the village council. The First Meeting, which is a formal traditional meeting with the council of chiefs, requires the presence of the department's director, cultural officer and the head of the program.

This important meeting provides DMWR with an opportunity to explain and introduce the program in a manner that gains the village's support and its permission to start the program. If the village accepts the program, then a date is set to conduct group meetings. The cooperative agreement is given to the village during this first meeting for its signature of cooperation with DMWR in the program. The agreements provide assurance from both the government (DMWR) and village of the tasks and obligations to the program, and the

**Summary of the Program's Extension Process**

- 1) Initial contact with the village
- 2) First meeting with the village council (to explain the program for village's acceptance)
- 3) Group meetings – 3 Groups
  - Chiefs
  - Women
  - Young men
- 4) Fisheries Management Advisory Committee (FMAC – to draft a Fisheries Management Plan)
- 5) Village Fisheries Management Plan (agreed to at the village council meeting)
- 6) Monitoring and Enforcement Committee (to oversee, monitor, and enforce the undertakings agreed to in the management plan)

endorsement and cooperate support from the village.

The purpose of the group meetings is to identify problems with village reefs and fisheries, and to identify solutions by using a problem solution tree. Meetings are carried out in three groups: the chiefs group, women's group and the young men's group. This is done because different people fishing the reef, use different fishing methods. After the group meetings, selected members from each group will then work as the Fisheries Management Advisory Committee to put together a Fisheries Management Plan with assistance from DMWR.

**Village Fisheries Management Plans**

Villages with MPAs have Fisheries Management Plans, which include a description of the village, village rules and regulations, information on village MPAs and map, information about their fisheries, concerns and recommendations gathered from group meetings, additional information necessary for the

protecting and monitoring of village MPAs, and a Cooperative Agreement. A draft Management Plan is sent to the village council for its approval before the final draft is given to different government agencies and the general public. Rules and regulations and other actions written in the Fisheries Management Plan will be enforced and implemented by the village's Monitoring and Enforcement Committee with assistance from DMWR.

The village and DMWR work together in co-managing the marine protected areas, with each party having its own role. The village works on establishing rules and regulations to be written in their Fisheries Management Plan (e.g. a ban on the use of destructive fishing methods, monitoring and protecting the reef area, and implementing other actions to protect the environment). DMWR provides technical assistance and advice, workshops and training, and other appropriate fishery support such as restocking of clams in MPAs and assisting villages with their Fisheries Management Plans.

**Criteria for selecting a village**

There are at least three criteria for selecting a village for the project. The first is to look at how well organized the village is in regards to its *matai* system, women's groups, and young men's groups. The second is to informally meet with the village mayor and leaders to briefly explain the project. The third is to carefully assess the village's potential as a target village for the program by determining: a) the significance of the marine environment to the village; b) the extent of any problems with the marine environment, fish catches, etc; and c) the level of concern and willingness to do something about existing problems. The extension staff will review the assessment of a village's potential for inclusion in the program.

As the program progresses, some villages have requested to have the program started in their village because of the reef condition and the need to improve their fisheries. In addition, media awareness programs about the ongoing progress and work in villages in the Community-based Fisheries Management Program have enticed many villages to participate.

**Increasing participation and support from communities**

Getting the program started in a village and working with the community is a difficult task; however, these are the ways to gain people's motivation, support, and understanding of why there's a need to improve resources. We have put together some information sheets about the program and other fisheries issues, brochures about the program, and workshops for the community and government agencies. We also send out press

releases about village activities to local newspapers, conduct radio advertisements and TV interviews, and held panel discussion with village representatives about the program.

In starting the community program, a series of three, one-day workshops were held to present and discuss the program to three different groups. The first workshop was with government officials working on conservation or management of inshore marine and coastal resources. The second workshop was with the legislature (*Fono*) to gain its support and recommendation on the implementation of the program. The third workshop was with the territorial mayors. The fundamental purpose of the workshops was to present the project to different stakeholders and achieve significant recommendations to aid the implementations of the program in American Samoa. In addition,

the workshops were held to inform island leaders about the benefits and limitations of co-management of fisheries at the village level.

**Conclusion**

The end result of the Community-based Fisheries Management Program will be a village with a Fisheries Management Plan including guidelines and regulations to monitor and protect its reef area, a productive and healthier reef area, improved fisheries, and an increased awareness, motivation, consultation, and participation from different stakeholders.

The Community-based Fisheries Management Program in American Samoa will increase conservation awareness in government, community, and the private sector. It will aid in recovering the reefs and improving fish catch.

In addition, the program allows the community to keep a close watch on the marine resources and their condition, and address management needs so that resources will continue to be healthy and productive for its people and future generations to come.

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# ALBACORE — THE OTHER SASHIMI TUNA

There has been a dramatic change in the longline fishery in the western and central Pacific Ocean (WCPO) since the early 1990s, when domestic longline fisheries began developing in Pacific Island countries and territories. The main target species in the fishery have been high value, fresh chilled bigeye and yellowfin tuna, bound for export markets in Japan, Hawaii, and the US west coast.

Fresh chilled, longline-caught bigeye and yellowfin tuna end up as sashimi or sushi in restaurants or for home consumption. Longline vessels targeting albacore tuna have mostly been foreign freezer vessels fishing south of the equator and off-loading at canneries in American Samoa and Fiji.

These boats make trips of several months duration and freeze all fish whole while at sea. Albacore is their main target species and all other tunas and billfish are considered byproduct. There is also a substantial fleet of albacore troll boats from the US, Canada and New Zealand that, until recently, have also produced frozen fish at sea for canneries. The albacore caught by the longline fleet and by troll boats usually ends up in salads or sandwiches. More and more, however, albacore is being consumed as sashimi.

In the early 1990s, albacore tuna (*Thunnus alalunga*) was considered a byproduct species of the fresh sashimi longline boats, which targeted bigeye and yellowfin tuna. Between 1991 and 2001, however — and in spite of the fact that the boats were targeting bigeye and yellowfin — the albacore catches in the

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WCPO have more than doubled in volume, going from less than 40,000 metric tons (mt) to more than 80,000 mt annually.

During the same period, the catch of all longline-caught tunas increased only about 1.6 times, going from 147,000 mt to 240,000 mt. In some Pacific Island countries the component of albacore in the longline catch is as high as 75 per cent. It is no longer a byproduct. In Fiji Islands, for example, the albacore catch has gone from 36 per cent to 66 per cent of the total catch in the last decade, while the catch of the main target species, bigeye tuna, has dropped from 21 per cent to 5 per cent.

There are more examples of a glut of albacore in the region. The developing longline fishery in New Caledonia had an overall catch of 2064 mt in 2001 of which 49 per cent was albacore. Tonga, which had a record catch of 1988 mt for 2001 reported that 74 per cent of this was albacore. That's 1268 mt of what used to be considered byproduct.

The increase in albacore in the longline catch may not seem

significant without understanding the market and the fishery. Since the early 1980s, longline vessels have been targeting the lucrative fresh sashimi markets in Japan, Hawaii and the US mainland. Albacore does not have the same value in these markets as bigeye and yellowfin tuna. Targeting parameters for catching albacore and bigeye tuna, however, are basically the same — deep day sets using sanma (saury), sardines, pilchards, or squid for bait.

The seasons and geography are slightly different for the two species, but basically, it is not possible to avoid catching large numbers of albacore when targeting bigeye tuna. Some fresh albacore has been exported to Japan in past years but usually only seasonally in the months of July and August. Markets in the US for fresh albacore have not been strong, especially when airfreight is factored into the equation. Airfreight is the single most important component of marketing costs in a fresh tuna export operation, and available air cargo space has been shrinking in the region. Often the price of fresh albacore is not high enough to justify export by air. The only options have been to market fresh fish locally, freeze whole fish for the canneries, or produce value-added frozen products. Local markets are often glutted with fresh albacore resulting in depressed prices, and whole fish, frozen for export to canneries, are sometimes rejected because of improper handling.



*Thunnus alalunga*

***Pacific Island fisheries cope with the increased albacore catches***

In French Polynesia the percentage of albacore in the longline catch has gone from 27 per cent to 55 per cent since 1991. During this same time the percentage of bigeye in the longline catch has dropped from 12 per cent to 10 per cent and the percentage of yellowfin has dropped from 32 per cent to 12 per cent. Tahitian fishermen found a solution several years ago and have been the forerunners in developing new value-added markets for albacore.

The longline fleet in Tahiti includes several 25 metre boats that have processing rooms and blast freezers for producing quarter loins on board. The vessels involved in this fishery are equipped with monofilament systems and HACCP-certified processing rooms, blast freezers, and large freezer holds. The vessels are capable of staying at sea for one to two months and catching and processing 50 mt or more of quarter loins. (see *Fisheries Newsletter #85* for a description of the fishery and *Fisheries Newsletter #90* for fish cutting techniques).

Most of these frozen quarter-loins are destined for US or EU supermarkets where they end up as steaks. The yield on quarter-loined albacore is about 50 per cent of the whole weight of the fish so the market price for quarter loins has to be more than twice the price of whole frozen cannery fish for this fishery to be feasible. When the price of cannery fish increases, some boats in the fleet switch to freezing whole fish. During 2002 two of these Tahiti style boats began fishing in New Caledonia, freezing albacore loins at sea for EU markets.

In Fiji Islands some vessels freeze whole fish on board while icing fresh sashimi grade fish. Many boats in the fleet, however, use ice or refrigerated seawater to chill the catch. These boats usually don't have freezing capabilities, so fresh chilled albacore are frozen on shore and then loaded into freezer containers for shipment to canneries.

Most of the New Caledonia based longline fleet handles albacore in a similar manner: fish are frozen on shore and stockpiled for later shipment to canneries. In both of these situations a separate company is used for freezing and shipping fish, adding to production costs and reducing profit margins for the vessels.

Many other fisheries, however, are not coping with the abundance of albacore as well as they could. There is often dumping on the local market, and frozen fish are either not handled properly or are handled so much that profit margins are low because of increased costs.

In Samoa, for example, there is often a high rejection rate for cannery albacore that are landed fresh and then frozen on shore. Many of the vessels are small, so freezing at sea is not an option. Some of the smaller boats, in fact, offload fish at ambient temperature because they do not carry ice. Histamine contamination has been an important cause of rejection. In 2001 the Samoa fishery exported 5150 mt of fish, of which 412 mt were rejected. That's almost one million US dollars worth of fish. The percentage of albacore in the longline catch in 2001 in Samoa ranged from 56 to 79 per cent, depending on the size class of vessel.

In New Caledonia one company re-ices fish on shore and then

trucks whole chilled fish from the north to the south (five hours by road) to be frozen at a freezer works for later shipment to canneries. Each handling costs money and provides opportunity for damage to the product. Profit margins, as a result, are not as high as they could be.

***Canadian fishermen have developed another strategy***

Albacore tuna is not usually thought of when the talk turns to sashimi. It has been a good substitute when there is no bigeye or yellowfin, but usually fresh albacore goes into the frying pan or on the barbeque. In contrast to the bright red flesh of bigeye and yellowfin tuna, albacore flesh ranges from pink to white in colour and doesn't have the texture or flavour of the other tunas. The status of albacore tuna is changing, however, and this has been largely due to the efforts of west coast Canadian fishermen and fish marketers.

The Canadian albacore fleet consists of two types of vessels: small coastal boats from 10 to 20 metres that fish from the southern California coast (under the Canada/US Albacore Tuna Treaty) to the northern tip of Vancouver Island, and larger boats over 20 metres that fish the high seas in the western and eastern Pacific from May or June to October or November, following the fish as they move from the waters around Midway Island to the US/Canada west coast. Some of the fleet ventures down into the South Pacific, east of New Zealand between December and April.

All of the boats in the fleet are called jig boats, which is another name for troll boats. The larger boats usually have two to four crew who stay at sea for

several months, freezing all of the catch. Some of the catch goes to the canneries but lately, a large portion has been bled and blast frozen at sea and then sold to the fresh-frozen sashimi market. A small percentage is smoked for smaller niche markets or loined and sold directly to consumers. In 2001 the total estimated catch in the north Pacific from this fleet was 6438 mt. Most of this was taken in the northeast Pacific. In 2001 the jig boats fishing in the southern fishery landed an estimated 206 mt of albacore.

About five or six years ago some of the Canadian boats switched from salmon fishing to albacore fishing. The salmon boats were equipped with high-capacity, low temperature plate freezing systems that can quickly take the catch down to  $-40^{\circ}\text{C}$  or lower. The result was that the albacore they were catching and freezing was of higher quality than that landed by the American jig boats, which for

the most part had been using spray brine systems for freezing fish. The Canadian fishermen began selling this high-grade product to sushi restaurants in California. Five years ago they were selling about 500 short tons a year but by 2001 the sales volume was up to 5000 short tons a year and the markets had expanded to the US east coast and Japan. Cannery prices for whole frozen albacore go as high as USD 2500/short ton but usually average lower than that at around USD 1700–1800/short ton. Top grade bled and blast frozen albacore, on the other hand, can reach prices as high as USD 3000/short ton. [A short ton is 2000 pounds; a metric ton is 1000 kg or 2204 pounds; 1 pound = 0.454 kg]

The secret to producing sashimi grade albacore tuna is to bleed the fish, freeze them quickly to  $-40^{\circ}\text{C}$  or below, and keep them at or below this temperature. Producing a suitable product is not enough, however. Care has

to be taken to ensure that the cold chain is not interrupted from the time the fish leaves the vessel until it reaches the market. That means that transport systems — storage facilities and shipping containers — must be able to maintain the same cold temperatures as the processing boat. On-board systems that have been successful in producing sashimi grade albacore include blast freezers and plate freezers.

Some boats use seawater/ice slurries to get the temperature of the fish down before freezing them with the blast or plate freezer. The old-fashioned spray brine freezers (often used with cannery grade albacore) don't get cold enough for sashimi grade fish. There are advantages and disadvantages to both blast freezing and plate freezing, but plate freezing seems to be the most popular. Blast freezing tends to dehydrate the fish — they may lose about five to seven per cent of their weight



*Jig boats in San Diego, California*  
[Photo: Lindsay Chapman]

through dehydration. With plate freezers dehydration is reduced to about one per cent. Another consideration is that most Japanese processors use plate freezers. Japanese buyers may expect foreign producers to follow their standards.

After the success of the Canadian fishermen, many US west coast albacore jig fishermen followed suit and have installed blast or plate freezing systems on their boats. This has been timely for these fishermen as most albacore buying stations and canneries on the US west coast have closed down, leaving the fleet without many options for marketing their catch. The Western Fishboat Owners Association ([www.wfoa-tuna.org](http://www.wfoa-tuna.org)), which represents about 500 US albacore jig boats and promotes marketing of fish and fishery products, issued a word of caution to its members in their June

2002 newsletter that the recent rapid growth in the albacore sashimi fishery may be a case of too many too soon.

But they also said there is no reason that the US could not consume more of the sashimi grade albacore. Not unexpectedly, in the latter part of 2002, prices for sashimi grade albacore dropped and new entrants into the fishery were having trouble. This may be just a case of growing pains for the industry, however, and not a permanent trend.

In any case, anyone wanting to enter this potentially lucrative alternative to marketing albacore to the canneries should study the markets and transport links well before investing in the refrigeration and other equipment needed for a vessel conversion. Another thing to consider is that higher latitude

troll-caught albacore generally have a higher fat content than larger longline caught albacore.

This may be a factor in producing sashimi grade fish and is something that requires investigation. Notwithstanding the potential problems, however, bleeding and blast freezing albacore for the sashimi market may well turn out to be a solution to increased albacore catches in the South Pacific and a saving grace for fishermen who are catching more albacore while at the same time finding it increasingly difficult to market fresh sashimi grade fish because of a shortage of air cargo space. SPC's Fisheries Development Section welcomes any comments on the subject and would like to hear from any fishermen, boat owners, processors, or marketers who would like to venture into this aspect of the fishery or who already have.



# SEAWEED FARMING IN KIRIBATI: THE 7th TRAINING AND EXTENSION WORKSHOP

The European Union is supporting the seaweed industry in Kiribati through a newly launched four-year Support to Seaweed Industry Project (SSIP). Cottonii seaweed (*Kappaphycus alvarezii*) has successfully been produced over the past 10 years in 12 different atolls within Kiribati, from the far north to the far south of the Gilbert group and in the northern Line Islands. The objective of the SSIP is to increase rural household incomes by supporting the institutional strengthening of the Atoll Seaweed Company Ltd. (ASC) and providing comprehensive research and development services.

ASC is based in Tarawa and buys dry product from its outer island agents, bails it and exports it overseas for processing. The agents on the outer islands are responsible for extension and development work as well as buying sun dried cottonii from the farmers prior shipping to Tarawa.

*by Antoine Teitelbaum,  
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The 7th National Training and Extension Workshop was jointly organised between 20 and 26 October 2002 by ASC staff, Océanic Développement (OD) technical advisers and VSO volunteers, targeting the outer island agents from the Gilbert group. A total of eight agents, four fisheries assistants and two top farmers were invited to attend the course. The training aims of the workshop were to improve the role of the agents in farm site selection and villagers' awareness, and implementing the latest farming principles along with environmental conditions.

Theoretical, accounting and quality control sessions were held at ASC in Tarawa, while practical sessions were held in Abaiang, where seaweed is produced. Most sessions were chaired by ASC technical staff as

well as Dr David Luxton, cottonii specialist and OD aquaculture adviser. Agents were taught or refreshed about seedling selection, farm design, plot construction, farm economics and management, and post harvest handling. Evening sessions were open discussions on various topics such as equipment maintenance or outer island budgeting. The SPC video "Grow seaweed, Grow your own money" was also presented, generating great enthusiasm from outer island agents and Abaiang villagers.

Participants were acknowledged by the Minister of Natural Resource and Development in an eventful closing ceremony held on Abaiang. The success of the workshop will be propagated by each outer island agents or fisheries assistant during the SSIP and after, on its own island. With the current local and international support provided on production sites, Kiribati is likely to remain an example for cottonii aquaculture in the region.

For more information:

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*Agents, fisheries assistants farmers and technical assistants: the workshop team in front of the island station, in Abaiang.*



*Tealoe Seese, ASC Extension Officer, exposing the latest farming activity situation in Abemama, during the opening of the workshop*

*In ASC warehouse, practicing quality control and post harvest maintenance sessions*



*In the Mwaneaba workshop, participants received training on the various factors affecting the growth of the seaweed*



*The agents from Maiana, Tabiteuea and Abemama practicing environmental monitoring*

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