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In this issue

Editorial

The picture below was taken in Papua New Guinea. Would you like to know what this man is celebrating? Here's the story.

This fisherman is coming ashore on a bay that is managed by two communities with the guidance of two older brothers and their middle-aged sons. One of the sons had been exposed to conservation methods from elsewhere and started advocating for using such methods 10 years ago, after a flood wiped out a village. The man was certain that the flooding was due to mangrove cutting in the watershed. He convinced the communities to implement a series of taboos on mangrove cutting and fishing within 30% of the bay. The communities also decided to set up a mangrove nursery – they have been planting mangrove seedlings – and to control how many people can fish and which types of fishing gear can be used.

When this picture was taken, eight years later, small pelagic fish had returned in abundance, together with other species that had not been seen for years. The communities now enjoy such an abundance of small pelagic fish that it is enough for one person – such as the fisherman here – to fish for one or two hours using a small-mesh gill net over the sandy bottom and come home with enough fish for everyone.

What the story shows is that very localised management can benefit communities. If you have heard of similar stories, please share them with us.

Jeremy Prince took the picture, and in this issue, he writes about how to provide communities with tools to manage their own resources (p. 43). The topic was also discussed during the first SPC Regional Technical Meeting on Coastal Fisheries, which focused on data collection for coastal fisheries management (pgs. 2 and 5).

Aymeric Desurmont
Fisheries Information Specialist, SPC

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Returning home with a nice catch after fishing for a couple of hours, Papua New Guinea. Image: Jeremy Prince

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

Improving regional data processes to safeguard the future of Pacific coastal fisheries[1]

"Fish is the cornerstone of food security in the Pacific Region". This statement, from the Pacific Community's 2011 report "Vulnerability of tropical Pacific fisheries and aquaculture to climate change"[2] is even more relevant today, as coastal fisheries are impacted by overfishing, poor land management practices, climate change and natural disasters.

The first SPC Regional Technical Meeting on Coastal Fisheries (RTMCF) was held in Noumea, New Caledonia from 28 November to 1 December 2017. The focus of the inaugural meeting was data, and how to bridge data gaps for better resource management. It was the first opportunity for 20 Pacific Island countries and territories (PICTs) to come together and discuss the challenges and opportunities of improving data collection for coastal fisheries in the Pacific.

The ocean and its resources are the foundation of Pacific cultural heritage, food security and economic development. Coastal fisheries provide many Pacific Island peoples with the bulk of the protein in their diet, and provides employment opportunities in the harvesting and selling of coastal marine species. But these vital marine resources are under increased threat from many factors, including overfishing to meet the demands of a growing population. This, combined with poor land management practices and environmental factors such as pollution, climate change and natural disasters, are putting pressure on Pacific coastal fisheries. Communities and fisheries managers need to make decisions about how to best manage, conserve and sustain coastal fisheries – and smart management decisions start with quality data.

Data provides the foundation on which communities and fisheries managers rely on when making management decisions that will make the most of marine resources in a cost-effective and sustainable way. Accurate data collected over a long period of time can help us understand what has happened in the past and what is happening now. Most importantly, it allows us to predict what may happen in the future, depending on the management decisions made today.

At the RTMCF, delegates from 20 PICTs gave presentations on the state of coastal fisheries in their home countries, and shared their experiences and challenges and what they learned from these throughout the week. Some recurring challenges faced by PICTs related to collecting data from fishers, and limited funds to employ, train and retain staff to undertake this work.

Fisheries are particularly complicated when making management decisions about how many fish should be caught, where fishing should occur or not occur, and what species can be fished amd which should be left to recover and rebuild populations. Data are collected by data collection officers as fishers bring their boats into ports around the region. This is an expensive and labour intensive process, especially given the Pacific's archipelagic geography of scattered and far-flung islands, and the fact that it is impossible to monitor all landing points in the region. Another challenge is that a large proportion of coastal fisheries harvests is used for subsistence purposes, and mainly goes unreported. The amount of unregulated subsistence fishing means that data that are collected are limited to regulated species, commercial fishing, and harvests that enter the formal sales market.

Along with the logistical challenges, fishers are also often unwilling to participate in data collection. This is due to a range of factors common across most PICTs as discussed at the RTMCF. First, there is often no incentive. Fishers spend their time and effort working with data collectors, but often do not see how the data are used, or how it benefits them. Fishers are frequently asked (numerous times) to fill in forms for data collectors, with no perceived benefit to themselves, which can lead to "survey fatigue". Another challenge is that fishers fear that the data collected could be used to increase their tax bill, or reduce any social security benefits they might currently be receiving. These misunderstandings are made worse when data collectors do not speak local languages, making communication difficult.

Because there are often no legal requirements for fishers to comply with data collection requests, it is important that data collectors have the training, skills and language to communicate effectively with fishers. Building a good relationship between data collectors and fishers increases the likelihood of compliance.

Across the Pacific, data are being collected, stored and analysed differently between countries, and even within ministries and departments within countries. The introduction of minimum standards of data collection, storage and analysis would mean that data that are currently sitting in isolation could be combined with other datasets. This would allow analysts to build a better picture of the health of coastal fishery stocks around the Pacific. Making better management

[1] Article by Melinda Morris, SPC FAME Communications Officer. Email: MelindaM@spc.int
[2] http://www.spc.int/coastfish/en/publications/412.html

The tedious task of entering data collected on paper sheets at the end of a long day in the field (A) may be over with the use of mobile applications such as Tails, which allows a user to directly enter data on a tablet or mobile phone (B). Images: Pierre Boblin (A) and Philip James (B)

decisions faster will help fishers see real improvements in their harvests, and encourage greater compliance with data collection and fisheries management.

Opportunities and possibilities for creating greater standardisation in the way that PICTs collect, store and analyse their information was discussed throughout the RTMCF, including challenges in developing and implementing any kind of standardised processes. One of the major improvements in efficiency and standards discussed at the meeting was the recent introduction of mobile technology to help collect and collate data.

In April 2016, SPC launched Tails, a new fisheries application. Tails is a mobile or tablet application designed for use by small-scale fishers, allowing data collectors to easily record the quantity and species harvested. The app can be used by fisheries officers when they are in the field, and works without internet access – an important feature given the connectivity issues in the far flung islands of the Pacific. The data are then uploaded to a database when Internet is available.

The delegate from the Cook Islands gave a presentation on the successful use of Tails to collect coastal fisheries data around the country. Tails was introduced in the Cook Islands a few months before the RTMCF. In those few months, more data were collected than in the entire previous calendar year, and the data that were collected were of a higher quality. In the Cook Islands, Tails is used to make data collection more efficient, and saves time because staff are not required to enter data from paper forms into a database. This means that analysis can be completed and applied to make good management decisions quickly.

Of course, data collection using Tails does not help to overcome the challenge of convincing fishers that it is safe and beneficial to participate in data collection. But mobile technology such as Tails can help make data collection more efficient and also reduce the workload of staff who no longer need to manually enter data. As more good quality data are collected and analysed, management decisions can be made faster. This information can then be fed back into communities, in the hopes that fishers will see how the data are being used and start to see real improvements, such as fish populations increasing, as coastal fisheries are managed sustainably.

This process is already underway at Kadavu in Fiji, where Tails is part of a successful data collection programme to understand the impact of fishing for tuna and other pelagic species around fish aggregating devices deployed off the island's coast by the Ministry of Fisheries and SPC. Here, new technology has allowed for data to be collected, analysed and applied quicker than traditional paper-based methods. Along with the use of new technologies, the Kadavu project is employing and training local data collectors who are able to communicate effectively with local fishers with no language or cultural barriers. The data collectors are taking the time to build good relationships with local fishers and overcoming barriers to successful data collection by making sure that fishers understand why the data are being collected, how it will be used, and how fishers can benefit from the process. Fishers are seeing positive changes from the speeding up of data collection and application, and now have access to information that allows them to target species that will maximise their profits while also being more sustainable.

While Tails has been a big help in some PICTs, it is just one part of a complex problem. In Tuvalu, Tails in its current form does not fit the needs of fishers and data collectors. Tuvalu has successfully introduced PacFish ID, another SPC-created mobile app that helps staff identify fish species and make the process of data collection more efficient. The app provides quick access to a pictorial database of fish, allowing fishers and data collectors to easily identify fish species. But Tuvalu will need an updated version of Tails to get the full benefit from paperless data collection.

All the delegates represented at the RTMCF were interested in finding new ways to improve data collection and storage, along with improving the way that data are analysed and applied. Members approached the meeting in a collaborative spirit, and across the board were keen to find new ways to better capture and use data on coastal fisheries.

There will be many challenges to creating minimum standards for the collection, storage and use of data throughout the region. Agreements will need to be made to protect privacy and confidentiality as data are shared more freely. Some countries will need training and support to meet minimal standards. Mobile technology such as Tails and PacFishID will need to be further developed and improved on in order to meet the needs of many PICTs.

By the end of the meeting, the delegates produced an Agreed Action Plan (see page 5, this issue), and agreed to establish a Data Standardisation Committee to set regionally agreed minimum standards for data collection. SPC will begin the process of establishing the Committee while countries will begin the task of internal preparation for changes. The first RTMCF was considered a great success, with participating PICTs eager to contribute, collaborate and find ways to work together to improve data collection, storage and analysis throughout the region.

For more information:

Lindsay Chapman
Deputy Director FAME (Coastal Fisheries), SPC
LindsayC@spc.int

Correctly identifying species is another challenge faced by fisheries data collectors. SPC has produced numerous identification guides and a new mobile app, PacFishID, to assist them (here, Solomon Islands). Image: Malo Hosken

Action Plan from the first SPC Regional Technical Meeting on Coastal Fisheries

Introduction

The first SPC Regional Technical Meeting on Coastal Fisheries (RTMCF) took place at the Pacific Community's Headquarters in Noumea from 28 November to 1 December 2017.

The meeting was arranged to address some specific outcomes as agreed to by representatives at the Tenth Heads of Fisheries Meeting held in Noumea in March 2017.[1] It also links to the New Song[2] and the direction set out in this document, as well as assisting with providing much needed information for reporting to Forum Leaders under the annual Coastal Fisheries Report Card[3]. The overarching theme is to address data shortages in coastal fisheries in support of better resource management. The Forum Leaders have also tasked SPC with coordinating with national fisheries agencies, Council for the Regional Organisations in the Pacific (CROP) agencies and regional and national community groups, to strengthen support and resourcing for coastal fisheries management. Better data will also allow countries to report against the indicators under the United Nations' Sustainable Development Goal 14.[4] The first RTMCF was intended to focus on specific issues, in this case coastal fisheries data, with input from member country governments and territory administrations. The make-up of the meeting was also intended to maximise country input through group discussions and plenary sessions. SPC views this as essential for longer-term planning and it can also be of considerable assistance to other agencies, regional non-governmental organisations (NGOs) and donors interested in national and regional coastal fisheries issues.

Agreed Action Plan

The following constitutes the agreed action plan from the meeting for both SPC and country members.

In this context, coastal fisheries and aquaculture data includes biological and environmental, economic and socioeconomic, monitoring control surveillance and enforcement, and fisheries management data and information.

The meeting recognises that to successfully progress data sharing, repository and standards, active cooperation and engagement with SPC is required by Pacific Island countries and territories (PICTs) and partners. The meeting commits to provide SPC with ongoing support for the process and active engagement.

The meeting recognises the huge opportunities that technology offers in data collection, analysis and dissemination. It is important that we first identify the questions that we wish to answer and then identify the appropriate data collection methodology and supporting technology and systems, while remaining clear to keep data collection as simple and efficient as possible.

Data Standardisation Committee

Countries agree to the establishment of a Data Standardisation Committee (DSC) for coastal fisheries and aquaculture. The DSC should set regionally agreed minimum data standards for data collection and for each of the identified priority areas and meet at least annually.

SPC is tasked with:

a) Drafting terms of reference, based on the discussions in this meeting.

b) Based on the information gathered during the RTMCF, undertaking internal meetings to progress the strategic and technical approach, the first of which should be held by the end of 2017.

We, as country members, commit to, by the end of February 2018:

a) Confirming the data focal point in each country.

b) Providing SPC with all forms used for coastal fisheries and aquaculture data collection.

c) Identifying key priority areas for data standards and communicate these to SPC.

The meeting suggests that countries investigate the options for setting up national data committees, including all authorities involved in coastal fisheries and aquaculture data collection.

[1] http://www.spc.int/FAME/en/meetings/239
[2] http://purl.org/spc/digilib/doc/b8hvs
[3] http://www.spc.int/DigitalLibrary/Doc/FAME/Brochures/SPC_2017_Coastal_Fishery_Report_Card.pdf
[4] https://sustainabledevelopment.un.org/sdg14

The meeting requests non-governmental organisations (NGOs) and other partners to share their own forms used for data collection with SPC by end February 2018.

Policy and/or legal development

SPC will explore the basic principles for working towards a regional framework for agreements and data sharing associated with coastal fisheries and aquaculture.

Countries will commit to providing SPC, where national laws allow, their examples of memoranda of understanding for data sharing by end February 2018. SPC will identify commonalities and appropriate structures for bilateral or multilateral data sharing agreements.

SPC will work with individual countries on a bilateral basis to develop appropriate data collection, analysis, sharing, dissemination, and usage arrangements.

SPC will develop robust internal policies related to research and ethics, and storing and protecting data.

SPC will ensure appropriate infrastructure is in place to safeguard country data held by SPC.

Data repository development

The meeting supports the development of the SPC Data Repository for archiving and searching datasets. We recognise that coastal fisheries and aquaculture data is a complex area and, as such, recommend a staged strategic process of development.

The discovery of the datasets is recognised as the initial priority. SPC will lead a stocktake exercise to identify all data related to coastal fisheries and aquaculture.

By January 2018, SPC will provide countries and other participants with a form to complete with the relevant information on the datasets required for the discovery process.

As a first step towards creating an operational repository, by the end of June 2018, we as country members task ourselves with:

a) Undertaking a stocktake of our data collection systems, including metadata.

b) Work with other relevant ministries to identify what data they hold relevant to coastal fisheries and/or aquaculture.

c) Request from NGOs, research organisations and others within the countries that they also provide a stocktake of data held.

Countries hereby request NGOs and research organisations to participate in this stocktake exercise.

The meeting tasks SPC with identifying if and how the fisheries data repository and the Pacific Community Data Archive can be jointly established.

Data storage

Data stored by SPC, in repository and as a backup, should be held primarily in a secure cloud system.

SPC should determine and present to the Heads of Fisheries the cost implications of this.

SPC must ensure all data stored are protected from inappropriate use.

National collections

We as countries commit to:

a) Working with our national statistics offices (NSOs) during the planning phase of a statistical collection to ensure that relevant information is collected and that the correct classifications are applied (e.g. fishing methods, vessels, fish classes).

b) Proactively approach our NSO colleagues to discuss the collection of these data.

SPC should develop appropriate agreements with county NSOs to ensure that at least one SPC Fisheries, Aquaculture and Marine Ecosystems staff member has full access to nationally collected raw data, similar to those in place with Statistics for Development Division.

SPC to work with countries to identify where powerful standard questions need to be added to national collections.

Dissemination

Funding dependent, SPC is tasked with developing mobile applications for dissemination of information and aggregate data or published sources. Countries commit to regularly updating the data upon which this information depends. SPC should not disseminate raw coastal fisheries and aquaculture data without country authorisation or other specified clearance procedure.

SPC to explore with countries, alternative options to printing for dissemination of information such as social media, radio and TV, and other applications.

SPC and countries to work with donors to secure funding for the development of fisheries and aquaculture-related school curriculum materials.

Training

We, as countries, request SPC to provide training for capacity building to cover data analysis, cleaning, collection and database management. We recognise this will be funding dependent.

We as countries commit to completing an audit of our training needs related to data and providing the results to SPC to assist in supporting future funding applications.

Funding and staffing

The meeting recognises that all requests require significant funding and support in both the short term and long term. With additional funding, SPC will be able to effectively complete many tasks within this action plan.

The meeting gratefully acknowledges and thanks Tuvalu for the funding offer for module development work.

The meeting recognises that regular meetings, such as a yearly RTMCF, are beneficial but costly.

We, SPC member countries, request our donor partners to provide SPC and countries with sufficient funding to successfully implement this action plan. We task SPC with preparing a budget to progress the work. We will support SPC and task ourselves with proactively identifying additional funding sources for this work.

We, SPC member countries, recognise that additional staff will be required to deliver on this action plan and note its complexity, understanding that the development of Tufman2[5] and Tails[6] required three full-time positions over two years.

We, the participants to the meeting, agree that, without prejudice to the selection of topics of the next RTMCF, there should be an opportunity for countries and community representatives to present and discuss their experiences and provide an update on progress on this action plan. SPC and member countries should seek funding for this meeting.

Data collectors training in Vitawa Village, Ra, Fiji. Image: Philip James

[5] http://www.spc.int/oceanfish/en/ofpsection/data-management/spc-members/dd/140-tufman
[6] https://play.google.com/store/apps/details?id=spc.ofp.tails

Training in small fishing operations

Many fishers in the Pacific Islands region use powered boats to get them to their fishing grounds. A lot of them lack training to conduct safe and sustainable fishing operations, so safety awareness is being advocated to ensure they return safely to fish another day. In addition, coastal communities around the region are being encouraged by governmental and non-governmental organisations, as well as by many fisheries consultants, to establish marine protected areas for conservation purposes to protect cultural or natural resources, mainly in heavily fished or exploited areas. As a consequence, fishers often have to move their effort away from inshore reef species to oceanic pelagic species.

In some places, fishers are familiar with plying the open seas to catch the fish they need but in other areas, coastal communities only know how to fish within their inshore waters and lagoons. They have to develop boating skills and additional fishing skills to venture offshore for the much larger pelagic species. In many cases, rural fishers and boat operators do not have formal training in proper boat handling and are not aware of some of the boating necessities that are important for their safety.

The Small Fishing Operations (SFO) course was developed to give small-scale fishers the appropriate training to carry out safe and sustainable fishing activities. The course emphasises small boat safety, safe fishing practices, and sustainable hook-and-line fishing methods. It is designed to give fishers basic fishing skills and safety knowledge to confidently and safely, operate a small fishing boat. In 2017, SFO courses were carried out in Fiji, Marshall Islands, Niue, Palau, Solomon Islands and Vanuatu (as part of the Safety, Fishing and Financial Management Course for Fisheries Officers), with 110 people trained.

Participants of the Small Fishing Operations course in Fiji learn how to build a Samoan handreel to target deep-bottom snappers. Image: William Sokimi

Participants were made aware of the safe operation and maintenance of fishing gear and equipment; proper on-board fish handling, sanitation and hygiene practices; and basic financial and resource management of a fishing operation. The course prepared participants to implement safe operation plans to ensure their vessels were organised and ready for safe fishing trips. They were also trained to deal with emergencies at sea.

Fishing methods included midwater fishing techniques to target offshore pelagic species. Participants were also briefed on deep-water bottom fishing but with the proviso that these species have a slow recovery rate and are prone to overfishing. The fishing training involved understanding the theory behind trolling and several midwater fishing methods, followed by practical sessions on gear construction and fishing activities.

The main topics discussed during the course were:

- Various trolling methods: midwater vertical longline; short horizontal longline; cloth, bag, and canister paluahi (chum fishing for pelagic fish); drop stone (theory); deep-water bottom reel fishing and deep-water bottom vertical longlining (theory); ika-shibi (theory); night fishing methods for small pelagic fish using lights and nets (theory).
- Proper fish handling, storage on ice and processing techniques.
- Hazards in the workplace and the need to conform to safe working habits.
- Environmental issues and controlled fishing practises to protect marine life and coastline preservation as a basis for a sustainable fishery.
- Basic understanding of economics and small craft management methods, including maintaining a logbook and details of vessel costs and returns.

For more information:

William Sokimi
Fisheries Development Officer (Fishing Technology), SPC
WilliamS@spc.int

Regional exchange on sandfish aquaculture for restocking

We sometimes wonder how far we have come and continuously look for ways to measure progress. What can be achieved through a south-south exchange, the depth of knowledge and expertise gained, the number of countries involved, and their degree of development, are all obvious signs of development.

In October–November 2017, participants from five Pacific Island countries and territories (Fiji, Kiribati, New Caledonia, Papua New Guinea [PNG] and Vanuatu) gathered together through a series of placements, visits and a workshop into what was the first regional exchange on sandfish aquaculture for restocking. The programme was organised by the Pacific Community with support from the New Zealand Ministry of Foreign Affairs and Trade. Twenty years ago, a south-south exchange on this same topic would not have been possible, and even ten years ago, the reach and scope of the programme would have been much more limited in terms of the number of countries involved and the variety and depth of expertise available.

In this first regional exchange on sandfish, participants were able to: 1) experience activities related to sandfish aquaculture in three countries (PNG first, then Fiji and New Caledonia); and 2) participate in a hatchery techniques workshop; and 3) be involved in another workshop to discuss what could be done at the regional level to address some of the constraints of sandfish aquaculture in order for restocking to become an effective way to increase fisheries productivity.

Action-packed week in Kavieng, PNG

The exchange programme started in Kavieng, PNG at the National Fisheries Authority Nago Island Mariculture Research Facility where we were welcomed by facility manager Peter Minimulu from the Australian Centre for International Agricultural Research (ACIAR) and scientist Thane Militz, along with Esther Leini and Nicholas Daniels who are both in charge of sandfish restocking activities and who were nominated as PNG representatives in our regional exchange.

During the week, activities were organised for participants to witness production phases — from spawning to sea ranching surveys. We were able to see first hand the innovative techniques that had been developed through repeated research trials for the development of larvae culture protocol, using 100% algal paste instead of live microalgae (Fig. 1), and to increase juvenile survival during the nursery phase using floating hapa net systems.

Figure 1. Shalendra Singh (left, Fiji Ministry of Fisheries) and Ajay Arudere (Vanuatu Fisheries Department) feeding sandfish larvae under the watchful eye of Esther Leini (PNG National Fisheries Authority). Image: Michel Bermudes

Fiji hatchery brainstorming

The activities that took place in Fiji started with a period of four weeks of hatchery placements at the Ministry of Fisheries's marine hatchery in Galoa for participants from Vanuatu (Derek French, Aquaculture Solutions Vanuatu), Esther Leini (NFA, PNG) and Joana Rabaua (Ministry of Fisheries and Marine Resources Development, Kiribati). Placements were overseen by Anand Prasad (facility manager) and Teari Tekebo (sandfish hatchery manager). The placements were an ideal opportunity for the less experienced hatchery operators to learn from regional experts such as Esther Leini and Teari Tekebo. The gathering in Fiji also presented a unique opportunity to hold a small workshop on hatchery techniques. Presentations were made by representatives from Fiji, Kiribati, New Caledonia and PNG, and at this workshop we were able to hear great stories from participants who have been able to develop techniques suited to their own country's set of conditions and circumstances.

The Fiji event concluded with the release of sandfish juveniles at Vitawa Village (Fig. 2), which was followed by a customary ceremony during which the tribe's chief, the village head and elders, and our group of regional experts engaged in a question-and-answer session on sandfish restocking and the management of community-based marine protected areas.

Closing the loop in New Caledonia

It always helps to have a vision, and to have this vision realised. To be able to see that vision in action is even better. This is what participants were able to do during their stay in New Caledonia where they visited a large-scale hatchery capable of producing in excess of 1 million sandfish juveniles per year, a farm where sandfish are grown in shrimp ponds (Fig. 3), and where there is a newly refurbished beche-de-mer processing plant. While this level of development is still a long way off for other countries in the region, and while the model is not necessarily adaptable to other islands, this state of advancement allowed us to see what is possible in the region, and to set the backdrop for the first Regional Workshop on Sandfish Aquaculture for Restocking, held in Noumea (22–23 November 2017) to conclude the exchange. The goal of the meeting was to identify gaps and potential solutions to move forward. The two main constraints in sandfish aquaculture that were highlighted during the workshop were insufficient seed supply and the lack of an effective model for sea ranching and restocking. Continued and enhanced regional collaboration was perceived as the motor for increasing the pace of development at the country level and for finding solutions to the constraints of seed supply and sea ranching models.

Figure 2. Releasing sandfish at the Vitawa Village marine protected area in Fiji. Image: Michel Bermudes

Figure 3. Kamarawa Tamton (MFMRD, Kiribati) holding a sandfish produced by Laurent Burgy (right) and his team (Société d'élevage de la Ouenghi, New Caledonia). Image: Michel Bermudes

Benefits for participants and participating organisations

Seeing is believing. From a technical capacity building perspective, the programme offered tremendous comparative value. Given how hard it can be to transfer techniques or technologies from one country to another, it was extremely satisfying to see participants truly embrace what they saw in other countries (e.g. larvae culture technique in PNG, nursery technique in Fiji, processing technique in New Caledonia).

The programme also intended to foster leadership, and leadership was observed in two ways: first, through the participants who stepped up to showcase their work during field visits and in-country activities, and second, through the participants who openly talked about the changes they wanted to implement when back to their home country and how they would run their own training workshops for their colleagues and staff.

Professional networks for the continued exchange of ideas and experiences among PICTs (e.g. the Facebook group Pacific Sandfish Exchange was created at the end of the programme) and capacity building from visiting experts demonstrating techniques in a different country context (e.g. New Caledonia demonstrated a new technique for transport of juveniles in Fiji) were direct benefits for both participants and organisations.

Benefits for SPC

SPC learned much from the exchange, which proved to be an effective model for technical capacity building. The programme also enabled the leveraging of previous investment in capacity building by SPC and other development partners (e.g. ACIAR's work in PNG, access to the Fiji hatchery where staff had previously received SPC funded training). Finally, this type of exercise is particularly useful in spotting emerging leaders and people with the capacity to work effectively with regional counterparts and SPC.

Needless to say, participants left with their heads full of ideas and some are already thinking about what the next regional sandfish exchange will look like. The challenge now is to harness this collaborative energy to support development at the country level. The next step for organisers and participants is to form a regional working group that can continue the work started during the exchange.

For more information:

Michel Bermudes
Mariculture and Aquatic Biosecurity Specialist, SPC
michelbe@spc.int

Tilapia sportfishing ecofarms in Vanuatu

You've travelled to Tanna Island in southern Vanuatu. You've swum. You've dived. You've just visited the famous active volcano, Mt Yasur, and find that you still have half of the day left before it's time to head back and admire the sunset. What will you do? Go fishing!

You've seen all there is to see at Tanna Island's active volcano. Now what are you going to do?

To help adventure-seekers do this, is the Imaio tilapia ecofarm, a community ecotourism venture in lush jungle about a 10-minute drive from the base of Mt Yasur. The farm's spring-fed fish ponds were initially established as a food security project, because in the uplands of Tanna Island fresh animal protein for human nutrition is scarce. The community started out growing Nile tilapia as a food fish for their own consumption, and any surplus fish were sold for about VUV 300 (USD 3.00) per 200 g fish.

With no net to catch them, the fish were caught by hook-and-line, with the line tied to a stick. This caught the eye of some visitors who also wanted to have a turn! Naturally this kind of activity can make you hungry and thirsty. All that was needed was a swept area under some shady trees and space for an esky, barbecue and picnic tables.

The concept now is for visitors to pay VUV 500 (USD 5.00) per person for admission to the beautifully landscaped gardens surrounding the Imaio community fish ponds, and be issued with fishing tackle and bait. They can catch and then release the tilapia purely for sport. Should they wish to eat the fish for lunch, however, then for another VUV 500 the fish will be barbecued for them. This earns the Imaio community VUV 1,000 (USD 10.00) for each 200-g tilapia. Now that's value adding!

News of the tilapia sportfishing venture has been travelling fast. Now there is a recently established tilapia farm that plans to offer the same experience on neighbouring Aneityum Island, where regular cruise liners bring ashore upwards of 2,000 passengers at a time.

The aquaculture and tourism sectors have occasionally been at loggerheads. In the case of the Imaio tilapia ecofarm, however, it's gratifying to see the two sectors come together for the benefit of a remote inland community that has few opportunities for income generation.

For more information:

Timothy Pickering,
Inland Aquaculture Advisor, SPC
TimP@spc.int

All images in this article are by Tim Pickering.

A. Fun can be had at well-stocked fish ponds, without any sophisticated fishing gear.

B. The Imaio community fish ponds have been landscaped into a tranquil and beautiful picnic spot.

C. This tilapia could now be released back into the pond to fight again on another day. Or it could be your lunch. If so, then please pay an extra VUV 500.

D. You can see the pride in the faces of Imaio community members who implemented this project with assistance from the Vanuatu Department of Fisheries and KfW, the German Development Bank.

Enhancing aquatic biosecurity in French Polynesia: A step on the pathway to sustainable development

French Polynesia's Biosecurity Office was formed in June 2017 when the Food Quality and Veterinary Division (QAAV) was separated from the Rural Development Department and merged with Plant Protection. This completely independent authority is now continuing QAAV's efforts to minimise the risks of an introduction, spread and establishment of pests, pathogens and invasive exotic species into French Polynesia.

Since then, much has been achieved in the field of aquatic biosecurity, with due regard for the territory's high level of aquatic biodiversity, the need to avoid the introduction of invasive aquatic species and pathogens, and the importance of protecting the fisheries and aquaculture sectors, whose importance to the territory is growing.

The Pacific Community began working with French Polynesia's biosecurity authority in 2017, leading to the the first French Polynesia Workshop on Aquatic Biosecurity in Papeete in September of that year.

Various government departments attended the workshop, including the Biosecurity Department, Marine and Mining Resources Department, as well as private-sector aquaculture operators, senior researchers in aquatic animal health and aquaculture, and local representatives.

The workshop's main objective was to assess French Polynesia's current aquatic biosecurity situation in terms of human and financial resources, disease management and diagnosis capacity. The meeting also identified key weaknesses where swift action and/or improvements are needed to optimise aquatic biosecurity protocols in the territory.

Opening this workshop on biosecurity in French Polynesia, the Minister for Primary Resource Development, Tearii Alpha, said: "At a time when population pressure is steadily driving global fish consumption upwards, just as resources are shrinking, aquaculture has become vital."

Initiated by SPC's Fisheries, Aquaculture and Marine Ecosystems Division (SPC-FAME), and represented by Ruth Garcia, in collaboration with the Biosecurity and Marine and Mining Resources departments, the workshop has led to the adaptation and implementation of the "Sustainable Pacific Aquaculture Development for Food Security and Economic Growth" programme in French Polynesia.

Following the workshop, and in order to meet the objectives set, an aquatic biosecurity steering committee was created, headed by the Biosecurity Department and composed of the Biosecurity, Marine and Mining Resources and Environment departments, private-sector aquaculture operators, and researchers. The goal is to foster discussions and develop the tools needed to implement a national aquatic biosecurity plan.

The committee has already met three times since October 2017, with some excellent results in three core performance areas:

1. Developing biosecurity best practices at the farm level
2. Assessing and updating existing legislation
3. Combining efforts and resources to diagnose the main diseases affecting aquatic animals.

As this programme continues, SPC-FAME will support French Polynesian authorities by providing key data to inform decisions on the management and development of their aquatic resources, and helping them build the tools and capacities required to implement those decisions. For aquatic biosecurity, this involves three aspects: aquatic animal health management, trade in live aquatic organisms, and food safety.

The implementation of an aquatic biosecurity strategy will impact a range of issues such as export health status and certification, animal and plant quarantine protocols, and requirements for importing aquatic animals and related products.

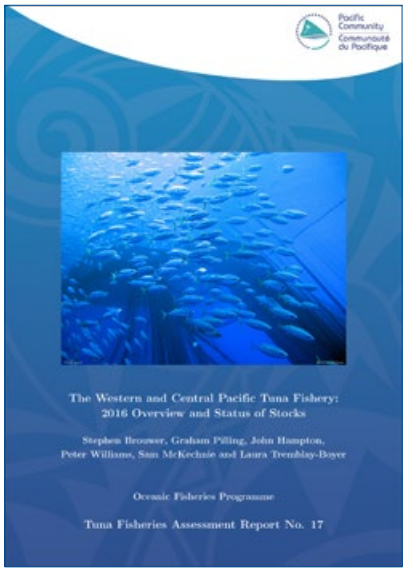
When it comes to aquatic biosecurity, the priorities for French Polynesia are protecting the health and biodiversity of aquatic ecosystems, facilitating the introduction of new aquatic production systems, making food resources and export activities sustainable, strengthening capacities to engage in fair trade, and protecting and capitalising on the territory's pristine environment.

For more information:

Dr Laurent Pasco
Biosecurity Direction, Ministry of Marine and Mining Resources, French Polynesia
laurent.pasco@biosecurite.gov.pf

TFAR 17: The latest on tuna catches and stock status in the WCPO

SPC's Oceanic Fisheries Programme has recently published its 17th annual Tuna Fisheries Assessment Report (TFAR 17).[1] *Tuna fisheries assessment reports provide information on tuna fisheries in the western and central Pacific Ocean (WCPO) and on fish stocks (mainly tuna) that are impacted by them. TFARs focus on the main tuna stocks targeted by the fishery: skipjack tuna* (Katsuwonus pelamis)*, yellowfin tuna* (Thunnus albacares)*, bigeye tuna* (T. obesus) *and South Pacific albacore tuna* (T. alalunga)*. Information on non-target species is also provided in TFARs.*



The main highlights of TFAR 17 were:

- The provisional total tuna catch in the Western and Central Pacific Fisheries Commission Convention Area in 2016 was estimated at 2,686,203 tonnes, a small drop relative to the record high catch in 2014. Total catches have been fairly stable over the past five years. As in previous years, the total catch was dominated by the purse-seine fishery (68%) and by skipjack (67%).

- The most recent tuna stock assessments indicate that all four tuna species are likely to be currently fished at levels that are less than the precautionary upper limits, and have stock levels that are above agreed on lower limits. In particular, the skipjack spawning stock is near the agreed on target of 50% of the unexploited level. The other tuna species have somewhat lower relative stock sizes, between 30% and 40% of unexploited levels. These levels of spawning stock depletion are considered moderate by international standards and do not pose a biological concern. Some fisheries, however, notably those targeting South Pacific albacore, are struggling to operate profitably at current levels of fishing intensity. The 2017 stock assessment for bigeye tuna indicated a substantial change in assessed stock status from previous assessments due to the availability of new biological information.[2] The stock is now considered to not be overfished nor experiencing overfishing, although follow-up work is being undertaken to confirm this change in estimated status.

- Updated estimates of overall catch composition for the various categories of both purse-seine and longline fisheries are presented. For purse-seine fisheries, catch from both unassociated (i.e. free-school) and associated purse-seine sets are dominated by tuna species (99.7% and 98.2% of the total catch, respectively). Longline estimates are provided for the four longline fisheries operating in the WCPO: the western tropical Pacific (WTP) shallow-setting longline fishery; the WTP deep-setting longline fishery; the western South Pacific (WSP) albacore fishery; and a small WSP shark fishery. The main tuna species account for 50.5%, 75.8%, 72.5% and 43% of the total catch (by weight) of the shallow-set, deep-set, albacore and shark target longline fisheries, respectively, with the remaining catch consisting of non-tuna species. The WTP shallow fishery has a higher proportion of non-tuna species in the catch, principally shark and billfish species, while mahi mahi and opah (moonfish) represent a significant component of the WSP albacore longline catch. Silky sharks are the most common shark species in the shallow-set and shark targetted longline fisheries, while blue sharks are the most common in the deep-set and albacore targetted shark fisheries.

For more information:

Stephen Brouwer
Senior Fisheries Scientist (national and subregional team leader), SPC
StephenB@spc.int

[1] The full TFAR 17 document is available from: http://purl.org/spc/digilib/doc/jcf7u
[2] John Hampton, manager of SPC's Oceanic Fisheries Programme, wrote a detailed article in the previous issue of the *Fisheries Newsletter* to explain the new bigeye tuna stock assessment: http://purl.org/spc/digilib/doc/76mjb

SPC's record-breaking tuna tagging voyage[1]

Bruno Leroy has tagged and released thousands of skipjack tuna like this one. Image: Malo Hosken

SPC's Oceanic Fisheries Programme has recently completed a successful tuna tagging voyage, releasing nearly 28,000 tagged tuna in the Pacific Ocean. As these tags are gradually recovered, the data collected will contribute to our understanding of the health of tuna fisheries in the Pacific by monitoring mortality, movement and growth of tagged fish. This information will provide critical population parameters that will then be used to estimate the health of tuna stocks, and the impact of fishing practices.

Tuna fisheries have expanded in the Pacific over the past three decades, and the region now produces over 60% of the world's tuna. The most critical fishing activities are the industrial-scale purse-seine, longline and pole-and-line fisheries, but large catches are also made by smaller fishing vessels. However, threats such as overfishing and climate change put this vital natural resource at risk.

The Western and Central Pacific Fisheries Commission (WCPFC) is responsible for setting sustainable management practices and conservation measures of highly migratory fish stocks (e.g. tunas and billfish) throughout the region. Data must be collected to improve our knowledge about the biology of tuna species, and to better assess the fishing impact on their populations to allow WCPFC to make sound management decisions. An important part of the data is collected from SPC's tagging voyages.

In September 2017, SPC's Oceanic Fisheries Programme embarked on a two-month-long tagging voyage in the waters of Papua New Guinea (PNG) and Solomon Islands, led by Bruno Leroy, SPC Fisheries Scientist. The voyage was part of the Pacific Tuna Tagging Programme, a WPCFC project implemented by SPC. Beginning in 2006, it is the largest tuna tagging project ever implemented in the world.

During the recent voyage, tagging technicians placed small plastic tags, called conventional tags, on the tuna that were caught using the pole-and-line fishing method. This allows the fish to be caught, measured, tagged and released in just a few seconds. Information on each tagged individual, including species, length, fish condition and tagging quality, was recorded using voice recorders.

During the tagging process, scientists also collected biological data on tuna and bycatch species such as mahi mahi, rainbow runner and wahoo that were too injured to be released. This collection included samples of gonad, liver, stomach, otolith, muscle and dorsal spine. All of these samples were kept frozen and sent to SPC's tuna tissue bank in Noumea, where they will help provide greater knowledge of the biology of tunas and bycatch species, and improve the assessment of the status of the Pacific tuna stocks.

The team on SPC's most recent tagging voyage endured challenging conditions as they searched for schools of tuna in the western Pacific Ocean. After some initial delays as the team navigated the complicated bureaucracy of obtaining permits and visas for research across the exclusive economic zone (EEZ) of multiple countries, the team set off for its first destination, Noro in the Western Province of Solomon

[1] Article by Melinda Morris, SPC Fisheries, Aquaculture and Marine Ecosystems (FAME) Communications Officer.

Islands. This little town is, in fact, one of the most active tuna fishing ports in the Pacific Islands and is the home base for the FV *Soltai 105*, the 37-meter pole-and-line vessel that SPC chartered to implement this tuna tagging experiment. Since 2008 (an older vessel of the same company was chartered in 2006 and 2007), this vessel and its 30 crew members, all Solomon Islanders, have assisted SPC scientists with releasing about 300,000 tagged tunas all over the western and central Pacific Ocean.

As the voyage moved into PNG's EEZ, the vessel fished near anchored fish aggregating devices (FADs), a tactic that was sometimes successful but also risked delays if FADs were missing. Even if a FAD was in place, there was no guarantee that any target species would be present. The team also tracked the movement of seabird flocks as a way to locate schools of tuna nearby.

Some days, despite hours of gruelling work in challenging conditions, not a single fish was tagged. On other days, the team was able to tag thousands of fish in a single day. Each tagging technician may tag hundreds of fish in a day, or none at all, often working in rough seas, high winds and heavy rain. Some schools contained large individuals over 60 cm in length. These fish are hard to work with, and their powerful tails can bruise and scratch the fishers as they are captured for tagging.

Tagging voyages require patience, grit and commitment from the crew and scientists living and working in cramped conditions onboard. They could spend days chasing elusive schools of tuna, only to lose them at the last moment. Other days, good luck and good planning combined to allow technicians to release thousands of tags into the ocean.

Now that the crew have finished the hard work of releasing the tags, Caroline Sanchez, SPC's Senior Fisheries Technician and Tag Recovery Coordinator, will begin the task of collecting and analysing data from tags as they are recovered by fishers throughout the region. Tags can be recovered over a vast swathe of ocean from Thailand to Ecuador and beyond, and the recovery of tags is a time consuming, long-term process.

When fishers find a tagged tuna, they receive a reward payment if they return the tag, along with information about the date and location of recapture and the size of the fish, to SPC. These data provide critical indications about fishing mortality, natural mortality, movements and growth, all of which are all important population parameters that are used to estimate the health of tuna stocks.

The goal of the voyage was to tag 20,000 tuna in the EEZs of PNG and Solomon Islands. With 27,780 releases, the voyage was a resounding success, with a record-breaking release of tags in the EEZ of Solomon Islands. The cruise also allowed the training of new tagging technicians and undertook extensive biological samplings that will help build our understanding of the ongoing health of tuna stocks in the face of intensive fishing activities and a changing climate. The data collected from the tags over next months and years will help increase our understanding of tuna fisheries, and the impact of fishing activities on tuna fisheries throughout the Pacific. SPC's latest record breaking tagging voyage will help inform future sustainable management decisions that will help protect tuna stocks and the people who rely on them.

For more information:

Bruno Leroy
Fisheries Scientist (Ecosystem Monitoring), SPC
BrunoL@spc.int

This skipjack tuna will be measured, tagged and released in less than 10 seconds. Image: Bruno Leroy

Local fish names added to PacFishID

In 2017, the Pacific Community's Coastal Fisheries Programme developed and released the innovative mobile application (app) PacFishID to assist with the identification of fishes and invertebrates from Pacific Island countries and territories. The app, based on SPC's earlier publication titled, Identification guide to the common coastal food fishes of the Pacific Islands region, *was primarly designed to assist fisheries officers with identifying common coastal food fishes found in catches or during market surveys. But, considering the several thousands of downloads made so far, it has obviously reached a far wider audience.*

An audience that will certainly further increase with the recent addition of two new features:

1. PacFishID is now available in French, a feature that was expected by scientists, managers, fishers and fish lovers from French Polynesia, New Caledonia, and Wallis and Futuna.
2. PacFishID now offers the possibility to display local fish names.

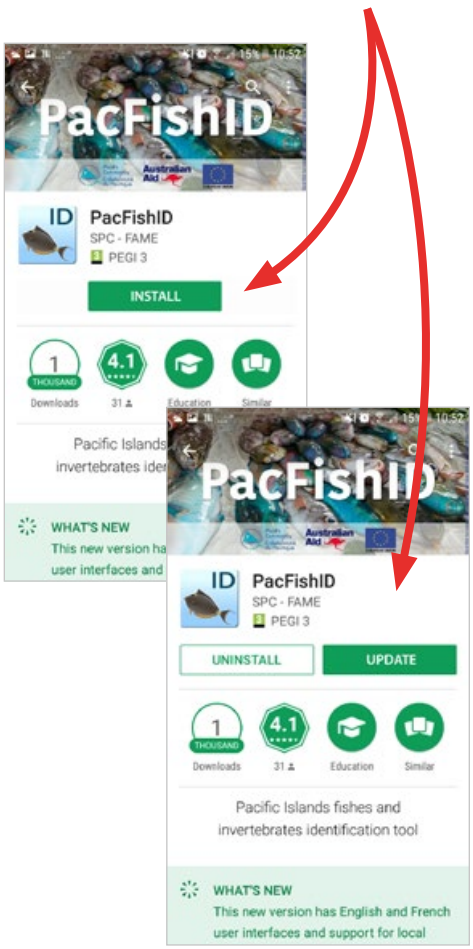
At present, common names used in Guam, New Caledonia, Tahiti, the Tuamotu Islands, the Austral Islands, the Marquesas Islands, and Wallis and Futuna have been added to the dataset. Fiji, Palau, Solomon Islands and Tuvalu fisheries authorities are currently putting together their list of local names, and it is hoped that other countries and territories will quickly follow.

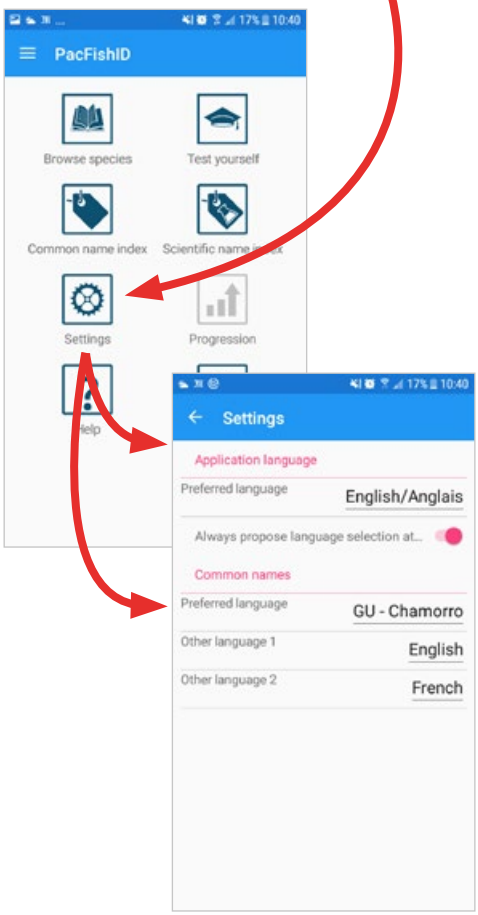
How to display local fish names

① Type PacFishID in the search box of the Play Store, App Store or Windows Store, and either install it or update the app.

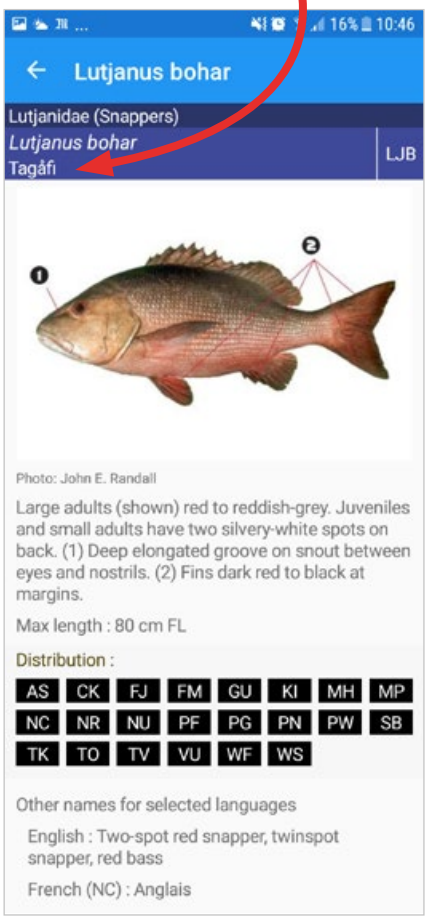
② Open the app, and go to "Settings". Select the language of the app itself (English or French), and select the local names you wish to display in priority.

③ The preferred common name is displayed at the top of the species page (e.g. *Lutjanus bohar* is called Tagåfi in Guam).





You can display three sets of common names.



Other common names are displayed at the bottom of the page.

Melanesian Spearhead Group of countries addresses sea cucumber fisheries management

Fiji, Papua New Guinea, Solomon Islands and Vanuatu – all members of the Melanesian Spearhead Group of countries – have agreed to common measures and a plan of action to improve the management of sea cucumber fisheries and help communities to maintain a sustainable income from this valuable but threatened fishery. This is one of the salient outcomes of the 6th meeting of the MSG Fisheries Technical Advisory Committee.

To better manage the fishery, minimum size limits for all commercial sea cucumber species, including for the high-value white teatish shown here, should be standardised across the region. Image: Steve Purcell

The Melanesian Spearhead Group (MSG) convened the 6th Fisheries Technical Advisory Committee (FTAC) meeting from 13 to 17 November 2017 at the MSG Secretariat in Port Vila, Vanuatu. The Acting Director General of the Secretariat, Peter Eafeare, welcomed participants from MSG member countries as well as the group's development partners, the Pacific Community (SPC) and the Pacific Islands Forum Fisheries Agency (FFA). The meeting was chaired by Rosalie Masu, Deputy Director Inshore Fisheries Division, Solomon Islands Ministry of Fisheries and Marine Resources.

At the meeting, FTAC progressed previous agenda items on offshore fisheries, and placed particular emphasis on the progress and implementation of two regionally unique coastal fisheries instruments that were endorsed by leaders in 2015: the "MSG roadmap for inshore fisheries management and sustainable development 2015–2024" (MSG roadmap) (MSG Secretariat 2015a) and the "Memorandum of understanding on technical cooperation in coastal fishery and aquaculture development" (the MoU) (MSG Secretariat 2015b).

Progress towards the following seven MSG roadmap outcomes was reviewed by the countries:

1. Development of an effective policy, legislation and management framework for the management of inshore resources, in accordance with other relevant international agreements, to empower coastal communities to manage their marine resources;
2. Education, awareness raising and the provision of information on the importance and management of inshore fisheries;
3. Capacity building to sustainably develop and manage inshore resources, with particular reference to experiences in MSG member countries;
4. Adequate resources to support inshore fisheries management and best available science and research;
5. Secure long-term economic and social benefits to coastal communities from the sustainable use of inshore resources;
6. Establish effective collaboration with stakeholders and partners; and
7. Restore and maintain sea cucumber stocks to maximise long-term economic value to coastal communities.

MSG member countries noted the achievements made in the areas of management plans, licencing, and management regulations. The efforts of fisheries agencies and the support of regional organisations were also noted, particularly SPC, most recently through the World Bank-funded PROP project.[1] The MSG roadmap and the MoU both raise sea cucumber fisheries and the beche-de-mer (processed sea cucumber) trade as priorities.

The sea cucumber fishery in MSG countries is reputedly the second-most valuable fishery in the Pacific Islands region after tuna. Sales of beche-de-mer represent the most significant source of income from marine harvesting for rural communities.

High market demand and challenges to sustainably managing sea cucumber fisheries have resulted in the four countries implementing moratoria or seasonal closures in an attempt to prevent commercial extinction of this fishery. FTAC meeting participants noted how average catches had fallen by around half in recent years which, combined with a shift towards lower-value species, and data presented in the SPC/World Bank PROP study, confirmed the finding of Carleton and colleagues (2013) that this represents tens of million dollars worth of lost revenue to countries and communities.

Representatives from four fisheries agencies in MSG countries agreed to strengthen collaboration under the auspices of the MSG roadmap on inshore fisheries in order to implement effective mechanisms for the management, maintenance and restoration of sea cucumber stocks for the goals of maximising long-term economic value and ecological sustainability.

A key requirement is political support for management plans and their enforcement, without which the recovery and increased long-term economic contributions to communities is not possible. Management plans include criteria for licensing buyers and exporters, restrictions on certain fishing methods, and bans on certain species or undersized animals.

Enforcing minimum size limits for sea cucumbers to ensure stock replenishment is a high priority. Countries adopted common standard minimum size limits, based on best available technical advice, to be incorporated into forthcoming management plans and regulations. The agreed minimum size limits are shown in Table 1. Countries also agreed to ensure a total ban on fishing for sea cucumbers with any kind of underwater breathing apparatus without exemptions.

The countries agreed to increase coordination and information sharing under the auspices of the MSG Secretariat with support from SPC and donors such as the World Bank. MSG Secretariat will seek financial support to establish an office for MSG beche-de-mer and coastal fisheries trade and information sharing.

Improved information on buyer and market prices will help ensure that fairer prices are paid to local fishers, and that increased collaboration with national customs authorities will ensure better control and improved returns to national governments to offset the costs of management.

Overall, the outcomes of the meeting represent a significant step towards achieving the call in the MoU for the development of harmonised systems for the sea cucumber fishery in the area of policy, development and management measures that address marketing issues and fishery development strategies, which are suited for MSG governments and communities.

Rosalie Masu, chair of the 6th FTAC meeting stated that:

> "The sea cucumber fishery is very highly valued in the Solomon Islands and the MSG region, only second to the tuna fishery. Our communities depend on this fishery for their livelihoods and economic benefits. Because of the threats posed to this fishery by overfishing, we, as regulators, must develop policies and regulations to ensure that the sea cucumber fishery is sustainable and we must also help communities maximize benefits from this limited resource. The MSG members recognize the importance of this fishery and a regional approach to make sure it is well managed that will facilitate information sharing and provide better ways forward."

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MSG Secretariat 2015b. Memorandum of understanding on technical cooperation in coastal fishery and aquaculture development. [http://purl.org/spc/digilib/doc/mgtfs]

Tabunakawai-Vakalalabure M., Kuridrani N., Lalavanua W., Mangubhai S. and Bertram I. 2017. Pre-export sizes of beche-de-mer in Fiji. p. 38–46. In: Mangubhai S., Lalavanua W. and Purcell S.W. (eds). Fiji's sea cucumber fishery: Advances in science for improved management. Wildlife Conservation Society. Report No. 01/17. Suva, Fiji. [https://fiji.wcs.org/Portals/82/reports/WCS%20Sea%20cucumber%20report%20260217.pdf?ver=2017-02-27-213114-827]

[1] The objective of the Pacific Islands Regional Oceanscape Program (PROP) project is to strengthen the shared management of selected Pacific Island oceanic and coastal fisheries, and the critical habitats upon which they depend.

Table 1. Agreed standard sea cucumber minimum size limits for Fiji, Papua New Guinea, Solomon Islands and Vanuatu. It is noted that these limits are also compatible within rounding errors with the limits imposed by the fifth Melanesian Spearhead Group member, New Caledonia.

Scientific name	FAO code	Common name	Live (cm)	Dry (cm)
Actinopyga echinites	KUE	Deep water redfish	25	15
Actinopyga lecanora	YVV	Stonefish	20	10
Actinopyga mauritiana	KUY	Surf redfish	25	10
Actinopyga miliaris	KUQ	Blackfish/Hairy blackfish	25	10
Actinopyga palauensis	YGP	Deepwater blackfish	30	15
Bohadschia argus	KUW	Tigerfish/Leopardfish (SI)	30	15
Bohadschia similis	BDX	Chalkfish	25	10
Bohadschia vitiensis	BDV	Brown sandfish	25	10
Holothuria atra	HFA	Lollyfish	30	15
Holothuria coluber	HHW	Snakefish	40	20
Holothuria edulis	HFE	Pinkfish	30	15
Holothuria flavomaculata	JCI	Snakefish red	30	15
Holothuria fuscogilva	HFF	White teatfish	35	15
Holothuria fuscopunctata	HOZ	Elephant trunkfish	45	20
Holothuria hilla	JCK	Tigertail sea cucumber	25	10
Holothuria lessoni	JCO	Golden sandfish	25	10
Holothuria leucospilota	HFQ	Snakefish white/white threadsfish	25	10
Holothuria scabra	HFC	Sandfish	25	10
Holothuria whitmaei	JDG	Black teatfish	30	15
Pearsonothuria graeffei	EHV	Flowerfish	30	15
Stichopus chloronotus	JCC	Greenfish	20	10
Stichopus herrmanni	JNG	Curryfish	35	15
Stichopus horrens	KUN	Peanutfish /dragonfish (SI)	20	10
Stichopus vastus	JPW	Brown curryfish	25	10
Thelenota ananas	TFQ	Prickly redfish	40	15
Thelenota anax	HLX	Amberfish	40	15
Thelenota rubralineata	JDZ	Lemonfish/candyfish	30	15
TBC (to be confirmed)		Brown curryfish	25	10
TBC		Deepwater blackfish	30	15
TBC		Honpai fish, pigfish	*NA*	*NA*
TBC		Labuyo	30	15
TBC		Loli's mother	40	20
TBC		Ocellated curryfish	25	10
TBC		Pink curryfish	25	10

Note: Minimum size limits should be set above the size at which sea cucumbers become fully mature to ensure adequate recruitment. Using size-at-maturity data from other countries in the region, such as Papua New Guinea, Solomon Islands, New Caledonia and Australia, three size limit groups (i.e. 10, 15 and 20 cm total dried length) were recommended by Tabunakawai-Vakalalabure et al. (2017). The above size limits were adopted by consensus and are based on the PROP report 'Sea cucumber fisheries and management in Melanesia: Review and policy briefs'[1], with few modifications to allow for countries to adapt to their own situation and environment.

For more information:

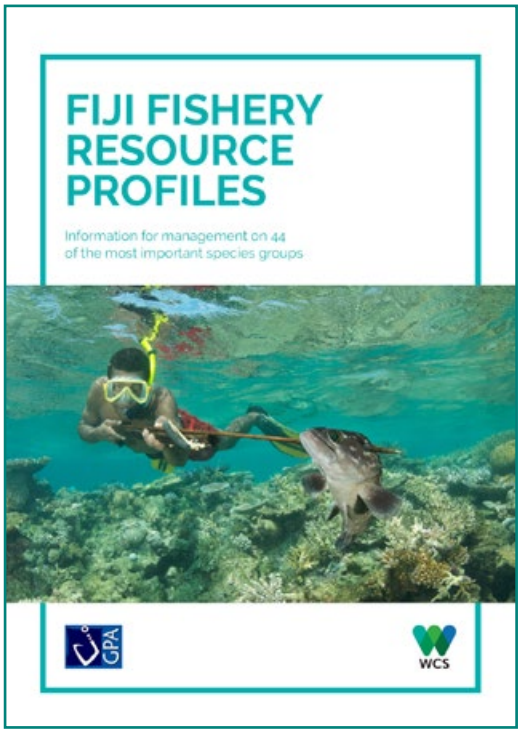
Stanley Wapot
Programme Manager, Governance and Sustainable Development, MSG
sj.wapot@msg.int

Hugh Govan
Consultant, SPC/World Bank PROP
hgovan@gmail.com

[2] http://www.msgsec.info/index.php/publicationsdocuments-a-downloads/study-reports. See also article by Hugh Govan on page 31 of this issue.

Fiji Fishery Resource Profiles: Information for management on 44 of the most important species groups

Steven Lee[1], Robert Gillett[2], Sangeeta Mangubhai[3]



Over the last three years, the David and Lucile Packard Foundation has supported a portfolio of projects specifically targeted at improving the governance of Fiji's inshore fisheries. In 2016, Gillett, Preston and Associates interviewed people from Fiji's Fisheries Department and non-governmental organisations (NGOs), as well as fisheries specialists in Fiji to determine specific problem areas that were constraining the management of inshore fisheries. Many of the people interviewed noted the lack of readily available reference material on the resources that support significant fisheries in Fiji. Accordingly, the Packard Foundation provided funds to update and enhance the 1994 Pacific Islands Forum Fisheries Agency (FFA) fishery profiles.

The 1994 FFA publication by Andrew Richards titled "Fiji Fisheries Resources Profiles"[4] was an update of a 1985 document produced by the Fisheries Division of Fiji's Ministry of Agriculture, Fisheries and Forestry.[5] These publications provided summary information on different categories of marine fish, invertebrate and plant resources for staff of the Fisheries Division, NGOs, students, communities, researchers, and others. Ultimately these documents informed government policy on natural resource management for some years.

The recently updated Fiji Fishery Resource Profiles is a 240-page document summarising information on 44 of Fiji's main species groups. Where groups of species are covered in a single profile (e.g. large coastal pelagics) there is also a separate profile on one exemplar species in that group (e.g. the Spanish mackerel, *Scomberomorus commerson*).

The updated Fiji Fishery Resource Profiles was published in early 2018, under the reference:

Lee S., Lewis A., Gillett R., Fox M., Tuqiri N., Sadovy Y., Batibasaga A., Lalavanua W. and Lovell E. 2018. Fiji Fishery Resource Profiles. Gillett Preston and Associates and the Wildlife Conservation Society, Suva, Fiji. 240 p.

Each profile includes information on, if available:

- The resource
  - species presence
  - distribution
  - biology and ecology
- The fishery
  - utilisation
  - production and marketing
- Stock status
- Management
  - current legislation and policy
  - recommended legislation and/or policy
- References

The full document is available online from:

- gillettprestonassociates.com/publications.shtml
- fiji.wcs.org/Resources/Reports.aspx

[1] Email: steven.d.a.lee@gmail.com, PO Box 4332, Nadi, Fiji.
[2] Gillett, Preston and Associates, PO Box 3344, Lami, Fiji.
[3] Wildlife Conservation Society, Fiji Country Program, 11 Ma'afu Street, Suva, Fiji.
[4] Richards A., Lagibalavu M., Sharma S. and Swamy K. 1994. Fiji Fisheries Resources Profiles. Report 94/4, Forum Fisheries Agency, Honiara, Solomon Islands. 205 p.
[5] Lewis A. 1985. Fishery resource profiles: Information for development planning. Fisheries Division, Ministry of Primary Industries, Suva, Fiji. 90 p.

FFA releases important report on the tuna longline industry in the WCPO

The latest report from the Pacific Islands Forum Fisheries Agency (FFA) on the tuna longline industry in the western and central Pacific Ocean (WCPO) was released in November 2017. The comprehensive report, "The Tuna Longline Industry in the Western and Central Pacific Ocean and its Market Dynamics" – available from: http://www.ffa.int/node/2025 – was authored by Liam Campling, Antony Lewis and Mike McCoy, and covers the distant-water tuna longline industries and fleets of China, Japan, South Korea and Taiwan, as well as global markets and value chains for longline-caught tuna. The report's 201 pages, contains over 60 tables and 20 figures, as well as photographs of fishing vessels and equipment, fish processing and retail products and markets.

The report provides information on the longline industry and markets by characterising the current status of the industry in terms of the four major distant-water fleets and the companies involved in the global value chains supplied by those fleets. The industry and market dynamics of the global longline industry are poorly understood, especially compared with the global canned tuna industry. It is widely known that the vast majority of sashimi-grade tuna goes to Japan and that the majority of canning-grade albacore is processed for sale in the United States (US). The primary focus of the report is on industry dynamics – key companies and organisations, industry organisation and corporate strategies – and this segment of the report takes up about half of its 200+ pages. A secondary focus of the report is on markets for longline-caught tuna and marketing strategies. These topics were chosen because the industry and market dynamics are not as well understood or publicised as the information on longline tuna catch and effort trends.

The study is timely because much is changing in the east Asian longline sector, including the rise of the Chinese-flagged fleet, new trends in sashimi product processing and international trade, shifts in traditional markets, and the growth of nascent ones. Two new regulatory initiatives by Pacific Island countries (PICs) also point to new management regimes (e.g. vessel day scheme and the Tokelau Arrangement) that seek to capture larger benefits for PICs.

The most significant distant-water longline fleets operating in the WCPO – and the eastern Pacific Ocean (EPO) – are those of China, Japan, South Korea and Taiwan in terms of fleet size, catch volumes and bigeye catch quota allocation. Thus, these four countries were selected as case studies for the report. The activities of these four major distant-water fishing nations are placed within the overall context of a global overview of tuna longline fisheries and their regulation. It is noted that collectively, China, Japan, South Korea and Taiwan's longline vessels accounted for 75–83% of the total number of longline vessels active in the WCPO from 2011 to 2015.

The report describes the long-term trend of below-average economic conditions in the WCPO tropical longline fishery, which has resulted in a declining number of vessels fishing for tuna, particularly distant-water vessels from Japan, South Korea and Taiwan. It is projected that the fishery will continue to follow a declining trend from 2017 to 2026 as a result of a forecasted increase in fuel prices and a decline in catch rates, primarily of bigeye tuna, which will more than offset projected above-average fish prices. Economic conditions for the WCPO southern longline fishery have also declined. Persistently low catches continue to impact the fishery negatively, and if prolonged, will result in below-average economic conditions for the fishery in the coming years.

The report describes the layered regulatory mechanisms that shape the longline industry, which work at multiple scales – regional, subregional and national – and at multiple points in the global value chains for longline products. The increased focus on labour standards is also addressed, and as the report concludes, such issues will be particularly challenging to address for large-scale, distant-water longline vessels that are away at sea for long periods and employ foreign crew who work very long hours under difficult conditions.

The report acknowledges that public regulatory frameworks are not achieving desired outcomes in terms of responsible fisheries management, environmental sustainability, food safety, quality and ethical employment. This concern has given rise to numerous fisheries-related private standards and certification schemes that have emerged over the past two decades. It is noted that while private standards are typically established by industry or non-governmental bodies and are voluntary, some may in practice become *de facto* mandatory, where compliance is a prerequisite for market entry.

The distant-water tuna longline industry

The major longline fleets of China, Japan, South Korea and Taiwan are described in detail in this section of the report. Following an introduction, Japan's longline industry is discussed in terms of national regulation and industry support, and a description of the fleet and review of its current status is provided. Subsequent sections describe Japan's longline catch, effort and transshipment situation, broken down by

global and WCPO fishing operations. Some indication of operating costs is followed by a summary of corporate governance and the profiles of several companies active in the fishery. Recent developments and future prospects of Japan's longline industry are discussed, and a final section presents some potential implications for PICs.

Key points identified in the report for Japan's longline fleet and its activities in the WCPO are:

- The number of vessels actively fishing has continued to decline in all fleets since 2010, with offshore/distant-water vessel numbers dropping from 160 in 2010 to 111 in 2016, and small offshore vessels from 272 in 2010 to 228 in early 2017. The sharpest decline over time has been in the medium offshore longline fleet (50–120 gross register tonnage, which are included in the offshore/distant-water vessel category), from 757 vessels in 1980 to just 28 vessels in 2017.

- It is unclear how many of these vessels are operating profitably, and the decline in numbers can be expected to continue. High fuel prices, the ageing of experienced officers, and problems with recruiting young Japanese crew members were identified as the most serious factors that will continue to impact the Japanese sashimi fishing fleets in the future.

- The catch has similarly declined from 48,226 tonnes (t) (all tuna species) in 2010 to 30,777 t in 2016 for the offshore/distant-water fleet, and from 34,524 t to 26,114 t for the small offshore fleet.

- The area fished by the distant-water fleet is now mostly high seas areas in both the WCPO and EPO, with 25% of the tuna catch taken in the exclusive economic zones (EEZs) of PICs in 2015, and even less in 2016; small offshore vessel activity has largely contracted to Japan's EEZ and adjacent high seas areas, with just one component of the fleet continuing to fish in Micronesian waters (Okinawan longline vessels).

- The species composition of the catch has also changed over time, with the bigeye tuna proportion of the total distant-water catch now around 20%, and albacore and yellowfin slightly lower. The small offshore catch is now dominated by albacore (close to 50%), with declining catch rates for yellowfin and bigeye tunas.

Taiwan

The discussion of the Taiwanese longline industry includes the topics of national regulation and industry support, a description of the large-scale and small-scale tuna longline fleets in the WCPO, longline catch and effort data and transshipment of the two fleet types, operating costs, corporate governance and company profiles, market dynamics, and implications for PICs. The report noted that:

- Taiwan's flagged and beneficially owned boats (i.e. registered with countries that have an open registry) are the largest component of the WCPO longline fleet.

- Some Taiwanese firms have good relationships with some PIC governments. However, the history of Taiwan's longline industry as a specialised fishing fleet with no, or minimal, shore-based investment outside of Taiwan means there has been limited interest in onshore investment in PICs. These attitudes will probably continue to dictate Taiwan's industry approach to such investment, at least under current economic and regulatory conditions.

- There are considerably fewer vessels on the FFA register than that which actively fished in the Western and Central Pacific Fisheries Commission (WCPFC) Convention Area in 2015 (126 vs 1,382). This is presumably because a large number of vessels, especially those in the small tuna longline category, are continuing to fish mostly in high seas areas, and not within the EEZs of FFA member countries.

South Korea

The growth of South Korea's longline fleet is described, beginning with its inception as an export-oriented industry to supply Japan's rapidly growing and profitable sashimi market. Subsequent sections of the report describe national regulation and industry support, fleet size and status, longline catch and effort data, transshipment, operating costs, corporate governance and company profiles, market dynamics and future prospects. Present and future challenges, as identified by the industry during discussions in 2017, are described:

- Reduced access to fishing grounds within PIC EEZs as result of the introduction of the Parties to the Nauru Agreement vessel day scheme or other catch management schemes, which the fleet feels are beyond its financial reach to adhere to. There is a resignation to fishing more and more outside of PIC EEZs and instead in high seas areas for as long as good catches are maintained;

- Concerns regarding continued overfishing of bigeye stocks;

- The ageing vessels in the longline fleet, with the average vessel age now close to 30 years, and no plans to replace or build new vessels, although there is optimism by some that the vessels can continue to fish effectively in the short to medium term because they have been well maintained and repaired as necessary;

- Recruitment of young Koreans to replace ageing vessel officers is difficult because longlining is not seen as a desirable career path, especially as there are very long periods at sea and difficult working conditions. Replacement by non-Koreans is probably not an acceptable option;

Shaving tuna loins in a -60°C room in Busan, South Korea. Image: Antony Lewis

- Increasing the focus on crew members' working conditions is seen as a potential threat, only because the necessary long working hours, essentially around the clock, are an accepted part of distant-water tuna longline fishing;
- Heavy reliance on a single market (Japan) where the market price has been stable but undermined by the depreciation of the yen against the US dollar, and downward pressure on profitability;
- Recent suggestions to consider a ban on high seas transshipments might be the ultimate blow for a fishery that is highly reliant on such transshipments during very long voyages (i.e. 18–24 months) for economic efficiency, with transshipment ports often far from fishing areas, especially in the EPO and eastern WCPO where most fishing occurs.

Key points identified in the report for South Korea's longline fleet and its activities in the WCPO are:

- In 2015, the global South Korean longline fleet consisted of 148 vessels (compared with 276 in 1990), with a total global catch of over 38,000 t. Most are large, ultra-low temperature (ULT) distant-water vessels, typically 350–500 gross register tonnage in size.
- In 2016, around 100 South Korean longline vessels operated in the WCPO, catching around 24,000 t of the main tuna species; 50% of the retained catch was bigeye and 30% yellowfin.
- An increasing portion of the catch in most recent years has been taken in high seas areas in both the WCPO and EPO, rather than within the EEZs of PICs, a situation that is likely to be exacerbated by the introduction of vessel day scheme and catch management schemes, which marginally profitable fleets feel unable to afford.
- The majority of the South Korean longline catch is exported to Japan after processing (70% of exports), and 10% of the total catch is landed directly in Japanese ports. The European Union (EU), US and China are minor export markets, while significant volumes of landed product are supplied to the domestic sashimi market.
- The main commercial challenge is the increasing highly-subsidised competition from other fleets, especially those from China.

- Given that most of the South Korean longline catch is taken in WCPO and adjacent EPO waters, future prospects for South Korea's longline fleet closely relate to ongoing developments in the region. Continuing high seas transshipment is seen as critical to the viability of the South Korean fleet. Hence, South Korean vessel owners are particularly concerned about the possible prohibition of at-sea transshipments in the WCPFC Convention Area.

China

The rise of China's longline fleet, which began fishing in 1988 with just seven vessels, is described and subsequent sections of the report describe national regulation and industry support, fleet description and status, catch and effort data, transshipment within the WCPO, operating costs, corporate governance and company profiles.

Some of the key points for China's longline fleet identified in the report and some implications for PICs are:

- Luen Thai Fishing Venture operates a fleet out of Majuro in the Marshall Islands that is China's only fully fresh, tropical longline fleet. Other bases are located in Pohnpei in the Federated States of Micronesia (frozen bigeye and yellowfin), Palau (fresh longline from non-Chinese vessels), and Samoa (frozen albacore). The Majuro base includes a processing facility with products going to Hawaii and the mainland US. Luen Thai's business model relies on close working relations with Pacific Island governments. This appears to have been successful given that the company has become the largest supplier of fresh bigeye and yellowfin to Japan.
- Although Luen Thai has expressed concern about the longline vessel day scheme, company officials do not seem as concerned as some of the other distant-water longline companies (particularly those from Taiwan) in their ability to retain fishery access for their operations.
- Kiribati Fish Ltd (KFL) started business at the end of 2012 and consists of a processing plant in Tarawa that is co-owned by the government of Kiribati (40% share), Golden Ocean Fish Ltd of Fiji (40%), and Shanghai Deep Sea Fisheries (SDSF) (20%). SDSF's partial ownership of Golden Ocean ensures that it has a significant, if not controlling, interest in KFL. SDSF believes that companies that invest in shore-based development in PICs will be better placed in the future to be assured fishery access.
- Some companies in China continue to seek other bases in PICs, encouraged by PIC government policies and support. An investigation of Kiritimati (Christmas) Island in Kiribati by one firm seeking a base for its longline vessels, found the necessary infrastructure for such an operation to be lacking at that location. This may signify a lack of interest in undeveloped sites if all funding must come from China.
- Southern albacore catches by Chinese-flagged and beneficially owned vessels have increased over the past five years, largely in relation to growing vessel numbers within the fleet, which are subsidised. Other fleets, particularly some PIC fleets, have experienced declining or fluctuating catches due to increased competition from subsidised Chinese vessels.
- Suva, Fiji remains the primary source of shore-based supplies for China's albacore fleet, although Santo in Vanuatu was suggested by one company as an alternative location for fuel acquisition when logistics and/or prices are unfavourable in Suva.
- Commercial concerns were expressed about the 100% local unloading requirements incorporated into Solomon Islands' licensing conditions.
- China's share of Japan's import market for processed ULT sashimi products grew from 30% in 2015 to 33% in 2016. In the first few months of 2017, China's share overtook South Korea as the leading supplier.

Luen Thai Fishing Venture vessels after undergoing maintenance in Zhoushan, China. Image: Mike McCoy

Tuna longline industry supply chains and market dynamics

This segment of the report focuses largely on two value chains for WCPO longline fisheries' tuna products. The main product linkages of large-scale and small-scale longline vessels with the principal markets – the Japanese sashimi market and the US canned albacore market – are highlighted. A number of secondary markets that exist for sashimi and other value-added fresh or frozen products are also briefly described.

Japan's tuna sashimi market

Japan is well known as the major global market for sashimi quality tuna, accounting for around 80% of global sashimi consumption in 2010. This may be slightly lower in 2017 with the growth of Japanese restaurants elsewhere and declining consumption in Japan, but this market continues to drive the global longline industry. Of the estimated 750,000 t of tuna consumed in Japan in 2014, an estimated 62% was consumed as sashimi, around 23% as *katsuobushi*[1] and 15% as canned tuna. It has been estimated that sashimi consumption, not including skipjack, in 2014 was 449,000 t whole round fish[2] equivalent. This demand is met by a combination of domestic landings by Japanese vessels and imports from fleets of various other nations. In 2014, bigeye accounted for 38% of the total supply volume (imports and landings) of sashimi-grade tuna, followed by skipjack (20%), bluefin (14%), yellowfin (15%) and albacore (13%). Notably, albacore is becoming increasingly attractive as a lower-value sashimi. Overall, Japan has experienced a decline in household consumption and expenditure of tuna in the past two decades. While there is little price linkage or competition with other fish species such as salmon, competition exists from other protein sources, particularly chicken and beef.

In 2015, around 80% of the sashimi market in Japan consists of frozen tuna (232,700 t) and 20% fresh (66,200 t), with imports comprising 60% of the total supply. While the majority of the sashimi supply comes from longline vessels, catches from pole-and-line and purse-seine vessels with ULT freezer capability are also utilised. The bulk of frozen catch (70–80%) is sold outside the auction system to trading companies and processors. Japan typically relies on about 10–15,000 t per month of imported, mostly frozen, tuna. China and South Korea have considerable sashimi-grade processing capability, with much of their frozen processed product also exported to Japan.

In 2015, Japan's market sales for fresh tuna totalled 66,200 t. The fresh tuna market is smaller than the frozen tuna market, with fresh catches generally marketed as whole round through wholesaler auctions (e.g. Tsukiji). Domestic landings, mostly

A. Pacific bluefin tuna sold at Tsukiji market.
B. Slicing bluefin tuna in Tsukiji market.
C. Bluefin *toro* sushi (three kinds) with seared -40°C albacore.
All images: Antony Lewis

[1] *katsuobushi*: dried, fermented, and smoked skipjack tuna (*Katsuwonus pelamis*).
[2] Whole round fish: gilled and gutted fish.

from the small offshore fleet, and all from the North Pacific, are dominated nowadays by albacore tuna, with declining catches of bigeye and yellowfin tunas. Fresh tropical tuna (bigeye, yellowfin) imports are dominated by Indonesia, by Mexico in the case of air-freighted farmed Pacific bluefin, and the US and Canada in the case of Atlantic bluefin.

The Japanese sashimi market is characterised by multiple complex market arrangements and distribution systems, but these can largely be distinguished as two channels: fresh and frozen. Fresh tuna (and to an increasingly less extent, frozen) sashimi-grade tuna is traded through government regulated wholesale market systems. Frozen sashimi-grade tuna is traded via "unofficial" channels that either bypass, or only partly flow through, the traditional wholesale market system.

With large advances in freezing technology and development of the cold chain over the past 20–30 years, coupled with the growing significance of trading companies in tuna sashimi trading, there has been a considerable shift in the volume of frozen sashimi-grade tuna sold through unofficial channels, rather than the traditional wholesale market channel. Unofficial channels dominate sales to supermarkets and large retailers.

Trading companies have become increasingly significant in Japan's sashimi distribution system. In 2016, the "big four" sashimi trading companies were reported to be Toyo Reizo, Try Sangyou, Fukuichi and Yamafuku. Combined, they may account for over 70% of the traded volume. Toyo Reizo and Try Sangyou are subsidiaries of *sogo shosa* – a unique business group in Japan that can be thought of as giant conglomerate of companies involved in a very diverse range of businesses, with a core competence in, but not limited to, trading.

US canning-grade albacore market

The major market for longline-caught albacore is the US, in canned or pouched form, with price and consumption driving the global market. The total global albacore catch was about 260,000 t in the mid-2000s and an estimated 50–60% of the catch was consumed by the US market. East Asian-owned longline vessels active in the WCPO that target albacore sell the bulk of their catch to trading companies or directly to loining plants or canneries. Product is then largely imported into the US as finished goods (i.e. pouch or canned), or as pre-cooked loins to be processed by Bumble Bee's cannery in Sante Fe Springs, California or Chicken of the Sea's facility in Lyons, Georgia.

The US's "shelf-stable" seafood market is dominated by canned and pouched tuna at 73% share of a USD 2.2 billion market, salmon follows at 10%. The US's shelf-stable tuna market is divided into light (typically, skipjack with some yellowfin), white meat (albacore), and value-added products (e.g. ready-made dishes). Water packs[3] are by far the greatest share of the US market, both pouched and in cans. The total supply of albacore to the US market in 2014 in whole round equivalent was 107,586 t.

Light tuna is the largest segment of the US shelf-stable tuna market, with almost 60% of the tonnage, but only 44% of value market share. For canned albacore (white meat), this is reversed, with a higher value (35%) than volume (29%) share of the market, reflecting higher retail prices paid for canned albacore. This tendency also applies to pouched tuna, which is typically a more profitable item than canned tuna.

Three brands dominate the US canned tuna market in volume and value, controlling 84% of the value market share in 2015. StarKist is owned by the South Korean giant Dongwon Industries – a large family-owned conglomerate (*chaebol*[4]) with investments in many areas, and which owns purse-seine vessels and a small number of longline vessels. Bumble Bee is owned by the private equity firm Lion Capital, which owns several other shelf-stable seafood brands, including the number one brand in Canada. It does not own any vessels but does control supplies to, and guarantees the purchase of, finished product from the Pacific Fishing Company loining plant in Fiji, although it is not the majority shareholder. Thai Union procures albacore globally and owns Chicken of the Sea, as well as many EU seafood brands and a growing number of other seafood businesses.

US market for high-value tuna

In contrast to the US market for canned albacore, the various fresh or frozen value chains for longline products feeding the US market are characterised by having both many suppliers and many buyers. These relations are moderated by the geographies of offloading and transshipment, the reliability of cold chains, historical business and marketing relationships, and linkages (or lack thereof) to market outlets.

The US fresh retail market for all fish species was valued at USD 4.6 billion market in 2015. Fresh tuna sales represent just 1.7% of this, with fresh salmon leading at 30.3% and shrimp following at 18.1%. Nonetheless, one source pegged the increase in value of the fresh tuna market at 40% between 2011 and 2015, reaching USD 76 million in 2015. The main species of fresh tuna consumed in the US is yellowfin. Suppliers include several countries in Latin America, Indonesia, Vietnam and Senegal.

Tuna treated with tasteless smoke and carbon monoxide (CO) is a high-volume, non-canned product sold in US supermarkets and, in recent years, is increasingly being used in food service. This is a relatively low-value segment and is generally less of a commercial focus of east Asian longline fleets. There can, however, be a significant amount of frozen

[3] Tuna cooked in water with no added flavours.
[4] A *chaebol* is a large industrial conglomerate that is run and controlled by either an owner or family in South Korea.

ULT bigeye tuna ready for processing, Ningbo, China, April 2017. Image: Mike McCoy

yellowfin tuna (-35°C) sent to Vietnam from Taiwanese- and Chinese-owned longline vessels for CO processing for the US market. It is assumed that much of the Vietnamese exports to the US is CO tuna and factories in the Philippines remain major suppliers. Hawaiian-inspired poke (fresh, marinated tuna cubes) has grown in popularity in 2016 and 2017 in the US, and often uses CO tuna (most commonly yellowfin).

Higher-value fresh tuna is mainly sold in specialty seafood retailers and higher-end mass retail stores. Supermarkets tend to procure non-canned tuna products from specialist distributors. Total frozen seafood retail sales in the US were about USD 4.5 billion in 2015, with shrimp representing nearly half (49%), followed by tilapia (13%). Data on retail sales of frozen tuna in the US compiled by one source valued the market at USD 31.9 million; less than 1% of total retail seafood sales.

There is, however, a major market for frozen tuna products (e.g. steaks), worth around USD 323 million in 2016. Frozen tuna is seen as having potential growth, given that only 1.5% of US households are currently buying the product. Frozen loins are imported and processed in the US for retail or food service. The main species used is yellowfin. The loin can be cut into steaks, medallion and kebab cuts, and half-size "sandwich" steaks. Ground tuna meat is used in sushi rolls.

Market channels for consumer purchase of frozen tuna are primarily supermarkets, warehouse club stores and food service sectors. A variety of products are offered, including individually frozen and wrapped single servings in bulk packaging, both cooked and uncooked, with some of the latter cooked with *faux* grilling marks applied, and value-added items in sauce. The most commonly sold frozen tuna is yellowfin.

EU market for high-value tuna

France, Italy and Spain are the principal markets for fresh and frozen tuna for direct consumption in the EU, especially in these countries' urban centres. The main product type is yellowfin and albacore steaks, believed to total around 40,000 t. The main supply comes from the western Indian Ocean, and is supplemented by some volume from the Atlantic and Pacific. There is a growing demand for ULT tuna products in some EU markets but the trade is limited by a lack of supporting infrastructure. However, where infrastructure is available, such as in Belgium, the Netherlands, Spain and the United Kingdom, it is legally permitted to sell defrosted ULT fish as "fresh", although packaging must make it clear that it was originally frozen. CO-treated tuna is illegal in the EU.

Yellowfin tuna is the most important fresh-chilled tuna species for all European countries, although there is demand for albacore in France, Italy and Spain. Steaks and sushi are the main product forms, and differences in prices of frozen tuna are considerable. EU consumption of fresh tuna is dominated by the intra-EU trade (around 81% of supply), mainly France and Spain. The leading EU supplier outside of Europe is now the Maldives because Sri Lanka lost its duty-free access under the EU GSP+ scheme,[1] and was delisted as a supplier of fish and fish products under the EU's illegal, unreported and unregulated regulation in 2015.

In general, western Europe has seen a shift in fish and fish product consumption to more convenience products and sushi, especially among younger consumers. There has been growth in the promotion and purchase of "sushi kits" in supermarkets, and it is predicted that there will be increasing demand for more premium sushi.

For more detailed information, the entire report can be downloaded from the Internet at **http://www.ffa.int/node/2025**.

[5] The General Scheme of Preference (GSP) allows vulnerable developing countries to pay fewer or no duty on exports to the European Union, thereby giving them vital access to the EU market and contributing to their growth.

Aid for oceans and fisheries in developing world drops by 30%

Sustainable fisheries make good sense for jobs, nutrition, and climate change resilience[1]

Financial aid to fisheries in developing countries has declined by 30% between 2010 and 2015, finds a new study from University of British Columbia (UBC) and Stockholm Resilience Centre researchers, published in the journal Marine Policy.[2] *Projects focusing on climate issues in fisheries had a 77% decline over the five years studied.*

"Sustainable fisheries make good economic sense not only as a source of employment and regular catches, but also because of their nutritional value," said co-author Colette Wabnitz, Research Associate at UBC's Institute for the Oceans and Fisheries and the Nippon Foundation – UBC Nereus Program. "Investments in small-scale, sustainable fisheries enhance climate change resilience and give vulnerable communities access to healthy food while preserving traditional diets", she added.

These sustainable food sources also limit the spread and prevalence of diet-related chronic diseases. Fisheries and aquaculture supply 17% of animal protein and provide livelihoods to 12% of the world's population. Official development assistance (ODA), commonly known as aid, is financial assistance to the developing world. From 2010 to 2015, ODA levels increased by over 13% to USD 133 billion, with further increases in 2016 and 2017. Yet, funding to fisheries projects in Oceania dropped by almost half.

"Demonstrating tangible results in fisheries as a result of donor support is often more difficult in oceans than it is on land," said co-author Robert Blasiak, postdoctoral researcher at the Stockholm Resilience Centre, and a Nippon Foundation Nereus Program Fellow.

ODA funds are used to help people fish more sustainably, protect the environment, and create better jobs. These funds are used in fisheries for varied projects, including undertaking research, supporting policy, providing equipment, and training and capacity building. Practical research could, for example, focus on how to improve fishers' access to less vulnerable stocks, and transfer fishing effort away from vulnerable ecosystems such as coral reefs to less threatened open ocean stocks, with strategically located fish aggregating devices (FADs).

"The types of projects are vast and include testing water quality and measuring ocean acidification, improving marketplaces; offering training and research opportunities for local staff; and providing solar-powered fridges to remote communities to reduce spoilage and losses," said Wabnitz. "According to our research, fisheries ODA has also increasingly been channelled towards improving policy and monitoring as well as management rather than fishery development."

Small Island Developing States that rely heavily on fisheries for food security, livelihoods, customs, and culture, will be particularly impacted by this loss of funding aid. Coastal communities in low-income countries are especially reliant on the micronutrients provided by fish. Many of the small Pacific islands have minimal land area and cannot turn to agriculture for their nutritional requirements.

"Fish supplies 50 to 90% of the animal protein to Pacific Island rural communities diets," said Wabnitz.

Research can improve understanding of the future impacts of climate change on fish stocks and link results from modelling work with on-the-ground monitoring and assessment efforts to improve adaptation strategies.

"Tremendous advances in modelling have made it possible to identify countries that will be particularly vulnerable to climate change impacts. Science is enabling practical action to prioritise the most vulnerable areas, in line with stated international commitments," said Blasiak. "Fisheries are at the nexus of health, nutrition, livelihoods, and economic security; if aid can help to get fisheries "right", the positive impacts will extend into lots of areas."

While recent activities appear to show promise in increasing funding allocations for oceans and fisheries, it is up to the international community to ensure that ODA allocations for fisheries under climate change are in line with international development goals and targets.

About the Nippon Foundation-UBC Nereus Program

The Nereus Program, a collaboration between the Nippon Foundation and the Institute for the Oceans and Fisheries at the University of British Columbia, has engaged in innovative, interdisciplinary ocean research since its inception in 2011. The program is currently a global partnership of 20 leading marine science institutes with the aim of undertaking research that advances our comprehensive understandings of the global ocean systems across the natural and social sciences, from oceanography and marine ecology to fisheries economics and impacts on coastal communities. Visit nereusprogram.org for more information.

[1] Source: http://oceans.ubc.ca/2018/01/16/aid-for-oceans-and-fisheries-in-developing-world-drops-by-30/
[2] https://www.sciencedirect.com/science/article/pii/S0308597X17306310

A review of sea cucumber fisheries and management in Melanesia[1]

Hugh Govan[2]

Summary

Countries of the Melanesian Spearhead Group (MSG) – Fiji, Papua New Guinea, Solomon Islands and Vanuatu – have made steady progress in developing sea cucumber management systems over the last five years. Three of the four countries have produced new management plans that include updated minimum sizes and/or higher levies and licence fees. These plans, along with the improved capacity evident in fisheries agencies, provide the basis for improving the sustainability of the sea cucumber fishery and increasing revenue for fishers and national coffers.

Two major challenges are now evident: ensuring political and public support for fishery management interventions and prioritising the implementation of the most feasible and effective management actions from the range of tools afforded by updated legislation.

Review of status of sea cucumber fisheries and management in Melanesia

Status of global and Pacific region sea cucumber fisheries

Records on landings, exports and values of the fishery are extremely varied but available information from fisheries agencies, supplemented by data from customs authorities, allow some conclusions.

- Pacific landings and exports of beche-de-mer[3] have declined from peaks of around 2,000 tonnes (t) in the 1990s to less than one-fifth of that in recent years to the extent that all four MSG countries have had to impose moratoria on the fishery. MSG countries have lost all of their international and much of their regional dominance, even though they are still the region's major producers (Fig.1).

- Global landings have increased, with an expansion into new countries and different species; MSG countries at present do not represent a significant proportion of global landings.

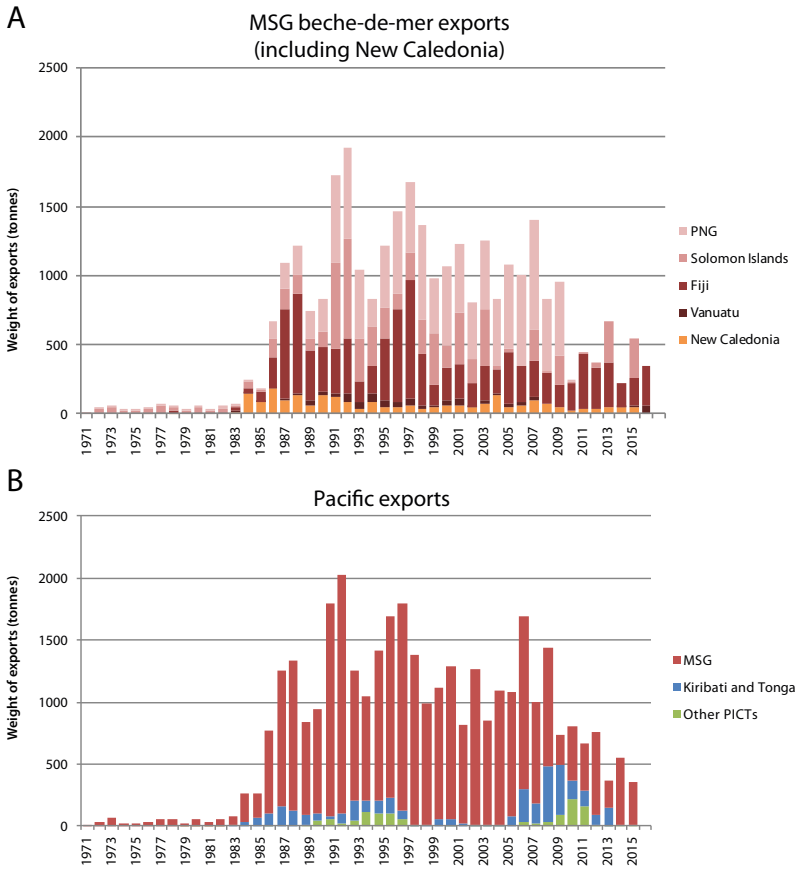


Figure 1: Records of exports of beche-de-mer in Melanesian Spearhead Group countries (A), and across all Pacific Island countries (B).

[1] This article is extracted from the report *Sea cucumber fisheries and management in Melanesia: Review and policy briefs* (http://www.msgsec.info/index.php/publicationsdocuments-a-downloads/study-reports), which is an output of the World Bank Pacific Regional Oceanscape Program (implemented by the Pacific Community) entitled: "Evaluating and providing management options and assistance for the beche-de-mer (BDM) fishery in the four Melanesian countries of Papua New Guinea (PNG), Solomon Islands, Fiji and Vanuatu".

[2] Fisheries Consultant and Adviser on Policy and Advocacy at the Locally-Managed Marine Area (LMMA) Network. Email: hgovan@gmail.com

[3] Beche-de-mer is the name given to the sea cucumber dry processed product.

Status of MSG sea cucumber fisheries

The boom-and-bust nature of MSG countries' sea cucumber fisheries and the imposition of moratoria obscures the trends. A comparison of five-year averages shows a decrease in yearly average exports compared with 5 and 10 years previously in most countries, and a major decrease in combined MSG exports. In the last 15 years, exports averaged 682 t per year compared with the average of the previous 15-year period of 1,137 t (i.e. a 60% decrease) (Table 1).

- PNG, Solomon Islands and Vanuatu have imposed several moratoria and recent short openings of their sea cucumber fisheries (1–4 months), while Fiji has just imposed its first moratorium.
- There is a shift from high-value to lower-value species in all countries (data available from Fiji, Solomon Islands and Vanuatu) (see Figs. 2 and 3).
- Large proportions of sea cucumber catch are thought to be undersize in Fiji (>31%) (Tabunakawai et al. 2017) and Vanuatu (>80%) (Léopold et al. 2016), and anecdotal reports suggest the same in all MSG countries.
- Although data collection is improving, there is no (or very limited) historical data on value, which means a comparison of current values with historical values is next to impossible; in addition, real time monitoring of landings, or first purchase location for quota tracking, has been a major challenge.

Tables 2, 3 and 4 summarise available data.

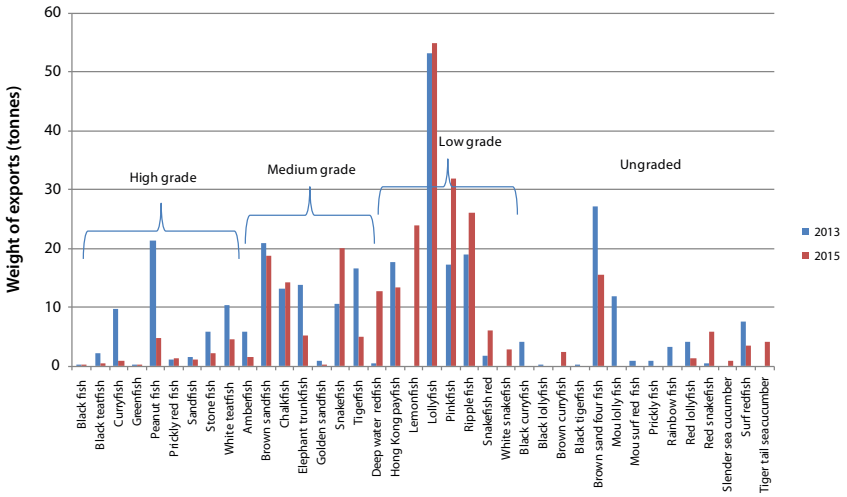


Figure 2. Comparison of different species of beche-de-mer exported in 2013 and 2015 in Solomon Islands (source: Ministry of Fisheries and Marine Resources data).

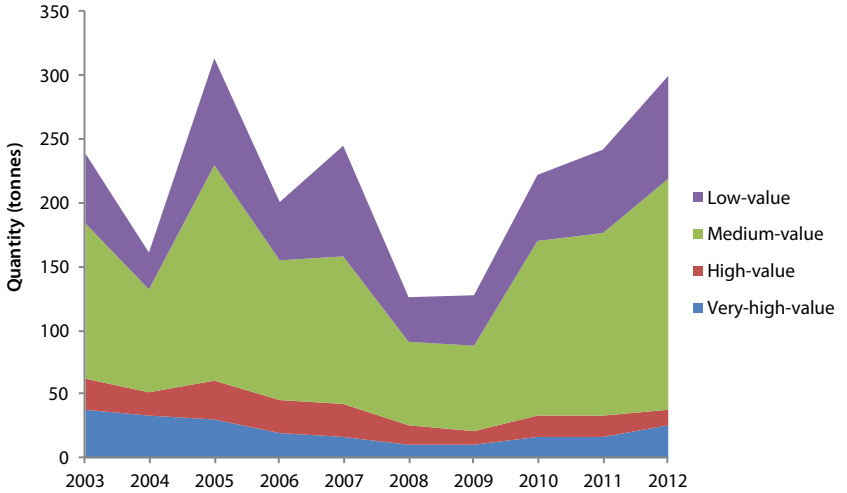


Figure 3. Comparison of different species of beche-de-mer exported from Fiji 2003–2012. Data from Fiji's Ministry of Fisheries collected in 2012.

Table 1. Beche-de-mer exports from four Melanesia Spearhead Group countries (in tonnes).

	PNG	Solomon Islands	Fiji	Vanuatu	Four countries combined
Average (1980–2016)	302.5	165.5	277.5	20.5	766.1
Maximum	791.0	715.4	862.0	66.0	1,840.7
Total (1980–2016)	11,191.9	6,125.2	10,269.2	759.3	28,345.6
Last year of harvest for which there are data	2017	2015	2016	2016	2016
5-year average preceding last year of harvest	158	126	257	16	464
Previous 5-year average (i.e. 6–10 years before last harvest)	212	92	248	6	716
Preceding 5-year average (i.e. 11–15 years before last harvest)	609	202	247	18	923
Recent 15-year average	326	103	239	13	682
Previous 15-year average	447	278	375	36	1,137

Table 2. Weights and values from the last sea cucumber harvests. Green, yellow and red highlights positive outcomes, potential issues and problems, respectively.

	Fiji	PNG	Solomon Islands	Vanuatu
Year of last harvest	2017 (2016 data)	2017	2015	2015
Export (Fisheries Dept. data, in tonnes)	NA	764	286	77
Export (Customs data, in tonnes)	289	791	328	56
Last harvest free on board value (local currency)	FJD 18,550,000		SBD 32,225,876	VUV 224,000,000
Last harvest export value (local currency)	FJD 18,550,000	PGK 81,530,092	SBD 29,460,332	VUV 300,000,000
Last harvest value (USD)	USD 8,912,348	USD 25,213,181	USD 3,794,491	USD 2,805,000
Value of imports to Hong Kong for that year (USD)	USD 7,148,880	NA	USD 2,581,106	USD 278,863 (USD 375,269 if incl. 2014)
Value (USD $tonne^{-1}$)	USD 30,839	USD 33,002	USD 13,267	USD 36,429
Export markets (for last year of harvest)	Hong Kong (90%), Vanuatu (7%), US (2%), Australia and New Zealand (1%)	NA	Hong Kong (75%) and Vietnam (23%) with 1% to Sri Lanka and New Zealand combined	Hong Kong (97.7%) and Fiji (2.3%)
Main species by weight	In 2012 65% of exports comprised (in order): lollyfish, amberfish, snakefish, tigerfish and brown sandfish[a]	NA	In 2015 50% of exports comprised (in order): lollyfish, ripplefish, pinkfish, lemonfish, snakefish, brown sandfish, Hong Kong payfish[a]	In 2014–15: surf red-fish 30% with tigerfish, brown sandfish and black teatfish account-ing for 37%[a]

[a] See Table 5 of Annex 1 on p. 38 for correspondences with scientific names

Sea cucumber management

- Management plans have been in place for Solomon Islands, Vanuatu and PNG since 2015–16.
- Vanuatu tested, implemented and evaluated a comprehensive management plan.
- PNG and Vanuatu set total allowable catches (TACs) based on stock assessments.
- Customs authorities collect valuable and potentially independent or at least complementary data but require better support from fisheries agencies.
- TACs were significantly exceeded, where applied, and the lengths of harvest seasons exceeded technical recommendations.
- Enforcement capability and/or political will is generally low – fines and licence suspensions were only issued in Vanuatu.
- Village and provincial enforcement has not proven logistically feasible.
- Exporter enforcement is not implemented and there is much room for improvement:
  - Few checks on sizes (except Vanuatu) and no penalties;
  - Little if any verification of exporters' reported data (value, species, grades) and there is suspected under-valuing.

Table 3. Management measures in place in each of the four countries. Green, yellow and red highlights positive outcomes, potential issues and problems, respectively.

	Fiji	PNG	Solomon Islands	Vanuatu
Management plan	No, in draft	2016	2014	2015
National total allowable catch (TAC)	No	350 t dry weight	No	21 t dry weight
Provincial TAC	No	Yes, 150%–680% exceeded	No	Yes but not issued
Individual species TAC		Possible but not applied		Yes but not enforced
Quota per export licence	No	No	No	No
Compliance with quotas	Not applicable	223% overharvest (but TAC had been precautionary)	Not applicable	240% overharvest (but TAC had been precautionary)
Length of last season	Open until 1/11/17	1 April–30 September 2017 / 6 months	1 December 2014–31 March 2015 / 4 months	September–December / 4 months
Size limits	Yes, too low (7.6cm)	Yes [a]	Yes [b]	Yes, updated [c]
Estimate of undersize harvest	35% below legal limits,[d] 60–100% below biologically recommended limits	Not available	"Sizes getting smaller"	>80%[e]
Community management	Some access control	1 example (Manus)	Unreported	A few communities / conflicts reported
Other prohibitions	Recent UBA ban	Various, no underwater breathing apparatus (UBA)	Long list in licence conditions: No UBA	Long list: Only harvest by resource owners, no UBA, daytime, presence of an authorised officer
Enforcement	Patrols / MoF staff	Compliance officers in provinces	Several cases of enforcement. No fines	Observers / DoF staff
Penalties	Low (~FJD 500), not applied	Compliance bond and penalties not exceeding for: crew member PGK 25,000; natural person PGK 500,000; corporation PGK 5,000,000	SBD 500,000 or imprisonment up to 4 months or both (regs 2014) / not applied	4 fines (up to VUV 150k) / 2 licence suspensions
Penalties max (USD)	240	7,700; 150,000; 1,500,000	64,400	1,403

[a] Size limits in 3 groups 8, 10, 15 cm; [b] Size limits in three groups: 10, 15, 20 cm; [c] Size limits calculated relatively precisely: 7,10,12,15,17, 20 cm; [d] Tabunakawai-Vakalalabure et al. 2017; [e] Léopold et al. 2016

Economics, market and prices

- Hong Kong remains the major market for sea cucumbers, with small reported exports to Vietnam (both of which are "grey routes" to China), Australia, New Zealand or the United States (US), which may be commanding higher values in some cases.
- Export is by sea and, increasingly, by air (PNG, Vanuatu and possibly Fiji) although data are not comprehensively collected.
- Monitoring and comparison of prices paid to fishers and exporters is complicated by the wide variety of grades and degree of processing of sea cucumber products traded by fishers. Improvements in processing and establishment of standard grades for the different species (and possibly minimum prices) have much potential for increasing the value left in country.

- Increase in government revenue generated in Solomon Islands and Vanuatu through increased licence fees and an export levy (Solomon Islands).
- Solomon Islands is moving towards market price certification to control export prices (declared) and guidelines on fisher buyer prices.

Table 4. Values of exporting and processing licences in the four Melanesian Spearhead Group countries. Green, yellow and red highlight positive outcomes, potential issues and problems, respectively.

	Fiji	PNG	Solomon Islands	Vanuatu
Export licence (local currency)	FJD 15–150[a]	Export + storage + 5 buyers = ~10,000	SBD 210,000	3,000,000
Export licence (number)	~5	80 (buyers' licences: 395)	10	6
Export licence (USD)	~USD 50	USD 3,093	USD 27,048	USD 28,050
Processing licence (local currency)	NA		SBD 50,000	VUV 120,000
Processing licence (number)	NA		0	12
Processing licence (USD)	NA		USD 6,440	USD 1,122
Export levy	No ("tax" 2,000)[a]	PNG removed tariffs on seafood products	10% (SBD 3,222,587 export duty)	5% not implemented
Export fee	FJD 30–4000[a]		Permit fee SBD 200	
Value of harvest tracked: fishers / export (local currency)	NA/ FJD 18.5 million	~PGK 40,000,000 / ~PGK 82,000,000	Collected but not tabulated / SBD 32,225,876	VUV 105 million / VUV 300 million
Government revenue (last year of harvest) (local currency)	licences ~USD250	Licences ~ PGK 800,000	SBD 5,322,587	VUV 22,000,000
Government revenue (USD)	Negligible	USD 247,400	USD 685,549	USD 205,700

[a] Source: Mangubhai et al. 2016

Recommendations of review for consideration

Country experiences and improved legislation and management plans provide an adequate basis for moving towards strategic implementation of management actions. National institutional capacity is limited and staff are rarely able to invest the time and effort needed for strategic implementation of management actions. Experience strongly suggests focussing on one or two specific areas for improvement that have the most likelihood of regulating fishing pressure and increasing returns to fishers.

National actions

The main technical recommendation is to increase the control of exports and exporters with a view to progressively implement export quotas and rigorously enforce these and associated rules (e.g. minimum sizes, prices). Particular support will be needed from trade and economic specialists and media and public relations personnel.

- Prepare a strategy for the control and enforcement of exporters, including:
  - declared export prices and accuracy of reported exports (i.e. size, grade, species);
  - develop and improve procedures with customs and/or inland revenue;
  - improve transparency and process of consultative mechanisms with exporters, together with other stakeholders; and
  - define and implement total allowable effort as a main, or backup, catch control mechanism.
- Specific country actions as defined elsewhere, such as review fees, set size limits, deliver information programmes, improve the process for sharing information, and access important MSG-level information on markets.

Political will

The major impediment to regulating the beche-de-mer trade and increasing the value to countries relates to political or other influences exerted by exporters, traders and communities, as well as the lack of clarity of both the public and politicians with regard to the intent of management regulations. This may be influenced and improved by:

- the targeted use of regional mechanisms to work with leaders and ministers (including MSG, the Pacific Island Development Forum, the Pacific Islands Forum Secretariat, and the Pacific Community (SPC); and
- specifically designed support for proactive media and public relations ,and information and awareness raising campaigns that help to increase understanding and suppot, and target leaders and the public .

Regional

Regional support includes technical support from SPC, the Australian Centre for International Agricultural Research, universities and non-governmental organisations. This level of support can help inform regional political influence and build the capacity of MSG to share and collect information. Data collection, the establishment of minimum sizes and licence fee schedules, and information on markets and prices are improving but would benefit from increased sharing between countries, which would be facilitated by:

- establishing an MSG trade and information-sharing office with staff (supported initially by SPC/Pacific Regional Oceanscape Program, PROP);
- developing a basis for common terms and conditions that all countries can adopt to improve their overall control and value retained, including on standard grades and quality (SPC/PROP with MSG in the interim);
- providing economic and trade advice to countries in specific areas, such as calculating minimum buyer prices, minimum export prices, and determining appropriate level of penalties, fees, licences and levies;
- initiating or completing data collection and sharing of companies and prices paid;
- continuing supporting the exploration of longer term opportunities (e.g. branding, Parties to the Nauru Agreement and cartel opportunities); and
- addressing political will.

Other issues

Processing remains a major issue but further information is required as to the proportions and quality of beche-de-mer processed at village and provincial levels. Major efforts may be required to maximize value but this will be distracting from the proposed first priority actions above and it is suggested this be addressed in a second phase.

Note

The full report (http://www.msgsec.info/index.php/publicationsdocuments-a-downloads/study-reports) ends with six short and detailed briefs that summarise the areas proposed for harmonisation, current status and the proposed way forward. It has been decided to reproduce here the main part of three of these briefs, as we are currently working on an article based on the findings of the original report's "Brief 1: Maximising long-term economic value and ecological sustainability of sea cucumbers", "Brief 2: Recovering the value of sea cucumber fisheries in Melanesia" and "Brief 5: Political will, transparency and information". This article will be published in a coming issue of this newsletter.

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Brief A:
Setting minimum size limits for Melanesian Spearhead Group sea cucumber fisheries[4]

Summary

- Minimum size limits are an important management tool for sea cucumber fisheries.
- These size limits bear review and improvement in all four MSG countries.
- Adopting simple, more easily enforceable categories based on reasonable biological advice.
- MSG countries are encouraged to review and harmonise these size limits to be implemented by the next harvest period.

Rationale

Setting minimum size limits is a strongly recommended strategy for ensuring sustainability and improving value for sea cucumber fisheries.

Setting minimum size limits:

- allow animals to reproduce and replenish stocks;
- help fishers earn more for each sea cucumber they catch;[5]
- encourage fishers to shift their effort once catches drop below a threshold; and
- provide a brake on fishing effort and slowing a "free-for-all" approach or mentality.

The minimum legal sizes in all MSG countries should be reviewed and improved. A common standard for minimum sizes would be advantageous for:

- reducing the focus of companies on countries with the least ecologically sustainable regulations; and
- common technical studies, awareness-raising materials and training for communities, fisheries and customs officers.

The proposed size limits should:

- be based on the best available biological data relating to reproductive sizes;
- be relatively easy to apply;
- be for live and dry animals, as well as providing the number of animals per given weight (e.g. 1 kg);
- have a reduced number of size classes to reduce complexity and confusion, owing to species identification;
- be enforced, at a minimum, at the point of export, and will need customs authorities to be involved and trained in their application, and for shipments to be separated by species and, optimally, sizes.
- be subject to an intense and thorough awareness-raising programme for all communities, fishers and stakeholders involved in the fishery; and
- be reviewed in future on a regular basis (possibly along with management plans).

Proposed size limits

The most recent work that addresses the criteria raised in the above paragraphs, and relevant to Melanesia was produced in 2017 by Fiji's Ministry of Fisheries and the Wildlife Conservation Society (MoFF/WCS). National minimum sizes are compared with the minimum size limits proposed by MoFF/WCS for dry and wet individuals in Table 5.

[4] The original report includes six briefs, although only briefs 3, 4 and the first part of brief 5 are reproduced in this article.

[5] In general, larger sized beche-de-mer command higher prices than smaller individuals. Market preferences for some species such as *Holothuria fuscogilva* and *H. fuscopunctata* are for medium sized animals but these are still larger than the proposed minimum legal sizes, and so imposing size limits would not represent a foregone commercial opportunity. *H. scabra, H. lessoni,* and *H. fuscogilva* show exponential increases in price with size, and larger size limits should be considered, which will increase fishery economic performance in the long term (Purcell 2014 and pers. comm.).

Table 5: Comparison of live (or wet) and dry minimum size limits for the four Melanesian countries in 2017. Green shading represents sizes that would not need modification (i.e. could be adopted) in a first phase, other shading represents the level of discrepancies.

Common name	Scientific name	FAO code[a]	Live minimum length (cm)				Dry minimum length (cm)				
			MoFF/WCS proposed	PNG	Solomon Islands	Vanuatu	MoFF/WCS proposed	Fiji	PNG	Solomon Islands	Vanuatu
Amberfish	*Thelenota anax*	HLX	40	20	40	40	15	7.6	10	15	15
Black teatfish	*Holothuria whitmaei*	JDG	30	22	30	30	15	7.6	10	15	15
Blackfish/Hairy blackfish	*Actinopyga miliaris*	KUQ	25	15	20	20	10	7.6	10	10	10
Brown curryfish	*Stichopus vastus*	JPW	25	25		20	10		10		10
Brown sandfish	*Bohadschia vitiensis*	BDV	35	20	25	25	15	7.6	10	10	12
Chalkfish	*Bohadschia similis*	BDX	25	20	20	15	10	7.6	10	10	7
Curryfish	*Stichopus herrmanni*	JNG	35	25	35	35	15	7.6	10	15	15
Deepwater redfish	*Actinopyga echinites*	KUE	25	25	20		10	7.6	15	10	
Deepwater blackfish	*Actinopyga palauensis*	YGP	30	20		30	15		10		15
Elephant trunkfish	*Holothuria fuscopunctata*	HOZ	35	45	40	40	15	7.6	15	20	20
Flowerfish/Black spotted sea cucumber	*Pearsonothuria graeffei*	EHV	30	25	30	30	15	7.6	10	15	15
Golden sandfish	*Holothuria lessoni*	JCO	25	22	25	25	10	7.6	10	10	12
Greenfish	*Stichopus chloronotus*	JCC	20	20	20	20	10	7.6	10	10	10
Lemonfish/ Candyfish	*Thelenota rubralineata*	JDZ		25	30				10	15	
Lollyfish/Reef lollyfish	*Holothuria atra*	HFA	30	30	30	20	10	7.6	15	15	10
Peanutfish/Dragonfish/ Selenka's sea cucumber	*Stichopus horrens*	KUN	20	20	15	20	10	7.6	10	10	10
Pinkfish	*Holothuria edulis*	HFE	30	25	20	20	15	7.6	10	10	10
Prickly redfish	*Thelenota ananas*	TFQ	45	25	35	35	20	7.6	10	15	17
Sandfish	*Holothuria scabra*	HFC	20	12	25	20	10	7.6	10	10	10
Snakefish	*Holothuria coluber*	HHW	40	30	30	40	20	7.6	15	20	20
Snakefish red	*Holothuria flavomaculata*	JCI		30	20	30			15	10	15
Snakefish white/White threadfish	*Holothuria leucospilota*	HFQ		25	20				10	10	
Stonefish	*Actinopyga lecanora*	YVV	20	15	20	20	10	7.6	10	10	10
Surf redfish	*Actinopyga mauritiana*	KUY	25	20	25	25	10	7.6	8	10	12
Tigerfish/Leopardfish	*Bohadschia argus*	KUW	30	20	30	30	15	7.6	10	15	15
Tigertail sea cucumber	*Holothuria hilla*	JCK		25					10		
White teatfish	*Holothuria fuscogilva*	HFF	35	35	35	35	15	7.6	15	15	16
Other species still pending proper identification											
Labuyo	TBC			30					15		
Loli's mother	TBC		40				20				
Ocellated curryfish	TBC			25					10		
Pink curryfish	TBC			25					10		

[a] The Food and Agriculture Organization of the United Nations (FAO) species codes are not commonly used but there is a need for countries to adopt a common and agreed coding for species in order to reduce any confusion caused by varied local names.

These MoFF/WCS sizes, summarised in Table 6, are presented for adoption and could be incorporated into management plans and regulations for the next open season. In Fiji's case, a period of moratorium would present the opportunity to subsequently implement size limits without creating a major impact on established fishers. Correct estimations of the maximum number of pieces per kilo need to be determined for the species for which Vanuatu has not already provided estimates (10 out of 33 species).

Table 6. Proposed initial harmonised size limits for beche-de-mer in Melanesia. For dry lengths, there are three size categories (10, 15 and 20 cm) and for live lengths there are six (20, 25, 30, 35, 40 and 45 cm). These sizes are broadly comparable to those in place in New Caledonia. Red typing indicates that these sizes need to be reviewed.

Common name	Scientific name	FAO code	Proposed minimum limits		
			live length (cm)	dry length (cm)	pieces kg^{-1} (dry weight)
Amberfish	*Thelenota anax*	HLX	40	15	12
Black teatfish	*Holothuria whitmaei*	JDG	30	15	10
Blackfish/Hairy blackfish	*Actinopyga miliaris*	KUQ	25	10	29
Brown curryfish	*Stichopus vastus*	JPW	25	10	96
Brown sandfish	*Bohadschia vitiensis*	BDV	35	15	35
Chalkfish	*Bohadschia similis*	BDX	25	10	128
Curryfish	*Stichopus herrmanni*	JNG	35	15	25
Deep water redfish	*Actinopyga echinites*	KUE	25	15	TBC[a]
Deepwater blackfish	*Actinopyga palauensis*	YGP	30	15	12
Elephant trunkfish	*Holothuria fuscopunctata*	HOZ	45	20	4
Flowerfish/Black spotted sea cucumber	*Pearsonothuria graeffei*	EHV	30	15	53
Golden sandfish	*Holothuria lessoni*	JCO	25	12	19
Greenfish	*Stichopus chloronotus*	JCC	20	10	222
Lemonfish/Candyfish	*Thelenota rubralineata*	JDZ	30	15	TBC
Lollyfish/Reef lollyfish	*Holothuria atra*	HFA	30	15	71
Peanutfish /Dragonfish/ Selenka's sea cucumber	*Stichopus horrens*	KUN	20	10	132
Pinkfish	*Holothuria edulis*	HFE	30	15	166
Prickly redfish	*Thelenota ananas*	TFQ	45	20	11
Sandfish	*Holothuria scabra*	HFC	25	10	66
Snakefish	*Holothuria coluber*	HHW	40	20	73
Snakefish red	*Holothuria flavomaculata*	JCI	30	15	100
Snakefish white/White threadfish	*Holothuria leucospilota*	HFQ	25	10	TBC
Stonefish	*Actinopyga lecanora*	YVV	20	10	30
Surf redfish	*Actinopyga mauritiana*	KUY	25	12	33
Tigerfish/Leopardfish (SI)	*Bohadschia argus*	KUW	30	15	31
Tigertail sea cucumber	*Holothuria hilla*	JCK	25	10	TBC
White teatfish	*Holothuria fuscogilva*	HFF	35	16	8
Other species still pending proper identification					
Brown curryfish	TBC		25	10	TBC
Honpai fish, pigfish	TBC		0	0	TBC
Labuyo	TBC		30	15	TBC
Loli's mother	TBC		40	20	TBC
Ocellated curryfish	TBC		25	10	TBC
Pink curryfish	TBC		25	10	TBC

[a] TBC: to be confirmed

Brief B:

Approximating buyer and market prices for beche-de-mer for Melanesia (October 2017)

Summary

- Data are sometimes urgently required to support unforeseen management actions at the national level. Such an occasion arose in Solomon Islands in September 2017, with the unexpected opening of the sea cucumber fishery.
- Data required for management decisions include prices afforded to fishers by buyers, export values and buyer prices in Hong Kong and China, which can be used to set minimum recommended prices for fishers, fair market prices for export, levy calculations and to determine license values.
- More emphasis on routine collection and sharing of available information on buyer prices, export values and trade information in both published and grey literature can provide a factual basis for decisions at short notice.

Prices paid by buyers to fishers

Table 7 provides a sample of recent prices from other Melanesian Spearhead countries. Note that large variations between and within countries may be affected by quality and size of processed beche-de-mer. Some traders have wet weight and dry weight prices. Wet weight prices are often higher than proportional dry weight prices. The absence of national or regional standards for the grading of beche-de-mer is a challenge.

Table 7. Average price for dry weight (kg) high-grade beche-de-mer.

Common name	Scientific name	FAO code	Value range	Price (USD)			
				Fiji 2015[a]	PNG 2017[b]	PNG 2017[c]	Vanuatu 2015[d]
Amberfish	*Thelenota anax*	AMF	L	6	6		3
Black teatfish	*Holothuria whitmaei*	BTF	M	24	40		26
Blackfish	*Actinopyga miliaris*	BF	L			22	10
Brown sandfish	*Bohadschia vitiensis*	BSF	L	6	9		8–27
Chalkfish	*Bohadschia similis*	CHF	L	8	5		7
Curryfish	*Stichopus herrmanni*	CF	L	19	28	25	9
Deep water redfish	*Actinopyga echinites*	DRF	M	13			
Deepwater blackfish	*Actinopyga palauensis*	BF	M	23			30
Elephant trunkfish	*Holothuria fuscopunctata*	ETF	VL	23	3		1
Flowerfish	*Pearsonothuria graeffei*	FF	L	7			4
Golden sandfish	*Holothuria lessoni*	GSF	M		55	23	
Greenfish	*Stichopus chloronotus*	JCC	M	43	29	15	13
Lollyfish	*Holothuria atra*	LF	VL	3	5		3
Peanutfish	*Stichopus horrens*	PNF	L				7
Pinkfish	*Holothuria edulis*	PKF	VL	3			
Prickly redfish	*Thelenota ananas*	PRF	M	28	32	19	17
Sandfish	*Holothuria scabra*	SF	H	29	65	34	30
Snakefish	*Holothuria coluber*	SNF	L	6	7		3
Stonefish	*Actinopyga lecanora*	STF	L	18	34	25	3
Surf redfish	*Actinopyga mauritiana*	SRF	M	18	31	20	21
Tigerfish	*Bohadschia argus*	TF	L			9	22
White teatfish	*Holothuria fuscogilva*	WTF	H	51	49	37	57

[a] From: Mangubhai et al. 2016. Average purchase price.
[b] From: Kinch J., personal communication. New Ireland, best trader price.
[c] From: Kinch J., personal communication. Kiwali, Milne Bay.
[d] Using dry weight conversion ratios from Carleton et al. 2013

Export value declared to government at point of export

Values declared by exporters to national customs authorities are detailed below. To date, only Solomon Islands levied an export tax based on the percentage of the declared value, and this may account for the low value reported. For 2015, the average value per tonne of beche-de-mer was: Fiji, USD 30,839, Vanuatu, USD 36,429, PNG approximately USD 32,000; but in Solomon Islands it was only USD 13,267. Note that because these data rely on voluntary declarations, Carleton et al. 2013 proposed that exporters should show a commercial invoice from Hong Kong importers with the buying value in Hong Kong dollars. The feasibility of obtaining such an invoice needs to be tested.

Table 8. Sample of recent average export values declared to governments.

Common name	FAO code	Average declared export values (USD kg^{-1})		
		Fiji 2015	Solomon Islands 2015	Vanuatu 2015
Amberfish	AMF	45	21	
Black teatfish	BTF	148	39	62
Blackfish	BF	96	38	
Brown sandfish	BSF	38	14	16
Chalkfish	CHF	17	19	15
Curryfish	CF	97	37	25
Deep water redfish	DRF	103	10	
Deepwater blackfish	BF	113		14
Elephant trunkfish	ETF	28	12	11
Flowerfish	FF	46	8	6
Golden sandfish	GSF	103	19	
Greenfish	JCC	110	35	27
Lollyfish	LF	18	10	11
Peanutfish	PNF	124	42	7
Pinkfish	PKF	13	10	
Prickly redfish	PRF	94	32	32
Sandfish	SF	83	35	58
Snakefish	SNF	36	11	7
Stonefish	STF	68	41	34
Surf redfish	SRF	68	36	90
Tigerfish	TF	45	14	24
White teatfish	WTF	183	41	70

Hong Kong and China buying prices

Exporters do not necessarily report accurate selling prices, and so gaining an independent estimate of the Hong Kong buying price is useful. Recent studies have shown that this is possible but that data are still emerging.

Table 9. Estimated wholesale prices (USD kg^{-1}) in China (Guanghzou) and Hong Kong based on 2011 data from Purcell 2012 and inflated to 2015 prices at 2.9% per year.

Common name	Guangzhou retail/wholesale price (USD kg^{-1}), 2015	Hong Kong retail price (USD kg^{-1}), 2015
Black teatfish	88.57	
Burying blackfish	16.82	
Curryfish	135.66	220.87
Deepwater blackfish	118.84	
Deepwater redfish	70.63	
Dragonfish	24.67	
Elephant trunkfish	53.81	
Golden sandfish	76.24	201.81
Greenfish		431.64
Hairy blackfish	88.57	
Leopardfish	65.03	
Peanutfish	77.36	
Prickly redfish	145.75	
Sandfish	153.60	339.71
Snakefish	42.60	
Stonefish	105.39	
Surf redfish	84.09	162.57
White teatfish	134.54	215.26

This exercise demonstrated that based on publicly available information, contact with select regional experts, and advice from SPC staff, it is possible to compile a defensible estimation of prices at various levels although this could be more up to date and complete.

- The Pacific Regional Oceanscape Program regional project responded to the request to provide best available data at short notice for improved decision making.
- The exercise also tested whether ongoing low-level data collection by staff at regional organisations such as SPC or MSG could provide useful information in this type of scenario.

Brief C:
Harmonisation of conditions for sea cucumber fisheries management in Melanesia

Background

The Melanesian Spearhead group's memorandum of understanding (MoU) on technical cooperation in coastal fishery and aquaculture development 2015[6] called for cooperation and collaboration on coastal fisheries and aquaculture. The MoU in relation to sea cucumbers states:

The Members agree to:

- develop harmonised systems for sea cucumber fisheries in the areas of policy, technical cooperation development and management; and to
- align management, monitoring and compliance approaches within the MSG sea cucumber fisheries to avoid illegal transhipment of product between Member countries to get around local management measures.

The MSG roadmap for inshore fisheries management and sustainable development 2015–2024 committed Heads of Governments to:

- improve data collection and sharing by and between fisheries departments and customs departments;
- improve coordination and sharing of harvesting, operator and market information between MSG members to increase prices and facilitate control; and
- harmonise prices and licence conditions, and maintain a regional database, including detailed information on all exporters.

Objectives of harmonising terms and conditions

- Share information that is useful to improving the sustainability of the beche-de-mer industry and maximising the proportion of the value that stays in countries and with fishers.
- Reduce or remove the incentive for illegal transshipment of product between MSG countries to get around local management measures.
- Engage Melanesian solidarity to increase control over the value and sustainability of the sea cucumber fisheries and to maximise benefits to communities.
- Adopt common standards that are more resilient to local interference and reinforce sustainable management and local value maximisation.
- Ensure a common high standard that improves the international image of Melanesian beche-de-mer as sustainable and high-quality products from pristine environments.

Aligning management, trade and market policy and information sharing

It is proposed that MSG fisheries agencies seek to align, at the earliest feasible opportunity, policies to achieve the mutually agreed objectives above in the following broad areas:

- harvest control rules and regulations;
- pricing and market information and standards; and
- fiscal, economic, trade, companies and customs measures.[7]

[6] http://www.msgsec.info/index.php/documents-of-cooperation/1225-2015-26-jun-mou-on-msg-coastal-fishery-and-aquaculture-development

[7] This brief is followed in the original report by three sub-briefs relating to: "Harvest control rules and regulations"; "Pricing and market information and standards"; and "Fiscal, economic, trade, companies and customs measures".

Informing community-based fisheries management with spawning potential surveys

Jeremy D. Prince[1]

Introduction

Since 2012, the David and Lucille Packard Foundation has funded the development and application of a new approach to community-based fisheries management (CBFM) of reef fish in the western Pacific called spawning potential surveys (SPS). The approach uses a new length-based and simple technique to assess local stocks (Hordyk et al. 2015a,b; Prince et al. 2015a,b) and provide scientific management advice on minimum size limits, mesh and hook sizes, and fishing pressure to communities. The aim of the Packard Foundation's Western Pacific Program has been to trial the new approach in the Pacific, and develop a communications strategy to support its implementation.

A team of non-governmental organisations (NGO) and donor partners working with local communities were involved in carrying out the programme, and trials began in Palau in 2012, Solomon Islands and Fiji in 2014, and northern Papua New Guinea (PNG) in 2015. In each country, early results have been encouraging. Partnering communities have been motivated to engage in CBFM and to begin implementing new forms of management techniques. The most exciting facet of this work has been how effective the SPS approach has been at informing communities about the overfishing crisis they face, and this is the focus of this article. Working with our communications partner, cChange of Fiji, we have found that the blockages to change are surprisingly simple and easy to overcome, using simple but highly targeted messaging.

Communicating for change

J.P. Kotter established an eight-step model for achieving change (1995). The first four steps all focus on communications and can be summarised as follows:

1. Inspire people to change by increasing their sense of urgency for change and making the objectives of change real and relevant.

2. Build a guiding team by getting the people in place with the right mix of skills and social levels, and who are emotionally committed to change.

3. Establish the right shared vision of change to focus the necessary emotional, creative and organisational energy needed to drive change.

4. To create "buy in", involve as many people as possible, appeal to people's needs by communicating the essentials as simply and effectively as possible.

A methodology for achieving change, called the Nudge Theory (Thaler and Sunstein 2008), proposes that the everyday choices that largely determine a society's cumulative impact on the environment are largely instinctive and emotional, rather than being thought through rationally and logically. These instinctive and emotional patterns of behaviour, called heuristic frameworks, save mental energy by making small, everyday choices easy and automatic. These choices are largely inherited without introspection as communal standards from surrounding societies, through tradition, family, friends and church. The Nudge Theory proposes that to successfully manage change, existing heuristic frameworks need to be understood and explicitly addressed, or they will simply absorb programmes of change, as societies continue to think and act heuristically and instinctively.

Heuristic thinking about fishing

Universally, Pacific Island communities are deeply aware of, and concerned about, the decline of marine resources without consciously connecting their own fishing behaviour to their observed changes in the marine environment. They are aware of the symptoms of overfishing: having to go farther afield to fish, fishing in deeper and deeper water, fewer and fewer large fish. They see the foodweb being fish down (Pauly et al. 1998); that is, the large-bodied, higher order predators such as groupers and sharks are disappearing first, followed by the larger parrotfish, snappers and emperors, and then all of the prized medium-bodied species and even the smaller-bodied species, until eventually, only the fish that once no one wanted to eat are left and people start eating what was once considered bait fish. Communities are aware of all of this, but in our experience they do not (prior to our intervention) interpret these events as symptoms of overfishing.

[1] Biospherics Pty Ltd, Biospherics@ozemail.com.au

For them the fish are like the air and water: renewable resources that almost all of us take for granted as we breathe and drink without consciously thinking about their sustainability. For Pacific Island people, fish and fishing are constants in their lives; fish have always been there for food, and people have always fished for food. This is summed up by the Pacific-wide saying of "God will always provide", which means fish have always been there, and presumably will always be there. We find, however, that apart from community elders, most people are generally unaware of the extent to which new fishing gear – and the ability to keep fish cool and transport them to market – have changed traditional fishing practices, let alone the degree to which this has allowed fishing pressure to escalate. Prior to our education programmes, we found that community members generally associate observed declines in local resources with other environmental changes they see occurring, or hear about. Sedimentation from building the ring road in Palau, unsustainable forestry practices in Solomon Islands, the destruction of juvenile fish and shellfish habitat from mangrove cutting, and previous destructive fishing practices and coral bleaching caused by climate change in many places. It is not that these many factors are not having an impact, but the primary factor that can most effectively be addressed by communities to address food security and maintain biodiversity is the unrecognised effect of overfishing. The fact is, overfishing is driving the loss of biodiversity and food security across the tropical Pacific, and its effect is being exacerbated by the loss of habitat caused by the other factors.

The Pacific way of thinking about fish is primarily concerned with not wasting food as encapsulated by the widespread saying that "the smallest fish have the sweetest meat", which is the metaphoric equivalent of the expression that "the sweetest meat is closest to the bone". Both sayings exhort (young) people not to waste the smallest or last bit of meat and encourage a "waste not, want not" way of thinking. So, no small fish is ever released to continue growing and start breeding, because that would be a nonsensical waste of good food.

Changing the Pacific way of thinking about reef fish

With the communications materials we have developed with cChange, we have created a sense of urgency and have built consensus within communities using simple imagery to make the connection between the changes being observed and the central cause of overfishing, thereby enabling communities to correctly attribute the observed changes to overfishing. Our simple graphics explain how: 1) traditional fishing techniques have become vastly more effective over time, 2) human populations have grown considerably (meaning there are more mouths to feed), 3) the incentive to fish has increased due to the development of cash-based societies, and 4) the penetration of consumer goods and access to markets have grown with the availability of ice, coolers and modern transport.

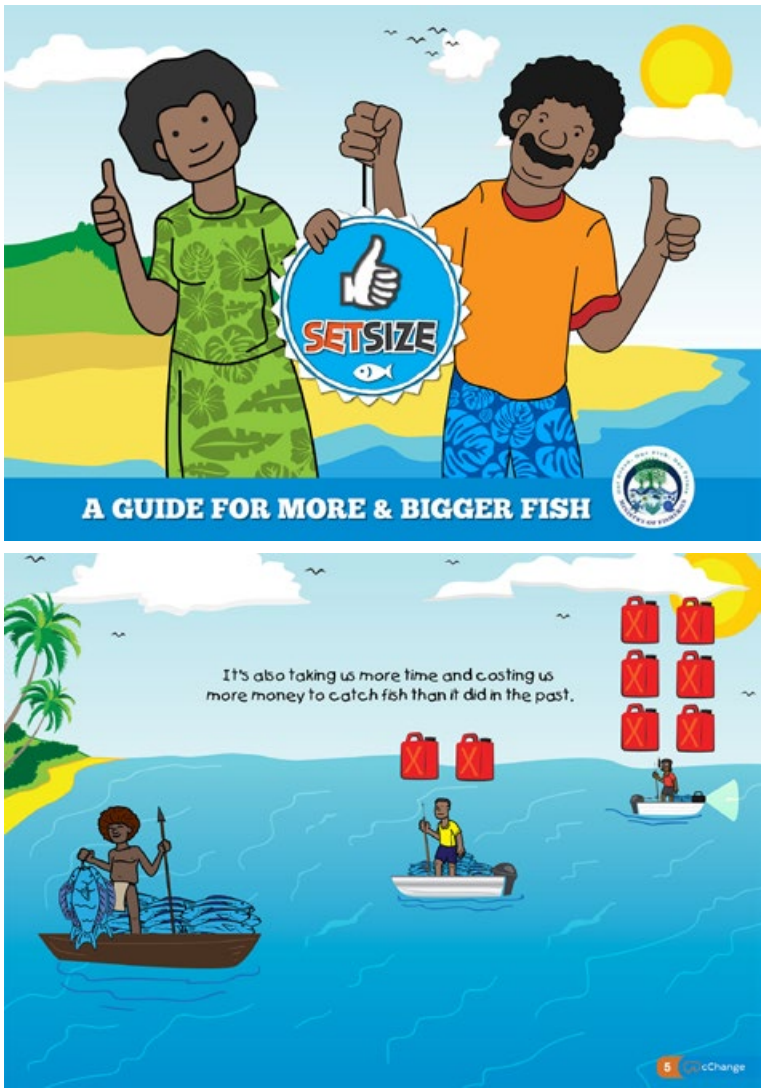

Figure 1. The cover and a page from *A guide for more and bigger fish*, one of the communication tools developed with cChange. Image: cChange

Typically, towards the end of an initial morning talk with a community, we break our workshops into small groups to discuss:

1. Which of their species are changing the most in terms of declining fish size, needing to go farther afield to catch them, declining catches and catch rates; and

2. Which species are most important to them, or would be the worst for them to lose.

In terms of adult education, this exercise serves a useful purpose by giving participants time to internalise and apply the concepts they have just learned to their own experience, thereby affirming with their community what we are teaching. As the break out groups report on their discussions to the workshop, with the help of guidebooks, we match scientific fish names to local names, and stories of fishing down the local foodweb. Through this process, we

begin to prioritise species that can be specifically identified and monitored by communities, and a sober appreciation of the overfishing crisis facing each community settles in. Fascinating, but sad, insights are provided into the extent that local foodwebs have been eroded. North of Madang in PNG, where a good day's catch now looks like a smash and grab raid on a marine aquarium, we were told that mangrove jack (*Lutjanus argentimaculatus*) was an important customary species for traditional feasts on during the annual initiation of girls into womanhood. The timing of that ceremony was based on the season when that species came inshore and could be caught in abundance, but is has not been caught in over 20 years, and the current cohort of young men have never caught, seen nor tasted one. Today, it is only known through oral tradition. We have also received eerily similar accounts from numerous communities of how large aggregations of Chinamanfish (*Symphorus nematophorus*) formerly came into the shallows on certain moons to attack land crabs, releasing their larvae into the sea. Traditionally, a handful of fish would be speared each moon, and were so highly prized that some communities reserved them for high ranking elders. However, in each case, after the first community member acquired a net and discovered that the entire aggregation could be encircled, it took just three moons to wipe out the aggregation. In each place, this often-told story ends the same way; for the last 20–30 years this fish has not been seen, or an occasional individual fish is seen rarely.

We now find that with these report-back sessions we can diagnose the extent to which local foodwebs in each place have been fished down. Is a community still concerned about the large-bodied groupers and parrotfish (e.g. in Macuata, Fiji), or is it mainly worried about small-bodied emperors and snappers (e.g. in Palau and Tavua, Fiji) or the loss of small wrasses and damselfish (e.g. in Madang, PNG)? After the report-back session, we crystallise for workshop participants the insights gained from the working groups with a series of images portraying the fish down of the foodweb – with images of the main species on plates, and the number of fish on plates diminishing in successive images – while we rhetorically ask each community where they are in this progression, and where they will end up. The last image in this series simply portrays a tin of fish sitting on a plate.

Developing a simple vision for change

At this point, the community is invariably asking about solutions, which as with most sustainability issues, is to change old ways of thinking and behaving (Hardin 1968).

We then begin to directly challenge their old heuristic way of thinking about fish (i.e. that the smallest fish have the sweetest meat), by describing how they think differently about the natural productivity of their gardens. Common sense dictates that in gardens, small plants and animals are nurtured until they have grown big, have ripened and have reproduced sufficiently to ensure future generations of plants and livestock. For this we generally use imagery of a pig farm that the World Wide Fund for Nature (WWF) in Fiji helped communities build to fund community schools. Piglets were bought and nurtured so that they grew up. The communities did not kill and eat the piglets, even though their meat would have been sweet, instead they were reared to produce three or four litters to stock the farm with, before being used for food themselves. In the context of gardens this is common sense, but while reefs are "marine gardens" they are treated differently, and it is considered a virtue to catch and eat a fish before it can breed and increase the population on the reef.

This analogy works powerfully in all settings, and can be adapted to the different cultures and traditions of fishing communities; for example, using chickens instead of pigs for Seventh Day Adventists, Muslims and South American communities; goats in Kenya; and coconuts or other fruits with communities north of Madang (PNG) and in Buddhist Sri Lanka. Whichever variant is used, we invariably see workshop participants opening their eyes wide, nodding their heads and murmuring affirmation, as the illogicality of their old heuristic framework becomes apparent, and their need for change is perceived.

In our workshops, this analogy brings us naturally to the question of "how much breeding is enough?", which we address by getting communities to think first about human couples who require, on average, about two surviving children to replace themselves and to keep the population stable (actually 2.1 surviving children per couple to make up for adults that do not have children). Above this replacement level, human populations grow, and below this level without immigration, they decline. We equate this concept to the fisheries concept of spawning potential ratio (SPR), which with communities we refer to simply as spawning (Mace and Sissenwine 1993; Walters and Martell 2004). Unfished fish live out their natural lives and complete 100% of their natural potential for reproduction or spawning. Fishing shortens their natural life span and reduces their potential for spawning below 100% of the natural unfished level. From scientific studies (Mace and Sissenwine 1993) we know that around 20% SPR is the replacement level for fish, just as 2.1 children per couple is for humans. Below 20% SPR, fish populations become increasingly likely to decline through the lack of young fish (recruitment overfishing), but above 20%, spawning populations can rebuild depleted populations and restock reefs.

On this basis, we inform our partnering communities that our breakthrough in data-poor fisheries assessment and management can be used to help them understand how much "spawning" is currently occurring in their fish stocks, and to develop simple management strategies to maintain spawning at sustainable levels. We then ask communities if they are prepared to work with us to initiate community-based SPSs and, if they are, proceed with teaching them how

Figure 2. Learning to measure fish in Solomon Islands. Image: Andrew Smith

to measure the length of fish (Fig. 2) and macroscopically inspect them to determine whether they are immature or mature (Fig. 3). In many communities, we first engage workshop participants in constructing fish measuring boards out of plywood and old measuring tapes previously used for laying out coral reef transects, so that they can begin collecting SPS data (Fig. 4). Again, within the context of adult education methodologies, and regardless of the value of the data community members may collect, these hands-on activities usefully consolidate the concepts being taught, and enable community members to validate the information for themselves. We invariably find that community members are extremely interested in acquiring these skills, particularly the ability to examine gonadal status and determine whether fish are mature or immature. To our surprise, only a very few of the most expert artisanal fishers have prior knowledge about this. For most of our workshop participants, this is entirely new, informational and transformational for their understanding of local overfishing.

To illustrate the great interest that community members have in these matters, a Fijian WWF staff member working on a different project told us he had visited a remote island in Macuata Province some months after we had trained community fish measurers in a central location, and observed that every evening when the men gathered to drink kava, their main topic of discussion concerned how the observer gauged the maturity of fish, and the gonadal

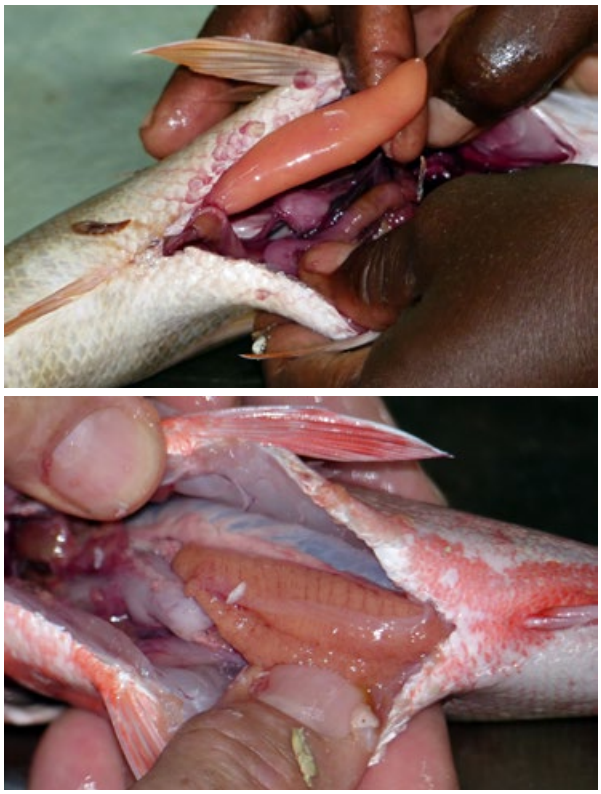

Figure 3. Learning to evaluate female gonad maturation stages is part of the training. Top: developing, bottom: ripening. Images: Andrew Smith

Figure 4. Making a fish measuring board in Fiji.
Image: Jeremy Prince

status of the fish he was observing in their catches. Similarly, in the Western Province of Solomon Islands where, with WWF, we have been measuring the fish catches brought in by surrounding communities, the communal examination of fish has engendered great discussions between the night-time spearfishers, who catch predominantly immature fish, and the hook-and-line fishers who catch a much higher proportion of mature fish.

Informing CBFM with spawning potential surveys

The results of the SPS methodology are easily turned into simple management advice for communities and governments that can then be used to conserve sustainable levels of spawning potential and maintain optimal harvest levels.

We have developed rules-of-thumb for setting minimum size limits at a size that ensures all fish complete at least 20% of their spawning potential before being caught. If all fish complete at least 20% of spawning potential, and most fish get to survive some time longer, then on average the stock of fish will achieve 30–40% of spawning potential, an internationally accepted target level for sustainability. In Fiji, the size at which fish reach 20% SPR is being called the "set size" of a species, after the Fijian tendency to use the word "set" the way Anglophones use "OK"; in PNG pidgin, the communities we work with refer to this as "rit mak" (right mark). For snappers, emperors and parrotfish, the rule-of-thumb for estimating the size at which 20% SPR is achieved is simply to multiply by 1.2, the size at which a species matures (the size at which 50% of the fish in a size class are adults).

Of course minimum sizes will not work with some species and fisheries; nets catch and kill a wide range of sizes, the swim bladders of hook-and-line-caught fish hauled up from the depths inflate and die if returned to the water on the surface. For these fisheries it will be necessary to adaptively manage the size of fish being caught by trial and error over time by adjusting the way the fishing is done to protect enough of the adult fish. The size of fish being caught can also be managed by communities by prohibiting some fishing techniques, setting minimum sizes for net mesh and hooks, regulating where and when fishing occurs, and by controlling how much fishing takes place, by adjusting the length of closed and open fishing seasons, by controlling the number of fishing permits issued, or by setting daily trip limits. All of these measures can directly and indirectly be used to manage the size of fish in a stock. With our approach, a target composition of sizes in the catch can be estimated for any stock – this is the size composition expected for the stock when the target 30–40% of SPR is maintained. Communities can then compare their own catches to the target size composition: if the sizes in their catches become smaller than the target indicating insufficient spawning potential is being maintained, they will know they need to implement more management measures (e.g. larger net mesh and hook sizes, shorter fishing seasons, fewer fishing permits, lower daily trip limits). Alternatively, when the size of the fish in their catches become larger than the target size, catches might be increased a little by relaxing management.

With these simple techniques, adaptive, science-based CBFM is now possible for communities. We are already seeing our partnering communities intuitively adopt the methodology and these concepts to evaluate their stocks and inform discussions within their communities about trialling new forms of management.

Early signs of success

Although it is still too early in the process of developing and implementing spawning potential surveys to be able to have achieved clear improvements in the abundance of fish stocks, some first signs of success are apparent, at least in changing community attitudes to the overfishing crisis and in motivating changed behaviour.

Palau

In Palau, with The Nature Conservancy (TNC) and the two northernmost states of Kayangel and Ngarchelong, we began in August 2012 with an initial training course that ended with a week of fishing, during which trainees measured about 900 fish, of which 65% were observed to be immature. By June 2013, some 2,089 fish had been sampled and six initial assessments completed. The results of

the assessments were reported on to the communities in each state, leading up to a joint summit meeting of the two states, attended by community members, traditional male and female leaders, and state and national politicians. Participants at the meetings agreed that the two states should move towards the coordinated implementation of new fisheries management laws. The mood of these meetings was summed up by Harper Skang, advisor to Ngarchelong's State Governor, who said, "We knew the house was burning down but did not understand why. Now that we do, there are many things we can do about it."

Steven Victor, Director of TNC's Micronesia Program, wrote to Dr Carmen Revenga, TNC's Sustainable Fisheries Director that:

- The method was well received in Palau and we have been able to collect enough data for some species that we can begin to discuss management options.
- It fits well with community-based fisheries management.
- I found the technique to be simple so that every fisherman can implement it. The data analysis seems very straight forward.
- The results just reinforced what fishermen knew about fish decline and made them understand how the fishing effort is leading to the decline.
- Basically, they realise that they are not giving the fish a chance to reproduce and if they continue to fish the way they do, then there will be no fish for them.

By September 2013, some 3,711 fish had been measured and 13 assessments developed, and by the time the initial sampling programme was completed in January 2016, 10,618 fish of 153 species had been measured, allowing us to: 1) evaluate the spawning potential of 18 species comprising >70% of the catch, and 2) provide advice on establishing minimum size limits.

New fisheries management laws – including temporary bans on catching groupers, size limits for an initial seven species and licensing of fishers – were legislated by Kayangel State in 2016 and Ngarchelong State in mid-2017, and a broader national discussion initiated about changing management arrangement.

In Palau, the Packard Foundation funded the Palau International Coral Reef Centre to conduct extensive baseline, stereo-video surveys of the country's northern reefs in late 2015, which were repeated for the first time during the second half of 2017. The results suggest that already some slight improvements in fish biomass and size have occurred on the reefs closest to the largest communities. Too soon to have resulted from the new legislation, if real and not just statistical anomalies, these early survey results may support community claims that prior to the legislated changes coming into effect, at least some fishers began to voluntarily catch and release fish below the proposed minimum sizes.

In October 2015, while my colleague Dr Steven Lindfield and I were fishing with a group of Palauans to collect gonad samples, we requested that they release fish that were smaller than the proposed minimum size limit. Much discussion ensued about the fact that it was the first time the Palauans had ever caught and released fish, but they acknowledged that it "felt good". Recently, in early November 2017, I was again fishing with a group of Palauans, this time for a fish barbeque, and was quietly thrilled to see them spontaneously releasing small fish without comment, as if it was now entirely routine.

Fiji

In Fiji, we began with WWF Pacific and 12 communities in the northern Province of Macuata on Vanua Levu as partners, and additional support from New Zealand Aid. With an initial workshop held in the chiefly village of Naduri in October 2014, we trained a fish measurer from each community, built measuring boards, and prioritised 20 species. By mid-2016, some 5,226 fish had been measured and, on that basis, initial five stock assessments were completed. In November 2016, the assessments were reported to the partnering communities who agreed that fishing for camouflage grouper (*Epinephelus polyphekadion*) and brown-marbled

Figure 5. More than 10,000 fish of 153 species have been measured in Palau, allowing the spawning potential of 18 species to be assessed. Image: Andrew Smith

Figure 7. Mathew Mirak with his fish measuring board and fishing canoe, Papua New Guinea. Image: Jeremy Prince

grouper (*E. fuscoguttatus*) would be banned during 2017 prior to the implementation of an initial minimum size limit in 2018.

In November 2016, with WWF, we also began working with the large urban community of Tavua on the north coast of Vitu Levu. By June 2017, with the data collected by community members and the Institute of Applied Science at the University of the South Pacific, it was possible to complete an assessment for the thumbprint emperor (*Lethrinus harak*), which is now the main species caught by that community. Our reporting of that result lead the Tui Tavua to declare an immediate six-month closure for that species and the implementation of a minimum size limit that will come into effect in 2018. In September 2017, WWF opened a third site in the Yasawa Islands northwest of Vitu Levu, and the community there began measuring a list of priority species. Parallel to WWF, the Wildlife Conservation Society has also been working with communities in Ba at the western end of Vanua Levu, measuring four main species of fish and mud crabs.

This grassroots work with the communities has been accompanied by a growing national awareness of the need to reform reef fish management. Within the Ministry of Fisheries, a Coastal Fisheries Management Division has been created to parallel the Offshore Fisheries Management Division, which has been in existence for many years. Community complaints that markets were not complying with the bans implemented in 2017 galvanised Ministry of Fisheries staff to work with the police and NGO legal advisors to resolve legal issues previously interpreted as preventing the enforcement of fisheries regulations in the market place. It is hoped that it will prepare the way for more effective enforcement of the first minimum size limits to be implemented in 2018.

In September 2017, NGO partners reached an agreement with senior Ministry of Fisheries officials and the Minister on a two-year timeline to use the results from the SPS monitoring programmes to reform and re-implement the existing system of size limits that has never been enforced.

Papua New Guinea

In March 2015, north of Madang on the north coast of Papua New Guinea, with staff from WWF PNG and funding from WWF, Australian Aid and John West, we provided an initial training for a few community members and provincial fisheries staff. By June 2017, approximately 4,000 fish had been measured and recorded using local names; at the time of writing, only 2,551 of these records had been matched to scientific names (152 species). The data collected are of extremely high quality, enabling good preliminary estimates of size of maturity to be developed for eight species and initial assessments of three species. Due to the extremely narrow reef area and large (human) coastal population, the marine foodweb in this area is extremely depleted, despite the basic fishing techniques used from single dugout canoes. The small species of emperorfish and snappers that normally dominate the catch in heavily fished areas have become extremely rare (<1% of the catch), and the main species being caught are damselfish and small wrasses. Fishers there tell me that they "no longer fish for meat, but now fish for soup".

Unlike Palau and Fiji, to date there has been very little buy in by government agencies but the community work is being coordinated by an extraordinary community member name Matthew Mirak (Fig. 7) who has trained and now supervises six fish measurers in neighbouring communities. Initially annoyed at being sent along to our training because it did

not teach him to fish more effectively, Matthew went on to deeply assimilate the SPS concepts. He spontaneously converted our pig analogy into a calculation of his community's yield of coconuts based on the number of trees it owns. He compared this to how many were being eaten, on average, at each meal, proving to his elders they would never have excess for making copra and earning income, unless they controlled consumption. Using this analogy, he moved on to convincing his community that it also needed to manage their fish, winning community agreement in the first year for a daily bag limit on rabbitfish during their spawning season, the timing of which he determined from his examination of gonads. Having been sensitised to the overfishing issue, when the run of rabbitfish through the spawning season was noticeably poorer than in previous years, the community moved quickly in the second year to agree to a three-year fishing ban, which they intend replacing eventually with a minimum size limit.

In the absence of government buy in, but with the support of WWF, fish measurers and their communities have begun discussing how they can work through local government frameworks to achieve the systemic reform they are now thinking is needed.

Solomon Islands

In February 2014, we began working with WWF Solomon Islands around Ghizo Island in the Western Province, and were again initially supported by WWF Australia and Australian Aid and John West, but now also being partially funded by the European Union and USAID. Beyond the challenges confronted in every situation, this project faces a particularly diverse mix of communities using a wide range of fishing gear and non-specific names for a particularly diverse reef fish fauna. Rather than develop community-based fish measurers, it has been necessary for the WWF project team to conduct most of the fish measuring with fishers who bring coolers of fish to be measured on their way to the market in return for fresh ice and a token payment. By October 2016, some 5,962 fish (224 species) had been measured on the way to market and nine species were assessed and their sizes estimated.

Beginning in 2017, WWF began working with communities around Nusatuva, on the south coast of neighbouring Kolombangara Island, measuring about 1,000 fish during the course of the year. While only a couple of hours by outboard-powered boat from Ghizo Island, it is beyond

Figure 8. In Solomon Islands, the WWF project team first conducted fish measuring around fish markets. Image: Andrew Smith

easy access to the Gizo fish market (most people still sail or paddle). Consequently, the state of the Nusatuva foodweb, which is still dominated by large-bodied species of groupers, snappers and parrotfish, is completely different from that around Ghizo, where the population has fuelled fishing pressure, which in turn has eroded the foodweb down to predominantly small- and medium-bodied emperors and snappers.

Buy in by both provincial and national government has been slow, but since presentations to a National Environmental Symposium about the project, levels of interest have increased, and negotiations are underway for incorporating the approach into the fisheries course being developed by the Solomon Islands National University. The Solomon Islands communities we work with have not yet made any decisions about implementing management trials. The issue of fishers from outside their communities encroaching on their fishing grounds, and not complying with agreed management measures, looms larger over all discussions to date. An association of fishers has been formed to foster intercommunity dialogue about change, and the provincial government's management committee is supportive of incorporating agreed to measures into regulation, but their capacity for enforcement is weak.

Looking ahead

In developing the spawning potential surveys methodology, we have been asking communities in each country to work with our NGO partners to conduct community-based data collection programmes for assessing the spawning potential of their main stocks and to develop species-specific management advice to inform discussions on trialling new forms of management. In addition to collecting the data needed to develop the approach, we have discovered that the community-based monitoring programmes are an extremely effective communication strategy, allowing people to see for themselves that much of the fish they catch have never bred, and through their own perception of overfishing, become viscerally committed to changing current fishing practices.

But in the big picture, this cannot be the final form of our methodology. There are simply too many communities, too many lagoons, and too many small-scale fish stocks to imagine that conducting community-based monitoring programmes with every community can offer a broad- scale solution to the depletion of the Pacific's reef fish stocks. Nor is it pragmatic to think that every species in every lagoon can end up with its own size limit or size composition target. Our developing SPS approach must lead to more generic solutions that can be spread throughout the Pacific with modern community technologies and passed by word of mouth between neighbouring communities. To this end, we think of our current partnering communities as "beach heads" in the region, giving us a toe-hold into the region and helping us develop our methodology, and providing local champions and some success stories to work with as we look to stepping up the approach for the broader region.

We are using the local estimates of size of maturity gifted to us by our local partners, along with available published estimates, to cluster all the main reef fish species into groups that can be covered by a limited number of size limits or targets (probably about 10). In Fiji, with an eye for branding and cognizant of Fijians' regard for royalty, the partners are already calling this the "Prince set size system" and have committed to finalising an initial version in the first half of 2018. From the literature and our own studies, we can already see that size at maturity varies between countries (mainly it appears in relation to latitude), which probably provides a proxy for ambient water temperatures (Pauly 2010). The initial version of the Prince set size system will be something like a Pacific-wide average system tuned towards Fiji, which will be better than nothing for any country, but probably a bit too large for countries closer to the equator and too small for higher latitude island groups. But the meta-analysis we are developing will enable us to study how fish size varies across the Pacific, and I am confident that within the next 1–2 years we will be able to provide a means of adjusting the Prince set size system up or down in relation to countries latitude and water temperature in a way which adapts for each country, releasing us from the need for conducting community-based sampling program in each location. Nevertheless, teaching community members to look inside a fish to validate the approach for themselves will remain an essential part of our overall communications strategy.

And while introducing a system of minimum size limits is likely to remain an important initial step in our strategy, it cannot be the only message put forth. Increasingly, the broader range of fisheries management measures successfully developed by our "beach head" communities will need to be incorporated into our ongoing communication strategy: establishing minimum mesh and hook sizes, regulating fishing methods, designating fishing places, setting daily catch limits. In terms of empowering the transmission of SPS through the Pacific's scattered and remote communities, we envisage that underwater video of recovered reef fish populations, both before and after, along with the experience and testimony of our local champions will be essential ingredients of our long-term communication strategies. This body of information will need to be made widely available in hard copy forms for communities that have no access to power or the Internet. We are starting to see smart phones being used to share video clips in the remote communities we work with, and so breaking down our messages into short "memes" that can easily be shared could encourage extensive transmission of information.

On the basis of their experience to date, the team of collaborating partners that has been fostered by the Packard Foundation's Western Pacific Program since 2012 are confident that the SPS approach supported by the communication

materials is on the verge of creating a solution to the reef fish crisis that has been spreading across the Pacific. The Western Pacific Program originally intended to support the development phase of SPS and some aspects of a roll-out campaign to extend it through the region. Recently, however, the Packard Foundation's board decided to close the Western Pacific Program and stop funding work in the Pacific Islands region by 2020. Most, but probably not all, of what is envisioned above will be completed and available by that time, but it is our hope that by seeing the potential in this approach, other donors and partners will pick up where the Western Pacific Program leaves off, completing any unfinished aspects of the SPS communication strategy and investing in its implementation across the Pacific.

The communications and assessment materials referred to in this article are freely available from the author at biospherics@ozemail.com.au or the website www.biospherics.com.au.

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Pacific Community, Fisheries Information Section, BP D5, 98848 Noumea Cedex, New Caledonia
Telephone: +687 262000; Fax: +687 263818; spc@spc.int; http://www.spc.int