Fisheries Newsletter

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Editorial

As often with fisheries-related matters, the contents of this newsletter may provoke mixed reactions. Apprehension, with Anouk Ride's or Giff Johnson's articles (p. 24 & 25), indicating that despite clear warning signals sent by scientists, decisions still need to be made on critical issues such as the overfishing of bigeye and yellowfin tuna; fear, with the very moving letter sent by a Pacific Island crew member working aboard a foreign fishing vessel (p. 27); or hope, with some good news from the aquaculture sector — villagers who are harvesting their first milkfish crop in Fiji (p. 20); a successful aquaculture meeting in Tahiti (p. 15); and slightly clearer skies for the prawn farming industry in New Caledonia (p. 19).

As usual, this issue also includes feature articles specifically written for this newsletter. Bob Gillett reports on a short survey he made of fisheries centres in the Pacific region (p. 29). He gives a list of lessons learned from past experiences that should be used when planning new fisheries centre installations. Emilie Fernandez and Valérie Allain write about their study of reef prey in tuna diets (p. 35). Surprisingly, reef prey represents almost 17% of tuna diets on average, and can be as much as 60% in certain areas. Finally, Éric Clua weighs the benefits and setbacks of shark feeding in the ecotourism industry (p. 40). On Moorea, French Polynesia, it was calculated that one lemon shark contributed USD 2.3 million in revenue to the island over its 20-year lifespan. This is certainly a strong incentive for the development of this type of activity, but, as Clua shows, there are risks associated for local shark populations. A fine balance must be found.

Don't hesitate to let us know what you think of this *Newsletter* 's contents and new format. We need your input to fine-tune them.

Aymeric Desurmont
Fisheries Information Officer (aymericd@spc.int)

Cage-cultured juvenile batfish, Tautira, Tahiti (see p. 15).

Secretariat of the Pacific Community

Prepared by the Information Unit, Division of Fisheries, Aquaculture and Marine Ecosystems

Central Pacific cruise #5: 6,359 tunas tagged and released onboard the FV *Pacific Sunrise*

The Central Pacific (CP) tagging cruises are part of the Pacific Tuna Tagging Programme (PTTP) that started in August 2006 with the objective of tagging and releasing tropical tunas throughout the western and central Pacific Ocean (WCPO). These CP cruises were designed to catch and tag tuna in areas where pole-and-line fishing gear is not efficient due to the absence of baiting grounds. Using specific trolling gear developed in Hawaii, and targeting US National Oceanic and Atmospheric Administration Tropical Atmosphere Ocean (TAO) oceanographic buoys anchored east of the dateline, CP tagging cruises have improved the overall spatial coverage of PTTP tag releases and have increased the number of tagged bigeye tuna that are rarely caught by pole-and-line gear in the western part of the WCPO.

The previous four CP cruises used a Hawaiian-based fishing vessel but this time, the *Pacific Sunrise* (Fig. 1a), a multi-purpose 22-meter boat based in Nuku'alofa, Tonga was chartered. The vessel left Tonga on 13 November with six people onboard, including captain Eti Palu, Bruno Leroy (cruise leader, SPC), Malo Hosken (assistant tagger, SPC) and four Tongan crew members (Fig. 1b). After a stop at Pago Pago, American Samoa for refueling, the vessel visited 10 TAO buoys moored along the 170°W and 180°W meridians, and passing through Tokelau, Kiribati (Phoenix and Gilbert Islands), Howland and Baker Islands, and Tuvalu. The cruise ended at Mata'utu (Wallis Is) on 7 December after a 3,200 nm journey (Fig. 2).

The crew were lucky to find good tuna aggregation around four of the TAO buoys. Although this was the first time for the Pacific Sunrise to fish that way, the vessel quickly revealed to be a very efficient "tagging machine"!

The captain is, in fact, a very experienced tuna tagger (he was one of the regular taggers during the Regional Tuna Tagging Programme in the late 1980s) and this was a big asset to the cruise. Three tagging cradles were mounted on the aft deck (two for conventional tagging and one for archival tagging). When the cruise leader was busy deploying archival tags, the captain was able to operate one of the other cradles. This was an efficient way of releasing conventional tags during the fast bite morning tagging sessions. The four crew members hauled the fish (Fig. 3) from the 10 to 12 short troll lines deployed around the deck. Most of the tuna were in the 8–12 kg size range but fish up to 25 kg were also caught.

On this cruise 6,359 tuna (a record for all CP cruises) were tagged, including 58 with archival tags; 96% of these were bigeye tuna (*Thunnus obesus*)(Fig. 4).

Fish that were unsuitable for tagging were kept for biological sampling.

Two crew members assisted in the collection of biological samples. Their efforts were of a high standard and, thus, in agreement with the captain they were trained in the sampling techniques and were instructed

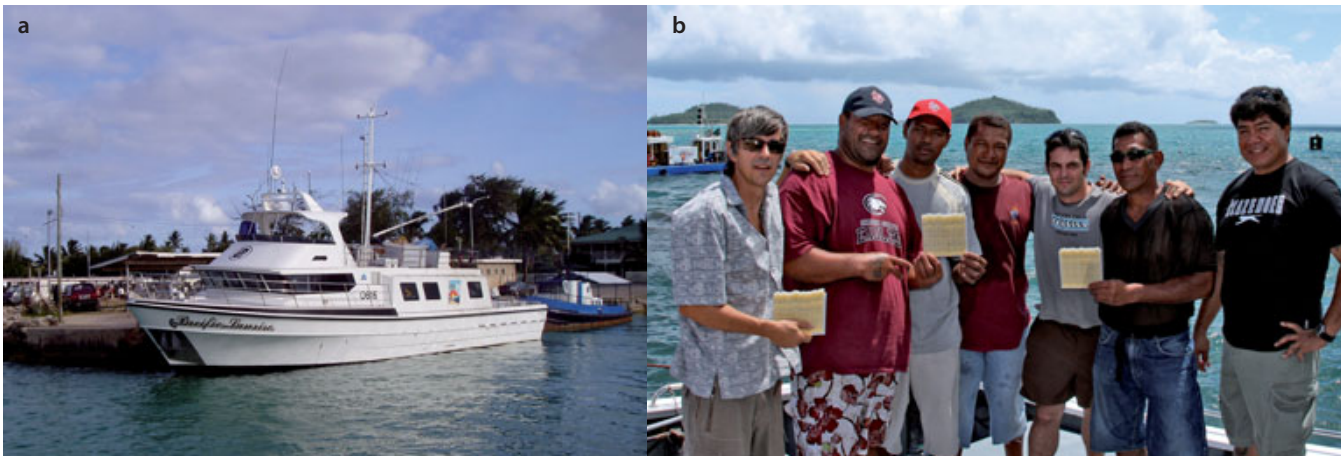


Figure 1. a) FV Pacific Sunrise *in Nuku'alofa harbour, Tonga; and b) End of cruise group photo. Left to right: Bruno Leroy, Hopoate Fakatoumafi, Alani Latuselu, Uilisanasi Fanua, Malo Hosken, Lousinimani Potoi and Etimoni Palu.*

Figure 2. The track of the FV Pacific Sunrise during the CP 5 tagging cruise.

in how to record data correctly. They will sample tunas and bycatch species during future commercial longline fishing operations in Tonga's EEZ.

For more detailed information, read the cruise report on SPC's tagging website: http://www.spc.int/tagging/en/publications

Figure 4. Juvenile bigeye marked with conventional 13-cm yellow tag.

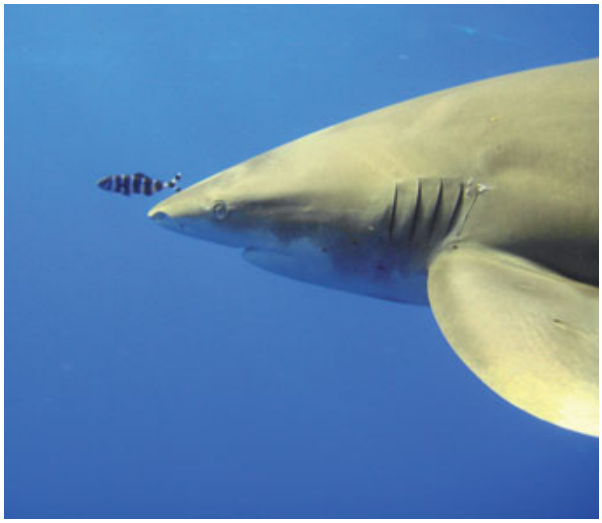
Figure 3. Crew members haul in two bigeye tuna from the first starboard dangler station. Note spray system.

Keeping track of sharks: SPC kicks off two new shark projects

SPC's Oceanic Fisheries Programme (OFP) is working to improve the understanding of the biology and movement of the oceans' top predators through tagging studies. These studies provide essential information on movement, habitat area, growth and natural mortality for use in shark species stock assessments. To complement ongoing work under the new Shark Research Plan (described in SPC Fisheries Newsletter #132), OFP tagging results from releases in Tongan waters will provide greater insights to the behaviour of oceanic whitetip sharks, and a new OFP database aims to capture information from all shark tagging research in the Pacific.

During a tagging cruise off Tonga in June 2010, SPC scientists attached pop-up satellite archival tags to two 2-m-long oceanic whitetip sharks, one of the 13 key shark species designated by the Western and Central Pacific Fisheries Commission (WCPFC). The first tag successfully "popped" off the shark after two months and downloaded its data to a satellite exactly as it was designed to do. The second tag's year-long tracking capability was curtailed when its host was captured by a longline vessel off Fiji in September. Upon capture, the tag was recovered by a member of the longline vessel's crew, who received a USD 250 reward for returning the tag to SPC. Although nine additional months of potential tracking was foregone, the return of the tag itself allows for more detailed data to be retrieved than would otherwise be available from the tag's satellite transmissions alone. Analysis of tag data has revealed that the first shark travelled 640 km into far northern Tongan waters in two months, and the second shark travelled 350 km northwest into Fijian waters in three months. These movements indicate that oceanic whitetip sharks are capable of moving large distances in a relatively short time, thus confirming their highly migratory nature.

OFP is about to begin work on a new database that will serve as a clearinghouse for Pacific shark tagging information under the WCPFC's Shark Research Plan. Because sources of tagging data for Pacific sharks appear to be scattered among government and academic research institutes around the Pacific Rim, the existence of some studies can be confirmed, but the details of each cannot. The goal of the new SPC project is to collect metadata (data about data) such as species, tag type, number tagged, recovery rate and availability of published results, as a basis for assessing the extent and usefulness of existing data and the need for further work. Once compiled, the database will be made freely available online via the SPC website. The project is not designed to analyze tagging data, but it may assist in pulling together new sources of information. This can lead to a better understanding of the connectivity of the resource in waters of various WCPFC member countries and support identification of critical habitats for sharks of different species, sexes and life stages. Readers with shark tag information to share are encouraged to contact OFP immediately to learn more about the project.



*Close up shot of an oceanic whitetip shark (*Carcharhinus longimanus*). Image: Julien Stein/Marine Photobank.*

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News from the SciCOFish project

The SciCOFish project provides a reliable and improved scientific basis for management and decision-making in oceanic and coastal fisheries, giving Pacific African, Caribbean and Pacific (Pacific-ACP) countries the means to develop efficient management measures, the skills to monitor their effectiveness, and some important tools to combat illegal, unregulated and unreported fishing activities.

The oceanic activities provide scientific support for new tuna management initiatives adopted by P-ACPs at a critical time for conservation of stocks, in particular, intensive observer training and enhancement of national fishing activity databases. Coastal activities are focused on projects combining an urgent resource management issue with a strong local capability to address the issue and maintain a long-term programme.

New staff

Four more people have joined the SciCOFish staff, bringing the counts to ten people.

Fisheries Data Officer: Bruno Deprez

Bruno is an engineer with a Master's degree in Information Technology. He has worked in different professional settings, from developing pharmaceutical software in the USA to setting up a new statistical information system for use with socioeconomic and stock evaluation surveys for the Seychelles Fishing Authority. For SciCOFish, Bruno will be in charge of the oceanic fisheries data audit. These audits will be conducted both in-country and at SPC headquarters, and will be applied to logsheets, port sampling and unloading data. The main purpose of conducting these audits is to increase the average quality of the data provided to the different commissions and to SPC scientists.

Observer Support and Development Coordinator: Peter Sharples

After securing a Bachelor of Science degree in physiology, Peter pursued a variety of technical and training roles around the world before training as a New Zealand fisheries observer. A decade of observer and off-shore field technician work in locations ranging from the sub-Antarctic to the equator included a diverse range of services to the SPC region, including monitoring drift net fishing; tagging tuna; surveying fishery resources for Pitcairn Island; and reviewing and re-designing the US Multilateral Treaty observer programme. Peter led a team of "super" observers in the European Union (EU)-funded South Pacific Regional Tuna Resource Assessment and Monitoring project as they laid a base for establishing national observer programmes throughout the region and established Papua New Guinea's large and effective observer programme. Peter's strong observing and training background, history of working and living in the Pacific Islands region, and his pivotal role in several major regional observer initiatives while working as the SPC Oceanic Fisheries Programme (OFP) Regional Port Sampler and Observer Coordinator funded under the EU's PROCFish and SciFish projects (2003–2010) have molded him for this role with the SciCOFish project.

Observer Training and Support Officer: Siosifa Fukofuka

Sifa was educated in Tonga and then at the University of the South Pacific where he graduated in 1990. After five years of working for the Cook Islands Ministry of Marine Resources, he joined SPC's OFP as one of the small team of "super' observers tasked with collecting baseline data from every major tuna fishing fleet in the SPC region. This experience led him into the world of observer training in which he has been the sole dedicated observer trainer for tuna fisheries in the SPC region from 2002 until now, funded under the EU-sponsored PROCFish and SciFish projects. In the latter years of that work, Sifa passed on his observer training skills to others and this will be a prime focus of his work under the SciCoFish project.

Fisheries Scientist (ecosystem modelling): Jesus Jurado Molina

Jesus Jurado-Molina received a Bachelor's degree in biology and Master's degree in sciences (biological oceanography and fisheries) from the University of Mexico. He received his PhD from the University of Washington (USA) in 2001, working with a multispecies virtual population analysis and a multispecies forecasting model for the eastern Bering Sea. He worked from 2001 to 2006 for the University of Washington as a contractor for the Alaska Fisheries Science Center, where he was in charge of updating and developing multispecies models, in particular, the multispecies statistical model for the Bering Sea. In 2007

he started working for the Instituto Nacional de la Pesca in Mexico as Director General de Investigación Pesquera del Atlántico, where he coordinated fisheries research in the Gulf of Mexico and Mexican Caribbean Sea. He began working at SPC in 2009 as a fisheries scientist (population dynamics and ecosystem modelling). His work focuses on the adaptation and development of the Spatial Ecosystem and Population Dynamics Model (SEAPODYM) as a tool for tuna resource management in the South Pacific.

Timor Leste: A new country partner for SPC

Timor Leste is a Pacific-ACP country for the purposes of EDF10 (European Development Fund), and therefore needs to be included in the SPC EU project SciCOFish. As a non-member of SPC, Timor Leste has never benefited from SPC assistance, and the organisation has little information and few in-country contacts. For this reason, an initial SPC visit was planned in order to meet national partners, identify priorities for project engagement, and make an initial assessment of the different issues in the sector.

Fisheries in Timor Leste

Timor Leste comprises the eastern half of the island of Timor; the island of Atauro and the Oecussi enclave on the north coast of Indonesian West Timor. The north coast of the main island is characterised by a narrow fringing reef that drops off sharply into deep water.

Most of the catches from this area comprise small pelagic fish species such as round scad, sardines, juvenile tunas, which are caught mainly with nets around FADs and with lights. Fishers deploy their own FADs using bamboo payao-style rafts. Some reef fish catches are also seen on the market in Dili.

Fishing is mainly from double-outrigger canoes, both paddled and with outboard motors. A number of fiberglass mono-hull vessels with outboards have also been provided under an aid programme. Many of the country's larger fishing vessels were destroyed in the fighting at the time of separation from Indonesia, but a dozen or so are now operational. These tend to fish more on the south coast, in the Timor Sea, which is shallow and suitable for trawling. There is reportedly a lot of illegal fishing in this area.

Inland fisheries resources include introduced tilapia and some endemic species. There is some aquaculture of Eucheuma seaweed. In the past, prawns and milkfish were cultured. The government is promoting diving and sport fishing as tourist attractions.

Fisheries, however is not the country's economic mainstay; instead, agricultural production for local consumption and growing coffee for export are the main economic activities. Never the less, there are an estimated 20,000 artisanal fishers in Timor Leste (more than many in Pacific Island countries), and fish is important for food security. The government also benefits from royalty payments for oil, which is collected directly from oil rigs in the Timor Sea under a resource-sharing agreement with Australia. Maritime boundaries have not been agreed to on either side, and are a contentious issue.

Fisheries Directorate office at Com, which has been suggested as a base for SPC support in monitoring offshore fisheries.

Fisheries Directorate

The Fisheries Directorate was formed (after independence) from a core staff of 13 who had been employed in the sector under the Indonesian administration. Australian technical assistance was provided during the first few years. Staff numbers have now grown to 115. The Fisheries Directorate has 10 observers on the payroll, trained in Indonesia and in Australia. The Director plans to deploy these observers on five foreign tuna longline vessels that will start operations soon under a licensing arrangement.

Maritime surveillance is primarily the responsibility of the navy, which has a base at Hera, a few kilometers outside of Dili, using the harbor that was originally built as a commercial fishing port. A committee deals with maritime security, which includes fisheries, border security and customs officials. A number of vessels have been impounded for illegal fishing in recent years.

As a result of this visit, the following priority areas were identified for assistance under the SciCOFish project: 1) an assessment of Timor Leste's tuna resources based on available data with recommendations on how such assessments can be improved in future; and 2) observer training and strengthening of the national observer programme.

There was also keen interest in building capacity to combat illegal, unregulated and unreported fishing activities under the DevFish 2 project.

SPC promotes community-based approach for coastal fisheries management

The five-day meeting of representatives from national government conservation and fisheries departments, regional and national non-governmental organizations (NGOs) held at SPC ended on 3 December 2010. The purpose of the meeting was to 1) bring together the main stakeholders working in the area of implementing the community-based ecosystem approach to fisheries management (CEAFM), 2) discuss management, monitoring activities and the challenges faced; 3) find common ground between conservation and fisheries management and monitoring approaches in the Pacific; and 4) develop and strengthen partnerships for collaboration. The meeting was funded by the SciCOFish project.

Propositions to fisheries management difficulties

Many country participants are working to address the wider ecosystem, fisheries and non-fisheries issues in their resources management approaches. However many conservation and fisheries management practitioners report inadequate capacity and resources with which to introduce fisheries and environmental management initiatives at a "whole of country" scale. Differences in management approaches were related to the scale and scope of activities and interest, where fisheries management approaches tend to be based on close connections with communities, governments departments and NGOs operating under well-defined legal and regulatory frameworks.

Participants reported that there has been very little data collection and analysis of social and economic aspects or the wider ecosystem cumulative effects, but adaptive resource management has continued to occur more on the basis of "learning by doing", rather than being driven by results of scientific monitoring. Workshop participants agreed that future monitoring and information strategies should be 1) based on well-defined outcomes and fit the purpose (use by governments and stakeholders); and 2) cost-effective and based on the overall needs of all coastal communities, avoiding expensive and unrepeatable "showcase" community approaches.

A poster announcing the CEAFM workshop.

Coordination for better recognition of coastal fisheries

Participants expressed concern that there was a lack of political will and support for coastal fisheries compared with oceanic (tuna) fisheries. Both areas of fisheries are critical to Pacific Islands countries and territories, and so should receive the same political support.

A workshop outcome recommended that SPC facilitate, encourage and support national and regional forums to exchange ideas, lessons learned and accelerate the introduction of adaptive management approaches that are suitable to national contexts. It was also recommended that SPC support national arrangements to develop or use existing multi-sectoral committees that recognise and incorporate NGOs, and are of sufficiently high level and have a legal mandate with appropriate community representation. SPC should work closely with NGOs under formal consultative arrangements and use joint implementation strategies, as guided by national fora, to extend regional initiatives at the national level.

Can the sea cucumber resource survive the next open season in Tonga?

Growing demand for beche-de-mer products in China and limited resources worldwide are driving the greatest pressure ever on sea cucumber fisheries. In Tonga, where the fishery was closed for 11 years, re-opening the fishery has been the most lucrative economic activity in the country in the past three years. Sales of raw and dried products contribute significantly to community income and export earnings for the country. Tonga made a decisive move to impose a 10-year moratorium on sea cucumbers in 1997 to protect the fishery after it declined. The fishery was re-opened in 2008 and is reaping the benefit of waiting 10 years; but increasing pressure may have done more damage than good for the resource.

Sea cucumber fishery

The sea cucumber fishery developed in the 1990s after resource surveys (Japanese Overseas Corporation) found a potential for a small-scale fishery development. Declining catches in the mid-1990s supported by a 50% decline of resources revealed by SPC studies in 1996, elicted concern by the government. A decisive move in 1997 saw a 10-year moratorium on the fishery to allow longer lived, slow-growing and high value species (white teatfish, black teatfish and golden sandfish) to reach sexually maturity. Reassessment of the resource in 2004 by SPC under the European Union-funded Pacific Regional Oceanic and Coastal Fisheries Development Programme project indicated recovery back to the 1990 population level for many of the commercial species. But there was still bad news for the high value black teatfish (*Holothuria nobilis*), which has not recovered. White teatfish has recovered by 80% of its pre-moratorium level while the golden sandfish *H. scabra versicolor* stock is uncertain.

Export production

Major production occurred in the 1990s when peak exports of around 70 tonnes (t) were achieved in 1995. Exports, however, quickly fell back to 10 t by 1997. High value species were important during this period. Tonga experienced its first "boom and bust" phenomenon in the fishery, which has been the characteristic of many small-scale sea cucumber fisheries in the Pacific Islands region. Sudden declines instigated concer,n resulting in the 10-year fishery ban. Recent production after the moratorium is a different story, with 15 t of beche-de-mer exported in the first open season in 2008; exports exploded in the latest two seasons with 370 t and 312 t, respectively. These exports represent the highest ever in the history of Tonga's sea cucumber fishery. With high value resources still depleted, attention was turned to whatever was left in the water. Low to medium value species began dominating production, with snakefish (*Holothuria coluber*) and lollyfish (*H. atra*), two of the lowest ranked products, making up 41% of total exports in 2010.

Besides beche-de-mer, Tongan's also love raw sea cucumber. They are among the few islanders who regularly consume sea cucumber in their subsistence diet. Gonads, body wall, and the polien vesicle of five sea cucumber species (*H. atra, H. coluber, H. scabra versicolor, Stichopus herrmanni* and *Bohadchia similis*) are edible in raw form as a local delicacy. Surplus of these products are sold at local markets in Nukualofa. The subsistence collection of sea cucumbers is not regulated and was unaffected by the last moratorium. Ongoing subsistence exploitation is likely to have contributed to the lack of recovery of golden sandfish whose stock status is uncertain today.

Management measures

The Tonga National Sea Cucumber Fishery Management Plan was developed in 2007. The plan provides policy guidance for the sustainable harvesting of sea cucumbers by restricting access to resources, controlling harvesting and processing to improve quality, and providing a mechanism for data collection and monitoring of the fishery during open seasons. Some of the measures in the plan include a total annual export quota (around 200 t divided between the three main island groups), a six-month annual fishing season, limit of nine beche-

de-mer export licenses per year, and many processing licenses. Unlike in the past, where fishers fished and processed their catch at will, now all fishers must be registered and only processing license holders are allowed to process products. The new policy will improve quality at the same time as facilitate effective monitoring. Implementation of the plan worked well in the first open season, although for the last two seasons, increased pressure by traders and the need for income by communities has forced decision-makers to open up export license and increase license fees. As a result, 26 export licenses were issued in 2009 and 22 in 2010, leading to record export figures.

Request for assessment

The Tonga Department of Fisheries is concerned that an increase in production may have resulted in significant damage to the resource. They fear the resource may have been depleted far beyond the pre-moratorium level. The principal question that is currently being asked is "Can the remaining resource support another open season, or is it time to call for another longer moratorium?" Tonga Fisheries is seeking an answer to this question and has requested SPC's assistance to find the answer. In response, SPC is conducting resource assessment and reporting trainings under the EU-funded SciCOFish project to build local capacity to collect data and generate answers to their own questions.

Kalo Pakoa, SPC Fisheries Scientist (invertebrates), was in Tonga's Vava'u Group from 6–19 November 2010 to begin trainings. Vava'u was the second most important producer (80 t) of beche-de-mer in the 2010 season, and so is an important site for the training. A team of six local officers from the Department of Fisheries and Environment Department went through the three-week training by Kalo. The two agencies are collaborating in many areas, and so training the training of officers together is very necessary to equip them with the appropriate skills to respond to Tonga's resources assessment and management needs.

Training in invertebrate resource surveys

The six officers: Sione Mailau, Poasi Ngaluafe, Vea Kava and Talaofa Loto'ahea from the Department of Fisheries and Senituli Finau, and Samuela Pakileata from the Environment Department were trained on the standardised invertebrate resource survey methodologies being promoted by SPC. Because the training is also expected to generate real data for the Vava'u Group for the national assessment, the training was planned to dedicate more time to in-water field training than classroom type exercises. Five invertebrate resource assessment protocols (shallow transect, manta tow, shallow scuba transect, deep scuba timed searches, and timed swim) were the focus. These protocols are not new but their proper use is necessary to ensure greater effectiveness.

Coverage of all invertebrates and habitats within a station is part of the standardised protocols used to generate data that can be used for different purposes. So although our target was sea cucumbers and trochus, other invertebrates were recorded as well. For the Environment Officers, these are important protocols for biodiversity status assessments. Areas covered

Senituli Finau (Tonga Environment Department) with white teatfish specimen from a deep dive station, Vava'u, Tonga.

in the trainings included survey planning, decision-making, communication, habitat selection, transect placement of transect, use of maps, proper use of survey equipment (manta board, GPS and transects), data recording, understanding records, measuring different invertebrates, species and habitat identification, and most importantly safety issues.

Outcome and follow up trainings

The package included field data collection, data entry, and in-country database familiarisation where the officers are further mentored to conduct in-country reporting. The Vava'u survey set up the local team on a countrywide sea cucumber survey for the overall understanding of the resource. At the end of two weeks, trainees were confident in using the methodologies and were ready to go ahead and complete the surveys.

They were left to complete the work in the Vava'u Group in November 2010, Tongatapu in December 2010, and Ha'apai in January 2011, before returning to Nuku'alofa. From there, two trainees will undertake attachment training in Noumea to learn data cleaning, entry, analysis and reporting. For the two Environment Officers, their only experience was in coral reef monitoring assessment of live coral using line intercept transects. This training has equipped them with the skills their agency needs in conducting biodiversity assessments. Sea cucumber resource status results for Tonga will come out after all the surveys have been completed. For Vava'u, the general feeling is that sea cucumbers stocks are not in good shape. Although diversity may not be affected, abundance and sizes, which are important characteristics in determining the health of a fishable stock may be seriously affected, which puts future harvesting into question.

Acknowledgement

SPC acknowledges the support of Tonga Fisheries staff in Nuku'alofa and the Vava'u branch for their support. The next stage of training (attachment) in Noumea is planned for February to March 2011.

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DevFish2 begins

Context

Pacific members of the African, Caribbean and Pacific Group of States (P-ACP countries) are located in the midst of the most important tuna fishing ground in the world, which annually supplies over 1 million tonnes of tuna (one-quarter of the world supply) valued at more than USD 1 billion. At present, the majority of the catch is taken directly by distant-water fishing nations in the exclusive economic zones (EEZs) of P-ACP countries in return for licence fees. A smaller, but growing share is harvested by P-ACP vessels or landed in P-ACP ports. These activities employ an estimated 12,000 Pacific Islanders, mostly women. Ninety per cent of these jobs are land-based processing jobs. The economic livelihoods of thousands more are dependent on small-scale commercial tuna fishing and marketing. There are, therefore, very large potential gains for P-ACP countries from increasing the share of benefits that they secure from tuna resources through increasing P-ACP fishing operations and capabilities, and from encouraging the localisation of other tuna fishery-related activities. Since there are limited opportunities to increase total catches, the emphasis will be on securing a greater share of the sustainable catch for local enterprises. Economic studies carried out under the first phase of DevFish (Development of Tuna Fisheries in the Pacific ACP Countries Project) under the ninth European Development Fund (EDF 9) have demonstrated empirically the benefits of this approach, and formed the basis for development planning and policy advice to promote private sector development and foreign investment.

The first phase of the DevFish project was designed to build on past projects by the Asian Development Bank, the Pacific Islands Forum Fisheries Agency (FFA) and other agencies, which identified constraints to the development of P-ACP domestic tuna industries. In particular, the DevFish project undertook interventions to improve economic and policy conditions as well as specific actions to mitigate constraints in areas including EU food safety requirements, port management, and rising fuel prices. Its success was recognised in annual Results Orientated Monitoring (ROM) missions as well as a mid-term review. However, these reviews acknowledged that a long-term commitment will be necessary to achieve the ambitious goals of the project, and a second phase was strongly recommended.

DevFish2: Reduce constraints to domestic tuna industry development

The two regional EDF10 projects, SciCOFish (Scientific Support for the Management of Coastal and Oceanic Fisheries in the Pacific Islands Region) and DevFish2, represent a coordinated approach by two regional agencies (FFA and the Secretariat of the Pacific Community [SPC]) to jointly address the three pillars of sustainable fisheries — science-based management, development and enforcement. They also complement activities under the proposed EDF10 Increasing Agricultural Commodity Trade (IACT) project, which will enhance capacity for trade in agricultural and aquaculture products.

DevFish2 has formally commenced and is jointly implemented by FFA as the lead agency, with support from SPC. In line with the mandates of the two organisations, work undertaken by FFA will focus on economic and policy issues relating to industry development, as well as the coordination of monitoring, control and surveillance activities. SPC will contribute technical expertise in fisheries development, particularly assistance targeting artisanal fishers and small and medium enterprises, and analysis of tuna fishery databases to quantify illegal, unreported and unregulated (IUU) fishing levels, as well as assistance to countries in better using national data for this purpose. The two organisations have an extensive history of joint work.

The overall objective of the programme remains the same as that of the original DevFish project — to increase the contribution from the sustainable use of highly migratory marine resources, particularly tuna, to the alleviation of poverty in P-ACP states, now also including Timor Leste. The project's purpose is to reduce constraints to domestic tuna industry development. These arise from economic and environmental vulnerabilities, such as a lack of local capacity to manage and support the tuna industry, including small-scale operations, and from IUU fishing activities, which both divert economic benefits and threaten efforts to sustainably manage the resource.

Implementation

DevFish2 is a four-year project that began in 2010, with a total budget of EUR 8.2 million, of which EUR 7.2 million represents project direct costs.

The targeted beneficiaries (P-ACP countries) are Cook Islands, Fiji Islands, Federated States of Micronesia

(FSM), Kiribati, Nauru, Niue, Palau, Papua New Guinea (PNG), Republic of the Marshall Islands (RMI), Solomon Islands, Samoa, Timor Leste, Tonga, Tuvalu and Vanuatu. The requests from countries for project assistance are required to come from fishers associations with endorsement of the ministry of fisheries.

SPC's responsibilities in this phase fall into the following areas:

- Support for industry (capacity development) including artisanal fishing stakeholders
- Industry training for expansion of exports
- Formal training for enterprise managers
- Upgrades of artisanal fishing activities, including running pilot projects to introduce new technologies such as the replacement of 2-stroke with 4-stroke engines, etc.
- Integrated assessment of enforcement and fisheries databases

FFA will take the lead in assisting with fisheries development strategies, and providing technical support to competent authorities.

Both agencies will collaborate with each other on activities as necessary.

Project Steering Committee

The project's Steering Committee is responsible for technical and administrative oversight. The first project steering committee meeting will coincide with the Heads of Fisheries meeting held by SPC in February/March 2011. The draft project work plan and cost estimates developed especially for the annual work plans for Year 1 and Year 2 will be discussed and formalised.

The project will require one representative from each fisheries department in the region as well as selected representatives from the private sector (i.e. fishing industry associations) to attend meetings of the Steering Committee.

Staff

Fisheries Development Officer (DevFish): Jonathan Manieva

Jonathan, who is from PNG, was the Fisheries Development Officer based at SPC in the first phase (2005–2009) of the DevFish project.

In his position in DevFish2, Jonathan's main task is to continue to administer the project activities coordinated by SPC. This includes assessing and coordinating support to the fishing industry and fishing associations, especially facilitating their initial establishment and strengthening their effectiveness.

He also helps to provide additional support to industry and fisheries authorities in focus areas of the project.

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Derelict longliners in Pohnpei, FSM. The local tuna longline fleet has struggled over the years to survive. Devfish2 will bring support to local tuna fishing operations by providing technical assistance and training for fishing companies through activities such as trials and the introduction of new technologies in fuel efficiency

Identifying Cook Islands' priorities for DevFish2 support

The second phase of DevFish has been introduced to about 20 members of the Cook Islands National Fishing Association. At the request of the Ministry of Marine Resources, Jonathan participated in the project's Cook Islands inception meeting on 22–25 November.

Jonathan presented work done during the first phase of the DevFish project, highlighting the area of focus: support to the fishing industry and fishing associations, especially facilitating their initial establishment and strengthening their effectiveness. He made observations on lessons learned (fishing associations' challenges and benefits), explaining why it is appropriate to have an association such as the Cook Islands National Fishing Association.

He stressed the success of the support provided to the industry association by the DevFish-funded officer: during the first phase of DevFish, this project assistance was noted as a model to expand in the region. The support enables a national association to have a full-time staff member to serve the collective affairs and interests of the association. Traditionally, association executives serve on a voluntary basis and seldom dedicate their time to association work. Unfortunately, many associations have small memberships and lack the resources to hire staff. Jonathan noted that this kind of support is still available under DevFish2.

During the meeting, representatives of member fishing associations and fishing clubs noted their priority needs with regard to future development. The following priorities were identified:

1. construction and maintenance of fish aggregating devices
2. sea safety gear, and training on their usage
3. increased supply of bait and fishing gear (hooks, fishing line, lures and nets)
4. formal incorporation of member associations/clubs
5. training in post-harvest fish handling and treatment
6. development of marketing arrangement (transportation mode) of fresh fish and processed products
7. replacement of aged outboard motors of clubs or associations

DevFish2 aims to enhance national Hazard Analysis and Critical Control Points (HACCP) practices in P-ACP countries in order to increase tuna exports, as for these exportable yellowfin tuna in chill bins.

8. ice-making facilities
9. leading lights at wharves/jetties
10. subsidies to offset fuel costs
11. reviving processing and storage facilities on outer islands
12. ice bags and chilly bins

These will guide the association in formulating its development plan and pursuing support.

Representatives recommended that DevFish2 support the funding of the support staff position as an immediate priority. The support officer, once in place, should coordinate and assist with administrative arrangements and undertake the development of strategies to address the list of priority needs, with guidance of the newly elected association executives

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For more information, please contact:

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The views expressed in this publication do not necessarily reflect the views of the European Commission.

Giant squid fishing in Okinawa... and soon in the Pacific

As part of its fisheries diversification initiative, SPC's Nearshore Fisheries Development Section (NFDS) is constantly looking at introducing new fishing technologies in the region. Diversifying nearshore fishing operations provides alternative food security and livelihoods to coastal communities and reduces fishing effort on heavily exploited marine resources while also ensuring the sustainable harvesting of newly targeted species. After the successful introduction of new shallow-water FAD designs (2007–2008) and the setting-up and promotion of tourism-based sport fishing operations (2009–2010), NFDS, in collaboration with the Pacific Islands Forum Fisheries Agency (FFA) Fisheries Development Division, will soon undertake fishing trials for baitfish and other small pelagic species, using the Indonesian bagan method. In October, the Fisheries Development Advisers of both FFA and SPC met in Okinawa to develop ties with the local fishing industry. The objective of this trip was to make arrangements for an experimental fishing campaign in 2011 to target the diamond-back giant squid (Thysanoteuthis rhombus).

The diamond-back giant squid is found worldwide in tropical and subtropical waters. The main fishing grounds are located in the Sea of Japan and around Okinawa Island where 90% of the Japanese total catch is made. In Okinawa, giant squid is fished primarily in the daytime with 500-meter-long free-floating droplines called hata-nagashi. Each dropline, made of 2 mm stainless steel multi-strand wire, is equipped with one flagpole and one pressure float at one end and three large squid jigs at the other end. Squid are attracted to the gear by a pressure-resistant light snapped onto the mainline, above the squid jigs. The Okinawan giant squid fishery runs mainly from November to April (northern hemisphere winter) and its catch has increased from 15 tonnes (t) in 1989 to 2,300 t in 2003. The yearly catch is currently averaging 2,000 t and all local production is exported to mainland Japan in frozen, vacuum-packed blocks. Giant squid is consumed as sashimi in Japan.

Some of the gear used in giant squid fishing: electrical reel, squid jig, pressure light (yellow), which is attached on the line close to the lure, and strobe lights (orange) for the flag poles (Image: Michel Blanc).

While in Okinawa, the FFA and SPC Fisheries Development Advisers met with representatives of the local fishing industry. They visited a tuna and squid processing plant and spoke with a local fisherman who agreed to come to the South Pacific to experiment with giant squid fishing in New Caledonian waters. The project is scheduled for June or July 2011 (southern hemisphere winter). While prices paid to Okinawan fishers (JPY 500–650 per kg) would not be high enough to sustain a new export fishery from the Pacific, this new commodity may be quite attractive to consumers, including tourists, on local markets. We know that giant squid are present in the tropical Pacific but the size of the resource and its accessibility remain to be assessed. It is hoped that this fisheries diversification project will provide the answers.

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Giant squid mantle ready to be processed (Image: Michel Blanc).

A successful conference on sustainable aquaculture in tropical islands: Tahiti Aquaculture 2010

Litopenaeus stylirostris, *the blue prawn is grown in three farms in French Polynesia.*

Over 200 participants from the Pacific, Asia, Americas, Europe and French Overseas Departments and Territories attended a week-long conference on aquaculture in Papeete, Tahiti from 6–11 December 2010. The conference was officially opened by His Excellency Gaston Tong Sang, President of French Polynesia.

Delegates came from several Pacific Island countries and territories (PICTs), including the Commonwealth of the Northern Mariana Islands, Cook Islands, Fiji, Palau, Papua New Guinea, Samoa, Solomon Islands and Tonga. The French territories were well represented through participation from Guadeloupe, La Réunion, Mayotte, Martinique, New Caledonia, Saint Pierre and Miquelon, Wallis and Futuna, and the host country French Polynesia.

The main theme of the conference — Tahiti Aquaculture 2010 — was "Sustainable aquaculture on tropical islands". Conference objectives included discussing progress made in aquaculture in tropical island settings, comparing experiences and know-how, and proposing strategies and solutions for aquaculture development taking place in tropical islands. Pearl oyster aquaculture was not covered during this conference as the main focus was on marine finfish and shrimp aquaculture.

Conference highlights

Some of the highlights included the following.

- The demand for fish and fish products continues to increase at national levels. The need to look at initiatives to produce fish in a viable manner and ensure that aquaculture activities blend in with the lifestyle of the local people is important.
- SPC's review of shrimp aquaculture in PICTs was timely. Tahiti Aquaculture 2010 provided an opportunity to discover alternatives such as super intensive culture, bioflocs (built-in pond biofilter that provides microbial protein as a feed additive) and cage culture, most of which are very relevant to PICTs.
- Hatchery-based marine finfish farming has a huge potential, as was thoroughly illustrated during Tahiti Aquaculture 2010. PICTs have an opportunity to learn from the experiences of French territories, USA (Hawaii) and Australia to further develop this activity. The use of native species (when possible) and thorough exploration of markets are required to ensure the success of such ventures.
- The need for a clear policy direction supported by national management and development plans — especially from small island tropical states — were necessary in directing the focus on developing the aquaculture industry. It is evident that successful aquaculture nations tend to have better arrangements for aquaculture governance.
- Ideas that are relatively new to the Pacific were also brought forward, such as integrated multi-trophic aquaculture (IMTA). [1]

As part of Tahiti Aquaculture 2010, several working group discussions took place, including one on aquatic animal health, which generated considerable interest and raised important issues, and another discussion on the potential for shrimp farming in Pacific Islands.

Jacky Patrois from IFREMER and Tim Pickering from SPC coordinated the working group discussions. These working groups were the final step of a regional shrimp aquaculture review across several PICTs, and aimed at developing an action plan for shrimp aquaculture across the region, using the advice and examples of countries that have experience in this field. The shrimp development plan and the regional review will be finalised and published in 2011 and available at www.spc.int/aquaculture.

- It was clear from the conference that a number of countries are working on the development of sea cucumber aquaculture, given the favourable market value in the fishery for some species.
- Biosecurity and health issues were also raised at the conference. Immediate action should take place in this area, such as the implementation of an SPC-based aquatic bio security focal point

During the conference, both SPC staff and Dr Jiansan Jia, Chief of the Aquaculture Services at FAO, exposed global and regional developments, emerging issues, and constraints arising from aquaculture development. In addition, resource people from the region and abroad were funded by SPC and other agencies to bring their expertise to the meeting in areas such as sustainable tropical aquaculture, hatchery techniques (broodstock handling live prey production), finfish and shrimp aquaculture, biosecurity and genetics.

The conference was divided in five sessions: 1) hatchery-based aquaculture (three subsessions: shrimp, fish and other species); 2) capture-based aquaculture; 3) aquatic animal health and the environment; 4) socioeconomic impact of aquaculture in tropical islands; and 5) governance. Each session was chaired and facilitated successfully, although there was so much to say and discuss that most sessions finished after the planned time.

Field trips organised by the fisheries service pleased everyone and gave a welcomed break to participants from the intensity of the conference. Field trips included a visit to the shrimp and fish farming projects on Tahiti's presqu'île and a visit of the IFREMER centre and the future national hatchery.

Challenges

Some of the key challenges that continue to hinder aquaculture development in countries were highlighted.

- Biosecurity was highlighted as an important issue and the need for a clearer regional biosecurity framework would be helpful to PICTs.
- Improvement on the collation of data to measure aquaculture development in this region needs to be strengthened through the provision of resources at national levels. Proper data keeping and reporting is important to member countries in order for them to assess the contribution of aquaculture to their national GDPs.
- Although certain PICTs have demonstrated that national aquaculture programmes could greatly benefit industry development, the lack of skills, facilities and high turn-over of trained technicians in the sector continue to be issues in smaller island countries.
- Countries that are undertaking sea cucumber aquaculture still face difficulties regarding technical know-how on seed production techniques and ocean rearing and restocking.

In conclusion

Overall, the importance of the aquaculture sector in meeting the growing global demand for nutritious food fish, contributing to growth in national economies,

Experimental floating cages moored in Tautira on Tahiti Island. This set up serves as a demonstration for other interested farmers. Here, batfish are being looked at for growth rates and other data related to cage farming.

Tahiti Aquaculture 2010 participants visiting Tautira experimental set up and rushing to land before the rain comes!

and supporting livelihoods in communities continued to be highlighted. However, challenges such as quality seed supply, feed supply and ingredients, genetic improvements, health and disease management, market access and trade barriers, continue to be faced.

The call for a regional biosecurity framework is not new and has been raised at various fora of SPC and other regional meetings to which SPC participates. SPC will look into working with its collaborating partners and agencies to continue to address the issue of establishing regional biosecurity framework. A concept note on developing a regional biosecurity framework will be put forward to the SPC Heads of Fisheries Meeting for Leaders' endorsement in February 2011.

There is an expression of interest for a regional focus on sea cucumber aquaculture. Both SPC and FAO will work towards developing a regional sea cucumber project.

Creating an enabling environment for aquaculture to maintain its growth while also meeting societal needs and preserving natural resources is important and must continue to be emphasized and promoted at national and regional levels.

SPC wishes to acknowledge funding assistance from AusAID (through aquaculture programme funding), from the French Pacific Fund and the Coral Reef Initiatives for the Pacific (CRISP) project in supporting the Tahiti Aquaculture 2010 conference.

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1 Integrated multi-trophic aquaculture (IMTA) provides byproducts, including waste, from an aquatic species as inputs (fertilizers, food) for another (see Wikipedia: http://en.wikipedia.org/wiki/Integrated_Multi-Trophic_Aquaculture).

New publications from SPC's FAME Division

Small-scale fishing techniques using light - A manual for fishermen

by William Sokimi and Steve Beverly

This manual presents some small-craft night baiting and fishing techniques commonly used in the Pacific Islands region, and provides Pacific Island fishermen with information that may help them develop their small-craft commercial fishing operations. Some of the techniques are improvements in canoe fishing methods and use basic gear, while other techniques include modern fishing equipment used on advanced small-scale fishing craft. Still other methods are adaptations of medium- to large-scale industrial fishing operations to small fishing craft operations.

The night baiting and night fishing methods covered in this manual encourage small-craft commercial fishermen to steer away from bottom fishing operations and move toward fishing for midwater pelagic fish, either inshore or offshore. Fishing methods focus on using light to aggregate phytoplankton and baitfish that in turn attract large pelagic fish.

This manual describes the use of bouke-ami stick-held dip nets, basnig lift nets and gill nets for catching baitfish and small pelagic fish. It is believed that if these net fishing methods are properly managed in coastal fishing communities, the accumulated bait, especially scads and sardinella, can be caught in sufficient volume to subsidise bait used in small-scale commercial tuna longline fishing operations.

The online version is available at: http://www.spc.int/Coastfish/en/component/content/article/375-small-scale-fishing-techniques-using-light.html

New guidelines on the proper handling of sport fish species

Sport fishing is becoming increasingly popular worldwide and the ethic of sport fishing fans, based on the "catch-and-release" principle, is in line with the fisheries management standards that SPC's Coastal Fisheries Programme promotes in the region. A recent integrated pilot project in the Cook Islands has shown that coastal sport fishing development can provide community livelihoods while improving the management of the targeted resource. SPC believes that what is working in Aitutaki could be successfully done in other Pacific Islands, provided the basic prerequisites are in place (e.g. suitable tourist accommodations, international airline connections, transportation to the fishing destination, dedicated local guides…and, obviously, enough fish — preferably an iconic fish — to lure overseas visitors).

SPC's Nearshore Fisheries Development Section has just developed guidelines on the proper handling of sport fish species. The guidelines, available in French and English, have been produced on waterproof plastic cards and can be obtained from SPC for distribution to sport fishing enthusiasts as well as established or prospective sport fishing operators. Bonefish and giant trevally are the first species covered, and SPC intends to develop handling guidelines for more species next year.

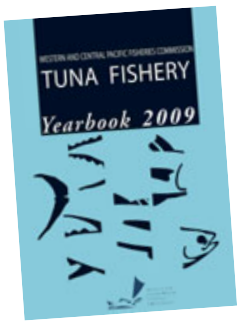
The first two guidelines, in PDF format, can be downloaded from the SPC website at:

- Part one: Bonefish (http://www.spc.int/DigitalLibrary/Doc/FAME/Brochures/Anon_10_Bonefish.pdf)
- Part two: Giant trevally and other large fish (http://www.spc.int/DigitalLibrary/Doc/FAME/Brochures/Anon_10_GiantTrevally.pdf)

The online version is available at: http://www.spc.int/Coastfish/en/features/nearshore-fisheries-development/376-new-guidelines-on-the-proper-handling-of-sport-fish-species.html

For more information, please contact Michel Blanc, Nearshore Fisheries Developement Adviser (MichelBl@spc.int)

WCPFC Tuna Fishery Yearbook 2009



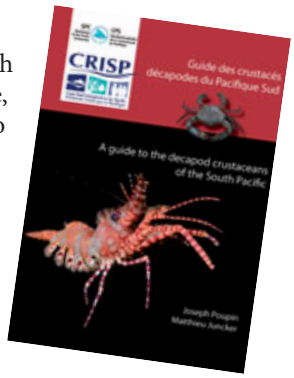
The WCPFC Tuna Fishery Yearbook presents annual catch estimates in the WCPFC's Statistical Area from 1950 onwards. Tables of catch statistics cover the four main commercial tuna species caught in the region: albacore (*Thunnus alalunga*), bigeye (*Thunnus obesus*), skipjack (*Katsuwonus pelamis*) and yellowfin (*Thunnus albacares*). The Tuna Yearbook is prepared by SPC's Oceanic Fisheries Programme under contract to the Western and Central Pacific Fisheries Commission.

This publication is only available online:

http://www.spc.int/OceanFish/en/publications/doc_download/695-wcpfc-tuna-fishery-yearbook-2009

A guide to the decapod crustaceans of the South Pacific

By Joseph Poupin and Mathieu Juncker



Most of the world's 50,000 species of crustaceans are marine and play an important role, both in fisheries and in the functioning of coastal ecosystems. Documented since ancient Rome, crustaceans have always been a major subsistence fishery, and today rank second only to fish in marine resource exploitation worldwide. The purpose of this guide is to facilitate the identification of common decapod crustacean species of the South Pacific. The guide includes 343 previously unpublished photographs used to illustrate identification cards for 223 species, and is intended for scientists, reef fishery managers, nature conservation agencies, professional fishers and recreational users of marine areas. It covers the species of the tropical South Pacific, from the Australian east coast to Easter Island; specific observations were made in New Caledonia, Loyalty Islands, Vanuatu, Wallis and Futuna and French Polynesia. Other island groups of this area (e.g. Cook Islands, Fiji, Samoa, Solomon Islands and Tonga), have been less frequently studied and are found less regularly under "distribution" in most identification cards. However, most of the species in this guide probably also occur in those locations, particularly those with broad distribution over the entire tropical Indo-West Pacific region, from the Indian Ocean and Indo-Malaysia to the central Pacific.

The online version is available at:
http://www.crisponline.net/CRISPPRODUCTS/Biodiversityknowledgeandconservation/tabid/317/Default.aspx

For more information, please contact Claire Dupré, In charge of CRISP communication: ClaireD@spc.int

Prawn farming in New Caledonia

Source: *Note Express de l'Institut d'Émission d'Outre-Mer, France (November 2010) (http://www.ieom.fr/IMG/pdf/ne26_aquaculture_crevettes_nc.pdf)*

New Caledonia's second largest export industry after nickel is prawn farming,[1] which has been in existence for over 30 years. With its XPF[2] 1.5 billion turnover[3] in 2008, and 500-strong workforce, it is a significant source of employment and income for the territory's rural population. After consistent growth up until 2005, the industry suffered considerable production and export setbacks following biological issues aggravated by a shortage of post-larvae. Although it has been in recession for several years now, it still has room for action as well as development potential in terms of production sites and farm expansion. Despite being heavily dependent on government subsidies, prawn farming has contributed to economic decentralisation and is one of the territory's major development sectors.

Industry overview

Significant contributor to rural New Caledonia's wealth and employment

The Établissement de régulation des prix agricoles (ERPA)-listed farms registered an XPF 1.5 billion turnover in 2008, making prawn farming the rural sector's second-largest income generator after vegetables. In 2008, it also accounted for nearly one-third of all revenues from animals and produce.

Since 1995, the industry has been the territory's second largest exporter, albeit far behind nickel. In 2008,[4] it accounted for 84% of all agricultural exports and 67% of all marine products.

In 2006, the industry had a 515-strong workforce in full-time-equivalent terms, and 32 separate companies, with farms and hatcheries employing nearly 60% of personnel and a packing plant one-third. Two-thirds of the jobs are seasonal. The average number of staff on a prawn farm is 7 workers and 29 in a packing plant.

Assuming that one aquaculture job generates five indirect jobs,[5] 2,000–3,000 extra jobs have been created in New Caledonia.

Prawn farming also contributes to keeping the rural population in their home areas. For example, most shareholders in the Webuihoone Farm in Voh are from neighbouring Melanesian villages.

A vertically integrated industry

Aquaculture is a vertically integrated industry made up of three tiers:

1. feed suppliers and hatcheries that supply prawn feed and post-larvae, respectively, to non-broodstock farms;
2. non-broodstock farms, where prawns are bred until they are mature (i.e. seven or eight months); and
3. packing plant that processes, packages and dispatches the prawns.

Being highly integrated, the industry incurs systemic risks, but also enjoys various synergies.

Most prawn-farm produce (i.e. two-thirds) is for export through two operators who handle packaging and marketing, namely STANC,[6] a SOPAC[7] subsidiary, and SAS Peneide de Ouano, a member of the Blue Lagoon Farm/Peneide de Ouano group (BLF–PO).

The main export markets are mainland France, Japan and the United States.

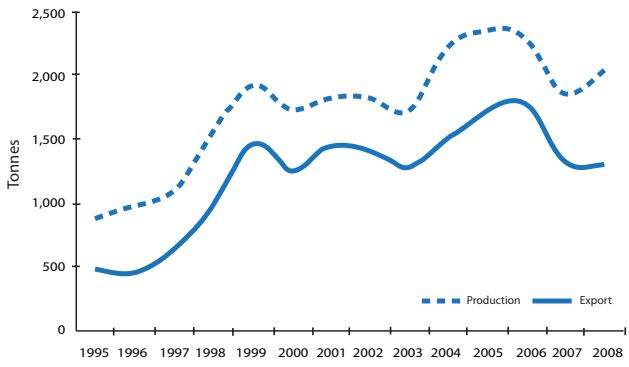
An industry in recession

Yields and exports clearly in decline …

After the 2,339-tonne peak reached in 2005, prawn yields fell by 13% over the following three years and export volumes plummeted by 24% during the same period.

In recent years, export destinations have undergone change, with mainland France falling to second place (from 56% to 36% between 2005 and 2008) and superseded by more profitable Japan.

China is a promising market, owing to high growth and rising living standards with an ever-increasing proportion of the population demanding luxury foodstuffs.

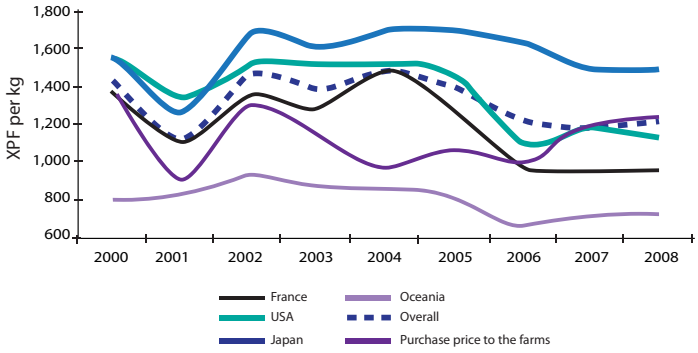


Prawn production and export in volume (Source: ISEE)

…against a backdrop of falling prices

New Caledonia's share of world prawn production is negligible at less than 0.1%. The local aquaculture industry has, therefore, to adjust to world price fluctuations. Following a worldwide glut and the US dollar's fall against the Euro, the average per-kilogramme export price of New Caledonian prawns declined from an XPF 1,482 peak in 2004 to XPF 1,223 in 2008 (i.e. an 18% decline).

Falling sale prices on mainland France market (–37% from 2004 to 2008) led to exports' being gradually redirected to other markets offering higher prices, but the trend has slowed for the time being by the production slump.



Average price per destination (in XPF per kg)(Source: ISEE)

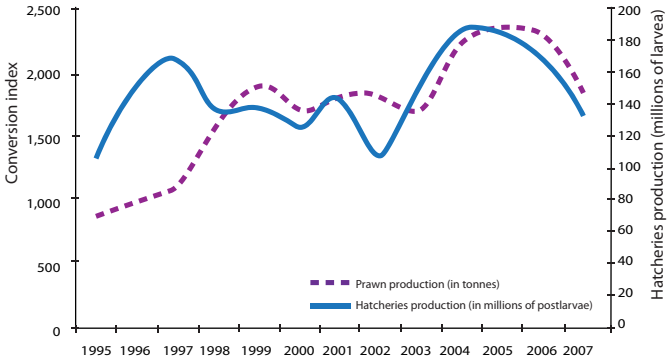
Japan is a wealthy market that clearly illustrates the industry's niche-market strategy. It is currently the most profitable, providing an average revenue of XPF 1,602 kg^{-1} (i.e. 37% better than other markets during the same period), although the sale price fluctuated significantly (–11%). The export price to Pacific countries[8] rose by 28%, but these markets only accounted for 9% of total export revenue in 2008.

The combination of declining export prices, production slump, and currently oversized processing plant led to a falling per-kilogramme purchase price at the plant, which fell on average from XPF 859 to XPF 744 between 2003 and 2008 (i.e. a decline of 13%).

The difficulties encountered by post-larval producers and farms…

➔ Post-larval shortage

Post-larval yields plummeted by 23% from 2004 to 2008. The steep yield decline, due to late seeding in production ponds, led to a major fall in farm operations and hence packing plant trade. Several hypotheses have been advanced to explain the significant post-larval shortage. The problems were caused by high pond temperatures (i.e. >30°C), particularly during the warm season and especially during the 2007/2008 production season. In more general terms, the root cause pointed out from the outset by operators was recurrently declining breeding stock fertility during the warm weather. Funds have been committed to resolve the issue and thereby ensure summer harvesting so as to make production more regular.



Production from farms and hatcheries (Source: ERPA)

➔ Disease leading to highly seasonal production

Yields have been affected by two diseases for several years (cf inset below) and these have spread to most farms, leading producers to opt for an annual production cycle so in order to avoid the cool season when mortality rates are particularly high. Approximately three-quarters of farm production was, therefore, conducted from December to June/July. Such timing was viable while prices and farm profitability were relatively high, but is no longer workable today. Although almost all farms seed their ponds only once a year, some seed a small surface area twice yearly to stagger their production.

Diseases affecting local farms

Two seasonal bacterial diseases affect New Caledonia's aquaculture, namely "winter syndrome", which appeared in 1993, and "summer syndrome" which appeared in 1997. Farms adapted to the first disease by shifting their production cycle to start after the cool season. Summer syndrome only affected a few farms, but did so severely. Both diseases lead to lower-than-normal survival rates and, therefore, a higher conversion index (CI). Experiments carried out by IFREMER in partnership with industry stakeholders on Aigue-Marine farm in Boulouparis, showed that the syndrome can be significantly mitigated by altering breeding protocols.

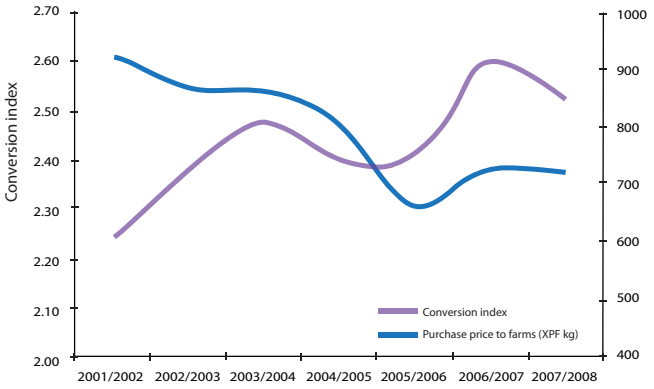
New Caledonia has so far been able to protect itself from major viral diseases that affect most prawn producers in the world, particularly in Latin America and Asia. When a Hawaiian stock was introduced to offset New Caledonian stock's low genetic variability and high inbreeding levels, the introduced stock proved susceptible to the IHHN virus, demonstrating how important it was to preserve and protect the local stock that is resistant to the virus. Once the Hawaiian stock was totally eradicated, the virus fortunately ceased to be a problem. UPRAC-NC adopted five resolutions to implement a programme for protecting the industry from disease and elaborating a genetic approach including a plan to re-introduce the Hawaiian stock as safely as possible.

… raise structural and profitability issues…

Packing plant capacities increased significantly while yields and prices were falling, leading to a considerable overall profitability loss to the industry. In addition, low survival rates were experienced largely due to disease. The average survival rate for the period 2000–2008 was low at 52%, and operators consider that below 50% the situation for farms becomes critical.

Conversion index (CI) trends (i.e. in the amount of feed required to obtain one animal unit), are good indicators of farm profitability because feed is the largest budget item, accounting for 25–30% of total production costs. This rose by 15% from 2001/2002 to 2007/2008, reaching CI of 2.5 in the latter season.

Industry operators consider a CI of 2 to be acceptable, and farms are aiming to reduce it in the short term to 2.4 (i.e. the average index from 2003 to 2006).



Purchase price to farms and conversion index (Source: ERPA)

… and weaken operators

The fact that farms concentrate their production into five months of the year requires the rest of the industry to operate seasonally. Hatcheries and feed suppliers who provide inputs have adapted to this, with hatcheries operating for seven months (from September to March) and feed suppliers experiencing a production peak in autumn. Such concentrated operations make the entire industry prone to any difficulty that any of the operators may encounter.

The post-larval shortage is a good illustration of this (cf. above).[9] The industry was able to overcome the crisis with government intervention through ERPA, which considerably increased its export assistance for farms, raising it twelve-fold from 2005 to 2008.

Also, for approximately seven months of the year (from August to February), the STANC packing plant operates at an average of 18% capacity, but close to full capacity for the rest of the year (over 80% in June). This seasonal pattern has a negative impact on the short-term payment of fixed costs and, more generally, on the whole industry's plant cost effectiveness. It also leads to a high dependence on seasonal labour.

Post-recovery policies and the industry's future prospects

Applied research

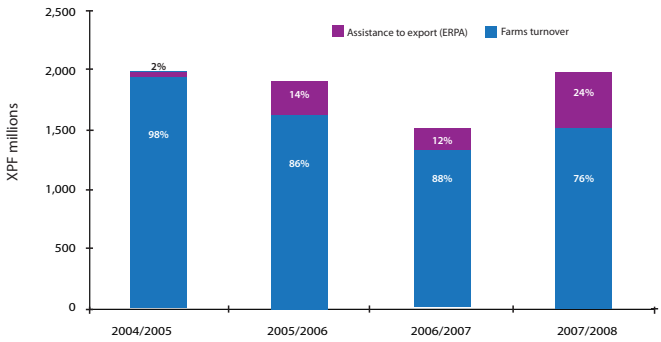
An experimental project entitled "Post-Recovery Experiments" aimed at conducting tests to mitigate summer syndrome in the short term by improving survival rates and yields was launched in late 2006 by the Groupement des Fermes Aquacoles (GFA) (aquaculture group) in partnership with IFREMER and Northern and Southern Provinces government departments. Experiments were carried out during the 2006/2007 and 2007/2008 seasons on Aigue-Marine farm that had been heavily affected by summer syndrome in the earliest stages of production. Results have so far been generally encouraging with both technical inputs and knowledge increasing significantly. It has been found that pond sediment richness plays a decisive role in lowering mortality rates.

The fact that the breeding programme has been shelved has, however, been disappointing for the industry as it promised progress.

Government impact on supply

➔ An industry heavily supported by government

Government assistance to the aquaculture industry increased sharply from XPF 400–900 million between 2007 and 2008. More than one-half of the assistance came from ERPA and the remainder from the Northern Province (38%), Southern Province (5%) and Territory (4%). Out of the total XPF 343 million of assistance provided by the Northern Province in 2008, 41 million was allocated to prawn farming proper, with most of the funding being earmarked for part of CCDTAM's (New Caledonian marine aquaculture development and transfer centre in Kone) preliminary construction costs.



Funding assistance to export and farm turnover (Source: ERPA)

In an attempt to mitigate recurrent post-larval shortages of recent seasons, a programme has been set up by ERPA to provide incentives to hatcheries to produce as many post-larvae as possible.

The industry also benefits from technical assistance in the form of research programmes conducted by IFREMER as part of the latter's partnership with the French, New Caledonian, Northern and Southern Provinces governments. The assistance programme is governed by a four-year contract between the various partners under the 2006–2010 development programme. Research mainly focuses on understanding the diseases affecting New Caledonian prawn farming, analysing the causes of low hatchery yields, developing optimised feed, and understanding prawn physiological phenomena and reactions in a farm environment. Through the partnership, the LAC (New Caledonian aquaculture laboratory) facilities in Boulouparis were restored, the first stage being completed in 2009, and a branch of the laboratory was set up in Kone.

➔ *Virtually no progress on tax exemptions for farm and hatchery start-up projects since 2004*

Tax incentives are provided for starting up aquaculture farms under the joint effects of the Girardin and Frogier Acts[10] (replaced in late 2007 by new overseas-country-based legislation[11]). The aquaculture industry was significantly developed with this assistance and now appears to be dependent on it. The per-hectare investment cost is high owing to rising overall costs of excavation and civil engineering works, the complex facilities required and the observance of environmental constraints.

Since 2004, only one project, which involved restoring a hatchery, was approved. If other projects are set up, they may contribute to developing the industry.

The industry's niche-market strategy

Obtaining quality certification is crucial to a high-added value, niche-market strategy. The blue prawn marketed by SOPAC was well received by buyers, because it had been awarded several quality certificates and SOPAC is currently attempting to gain the "red label". In order to find other more profitable market outlets and to promote New Caledonian prawns as a luxury produce, SOPAC has also launched a high-end prawn, which has been adopted by several leading Parisian chefs and accounts for about 15 tonnes of the local yearly yield.

Conclusion

Prawn farming has been practised for 30 years in New Caledonia and has developed significantly up until the early years of this century. It was able to acquire the techniques and know-how to expand and produce a quality product that has received worldwide recognition. The industry currently has excess processing capacity and is suffering from over-investment in addition to a structural problem caused by high prawn mortality rates and a highly seasonal production cycle that hinders significant development. Low survival rates have had a considerable impact on farm cost-effectiveness. The recession has deepened in recent years, with hatcheries under-producing, underlining the whole industry's currently fragile state and, as a result, government has significantly increased its assistance. For the time being, however, the industry's critical situation is no incentive for funding new projects.

There are, nevertheless, ways out of this difficult situation and some such avenues have been explored for several years now. Initially, the prime objective is to strengthen post-larval production and enable farms to return to yield levels that will ensure sufficient volumes for marketing. It is vital to hold on to traditional clients, avoid losing the ground gained by the search for new niche markets, and promote New Caledonian prawns as a luxury produce.

With new nickel smelters being built in the territory, diversifying the economy is a critical issue and prawn farming is a sustainable source of income and employment for the rural population.

The blue prawn (Litopenaeus stylirostris). *Image: Jacky Patrois*

1 Based on *Litopenaeus stylirostris*, also known as "blue prawn".
2 XPF 100 = EUR 0.84 (or USD 1.15 or AUD 1.15 in January 2011)
3 Source: ERPA (agricultural price regulation body). This figure only covers sales by all farms, except Bassins de Dumbéa, to the packing plant and direct sales on the local market. It does not, therefore, include packing plant and hatchery income that, taken together, would double the industry's turnover.
4 Sources: ISEE (New Caledonia institute of statistics and economic studies) and DAVAR (New Caledonia directorate of veterinary, food and rural affairs).
5 Source: FAO (Food and Agriculture Organization of the United Nations).
6 Société de Transformation Aquacole de Nouvelle-Calédonie (New Caledonian aquaculture processing company).
7 Société des Producteurs Aquacoles Calédoniens (New Caledonian aquaculture producers' company).
8 Australia, New Zealand, Tahiti and Wallis and Futuna.
9 Unité Néo-Calédonienne de Sélection et de Promotion des Races Animales (New Caledonia unit for the promotion and selection of animal breeds)
10 The Frogier Act, ie Overseas Country Act no 2002-019 of 29 April 2002
11 Overseas Country Act no 2008-1 of 3 January 2008 on tax incentives for investment purposes.

A successful first harvest from milkfish aquaculture project in Fiji

By Tim Pickering (SPC Inland Aquaculture Officer)

Following up on an earlier report in Fisheries Newsletter #132 about a new community-level milkfish aquaculture project for food security in Fiji, we now report on the successful harvest of milkfish from the project's first pond cycle on 23 December 2010, just in time for Christmas.

The Vitawa Aquaculture Development Project at Vitawa Village in Ra Province was launched in March 2010 as a collaboration among the Japan International Cooperation Agency, Fiji's Department of Fisheries, and the Vitawa Village community. The project is a capture-based culture trial using milkfish caught as small fingerlings on intertidal mudflats in the surrounding area. Technical advice was provided by Hideyuki Tanaka of the South Pacific Liaison Office for Fisheries and Aquaculture International. The project aims to be as low-tech as possible, as a low-cost way to increase the amount of fresh fish available to villagers.

In the first partial-harvest on 23 December, over 1,000 fish (approximately 300 g each) were netted from the main pond drainage channel by village youth under the supervision of the Minister of Fisheries, Joketani Cokanasiga, other visiting dignitaries, and the entire village. Some of the fish were immediately prepared for a *magiti* (feast) for visitors, while the remainder were distributed among village households. There were many requests to buy fish from the harvest; however, the priority at this time was for villagers to enjoy the fruits of their labour in the project.

The first pond cycle encountered some initial problems, including low water pH due to an acid-sulphate soil, which repeated pond use over time will correct. Another issue was high water salinity (more than 50 ppt) due to considerable sunlight and low water exchange, which pond managers can, in the future, take steps to ameliorate as they gain experience in pond water management. Unstable plankton blooms resulted in the need to purchase some supplementary feed in the form of commercial pellets, a situation that the project hopes to avoid in the longer term through careful pond management and low stocking density, which will allow fish to grow entirely on natural feed in the pond.

SPC's fish-pond economic decision-making tool software is being used by the project's managers in order to assess the economics of this type of milkfish farming.

For those interested:

SPC's fish-pond economic decision-making tool software is available as a free download from the Aquaculture Portal website at:

www.spc.int/aquaculture.

Fiji's Department of Fisheries officer Mr Senikau holds up two of the milkfish harvested, to show that they have reached a good eating size.

Vitawa Village youth netting the first partial-harvest of milkfish from the drainage channel of the culture pond system.

Acoustic training of fish

Adapted from an article in Star Oddi Newsletter, Issue 7, October 2010 (http://www.star-oddi.com/news/newsletters/issues/2010/10/20/default.aspx)

In traditional fisheries, great energy consumption is required to catch fish by trawling, and there is a high risk of catching bycatch when using longline fishing gear. The question arises whether it might be feasible to use knowledge about fish behaviour, social learning and acoustic training to aggregate fish, and entrap them with minimal energy requirement and with the possibility of sorting out and releasing all unwanted bycatch without mortalities.

Fish are particularly sensitive to low-frequency sounds and can detect sounds coming from several kilometers distance. However, the fish do not come to the sound source unless they are rewarded, for example, with food. Bjorn Bjornsson at the Marine Research Institute of Iceland carried out a study find out how long it would take to train cod to come to a specific feeding location as a response to a sound signal. He also looked at how much this training time could be reduced in the presence of "teachers". The experiments were carried out in a sea cage in northwest Iceland.

Two feeding platforms were placed inside the cage, one on each side. Pipes were used to deliver the feed from shore to each platform with a seawater pump. An underwater video camera and sound source were placed at each of the feeding platforms. The sound source included a special buoy that was developed by Star-Oddi, a product named FishCall.

The results showed that it took one week to acoustically train 20 naive cod, but less than two days to train 19 naive cod accompanied with one trained cod. It is hypothesized that acoustically trained fish released in the open sea will swim between two feeding stations equipped with FishCall, leading a school of wild fish into a trap and thereby facilitating the capture or ranching of wild fish.

New Pacific tuna regulations to protect resource
Greater revenues, smaller catch envisioned

By Giff Johnson

***Source:** Marianas Variety, 9 November 2010 (www.mvariety.com)*

A new licensing system for longline fishing vessels in the Pacific will go into effect on 1 January 2011, the latest in a series of measures from the Parties to the Nauru Agreement (PNA) to generate more revenue for the islands while cutting catch levels.

Longliners target bigeye tuna, a lucrative catch for the voracious sashimi markets in Asia but one that scientists warn is being heavily overfished. The eight PNA island nations control waters where the bulk of the Pacific's USD 3 billion annual tuna haul is caught. Until recently, they've focused on the purse-seine industry whose fishing vessels use a massive net to catch skipjack tuna that is used for canning.

Starting in January, the PNA countries will no longer sell licenses for individual longline vessels, which use hooks and lines to catch tuna.

Instead, PNA is shifting the boats to a "vessel day scheme" that sells a limited number of days to fishing companies that are based on size and sophistication of vessels.

The new vessel day scheme, or VDS, for longline fishing boats is "aimed at stimulating domestic development of the longline fishery, enhancing PNA's control of tropical long line fisheries, and is further testament to PNA's role in ensuring effective conservation and management of this fishery," said PNA Director Dr Transform Aqorau, who is based in Majuro at the PNA headquarters.

But Aqorau blasted the foreign flagged longline industry, saying that it has failed to provide tuna catch data for the past five years, and also criticized the Western and Central Pacific Fisheries Commission for lack of support for islands attempting to develop their domestic fishing industries.

A VDS for purse seiners went into effect last year. But this is the first major change in the licensing regime for the longline fleet, which numbers more than 1,000 boats in the region.

Five years ago, PNA agreed with fishing nations to set longline vessel catch limits by country under which the vessels were flagged, a scheme Aqorau said PNA only partially agreed with but accepted because of an urgent need to bring some regulation and sustainability to an out-of-control segment of the Pacific tuna industry.

But part of the agreement was distant-water fishing nations were to provide catch data as part of helping with stock assessments for the long-term viability of the big eye tuna industry. "There has been no effective verification or monitoring of longline bigeye catch limits, Aqorau said. No major longline state has provided the operational catch and effort data that they are obliged to provide and which is essential for verification, and no progress has been made on a catch documentation scheme. This means that the flag-based bigeye catch limits are an ineffective sham."

Aqorau said there has also been a lack of encouragement by foreign fishing interests for the small island developing states attempting to develop their domestic fishing operations.

"PNA leaders have had enough of selling licenses and being observers", said Maurice Brownjohn, PNA's commercial manager. "We need more participation in jobs, manufacturing, and joint ventures." While PNA has made some headway in this, it is meeting resistance from a number of foreign fishing nations wanting to maintain the status quo.

"There have been systematic efforts by the Western and Central Pacific Fisheries Commission Secretariat and the United States to remove the modest benefit provided by an exemption for small island nations to fish for bigeye without proposing an alternative form of recognition of sovereign rights of PNA members to develop their domestic longline fleets, even though the United States has demanded an exemption from bigeye tuna catch cutbacks for its own fleet," Aqorau said.

Unfinished business remains as WCPFC meeting ends

By Anouk Ride - Communications and Media Officer, Pacific Islands Forum Fisheries Agency

Source: *FFA Press release (http://www.ffa.int/node/431)*

When the Western and Central Pacific Fisheries Commission (WCPFC) annual meeting closed on 10 December 2010, Pacific Islands Forum Fishery Agency (FFA) members said there was unfinished business that the Commission needed to address next year. While FFA members made advances on some technical issues, there were no decisions made on the critical issues of overfishing of bigeye and yellowfin tuna, catches of whales and dolphins, and adequate severity of punishment for illegal fishing. Pacific Island countries are the custodians of the last remaining healthy tuna stocks in the world and manage a marine area of 30 million square kilometres, supported with technical advice and services from FFA. FFA members participate at the Western and Central Pacific Fisheries Commission along with other fishing nations (Asian nations, European Union and the United States) to set rules for fishing in the western and central Pacific Ocean. Much of the debate around overfishing of bigeye tuna centred on proposals that would freeze the number of boats at their current levels in a way that cements the rights of foreign fishing nations that come and fish in the Pacific Islands. FFA members instead pushed for measures that would cut the level of fishing of bigeye tuna, while preserving their rights as small island developing states to develop their fisheries. The WCPFC's conservation and management measure on bigeye and yellowfin tuna needs to be renegotiated at the next WCPFC meeting, in December 2011.

FFC Chair Sylvester Pokajam said:

"FFA members are committed to delivering a package of measures in 2011 that would maintain the critical tuna stocks at sustainable levels. FFA members are proud of the leadership role that we played in 2007 and 2008 that led to the eventual adoption of the current conservation and management measure on bigeye and yellowfin tuna that included some world firsts such as cuts to overfishing, closure of some high seas areas, and controls on fish aggregating devices (FADs) and associated catch of juvenile tuna. We urge all WCPFC members to support taking these initiatives forward to develop a measure that will cut overfishing and ensure sustainability of our vital tuna stocks".

Other outcomes of this year's WCPFC include:

- High seas areas: The Cook Islands' proposal for a special management area in the eastern high-seas pocket was accepted by the WCPFC. The PNA[1] proposal to seek WCPFC support for their closures of high-seas areas was rejected, although it will go ahead as a condition of licences for fishing in PNA waters.
- South Pacific albacore: WCPFC members agreed to report about their implementation of the South Pacific albacore conservation and management measure, as proposed by FFA members.

- Illegal fishing: FFA members pushed for amendments to conservation and management measures to make sure prosecutions and penalties for illegal vessels are to the satisfaction of the state where the vessel committed the offences (this follows the experience of Tonga in 2008, which argued at WCPFC meeting that a foreign fishing nation's penalties for a vessel found fishing illegally in Tongan waters was not adequate – see www.youtube.com/pacificislandfish for details of the case). The issue is to be further discussed at the next meeting of the Technical and Compliance Committee (TCC) meeting of the WCPFC in 2011. Another FFA proposal to reduce time limits on presentation for vessels for the vessel blacklist was successful (so vessels can be presented 70 days before the TCC).
- Whale sharks, whales, dolphins: FFA and PNA proposals to ban purse-seine setting on whale sharks, whales and dolphins was not approved by other WCPFC members.

1 The Parties to the Nauru Agreement (PNA) include the Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Palau, Papua New Guinea, Solomon Islands and Tuvalu. The Nauru Agreement is a subregional agreement on terms and conditions for tuna purse-seine fishing licences in the region.

NOAA approves unpopular catch and trade policy for US fisheries

by Wenonah Hauter, Executive Director, Food and Water Watch

Source: *Food and Water Watch press release (http://www.foodandwaterwatch.org/pressreleases/)*

On 4 November 2010, to the dismay and outrage of fishermen and consumer advocates around the country, the National Oceanic and Atmospheric Administration (NOAA) officially announced the completion of its new catch shares policy, which encourages the privatization of US fishery resources. Also known as "catch and trade", these programs have been criticized as having similar problems as the cap and trade effort to reduce air pollution.

At its essence, catch and trade is a means to allow almost complete control of our fisheries by bigger business interests. It divides up the fish in any given region and doles them out as shares to certain companies and individuals based on past fishing history. While this may sound fair, in reality it often forces smaller historic fishermen out of the industry, skews fisheries toward industrial production, and decreases job opportunities and wages for crew, leading to widespread devastation in coastal and fishing communities.

NOAA announced its official policy on catch and trade after having already enacted the programs on the East, West and Gulf coasts, where countless fishing operations are slowly being pushed out of business. The legality of the catch and trade model is being challenged in three major lawsuits, one in each region where new programs have been finalized: California, Massachusetts and Florida.

What NOAA failed to announce publicly is that catch and trade programs were already ruled a human rights violation in Iceland in 2007, when the UN Human Rights Committee determined that they violated international law and the rights of fishermen by transforming a public resource into individual property.

Unfortunately, NOAA has been establishing catch and trade programs across the nation for some time now, despite global evidence that they often hurt, not help, both fisheries and consumers. The quality of fish often decreases as industrial-scale vessels increasingly dominate the industry. Fish can be crushed through mechanic sorting and by being pulled up in large nets with thousands of other fish. Fish are then processed en masse – sometimes shipped across the world to places with lower food safety standards – for filleting and packaging before they are shipped back to the U.S. for sale.

It is shameful that NOAA is championing private interests rather than doing its job to ensure healthy fish populations, stable fishing communities, and quality seafood for consumers. Recreational and commercial fishermen have spoken out against catch and trade but NOAA refuses to listen, opting instead to push toward consolidation of US fisheries until they become like factory farms on land — large industrial operations that bring profit to a few at the expense of many.

For more information, see Food and Water Watch's 2010 report "Catch and trade catastrophes: Failures in fishery quota programs" [http://www.foodandwaterwatch.org/fish/fair-fish/catch-and-trade-catastrophes/]

Letter from Mr Able Seaman, Pacific Islands crew member onboard Alienlandic purse seiner, *Sweep the Ocean*

Introductory note by Peter Sharples, SPC's Observer Support and Development Coordinator

"I am employed by SPC's Oceanic Fisheries Programme to advise tuna fisheries observer programmes throughout the Pacific Islands region, to train those observers and to coordinate and participate in some areas of data quality control, most notably the process of debriefing observers after they have completed trips onboard fishing vessels that are most often foreign to the country that the observer is from. For this, I travel extensively and cross paths with many Pacific Island fisheries observers and some crew members. I hear many stories, and sadly, more tend to be stories of woe than of good things, but then that is the nature of humans – to complain – and without doubt, observers work in difficult situations and often in very uncomfortable environments. They need to let off a bit of steam, and … I tend to be as guilty as many others of being "too busy" to follow up. For the story that follows, it turns out that I was no better but the extra efforts that the crewman went to, to ensure that his story gets told may yet pay off.

A few years back now, I was given this letter by a Pacific Islands observer who was asked by a Pacific Island crewmember on a Taiwanese purse seiner to please pass it on. The observer did but sadly, I never did – it was one of those things that got lost in the "to do" list between missions. However, as I was about to begin another observer training workshop at the time, I edited the letter to use as a training aid article of interest. I recently came across this version, buried in my files and it seemed like a suitable accompaniment to some of the other articles in this issue of the Fisheries Newsletter. The edited version has the names and other means of identity changed, and the grammar tidied up a little. But otherwise, the message to Pacific Island politicians, fisheries managers and others remains exactly as told by this Pacific Island crewman."

I have spent most of my sea time as an able fisherman, usually isolated from authorities. I take this great opportunity to explain my situation on behalf of other Pacific Islanders crewing onboard foreign fishing vessels. I thank the fisheries observer, Mr Seemore Carefully, employed by the Responsible Fisheries Authority, for allowing me this chance to express the concerns and comments on behalf of Pacific Island crew members onboard the vessel Sweep the Ocean.

There are four of us from Pacific Island countries. There are also five Vietnamese and the rest are mostly Chinese and Alienlandic. We, the Pacific Islanders, are currently working onboard this foreign fishing vessel as deckhands. We earn an average salary of USD 270.00 per month that is accredited to our individual accounts for the duration of our employment contract, which started 4 April 2003 ending 3 April 2004.

While being employed by this foreign fishing vessel and fishing in our Pacific waters, I feel that I am actually fishing in foreign waters, not my own Pacific Island waters. This is because foreigners who have been sweeping up the fish across the Pacific are labouring Pacific Islander crews almost to slavery in their own backyard and leaving scars that may not ever heal. They are polluting our waters, overharvesting our Pacific tuna resources and killing so many other species commonly referred to as "bycatch". Having worked for about 10 years onboard various foreign fishing vessels that employ Pacific Islanders as crew, I feel very embarrassed to say that we slave at great risk and uncertainty for just a little cash in return.

I understand that our Pacific Island countries may not yet have the technology, skills and ability to invest more in their own domestic fishing vessels, but in the meantime, more effort should be put into supporting fishing companies that are willing to recruit more Pacific Islanders as crew and who treat those crew fairly and with dignity.

The fact is, our island countries are probably feeling proud that their countrymen work onboard foreign fishing vessels. Our politicians boast that it boosts our local economy by providing employment to local Pacific Islanders, but which of them has had the initiative to check on the working environment, treatment, and salary of their countrymen who risk their lives for so little money to be able to feed their families and loved ones back home. Why can't we just quit this painstaking job? Well, our governments function on low budgets. Job opportunities, even for people with a good educational background, are limited, leaving us no options but to accept laborious employment with foreigners.

There are many Pacific Islanders who have worked 15 years or more on purse seiners and longliners, moving from boat to boat developing skills to become very able seamen but who still labour as deckhands, the lowest rank onboard vessels, without promotion or increase in salary simply because the foreigners use rank to dominate Pacific Island crew. It is unique to find a Pacific Islander that ranks over a foreigner.

Another aspect is safety. Recently, news has circulated among Pacific Island crewmen onboard foreign fishing

vessels about two Pohnpeian crewmen that went missing from a Alienlandic longliner in Papua New Guinea's East New Britain Province. Stories such as these have a most discouraging and disturbing effect, contributing a great deal to the insecurity that Pacific Island crews must be feeling. Such a report dwells and lingers with us in every corner of the ocean, haunting us to live in fear, even though we fish in our own waters. We do so knowing vast waters prevent us from communicating with our brothers, uncles and fellow islanders that could protect us and/or speak on behalf of our safety and comfort. We work in a situation where one lives under strict orders and should the orders be disobeyed or hindered, the penalties are harsh. Anything can happen to us out here and nobody will be able to tell what really happened.

My final wish is that our Pacific Island countrymen recognize that being crew onboard foreign fishing vessels is a difficult lifestyle. More strongly, they must realize that such employment is next to slavery. All we want is to work and provide for our families the best way we can; however, to risk our lives for meagre wages is not what we had in mind. I kindly ask that our governments' appropriate authorities closely monitor the activities of the licensed fishing vessels and whatever circumstances may arise in the fishing grounds. We would rather struggle for the benefit of our own people and our nations rather than work as slaves to others who treat us like dirt in our own territory.

Thank you for your thorough consideration!

Tuna longliners like this one, on which Pacific Island crew are sometimes employed, can spend months at sea before returning to port

Fisheries centres in the Pacific Islands: Lessons learned?

Robert E. Gillett

Gillett, Preston and Associates Inc. (gillett@connect.com.fj)

Introduction

Numerous schemes have been used over the years to promote the commercialisation of fisheries in rural areas and outer islands of Pacific Island countries by using fisheries centres. These facilities go by a variety of names in the region, including community fishing centres (Tuvalu), coastal fisheries stations (Papua New Guinea), fish bases (Marshall Islands), and rural fisheries service centres (Fiji).

These centres have various functions, such as ice making, serving as a collection points for fish transport to markets, mechanical repair, and a base for fisheries extension activities. In addition to promoting commercial fisheries development in rural areas, the wider objectives of fisheries centres have included improving cash incomes, mitigation of rural–urban drift, and diet enhancement.

Fisheries centres have assumed a very important role in Pacific Island countries, and are often the largest government expenditure in the fisheries sector and/or consume a substantial portion of overseas aid. In addition, considerable rural fisheries development in the region is predicated on these centres, and many are planned for the future.

A report by the Secretariat of the Pacific Community (SPC 2004) states: "The commercial success of rural fisheries centres, with either private sector or fishermen's associations/cooperatives management, is viewed as fundamental to having small-scale commercial fisheries play a positive role in the rural economy." These features combined suggest that a review of the lessons learned from establishing and operating fisheries centres could be a valuable exercise.

This brief study is undertaken from the perspective of guiding future initiatives dealing with fisheries centres. The objective is not to decide the value of the centres or whether it is appropriate to build more. The scope of a cost–benefit analysis, including social aspects, would be well beyond the three days dedicated to the present study.

By necessity, much of the information used in this study is anecdotal. Because most of the documentation on fisheries centres is purely descriptive, this exercise relies heavily on the experience of individuals familiar with fisheries centres in several countries. The 20 people mentioned in the acknowledgement section below contributed their ideas on lessons learned from fisheries centres in the region.

Country involvement with fisheries centres

The available documentation shows that most Pacific Island countries have had major involvement with fisheries centres.

Cook Islands: Fisheries centres were established on Palmerston Island in the early 1970s, on Penrhyn in 1982, and on Rakahanga and Manihiki in the early to mid-1980s. Most centres were closed within a couple of years due to poor maintenance of machinery, low catches and transport problems getting the catch to market (Chapman 2004).

Fiji: There are currently five rural fisheries service centres (Wainikoro, Levuka, Kavala, Vanuabalavu, Lekeba). A major component of the Department of Fisheries' strategy for rural fisheries development in the next decade is the use of rural fisheries service centres (ADB 2005; and Department of Fisheries 2009). There was an earlier wave of fisheries centres in the early 1970s.

Kiribati: Over the last 30 years, several aid-funded projects have attempted to set up fisheries centres on outer islands. A number of these centres have closed and been abandoned for lack of business management skills, maintenance capacity and commitment by local communities and government agencies. Four out of six established in the 1990s with European Union (EU) aid were still operating in 2007. The latest programme, supported by Japanese aid, has now established centres at Beru, Onotoa, Tamana and Arorae (ADB 2008).

Marshall Islands: Seven outer atoll fish bases were established using Japanese and government funds. These bases are at Arno, Likiep, Ailinlaplap, Namu, Aur, Maloelap and Jaluit atolls (McCoy and Hart 2002).

Papua New Guinea: One of the largest publicly-funded fisheries development activities in the 1980s was a proposal to establish 20 coastal fisheries stations around the country, separated by distances of about 120 miles, and each equipped with ice-making (5 t/day), freezing (1 t/day), and cold storage (20–30 t) facilities (Preston 1996). About 13 fisheries stations were actually established under the programme, operating 10 large fish transport vessels and at least 50 smaller collection boats. By 2005 all but one station was out of business.

Solomon Islands: Thirty fisheries centres and subcentres were established over the years in the

provinces under technical assistance from Japan, the United States, EU, Canada and The Nature Conservancy (Boape 1999). These centres, generally equipped with ice-making and/or cold storage plants, were intended to serve as market outlets (for fish caught by rural fishermen), sell fishing gear, and provide training in new fishing techniques and improved catch handling. Most centres fell into disrepair as soon as aid funding ceased, mostly in the early 1990s.

Tonga: The general scheme for outer islands fisheries development is based on a model of having fisheries centres that provide numerous fisheries-related functions, including the provision of ice to fishers. Several centres have been established, including three in Ha'apai, using funding from Australia and Japan (Cusack 1998).

Tuvalu: Community fishing centres have been established on each outer island, starting with Vaitupu (Japan funded, about USD 1.4 million), and then Nanumea and Nukufetau with funding from Australia (Anon 2004).

Vanuatu: Eleven EU-funded rural fisheries centres with ice making facilities were established under the Village Fisheries Development Project in the 1980s and were revived in the early 1990s (Hickey and Jimmy 2008). When EU money ran out in the mid-1990s, the Fisheries Department decided to privatise them. Since 2003, additional fisheries centres have been established in seven locations.

Observations

Around 150 fisheries centres have been established in Pacific Island countries in the past few decades. One of the most remarkable features of fisheries centres in the Pacific Islands region is that few, if any, have been commercially viable. Some documented examples are:

- Tuvalu: Community fishery centres in the outer islands — intended to promote fishing as an income earning activity — are mainly lying idle, while still receiving a costly annual subsidy (Ministry of Natural Resources 2008).
- Solomon Islands: A 1998 review concluded that the centres were not financially viable, and would probably be unable to sustain operations after the EU project's conclusion unless some other form of support could be arranged (Preston et al. 1998).
- Papua New Guinea: A study in the mid-1990s (Preston 1996) concluded that "the six stations for which published data are available only managed a collective throughput of about 600 tonnes during their best-ever year. The profit from such a product volume would probably be insufficient to cover the true economic cost of even one station if it were being run on a fully commercial basis". The same author also noted that making a profit was never stated as an objective of any of the coastal fisheries stations, and project documentation discusses the fish processing operations of the stations not in terms of profit, but what would be an acceptable level of subsidy.
- Vanuatu: None of the centres or satellites in the rural areas produce enough fish to create an adequate surplus of cash to cover the costs of the infrastructure. Thus, the long term viability of the centres hinge on the physical ability and willingness of the existing fishermen to spend approximately double the time fishing for the same net income (Lindley 1993).

The above comments on economic viability do not imply that the centres have been a waste. On the contrary, many centres have provided valuable services to the communities in which they were established (e.g. increasing cash income, generally improving standards of living) and to the wider society (e.g. helping to stem rural–urban migration, increasing domestic fish supplies). These social objectives are far less amenable to quantification than financial performance, and are likely to be less-appreciated by non-villagers. There is also the perception among coastal and outer-island communities that, because governments support schools and health centres in rural areas, there is strong justification for support of fisheries centres.

Having emphasised the important objectives of fisheries centres other than commercial viability, several financial points should be stressed. After all, few objectives of any kind are being accomplished by centres that have closed down due to being too expensive a burden on sponsors.

- Many, if not most, centres were established with the expectation (on the part of governments and recipient communities) that the centres would be profitable or at least not a financial burden.
- The insertion of fisheries centre infrastructure into a rural community typically does not alter the underlying economics of catching fish in isolated locations and marketing them in urban areas.
- "Handing fisheries centres over to island councils or provincial governments" is often the solution when national governments feel burdened by ongoing expenses of centres. In many cases, it is really dumping the centres on communities that cannot afford to provide the required subsidy.

Many of the fisheries centres have experienced similar difficulties. Box 1 summarises the problems identified by three country reviews, many of which are common to fisheries centres across the region.

One of the most expensive components of a fisheries centre is the production of ice. Quite simply, the making of ice in remote locations is inherently expensive. Careful planning for ice production can have a large positive effect on the expense of running a fisheries centre. The region has accumulated decades of experience on the use of ice in small-scale fisheries, but the collected wisdom (some points are given in Box 2) is not often used when planning for fisheries centres.

Box 1. Difficulties of fisheries centres identified in three reviews

Papua New Guinea: A review of four stations (Lorengau, Kimbe, Tufi and Kupiano) concluded that these were over-capitalised, under-utilised, economically non-viable, providing only minimal benefits to village communities, and incurring excessively high production and marketing costs in handling frozen fish. Principal difficulties associated with the stations were identified as:

- Modest landings due to motivational constraints associated with villages having conflicting agricultural and social obligations and disruption in collection schedules because of vessel breakdowns.
- High fixed costs of station operation, particularly in regard to energy requirements, because of the scale of freezing and frozen storage capacity and over-large collection vessels relative to the low throughput.
- Expensive and complex distribution systems for frozen products derived from isolated areas.
- Insufficient emphasis on the needs of urban markets, which demonstrate a clear preference for fresh rather than frozen product.

Solomon Islands: Situations in which the private sector does not make use of natural resources — despite their apparent abundance and accessibility — may be the result of the operation being fundamentally unprofitable or financially unattractive. In Solomon Islands, the private sector has been capable of fishing high-value, non-perishable marine resources almost to commercial extinction. The fact that this has not happened with fresh fish and seafood is not necessarily because the private sector lacks initiative, funds, knowledge or technology, but may also be because there is not very much money to be made. Even where there is commercial potential, the assumption that an aid donor can invest some money in infrastructure, equipment and training and then walk away after a relatively short period leaving behind a going commercial concern, may be over-optimistic.

Marshall Islands: The Japanese-funded fish base at Buoj, Ailinlaplap, was opened in 1994 at a total cost of over USD 2 million. The primary purpose of the facility is to supply fresh reef fish at low cost to residents of Ebeye Island at Kwajalein Atoll, and secondarily, to provide a means of supplementing income for Ailinlaplap residents. Precise data on catch values are available only for 2000–2001. Benefits to Ailinlaplap as a whole seem small, averaging only USD 1.57 per capita annually for 2000–2001, given the considerable infrastructure and operational costs of the fish base. Some of the major difficulties experienced were:

- Maintaining transport to markets increased with the age of the project due to increased maintenance requirements of vessels used.
- Producers' expectations of significantly higher incomes could not be met.
- Access to remote areas by outboard boat was required to produce sufficient quantities for sale

Sources: Preston et al. 1998; Preston 1996; McCoy and Hart 2002.

Box 2. Lessons learned in refrigeration for small-scale fisheries

Over 20 years ago, SPC surveyed small-scale fisheries refrigeration of the region. Many of the practical approaches to improving freezing and ice making remain valid today – and are certainly applicable to fisheries centres. The survey report offers several suggestions that are especially helpful, including:

- **Proper scale:** Characteristically, in planning for the fisheries product throughput of a refrigeration plant in a remote location, optimism results in over-estimates. The larger the capacity of the plant, the greater the financial burden if production is not as large as expected.
- **Compartmentalisation:** This concept involves the use of multiple (preferably identical) freezing units at a site, rather than a smaller number of larger units. Under-utilisation of capacity can be reduced by shutting off units as required. Because the parts are the same, one functional unit can sometimes be made from two or more broken units.
- **Capital expenditures:** Recurrent costs of refrigeration units can be reduced by larger initial capital expenditure. In the case of an aid-funded project, this may be desirable in order to minimise the subsequent cost to a recipient country. The capital costs of, for example, enhanced insulation or a large stock of expendable parts will be repaid by reduced operating costs.

Source: Preston and Vincent 1986.

Arno Fisheries Centre, Marshall Islands

Many fisheries specialists in the region believe that a fundamental problem of fisheries centres (and one that has an impact on operational costs) is "appraisal optimism": over-estimating the throughput of fishery products and under-estimating operational costs. Three individuals with substantial experience with fisheries centres in the region offered their perspective on the situation (their names have been purposefully left off):

- "The aid projects/fisheries departments cooked the figures when they did the economic justifications for the centres."
- "Administrators and/or politicians in the capital who plan or seek funding for the outer island fisheries centres are often former residents of those islands and in many cases their perceptions of fishery resource abundance in those places is often formed by nostalgic recollections of high abundance."
- "The major donor for fisheries centres in the Pacific has a process in which a commitment for a centre is made to a government, and then the feasibility study is carried out, rather than the other way around."

The reality is that the centres' suppliers, mostly subsistence fishers, characteristically produce subsistence quantities of fishery products. Appraisal optimism results in many fisheries centres in the region being too large for the likely production and, therefore, more costly to run than what is required. As explained by an SPC masterfisherman: "Most of the rural fish centres I've come across in the region are too big and unnecessary for their operations. There is a lot of wastage in terms of electricity...Operations and maintenance costs to run these centres are very high, mainly because they are too big for what's required."

The sites chosen for centres are critically important. In general, the more isolated the centre, the higher the operational costs. From a social perspective, remote communities are likely to benefit the most from a functional fisheries centre. On the other hand, a centre with good transport to a not-too-distant urban market is more likely to be viable (or require less of a subsidy). In siting a fisheries centre, viability must be reconciled with welfare objectives.

Another consideration is that a site that has the right conditions with respect to viability also may have the private sector involved in trading fish. Although most governments in the region are committed to private sector development, at the level of the fisheries sector there is still room for disagreement:

- "If the private sector is already successful at doing something in the outer islands the Fisheries Department trying to duplicate the service or products can be very counterproductive." (fish trading company manager)]
- "According to the Acting Principal Fisheries, the centre will also do away with the problem of middlemen." (Fiji Government Online, 15/4/2003)

Another observation is that at least one important donor supporting fishery centres has selectively provided long-term support. In Kiribati, the Japanese built several centres in the 1990s and have continued to do maintenance and replace generators and ice machines

as needed since the beginning to this day (M. Savins, Managing Director, Teikabuti Fishing Co. Ltd., pers. comm., September 2010).

In cases where a government or donor is committed to long-term subsidies for a fisheries centre, overexploitation of inshore fishery resources can be an issue. In extreme cases, centres that were intended to help disadvantaged rural communities resulted in a reduction of food fish for those communities. SPC (2006) reported concerns over fish depletion in the areas near Arno and Likiep fish bases in the Marshall Islands. An ADB report (2005) commented on Fiji's Wainikoro fisheries centre: "the present efforts to counter possible over-exploitation of inshore fishery resources appear to be fairly weak: some plans to eventually encourage offshore fishing, and some attention to establishing a marine protected area. The present managers of the Wainikoro centre indicate that they are unable to even avoid buying fish that contravene fisheries legislation." As stated by an SPC Fisheries Development Officer: "Establishing fishing centres is, in a sense, moving the overfishing problem to fishing areas around the centres."

Applying past experiences

Reflecting on the overall situation, in the outer islands business conditions are typically very difficult, logistics are horrendous, and the people/agencies that operate the fisheries centres rarely have much business experience. On the other hand, the various options for a government to improve the welfare of residents in the outer islands are quite limited — and promoting the fisheries trade through fisheries centres in many cases may be the best opportunity. The appropriate strategy to develop the opportunity obviously depends on local and national conditions, but effectively applying past experience in the planning and operation of centres is likely to improve benefits and reduce required subsidies. Some of the lessons learned with regard to fisheries centres in the region include:

- In the absence of unusually favourable conditions, it is unlikely that the operation of a fisheries centre will be profitable. Provision for a long-term subsidy is required in the planning process and should be reflected in the donor and/or government budget. In general, the more remote the location, the larger the subsidy required.
- In planning for a fisheries centre, it should be made very clear to residents in the recipient community that the centre will require substantial financial support. They should also be made aware that, historically in most Pacific Island countries, the burden of providing that support in the medium to long term has fallen on the communities that receive centres. "Handing the centre over to the island council" may not be as wonderful as it sounds.
- Some features of the planning process and centre design can reduce the level of subsidy required for a fisheries centre. One of the most important is a realistic and objective assessment of the likely fishery product throughput of the centre. Going further, a second opinion on such an assessment could improve the current situation in which many existing centres are simply too large and more costly to operate than necessary.
- Careful attention to the refrigeration aspects of a fisheries centre project could also reduce required subsidies. Box 2 above shows some simple practical measures for reducing cost of producing ice.
- The fact that recurrent costs of operating a fisheries centre can be reduced by larger initial capital expenditure, should be taken into consideration in the planning stage, especially for a centre funded through an aid project.
- Although it is tempting to place a fisheries centre at a location where conditions promise commercial feasibility, this may result in crowding out the private sector. A subsidised fisheries centre in competition with an existing private sector fish trader is likely to be counterproductive in the long term.
- A fisheries management component should be incorporated in all fisheries centres. Centres can promote simple resource conservation measures: he who controls the buying at the centre can exert considerable positive influence over fishing practices in the area.

Buying fish at the Wainikoro Centre, Fiji

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Semeghe Fisheries Centre, Solomon Islands

Importance of reef prey in the diet of tunas and other large pelagic species in the western and central Pacific Ocean

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Recent descriptive ecology work has demonstrated that tuna and other pelagic species associated with oceanic tuna fisheries feed on reef prey, particularly around fish aggregating devices located in specific geographic areas.

Introduction

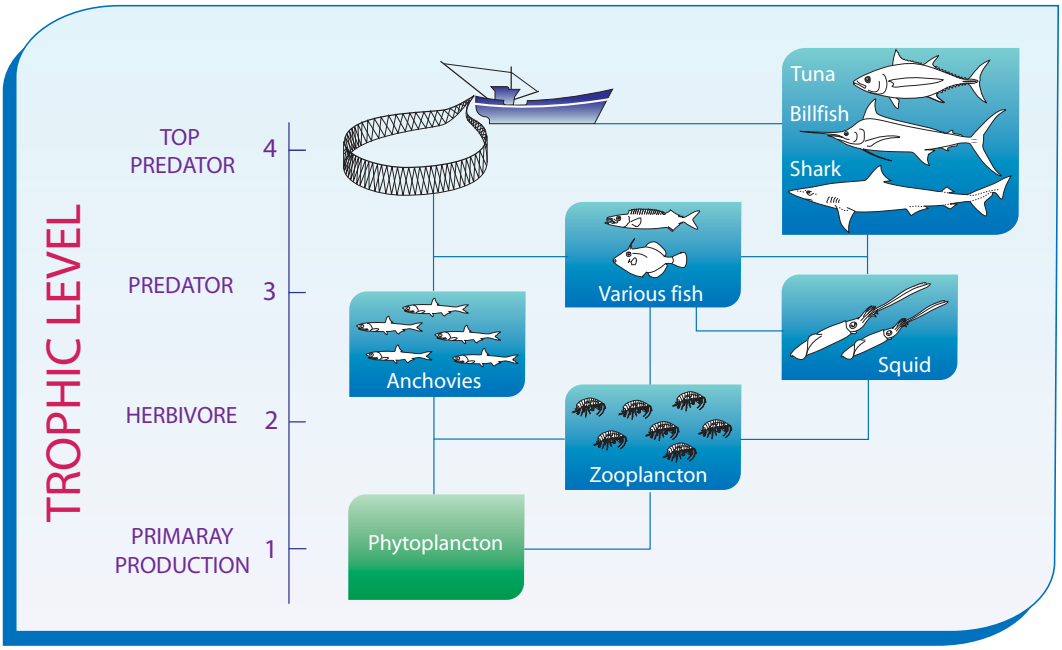
It has been demonstrated that targeting a specific fishery species affects untargeted individuals as well within an ecosystem through the interactions in the food chain's prey–predator relationships. Up until the 1980s, however, work focused on the single-species management of fisheries and did not consider the impact that capturing one species could have on other associated species.

In 1982, the United Nations Convention on the Law of the Sea introduced the ecosystem management concept, which involved managing not only target species, but also associated and dependent species in the ecosystem as a whole. Such an approach is particularly important in the western and central Pacific Ocean (WCPO), which contains the planet's largest tuna stocks. Tuna and other large pelagic species are upper-trophic-level predators (Fig. 1), and fishing effort there has very likely had a major impact on the rest of the ecosystem.

The Oceanic Fisheries Programme (OFP) of the Secretariat of the Pacific Community (SPC) has been working on acquiring biological knowledge of tuna and their environment since 2001. Among the various research avenues pursued, OFP has described the diet of tuna and other large WCPO pelagic species, with a particular emphasis on the disparity between current tuna stock estimates and the amount of oceanic micronekton available in the area.

Tuna diet

Tuna diet studies have demonstrated that tuna and other large pelagic species are not selective in terms of their diet, adapting to available prey and the latter's vertical distribution in the water column. Different diets were identified based on the tuna species considered, fishing grounds, or school configuration while fishing



Adapted from: Christensen and Pauli. 1997. Placing fisheries resources in their ecosystem content. EC Fisheries Cooperation Bulletin 10(2):9–14.

Figure 1. The food chain and the relationship between tunas and associated species.

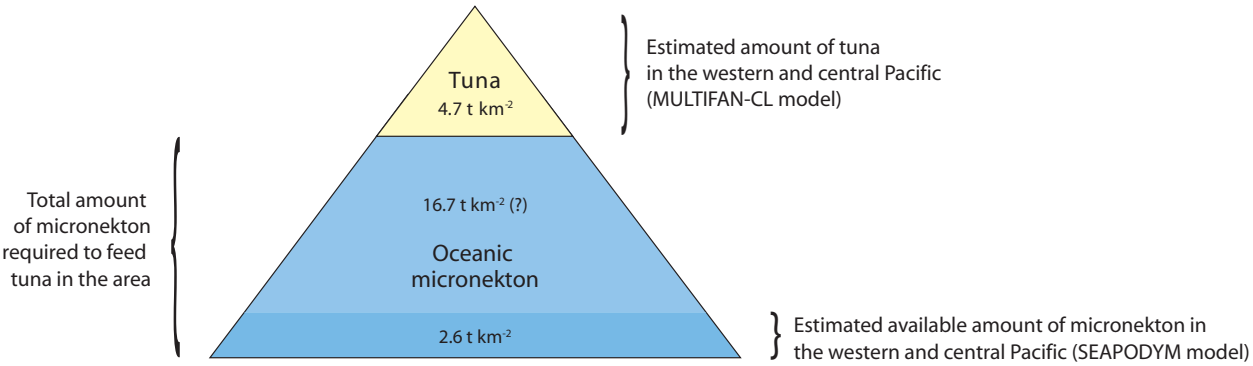


Figure 2. Diagram of the shortfall between tuna quantities and available micronekton as estimated by pelagic ecosystem models.

(e.g. schools near fish aggregating devices [FADs)], schools associated with whale sharks, and free schools). For example, a recent study showed that yellowfin tuna caught in Papua New Guinea (PNG) and French Polynesia feed mainly on crustaceans, such as mantis prawns (Stomatopoda), while those caught in New Caledonian waters mainly consume flying fish, reef fish and crab larvae (Allain 2005).

Pelagic ecosystem models now integrate these diet differences, even though there are still many problems with balancing them in terms of weight and prey numbers.

Two mathematical models were developed by SPC to study tuna population dynamics.

1. The spatial ecosystem and populations dynamics model (SEAPODYM), which integrates population dynamics and an ecosystem's spatial aspect to provide a general framework for integrating biological and ecological knowledge on tuna and other oceanic predators and their responses to fishing pressure. The model targets three tuna species found in the South Pacific: skipjack (*Katsuwomis pelamis*), bigeye (*Thunnus obesus*) and albacore (*T. alalunga*). The model matches ocean-basin-scale biological and physical fishery data by including phytoplankton-zooplankton quantities, micronekton quantities and tuna ages.
2. MULTIFAN-CL, a stock assessment modeling approach, was developed by Fournier et al. (1998), and is the main tool for assessing WCPO tuna stocks. This computer programme conducts a statistical analysis based on tuna length and age.

By integrating data from both models, plus using information acquired on diet into a third model (known as Ecopath), we were able to gain an understanding of how the WCPO ecosystem functions.

Ecopath showed that micronekton in the WCPO (as estimated by the SEAPODYM model at 2.6 t km^{-2}), was insufficient to feed the tuna in the area as estimated by the MULTIFAN-CL model (at 4.7 t km^{-2}). According to available biological data, 19.3 t km^{-2} of oceanic micronekton are required to feed such numbers of tuna. The Ecopath model, therefore, suggests a shortfall of 16.7 t km^{-2} in micronekton or other prey items (Fig. 2).

Reservations regarding estimates based on the models may partly explain the discrepancies. It has also been shown that the models do not account for two major factors: prey transfers from other areas, and reef prey (Allain et al. 2007).

The latter hypothesis was examined by OFP's Ecosystem Monitoring and Analysis Section during a master-degree attachment that focused on measuring the importance of reef prey in these upper-trophic-level pelagic fishes diet.

Importance of reef prey in the diet of upper-trophic-level predators

Several studies have shown that reef prey was present in tuna diets (e.g. Bertrand et al. 2002; Jacquemet et al. 2011), but no qualitative or quantitative studies have yet been undertaken. It was, therefore, difficult to estimate how important reef prey was in the diet of tuna and large pelagic fish.

Our study consisted of carrying out a quantitative taxonomic analysis of the stomach content of 4,357 predators sampled during commercial fishing campaigns conducted in the exclusive economic zones (EEZs) of the WCPO. The results focused on the proportion of reef prey estimated in terms of weight, and excluded other prey. Major fluctuations in reef prey proportions were observed in the diet.

In order to attempt an explanation, various factors were examined such as space-time variability, fishing gear type, school configuration during fishing, reef/lagoon distances and surface area, and some predator biological characteristics such as weight, length, habitat and species.

Despite major variability in the results based on the tested factors, the results demonstrated that:

1. reef prey accounted for an average of 16.3% of predators' diet (Fig. 3), with figures fluctuating from one month to another, and remaining low in December–January and June–July;

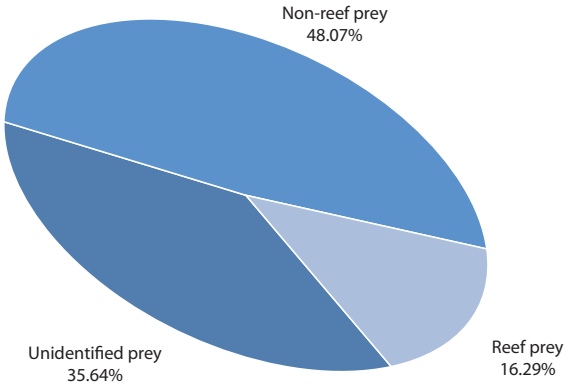


Figure 3. Illustration of reef, non-reef and unidentified prey weight proportions as analysed in the sampled stomach content

2. in the area examined, predators captured in PNG's EEZ showed higher rates of reef prey in their stomach content (Fig. 4);

3. a higher rate of reef prey were noted in predators that were captured using surface gear, such as seine nets or pole and line, used mainly in PNG and Federated States of Micronesia than in predators captured using deep-sea longlines in French Polynesia's EEZ farther to the east of the area under consideration;

4. predators caught using surface gear near anchored FADs in PNG's EEZ had higher amounts of reef prey in their diet than those caught near free-floating and drifting FADs or in free schools;

5. the proportion of reef prey in the diet of tuna and large pelagic species fell as the prey moved away from coasts, reefs or lagoons (Fig. 5); and

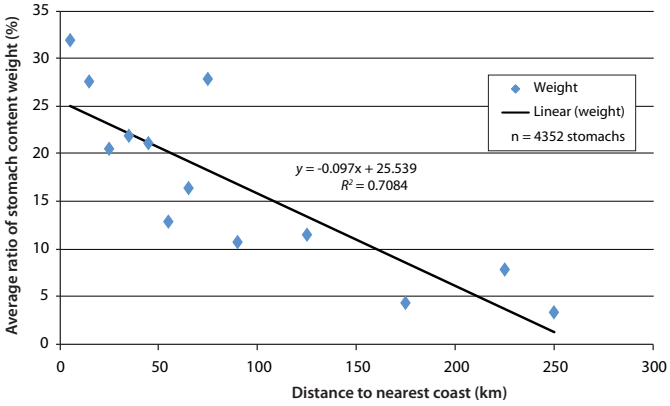


Figure 5. Correlation between reef prey weight in the stomach of predators and the distance from the nearest coast.

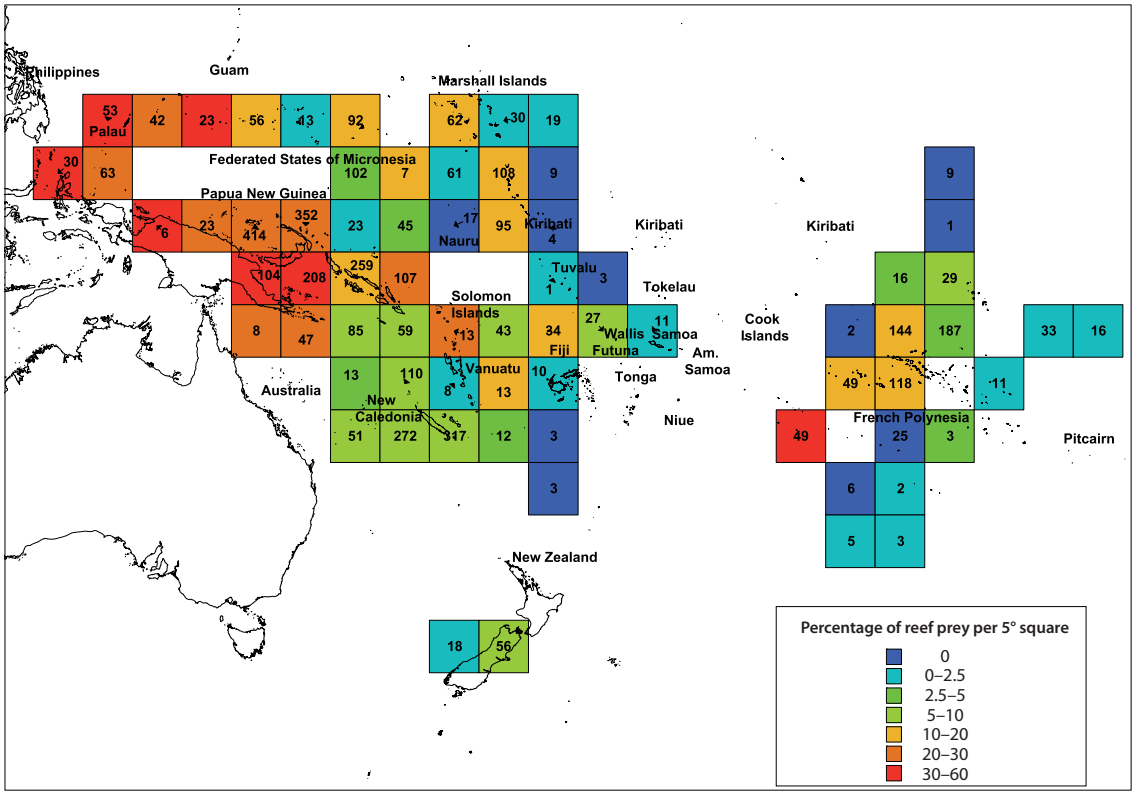


Figure 4. Spatial distribution of reef prey weights in the stomach of predators by five-degree squares of latitude and longitude with the number of predators captured in each square.

6. small predators living mainly in surface waters, particularly yellowfin (*Thunnus albacares*) and skipjack (*Katsuwomis pelamis*) had higher rates of reef prey in their stomachs than larger predators, such as bigeye (*T. obesus*), which tended to feed in deeper waters.

Reef prey could be classified into three categories (Fig. 6):

- fish, mainly triggerfish (Balistidae) and surgeonfish (Acanthuridae) (Fig. 7).
- crustaceans, mainly mantis shrimps (Stomatopoda) (Fig. 8)
- molluscs (Fig. 9).

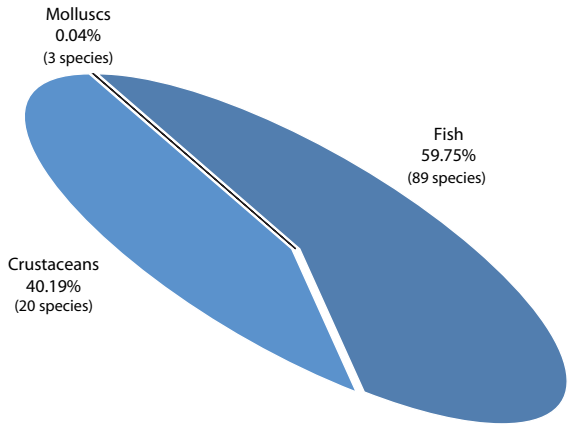


Figure 6. Distribution by major categories of reef prey identified in sampled predator stomachs.

In total, 109 different reef species were identified.

Several hypotheses can be advanced to explain the results.

1. The observed seasonal minima can be explained by seasonal larval production in reef spawning environments and pelagic larval lifespans prior to recruitment.
2. Geographic areas where predators had higher rates of reef prey in their diets were natural sources of larval production. The farther the larvae moved from areas with reefs, lagoons and coasts, the more dispersed they became and the less they appeared in predator diets.
3. PNG-anchored FADs aggregated larvae by acting as reef substitutes (Kingsford and Choat 1989) to which larvae recruited, guided by FAD sound emissions (Mann et al. 2007).
4. Small predators prefer smaller prey, particularly reef fish larvae, although proportions varied in terms of the predator under consideration. Such variability could also be explained by opportunistic feeding.

By linking information on space-time factors and biological characteristics of predators tested for reef prey

Figure 7. Acanthuridae (top) and Balistidae (bottom) larvae found in the stomachs of a predator caught in Federated States of Micronesia and Solomon Islands, respectively. (Photos: Dominique Ponton, IRD).

Figure 8. Stomatopoda larva found in the stomach of a predator caught in Solomon Islands (Photo: SPC).

Figure 9: Octopus defilippi *larva found in the stomach of a predator caught in New Caledonia (Photo: SPC).*

variability rates, the results showed that small predators around FADs that were anchored less than 80 km from coasts, particularly in PNG's EEZ, had maximum reef prey rates of 62.3% in their stomachs.

Conclusion

The study conducted in the WCPO revealed a number of general trends and showed that despite sampling biases, such as spatial coverage restricted to EEZs, the proportion of reef prey in the diets of tuna and other upper-trophic-level pelagic species was quite significant in some circumstances, particularly when school configuration during fishing and the geographic area were considered.

More in-depth and finer-scale analyses, however, particularly a cross analysis between geographic areas and seasons in areas for which a large number of samples are available, could better explain the space-time distribution of reef prey and the diet preferences of some predators. Similarly, better knowledge of ocean phenomena such as currents, could provide more accurate explanations for larval dispersion and explain why larvae are encountered in tuna diets at distances of hundreds of kilometres.

The ultimate aim of this work would be to integrate the "reef prey" variable into future pelagic ecosystem models, in order to better estimate actual oceanic micronekton quantities required to feed the numbers of tuna present in the area, as estimated by mathematical models.

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Reef fish juveniles around a FAD anchored in Papua New Guinea waters.

The pros and cons of shark feeding

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Introduction

Feeding wild animals is a common practice in the ecotourism industry. Operators do so both on land and under water to gather fauna at particular spots so that they can be viewed by tourists. Operators would otherwise be unable to guarantee their customers sightings of particular animals that are generally shy and reclusive. The practice is often controversial because although it has undeniable advantages for humans — discounting the inherent danger of attack by large predators — it involves potentially negative effects for wild animals. Shark feeding is no exception and much has been written on the issue, although, until recently no scientific studies were available, despite sharks being emblematic animals in the Pacific. The gap has now been filled with a project implemented jointly by the Secretariat of the Pacific Community (SPC) and the French Centre de recherche insulaire et Observatoire de l'environnement (CRIOBE) in Moorea, French Polynesia.

Moorea's lemon sharks

French Polynesia is a high-end tourist destination in the Pacific. Water sports are highly developed there amid crystal-clear waters and coral reefs with brightly coloured fauna. Diving sites such as Rangiroa, Bora Bora and Moorea have a worldwide reputation, due in large part to their imposing, but docile sharks. The sicklefin lemon shark, *Negaprion acutidens* (Box 1) is the star attraction of Moorea and Bora Bora, where thousands of divers flock every year to watch amazing underwater shark feeding sessions, with animals sometimes measuring more than three metres long. Because they are fed by humans (usually tuna or mahi mahi scraps), these normally solitary sharks can congregate in large numbers, sometimes up to 15 or so in a space of just a few hundred square metres. Groups of about a dozen divers at a time are taken to depths of 15–20 metres, where small cages containing food are placed out of reach of opportunist sharks and other fish. Attracted by the smell, sharks prowl about the cages to the astonished gaze of the divers for several minutes. The food is then released, and a hectic swirl ensues — including not just the imposing lemon sharks (Figs. 1 and 2),[1] but also dozens of reef fish and smaller, but extremely lively, nervous blacktip reef sharks.

Under the Marine Management Plan (PGEM) as applied to Moorea Island, this shark-oriented ecotourism activity has been restricted since 2002 to the outer reef slope. At the Bathys Diving Club, formerly TopDive diving instructor Nicolas Buray has developed extraordinary expertise in visually recognising about 40 lemon sharks that regularly visit the feeding site. Because of his natural science knowledge, Buray was supervised by CRIOBE Director Serge Planes and CRISP Coordinator Eric Clua from 2006–2010 while undertaking an EPHE[2] qualification on Moorea's lemon shark population. The qualification gave rise to a scientific publication on a recognition method for these sharks using photo identification (Buray et al. 2009).

Figure 1. Nine lemon sharks congregating at the Moorea feeding spot, near Oponuhu Bay.

Figure 2. Lemon shark (2.8 m) searching for food hidden in the coral under the watchful eye of a diver.

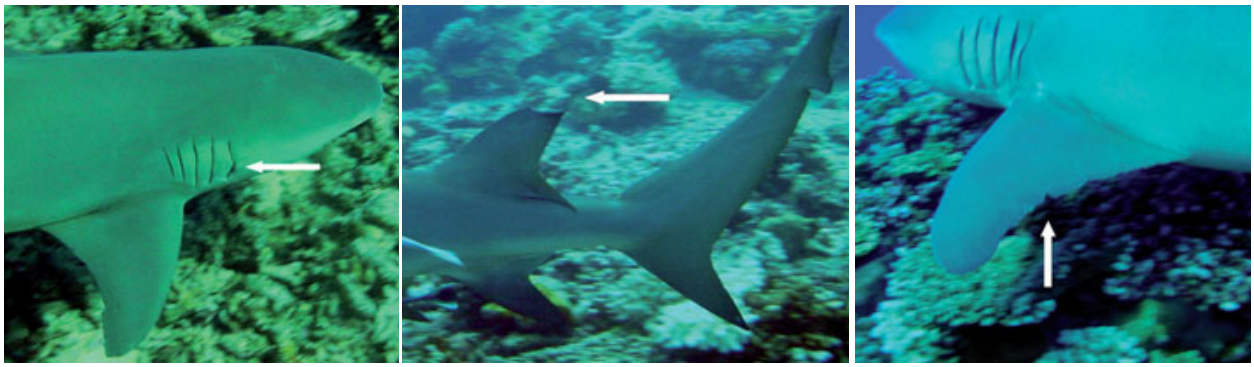

Figure 3. Distinctive marks are used to identify individual sharks: scar on the right-hand gills (a), severed apex on the second dorsal fin (b) and notches in the left-hand pectoral fin (c).

Because the lemon shark's skin is an even yellowish-beige, the idea was to first sort the animals by sex and overall size, and then compile distinguishing traits for each individual, using scars or notches and slits in the fins or other spots (Fig. 3). As a result of the study, each shark could be identified individually, which was the first step towards observing their behaviour with regard to feeding over a period of months or even years, as was the case from 2006–2010. As well as observing sharks, Buray carried out underwater biopsies for genetic testing (see Box 2 on p. 44).

Advantages of feeding

Positive aspects of shark feeding are real and deserve to be mentioned. The first is the profit it generates for the local economy through tourism, which will be dealt with in detail below. The second involves shark biology. According to some authors, feeding helps low-density animals to meet and, thus, reproduce. The third argument concerns the shark's image. In many societies, sharks have a poor, deeply rooted, although undeserved, reputation that has been reinforced by the success of sensationalist films such as "Jaws". Improving their image is crucial, considering the danger they face worldwide from overfishing, with over 50 million sharks being caught yearly, particularly to supply the sharkfin market (Clarke et al. 2006). The struggle to ensure their survival, which some scientists and non-governmental organisations are engaged in, could never be won without favourable public opinion. Feeding is, therefore, a useful tool for promoting the concept that sharks are not killing machines thirsting for human blood, as some irresponsible films would have us believe. Through shark feeding, thousands of divers around the world have swum at close quarters with these animals with their razor-sharp teeth and extra-powerful jaws and suffered few if any attacks at all. If people looked objectively at the figures, they would realise that fatal shark attacks in

Box 1. Sicklefin lemon shark

There are two lemon-shark species: the Indo-Pacific *Negaprion acutidens*, dubbed "sicklefin" because of its sickle-shaped pectoral fins, and the Atlantic *N. brevirostris*, which is easily identified by its even yellowish-beige coat and a highly developed second dorsal fin that is nearly as large as the first. It is a placental viviparous shark that prefers lagoons and bears its young for about 12 months. It prefers to give birth in areas near mangroves. Juveniles tend to live inside lagoons while adults are more often found on outer reef slopes. It is a somewhat solitary and territorial shark at the adult stage and can be irascible and aggressive with humans. It has a powerful jaw full of razor-sharp teeth and tends to eat fish. It has a lifespan of approximately 25 years and can grow up to 3.5 metres long.

Sicklefin lemon shark (*Negaprion acutidens*)

the last decade varied from one to two a year, according to International Shark Attack File, which is extremely low. By way of comparison, mortality from insect stings has been estimated at between 0.09 and 0.45 deaths per million people per year (Annila 2000),[3] or 550–2,700 deaths per year worldwide (total population of 6 billion). One wonders how many people objectively think of bees as being hundreds of times more dangerous than sharks.

Potentially negative effects

Despite the positive aspects of shark feeding, in the long term it involves a number of potential hazards. These include i) human interaction, in which sharks could attack and kill, even involuntarily; ii) ecosystem interaction in which the ecosystem may be deprived of these super predators' beneficial effects while they wait for free food at a particular spot; and iii) sharks themselves, whose biology and ecology have been disturbed. It has been demonstrated (Guttridge et al. 2009) that sharks' learning abilities are extremely well developed and feeding quickly leads to dependence when food is easily available, as well as to sharks' becoming accustomed to the presence of humans. Humans are soon associated with food and otherwise wary, distant sharks no longer hesitate in approaching humans and even entering into close contact with them. This significantly heightens the risk of accidental biting (e.g. a shark biting a diver's limb that it mistakes for food) or intentional biting out of domination or territorial instincts. In such cases sharks ward off potential competitors, much as a dog would near its dish. Regarding the ecosystem, confining several normally solitary, territorial sharks in a restricted area means they are no longer active in their respective territories.

It is common knowledge that sharks act as "dustmen", ridding their environment of dead or sick animals. The negative "domino effect" of disappearing large sharks has also been observed, such as the exponential increase in rays, sharks' usual prey, in the North Atlantic. Recent studies tend, however, to show that their importance to the ecosystem as "motors of evolution" is as diffuse as it is crucial. By daily catching prey such as fish, particularly smaller, less wary ones, sharks force the fish to devote more energy to reproduction and, therefore, breed faster while at the same time selecting for fitter individuals. In other words, the more sharks there are, the more fit fish there are as well. Although this undeniable effect is difficult to assess in scientific terms, the negative effects for the sharks themselves can, nevertheless, be evaluated, as demonstrated by the joint SPC-CRIOBE team from 2006–2010, following over 1,000 dives. By analysing 39 individual lemon sharks, it could be demonstrated that they became increasingly faithful to the feeding site as the years went by (Clua et al. 2010). This trend implies that there is a heightened risk of inbreeding within the population, even though there was contact between resident and non-resident sharks during the mating season from September to November. During this period, some females that are not seen during the rest of the year enter the site, while some males leave it temporarily. Such exchanges do indeed contribute to genetic variety. This is also the time when skirmishes between sharks reach a peak, as competition for mates compounds clashes over food. This uneasy period also heightens the mauling hazard for humans, so much so that the research team suggested that French Polynesian authorities impose a feeding freeze during the mating season. Not only can shark feeding be dangerous during mating season, but it also keeps the same lemon sharks within a restricted area, favouring inbreeding within a population (lemon sharks) for which low genetic variety is already a problem.

The information was obtained by adding DNA samples from juveniles in the area, which were mainly offspring of the group under investigation, to adult samples (Mourier et al. submitted). A lack of genetic variety is synonymous with low resistance to external stress, such as potentially fatal diseases.

Economic value of sharks through ecotourism

Although the researchers warned authorities of the inherent risks of shark feeding, the idea was not to obtain a ban on it. Ecotourism generates large revenues for the local economy, as it does everywhere in the world where it is practised. Shark feeding occurs in the Bahamas and Maldives with the grey reef shark (*Carcharhinus* sp.) and in South Africa with the great white shark (*Carcharodon carcharias*) and tiger shark (*Galeocerdo cuvier*) north of Durban. In the South Pacific outside of French Polynesia, the only truly developed shark feeding venture is on Beqa Island in Fiji, off southern Viti Levu, with bulldog sharks (*Carcharhinus leucas*). "Cage diving", attracting sharks with teaser bait, but not feeding them, has been developed in Hawaii with the Galapagos shark (*C. galapagensis*) and sandbar shark (*C. plumbeus*). Several publications emphasise the economic advantages of such ecotourism activities. In Fiji, for example, part of the dividends earned by diving clubs, amounting yearly to several tens of thousands of Fijian dollars, are paid to villages lying adjacent to the reserved area, where bulldog sharks congregate, in return for not fishing in it. All of the studies deal with the issue in general terms, and do not provide specific figures for sharks. On Moorea, it was calculated that direct profits generated by shark diving provided a yearly revenue of USD 5.4 million and that one lemon shark contributed USD 2.3 million over its 20-year lifespan. By basing the study on separately identified individuals, it was possible to calculate individual yearly contributions that averaged USD 315,000 for each of the 13 resident sharks, which accounted for 73% of onsite observations. The most productive resident female alone contributed USD 475,000 (Clua et al. in press). Shark fishing has been banned in French Polynesia since 2006, but evidence has

come to light of poaching by local fishermen (Fig. 4). The researchers supposed that if local fishermen were provided with precise figures on the economic value of a single shark, even a lemon shark, they could better appreciate the fact that a shark is worth much more alive than dead. They would, of course, need to have a direct or indirect stake in the profits generated by ecotourism shark feeding. That, however, is a matter for the local authorities.

Figure 4. Lemon shark with a hook to the left of its mouth and potentially fatal knife gouges, probably inflicted by a fisherman.

Other economic advantages of sharks

In order to convince marine world stakeholders (e.g. tourism operators, fishers, tourists, coastal populations) and political decision-makers of the economic advantages of keeping sharks within their ecosystems, the SPC-CRIOBE team envisages taking up the daunting challenge of calculating other contributions sharks make to local and world economies. This requires looking beyond their direct value in terms of contributions to ecotourism, as described above, and beyond the market value of shark fisheries that are easily quantifiable by consulting market prices, even if these were sustainable (which is highly unlikely). As previously mentioned, sharks contribute to ecosystems that are richer in fishery resources, which are useful to humans, and this more indirect value needs to be better understood. Sharks also have an "optional" value as reservoirs of active ingredients in therapeutic applications, such as squalene.[4] Finally, in the Pacific probably more than elsewhere in the world, sharks also have what is known as a "non-use" value, whether it is an "existence value" (the intrinsic worth assigned to a common property), a "heritage value" (the importance attached to being able to transmit it to future generations), or a "cultural value". The latter is extremely difficult to define, but undeniably present throughout the Pacific, where the shark is often a "totem" animal into which the souls of ancestors are re-incarnated. It is traditionally respected and not fished. Increasing demand from Southeast Asia for sharkfins is, however, spreading farther into Pacific Island states and inciting local fishermen to catch sharks and chop off their fins, discarding the rest of the animal. What do the spirits of the elders think of this? May they inspire their Polynesian, Micronesian or Melanesian descendants to behave as worthy heirs of an extraordinary marine heritage?

Conclusion

To feed or not to feed. The answer no doubt lies somewhere between the two. In any case, if feeding contributes to saving sharks, then perhaps this justified feeding. It obviously should be done with due heed paid to the negative aspects raised above. Scientists are providing fisheries managers with increasing amounts of information for reaching the right compromises, as humans' quest for a fun-seeking approach to nature should not prevail over the welfare and survival of wild animals, as many believe. Humans are nothing more than an intelligent but whimsical animal with too much power — the only one that can destroy the ecosystem in which it lives.

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Box 2. Underwater sports: Undersea biopsies

Biopsies consist of sampling a piece of skin (sometimes with fat and muscle) for genetic testing. On Moorea, such tests assessed the degree of kinship between two individual sharks over one or two generations. The tests were carried out using an underwater crossbow and arrow with a puncher at the tip, usually used for whale biopsies. The punch is made up of a hollow tube with a sharp rim and round stop preventing the shark from being pierced to depths of more than 2 or 3 cm. Inside it, barbs hold the flesh in as the arrow is expelled and bounces off the shark (Fig. 5a). The arrow is usually shot at the fin's base so it can cross it and take a core sample, increasing the chances of obtaining a piece of skin (Fig 5b). The sampling is painless for a shark that suffers far more violent attacks from other sharks, but it is often very surprised and sometimes reacts by turning on the shooter. Needless to say, such situations become fairly unpleasant.

Figure 5. a: Scientific diver displaying a punch containing a piece of flesh following a biopsy; b: Scientific diver shooting at lemon shark's dorsal fin for a biopsy.

1 All pictures in this article are by Nicolas Buray. © Copyright reserved.
2 A qualification awarded by École pratique des hautes études (a practical postgraduate studies institution) equivalent to a two-year master's degree in the French university system.
3 Post-mortem studies suggest that this is could be an underestimation (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3233724&dopt=Abstract)
4 Squalene is a substance known for its medically proven antioxidant and colon-cancer-inhibiting properties.

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