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Editorial

A few years ago, while sheltered in a safe anchorage listening to the approaching storm, lightning struck our boat. A white lightning bolt went through the cabin and all lights went out. Once the shock of the first few seconds had passed, we took an inventory of the damage. Electrical power and electronics were out of order, but the rigging looked fine and the hull stayed afloat, even if burned in a few places. In fact, once the boat was back in port and dry-docked, it took us weeks to identify and repair the countless consequences of this incident, as lightning had struck the farthest reaches of the boat, including electronics that were disconnected at the time of impact. We even discovered two small holes in the hull, just at the waterline, through which the lightning had dispersed into the ocean.

Similarly, it will likely take months, if not years, to identify the myriad consequences of the COVID-19 crisis that has been affecting the world since the beginning of 2020. From a health perspective, our region has been relatively unscathed, with only a few cases, thanks in part to the rapid closure of borders. But what struck me, when reading the articles in this issue about the possible impacts of COVID-19 on our fisheries, was the variety of possible or proven consequences, and especially the fact that no one is spared, not even remote coastal communities, which, despite everything, depend on trade that can no longer take place because seafood markets are closed, or means of transport are at a standstill (see articles by Neville Smith on p. 2, Francisco Blaha on p. 15 and LLMA et al. on p. 19).

Another surprising consequence of the COVID-19 crisis has been the return of many urban dwellers to their villages when the sharp economic downturn affected the labour market. Additional resources will be needed to ensure food security for these people. The pressure on natural resources will, therefore, increase. Sound management of these resources has never been more important. The challenge is immense, it will take time, but the region has often shown its incredible capacity for resilience.

Aymeric Desurmont, *Fisheries Information Specialist, SPC*

Offloading the catch from a USA-flagged purse seiner fishing in the western Pacific. (image: Francisco Blaha)



How the COVID-19 crisis is affecting Pacific Island fisheries and aquaculture

The following article has been adapted from a transcript of an interview with Neville Smith, Director of the Pacific Community Fisheries Aquaculture and Marine Ecosystems Division that took place on 20 March 2020. At that time, New Caledonia was under strict confinement, meaning that all Pacific Community (SPC) staff had to work from home.

The Fisheries, Aquaculture and Marine Ecosystems (FAME) Division of SPC deals with three different sectors in the Pacific Islands region, and the COVID-19 crisis is affecting each of these sectors differently.

The tuna sector consists of large, industrial tuna fisheries; the coastal fisheries sector, which is at a much smaller scale and operates at the community level, impacts many more people in the region; and the aquaculture sector, which is split into food production for local consumption and high-value aquaculture production for export.

The main impact on the tuna fisheries sector is the ability of people to move about and keep the fisheries going. For example, fisheries observers are unable to travel and embark on fishing vessels. In addition, many ports are currently closed. There are also people-related issues, such as the observers with families at home, and these observers need to be repatriated.

At the same time, countries must find ways to keep their fisheries operating because this sector is crucial for the region. The tuna industry is worth considerable income for countries, and with tourism currently shut down, it is critical that this money continues to flow into the region.

The impact on coastal fisheries is also important. With the shutdown of tourism and the related loss of work, many people move away from urban centres, from their jobs, and go back to their villages. This means that more people are active in subsistence and artisanal fishing, resulting in increased pressure on coastal resources, which were already under pressure. In the longer term, our challenge of ensuring the sustainability of coastal fisheries will be greater.

For the aquaculture sector, some of the key issues relate to people's movement and the transport of products, but this crisis also significantly increases the demand for food production in order to address food security issues.

What are the risks associated with this situation?

The reliance on tuna fisheries in the region is significant, particularly within SPC member countries that are Parties to the Nauru Agreement (PNA).¹ One result of the COVID-19 crisis could be a significant drop in the gross domestic product of PNA member countries.

Another key risk relating to tuna fisheries is the flow of information. With fisheries observers no longer on fishing vessels, there has been a change in the flow of data available to us for future fisheries management. This will not be a problem this year because the information we are using for the 2020 tuna fisheries assessment is based on data from 2019. For 2021 and beyond, however, it will potentially be an issue, depending on how long the disruption to fisheries lasts.

For the aquaculture sector, some of the immediate potential issues pertain to the supply of feed. For instance, how do we ensure that feed for tilapia production continues to flow into the region? This could become a significant issue because a lack of feed could lead to a decline in production from this sector. Moreover, it occurs in combination with a potential reduction in the availability of coastal fish, due to increased pressure on these resources. These two factors could contribute to exacerbating any potential humanitarian crisis in the region, with respect to access to food supplies, and that is a particular concern to us.

How SPC is helping to support these sectors

In the tuna sector, SPC continues to provide scientific and technical advice to the Pacific Islands Forum Fisheries Agency (FFA), which works on the management of tuna fisheries in the region. Very regular meetings are held with FFA, and with its member countries across the Pacific, and this integral piece of work continues to happen at a fast pace.

¹ The Parties to the Nauru Agreement (PNA) is a subregional agreement on the coordination of management of tuna fishing in the exclusive economic zones of PNA members: Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Palau, Papua New Guinea, Solomon Islands and Tuvalu.

SPC is also in the midst of preparing the annual tuna fish stock assessments for 2020. The team continues to work remotely on these assessments, which will still be delivered on time, just as they would have been in a year without the COVID-19 crisis.

In addition, SPC is helping members meet their annual reporting requirements for tuna information, which they must provide to the Western and Central Pacific Fisheries Commission. This is happening right now, with a two-day online workshop with members, using the online communications tool Zoom. This workshop is going very well, and there are over 70 participants.

In the coastal fisheries sector, SPC is focusing on re-scheduling work for later in the year, but is also trying to be innovative in how it does certain tasks: What training can we deliver online? What are the other tasks that we can complete right now? For instance, SPC is updating manuals on how to utilise fish aggregation devices in national fisheries, and developing new data collection apps that can be delivered electronically to fisheries staff to help them better assess the impacts of fishing, supported by online training videos.

In the aquaculture sector, SPC is actively working with countries to ensure there is a continuous flow of aquaculture feed coming into the region, and that this feed and hatchlings

can continue to move from areas outside the lockdown to areas under lockdown inside countries.

How SPC keeps the work going

In terms of keeping FAME working, one of the key priorities for us is communication. We have used online communications tools previously, but we have had to change our use of online tools, and in particular the frequency of our online meetings. That obviously creates some challenges for staff, including fatigue with too many meetings, and too much time staring at screens. SPC has also been improving its approaches to communicating through both formal and informal networks in the region to ensure we are aware of any new or changing developments, and to help disseminate information, especially where fisheries officers are also in lockdown.

The FAME team has had to become quite inventive in order to smoothly handle the transition from working in the office or in the field to working online. It takes quite a bit of energy, and an important task for the FAME leadership team has been to make sure people's energy levels remain high, that staff stay motivated and focused on the work so that SPC can continue delivering services to its member countries and territories.

During the COVID-19 crisis, many seafood markets had to limit vendors selling at the market or close during lockdowns. Ongoing curfews are also limiting the ability of some fishers to travel into and sell at major market centres; Suva market, Fiji. (image: Sangeeta Mangubhai, WCS)





Supporting fisheries rehabilitation in Tonga's special management areas by promoting alternative fishing methods

Watisoni Lalavanua,¹ William Sokimi,¹ Siola'a Malimali,² Sione Mailau,² Amanda Le'ota² and Jeff Kinch¹

Introduction

In many Pacific Island countries and territories (PICTs), human populations are increasing, creating additional pressure on the coastal fisheries resources that they depend upon (Bell et al. 2009). This problem is also evident in the Kingdom of Tonga (Sun et al. 2011). To address this issue, PICTs need to seek out ways to ensure the sustainability of their coastal fisheries resources. One possible option is through co-management arrangements between government, other stakeholders and communities (Likiliki 2006). Community-based fisheries management (CBFM) is where communities take on the primary responsibility for managing their coastal fisheries resources. In the case of Tonga, a co-management programme is in place that supports CBFM through the Tonga Ministry of Fisheries (MoF) Special Management Area (SMA) programme (Malimali 2013; Gillett 2009, 2017). The use of SMAs allows communities to set their own management rules and take responsibility for enforcing them.

Special management areas

In Tonga, fisheries operate under an open access regime whereby there is no community ownership and all coastal fisheries resources belong to everyone. MoF has the overall responsibility of managing Tonga's fisheries, but understands that communities also have an important role to play, hence the SMA programme. The SMAs give communities a sense of ownership and responsibility for the management and control of coastal resources in the immediate waters of their village area.

In 2002, communities were provided with the legislative mandate – through the Tonga Fisheries Management Act – to manage their coastal fisheries resources by establishing SMAs (Malimali 2013). The first SMA was established in 2006 in the island of 'O'ua in the Ha'apai group and, to date, 42 communities in Tonga now have established SMAs. In May 2019, MoF, together with other partners including SPC, implemented a national SMA lessons learned workshop (Muron 2019). One of the key recommendations from this workshop was the need to assist SMA communities in reducing pressure on coral reef fisheries through alternative fishing practises.

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In support of SMA communities, MoF, with the support of the Pacific Community (SPC), conducted a two-week, small-scale fishing operations (SFO) course in February this year for SMA communities to learn new fishing techniques that target offshore pelagic fisheries resources. The rationale behind this is to move fishing efforts away from coastal fisheries resources to allow them an opportunity to rebuild.

The SFO training was targeted at local fishers from several SMA communities from the islands of Vava'u, Ha'apai, Eua and Tongatapu. MoF fisheries extension officers also participated. In total, 21 participants (16 males and 5 females) attended the SFO training.

Fishing practises

The people of Tonga have a rich fishing tradition. Both women and men target various marine areas using a variety of techniques to catch fish, harvest molluscs, invertebrates and seaweeds (Kronen 2002; Halapua 1982).

To understand current fishing practises, SMA community members who attended the SFO training were asked to identify the current fishing methods they use, target species, who uses those methods and if there are any impacts perceived by fishers in using those methods (Table 1). Apart from trolling, which mainly targets pelagic fish such as tunas, wahoo and mahi mahi, the most common fishing methods used by attendees were spearfishing, handlining, gillnetting and gleaning, which are used to target reef fish and invertebrates.

Small-scale fishing operations

The SFO training raised trainees' awareness on how to fish safer, fish better, fish smarter, fish comfortably, fish economically and fish sustainably. As most attendees fish within their immediate coastal waters, sea safety was a major component of the SFO training, especially as the emphasis is to get fishers to go offshore and target pelagic fish using a variety of horizontal and vertical fishing methods, including single and multiple lure trolling, vertical long line, chum bag *palu abi* (scatter bait) and spreader rod jigging.

Small boat safety at sea included appropriate planning of a fishing trip, noting the weather and sea conditions, ensuring a first aid kit and other emergency equipment was prepared and onboard, managing work space, arranging fishing gear, working with sharp-edged and pointed tools, proper loading conditions, responding to different emergency scenarios (e.g. swamping, grounding, engine breakdown, leak, collision), how to safely board fish, and the type of boats to use (these have to be certified and classed as suitable for offshore fishing).

Training was also provided on developing a set of standard operating procedures for a fishing trip, including the use of appropriate tools and accessories, wearing suitable clothing for different weather conditions (e.g. being protected from the sun with hats and sunglasses, having rain coats handy, using gloves), always having an overhead shelter, choosing the optimum time to go fishing (i.e. there is no point going fishing when you expect rough seas), picking target species to suit market demands, and keeping boat(s) clean and the work area clear at all times.

Financial planning was also part of the SFO training, with simple examples of how to keep financial records, monitor income and expenses, keep catch records, keep up insurance and loan repayments, and other matters.

Finally, fishing sustainably involves an awareness of how to release undersize fish using appropriate release methods, releasing non-target species, changing fishing spots frequently, not fishing for target species during their spawning season, stowing fish on ice or refrigerating to 0°C to keep retain quality, and catching only what you can retain under quality conditions.

To build attendees' capacity and ensure they understood the methods, gear construction was an interesting aspect of the training. Attendees were provided the opportunity to learn about different hook sizes and target species, the various breaking strengths of monofilament line, appropriate sinker weights, and working depth for the floats needed. Attendees were also taken on two fishing trips to trial fishing gear that they had constructed and test new fishing methods.

Conclusion

While the SFO training provided fishers from several SMA communities with the ability to target offshore pelagic species, this cannot be a one-off activity. Further support to SMA communities is required by MoF, with the support of SPC, to ensure that the benefits of the SMA programme are realised for each SMA community. The future of Tonga's coastal fisheries resources is at stake as well as the people that depend on these resources. An important activity that is required is future monitoring to determine if the skills and techniques imparted by the SFO training have been taken up by fishers in the SMA communities. Monitoring of SMAs is complicated, but simple methods based on perceptions and complemented by more rigorous assessments (see Gillett 2017; Webster et al. 2017) can contribute to highlighting the important relationship between MoF and SMA communities as they continue to manage their coastal fisheries resources in a partnership of co-management and CBFM.

Table 1. Small-scale Fishing Operations training attendees' perceptions of the fisheries in their area.

Place	Spearfishing	Handlining	Trolling	Gleaning	Gillnetting	Fish traps
Ha'apai	Who uses?	Who uses?	Who uses?	Who uses?	Who uses?	Who uses?
	Everyone	Everyone	Everyone	Everyone	Everyone	
	Target species?	Target species?	Target species?	Target species?	Target species?	Target species?
	Parrotfish Unicornfish Surgeonfish Rabbitfish	Snapper species	Wahoo Mahi mahi Tuna	Shellfish Invertebrates	Scads Mulletts Emperor	
	Issues?	Issues?	Issues?	Issues?	Issues?	Issues?
	Difficult to fish in inclement weather	Difficult to fish in inclement weather	Difficult to fish in inclement weather as well as having to travel farther to find fish	Reef damage due to cyclones as well as human activity	Difficult to fish in inclement weather	
Vava'u	Who uses?	Who uses?	Who uses?	Who uses?	Who uses?	Who uses?
	Men mostly	Everyone	Men mostly	Women mostly	Everyone	
	Target species?	Target species?	Target species?	Target species?	Target species?	Target species?
	Parrotfish Groupers Rabbitfish	Groupers Emperors	Tuna species	Shellfish, notably giant clams	Goatfish Mulletts Grouper	
	Issues?	Issues?	Issues?	Issues?	Issues?	Issues?
	Reef damage due to cyclones as well as human activities	Nothing specific	Nothing specific	Damage to seagrass beds as well as a notable reduction in size of shellfish and giant clams harvested	Reef damage due to cyclones as well as human activities	
Eua	Who uses?	Who uses?	Who uses?	Who uses?	Who uses?	Who uses?
	Mostly men	Mostly men	Mostly men	Everyone	Men mostly	
	Target species?	Target species?	Target species?	Target species?	Target species?	Target species?
	Octopus Lobster Various fish species	Snapper Groupers	Tuna species Mackerel Marlin	Octopus	Scads Parrotfish Various fish species	
	Issues?	Issues?	Issues?	Issues?	Issues?	Issues?
	Difficult to fish in inclement weather	Difficult to fish in inclement weather as well as high costs of fuel and fishing equipment	Difficult to fish in inclement weather as well as high costs of fuel and fishing equipment	Difficult to fish in inclement weather	Difficult to fish in inclement weather	
Tongatapu	Who uses?	Who uses?	Who uses?	Who uses?	Who uses?	Who uses?
	Men mostly	Everyone	Mostly men	Everyone	Everyone	Everyone
	Target species?	Target species?	Target species?	Target species?	Target species?	Target species?
	Wahoo	Snapper Groupers	Tuna species Mackerel Marlin	Sea urchins Shellfish	Mullet Emperors	Mulletts Emperors Rabbitfish
	Issues?	Issues?	Issues?	Issues?	Issues?	Issues?
	Safety	Reef damage due to cyclones as well as human activity	Difficult to fish in inclement weather as well as high costs of fuel and fishing equipment	Reef damage due to cyclones as well as a notable reduction in size of sea urchins harvested	Reef damage due to cyclones as well as a notable reduction in size of fish caught	Damage to seagrass beds as well as being a navigation issue

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Page 5 image and images below: Participants to the training learned how to make a mini tuna longline, set it from a small craft and retrieve it by hand. (images: William Sokimi and Watisoni Lalavanua)



Positive impacts observed from the Effective Coastal Fisheries Management project in the Pacific

After three years of implementation, the Effective Coastal Fisheries Management (ECFM) project, which has been implemented in 17 Pacific Island countries and territories, an independent assessment of the project shows positive results for national capacity in the areas of legislation, policy, and monitoring, control, surveillance and enforcement.

The ECFM project has invested heavily in developing government capacity to address the increasing concern over the use and sustainability of coastal fisheries resources across the Pacific Islands region. The project started in June 2016 and is scheduled to continue through to June 2021, thanks to funding from the New Zealand Ministry of Foreign Affairs and Trade. The Pacific Community's Fisheries, Aquaculture and Marine Ecosystems (SPC/FAME) Division has employed three full-time specialist staff as well as four Pacific Island Fisheries Professionals to implement this project. The project contributes to strengthening governance structures and processes, specifically legislation, policy and MCS and enforcement, with the ultimate goal of bringing about enhanced food security and sustainable livelihoods in Pacific Island countries.

SPC/FAME commissioned a review to assess the relevance, impact and sustainability of the regional ECFM project among its member countries. An evaluation was conducted to identify the key results as well as some lessons learned, and to provide key recommendations that will help to make important improvements in this project.

The review, carried out between November 2019 and February 2020, entailed consultations with SPC staff, stakeholder interviews in the margins of the third Regional Technical Meeting on Coastal Fisheries, and country visits to Fiji, Kiribati, New Caledonia, Solomon Islands and Vanuatu. The assessment highlighted the following findings:

- The ECFM project has been strongly relevant to regional and SPC priorities.
- SPC has been able, through the project, to provide a high level of service, such as increased capacity in core project areas (e.g. legislation, policies, plans).
- Project activities have been responsive to gender, social inclusion and environmental issues.

Based on its effective delivery to date, the independent review supported the continuation of the ECFM project and made some recommendations to optimise the project's impact and sustainability for the remaining two years, including:

- ensure arrangements and funding are in place for the certificate programme;
- further develop learning exchanges and cooperation between countries;
- reinforce monitoring and evaluation processes; and
- review the coastal fisheries content in the "New Song for Coastal Fisheries" and "Regional Roadmap", to ensure that these remain current in light of shifting priorities at the regional level.



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Verifying fish sizes at a Fiji market, was part of MCS and enforcement training sessions organised during the ECFM project. (image: Steve Dunlop)

Kiribati takes a major governance step towards sustainable coastal fisheries

The new fisheries regulations for the conservation and management of Kiribati's coastal marine resources officially went into effect on 21 February 2020. These regulations are the result of a six-year effort by the Ministry of Fisheries and Marine Resource Development (MFMRD) to raise the profile of coastal fisheries in Kiribati, in consultation with local communities, government agencies and non-governmental stakeholders. In line with national and regional policy directions, coastal fisheries legislation has now been updated and strengthened with enforceable management measures for vulnerable species, and community-based fisheries management (CBFM) is given a clear legal basis.

A dedicated legal framework for coastal fisheries management

Kiribati has taken a key step in the development of a more comprehensive set of hard measures tailored to address the sustainable management of coastal fisheries resources. The new regulations are the first legal instrument covering coastal fisheries in an integrated manner throughout the country. The regulations were adopted under the authority of the Fisheries Act 2010, which mainly focuses on offshore fisheries. Previous regulations, adopted under the repealed Fisheries Act 1979 (known as the Fisheries Ordinance 1977 before independence), cover prohibited fishing areas, rock lobster fisheries, fish processing and export, and Kiritimati's bonefish fishery.

The Government of Kiribati has been actively trying to regulate coastal fishing activities at the national level for many years, but it was not until 2013 that firm commitments were made to that end. As can be seen in the timeline below, the turning point is marked by the adoption of the National Fisheries Policy 2013–2025. Strategic Action 8 of the policy acknowledges the need to review and strengthen coastal fisheries legislation, including community management, thus embracing the key role of community participation in the management of coastal fisheries. This commitment was further confirmed in the Pacific regional strategy “A New Song for Coastal Fisheries”,¹ which was adopted in 2015.

43 years of evolution in Kiribati's coastal fisheries law and policy

1977	Fisheries Ordinance 1977, renamed Fisheries Act 1979 (now repealed)
1978	Prohibited Fishing Areas (Designation) Regulations 1978
1979	Fisheries Conservation and Protection (Rock Lobster) Regulations 1979
1981	Fisheries (Processing and Export) Regulations 1981
2008	Fisheries (Protection of Bonefish on Kiritimati) Regulations 2008
2010	Fisheries Act 2010, amended in 2015 and 2017
2012	Fish Export Regulations 2012
2013	National Fisheries Policy 2013–2025
2013	Draft Sea Cucumber Regulations 2013
2014	Draft Management Plan for the Protection of Certain Coastal Marine Species 2014
2015	Shark Sanctuary Regulations 2015
2018	Draft Kiritimati Island Marine Aquarium Fishery Management Plan 2018
2018	Commonwealth Blue Charter (CBC) 2018
2018	Cabinet endorses the establishment of the National CBFM Steering Committee (now National CBRM Taskforce) 2018
2019	Coastal Fisheries Roadmap 2019–2036
2019	Fisheries (Conservation and Management of Coastal Marine Resources) Regulations 2019
2019	Kiribati stepped forward to lead CBC Action Group on sustainable coastal fisheries 2019 ²
2020	Cabinet endorsed the establishment of the National Coordinating Taskforce for CBC Action Group 2020
2020	Draft Fisheries (Aquaculture) Regulations 2020
2020	Draft Fisheries (Penalty Notice) Regulations 2020

¹ <http://coastfish.spc.int/en/component/content/article/49-other-documents/461-a-new-song-for-coastal-fisheries.html>

² <https://thecommonwealth.org/media/news/blue-charter-ramps-momentum-new-action-group-cop25>



MFMRD staff doing inspection at the market - Tarawa, Kiribati. (image: Jeff Dunlop, Ministry of Primary Industries, New Zealand)

How the new fisheries regulations were developed

To develop the new regulations, legal assistance was provided in 2018 and 2019 by the Pacific Community (SPC) under the Coastal Fisheries Governance Project³, in collaboration with the University of Wollongong under the Pathways Project.⁴ Training opportunities at SPC headquarters were also offered to Kiribati Coastal Fisheries Officers to enhance their ability to write legislation, including placements for legal attachment training and participation in a Short Course on Legislative Drafting for Coastal Fisheries.

Most notably, a cross-sectoral stakeholder consultation on the draft regulations was organised by MFMRD in Tarawa, in collaboration with SPC, the University of Wollongong and the *Tobwan Waara* Programme.⁵ The consultation was a collaborative inter-agency effort to define adequate management measures for coastal fisheries at the national level, with the participation of fishers from the Kiriwaru Maritime Cooperative Society.⁶ Partaking government agencies included

the Ministry of Environment, Land and Agriculture Development, the Ministry of Women, Youth, Sports and Social Affairs, the Office of the Attorney-General, and the Ministry of Internal Affairs (MIA) in charge of island councils.

These fisheries regulations are one of the milestones in the formalisation of a legal framework and regulatory backbone that embraces the management of coastal fisheries in Kiribati. This was achieved through a series of community visits and wider consultations and a national dialogue at the two National Fisheries Summits in 2017 and 2019, which provided feedback on the content of the regulations. These activities were supported by the *Tobwan Waara* Programme and the Coastal Fisheries Governance Project.

A legal basis for community-based fisheries management

The new regulations provide a solid CBFM framework that allows communities to adopt enforceable fisheries management plans with MFMRD's support. In Kiribati, most

³ The Coastal Fisheries Governance project, officially titled "Improving fisheries food security and sustainable livelihoods for Pacific Island communities", is funded by the New Zealand Ministry of Foreign Affairs and Trade. More information is available at: <https://fame1.spc.int/en/projects/mfat>.

⁴ The Pathways Project, officially titled "Strengthening and scaling community-based approaches to Pacific coastal fisheries management in support of the New Song", is funded by the Australian Government through the Australian Centre for International Agricultural Research, project FIS/2016/300.

⁵ The Joint Kiribati Sustainable Fisheries Development and Management Programme (*Tobwan Waara*) is funded by the New Zealand Ministry of Foreign Affairs and Trade and implemented in partnership with MFMRD.

⁶ See SPC Fisheries Newsletter #156, May–August 2018 available at: <https://coastfish.spc.int/en/component/content/article/489-spc-fisheries-newsletter-156.html>.

island councils have the mandate to regulate fishing activities within adjacent waters, which extend from shore (low-water line) to three nautical miles seaward, as stipulated under the Local Government Act 1984. So far, CBFM has been developed under different projects with a variety of approaches without an overall legal framework. The regulations now provide an “umbrella” under which communities can create formal associations recognised by law in order to manage their fisheries in collaboration with island councils.

Since 2014, MFMRD has collaborated with the University of Wollongong and SPC – via two projects funded by the Australian Government (PacFish and Pathways)⁷ – to consistently work with communities to establish CBFM in Kiribati. The inclusive community engagement approach piloted in five communities was scaled out in 2017 to reach 60 communities (via different levels of engagement) in 10 islands,

mainly those in the Gilbert Group. At the time of writing, ten communities are implementing their management plans while five other plans are in draft form or at the final stage of formalisation under the newly endorsed legal instrument.

MFMRD is currently working with the CBFM Pathways team and SPC to develop several tools to effectively continue the implementation of CBFM throughout the country in a consistent manner. For instance, CBFM guidelines are being prepared for Coastal Fisheries Officers to assist communities in establishing formal associations under the Incorporated Societies Act 2002 and to provide a clear streamlined process on how respective communities are formally recognised as CBFM villages under fisheries legislation. Communities will also be provided with templates for the constitution or statute of their association and for their CBFM plans.

⁷ PacFish (2012–2017) is the predecessor programme to Pathways (2017–2021) and was officially called “Improving Community-Based Fisheries Management in Pacific Island Countries”.

Women selling fish - Tarawa, Kiribati. (image: Céline Muron, SPC)



Stronger monitoring, control and surveillance

The regulations also contain many provisions aiming at strengthening monitoring, control and surveillance (MCS) in coastal waters.



They establish a total ban on commercial fishing by foreign vessels in Kiribati's waters up to 12 nautical miles from shore.



They establish licensing requirements for designated coastal fisheries and improve coastal fisheries data collection through the creation of a record of licensed fishing vessels and the provision of reporting obligations on licensed fishers. This will help MFMRD map out and control the fishing effort of commercial coastal fisheries throughout the country and promote sustainable fishing practices.



Enforcement is also made easier by empowering authorised fisheries officers to issue penalty notices (also known as spot fines) for minor coastal fisheries offences, whereas more serious offences are subject to prosecution in a judicial court of law. The Draft Fisheries (Penalty Notice) Regulations that are currently being developed by MFMRD with SPC's support will identify specific coastal fisheries offences that can be penalised on-the-spot, in accordance with the Fisheries Act 2010.



MCS standard operating procedures are being prepared by MFMRD with support from the SPC Coastal Fisheries Governance Project, to ensure fairness and transparency of coastal fisheries enforcement interventions so that they are performed professionally.



Finally, SPC and the New Zealand Ministry of Primary Industries (MPI) are assisting MFMRD with train-the-trainer capacity development to enable coastal fisheries officers to educate the public on sustaining healthy ocean resources. This includes the development of a tailored Field Incident Book to facilitate the reporting of coastal fisheries offences.

Awareness raising on new management measures

Based on scientific assessments of the status of coastal marine resources in Kiribati's waters, the new regulations introduce several conservation and management measures to protect the most vulnerable species of fish, clams, crustaceans and sea turtles.



Size limits for 10 key fish species, 5 species of invertebrates and 2 species of turtles.



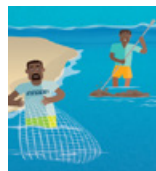
Seasonal closures during full or new moon periods for 3 key fish species and power of Director to declare closed season for other coastal marine species.



Catch quotas for 5 species of invertebrates.



Special protection for true giant clams (*Tridacna gigas*), called *te kima* in I-Kiribati.



Mesh size restrictions for gill nets and other fishing gear limitations.

To raise awareness of the sustainable use of marine resources and to improve public support of and compliance with the new regulations, MFMRD is working on a national MCS Communication Strategy. As part of this strategy, MFMRD will soon finalise an information toolkit with assistance from SPC and the Pacific-European Union Marine Partnership programme.⁸ It includes posters targeting schools and communities, a handbook with the main messages for all stakeholders, a series of roll up banners, stickers and rulers for fisheries officers. Most importantly, the communication strategy lays out an effective plan to produce key messages and appropriate awareness vehicles tailored for robust community participation and engagement towards achieving a change in behaviour. The plan includes public meetings, church sermons, radio drama programmes and peer-to-peer

⁸ Funded by the European Union and the Government of Sweden, the EUR 45 million PEUMP programme promotes sustainable management and sound ocean governance for food security and economic growth, while addressing climate change resilience and the conservation of marine biodiversity. It follows a comprehensive approach, by integrating issues related oceanic fisheries, coastal fisheries, community development, marine conservation and capacity building under one single regional action.

education activities with the help of leaders and community champions to influence a perspective of change for sustainable fisheries practices at the community level.

The task ahead

The ongoing commitment of Kiribati's national authorities to protect coastal marine resources and promote sustainable development is needed to achieve the task ahead. As highlighted by Tooreka Teemari, Director of Coastal Fisheries at MFMRD:

Success will ultimately depend on voluntary compliance of fishers and communities with the new regulations and management measures. In this effort, the role of fisheries officers cannot be overstated: they are the ones taking the journey from improved understanding of their laws to passion for educating their people and ability to balance enforcement with awareness raising on critical aspects of coastal fisheries management.

The objective is to generate collaboration among Kiribati people and build a sense of ownership as custodians of their coastal resources. MFMRD will continue to convey this important message to local communities so they can take

pride in supporting this effort. Given the magnitude and challenge of the task ahead, the MFMRD cannot achieve what is required on its own but will seek the opportunity to build stronger collaboration among key government ministries for support in implementing future activities towards the sustainable management and conservation of our coastal fisheries, for present and future generations.

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Women selling fish - Tarawa, Kiribati. (image: Céline Muron, SPC)

Experiencing fisheries data management enhancement as a Pacific Island Fisheries Professional at SPC

Lavinia Vaipuna¹

I never dreamed of working for the Pacific Community (SPC) as a Pacific Island Fisheries Professional (PIFP). But, I had been dreaming and longing for SPC's assistance and support for my work with the Tonga Ministry of Fisheries as a computer programmer for over 20 years. I have been responsible for all data management systems that have been developed locally by the Ministry or by regional agencies such as SPC, which are used by the Ministry to manage fisheries data. Collecting and submitting quality and accurate data in a timely manner has been and is still an issue across the region. To ensure informed management decisions can be taken, there is a need to improve the way we collect and manage our data at the national level.

The PIFP programme is a 12-month working opportunity offered by SPC. It aims at building the capacity and professional development of nationals and residents of Pacific Island countries and territories who are employed in a fisheries-related role.

Being offered the PIFP job was beyond my expectations but, on 13 February 2019, I took it knowing that this was the support I had been longing for.

My one-year contract as a PIFP with the Data Management Section of the SPC Fisheries, Aquaculture and Marine Ecosystems Division has been very productive in many ways. The experience accumulated, the skills and knowledge developed, the self-confidence gained, the opportunity to network with professionals have been priceless.

My experience with database development relied heavily on the Microsoft Access database and applications. All the local systems that I have built for our data collection at the Ministry of Fisheries are based on Access database systems. I knew and heard of other programming platforms, but never had the chance or time to study or try them out. During my PIFP time, I learned about Vue.js and its concepts. I learned about Nodes.js, JavaScript and the WebStorm environment. I also learned to code in SQL as it was necessary for the support of my local system in Tonga. And I was keen to use all these new skills to the coding of a new online Tonga's export application system. I made progress in developing the first phase of this application while at SPC. Now that I have learned another programming language and all its concepts and have developed the export application, I am taking it back to Tonga Fisheries and will work on it to replace my current local export permit application. I am sure Tonga will benefit from having this new online web application, as less data entry, and less processing time will be needed. And, of course, it will be accessible from anywhere and any device. Exporters won't have to drive to the Ministry of Fisheries office to request their permit, they will just have to apply online. Maintenance will be done online and in a timely manner. This will save time and money.

On my return, I am planning to install the system on our server. I will work with our network administrator to make sure this online system can be utilised in Tonga. I will, of course, continue to seek the assistance of SPC's programming experts when necessary. When this project is successful, I will transfer the rest of my local access system to an online web-based system. At the same time, I will continue my training by taking online courses in programming languages to further my career in database and data management system development.

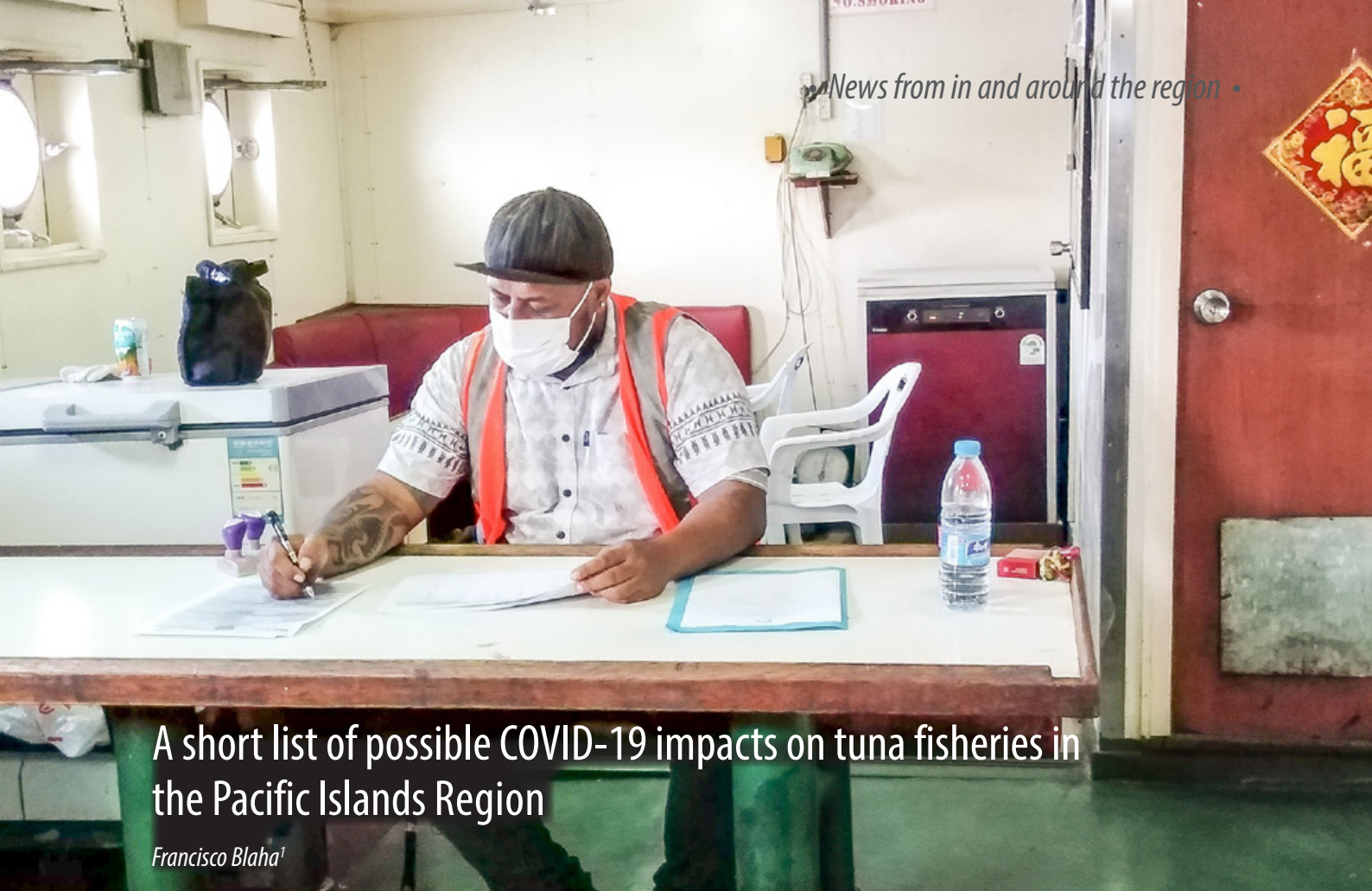
As I have now completed my one-year contract, and just before returning to my homeland, I wish to encourage my Pacific Island colleagues to take advantage of this PIFP programme opportunity. It has been set-up to help us develop and refine our skills and knowledge, build our professional capacities, and use what we have learned to help in the management of our own fisheries at home. Take it up!

I would like to conclude by acknowledging SPC for the opportunity to work within the Data Management Section of its Oceanic Fisheries Programme. Mālō 'aupito



Lavinia Vaipuna and SPC colleagues Benoît Pohl and Andrew Hunt.

¹ Computer Programmer, Head of ICT Section, Ministry of Fisheries, Kingdom of Tonga; and SPC Pacific Island Fisheries Professional (from 13 February 2019–12 February 2020). Email: laviniav@tongafish.gov.to



A short list of possible COVID-19 impacts on tuna fisheries in the Pacific Islands Region

Francisco Blaha¹

Slota Faite, boarding officer in Rabaul, Papua New Guinea, working under the “new normal” (image: Francisco Blaha)

The first question that comes to mind when asked about the impacts of COVID-19 on tuna fisheries is: Where to start? We have not had anything at this level ever before.

To me, the tuna fisheries world is not too different from tuna fishing boats. Yet, fishing operations are very choreographed, there are many specific manoeuvring routines around each fishing day that need to be strictly followed for things to work, everyone has a job to do in sequential order and that job has to be done right, all the while being aware of the weather, swell, gear design, manoeuvring mistakes, and other factors. Most times, things work out all right, but sometimes they do not and need to be fixed.

Because COVID19 came quite fast, there were no manoeuvring routines and a lot had to be improvised, and while many things will turn out okay, some things will not.

As on a boat, we have the bridge operations, deck operations, engine and refrigeration operations, and each of them is, to a certain extent, a different world. Still, they interact with each other. In the tuna fishery, I see and operate in four different worlds: 1) the office and policy section, 2) the boats themselves, 3) the wharf, and 4) the factories and markets. (There is also the political and diplomatic world, but that arena is way above my head). So I will discuss these four worlds.

Office

The office and policy world is made up of a series of annual meetings on various topics around the regional organisations: the Forum Fisheries Agency, the Pacific Community, Parties to the Nauru Agreement, the Western and Central Pacific Fisheries Commission, and others. It is in these meetings that policies are formulated, advice is provided and discussed, and scenarios evaluated. All of this takes place along culturally established sit-down meetings, negotiating agreements, face-to-face discussions, and trust-based consensus building; and being the Pacific, all is well framed by sharing food, drinks and stories.

With COVID-19, that well-oiled routine that had been built up for many years, disappeared. The travel ban took all that away and now meetings are “virtual” only. The simple fact is that we all had to learn a new way of doing things without much preparation and very varying quality of internet service, which makes some of these meetings very frustrating.

I am sure that while some advances will be made, the region will struggle to agree on some negotiations on contentious matters. And the reality is that we do not know when this will change. Many countries have closed their borders, and the regional travel hubs we need to go to in order to attend meetings (e.g. Nadi, Auckland, Brisbane and Honolulu) are far from being accessible.

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Fishing vessels

Longliners

The freezer longliners can also be subdivided between those that have ultra-low temperature freezing capability at -60°C , and those that have -35°C to -40°C freezing capacity, with the former commanding a premium price, and the fresh small-scale longliners, all of which mainly supply Japan's sashimi market.

All that went downhill fast, as fresh fish uses, in most cases, excess capacity on commercial flights. So, unless charter flights or designated cargo planes are picking up the fish, or there are airlines that make cargo flights and not just passenger flights, that segment of the industry is the hardest hit. While this segment is small in volume, it is significant in value, and unfortunately it is one of the few that have Pacific Island domestic investments.

Because 80% of the sashimi market in Japan consists of frozen tuna, the rest of the operators are directing their efforts to the frozen markets as long as carriers and containers will keep operating. But -60°C and -35°C to -40°C ultra-low temperature containers are expensive and require excellent logistics to be mobilised, and that capacity is not available in all ports.

The bulk of the frozen catch (70–80%) imported into Japan is sold outside the auction system to trading companies and processors. China and South Korea have considerable sashimi-grade processing capability, with much of their frozen processed product also exported to Japan.

Furthermore, Japan was storing a lot of frozen tuna for the Olympics that were to start in July. With the games being delayed by a year, prices will go down because the expected demand is not there. Importers will need to “do the math” on how much will it cost to keep the fish frozen for another year. I cannot see the sector recovering soon.

Purse seiners

One assumes that with frozen fish, there is little impact on fisheries operations, vessels come to port only to unload and transship, and there are many measures to limit human interaction. Most of the resupply of food and fuel to purse-seiner vessels is done from carriers and bunkers with very limited contact between crews. Stopping fishing was not an option because, as we will discuss further below, demand has soared.

But then there is also a more complex issue: purse seiners require 100% observer coverage and that is not happening these days. Ideally, one could have asked the vessels to not change crew for two weeks before coming to port and only take observers from the four main ports in the regions that are all COVID-19 free (i.e. the Federated States of

Micronesia, Kiribati, Marshall Islands and Tuvalu) and then return to the same port. Even though those countries have closed their borders and no flights are serving them, one could have recirculated the observers from those ports only, but that option was not pursued.

This has had various impacts. The first is that there are around 600 active observers in the region that are now out of work and income. This also extends to the transshipment monitors that are generally on-board during transshipments, and this is a harsh reality for observers in many countries in the region as it is their main source of income.

The second impact is that the lack of monitoring by observers will impact not only the issue of compliance, but also the already low flow of data from biological sampling done onboard that is used for fisheries science purposes.

This brings us to the third impact: the verifiability of some of the requirements for the Marine Stewardship Council (MSC) certification of purse-seine fleets in the Pacific. For example, MSC certification requires a separation in onboard storage of fish that were caught while associated with a fish aggregation device (FAD), and non-FAD associated fish. This is verified by observers in some MSC units of certification. It seems that certification will continue for all fleets, based on the chain of custody requirements that come along with the fishery certification, but with no (or very limited) external oversight by observers or monitors during transshipment. This, of course, is not ideal as all information is now taken on face value only.

Of course, this also is going to intersect with compliance issues from July onwards when the FAD-associated fishing closure starts for three months. While it should be possible to assess whether a fishing set was FAD associated or not by using the vessel monitoring system (VMS) to analyse manoeuvring movements or by analysing the catch composition during offloading, the dissuasive effect of having an observer onboard cannot be replicated.

A further interesting plot here is the current availability of cheap fuel. Usually FAD-free fishing implies a huge fuel bill, as fishermen must find and chase fish, instead of just going straight to the next FAD sonar buoy, which tells fishermen exactly how many fish are below the surface. So, in principle, this should facilitate FAD-free fish and more risk-taking by vessels in finding schools; yet without observers, it will be much harder to monitor and verify.

In port, the situation is not any easier. The distribution of transshipments in the region moved from the traditional model of convenience and services, to one where ports have undergone different degrees of shutdown or temporary measures in the last two months or so. Each port has its own ways of dealing with vessels, which impacts port operations. Those involved in the logistics of landing and transshipments need to follow the port situation on a day-to-day basis, waiting for



Fishers are well aware that there will always be a sunny day, even after the most violent of storms.
Majuro, Marshall Islands. (image: Francisco Blaha)

news that a particular carrier may enter a specific port and try continuing transshipment as normal. Hence, the whole process is quite inefficient, and inefficiencies mean higher costs in tuna. Industry would have welcomed a more standardised approach among the main transshipment countries as they are all PNA and FFA members.

On the fisheries and boarding officer side, the whole process of incoming clearance for vessels has gotten substantially more complex, particularly for countries such as the Marshall Islands that are applying Port State Measures best practices, which include pre-arrival intelligence analysis. For example, if a purse seiner wants to come into port, it has to track and report its fishing routes back to 1 January. If the vessel bunkered or came alongside any other vessel during the trip before entering port, it has to track the routes of those vessels back to 1 January. And if compliance issues are found during pre-arrival analysis, the whole dynamic of inspection on board changes as a boarding officer will need to get to the bridge or engine room to collect evidence, under really logistically complex situations.

And, because all human contact must be avoided, who will be interrogated for evidence?

This is better exemplified by the words of one of my colleagues:

The biggest worry is that there are no fisheries officers physically present in the entire fisheries operation anymore. A vessel can literally catch 1000 species of interest, not report them, transship them to a carrier and it will all go unseen, very, very easily (not that this happens usually). As a boarding officer as well, it feels really weird not showing a presence by going on these vessels and just checking them. Yet, they are fishing in our waters and transshipping in our lagoon. I understand the situation and the importance of the economic benefit to our country by allowing the operation to continue as best as we can, but as a boarding officer it's like an itch on your back you can't reach.

Factories and market

People panic, and rush to buy shelf stable food, and tuna is a tested and trusted choice. I have heard that shelves of tuna cans and pouches in the developed world are been emptied fast. This, of course, means that demand rises, and brands put out more orders.

To me, the fragile point in the value chain is processing. Processing tuna is really labour intensive, and requires many people to process tuna, which is the reason why canning countries are mostly in countries with cheap labour, such as Thailand, Ecuador and Viet Nam. Even in developed countries that have the most automatised production lines (e.g. Italy, Spain, France) quite a few well-trained people are still required to run those fancy machines.

Processing, therefore, is pushed for products. On the other side, factories are a really wet environment, and while personal hygiene has improved a lot in the last few decades, I see two problems arising that will impact production:

- The requirement of personal distancing of 1–2 meters between people in the workplace. Processing lines are normally elbow to elbow, so if there are fewer people, there will be less production.
- Some people working in processing will get sick and put in quarantine or self-isolation. And people that have been working close to them will have to be isolated as well. Absenteeism will increase, and if there are fewer people working, that too means less production.

And, as the tuna value chain is not really tuned, more fish will be caught and waiting to be processed than can be processed. So, cold rooms will be full, carriers will not be able to unload and free up space, and vessels will be full and waiting at transshipment ports, as happened in May 2019 when 32 purse seiners were waiting to transship in Majuro. Prices will go down and fishers will get paid less.

For factories in the region, the situation is a bit different as they are located in countries where there has been no declared COVID-19 cases so far, except for Papua New Guinea. Yet, they have increased distancing and in-and-out of the country controls, which in turn affects production.

According to the information I could collect from various sources for April 2020, the land-based tuna industry situation was as follows. Very few consignments came out of Samoa. In Kiribati, the local company operated at around 50% capacity, with frozen products only, and it planned to further reduce its operations if the lockdown continues. Papua New Guinea was back to about 80% capacity. Solomon Islands has scaled down on the number of employees, continues to process and export to the European Union, but has reduced its production by 50%. In Fiji, companies based on yellowfin tuna longlining were barely operating, while

those concentrated on frozen albacore loins (Viti Foods and Pafco) were experiencing an increased demand for their products and were operating six days per week.

The challenge is the lack of raw materials and the big question is whether we are going to get back to normal, and if so, when.

A further area of complications is documentation as many markets require paper originals of Bills of Lading, Health and Catch certificates and other business documents. As there are no or very few flights, courier companies are not operating and those documents cannot leave. Yet, on the market side, import clearing officers (that already have difficulties knowing where some Pacific countries are), seem not to believe that some Pacific Island countries are literally closed to all flights.

Yet, as they say, from crisis opportunities arise, and we have learned the following.

1. While sometimes frustrating, technology has enabled us to have meetings and discussions globally without the need for creating greater carbon footprints. And, we have learned about what constitutes “essential” travel.
2. Improved communication is needed. The fishing business revolves around the regional fisheries management organisations and their frameworks, and in times of a crisis, it shows the inefficiencies that may be improved between all members (e.g. establishing practical requirements on observer coverage, port entries and transshipments).
3. Medical support and infrastructure in the Pacific Islands must be improved. Key to port restrictions was the fact that several Pacific Island countries simply did not have the resources or available medical facilities, to deal with a single case of COVID-19. Therefore, these countries had to take drastic measures against vessels entering their ports, even though these vessels are the basis of their national income.

In conclusion, we are not discussing what is impacted or not, we are discussing the differential extent of the impact in the different areas. Furthermore, people are trying to assess (with very limited tools) the impacts on the areas we cannot really see yet.

If it helps as anecdotal evidence, I have never in my life finished so many meetings (albeit all online) with the words: “Well... let’s see what happens” ... and that cannot be good in the long term.

Rapid and preliminary assessment of the impact of COVID-19 on Pacific Island coastal fishing communities

The Locally Managed Marine Area Network International in collaboration with WorldFish, the Wildlife Conservation Society and the Australian National Centre for Ocean Resources and Security

The global COVID-19 pandemic is having a major impact across the globe and on all segments of the population. The effects on Pacific Island countries and territories have been extremely varied; some countries have had to manage viral infections while others are so far managing to keep the virus entirely from their shores. National responses have many potential implications for coastal communities, but these need to be better understood if international and government responses are to be effective and appropriate for the particular circumstances of different villages and countries.

As a response, the Locally Managed Marine Area (LMMA) network and partners such as WorldFish, the Wildlife Conservation Society (WCS) and the Australian National Centre for Ocean Resources and Security (ANCORS) have been developing a survey tool that aims to gain basic and rapid insights into changes occurring in villages and their fisheries. A joint questionnaire has been developed for a rapid appraisal, and our organisations are at various stages of implementation in Fiji, Solomon Islands, Vanuatu, Kiribati and Timor-Leste, with contacts also made in Papua New Guinea, Palau, Federated States of Micronesia, Cook Islands, Tonga, Indonesia and the Philippines. The survey, administered to men, women and youth, is intended to be short and simple enough to be asked relatively quickly over the telephone or social media, look at impacts through a gender lens and provide the most important feedback quickly. This is intended as a first step to inform other more elaborate surveys or emergency responses.

This civil society and community-focused survey is not limited to a specific organisation; recipients are free to send the survey on to their partners. Information from local coastal communities is welcome provided the community and partner rights are respected according to the surveyor's own ethics procedures and the LMMA network's Social Contract (ethics agreement). The LMMA network places community

rights and recognition at the centre of all it does, and elements of "Our Promises to Each Other: the Social Contract" are included in the questionnaire.

The following principles from the Social Contract are key to undertaking this work and apply to LMMA's relations with communities and between each other (i.e. LMMA will only share information outside its group that the relevant partner has authorised).

- **Rights:** Communities have the right to information about themselves, which they possess or help generate.
- **Permission:** To use information not previously in the public domain from any site or other partner, Free, Prior, and Informed Consent must be obtained from the project site communities or other rights-holder, in consultation with the relevant project organisation.
- **Return of information:** Results and communication products arising directly from the use of community information will be shared with the participating communities and other stakeholders in a timely and appropriate manner.

Image at the top: Even in remote areas, COVID-19 can have an impact on communities, for example through the closure of sales markets or the need to provide for the needs of people returning to the village after losing their jobs in the city; Fumato'o, Malaita Province, Solomon Islands. (Image: Filip Milovac, WorldFish, Flickr)

The questionnaire is freely available, and we encourage you to contact the LMMA network to indicate that you will be undertaking the surveys and to send your survey results, raw or summarised. The LMMA network will compile all information from the region and will provide feedback to partners for them to report to participating communities. Partners will involve national fisheries authorities, as appropriate, in each country.

For more information:

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LMMA Network and partners (WCS, WorldFish and ANCORS) responses to COVID-19 Community Survey (condensed version)

Respondent information: Village, district, province, gender, age, role in the community (fisher, seller, farmer, committee member, stay at home, other). Name and phone details are confidential.

Prompt: We are just calling to check in with you how life is in your village. If you don't mind, I will ask you some questions, your answers will be anonymous, they won't be shared without your permission and the results of this work that we are undertaking with several communities will be reported back to you. You can also withdraw from the call at any time. Are you OK to participate?

1. Consent: ☐ Y ☐ N
2. Can you explain a bit about what is happening in your village now?
3. Have there been any major national events that have affected the community this year (2020)? ☐ Y ☐ N - Explain.
4. (a) Since mid-February this year, have more people moved to or away from the village? ☐ Same, ☐ Into the village, ☐ Away from the village
(b) If yes, how many people do you estimate?
5. How many people were living in the village in early February?
6. Do you think there is enough food in the village for every one, compared to normal, for this time of the year?
☐ Big problem, ☐ Not enough, ☐ Enough, ☐ More than enough, ☐ Lots - Explain.
7. How are people making sure there is enough food for everyone?
8. What are the main ways people are producing / obtaining food?
9. Are you seeing changes in how people are sharing food?
☐ Y ☐ N - Explain.
10. Are people fishing more now compared to in the beginning of February this year? ☐ A lot less, ☐ Less, ☐ Same, ☐ More, ☐ A lot more - Explain.
11. Is everyone that fishes (in your fishing ground) aware of the local and customary practices and rules around fishing? ☐ Less people than before, ☐ Same, ☐ More than before - Explain.
12. Is everyone that fishes (in your fishing ground) aware of the national rules around fishing? ☐ Less people than before, ☐ Same, ☐ More than before - Explain.
13. Are people breaking any fishing rules? - ☐ Y ☐ N - ☐ Less people than before, ☐ Same, ☐ More than before - Explain.
14. (a) Which rules are currently the most common rules being broken?
(b) Do you know who in the community is breaking the rules?
15. (a) Regarding fisheries management / rules - have those in charge of fishing rules (chief, leaders, clan heads, committee) taken any action? - ☐ Y ☐ N
(b) What specific actions or advice have the leaders given to the community?
16. Have any of the current rules changed or been removed recently? ☐ Y ☐ N - Explain.
17. Do you think that the management actions implemented before mid-Feb has been beneficial to the community during this current situation? - ☐ None OR List
18. From your recent observations and in conversations around the village, is more fish being caught in total?
☐ More, ☐ Less, ☐ Same amount - Explain.
19. Have there been any changes in the sales of fish from the village? ☐ More, ☐ Less, ☐ No change - Explain.
20. Have there been any changes to the price of fish being sold? ☐ Cheaper, ☐ More expensive, ☐ No change - Explain.
21. Has there been any changes to the price of rice people in the village have to pay? ☐ More, ☐ Less, ☐ No change - Explain.
22. Has there been any changes to the price of rice people in the village have to pay? ☐ More, ☐ Less, ☐ No change
23. Which stresses are your family feeling right now? ☐ Stress on physical health, ☐ Stress on mental health, ☐ Food availability, ☐ Financial stress, ☐ Family stress, ☐ Livelihood loss, ☐ Other
24. If you had to ask for any assistance or support (from the government) right now, what would it be?

Thanks a lot for your time and contribution. Do you agree for us to share the information you have kindly provided to compile it with other interviews? As I said earlier this will be anonymous, your name will not appear.

A snapshot of freshwater prawn (*Macrobrachium lar*) collection activities in Naone community, Vanuatu

Background

There are about 210 currently known species of freshwater prawns in the genus *Macrobrachium*. These prawns are widely distributed throughout the world's freshwater systems, lakes and creeks, largely in subtropical and tropical regions (Sethi et al. 2014) and have been an important source of food security and livelihood for people (Nandlal 2005).

Several species of freshwater prawns are known to occur in Vanuatu, including *Macrobrachium lar*, and these are widely found throughout the islands (Nandlal 2005). The island of Maewo is one of several islands in the Vanuatu archipelago where shrimp stocks are abundant (Amos 2007). *Macrobrachium lar* is the focus of this study.

Macrobrachium lar is a designated fishery under the Vanuatu Fisheries Act, and an important freshwater fishery in Vanuatu. Indeed, it plays an important role in food security and is a source of income for local people (Nandlal 2005).

Various prawn harvesting methods have been recorded and include collection by hand, push nets, woven traps and fine spears (Nandlal 2005). On Maewo Island, one of the most common methods is pond fishing, which involves diverting water into existing rock pools or dugout earth ponds on the side of the riverbank (Fig. 1). Feed such as coconut, manioc, taro or pawpaw is then placed into the pond to attract the prawns. A day or two after food has been placed in the ponds, the water intake is cut off and the pool is drained to expose the prawns, which can then be collected by hand.



Figure 1. An example of earth pond dug on the side of the riverbank. (image: Jason Raubani)

Fishing for *M. lar* on Naone Island dates back centuries. The first recorded interaction was by Charles Bice (Bice and Brittain 1886), the first Anglican missionary to the island. He recounts a scene where natives used the midribs of coconut leaves to make a trap to catch prawns to eat while tending their water taro gardens.

The commercialisation of prawns did not begin until the late 1980s and early 1990s. Since then, prawns have become a key economic activity of the people of Naone community. However, collection activities back then were not documented, and as a result, the production level during this period is unknown.

In 2017, the Vanuatu Fisheries Department (VFD) recorded for the first time that a production volume of 927 kg of prawns had been exported from Naone to the two main urban centres in Vanuatu, Port Vila on Efate, and Luganville on Santo (Vanuatu Fisheries Department, unpublished data). This figure, however, does not include the volume consumed by the community itself. Prior to that, there was no effort to capture that information or any information related to prawn collection. In the period between 1990 and the early 2000s, up to 100 kg of prawns were reported to be exported by air on a monthly basis to Port Vila and Luganville (Mr A. Weris, prawn fisher, pers. comm., 7 January 2019).

The main author of this article is a member of Naone community. The four decades of continued commercial collection of *M. lar* – coupled with the unknown level of production, stock and the social and economic contributions – have always been a huge interest to him. As such, he has taken the initiative to undertake this study.

Therefore, the purpose of the study was to document and understand the activities of the prawn collectors and try to establish a snapshot of their collection activities, production levels, social and economic returns, and their views on the status and management of the stock. This study was carried out through interviews conducted with some of the key active prawn collectors.

Methodology

The study area covers Naone community (Fig. 2), which is located at the northwestern part of Maewo Island in Penama Province, Republic of Vanuatu. It consists of the main village and a few clusters of 1–2 households on the outskirts of the village. The community has around 37 households and a total estimated population of about 200 people, of which almost 40% are women and girls. More than half of all households have engaged in prawn collection at some point over the past few years. A portion of a river that runs through the study area is the main collection area. The river runs above the community and parallel to the coastline, and cascades into the ocean beside the main village. This river is usually referred to as “Big Wota” (which means big river), and it is the biggest and longest river on the island.

In January 2019, a survey of some of the key active prawn collectors in the study area was conducted. In total, 12 people were interviewed, 4 of whom were females. Interviews were voluntary and conducted in the local dialect of the study area.



Figure 2. Map of the study area.



Local freshwater prawns, *Macrobrachium lar*. (images: Pita Neihapi (L) and Glen Alo (R), Vanuatu Fisheries Department)

Results

Twelve prawn collectors, eight men and four women, were interviewed in January 2019. They ranged in age from 30 to 60 years and have been engaged in prawn collection for three to over ten years. This figure represents over 90% of the active prawn collectors in 2018.

The main collection area spans a total distance of about 3 km of the river. The average width of the river ranges from 5 m to more than 20 m, with depths ranging from less than 1 m up to 10 m.

All prawn collectors interviewed use the pond collection method and collected prawns either daily or twice a week. Most preferred collecting during the early morning, although two people said that afternoon collection times produced higher yields than morning collection times. Most collectors said they spend 1–2 hours each time, while one person reported 3–4 hours.

Most collectors reported having one pond each but two reported having two ponds. Ponds were located on both sides of the river at about 50–200 m from each other along the riverbank, and sizes ranged from about 1 m² to less than 5 m². Pond ownership can change from one collector to the other at different times but with permission from the original owner.

Most collectors indicated that their average weekly production in 2018 was about 1–2 kg, but one collector reported an average catch of 3–5 kg and two reported average catches of 5–10 kg. Asked if there were any observed difference in their average catch in the past 5–10 years, all reported seeing

no difference. In addition, all but two collectors stated that in order to collect the same volume, they do not need to put in more effort today than they did in the past 5–10 years.

All collectors reported that not all of the prawns they collected were for sale, and that they took a few home for personal consumption. The survey found that in Naone community prawns are consumed on average between two and three times a week by over 50% of all households.

From 2017 to 2018, collectors reported that the price offered for 1 kg of prawns was USD 8.00.¹ Between three and five years ago, the price/kg was USD 6.40, and five to ten years ago it was USD 4.00. Over 10 years ago the price was about USD 2.40. Collectors reported that the price increase was mainly due to market demand. Figure 3 illustrates the continuous increasing trend in the price of prawns over the years.

All collectors confirmed that income generated from the sale of prawns was their most consistent income source, and two stated that it was their number one income source for 2018. Other cash income sources include copra, taro, kava, business and labour. Kava and labour top the list of income sources for the rest of the collectors. The average annual income for 2017 and for 2018 from prawn sales was estimated to be around over VUV 900,000, which is equivalent to USD 7200.

On the question of whether an increase or decrease in the state of the shrimp stock was observed, all collectors responded that based on their production, they had not noticed an increase or decrease in the state of the stock over the past 5–10 years. However, all collectors agreed that management controls should be put in place now to ensure the long-term sustainability of the fishery. Collectors proposed that if management controls were to be put in place, they should focus on protecting juveniles, using minimum size limits, and imposing a ban on the harvest of berried females. However, they all agreed that enforcement of such controls would be a challenge. One collector proposed that collectors, or the community, should be organised and take the initiative of self-managing the fishery and put in place and enforce management controls to ensure sustainability for their long-term social and economic benefits.

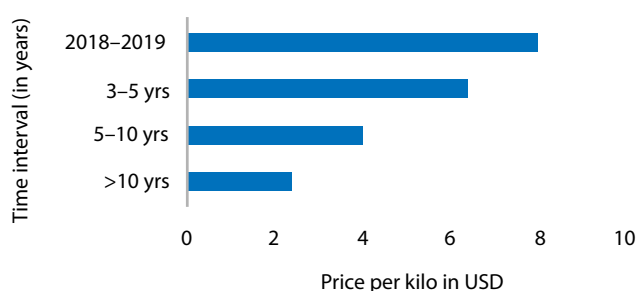


Figure 3. Increasing trend in price per kilogram of prawns over the years.

¹ 1 USD= 125 VUV (<https://www.xe.com/currencyconverter/convert/?Amount=900%2C000&From=VUV&To=USD>: Accessed on 25 March 2020)

Discussion and conclusion

From the study, it was evident that almost all households in Naone community were engaged in prawn collection at some point over the past few years. In addition, prawn collection is not a gender-specific activity, and both males and females participate in prawn collection.

Out of all the collection methods, pond fishing was the only method used by the prawn collectors who were involved in the interviews.

The results indicate that Naone community sold 936 kg of *Macrobrachium lar* in 2018. This figure was consistent with the production figure for 2017, as reported by VFD, which was 927 kg. Based on this figure, it means that in 2018, income generated from prawn collection was about VUV 936,000 (USD 7488).

Based on the 2018 production figure of 936 kg, this would mean that monthly production is around 78 kg. This is a 22% decrease from the *ad hoc* historical information that 100 kg used to be exported per month more than a decade ago. This decrease may indicate a decrease in stocks. However, other factors could be at play and a more in-depth study is needed for verification, especially given the responses from all collectors that there was no observed decrease in the prawn stock based on their catch production.

Given the significance of prawn collection to food security and livelihoods, and the increasing demand as shown by constantly increasing prices (Fig. 3), collectors agreed that control measures should be put in place to ensure long-term sustainable benefits, and that such measures should focus on protecting juveniles and berried females. However, to put in place effective management measures, understanding the reproductive biology of the prawns is critical (Sethi et al. 2014).

Today, the fishery remains open access with no management controls in place, either from the community or VFD as the government agency responsible for the sustainable management, conservation and development of fisheries in Vanuatu.

Acknowledgements

We would like to acknowledge the 12 prawn collectors from Naone community who gave their time and provided valuable information towards this study.

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Vanuatu sea cucumber fishery opens under a strengthened quota management system

Rocky Kaku,¹ Ajay Arudere² and Jason Raubani³

Background

The sustainable management of sea cucumber fisheries is a challenge due to the high value and highly lucrative price offered for sea cucumber products. The aggressiveness and demand from the Asian market continues to be the key catalyst in the increase in fishing pressure on these resources (Kinch et al. 2008), and the reality in the Pacific Islands region as a whole is that countries struggle to keep up with the demand. The result is evident through the boom-and-bust characteristics of this fishery.

Sea cucumber harvesting in Vanuatu began in the early 19th century but no form of management was in effect until after independence in 1980. Management practices since then have continued to evolve. Figure 1 documents the phases of harvest since the 1980s, and the management measures applied during those phases as revised and updated from Léopold (2016).

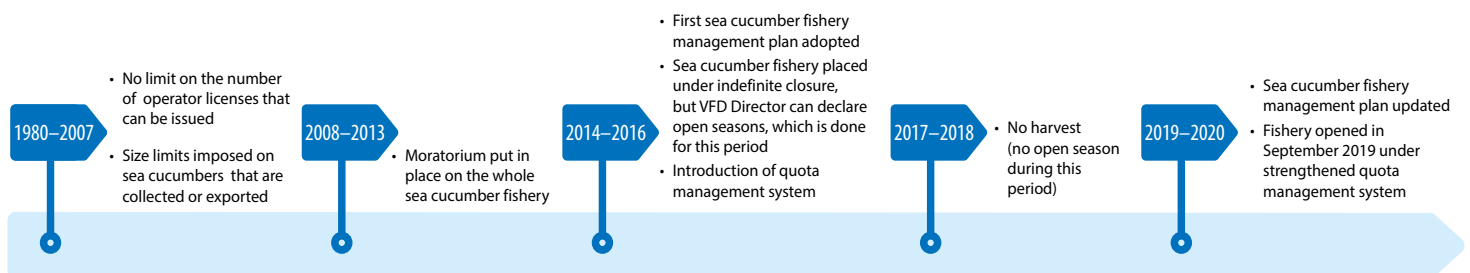


Figure 1. Harvesting phases, and the management measures and approaches applied.

In 2014, there was a notable change in management, from imposing a simple regulatory measure of size limits, to a more complicated quota system of spatial total allowable catch (TAC) and a short nationwide fishery opening that was guided by a fishery management plan and regulated by comprehensive fisheries regulations. This is a clear demonstration on the part of the Vanuatu government to come up with effective and efficient management controls for its sea cucumber resources. However, despite that, exploitation and overfishing continued, mainly due to ineffective control and monitoring of the quota management system, which was developed in collaboration with the Institute of Research for Development (IRD) and the Northern Province of New Caledonia. The Pacific Community (SPC) provided technical assistance with reviewing and updating the fishery management plan.

In 2019, Vanuatu again declared an open season after the fishery had been closed for two years. This time, through the recommendation by Léopold (2016) and through an independent review, Vanuatu decided to review the 2014 sea cucumber fishery management plan with a view to incorporating new and innovative ways of strengthening the measures in the quota management approach.

Purpose

In this article, we discuss the new strengthened measures, how these are different from the previous management approaches, and outline the operationalisation of this strengthened management approach. These are discussed in the context of the current open season 2019–2020. The current season was declared open in late September of 2019 and will be closed when declared TACs from all declared areas are harvested. The data presented in this article refer to the first six months of the current open season.

The framework of the strengthened management approach

Three key documents provide the framework of the strengthened management approach: the Fisheries (Amendment) Act No. 38 of 2019, Fisheries (Amendment) Regulations Order No. 98 of 2019, and the Vanuatu National Sea Cucumber Fishery Management Plan 2019–2024.

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Four key management principles underpin the strengthened management approach:

1. limited number of licensed operators,⁴
2. indefinite closures and rotational open seasons for harvest by area,
3. a quota system, and
4. effective monitoring.

These principles have their basis under the newly approved Vanuatu National Sea Cucumber Fishery Management Plan, 2019–2024 (referred in this article as “the plan”) and regulated under Fisheries (Amendment) Order No. 98 of 2019.

Limited number of operators

Since the quota system was adopted in 2014, one of the biggest challenges to ensuring effective monitoring of the total allowable catch (TAC) has been the fact that there are too many operators, thus stretching and draining the financial and human resources of the Vanuatu Fisheries Department (VFD) (Léopold 2016).

The new plan limits the number of operators to no more than two companies for purchasing, processing and exporting sea cucumber products during an open season. The intent of this is directly in response to the capacity of VFD to ensure effective monitoring.

Currently, only one company has been issued a license and it is actively operating in the current open season, which began in late September 2019. This company was set up as a public–private partnership arrangement between the Vanuatu Government and a private company that was selected through a tender process.

Indefinite closure and limited duration of declared open seasons

The plan states that the sea cucumber fishery will be managed by an indefinite closure, with occasional open seasons of limited duration. An open season is declared by the Director of VFD by area⁵ and by species, but only after 1) VFD has conducted a survey to assess the stock biomass, and 2) the results of the assessment indicate that stock estimates allow for sustainable harvesting. Once an area is declared open, harvesting is done on a rotational basis, meaning no two areas can be open for harvesting at the same time. This allows for the coordinated mobilisation of the VFD monitoring team to ensure effectiveness.

Quota system

The quota system is based on the total allowable catch (TAC). TAC is based on three reference indicators: biomass, abundance and density estimates for all species. The biomass figure is limited to the biomass of legal-size individuals, and is estimated after a stock assessment has been carried out by VFD. However, only 21–25% of the estimated legal-size biomass can be declared for harvesting during an open season, depending on the health of the stock.

Effective monitoring

Given that areas are opened on a rotational basis, the VFD team monitoring the TACs of each open area will be under less pressure and be more effective. The plan states that monitoring can be carried out in collaboration with other partners – such as provincial governments, community-based fisheries authorised officers and communities – thus allowing for better resource mobilisation on the ground and subsequently ensuring effective control and monitoring of the fishery.

How does this strengthened approach differ from past approaches?

Past approaches were market-driven, with more than one operator allowed to enter the fishery, and multiple areas opened simultaneously during an open season, resulting in limited control and overexploitation, which eventually led to the permanent closure of the fishery.

Key differences between the current strengthened management approach and past approaches are: 1) the restriction on the number of operators allowed to participate in an open season, and 2) rotational harvesting. Monitoring TACs among several buyers and exporters, and with multiple areas opened at the same time were the greatest challenges confronted by VFD during past open seasons.

In addition to the limitation on the number of operators, one of the main differences is that the current operator is a joint venture between the Government of Vanuatu and a private operator. This arrangement allows the government to be involved in the operations of the company, and to ensure that the sustainability of the sea cucumber fishery is fully taken into account.

⁴ The term “operators” refers to company(ies) licensed to purchase, process and export sea cucumbers.

⁵ According to the plan, an area is declared by the national government or provincial government as a place where certain fishing activities can be undertaken. For the current open season, an area can be a provincial jurisdiction, an island or part of an island

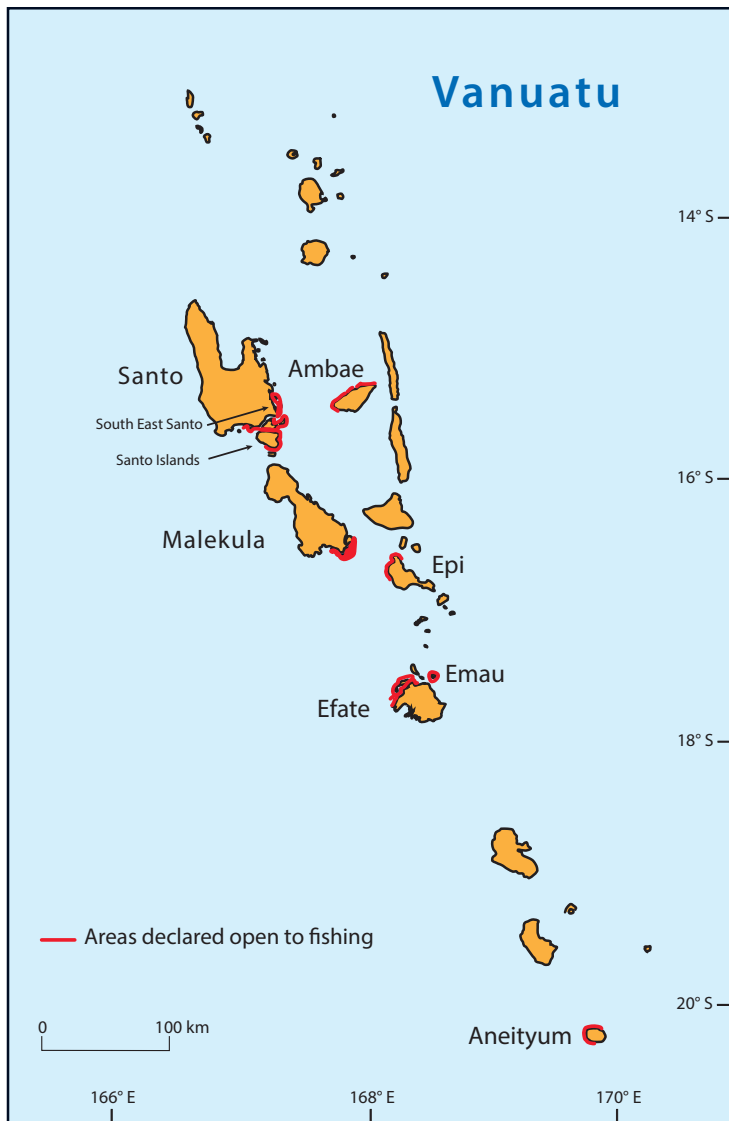


Figure 2. Vanuatu showing the declared open areas identified in red.

Operationalisation

The section that follows outlines the operationalisation of the strengthened approach.

Declaration of open season

Section 62E of Fisheries (Amendment) Regulation Order No. 98 of 2019 states: “The Director of VFD may from time to time and in accordance with the Fishery Management Plan declare an open season for the harvesting of sea cucumber in certain areas of Vanuatu”. The current open season was declared in September of 2019, and harvesting began immediately after that. The open season will be closed when the declared TACs for all areas are harvested

Eight areas throughout the country were declared open to fishing for the current open season only after stock assessments were carried out in those areas and the results showed that certain species met the healthy stock indicator of more

than 2 tonnes (wet weight) of legal-size individuals. Only those species are declared accessible for harvesting in those areas. Figure 2 shows the areas declared open to fishing.

Stock assessment and quota declaration

The stock assessment methodology involves three steps: habitat mapping, an underwater survey and data analysis.

Habitat mapping focuses on the area of interest using high resolution satellite imagery. This assists with determining categories of habitats, such as seagrass beds, inner reef flats, outer reef slopes, reef crest and lagoons. The delineation of habitat categories and sampling points are then generated using a geographic information system tool. From this, sampling points are then uploaded into portable global position system device to assist with actual field work.

The underwater survey is carried out using a 100-m transect. Each sea cucumber found within one meter from each side of the transect is counted and measured (body length and width). This allows individual weights to be calculated and sea cucumber abundance and biomass (wet weight) to be estimated in order to determine the TAC for an area.⁶ The survey is carried out by walking or wading, snorkelling or scuba diving, depending on the depths and habitat of the sample station.

The final step is data analysis. Data collected from the field survey are then entered into BDMER, a predefined VFD database, which is designed to integrate and process data for estimating invertebrate stocks (sea cucumber, trochus and green snail).

The BDMER database calculates the TACs. For each area, TACs are only provided and declared for species that have stocks of legal-size individuals that exceed 2 tonnes in wet weight. The dry weight of each TAC is also estimated for verification during export operations (hence, the exported volume of dried sea cucumbers cannot exceed the corresponding wet weight TAC allocated).

The allocated TAC by species and area is then sent to the Director of VFD for approval and public declaration.

Following stock assessments, TACs are declared for each open area. For the current open season, eight areas were declared open with a total of 10 species allowed for harvesting. Table 1 shows the declared TACs by area and species. However, the final decision to utilise the TAC for a specific area must be made in consultation with the communities concerned, which is part of the TAC declaration process.

Because the collection of sea cucumbers is done by the community of the authorised open area, and because the quota is a collective quota, communities must agree on how the quota will be shared among them.

⁶ The formula used for the calculations of individual weight is found in Purcell et al. 2009.

Table 1. The declared total allowable catch (TAC) by area and species for the current open season.

Declared open areas	Declared allowed species	Scientific name	Declared TAC (wet weight in tonnes)
Mangaliliu (Efate West)	Lollyfish	<i>Holothuria atra</i>	4
	Greenfish	<i>Stichopus chloronotus</i>	4
	Surf redfish	<i>Actinopyga mauritiana</i>	2
	Tigerfish	<i>Bohadschia argus</i>	3.5
Ambae Island	Black teatfish	<i>H. whitmaei</i>	4
	Surf redfish	<i>A. mauritiana</i>	19
	Tigerfish	<i>B. argus</i>	2
Aneityum Island	Lollyfish	<i>H. atra</i>	101
	Greenfish	<i>S. chloronotus</i>	20
	Black teatfish	<i>H. whitmaei</i>	4
	Surf redfish	<i>A. mauritiana</i>	4.5
Epi Island	Lollyfish	<i>H. atra</i>	6
	Greenfish	<i>S. chloronotus</i>	2
	Tigerfish	<i>B. argus</i>	2
	Black teatfish	<i>H. whitmaei</i>	2
South Malekula Island	Lollyfish	<i>H. atra</i>	24
	Brown sandfish	<i>B. marmorata</i>	2
	Curryfish	<i>S. hermanni</i>	2
Emau Island	Tigerfish	<i>B. argus</i>	2
	Prickly redfish	<i>Thelotrema ananas</i>	2.3
Santo Island	Tigerfish	<i>B. argus</i>	5.5
	Prickly redfish	<i>T. ananas</i>	5
South East Santo	Curryfish	<i>S. hermanni</i>	4
	Elephant trunkfish	<i>H. fuscopunctata</i>	3
	Prickly redfish	<i>T. ananas</i>	4
	Surf redfish	<i>A. mauritiana</i>	4
	Tigerfish	<i>B. argus</i>	4
	White teatfish	<i>H. fuscogilva</i>	0.5
	Stonefish	<i>A. lecanora</i>	0.5
	Black teatfish	<i>H. whitmaei</i>	0.5

Rotational harvest

The rotational harvested principle is stipulated in section 62E (4) of the Fisheries (Amendment) Regulation Order No. 98 of 2019, and states that, “Sea cucumber must only be harvested at one declared area at a time”.

Monitoring the TAC

Harvesting is carried out by the community of the authorised open area. Prior to harvesting, VFD observers and community-based authorised officers are deployed to the authorised harvest area and station at allocated landing sites. Landing sites are chosen by the communities in collaboration with VFD. This is where the wet product is purchased by the processor and where the TAC is monitored and updated daily. Whenever a quota for an individual species is reached, collectors and the community are notified accordingly, and this information is relayed back to VFD headquarters for update. When the TAC for all species is reached, the Director of VFD declares the area closed in accordance with the regulations. During this open season, the average number of days spent harvesting in each open area was about 26 days. To assist with an effective monitoring, a standard operating procedure was developed as a guide.

Figure 3 details the declared TAC for each species in each declared open area for the current open season, and the catches made after six months.

Exports

There are two exports in the value chain: domestic exports of semi-processed sea cucumber products from the islands to the main processing base in Port Vila or Luganville, and overseas exports of final dried products to overseas markets.

Domestic exports are monitored through a shipment form filled out by the operator, and which must be attached to the shipment to Port Vila or Luganville and checked and verified by VFD upon arrival.

Overseas exports are monitored through an export permit. Out of 11.69 tonnes (dry weight) that were declared authorised for export, over 4.4 tonnes have been exported so far. Figure 4 shows the export composition by species.

Summary

Although the current open season is still underway, it seems that, so far, the strengthened management approach is holding up well. The management frameworks are clear and the mechanisms for operationalising the approach under the three legislative and policy frameworks have helped with

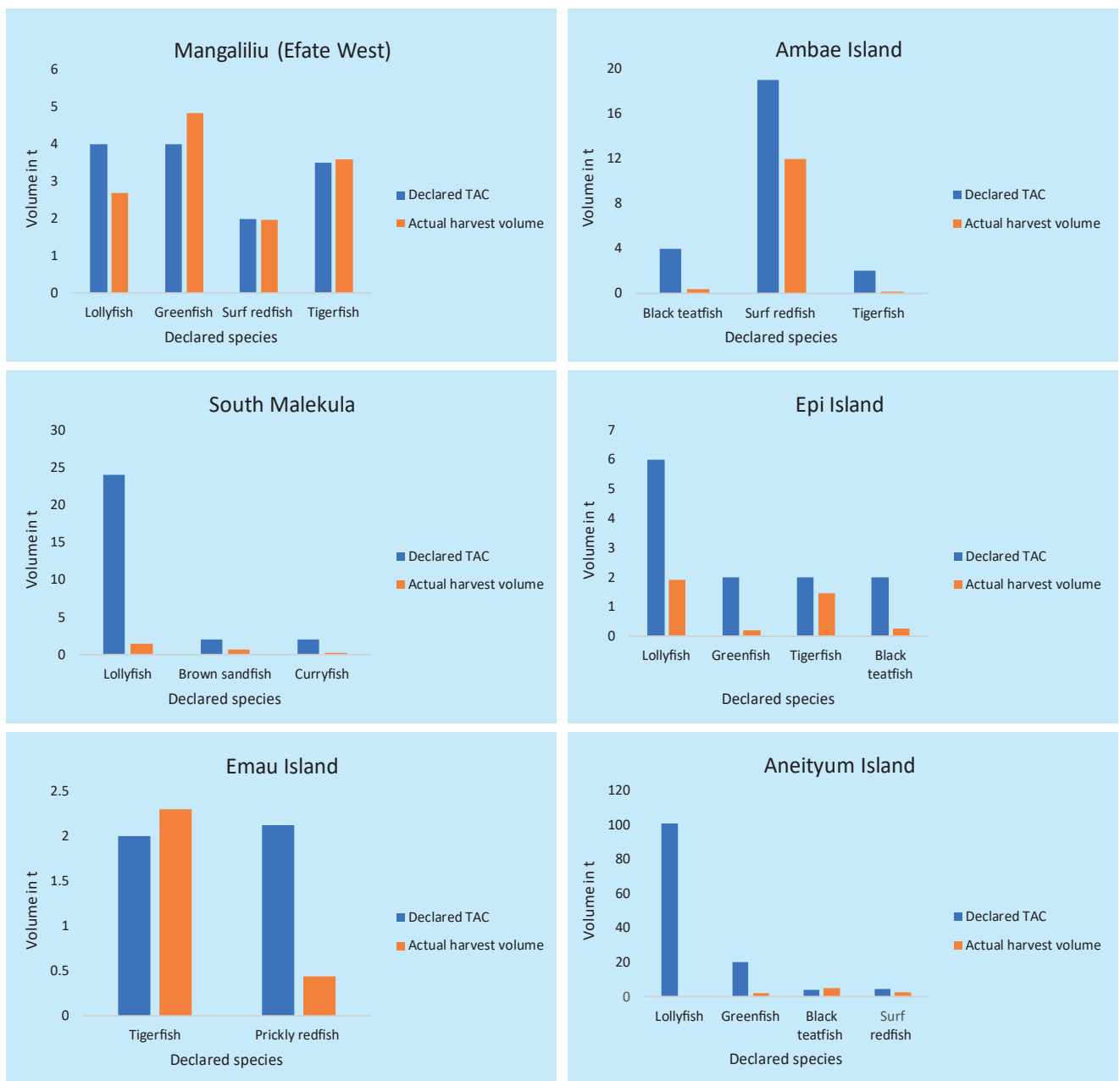


Figure 3: Volume harvested after six months of operation in six of the eight areas declared open to fishing and total allowable catch by area and species in each of these areas for the 2019–2020 open season.

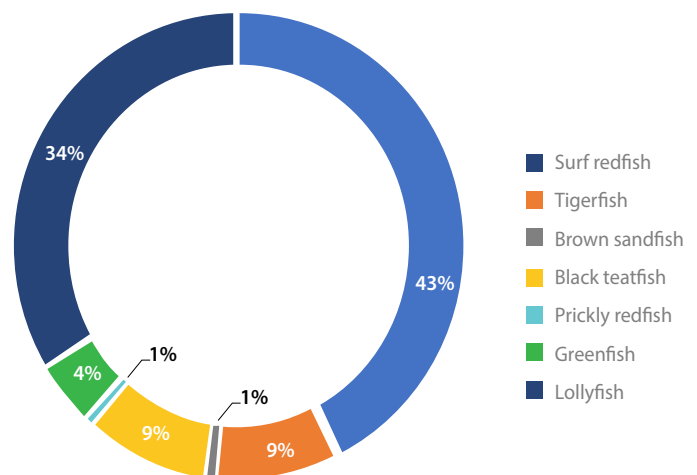


Figure 4: Overseas export composition by species after six months of operation.

implementation. For example, the process, guidelines and standard operating procedures for the stock assessment, declaration of open and closed seasons, declaration of TACs, and monitoring of the TACs help in the smooth implementation of the approach.

The company operating in the joint venture arrangement has complied well with government laws and policies in the purchasing, processing and exporting of sea cucumber products.

Despite that, the human and financial resources dedicated to monitoring the fishery will need to be increased in order for monitoring to be more effective. Other challenges include the absence of a clear process or guideline to address what happens when the actual harvest goes above the declared TAC, and monitoring TACs when there is more than one landing site per open area. Figure 3 shows that the actual harvest for some species in the two areas overshot the declared TAC. VFD will need to put in place a mechanism that addresses this issue. In addition, Figure 3 shows that many TACs were not fully utilised in areas already covered for harvest, and VFD will need to understand the reason why, and think of ways to address this issue. This is critical in a business sense because a declared TAC equates to a monetary value and could put VFD under considerable pressure to ensure declared TACs are meaningful.

VFD will continue to learn and strengthen its management approach to ensure the sea cucumber fishery continues to benefit the people of Vanuatu, especially those in rural coastal communities, while still remaining sustainable.

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A survey to illuminate Fiji's domestic fish trade

Robert Gillett¹ and Kolinio Musadroka²

Background

In the past several decades, Fiji's major urban areas have expanded considerably, both in physical size and in population numbers. This enlargement has usually been accompanied by a depletion of coastal fishery resources close to the cities, and fish for urban residents has to be sourced from new areas. Entrepreneurs have seen opportunities for transporting fish from underexploited fishing grounds to major population centres, especially Suva, and a significant domestic fish trade has developed. An understanding of this trade is important for fisheries development and management purposes. In addition, an important aspect of food security in the country is the need for a good understanding of the domestic fish trade and its associated vulnerabilities.

A study on Fiji's domestic fish trade,³ summarised here, was supported by a grant from the David and Lucile Packard Foundation. It was carried in early 2019 and involved work in the greater Suva area, with excursions to Vanua Levu (Labasa, Nabouwalu, Savusavu), Kadavu (Vunisea), and around Viti Levu (Navua, Sigatoka, Nadi, Namaka, Lautoka, Ba, Tavua, Rakiraki, Korovou, Nausori). A large number of people contributed information to the study, including people at the Ministry of Fisheries, shipping companies, fish vendors, non-governmental organisations, seafood and transport firms, ice-plant operators, universities, and fisher associations. Altogether 87 individuals were contacted during the study.

Very little data on Fiji's domestic fish trade are available. Although the fish market survey conducted by the Ministry of Fisheries could conceivably be used for a study of domestic fish marketing, past budgetary cutbacks have meant that data have not been available for several years. Given the paucity of data, the methodology of the present survey relied heavily on discussions with stakeholders in the trade, and as a result, has many of the limitations associated with relying on anecdotal information. It is recognised that there are incentives for some stakeholders, especially the major private sector players in the fish trade, to give incorrect information. This deficiency was partly mitigated in the following ways:

- A large number of individuals were interviewed. When gathering information on important aspects of the study, replies from multiple people were considered, with more weight given to statements by people who do not have reasons to misreport.

- Experienced officers of the Ministry of Fisheries (20 contributed to this survey) were able to provide non-biased assessments on many subjects.
- The two authors of this report have a combined involvement in Fiji fisheries spanning 50 years, and are quite familiar with many of the individuals and most of the issues involved. This enabled the authors to ask questions for which they knew very well the answers, enabling the relative credibility of respondents to be established.

Despite the above efforts to compensate for the use of much anecdotal data in this study, the fact remains that the scarcity of good data on Fiji's fish trade means that results of the study should be considered indicative, rather than accurate.

Results

Because it is generally recognised that much of the fish sold in Suva's urban region comes from the north coast of Vanua Levu, the survey was initially focused on that area.

The survey revealed that fish marketing in Labasa and other places on the north coast of Vanua Levu is characterised by: a) fish production that is many times greater than the absorptive capacity of the local markets, and b) the presence of few resorts or up-market restaurants in the area, which means that premium prices for high-value species can only be obtained elsewhere.

Estimates obtained from knowledgeable individuals (fish vendors, middlemen) indicate that from 70% to 90% of the fish caught in the area is sent to the greater Suva area, with a small amount going to Nadi for air export.

Because almost all of the Labasa-Suva fish trade is carried by trucks travelling on the Nabouwalu to Natovi ferry, the number of fish-carrying trucks each week on those ferries can be used to estimate the flow of fish. During the present survey, two students studying fisheries at Fiji National University were employed to count fish trucks waiting to board the Nabouwalu–Natovi ferry. In summary, that sampling – together with some speculation on the dynamics of the fish trade – suggests that the amount of fish shipped on the Nabouwalu–Natovi ferry is somewhere around 5000 tonnes per year.

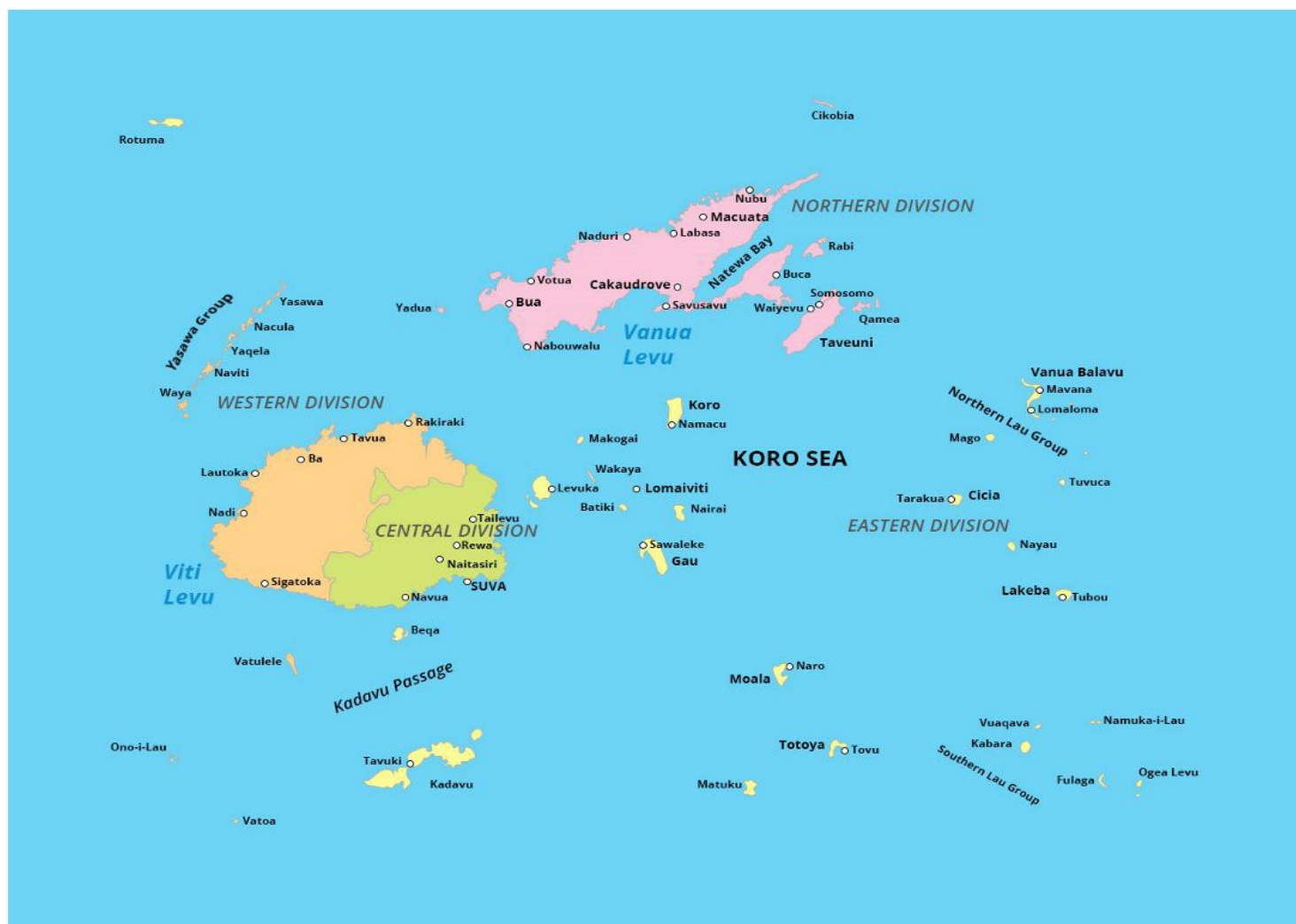
¹ Director, Gillett, Preston and Associates. Email: gillett@connect.com.fj

² Consultant, Labasa, Fiji.

³ Gillett R. and Musadroka K. 2019. Aspects of Fiji's domestic fish trade. Gillett, Preston and Associates for the David and Lucille Packard Foundation. 30 p.



Trucks (some of which are carrying fish) waiting in the Nabouwalu queue to board the ferry to Natovi on Viti Levu. (Images: Robert Gillett)



Fiji, showing the four geographic divisions covered by the survey. The Natovi ferry landing is located close to Tailevu.

The other results of the survey can be summarised as follows.

Western Division	The major flow of fish in the Western Division is from Ba (and to a lesser extent Tavua and Rakiraki) to markets in Lautoka, Namaka, Nadi and Sigatoka. This represents a movement of fish from areas with excess labour and low-income farm consumers to areas where there is much cash employment and tourism. Another major feature of the fish trade is that fishers who fish near resorts (or pass close to them while transiting from the fishing areas) will use the opportunity to sell as much fish at premium prices to the resorts, before proceeding to sell the remaining fish at lower prices at landing sites and markets. Only a very small amount of fish is sent from the Western Division to Suva.
Eastern Division	The Eastern Division is characterised by a small population, lack of sites where significant amounts of fish are marketed, poorly developed transport to Suva, relatively low exploitation of coastal fishery resources, and (with the exception of Kadavu) few resorts. Lomaiviti, Kadavu and Lau send small quantities of fish to Suva, but estimating the amounts is difficult.
Central Division	The main feature of the Central Division with respect to the national fish trade is that the markets of the Suva area serve as a destination for almost all the fish exported from the Northern and Eastern divisions – but only a small amount from the Western Division. By far the largest source of fish sold in Suva is northern Vanua Levu. A significant amount of fish comes from teams of divers based in Nabukalou Creek, Bailey Bridge, and villages north of Korovou that make multiday trips to places as far away as Vatulele and Vanua Levu.
Major Suva area fish markets	The main fish markets in the greater Suva area are Nabukalou Creek, Baily Bridge, Laqere and Nausori, and many smaller sites. There is a complex web of fish marketing arrangements in Suva (e.g. markets, fish shops, roadside sales, restaurants), and almost no data are available for any of the components.
Coastal fish exports	Data from the Fiji Customs and Revenue Service show that in 2016 and 2017, Fiji's exports of coastal fish amounted to 434 tonnes and 451 tonnes, respectively. Chilled fish are exported by air from Nadi, while frozen whole fish and fillets are exported mainly by sea from Suva.
Fiji's offshore catch in the domestic fish trade	For 2017, 17,149 tonnes of tuna and other species were landed by longline vessels, of which 13,852 tonnes of tuna were processed and exported, while 3297 tonnes were sold locally. Currently, areas as far from the Suva longline bases as Savusavu and the resorts in the Western Division purchase longline bycatch.

In summary, the short period of the survey was inadequate for making good estimates of some of the major flows of fish in the country, but it allowed some educated guesses.

- Longline exports: 14,000 tonnes
- Longline bycatch sold domestically: 3700 tonnes
- Labasa to Suva: 5000 tonnes
- Ba to urban areas and resorts in the west: unknown but probably large
- Areas of the Central Division to the greater Suva area: a crude guess is about 500 tonnes
- Coastal fishery exports: 450 tonnes

The most surprising result of the survey was the huge size of the Labasa–Suva fish trade, which is close to the most recent estimate by the Ministry of Fisheries of all coastal commercial fish production in the entire country. Other remarkable findings were the large degree to which: a) the region around Ba town supplies fish to the major urban and tourist areas of the Western Division, and b) some of the major commercial traders understate the volume of fish in some of the major fish flows in the country.

A complete report of the survey is available from the principal author at: gillett@connect.com.fj

A comparison of sea cucumber fishery management plans, and implications for governance in Pacific Island countries

Steven Lee,¹ Hugh Govan,² Ian Bertram³ and Jeff Kinch⁴

Introduction

The main objective of the Pacific Islands Regional Ocean-scape Program (PROP) is to strengthen the shared management of selected Pacific Island oceanic and coastal fisheries, and the critical habitats they depend on. Funded by the World Bank, PROP aims to improve environmental and resource quality in the Pacific Islands region in order to increase the economic benefits generated by the sustainable management of the region's oceanic and coastal fisheries, and the critical habitats that sustain them.

One component of PROP is to improve the management of sea cucumber fisheries and the beche-de-mer trade of PROP-recipient Pacific Island countries (PICs), including selected Melanesian Spearhead Group countries. For this paper, sea cucumber fishery management plans for eight PICs were reviewed in order to: 1) understand the various management approaches adopted, 2) identify their strengths and weaknesses, and 3) work towards a minimum standard for national sea cucumber fishery and beche-de-mer fishery trade management throughout the Pacific Islands region.

Sea cucumber management plans were reviewed for the following PICs:

- Fiji (2018) draft
- Kiribati (2013) draft
- Papua New Guinea (2016, 2018)
- Marshall Islands (2012, published in 2014)
- Samoa (2015)
- Solomon Islands (2014)
- Tonga (2007)
- Vanuatu (2017)⁵

Assessment of sea cucumber fishery management plans

After reviewing the sea cucumber fishery management plans for the countries listed above, several “good”, “possibly good” and “not-so-good” ideas were identified. This article summarises these ideas, while providing further justification and advice for developing sea cucumber fishery management plans in PICs.

Good ideas

Inclusive committees. Including relevant non-governmental organisations (NGOs) and civil society organisations (CSOs), as well as ensuring fisher representation in management committees, will help to ensure better decision-making and management advice. When selecting representatives for committees, it is important to remember that each person may play different roles and be accountable to different groups or parts of government. One of the purposes of these committees is to achieve accountability, which can be achieved through the inclusion of other government agencies, although more importantly, independent organisations and NGOs. Representatives from national Customs, Finance and Revenue services as well as national conservation agency staff (especially in the context of the Convention on the International Trade in Endangered Species and biodiversity conservation) will be able to ensure the country's best interests – in terms of revenue and biodiversity conservation – are considered. NGOs may represent the interests of conservation, community development, and fisheries management, or represent certain constituencies (e.g. women). Fishers may be represented by resource owner groups or traditional structures, associations or cooperatives. It is important to balance the number of representatives of each organisation, including those from the exporting industry. Involving legal advisors and monitoring, control and surveillance (MCS) officers⁶ can also help make

¹ This article is a tribute to Steven Lee who was working on this and other projects at the time of his tragic passing last year. A talented young marine biologist with a passion for the ocean, Steven had so much to offer, and his presence will be missed by the seas and all who knew him.

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⁵ Vanuatu produced a new sea cucumber fishery management plan in 2019 (Vanuatu Fisheries Department 2019), after this study was completed.

⁶ MCS officers include fisheries officers, custom officers, export inspectors

policy more sensible, practical and enforceable and, therefore, may help improve compliance and/or conviction rates.

A national management plan acts as a baseline. A local or subnational rule cannot be more permissive than the national one. The vast majority of sea cucumber management plans include this measure, but few state it as clearly as Papua New Guinea's 2016 and 2018 plans, which state that: "The Maritime Provincial Governments will be responsible for implementing the Management Plan at their respective levels; this includes the ability to set a lower Total Allowable Catch (TAC), higher size limits, longer closed seasons, new provincial and Local Level Government management strategies, must not conflict with this Management Plan."⁷ However, given the capacity constraints prevalent at the subnational level in most PICs, it is important not to rely on decentralised mechanisms unless provisions are explicitly made for their support.

Limiting access. Short open seasons are easier to monitor and enforce than long ones, and can be timed to take into account factors such as the target species' spawning season, which should protect stock replenishment, particularly if the species aggregates in order to breed. Other factors include times when overseas market prices are highest or when cash needs for fisher communities are most pressing. These three factors may not intersect at the same time, but due consideration should be given to each when determining open seasons.

Encourage local participation in the fishery. Priority should be given to local businesses to participate in the fishery, but not if subsidies are required. Solomon Islands' 2014 sea cucumber management plan does this by requiring processors to be citizens, and reserving 10 out of 15 export licences for citizens. Prioritising or reserving licenses for local businesses supports the employment of nationals, and may benefit the local economy if enforceable, as local businesses are more likely to retain and invest any income earned in-country.

Size limits. Wet and dry minimum size limits should be based on biological information, and set well above the size at which 50% of the population can reproduce. Wet sizes will be most useful for fishers in order to avoid catching animals that, upon processing, will be undersized, but live animals' sizes are harder to enforce given the flexibility of the animals. Therefore, dry sizes at the point of purchase or export should be most emphasized. Size limits are an essential component of any sea cucumber fishery management plan, and enforcement of these should be prioritised. The Melanesian Spearhead Group's agreed size limits (Govan 2018) are a good start but should be regularly reviewed.



Nine published or draft sea cucumber fishery management plans were reviewed to understand the management approaches adopted in eight different Pacific Island countries.

⁷ Papua New Guinea National Beche-de-mer Fishery Management Plan 2018, Section 6: Joint Management.



Live sea cucumbers' minimum sizes are hard to enforce given the flexibility of the animals; controlling minimum dry sizes at the point of purchase or export will be a lot easier (image: SPC)

List of permissible species. Such a list would make monitoring and enforcement easier, and would help to prevent a previously unknown species from becoming commercialised before there are any relevant management measures pertaining to that species. TACs can also be set to “zero” for permissible species that are deemed to be overharvested.

Restricting harvest methods. All of the previously mentioned PIC sea cucumber fishery management plans prohibit certain harvesting methods, most notably the use of an underwater breathing apparatus (UBA). However, when writing legislation that restricts harvesting methods, how these restrictions will be monitored and enforced should be taken into consideration, especially if a case is taken to court. Ambiguous wording should be avoided.

Tonga's 2007 sea cucumber plan has a good example of clear wording that aids monitoring and enforcement: “Sea cucumbers must be collected only by wading and freediving. The use of artificial breathing apparatus (SCUBA, hookah) to take sea cucumbers is banned. Any person found in possession of sea cucumbers in a boat that carries artificial breathing apparatus will be guilty of an offence.”

Export restrictions. Define a limited number of allowed export points (e.g. any sea cucumber products bound for export may only pass through Airport “x” or Port “y”. This helps to create bottlenecks where monitoring, control and surveillance can be concentrated, and helps to close loopholes where a product is able to be exported through a port without the capacity to properly monitor and inspect.

Restrict the number of export licences. Have a fixed number of export licences available per year, or per season, with the number of available licences capped at a sensible limit. The total amount of product allowed for export under each licence could be stipulated in an effort to enforce national catch limits. Regardless of how well the fishery may be doing, it is important to not issue more licences than the limit stipulates; instead, licence fees should be increased. Restricting the number of export licences also brings in the possibility of auctioning off licences.⁸

Standardised labelling and packaging. This makes monitoring easier, which is an essential step as beche-de-mer in PICs are almost exclusively for export and may transit through other PICs.

⁸ Table 1 of the SPC, 2015. Tonga Sea Cucumber Fishery Advisory Note (March 2015) is a good case for increasing export licence fees rather than the number of export licences issued. While the fishery apparently did well – based on export tonnage alone – from 2009 to 2010 export licence fees increased by 1500%, yet there was still a strong demand for these licences; demand only began to decrease as it became apparent that the fishery had once again been overfished (2011 onwards).

Involve customs, central bank and tax authorities in export permitting, inspections, data collection and cross checking: Involving other relevant authorities or organisations in the permitting process increases bureaucracy, but has the added advantage of increased checks and balances, thereby reducing opportunities for corruption. It also provides the opportunity to levy taxes to ensure that a greater proportion of the value of the beche-de-mer trade stays in the nation and can contribute to management costs.

Solomon Islands' Ministry of Fisheries and Marine Resources (MFMR) introduced an additional check in 2017, involving the Central Bank of the Solomon Islands (CBSI). Exporters must declare the freight on board (FOB) cost of the consignment to MFMR (a sales contract is a required document), and MFMR will then provide a Market Price Certificate to the exporter. This Market Price Certificate, along with a letter of credit from a commercial bank, is taken to CBSI in order to apply for Specific Authority approval to export the consignment. If approved, the exporter must then take the approved Specific Authority and a bank guarantee to the Department of Customs. The goal of this system is to prevent exporters from under declaring the value of consignments, which ultimately undercuts government income in the form of duties and taxes; Solomon Islands has a 10% levy on sea cucumber exports.

Annual report and/or evaluation of the state of the sea cucumber fishery. Some countries (e.g. Vanuatu and Solomon Islands) have produced reports on the sea cucumber fishing season. These reports, preferably carried out by an external agency or adviser, give an opportunity to assess the status of the sea cucumber fishery and, in particular, evaluate how well the management plan is functioning and what improvements can be made.

Possibly good ideas

Minimum price guide for fishers, sellers and buyers. This would prevent fishers and sellers from being underpaid, although this may be tough to enforce and would need to take into account the different grades of each species and the specific ways that market and value chains operate in a given PIC. It may not achieve the desired effect to make this a legal provision, although ensuring fishers have information on market prices is important.

Minimum price guide for export declarations and export levies. This would help to determine export value and more accurate export levies. A minimum price guide reduces exporters' understating of the value of their exports, and transparent export values may enhance the ability of fishers to demand fairer prices.

Auctions. Auctioning export licences may increase income from licensing fees. Auctioning the final product is likely to obtain the best possible price from importers (Carleton et

al. 2013). An auction of confiscated beche-de-mer in Solomon Islands is thought to have generated between 6 and 10 times the value per tonne as declared in the previous year of export (Anon. 2016). Vanuatu's draft 2017–2022 sea cucumber fishery management plan is the only one in the region that requires the final product (i.e. "dried products") to be sold by way of auction, and it rightly requires that "minimum export grades, standards and prices shall be set for all products". What raises concern is that before auctioning can become feasible, appropriate legislative support and procedures for auctions are needed.

Compliance bond. Papua New Guinea utilised these for exporters in their 2016 and 2018 management plans. It is a bond (PGK 50,000 = USD 15,000) that is held as a security by the fisheries authority in case the exporter violates a law. If a law is violated, the compliance bond is forfeited to the management authority. If the licensee commits no infringements during the season, the compliance bond rolls over to the next season, and if the licensee operates throughout the entire licence period with no infringements, the bond is refunded to them. The compliance bond is a good way of ensuring that fines are paid without the burden of extensive judicial processes. It is possible, however, that not all PICs are able to legally support this mechanism.

Not-so-good ideas

Unclear structure of management and committees. If there is delegated authority for the management of the sea cucumber fishery and beche-de-mer trade between national (e.g. management committees or governing boards) and lower-level authorities (e.g. provincial or island management committees or councils), then clear lines of communication need to be established and adhered to in order to avoid confusion over management decisions at the different levels (e.g. who determines the number of export licenses to be issued). All management decisions made by lower-level authorities must not contradict or contravene the respective national legislation regarding the sea cucumber fishery and beche-de-mer trade. Finally, for the sake of transparency and accountability, the affiliation of all committee members within national and lower-level authorities should also be stated, along with the number and type of representatives that are allowed to be on these committees. Provision should be made for public disclosure of documentation, decisions and licencing procedures, as well as mechanisms for addressing complaints.

Undefined time frames. One of the management plans we reviewed stated that quotas and size limits should be reviewed "from time to time as deemed necessary". This is in contrast to PNG's National Beche-de-Mer Fishery Management Plan, which is reviewed by the National Fisheries Authority every two years (PNG 2016). PNG's plan was updated in 2018, with roughly six notable changes; the other PIC did not update its management plan for more



If sea cucumbers can only be collected by wading or freediving, they remain accessible to most coastal community members, as these techniques only require very basic fishing gear.
Woman gleaning sea cucumbers in Palau. (image: Mecki Kronen, SPC)

than 10 years, despite the fishery continuing to operate and new information that could aid the fishery's management becoming available. Undefined timeframes risk prolonged delays without reasonable justification.

Quotas, cut-off points and triggers. The use of quotas has proven challenging to enforce effectively. In almost all cases where they have been set, quotas have been dramatically exceeded. Given the effort required to establish biologically meaningful figures, and in particular, the logistics (communications, data-handling, coordination) required to implement them, they should be avoided as a primary management tool.

Export quotas. Export quotas might be worth considering as part of a licencing system but they may incentivise discards of lower-value specimens. Careful consideration is required before implementing these.

Lack of definitions for terms used in the management plan. For example, "sea cucumber ranching" is permitted in all of the nine management plans reviewed, although the term is only defined in two: Kiribati's 2013 draft plan and PNG's 2018 plan. Not defining terms used in a plan leaves

things up to interpretation. In the case of ranching, the big question is whether grow-out stock are wild caught or hatchery raised. Using wild-caught animals and then growing them out to legal size undermines the effectiveness of minimum legal size limits.

Promotion of unproven and/or over-complex approaches.

The national fisheries agencies of most PICs are underfunded, understaffed and overstretched. As such, management measures that are resource intensive – including quotas and measures that are simply unproven such as aquaculture for "restocking" reefs – should be avoided in favour of robustly practical and locally and/or nationally enforceable approaches based on evidence.

Advice

Get the basics right. Given the capacity constraints of many national fisheries agencies, simple and achievable approaches to monitoring, control, surveillance, data collection, reporting, size limits, limited open seasons, licensing and enforcement are required. Overall, it may be best to enforce one or two critical management tools effectively before adding others. It is suggested that national fisheries agencies consider the following two measures as priorities:

1. **Strong enforcement of minimum size limits:** A minimum size length should be set at sizes that allow a sufficient number of animals to breed. This, along with intensive and wide-coverage information campaigns, will ensure that fishers and exporters are aware of the rules and their rationale (as well as the penalties for not complying with them). In addition, systematic MCS should be carried out, focusing on exporters.
2. **Control of exporters:** Ensure that all exporters abide by all licensing conditions and comply with rules on pain of forfeiture the licence and/or accruing heavy fines. Conditions should only include exporting through certain points of export, only purchasing *beche-de-mer* at the right size limits, complying with all reporting requirements, and paying equitable prices to fishers.

Do not interfere with management and enforcement.

Perhaps two of the main reasons for the failure of sea cucumber fishery management is interference with management plans and measures, and the lack of enforcement (e.g. lifting moratoria before stocks have recovered, lifting moratoria before regulations and management systems are operational, interfering with enforcement, avoiding the enforcement or implementation of management measures). Improved governance and support for fisheries agency enforcement functions is likely to go a long way towards increasing both the sustainability and profitability of the sea cucumber fishery (Baker-Médard and Ohl 2019; Carleton et al. 2013; CFWG 2019; Purcell et al. 2014; Steenbergen et al. 2019).

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A carefully protected treasure: the Pacific Marine Specimen Bank

Annie Portal,¹ François Roupsard,² Élodie Vourey³ and Valérie Allain⁴

The treasure the Pacific Community (SPC) is accumulating at its headquarters is not precious stones and gold, but rather a wealth of science and knowledge that is constantly being expanded through the work of the Pacific Marine Specimen Bank (PMSB).

The PMSB is managed by SPC's Oceanic Fisheries Programme, which produces annual tuna stock assessments that enable the countries and territories of the western and central Pacific Ocean to determine sustainable management measures for their tuna resources. SPC's Fishery and Ecosystem Monitoring and Analysis (FEMA) Section contributes to this work by providing scientific knowledge on the biology of various tuna and tuna-associated species. The acquisition of this knowledge includes the collection and analysis of biological samples, which form PMSB. What was initially no more than a repository of specimens collected in an opportunistic manner (e.g. otoliths collected for growth studies, stomach and muscle samples collected for the purpose of studying dietary information) has, over time, grown into a much more structured specimen bank associated with a database and analysis results, and which has been expanded to include increasing numbers of species from the pelagic ecosystem in which tunas live (see box 2).

SPC and the Western and Central Pacific Fisheries Commission, as a partner in this project since 2015, are now able to provide scientists with 120,000 samples – from 38,000 specimens gathered from 120 different species – stored within the PMSB. Through the PMSB, research teams can access samples collected at extensive spatial and temporal scales, and Pacific Island countries and territories enjoy the benefit of more reliable stock assessments through a better understanding of species biology as permitted or facilitated by examination of these samples.

From collection to analysis, these specimens will go through many pairs of hands and often travel across the Pacific. These movements generate a succession of challenges from the point of view of maintaining quality in data, samples and results. Prior to analysis, the specimens may be stored for a number of years, and constant improvement is therefore needed, whether through the purchase of more modern and efficient equipment or through training for SPC staff by specialist agencies.

Sample storage

Storage is one of the many challenges in managing the specimen bank. This stage may not seem demanding in comparison with the human and financial efforts required by the annual collection of thousands of specimens, but it is an essential stage because the quality of storage and the accuracy of traceability are crucial to rapidly providing scientists with the high-quality samples they need.

At present, the vast majority of specimens are stored in freezers at -20°C. Each freezer is mapped in detail and the exact location of each sample in the freezers is known in order to be able to relocate each one as quickly as possible.

Depending on the kind of analysis to be carried out, researchers may express special sample storage requirements. With genetic analysis work, for example, the optimum storage temperature for muscle material is -80°C, whereas for histological purposes, gonads must be stored in a formalin solution and then transferred into ethanol. These requirements have led to the acquisition of new storage options, such as a deep freezer (a freezer at -80°C), solvent cabinets and desiccators.

In addition, storage capacity has increased over the years and the size of the laboratory at SPC in Noumea, which currently contains 14 freezers, totalling 9 m³ in volume, has become insufficient. SPC is, therefore, reaching out to its partners in the region and some 22,000 PMSB samples are currently in storage in Australia, in the laboratories of the Commonwealth Scientific and Industrial Research Organisation (CSIRO), in Hobart and Brisbane. In Noumea, the New Zealand Incubator Fund has made it possible to renovate a below-zero cold storage facility in 2019–2020, thus expanding Noumea's storage capacity by 30% (to 12 m³). In addition to the Noumea and CSIRO sites, SPC has funded the purchase of freezers in the main Pacific Island fishing ports in order to be able to store samples prior to their transfer. In some cases, collaborative arrangements with fishing companies has also made it possible to gain access to their storage areas.

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SPC's role is not restricted to the collection, storage and maintenance of the PMSB. FEMA teams also prepare certain samples (e.g. muscle lyophilisation, gonad fixation, otolith slicing) to make transporting them easier and safer (in an unfrozen state) to the analysis laboratories located outside New Caledonia. SPC is also deeply involved in the analysis process for certain samples.

Acquiring knowledge through sample analysis

The FEMA team is trying to gain a better understanding of the biology of top predators, including tunas, but also to understand how the pelagic ecosystem functions as a whole. More knowledge in these areas will help improve our understanding of tuna population dynamics and the influence of their environment on their behaviour, which are essential data for decision-making focusing on stock conservation.

FEMA staff have, for example, acquired high-level expertise in species identification and taxonomic assessment (see box 1). This kind of analysis is used by SPC's Oceanic Fisheries Programme to characterise the pelagic ecosystem and understand the feeding habits of tunas and other top predators.

Tunas' diet comprises a highly diverse group of prey known as micronekton, which consist of fish, crustaceans, molluscs and gelatinous organisms measuring between 1 and 20 cm. In order to understand tunas' feeding habits, it is necessary to be able to identify all forms of prey that are collected by either removing the stomachs of captured tuna in order to assess their content, or using fine-mesh pelagic trawl nets to directly catch micronekton in the ocean.

- **Stomach content analysis** makes it possible to perform qualitative and quantitative characterisations of top predator feeding habits by identifying, measuring and weighing prey, so as to enrich knowledge on trophic interactions (who eats who?) between species.
- **Trawl content analysis** from oceanographic cruises pursues the goal of acquiring new knowledge on ecosystem functioning in order to extend the study of the pelagic trophic web using stomach content analysis.

Adding value by creating and curating collections

Through the PMSB's work in taxonomic assessment and stomach and trawl content examination, SPC has been able to incorporate a range of collection types that are an integral part of the PMSB:

- reference collection of digested specimens from analysed stomach contents and whole collected specimens, preserved in alcohol-filled jars;
- collections of fish skeletons, otoliths and cephalopod beaks;

- collection of frozen specimens for the purpose of future analysis (e.g. genetic analysis);
- collection of fish radiography; and
- photographic collection of reference specimens.

Each of these collections forms a very important database for species identification purposes and research on pelagic marine biodiversity. SPC supplies them to scientists around the world in order to foster research on the pelagic ecosystem and top predator biology. It is, therefore, essential to keep these collections in good condition.

In order to learn the latest cutting-edge specimen storage and analysis techniques, the FEMA team is working with other taxonomists around the world, and team members will pursue training opportunities in museums that maintain collections. In November 2019, Élodie Vourey and Annie Portal visited the Te Papa Museum in Wellington, New Zealand. Funded by the New Zealand Ministry of Foreign Affairs and Trade, this exchange enabled them to discover the behind-the-scenes realities of New Zealand's biggest collection, which contains over 200,000 specimens and operates within a highly developed and secure infrastructure.

A museum's collections are of incalculable value. Centuries-old specimens and specimens of extinct species can be found there (e.g. the skeleton of the giant New Zealand bird known as the moa), and these are testimony to a period or a species. It is therefore absolutely essential to maintain the full range of these collections under high security. Researchers, technicians and illustrators work together in these spaces that are not open to the general public. Élodie and Annie met these people and worked for two weeks with Carl Struthers, Andrew Stewart, Jeremy Barker and Michelle Freeborn, specialists in the New Zealand National Fish Collection, whose work culminated in 2015 in the publication of an illustrated identification guide "The Fishes of New Zealand". Élodie and Annie followed and observed them through every phase of accession of the specimens to the collection (Fig. 1).

The visit to the Te Papa Museum was also an opportunity to discover their radiography system (Fig. 2). In taxonomy, radiographic images make it possible to more closely observe visible hard structures (e.g. fin spines) and invisible hard structures (e.g. vertebrae) in specimens. It is, therefore, an additional tool to assist in identification.

This experience also helped determine how to improve and develop the SPC fisheries laboratory and PMSB.

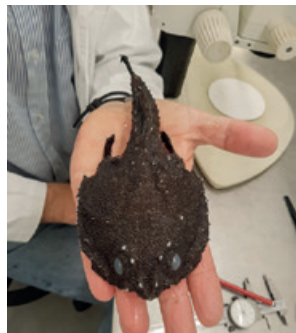
Conclusion

In order to supplement its available equipment, in 2020 the SPC Fisheries Laboratory acquired:

- a digital radiography system that can be used to conduct specimen radiographic examinations;

1 Identification

The specimens collected are examined through a stereo microscope for identification purposes.



2 Sampling and data

A muscle sample is removed from each specimen for genetic analysis. The data (species, weight, size, origin) are entered into a data base.



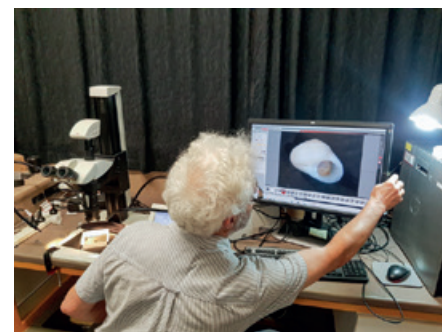
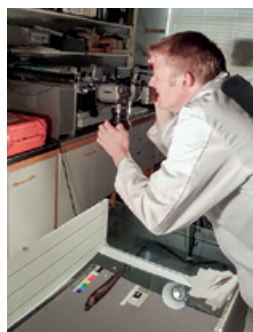
3 Fin fixation

In order to facilitate future observations, fish fins are kept open by needles on a backing and fixed with formalin.



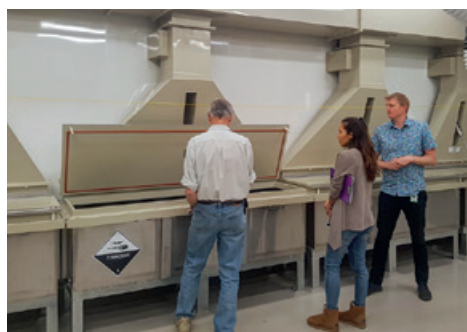
4 Photography

In a studio with dimmable lighting, the specimens are photographed in order to compose a reference catalogue.



5 Final fixation

The specimens are first fixed in formalin, then immersed in alcohol baths in gradually increasing concentrations.



6 Accession to collection

The specimens are placed in labelled hermetic containers. Te Papa has three large rooms set aside for the collection.



Figure 1. The stages in adding a specimen to a collection.

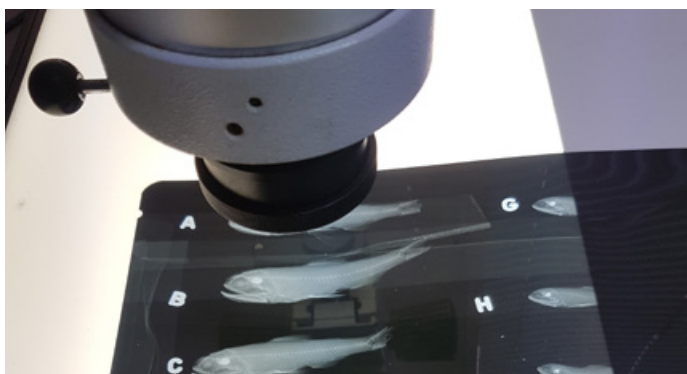


Figure 2. Reading a specimen radiography on a light table.

- ultra-low-temperature freezers (-80°C) that will make it possible to store tissue samples under optimum conditions; and
- a below-zero cold room (-20°C) to expand the PMSB's sample storage capacity.

Our aim now is to continue to develop the PMSB to make it the most comprehensive specimen and data bank possible. As part of the activities designed to achieve this goal, the FEMA team would like to create a kind of "identity card" for every specimen added to the collection. This card would include:

- a good-quality photograph displaying the features having enabled identification;
- pieces of tissue so as to be able to carry out genetic analysis;
- a radiography; and
- a summary of the bibliographical references used for identification purposes.

The contents of the sample and specimen collection managed by the PMSB help us to improve the available knowledge on the pelagic ecosystem and to contribute to better Pacific marine resource management. It is essential that this scientific treasure be very carefully curated by improving the relevant infrastructure and constantly developing our conservation and management techniques.

The PMSB has not been spared by the COVID-19 crisis. The suspension of observer embarkation on fishing vessels for health reasons, and the ban on international flights to and from many countries has made it impossible to collect new specimens at sea. But SPC and the observer programmes have

adapted to this by consolidating port-sampling operations where those have remained possible. This very unusual situation highlights the importance of tools such as the PMSB, which enable us to monitor ecosystem health and, thus, to contribute to the resilience shown by Pacific Island countries in facing major emergencies such as COVID-19. Countries' economies and social organisations are suffering throughout the region and it remains of primary importance to be able to sustainably manage primary resources, such as fisheries, which contribute to food security and economic well-being in Pacific Island countries.

Acknowledgements

The development of the PMSB is the result of commitment and support from many SPC staff in terms of securing funding, collecting samples, and maintaining and improving the facility. The FEMA team, which manages the repository, wishes to warmly thank the at-sea observers and regional observation programmes who collect specimens, partners who store such specimens in their facilities, and the organisations that contribute to funding for the specimen bank. Our thanks go also to the Te Papa Museum for their hospitality and precious advice.

Other articles on the same theme

Sanchez C., Roupsard F., Allain V. and Nicol S. 2014. Tuna tissue bank for ecosystem management in the Pacific. SPC Fisheries Newsletter 144:6–8. Available at: <http://purl.org/spc/digilib/doc/ye7y3>

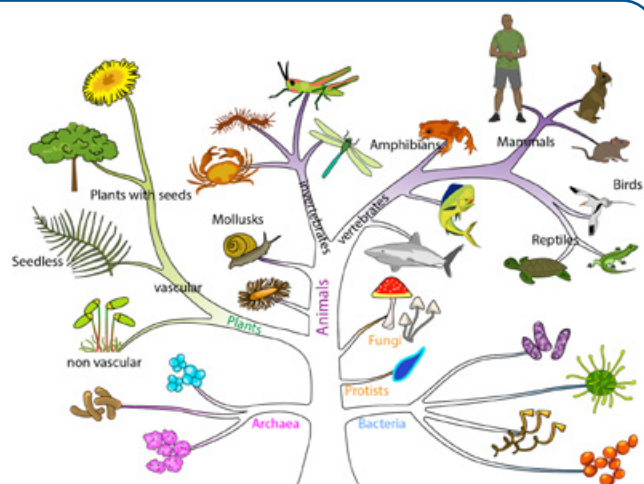
Smith N., Donato-Hunt C., Allain V., McKechnie S., Moore B. and Bertram I. 2017. Developing a Pacific Community Marine Specimen Bank. SPC Fisheries Newsletter 152:43–47. Available at: <http://purl.org/spc/digilib/doc/4kxdc>

Vourey E. 2016. CSI: Noumea! Can anyone identify this mysterious fish? Episode 1. SPC Fisheries Newsletter 150:6–9. Available at: <http://purl.org/spc/digilib/doc/yj5h6>

Box 1: What is taxonomy?

Taxonomy is the branch of science that describes living organisms and classifies them into groups called taxa in order to be able to identify and name them. A taxon, or taxonomic group, encompasses species sharing the same morphological characteristics (e.g. the number of spines in a fin, the number of bioluminescent organs, the shape of the teeth).

Taxonomic classification is structured as a tree, going from the most general (the trunk) into successive divisions (branches) that eventually lead to the most specific (the leaves). The most general level is called "kingdom"; for example the animal kingdom and the plant kingdom, and contains all animals and all plants, respectively. An intermediate taxon level is "family", such as Scombridae, which include the tunas. The species, associated with the genus, forms the most specific level; these are the leaves of the tree and, in the case of yellowfin tuna, includes the genus *Thunnus* and the species *albacares*.



The tree of life. Designed by Boris Colas, based on an illustration from the Mammoth Memory website.

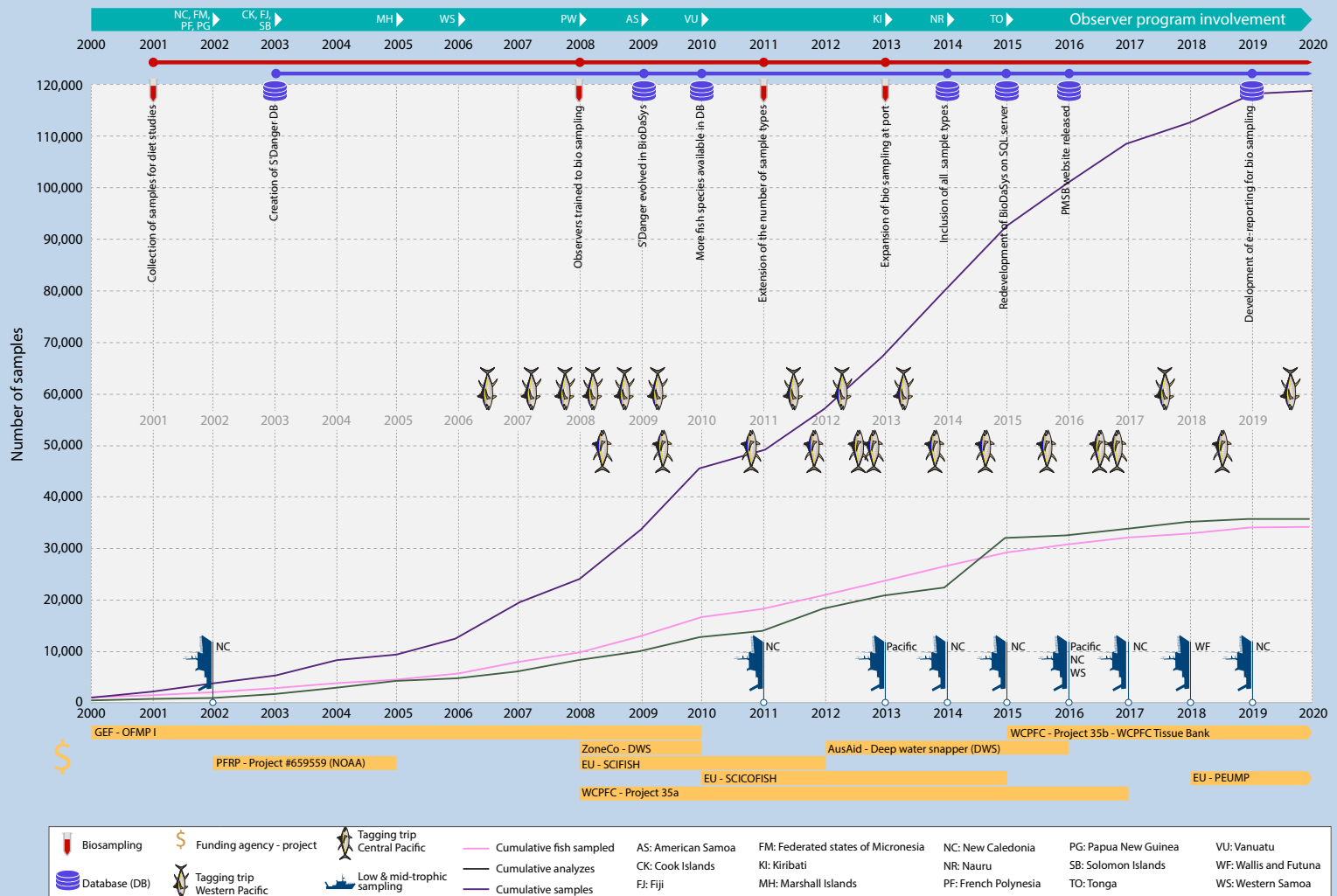
Box 2: Chronology of the Pacific Marine Specimen Bank (PMSB)

The collection of samples from the Pacific, which began in 2000, has continuously progressed. As of April 2020, PMSB had nearly 120,000 samples collected from 34,000 specimens, on which 36,000 analyses had been carried out. Some national observer programmes have participated in the PMSB since 2002, such as New Caledonia and Papua New Guinea, and other programmes have recently begun contributing.

Several events have accelerated the collection of samples:

- the launch of the tagging programme (2006) during which many samples are taken each year;
- the integration of biological sampling in the training of observers (2008);
- the addition of the collection of otoliths, spines and gonads to the collection of stomach, muscle and liver samples that was already taking place (2011); and
- the introduction of training for port samplers (2013).

Whole specimens of tuna prey (micronekton) began to be collected on a regular basis starting in 2011 during scientific campaigns on low and intermediate trophic levels (zooplankton, micronekton); these samples are available for analysis and enter in the reference collections. In parallel with the collection of samples, a database has been created, requiring regular improvements, including the creation of a website to enable everyone to query the database. This important work benefits from the financial support of many organisations.



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