Fisheries Newsletter

Number 129 (May–August 2009) ISSN 0248-076X

Editorial

We open this issue with a tribute to our colleague Michael Manning, who passed away on 7 September while on duty travel in Tuvalu. Michael, a young and brilliant fisheries scientist, had only been working for eight months with SPC's Oceanic Fisheries Programme, but it was enough to leave a mark on all the people who had the chance to work with him.

Tuna is probably the most cited word in this issue, as we publish five articles related to it: a report about the outcomes of the latest meeting of the Scientific Committee for the Western and Central Pacific Fisheries Commission (p. 4), preliminary results of a study on tuna fisheries around seamounts (p. 6), an update on tuna fisheries in the region (p. 8), a description of fishing techniques used by purse seiners around FADs (p. 25), and a detailed report on the efforts made to better understand the tuna fisheries of our neighbour, Indonesia (p. 29).

And these are only some of the many fisheries and aquaculture-related topics we address here, and we hope that they will capture your attention. Don't hesitate to let us know what you think of this issue, and to share any news you would like to see published here.

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

Unloading tuna from a purse-seine carrier to a local cannery in Bitung, North Sulawesi, Indonesia (see article p. 29) (Photo: Craig Proctor, CSIRO).

in This Issue

SECRETARIAT OF THE PACIFIC COMMUNITY
Prepared by the Information Section of the Marine Resources Division and printed with financial assistance from France.

MARINE RESOURCES DIVISION

Tribute to Michael Manning

Michael John Manning, OFP Fisheries Scientist, passed away suddenly of natural causes at age 35, on Monday, 7 September 2009, while on duty travel in Tuvalu.

Michael at sea while he was working for NIWA.

Michael was born on 17 September 1973 in Palmerston North, New Zealand, and grew up in Wellington. After studying for a BSc in Ecology and Zoology at Victoria University (Wellington), his first professional employment was at the New Zealand Seafood Industry Council (SeaFIC), starting in mid-1998. There, he organised biological sampling programmes that were conducted on commercial vessels. Michael excelled at training fishers to do this work. After two years at SeaFIC, he recognised that he needed more study to develop his talents, a decision supported by SeaFIC, who arranged financial support from the fishing industry. He obtained an MSc in Statistics from the University of Auckland, and graduated in 2006. His thesis was titled "On fitting and comparing selected statistical models of fish growth".

In 2001, he took a position with New Zealand's National Institute of Water and Atmospheric Research (NIWA) in Wellington as a Fisheries Technician, and obtained a position as a scientist in 2003. He became involved in a wide range of projects, leading a number of them himself, and quickly developed skills across the spectrum of fisheries science (in ageing, tagging, statistics, sampling methodologies, stock assessment modelling, report writing and project management). He demonstrated great commitment and enthusiasm in every task he took on. He also discovered a love for sharks, and tagged rig, school, and great white sharks in the course of his time at NIWA. One white shark that he helped tag in New Zealand was tracked north to New Caledonia, and Michael was keen to follow this up after arriving in Noumea.

During this period, Mike's enthusiasm extended well beyond his working environment. He also developed a passion for running, including marathons, and was an extra in the second instalment of the Lord of the Rings trilogy.

Michael started working for SPC's Oceanic Fisheries Programme in February of this year, in the Stock Assessment section, and his appointment was seen as a coup for the programme. With his expertise in all aspects of fisheries science, there was not a job within OFP that he could not have done. While he came from a New Zealand fisheries system with a few more creature comforts, it quickly dawned on him what Pacific tuna fisheries were all about. He could see past the technical aspects of the work, and became excited about the opportunity to make a real contribution to people and countries with little but the sea around them to support their nations' economies and food requirements.

In June and July of this year Michael worked as part of a team to prepare and deliver fish stock assessment training workshops to participants from all over the Pacific, to help these countries make decisions to ensure the sustainability of their only resource. Michael was a naturally gifted, engaging and enthu-

siastic teacher and presenter. The mark he left on those he taught was highlighted in the many tributes that have flowed in from around the Pacific. Of these, the following perhaps best sum up his impact and the regard with which he was held.

His passing away is a great loss not only to SPC, but also to the Pacific region. He was a great friend to us all, especially in promoting Pacific Island scientists whom he helped and assisted during the series of stock assessment workshops. We here in Samoa join with SPC and friends from the region in appreciating and thanking him for his tireless and tremendous efforts through SPC in helping the island states members to build our scientific capacity and knowledge and understanding of stock assessment issues.

Atonio P. Mulipola, Acting Chief Executive Officer, Samoa

We first met Michael Manning at the SPC Stock Assessment Workshop in Auckland this past June/July. As a relatively new addition to the SPC Oceanic Fisheries Division, we were eager to get to know, and learn from Michael. Many of us continued to develop a friendship with Michael at the WCPFC Science Committee meeting in Port Villa, Vanuatu.

During the course of the Stock Assessment Workshop in Auckland Michael proceeded to impress us with his ability to take complex statistical concepts and present them in an unpretentious, straightforward and easy to understand manner. Michael exuded patience and affability in listening to and responding to our questions, providing thorough answers. These attributes of Michaels continued to be very helpful to us at the Science Committee Meeting in Vanuatu.

Although we only knew Michael for a short period of time, we found him to be an amiable and genuine person, who was always willing to provide guidance and clarity to our understanding the essential tenets of stock assessment, so we could in turn better represent and serve our colleagues and countries.

It was an honor to get to know Michael and we will truly miss him.

From: All participants at the 2009 Stock Assessment Workshops

Michael Manning (fourth from left) at the SPC-GEF stock assessment training workshops in Auckland, New Zealand, June 2009.

In August at the WCPFC Scientific Committee meeting in Port Vila, Michael presented the Western and Central Pacific's first ever Shark Stock Assessment Feasibility Plan (a paper on which he was the lead author), and potentially a significant step towards future shark conservation. While it was a task he took extremely seriously, it was also probably the first Pacific fisheries presentation to include a slide of Bob the Builder. His enthusiasm and passion for sharks were noted by many at the meeting.

But more important in his life were friendship and love. In coming to New Caledonia Michael brought with him his two great loves, his wife Juliette and daughter Caitlin, and together they continued old friendships and made many new ones. Michael became as well known for his ready and engaging smile, constant joking and laughter, and understanding and considerate nature, as he was for his professional skills.

Michael demonstrated the most important attributes for any scientist working at SPC, namely a very high level of technical skill, self-motivated dedication to his job, and enthusiasm for teamwork with his colleagues. We are fortunate to have known him. From the people of the Pacific, may he rest in peace.

OCEANIC FISHERIES PROGRAMME

Scientific Committee meeting of the Western and Central Pacific Fisheries Commission

One of the most important meetings for SPC's Oceanic Fisheries Programme (OFP) and SPC member countries and territories is the yearly Scientific Committee (SC) meeting of the Western and Central Pacific Fisheries Commission (WCPFC). The SC reviews the current state of scientific knowledge, and sends recommendations and advice to WCPFC, which manages the world's largest and most valuable fishery.

In its role as the science provider to WCPFC, OFP provides stock assessments, fishery statistics and other scientific work. Before and during each meeting of the SC, OFP also gives scientific support to SPC member countries and territories.

This year, the fifth meeting of the SC was held in Port Vila, Vanuatu, from 10–21 August (see Fig. 1). OFP provided the majority of the science with over 40 papers, including a review of fisheries; stock assessments for yellowfin, bigeye and albacore tuna; an evaluation of current management measures; and a review of progress in the regional tuna tagging project. A brief summary of these presentations is presented here. The meeting's summary report and meeting papers can be found at http://www.wcpfc.int/meetings/2009/5th-regular-session-0.

Fisheries review

In 2008, the tuna catch in the western and central Pacific was the highest ever recorded, at 2.4 million mt, which represents 56% of the global tuna catch. The yellowfin catch was also a record, with bigeye and skipjack the second highest ever. The albacore catch, however, was the lowest it has been for more than 10 years. The largest part of the catch was skipjack caught by the purse-seine fishery (Fig. 2).

Stock assessments and management advice

The 2009 bigeye tuna assessment, presented by Shelton Harley (head of the SC's Stock Assessment Specialist Working Group), indicated that overfishing was occurring (i.e. fishing mortality was above F_{MSY}[1]), and that the stock was either slightly overfished or soon would be (i.e. spawning biomass was close to or below SB_{MSY}[2]). Overall, the 2009 assessment was more pessimistic than the 2008 assessment, following which a 30% reduction in fishing mortality was recommended by the SC. In addition, the evaluation of the existing WCPFC management measure for bigeye and yellowfin tuna, presented by OFP's manager John Hampton, indicated that it fell well short of achieving its aim of reducing bigeye fishing mortality by 30% from 2001–2004 average levels. As a result, the SC recommended that more should be done to reduce fishing mortality on bigeye, and ensure that the fishery is sustainable for the long term.

Results of the 2009 yellowfin stock assessment, presented by OFP consultant Adam Langley, were more optimistic than the 2007 assessment. Overfishing was not occurring on the stock as a whole, and the stock was not overfished. However, there were concerns about the high fishing impact on the western equatorial region, which supplies 95% of the catch. The SC recommended that fishing mortality on yellowfin in this region should not increase.

Results of the 2009 albacore assessment, presented by OFP's Senior Fisheries Scientist Simon Hoyle, indicated that the stock was not in an overfished state, and not being overfished. However, current levels of fishing appear to be affecting longline catch rates, which may have economic implications for Pacific Island countries that target this species.

Other matters

From SPC-OFP's perspective, an excellent outcome of the

Figure 1. The fifth meeting of the WCPFC Scientific Committee in Port Vila, Vanuatu. The SC's Chair, Dr Naozumi Miyabe (right), and Vice-Chair Dr Keith Bigelow (left), lead the meeting.

meeting was the nomination of a new Vice-Chair of the SC, Pamela Maru of Cook Islands. Pam, the first Pacific Islander in a leadership position in a regional fishery management organisation, has attended OFP's stock assessment training workshops for the last four years to increase her understanding of the science that underlies fishery management. We wish her well in her new role.

Many issues were covered at the SC meeting, with the most important summarised below. Working papers are available from the WCPFC website.

i. A review of the fisheries in the western and central Pacific Ocean and eastern Pacific Ocean;
ii. A review of the stock status of yellowfin, South Pacific albacore and bigeye tuna (the latter based on a streamlined assessment), with a focus on requests for advice and recommendations arising from the Fifth Regular Session of the WCPFC at Busan, Korea in December 2008;
iii. An appraisal of Conservation and Management Measure 2008-01 with respect to the potential for achieving the measure's objectives;
iv. A summary of the most recent information and assessments for tuna and billfish stocks in the North Pacific;
v. A dedicated session of the SC's Methods Working Group to discuss biological reference points against which WCPFC assesses stock status;
vi. Bycatch mitigation issues associated with seabirds, sea turtles, sharks, juvenile bigeye and yellowfin tunas;
vii. Issues associated with the data available to WCPFC and initiatives to address data gaps;
viii. A review of the advice and recommendations arising from the Independent Review of the Commission's Transitional Science Structure and Functions;
ix. The status of the Indonesia and Philippines Data Collection Project (IPDCP)/ West Pacific East Asia Oceanic Fisheries Management Project (WPEA), the Japan Trust Fund (JTF) and the Pacific Tuna Tagging Project (PTTP);
x. Relations with other organisations;
xi. Special requirements of small island developing States and territories;
xii. The process for developing the SC's work programme and the 2010–2012 work programme and budget; and
xiii. Administrative matters associated with the functioning of the SC, streamlining the operations of the SC and reviewing WCPFC's Research Plan.

The next SC meeting will be held in Tonga in August 2010.

1. F_{MSY} = The fishing mortality rate that would, in theory, give the maximum sustainable yield (MSY) from a particular stock year after year. MSY is the average or maximum catch that can be removed under existing environmental conditions over an indefinite period without causing the stock to be depleted, assuming that removals and natural mortality are balanced by stable recruitment and growth.
2. SB_{MSY} = The reproductive output by sexually mature female fish in a population (also known as the "reproductive potential") needed, in theory, for a population to provide MSY year after year.

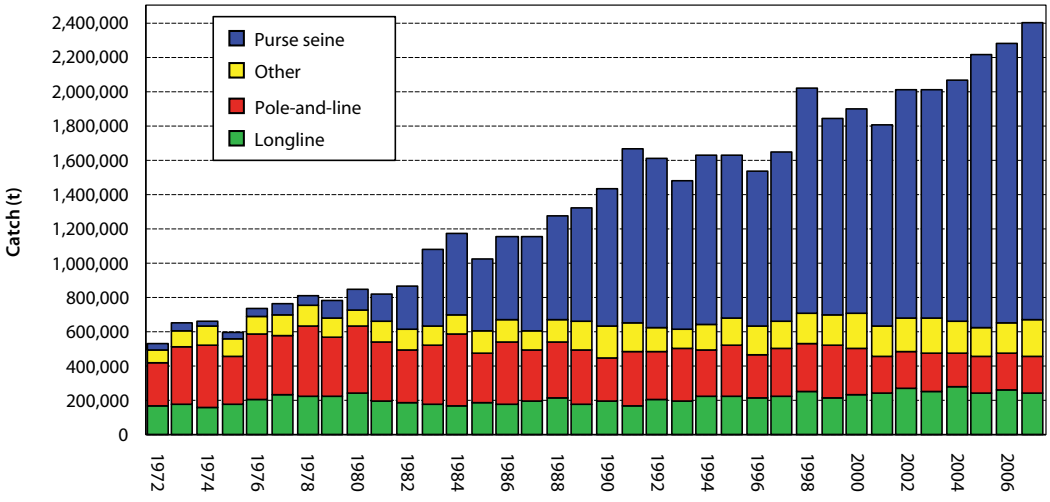


Figure 2. Total 2008 catch of tuna (albacore, bigeye, skipjack and yellowfin) in the western and central Pacific Ocean by longline, pole-and-line, purse-seine and other gear types.

Tuna fisheries and pelagic biodiversity around seamounts in the western and central Pacific Ocean

SPC's Oceanic Fisheries Programme has recently completed a study on tuna fisheries around seamounts in the western and central Pacific Ocean (WCPO). This research is part of the Pacific Islands Oceanic Fisheries Management Project, which is supported by the Global Environment Facility. There is high biodiversity of benthic communities on seamounts, which form important marine ecosystems. Little, however, is known about the importance of seamounts for pelagic fish species such as tunas. This study was undertaken in three parts: 1) use of remote sensing data and existing literature to identify and validate the location of all seamounts in the WCPO; 2) an investigation of whether tuna catches were higher on seamounts as opposed to coastal or other oceanic habitats; and 3) an analysis examining whether pelagic biodiversity was higher on seamounts than in coastal or other oceanic habitats.

Seamounts in the WCPO

Twenty datasets on seamounts and bathymetry from different sources and on different scales (from individual cruises to worldwide satellite data) were compiled to form a detailed list of underwater features for the WCPO. One dataset (KL04) from satellite altimetry data provided the baseline for this study because it covers the entire region of interest and includes information on depth. All potential seamounts in this dataset were cross-checked with other datasets to: 1) eliminate any atolls and islands that were incorrectly classified as seamounts; 2) include seamounts previously undetected by KL04; 3) update the overall database (geolocation, depth); and 4) provide a 12-class typology of the different types of underwater features. Of the 4,627 potential seamounts identified in KL04, 822 (18%) were actually emerged banks, atolls and islands, while 272 were multiple identifications of the same underwater feature (e.g. multiple peak seamounts), leaving 3,533 actual underwater features. Conversely, 490 underwater features documented in other datasets, but not registered by KL04, were added. The screening of all potential WCPO seamounts produced a final list of 4,023 underwater features with accurate positions and information (Fig. 1).

Tuna fisheries around WCPO seamounts

This study was the first large, ocean basin-scale study of the association between pelagic fisheries and seamounts, using a spatially explicit dataset of tuna longline catches collected over the last 47 years in the WCPO, together with the recently validated database on seamount locations held at SPC. The study found higher catch per unit of effort values for at least one tuna species near the summits of many seamounts, however not all seamounts showed higher tuna catches. Extrapolation of this analysis estimates that Pacific Ocean seamounts may be responsible for a combined annual longline catch of 17,000 mt for yellowfin, bigeye and albacore tunas (Fig. 2). These numbers, however, should be interpreted as being indicative only because there was considerable statistical uncertainty associated with their estimation. Although

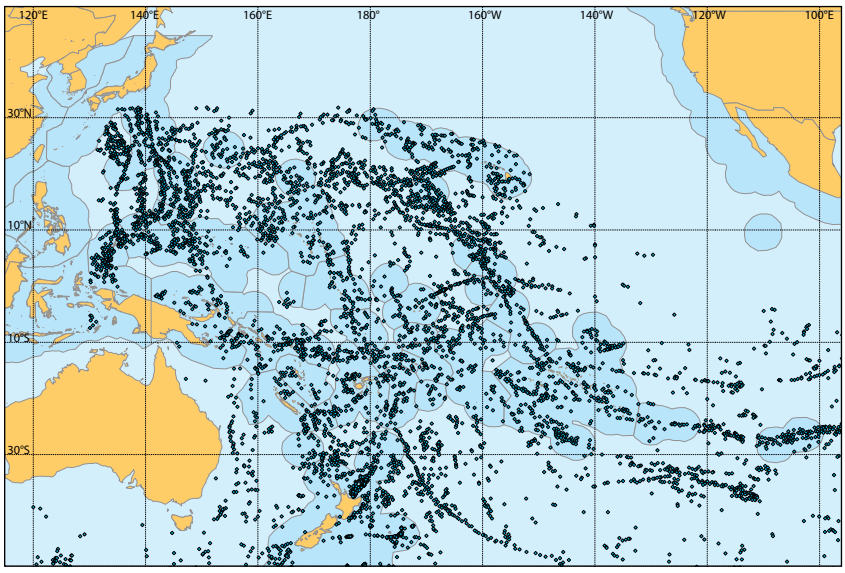


Figure 1. The 4,023 underwater features in the WCPO.

yellowfin (*Thunnus albacares*) and bigeye (*T. obesus*) stocks declined between 1980 and 2007, temporal changes were not apparent on seamounts. These results have important implications for tuna fisheries management, particularly for yellowfin and bigeye. When overall population abundance declines, as is the present situation for yellowfin and bigeye, fishing vessels may concentrate on areas where fish remain. Such aggregation areas may promote what fisheries scientists call hyperstability of catch rates. While this is generally a positive sign for the viability of the tuna industry, it is important that such hyperstability does not hide real trends in the data that might indicate a decline in the status and viability of tuna stocks. The results from this study will allow SPC's Oceanic Fisheries Programme to include the effect of seamounts when preparing data for the regular assessment of tuna stock status in the WCPO.

Pelagic biodiversity around WCPO seamounts

Some researchers have used detailed fisheries observer data to clarify the role of seamounts in aggregating large pelagic biodiversity, and to identify pelagic species associated with seamounts. These analyses suggest that seamounts, mainly within 30–40 km from the seamount summits, are hotspots of pelagic biodiversity, showing consistently higher species richness than coastal or oceanic areas. Many species were observed to aggregate near seamount features, such as blue shark (*Prionace glauca*), oceanic whitetip shark (*Carcharhinus longimanus*), swordfish (*Xiphias gladius*), moonfish (*Lampris guttatus*) and sunfish (*Mola mola*), but also albatross and dolphins. The results indicate that seamounts are potentially areas of special interest for conservation, particularly because many occur within the exclusive economic zones (EEZs) of SPC member countries and territories. Management of oceanic ecosystems is considered easier within the boundaries of EEZs than in high seas areas. Observer data are insufficient for identifying which seamounts aggregate more biodiversity than others, but with continual improvement and expansion of observer programmes in SPC member countries and territories, such analyses will be possible in the near future.

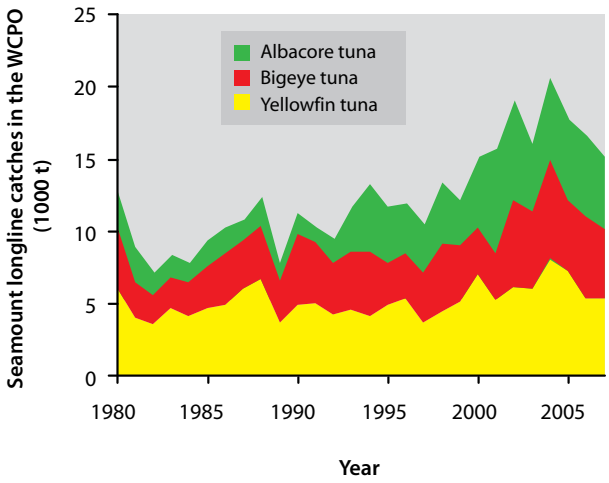


Figure 2. Cumulative longline tuna catch from WCPO seamounts in thousands of metric tonnes.

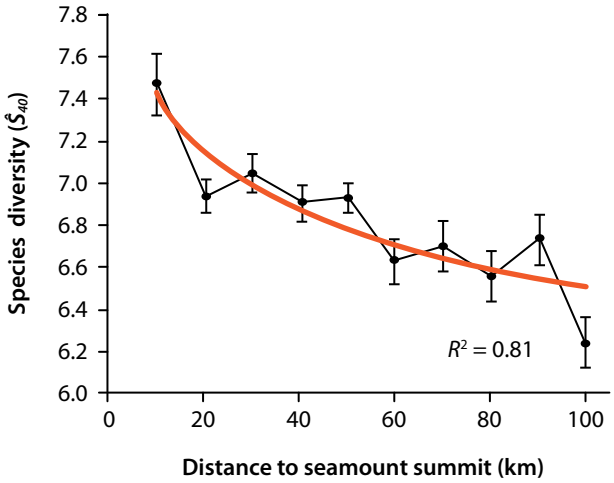


Figure 3. Mean species diversity rarefied from 40 ($\hat{S}_{40}$) individuals as a function of distance to seamount summit. The fitted logarithmic regression is also shown (orange line).

Fore more information:

Telmo Morato, Fisheries Scientist (Spatial Analyst), SPC
Email: t.morato@gmail.com

Valérie Allain, Fisheries Scientist (Ecosystems Analysis), SPC. Email: ValerieA@spc.int

Simon Nicol, Principal Fisheries Scientist (Tuna Ecology and Biology), SPC
Email: SimonN@spc.int

Simon Hoyle, Senior Fisheries Scientist (Stock Assessment), SPC. Email: SimonH@spc.int

Tuna fisheries in the western and central Pacific, an update

Tuna fisheries are an important source of income and employment for many Pacific Island countries and territories. For many, the tuna resources within their 200-mile exclusive economic zones (EEZs) represent their only significant renewable resource and their best opportunity for economic development.

Tuna fisheries in the western and central Pacific Ocean (WCPO) target four main species: skipjack (*Katsuwonus pelamis*), yellowfin (*Thunnus albacares*), bigeye (*T. obesus*) and albacore (*T. alalunga*). The total annual catch in 2008 was approximately 2.4 million metric tonnes (t) (Fig. 1), an all-time record, and representing 56% of global tuna production. The estimated delivered value of the WCPO catch in 2008 was a record USD 4.4 billion. Several major gear types are used in the fishery. Three-quarters of the regional catch comes from the purse-seine fisher, which provides tuna for canning in regional and Southeast Asian canneries. The purse-seine fishery targets skipjack tuna, but also takes significant catches of juvenile yellowfin and bigeye tuna. The longline fishery, which targets adult bigeye, yellowfin and albacore tunas, constitutes a much smaller portion of the catch (10%), but its value is relatively high (30% of the total value). Longline-caught bigeye and yellowfin tunas are exported fresh or frozen to sashimi markets in Japan and the USA, while albacore is a premium "white meat" canned tuna product.

While the overall catch is distributed throughout the WCPO region, it is particularly concentrated in tropical waters, where the EEZs of Pacific Island countries and territories predominately occur. Approximately half of the total WCPO catch (i.e. 1.2 million t annually), comes from the waters of Pacific Island countries and territories.

Stock assessments

Skipjack

Skipjack tuna are a short-lived species (maximum age ~3 years) that grow rapidly (reaching a maximum size of ~10 kg) and have rapid population turnover. Skipjack are highly resilient to fishing pressure and seem capable of supporting annual catches at the current level of about 1.6 million t annually. The majority of exploitation occurs on fish that have already reached reproductive maturity (age 1+ year). Most skipjack, therefore, have the opportunity to reproduce before being exposed to intensive fishing pressure. This provides a measure of protection to the stock's reproductive capacity. The fishery's current impact represents a depletion of equatorial adult biomass of about 40% from unexploited levels.

Yellowfin

Yellowfin tuna live up to seven years, grow rapidly and have moderate population turnover. Yellowfin reach a maximum size of about 70 kg, and begin spawning at around 1.5-2.0 years of age (~100 cm fork length, or 20 kg). Current catch levels are 400,000-450,000 t annually, mainly taken in the western equatorial region of the WCPO by the purse-seine fishery and the domestic fisheries of the Philippines and Indonesia. The purse-seine fishery catches juvenile yellowfin in floating objects sets (logs and fish aggregation devices, or FADs) and large yellowfin from free-school sets. Large catches of juvenile yellowfin are taken by the domestic fisheries of the Philippines and Indonesia. The most recent (2009) stock assessment for yellowfin indicates that the stock is at or near fully exploited levels. The assessment

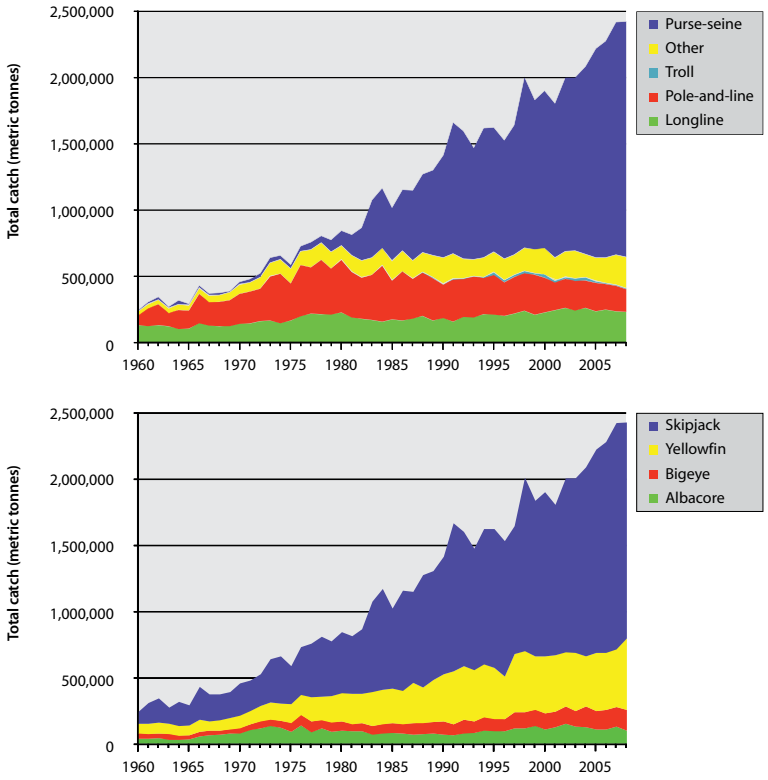


Figure 1. Total 2008 tuna catch in the WCPO by gear type and species.

indicates that the western equatorial area is the most impacted, while fishery impacts in subtropical regions are not large. The Western and Central Pacific Fisheries Commission (WCPFC) Scientific Committee has recommended that there be no increase in fishing mortality in the western equatorial Pacific, where the fishery has depleted the adult biomass by about 70% from unexploited levels. Most of this impact is attributable to the Indonesian and Philippines domestic fisheries and the purse-seine fishery. The longline fishery has a relatively low impact on the yellowfin stock.

Bigeye

Bigeye tuna live to be at least 12 years of age, grow more slowly than yellowfin, have lower natural mortality, and a lower stock size. Bigeye reach a maximum size of about 120 kg, and begin spawning at around three to four years of age (~110 cm fork length, or 30 kg). While the largest component of the catch is larger fish caught by longline gear, significant exploitation of juveniles occurs by the purse-seine fishery setting on floating objects and by the domestic fisheries of the Philippines and Indonesia. These juvenile catches have a substantial impact on the subsequent adult population. Recent assessments (2008 and 2009) show that overfishing of bigeye tuna is currently occurring. The WCPFC Scientific Committee has recommended that fishing mortality be reduced by a minimum of 30% from 2001–2004 average levels. The current impact on the fishery represents a depletion of adult biomass of over 80% from unexploited levels. This impact is attributable to the longline fishery and, to a lesser extent, those fisheries capturing juvenile bigeye tuna.

South Pacific albacore

Albacore tuna live up to 10 years, are relatively slow growing and reach a maximum size of about 25 kg. Albacore begin spawning at about five years of age (~80 cm fork length, or 10 kg). Apart from a minor troll fishery that targets juvenile albacore, most of the catch is by longline gear, which catches few juvenile albacore. As with skipjack, most albacore have the opportunity to reproduce before they are exposed to significant fishing pressure. This provides a measure of protection to the stock's reproductive capacity. The fishery's current impact represents a depletion of adult biomass of 35% from unexploited levels. While overfishing is not estimated to be occurring, further expansion of catch or effort would have negative impacts on the longline fisheries that rely on this species.

Management issues

WCPFC has the responsibility of implementing conservation and management measures for WCPO tuna fisheries throughout the geographic range of tuna stocks. The main management issue currently facing the WCPFC is overfishing for bigeye tuna. In 2008, the WCPFC adopted a conservation and management measure (CMM2008-01) that contains a mixture of catch, effort and capacity limits, as well as time/area gear restrictions. SPC's Oceanic Fisheries Programme conducted analyses to evaluate the potential impacts of the measure, and found that:

- CMM2008-01 is highly unlikely to meet its objectives of a 30% reduction in bigeye tuna fishing mortality from the 2001–2004 level, or maintenance of the bigeye tuna stock at a level capable of producing the maximum sustainable yield (MSY) over the long term.
- The measures are predicted to result in little, if any, reduction in bigeye tuna fishing mortality from the high levels in excess of two times F_{MSY} estimated for 2007–2008, and accordingly, spawning biomass is predicted to fall to around 40–60% of the level necessary to support MSY.
- The main reasons for the measure's lack of effectiveness are i) the many exemptions that are built in, including the exclusion of archipelagic waters; ii) likely increases in purse-seine effort and efficiency; and iii) insufficient reductions in the longline catch of large bigeye tuna.
- While the outcome from the first year of implementing CMM2008-01 is not yet known, it seems clear that there will be a need to strengthen the measure if bigeye tuna stocks are to remain near levels capable of producing MSY.

WCPFC is now at a crossroads in managing tuna fisheries in the region. Its early efforts to limit the increase in fishing effort and capacity have been ineffectual, and there are concerns regarding sustainability for some key species. Meanwhile, there is continued pressure to expand fishing effort to meet the legitimate development aspirations of Pacific Island countries and territories, and to provide access for new entrants to the fishery from Europe and Latin America. At the same time, the established distant-water fishing nations wish to maintain their historical share of the fishery. The need to allocate an increasing share of the tuna catch towards ensuring food security for rapidly-growing Pacific Island populations will result in further pressure on tunas. The Pacific now needs to take the lead, both within and outside the WCPFC, to ensure the long-term conservation and sustainable use of this critical resource.

For more information:

www.spc.int/oceanfish/

COASTAL FISHERIES PROGRAMME
NEARSHORE FISHERIES DEVELOPMENT AND TRAINING SECTION

Techniques to reduce bycatch of endangered species

Bycatch has become an increasingly prominent issue in commercial tuna fisheries of the western and central Pacific Ocean in recent years. Increased observer coverage has resulted in a better understanding of the nature of interactions between these fisheries and both protected species and other species of concern. Sea turtles, seabirds and cetaceans are some of the animals currently attracting the greatest concern, primarily because they take a long time to mature, are long-lived, and produce relatively few offspring. For the same reasons, increased attention is also being paid to shark bycatch in commercial tuna and swordfish catches. Certain management measures that are, or soon will be, in force have been established by the Western and Central Pacific Fisheries Commission regarding the mitigation of bycatch. These measures will have an impact on vessels fishing in the SPC region, including domestic and domestic-based fleets.

Over the years, SPC's Nearshore Fishery Development and Training Section has been involved in bycatch awareness and mitigation, including the provision of workshops for the commercial tuna industry, publication of booklets on protected species, and the production of a variety of bycatch awareness materials for both artisanal and commercial fisheries.

A workshop was convened by the Nearshore Fishery Development and Training Section to improve the capacity of training institutions and fishery departments in the SPC region. The purpose of the workshop (which ran from 8–12 June) was to enable participants to deliver awareness programmes to their local fishing industries, and to develop a specific training module on bycatch to be included in the development of new training courses in the future. Workshop participants came from Cook Islands, Fiji, French Polynesia, Kiribati, New Caledonia, Solomon Islands, Palau and Papua New Guinea. The workshop was conducted by Hawaii-based consultant Mike A. McCoy of Gillett, Preston and Associates. Three members of SPC's Oceanic Fisheries Programme gave presentations. Peter Williams provided an overview of the collection and use of bycatch data, and spoke on the importance of collecting such data. David Kirby gave an overview of the Oceanic Fisheries Programme's ecological risk assessment project for bycatch monitoring that is being undertaken for the Western and Central Pacific Fishery Commission's Scientific Committee. Peter Sharples gave a presentation on observer activities related to bycatch, and provided insights into bycatch-related observer activities.

In addition to the specific presentation by SPC-based experts, topics covered during the week-long workshop included:

- a brief overview of the aspects of commercial tuna fishing methods most relevant to bycatch;
- why avoiding bycatch is important (both from biological and economic points of view);
- current national legislation and regional and international instruments that govern bycatch practices by fishers;
- estimates of bycatch levels in the western and central Pacific commercial tuna fisheries (longline and purse seine);
- methods and gear configurations that can mitigate bycatch interactions;
- methods and tools to mitigate mortality in certain species caught incidentally to fishing operations;
- the importance of collecting and recording bycatch data onboard; and

Mike McCoy shows how to use a de-hooker to Mbwenea Teioki from Kiribati

- an example of a required protected species workshop designed for longline fishing operators.

During the last day and a half of the workshop, participants from fishery management administrations devised a brief outline of course content for a standardised Pacific Islands bycatch workshop that could be used as the basis for the development of more detailed workshops at the national level. Participants from training institutions created individual approaches to a bycatch training module that will be taken forward by SPC to develop a regional training module to provide basic knowledge and skills in bycatch mitigation. Each participant also created a short plan on how these activities could be implemented at the national level.

Samol Kanawi and Manoi Kutan, from Papua New Guinea, watch Marie Yonger, from French Polynesia, learning how to use a de-hooker...using cardboard.

Hook exchange project in Cook Islands reduces sea turtle bycatch

Concerns about the high numbers of sea turtles caught by Rarotonga's domestic longline fleet have resulted in a hook exchange project. Cook Islands' domestic longline fleet, which targets mainly swordfish and bigeye tuna, was catching sea turtles at an unsupportable rate, and concerns were raised that efforts needed to be taken to mitigate the capture and post-capture mortality of these turtles. During the project, a loggerhead turtle was caught by a domestic longline vessel and released alive. Interviews with boat captains revealed that, although the Cook Islands Ministry of Marine Resources (MMR) had no data on turtle bycatch for the domestic fleet, turtle interactions were not uncommon. In fact, since 2007, there have been three more observed turtle interactions (one each of loggerhead, hawksbill, and leatherback) with the domestic fleet, all during 2009. This is particularly alarming considering that the fleet was down to only three vessels when these interactions were reported. Two of the turtles were released alive but the leatherback died. All three turtles were hooked in the mouth.

Subsequently, it was decided to organise and conduct a hook exchange project with vessels in Rarotonga's domestic-based longline fishery. The project was a collaborative effort, with inputs from MMR and the Pacific Island Fisheries Science Center (PIFSC), which is part of the US National Marine Fisheries Service. More specifically, the project's objective was to conduct an experiment using large circle hooks in the Cook Islands domestic longline fishery to determine whether or not their use would mitigate bycatch catch rates while not affecting target species catch rates. SPC and PIFSC organised and initiated the experiment, while MMR carried on with the experiment for a specific time in order to capture a robust data set.

PIFSC subsequently donated 16,000 16/0 stainless steel offset, non-ringed circle hooks to be used in the project. SPC, using funds secured from the Pacific Islands Forum Fisheries Agency (FFA), purchased all ancillary gear, including bench crimpers, sleeves, protective tubing and monofilament for the branchlines. MMR provided assistance in setting up the project (Pam Maru was selected as project supervisor) and provided a vehicle for the initial phase of the project while SPC and PIFSC were present in Rarotonga.

During the project's first week, half of the gear on the project vessel, F/V *Gold Country* was converted to experimental gear. Although some of the boats in the fleet used Japan tuna hooks and/or Teracima hooks (similar to Japan tuna hooks) exclusively, the F/V *Gold Country* already had a good proportion of circle hooks on their branchlines. In fact, 14 different hook types and sizes were found.

The experimental plan was simple. One half of the hooks normally used on the project vessel were cut off of existing branchlines and replaced by project

Fourteen different hook types and sizes were found among F/V *Gold Country*'s gear.

hooks (16/0 SS offset circle hooks without ring). No other changes were made with the exception that, as hooks were replaced, monofilament was also replaced if damaged. This is a usual practice for longline boats in normal circumstances. Thus, there were effectively two sets of terminal gear — control and experimental. F/V *Gold Country* routinely deploys about 1,500–2,000 hooks per set. The project team made up 1,500 experimental branchlines in three branchline bins, which was sufficient for half the set, plus spares on the first trip and a reserve for subsequent trips. The snaps on all of the experimental gear were spray-painted with blue enamel so that they could be readily distinguished from control branchlines (see Figure).

The SPC/FFA Regional Longline Observer Catch Monitoring Form LL-4 was used to record all catch data. In the blank column, the hook type was recorded as O (control) or X (experimental) so that it was known for every animal caught which hook type it was caught on. All other relevant information was taken on this form. It was decided that the best sequence for setting initially would be OX-OXOX. In other words, control hooks would be alternated with experimental hooks, one to one. The first set and haul operation, however, had operational difficulties resulting from this set up. It was not easy for the crew to keep up with hauling and coiling while having to alternate blue snaps with plain snaps. After the second set it was decided to abandon the alternating hook approach, and allow the branchlines to be returned to the bins in random order. By the end of the trip it appeared that the two types of branchlines were randomly distributed in the branchline bins.

Results of the first trip were very promising. Although the dataset is too small to draw any definitive conclusions, the new hooks caught more fish, including more of the target species, than the control hooks. In total, 9,130 hooks were set during five sets, catching 127 fish of 14 species. Table 1 shows a breakdown of catch by hook type. The X hooks caught 58% of the albacore, 57% of the bigeye tuna and 83% of the swordfish, the three main target species. The X hooks caught 58% of the overall catch. No turtles were encountered.

To facilitate future experiments of this kind, and to aid observers and researchers in identifying hook types used in longline fishing, SPC is producing a booklet titled "Longline terminal gear identification guide". Copies of this booklet should be available in early 2010. The guide will include drawings (to actual size) of all the various hooks used in longline fishing operations in the Pacific.

Table 1. Total fish caught by species on each hook type: O hooks are control, X hooks are experimental.

Species	O hooks	X hooks	Total
Albacore	10	14	24
Bigeye	3	4	7
Skipjack	4	1	5
Swordfish	2	10	12
Striped marlin	0	1	1
Wahoo	1	0	1
Mahi mahi	10	11	21
Snake mackerel	4	14	18
Mora	8	10	18
Oilfish	6	4	10
Blue shark	1	4	5
Pelagic stingray	3	0	3
Lancetfish	1	0	1
Shortfin mako	0	1	1
Total	53	74	127

For more information contact:

Steve Beverly, Fisheries Development Officer, SPC
Email: steveB@spc.int

Note: Article written with input from Dan Curran, NOAA PIFSC

MMR staff exchanging hooks and painting snaps

REEF FISHERIES OBSERVATORY

Ciguatera-like fish poisoning from giant clams on Emao Island, Vanuatu

Ciguatera — a particular type of marine fish poisoning — is caused by eating tropical coral reef fish that have accumulated ciguatoxins through the marine food chain. The social and economic impacts of such intoxications are highly significant in the Pacific, where fish is an important part of people's daily food and is one of the few sources of cash income for coastal communities.

In October 2008, during a ciguatera and marine biotoxins conference organised by SPC, the Institute of Research for Development (IRD), the Pasteur Institute, and the Papeete-based Louis Malarde Institute (ILM), a representative from Vanuatu's Fisheries Department highlighted a severe outbreak of fish poisoning on Emao Island near Efate (see Fig. 1). Although there are six villages on Emao, only Lausake village (located on the southeastern side, see Fig. 2) was being affected by fish poisonings. People were becoming seriously ill from eating fish as well as giant clams.

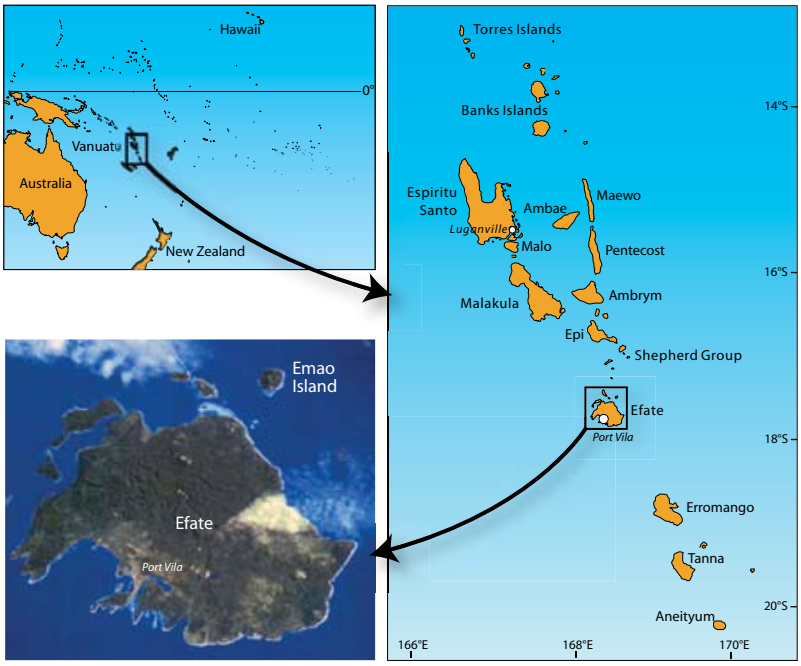


Figure 1. Vanuatu, Efate and Emao Island
(Picture source: Millennium Coral Reefs Landsat Archive).

Ciguatera-like poisoning from New Caledonia and French Polynesia

Poisoning caused by eating giant clams was recently studied on Lifou in New Caledonia's Loyalty Islands. The study found that within an area claimed to be the source of ciguatoxic fish and molluscs, there was an absence of *Gambierdiscus* sp., the dinoflagellate usually associated with ciguatera outbreaks. Present, however, were large populations of filamentous cyanobacteria identified as *Hydrocoleum*. Further *in vivo* and *in vitro* toxicological studies on samples of these cyanobacteria and giant clams showed the presence of lipid-soluble compounds that are ciguatoxin-like, and which are associated with water-soluble paralysing toxins such as paralytic shellfish toxins and/or anatoxin-a, and homoanatoxin-a.

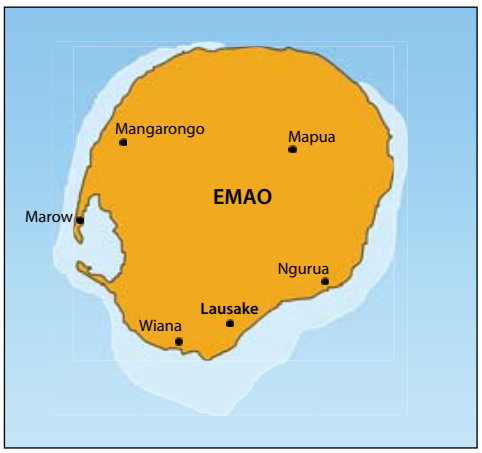


Figure 2. Emao Island and Lausake village.

Another case of poisoning from giant clams was reported from Raivavae in French Polynesia. This poisoning formed the focus of another similar toxicological study. The study revealed a strong relationship between anthropogenic impacts, the development of Oscillatoriales (cyanobacteria) blooms, and the resulting outbreak of ciguatera fish poisonings caused by eating giant clams in affected areas, all of which suggest a new trophic pathway of human poisoning via molluscs such as giant clams. Indeed, the symptoms experienced by patients included the characteristic sensation of temperature reversal. Therefore, the term "ciguatera" is still used for this new intoxication.

The case on Emao Island in Vanuatu provides a suspiciously curious and interesting case that could provide another possible example of cyanobacteria-related fish poisoning. The sampling and chemical analy-

ses required for a proper toxicological study will require a good experimental design and extensive field efforts. This first preliminary investigation serves as a preparatory first step toward this larger study.

Emao Island study

In response to a request from Vanuatu's Fisheries Department, a joint SPC, IRD and ILM mission to visit Emao Island was organised in order to:

- Contact communities affected by the fish poisoning epidemic, and collect historical information on when the fish poisoning began, who was infected, which fish were implicated, and the types and duration of symptoms;
- Present the current knowledge and improve the community's understanding of ciguatera and marine-related illnesses related to eating fish and shellfish;
- Gain an idea of the extent of the infected reef area through field inspection, and evaluate the quality of the reef by taking pictures and conducting some preliminary investigative sampling;
- Conduct a chemical analysis of collected samples in order to identify the presence of ciguatera- and cyanobacteria-related toxins; and
- Use preliminary results and observations to design a more detailed research project to investigate and understand the problem.

In May 2009, SPC's Senior Fisheries Scientist, Being Yeeting, and a doctoratal student working on marine biotoxins, Anne-Sophie Kebrat from IRD visited Emao Island. Being and Anne-Sophie worked with two local counterparts from Vanuatu's Fisheries Department, Sompert Gereva, Senior Fisheries Biologist and Jeremy Kaltavara, Fisheries Research Assistant.

Field methods

Informal interviews

During the visit, information on the number of ciguatera cases admitted was collected from the Public Hospital in Port Vila through an interview with the Director of Public Health, Dr Griffith Harrison.

Historical and epidemiological information was collected through consultations and informal interviews with the community of Lausake village. Only a few people of the interviewees could fully understand English, and so it was important to have the fisheries officers assist in translating questions from English to Bislama to the local people, and to translate responses from Bislama to English for us, the research team. The questions asked were generally addressed to the entire community, with more detailed questions targeted at individuals who were willing to share their experiences of their poisoning. During consultations, the team took the opportunity to give a poster presentation, explaining the ciguatera problem and the ongoing research and investigations that are being carried out to try and better understand the problem. A copy of the poster used in Bislama was given to the Vanuatu Fisheries Department for use at other ciguatera public awareness meetings.

Site observations

A site visit was made to evaluate reef conditions, water quality, and the size of the infected area based on information collected from fishers. Underwater observations were made using mask and snorkel, swimming in a square from the beach out to the outer reef, across the area close to the outer reef, from the outer reef to the beach and along the beach side. Photographs of corals and substrate observed were taken.

Collecting samples

Samples of cyanobacteria were collected by hand from various locations and different biotopes. The samples were preserved in sealed containers for later analysis. Macroalgal samples were also collected and tested for *Gambierdiscus* sp. Some reef fish species and clam specimens were also collected to analyse their toxicity.

The samples were taken to New Caledonia for analysis at IRD's laboratory. A permit to take the samples out of Vanuatu was provided by the Vanuatu's Fisheries Department. A CITES permit for export had to be obtained for giant clams, a CITES-listed species.

Some results and observations

Informal interviews

An interview with the Director of Public Health at Port Vila Public Hospital revealed that the actual number of ciguatera cases has been increasing in recent years; and since October 2008, the hospital has recorded eight cases. Two cases involved whole families although the other family members were not admitted into hospital. A very serious case from Emao resulted in the patient being evacuated to New Zealand for treatment. Information obtained from patients indicated that the source of the ciguatoxic fish was the local fish market, where fish from Emao are sold. As a result, people in Port Vila are now avoiding fish from the market unless they are certain that the fish do not from Emao.

Also recently, there was a case of a boy who became ill and died from eating some kind of shellfish collected at the wharf in town. Yet another recent incident involved two deaths from eating mud crabs. Santo is another area with significant

numbers of ciguatera fish poisoning cases.

Lausake villagers were very interested in the study and were very cooperative during interviews, an indication of their desire for help in solving their fish-poisoning problem and to regain the seafood sources they have lost from their reefs. About 40 people were interviewed. Fish, shellfish or both had poisoned each of these people at least once. Because of the fish poisoning, villagers have stopped eating seafood from their reefs and have turned to root crops instead for food. The only fish they are comfortable eating now are tuna (which are never ciguatoxic), although catching tuna requires a boat and engine, which most villagers do not have.

The infected area seems to be localised to the reef adjacent to Lausake village, from the beach outwards to the barrier reef. The reef fish started becoming toxic 10 years ago, but giant clams, trochus, gastropods (e.g. *Nerita polita*), crabs and other shellfish (e.g. *Atactodea striata*) (Fig. 3) became toxic about three to four years ago.

Figure 3. *Nerita polita* and *Atactodea striata*, two invertebrate species found to be toxic off Lausake village.

One recent case was hospitalised, but thus far, no fatalities have been recorded. To test for toxic fish, villagers commonly use cats and dogs and, interestingly enough, there were hardly any cats or dogs in Lausake compared with Marow village.

Villagers noted differences in symptoms from eating toxic fish and toxic shellfish. The symptoms associated with eating toxic fish are typical of ciguatera: fatigue, nausea, diarrhoea, joint pain, and hot-cold sensory reversals. With shellfish, symptoms are quick to appear: tingling lips and burning sensations in the mouth, followed by gastrointestinal problems (diarrhoea and vomiting) that occur within the first hour, and neurological symptoms that last for several weeks (whereas with ciguatera, these tend to last for several months).

Field observations

The infected reef area from the beach to the barrier reef covered a distance of about 1,000 m. The reef area consisted mostly of *Acropora* spp., most of which were dead and covered with carpets of filamentous cyanobacteria (Fig. 4). The Oscillatoriales (cyanobacteria), mainly *Hydrocoleum* and *Phormidium* were seen in large and small diversified mats. At a distance of 10–20 m from the beach and along the beach over a stretch of about 100 m, gardens of *Sinularia*-like soft corals were found. The coast was very turbid, especially 50 m out from the beach.

Figure 4. Dead coral covered with carpets of filamentous cyanobacteria.

Samples collected

Batches of cyanobacteria — collected from different biotypes — will be properly identified in the laboratory. Several visually different coloured specimens were seen in the infected reef area (Fig. 5).

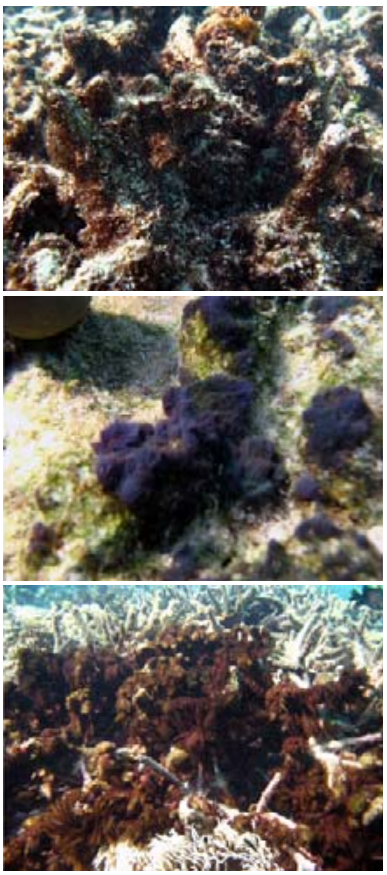
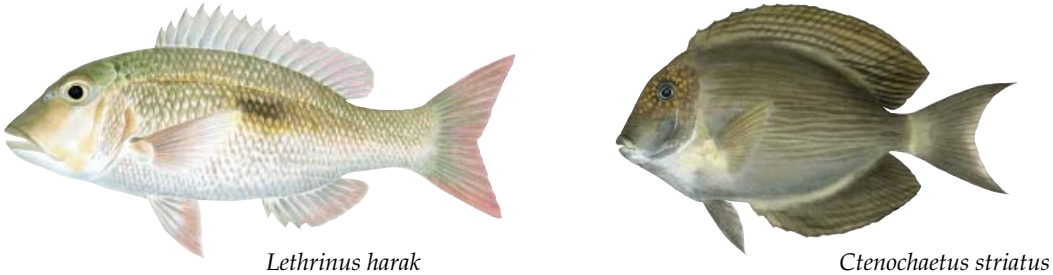


Figure 5. Cyanobacteria visible on different biotypes.

Three reef fish species — the parrotfish, *Hipposcarus longiceps*, the emperorfish, *Lethrinus harak*, and the surgeonfish, *Ctenochaetus striatus* (Fig. 6) — and one clam specimen, *Hippopus hippopus* (Fig. 7), were collected. Chemical analyses of these samples are being conducted at the IRD laboratory in Noumea.

The results should be available soon, and will hopefully provide some insights to the cause of the fish poisoning and whether the



Lethrinus harak *Ctenochaetus striatus*

Figure 6. Two of the three species of reef fish collected for ciguatoxin testing.

Figure 7. A giant clam sample collected for analysis.

toxins are ciguatera-based or cyanobacteria-related. The results will also be sent to Vanuatu's Fisheries Department and the Lausake village community when they are available, and will be used to develop a larger research project to examine the problem in greater detail.

Preliminary results from analyses

The samples collected revealed the absence of *Gambierdiscus* dinoflagellates, which are known to produce ciguatoxins.

Chemical analyses of samples taken from i) a mat of cyanobacteria, ii) fish, and iii) giant clams were also conducted. The water-soluble and lipid-soluble compounds obtained were screened for their toxicity with mouse bioassay and cytotoxicity test respectively.

These tests revealed a strong paralytic toxicity for both the cyanobacteria and giant clam samples. In addition, ciguatoxic-like toxins seem to be present in the giant clams collected. Theses results, however, need to be further confirmed. The lipid-soluble extract from cyanobacteria and the fish are currently being analysed for their ciguatoxic potential. The results of these further analyses were not ready when this article was written, but will be described in a more detailed technical report.

Concluding remarks

Recently, cyanobacteria have been found to play an important role in seafood poisoning, especially in relation to giant clam poisoning. Studies in Raivavae, French Polynesia and Lifou, New Caledonia have shown that it is possible for cyanobacterial toxins to enter the food chain directly through grazing fish (e.g. parrotfish) or via molluscs through molluscivorous fish (e.g. emperorfish).

Although the results of the chemical analyses of the Emao samples are not yet known, the presence of mats of cyanobacteria in the area of Lausake village certainly provides a strong possibility that cyanobacteria is the cause of the food poisoning currently occurring on Emao Island.

It was also interesting to note that the symptoms reported by Lausake villagers who became sick from consuming giant clams, seemed to correspond with those of the cyanobacterial-associated giant clam poisoning cases reported in Raivavae, French Polynesia and Lifou, New Caledonia. These symptoms are very similar to ciguatera-based fish poisoning symptoms, but seem to occur more rapidly and last only a few weeks, whereas ciguatera-based fish poisoning symptoms can last for several months.

It should be noted that such cases of seafood poisoning could be more common than currently known and are often regarded as ciguatera-related fish poisoning. People who experience peculiar symptoms of fish poisoning after eating molluscs or grazing fish (e.g. parrotfish) and molluscivorous fish (e.g. emperorfish) should contact their medical doctor or nurse, or the Fisheries Department. Such information could improve the understanding of seafood poisoning from different marine biotoxins.

Acknowledgements

SPC, IRD and ILM thank the community of Lausake village for their hospitality and co-operation during the visit, and the Vanuatu Fisheries Department for its support. Funds for this study were provided by the Pacific French Fund through ILM; French Polynesia, covered airfares and some fieldtrip expenses.

Fore more infomation, please contact:

Being Yeeting, Senior Fisheries Scientist (Live Reef Fish), SPC
Email: BeingY@spc.int

News from the CoFish and PROCFish projects

Coastal Fisheries Development Programme (CoFish) staff continue to compile and edit country reports, work on the regional assessment, write a manual on invertebrate survey methodologies, and assist Vanuatu with its coastal fisheries database. The Live Reef Fish Specialist was involved in ciguatera fieldwork in Vanuatu and the development of the live reef fish database.

CoFish team shrinks further

The contracts of three CoFish staff ended on 31 July 2009. Kalo Pakoa, Reef Fishery Officer (invertebrates) finished after five years with the project. Kalo is now working with the Vanuatu Fisheries Department on a project to enhance coastal and marine ecosystems resilience to climate change impacts through strengthened coastal governance and conservation measures. Although working in his new position, Kalo has been assisting with the finalisation of several of the project reports.

Emmanuel Tardy, Reef Fishery Officer (invertebrates) finished after four years with the project. Emmanuel now works as a private consultant, and is currently working with the CoFish project (on a short-term contract) to complete sections of the invertebrate survey methodologies manual. He is also assisting with the finalisation of several project reports.

Dr Silvia Pinca, Senior Fisheries Scientist (finfish) finished after three years with the project. Silvia will work with the project for two months later this year to complete the regional finfish assessment. She is also assisting with the finalisation of several project reports. Silvia plans to be a private consultant afterwards.

Country reports update

To date, 11 country reports have been published (French Polynesia, Kiribati, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tuvalu, Vanuatu, and Wallis and Futuna). Reports are available on the PROCFish/C web portal (http://www.spc.int/coastfish/Sections/reef/PROCFish_Web/PROCFishMain.aspx) on the country-specific page as public domain documents.

Several other reports will be available soon — Cook Islands, Federated States of Micronesia, New Caledonia and Tonga. All reports will be published before the end of 2009. The CoFish project concludes on 31 December 2009.

While the reports are being finalised by Celine Barre and Sarah Langi, the project's remaining scientific staff will focus on data analysis and the production of the regional assessment. The assessment will attempt to identify indicators of reef fishery status.

Kalo Pakoa,
former Reef Fishery Officer
(invertebrates)

Emmanuel Tardy,
former Reef Fishery Officer
(invertebrates)

Silvia Pinca,
former Senior Fisheries Scientist
(finfish)

AQUACULTURE SECTION

Promising spat collection trials in New Caledonia

There are times when one needs to listen to nature to seek the fantastic opportunities it can offer. Aquaculture that is based on spat collection is one of these. At certain times, millions of free-swimming pelagic shellfish larvae float within the water column, seeking a substrate to settle on. By submersing spat collectors at the right time and place, an unlimited supply of bivalve spat can be harvested and then grown to commercial size. Motivated by the New Caledonian development agency ADECAL and the willingness of local entrepreneurs, SPC's Aquaculture Section, together with a team of divers, has been undertaking a spat collection campaign targeting tropical scallops in New Caledonia's lagoon.

Recently set spat collectors (Image: Sandrine Job).

New Caledonia has diverse tropical scallop resources that could be harvested commercially given their various size ranges. Two species in particular — *Mimachlamys gloriosa* and *Bractechlamys vexillum* — can be collected in great quantities using spat collection techniques. *M. gloriosa* and *B. vexillum* are the most common scallop species found in New Caledonia's lagoon. *B. vexillum* is a mobile species that lives exclusively on soft-bottoms while *M. gloriosa* lives fixed on algae, sponges or on hard substrates. Spawning of these species occurs year round with some seasonal peaks.

For an initial spat collection trial it was decided that the spat collectors would be submerged during the winter, which corresponds to one of the spawning peaks for these species. Four sites were identified for spat collection: Nouville, Tontouta and La Foa in the Southern Province, and Pagop in the Northern Province. Previous trials carried out in Nouville are showing promising results already. The area around Pagop area was also sampled the year before and has also scored promising results, while Tontouta and La Foa were new sites that were never tested.

Most of the spat collectors were made from locally available materials (e.g. onion bags filled with a 1-m² shade cloth). Some other types of collectors (including commercial Tahitian collectors and other prototypes) were also trialed. A small float was attached to each spat bag in order to keep it above the seafloor because the lines were fixed down in the water column, towards the substrate.

Spat collection line before deployment (Image: Yves-Marie Anne).

Tahitian pearl oyster spat collector with scallop spat (Image: Antoine Teitelbaum).

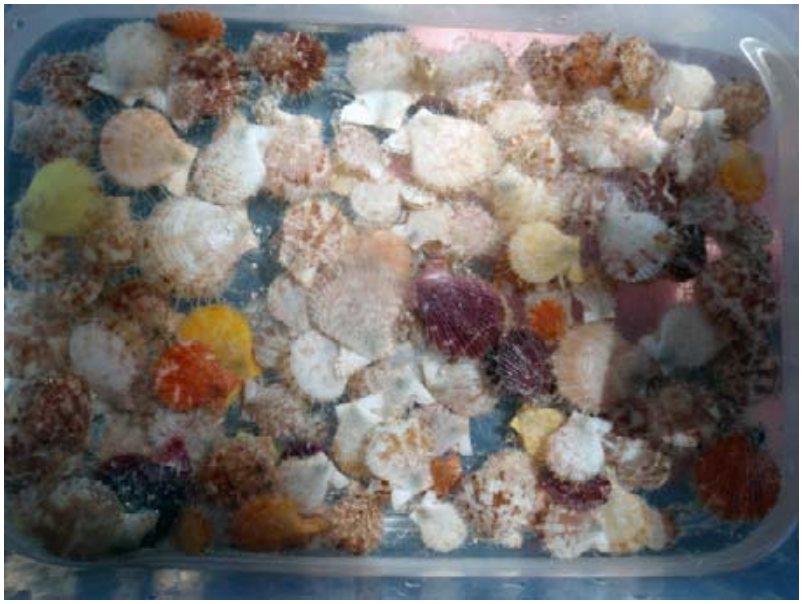
Anchorage was made with either sand bags or other types of moorings that were placed using scuba. All spat collection lines carried 30 bags and were placed at three different sites in each area in order to define the potential of the different stations that were sampled.

Collectors were left in the water for two months so that spat could settle and grow to a size at which they could be identified. In mid- to late August 2009, the team went back and harvested the collectors. All collectors were recovered and catches were identified by Dr Paul Southgate, bivalve specialist and head of the Aquaculture Division at Australia's James Cook University. *M. gloriosa* and *B. vexillium* were the most represented species in the catch, although many other shells were also collected (but with no commercial importance) but which may have potential for sale as specimen shells. A key to the identification of scallop spat is currently being produced by SPC as a tool for farmers.

Overall, the initial study results are promising, with spat numbers ranging from 0–400 scallops per bag, depending on the site and the type of collection device used. The size at which the scallops were collected ranged from 5–19 mm; smaller specimens were put back to the lagoon. The project will soon start a grow-out trial period for the collected spat using suspended culture techniques on longlines.

For more information, please contact:

Antoine Teitelbaum
Aquaculture Officer, SPC
Email: AntoineT@spc.int



Mimachlamys gloriosa spat (Image: Nadine Sephar).

Aquaculture potential in Wallis and Futuna

Wallis and Futuna have had very limited aquaculture development over the past few decades. In the 1980s, CNEXO (now IFREMER: Institut français de recherche pour l'exploitation de la mer) examined Wallis and Futuna's potential for aquaculture development, and short-term possibilities were identified, including the culture of exotic bivalves imported as spat. Medium-term possibilities included prawn and milkfish culture to support a pole-and-line fishery. Restocking reefs with trochus was considered as a long-term possibility. From 2004–2005, experiments on *Macrobrachium lar* (native fresh water shrimp) were carried out in Futuna by the Service des Affaires Rurales in partnership with SPC. The experiments were aimed at developing an integrated culture of freshwater shrimp in taro ponds.

In September 2007, a delegation from Wallis and Futuna visited SPC and met with fisheries specialists from SPC and the WorldFish Center to learn about the potential for developing aquaculture in their islands. It was decided that SPC would assist Wallis and Futuna in assessing its potential for aquaculture development by reviewing suitable aquaculture species, taking into account human, natural, technical and economical factors.

A grant provided by the 'French Pacific Fund', has, among other things, enabled the undertaking of a strategic analysis of aquaculture potential conducted by a consultant. The SPC Joint Country Strategy mission that visited Wallis and Futuna in February 2009 endorsed this consultancy.

IDEE Aquaculture from France was selected to carry out the review, and a consultant (Jacques Trichereau) visited the territory in June 2009. The consultant undertook the following activities, after visiting both Wallis and Futuna:

- Established a list of economically viable commodities for Wallis and Futuna. This list took into account human, natural, technical and economical factors and described their corresponding markets (export and domestic);

Aerial shots of suitable floating cage aquaculture sites in Wallis island: in the southern lagoon near Honikulu pass (left) and in the south-eastern lagoon near Faioa islet (right) (Images: Jacques Trichereau).

- Identified obstacles and constraints that would hamper the development of aquaculture in Wallis and Futuna, and proposed solutions to solve them;
- Prepared a checklist of necessary financial and technical steps to be taken (e.g. capital investment, training) in order to achieve the above; and
- Reviewed the potential for collaboration and synergies in aquaculture with neighbouring countries and Pacific francophone countries, as well as regional and national institutions.

As a result of the above, the consultant will draft a national strategic aquaculture plan for Wallis and Futuna, which can be used as a roadmap for developing aquaculture in this territory. So far, the consultant has identified two priority commodities: marine shrimp and finfish. Although these commodities would need to be imported as post larvae or fingerlings, both have promising potential in a country where the demand for seafood is high but the supply is currently low, and is mostly imported at high prices.

Another outcome of the study is that a delegation of officials from Wallis and Futuna will visit New Caledonia's aquaculture sector where they will make much needed contacts with public and private sector counterparts in the shrimp industry, and also have a close look at two marine fish projects that are currently being developed in New Caledonia.

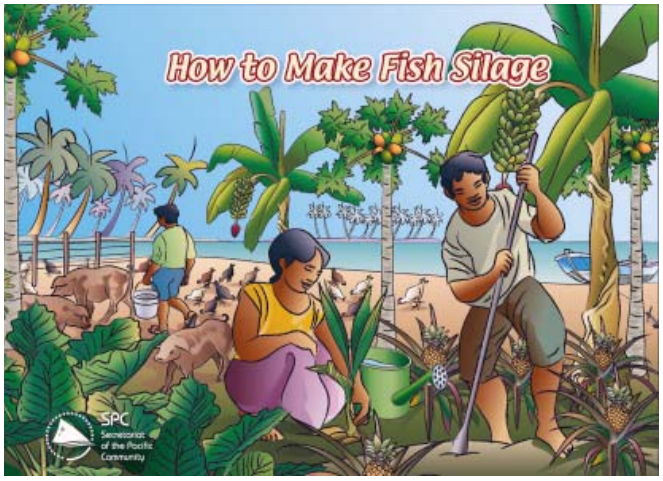
For more information, please contact:

Antoine Teitelbaum
SPC Aquaculture Officer
Email: antoinet@spc.int

or

Bruno Mugneret
Service de la Pêche
de Wallis et Futuna
Email: speche@mail.wf

NEW SPC COMIC BOOK ON HOW TO MAKE FISH SILAGE



Every year, hundreds of tonnes of fish waste are thrown away in Pacific Islands. This waste is often disposed of in rubbish dumps, where it attracts flies, rats and other pests that can carry diseases and contaminate water.

This new comic book produced by SPC's Nearshore Fisheries Development and Training Section explains simple techniques that can be used to process fish waste into liquid fish silage, an environmentally friendly fertiliser.

For more information, please contact:

Michel Blanc
Fisheries Development and Training Adviser
Email: MichelBl@spc.int

MAKING DECISIONS ABOUT TUNA FISHING IN THE PACIFIC — WCPFC FACT SHEETS

by Anouck Ride, Media and Publications, Pacific Islands Forum Fisheries Agency

Ever wondered how countries negotiate the rules on tuna fishing? Do you know how international decisions between Pacific Islands countries and the world's biggest fishing countries are made? Do you know what the Western and Central Pacific Fisheries Commission (WCPFC) is, or what it is doing to control fishing and illegal fishing activities?

These questions and more are answered in a set of WCPFC fact sheets produced by the GEF-funded Oceanic Fisheries Management Project (OFMP). Written for non-governmental organisations and fishing industry association as well as high schools, universities, government department staff, media and others interested in fishing issues, the WCPFC fact sheets are presented with photos, diagrams and easy-to-read explanations of the technical and political decisions made at the WCPFC.

WCPFC is the central decision-making body for managing tuna fisheries in the western and central Pacific Ocean. WCPFC's conservation and management measures (CMMs) are legally binding and apply to all WCPFC members and the Convention Area. Whereas members of the Pacific Islands Forum Fisheries Agency (FFA) are from the Pacific Islands region, WCPFC members are FFA members and members of distant-water fishing nations.

WCPFC's current members include Australia, China, Canada, Cook Islands, European Community, Federated States of Micronesia, Fiji, France, Japan, Kiribati, Korea, Republic of Marshall Islands, Nauru, New Zealand, Niue, Palau, Papua New Guinea, Philippines, Samoa, Solomon Islands, Chinese Taipei, Tonga, Tuvalu, United States of America and Vanuatu. Out of a total of 32 participating territories and members of WCPFC, over half (17) are FFA members, forming a significant voting bloc (although to date, WCPFC decisions have been made by consensus).

The western and central Pacific Ocean accounted for 54% of the world's tuna catch in 2007, making tuna a key economic resource. Increasingly, industry, environmental organisations and the international community are closely monitoring the outcomes of WCPFC annual meetings.

Fact sheet 1: Managing a global food resource: A Fisheries Commission and Convention for the Pacific

Fact sheet 2: Members of the WCPFC

Fact sheet 3: How does the WCPFC make decisions?

Fact sheet 4: What has WCPFC done so far?

Fact sheet 5: How WCPFC enforces the rules

Fact sheet 6: What Pacific islands are doing to manage tuna fishing

Fact sheet 7: Tuna stocks: how much tuna is in the region?

Fact sheet 8: How tuna is fished in the WCPFC area

Fact sheet 9: Who fishes in the WCPFC area?

Fact sheet 10: What happened at WCPFC 5?

All fact sheets can be freely downloaded in PDF format, from:
http://www.ffa.int/gef/factsheets

14TH PIMRIS STEERING COMMITTEE MEETING

by Maria Kalenchits, PIMRIS coordinator

Marine information professionals, librarians and people in charge of fisheries libraries from the region (as well as a number of observers) came together at the University of the South Pacific (USP), in Fiji on 24 September to attend the 14th Pacific Islands Marine Resources Information System (PIMRIS) Steering Committee Meeting. Participants came from seven Pacific Island countries and territories, including Cook Islands, Fiji, Kiribati, New Caledonia, Papua New Guinea, Samoa and Solomon Islands.

PIMRIS was established more than two decades ago with the aim of improving access to information on marine resources in the Pacific Islands region. PIMRIS participants come from ministerial or departmental libraries from most Pacific Island countries and territories, as well as four regional agencies: 1) the Pacific Regional Environment Programme (SPREP), based in Apia, Samoa; 2) the Pacific Islands Forum Fisheries Agency (FFA), based in Honiara, Solomon Islands; 3) the Secretariat of the Pacific Community (SPC), based in Noumea, New Caledonia; and 4) the South Pacific Applied Geoscience Commission (SOPAC), based in Suva, Fiji. The PIMRIS Coordination Unit is based in the Division of Marine Studies, at USP in Fiji.

PIMRIS Steering Committee meetings are held biannually to evaluate activities completed during the intersessional period and to decide on future plans and priorities. This year's reports and discussions were framed around the topic "from a print to a digital environment", and emphasised a need to preserve locally produced documents in digital format for each fisheries department in the region. Starting in 2009 in the framework of ODIN (Ocean Data and Information Network) - PIMRIS project, PIMRIS participants from five pilot countries — Cook Islands, Fiji, Kiribati, Samoa and Solomon Islands — have been involved in establishing institutional repositories in their fisheries departments. The project is supported by the International Oceanographic Data and Information Exchange Programme (IODE) of UNESCO's Intergovernmental Oceanographic Commission. As a result of collective efforts by PIMRIS agency participants and staff of the IODE Project Office, the Pacific Islands Marine Portal (http://www.pimrisportal.org) was established earlier this year as part of this project. The portal contains news, articles and directories of websites relevant to Pacific fisheries and to the coastal and marine environments of the Pacific region. The portal is administered jointly by all PIMRIS stakeholders and is hosted by UNESCO's IODE.

The PIMRIS Coordination Unit also reported on the establishment of two new digital collections — the USP Aquatic Repository for documents on marine and aquatic studies produced by USP, and the PIMRIS Regional Repository for published and unpublished documents produced by fisheries departments in the region. SPC, SPREP and SOPAC participants reported on developments of their own digital libraries.

Establishing a sustainable funding mechanism was discussed during the meeting as one of the most critical issues for PIMRIS. It was noted that all PIMRIS stakeholder agencies (i.e. FFA, SPC, SPREP, SOPAC and USP) should consider joint multilateral funding for PIMRIS regional activities. Including PIMRIS regional activities into SPC and SPREP projects funded by the European Union was recommended, and the possibility of writing joint funding proposals to donor agencies (e.g. New Zealand Agency for International Development and Australian Agency for International Development) was discussed.

A list of standing orders, recommendations and actions for the coming intersessional period was agreed on. The next PIMRIS Steering Committee Meeting is scheduled to be held in Suva, Fiji in 2011.

2009 PIMRIS Steering Committee meeting participants.

DEPLOYING A SUBMERGED FISH AGGREGATING DEVICE AT KAVALA, FIJI

by Tekata Toaisi and Sailosi Drili, Fiji Fisheries Department

In mid-2008, a surface fish aggregating device (FAD) was deployed outside Lasemarawa reef by the Fiji Fisheries Department in order to encourage local fishermen to partake in FAD fishing activities as an alternative source of income as well as to improve food security. It was also hoped that the FAD would provide a substitute fishing area to divert fishermen away from their inshore fishing activities and to relieve pressure on inshore reef stocks. It was intended to channel catch from the FADs to the Wainikaculoa Rural Fisheries Service Centre for distribution, through sales, to the people of Kavala Bay as well as the rest of Kadavu and Fiji, if fish supplies were abundant.

Figure 1. Wainikaculoa Fisheries Service Centre in Kavala Bay, Kadavu.

Lasemarawa reef is a system of submerged patch reefs clustered outside Kavala Bay, about 2 nm southeast of the government Wainikaculoa Rural Fisheries Service Centre, which was established by the Fiji Fisheries Department in 2006 (Fig. 1). The centre has an ice plant, a marketing display and storage facility, and fisheries staff to assist local communities with setting up a fishermen's association and to use the facility to market their catch for urban areas such as Suva.

The floating FAD deployed in mid-2008 consisted of a large orange float with a bamboo raft. This FAD was lost, however, after only three weeks. Villagers reported seeing divers with the orange FAD float, indicating that the FAD was probably vandalised and cut by the divers.

In light of the FAD's short life span, it was decided to replace it with a subsurface FAD settled at 46 m (25 fathoms) below the sea surface, rather than redeploying another surface floating FAD, and so would not be exposed to strong winds and high swells that are often experienced during certain times of the year in Fiji. It would also reduce the risk of local divers vandalising it.

Survey of FAD site

A FAD site survey was carried out using a GPS (global positioning system) to determine the coordinates of the surveyed sites (Fig. 2), and an echo sounder to determine depth. While the GPS functioned well, the echo sounder did not, and manual sounding had to be undertaken at each site. This was done using a fishing line with a lead attached at the end. The lead and line was dropped, retrieved, and measured at each sounding site. A total of 0.5 nm^2 was sounded with the coordinates in latitude and longitude recorded on graph paper.

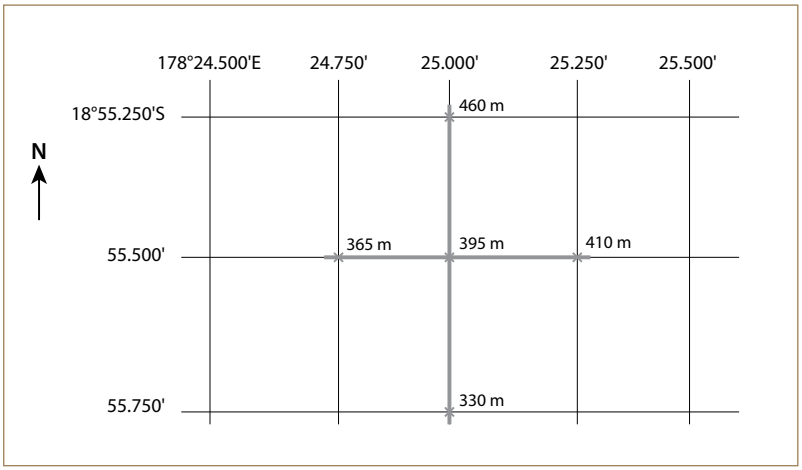


Figure 2. Area and coordinates of survey.

After the survey, a site with a depth of 395 m (216 fathoms) was selected. Mooring ropes were spliced to the appropriate length to set the float 46 m below the sea surface.

Deploying the FAD

Kavala Rural Fisheries Service Centre did not have a boat to deploy the FAD or carry out FAD surveys. Therefore, a 7-m fibreglass boat fitted with a 60 hp outboard engine, travelled from the Fisheries Department base in Lami to Kadavu to carry out the FAD survey and deployment.

FAD components were constructed in Suva and transported to Kavala on the MV *Sinu Wasa*; a local passenger/cargo vessel servicing the Suva Kadavu route on a weekly basis. These components were assembled at the Wainikaculoa Fisheries Centre (Fig. 3).

Despite unfavourable weather conditions, with a strong southeasterly wind, the FAD was deployed.

When the exact FAD location was reached, the subsurface FAD flotation section was put into the water (Fig. 4), then the deployment vessel moved upwind while paying out the mooring rope.

Figure 4. Flotation section being deployed.

The vessel did a long anticlockwise turn to prevent crossing the part of the mooring line already in the water. Once all the rope was paid out, the vessel had to be in position at the exact coordinates (18°55.518′ S and 178°25.051′ E) chosen for deploying the anchor. As soon as this was confirmed the anchor was released.

Figure 3. Assembling the FAD components at the Fisheries Centre.

Floating line marker

A floating line, with one end attached to a 2-L coke bottle and the other tied to the submerged float, was released after the flotation section was deployed. The floating line was marked with red insulation tape at 10-m intervals to determine the exact depth at which the flotation section settled below the surface. After it was determined that the FAD had reached its final settling position, the floating line was retrieved and the depth measured. The FAD flotation section was observed to settle at 46 m (25 fathoms).

Followup work

After completing the FAD deployment operation, some followup work was carried out:

- The Fiji Islands Marine and Safety Authority were informed of the location of the submerged FAD for the safety of seafarers.
- Fishermen from the area were informed of the location of the submerged FAD by the Kavala Fisheries staff, which carried out a briefing on the importance FADs for their livelihood.
- Monitoring the FAD on a weekly basis by Kavala Fisheries staff.

It was also noted that a new echo sounder with a depth range of 1,000 m or more will need to be purchased for future FAD work.

As of late August, the Fisheries Department office was receiving reports from fishermen confirming that the submerged FAD was still in place and starting to be productive. During the second phase of this Kadavu FAD development project, Fisheries Department staff will concentrate on working with FAD users to encourage them to regularly report their FAD catches.

PURSE-SEINE FISHING AROUND MOORED FADs IN PAPUA NEW GUINEA

William Sokimi
Fisheries Development Officer
SPC Costal Fisheries Programme
(WilliamS@spc.int)

Introduction

In Papua New Guinea (PNG), the domestically based purse-seine fleet mainly focuses on moored fish aggregating devices (FADs) and occasionally, drifting logs. This is one of the main reasons for the endurance of this fishery in PNG. Catches have fluctuated over the years due to climatic effects and economic factors, but overall, purse-seine fishing around moored FADs in PNG has provided more consistent and better economic returns than fishing on running schools.

FAD purse-seine fishing operations in PNG duplicate operations carried out in the Philippines. FADs reduce fuel costs for catcher boat activities and increases the chances of catching tuna. Backup operations to support catcher boats in this operation, however, somewhat offset the full benefits that may be attained if only a catcher boat and FADs were involved. Installing, monitoring and maintaining FADs is costly, and includes expenses such as supporting ranger boats to enhance operations. Additional expenses include providing regular supply boat service to ensure the purse-seine fleet is adequately replenished. FADs and backup operations greatly reduce catcher boats' operational costs, although support services to fishing company fleets add up and need to be constantly monitored to ensure that the benefits outweigh the costs of supporting catcher boats.

Two purse-seine fishing companies with domestic bases operate in PNG: Frabelle Fishing Company in Lae and RD Fishing Company in Vidar, Madang. Both companies originated in the Philippines where their mother bases still operate. Frabelle has its roots in Manila while RD operates out of General Santos City on Mindanao Island. Both companies predominantly use FADs as the centre of their purse-seine operations.

RD Fishing Company consists of several sections that are interwoven in their functions to support tuna catcher boats (Fig. 1), including:

- Shore-based operations
  - Main wharf for loading, offloading, replenishment, repairs, etc.
  - Workshop for engineering, mechanical, electrical and electronics repairs
  - Net repair and reconstruction shed
  - FAD construction, maintenance and deployment section
  - Ice plant that produces 150 mt/day (20 kg block @ K12/block)
  - Supplies store for fishing gear, rations, medical kits, spare parts etc.
  - Fish storage rooms with capacity to store 7,600 mt frozen tuna (1,600 mt old storage + 6,000 mt new storage)
  - Piggery, poultry, cattle, copra, rice and vegetable farming to supply provisions for the fishing fleet
- Sea operations
  - Supply and carrier boats: 10 ice carriers, 3 freezer export carriers, 1 provisions supply vessel, 1 tanker, 1 FAD tender vessel solely designated for servicing and replacing FADs at sea
  - 14 catcher boats of which 11 are currently operational
  - 28 ranger boats
  - 485 FADs deployed around PNG; mainly in the Bismarck Sea.

This is a major purse-seine operation, requiring skilled management to keep the company functioning profitably. An operation of this magnitude capitalises on government concessions and "holiday" schemes directed at attracting investment for developing the tuna fishery. Any cost increase that affects a component of the company can ad-

Figure 1. RD Fishing Company base in Madang, PNG

versely affect the economics of the whole operation.

Papua New Guinea purse-seine operations

In the Pacific region, tuna purse-seine fishing operations target skipjack (*Katsuwonus pelamis*) and yellowfin (*Thunnus albacares*) but, as is common with large-scale commercial fishing methods, bycatch is an unavoidable part of the operation. Purse-seine bycatch includes undersized yellowfin and big eye tuna (*Thunnus obesus*), wahoo (*Acanthocybium solandri*), rainbow runner (*Elagatis bipinnulata*), mahi mahi (*Coryphaena hippurus*), frigate mackerel (*Auxis thazard*) and triggerfish (Balsitidae).

Occasionally, sea turtles, cetaceans and sharks interact with purse-seine gear, which sometimes results in mortality. These occurrences, however, are not common. RD Fishing Company does not discard or waste any of its bycatch, and uses it to produce value-added products such as fish balls, fish sausages, marinated tuna steaks, and fish patties.

Purse seining is a very efficient fishing method that captures the bulk of the targeted fish school. Catches are large, ranging from 20 mt to more than 100 mt, depending on the size of the school and the efficiency of the setting operation. Tuna caught by purse seine are mainly used for canning. Purse seining is mainly designed to supply quantity rather than quality. Relatively high fish prices offered by canning factories for bulk tuna make this type of fishing viable.

PNG's purse-seine fleet consists mainly of catcher boats constructed to the US system of purse seining (Fig. 2). Most of these vessels were owned by American companies previously engaged in Pacific tuna fishing, but which pulled out because of increasing costs.

Figure 2. Typical American style purse seiner used in PNG's purse-seine fishery

Fish aggregating devices

The two companies engaged in PNG tuna purse-seine fishing construct, deploy and maintain their own FADs. RD Fishing Company has 485 FADs deployed, and Frabelle has a substantial number of FADs deployed in similar areas. Most probably, future PNG-based companies that plan to carry out similar operations, will have to deploy their own FADs. This may result in conflicts over FAD access unless the PNG government takes ownership of the FADs, or implements a more comprehensive FAD-sharing code. PNG's National Fisheries Authority established the PNG National FAD Management Policy in 2002. This policy is enforced and works reasonably well with the two domestically based companies; however, only one paragraph (21.a) in the policy actually addresses FAD sharing: "Each FAD and its surrounding area shall not be regarded as an exclusive fishing area for the company that deploys the FAD in the area". However, fishing etiquette suggests that companies do not use each other's FADs. In a situation where two catcher boats of different companies arrive at the same FAD at the same time, the catcher boat from the company that deployed that particular FAD has the right of exclusive access; the other vessel must move on to another FAD.

Any company concentrating the core of its operations on moored FADs must include in its operations a section dealing only in designing, constructing, deploying, maintaining and replacing FADs. RD Fishing Company is a typical tuna purse-seining company that does this. RD has a section that deals only with FAD work, and also has a vessel dedicated to carrying out this work.

The Philippine-type FAD (Fig. 3) has a 3-m-long float that is bullet-shaped and constructed of a mild steel casing sprayed with two inches of Styrofoam™ on the inside. The mooring system consists of wire cable and polypropylene rope with a combined length that includes the mooring depth plus 30% scope. These FADs are deployed in depths ranging from 1,000–4,000 m with a flat or very slight incline to the sea bottom.

FADs are visited periodically by ranger boats, which give a report on each FAD's i) position and condition; ii) whether the FAD is aggregating fish schools; and iii) the condition of the aggregators connected to the FAD.

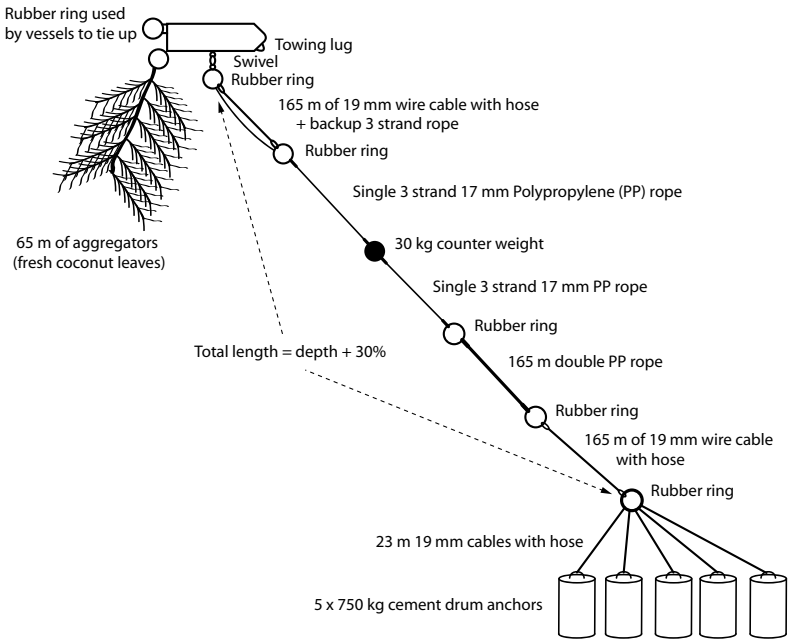


Figure 3. Philippine-type FAD (payao)

Whenever possible, the ranger boat skipper reports on the condition of the wire cable and connections immediately beneath the FAD.

Ranger boats and echo sounder information

Ranger boats (Fig. 4) are used as scout boats for the larger catcher boats. Each catcher boat has two ranger boats supporting its operations. Ranger boats usually have six crewmen, including the skipper and engineer, who are skilled handline fishermen.

Figure 4. Ranger boat commonly used in the PNG purse-seine fishery

Up to six or more FADs are checked daily to determine which one is most likely to have the highest numbers of fish for the following morning's fishing operation. At each FAD, the size of the school in the area is determined with the aid of an echo sounder as well as through visual observations of seabirds and fish feeding activity. Handline jigging is done at differing depths to determine the size and type of fish in the school. This information is relayed to the catcher boat's skipper.

Before dusk, the ranger boat returns to the FAD with "best potential" and ties up to it. Four to six 1,000 W halogen lamps are turned on at sunset and pointed at the water's surface to aggregate baitfish and tuna closer to the FAD. At night, the skipper periodically checks the echo sounder to evaluate the aggregated school's size (Fig. 5).

Figure 5. Echo sounder showing fish school passing beneath the vessel

(The echo sounder is the main equipment used by the ranger boat skipper to determine the size of a fish school near the FAD.) The method is not infallible, but it has worked over the years and is the accepted mode for determining whether a set should be made or not.

Just before daybreak the tuna school typically settles directly beneath the lights of the ranger boat. This enables the skipper to assess the school's size and relay this information to the catcher boat. The catcher boat's skipper then matches this with his sonar scan and makes the final decision on whether to fish or not.

Catcher boat operations

There are two types of catcher boat operations. One involves catcher boats that are also mother boats, which store their catch in brine or freezer holds; the other involves small catcher boats that offload their catch to fresh fish ice-carrier vessels, which, when full, return to their base for offloading. Catcher boats remain in the fishing grounds for as long as possible.

PNG purse-seine FAD operations more or less follow a routine schedule. The lead up to the morning's fishing operations depends on the time of sunrise, although generally at 03:00 each morning the catcher boat closes in on the ranger boat, which is still moored to the FAD. It then drifts about 500 m away while the skipper scans and monitors the FAD school with sonar for about an hour. At 04:00, both skippers liaise again on the fish aggregated at the FAD. Once the catcher boat skipper is satisfied that there is good potential, he gives the signal to lower the workboat, which proceeds to assist the ranger boat in separating the fish school from the FAD.

The ranger boat crew first removes the aggregator from the FAD and ties it to their vessel.

Simultaneously, the workboat hooks up to the FAD and slowly tows it up current. The ranger boat, with its bright halogen lights still on, then drifts with the FAD aggregator, drawing the fish away from the rest of the FAD.

In the meantime, the catcher boat skipper continues to monitor the movement of the fish school until it is again aggregated under the drifting ranger boat and orbiting in formation. It usually takes between 30 minutes and an hour to have the fish school settled again under the ranger boat lights.

Once the catcher boat skipper judges that the situation is right, the signal is given to standby for deploying nets. The skipper then manoeuvres his vessel into position and gives the signal to deploy the skiff, thus commencing the fishing operation.

Progressive stages of the operation after deploying the skiff include: closing and pursing the set (Fig. 6), hauling in the net (Fig. 7), drying the net in preparation for brailing (Fig. 8), and brailing (Fig. 9). Each of these stages must be carried out systematically and efficiently to ensure that the bulk of the fish school is caught and brought aboard for freezer storage.

Offloading fish and transshipment at sea

The basic approach to efficiently operating a fishing vessel is to attain as many fishing days possible during a fishing season. In light of this, transshipment at sea is a strategic measure to cut travel costs to and from fish bases as well as to produce more fishing days for catcher boats.

Transshipment at sea (Fig. 10) is part of the *modus operandi* of PNG's purse-seine fleet (unless the catcher boat has to return to base for repairs or in circumstances of prolonged adverse weather conditions).

Figure 6. Closing and pursing the net

Figure 7. Hauling the net

Figure 8. Drying the net in preparation for brailing

Figure 9. Brailing fish out of the net

Figure 10. Transshipping fish at sea

Safety

To conclude, purse-seine fishermen, as all modern seafarers, pay constant attention to safety. This is fuelled by necessity rather than a routine obligation to maintain safety standards. Almost all aspects of a purse-seine operation involve some form of possible hazard, which requires the crew to be alert and aware of activities happening around them at all times.

Fishing operational hazards include danger from the use of high-powered winches and steel wire cables; net entanglement; falling objects such as fish, blocks and tackle parts; slippery decks; capsizing of skiffs and workboats; and falling booms and rotating rollers. While every precaution is taken to make the work environment as safe as possible, and ensuring that crew are equipped with the appropriate tools and clothing to counter hazardous situations, accidents may still occur.

Other than the fishing operational hazards, crew should be prepared for the normal seafaring hazards through periodical drills. "Muster lists" are displayed on the bulkhead in the wheelhouse and the mess room, in a position that can be viewed by all, stating each crew member's name, his position on board, his distress (abandon ship) station and duties and his fire (emergency) station and duties.

The periodic "muster" drills focus on six areas:

1. Safe watchkeeping principles
2. Safe working practises
3. General emergency drill
4. Fire fighting drill
5. Abandon ship drill
6. Man overboard drill

Posters on safe working practises are also posted throughout the vessel.

INDONESIAN TUNA FISHERIES: GETTING TO KNOW OUR NEIGHBOURS

Peter Williams
Fisheries Database Supervisor
SPC Oceanic Fisheries Programme
(PeterW@spc.int)

Introduction

Indonesia is the world's largest archipelago, comprising over 17,500 islands with a combined coastline of about 81,000 km. The enormous number of highly varied ecosystems that exist in Indonesia's archipelagic waters has resulted in high biodiversity and productivity.

Indonesia's EEZ is adjacent to several Pacific Island countries (e.g. Palau, Papua New Guinea and the Federated States of Micronesia) and, therefore, shares the valuable highly migratory fish resources of the western and central Pacific Ocean. It is important that Pacific Island countries have an understanding of what is happening with tuna fisheries in Indonesia, with a view for enhanced future cooperation under the umbrella of our regional fisheries management agencies.

Indonesia's tuna fisheries in the Pacific Ocean

According to official FAO statistics (http://www.fao.org/fishery/statistics/tuna-catches/en), Indonesia catches a significant portion of the world's tuna. Indonesian fisheries comprise a complex mix of industrial and artisanal fisheries spread out over a wide area with unloadings undertaken in many ports. Artisanal fishing craft in Indonesia number in the hundreds of thousands over the past decade — a daunting statistic for any fisheries monitoring staff. The number of non-motorised fishing vessels in Indonesia is estimated to range from 220,000–250,000, while the number of vessels with outboard and inboard motors ranges from 160,000–180,000 and 80,000–90,000, respectively. Indonesia's fisheries are mainly traditional or small-scale (artisanal), consisting of gill nets (30%), traps (11%), trolling (7%), seine nets (6%), lift nets (5%) and other minor gear types. Commercial purse-seine and longline fisheries account for only 2% and 1%, respectively, of the total number of inboard fishing vessels.

The main gear types used to target pelagic tuna species in Indonesia are the industrial and small-scale purse seine (*pukat cincin/jaring pajeko*), pole-and-line (*huhate/pancing funae*), troll line (*pancing tonda*), handline (*pancing ulur tuna*) and longline (*rawai* tuna). Most tuna fishing involves fish aggregation devices (*rumpons*), which have been used traditionally in Indonesia for centuries. Indonesia is now one of the few places where pole-and-line fisheries persist on a large scale; live bait for these vessels is often supplied by a separate lift net fishery, with fixed or mobile platforms (*bagans*) deployed to catch and supply bait. The diverse fisheries within Indonesia and the way in which fish catches are disposed of, requires a detailed exposé, which will be covered in a future SPC *Fisheries Newsletter* article.

Indonesian fishing vessels targeting tuna operate mainly within the Food and Agriculture Organization (FAO) statistical areas #57 (eastern Indian Ocean) and #71 (western-central Pacific Ocean) (Fig. 1). Tuna fisheries in these broad ocean areas are managed by several regional fisheries management organisations

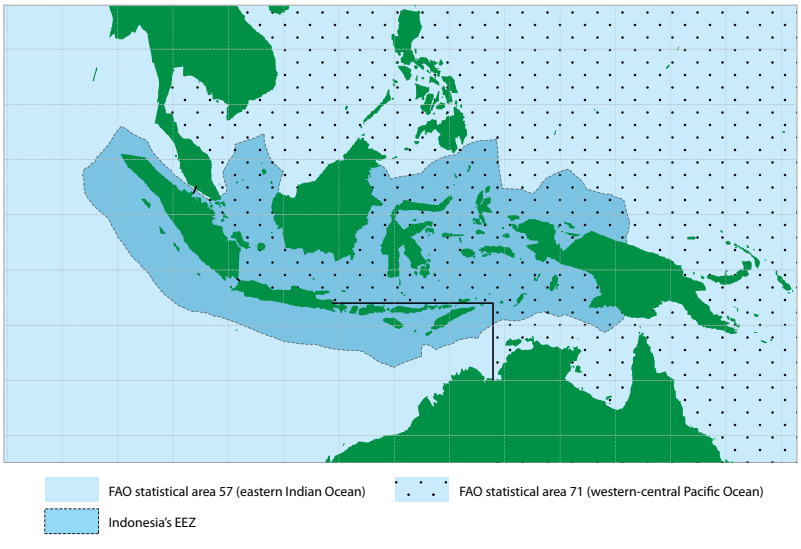


Figure 1. The Indonesian archipelago, showing the approximate 200-mile boundaries (darker blue) and the area covered by the WCPFC Convention Area (blue shading with dots, which is also FAO Area 71). Indonesian waters that do not overlap with the WCPFC Convention Area, and are included in the Indian Ocean Tuna Commission Convention Area (also FAO Area #57, light blue shading on this map)

(RFMOs): the Western and Central Pacific Fisheries Commission (WCPFC), Indian Ocean Tuna Commission (IOTC), and the Commission for Conservation of Southern Bluefin Tuna (CCSBT). Indonesia is a member of IOTC and CCSBT and was granted cooperating non-member status of WCPFC in December 2008, with a view to becoming a fully-fledged member in the next few years. WCPFC is responsible for regional tuna fisheries management that includes the part of Indonesia's EEZ on the Pacific Ocean side.[1] For national management purposes, Indonesia has divided its EEZ into 11 fisheries management areas, which were established through Ministerial Regulation 01/2009.

The main area of oceanic tuna fisheries in eastern Indonesia are the Sulawesi Sea, Maluku Sea, Halmahera Sea, Ceram Sea, Flores Sea and Banda Sea, and excludes the large continental shelf areas in the Java and Arafura Seas, and the southern part of the South China Sea where oceanic tunas do not occur.

Historically, the tuna fisheries of Indonesia's less densely populated eastern portion were subsistence, with only very minor commercial activities. However, by the 1970s and 1980s, the higher price of fish commodities abroad compared with those in the local market, along with an increased international demand for tuna resulted in a boom in fisheries exports from many coastal states, including Indonesia, which soon led to the development of pole-and-line, longline and purse-seine fisheries in Indonesia. These commercial fisheries were initially established through foreign involvement, but progressively moved to become fully domesticated, particularly over the past 10–15 years.

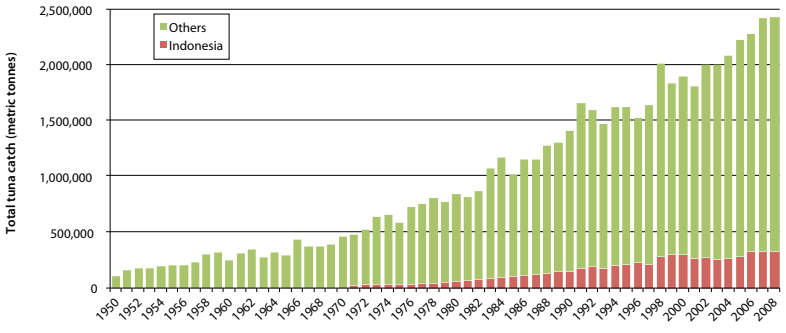


Figure 2. Comparison of Indonesia's annual total tuna catch to the annual WCPFC Convention Area tuna catch, 1950–2008

Indonesian catches of oceanic tuna (skipjack, yellowfin, bigeye, albacore and southern bluefin) and billfish species (swordfish, marlin and sailfish) represent a significant proportion of the total catches recorded in the Indian and Pacific Oceans by respective RFMOs. Eastern Indonesian catches account for around 15% of the total WCPFC Convention Area tuna catch and, therefore, represent an important component of the WCPFC tuna fisheries (see Fig. 2).

Monitoring eastern Indonesia's tuna fisheries

The complexity of Indonesia's tuna fisheries (comprising mostly artisanal craft that landing their catches at many ports) has made the task of monitoring the catch and effort extremely challenging. In the 1970s and 1980s, the Indo-Pacific Tuna Programme (IPTP, forerunner to the IOTC) was involved in establishing port sampling *inter alia* in several ports throughout eastern Indonesia. The IPTP eventually ceased involvement in Indonesia, but monitoring through port sampling and the work of scientists from Indonesia's Research Centre for Capture Fisheries (RCCF[2]) continued into the 1990s; however, data collection activities were sporadic and depended on the availability of funds. Coverage was generally very poor, which hindered the work of scientists and statisticians tasked with determining reliable catch estimates, and the provision of any data that could be used in stock assessments.

The Scientific Committee (SC) of the WCPFC noted as recently as August 2009 that there is a paucity of data on Indonesian tuna fisheries for conducting regional assessments of Pacific Ocean tuna stocks. Major problems include: i) the complete lack of operational and aggregated catch and effort data, and the paucity of size composition data; and ii) annual catch estimates provided by Indonesia have not been stratified by gear type, and bigeye tuna (with other large tuna and billfish species) were included in the catch estimate for "yellowfin" for years prior to 2004.

In recent years, the Indonesia's Directorate General for Capture Fisheries (DGCF) and RCCF have implemented a range of measures intended to strengthen the collection and processing of fisheries statistics in Indonesia, albeit with work that started earlier in the Indian Ocean than in the Pacific Ocean. Implementing some of those measures has come in response to recommendations from RFMOs, highlighting the need for Indonesia to satisfy its obligation to provide scientific data

as a member country of each RFMO. IOTC, with assistance from several member country agencies (e.g. the Australian Commonwealth Scientific Industrial Research Organisation [CSIRO], the Australian Centre for International Agricultural Research [ACIAR], and Japan's Overseas Fishery Cooperation Foundation [OFCF]), have successfully established monitoring at several key ports, servicing longline vessels fishing in the Indian Ocean over the past 10 years. These ports include Benoa (Bali), Muara Baru (north Jakarta), and Cilacap (south coast of central Java). Since the early 1990s, Benoa has been a focal point for sampling and, more recently, as a base for observer activities, largely as the result of this port being the primary landing place for Indonesia's catch of southern bluefin tuna. Recent improvements in Indonesia's fisheries statistical system have led to marked improvements in the estimation of total catches by species for Indonesia's longline vessels operating in the Indian Ocean, and in the estimation of catches by species and gear types for Indonesia's artisanal fisheries, also operating in the Indian Ocean.

The success in establishing monitoring systems for the Indian Ocean fisheries came after considerable effort by the Indonesian government fisheries departments and industry, with significant assistance from IOTC, OFCF, ACIAR, CSIRO and other agencies. This success provides optimism for establishing similar projects for the eastern Indonesian tuna fisheries. Since 2007, WCPFC has taken the lead in providing assistance to RCCF and the DGCF in establishing tuna fishery monitoring systems in eastern Indonesia (with funding assistance provided by the United Nations Development Program/Global Environment Facility [UNDP/GEF] and several WCPFC member countries) through several workshops conducted under the "Indonesia Philippines Tuna Fisheries Data Collection Project" (IPDCP), and more recently the UNDP/GEF West Pacific East Asia Oceanic Fisheries Management Project (WPEAOFM, established in mid-2009[3]). The Oceanic Fisheries Programme (OFP) of the Secretariat of the Pacific Community (SPC) is the science and data service provider to WCPFC, and has been primarily involved from the outset in providing technical advice to this important process.

There are major gaps in the available information on tuna fisheries in the waters of eastern Indonesia (despite recent comprehensive work done by the World Wildlife Fund 2008 and Proctor et al. 2003), but there are encouraging signs that this situation will change in the coming years with the establishment of several new fisheries monitoring initiatives. The importance of robust data collection systems that provide appropriate data cannot be underestimated, and the initiatives (briefly described below) will ultimately fill in some important gaps in regional fisheries data, which will be fundamental in providing more informed output from the regional assessments of Pacific Ocean tuna stocks.

Port sampling

Workshops funded through the WCPFC-administered IPDCP have been conducted on an annual basis since 2007 for the purpose of designing, planning and implementing port sampling data collection in key tuna fishery ports in eastern Indonesia. OFP's involvement has ensured that the data collection protocols and forms closely resemble those used by Pacific Island countries and, thereby, satisfy WCPFC's data requirements. At this stage, pilot sampling sites have been successfully established in Bitung (north Sulawesi) (Fig. 3) and Kendari (south Sulawesi) where landings and port sampling are conducted on all fishing

Figure 3. Enumerators (port samplers) measuring and recording the catch from a mini-purse seine vessel (*pajeko*), at the Bitung Port Fish market, North Sulawesi, Indonesia, which is adjacent to the Tuna Fisheries Monitoring Station (see insert) — note the important association with the WCPFC (Photos courtesy of Craig Proctor, CSIRO)

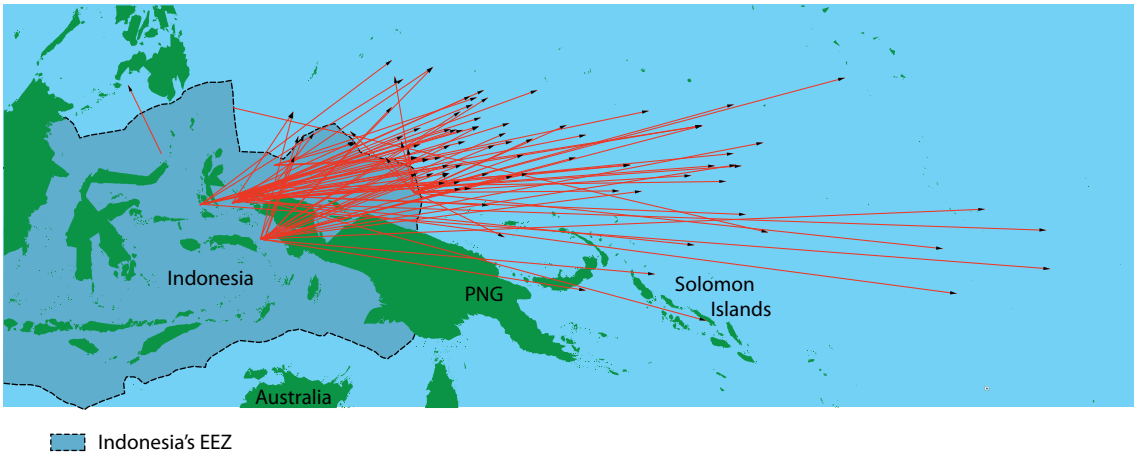


Figure 4. Long-distance movements of tunas tagged in Indonesian waters and recovered outside of Indonesian waters (Source: Regional Tuna Tagging project conducted by OFP, 1989–1992).

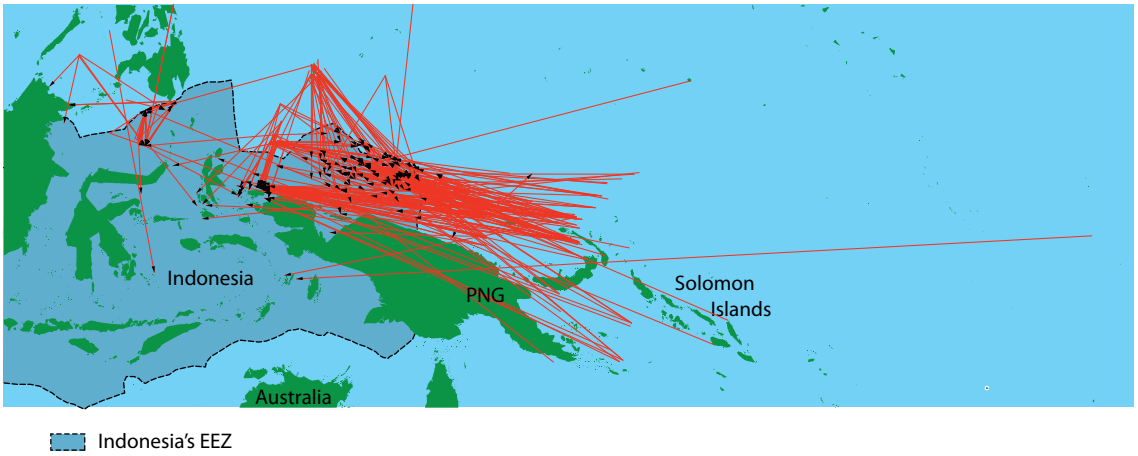


Figure 5. Long-distance movements of tuna tagged outside of Indonesian waters that were recovered in Indonesian waters (Source: Regional Tuna Tagging project conducted by OFP, 1989–1992).

gear types that target pelagic tuna species. Establishing the WPEAOFM project will result in considerable expansion of port sampling activities to several other key ports in the next three years.

Tuna tagging

Indonesia has a long history of tuna tagging initiatives, including the IPTP in the 1980s, the SPC Regional Tuna Tagging Project in 1991 (see Figs 4 and 5) and the World Bank North Sulawesi Tagging project in 1996–1997. As a part of the region-wide Pacific Tuna Tagging Project (PTTP) managed by OFP,[4] a tagging cruise was conducted in Indonesian waters in late 2008, which resulted in 25,197 tag releases (19,576 skipjack, 5,267 yellowfin and 354 bigeye tuna). At the time of writing this article, a second tagging trip was well underway and expected to be completed in mid-September 2009. There have already been 4,250 tag recoveries (16.8%) from the 2008 Indonesian tagging trip, and the information collected will provide invaluable input to stock assessments, in particular, the determination of natural mortality, growth and movement parameters of pelagic tuna species.

Logbook programme

Logbooks (or logsheets) provide the only means of obtaining information at the fishing operation level other than observer programmes, which, due to their expense and complexity, are usually not designed to provide 100% coverage of fishing activities. Until now, logbooks were only used on a sporadic basis in Indonesia's tuna fisheries, without any national legislation enforcing their collection, or where present (e.g. the longline fleet operating from Benoa), have failed to produce quality catch and catch per unit of effort

information. Some of the large industrial fleets use logbooks for their own purposes and only in rare instances are these provided to government research agencies (e.g. RCCF). In 2008, the DGCF embarked on a project to implement a logbook system for Indonesia's fisheries, and requested help from the tuna RFMOs to provide assistance in designing and implementing a logbook system that would satisfy the requirements for both Indonesia and RFMOs. A workshop was convened in May 2009 by IOTC and DGCF, and was attended by all Indonesian stakeholders (e.g. government fisheries agencies, fishing industry and associations) and RFMOs (IOTC, WCPFC). The workshop resulted in general acceptance of logbook forms for the longline, purse-seine and pole-and-line and handline fisheries and the planned implementation next year will be a significant achievement towards better monitoring of thee fisheries and will provide invaluable information to both national and regional fisheries science and management. OFP played a key role in designing the logbooks, and their similarity to the regional standard logsheets used by Pacific Island countries will ensure that the data available for regional stock assessments are in a standardised format.

Observer programmes

Participants at the national Tuna Fisheries Monitoring Workshop held in Jakarta in May 2008 agreed on the need for national coordination of future observer activities. World Wildlife Foundation and CSIRO, working with DGCF and RCCF have been involved in several observer initiatives on longline vessels in the Indian and Pacific oceans in recent years, and their experience will be fundamental to establishing national observer programme coordination, which will extend to eastern Indonesian tuna fisheries at some stage in the future. The data collection forms used by observers associated with the CSIRO project in Indonesia were based on the regional observer data collection forms used in the Pacific Island observer programmes, so data standardisation has already been achieved. It is envisaged that WCPFC, through the WPEAOFM project and assistance from OFP, will be strongly involved in establishing observer activities in eastern Indonesia's tuna fisheries in the future.

Other cooperative initiatives

OFP has been intermittently involved with Indonesian scientists for more than 20 years, through jointly conducted tagging cruises in the early 1990s, and again more recently (see the Tuna tagging section above) by engaging Indonesian scientists in the annual meetings of the Standing Committee on Tuna and Billfish (SCTB). However, OFP has also extended its technical support to capacity building, sourcing funds to ensure Indonesia participates in the annual Tuna Data Workshops and Stock Assessment Workshops conducted by OFP.[5]

The Pacific Islands Forum Fisheries Agency (FFA) also recognises the important role that Indonesia can play in Pacific Ocean tuna fisheries management, and recently held a formal consultation with senior fisheries officials from Indonesia.[6] Agreement was reached on a broad area of cooperation in fisheries management and science; the mechanisms for cooperation will cover areas including i) Indonesia's participation in FFA meetings and workshops; ii) FFA's participation in Indonesia's relevant meetings and workshops; and iii) meetings, on an opportunistic basis, in the margins of meetings of WCPFC's subsidiary bodies (e.g. the Scientific Committee, Technical and Compliance Committee), joint tuna RFMOs and FAO's Committee on Fisheries.

References

Proctor C.H., Gede Merta I., Fedi Sondita M., Wahu R., Davis T., Gunn J. and Andamari R. 2003. A review of Indonesia's Indian Ocean Tuna Fisheries. CSIRO. Marine Research.

WWF. 2008. Getting off the hook: Reforming the tuna fisheries of Indonesia and considerations for Ecosystems-based management (EBM). WWF contact Dr Jose Ingles, Strategy Leader, Tuna Strategy, WWF Coral Triangle Initiative.

---

1. For convenience, we refer to the fisheries that target tuna in the part of the Indonesian EEZ that falls within the WCPFC Convention Area as the "East Indonesian Tuna Fisheries".
2. Also, the predecessors of RCCF — Central Research Institute for Fisheries (CRIFI) and Indonesian Research Institute of Marine Fisheries (RIMF).
3. WPEAOFM will also fund activities in the Philippines and Vietnam. See http://www.wcpfc.int/west-pacific-east-asia-oceanic-fisheries-management-project
4. See http://www.spc.int/oceanfish/Html/TAG/index.htm
5. See http://www.spc.int/oceanfish/Html/Meetings/TDW3/index.htm
6. "The Preliminary Consultation on Future Cooperation between the Ministry of Marine Affairs and Fisheries and The Pacific Islands Forum Fisheries Agency, March 2009.

ADB BENEFISH STUDY

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

In early 2001, the Asian Development Bank expressed concern that the importance of fisheries to Pacific Island economies was not fully appreciated by the countries of the region, nor by the donor community. Discussions with the Pacific Islands Forum Fisheries Agency, the Secretariat of the Pacific Community, and the World Bank led to a study to improve the accuracy of estimates used to determine the contribution of fisheries to national economies. The output of that study was the document "The contribution of fisheries to the economies of Pacific Island Countries". Eight years later, discussions between these development partners and the Australian Agency for International Development have resulted in an agreement to update and expand that work in a project referred to as the "Benefish Study"[1].

The benefits of fisheries is provided for each of the 22 Pacific Island countries and territories. These country sections contain recent, readily available data in the following areas:

- Annual fishery harvests: values and volumes covering the six fishery production categories: 1) coastal commercial fishing, 2) coastal subsistence fishing, 3) locally based offshore fishing, 4) foreign-based offshore fishing, 5) freshwater fishing, and 6) aquaculture.
- Fishing contribution to GDP: current fishing contribution, how it was calculated, and a local production approach recalculation based on annual harvest levels obtained during the study.
- Fishery exports: amounts, types, and the ratio to all exports.
- Government revenue from the fisheries sector: access fees and other revenue.
- Fisheries employment.
- Fisheries contribution to nutrition.

Results of the Benefish Study show that the total volume of fisheries production in the Pacific Islands region in 2007 is estimated to be 1,327,361 metric tonnes (t), plus an aquaculture production of 2,984 t and 305,336 pieces. The total value of fisheries and aquaculture production in 2007 is estimated to be about USD 2,049,500,000.

Offshore foreign-based fishing is responsible for about one-half of the value of fisheries in the region, offshore locally based about one-quarter, and for the remaining quarter, about equal shares of coastal commercial, coastal subsistence and aquaculture.

With respect to changes in fishery production between 1999 and 2007, there was a remarkable increase by Papua New Guinea and a moderate increase by most other countries. By category of fishing, there were substantial production increases for offshore fisheries, whereas coastal fisheries levels were stagnant.

If aquaculture production from three atypical countries in the region is eliminated from consideration, significant aquaculture production comes from a limited range of activities: large-scale private sector pearl culture and shrimp culture where there is a significant tourist trade. There is significant tilapia, milkfish and giant clam culture, but whether net benefits are produced depends on the degree of subsidization, a situation that is often not clear.

In most countries there is an extremely weak factual basis for the estimates of coastal commercial and coastal subsistence catches. There seem to be three types of situations, however, where good estimates are available:

- Countries that have a dedicated ongoing national fisheries statistical system supported for many years by an overseas agency.
- Countries that have carried out an intensive, well-planned survey of fisheries to obtain an accurate snapshot.
- Countries that use a household income and expenditure survey for small-scale fisheries production purposes.

For each country, the official fishery contributions to GDP are given, along with the relative importance in the economy. In addition, a re-estimation is provided for the fishing contribution to GDP in each country. It is not intended that the re-estimate replace the official methodology, but rather the results can serve as a comparator to gain additional information on the appropriateness and accuracy of the official methodology — and possibly suggest a need for modification.

In most locations, the re-estimate by the Benefish Study of the fishing contribution to GDP

is larger than the official figure. In two locations the re-estimate was substantially smaller. On the basis of a good knowledge of the fisheries sector, the results in those two countries are likely to be erroneous.

Changes in fishing contributions to GDP were greatest in the Marshall Islands (with the establishment of a locally based offshore fleet) and Papua New Guinea (with increased activity of the locally based offshore fleet). Fishing contributions to GDP decreased the most in the Cook Islands (with the decrease in production from pearl farming) and Nauru (with the termination of locally based offshore fishing and a decrease in coastal commercial fishing). At least some of the observed changes were due to improved estimates of various fishing categories.

Fishery exports are very important to the countries of the region. In about half of the countries, fishery exports represent over one-half of all exports. Where they represent less than one-half the value of national exports, they are mostly quite large in nominal terms: New Caledonia (USD 157 million), Papua New Guinea (USD 101 million), Fiji (USD 63 million) and Marshall Islands (USD 37 million). The three entities that have the largest value of exports are American Samoa, New Caledonia and French Polynesia. Of the total of about USD 996 million in fishery exports in the region in 2007, about three-quarters are from these three territories.

In terms of export commodities, tuna products are by far the most valuable. Tuna exports from American Samoa alone approach the value of *all* fishery exports in *all* other Pacific Island countries combined.

In nominal terms, the value of regional fisheries exports almost doubled in the period 1999–2007. Fishery exports have increased relative to total exports in most countries, but have fallen significantly in the Solomon Islands and Samoa.

Access fees received by Pacific Island countries are provided and compared with the total government revenue, population, and catch value. Total access fees received in 2007 were USD 78.5 million, an increase of about 25% since 1999.

The national fisheries employment information in the country sections is very much a jumble of facts. Nevertheless, an attempt has been made to extract the information that best characterizes the national fisheries employment situation. For each country of the region, the best available information is provided on the relative importance of employment in commercial fisheries, and involvement in subsistence fishing.

Two important features of the data are the importance of: 1) participation in subsistence fisheries, which seems to have a strong relationship to island type. The level of importance is highest in atolls, followed by small islands, and least in large high islands; and 2) fisheries in formal employment, which seems to be related more to business conditions than to island type. These conditions include, among others, proximity to processing facilities and airline connections to fresh fish markets.

The readily available information on the consumption of fish and other fishery resources has been compiled and compared. Some of the past comparisons between fish consumption surveys and between countries may be inappropriate due to methodological differences. The main difficulty is that most studies on fish consumption in the region determine one of two kinds of consumption: either the amount of food actually ingested or the whole weight of the fish that produces the food. Comparing fish consumption surveys should be avoided unless the methods used by the studies are known and they are either the same or corrected so that equal features are being compared.

Some surprising results of the Benefish Study

- Tuna exports from American Samoa approach the value of all fishery exports in all other Pacific Island countries combined.
- French Polynesia and New Caledonia produce 95.5% of the combined value of aquaculture in all 22 Pacific Island countries and territories.
- The range in estimates for participation in the coastal subsistence fisheries in Papua New Guinea (often given as between 250,000 and 500,000 t) approaches the magnitude of the participation in all other countries of the region combined.
- Several countries located in areas of good tuna fishing (as judged by access fees) export little or no tuna: Kiribati, Nauru, Tokelau and Tuvalu.
- The export value of fishery products is about 80% or greater than that of all exports in six Pacific Island countries and territories.

The fishery categories used in the Benefish Study (coastal commercial, locally based offshore, etc.) could be re-arranged slightly to represent ecological zones. In partitioning benefits by those zones some interesting patterns emerge. A large part of the benefits from employment and nutrition — things that direct affect Pacific Islanders — come from the coastal zone. The less tangible and more abstract benefits (contribution to GDP, exports and government revenue) tend to come disproportionately from the offshore area.

In recent years, most Pacific Island countries have had a household income and expenditure survey (HIES) conducted. All of the independent Pacific Island countries and several of the territories are planning for a HIES in the next few years. An HIES may be a good opportunity to improve the measurement of small-scale fisheries, but on the other hand, some significant problems are apparent in the use of HIES for fishery purposes. A feature common in many countries of the Benefish Study was that coastal fisheries production estimates by an HIES were relatively low. The way forward appears to be for fisheries specialists to cooperate with HIES specialists on an initiative for improving the applicability of HIES to the fisheries sector.

By international convention, the "fishing" sector for GDP purposes does not include post-harvest activities, which are quite important in many Pacific Island countries, and are likely to become more important in the future. To rectify this problem, a "satellite account" can be constructed. Groups and subgroups of industries can be identified and aggregated to form a satellite account that, in the case of fisheries, would include post-harvest activities. As an example, a simple first order satellite account was constructed for Fiji's fisheries sector. It showed that the estimated FJD 104,375,000 for the broad fisheries sector in the satellite account is about 34% greater than the estimated FJD 77.8 million for the narrow fishing sector. If Fiji's total GDP in 2003 was FJD 4,390,551,000, then the contribution to GDP increases from 1.8% for the fishing sector to 2.3% for the fisheries sector.

The Asian Development Bank is scheduled to finalize and make available the Benefish report by early November 2009.

[1.] Gillett, R. 2009. The contribution of fisheries to the economies of Pacific Island countries and territories. Pacific Studies Series, Asian Development Bank, World Bank, Forum Fisheries Agency, Secretariat of the Pacific Community, and Australian Agency for International Development. 362 p.

Original text: English

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