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Deploying giant clam spat collecting stations in Reao, Tuamotus, French Polynesia (Image: Colette Wabnitz).

Editorial

Non-fishing stakeholders — or, to be more precise, conservation stakeholders — have become regular and active partners of fisheries stakeholders in the Pacific Islands region. They are mostly involved in identifying and raising awareness of environmental issues, as well as helping to design management schemes that address these issues. In California, they have gone one step further to become financial partners of the fishing industry. In the last article of this issue (p. 35), Jay Udelhoven from The Nature Conservancy explains why and how his organisation bought fishing rights to help struggling small-scale fishermen and local communities, while improving fishery and habitat. At first sight, it seems that there is little scope for such a scheme in the Pacific Islands region, at least in coastal fisheries where few formal fisheries allocation systems have been put in place. But, whether in the tuna fishery, with the Parties to the Nauru Agreement vessel day scheme, or in the sea cucumber fishery, with export quotas that have been set by several countries, the possibility exists and is certainly worth exploring.

As usual, we have tried to provide short stories about a little bit of everything related to fisheries in our region, including two articles (pp. 23 and 25) that were spontaneously sent by the Department of Marine and Wildlife Resources of American Samoa. Let's hope they are the first of a long series.

Aymeric Desurmont
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In this issue

Secretariat of the Pacific Community

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

Getting to the point on Pacific tuna fisheries: Scientists call for reference points to replace the current gridlock

Scientists attending the annual meeting of the Western and Central Pacific Fisheries Commission (WCPFC), held in December 2012 in Manila, indicated that the viability of the western and central Pacific tuna fishery is at risk, due to the failure of WCPFC to reach decisions on management as a result of competing political and economic goals.

The western and central Pacific tuna fishery is the world's largest, with total catches worth USD 5.5 billion in 2011. Recent analyses by scientists from SPC's Oceanic Fisheries Programme (OFP) show that overfishing of bigeye tuna is already occurring, while the albacore tuna catch has risen rapidly to levels that threaten the profitability of Pacific Island fisheries. While not all tuna are at risk, stocks of all four main tuna species have fallen to historically low levels. Many Pacific Island countries rely on tuna fisheries for employment, food security and income, and a continuing increase in fishing effort will negatively impact these countries.

Management decisions at WCPFC are reached through a consensus-based system. Unfortunately, the competing interests and values of WCPFC members produce gridlock and watered-down decisions that favour short-term economic interests at the expense of long-term productivity and sustainability.

To address this problem, WCPFC organised a special two-day management workshop that aimed to identify desirable stock levels for tuna and support sustainable management decisions. SPC scientists provided advice on and support to this process, which resulted in a range of candidate long-term objectives for WCPFC fisheries.

Long-term objectives for Pacific tuna fisheries need to be based on both economic outcomes (such as revenue, employment and stable sources of fish for processing) and environmental outcomes (such as the sustainability of fish stocks and reduction of bycatch and interaction with species such as sharks and turtles). These objectives will help WCPFC members identify desirable stock levels for tuna species, and support sustainable management decisions.

These outcome-based objectives can be formalised into a system of management "reference points". The adoption of reference points and harvest control rules that define the allowable level of fishing would enable fisheries managers to act swiftly and efficiently to ensure tuna stocks provide a sustainable, consistent supply of tuna to markets. The WCPFC workshop represents the first step in a long process toward achieving these goals. OFP will continue to support its members and WCPFC in the further development of sustainable management approaches for these stocks.

OFP wishes to thank AusAID, the European Union SciCOFish project, WCPFC, Pew Charitable Trusts and the World Bank for the funding support that allowed this work to be undertaken.

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A limit reference point is the minimum allowable stock size or maximum level of fishing effort. Exceeding the limit reference point will endanger the resource; it is a danger signal, and reaching this point should be avoided.

A target reference point is the specific fishery stock size or level of fishing effort that ensures a fishery provides optimum benefits. The target reference points are established by investigating the biological, ecological, social and economic factors that affect a fishery, and constitute "where we want to be".

A harvest control rule is a pre-agreed upon action to be taken by fisheries managers to achieve a target reference point. For example, "If the albacore fishery reaches 40% of its unfished state, then the level of fishing must be reduced by 20%".

OFP launches country webpages

Thanks to resources provided by the New Zealand Overseas Development Administration, and the Europe Aid Cooperation Office (AIDCO) through the European Union SciCOFish project, SPC's Oceanic Fisheries Programme (OFP) has been able to perform a major overhaul and expansion of the "country pages" on its website (www.spc.int/OFPMemberCountries).

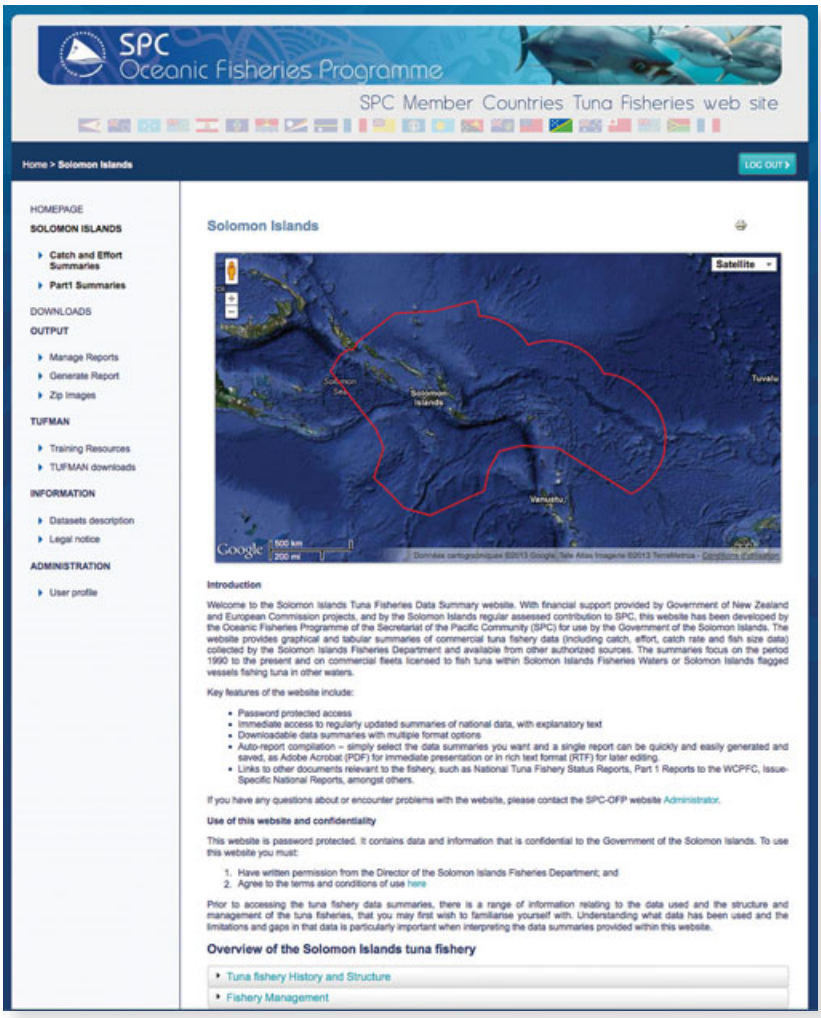
These webpages provide a series of exclusive economic zone-specific "windows" onto the catch and effort data that are held on behalf of each SPC member island country and territory in SPC's tuna fisheries databases.

As well as providing secure access to printer-ready graphs, plots, and interpretations for inclusion into national tuna fisheries reports — particularly Part 1 of the Annual Report that SPC island members have committed to share through the Western and Central Pacific Fisheries Commission each year — the website also provides ready access to OFP national tuna fisheries reports and national database updates. The site can also host copies of national tuna fisheries management plans and other important national tuna fisheries documents if desired, providing instant access to authorised national staff wherever they are in the world.

Security and confidentiality is an important feature. Each SPC island member has a separate subsite and password-required logons are only provided by SPC to persons specifically authorised in writing by the relevant Head of Fisheries. And in accordance with SPC and the Western and Central Pacific Fisheries Commission data confidentiality rules, the summaries available to each SPC member are confined to fishing within their own waters, fishing by their vessels in the rest of the region, or which use data already in the public domain.

However, as data-sharing agreements evolve, such as through the Niue Treaty Multilateral Subsidiary Agreement, the data that go into the summaries available to each SPC island member on this website will need to be adjusted.

All of the national data summary pages have been on the secure site since 1 January 2013, and individual country pages can be accessed by authorised users logging on to http://www.spc.int/OFPMemberCountries/. If you don't already have it, then access to your country pages can be obtained by your national Head of Fisheries writing to spc@spc.int (attention: Director, FAME) and providing authorisation for you to be given a password. If you are not a government fisheries staff member, contact details for your national or territorial Head of Fisheries can be found in the SPC Fisheries Address Book at www.spc.int/coastfish/doc/coastfish_docs/Address_book.pdf



The Solomon Islands country homepage, leading to catch and other data specific to the Solomon Islands tuna fishery. This page can only be accessed by authorised users.

With time, and provided resources are available, the national data summaries and visualisations available on OFP's website will be expanded to address the ever-increasing reporting requirements that SPC members agree to at WCPFC meetings. Part 1 Annual Reports are only the tip of a reporting iceberg, which gains a new layer every time a new WCPFC conservation and management measure is agreed on.

This obligation rests particularly heavily on Pacific Island countries, which are developing their own commercial tuna fisheries, because most WCPFC reports require action by the country that flags the vessels that do the fishing, not the country where the fishing occurs. At the moment however, this website concentrates on "SPC" rather than "WCPFC" aspects of the data, and most of the information available is about catch and effort in national fisheries waters.

The OFP country webpages themselves are not "live", but neither are they static and changeless. Thanks to a code engine written in the statistical toolbox language "R", each of the graphs and summaries on the site is updated and refreshed regularly from the central database. Any interpretation and explanatory text has to be updated manually by OFP staff however, and the task of reviewing nearly 1000 pages (up to 60 per SPC island member) does not happen instantaneously.

In addition to the data summary pages already available for all countries, national tuna fishery overview pages are also being prepared, with overviews for Cook Islands, Fiji, Nauru, and Solomon Islands first off the mark. Explanatory text is also being added to individual data summaries — a major task that will be completed by the end of March 2013.

Sections are also being added that summarise the available data on non-tuna species caught by commercial tuna fisheries, and the oceanography in each exclusive economic zone. Issue-Specific National Reports are also being prepared for several countries on the potential for interaction between commercial tuna fisheries and artisanal fisheries.

Additional future developments that are planned — resources and personnel permitting — include the following:

- a regional overview site — one that applies to the entire regional dataset the same analyses that are currently applied to national datasets, so that countries can compare fishing in their own waters with the overall regional context. This will require additional work to ensure the integrity of data bound by any rules of confidentiality;
- programming additional data summaries that address new reporting obligations, particularly those under WCPFC conservation and management measures that are not captured by Part 1 reports; and
- adding interactivity to the more heavily-used summaries, allowing users to specify time-periods and sub-zones for summarisation (a kind of "online Catch and Effort Query System").[1]

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[1] http://www.spc.int/OceanFish/en/ofpsection/data-management/spc-members/dd/247-ces

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Regional action to fight illegal tuna fishing in the Pacific

A new data-driven process to further crackdown on illegal tuna fishing in the Pacific will help reduce the loss of local fishing industries.

Boarding party from the Royal Solomon Islands police vessel Lata *commencing inspection of a fishing vessel.*

A recent two-week surveillance operation to detect illegal, unreported and unregulated (IUU) fishing activities in the region has confirmed how necessary data collection is to deter and eliminate fish plundering from the world's biggest and most important tuna fishery.

More than 320 vessels were sighted, 206 were boarded and 27 infringements were recorded during the operation last November. "Kurukuru" 2012 was the region's biggest ever surveillance operation and involved 5 maritime patrol aircraft, 12 patrol boats, a frigate and a Coast Guard boat all surveying an area of approximately 30 million square kilometres.

"Controlling illegal fishing in the region is complex," explains Bryan Scott, Fisheries IUU Liaison Officer at SPC. "There are multiple organisations and nations in the Pacific that govern the rules that fishers can fish under, depending on when and where they are. To cross check and analyse a vessel's catch history and other information during the time of a single boat boarding is extremely difficult because it is all paper-based," he explained.

Regional estimates put lost earnings from activities such as under-reporting or misreporting catch sizes at anywhere from millions to over a billion dollars. SPC and the Pacific Islands Forum Fisheries Agency (FFA) are working together to put exact figures on these losses by building a comprehensive data network.

The Kurukuru operation helped inform the early stages of a USD 10 million European Union-funded project known as DEVFISH2 (Development of Tuna Fisheries in the Pacific African, Caribbean and Pacific Countries). The project will improve information management and data analysis as a means of providing additional deterrence for illegal fishing.

Hugh Walton, FFA Policy Specialist and Team Leader for the DEVFISH2 project, says the measure of success of these projects is not just about the number of fishing vessels recorded or violations detected. "There needs to be effective deterrence; proper penalties for deliberate misreporting or under-reporting catch sizes, compliance with licence conditions, and the means to enforce license conditions," he said.

Work in the Regional Fisheries Surveillance Centre at FFA.

"If vessels get away with offenses, they will continue to offend. But if they, for example, lose their licence or fishing right, the example will ripple out to other operators. Being able to compare datasets will allow us to make more reliable estimates of the extent of under-reporting and misreporting," Walton added.

SPC and FFA aim to have the improved information management and data screening systems in place over the next 12 months. The future database management system will help authorities quickly and accurately identify inconsistencies between fishing vessel logbooks and data captured from surveillance through the vessel monitoring system and the reports of at-sea fisheries observers and in-port monitoring of catch landings.

The Kurukuru 2012 surveillance operation was headquartered in Honiara, Solomon Islands at the FFA Regional Fisheries Surveillance Centre, and data were collected from aerial, ship and electronic surveillance sources.

The 30 million square kilometres surveyed included the Cook Islands, Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Niue, Palau, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu and Vanuatu. Australia, New Zealand, France and the United States also provided surveillance support.

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All images in this article are by Ben Bosschieter, Australian Fisheries Management Authority Officer.

Royal Solomon Islands police interviewing vessel crew during a fishing vessel inspection.

On spot check for scombroid fish poisoning on fishery products

Food safety has always been an important public health issue. Consumer demand and prices are closely related to the quality and safety of food items, and, even more so, of seafood items. Seafood regulatory authorities around the globe are responsible for certification for human consumption, and ensure that all relevant food safety standards are met before the products are allowed to enter the market distribution chain.

Fish poisoning, an important issue with seafood products, can be divided into two categories: poison already present in live products (e.g. ciguatera or pufferfish liver poisoning), and poison produced after capture by bacteria contamination (e.g. scombroid toxin). Although named "scombroid toxin", this type of poisoning not only affects fish species in the Scombridae family (e.g. tunas) but also many other fish species (e.g. mahi mahi, mackerels and sardines). Exposure of these fish species to air and water temperatures above 28°C for more than 6 hours (after time of death) has high potential for scombroid toxin development. This fish poison cannot be eliminated through either heat processing and cooking, or freezing once it is present in the fish flesh. Scombroid fish poisoning is also commonly known as histamine.

A high level of histamine can cause illness, with symptoms including tingling or burning in or around the mouth or throat; rash or hives on the upper body; drop in blood pressure; headache; dizziness; itching of the skin; nausea; vomiting; diarrhoea; asthmatic-like constriction of the air passage; heart palpitation; and respiratory distress. Symptoms usually occur a few minutes to a few hours after consumption and can last from 12 hours to a few days. They can usually be treated with anti-histamine drugs.

Proper handling and preservation of fresh fish — either for personal consumption or export purposes — after harvest is very important. Fishery products must be kept under chilled conditions (below 4.4°C), and cooling them immediately after catch will greatly reduce the chances of histamine formation.

Testing histamine levels in fish flesh ranges from simple on spot checks to sophisticated laboratory testing. From 10–14 September 2012, as part of SPC's continued support to regulatory government agencies and private fisheries enterprises, a training workshop on methods to run histamine spot checks was organised in Fiji. The training, as well as the delivery of histamine test kits, was conducted for the Fiji Competent Authority (Ministry of Health) and Fiji-based private operators, including Celtrock Holdings Ltd., Seaquest Ltd., Hangton Pacific Ltd. and Tripacific Ltd. These agencies and companies are now able to detect histamine when they process their catch, and can ensure that affected fish do not enter the market chain.

International markets, such as the European Union, United States, Japan, Australia and New Zealand, are very strict about fish poisoning. The Pacific region has had cases of fishery products rejected in the European Union and the United States that have especially caused great economic losses to the operator and altered the confidence established between the international trading partners. By performing necessary checks on fish products before the certification for export, such incidents will be avoided.

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Tomasi Tabanidalo from Celtrock Holdings Ltd. transferring histamine extract to sample testing cups.

Expanding Pacific horizons[1]

Mary O'Callaghan

Econnect Communication

Climate change is projected to reduce the productivity of Pacific coastal fisheries over the coming decades. But how can we tell what is changing and whether the changes observed are being caused by climate change or other factors such as overfishing?

"The only way Pacific Island countries will know if productivity is changing, and what is causing that change, is by monitoring fish, invertebrates and coral over the long term to build up a time series of data," explains Lindsay Chapman, who heads up SPC's Coastal Fisheries Programme.

With nearly AUD 1 million in funding from AusAID, SPC's climate change project is helping Pacific Island countries and territories do exactly that. Baseline data has already been collected and analysed for pilot sites in five countries — the Federated States of Micronesia, Kiribati, Marshall Islands, Papua New Guinea and Tuvalu — and the plan is to re-survey every two years.

To address the acute shortage of monitoring and analysis skills in the region, SPC has established the Pacific Islander Young Professional programme.

"Efforts to build capacity in the region have often been ad hoc, sporadic and of short duration," says Chapman. "We are taking a longer term approach, with 12-month assignments for Pacific Islanders working in the field of marine science or conservation. Our aim is to develop in-depth technical skills, and to link these skills to the work being done at the national level in coastal fisheries."

Leaving their homes and families, the first three young Pacific Islanders have now completed 12-month assignments based at SPC in Noumea, New Caledonia.

Maria Sapatu and two Fisheries Officers after a data collection dive in Kiribati.

[1] A shorter version of this article appeared in the magazine of Australia's overseas aid programme, FOCUS vol. 27 n° 3 Oct–Dec 2012.

The fisheries officer from Samoa

Maria Sapatu, a senior fisheries officer with Samoa's Ministry of Agriculture and Fisheries, was the first person appointed to the programme in February 2011. Maria received intensive training from SPC's coastal fisheries scientists, including field training on survey methods in the Marshall Islands. She then analysed the Marshall Islands survey data and drafted a report before being put in charge of logistical arrangements for fieldwork in Tuvalu and Kiribati, and training her local counterparts in Tuvalu.

"I was used to managing smaller projects across a smaller area, and having the accounting people deal with budgets," she says. "At SPC, I was managing a budget for all logistics for three in-country surveys. It was good to be exposed to that — planning for a bigger region."

"I also really enjoyed being able to collaborate with fisheries officers in country, sharing what I've learnt about monitoring methods, sharing the issues. It's a two-way thing. I tell them what I know about Samoa and they share with me."

But being away from her one-year old daughter, Alda, was hard. "Alda was with me in Noumea for about 10 weeks and I went home for a few weeks at Christmas for her birthday. In between, I skyped her every day. I pretty much missed out on all the stages between age one and two — her learning new words, getting attitude. But I have many more years of attitude ahead!"

"When I got back to Samoa, I was placed in charge of all marine survey work. I trained about 20 people in the SPC monitoring methods and we are using them now to monitor sea cucumbers. I am also trying to upskill our monitoring people to use scientific names. The same common name is often used for more than one species so using the scientific name will give us more robust data. And I'm trying to improve our data storage system. Bringing together our many different databases onto one centralised database could give us new information for Samoa."

Thinking outside of the box, says Maria, is the most important thing she learned at SPC. She was also struck by the approachability of senior staff.

"The culture was very open at SPC, and I was inspired to come back and try that. Now, when my staff ask me a question out in the field, I take the time to explain. I want them to feel that I am not too busy to be asked."

The underwater environmentalist from Fiji

Watisoni Lalavanua from Bua, Fiji, began his 12-month assignment with SPC in July 2011. He works as a project officer with local NGO Partners in Community Development Fiji (PCDF).

"I work with communities, helping people manage their marine environment to have a healthy reef and, therefore, healthy fish stocks for food security," he says.

After initial field training in Tuvalu, Watisoni was made responsible for conducting the survey fieldwork for Kiribati, training his local counterparts and overseeing the local survey teams. Later, his role extended to the pilot sites in Micronesia and Papua New Guinea. Underwater work is what Watisoni loves most. He is a qualified advanced open-water diver.

"It's amazing to see the variety of living things down there with their different colours. To me, it shows that God is still the number one creator in the world."

Being away from his wife was the biggest challenge for the newly-wed Watisoni. "I got married on Wednesday, and left for SPC on Saturday for a year!"

Watisoni Lalavanua holding three hairy blackfish specimens during a sea cucumber stock assessment survey, Pohnpei, Federated States of Micronesia, March 2012.

Over the 12 months, he saw his family three times. He battled homesickness and, speaking no French, found it hard to communicate with the locals outside of work. The death of his grandmother, who brought him up, compounded his loneliness.

But he was determined to see his assignment through. "For me, I call it a sacrifice to boost my career as a young environmentalist and to provide bread and butter for my family."

Back in Fiji now, Watisoni is looking after a climate change project and a community leadership project at PCDF. Being part of the natural resource management team means he can use the skills and experience that he gained at SPC, and share it with his colleagues. PCDF recently took part in sea cucumber assessment training organised by SPC. Watisoni helped to deliver the training.

His time at SPC has changed the way he thinks, not just about the marine world, he says, but about communicating with local people.

"Our communities need the best advice. Now, I am better at translating the scientific ideas into simple ideas in a language that they can understand."

His confidence in dealing with people in senior positions has also been boosted.

"I have arranged logistics with heads of departments and people working at the national level in the region. I have built connections with heads of fisheries in other countries. This was challenging for me because I am used to working at the community level with the *mata ni tikina* (district leaders) and *turaga ni koro* (village leaders)."

Madi Kwarara (left) helping a trainee from Cook Islands during one of the database fundamentals training workshops held in 2012.

Some figures:

35 kg ▶ The amount of fish a Pacific Islander needs to eat each year to meet 50% of its protein requirements

100,000 tonnes ▶ The predicted shortage of fish there will be in Melanesia by 2030

62% ▶ The ratio of fish consumed in the Pacific that comes from subsistence fisheries

50–90% ▶ The ratio of animal protein provided by subsistence fishing for diets in Pacific Island coastal communities

Sources: World Health Organization; SPC

The information manager from Papua New Guinea

A computer programmer by profession, Madi Kwarara from Papua New Guinea (PNG) joined the SPC programme in July 2011 in an information management role.

She had previously worked with the PNG Quarantine and Inspection Authority, during which time she spent three years on attachment to SPC, installing a biosecurity information system across the Pacific.

As an SPC young professional, she developed a training course on basic database skills, which she later delivered to fisheries officers from 15 countries through four sub-regional workshops held in Noumea.

"The small island nations find it hard to manage their data because they lack either the equipment or the skills. Many fisheries officers don't have IT skills so I had to make things simple in writing up the manuals."

"It was rewarding to see people who had no idea about databases coming out after two weeks with a skill and a better understanding, and always at least one or two of them with flying colours. Having to relay that knowledge has also been good for me."

Madi also learned how to set up mini-servers and installed them in Palau, Tuvalu and Kiribati, plus provided training in their use.

Not having a fisheries background was difficult for her at first.

"Everyone is busy, so I had to take the initiative to try and learn on my own about things like fish size and fish densities. That was the biggest challenge. But I managed to overcome this."

And like Maria and Watisoni, she fought homesickness.

"I loved the experience at SPC and I loved New Caledonia. I came back with so many friendships. But I had a big family back home — a husband and four kids."

"The two younger ones missed me a lot. My youngest, who was six years old, couldn't live without me so after three months my husband sent him to Noumea with a relative who could babysit him when I was away on field trips."

"It was really hard but I wanted to show my children that as a Papua New Guinean mother you can still achieve things, no matter how many children you have."

"I also wanted to progress my career because I had just spent a year as a housewife in Brisbane while my husband studied for his masters there."

Madi is now seeking work, preferably in PNG so that she can be with her family.

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Ingraining the skills

In SPC's view, the Pacific Islander Young Professionals programme has been an outstanding success.

"The programme has made a significant contribution to the region's coastal fisheries science capability at the national level," says Lindsay Chapman.

"Unlike a two-week workshop where little changes back in country, with a 12-month attachment the new skills are ingrained."

"It's also about developing skills that we can call upon in the future. For example, we can ask Maria to deliver training in Tonga if we can't do it ourselves."

SPC is offering more positions on the climate change project and plans to adopt the model in other areas of its fisheries programme. Fulitua Siaosi from the Tuvalu Fisheries Department came on board in late 2012 and another position will be advertised in 2013.

"It has been very encouraging seeing these young people gain the skills and confidence," says Lindsay, "and seeing their self-motivation in taking responsibility for organising the in-country work and delivering training. These skills are essential for identifying climate change adaptation needs in coastal fisheries. But to be sustainable, support must be provided to national institutions to utilise and retain the skills developed."

Fulitua Siaosi (4th from left) and Watisoni Lalavanua (3rd from right) with members of the communities of Ahus and Andra, PNG fisheries trainees from Moresby, Manus and Kavieng, and SPC staff (Ahus Island, Manus, PNG).

Using a geographic information system for coastal fisheries management

Coastal fisheries management includes collecting data in the field to determine the status of marine resources and the environment (habitat). A geographic information system, or GIS, is useful for field survey planning to determine coordinates of sampling stations using satellite imagery, past survey data, and habitat maps. It is also handy after a survey to show the locations of sampling stations and associated data on a map. Finally, GIS is often used for delineating zones such as marine protected areas or survey sites, calculating corresponding areas, and plotting the location of resource-related attributes such as pearl oyster shell lines, fish traps, farms or dwellings.

In most Pacific Island fisheries authorities, the need for and use of GIS is gradually increasing. Yet, because of cost and licensing issues, the availability of commercial GIS software (such as ArcGIS or MapInfo) is often limited to a few desktop positions, and the use of GIS is not widespread despite its usefulness.

To solve this issue, a free alternative to commercial software — capable of being used on all desktops — is needed. Several open-source applications are available although Quantum GIS (QGIS) is most appropriate for the Pacific because of its relative ease of use and features, as well as for the support of an active developer community that constantly improves and maintains the software. QGIS version 1.8 provides all of the features needed for most coastal fisheries applications. It is compatible with both ArcGIS and MapInfo, and SPC's Coastal Fisheries Programme (CFP) team uses it on a daily basis.

QGIS can usually be installed from the microservers that CFP has deployed in Pacific Island African, Caribbean and Pacific countries as part of the EU-funded SciCOFish project, and can be freely downloaded from http://www.qgis.org

QGIS training: Lessons learned

In 2012, CFP conducted on-the-job QGIS trainings for marine resource assessment and management in several Pacific Island countries. Training sessions were customised to use existing country survey data and satellite imagery, highlighting the usefulness of GIS for survey planning and habitat mapping prior to field work, displaying survey data analysis, and calculating areas for stock estimation.

Various training activities were conducted, ranging from overlaying bubble maps and pie charts on top of satellite imagery, to more advanced activities such as delineating zones and using geoprocessing tools to manipulate polygons and calculate habitat areas.

During the training, several problems, which most trainees struggled to solve without the active help of the trainer, were identified. These problems would probably prevent fisheries officers from conducting similar tasks by themselves. To ensure that future QGIS users will not be discouraged and will quickly benefit from QGIS use in their daily tasks, special emphasis was given to addressing these issues during the training.

Some issues relate to the choice of the project projection and the simultaneous display of layers in different projections, and include:

- on-the-fly re-projection is not enabled and, therefore, some layers do not show up;
- QGIS sometimes crashes when enabling on-the-fly projection for a universal transverse mercator (UTM) raster that overlaps the date line; and
- for a longitude-latitude geographic coordinate system (GCS) layer, the unit is the degree for scale bar and square degree for areas; for UTM layers, the unit is the meter (Fig. 1).

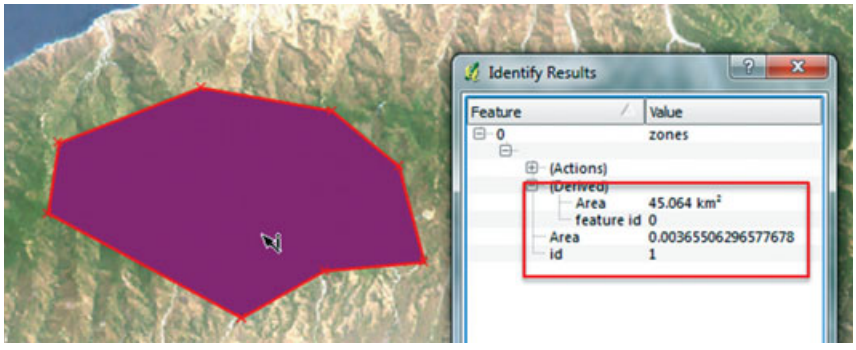

Figure 1. In this figure, the calculated area is expressed in square degrees while derived area is expressed in square kilometers.

These issues can be solved by changing the default settings, carefully choosing the project and layer projections (UTM or longitude–latitude) according to desired outputs, and using geometric columns in addition to area-calculated columns to determine polygon areas in square kilometers.

Trainers also found that due to differences of behaviour between QGIS and MapInfo (e.g. polygon closed with a right click in QGIS instead of a double click in MapInfo), former MapInfo users were likely to produce polygons with geometric errors (duplicate nodes and knots) when delineating zones (Fig. 2). Users must be trained to detect and correct geometric errors, and must be aware that geometric errors can possibly cause geoprocessing errors that are not always easy to interpret at later stages.

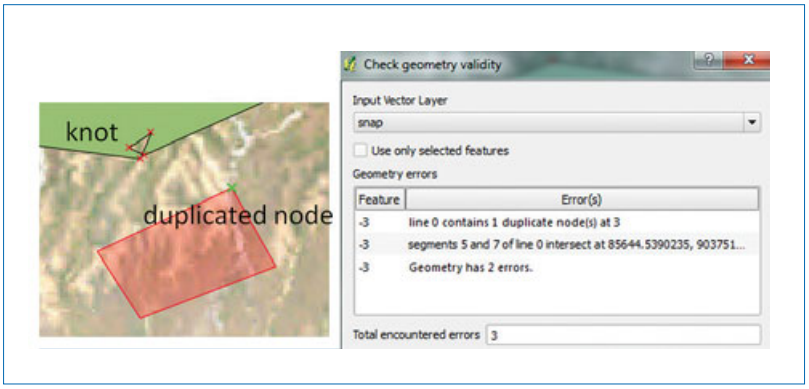

Figure 2. Common geometric errors.

Finally, fisheries officers were shown how to produce bubble maps to display survey data. From layer properties, it is possible to make the size of the chosen symbol proportional to a field value. The problem is that for a round shape (disk), size corresponds to the radius of the disk, and thus its area increases proportionally to the square of the value, which provides the wrong visual clue. Users are more familiar with bubble representations where the disk area (not radius) increases linearly to the value (which means that the size must be proportional to the square root of the value) (Fig. 3).

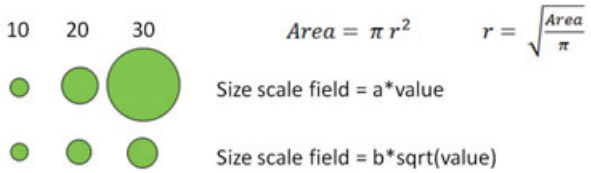

Figure 3. Disk size scaled by field value.

Calculating the square root of the field value must either be done before importation into QGIS or by adding a calculated field to the layer. The latter method is more flexible but some users faced difficulties due to shapefile limitation on field names (no more than 10 characters) and data type (decimal number for which the precision must be set).

Because most beginner GIS users will face these problems, training sessions should concentrate on providing solutions and tips to help new users explore the full potential of QGIS.

Extending QGIS for fisheries

QGIS is not just an open-source GIS program; it also has a mechanism that allows users to extend the basic application by developing additional plugins in Python to solve specific problems not covered by QGIS's standard features. Hundreds of plugins can be downloaded from official repositories, such as Points2One to generate a path from a list of waypoints; OpenLayers to download background images from Bing Maps, Google Maps and others; or Table Manager to edit the structure of shapefiles.

Special purpose plugins can also be developed for Pacific Island fisheries. For example, SPC is promoting the use of manta tows for resource assessments. Each tow has a start and end GPS position. Because there is no natural way to convert these pairs of points into lines, SPC created a plugin that creates transect lines from start and end positions.[1] More features can be added to facilitate the analysis and display of survey data, and SPC plans to develop additional plugins in 2013.

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[1] Plugin available from http://www.spc.int/CoastalFisheries/qgis/plugins.xml repository

SPC aids squaretail coral grouper efforts in Guam

The squaretail coral grouper,* Plectropomus areolatus*, is one of the coral groupers that form spawning aggregations. It is a highly prized food fish, particularly in Asia, and a recent assessment by the International Union for Conservation of Nature indicates that the species is vulnerable to extinction. In Guam, it has almost disappeared from the nearshore catch and is seldom seen in the wild.

Several agencies — the Southeast Asian Fisheries Development Center Aquaculture Department (SEAFDEC/ AQD), SPC's Aquaculture Section, and the Center for Tropical and Subtropical Aquaculture (CTSA) — are helping Guam to restore a coral grouper broodstock population and establish a marine finfish hatchery that will focus on this species.

The Guam Aquaculture Development and Training Center (GADTC) has received funding from CTSA to determine the health status of a founding population for a planned restocking and fisheries enhancement programme. As part of the project, Dr Leobert de la Peña of the SEAFDEC/AQD Fish Health Section has been assisting the project with technical advice and onsite training. Dr Jenee Odani, from the Hawaii Department of Agriculture Veterinary Laboratory, also provided technical assistance to this project.

Dr Leobert de la Peña of the Fish Health Section of SEAFDEC/AQD (left) instructs Dr Hui Gong on health examinations of coral groupers.

In 2012, SPC's Aquaculture Section provided technical assistance to GADTC on aquatic biosecurity and aquatic animal health-related issues, and funded GADTC's Dr John Brown to attend the 8th Regional Training Course on Grouper Hatchery Production. The training course was held in Krabi, Thailand from 8–26 October 2012, at the Krabi Coastal Fisheries Research and Development Center.

The course was organized into five topics: 1) broodstock management, maturation and spawning; 2) larval rearing; 3) culture and maintenance of live feeds; 4) fish health; and 5) physical facilities. The training began with an overview of the physical facilities at Krabi. Presentations were given on site selection and design, water systems, rearing units and water quality management. Broodstock management lectures provided an overview of grouper biology, with an emphasis on reproduction and hormonal control pathways. Additional lectures were on broodstock selection and management, nutrition, assessment of maturation, and preparation for spawning and spawning protocols. Hands-on exercises included anaesthetizing and handling broodstock, determining egg maturity, and inducing spawning with hormones.

Larval rearing lessons were initiated with the spawning of two sets of broodstock. Egg numbers and fertilization rates were determined. Embryonic development was observed and hatching rates were determined. Once the larvae were stocked into two tanks, daily monitoring was begun (and continued for the remainder of the course) for larval health, feeding status and development.

Concurrent with the initial stocking of newly hatched larvae, a series of lectures and hands-on exercises on live feed culture and feeding was carried out. Techniques for culturing marine algae, rotifers, Artemia and marine yeasts were presented.

The three-week course included various field trips to a number of relevant sites. These included other government hatcheries, private grouper nurseries and grow-out operations, as well as shipping facilities.

Sponsoring a GADTC staff member to attend the training course on grouper hatchery production has been a highly cost-effective method for transferring some of the skills and techniques that will be necessary if Guam is to succeed in its planned effort to revitalize its population of squaretail coral groupers.

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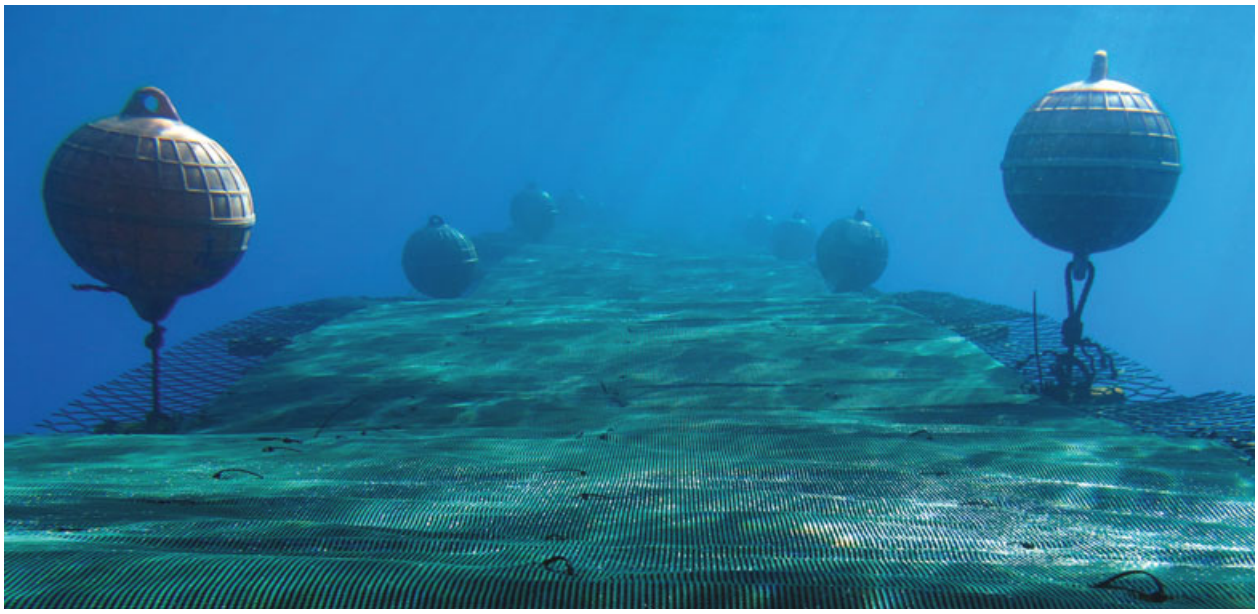
Taking a tissue sample from a coral grouper for testing by polymerase chain reaction (PCR) for viral nervous necrosis.

Dr John Brown (far left) with his classmates waiting to see what the farmer has in this net during a visit to a floating cage grouper farm in Krabi, Thailand.

Postlarval capture and culture of *Tridacna maxima* giant clams in French Polynesia



Eight giant clam spat collecting stations were set up on Reao Atoll in the eastern Tuamotu Islands of French Polynesia, in a recent joint intervention between the Direction des Ressources Marines (DRM) and SPC. The intervention was funded primarily through the auspices of a Fonds Français pour l'Environnement Mondial (FFEM) grant. This brings the total number of collecting stations on Tatakoto and Reao atolls — the only two atolls in French Polynesia where this type of giant clam mariculture is allowed — to 26. It is hoped that the giant clam (*Tridacna maxima*) spat collected from these stations will provide local farmers with a sustainable livelihood, either with the colourful clams reared to a size of at least 4 cm and exported for the aquarium trade, or reared to a bigger size for the meat market (DRM's main long-term goal).

Postlarval capture and culture

Postlarval capture and culture (PCC) is an aquaculture technique that catches pre-settlement organisms during the high-mortality phase as they "settle out" of the plankton onto their settlement habitat, and rears them on artificial structures away from predators to ensure higher survival rates than under natural conditions. These methods were first developed for oysters and mussels centuries ago (Southgate and Lucas 2008). More recently, PCC methods have predominantly been adapted and applied to fish and crustaceans, such as shrimps and lobsters (Bell et al. 2009).

Background to bivalve PCC techniques and development in French Polynesia

During the 1980s, French Polynesia's Fisheries Department[1] developed and adapted PCC bivalve spat collection techniques for *Pinctada margaritifera* (Cabral et al. 1985). Large-scale adoption of this relatively inexpensive and simple way to obtain mother-of-pearl spat in a number of characteristic lagoons led to the economic boom of the Tahitian pearl culture industry.

In French Polynesia, running a giant clam hatchery is too expensive to be competitive, in large part due to high operating and labour costs. But the remarkable abundance and densities of *Tridacna maxima* giant clams in the eastern Tuamotus (up to 500 ind m^{-2}) (Andréfouët et al. 2005; Gilbert et al. 2005), and the ecology of these atolls, offer the opportunity to successfully apply spat collecting methods to this species (Gilbert et al. 2006). Initial work to refine and adapt PCC techniques to the local setting, and determine whether spat collection could be economically viable, was undertaken by the Fisheries Department in the early to mid-2000s in Tatakoto and Fangatau atolls (Remoissenet et al. 2009). Trial results showed that spat densities of up to 400 m^{-2} could be reached, with growth averaging 3 cm after one year.

[1] The Fisheries Department was called Service des Pêches at the time. In 2012, it was merged with the Service de la Perliculture (Pearl Aquaculture Division) to form the Direction des Ressources Marines (Marine Resources Division).

This indicates that PCC could indeed be a viable alternative to the wild collection of giant clams and provide local communities, who have few economic opportunities, with a sustainable livelihood.

The development of this technique is part of a larger PCC project funded by FFEM in 2010 and with activities throughout the Pacific region (www.crisponline.net). Initially spearheaded by the Coral Reef Initiative for the South Pacific (CRISP), it has been managed by SPC's Coastal Fisheries Programme since April 2012.

Initiative in the eastern Tuamotus

Tatakoto and Reao were the first lagoons legally opened by the country's government for giant clam PCC activities. One of the main legal (and ecological) prerequisites for opening lagoons to spat collection is the presence of *mapiko*, a local name describing the natural high-density aggregations of giant clams that form visible (including on satellite imagery) mounds in the lagoon's of these atolls.

Tatakoto

In collaboration with DRM, 12 spat collecting stations were constructed and deployed on Tatakoto in January and February 2012. Two more stations were set up by a farmer with support from one of the local exporters based in Papeete in September 2012. Together, with a previous station deployed in September 2011, the total number of stations in the lagoon is 15 — with a total collecting surface area of about 435 m^2 — split between six farmers. Close inspection of the stations during a recent visit by SPC and DRM showed that all were covered by fine silt (Fig. 1), with algae and small gastropods present on some stations, and oysters often encrusting ropes and the spaces between the stations' mesh and wood supports. Unfortunately, giant clam recruitment at the stations themselves was found to be very low, with records of only a few individuals ranging in size between several millimetres and 2 cm.

Initial results from stock surveys conducted at the same time, in collaboration with the Université de Polynésie française (UPF), at a number of sites previously surveyed in 2004 and early 2012, indicate that giant clam population has suffered a further decline in abundance from the 90% natural mass-mortality estimated to have occurred in 2009 (André-fouët et al. in press). This could potentially limit recruitment and, thus, PCC activities. However, strong variation in stock abundances have been recorded in the past, and are likely to be part of a natural cycle, although these may be exacerbated by climate change. It is, therefore, hoped that new recruits will be observed at the stations and in the lagoon when DRM and UPF next monitor the sites. Fishing pressure exerted by local communities on adult wild giant clam stocks for personal consumption and meat exports present additional threats to the emerging sector. However, a number of existing factors — including financial support, by local and foreign authorities, existing PCC expertise by residents on the atoll, local authority involvement and good follow up and enforcement, and technical support and monitoring provided by the DRM — give strength to the sector in Tatakoto.

Figure 1. Looking for spat at collecting station on Tatakoto, eastern Tuamotus.

Reao

Under the same funding arrangement, and with assistance from AusAID, a collaborative mission between SPC and DRM, with support from local authorities and communities, has allowed eight spat collecting stations (30 m^2 each) (Fig. 2) to be constructed and deployed on Reao Atoll in November 2012. Two days were spent building the stations, and four days were spent on (Fig. 3) and under the water (Fig. 4), bringing the total number of stations on Reao to 11 (3 stations had been previously deployed; 1 in September 2011, and 2 in February 2012).

In parallel to the technical activities undertaken on the ground, a number of workshops were held to train farmers and their assistants in essential giant clam biology and basic mariculture principles. During these workshops, staff also introduced the new paperwork ("carnets à souche") that will be required of farmers to ensure traceability of all PCC clams exported to Papeete. All participants were asked to go through a number of exercises, which allowed staff to address any potential misunderstandings and/or outstanding queries. Additional hands-on, in-water activities included cleaning stations that had been deployed earlier in the year, mostly to remove silt, ascidians and bryozoans with the use of brushes and chisels (Fig. 5); and how to estimate spat densities using quadrats (Fig. 6). Activities were well received and provided a forum for stakeholders to voice some of their concerns and clarify and address some commonly held misconceptions. Participants were highly motivated, lively, curious and eager to learn, with hands-on activities requiring and fostering a cooperative group dynamic.

Surveys of previously deployed stations indicated that some recruitment had occurred, with individuals of exportable colour and size for the aquarium trade (4 cm and larger) on one, and an estimated 1000–2000 recruits ranging between 1 mm and 2 cm on the other two more recently deployed stations.

Follow-up activities are planned by DRM in April and May this year, and a joint visit with SPC is scheduled for the end of 2013, with the hopes that there will be many colourful giant clams to count on all deployed stations at both atolls!

Figure 2. Spat collecting station prior to deployment.

Figure 3. Loading the concrete blocks that will anchor the collecting stations in place.

Figure 4. Underwater deployment of the stations.

All images in this article by Colette Wabnitz.

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Figure 5. Removal of undesirable epibionts, including oysters, bryozoans and other encrusting organisms.

Figure 6. Counting spat with the help of a magnifying glass and a quadrat. Recruits ranged between 1 mm and 2 cm.

Promoting sustainable mariculture in Papua New Guinea

Inception meeting of "Mariculture Development in New Ireland Province, Papua New Guinea".

A new mariculture project focusing on the development and promotion of sustainable mariculture activities in New Ireland Province in Papua New Guinea (PNG) was recently launched. The project is funded by the Australian Centre for International Agricultural Research and is based on Nago Island near the town of Kavieng. SPC's Aquaculture Section is involved in the project's implementation, in partnership with Australia's James Cook University, PNG's National Fisheries Authority (NFA), and PNG's University for Natural Resources and Environment, the main implementing agencies.

Despite substantial efforts and large injections of research and development financing, mariculture development in many Pacific Island nations such as PNG has been relatively limited. This is, in part, due to the manner in which mariculture has been promoted in the past[1] and a range of more specific practical and economic constraints.

In addition, there is little tradition of mariculture in PNG coastal areas; however, the development of livelihood opportunities for poor coastal communities in PNG is among the highest priorities of both NFA and the PNG government.

In order to support such development, NFA recently completed the Nago Island marine hatchery and training facility in Kavieng, which is equipped to support mariculture-related research and training activities, and which is now fully operational. The facility has been established to support development of mariculture opportunities in PNG, and is intended as a training centre for students from the National Fisheries College (Kavieng) and affiliated with the University of Natural Resources and Environment.

Key components for successful mariculture development in PNG have been assessed and include increased institutional capacity in the sector and improved baseline information on the feasibility of village-based mariculture of key marine commodities. This new project will address the need for capacity building by developing a strategy to strengthen institutional mariculture training in PNG, and will identify local species that have the potential to support viable, sustainable mariculture industries for coastal communities.

[1] "…mariculture is often viewed as a solution, not as an option; critical factors for financial and economic success have often been regarded as of lower priority; many projects are designed with a very small duration…" From: Hambrey Consulting and Nautilus Consultants. 2012. Opportunities for the development of the Pacific Islands' mariculture sector. Report to the Secretariat of the Pacific Community. Noumea, New Caledonia: Secretariat of the Pacific Community. 129 p.

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Working at Nago Island Mariculture Centre's wet laboratory.

The main aim of the project is to provide a sustainable basis for development of a mariculture sector in PNG and to build capacity within country partner organisations to support this development. Specific objectives include:

- developing community-based sea cucumber culture methodologies;
- trialling and assessing other mariculture commodities, such as edible oysters and marine ornamentals; and
- improving the capacity of PNG institutions to support mariculture development.

The project is closely aligned with SPC's Aquaculture Action Plan 2007,[2] which identified sea cucumbers and marine ornamentals as high priority commodities for aquaculture development within the region.

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A visit to the Nago Island Mariculture Centre's outdoor facility during the inception workshop.

Successful red emperor snapper spawning at the Mariculture Development Centre in New Caledonia

New Caledonia's Northern Province has been selected for the establishment of the new Mariculture Technical Development Centre (CCDTAM) on the Foué peninsula in Koné, the administrative capital of the Northern Province. The construction of CCDTAM was a partnership between the local government and New Caledonia's three provinces (Northern, Southern and Loyalty Islands). CCDTAM is currently being managed by ADECAL (the territory's Agency for Economic Development) as part of the activities of an innovation and technological park created in 2011 (Technopole de Nouvelle-Calédonie).

Mariculture promotion and development is among the key priorities of the New Caledonian government, as an economically viable and technically feasible alternative to other income generating activities, such as capture fisheries or mining activities. For that reason, and in order to support such development, CCDTAM has been recently equipped to assist mariculture-related development, research and training activities, and will be fully operational in early 2013.

The main objective of CCDTAM is to develop technically feasible farming operations for local, marine reef finfish species of high commercial value (for the domestic and export market), such as the humpback grouper, *Cromileptes altivelis*, and the emperor red snapper, *Lutjanus sebae*, in order to transfer and disseminate these technologies or farming strategies to future local farmers and investors.

Emperor red snapper fry produced at CCDTAM in New Caledonia.

Emperor red snapper brooders kept at CCDTAM, New Caledonia.

SPC's Aquaculture Section has been involved in facilitating a technical exchange between different Indonesian mariculture centres and CCDTAM in 2012. As a result of this fruitful exchange, an expert on marine finfish broodstock management and breeding, Suci Antoro, a researcher at the Lampung Mariculture Centre in Indonesia, has travelled to Koné on two separate occasions (the last one for three months), in order to provide technical assistance on marine finfish breeding and larval rearing technologies.

At the beginning of December 2012, emperor red snapper (*Lutjanus sebae*) individuals, collected in 2012 from different coastal areas of New Caledonia, reached maturity and spawned in captivity at the facility. The larvae obtained from this spawning event are currently reared at CCDTAM, using Indonesian larval rearing protocols, with promising results for survival and growth.

In parallel, the production of microalgae and rotifer, used as food for the emperor red snapper larvae, has also been very successful. It is an essential component for the successful production — both in terms of quantity and quality — of a steady volume of larvae destined to be distributed to private farmers.

The next step will focus on grow-out strategies. In 2013, CCDTAM experts are planning to deploy floating cages where emperor red snapper juveniles will be stocked and reared. Survival, feeding, conversion and stocking density trials are planned to be carried out at this forthcoming stage.

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Commercial fisheries biosampling programme in American Samoa

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In 2009, the United States Congress approved funding to the National Marine Fisheries Service in recognition of expanding data requirements to meet responsibilities under the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006. Under this federal funding, fisheries science initiatives in the Pacific Islands region have focused on implementing a Commercial Fisheries Biosampling (CFBS) programme.

The CFBS programme, implemented through the Pacific Islands Fisheries Science Center under the National Oceanic and Atmospheric Administration, has goals to acquire comprehensive life history and size- and age-specific population structure data in order to develop sustainable management regimes for each Pacific Island territory. The CFBS programme has been designed to identify important commercially harvestable species; determine age, growth, life history parameters and reproductive cycles; and provide size-at-age data to estimate levels of exploitation and sustainable yield.

In 2010, the CFBS programme started as a pilot project in American Samoa and has since been implemented through the Department of Marine and Wildlife Resources (DMWR). Although DMWR has already run a successful creel survey programme, the surveys conducted do not include species-level identification. Moreover, the CFBS programme is intended to conduct total catch survey information for each fisherman in order to circumvent sampling issues. Motivation to participate is a perennial problem in fisheries creel surveys; therefore, this programme is unique because it pays for each fish measured, and purchases fish for otolith and gonad extraction at a rate higher than the prevailing market rate.

The objectives of the CFBS programme are to:

1) hire and capacitate a staff member of American Samoa's DMWR to identify the catch from any fisherman to the species level;

2) develop and field-test logistics for maximizing the amount of length-and-weight-frequency data collected from a broad cross-sample of the fishery;

3) develop a protocol for collecting and processing otolith and tissue samples from the field to the laboratory for processing; and

4) evaluate lessons learned and be able to make recommendations as a point of departure for expansion and refinement of the programme.

Milestones

Since the pilot project began in 2010, DMWR now has seven personnel trained to identify (to the species level) the catch of boat-based spear fishermen (the major coral reef fishery), and from trolling, handlining and bottomfishing activities. There has been a deluge of data due to financial incentives. Most of the fieldwork has been conducted in the Tutuila fish market in Pago Pago where fishermen bring their catch. For spearfishing, fieldwork is conducted in the early morning (from 5:30–8:30 am). Bottomfishing has a more variable landing time throughout the day, but sampling is coordinated through close communication between fishermen and DMWR personnel. Bottomfish fishermen inform DMWR staff of their departure time and estimated arrival time in order to coordinate the timing of catch surveys. Sampling is always conducted on Saturdays because this is the most important fishing day — in preparation for the traditional family weekend get togethers, known as *to'anai*. These gatherings usually require that fish be served.

DMWR staff members Alama Tua and TeeJay Letalie measuring and weighing each fish caught by a spear fisherman.

DMWR staff have routinely accessed the catch of 10 spear fishermen, 4 bottomfish boats and 2 troll and handline fishermen, logging approximately 84,000 length-weight fish measurements since October 2010. During biosampling fieldwork, a fisherman is the sampling unit, and audio recorders are used to record catch data and other information. At the beginning of each audio recording, the following data are recorded: date of fishing; fisherman's name; type of fishing activity; mode of transport (boat or fishing from shore); fishing area; boat registration number; total number of fishermen in the boat; and number of hours spent fishing.

Our data indicate that the blue-banded surgeonfish, *Acanthurus lineatus*, dominates the commercial fisheries catch, accounting for about 45% of the total catch. The rest of the commercial catch is dominated by other surgeonfish species (e.g. *Naso lituratus, N. unicornis* and *Acanthurus guttatus*), parrotfish and soldier or squirrelfish. The snapper *Lutjanus kasmira* and redgill emperor *Lethrinus rubrioperculatus* were abundant in bottom-fishing catches. The spiny lobster was the most highly targeted invertebrate. Spearfishing accounted for most of the commercial catch, based on the number of fish sold on Tutuila.

DMWR has routinely collected otoliths and gonads of the following species from spearfish catches: *Sargocentron tiere*, *Myripristis berndti, M. murdjan*, *M. amaena*, *Naso unicornis*, *Scarus rubroviolaceus* and *Sargocentron spiniferum*. From the bottomfish catch, DMWR has routinely collected otoliths and gonads from *Lutjanus gibbus*, *L. rufolineatus and Lethrinus xanthochilus.* Because spearfishing is a size-selective fishery, DMWR has asked some fishermen to collect newly settled larvae and juvenile fish if they are encountered. The CFBS programme also conducts pectoral fin clip collection to confirm species identification via the DNA ("Fish Barcode of Life") international database. Length and weight measurements, and two whole fish photographs are taken from each sample collected for the fin clip (DNA) collection.

Audio data are later entered into the biosampling database designed by the National Oceanic and Atmospheric Administration's Pacific Islands Fisheries Science Center in collaboration with DMWR staff. Audio files have been archived according to labeling protocols required by the center. DMWR has also developed a system that allows fish purchased for otolith and gonad extraction to be traced to a particular fisherman on a given date.

The benefits of the CFBS programme in American Samoa have been many-fold: it refines current creel survey to the species level and total catch level data, and has enhanced local capacity to identify fish and invertebrate species. It also provides funds for continued off-island training for DMWR staff. The programme will produce valuable information on growth rates, longevity and reproductive patterns for the most important fish species. Together with fish length data, this information will be very critical in length-based coral reef fishery stock assessment, which can determine natural and fishing mortality rates, and estimate sustainable exploitation rates and provide directions on appropriate size limits for fishing.

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DMWR staff member TeeJay Letalie extracting otoliths (ear bones) from a parrotfish in order to estimate its age.

American Samoa revives its FAD programme

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Ta'u Island's shallow-water FAD.

In recent years, American Samoa's Department of Marine and Wildlife Resources (DMWR) has had difficulties implementing its fish aggregation device (FAD) programme. Only one FAD was in place and two FADs had been lost during deployment due to poor design. After some changes in programme management, DMWR approached SPC in order to discuss how best its FAD programme could be revived.

As a first step, it was decided to run a FAD workshop as a refresher course for DMWR staff. The workshop was held from 30 April–04 May 2012 on Tutuila Island with the assistance of William Sokimi, SPC's Fisheries Development Officer. Twenty participants from DMWR participated in the training, which covered FAD rigging, design, maintenance and deployment. The opportunity was used to deploy two deep-water FADs.

In September 2012, DMWR also deployed two shallow-water FADs (subsurface and surface FADs) in Tau, Manua using the MV *Sili*. The subsurface FAD was deployed between Faleasao and Ta'u, and the surface FAD was deployed north of Ta'u. The choice of the deployment sites was based on the advice of William Sokimi. The FAD programme manager, TeeJay Letalie, also conducted a FAD presentation for the village community in order to brief them about the importance of FADs for the livelihood of Manua people. FADs are often very popular with costal communities and the village asked about the possibility of DMWR deploying more deep- and shallow-water FADs in the future. To make sure that FAD catches are properly recorded, a creel survey technician is based on Ta'u to collect data. DMWR used the FAD presentation to further explain how important data collection was to eventually justify the need for more FADs to be deployed.

Related to these developments, two meetings were conducted by DMWR with members of the Pago Pago Gamefishing Association. In these meetings, DMWR requested the cooperation of association members for the provision of data on fish catches associated with FADs. Members were asked about the best way for them to submit sport-fishing data. They suggested that a DMWR technician should conduct weekly phone calls to members for these data. DMWR, therefore, decided to assign a technician for this task. Between June and December 2012, the technician has collected data corresponding to 38 gamefishing-days, which was a major accomplishment. DMWR has tried to collect these data for many years, but it is only now, with this new phone-calling procedure that gamefishing data collection has been effective.

In October 2012, as a further step towards a better implementation of its FAD programme, DMWR sent two staff members, TeeJay Letalie and Mika Letuane, to a workshop in Vanuatu that was organised by SPC. Workshop topics covered FAD construction, deployment, use and monitoring, as well as boat safety and fisheries development. The FAD programme has become a priority for DMWR because it has proven to enhance fisheries livelihood in American Samoa.

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Te Korowai o Te Tai o Marokura

A fresh look at fisheries management by communities

Fisheries management is a dynamic and often challenging pursuit. Too often, fisheries managers find that industry and recreational users are way ahead of them — the managers "shut the stable door" only to find that the "horse has bolted". To avoid this "us and them" scenario, new ways need to be found to ensure that our marine environment is able to support the needs of present and future generations.

Recommendation 2 of the 2003 review of the Nelson/SPC Fisheries Training Course asked that the Nelson component of the course be "re-aligned more towards sustainable management and industry development…" Following on from this recommendation, several new topics were introduced: fisheries science, aquaculture, Pacific fisheries, fisheries management, and observer workshop. Delivery of these new topics began in 2004, and 2013 will be the fifth year in which they have been an integral part of the course.

In the current Nelson course structure, seven days have been set aside for the fisheries management module, and in 2012 a new study focus was introduced. The 2012 group of 11 students, accompanied by Viliami Langi and Alec Woods, travelled to the seaside tourist town of Kaikoura, New Zealand.

A new conservation strategy

The aim of the visit was to study the ecological system, that is Te Tai o Marokura — the Kaikoura marine environment. It has taken the Kaikoura community seven years to develop this strategy. In this endeavour, they have been helped by experts from throughout New Zealand and guided by a similar strategy developed several years earlier by the Fiordland Marine Guardians.

In essence, the document is a challenge to government and is, in effect, the community saying to government that, acting as a community, it wants to develop its own strategy to manage the future well being of the Kaikoura marine environment. This may require special legislation, and the government is presently considering the implications of this strategy (Te Korowai).

2012 Nelson course students and Viliami Langi (left) at the Takahanga marae, Kaikoura. The carvings behind them are by Cliff Whiting.

The vision

The vision of Te Korowai can be summarised as:

By perpetuating the mauri and wairua of Te Tai o Marokura

The community act as kaitiaki of Tangaroa's taonga

To achieve a flourishing, rich and healthy environment

Where opportunities abound

To sustain the needs of present and future generation

The key to realising this vision has been a philosophy of "gifts and gains". Each stakeholder group, such as commercial fishers, tourism operators, *tangata whenua*, recreational fishers and local residents, has gifted concessions — that is, given something up to Tangaroa — to sustain the integrity of the whole resource for the future.

The vision has four key outcomes:

- Sustaining customary practices
- Protecting our treasures
- Fishing for abundance
- Living sustainably

"Sustaining customary practices" means that the traditional fishing areas of Ngati Kuri are restored and maintained and that traditional knowledge (*matauranga*) and customs (*tikanga*) are used to protect the fisheries of Te Tai o Marokura. The overall approach is to use the tools provided by the government, following the treaty settlement on fisheries. *Tangata whenua* will have control over key food baskets through the mechanisms of *mataitai* and *taiapure*. Reserve managers will be assisted by customary and scientific baseline surveys in order to monitor the health of both *mataitai* and *taiapure*.

"Protecting our treasures" will be achieved by giving special status to unique areas, such as through a range of protection measures, including World Heritage status, a marine mammal sanctuary, local codes of practice for commercial fishers, a marine reserve and several *rahui* (temporarily closed areas).

"Fishing for abundance" means that it is okay to fish but that managing fishing effort needs to be done at a local level. The social and ecological objectives of the community must be integrated with the use of national tools for fisheries management. The rules on commercial, cultural and recreational harvests will have to conform to a local consensus so that resultant decisions are fair to all sectors. Fishing for abundance will require better enforcement and education of fishers, local codes of practice, a greater level of research and monitoring of local fisheries, local recreational fishing rules, and a charter fisher's code of practice.

"Living sustainably" will require integrated land and water planning through resource management processes that are under local control. The objective is to sustain and enhance the quality of the Kaikoura coastal and marine environment. This will include a public access and highway management plan for the Kaikoura coast and effective marine biosecurity measures for the area.

Cross-cutting actions to achieve outcomes

There are four broad actions that cut across and support these outcomes.

1. Engaging understanding is fundamental to improving the way in which people interact with their environment. It is vital that the community is informed or educated about the strategy in a way that is both relevant and understandable. Sources of traditional, local and scientific knowledge will need to be sustained and enhanced. By directly engaging with key groups, a sense of ownership and *kaitiakitanga* will be promoted.

2. Governance must be effective and locally led. The strategy seeks neither independence from government nor to usurp statutory functions for decision-making and enforcement. Rather, it is about local communities taking initiative and developing a regional view of things. The role of Te Korowai will need statutory recognition so that the suite of legal instruments identified in the strategy can be made to work effectively. Ongoing funding will need to be secured to support the strategy's implementation.

3. Compliance with the outcomes of the strategy will involve developing a cultural and social expectation that supports the vision. Implementation will also require enforcement where legal rights and obligations are transgressed. Enforcement would still remain with the relevant agencies, and code-compliant companies would use Te Korowai-endorsed branding.

4. Monitoring and review will be necessary so that the strategy is kept up to date and effective. It will be important to identify and monitor key indicators such as growth in fish size or numbers and the effectiveness and health of reserves and sanctuaries. Where necessary, management will need to adapt or change direction.

A *korowai* is a cloak worn by a chiefly person and is laid over something to ensure its care and protection. In this instance, that "something" is the coastal marine area of Marokura. The community is weaving this *korowai* together.

We believe that the efforts of the Kaikoura community in achieving their vision are worthy of study. There is much here that is relevant to any coastal community that depends on the marine environment to sustain it, and it is hoped that visiting Pacific Island fisheries officers will see developments here that are relevant to their own countries.

The strategy is still evolving and there are hurdles to overcome, many as yet unknown. The value in visiting Kaikoura is to have the chance to experience this unique environment and to begin to understand the importance the community sees in perpetuating the *mauri* and *wairua* of Te tai o Marokura.

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Some definitions

Mataitai is a traditional fishing ground established under the Fisheries (South Island Customary Fishing) Regulations 1999, giving local Maori the right to sustainably manage the fisheries resources in that reserve (usually a customary food gathering site). Generally speaking, commercial fishing is excluded from such areas.

Taiapure identifies an area of estuarine or coastal water that is of special significance to an *iwi* or *hapu* (tribe or subtribe) as a source of food or for spiritual or cultural reasons. The management committee is nominated by local Maori and will be drawn from all stakeholders. This committee has the power to recommend regulations that allow *taiapure* to function according to custom.

Kaitiakitanga is the exercise of guardianship by *tangata whenua* (local Maori) of an area in accordance with tikanga *Maori* (Maori customs).

Mauri is the life force, in this case, of the Kaikoura coast, which binds its physical and spiritual elements, generating and upholding all life.

Wairua is the spirit of the living system (i.e. the Kaikoura coast). "The Coast" embodies an holistic "mountains-to-sea" philosophy or *ki utaki tai.*

Three very lucky seafarers in Kiribati[1]

During the 6–7 October weekend, the Hawaii-based US Coast Guard managed to rescue three fishers from Kiribati who had been lost at sea since Tuesday, 2 October 2012, in the open waters off Tarawa Atoll.

At the end of the week, search efforts began to find the three people on the small five-metre vessel travelling from Maiana Atoll to Tarawa. After being contacted, the US Coast Guard sent out a Hercules C-130-type, wide-body aircraft on Friday, 5 October 2012 to conduct air reconnaissance.

The plane methodically searched the zone in a grid pattern, taking into account the possible drift of this type of vessel. After spotting the boat on the plane's radar, visual contact was made at about 160 kilometres from Maiana Atoll and the plane then dropped a watertight container filled with food, drinking water and a GPS transmitter kit.

Next, a Korean fishing boat, which was deployed in that area, was contacted and changed course to recover the three survivors, who were in a satisfactory state of health according to the first reports.

In addition, on Saturday, 29 September 2012, 11 people, including two children, were rescued in Papua New Guinea after their life raft (an inflatable eight-meter dingy equipped with an outboard motor) capsized in Madang province, in heavy seas, the daily newspaper The National reported on Thursday, 4 October 2012.

They spent the night adrift, clinging to the overturned boat, before being rescued by a larger coastal vessel. Once again, this involved a trip between the main island and one of the islands off the coast of New Guinea. The accident occurred not far from the place where the Rabaul Queen ferry sank on 2 February 2012, resulting in the deaths of at least 150 of its passengers.

Troubling near-coincidences

The waters around Kiribati have been the site of several disappearances and, occasionally, reappearances of sailors lost at sea.

In mid-September 2012, a sailor was found in Kiribati after three and a half months adrift in the open ocean. The castaway, whose name was Toakai Teitoi, was spotted north-east of Nauru onboard his small skiff and then taken abroad a fishing boat sailing under the Marshall Island flag, the Ali Ezekiah. His overall health was relatively good according to a member of the crew.

He disappeared at sea after sailing out from the small atoll of Maiana (Kiribati) on 28 May 2012, for what was supposed to be a simple fishing trip.

There had been another man on board the small six-metre outboard vessel but he apparently died after they had been adrift for one and a half months, i.e. in early August 2012, according to the survivor. The small boat began its long journey after its engine broke down.

Numerous accidents of this kind in the region

In terms of the most recent incidents, in early March 2012, a small five-metre fishing boat and its occupant, who had disappeared offshore from Kiribati (formerly the British Gilbert Islands) several days beforehand were finally located by an Orion P3 from the New Zealand Army.

The small fishing boat had apparently drifted since it had been seen for the last time.

Called to assist on Sunday, 4 March 2012 after an initial unsuccessful search locally, the New Zealand authorities and their Rescue Coordination Centre (RCC) rapidly put to work one of their specialised observation aircraft, the Orion. This quick action made it possible to locate the small boat before it drifted too far away, rescue workers felt.

The Orion arrived in the restricted search area at midday on Monday, 5 March 2012 and was able to locate the vessel just 20 minutes after its arrival. They then dropped food, water and first aid equipment.

A fishing boat crossing the zone was then contacted and changed course to take on the boat's single occupant.

Nevertheless, the New Zealand Army explained, the Orion has continued to fly over the waters of Kiribati as part of a second rescue mission, also in response to a request by local authorities.

A few miraculous survivors

In late February 2012, three young Samoans who had disappeared in the seas off the coast of Apia were found safe and sound and rescued by a cruise ship, which spotted them by accident a week after search efforts had been called off.

The three young men, Oli Faavae, Sailigi Simi and Tuitea Talavou, had gone out to sea on 6 February 2012 saying they would be back the next day.

[1] Article reproduced from: Flash d'Océanie, 8 October 2012 (http://newspad-pacific.info). Translation from French by SPC

On Monday, 20 February 2012, the Seabourne Odyssey, which was in that part of Samoan waters, spotted them and took them onboard before putting them ashore at the next stop in Pago-Pago, the capital of American Samoa. They were in fairly good health considering the circumstances.

The three miraculous survivors said they had luckily been able to catch fish to eat on a regular basis.

Search efforts, which had been coordinated by Samoan authorities with the support of New Zealand and the US, were suspended on Tuesday, 14 February 2012.

The police, who were coordinating these operations, had explained at the time that search efforts had been suspended as the rescue services were convinced that the small vessel had probably sunk in rough weather with all onboard, somewhere in the seas off the Upolu Islands.

"This is a sad end to an all too common story in our islands," dramatically stated Superintendant Tagaolo Iosefatu Wright, Officer in Charge of the Samoan Police Maritime Wing.

After these three young men disappeared, several small fishing boats from Samoa and nearby American Samoa joined the search efforts to try to find any sign that the people on the little fishing boat, the Fefe i le Sou II, were still alive

The most extensive resources came from the New Zealand Army (an Orion, specialised in observation) but also, as American Samoa was close by, from the US Coast Guard, which sent out several vessels.

Again in the same region, two fishers from Kiribati, who had been missing for 33 days, were found safe and sound on Thursday, 24 November 2011 on a small uninhabited island south of the Marshall Islands, which they had managed to reach.

Kiribati authorities had been searching for the two men, 26 and 53 years old respectively, with the logistical support of the US Coast Guard, called in to take part in rescue operations.

The men had disappeared on 22 October 2011, after leaving Tarawa (capital of Kiribati).

After several unsuccessful search flights over this enormous area, the boat was finally spotted and located. A medical exam found the men to be in a "reasonably good" state of health, in spite of the severe lack of food, which had left them very weak.

The two men were then taken home to Tarawa from Majuro, the capital of the Marshall Islands.

One of the adventures that gained the most media coverage worldwide over the past few years involved three teenagers who disappeared on 5 October 2010 off the coast of Tokelau and who were miraculously found east of the coast of Fiji by a New Zealand tuna boat, after being adrift for 50 days and covering some 1200 km.

The three young men who disappeared, two aged 15 and the third, 14, had gone out to sea on a small aluminium skiff whose motor was not working

Intensive search efforts were made to find them several days after the alert was raised by their country's authorities, who had requested the assistance of Tokelau's overseeing country, New Zealand.

During the days that followed the New Zealand Maritime Rescue Coordination Centre mobilised one of its military Orion aircrafts to conduct a series of flyovers of the area so as to extend the work of local patrol boats. But none of those efforts succeeded in locating the teenagers lost at sea.

After searching for three days, New Zealand authorities, who felt that the chances of finding someone alive inside this enormous area (about 25,000 km^2) were very slim, decided to suspend the operations.

On Tokelau, the families had resigned themselves to this loss and held religious services in honour of the three young men, Samuel Perez, Filo Filo (15 years old) and Edward Nasau (14 years old).

But a few days later, when the New Zealand tuna boat the San Nikunau was crossing the ocean north-east of Fiji not far from Wallis and Futuna, the crew managed to spot the hull and then the silhouettes of the three young men onboard, who were waving to draw their attention.

They were taken on to the ship in a "relatively good" state of health and said they had survived by drinking rainwater, sometimes saltwater and eating raw fish and, occasionally sharing a seagull. They were given first aid on board, particularly for severe sunburn. "We gave them some cream to help with the pain but that was about all," said one crewmember.

The tuna boat took these unexpected guests to Suva port, where the three miraculous survivors were given a thorough medical exam before returning to their home country.

Incidents of this type, involving small motorboats for inter-island transport or short fishing trips, are very frequent in this region, both in the areas around Kiribati and the Marshall Islands, but also to the west in Melanesia.

One of the most frequent causes is the breakdown of the small outboard motor or running out of fuel.

Global study of the management of baitfisheries that support pole-and-line tuna fishing

Robert E. Gillett

Director, Gillett, Preston and Associates

Pole-and-line tuna fishing is generally recognized as having many positive characteristics, especially in terms of its social and environmental attributes. An important aspect of pole-and-line fishing is that it requires live baitfish — and catching baitfish is associated with both opportunities and constraints. There is a widely held view that there are significant prospects to improve the pole-and-line fisheries (i.e. mitigating negative impacts, enhancing benefits) through modifications to baitfishing and its management.

A global study was undertaken of baitfisheries that support pole-and-line tuna fisheries. Visits were made to most countries in the world where pole-and-line tuna fishing is significant, in an attempt to understand the associated bait fisheries and their management.

The initiative and funding for this study came from the International Seafood Sustainability Foundation (ISSF). It is important to note that the choice of countries visited, specific subjects examined, and methodology used was largely left to the consultant.

Fieldwork for the study began in early March 2012 and was concluded in mid-May 2012. Eleven areas in Africa, Asia, Europe, North America, Oceania and South America were visited.

The study allowed for an estimation of the production of tuna by pole-and-line fishing (Figs. 1 and 2).

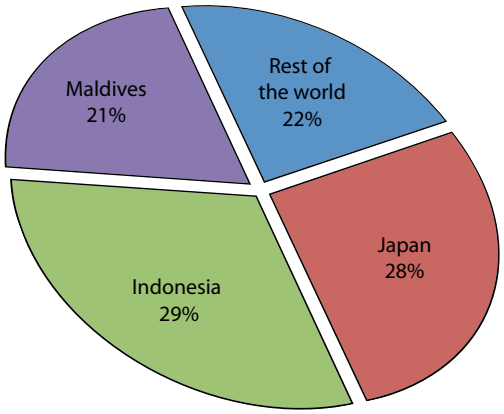

Figure 1.
The major countries involved in pole-and-line tuna fishing.

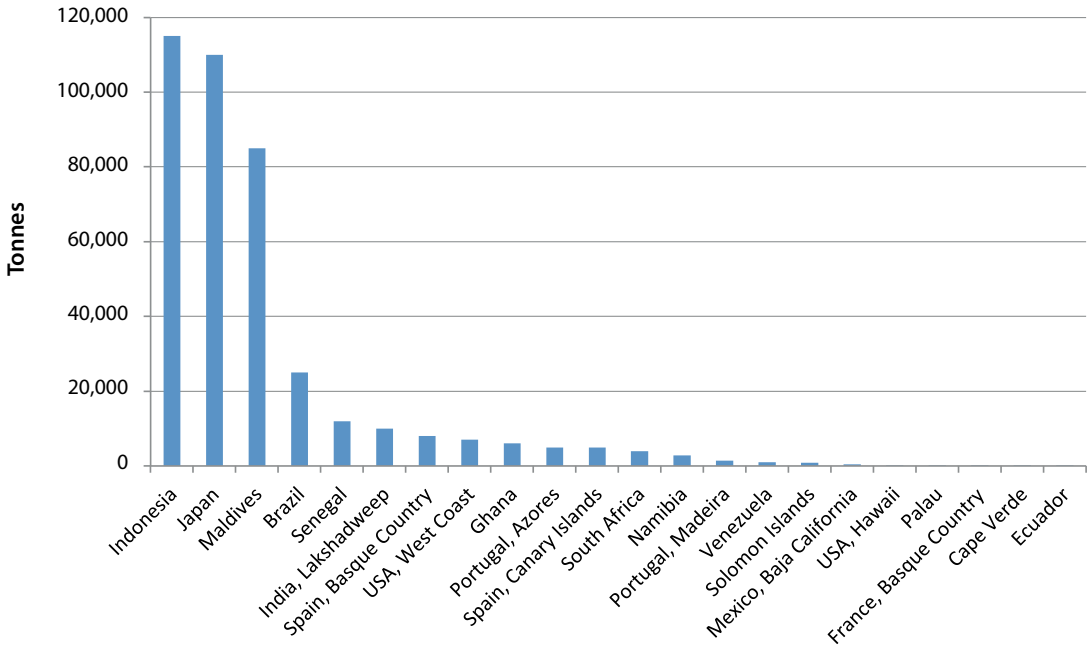

Figure 2. Estimates of recent annual pole-and-line tuna catches (in tonnes).

The study's major findings with respect to baitfishing include the following.

Some major features of the baitfisheries	The baitfisheries of the Maldives, Indonesia, and Solomon Islands involve a large number of species (i.e. complex tropical, multi-species fisheries), whereas other fisheries make use of only a small number of species. In Indonesia and Japan, baitfish are characteristically purchased from separate baitfish capture operations. In Senegal, most of the baitfish comes from separate operations, whereas in Ghana only some does. Only in the Solomon Islands and Maldives is baitfishing a discrete, stand-alone fishery. In other areas, baitfishing is a component (mostly very small) of the total amount of fishing effort on the species used as bait. In a sense, baitfisheries are "nested" inside a larger, overall fishery. The most dominant baitfishery trend is a decline in production that mirrors the production decline of the associated pole-and-line tuna fishery. There is great diversity among the various baitfisheries in the relationship between baitfishing and local communities.
Management measures that are specific to baitfisheries	Presently, there are only a small number of management measures that are specific to baitfisheries. The two stand-alone baitfisheries (Solomon Islands, Maldives) are only lightly regulated, while in cases where baitfisheries are nested in larger, overall fisheries, the management unit is the overall fishery, and most management measures are not specific to the baitfishing component.
Limits on amounts of baitfish captured	Limits on amounts of baitfish captured are not characteristic of the world's baitfisheries. This appears to be due to perceptions of resource abundance and/or resilience (Solomon Islands), an inability to place catch restrictions on fishers (Maldives, Indonesia), declines in baitfishing production resulting in a sense of less urgent need for management (most locations), and the fact that a catch restriction for a nested and relatively small baitfishery characteristically has little impact on the overall fishery (most locations).
Fishery management plans for baitfisheries	Currently there are no functional fishery management plans for any significant baitfishery in the world. Management plans are presently being prepared for two baitfisheries: the Maldives and Solomon Islands. Fishery management plans are in place for the overall fisheries that encompass the baitfisheries of the USA West Coast, and (to a degree) the Basque Country (Spain). Fishery management plans are not in place for the overall fisheries that encompass the baitfisheries of Indonesia, Japan, Brazil, Azores, Canary Islands, Senegal and Ghana.
What is a fishery management plan?	In the areas covered by the study there is no consistent concept of what a fishery management plan actually is: many different types of documents are called fishery management plans.
Monitoring of baitfisheries	Monitoring catches (i.e. collecting catch and effort information) is an essential activity in support of fisheries management. Given the simplicity of collecting, analyzing, and using that information (and the utility of the analyzed information), it is somewhat surprising that few baitfisheries are adequately and routinely monitored. The usual case is that catch and effort data are: 1) not collected, 2) collected only during specialized research projects, 3) collected only during the height of the fishery, or 4) collected and not analyzed.

Baitfish resiliency	The nature of many baitfish species points to relatively high productivity and some degree of resilience to fishing: low trophic level, highly fecund with rapid growth, and relatively short lifespans. On the other hand, this favorable productivity is often tempered to some degree by recruitment variability due to environmental influences.
Some major challenges in improving the management of baitfisheries	Improving the outcomes of baitfish management in some countries would require a major overhaul of the entire coastal fisheries management regime, which would be a monumental undertaking. Improvements in other baitfisheries require some ability to restrict a large amount of "semi-unmanageable" artisanal fishing effort. A significant challenge for improving most of the world's baitfisheries concerns "nested" baitfisheries. The logical way to improve management would be to deal with the overall fishery rather than tinkering with the small baitfish component, but it is uncertain what should be the appropriate role of the baitfishery and its stakeholders in improving the management of the overall fishery.
Improvements are mainly site-specific, except for monitoring	There are few improvements to baitfish management systems that would be universally applicable. In the recent past, there has been a notion that fishery management plans are essential for good baitfishery management everywhere, but this is probably not the case. It has become apparent during the present study that perhaps the only improvement that is broadly applicable to the management of most baitfisheries concerns monitoring. The relatively simple process of collecting and analyzing baitfishing catch and effort data would help improve the management of most of the world's baitfisheries by providing key information for decision-making. Baitfishing catch and effort data are obviously important to dedicated baitfisheries (e.g. Solomon Islands, Maldives), but are also of value in the "nested baitfishery" component of a large, overall fishery.
Fishery management plan role in improvements	Management plans can be a convenient way to organize fisheries management, improve efficiency, assure that interventions are tied to objectives, guide less-sophisticated managers, and promote transparency. They become even more useful in complex situations and where stakeholders are unfamiliar with fisheries management processes. In short, they are quite appropriate for the conditions commonly found where there are baitfisheries in developing countries. This desirability, however, seems to fall somewhat short of such plans being absolutely essential. Therefore, a blanket statement on the necessity of a fishery management plan for all baitfisheries could be too prescriptive. In addition, a template baitfishery management plan or "best practices" or "common standards" for management plans for the dedicated baitfisheries, may not be applicable to the overall fisheries that contain nested baitfisheries.

Baitfishing boats in the Maldives.

Common elements of effective management	If fishery management plans are not essential for effective management (i.e. where objectives are being achieved), can some essential elements be identified that are common to all effective management arrangements? Such a list (at least for baitfisheries) would probably include: 1) some type of monitoring of the fishery, 2) some formal statement of the rules (e.g. plan, legal instrument, policy document), and 3) a mechanism for applying those rules.
Conclusions on stock assessment	Rather than promoting regular comprehensive baitfish assessments, another approach worth considering is to collect and analyze catch and effort data for major trends, while opportunistically making use of a more sophisticated analysis when it becomes available. Trends in catch and catch per unit of effort have the advantage that they are simple, easy for developing country managers to use, and are readily understood by fishers and the general public.
Suggestions for research	Because there appears to be considerable interest in researching topics that have already been well-studied, there is a need to compile previous baitfish research findings, including overall lessons learned. Another important category of research that is applicable to many baitfishing countries concerns making progress with the three "major challenges" cited above.
Specific activities for improving the management of baitfisheries	Ideas improving baitfishery management that emerge from this report include promoting the monitoring of all baitfisheries, and promoting the concept of a "fisheries management framework" in countries with favorable conditions (i.e. where there is political will and stakeholders willing and able to engage). Such a framework would feature collecting, reporting, using catch and effort data on the baitfishery, and some formal statement of the rules and how they are to be applied.

A full copy of the report is available from Robert Gillett (Gillett@connect.com.fj) and the ISSF website (http://iss-foundation.org/wp-content/plugins/download-monitor/download.php?id=ISSF-2012-09-Baitfish-Management-Report-August-18-VERSION.pdf)

A fixed bagan *(platform used to catch baitfish at night with a large lift-net and lights) in Indonesia.*

Pioneering American experiment may hold lessons for European fisheries[1]

Stakeholder collaboration improves fishery, livelihoods, and habitat

Jay Udelhoven

Global Marine Initiative, The Nature Conservancy

Originally conceived as a one-time fisheries buy-out to reduce fishing pressure, the California Central Coast Groundfish project in the United States has evolved into a long-term fisheries "buy-in" for an environmental organisation that has invested considerable funds, time, and staff to help struggling fishermen and local communities while simultaneously improving a fishery and habitat. The project story presented here provides insights for possible engagement strategies in Europe.

Groundfish have been successfully harvested in the waters off the west coast of the US since the early 1900s, contributing significantly to local economies. The groundfish fishery included over 90 species of flatfish, rockfish, roundfish and others and was managed under complex and overlapping institutional arrangements involving federal, state, and tribal authorities. Landings in the groundfish fishery peaked in the early 1980s, but soon thereafter fisheries managers and scientists documented large declines in the populations of several vulnerable groundfish species.

Collapsing fishery had widespread economic, social impacts

From 1983 to 1999 the groundfish fishery experienced a 47% reduction in ex-vessel value of catches. The ensuing decline in landings and revenue through the 1990s was exacerbated by increasingly strict regulations aimed at curtailing the overfishing of vulnerable species, such as canary rockfish, which is not predicted to recover until 2063. The collapse came to a head in 2000 when the federal government declared the fishery a national disaster. During this period, the size of these vulnerable or weak stock species fell below prescribed sustainable levels. Harvest rates for vulnerable or weak stock species were subsequently limited due to a legal obligation under federal law.

The collapse of the fishery was experienced intensely in the central California coast, where the cost of conducting fishery related business was high. Many individual fishermen had invested heavily in bottom trawl gear. Also, many local ports and processors had become economically dependent on large volumes of fish delivered by trawlers. As landings declined, many of the processing and port businesses started to close, which had social and economic impacts on local communities and fishers. While significant fishery policy reforms had been made to the groundfish fishery, these changes had not been effective in making local fishing communities environmentally and economically sustainable.

Understanding the science

In the early 2000s studies by the National Academy of Sciences and The Nature Conservancy, global conservation organisation working in 33 countries throughout the world including the United States, identified bottom trawling as the greatest threat to benthic biodiversity and offshore marine ecology in general and in particular to the Californian Central Coast region. When federal authorities announced bottom trawling closures the organisation agreed to buy federal trawl permits and fishing vessels from fishermen who wanted to exit the fishery. Some years later when fishers and others decided to experiment with switching to non-trawl gear the organisation leased the vessels back to the fishers under certain conditions. These required fishermen to: 1) collaborate on the iterative development of a harvest plan; 2) use alternative gear that was more selective and did less damage to seafloor habitats, such as traps, pots, hook-and-line, or set longline gear; 3) harvest a defined allocation of fish following geographic restrictions (much like a quota, including by catch); 4) retain all rockfish (e.g. not discard at sea); and 5) carry on-board observers on every trip.

To oversee the implementation of the gear-switching experiment, a new community-based fishing association was created which brought together the local fishing communities, fishing industry participants, and conservation organisations. The concept behind the fishing association was to test whether a cooperatively

[1] This article was first published in *Eurofish Magazine*, EM6 2012 (www.eurofishmagazine.com) and is reproduced with their kind authorisation.

managed local entity could meet harvest objectives and conservation standards while improving economic output, basically by leasing and managing The Nature Conservancy's fishing permits as well as incorporating community, conservation, and industry in its fishery decision making. This project simulated conditions that would follow implementation of an individual fishing quota system in the groundfish trawl fishery and provided guidance for fishing communities on how to take best advantage of that system to secure access to the resource.

The fishery management transition

In 2011, after 40 years of a limited-entry and total allowable catch management system, the west coast groundfish fishery in the US transitioned from a permit structure to an individual fishing quota (IFQ) system. Under the new IFQ system, fishermen own shares of the overall allowable catch for the fishery. The individual quota shares can be bought and sold, but the share that any single fishing entity can own is capped to discourage the accumulation of fishing rights in the hands of any one enterprise. As an owner of 13 fishing permits, The Nature Conservancy was allocated approximately seven percent of the overall quota share. Because of its rights-based standing within the fishery, The Nature Conservancy is now helping initiate three types of co-management institutions in the West Coast groundfish fishery.

Establishing co-management institutions

Co-management institutions are locally organised groups of diverse fishery stakeholders who work to advance the scientific understanding of their surrounding marine resources and develop effective solutions to local fishery problems, essentially using innovative approaches to "co-manage" the fishery. Different types of co-management institutions — including community quota funds, risk pools, and marketing cooperatives — are now under development to solidify changes in the fishery and empower local fishermen and communities to help manage the fishery.

Community quota funds (CQFs) are being established to combat the threat of the consolidation of fishing quota and fishery access in large commercial enterprises and larger ports — to the detriment of smaller ports and their fishing businesses — and create durable co-management institutions that can play a role in achieving sustainable management of the marine resources. The CQFs hold and manage quota and create incentives for local fishermen to advance both best management practices and stable local fishery landings. As The Nature Conservancy must divest itself of approximately half of its quota share by the end of 2014 in order to comply with the regulatory cap on the total amount of catch share that one entity can own or control, the CQFs are an essential part of The Nature Conservancy's long-term

Central California Coast fisherman bringing in catch. © Bridget Besaw 2008

fishery reform strategy. As part of this effort, CQF operational plans have been developed, which define their functions and responsibilities, structure, governance, budgets, and necessary financing to secure and manage quotas.

Risk pools are also being created to reduce bycatch of overfished species. Under the new IFQ system, fishery managers release only small amounts of overfished species quota in an effort to rebuild these species' stocks. To harvest more abundant groundfish stocks, fishermen must manage their incidental catch of overfished species and once they exceed quota for any species they must stop fishing, tie up their vessel and acquire more quota on the open market. Because overfished species quota is in such low supply it can be quite difficult and even unaffordable for many fishermen to obtain. The limited amounts of overfished species quota thus represent a serious challenge facing west coast groundfish fishermen. Borrowing a concept from the insurance industry, The Nature Conservancy and fishermen from central California ports pursued an innovative solution to the overfished species problem by creating a voluntary risk pool (or joint pool of the limited quota). Members of the risk pool who catch overfished species are covered by the pool's quota (made up of the combined quotas of individual fishermen and The Nature Conservancy), in return for adhering to a suite of best management practices designed with local fishermen knowledge and science to reduce the risk of encountering overfished species. The best management practices employed during the 2011 fishing season included zoned fishing areas (Fig. 1), voluntary closure areas, gear switching, having 100% observer coverage and sharing of information on the location of overfished species. Sharing of location data was made possible via a web-based application called eCatch developed by The Nature Conservancy that enables fishermen at sea to use iPads to upload their catch data to a central database and map and share that information with other fishermen in near-real time (Fig. 2).The Nature Conservancy catalyzed the risk pool by committing its substantial overfished species quota to the pool and by providing the science and technology needed to help fishermen identify high risk areas and practices and capture information to improve the performance of the pool over time. The novel concept of risk pools for overfished species has caught on across the fishery as three additional risk pools have been established along the West Coast.

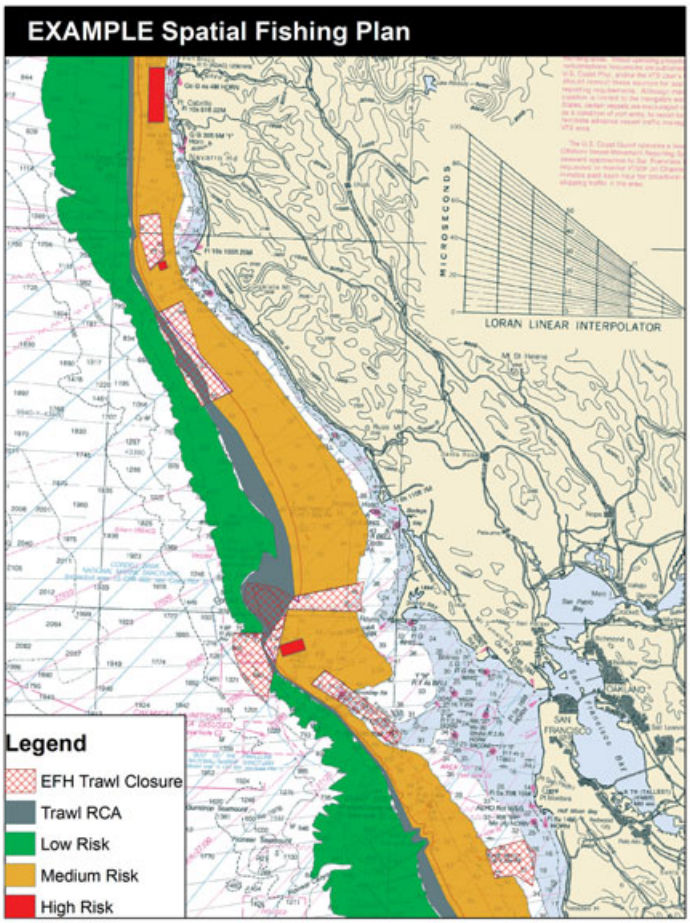

Figure 1. Example map of fishing areas along the Central Coast region of California that depicts high, medium and low risk zoned areas, as well as existing trawl closures (EFH Trawl Closure and Trawl RCA). Each zone would have specific fishing prescriptions.

Figure 2. eCatch interface.

Lastly, Marketing Cooperatives are being established to help fishermen succeed in the marketplace thereby ensuring the viability and durability of the fishery reforms. The Nature Conservancy's involvement with co-management institutions in the fishery has resulted in fishermen harvesting high-quality seafood using best management practices. Market success will reward fishermen and community partners with higher fish prices for their products and possibly lead to more consistent demand. Demonstrating a viable, functioning model of market rewards will reinforce the fishery reforms achieved and inspire other fishing industries and communities to undertake similar reforms.

Promising results

This risk pool operated throughout the 2011 fishing season and thus far all of 2012. In 2011, the entire west coast fleet utilised almost 40 percent of its annual quota for overfished species, yet the members of the risk pool utilized only two percent of their quota, helping rebuild these important species' populations (Fig. 3). During this period, compared to the total fleet, members of the risk pool collectively utilized more of their target species quota for seven economically important species (Fig. 4). These results are representative of the first year of fishing under the new IFQ system and thus may not be entirely representative of future performance. Nonetheless, the 2012 performance of the risk pool appears to be on a similar positive trajectory.

Other Conservancy fishery buy-in projects

The Nature Conservancy's California Sustainable Fisheries Initiative is helping the groundfish fishery move toward economic and environmental sustainability through innovative transactional and partnership strategies that create strong economic incentives for change in the fishery through the leveraging of trawl permits and quota share assets. The Nature Conservancy oversees and assists with the implementation of rights-based incentive agreements such as these (collectively referred to as Marine Conservation Agreements; see: www.mcatoolkit.org) in several countries and in a variety of ocean and coastal conservation interventions. Other projects in which The Nature Conservancy is actively "buying into a fishery" through agreements with fishermen include a permit banking project in Maine of the United States, a territorial user rights project in Chile, and a public-private sustainable fisheries initiative in Indonesia. The Nature Conservancy is currently working with partners to assess if and how similar strategies can be applied in other regions.

The need and potential for fishery buy-ins throughout Europe

After 60 years of operation, The Nature Conservancy attended the World Fisheries Congress in Edinburgh in 2012, where they presented their experiences. While

Central California Coast fisherman sorting catch. © Bridget Besaw 2008

much was learned and gained from the Congress, the private buy-in approach to fisheries engagement as demonstrated by The Nature Conservancy was well received, but was largely a new concept for many attendees. Considerable interest was expressed in understanding more about how The Nature Conservancy functions and how private conservation-minded buy-ins to fisheries reform might work throughout Europe. Some important lessons in regards to fishery buy-ins that practitioners should consider as opportunities in Europe include:

- Fishery buy-ins are not a quick-fix solution to fisheries reform. On the contrary, a fishery buy-in represents a long-term commitment to fishermen, local communities, the fishing industry and regulatory agencies to work collaboratively to ensure economic and environmental sustainability can be achieved.

- There is no road map to fishery buy-ins. Each fishery and the coastal communities they support are unique. As such, general guidance regarding buy-ins

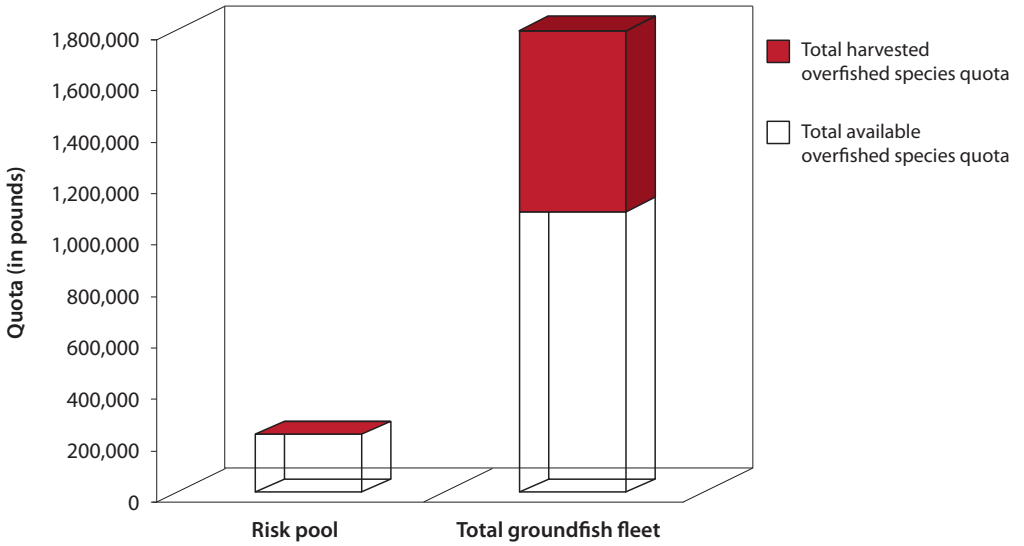

Figure 3. Total unused overfished species quota (clear bars) and harvested overfished species quota (red bars) by risk pool compared to the total west coast groundfish fleet. The risk pool harvested 2.1% of available quota, while the total fleet harvested 39.1% of available quota (less the risk pool quota).

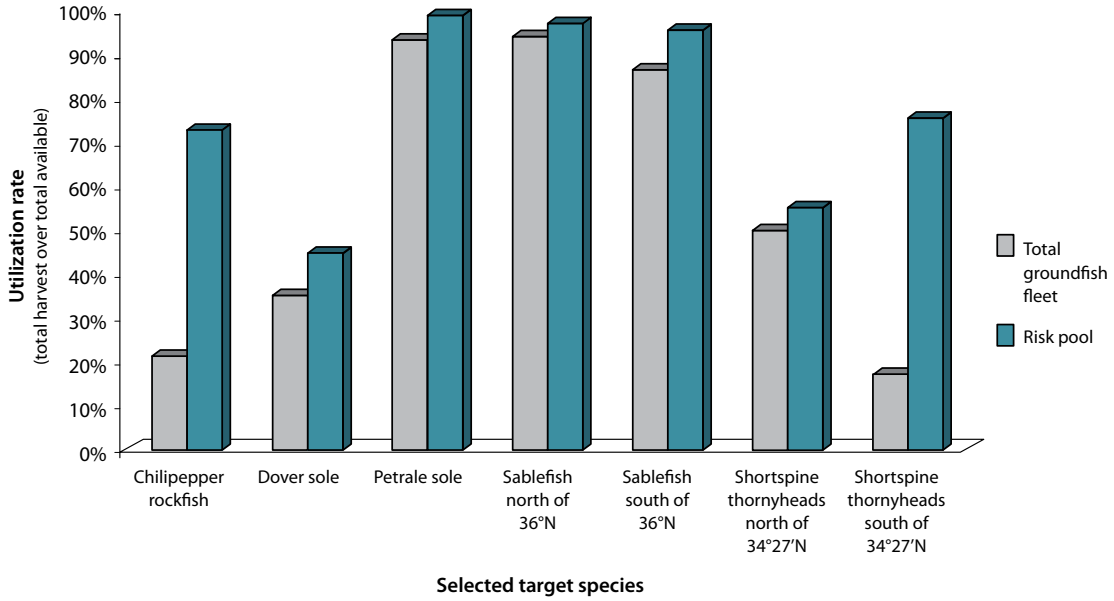

Figure 4. Selected target species (based on high economic value) quota utilization rates (shown in percentage) compared between the total groundfish fleet (grey bars) and the risk pool (blue bars).

should be considered, but each project must be designed and adapted over time based on the specifics of the fishery.

- Fishery buy-ins are not appropriate for every fishery. A universal set of enabling conditions (including the desire and ability on behalf of conservationists to engage communities over the long term) should be considered prior to launching a fishery buy-in. If most of the enabling conditions are not present or otherwise cannot be addressed, a fishery buy-in may not be appropriate.

- Fishery buy-ins are not necessarily required to employ many of the tools and methods used in this example to achieve real fishery reform. There is potential to incentivize reform without ownership status within a fishery. For example, capacity building assistance for co-management institutions need not come from a quota or permit owner, but can come in the form of scientific collaboration, technology development, or business development consulting.

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Note from the Editor

We thought this article worth reprinting because it operationalises a concept that that we have been thinking about since the 1995 "SPC and FFA Workshop on the Management of South Pacific Inshore Fisheries": the possibility that non-fishing stakeholders financially buy into fishing rights allocation schemes in the same manner as fishing stakeholders.

Although informal suggestions have been made, as far as we know there is no such scheme operating in the Pacific Islands region. In the absence of formal fisheries allocation systems for conservation stakeholders to actually buy into, that is hardly surprising. Their input has continued to be along more traditional lines — encouraging the set-up of protected areas with project funding input, or making one-time payments for areas to be set aside from commercial fishing in perpetuity.

However, with the advent of the Parties to the Nauru Agreement vessel day scheme, where rights to fish for tuna are clearly defined, costed and allocated, other possibilities are opened up. Would conservation organisations be interested in buying annual vessel-day fishing opportunities in the same manner as purse-seine or longline vessels, and setting those opportunities aside, or releasing them at a subsidised price to vessels which implement stringent conservation measures? It would of course depend heavily on the accuracy of ecosystem and stock assessment science, and on the integrity of the allocation and monitoring system, but it could be worth exploring.

Pacific Island national governments may also want to think about the idea of allocating a proportion of their vessel-days to protect the interests of small-scale local (artisanal) tuna fishers. Coastal trollers and handliners would not, of course, be able to utilise purse-seine or longline vessel-days directly, but keeping a proportion of days unfished would at least ensure that less of the available tuna (and bycatch species) were caught by industrial fishing in the exclusive economic zone and, in theory, thus more available to the artisanal sector.

This article provides food for thought.

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