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Traditional *nefu* fishing in Gahi Bay, Wallis. Image: © Leone Vaitanoa, Wallis

Around the world in an archival tag

Bruno Leroy[1]

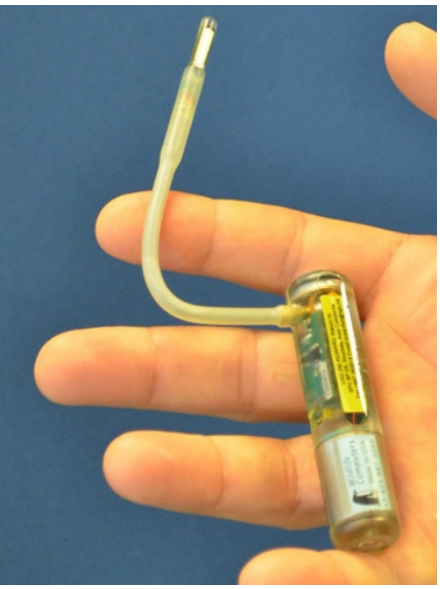

Figure 1. Archival tag. Image: ©SPC

Figure 2. Archival tag inserted into a yellowfin tuna ready for release (the fish was also tagged with a red spaghetti tag). Image: ©Fabien Forget

Tagging is used to study fish movements and behaviour. For stock management purposes, tagging can also facilitate estimates of mortality rates, whether natural or due to commercial or recreational fishing. Unless an acoustic or satellite tag is used, however, a tagged fish needs to be recaptured in order to obtain the relevant information. The probability of re-catching a fish as mobile as a yellowfin tuna, which has been tagged and released in the middle of an ocean that covers almost one-third the Earth's surface, may seem miniscule, but the reality is surprising and can produce some rather unusual stories. Here is one for you to think about.

Between July and August 2018, the Pacific Community (SPC) ran the 13th Central Pacific tagging cruise, which mostly involved sailing through the exclusive economic zones of Nauru, Kiribati and Tuvalu, plus adjacent international waters. The purpose of these cruises is to tag tuna in areas where the use of pole-and-line vessels is extremely difficult because of the lack of sufficient baitfish resources. Instead of live anchovies or sardines in baitwells, frozen bait and trolling lines are used to catch the tuna. This method is really only effective on bigeye and yellowfin tunas, and when they are associated with fish aggregation devices (FADs), whether anchored or drifting. Tuna are usually tagged with conventional "spaghetti" tags[2], but some are also fitted with an electronic tag called an archival tag (Fig. 1) that collects and records data on the surrounding environment, both within the fish and in the surrounding water body. Depth, the fish's internal temperature, surrounding seawater temperature, and ambient light, are recorded every 30 seconds and stored in the tag's memory. Inserted in the fish's abdominal cavity through a minor surgical operation (Fig. 2), the tag can be recovered when and if the animal is ultimately recaptured. Tuna tagged in the central Pacific are most frequently recovered by one of the industrial purse-seine vessels operating in the region. This is a logical outcome because more than 70% of the annual commercial tuna fish catches in the central and western Pacific are taken by purse-seine vessels. This fishery is the biggest in its category (over 35% of all tuna catches throughout the world) and provides the largest tuna canneries on the planet. It was, therefore, unsurprising that someone working in one of the canneries contacted us, using the address printed on the tag, claiming that they had come across the tag at the beginning of the canning process.

Our tags are usually recovered by one of the large tuna canneries in the Indo-Pacific region, in particular in Thailand and Ecuador, but also in the Philippines, Mexico and American Samoa. This time, however, at the end of March 2021, we were contacted by a person working in a cannery in Spain, advising us that he discovered what he thought was a kind of GPS when cutting up frozen tuna using a bandsaw. (He attached a photo to his message.)

[1] Fisheries Scientist, Pacific Community. Email: BrunoL@spc.int

[2] A spaghetti tag, also called a "dart tag" is a piece of coloured plastic tube that can be attached to a fish's back. It has a unique ID code and an address written on it that helps tag finders to report the tag.

Figure 3. Archival tag sawn in two (on the right) and acoustic tag (on the left, black) recovered at a canning plant in Spain.

Figure 4. Electronic circuitry inside the tag. When connected to components from a similar tag, it was possible to access the data within the tag's memory.

Disaster! The saw sliced the archival tag in two, destroying the battery and some of the electronic components (Fig. 3). Unavoidably, we will not be able to recover the data that this tag had recorded throughout the period the fish spent at liberty before being caught by – what we assume to be – a Spanish purse-seine vessel somewhere in the Pacific. This is truly unfortunate because this yellowfin tuna was also carrying an acoustic tag that had enabled us to detect the times when the animal was close to a FAD where it had been caught and released on 30 July 2018. Potentially, we would have been able to recover more than two years of precious data on the behaviour of an adult tuna (the animal weighed about 20 kg when tagged, which is unusual). Most yellowfin tunas are tagged when they are juveniles, and are recaptured before they reach maturity.

After a few weeks of waiting, partly due to movement restrictions due to COVID, one of the company's engineers reported back, after having spent six hours repairing the electronic circuitry (Fig. 4) in the tag, and managed to recover 136 days' worth of data. A miracle!

After glancing through the data (Fig. 5), the temperature and pressure recordings showed us that the fish was recaptured on 13 December 2018, and was probably transferred from the purse-seine vessel to a refrigerated freighter around 11 or 12 January (a temperature drop from -14°C to -19°C, suggesting that the fish was probably transferred from the fishing boat's brine well to a better refrigerated hold in a cargo ship). The fish was probably transferred at some stage from the freighter to a container ship (a further fall in temperature), where it then travelled to Spain via the Panama Canal and was stored in the container or transferred to a cold store before ending up under the not-so-tender ministrations of the cannery's bandsaw...

But that is only part of the story. This is also the beginning of a detective's job to identify the purse-seine vessel that caught our fish. If the cannery cannot trace that vessel, we would need to search through the catch transshipment data around the dates of the obvious temperature changes, and lastly try to determine the place where the fish must have been caught by locating the vessel's fishing position at the date of recovery as recorded by the tag. And all that before we even begin the detective work on the behaviour of the fish itself over the three and a half months that elapsed between its tagging and recapture! Plenty to do my dear Watson!

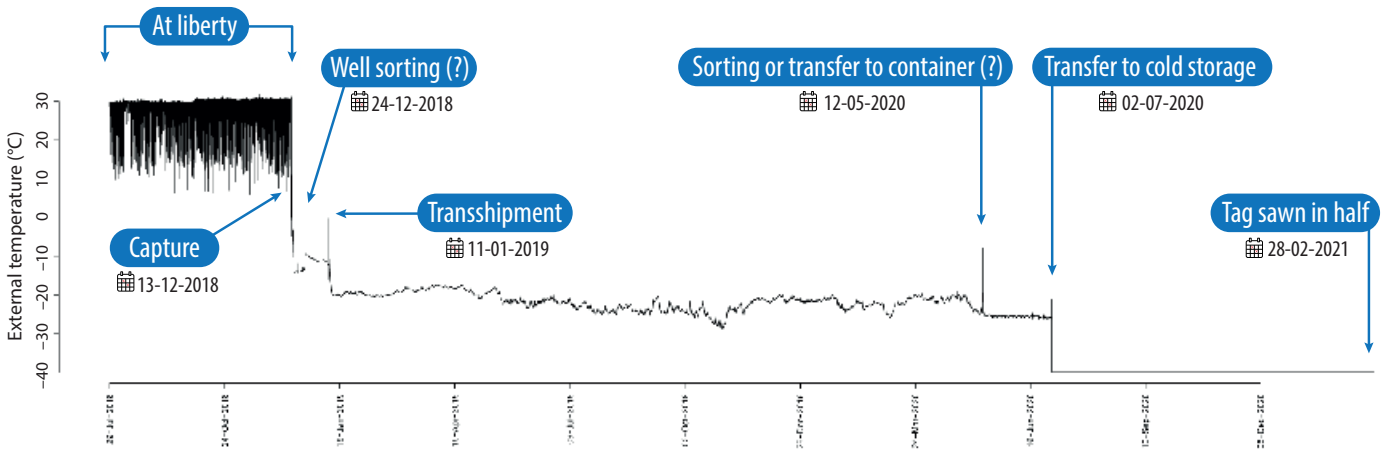

Figure 5. External temperature data extracted from the archival tag, and possible interpretations of the temperature variations over time.

A quick Zoom on the outcomes of the 17th meeting of the WCPFC Scientific Committee

Graham Pilling[1]

The Scientific Committee (SC) meeting of the Western and Central Pacific Fisheries Commission (WCPFC) is held in August each year, prior to the annual WCPFC meeting in December. It is attended by the WCPFC's 33 member countries and territories, and by observers, and examines a range of scientific issues, including data and statistics, stock assessments, management issues, and ecosystem and bycatch mitigation.

The Oceanic Fisheries Programme (OFP) of the Pacific Community has been the WCPFC's scientific services provider and data manager for approximately 15 years, which means that the SC meeting is a key period for OFP to present all of its analyses and provide the SC with scientific advice that underpins fishery management decisions taken by the Commission. This year, OFP scientists authored nearly 50 papers that provided information and recommendations to the SC across the different issues covered.[2]

The COVID-19 pandemic continues to have a massive impact on regional fishery management processes in the Pacific, and this year's SC meeting did not escape its effects. Like last year, the SC was held online using Zoom, with a shortened agenda covering only those essential issues that required SC's advice to the Commission. To help deal with other important issues, an online forum was again set up by the WCPFC Secretariat prior to the meeting in order to get written responses from members. In general, while the level of discussion was more constrained and less free flowing than it typically is during an in-person meeting, and we could not discuss all the papers submitted, the process again worked well enough to develop key scientific advice.

A key component of the SC meeting is the presentation and discussion of the latest stock assessment results for Pacific tuna and tuna-like stocks, with SC reviewing the assessments and using them to provide advice for managers on stock status and potential issues of concern, and to provide recommendations for future work to improve the next assessments. This year, the three key SPC-led stock assessments were for South Pacific albacore, performed in collaboration with the Inter-American Tropical Tuna Commission (IATTC) to cover the whole of the South Pacific; southwest Pacific swordfish; and southwest Pacific blue shark.

A key area of discussion this year was how "uncertainty" in OFP's stock assessments is captured. While the work represents the best scientific information available, OFP does not have perfect knowledge of all our key inputs. These include:

- our understanding of the biology of a stock (e.g. how good is our estimate of growth, and how well does it apply across all fish in the Pacific region?);
- our understanding of the fishery and how it has changed over time (how representative is the time series of fishery data on catch rates – e.g. the number of fish caught per day fishing – that is assumed to reflect the amount of fish in the sea?); and
- how good our assessment models are at accurately capturing what is going on in both.

Traditionally, OFP has represented the impact of that uncertainty on scientific advice by presenting the results of different assessment model runs, where each run has a different setting for those key inputs that we do not know the true values of. For example, we might run different models with alternative settings for the pattern of growth, or with different sources of fishery data included, and the spread of estimates of stock status that results captures the consequences for advice.

This approach was taken in the South Pacific albacore stock assessment, with the results of 72 different models summarised to SC17 (see Fig. 1). A key area of uncertainty was how albacore moved between areas of the South Pacific during their life. The two different scenarios used within the assessment proved influential on management advice, and SC's discussions led to one of these movement scenarios being "down-weighted" during the provision of advice (results being given half the weight of the other scenario). That advice was generally positive, but particular concern about recent declining trends in the albacore stock was highlighted to managers.

A similar approach was taken for the blue shark, but reflecting the significant uncertainty arising from the lack of information and understanding around this stock, the results of almost 3900 different models were presented. While transparently indicating the limits of our knowledge,

[1] Deputy Director FAME (Oceanic Fisheries Programme), SPC. Email: GrahamP@spc.int
[2] See https://meetings.wcpfc.int/meetings/sc17-2021

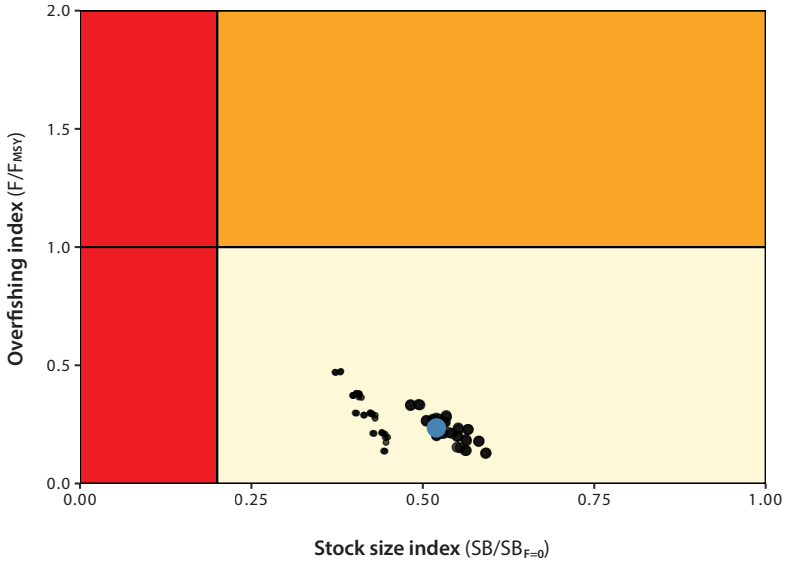

Figure 1. Stock status of albacore (*Thunnus alalunga*) in the western and central Pacific Ocean.

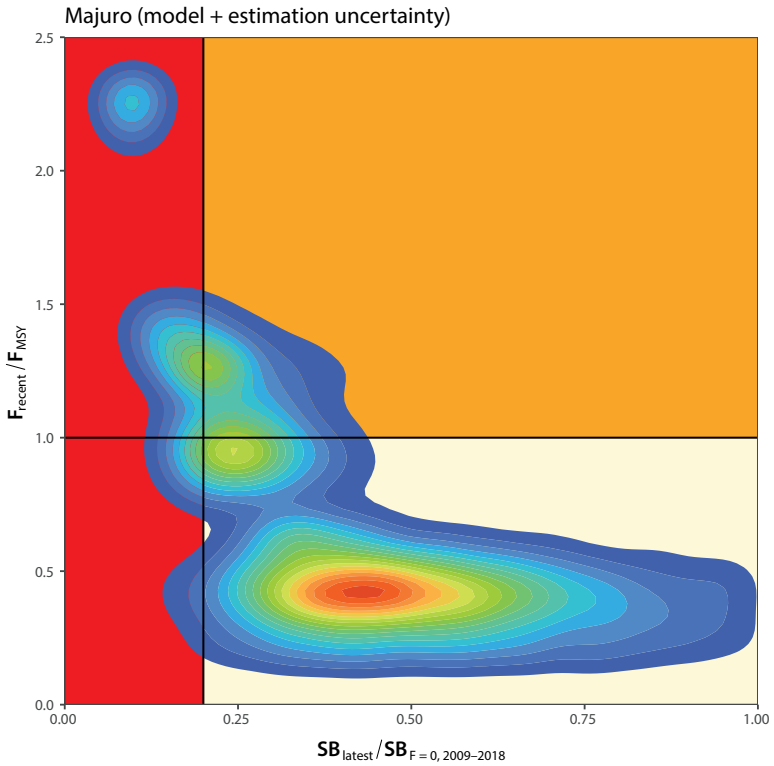

Figure 2. Stock status of the southwest Pacific swordfish (*Xyphias gladius*) in the western and central Pacific Ocean.

this was a volume of results that challenged SC members. Acknowledging that this assessment was an improvement on the last one, SC's advice for managers noted the general positive trends indicated by the models and data and identified further work to be done to refine this assessment over the coming year.

A new approach to capturing uncertainty was developed for the southwest Pacific swordfish, and discussed at SC17 (see Fig. 2). This improves on OFP's standard method and helps ensure that model settings capture more biologically plausible combinations. SC supported the approach, and OFP will be developing it further over the coming years. SC noted that the assessment results indicated that on average, this stock was not currently overfished, nor subject to overfishing.

The second half of 2021 will be a busy time for WCPFC, with an additional meeting scheduled in early September to continue discussions on the development of the Commission's replacement of the tropical tuna conservation and management measure, which should be finalised in December. OFP will be there to present the results of their analyses to help inform member's decision-making – another busy few months of Zooming ahead. Let's hope that by this time next year, we will be able to meet face-to-face. Fingers crossed!

Harvest strategies - the future of tuna fisheries management in the western and central Pacific

Nan Yao,[1] Robert Scott,[2] Finlay Scott[3] and Paul Hamer[4]

The world's largest tuna fishery is in the western and central Pacific Ocean (WCPO). Four main tuna species – skipjack, albacore, yellowfin and bigeye – are targeted by diverse fleets and fishing methods, contributing to the complexity of managing this immense fishery. For many countries in the WCPO, tuna fisheries are crucial for their economies, livelihoods and culture. However, tuna stocks will only be a dependable and renewable resource if they are managed responsibly. Poor management could lead to overexploitation of tuna stocks in the WCPO, which would have dire consequences for many Pacific Island countries.

The regional fisheries management organisation with oversight of tuna fisheries management in the region is the Western and Central Pacific Fisheries Commission (WCPFC). WCPFC has been working on building sustainable fisheries for tuna species for several decades. Under the current management framework, stock assessments, conducted by scientists using data collected by member countries through various means (e.g. observer and tagging programmes and fishery logbooks), are used to inform management decisions and measure performance against objectives. Management decisions may include measures such as limits on catches or fishing effort, or time-area closures. This approach has several limitations, however. One of the challenges is that WCPFC's membership comprises a diverse group of stakeholders with different, sometimes competing, objectives. The complex negotiations relating to management actions can become contentious and time consuming. The current management framework can also be reactive, and often focuses on achieving short-term goals at the expense of long-term objectives.

WCPFC harvest strategy roadmap – driving forward with stakeholders at the wheel

To better manage this multi-billion-dollar fishery and enable small island developing states in the Pacific to retain the benefits from the fisheries that operate in their waters, a long-term strategy is required. In response, in 2014 the WCPFC agreed to a work plan for adopting a "harvest strategy" approach for the four key tuna species (CMM 2014-06).[5] Since then, the Pacific Community (SPC), which is WCPFC's scientific services provider, has been working to support the development of the harvest strategy approach. The work includes development of technical tools and robust science to inform the development of harvest strategies combined with a comprehensive stakeholder engagement programme to ensure that all WCPFC members can actively contribute to developing strategies that will impact their fisheries. It's their fishery after all!

The latest development of the harvest strategy was presented to the 17th WCPFC Scientific Committee meeting in August 2021. The framework for skipjack is well advanced and the results of evaluations of a range of candidate management procedures has been presented to stakeholders. The framework for South Pacific albacore is fully operational and has been used to evaluate a number of exploratory management procedures. Preliminary trials of the mixed fishery framework, for a simplified scenario, indicate that the conceptual approach being explored is tractable. The development of the harvest strategy is led by stakeholders.

What is a harvest strategy and what are its benefits?

A harvest strategy is a framework that specifies the management actions in a fishery for a given species, or group of species (at the stock or management unit level) that are necessary to achieve agreed biological, ecological, economic and/or social management objectives. A central idea is that of "pre-determined" management actions. These actions are agreed on in advance, and specify what action to take given the estimated status of the stock. By determining, in advance, the management actions that should be taken for a given stock status, a harvest strategy reduces the need for negotiations, and leaves more time for focusing on other important aspects of fisheries management. It also means greater stability for industry by ensuring that appropriate management action can be taken without delay. It makes the process of managing the fishery more responsive and predictable, and thus provides all stakeholders with certainty and a clear, long-term vision of a sustainable stock and fishery.

Importantly, the development of the harvest strategy is a stakeholder-led process in which stakeholders are actively involved in all key decisions relating to the design, testing and implementation of the strategy. The harvest strategy approach provides managers with clear guidance to determine the best path forward for the fishery in order

[1] Fisheries Scientist, SPC. Email: nany@spc.int
[2] Senior Fisheries Scientist, SPC. Email: robertsc@spc.int
[3] Senior Fisheries Scientist, SPC. Email: finlays@spc.int
[4] Principal Fisheries Scientist, SPC. Email: paulh@spc.int
[5] https://www.wcpfc.int/doc/wcpfc17-att-h/indicative-work-plan-adoption-harvest-strategies-under-cmm-2014-06

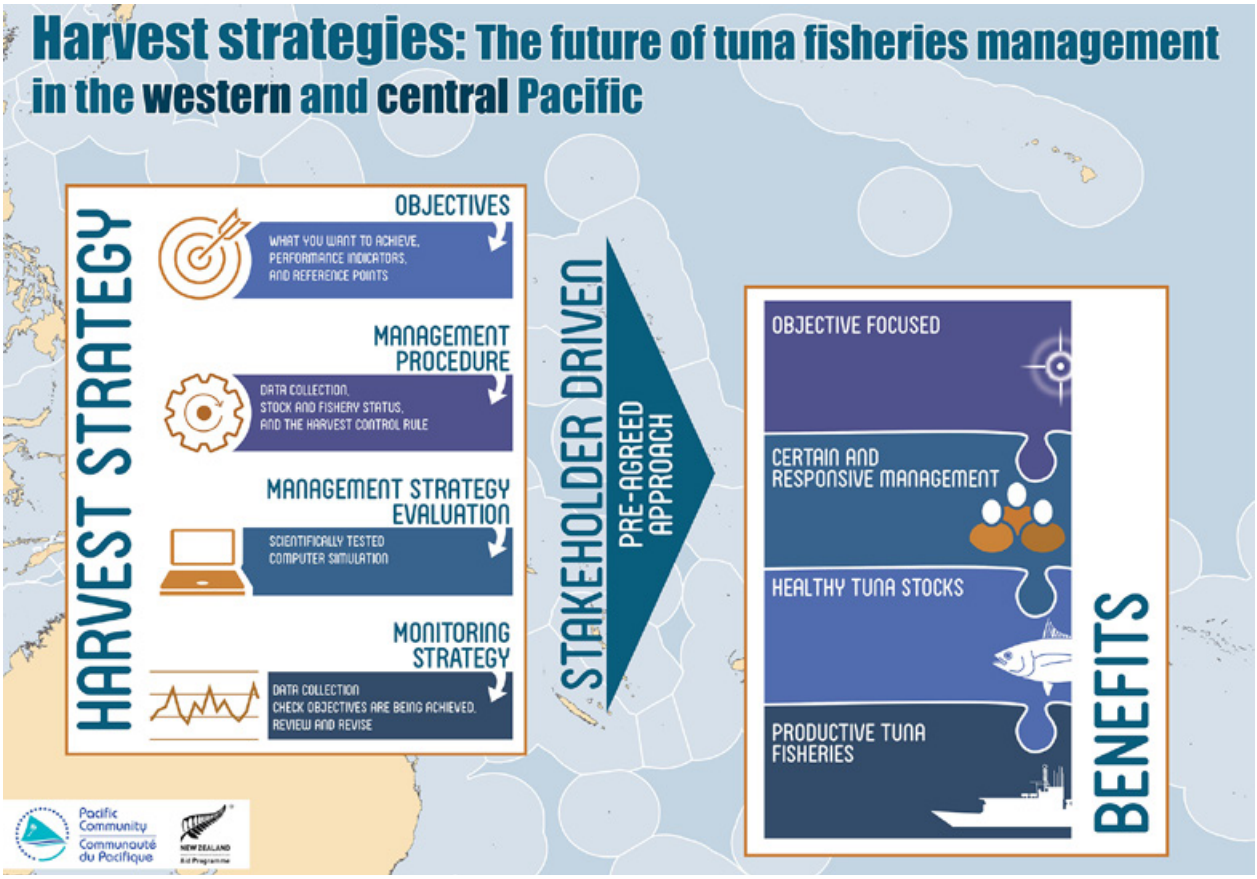

Figure 1. Key components of a harvest strategy and expected benefits. The harvest strategy framework consists of four components: objectives, management procedures, a management strategy evaluation, and a monitoring strategy. All the components of the harvest strategy are agreed upon and work together to ensure a sustainable future for the WCPO's key tuna species.

to meet the objectives. A key step in the development of a harvest strategy is stakeholder capacity building, to ensure that all stakeholders are equipped with the necessary skills to actively participate in the process.

Developing a harvest strategy for skipjack tuna: an example

The development of a harvest strategy starts with stakeholders identifying management objectives for the fishery. For skipjack, a candidate list of management objectives for the tropical purse-seine fishery was proposed by stakeholders at a dedicated WCPFC workshop.[6] These objectives are high-level and conceptual in nature; for example, "maximise economic yield from the fishery". The next step involves developing performance indicators for the objectives that describe in more detail how the objectives will be measured. For example, average expected catch may be considered as a useful indicator for maximising the economic yield from the fishery. One of the more challenging elements of the harvest strategy to develop is the management procedure, which pre-determines what management action is recommended under certain stock levels to achieve the objectives. The management procedure includes data collection, the approach that uses the data to estimate the stock status, and a control rule, often referred to as the harvest control rule. The harvest control rule is often the component of a harvest strategy that receives the most attention by stakeholders as it determines under what stock status should fishing pressure (i.e. catch or effort) be increased or decreased and by how much.

Before selecting and implementing a management procedure, many candidate procedures should be tested to see which is most likely to achieve the agreed-on management objectives. This testing process involves extensive computer simulations of the dynamics of the fisheries system to test the expected future performance of the management procedure in terms of achieving objectives. This integral step is called management strategy evaluation (MSE). MSE also incorporates uncertainties in the estimation of stock status to understand which of the various management procedures will work over a broad range of possible uncertainty. This provides greater confidence that a particular management procedure will perform adequately even when the information on stock status is imperfect.

SPC has developed a decision-making tool for stakeholders to explore and compare the performance of alternative candidate management procedures. This tool is called: performance indicators and management procedures explorer or PIMPLE.[7] Using PIMPLE, stakeholders can explore the possible outcomes from adopting different

[6] WCPFC 13 Summary Report, Attachment M - https://meetings.wcpfc.int/file/6118/download
[7] PIMPLE (for skipjack) - https://ofp-sam.shinyapps.io/pimple/

management procedures for skipjack tuna and select the ones that have the best chance of meeting their objectives.

Even when stakeholders and WCPFC members have selected and implemented their preferred management procedure, this is not the end of the harvest strategy. While the procedure is operating, a monitoring strategy is required to regularly track the performance of the fishery and compare it to the expected performance of the management procedure as predicted by the MSE. If the procedure is not working as expected, for example if stock abundance becomes too low or even too high, then revisions to the management procedure may need to be made to better optimise it. In other words, it is pre-agreed, but not "set and forget" and it definitely is not set in stone.

Stakeholder engagement

During harvest strategy development, stakeholders are required to make a range of informed decisions. Therefore, capacity building work is integral to preparing them to drive the process. Since 2018, SPC, along with the Pacific Islands Forum Fisheries Agency, has conducted in-country national harvest strategy workshops in Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, New Caledonia, Papua New Guinea, Solomon Islands and Tonga. This work has continued but moved online since the introduction of travel restrictions in 2020 (due to COVID-19), with online national workshops having been conducted for Palau, Solomon Islands and Tuvalu. The workshops do not assume any prior specialist knowledge, and provide participants with an introduction to the harvest strategy approach. Interactive activities that use a range of different training tools allow participants to explore the development and performance of management procedures. (See links below for further information.)

Interactive activities at an in-person capacity building workshop in Papua New Guinea. This activity imitates the process of identifying the objectives by stakeholders and furthers participants' understanding of the objectives. Image: Finlay Scott, ©SPC

Developing harvest strategies can appear complex at first. The workshops have been particularly successful at reaching a large number of members and demystifying many of the concepts that are often not as difficult as they seem; so far, across 17 workshops, over 260 people have been involved. Participants have reported significant improvements in their knowledge and understanding of harvest strategies by the end of the training. Feedback from participants also informs the continual efforts to improve the workshops. Ultimately, capacity building efforts will give way to a two-way dialogue between scientists and fishery managers as stakeholders increasingly take command of the development, make key decisions, and implement harvest strategies for the management of their fisheries.

Find out more

To further enable learning opportunities outside the workshops, SPC has also prepared posters, online learning materials, and videos for stakeholders to dig even deeper into the harvest strategy world! To find out more, contact our team or visit the Slack channel: tropicaltunamse.slack.com

Useful links:

- Introduction to Harvest Control Rules (https://ofp-sam.shinyapps.io/amped-intro-hcr/)
- Introduction to Performance Indicators (https://ofp-sam.shinyapps.io/amped-intro-indicators/)
- Comparing Performance of Management Procedures (https://ofp-sam.shinyapps.io/ampedcomparing-performance/)
- PIMPLE (for skipjack) (https://ofp-sam.shinyapps.io/pimple/)
- SPAMPLE (for South Pacific albacore) (https://ofp-sam.shinyapps.io/spample/)

Further reading

WCPFC. 2014. Conservation and management measures to develop and implement a harvest strategy approach for key fisheries and stocks in the WCPO. CMM 2014-16. Available at: https://www.wcpfc.int/doc/cmm-2014-06/conservation-and-management-measures-develop-and-implement-harvest-strategy-approach

Scott R., Scott F., Yao N, Hamer P, Pilling G. and Hampton J. 2021. Recent progress in the technical development of harvest strategies for WCPFC stocks and fisheries. SC17-MI-WP-03. Available at: https://meetings.wcpfc.int/node/12580

A novel approach to quantifying drifting fish aggregating device use in the Pacific

Lauriane Escalle[1]

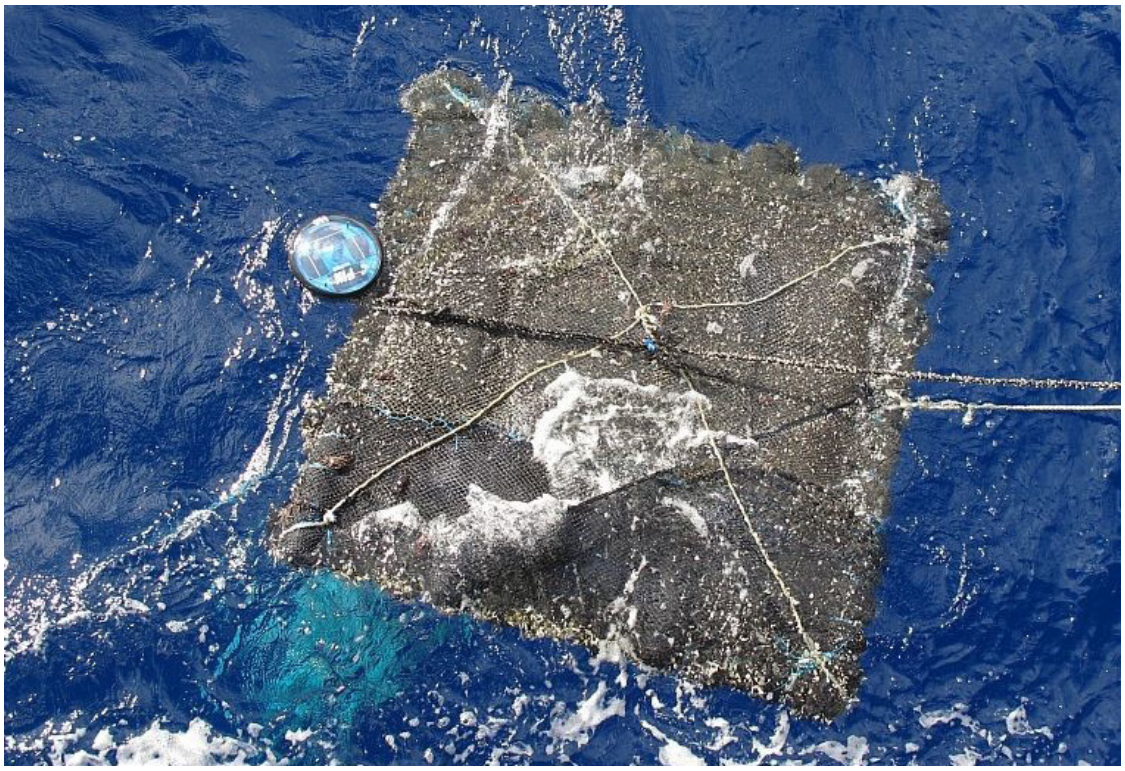

Figure 1. A drifting fish aggregating device equipped with a satellite echosounder buoy. (© SPC)

The western and central Pacific Ocean (WCPO) provides 52% of the world's five million tonnes of tropical tuna catch (Williams and Ruaia 2021). While stocks of the four main tuna species – skipjack, yellowfin, bigeye and albacore – are currently assessed as being fished sustainably, the industry is worth six billion dollars and is crucial for many Pacific Island nation economies, providing up to 84% of government revenue via fisheries access fees (Bell et al. 2021).

One of the main WCPO tuna fisheries is the purse-seine fishery, which relies on drifting fish aggregating devices (dFADs) for about 40% of the catch. Anchored FADs have long been used by artisanal and industrial fishers because many fish species such as tunas have a natural tendency to gather under and around floating objects. In the open ocean, purse-seine vessels have also used terrestrial debris and logs to locate tuna schools for many decades. Since the 1990s, however, bamboo rafts have been specifically designed and built by fishers to aggregate tuna schools, mostly skipjack tuna. Nowadays, modern dFADs are equipped with satellite buoys and sonar technology, which allow fishers to track dFADs and estimate the quantity of tuna beneath them (Fig. 1).

Knowing where, and how many, fish are present is clearly an advantage to the fishing industry. Fishing on dFADs has, therefore, allowed for a general increase in tropical tuna catches, while reducing the effort and costs spent in locating tuna schools. The development of dFAD fishing is thought to have become important for the efficiency of the purse-seine fleet targeting skipjack tuna. However, the use of dFADs can also have undesirable impacts, such as sustainability issues linked to catches of small bigeye and yellowfin tunas; increased bycatch, and environmental pollution; ghost fishing; and habitat damage from lost or abandoned dFADs. In addition, while the purse-seine fishery has 100% observer coverage, monitoring dFAD use remains challenging. Tracking the number of dFADs deployed annually, and their spatio-temporal prevalence, is important for assessing their influence on tuna fisheries, and environmental and ecological risks.

Over the last decade, the management of the purse-seine fishery by the Parties to the Nauru Agreement (PNA) and the Western and Central Pacific Fisheries Commission (WCPFC) has been through the implementation of two main mechanisms: an annual three to five month

[1] Fisheries Scientist, Oceanic Fisheries Programme, the Pacific Community. Email: LaurianeE@spc.int

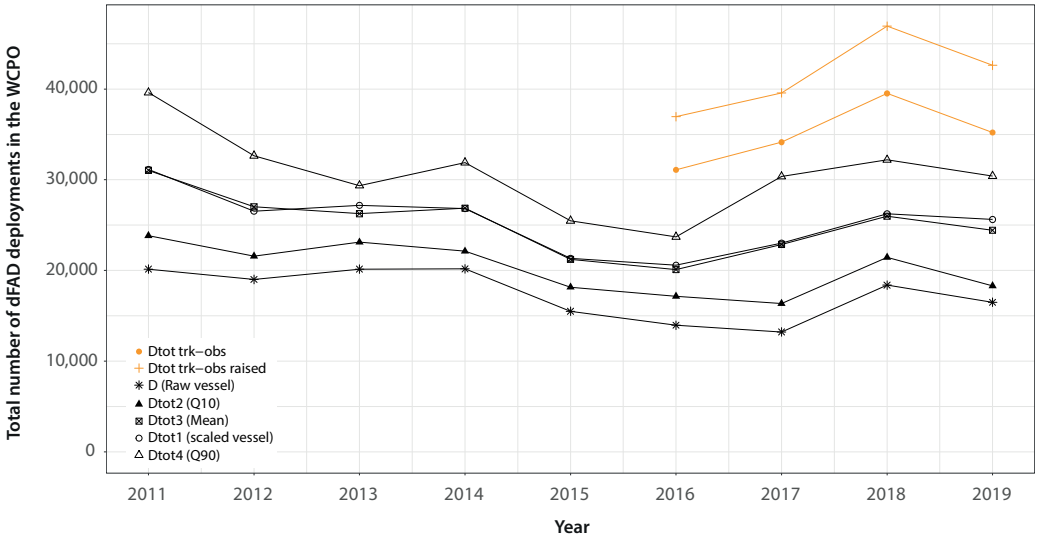

Figure 2. Estimates of the total number of dFAD deployments per year in the WCPO for all vessels. Different estimation metrics were used based on fishery data only (black line, with D representing the raw number of deployments recorded by observers; Dtot1 and Dtot3 representing the estimates per vessel and the average across vessels and Dtot2 and Dtot4 an 80th-percentile range of uncertainty around these values), and a combination of PNA dFAD tracking and observer data (orange line, with total and raised estimates). Figure from Escalle et al. (2021).

dFAD closure, during which all dFAD-related activities (e.g. fishing, deploying, servicing) are prohibited; and the implementation of the vessel day scheme by PNA, which sets a total allowable effort in fishing days per year across the main purse-seine fishing grounds in the WCPO. Both were implemented, in part, to manage the number of dFAD sets made by limiting total effort and reducing purse-seine dFAD fishing during some months of the year. This led to a stabilisation of the number of dFAD sets and associated catches. However, the number of dFADs deployed annually in the WCPO remains unknown. Recently, WCPFC adopted a conservation and management measure to limit the number of active buoys monitored by a vessel to 350. However, data and analyses to evaluate this management limit and its effectiveness are lacking. Estimating the ideal number of dFADs to strike a balance between profitability and limiting impacts on ecosystems and tuna stocks is, therefore, vital to ensuring sustainability of the resource and industry. But how can fisheries scientists keep track of how many dFADs are being used in order to achieve better analyses and provide advice for the management of their use?

A recent study from scientists of the Pacific Community (SPC), in collaboration with PNA, in the peer-reviewed journal *International Council for the Exploration of the Sea (ICES) Journal of Marine Science*, presented a novel approach to estimating the number of dFADs used in the WCPO.[2] This deeper understanding provides a firmer foundation for achieving profitable, yet sustainable, tuna fisheries that depend on dFAD use in the WCPO, as well as offering a model that could be used to inform estimation and monitoring of dFAD use in other ocean regions. This study, which sets the stage for the sustainable management of dFADs and for future scientific work, would not have been possible without a strong relationship and a considerable level of partnership between scientists, fisheries managers, and the fishing industry in the Pacific Islands region.

The study presents new ways of estimating the use of dFADs in the WCPO through a novel combination of four fisheries datasets over the period 2011–2019: at-sea observers' data, vessel logbook reports, vessel monitoring system data, and trajectories from the satellite buoys on dFADs. Using these data, which are often commercially sensitive and confidential, requires a secure collaboration between partners.

Combining these data sources for the first time, estimates of the number of deployments and active dFADs per vessel and in the whole WCPO were derived using two different approaches that combine fishery data with dFAD tracking data to evaluate trends in dFAD use across the entire WCPO between 2011 and 2019. SPC scientists found that between 20,000 and 40,000 dFADs are deployed per year, depending on the estimation methodology, with the total number of deployments appearing relatively stable over the last decade (Fig. 2). A striking result was the relatively stable trend in terms of dFAD deployment detected over the last decade, which is different from the increasing trends seen in other oceans that rely more heavily on dFADs. The annual number of total deployments estimated in the WCPO is nevertheless the highest of all oceans. Comparing our estimates of 20,000–30,000 for the WCPO in 2013 to estimates of 15,000 in the Indian Ocean; 18,000 in the Atlantic Ocean; and 19,000 in the eastern Pacific Ocean in 2013

[2] https://academic.oup.com/icesjms/advance-article/doi/10.1093/icesjms/fsab116/6307380

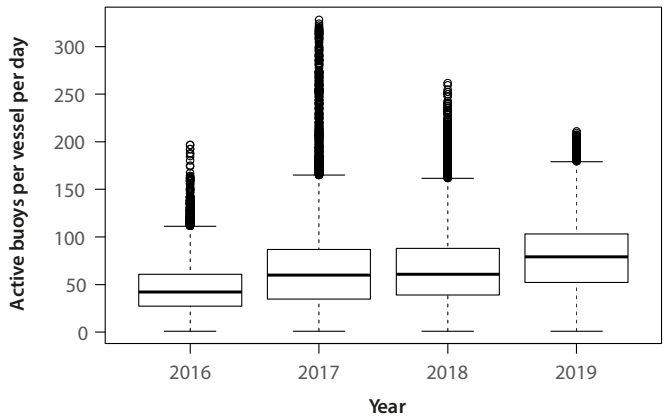

Figure 3. Annual variability in the raised number of active buoys per vessel and per day in the PNA dFAD tracking data for the top 50 vessels deploying the highest number of dFADs. Figure from Escalle et al. (2021).

(Fonteneau et al. 2015; Gershman et al. 2015; Maufroy et al. 2017). Although, the number of dFADs deployed is higher due to the scale of the fishery, less dependence on dFADs is found in the WCPO than in other oceans. Forty per cent of the WCPO purse-seine catch in 2019 was on floating objects, compared to approximatively 60%, 70% and 80% in the eastern Pacific Ocean, Atlantic Ocean and Indian Ocean, respectively.

An increasing trend was detected, this time from 2016 to 2019, in terms of the number of active buoys monitored per vessel (Fig. 3). This might indicate that vessels may share the position of their buoys with other vessels (e.g. vessels from the same company). The median number of active buoys monitored per vessel per day ranged from 45 to 75 during this period (Fig. 3), well below the current management limit of 350. The overall number of dFADs deployed has remained relatively stable, but vessels in the WCPO have access to more dFADs that are equipped with tracking and acoustic capabilities, thereby providing valuable information on positions and echosounder data.

The methods implemented represent a significant move towards improving the quality and quantity of data available for WCPO fishery managers through regional cooperation in collecting data, and scientific creativity in the way those data are analysed. Methods and results compiled will also provide a baseline to monitor and manage dFAD use in the WCPO, and a model that can be applied to other oceanic regions where dependence on dFADs is higher, yet data are lacking. It also demonstrates the confidence that Pacific fisheries can have in the way in which their data are managed and used by SPC and its partners. This in turn paves the way towards more sustainable and economically successful fisheries.

Acknowledgments

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SAWs: Making the rules of the game clearer every year

Sam McKechnie[1] and Steven Hare[2]

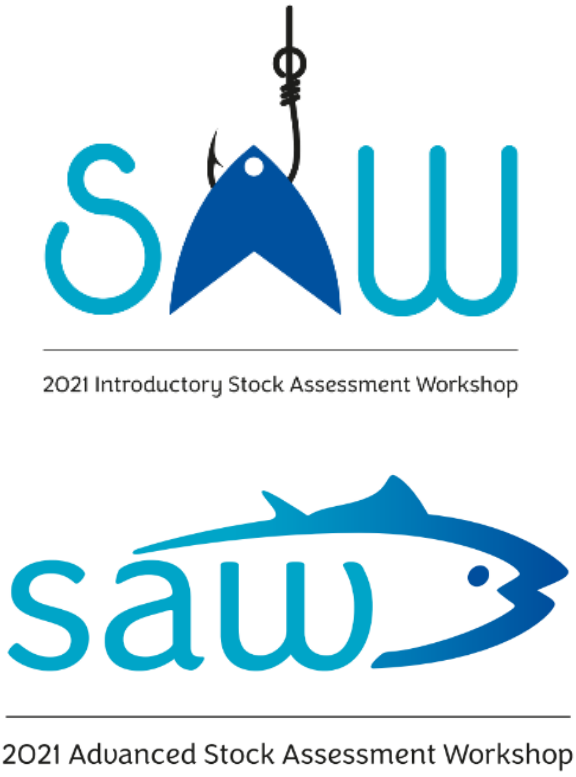
Since 2006, the Pacific Community (SPC) has held annual stock assessment training workshops (widely known as the "SAWs") for participants from member countries. The purpose of the workshops is to: 1) help fisheries professionals in the region improve their understanding of stock assessments of tunas (and tuna-like species); 2) communicate this information to fishery managers and stakeholders within their countries; and 3) increase their confidence in participating in scientific discussions of the Western and Central Pacific Fisheries Commission (WCPFC), in particular during meetings of its Scientific Committee. These topics can be quite technical, and fisheries professionals from member countries are often keen to expand their knowledge in a setting more supportive than regional meetings. The content of SAW courses is also useful for day-to-day fisheries work, and for other WCPFC and subregional meetings.

Because the courses have been run for many years, some previous participants have gone on to become well-known fisheries personalities in the region. Many of the more than 150 previous participants have attended the courses multiple times (the record is seven attended courses), and it is common for participants to progress from the introductory course to the advanced course in the same, or subsequent years. This repetition is beneficial for understanding more difficult topics, and the improved confidence of participants with each attendance is clear.

In recent years, two back-to-back, one-week-long workshops have been held in Noumea, and the content has been delivered as a mix of presentations and hands-on, computer-based practical sessions. The first week is aimed at people new to the topics, while the second week digs a deeper into technical details and is typically attended by more experienced participants.

The COVID pandemic has necessitated a change of tact for how these workshops are delivered. The 2020 workshops were cancelled under the assumption that travel restrictions would be relatively short-lived, and that face-to-face workshops would resume at some point. Unfortunately, the reality has meant that online-based alternatives needed to be explored.

For the 2021 workshops, a more compact agenda was adopted, with two, four-day workshops run, which were again split into introductory and advanced modules. A fewer number of topics could be delivered, and so the focus was directed towards only the most important stock assessment topics. The workshops were still based on presentations by SPC scientists, but these had to be delivered via Zoom, which meant that much of the usual interaction among participants was lost. The practical sessions, which typically are the more popular component of the in-person workshops, were not used due to the high level of interaction required between tutors and participants, which was impossible through Zoom. Instead, short quizzes were given to reinforce the main points of presentations. These quizzes, along with the presentations and other content, were packaged and organised as modules in "Moodle", an online learning platform.



The introductory and advanced SAW logos.

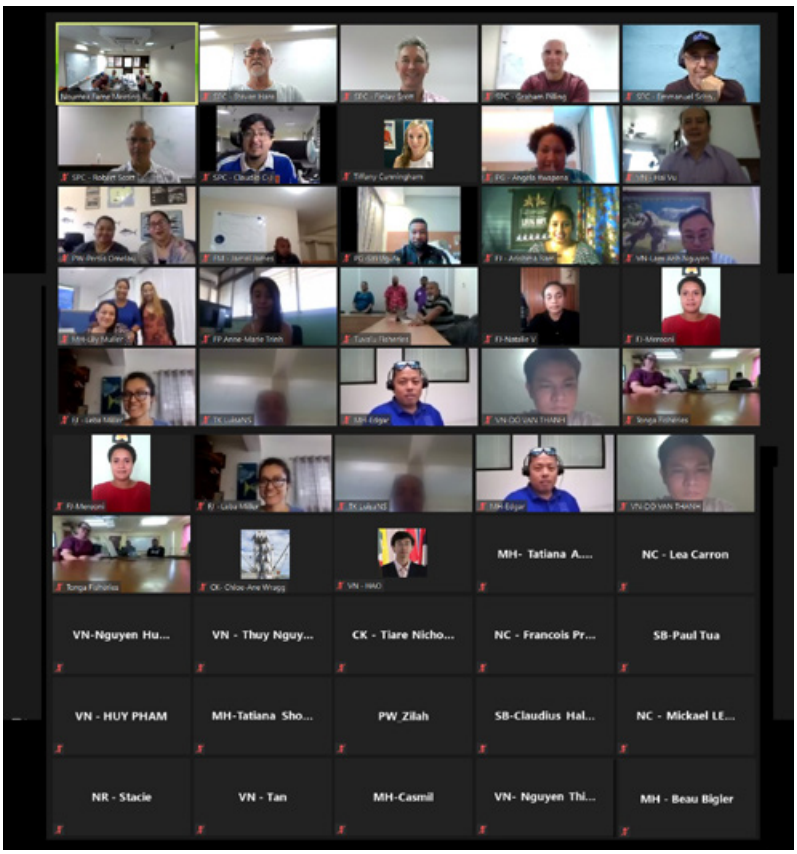
While e-workshops have their drawbacks, the positive side of the SAW online courses was that a higher number of participants could be involved. In a typical year, only 15–20 people can attend each week due to travel and accommodation costs. This year, 107 people registered, although the

[1] Fisheries Scientist (national-level support), SPC. Email: SamM@spc.int
[2] Senior Scientist (national and sub-regional team leader), SPC. Email: StevenH@spc.int

true number of attendees was difficult to know, with some of those registered unable to attend, and multiple people (some unregistered) sharing screens. However, 61 individuals completed the final introductory test and 41 completed the advanced test, with a 50–50 gender split. Participants from 18 countries participated, with some countries not having been represented at the workshops in recent years.

Feedback from participants suggests that the workshops were well received, and the Zoom and Moodle approach was very user-friendly. This approach also has the benefit of providing a repository for the course content, including recordings of presentations that were delivered during the live workshops. Several people who missed the courses due to work commitments were subsequently able to work through the content on their own time by viewing the presentations and completing the associated quizzes and final tests. Anyone who would like to do the same is encouraged to contact the authors of this article for access directions.

The outlook for SAW workshops remains uncertain. Re-establishment of face-to-face workshops would require a return to regional travel, and it is unknown when that will happen. Until that time, the e-workshop approach will continue to be the focus of the workshops, and if, and when, travel becomes possible, there is still the question of how much the e-learning component can continue to complement the traditional workshop. The delivery of e-workshops this year provides a strong base to work from in refining the approach and trying to maximise the benefits to participants from member countries.



SAW workshops before (left) and after (right) the start of the COVID crisis. The virtual format of SAW 2021 limited the usual interaction among participants but increased the number of participants able to attend.

Pacific fisheries leaders emphasise building resilience and strengthening recovery in fisheries

Sonia Schutz-Russell[1] and Terry Opa[2]

Pacific fisheries resources[3]

Home to
12.5 million people

The Pacific Islands region consists of
14 independant countries and **8 territories**

14 countries | **8 territories**

The Pacific Ocean
occupies **one-third of the globe**

The Pacific Islands region covers about
28 million km² of ocean and 551,000 km² of land

[1] Programme Planning Officer, Fisheries, Aquaculture and Marine Ecosystems, SPC. Email: SoniaS@spc.int
[2] Team Leader – Planning, Monitoring, Evaluation and Learning, FAME, SPC. Email: TerryO@spc.int
[3] https://stats.pacificdata.org/vis?lc=en&df[ds]=SPC2&df[id]=DF_POP_PROJ&df[ag]=SPC&df[vs]=3.0&dq=._T.MIDYEARPOPEST..&pd=2015%2C2025&ly[cl]=TIME_PERIOD

Varied in landmass, ocean space, culture and different levels of economic development, Pacific Island countries and territories (PICTs) are vastly diverse, yet uniquely similar in the challenges they face. The phrase "one size *does not* fit all" is a fitting description of the region. It is also a model to keep in mind when developing and introducing fisheries management measures.

Fisheries resources are the lifeline of Pacific people, providing food security, supporting livelihoods and employment, and promoting economic growth. For many, these resources are a significant source of government revenue, especially for ocean states with limited landmass and land-based natural resources. For example, Kiribati's revenue from fisheries contributed 16.2% of the total gross domestic product in 2014 (Gillett 2016), by far the largest contribution among its other natural resources.

Marine fisheries resources are categorised as coastal and oceanic. Both are different with respect to species diversity, resource conditions, and the interventions used in their management (FAO 2009). For instance, the region is home to the largest tuna stock in the world. The tuna fishery provides revenue through fishing access fees, tuna fishing, processing and employment, with an estimated value of USD 4.9 billion per year (Williams and Ruaia 2021). Coastal fisheries on the other hand are a vital source of nutrition, welfare, employment and food security, and are valued at an estimated USD 320–500 million (Gillett 2016).

The benefits derived from these two fisheries resources varies across the island nations. The dispersed geography of these islands within this vast area of water presents several challenges for effective management and monitoring of fisheries resources.

Another challenge for the island nations is their ability to balance their coastal fisheries in a manner that meets the demands of their people to support their livelihoods and economic aspirations versus the need for resource protection, rehabilitation and management of coastal fisheries resources.

Regional efforts to strengthen recovery and build resilience

While the management of these important fishery resources are subject national interests, regional cooperation is required when it comes to conservation and protection. Over the years, the region's leaders have agreed on several management measures and mechanisms to protect and oversee these valuable resources. In June 2019, a Special Regional Fisheries Ministers Meeting was held to review and adopt terms of reference establishing an annual Regional Fisheries Ministers Meeting (RFMM) and this was endorsed by the Pacific Leaders at the 50th Pacific Islands Forum in Tuvalu in 2019. The RFMM is responsible for sectoral oversight of fisheries issues, including coastal fisheries, and is required to report to Forum Leaders.

This year, during the second Regional Fisheries Ministers Meeting (RFMM2), the fisheries leaders recognised the urgency to strengthen recovery and build resilience at this juncture, as the region struggles to respond to and recover from the impact of the ongoing COVID-19 pandemic alongside the effects of climate change on fisheries.

Three important fisheries items were discussed and endorsed as part of the regional effort to build resilience and strengthen recovery:

1. The Pacific Framework for Action on scaling up community-based fisheries management;
2. a proposal to develop a new regional strategy on aquaculture development; and
3. addressing the impact of climate change across the fisheries sector.

The chair of RFMM2, the Rt. Honourable Semi Koroilavesau of Fiji, reiterated a call for concerted action on issues that have historically been addressed in isolation.

> "I am hopeful that we can bridge the gap and ensure that our decisions are holistic in nature and are beneficial to our people. Our people expect of us to make traction with some of these key issues because they affect livelihoods, economies, and the sustainability of our resources." Rt. Honourable Semi Koroilavesau, Minister for Fisheries, Republic of Fiji.

Regional leadership in strengthening community-based fisheries management

Traditionally coastal communities in the Pacific have been involved in managing and protecting coastal fisheries. These communities rely on inshore fisheries for their daily sustenance and income generation. Recognising the vital role of communities in protecting their coastal resources, the fisheries leaders stressed the importance of empowering coastal communities to play a larger role in gaining access and managing marine resources.

At RFMM2, leaders recognised the vital role of communities in protecting coastal resources and have endorsed the Pacific Framework for Action on Scaling-up Community-based Fisheries Management. The framework recognises that coastal community empowerment and support are crucial for scaling up effective management and ensuring sustainable coastal fisheries that provide benefits to Pacific people in terms of food, nutrition, livelihoods, culture and health (Pacific Community 2021).

The ongoing pandemic has caused unprecedented job loss across the region. This is contributing to increasing pressure on coastal fisheries as people migrate back to rural communities and rely on local fishery resources to support their families. The timely endorsement of the framework for action allows PICTs to pick and choose appropriate community-based fisheries management measures that fit their national context without compromising communities' access to their food source.

Regional effort to improve food security, livelihoods and economic resilience through aquaculture development

In the Pacific, aquaculture contributes to food security and income generation through the rearing of low-value fish such as tilapia and milkfish, to high-end products such as pearls, shrimps and marine ornamentals.

The COVID-19 pandemic has disrupted markets and supply chains for almost all primary production in and among PICTs, including aquaculture. Small and large businesses involved in aquaculture are struggling, while national food security needs and priorities have changed and continue to change. The United Nations Food Systems Summit in 2021 and the upcoming United Nations Year of Small-Scale Fisheries and Aquaculture are bringing to the fore the central and critical role of aquatic and "blue" foods in global food systems. These discussions are highlighting ways in which aquaculture, through integration and adaptation of food systems approaches, can be harnessed to contribute to sustainable and healthy foods.

The ministers acknowledged the ongoing impact of COVID-19 on the social and economic wellbeing of the Pacific people, and emphasised the importance of coastal fisheries and aquaculture for food security and economic development as the region rebuilds from the impacts of COVID-19.

The ministers endorsed the proposal by SPC's Division of Fisheries, Aquaculture and Marine Ecosystems (FAME) to take stock of where aquaculture currently stands in PICTs' and what direction(s) to take from here to remain resilient and to meet the expectations of Pacific people.

Regional effort for climate resilient and sustainable coastal fisheries and aquaculture

Rapid population growth and movement of people in the Pacific is straining fish stocks and affecting food security and livelihoods. As the Pacific population continues to grow, so will the demand for marine resources. Adding to this dire problem are the effects of climate change: increasing sea surface temperatures cause ocean acidification, rising sea levels and high rainfalls, resulting in significant loss of coral reefs, mangroves, seagrass, and intertidal habitats that provide shelter and food for coastal fish and shellfish. This poses a severe threat to the fisheries and aquaculture sector, which plays a significant role in food and nutrition security for Pacific people.

To address these challenges, fisheries leaders emphasised the importance of having a better understanding of the effects of climate change on the fisheries and aquaculture sector, and endorsed SPC FAME' s work programme on climate change and fisheries. They also recognised the need to continue enhancing technical and scientific capacity to support evidence-based planning and management policies that strengthen members' adaption and mitigation activities in the region. SPC's involvement in the Green Climate Fund project – "Adapting tuna-dependent Pacific Island communities and economies to climate change" – was supported. The project aims to strengthen climate change adaptation in 14 Pacific countries by supporting reforms needed to minimise the risks for citizens of countries with economies that are vulnerable to climate-driven redistribution of tuna.

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Scaling-up community-based fisheries management in the Pacific: Key outcomes of subregional workshops

Watisoni Lalavanua,[1] Hugh Govan[2] and Dirk Steenbergen[3]

A regional assessment of the status of community-based fisheries management (CBFM), and requirements to achieve its effective, scaling-up was successfully conducted through virtual workshops. The workshops brought together over 200 participants from 18 Pacific Island countries and territories.

The greatest challenge for the region's coastal fisheries is ensuring that widespread sustainable management is practiced across the vast coastal fishing areas; areas that are subject to both immediate local pressures and external ones. The Regional Roadmap for Sustainable Pacific Fisheries[4]and A New Song for Coastal Fisheries[5] provide the regional context for managing coastal resources in ways that are underpinned by community-based fisheries management (CBFM). Management approaches that are community-driven are inclusive, equitable and consider the whole ecosystem in sustaining livelihoods and ensuring resilient communities. Such approaches have been identified as the most suitable in harnessing the diverse, dispersed and dynamic fishing practices in the Pacific Islands region to ensure consistent, productive coastal fisheries that can sustainably support the well-being, food needs and income of Pacific people.

To address this challenge, the Heads of Fisheries Meeting in May 2020, requested the Fisheries Aquaculture and Marine Ecosystems Division of the Pacific Community (SPC FAME) to assist member countries with the scaling-up of CBFM. SPC FAME was requested to assist members in assessing CBFM status, and in developing and implementing effective scaling-up approaches that are appropriate to national contexts.[6]

Initiating this, SPC FAME and its regional partners, the Locally Managed Marine Area Network and the University of Wollongong, facilitated a series of virtual CBFM scaling-up workshops in January–February 2021. Three one-week, subregional workshops were organised for Polynesia, Micronesia and Melanesia each. Participants logged into the common Zoom meeting portals for the different virtual subregional workshops, bringing together more than 200 representatives from national and subnational fisheries agencies, community groups (traditional leaders, youth and women representatives), local civil society organisations, non-governmental organisations, and regional and international organisations.

Scaling-up community-based fisheries management in the Pacific

To establish a basic collective understanding among participants about scaling-up CBFM in the region, an information paper[7] was developed to help frame the principles of scaling-up CBFM that are both regionally appropriate and nationally useful. This formed a reference point for participants in their discussion on ways to scale-up CBFM to secure long-term sustainability of national coastal fisheries.

Understanding current CBFM challenges are important before mapping scaling-up approaches. Common CBFM challenges include: geographic isolation of communities; the need for securing political support for CBFM; inadequate budget and staff to support and implement CBFM needs; ensuring participation; and empowerment of communities through strong legal frameworks. Given the challenges faced, a strategic approach to scaling up CBFM is vital to ensuring that countries achieve their national development targets related to productive and healthy coastal fisheries. The information paper proposes two key strategies involving direct CBFM actions and actions towards developing enabling conditions for CBFM.

The subregional workshops enabled countries from the same regional and cultural context to share what they have accomplished, and what is needed to scale-up CBFM. In each virtual workshop, participants engaged in a range of facilitator-guided, break-out group sessions by country to discuss and assess the current status of CBFM; share approaches, experiences and lessons-learned; and identify

[1] Community-based Fisheries Management Officer, SPC. Email: WatisoniL@spc.int
[2] Policy Adviser, Locally Managed Marine Area network. Email: hgovan@gmail.com
[3] Senior Research Fellow, ANCORS- University of Wollongong. Email: dirks@uow.edu.au
[4] Future of fisheries: A regional roadmap for sustainable Pacific fisheries (http://purl.org/spc/digilib/doc/xnc9f)
[5] A new song for coastal fisheries (http://purl.org/spc/digilib/doc/b8hvs)
[6] Twelfth SPC Heads of Fisheries Meeting outcomes (http://purl.org/spc/digilib/doc/ra7tj)
[7] Scaling-up community-based fisheries management in the Pacific region – Information paper (http://purl.org/spc/digilib/doc/cc937)

opportunities to bring such ideas to scale. Workshop participants ultimately sought to identify potential avenues by which CBFM could be scaled up in each country.

The outcomes of the subregional workshops informed discussions at a combined regional workshop that was held in March 2021. This regional workshop consolidated findings from across the different subregions, with a view to co-develop and refine a Regional Framework of Action for Scaling-up CBFM. Here, we will not discuss the outcomes of the combined regional workshop nor the Framework for Action. Instead, we present the main results from the subregional workshops and highlight key differences and commonalities across the three subregions. Additional and detailed information about the workshop-series can be found in the SPC FAME meeting page.[8]

Key workshop outcomes

In discussions among participants, two major challenges requiring high-level political engagement were commonly identified in all subregional workshops:

1) inadequate budget and staffing of fisheries agencies to support the urgent need of managing coastal fisheries, and

2) difficulties supporting subnational approaches to CBFM, particularly in larger countries.

Ensuring community support structures are in place requires budgetary investment in coastal fisheries management. To make this support accessible, subnational approaches need to be strengthened. These were noted by most country participants as being essential but largely out of their control.

Summarised below, by subregion, are key outcomes identified from the three subregional workshops relating to actions that can be taken by fisheries agencies.

Melanesia

Status and needs of direct CBFM action

In Melanesia, there is a broad variety of experience on information and awareness, with radio being the most common medium used. However, there are issues with coverage, regularity and continuity of information dissemination and awareness raising. Additional strategic approaches are needed to ensure regular and cost-effective ways of disseminating information, monitoring the performance of tools used, and identifying capacity needs.

Communication from government to communities generally exists, although improvements are required in the feedback mechanism from communities to government. The communication between communities and non-fisheries agencies, as well as between communities themselves, need to be improved as well. Therefore, specific attention on strategising, and formalising feedback and representation mechanisms across these channels are needed.

Site-based CBFM is implemented in various ways, although it is challenging to do at scale due to large numbers and extensive geographical spread of communities and limited resources. This can be addressed in part through strengthening the engagement of, and support for, the provincial government to ensure that services for local communities are more accessible.

Status and needs of enabling environment

Non-governmental organisations provide significant direct CBFM activities that could be better utilised through strategic collaborations. Although, policy and legal frameworks are adequate, the actual implementation of action plans and enforcement is lacking.

Wider environmental planning mechanisms are lacking, and improvements are suggested in community involvement, public awareness, government-to-government coordination and enforcement. With the continuing focus on improving processes of inclusion of marginalised groups in the subregion, some progress has been achieved in the inclusion of different stakeholder groups.

Ways forward for scaling-up based on lessons learned from current initiatives

- Investing in cost-effective approaches that ensure availability of information to all fisheries stakeholders, especially communities.
- Strengthening cost-effective approaches on community representation, exchanges, feedback and engagement at all levels of communication on coastal fisheries management are important in scaling-up.
- Prioritising and increasing subnational level support to ensure effective and efficient service for communities and to achieve scaling-up of CBFM.
- Improving development planning, environment impact assessment processes and particularly enforcement mechanisms of wider environmental regulation and plans.

[8] https://fame1.spc.int/en/meetings/255

Micronesia

Status and needs of direct CBFM action

Micronesian workshop participants noted that the provision of information is challenging and, therefore, generally irregular or infrequent, with uncertain coverage and impact. There is a need to review, develop and implement strategic approaches for messaging, and ensuring reach and regularity, so that all communities and stakeholders have the information they need.

Various communication systems between government and communities have been established and used in some countries, while others are developing their approaches. Participants identified a need to improve feedback and representation mechanisms from communities to government, between communities, and with non-fisheries agencies.

Across the Micronesian region, site-based joint action approaches vary widely in coverage between countries. Some countries have no confirmed data on CBFM coverage while in others site level activities are already reaching a wide coverage (e.g. Marshall Islands), in some the reach is increasing (e.g. Kiribati), while others are in the early stages of developing and implementing CBFM (e.g. Nauru).

Status and needs of enabling environment

CBFM specific strategies and policy are required in most countries (except Kiribati) as well as capacity development in CBFM and monitoring compliance and surveillance (MCS). Supportive legal frameworks are adequate, although rights and roles need to be clarified.

Ecosystem planning mechanisms exist and are functioning, but improvements are needed in community involvement and awareness and effective enforcement. There is progress in inclusivity, although some effort is needed in including potentially overlooked marginalised groups.

Ways forward for scaling-up based on lessons learned from current initiatives

- Ensuring effective use of current available resources requires a strategic national CBFM strategy that includes information and awareness, community participation (including outer island communities) and MCS.
- Implementing a national CBFM registry will help assess and monitor the effectiveness of site-based approaches and the contribution of CBFM to the broader coastal fisheries management.
- Assessing potentially marginalised groups.

Polynesia

Status and needs of direct CBFM action

All countries and territories in Polynesia have experience with a variety of information and awareness tools, with radio and television being widely used for broad coverage messaging. Strategic approaches for information and awareness, especially for CBFM, need to be developed and implemented.

Systems of communication between government and communities are well established and may also be used for feedback of community interests to government. However, it may not be ideally suited for fishers as their concerns are not always adequately raised and addressed by fisheries agencies or other government agencies.

Overall, site based CBFM approaches are estimated to reach a large proportion of communities in some Polynesian countries, with numbers varying significantly from country to country. Whereas Tuvalu is implementing CBFM at the community level in all islands, Wallis and Futuna have not yet initiated site-based approaches. Larger countries such as Samoa and Tonga have strongly supported site-based approaches and reach around half of the coastal communities. Cook Islands' approach is ad hoc and relies on traditional closures placed by island authorities and local communities, while in French Polynesia it is implemented based on fisheries, environmental and traditional approaches.

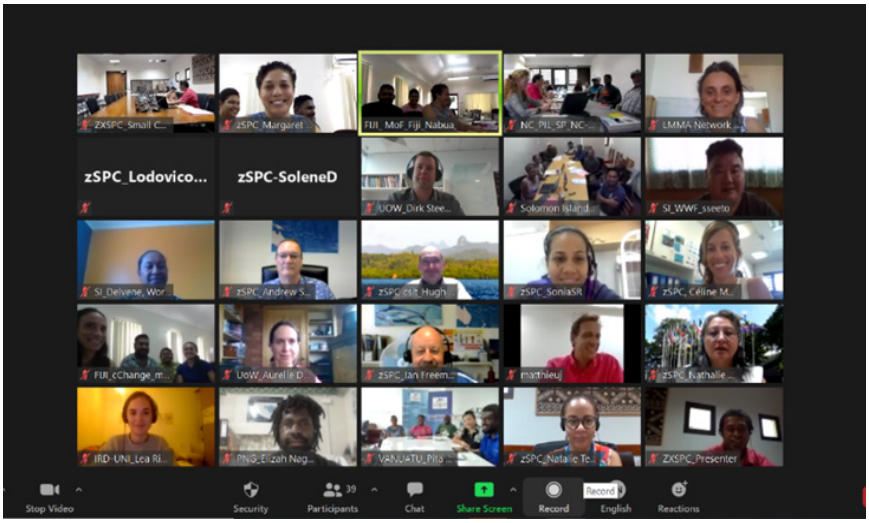
Status and needs of enabling environment

Specific CBFM strategies and/or policies do not exist in countries and territories. Particular note was made by some participants of the need for effective national and subnational enforcement of current regulations.

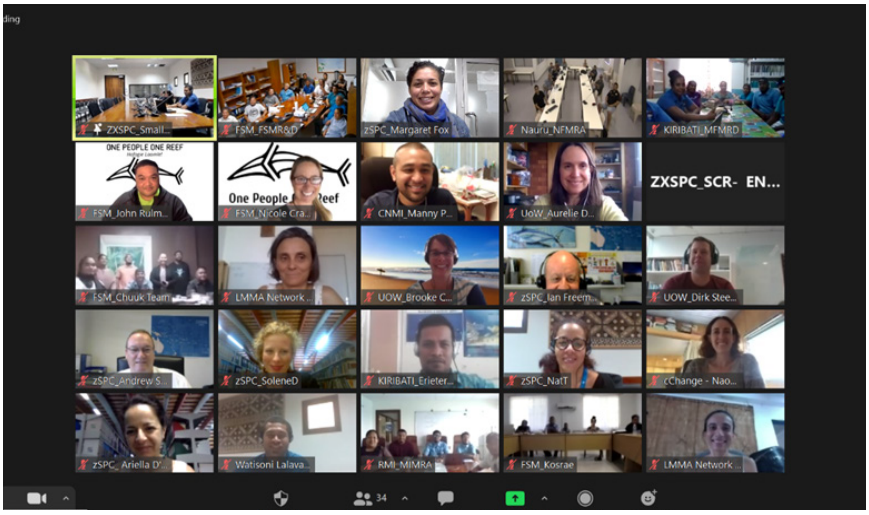
Wider environmental planning mechanisms exist, but participation of communities and fishers needs improvement with needed effective inter-agency collaboration. There has been good progress in gender, some improvement required in the inclusion of marginalised groups.

Ways forward for scaling-up based on lessons learned from current initiatives

- Strengthening current efforts on information and awareness, a cost-effective strategic approach is needed.
- Improving effective participation of community, especially on approaches that will allow fishers to raise their concern to relevant authorities.
- Developing or defining CBFM strategies where needed.
- Increasing support of effective compliance and enforcement of rules.
- Improving ecosystem and disaster response approaches.
- Assessing the potential existence of marginalised groups and impacts on equity.



A subset of the Melanesia workshop participants.



A subset of the Micronesia workshop participants.

A subset of the Polynesia workshop participants.

Conclusion

Given the global COVID-19-induced travel restrictions, in-person workshops were not possible. However, convening subregional virtual workshops on CBFM that involved break-out sessions proved very effective at facilitating discussion and sharing of experiences from countries and territories of the same subregion in a relatively short amount of time. Participants noted substantial financial and staffing constraints on implementing CBFM let alone scaling it up. Despite the need to urgently address this, participants concluded that specifically tailored interventions in each country could substantially improve implementation. Depending on the country, these included strategic information and awareness approaches, improvement in CBFM strategy, policy or legal support and effective enforcement of existing rules.

Acknowledgements

The authors first and foremost acknowledge all workshop participants for their valuable contributions during the workshops. The financial support of the Pacific-European Union Marine Partnership programme (funded by the European Union and the Government of Sweden) and the Australian Government through SPC Programme funding and the Australian Centre for International Agricultural Research project FIS-2016-300, are acknowledged. The contents of this article do not necessarily reflect the views of the European Union, the Government of Sweden or the Government of Australia.

This report represents the discussions and analysis carried out during the workshop by governments, non-governmental organisations and community participants, with the facilitation of staff from SPC, the University of Wollongong and the Locally Managed Marine Area network. The full results of the workshop and other workshop documents are available from the Scaling up CBFM Workshop webpage, which should be referred to for the full account. Any inaccuracies or omissions are the responsibility of the authors.

A regional commitment supporting communities in sustaining coastal fisheries in the Pacific

Watisoni Lalavanua[1] and Andrew Smith[2]

Background

Pacific Island countries and territories (PICTs) have agreed to scale up community-based fisheries management (CBFM) in the region. This commitment was established by fisheries ministers at the July 2021 Second Regional Fisheries Ministers Meeting (RFMM2) through the endorsement of the "Pacific Framework for Action on Scaling up Community-based Fisheries Management: 2021–2025" (Framework for Action). This is the first regional policy to focus on CBFM in the region's coastal areas. The Framework for Action was also approved by the 13th SPC Heads of Fisheries (HoF13) meeting that was held virtually in June 2021.

Framework for Action: 2021–2025

The vision of the Framework for Action stems from the vision of "A New Song for Coastal Fisheries – pathways to change: The Noumea strategy",[3] and follows the lead of the "Future of Fisheries: A Regional Roadmap for sustainable Pacific fisheries".[4]

Coastal fisheries management, including CBFM, is a national responsibility. In acknowledging the sovereignty of PICTs over their coastal resources and the need for a strategic approach to support all coastal communities, the purpose of the Framework for Action is to provide guidance to PICTs in scaling up CBFM that supports local communities and achieves national and regional coastal fisheries management goals. The Framework for Action is available online in both English[5] and French.[6]

Figure 1. Pacific Framework for Action on Scaling up Community-based Fisheries Management: 2021–2025.

[1] Community-based Fisheries Officer, SPC. Email: WatisoniL@spc.int
[2] Deputy Director Fisheries, Aquaculture and Marine Ecosystems (Coastal Fisheries), SPC. Email: AndrewS@spc.int
[3] https://purl.org/spc/digilib/doc/b8hvs
[4] https://fame1.spc.int/fr/publications/roadmap-a-report-cards
[5] https://purl.org/spc/digilib/doc/yr5yv
[6] https://purl.org/spc/digilib/doc/5fgmk

Implementation

The Pacific Community (SPC) is pleased to present the Framework for Action to its members and partners, and to help enable the effective support and empowerment of coastal communities to scale up CBFM. SPC will work with government agencies and staff, CBFM practitioners, other regional agencies, non-governmental organisations and civil society organisations, donors and other development partners to support its implementation through effective coordination and fruitful collaboration for the benefit of our local communities.

High-level political engagement

Two key challenges for scaling up were identified during regional consultations: 1) inadequate budget and staffing of fisheries agencies for coastal fisheries management, especially for CBFM; and 2) poorly supported subnational approaches to CBFM.

These two key challenges cannot be addressed by local communities but are important aspects that require high-level political support and engagement. The Framework for Action recognises these current constraints by providing regionally appropriate priority actions that could be selected by PICTs to assist in producing nationally relevant strategic approaches for scaling up CBFM.

Acknowledgements

Thanks are given to the many people and organisations that participated in the development of the Framework for Action, including national and subnational fisheries agencies, local communities (including traditional leaders, fishers, men, youth and women), local non-governmental organisations, civil society organisations, and academic institutions.

Special thanks are given to the Locally Managed Marine Area Network and the Australian National Centre for Ocean Resources and Security of the University of Wollongong for their overall assistance in running the workshops that led to the development of the Framework for Action.

The Framework for Action was produced with financial support from the European Union and the Government of Sweden through the Pacific-European Union Marine Partnership programme, and the Government of Australia through SPC programme funding and the ANCORS-ACIAR project FIS-2016-300.

Community management planning workshop in North Tarawa, Kiribati. Image: © Watisoni Lalavanua

Using COVID-19 travel bans to precipitate a digital transition in coastal fisheries science

George Shedrawi,[1] Pauline Bosserelle,[1] Bernard Vigga,[1] Franck Magron,[1] Sebastien Gislard,[1] Sapeti Tiitii,[2] Esmay Tanielu,[2] Faasulu Fepuleai,[2] Prakriti Rachna[1] and Andrew R Halford[1]*

Introduction

Collecting scientifically robust data to understand and sustainably manage coastal fisheries across the Pacific requires sustainable and well-designed scientific monitoring programmes – an outcome that has proven to be a difficult objective, given the limited capacity of many coastal fisheries agencies across the Pacific Islands region.

Severe COVID-19-related economic downturns and subsequent job losses have caused coastal communities across the Pacific to rely more heavily on food and income derived from the sea, which in turn has increased the already substantial pressures on coastal fisheries resources (Bennett et al. 2020; Steenbergen et al. 2020; Wale and LMMA Network 2020; Davila et al. 2021). Coastal fisheries agencies, already struggling to obtain data and make effective management decisions in a timely manner pre-COVID, are now facing an even greater crisis of information deficiency.

The complete cessation of travel due to COVID, which forced an almost total shift to online delivery of information between the Pacific Community (SPC) and its member countries, has in turn created the conditions for coastal fisheries departments to embrace the efficiencies of using e-data systems to collect, store, analyse and report on the status of their fisheries.

Accordingly, staff from the Coastal Fisheries Science and Data units within SPC's Fisheries, Aquaculture and Marine Ecosystems (FAME) Division have invested significant time and resources to develop an e-data system that has evolved based on feedback from regional meetings and workshops. Such a system will provide much improved efficiencies and facilitate more timely and effective management of already strained fisheries.

SPC has already begun training and implementing the e-data system across multiple countries, and will seek to provide this opportunity to all interested member countries at a mutually agreeable time. It is envisaged that successful uptake of the e-data system across the broader region will:

1) ensure delivery of capacity development and technical assistance that will provide specific capability for Pacific Island coastal fisheries agencies to assess the impacts of the COVID-19 pandemic;
2) help SPC's member countries transition away from human resource-heavy, inefficient conventional data collection methods to more efficient e-data collection methods; and
3) provide a regionally consistent approach to scientific data collection on coastal fisheries, which will enable local, national and regional approaches to dealing with declining coastal fisheries resources.

Implementation and results

The core application of the e-data collection framework is called "Ikasavea", an Android-based application for both online and offline use, which can be installed on phones or tablets.[3] Data collected using the suite of e-tools that Ikasavea provides was entered directly into the app in the field, which has streamlined efficiencies across monitoring programme data chains.

FAME's Coastal Science and Database teams have provided training and technical assistance to participating SPC member countries to help them transition to e-data systems and gain significant improvements in their coastal fisheries landing (creel) and market monitoring programmes. Training in this system has so far been undertaken with Fiji, Kiribati, New Caledonia and Samoa, with invitations to be extended to all interested members over the next 12 months.

Together, these countries provide a contrasting range of coastal fisheries work with which to demonstrate the effectiveness and broad applicability of our e-data system. For example, landing (creel) surveys carried out across Abemama and Onotoa atolls in Kiribati predominantly capture subsistence fisheries, whereas markets across Fiji, particularly in Suva, are driven largely by the commercial coastal fisheries sector and products purchased for household consumption, and Samoa has a combination of the two (Fig. 1).

[1] Pacific Community (SPC), New Caledonia
[2] Matagaluega O Faatoaga Ma Faigafaiva (Ministry for Agriculture and Fisheries), Inshore Section, Samoa
[3] See article in SPC Fisheries Newsletter #163: https://purl.org/spc/digilib/doc/vzr46
* Author for correspondence: GeorgeS@spc.int

Figure 1. Samoa, SPC, and Wallis and Futuna fisheries technical officers measuring and weighing fish and invertebrates sold at markets.

Feedback and evidence from the transitioning process in Samoa and elsewhere has seen improvements in the actual designs of their survey programmes and time savings through efficiencies in recording data using the Ikasavea application, instant transfer of these data to cloud-based storage, data consistency between surveys and surveyors, automated species identification, and rapid quality control of collected data.

Data collection programmes using an integrated electronic system enables managers to carry out quality control of collected data in near real-time and, as these programmes mature, key metrics to assess stocks can be generated and summarised with push-button efficiencies, enabling prompt reporting of trends. For example, in Samoa, data entered using the Ikasavea app was checked in near real-time, with follow-up training and discussions provided by fisheries managers to data collectors so that they could rectify errors quickly (Fig. 2).

So far biological indicators have been collected for various coastal fisheries species (Fig. 3) and the resulting information will be used to inform managers of for example, the percentage below minimum legal length or average price for these species (Table 1). Efficiencies driven by the e-data system in collecting the foundational metrics of fisheries data (e.g. catch species, length and abundance) will enable easy integration into higher-level data analysis and assessments so that models can be developed that will reflect how populations of key fisheries species are responding to fishing pressures, climate change and other local disturbances. Models based on length measurements taken from catches include, for example, proportion above length at maturity, length-based spawning potential ratio, length-based integrated mixed effects, and length-based Bayesian (for further reading and review of length-based metrics in fisheries see Chong et al. 2020). This capability is currently lacking for most coastal fisheries species across the region.

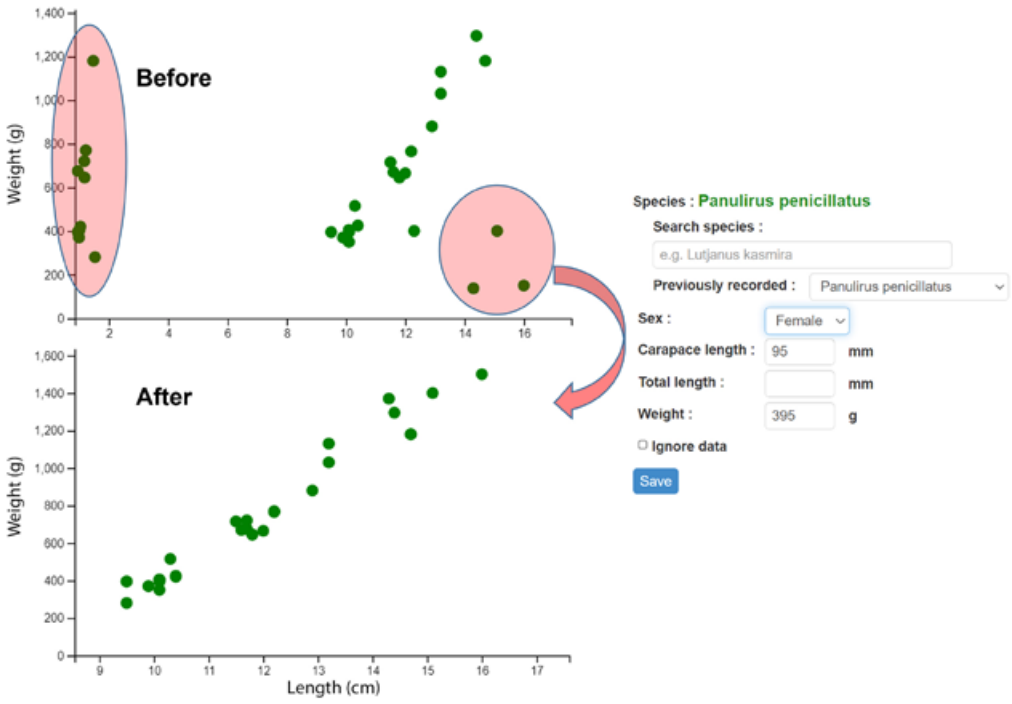


Figure 2. An example output showing before (top) and after (bottom) errors that are removed by using the data point description window (right). Red shading indicates that data were entered incorrectly.

Table 1. Example data showing proportion of catch below minimum legal size (based on length at maturity) collected on several coastal fisheries finfish species from various countries across the Pacific.

Species	Minimum legal size (cm)	Percentage below legal size
Naso unicornis	30	14.20%
Naso hexacanthus	30	3.30%
Naso brevirostris	30	35.50%

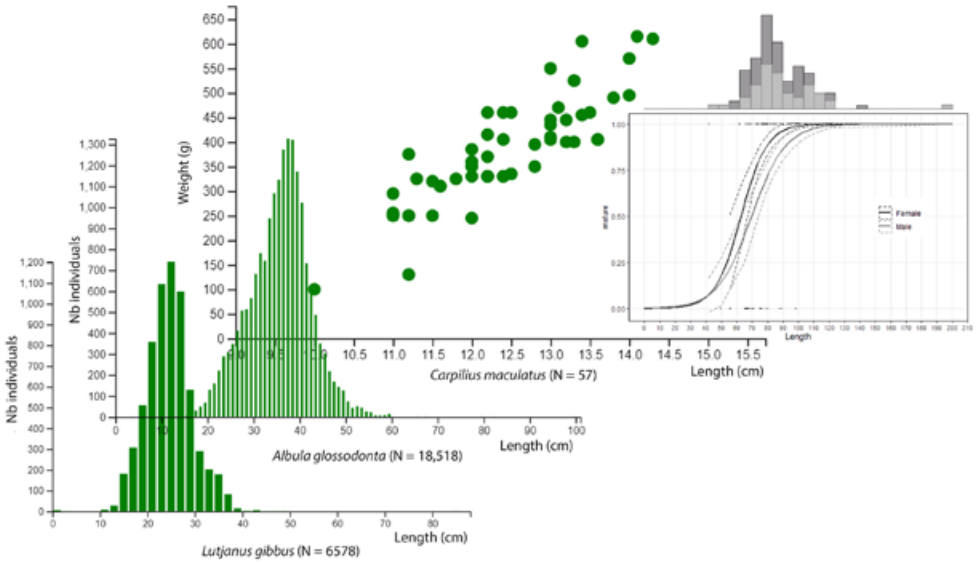


Figure 3. Example length frequency, length weight relationships, and length at maturity models for finfish and invertebrate species from various markets and landing sites across the Pacific.

Collecting scientifically robust data using electronic-based systems not only enables near real-time access to raw and summarised data, but also allows for rapid publication of graphics, plots and figures, thereby allowing managers to quickly interpret results and provide key information to policy-makers so that decisions can be more adaptive to changing stock status and, importantly, to the needs of communities that utilise these resources.

Further work

Delivering an e-data platform to Pacific Island countries and territories that is relatively simple to use and requires minimal extra investment by coastal fisheries agencies will further enhance upskilling and capacity development in fisheries science and management. We anticipate the next steps in assisting member countries with transitioning their coastal fisheries monitoring programmes will include:

- ongoing training and support for uptake and effective use of e-data systems;
- integration of legacy (existing and previous) datasets into the e-data system; and
- ongoing work on reporting templates for delivering information to managers.

Streamlined efficiencies in data collection programmes within countries will free up much needed time and enable fisheries officers to focus on other areas of fisheries management – for example, education, compliance, and development of dedicated programme s to estimate the economic contribution of coastal fisheries to overall gross domestic product – all of which are currently limited.

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An assessment of socioeconomic impacts due to COVID-19 on coastal fisheries in Tonga

Jean-Baptiste Marre[1] and Carolina Garcia Imhof[2]

The COVID-19 crisis has already severely impacted several sectors in Tonga and poses significant risks to the country's health security, stability and economic recovery. However, the extent to which COVID-19 has affected coastal fisheries, and in particular the communities in the different island groups who depend on them, has been poorly documented.

At the end of 2020, Tonga's Ministry of Fisheries (MoF) sought assistance from the Pacific Community (SPC) to conduct a socioeconomic assessment of the impacts of the COVID-19 pandemic on the coastal fisheries sector. The main purpose of this assessment, as stated by MoF, is for the ministry to provide information to donors to help inform their decisions on future funding activities, such as COVID-19 recovery or response planning, and develop financing facilities that are made available for countries to apply for. In addition, the findings from this assessment could be used to improve MoF's current management plans and strategies, such as the current COVID-19 response plan.

Following consultations with MoF, it was decided to conduct two separate assessments: one targeting households that benefit from subsistence and artisanal fishing, through a national survey, and one targeting registered commercial small-scale fishers through focus group discussions (FGDs) to be run by MoF with guidance from SPC. Given that a national household survey examining the socioeconomic impacts of Special Management Areas[3] (SMAs) was planned for the first quarter of 2021, it was collectively decided to take advantage of this opportunity and include a dedicated COVID-19 module in the questionnaire. The specific objectives of both assessments were to: 1) better understand the effects of COVID-19 on coastal small-scale fishers and SMA households; 2) examine how they have coped and recovered from the effects of COVID-19; and 3) identify the types of support that they would find helpful to cope with and recover from the effects of COVID-19, as well as future crises.

This article summarises[4] the methodologies and main findings for both the SMA household surveys and the FGDs, and concludes by providing some recommendations.

Methodology

SMA household survey

The questionnaire,[5] including the COVID-19 module, was designed in full collaboration with MoF and other partners involved in the SMA socioeconomic assessment, through multiple meetings, correspondences, and reviews. It also included a demographic section that can be used for additional socioeconomic analyses, including from a gender and social inclusion perspective.

Multiple meetings and correspondences with stakeholders involved in the SMA survey, including MoF, were conducted in order to design appropriate samples. Participating villages were randomly selected and then the stratified sample[6] size of each village was calculated proportionately to the total sample size, and based on the 95% confidence level and 5% confidence interval.

The questionnaire was uploaded on Survey Solutions.[7] After enumerator training and multiple testing, the survey was conducted by MoF in March 2021, using tablets. In total, 312 SMA households were surveyed. SPC then provided MoF with data pre-processing and exporting assistance, while MoF conducted data checking and cleaning. Of the 312 interviews conducted, data were collected from 275 respondents,[8] comprising 135 females and 140 males.

[1] Economist, Coastal Fisheries and Aquaculture Programme, SPC. Email: jean-baptistem@spc.int
[2] Social Scientist, Coastal Fisheries and Aquaculture Programme, SPC. Email: carolinag@spc.int
[3] The SMA programme is Tonga's version of community-based marine management, whereby communities are given the responsibility of looking after their own marine resources, both for themselves and for future generations. The definition of an SMA and associated regulations are provided in the Fisheries Management Act 2002.
[4] An exhaustive presentation of existing information on COVID-19 impacts, the two assessments' methodologies and results (including detailed analysis for youth and by income categories), and discussion points can be found in the final report (https://purl.org/spc/digilib/doc/8gqjg).
[5] The questionnaire can be made available by the authors upon request. Additional details on the COVID-19 module and demographic section can be found in annex 1 of the final report.
[6] Additional details on the sampling can be found in annex 2 of the final report (https://purl.org/spc/digilib/doc/8gqjg).
[7] https://mysurvey.solutions/en/
[8] 35 households did not complete the questionnaire because they did not know about the SMA programme, and 2 did not give their consent.

Focus group discussions

The purpose of the FGDs was to gather information directly from small-scale fishers in the different island groups. SPC provided MoF with guidance[9] on how to conduct the FGDs, including indicative questions, suggestions to capture profiles of participants, and recommendations on how to facilitate, take notes and report on the discussions.

In March and April 2021, a team from the MoF's Fisheries Management and Development Division (FMDD) conducted FGDs in Ha'apai, Vavau, Euia and Tongatapu. Around 10 participants per island group (42 in total) were selected by MoF, based on several criteria: frequent fishing activity, knowledge of the topic (COVID-19 impacts and recovery), ability to convey information from fellow small-scale fishers, and ability to articulate. Most participants were small-scale commercial fishers, with fishing being a primary source of income for almost 90% of them.

Results

Socioeconomic impacts of COVID-19

The main findings from both assessments show the following socioeconomic impacts:

- SMA households and small-scale fishers suffered numerous stresses from COVID-19, such as reduced local availability of fresh fish and seafood (which is the most prominent one reported by SMA households), stress on physical and mental health, loss of sociocultural activities, and financial hardship among others.
- While most SMA households reported an unchanged level of fishing effort or catches as compared to before COVID-19, most small-scale fishers reported reduced fishing effort.
- Half of SMA households and almost all small-scale fishers reported making less income from fishing, due to numerous factors but also an increase in home consumption of seafood. A detailed illustration of the impact chain on income, based on the FGDs, is presented in Figure 1.

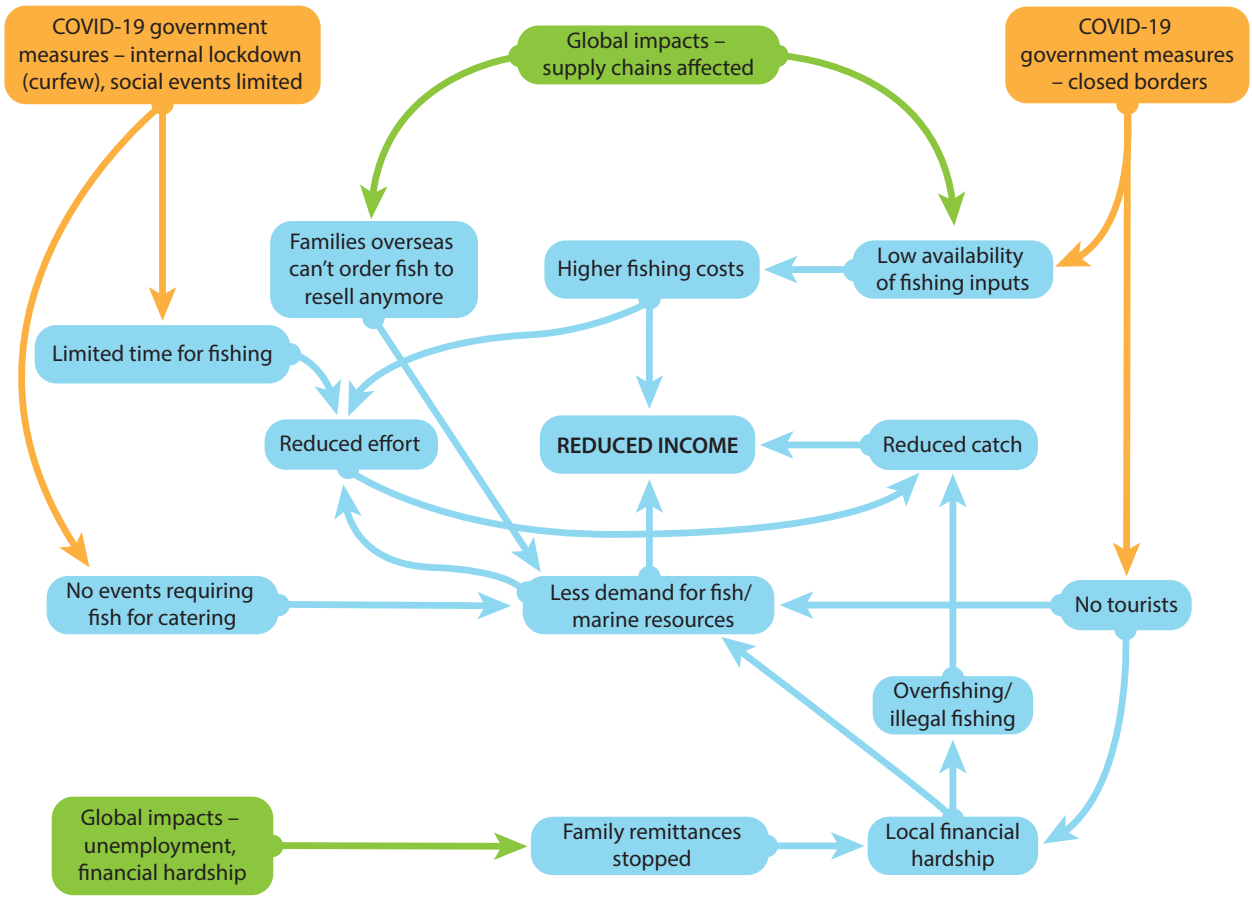

Figure 1. Inter-related factors behind the reduction of income of small-scale fishers due to COVID-19.

[9] See annex 4 of the final report (https://purl.org/spc/digilib/doc/8gqjg).

Coping mechanisms

Despite these impacts, the assessments' findings also illustrate a solid coping capacity from both SMA households and small-scale fishers:

- Almost all SMA households and small-scale fishers used multiple coping strategies to minimise COVID-19 socio-economic impacts (see Fig. 2). New livelihood activities (such as farming, or handicraft making for women) were key coping mechanisms. For SMA households this was particularly successful as half of respondents felt that COVID-19 did not impact their households.
- Results highlighted the key role played by women in the use of coping mechanisms (see Fig. 2). This underscores the importance of targeting development support to ensure a compelling participation of women as part of a generalised resilience strategy for SMA communities.
- COVID-19 caused one-fifth of SMA households to start new fishing activities (see Fig. 3) that focused mostly on invertebrates, including sea cucumbers. Small-scale fishers also reported changing their fishing practices (e.g. no more night fishing) and marketing strategies.

Response and recovery options

Investigating the preferred types of short- to medium-term assistance needed by SMA households and small-scale fishers to better cope with COVID-19 impacts on fisheries is critical to enhance response and design recovery interventions.

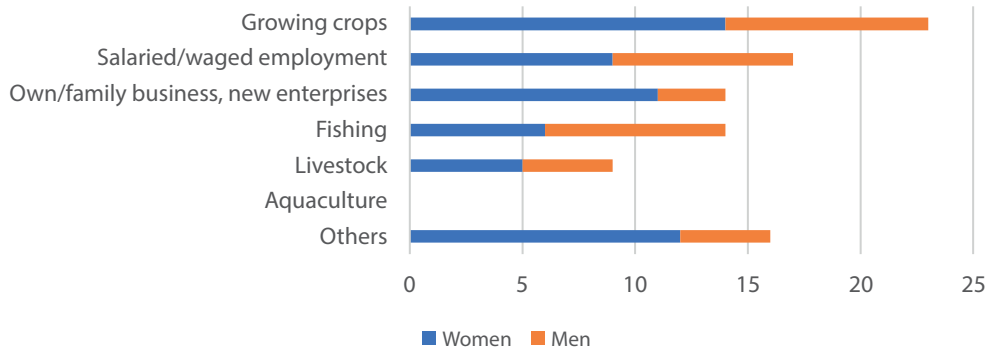

Figure 2. Type of new activities undertaken by SMA households to earn income in order to cope with COVID-19 (n = 63).

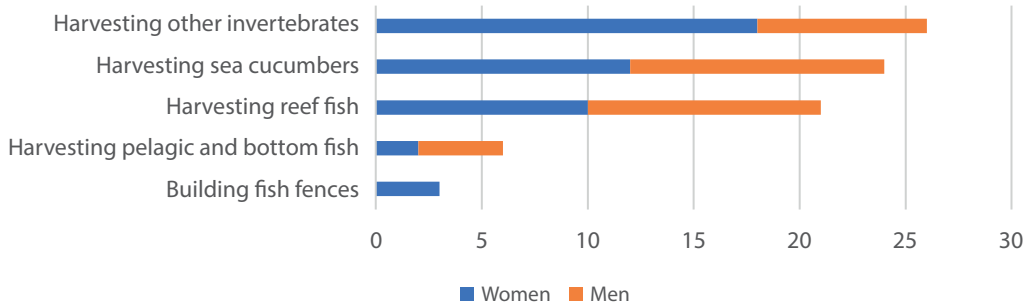

Figure 3. New fishing or harvesting activities started by SMA households due to COVID-19 (n = 56).

Figure 4 presents the preferred types of support selected by SMA households, which include: provision of fishing tools (selected mostly by men), training[10] (selected mostly by women), new livelihood development (slightly preferred by women), and fish aggregating devices[11] (selected mostly by men).

Table 1 summarises the possible recovery options identified by small-scale fishers during the FGDs. These are classified into three groups according to three criteria: timeframe of benefits, potential environmental impacts, and beneficiaries. The grouping is subjective, as it was done by the authors based on their own judgements.

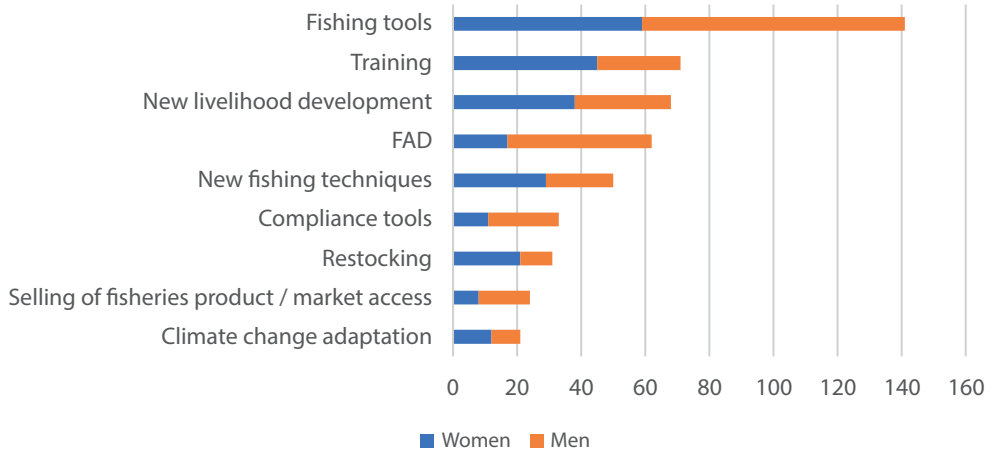

Figure 4. Most important types of assistance needed (n = 275).

Table 1. Recovery options identified by small-scale fishers, classified into three groups by the authors based on their own judgements, using three criteria: potential environmental impacts, timeframe of benefits, and beneficiaries.

	Recovery options
Group 1: short- to medium-term benefits, negative environmental impacts, only targeting fishers	• Provision of fishing equipment and inputs (e.g. gear, ice, sea safety, buoys, boats, engine) • Subsidies for fuel or gear costs
Group 2: medium- to long-term benefits, possible environmental impacts, targeting fishers and others	• Tailored support (technical and financial) for women involved or interested in fishing or aquaculture • Building infrastructures to facilitate access to fishing grounds (e.g. canals) • Establishing a shipyard to build and repair fishing boats (e.g. Ha'apai) • Assistance to set up local fishers' associations • Deployment of FADs to target more pelagic fish • Microfinance scheme (e.g. concessional loan) for fishers • Financial and technical support to establish new aquaculture ventures • Training in sustainable fisheries management and techniques
Group 3: mostly long-term benefits, positive environmental impacts, targeting the community	• Awareness and tools to increase compliance • Tailored support to SMA management • Development of local marketplace (e.g. Hofoa, Ha'apai)

[10] The type or purpose of training was not specified in the questionnaire.
[11] The option that respondents could select was simply "FADs", which in the context of Tonga includes offshore and nearshore artisanal FADs.

Recommendations

Based on all these findings, the following recommendations can be made:

- Prioritise COVID-19 response and recovery interventions that would allow longer term benefits, have minimum environmental impacts, and cover a wider section of the community (groups 2 and 3, Table 1). Such interventions should also demonstrate higher eligibility to donor funding.
- Despite households' and fishers' reported needs for fishing development activities (e.g. provision of equipment or FADs), COVID-19 response and recovery assistance from the government should include strengthened management actions, such as monitoring, control and surveillance of changes in fishing activities (in particular, reported new activities), tailored training for community-based management, and increased awareness of regulations and sustainable fishing practices.
- Development support to facilitate household access to local seafood should be prioritised as a short-term response to improve food security and local economies. Examples include assistance to set up new local marketplaces and fisher associations that encourage both male and female fishers to join and actively participate.
- Targeted training and support for those who ventured into new livelihood opportunities should be provided to overcome hardship and ensure sustainability, making sure gender specific barriers and needs are addressed.
- Promoting new alternatives or additional fishing activities that help to relieve the pressure on marine resources that are already overharvested (e.g. sea cucumber) is key to strengthening resilience to future crisis.
- Among the SMA household respondents, the higher percentage of women undertaking new activities, including fishing invertebrates, advocates for tailored livelihood development support with a women's economic and financial empowerment angle. For instance, gender sensitive access criteria should be included in microfinance schemes.
- The diversity of reported socioeconomic impacts and coping mechanisms used by SMA households in the face of COVID-19 calls for a coordinated and integrated national response. Gender consideration and conditionalities should be included in any interventions to avoid unequitable outcomes.

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Original text: English

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

The Fisher's Tales: an awareness tool for promoting sustainable fishing practices

Céline Muron[1]

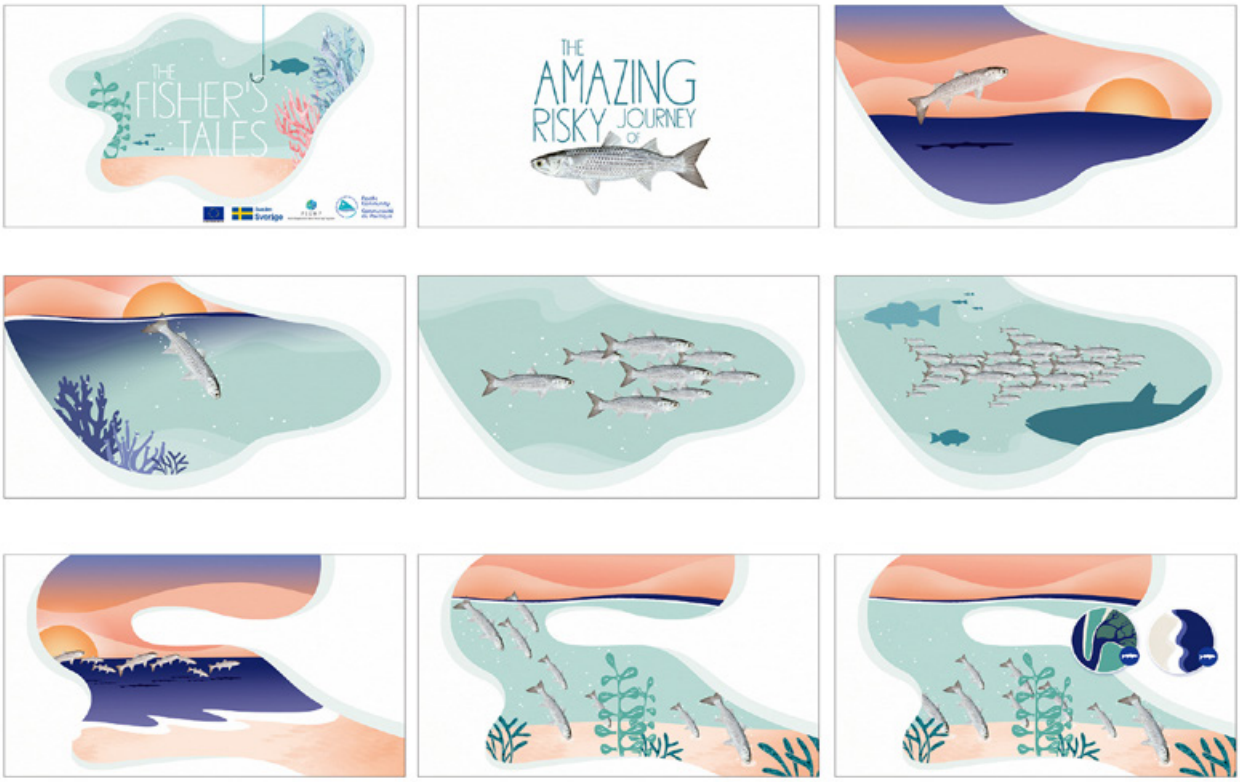
After the production of the first five episodes, Season 2 of "Fisher's Tales" is now available. Aiming at disseminating informative and educational information on sustainable fishing practices, these videos, produced by the Pacific Community, are targeting coastal communities and youth of the Pacific Islands region.

A glimpse into the lagoon's inner workings

From the amazing journey of mullet, the giant clams' team spirit, the size limits as a golden rule, the smart mesh size for nets, or the privacy needed by groupers during their breeding season, the animated videos give audiences a glimpse into the lagoon's inner workings. These two-minute videos reveal some characteristics of several species' groups, while highlighting sustainable practices to ensure that fishing can continue for a long time to come.

Online campaign

The first season was promoted during a tailored and online campaign on Facebook between October and November 2021, with an average reach per video of 190,000 people, a total estimated reach of 950,000 people, and 56,000 interactions.



The amazing risky journey of mullets; an extract of the story board. © Mélodie Lecoeur

[1] Information and Outreach Officer, Fisheries, Aquaculture and Marine Ecosystems Division, SPC. Email: CelineM@spc.int

TV broadcasting and targeted awareness events, or "local is always best"

In order to maximise the reach, the videos were also broadcasted on TV throughout the region and used for targeted awareness activities in Fiji during the World Ocean Days celebrations, and in Vanuatu.

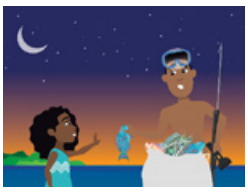
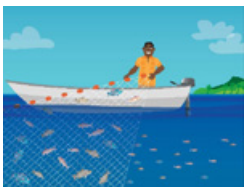
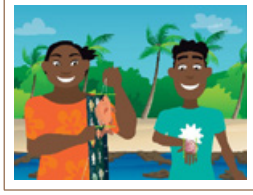
As highlighted by Ajay Arudere, Senior Fisheries Management and Policy Officer at Vanuatu Fisheries Department:

> "The Fisher's Tales were translated into vernacular languages thanks to a collaboration with SPC. The videos were played on screen during the Maewo Island Business Forum, which is a platform to strengthen and clarify governance. The whole island asked to repeat playing the films over and over. For targeted awareness activities, I see that the use of short films in vernacular language is very effective. After displaying the videos, some communities on Maewo, especially the Naone village, have put a ban on harvesting the blue parrotfish. This is still in place."

Season 2

In 2021, Season 2 was produced in collaboration with many partners, including the Locally-Managed Marine Areas network. The main messages focus on the roles and benefits of rules, such as size limits in fisheries, the protection of coral reefs, mesh size restrictions, and seasonal bans on fishing during breeding seasons. The videos will be promoted through several channels and adapted in local languages upon request, including in Tuvalu, which took part in the script's production.

"I am delighted to be part of this project. With the Season 2 being finalised, we plan to set up awareness activities at schools. Those videos are great for our targeted audience to understand and pick the important messages we are trying to impart to them," explains Matelina Stuart, Fisheries Librarian and Public Relation Officer at the Tuvalu Fisheries Department.

	**Ban on night spearfishing** **A fisher's dream** The Fisher's Tales, Season 2, Episode 1 https://youtu.be/260a4TBRPC4
	**Net restrictions** **A smart mesh** The Fisher's Tales, Season 2, Episode 2 https://youtu.be/nagxpV_VcTo
	Use of destructive fishing methods **Protecting homes** The Fisher's Tales, Season 2, Episode 3 https://youtu.be/H-QHiD6NXC0
	Seasonal ban **A little privacy please** The Fisher's Tales, Season 2, Episode 4 https://youtu.be/QLiM3svAAZ0
	**Size limits in fisheries** **Limits: A golden rule** The Fisher's Tales, Season 2, Episode 5 https://youtu.be/70PUVVzDKB4

Illustrations: Hugues Charron, Eudanla © SPC

Synergies

Synergies were also developed with the European Union-funded PROTEGE project (Pacific Territories Regional Project for Sustainable Ecosystem Management) in order to produce the French and Wallisian versions of the videos and promote them on TV during awareness activities with fishers and during the International Underwater Film Festival. For Sylvain Charrière, President of the Festival, "These extremely well-made short films provide a clear and suitable message for people of all ages. It uses humour to let us discover often poorly known aspects of certain key species and, in the end, understand that every one of our actions may have a much greater impact that we imagine."

Access to the videos

The series of seven videos is available from the You Tube playlist:

https://www.youtube.com/playlist?list=PLCq-WnF3Hdrgsc2rknxQCus1yFoAysEou

Access to high-resolution files

If you need high-resolution files for awareness activities or TV, please feel free to contact the SPC Division of Fisheries, Aquaculture and Marine Ecosystems (cfpinfo@spc.int).

Acknowledgements

The "Fisher's Tales" videos have been produced through the Pacific-European Union Marine Partnership (PEUMP) programme, funded by the European Union and the Government of Sweden. Their contents do not necessarily reflect the views of the European Union and the Government of Sweden.

Watching Fisher's Tales videos on a tablet fixed to a stand specially designed for public events. Images: © Baptiste Jaugeon

Fish smart. Set FADs: a series of awareness and training videos

Céline Muron[1] and William Sokimi[2]

How do you deal with technical demonstrations that show 1250-meter ropes in 1000-meter depths through a virtual screen? This time, our familiar friend "Zoom" doesn't have a magic button to help our experts make remote trainings feel real. This is where training videos are helpful.

Training videos as pre-learning tools

In December 2020 and April 2021, following requests from fisheries authorities in Cook Islands and the Federated States of Micronesia, the Pacific Community (SPC) set up online workshops to build capacity on artisanal fish aggregating devices (FADs). The workshops included theorical explanations, such as how to calculate appropriate rope lengths, or how to choose the best locations to deploy FADs.

Some of the main challenges of these remote workshops were the training sessions on practical topics. They required the demonstration of precise manipulations and specific materials. To address these challenges, prior to the workshops, SPC produced a series of awareness and training videos explaining how to fabricate and deploy artisanal FADs. The general idea was to send the films before the workshop and to use them as pre-learning tools, or, to refer to particular scenes in the video during the workshop, to further highlight a topic of interest.

Scripting first

The first task was to script the text. Before planning the filming, the team gathered to decide which information should be highlighted in the videos, keeping in mind the targeted audiences: fisheries officers and fisheries associations in the Pacific Islands region. It was also important to sequence the text into several chapters, with each one corresponding to one short video alongside identified key messages and a list of needed illustrations. The filming work plan was done in collaboration with the New Caledonian fisheries authorities, and included two main parts:

- Filming at SPC to show how to rig the materials: surface marker, floatation system, main mooring line, and anchor system.
- Filming at sea, onboard the government vessel, RV *Amborella*, to demonstrate how to connect the different parts of the FAD and how to deploy the FAD.

Access to the videos –The series "Fish smart. Set FADs" is now available

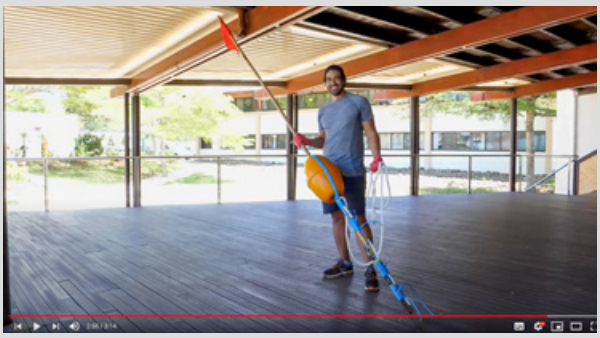
The series of seven videos is available from the YouTube playlist:

https://youtube.com/playlist?list=PLCq-WnF3Hdrh8-2b5e4ocetbwBaUUrGCY

[1] Information and Outreach Officer, Fisheries, Aquaculture and Marine Ecosystems Division, SPC. Email: CelineM@spc.int
[2] Fisheries Development Officer, FAME, SPC. Email: WilliamS@spc.int

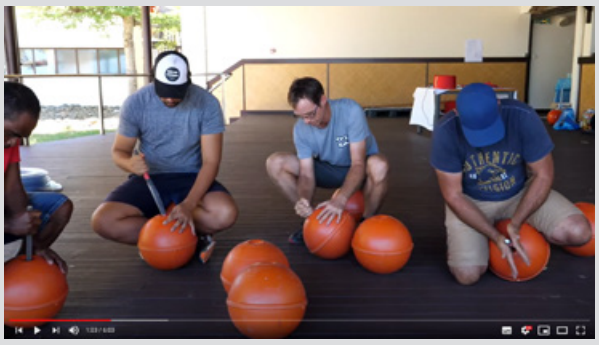
Four tips on how to fabricate artisanal FADs

Here is a glimpse of what is on the videos about each of the four parts of a FAD:



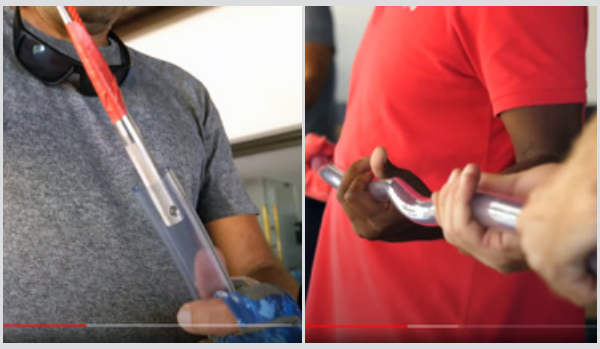
Surface markers

To rig a surface marker, you need materials such as a weight, several pieces of rebar to counter-balance the flag pole, whipping twine or rope, strong adhesive tape or cable ties, a flag pole, 3 m of attachment rope, and a buoy. Note that the higher the pole is out of the water, the heavier the counter-weight needs to be.

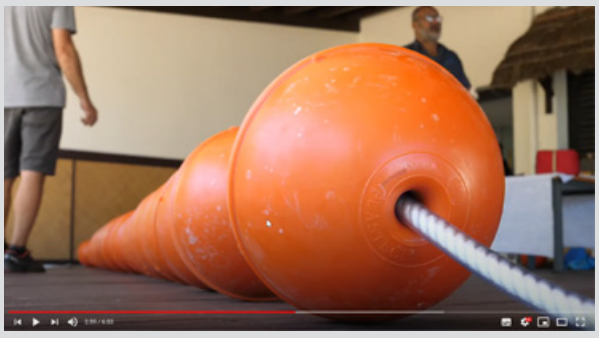


Floatation system

Before rigging the flotation system, make sure that the float's centre holes are smooth.

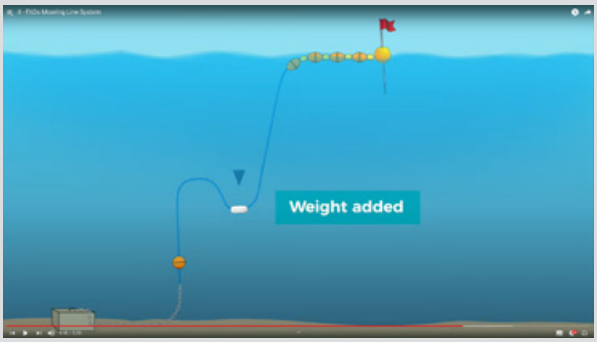


Using a messenger cord fixed to a lead or a splicer, pass the main mooring through a 12-m length of plastic hose sheath as a protection against float chaffing.



Slide the floats along the part of the mooring line covered with the plastic hose sheath.

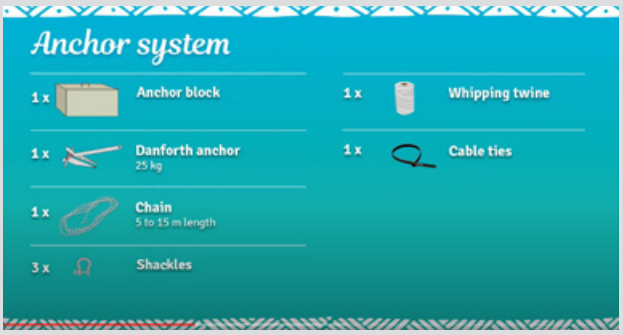
Twist 4-m ropes between each float to keep them well separated and avoid excessive chaffing.



Main mooring line system

FAD moorings commonly consist of floating and sinking ropes. What if you don't have access to sinking ropes and only use floating ropes? There is a lot of excess rope as the length of the mooring line is 1.25 times the depth. With current or wind, no problem, there is tension on the line and the rope remains underwater.

But, in calm weather, the excess rope will end up floating at the surface. So, you will need to add weight to the floating section of the rope to make it sink! The video shows you how.



Anchor system

What do you need to rig an anchor system?

A cement block reinforced with rebar with a weight of four to six times the total floatation system buoyancy; a 25-kg Danforth anchor, 5–15 m of galvanised chain, shackles, whipping twine and cable ties.

Five tips to produce training videos

1. If you wish to produce a training video: don't!
   First, think about the overall training content and your target audience(s). Then, decide if the video is the appropriate tool. Be aware that videos are not necessarily the easiest way to build capacity. Some topics would be better encapsulated into a manual than in a video. For other topics, the videos can be a nice complementary tool.
2. Do not produce one video: make several.
   To keep the attention of your audience, you will have to make the videos short. Sometimes, it is better to produce a series of five 6-minute-videos, than to produce one 30-minute video.
3. Scripting is one of the very first steps.
4. Use visual recap for key take-away messages.
5. Combine real footage and illustrations.

Acknowledgements

The "Fish Smart. Set FADs" videos have been produced through the Pacific-European Union Marine Partnership (PEUMP) programme, funded by the European Union and the Government of Sweden. Their contents do not necessarily reflect the views of the European Union and the Government of Sweden.

All pictures and illustrations in this article:
Boris Colas, ©SPC

Empowering seaweed farmers to develop new products in Solomon Islands

Avinash Singh[1] and Ivy Lulu[2]

"Cottonii" seaweed is the traditional name of farmed seaweed in Solomon Islands, a country made up of six major islands and over 900 smaller islands in the Pacific Islands region. With a population of over 700,000, Solomon Islands has a GDP per capita of USD 2295.

Seaweed farming is one of the main sources of income on Wagina and Manaoba islands, and is often run as a family business. All steps of farming, including establishment of the farm, harvesting, replanting, maintenance, drying and packing, are taken care of by family members.

Since the establishment of seaweed farming in Solomon Islands in 2002, seaweed has been farmed primarily for export as a dried raw product. Until recently, there has been no value-added processing of raw seaweed (e.g. cooking or packing), which could further strengthen a small family business.

This began to change in 2018, when the Solomon Islands Ministry of Fisheries and Marine Resources (MFMR) requested the Pacific Community (SPC) to assist its seaweed farmers in developing alternative seaweed products to supplement farmers' daily income in rural coastal areas.

Experience shows that when a product, especially a food product, gets a value-added transformation, it increases its commercial value. A study was carried out in 2019 to identify suitable products that could be developed using locally available resources and improve their livelihood options.

"This is why SPC and MFMR have teamed up to train seaweed farmers in Wagina and Manaoba in developing value-added products, including its cost–benefit analysis and supplying simple equipment for these farmers," explained Avinash Singh, SPC Aquaculture Officer.

[1] Aquaculture Officer, FAME, SPC.
[2] Project Assistant, FAME, SPC. Email: Ivyl@spc.int

Seaweed and cheese chips made during the training. Image: ©SPC

Showing how to make several possible tasty dishes with seaweed. Images: ©SPC

During two training sessions jointly organised by SPC and MFMR in May 2021, with support from the consulting firm Aqua Energie LLC, 33 women and 16 men from Wagina and Manaoba learned new techniques and tips to boost their seaweed businesses. Using a blend of online training resources and in-person support from MFMR and SPC, participants learned to manufacture healthy, locally produced seaweed snacks, such as crackers, chips and sticks.

Responding to the continued travel restrictions in the region, trainers developed training videos on production, food safety, packaging, storage and domestic marketing. "Once the farmers have learned the basic concepts of making these seaweed products, they can experiment and try more local ingredients to reduce production costs," explained Anna Larson, one of the lead trainers. "Introducing seaweed into diets may also provide some nutritional benefits," she added.

While the training has provided a firm foundation in the basics of production, the farmers are keen to use their local knowledge and resources to better manage production costs while exploring and developing new flavours to suit local palates.

During the training, trainees experimented with new batches at home and tested them the following day with their peers and trainers. These experiences were quite successful, according to Sylvester Diake from MFMR, who noted that "the products were so good that the participants ate them all before they could be packed for trial marketing."

Recognising the potential to build on this new market, Irene Billy, a farmer from the Manaoba Hatodea Seaweed Association said that "this training will revive interest in seaweed farming. I can now produce and sell seaweed chips even when there is no opportunity to export the dried form of the seaweed."

Through expanding the uses of locally grown seaweed, there are also opportunities for the farmers to sell their products to neighbouring communities as well as in the capital, Honiara. "The training provided me with the knowledge of a new product from seaweed," explained Daene Peter of Wagina Seaweed Farmers. "I am very happy and pleased to be part of this new direction," he concluded.

This training has been organised through the PacAqua project, a five-year project that aims at improving food security and economic development in the Pacific through sustainable aquaculture by enhancing business acumen among aquaculture operations, reducing aquatic biosecurity risks, and increasing uptake and adoption of improved aquaculture practices.

Funded by the New Zealand Ministry of Foreign Affairs and Trade, PacAqua is currently supporting 15 enterprises, including 14 private sector enterprises and 1 farmer's association, spread across eight countries (Fiji, Federated States of Micronesia, Kiribati, Marshall Islands, Papua New Guinea, Solomon Islands, Tonga and Vanuatu) and two territories (French Polynesia and New Caledonia). The project also supports six farmer clusters in Fiji and Papua New Guinea.

New paper: Pathways to sustaining tuna-dependent economies during climate change

The following article briefly summarises a paper published in July 2021 in the journal* Nature Sustainability, *which is available online as open access.[1]

This comprehensive analysis by 30 authors, representing 21 institutions, provides the strongest evidence so far that the effects of climate change on Pacific Island countries and territories are highly likely to include negative impacts on the economies that depend on the region's valuable tuna resources. The analysis builds on earlier work published by the Pacific Community (SPC)[2] and the Fisheries and Agriculture Organization of the United Nations (FAO)[3], and shows that climate-driven redistribution of tuna threatens to affect 10 Pacific Island countries and territories that depend heavily on tuna access fees for government revenue (Fig. 1). The threat to these tuna-dependent economies comes from the redistribution of tuna from their combined jurisdictions to the high seas.

The new study estimates that the total biomass of skipjack, yellowfin and bigeye tunas in the combined exclusive economic zones (EEZs) of these 10 Pacific Island countries and territories is likely to decrease by an average of 13% (range = 5% to 20%) by 2050 under continued high greenhouse gas (GHG) emissions. As a result, the total purse-seine catch from the combined EEZs is expected to decrease by an average of 20% (range = 10% to 30%) by 2050. The reason that the projected decline in catch is greater than the decline in biomass is that skipjack tuna responds more to climate change than yellowfin and bigeye tunas, and the proportion of skipjack tuna is higher in purse-seine catches than in total tuna biomass.

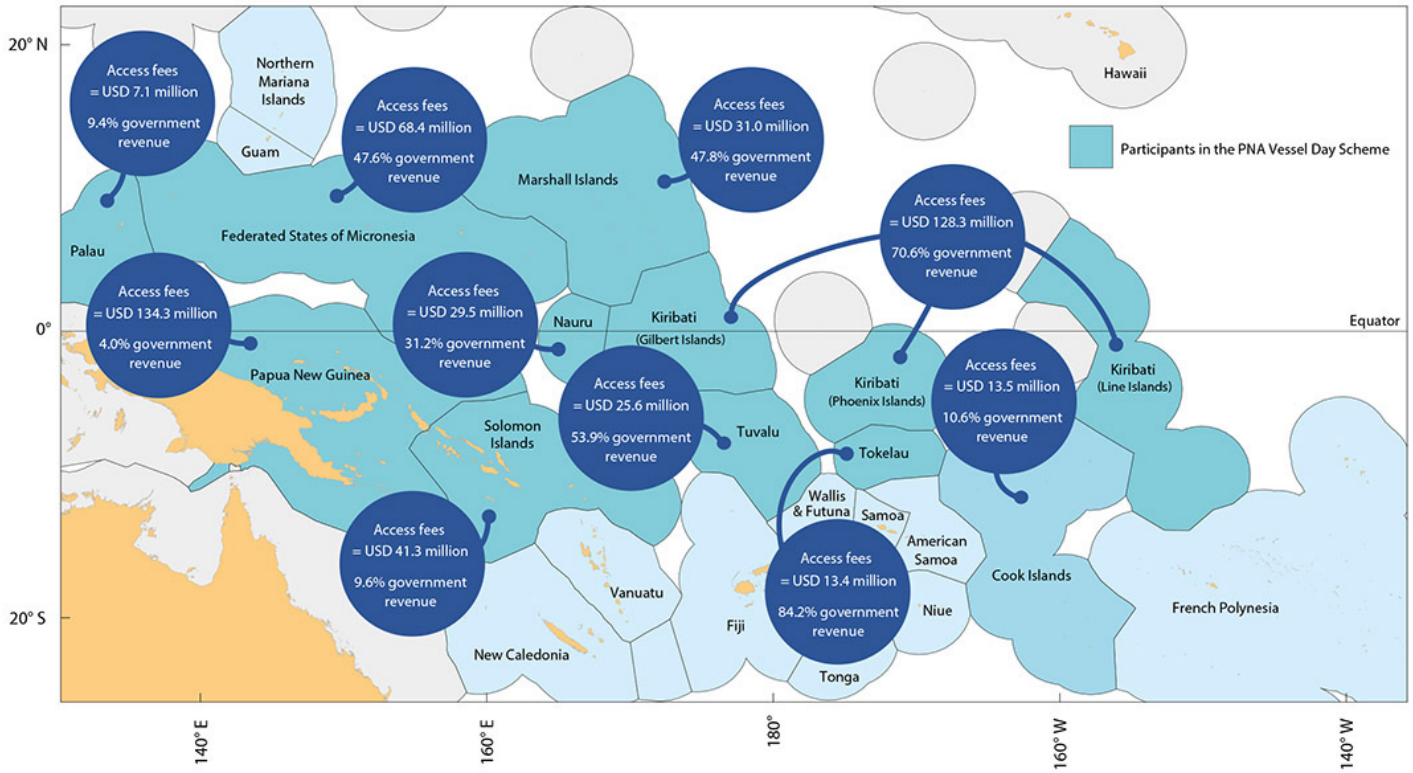


Figure 1. The 10 Pacific Island countries and territories that depend on fishing access fees for government revenue. The information in blue circles shows the average annual tuna fishing access fees (in USD) for the period 2015–2018, together with the average percentage contributions of access fees to total government revenue (excluding grants). Source: Pacific Islands Forum Fisheries Agency

[1] https://www.nature.com/articles/s41893-021-00745-z
[2] Chapter 8 in: https://coastfish.spc.int/index.php?option=com_content&Itemid=30&id=412
[3] http://www.fao.org/3/i9705en/I9705EN.pdf

The new analysis also shows that purse-seine catches are expected to decrease in the waters of all 10 countries and territories by 2050 under a high emissions scenario. These projections are in contrast to previous modelling, which indicated that tuna catches in countries in the western portion of the region would be lower, and catches in countries in the eastern portion would be higher.

The implications of continued high GHG emissions for the 10 tuna-dependent economies are substantial. If high levels of GHG emissions continue until 2050, the annual loss in combined access fees is estimated to be USD 90 million (range = −USD 40 million to −USD 140 million), representing reductions in government revenue of up to 13% (range = −8% to −17%) for individual countries and territories.

The loss of government revenue due to the redistribution of tunas is a climate justice issue. Pacific Island countries and territories make negligible contributions to global GHG emissions but will lose a substantial proportion of the finance they rely on to support government functions, including the provision of health and education systems. In contrast, the developed countries that catch tuna in the region have contributed 60% of GHG emissions and will be able to fish at lower costs because a higher proportion of their catches will be taken from the high seas where fees do not apply.

The study identifies two pathways for addressing this climate justice issue. The first involves achieving the goal of the Paris Agreement to limit global warming to 1.5° C by the end of the century. The modelling described in the analysis indicates that meeting this goal would largely prevent the redistribution of tunas. SPC, the Pacific Islands Forum Fisheries Agency and other Council of Regional Organisations of the Pacific agencies will be assisting Pacific Island countries to emphasise this vital need at the 26th United Nations Climate Change Conference in Glasgow, Scotland in November 2021.

The second pathway is to empower the governments of Pacific Island countries and territories to negotiate effectively through the Western and Central Pacific Fisheries Commission's Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean to retain the rights to historical levels of tuna catches made within their EEZs, regardless of the effect of climate change on the distribution of the fish. This pathway is also essential, in case the global community does not succeed in implementing the Paris Agreement successfully.

The analysis also highlights that climate-driven redistribution of tuna has implications for the sustainable management of the region's rich tuna resources. At present, the tuna sustainability goal of the Regional Roadmap for Sustainable Pacific Fisheries[4] is being achieved largely through the successful implementation of the Vessel Day Scheme operated by the Parties to the Nauru Agreement (PNA).[5] Nine of the 10 tuna-dependent countries and territories participate in this cooperative fisheries management scheme (Fig. 1). The sustainability of tuna catches could, however, be at greater risk once a higher proportion of the fish occur in the high-seas areas because the monitoring, control and surveillance required to combat illegal, unreported and unregulated fishing is more difficult there than within EEZs. The redistribution of tunas to the east will also require greater collaboration between the WCPFC and the regional fisheries management organisation for the eastern Pacific Ocean, the Inter-American Tropical Tuna Commission (IATTC). In future, discrete tuna stocks are expected to span the jurisdictions of the WCPFC and IATTC to a greater extent, necessitating the development of a more robust framework for collaborative management of shared tuna resources.

The analysis concludes by identifying the research needed to reduce the considerable uncertainty that still remains in the models used to forecast the redistribution of tunas during climate change. Examples of the research required include improving the spatial resolution of SEAPODYM,[6] and identifying the number of self-replenishing populations (stocks)[7] within the distribution of each tuna species so that the response of each stock to climate change can be modelled separately. Investment in such research will not only enable the information on the timing and extent of tuna redistribution to be predicted with greater confidence, it will also help identify stocks shared by WCPFC and IATTC and improve stock assessments.

For more information:
cfpinfo@spc.int

[4] https://fame1.spc.int/en/publications/roadmap-a-report-cards
[5] Chapter 12 in: https://doi.org/10.4060/cb3095en
[6] https://doi.org/10.1139/cjfas-2018-0470 and www.seapodym.eu
[7] https://www.sciencedirect.com/science/article/pii/S0165783620300412

World Tuna Day from a professional and personal perspective[1]

Francisco Blaha[2]

It is a hard job, but all the purse seiner crew I met in the Pacific Islands region were genuinely great people. Image: ©Francisco Blaha

World Tuna Day is observed globally on 2 May every year. It was officially proclaimed by the United Nations General Assembly by adopting resolution 71/124 in December 2016. The aim is to spotlight the importance of conservation management and ensure that a system is in place to prevent tuna stocks from becoming unsustainably fished.

And a well-deserved day it is for tuna; a substantial number of nations worldwide depend on tuna for food security and nutrition. At the same time, more than 96 countries have tuna fisheries, and their fishing capacity is constantly growing.

For some areas of the world, the tuna situation is worse than for others. I will focus on the region where I have been working for over 30 years, the Pacific Islands in the western and central Pacific Ocean (WCPO), the source of over 30% of global tuna catches.

The sustainability and economic performance of tuna fisheries in the Pacific Islands is a good story in fisheries, a key area of food production that does not promote many good stories.

For many years now, Pacific Island nations have shown substantial leadership in coastal States' rights and responsibilities. Our region has the strongest unions among coastal countries (countries responsible for the waters where the tuna is fished) anywhere in the world. Exemplary institutions such as the Pacific Islands Fisheries Forum Agency (FFA) are rare, even rarer when one considers that the FFA has been working for over 40 years to support its 17 members in the following critical areas:

- **Compliance and surveillance.** Anyone with a laptop and adequate access through the shared vessels monitoring system can see where over 2500 vessels fishing in the western Pacific are, what they are doing, their licences, their compliance history, their last port of entry, their electronic reporting, solid registers like the FFA Regional Register of Fishing Vessels in good standing (for those that are in compliance with the Harmonized Minimum Terms and Conditions for Access by Fishing Vessels - HMTCs), and so on. FFA also coordinates the four most extensive sea and aerial surveillance operations in the world every year, with the support of assets from the United States, France and Australia to make sure all vessels in the area are authorised (and the system must be efficiently preventing illegal fishing as no illegal vessel has been found in the last five years).
- **Policy and management.** The Pacific has been very supportive in terms of reference points, effort controls, fish aggregating device management, and others. The recent incorporation of standardised port State measures through the Western and Central Pacific Fisheries Commission (WCPFC) conservation and management measures, and FFA's port state measures regional framework is a further example of this vision and one I've been working substantially on.

But also, in terms of who, how, when and where vessels can fish, the 17 countries share harmonised minimum terms of condition for those wishing to fish in their waters; these

[1] Adapted from: http://www.franciscoblaha.info/blog/2021/4/29/world-tuna-day-from-a-professional-and-personal-perspective

[2] Fisheries Consultant. Email: franciscoblaha@mac.com

conditions include the size of the identification markings on the vessels, fishing gear specification, bycatch conditions, and others. And remarkably, this includes fishers' labour rights because a minimum set of requirements – based on the International Labour Organization's Working in Fishing Convention (C188) – has been included as part of the requirements for vessels to be allowed to fish in coastal state waters. This is a momentous event because, as of 1 January 2020, if a vessel does not respect these rights and working conditions as part of its licence, its right to fish can be withdrawn and it will be removed from FFA's list of vessels in good standing, which are all vessels in compliance with FFA's HMTCs.

This is the first time in the world that a direct link between labour standards and the right to fish has been established by a coalition of coastal states!

To add to these harmonised conditions, a subgroup of FFA members, countries that are Parties to the Nauru Agreement (PNA), have created additional conditions for purse-seine vessels and, more recently, longline vessels. These conditions include, among others, the vessel day scheme (an effort management measure, where vessels pay for every day their gear is in the water, even if nothing is being caught), 100% observer coverage on purse-seine vessels, a state-of-the-art information management system, and a prohibition on transshipping to outside ports, all constitute some of the most exigent fisheries access conditions in the world.

Developing fisheries and maximising national fisheries revenues have been the priority of these countries, and these are working. The average value of the annual catch in FFA waters between 2016 and 2018 was USD 2.9 billion, 51% of the average value of the WPCO annual catch of USD 5.7 billion.

In the same period, the purse-seine fishery contributed, on average, slightly more than 80% (USD 2.4 billion) of the total average catch value in exclusive economic zones (EEZs) of FFA member countries; the average value of the skipjack catch was 60% of the total value of the harvest; yellowfin, bigeye and albacore contributed 29%, 8% and 4%, respectively.

Foreign fleets, which once dominated the harvest sector in FFA EEZs, have seen their share of catch value decline significantly in recent years. In 2010, the share of the catch value taken in FFA member water by their national fleets (i.e. vessels flagged by or chartered to them) was 29%, while in 2018 this share had increased to 48% (Fig. 1).[2]

The value of access fees paid by foreign vessels to FFA members has continued to increase over recent years, rising from around USD 114 million in 2009 to USD 554 million in 2018.

These license and access fee revenues make an important contribution to FFA members' government finances, representing 25% or more of government revenue (excluding grants) for six FFA members and as much as 85% for one country.

Government revenue from the purse-seine fleet increased by an average of 27% per annum between 2011 and 2015. Growth then slowed, increasing by just 2% in 2016 and 4% in 2017 before rising to 12% in 2018. This growth has been driven by the increase in the value of days under the PNA purse-seine, effort-based vessel day scheme. Prior to 2011, the value of the day was generally less than USD 2000 but this increased rapidly following the introduction of a benchmark price that set an agreed on minimum price.

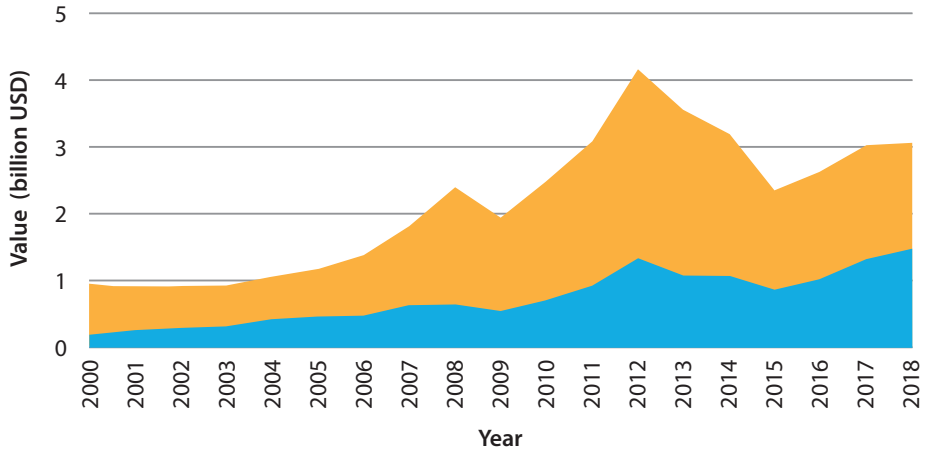


Figure 1. Value of tuna caught in FFA countries' exclusive economic zones (USD billion).[3]

[3] Source: Tuna Economic Indicators 2019 https://www.ffa.int/system/files/FFA%202019%20Tuna%20Economic%20Indicators%20Brochure%202019.pdf

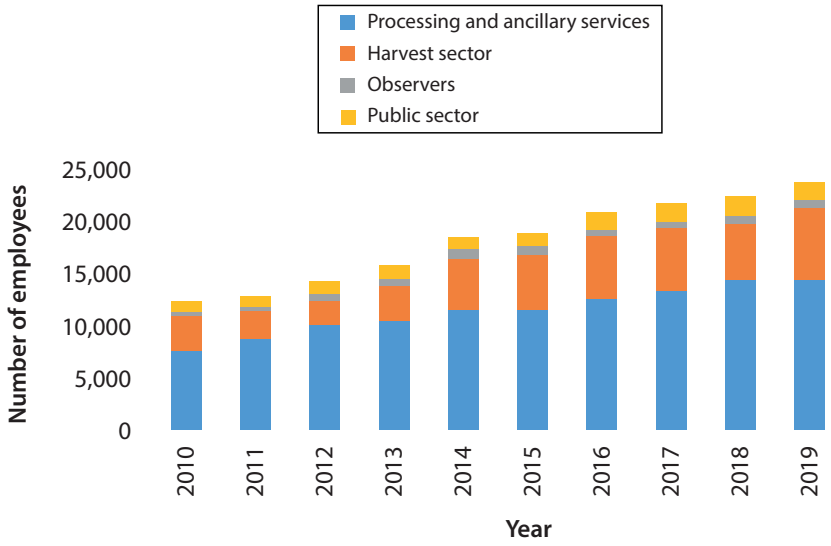


Figure 2. Employment related to tuna fisheries in FFA member countries.[4]

This benchmark price was set at USD 5000 in 2011, which then increased to USD 6000 in 2014 and to USD 8000 in 2015, where it currently stands. Vessel day scheme days in 2018 sold between USD 9000 and 14,000 per day.

Total employment related to tuna fisheries in FFA member countries for 2018 is estimated at around 22,350, an increase of 3% from 2017. Since 2010, there has been consistent growth in employment numbers. The onshore processing sector makes the largest contribution to employment, with about 65% of total employment related to tuna fisheries coming from this sector. Total employment in the onshore processing sector in 2018 was estimated at 14,497, an increase of 7% from 2017. The harvest, observers and public sectors contribute around 25%, 4% and 7% of total employment, respectively. The majority of those employed in the processing sector are employed in Papua New Guinea, which accounts for about 60% of all processing works. Around 16% of processing employment is in Solomon Islands, 15% in Fiji and 3% in the Marshall Islands. Among processing workers, an estimated 10,800, or 75%, are women while an estimated 3600 are men. Significant growth in employment was also observed in the public sector, with numbers increasing to around 1568, over 60% higher than five years ago.

[4] Source: Tuna Economic Indicators 2019 https://www.ffa.int/system/files/FFA%202019%20Tuna%20Economic%20Indicators%20Brochure%202019.pdf

Marshall Islands fisheries officers inspect an average of 450 fishing vessels in Majuro Lagoon every year. Image: ©Francisco Blaha

And all this has been achieved while maintaining the stock at sustainable levels as evaluated by arguably the best tuna and stock assessment scientists in the world, such in the Oceanic Fisheries Programme of the Pacific Community (SPC) headquarters in New Caledonia, and confirmed by the peer review process. All four main WCPO tuna stocks (albacore, bigeye, skipjack and yellowfin) are deemed to be "biologically healthy" in that they are not overfished nor is overfishing occurring (Fig. 3).[5]

A great four-minute video[6] explains how tuna governance works in the western and central Pacific, and this governance is probably one of the reasons why our sustainability record is different from other ocean basins.

Yet this is not to say that it is perfect; the region has seen a changed perception of the stock provided by the 2019 assessment, and discussions on the appropriate target reference point (TRP) value for skipjack tuna continue. The albacore stock is expected to continue to decline below its TRP of 56% of unexploited biomass if recent high catch levels continue, and there are significant concerns about the low catch rates in longline fisheries targeting albacore, and the economic benefits that these fisheries generate. Therefore, FFA countries push for stronger conservation and management measures at the Western and Central Pacific Fisheries Commission, the management body that brings together the region's coastal states and distant-water fishing nations (DWFNs).

Substantial challenges remain, such as: 1) increasing fishing effort, and transshipment and labour issues in the high seas, where flag states have sole responsibility; 2) the impact of "fishing effort creep" through new technologies such as fish aggregation devices equipped with echo sounders, able to transmit via satellite not only the positions of the devices, but also the volumes and species composition of fish below; and 3) the impact of climate change. Yet, the Pacific Islands region has some of the best people in the world dealing with these issues. As an example, in 2016, FFA countries were the first to identify underreporting and misreporting as the main elements of illegal, unreported and unregulated fishing, as well as quantifying the subsequent loss of revenue to coastal countries, estimated to be around USD 160 million, well below previous estimates. The 2021 update of this work is underway and is showing promising results.

[5] Source: SPC. 2020. The western and central Pacific tuna fishery: 2019 overview and status of stocks. https://fame1.spc.int/en/component/content/article/251

[6] https://youtu.be/X6rzc4WNSvU

Leakage of tuna from transshipment has massive impact on food security on many ports in the Pacific (Tarawa, Kiribati). Image: © Francisco Blaha

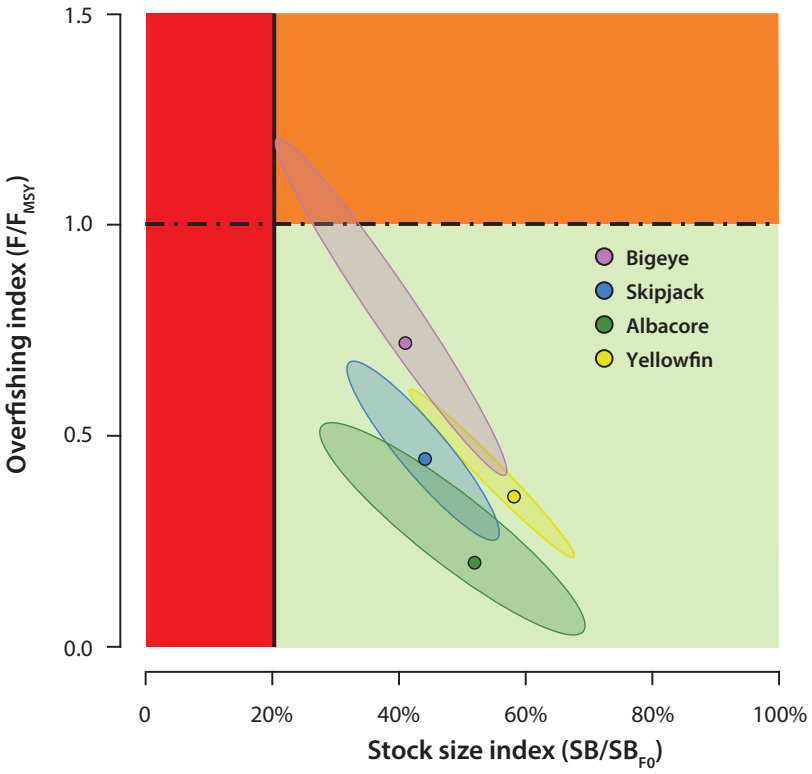


Figure 3. Majuro plot stock status summary for the four WCPO target tuna stocks.

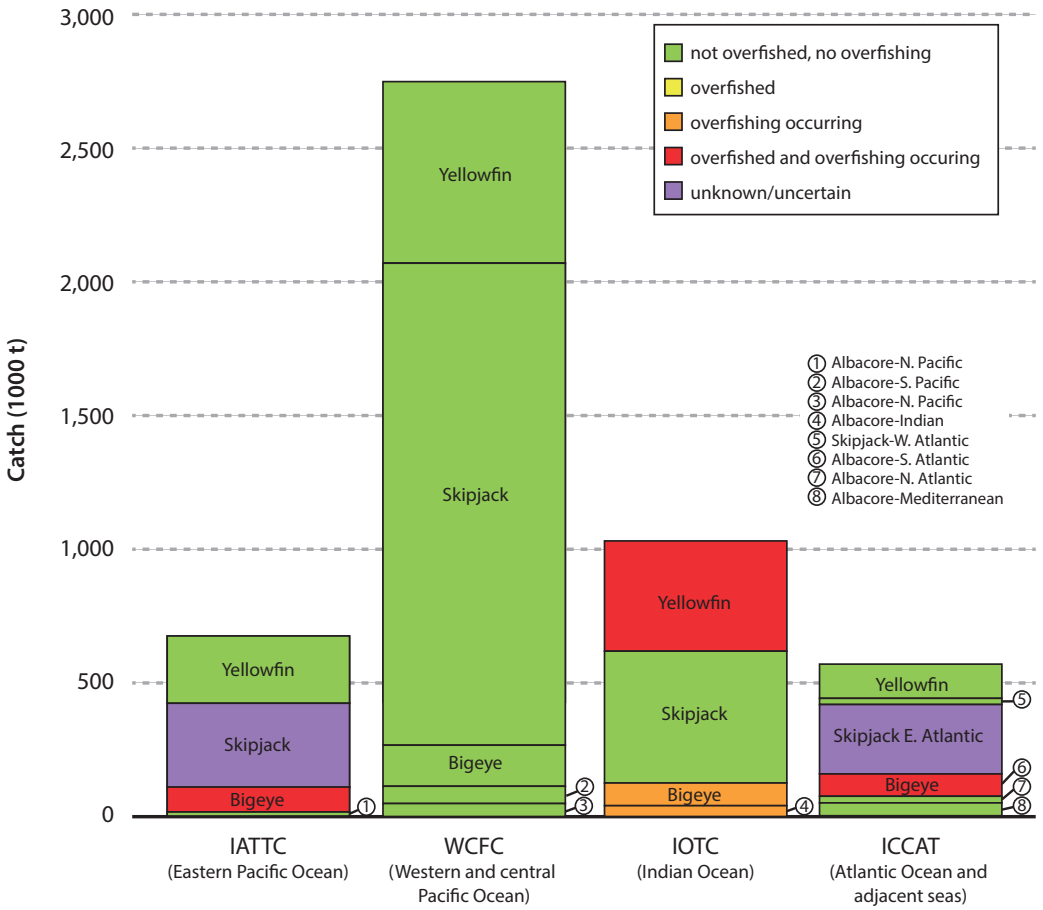


Figure 4. Comparison of stock status for the same four tuna species in the four major ocean basins.[7]

[7] Source: SPC. 2020. The western and central Pacific tuna fishery: 2019 overview and status of stocks. https://fame1.spc.int/en/component/content/article/251

So yes, tuna is fundamental for the Pacific region, and Pacific Island countries are managing their fisheries sustainably because they are capable and understand better than anyone else the implications of failure.

And this is a critically important issue as competing interests impact on the sustainability of tuna. There is a fundamental (and perhaps insurmountable) difference between these interests, as my Nauruan friend and colleague Monte Depaune made clear to me: "For non-Pacific Islands and distant-water fishing nations, the issue of tuna sustainability is one of long-term financial benefit. However, for Pacific Island countries, it is also an identity and food security issue, one that distant-water fishing nations have less trouble with, as they can leave... but Pacific Island countries cannot."

Pacific leaders (despite their cultural differences) have always understood that unity and collaboration are the best approaches against the divide and conquer strategies they sometimes face. While there is little they can do in terms of managing the high seas, they are themselves "Large Oceanic Nations" instead of "Small Island States", and in their waters, they have the last word.

Figure 4 compares the sustainability of the four main tuna stocks in the four major ocean basins of the world; the WCPO is the proud green tower, and this is really good news, which should be known!

In the fisheries world, the power shift is moving to the ones "with the fish" from the ones "with the boats", even if the latter are richer and more influential. Without the strong cooperation and cultural linkages among Pacific Island coastal states that I have been honoured to witness and learn from, I doubt there would be a healthy tuna fishery such as the one they now have. I am incredibly proud to be trusted by my hosts in the region and to be a small part of the massive team that has achieved that.

Beau Bigler, Marshall Islands fisheries officer, inspecting a vessel's activities in accordance with the Marshall Islands Marine Resources Authority's Port State measures procedures. Unloading is only authorised after compliance with licensing conditions has been proven. Image: ©Francisco Blaha

Enhancing fish-based livelihoods and safe aquatic food distribution in island food systems

Hampus Eriksson,[1,2,] Rosalie Masu,[3] Paul Tua,[3] Stenneth Atu,[3] Ivory Akao,[3] Faye Siota,[1] Margaret Batalofo,[1] Anouk Ride,[1] Chelcia Gomese,[1] Delvene Boso,[1] Jillian Tutuo,[1] Anne-Maree Schwarz[2], Agustinha Duarte,[4] Mario Pereira,[4] Alex Tilley,[4] Celestino Cunha Barreto,[5] Alda de Sousa,[5] Janice Natasha,[6] Katharine McKinnon,[7] Anna Farmery,[2] Matthew Roscher,[2] Neil Andrew[2] and Shakuntala Thilsted[8]*

Introduction

Fish and other aquatic foods are the backbone of island economies in Southeast Asia and the Pacific (e.g. Gillett 2016). Almost everyone in the Pacific eats fish regularly (Farmery et al. 2020), but most people are not fishers. Fish are caught, distributed and acquired by consumers through purchase, gifting or bartering. This system of producing and distributing aquatic foods connects remote sources of supply with urban and inland demand, and generates indispensable value, both in the form of fish-based livelihoods for the many people involved, and for food and nutrition security in island populations (Gillett and Cartwright 2010). During periods of hardship and disruption, such as the ongoing COVID-19 pandemic or natural disasters, fish and fish-based livelihoods play an important role in the resilience of community economies (Eriksson et al. 2017, 2020). Regional and national development policies and strategies identify that improving the livelihoods of people who catch, process or trade fish, is a critical pathway to improved food and nutrition security (e.g. SPC 2015; DRTL 2011, 2017; World Bank 2017; MFMR 2019). Maintaining the contribution of aquatic foods to food and nutrition security for growing urban populations depends on the sustainability of supply, in addition to improved access to safe aquatic foods from rural origins and reducing waste and loss. In response to these broad objectives, we identify four key opportunities for enhancing fish-based livelihoods and the safe distribution of aquatic foods, and outline a programme that will be undertaken to meet these opportunities.

Inadequate understanding of fish distribution practices and opportunities for livelihood innovation

In many island food systems, perishable goods are stored and transported using relatively simple and short supply chains, which greatly limits the effective distribution of food that is safe to eat and constrains opportunities to enhance rural fish-based livelihoods (Steenbergen et al. 2019; Tilley et al. 2020). Broad observations about the structural challenges with fish-distribution have highlighted a range of issues along fish value chains, including a lack of hygienic fish handling and processing, limited transport opportunities, limitations in processing and storage options, and barriers to market access (e.g. Kruijssen et al. 2013; Lopez-Angarita et al. 2019). But not enough is currently known about **how** fish and fish products circulate in local economies, and the key factors underlying **why** fish distribution has developed the way it has. As a result, there is also a knowledge gap around opportunities for women's and men's innovation to address production and distribution challenges leading to waste and loss, as well as around gender barriers, education needs and effective policy implementation (World Bank 2017; Tua et al. 2020). Fisheries development programmes seeking to address these challenges need to identify promising areas and activities for innovation, and consider how the benefits can be distributed equitably.

Learning from existing initiatives in rural fish-based livelihoods

Coastal fisheries have long been the focus of development investments in the Pacific (Preston and Vincent 1986; Boape 1999; Bailey and Jentoft 1990; Chapman 2004). Many initiatives have struggled to achieve intended livelihood benefits broadly because they are out of tune with the way people live their lives (O'Garra et al. 2007). Evaluating and learning from past and ongoing activities is critical to improving fisheries development programmes, with a balance between externally supported and locally led innovation processes (e.g. Cox 2017; Eriksson et al. 2020, Roche et al. 2020; Suti et al. 2020). This includes also considering the many traditional practices used to preserve and produce delicious and

[1] WorldFish, Honiara, Solomon Islands
[2] Australian National Centre for Ocean Resources and Security (ANCORS), University of Wollongong, Australia
[3] Ministry of Fisheries and Marine Resources, Honiara, Solomon Islands
[4] WorldFish, Dili, Timor-Leste
[5] Directorate General of Fisheries, Dili, Timor-Leste
[6] University of the South Pacific, Suva, Fiji
[7] Centre for Sustainable Communities, University of Canberra, Australia
[8] WorldFish, Penang, Malaysia
* Author for correspondence: H.Eriksson@cgiar.org

Figure1: Pictures representing a gradient of externally supported and locally led initiatives. There is much to learn from the many examples of innovation and investments to enhance livelihoods in the coastal fisheries sector. Infrastructure development in the form of "fisheries centres" is a common modality in the Pacific.

1 The Constituency Fisheries Centre at Hauhui in Solomon Islands is one example. These centres often focus on cold storage and ice making for preserving fish during transportation for sale in urban areas, or even export. 2 The ice machine at the Provincial Fisheries Centre at Gizo in Solomon Islands is supplying fishers with flaked ice. Such types of developments are usually very costly, but new technologies are now available that are opportunities for less costly and lighter touches, such as compact solar powered freezers. 3 In Malaita, women's groups rent out freezer space to people in the village for storing fish and other foods. But novel technologies are not the only way enhancement of fish-based livelihoods can occur.

Social innovation in the form of cooperation is also a way of thinking and planning. These movements can incorporate group training. For example, 4 training in cooking for value adding in microenterprise-style initiatives in Timor-Leste, or 5 peer-to-peer demonstration activities to spread the recipe and practice of nutritious fish-powder with other groups for their sale or consumption. Often, people have developed local solutions or recipes to local challenges or preferences. For example, 6 Ipu is made from tiny fish caught with nets in the Laclo (Manatuto) River in Timor-Leste, mixed with locally produced salt and poured into small bottles that keep for up to a year and can be sold on the roadside.

These traditional practices are made more efficient through continuous innovation. For example, 7 even though drying fish is a traditional practice at Atauro Island in Timor-Leste, making upgrades to such practices using local materials can be a way of enhancing livelihoods using intermediate technologies. 8 Smoking is a practice used to preserve reef fish taken to Gizo and Honiara for markets and family consumption from Vella La Vella in Western Province, Solomon Islands.

Images: 1, 2, 3, 5, 6: Hampus Eriksson; 4: Joctan Dos Reis Lopes; 7: Holly Holmes; 8: Chelcia Gomese

convenient aquatic food products (e.g. Duarte et al. 2020). Despite widespread investments and planning, rural women still feel their fish-based livelihood practices are ignored in many interventions (Ride et al. 2020). Inadequate attention has also been given to the gendered dimension of fish distribution networks and the social and cultural dynamics of fish-based livelihoods. As a result, much of the development programming around coastal fisheries fails to properly engage or benefit the full complement of stakeholders, or to consider the gendered impacts of interventions (e.g. Lawless et al. 2017; Labouinao 2020). There is much to be learned from the many examples of existing innovation in production, storage, processing and packaging (Fig. 1).

Recognised need for upskilling to enable improvements in livelihoods and access to safe aquatic foods

Food loss before consumption is a feature of inefficient food systems, with implications for sustainable resource use, as well as for livelihoods, and food and nutrition security (Chen et al. 2020). Perishable foods, such as fresh fish, are typically at much greater risk of contamination by food-borne pathogens and spoilage by complex biochemical and microbiological processes than more shelf-stable products, such as processed foods. Product degradation from inefficient supply chains and poor handling practices can affect quality, leading to products being sold or exchanged at gradually lower prices, as well as resulting in both reduced nutritional value and increased food safety issues (HLPE 2014). Food spoilage can affect nutrition through nutrient depletion in products, or reduced availability of nutrients through waste; it is estimated that 18–41% of vitamins and minerals, including 23–33% of vitamin A, folate, calcium, iron and zinc are lost from food globally (Global Panel 2020). This nutrient loss, which can occur at different stages of the supply chain, including during fishing, processing and cooking, is poorly understood in seafood, which has highly varied nutrient composition across species, and is often an important source of vitamin A, calcium, zinc and iron (Farmery et al. 2020). The loss of fish quality can limit peoples' financial benefits, in particular for women (Kaminski et al. 2020). For example, post-harvest loss accounted for up to 10% of all food products in the Honiara municipal market and up to 7% in roadside markets, including fishing village markets, in Solomon Islands (Underhill et al. 2019). The provision of training and awareness on alternative processing options has the potential to improve financial benefits through better preservation practices and reduce wastage, which can increase shelf-life and extend the distribution of good quality aquatic foods (Kruijssen et al. 2013; Diedi-Oadi and Mgawe 2011). Novel technologies and social innovation for hygienic handling, processing and sales are key areas of opportunity to enhance livelihoods and access to safe and nutritious aquatic foods.

Readiness of national agencies for community-led development pathways

Partners in Timor-Leste and Solomon Islands recognise the need to shape fisheries development investments towards building local capacity. Policy to support community-led development in rural fish-based livelihoods is already in place in both countries, however, putting policy into practice remains a recognised challenge for national programmes. For example, the reach of agricultural extension services in Solomon Islands is very limited. In the 2019 agricultural census, 4% of agricultural households stated that they had received extension services from a government agency or non-governmental organisation, while 68% gained information from peers (SIG 2019). There is more agricultural extension capacity than fisheries extension capacity, so the information gap is likely to be even greater for the fisheries sector. In the absence of broad-reaching services, alternative models of community-led development and peer-to-peer sharing are needed, with associated targeted support from fisheries agencies.

Our response

We are a consortium of colleagues and projects from the Ministry of Fisheries and Marine Resources in Solomon Islands, the Directorate General of Fisheries in Timor-Leste, the University of the South Pacific in Fiji, and the Centre for Sustainable Communities at the University of Canberra in Australia, all coordinated by WorldFish and the Australian National Centre for Ocean Resources and Security (ANCORS) at the University of Wollongong in Australia. We will seek to address aquatic food distribution opportunities in island food systems through place-based action research in Solomon Islands, Timor-Leste and Fiji over the next four years. Our programme is organised according to four interrelated work packages seeking to achieve outcomes framed around the justifications described above (Fig. 2).

Reducing food loss and waste, through upgrading supply systems, has the potential to significantly improve benefits related to diet quality, food safety and income generated from higher-quality fish products (HLPE 2014; Rosales et al. 2017). Enhancing storage, processing and distribution of local food commodities is vital in mitigating food and nutrition security impacts from changing food production patterns, and has become especially important during the current COVID-19 crisis (Farrell et al. 2020). A strong link exists between the supply of education, training and skills and the increased demand for, and supply of, practical and organisational innovation (Toner 2011). However, no technical training or sharing of practices suited to rural areas currently exist, and there is very limited understanding on how best to enable rural innovation, based on newly gained skills. Therefore, a central and important part of our programme is to develop accessible information and training.

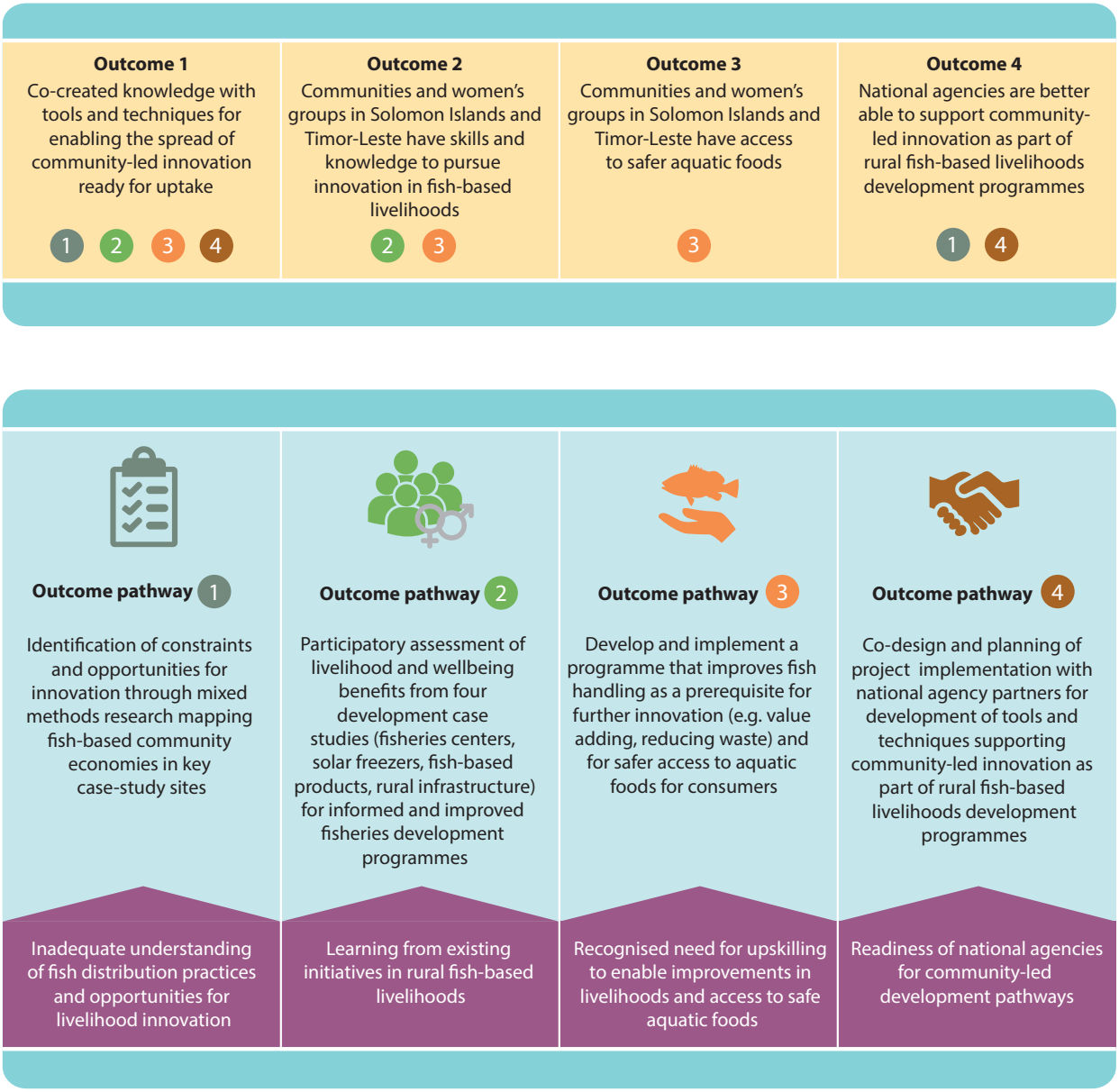


Figure 2. A logic for our work programme focusing on reducing aquatic food waste and loss, upgrading marketing practices through upskilling, and assessing fish-based livelihoods to guide fisheries development programming.

Improving the accessibility of training, and ensuring that training is suited to local needs and context, is an area of work that has been recognised for many years as being important in the Pacific (e.g. Chamberlain et al. 2001), but rarely addressed in a systematic way. We know that external support activities, when shaped to the priorities and concerns of local stakeholders, can have an impact. For example, responding to observed poor handling practices leading to spoiled and unsafe fish, we piloted activities for raising basic handling skills, identification and prioritisation of action plans to share with authorities and market managers in Malaita, Solomon Islands (Fig. 3). Vendors at the workshop prioritised upgrading to market infrastructure, which was recently done (Solomon Star 2021), showing that workshops where priorities are identified and mobilised can generate upgrades. As part of these activities, we developed fish-handling information materials, focusing on basic facts and illustrations (Li et al. 2018). These materials are freely available from SPC[9] and now translated to Bislama (Vanuatu), Tuvaluan (Tuvalu) and Tetun (Timor-Leste).

There is growing recognition of the need for more community-based approaches to coastal livelihood development, and this is an opportunity to shift costly development blueprints towards community-based resource management (CBRM)-like practices (FFA and SPC 2016; SPC 2020). Countries have programmes seeking to support rural economic activities around fish distribution, so there is a clear opportunity

Figure 3. 1 Fish marketed at Auki, Solomon Islands, both on the ground and in the sun, leading to rapid spoilage. 2 Diagnosis of ways to address the structural problems with the market. 3 Practical upskilling with market vendors. Images: Jan van der Ploeg

for integration (e.g. Alonso et al. 2012; Tua et al. 2020). The focus of these programmes in the past has been capital-intensive investments (e.g. fleet mechanisation programmes, infrastructure, deep-sea fishing methods and export mariculture) that local women and men have often been unable to benefit from. Significant advancements in the recognition and use of participatory community approaches in the sector (van der Ploeg et al. 2016) provide opportunities for more sustainable development of coastal fisheries that are better integrated with local fisher communities. The increasing profile of the CBRM policy and practice in the Pacific over the past decades demonstrates the potential for participatory community approaches to better serve the needs and strengths of local communities (SPC 2015; Schwarz et al. 2020), and that the policy platforms are already in place to use community-based approaches for enhancing rural livelihoods and addressing challenges such as fish waste and loss.

Summary

We will assess fish distribution practices and identify women's and men's livelihood benefits from development initiatives in the coastal fisheries sector, to aid planning with national partners and prioritise innovations that show evidence of equitable benefits. Activities will support rural women and men to develop and share innovative solutions for sustainable fish-based livelihoods, reduce waste and loss of aquatic foods, and increase the capacity of national agencies to support community-based initiatives and ensure equitable rural fisheries development investments.

Acknowledgements

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Quantifying non-metric measurements of seafood products at the Suva market

Vutaieli B. Vitukawalu,[*] Sangeeta Mangubhai,[1] Ana Ciriyawa,[1] Waisea Naisilisili,[1] Nanise Kuridrani and Semisi Seru[2]

Fishery resources play a crucial role in Fiji's economy, contributing to food security, employment and exports, in addition to their recreational and social attributes (Lee et al. 2020). There is growing concern about the declines in populations of popular reef fish species, with 17 species assessed as having <20% spawning potential ratio, the international limit reference point above which fish stocks should be maintained to minimise the risk of stock decline (see Table 1 in Prince et al. 2019). While estimating the production and status of these resources is a complex and challenging process (Gillett et al. 2014), assessing and monitoring their harvest and sale is essential for effective fisheries management.

The Suva municipal market is the largest in Fiji and where a diversity of seafood – including finfish, invertebrates, marine algae and freshwater species – are sold. While there has been weekly monitoring by the Ministry of Fisheries' Inshore Fisheries Management Division of finfish species and sizes sold at major municipal seafood markets in Fiji, there is a scarcity of information on the production volume of invertebrates and algae. The ministry is interested in finding innovative, cost-effective ways to fill this data gap and expanding their programme to include invertebrates and marine algae.

However, one of the challenges is that invertebrates such as bivalves and algae traded at for example the Suva market, are not sold according to standard metric units, and therefore there is no information on the volumes, sizes, and numbers being sold. "Non-metric units" used in markets include heaps (or piles), bags, strings, and plates for a range of invertebrates and algae (Thomas, et al. 2020). For example, seagrapes (*nama*) and sea cucumbers (*dairo* or *sucuwalu*) are sold in a heap on plastic plates, rather than by weight. Freshwater mussels (*kai*) are sold in heaps separated into two sizes – medium and large. This issue makes it challenging to calculate the volume of invertebrates and marine algae traded, and their contribution to the Fijian economy.

The Wildlife Conservation Society and Fiji's Ministry of Fisheries carried out a study to convert non-metric measurements of freshwater and marine species sold at the Suva market to standardised units. Specifically, the conversion factor was determined to turn non-metric units (e.g. 1 pile of *kai*) into estimates of the number of pieces and/or weight in kilograms. The information documented from this study can be integrated into the ministry's market survey programme to monitor the trade of invertebrates and algae being sold at municipal markets around Fiji to provide information critical for managing fisheries resources.

[1] Wildlife Conservation Society Fiji Program, 11 Ma'afu Street, Suva, Fiji Islands
[2] Ministry of Fisheries, Fiji Islands
[*] Author for correspondence: bvitukawalu@wcs.org

Seagrapes sold in heaps on plastic plates at the Suva market.

Wildlife Conservation Society Fiji Fish Specialist, Waisea Naisilisili, and Ministry of Fisheries Field Officer, Semisi Seru measure the weight of freshwater mussels.

Methodology

This study collected data on four invertebrate and two algal-species sold at the Suva market that are sold in non-metric units. Data on sea cucumbers were not included due to a national sea cucumber ban in place. Invertebrates and algae were purchased from vendors at the Suva municipal market. For each invertebrate species, data were collected on individual size, total count, volume and price per non-metric unit. The size of key invertebrate species sold was measured with Vernier callipers to the nearest millimeter. The count per non-metric unit was derived from the total number of counts or individuals in a unit (e.g. heap, bag, plate). An electronic scale was used to measure the volume of both the samples and individuals with the individual weight measured to the nearest gram. To determine the final weight of seafood products, the weight of the container or plastic used in weighing seafood was subtracted from the sample weight. The price of each unit of seafood product was also documented.

Results

The data in Table 1 show the average volume of the freshwater and marine species being sold when sellers use non-metric units. The average volume can be used as a conversion factor to turn non-metric units into standardised weight measurements that can be used for fisheries reporting. This is done by simply multiplying the number of heaps, plates or bags being sold of each species by the average weight or non-metric unit to calculate the overall volume of the species sold. For instance, the ministry simply needs to count the number of plates of seagrapes sold (e.g. 50 plates) and multiply this by the average weight per plate (conversion factor of 0.18 kg average weight/plate) to provide the overall volume of seagrapes sold (e.g. 9 kg). The standard deviation for all products was not exceptionally high (less than 50% of the average), thus representing a reliable dataset. However, more samples can be collected if the Ministry of Fisheries wanted to further refine the conversion factor.

Table 1. The price, average number and volume of invertebrates and algae per non-metric unit. Currency is in Fijian dollars. N/A = not available, meaning the average counts per non-metric unit was not applicable to species surveyed.

Seafood products	Species	Local name	Non-metric unit	No.	Price	Average count	Average volume ± standard deviation (kg)	Volume range (kg)
Saltwater clams	*Anadara antiquata*	*Kaikoso*	heaps	20	FJD 5	40	2.09 ± 0.56	1.01–2.78
Freshwater mussels	*Batissa violacea*	*Kai*	heaps (small)	9	FJD 4	91	3.63 ± 1.19	2.36–5.39
			heaps (large)	15	FJD 5	48	2.96 ± 0.69	1.90–4.31
Seagrapes	*Caulerpa racemosa*	*Nama*	plates	20	FJD 2	N/A	0.18 ± 0.04	0.10–0.28
Seaweed	*Hypnea* spp.	*Lumi cevata*	heaps (small)	19	FJD 2	N/A	0.15 ± 0.10	0.05–0.35
			heaps (large)	6	FJD 3	N/A	0.09 ± 0.02	0.07–0.12
Sea urchins	*Tripneustes gratilla*	*Cawaki*	bags	12	FJD 5	35	5.31 ± 0.78	4.39–7.31
Turban shells	*Turbo chrysostomus*	*Vivili*	bags	18	FJD 3	432	1.50 ± 0.24	1.15–1.89

Determining the weight of sea urchins using an electronic scale.

Freshwater mussels sold in heaps at the Suva market.

Summary

The study shows a quick, relatively cost-effective method to calculate conversion factors to enable the Ministry of Fisheries to convert non-metric units of sale of invertebrates and algae into weights. This negates the need to measure individual non-metric units each time, thus saving time and resources. This method can also be used to collect weight data on other bivalve species, or potentially crustacean species, if for example they are being sold in strings. The method and approach used in this study have been successfully tested and may be valuable for market survey monitoring programmes being implemented in other Pacific Island countries. The conversion factor is an essential component in market surveys and can also be used to convert non-metric data collected during fisheries value chain analyses (e.g. Mangubhai et al. 2017) or broader socioeconomic surveys (e.g. Thomas et al. 2020). The approach used can be applied to other places and proves to provide reliable data. Managers can determine for their geography and management needs how much data and sample sizes they wish collect to build a more robust dataset. This survey should be repeated every two to three years, in case conversion factors need to be adjusted.

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Reflecting on four years of community-based fisheries management development in Vanuatu

Sompert Gereva,[1] Dirk J. Steenbergen,[2] Pita Neihapi,[3] Regina Ephraim,[3] Vasemaca Malverus,[3] Abel Sami[3] and Douglas Koran[3]

Since 2017, the Vanuatu Department of Fisheries (VFD) has been collaborating with partners to implement its component of a regional project to strengthen community-based fisheries management (CBFM). Known as the Pathways Project (hereafter referred to as the project), its overall aim is to improve the wellbeing of men, women and children in coastal communities through more productive and resilient fisheries, and better food and nutrition security. This four-year project is the second in a series of investments into strengthening CBFM in Kiribati, Solomon Islands and Vanuatu.[4] It is led by the University of Wollongong (UoW) in Australia in collaboration with the Pacific Community (SPC), WorldFish and respective national fisheries agencies.

In Vanuatu, the project is the largest of several bilateral projects under VFD's coordination that seeks to strengthen the coastal fisheries sector, and supports a team of five VFD-CBFM officers. The team is collaborating with over 30 communities across all six provinces in the country. As such, these collaborations vary in character and intensity, with some requiring higher degrees of on-the-ground support and others only distanced support. While some communities are advanced in their CBFM efforts (e.g. have and use CBFM plans, have *tabu* areas formally gazetted and/or are monitoring resources), others are just starting to apply management measures. The project's activities are institutionally embedded in VFD. This means the project coordinates implementation to fit with programmes and other bilateral projects run through VFD. In doing so, the project directly contributes to VFD's obligations to development goals in the National Sustainable Development Plan. The project employs a "research for development" approach, which uses collaborative research and co-learning with communities, to accelerate development. All work seeks to produce outputs that are readily usable and impactful on practice as part of a collective learning process.

With the project concluding in December 2021, it is timely to reflect on its contribution to CBFM development in Vanuatu. Given the broad scope of CBFM, implementation utilised a range of pathways to achieve change. It is the sum of outcomes along those various pathways that come to shape outcomes for CBFM development, both in terms of practice across coastal communities and as policy and management along scales of governance. Without being able to capture here the full range of project activities, we have selected five action areas for which we present outcome briefs. We start with Pita Neihapi's account of the project's efforts to strengthen CBFM institutions, highlighting national policy impacts and impacts on management practices in communities. Regina Ephraim continues by presenting capacity development initiatives that were undertaken for VFD staff. Herein she focuses on capacity building areas of gender-sensitive CBFM and nutrition-based management, as well as regional professional networking initiatives allowing knowledge and skills exchange among officers. In the third outcome brief, Vasemaca Malverus reflects on innovative strategies that were developed with partners for improving how CBFM information gets disseminated to coastal communities. Abel Sami presents several programmes that were developed to improve the collection, management and application of data as part of national monitoring efforts. He highlights, in particular, VFD's uptake of a solar-powered freezer monitoring programme that was piloted by the project. Finally, Douglas Koran reports on measures taken to quickly mobilise resources, funding and technical advice in support of disaster relief efforts, also underlining the importance of CBFM in improving the resilience of coastal communities.

We acknowledge work by many parallel initiatives undertaken in the CBFM arena, and other influences on CBFM progress. Attributing change to interventions is, therefore, difficult and we have done so conservatively. Where directly observed or measured changes are immediate, such attribution is more straightforward. In cases where actions are connected to broader change, we strongly acknowledge that the project forms one of many drivers of change, and claim a *contribution* rather than full *attribution*.

From 2022 onwards, the project will transition into a third CBFM investment phase until 2025. With the solid foundations of CBFM, strong collaborations in place, and strategic long-term policy visions now guiding coastal fisheries de-

[1] Deputy Director Coastal Fisheries, Vanuatu Fisheries Department. Email: sgereva@vanuatu.gov.vu
[2] Senior Research Fellow, University of Wollongong-Asutralian National Centre for Ocean Resources and Security. Email: dirks@uow.edu.au
[3] Community-based Fisheries Management Officer, Vanuatu Fisheries Department
[4] The first phase, known as PacFish, was led by WorldFish through Australian Centre for International Agricultural Research project FIS/2012/074; 2014–2017.

velopment in Vanuatu, the next phase of support will focus on scaling up CBFM through a self-sustaining, well-coordinated national CBFM programme. To this end, VFD will extend its CBFM support to coastal communities through both its own decentralised structures and through partners (e.g. non-governmental organisations and other civil society organisations). Pathways-2 aims to work towards complete absorption of CBFM capacity into VFD and its partners.

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Strengthening institutions that support CBFM

Pita Neihapi, SPC-FAME and VFD-CBFM team leader, VFD

Community-based fisheries management (CBFM) builds on collaborative arrangements between government and communities, and is the primary form of management applied across Vanuatu's highly dispersed, dynamic and diverse coastal fisheries (Tavue et al. 2016; Raubani et al. 2017). Over the last decades, initiatives to develop CBFM have focused on direct support to communities. Yet for that support to have a lasting impact, it is equally important to develop enabling environments made up of strong organisations, supporting rules and collaborations among service-providing stakeholders. The policy backdrop for Vanuatu's coastal fisheries is guided by key national policies, including the National Sustainable Development Plan, the Vanuatu Fisheries Act and the National Fisheries Sector Policy. The Vanuatu Department of Fisheries (VFD) oversees the coordination of policy and management over coastal fisheries, through the formal government layers outlined in Vanuatu's Decentralisation Act (CAP-230), from national to province and area. At the community level, government-supported management is implemented through fishers associations, authorised officers, resource (e.g. TAILS) monitors, and various management committees.

One of the Pathways Project's first priorities was to respond to VFD's interest in instituting long-term strategic planning that could translate higher policy objectives into effective implementation. VFD, furthermore, noted the particular need to improve collaborations with other line agencies and civil society groups, as well as technical skills to support CBFM implementation. At a grass-roots level, the project supported community groups in resource management planning (through establishing CBFM plans), adaptive management (through facilitating CBFM plan reviews), and strengthening local organisations (through establishing fisher associations). The project, through its VFD-CBFM team, was well placed to address these gaps, with an on-the-ground presence in communities in all provinces, and productive partnerships with civil society groups. Key examples of how the project supported institutional strengthening for CBFM – at the national, subnational and community levels – are illustrated below.

Strengthening policy coordination and implementation

With support of the project and SPC-Fisheries, Aquaculture and Marine Ecosystems (FAME) Division, VFD developed its first National Coastal Fisheries Roadmap 2019–2030.[5] This 10-year strategy aligns actions with a series of short-, mid- and long-term milestones towards reaching a vision for coastal fisheries. The roadmap was developed over a two-year period starting in 2017 and endorsed in 2019 by the Honourable Hosea Nevu, Minister for the Ministry of

[5] https://purl.org/spc/digilib/doc/bhawm

Agriculture, Livestock, Forestry, Fisheries and Biosecurity (MALFFB) (for more details on process and content see Raubani et al. 2019).

The roadmap has become an integral tool for VFD to develop annual implementation plans that ensure activities contribute towards realising key policy goals. Fisheries Development Officers, for instance, have used the roadmap to integrate targets outlined in the NSDP into designing and implementing fishing aggregation device programmes. Bilateral projects, such as Pathways, have been guided by focal priorities of the roadmap. Utilising subnational government structures to expand governance reach, for example, was a key driver in developing area-level CBFM plans instead of single community plans. This led to the development of Vanuatu's first two area-level CBFM plans, for Aniwa and Futuna islands (Tafea Province). Similarly, senior VFD officers planned training schedules for 2020 based on priorities set in the roadmap, including the roll-out of fish value-adding training and catch monitoring training. At a strategic coordination level, VFD has used the roadmap to highlight remaining gaps for development, to coordinate external funding and align scopes of new proposed projects. In the design of the next phase of Pathways, for example, VFD used the roadmap to ensure proposed ideas meaningfully contribute towards the national vision for coastal fisheries. As noted by VFD's Deputy Director Coastal: "the roadmap links our practice to high policies and is an important guide for coastal fisheries implementation [...] all my advice to the Director on coastal fisheries development is informed by this document".

MALFFB Minister Honourable Hosea Nevue, Director General Moses Amos and Deputy Director Coastal Sompert Gereva during the ministerial endorsement of the National Coastal Fisheries Roadmap. Image: © VFD 2019

New collaborations with other government line agencies that have mandates beyond fisheries were initiated under the project, such as the Ministry of Health and the Office of the Registrar of Cooperatives and Business Development Services (ORCBDS).[6] Collaboration efforts with the Ministry of Health promoted fish as an important nutritional source of protein and micronutrients, and resulted in the joint production of a "fish for nutrition" awareness video for public dissemination (see also "Capacity development" outcome brief). Collaboration with ORCBDS led to the development of a cooperative training manual tailored for community fish markets, and has since been used in community fish market trainings (see also "Fisheries monitoring" outcome brief). To galvanise knowledge and experience from various initiatives led by government and non-governmental stakeholders, project staff also initiated an annual CBFM symposium. This annual event allows for updating on activities, progress and achievements, as well as reflecting on best practice among programmes, government departments and community groups involved in CBFM. The VFD-CBFM team hosted the first series between 2018 and 2020, and in 2021 VFD expanded its scope by utilising the National Agriculture Week, to host a three-day national coastal fisheries symposium, entitled Fish Toktok on Tanna, in August 2021.

Strengthening CBFM institutions on the ground

Institutional strengthening in communities focused in part on co-developing management tools. The project worked with 20 communities across all six provinces to co-develop or revise CBFM plans. New CBFM plans were co-developed in 13 communities. In seven communities, the project facilitated reviews of CBFM plans, using a participatory review tool[7] co-developed with colleagues in the project from WorldFish and SPC. These reviews resulted in adaptation of management through revisions of rules, committees, and/or closure area delineations.

One of the outcomes of having CBFM plans was communities' ability to better control impacts of peaks in demand for fish following disasters, in preparations for religious events, and/or during Christmas holidays. The Ikaukau community on Aniwa Island, for example, sought advice from VFD following the 2020 COVID-19 inter-island travel restrictions before opening one of their tabu areas when food stocks on the island ran low. In accordance to their CBFM plan, harvesting was subject to measures around gear use and species targeting, as regulated by the tabu area committee. The tabu area returned to closed status after two weeks, when travel

[6] These interdepartmental collaborations within the government differ from other partnerships established by Pathways, and are reported on elsewhere (e.g. with Wan Smolbag, see also "Information dissemination" outcome brief).

[7] https://purl.org/spc/digilib/doc/v33gz

restrictions eased and trade resumed. In another example, the Kwamera community in Tafea Province applied their CBFM plan during a *kastom* tabu area opening associated with the annual yam harvest on Tanna. The tabu area committee deliberated with the community tribes and opened their tabu area for a day rather than the normal two weeks. John Sapa, a tabu area committee member and *kastom* elder, noted at the time of opening, "Since actively managing our resources it has allowed us to cooperate with neighbouring communities and come up with the ways to continue *kastom* fishing today [...] as a result today we caught fish of sizes similar to the ones our elders used to catch".

The VFD-CBFM team's work with communities to develop CBFM plans has facilitated entry points for other VFD divisions and FDOs to (re-)engage with those communities. After going through the process of co-developing CBFM plans, some communities have gone on to establish fisheries governance structures (e.g. fishers associations, committees and appointment of authorised officers) in their work with other divisions.

Lessons learned

Efforts by the project to strengthen institutions for CBFM growth have highlighted the importance of enabling environments at several levels. Future investments seeking to support the scaling out of CBFM activities, therefore, require a focus not only on improving management practices across larger areas, but also on ensuring there are mechanisms and structures in place that enable a CBFM support programme to be self-sustainable. It is important that programmes be able to adjust in ways that maintain CBFM's growth trajectory under changing social, economic, political and/or environmental conditions. Critical building blocks for this include (but are not limited to) productive collaborations (e.g. public-private, interdepartmental and regional), effective governance tools (e.g. up-to-date policies, rules and regulations, and long-term planning), technically sound and locally appropriate management (e.g. co-developed CBFM plans), and mechanisms for inclusion of diverse interests in decision-making.

Developing CBFM capacity in fisheries agencies

Regina Ephraim, CBFM officer, VFD

National coordinating institutions need adequate capacity in order to support CBFM across many communities. This responsibility falls on VFD and its staff as the overarching point of coordination on matters of coastal fisheries, as defined in Vanuatu's Fisheries Act (No.10/2014). As dynamic as the coastal fisheries sector is, so too are the skill requirements and competencies needed to support it. As such, demand for certain skillsets within VFD change over time. Equally important is that there are mechanisms in place for skills to be passed on from one staff member to another, thus broadening the base of technical capacity within VFD without solely depending on singular moments of training. To address this, the Pathways Project sought not only to contribute to building the technical capacity of VFD staff, but also to establish means by which skills, experience and knowledge can be passed on to and among CBFM officers. Two aspects of the broader capacity building program under the project are presented below: 1) capacity development activities undertaken in core areas of need, and 2) networking activities to allow for the transmission of skills, knowledge and experience.

Women's group from Naone community on Maewo Island presenting during a community meeting on resource mapping.
Image: © Pita Neihapi, 2020

Developing capacity in gender-sensitive and nutrition-based CBFM

Several independent assessments (SPC 2019; Mangubhai and Lawless 2021), found that more integration of different social groups in fisheries management and decision-making was needed, in particular women. Under VFD's guidance, the project sought to address this need. In doing so, three VFD staff members participated in an initial speciality training in December 2018 on gender integration in CBFM, offered through WorldFish. Participants learned about gender-sensitive approaches for community extension work. Then, in February 2020, the project supported a "Gender and social inclusion in fisheries and aquaculture" workshop at VFD. This brought together gender experts, VFD staff and participants from other government line agencies to learn why women's involvement in fisheries management is important and how their true participation can be achieved. In parallel, the project put to practice these

inclusivity principles during extension work by, for example, instituting monitoring and reporting measures that capture the extent of women's participation, and applying inclusive facilitative measures to allow diverse voices to be heard during planning and management discussions.

The gender training held at VFD contributed to significant changes in practice among staff in VFD. Following participation in the training, one senior staff member made deliberate efforts to encourage a female principal officer to organise and facilitate mini workshops, with the explicit intention to build her leadership confidence within a majority-male division. Other VFD staff have taken measures to ensure there is a gender balance in VFD meetings and outreach activities, and have provided an opportunity for women to have their interests and concerns heard during meetings. Initiatives of the project are part of broader drivers of gendered approaches in fisheries, which are seeing VFD moving from applying gender-blind to gender-aware practices, with activities increasingly designed to reach women.

Nutrition-based fisheries management was introduced through VFD because fish, as a source of protein and micronutrients, is vital towards ensuring food security and addressing the chronic under nourishment among prime groups in coastal communities, such as women and children. In 2018, an awareness workshop on the importance of approaching fisheries management from a nutrition perspective was held for all VFD staff. This led to a body of collaborative research coordinated by colleagues from WorldFish, and sought to better understand the nutritional intake of people in the remote coastal communities of Ikaukau (Tafea Province) and Peskarus (Malampa Province). Findings from this work were reported to VFD staff during a follow-up workshop in 2020, and further informed the development of posters and an awareness film on the importance of fish for nutritious, balanced diets.

Findings from the fish-based nutrition work were also taken up into practice by a VFD outreach team that integrated them into management measures around tabu areas. Proposed measures were informed by first gaining an understanding of nutrition needs in the community, so that the *tabu* area could better serve needs for food security. This complemented previous management approaches based on justifications of sustainability, technical fisheries science and/or biodiversity conservation, which were all harder to convey to community members. The nutrition information video was also widely used in workshops and distributed to all Fisheries Development Officers for use in their outreach work. Similar to the gender trainings, the project's nutrition work complemented other food security initiatives by VFD, including the supply of packaged fish during disaster response. Collectively, these are driving VFD to strategise activities from a nutrition perspective.

Establishing a regional community of practice

Building on the project's in-country CBFM teams in Solomon Islands, Kiribati and Vanuatu, offered the opportunity for networking among officers from different countries.

An elder woman speaking out during a CBFM meeting in Newora, Efate. Image: © Dirk Steenbergen, 2019

Community resource assessment during the FishSMARD visit to Takara. Image: © Pita Neihapi, 2019

Although there are many regional collaborative initiatives, these often involve senior staff. Fewer opportunities exist for younger field-active officers to collaborate with colleagues in the region. In order to learn how other countries conducted CBFM, a meeting was organised in Kiribati in 2018 that brought together the three country teams. During this meeting, the teams collectively proposed to establish a regional community-of-practice of CBFM officers, named Fish-SMARD (Sustainable Management Approaches and Research for Development). Fish-SMARD was established to allow for peer-to-peer learning among officers, provide an opportunity for exchange of knowledge and skills, and provide the means for consultation with officers in other countries. The VFD-CBFM team led this effort in the network's early stages by hosting the first Fish-SMARD workshop in May 2019. This brought all the project's in-country staff together to share ideas, practices, methods and success stories, and organise for capacity development training in proposal writing (prioritised by teams prior to the meeting). The VFD-CBFM team showcased the CBFM community play, *Twist Mo Spin*, developed in partnership with Wan Smolbag theatre group (see also "Information dissemination"outcome brief below). This first meeting also involved a community CBFM site visit to the Takara community on North Efate to show first-hand insights into CBFM practices in Vanuatu.

Inspired by the *Twist Mo Spin* play, the Kiribati team returned home with the idea to collaborate with a well-known choir in Kiribati to spread CBFM awareness there. Furthermore, using guidelines from the proposal training, the Kiribati team assisted two communities with successful community grant applications. The Solomon Islands team started a dialogue with Wan Smolbag, for them to run training sessions in Solomon Islands on using theatre to communicate CBFM (postponed due to COVID-19 travel restrictions). The workshop forged stronger relations among all in-country team members, forming a network that functions as an extension of the teams and allows for innovative ideas to spread. An online communication platform was set up to allow for communication, and sharing of articles, awareness materials, monitoring and reporting tools and experiences. The visit to Takara inadvertently also re-energised the community, and led to their request to VFD for a review of their outdated CBFM plan (amended and endorsed in late 2020 with the project's support).

Lessons learned

Key to ensuring impactful capacity development started with a thorough collaborative assessment with VFD staff on gaps and needs, resulting in clearly defined priority areas as part of VFD's broader coastal fisheries management work. The trainings provided through the project contributed as one of several simultaneous drivers of change that steered larger shifts in both gendered practices and applications of nutrition-based fisheries management. The Fish-SMARD network, and the cross learning that it facilitates, serves to improve CBFM practices in Vanuatu by introducing new ideas from other countries, as it did for the other country teams. Experience in Vanuatu shows that a dual focus is required for capacity development to be effective: namely that correct and relevant technical training is provided with a simultaneous focus on ensuring new knowledge, skills and/or experiences are applied, shared and taken up by others in or around the institution.

Innovating strategies for information dissemination

Vasemaca Malverus, CBFM officer, VFD

Ensuring coastal communities have access to accurate and relevant information about their marine environment is crucial to enabling people to make informed resource management decisions. VFD's ambitions to strengthen CBFM in communities draws attention to the need for the *right* information to reach the *right* people in the *right* ways. With conventional information dissemination often relying on community meetings and generic information tools (e.g. information posters), it is a challenge for national agencies such as VFD to ensure that people across the board are well informed.

The Pathways Project, therefore, set out to find more effective information dissemination alternatives. This involved developing 1) content that is relevant and appropriate to the cultural, demographic and linguistic framing of ni-Vanuatu worldviews, and 2) more engaging modes of delivery. Across all the project's information dissemination initiatives, much of the work relied on collaborations between VFD and private (civil society) sectors (e.g. Wan Smolbag theatre group, Vanua Tai resource monitor network), and the Pacific Community (SPC). This deliberate approach ensured new, previously untapped, dissemination channels could be used to maximise the distribution and reach of information flows. To strengthen these partnerships, joint fundraising was undertaken to further develop promising and innovative dissemination initiatives under the VFD-Wan Smolbag partnership.[8] Below we outline two of the project's main packets of information dissemination work that have advanced how CBFM information reaches and impacts communities in Vanuatu.

[8] A Swedbio-funded project (2018–2020) and a Locally Managed Marine Area and Pacific-European Union (EU) Marine Partnership-funded project (2020–2022) (see also acknowledgements).

Disseminating information through theatre

To increase participation and interaction, the Project explored creative, more engaging means of information dissemination. The VFD-CBFM team worked with Wan Smolbag (WSB) to collaboratively research, create and tour a CBFM theatre production for communities, entitled *Twist Mo Spin* that would be accompanied by an interactive workshop. The storyline sought to communicate the importance of fish and sustainable management of coastal fisheries, and integrated broader themes that strongly influence management in communities such as gender in fisheries, social life in community, intergenerational dynamics, local governance, and food security (see Neihapi et al. 2019 for more details).

A scene in the Twist Mo Spin play, during a community performance on Tanna. Image: © Paul Jones, 2019

A page from the comic book on sea cucumber management. Source: Wan Smolbag, 2019

Over 3000 people have watched the play live in more than 20 communities across Tafea and Shefa provinces. In Port Vila alone, over 1000 people watched the play at the WSB centre. A common sentiment from community audiences conveyed that theatre presented far fewer barriers and engaged more people to enjoy, learn and contribute, whereas people felt reluctant to participate in past awareness activities. There were also cases where the play influenced local management. On Futuna Island (Tafea Province), discussions during and after the workshop resulted in a community placing an immediate 10-year fishing ban on parrotfish. The Waisisi community in Tafea Province noted that the facilitated discussions during the workshops helped them come to a consensus on a few key local resource management issues, while Loukatai and Lenakel communities (Tafea Province) independently established *tabu* areas motivated by the play. Fisheries Development Officers (FDOs), who accompanied the touring crew where possible, saw the play as helpful in informing communities about national rules for example,[1] particularly because the play's language and thematics made it easy to understand. The Tafea FDO, noted how "the play has unlocked an understanding of the importance of managing our resources in communities, and understanding the role of key species in the environment and the need to properly manage them". The production's success has led to additional funding to develop the play into a film that is openly available, including for use by FDOs.[9] The film was launched in July 2021 in Luganville (Santo), and will be featured in the 2021 National Agriculture Week on Tanna as part of VFD's three-day national coastal fisheries symposium programme.

Developing appropriate information materials and distribution channels

The VFD-CBFM team invested in making existing technical CBFM information materials more accessible and usable. Partnering with SPC-FAME and WorldFish, several posters and CBFM materials were translated into Bislama (e.g. a seafood handling guide, nutrition and deep bottom fisheries awareness posters, and technical fisheries info sheets). The translated seafood handling guide has contributed to improvements in market vendors' practices. A VFD officer in the Seafood Agency division stated, "Although some vendors are not adhering to the guide completely yet, overall there is much improvement in the fish quality displayed at the road side vendors in Port Vila [...] people are now layering ice and fish when filling eskies."

Under the VFD-CBFM team's collaboration with Wan Smolbag (WSB), CBFM information materials were developed in a format that is appealing, accessible and understandable for community members who have difficulty reading. Six pictorial comic books, addressing different as-

[9] Workshop evaluations indicated that in most communities, the majority of people did not know or understand national rules around size limits and species prohibitions prior to the play and workshop.

pects of CBFM through a story, were developed and made available to distribute and/or use in facilitating discussion in communities.

Display boards were developed and installed in eight communities to inform people of new rules and where tabu areas were established. The display board consists of a map, specific community rules and a mother-tongue phrase encapsulating the community's CBFM plan. For some communities, such as Kwamera (Tafea Province) where most people only speak Tannese (their mother tongue language), the phrase they chose was a key message understood by everyone in the community.

In ensuring reach and delivery to intended social groups, the project simultaneously utilised various channels to disseminate information, such as by leveraging VFD's various extension work activities, public events and social media platform. This included providing more than 3000 copies of information materials to all VFD divisions (to use in their extension work), using an extensive CBFM survey across over 160 communities in Tafea and Sanma provinces to distribute information material, and organising information booths at events such as the annual National Agriculture Festival. Another way that the reach and delivery of information was achieved was by leading a CBFM-themed radio call-in (*tok-bak*) show, involving a panel of community representatives and VFD-CBFM officers to discuss tabu area management. The *tok-bak* show offered a high-exposure platform in which the general public could call in to comment, pose questions and join the discussion. One caller from Santo voiced her concern and encouraged more communities to establish tabu areas, as she spoke of a community in Big Bay (Sanma Province) that benefited hugely from their management measures. Following the *tok-bak* show, the community of Mele (Efate) sought advice and support from the VFD-CBFM team to set up a CBFM committee.

Engaging with community networks such as the Vanua Tai network of resource monitors, coordinated through WSB, also cultivated interest in CBFM and offered dissemination opportunities. Some members had seen their neighbouring communities participating in CBFM activities and used the Vanua Tai annual meeting as an opportunity to request more information from VFD. The VFD-CBFM team hosted a dedicated CBFM day during the meeting and provided awareness materials for interested resource monitors to take back to their community.

Lessons learned

Key collaborations between VFD and other stakeholder groups outside the field of fisheries have proven critical. Bringing in new perspectives breaks the status quo of conventional awareness meetings in community. These collaborations have also been instrumental in translating or "ni-Vanuatising" information material (utilising local partners' cultural knowledge). As described by the VFD-CBFM team leader, "WSB has the ability to explain issues in ways that reach the layman and translate information into more understandable materials for communities [...], so WSB's experience and knowledge of ni-Vanuatu rural life are important assets in our partnership". Taking a culturally sensitive approach ensures information presented is understandable to the intended audience. Therefore, text-based information is best paired with fun identifiable elements (e.g. drama, illustrations) and should incorporate thematics that people can relate to (e.g. health and social relations). Similarly, digital media is set to play a bigger role and improve information access as people increasingly have mobile phones and as networks continually expand.

Improving community-based coastal fisheries monitoring

Abel Sami, CBFM officer, VFD

Timely and accurate data are critical to VFD, both for strategic decision-making about where to allocate resources, and to show how CBFM can improve the wellbeing of coastal people at large. The latter is particularly important in justifying to political stakeholders the need for greater allocation of national budget to coastal fisheries management. Coastal fisheries monitoring has proven challenging in Vanuatu. Past initiatives such as the Good Receiving Notes (GRN) system, implemented in the 1990s, relied on fuel subsidies to incentivise fishers to record fishing effort and catch composition. Forms were detailed and lengthy, and fishers often only completed them when they needed fuel, resulting in inconsistent data. GRN, furthermore, fell short of capturing mixed reef fisheries data (central to CBFM), which had to be separately captured through trade monitoring at central markets (Amos 2007). When the GRN system was discontinued in 2010, VFD worked with SPC to implement a regionally developed tablet-based catch monitoring programme called TAILS. After a three-year pilot project across 19 communities, in 2019 VFD allocated a four-year budget to tailor TAILS to Vanuatu's needs and to implement it in 53 communities.

The Pathways Project supported the scaling up of TAILS by providing tablets, funding for enumerator training, extensions to new sites, and technical data management support through a ni-Vanuatu PhD researcher[10] and a CBFM data coordinator. These advisors became part of a VFD data team

[10] Jeremie Kaltavara is a University of Wollongong PhD candidate based in Port Vila, Vanuatu, studying the distribution and trade of coastal finfish in Vanuatu.

whose mandate was to strengthen the department's data management. They led the process of establishing a memorandum of understanding between VFD and the National Statistics Office in 2020, allowing access and integration into national data systems. As part of this broader support package, the VFD-CBFM team also developed and tested new means of data collection and fisheries monitoring. Two of these initiatives are outlined below.

Introducing a "catch mat" CBFM monitoring programme

To demonstrate that CBFM interventions are contributing to changes in the community (e.g. fisheries productivity and/or fishing behaviour) the Pathways Project developed a methodology to capture such changes in places where CBFM plans were being implemented. The objective was to measure effectiveness of CBFM interventions in five communities. The tool was also designed to enhance participation in local adaptive management processes, minimise burdens on participating fishers, and contribute meaningfully to VFD's data section. For full details see Andrew et al. (2020) and Sami et al. (2020).

Enumerators' fieldwork diaries and debriefs with the CBFM data coordinator revealed two major design aspects that impacted monitoring. First, a large majority of fishers across all sites reported that the catch mat photo method was less burdensome than previous monitoring programmes. Data collection at landing sites took on average less than 10 minutes, thus allowing fishers to proceed quickly, and more fishers to be monitored when several boats simultaneously landed their catches. As noted by one participating fisher from Peskarus (Malampa Province), "I have been fishing for more than 30 years and have never come across photos taken of catch mats that can be used to estimate weights and lengths of fish [...] our fishers are happier to work with the enumerator now". Second, the visual nature of the monitoring method was important. Providing timely return of findings in visual formats became effective periodic check-ins on management. A tabu area committee member in Kwamera (Tafea Province) reflected, "I was very disappointed with what I saw on the presentation today, but it is the reality. 100% of our fishing was on the reefs; we need to limit fishing there and encourage fishing to the deep [pelagic] areas to avoid over fishing our reefs". In cases like Kwamera, the graphic, visual reporting functioned as red flags for leaders and tabu area committees to adjust management measures. Whereas the first feedback meetings involved mainly leaders, later rounds saw enumerators in all sites challenged to accommodate demand from fishers to participate.

Findings were periodically presented to all VFD divisions. Discussions identified potential applications for VFD. First, to help establish baselines for monitoring tabu area management and, second, as a source of data that can feed into strengthening existing national datasets on stock status in selected locations. The Research and Aquaculture Division, for example, requested CBFM catch monitoring data to assist in developing fisheries management measures for some economically important species, and to supplement their rabbitfish and parrotfish stock assessments. High participation levels in the monitoring programme has prompted other VFD divisions to establish community collaborations, as in the case of Kwamera (Tafea Province), where additional fisheries initiatives have begun (e.g. aquaculture development and the national TAILS+ monitoring).

Developing a solar-powered freezer monitoring tool

Over the last decade, VFD has distributed more than 50 solar-power freezers to coastal communities. In supporting livelihoods and food security, freezers offer longer storage options for fish. Often initially distributed to manage post-disaster food shortages, freezers subsequently functioned as

An example catch mat photo from Peskarus (Malampa Province), showing a diverse reef species catch. Image: © Abel Sami, 2020

CBFM data coordinator assisting enumerators with the monitoring forms in Pellongk (Malampa Province). Image: © VFD, 2020

cooperative fish markets where fishers sell their catch or rent storage space. However, freezers were rarely effectively monitored to understand their usage in communities. As such, VFD prioritised more effective, centralised freezer monitoring so as to better understand and regulate the fish trade along established fish supply chains, running from community fish markets (primary markets) to provincial markets (secondary markets), and finally to central urban markets (tertiary markets).

In 2018, the VFD-CBFM team co-developed a simple, paper-based log sheet tool with the Research Division, consisting of three components that respectively monitor: 1) solar-powered freezer capacity, 2) incoming fish from fishers, and 3) outgoing fish to traders and consumers. In 2019, the tool was piloted for three months across six communities in two provinces. In parallel, the VFD-CBFM team worked with the Cooperatives Department (ORCBDS), under a collaborative agreement to co-develop tailored book-keeping training modules in Bislama for community market managers. An eight-day training course for fish market managers was held to develop basic accounting and management skills, and implement the monitoring tool. After the pilot, data was analysed and presented to VFD in December 2019, and whose feedback guided modifications to the forms. Finally, the VFD-CBFM team trained Fisheries Development Officers (FDOs) to lead implementation and coordination within their respective provinces, before a one-year roll out across 55 community freezers commenced in April 2020.

The analysis and reporting of the first year's data will be completed in September 2021. While these results will highlight outcomes, VFD has already gained valuable insights from the pilot phase. Tassariki (Noka fish market, Sanma Province), for example, is a well-known supply site for deep-bottom snapper and pelagic fish. Freezer monitoring results, however, clarified that the vast majority of supply came from six extremely remote communities along the western coast of Santo (1810 kg), with only 84 kg from Tassariki fishers. Furthermore, purchase records showed the market was frequented mostly by Tassariki community members (purchasing small amounts), followed by middlemen trading at the Luganville central fish market (purchasing large amounts) and finally by residents of nearby communities. Tassariki thus functions as a rural distribution hub rather than a primary supply site. Accordingly, VFD adjusted its fisher-oriented training plans there to a more market management orientation (i.e. fish handling).

Design-wise, the log sheets' simple format allows for higher data density and less risk of error by community enumerators than previous freezer monitoring tools. The latter proved particularly important in eight cases where enumeration duties had to be transferred to a new person. Whereas with previous tools such incidences meant data collection paused or terminated, collection continued with this tool. For participating communities that are also part of the national cooperative network, the monitoring assisted in book-keeping, which is important for annual auditing. Market managers also reflected how useful the monitoring tool is in tracing sales. This proved important in Sara community (Sanma Province), where purchase records were used to trace back the origins of a ciguatoxic fish that made several people sick. Fishers were consulted and the harvest area was identified as a source of ciguatera.

Freezer monitoring and reef fish stored in a community solar-powered freezer in Sara (Sanma Province). Images: © Dirk Steenbergen, 2019

Lessons learned

For community-based monitoring to be effective, data collection tools should be not only simple and workable for enumerators, but also compatible for use by VFD to influence management and policy. Spin-off benefits from the various monitoring initiatives also saw collaborations deepened between communities and VFD, and increased participation in other community fisheries initiatives as frequent feedback of findings bolstered interest from communities.

As VFD moves to scale up CBFM over the next few years, these monitoring modalities will be critical to supporting and informing CBFM's scaling trajectory. Efforts to streamline these data collection initiatives into a centrally managed data system is likely to drive a transition from paper-based tools to digital systems involving tablets for data collection.

Supporting disaster response

Douglas Koran, CBFM officer, VFD

Vanuatu is ranked as one of the most natural disaster-prone countries in the world (Richmond and Sovacool 2012). The majority of the population resides in coastal areas, and are vulnerable to unpredictable events that disrupt income flows and access to food. Fish has proven to be an important source of easily accessible protein, particularly in the aftermath of disasters when gardens and other food sources cannot deliver (Eriksson et al. 2020). VFD, therefore, plays an important role in post-disaster responses.

In Vanuatu, the National Disaster Management Office (NDMO) is mandated with the tasks of organising, coordinating and implementing disaster relief. NDMO coordinates various "clusters", which are embedded within different government departments. Each cluster manages a different aspect of disaster relief. The Ministry of Agriculture, Livestock, Forestry, Fisheries and Biosecurity (MALFFB) hosts the Food Security Cluster, which also involves VFD. The NDMO follows response protocols, whereby immediate assessments inform the implementation of short-, mid- and long-term recovery strategies. This system allows for a coordinated roll-out of relief that integrates the expertise and resources of various departments and stakeholders. This systematic approach delivers recovery coordination, but its support to communities in the immediate aftermath of disasters remains particularly challenging. The Pathways Project's embeddedness in VFD, in combination with its widespread geographic presence throughout Vanuatu, means it is well-positioned for on-the-ground assistance and contributes to NDMO-coordinated efforts. This was evident in the previous phase of the project, when tropical Cyclone Pam passed over Tafea Province and project staff were the first on outer islands, like Aniwa. Learning from this, the project integrated a disaster relief component that enabled the VFD-CBFM team to re-focus implementation and reallocate resources when needed. A disaster response account was set up to allow quick deployment of funds for VFD's immediate relief response. Two examples of how the project supported VFD disaster response are illustrated hereafter.

Displaced residents from Ambae Island on nearby Maewo, following the eruption of Lopenpen volcano. Image: © Paul Jones, 2018

Lopenpen volcano eruption on Ambae Island

On 26 July 2018, following the eruption of Mt Lopenpen, the Vanuatu government declared a state of emergency on the island of Ambae (Penama Province) that would last for four months. This resulted in the evacuation of all residents to the neighbouring islands of Santo and Maewo. The VFD-CBFM team was one of the first on the ground, joining an NDMO assessment team on Maewo. The acute population increase on Maewo translated into a spike in the demand for fish, resulting in larger numbers of inexperienced fishers fishing the reefs. The team conducted awareness activities to inform people of local fishing rules and regulations, and on the risks of ciguatera poisoning, something the team's ongoing CBFM work found was particularly prevalent on Maewo's fringing reefs. The VFD-CBFM team also contributed to NDMO's work with an assessment of fisheries-related impacts and opportunities, findings of which fed the Ministerial Food Cluster's strategic response plan. To address immediate food insecurity concerns, access to fresh protein such as fish and other marine resources was critical. As such, funds from the project's disaster response account were mobilised to buy and distribute fishing gear to evacuees and their host households on Maewo and Santo. This set a basis for increased, but controlled, fishing capacity, later supplemented by additional VFD initiatives, including a fish aggregation device (FAD) deployment off Maewo, solar freezer installations, and the provision of hard-hull fishing boats for pelagic fishing. VFD's broader response used fisher associations, established through the VFD-CBFM team's earlier work in villages such as Talise, to coordinate the equitable distribution of relief help.

The activities undertaken by the VFD-CBFM team aligned with NDMO assessment work, and critically bridged the immediate period after the initial shock and before broader relief support arrived. The project-supported VFD response has also contributed to a shift in fishing practices there. Like most Maewo communities, fishers on Talise previously only fished along nearshore reefs. The post-disaster response (i.e. fishing gear and boats) has enabled more pelagic fishing to be done. This mitigates potential excessive fishing pressure on nearshore reefs that is expected with population increases, and in doing so, avoids not only ecological damage but also widespread ciguatera poisoning in the community.

Tropical Cyclone Harold and COVID-19

In April 2020, communities across northern Vanuatu faced the double burden of a national COVID-19 lockdown and restrictions, and the devastation left by the category 5 tropical Cyclone Harold (6 April 2020). Reaching communities across the five most effected large islands of (south) Santo, Malo, (northern) Malekula, Ambrym and Pentecost was made more challenging without inter-island travel being possible. In supporting VFD's disaster relief efforts, the project first designated a staff member to serve on MALFFB's Food Cluster assessment team. The team conducted a loss and damage assessment survey on Ambrym, with specific attention to implications for food security and seafood safety. The VFD-CBFM team also carried out a rapid COVID-19 impact assessment by phone across communities working with the project, to identify priority needs (for details see Steenbergen et al. 2020). As part of a medium-term relief support package, the Project mobilised funds from the disaster response account to contribute to VFD's provision of solar-powered freezers and fishing gear. The project funded 10 of the 30 total freezers VFD deployed; 6 to Ambae communities and 4 to communities in northwest Malekula. Freezer distribution included onsite training on installation and maintenance by technicians, and freezer monitoring training for fish market managers (see also "Fisheries monitoring" outcome brief). The distribution of fishing gear sought to contribute to communities' ability to source food while air or sea cargo services were not functioning.

Natural disasters will certainly reoccur and it is highly likely that domestic COVID-19 travel restrictions be reinstated at some point. In addition to attending to immediate needs, work under the project has contributed to increasing communities' long-term self-sustainability and ability to deal with these acute shocks. Project sites with CBFM plans that were affected, for example, showed significant ability to provide food under such stress with management measures in place. One chief from Wiawi community (Malampa Province), reflected that his community's established tabu area meant they could deal better than other communities with the combined impacts of tropical Cyclone Harold and the added isolation from the COVID-19 restrictions. Fishers there were able to source sufficient amounts of fish to sustain needs in the community. After a solar-powered freezer was installed in Wiawi, a woman noted how availability of fish through the community fish market meant households now ate fish at times when normally they could not, "Before the freezer fish market, we only ate fish on days fishers went fishing, or the day after, but now in one day I can work in the garden to collect vegetables and eat fish" (see also the "Institutional strengthening" outcome brief for further examples).

Lessons learned

The project is an extension of VFD, and thus has aligned resources to be mobilised when needs change or unpredictable events occur. When natural disasters occurred, the project's ability to provide technical field assistance to VFD in the critical first days after disruption was possible because funds and human resources could be mobilised immediately. These experiences are informing current work towards developing a standard operating procedure that will streamline VFD's disaster relief response with internal coordination across divisions and bilateral projects, and external coordination by NDMO.

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National investments allocated to coastal fisheries and community-based fisheries management in the Pacific: A review of past monitoring efforts and recommendations

Jean-Baptiste Marre,[1] Watisoni Lalavanua[2] and Hugh Govan[3]

Background

A New Song for Coastal Fisheries[4] and the Future of Fisheries Roadmap[5] both outline pathways agreed on by government officials and other stakeholders from Pacific Island countries and territories (PICTs) to achieve long-term economic, social and ecological benefits for coastal communities from sustainably managed coastal fisheries. A key emphasis of these policies is to scale up community-based fisheries management (CBFM).

National fisheries agencies' staff and budget are critical inputs towards sustainable coastal fisheries management and scaling up CBFM. Monitoring this investment responds to one of the New Song's key outcome areas: "Re-focused fisheries agencies that are transparent, accountable and adequately resourced, supporting coastal fisheries management and sustainable development underpinned by CEAFM".[6] Tracking these national investments can also be useful to countries for reporting, accountability, advocacy and resource mobilisation purposes.

Estimating and monitoring fisheries agencies' staff and budget allocated to coastal fisheries is challenging, even more so when focusing on management and CBFM. To date, three main efforts have been undertaken by the Pacific Community (SPC) to do so:

- the SPC 2015 report[7] "Preliminary review of public expenditure of the Fisheries Agencies of Pacific Island Countries and Territories: Policy, operational budget and staffing" (Govan 2015);
- the ongoing data collection by SPC as part of the Coastal Fisheries Report Card since 2017;[8] and
- a dedicated questionnaire sent out to countries in early 2021 prior to the subregional and regional CBFM scaling-up workshops[9] organised by SPC and partners between January and February 2021.

An internal review[10] of these monitoring efforts has led to the following identified challenges, findings and recommendations.

Challenges

Hurdles in obtaining data

Given the limited information that is readily available online, either in fisheries agencies annual reports or in national government budget reports (when these are available), past monitoring and reporting efforts have relied on extensive bilateral exchanges and/or questionnaires that were sent out to different national fisheries agencies' focal points.

Collecting staff and budget data through a dedicated questionnaire and/or bilateral exchanges is, however, challenging for several reasons:

1. Respondents can be reluctant to share or ask about budgetary information that are traditionally regarded as sensitive. Political or high-level support for the request is needed to address this challenge.
2. Targeted respondents must be able to collect and provide the right information. For instance, the 2021 questionnaire was sent to the CBFM workshop participants, and only a few were completed by senior staff or directors with a better knowledge of resource allocation.
3. The topic and the information to collect is much more complicated than it first appears. Whomever is leading the data collection effort must be able to clearly define and identify, be it in a questionnaire or during exchanges, what is the "coastal fisheries staff" and the "coastal fisheries management budget" information to be collected. This is not straightforward because different categories of budgets are usually used in national reporting by fisheries agencies or Pacific Island countries and territories.[11] Agreeing on a definition of "coastal fisheries staff" at the outset is also necessary (e.g. Would a staff member spending around 20% of his/her time on coastal fisheries work be considered as coastal fisheries staff?).

[1] Coastal Fisheries Economist, SPC. Email: jean-baptistem@spc.int
[2] Community-based Fisheries Management Officer, SPC. Email: watisonil@spc.int
[3] Independent consultant
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[7] http://purl.org/spc/digilib/doc/43c9k
[8] https://fameresults.org/cfreportcard/
[9] https://fame1.spc.int/en/meetings/255
[10] The internal report can be made available upon request.
[11] For instance, national budgets are usually presented per main outputs or activities for each ministry and then broken down into several categories, such as personnel, operating expenses (or "operations"), capital costs. The main activities and outputs categories vary across countries, which makes regional reporting and comparisons challenging.

4. Even if well identified and defined, the information requested may not be readily available and can be challenging to collect by respondents (e.g. need to circulate the request, access unpublished budgetary data). Strengthened monitoring efforts from fisheries agencies, including disaggregated fisheries budget structure and reporting, is needed to address this challenge.

Limited comparability of data

Comparing results between the three main monitoring efforts undertaken by SPC is not straightforward, mainly because of important differences in data collection methodologies and data quality issues. For instance, the SPC 2015 report relied on extensive bilateral consultations, with significant data cross-checking efforts, including through a dedicated questionnaire, whereas the data collection for the 2021 CBFM only relied on a questionnaire with no subsequent data verification. The Coastal Fisheries Report Card (CFRC) data collection process does not involve bilateral consultations either, but the data collected through the dedicated questionnaire is cross-checked with publicly available sources, where possible. In addition, aquaculture is included in the staff and budget data collected through the CFRC, whereas this is not the case for the SPC 2015 report and 2021 questionnaire data. There is also no clear definition of coastal fisheries staff in the CFRC questionnaire, while the SPC 2015 report estimated the number of staff spending 25% or more of their work time on coastal fisheries. The 2021 CBFM questionnaire collected the number of staff employed in coastal fisheries, coastal fisheries management, and CBFM, counting those engaged in these areas for more than 25% of their time as well as those engaged for 100% of their time.

Main findings

A focus on operational budgets

The SPC 2015 report made the case that budget monitoring and reporting efforts, both at the country and regional level, should first distinguish operational[12] budgets from development and capital ones. This is because operational budget may better reflect the long-term commitment of governments to fisheries agencies, and is essential for allowing and sustaining activities associated with management and CBFM. These usually require little infrastructure and other capital investments, and are focused on fisheries agencies staff providing information; formulating, disseminating and implementing policy and rules; and conducting monitoring and enforcement operations (Govan 2013; Govan et al. 2013). Monitoring and reporting efforts should then allow for a distinction between resources invested in fisheries management versus fisheries development, because the latter do not contribute directly to management and may often result in increased pressure on resources. The CFRC data collection process does not currently allow a focus on operational and management budgets. The 2021 CBFM questionnaire included specific questions inquiring about operational budgets for management and CBFM, but data could not be obtained for 15 PICTs.

Monitoring changes in operational budget versus staff

The comparison between the 2015 report and responses to the 2021 questionnaire indicates that national resources allocated to coastal fisheries (staff and operational coastal fisheries budget) may have increased in five PICTs.

Two to four PICTs, however, reported in the 2021 questionnaire that resources have decreased (two PICTs with lower operational coastal fisheries budget, and four PICTs with a lower number of staff working on coastal fisheries). Direct comparisons on operational budgets and staff were not possible for 10 and 15 PICTs, respectively. The comparison exercise, including with CFRC 2020 data, therefore, shows that associated findings must be subject to caution, and do not allow the provision of reliable indications of possible changes in management and CBFM investments overall.

The overview and comparison of monitoring efforts also suggest that the number of staff seems to be a more rigorous and reliable indicator of national investments in management and CBFM than the various budget categories. This indicator is easier to collect, numbers are more likely to be known by interviewees, the terminology is less problematic, and the request is regarded as being less sensitive. To estimate the number of staff, it is recommended – based on the 2021 CBFM questionnaire experience – to focus solely on staff working more than 25% on coastal fisheries management or CBFM.

Other indicators

While the focus of this review is on national budget and staff as key indicators of resources allocated to coastal fisheries and CBFM, looking at additional indicators – such as the number of coastal fisheries extension officers and the number of CBFM authorised officers – could provide a refined assessment. The 2021 questionnaire was aimed at collecting some of the number of CBFM authorised officers and community champions, but only a few countries managed to provide estimates. The CFRC questionnaire is collecting information on the number of extension officers to then estimate the ratio of extension officers to fishing households, which is used as one of the key indicators under goal 1 – empowerment (this indicator was available for eight countries in 2020).

It is also important to put in perspective any changes in national resource allocation to changes in coastal fisheries management and CBFM outcomes. For instance, according to the regional scaling up CBFM workshops 2021 reports,[13] the CBFM coverage has increased between 2015 and 2021 for at least eight countries where the number of coastal fisheries staff has increased as well (bearing in mind the limitations of the 2021 CBFM questionnaire data). This could show that additional resource allocation has been effective

[12] Also called "recurrent" budget.
[13] https://fame1.spc.int/en/meetings/255

for CBFM. Looking at other indicators of success (e.g. adoption of coastal fisheries policies or strategies that demonstrably support CBFM,[14] resource status and sustainability) is beyond the scope of this article but could be considered for future reporting or for a potential cost-effectiveness analysis, providing that the data gathered are robust enough to do so. Govan (2013) provides some examples of possible improvements in cost-effectiveness.

Underinvestment in coastal fisheries management and budget adequacy

Overall, the three main past monitoring efforts show that staff and budgets allocated to coastal fisheries remain low in comparison to the total staff and fisheries budget for most countries. According to data from the SPC 2015 report and the 2021 questionnaire, this is even more the case for operational budgets. Given that coastal fisheries budgets often include a large proportion of budget dedicated to fisheries development activities that may be expected to increase pressure on the resource (see Govan 2013 and 2015), this means that most countries may be severely under-investing in resource management.

This is in line with a recurring issue raised by stakeholders involved in coastal fisheries management in the Pacific region: inadequate resources, or lack of funding. This was near unanimously highlighted as the major factor by government stakeholders in the 2021 regional CBFM workshops.[15] A key result area of the New Song is also for fisheries agencies to be "adequately resourced".

However, assessing what is meant by "adequate" is not straightforward, and the literature does not provide much guidance on this. Several indicators can be used to offer insights on budget adequacy and to make comparisons across countries. Some exploratory work conducted by Govan (2013 and 2015) intended to identify such indicators that could be tracked over time with more relevance than the percentage of overall fisheries budget allocated to coastal fisheries:

- total population to serve or manage,[16]
- area to cover or manage,[17]
- economic value of fisheries production,[18] and a ratio between the operational coastal fisheries budget and the coastal fisheries production value, and
- pressure or reliance on resource.[19]

Further examining the level of operational coastal fisheries budgets from the 2015 report and the 2021 CBFM questionnaire in view of these indicators also point to a possible severe under-investment. However, the relevance of these indicators to assess budget adequacy and allow comparisons between countries would need to be further assessed and discussed individually, based on their robustness and data availability. For instance, changes in the ratio between operational coastal fisheries budgets and fisheries production value may not always reflect appropriate trends in budget adequacy. Such changes could be due to a variation in catch volume or prices that are independent of management efforts. Under certain circumstances, well-managed high value fisheries such as sea cucumber[20] could also generate a strong increase in production value.

Recommendations

Comparing the methods and results from three main past budget and staff regional assessments pointed out needs to further strengthen the ongoing monitoring efforts at various levels, with the following recommendations.

General recommendations

- Monitoring and reporting, including through the CFRC, should focus on coastal fisheries management and allow the exclusion of resources allocated to fisheries development activities. This is crucial because most countries may still be severely under-investing in coastal fisheries management incorporating CBFM approaches, and solely reporting on overall coastal fisheries budget can be misleading.
- Budget monitoring and reporting should focus on operational or recurrent budgets as opposed to development or capital budgets, mainly because management and CBFM mostly require steady and secure recurring costs, and development and capital budgets are broadly adding pressure to resources, or at least not contributing to management.
- Budget monitoring should focus on actual expenditures rather than budget forecasts or estimates which may not represent what ends up disbursed to fisheries agencies.
- The number of staff working on coastal fisheries management might be a more reliable indicator as it is easier to measure or survey, is less sensitive, and is directly linked to actual management activities.

[14] See objective 3 and associated guidance of the Pacific Framework for Action on Scaling up Community-based Fisheries Management: 2021–2025. https://purl.org/spc/digilib/doc/yr5yv

[15] See article by Lalavanua and Smith on page 18 of this issue (https://purl.org/spc/digilib/doc/2z6y6)

[16] Latest data available here: https://sdd.spc.int/topic/population

[17] Inshore fishing area from Sea Around Us 2015, see http://www.seaaroundus.org/data/#/fishing-entity

[18] The data used in the SPC 2015 report are from Gillett, 2009. The SPC internal review used updated figures from Gillett 2016.

[19] Countries are classified in three food security groups based on assessment of their capacity to provide the 35 kg of fish per person per year recommended for good nutrition of Pacific Island people under projected population growth (dominant influence) and climate change (longer-term influence). See for instance Bell et al. (2018).

[20] See for instance: Lee S., Govan H., Wolff M. and Purcell S. 2018. Economic and other benefits of enforcing size limits in Melanesian sea cucumber fisheries. SPC Fisheries Newsletter 155:29–36. https://purl.org/spc/digilib/doc/ocggg

Recommendations for fisheries agencies

- National fisheries agencies need to strengthen their monitoring of staff and budget allocated to coastal fisheries and, in particular, to management activities and CBFM in order to track progress against regional and subregional commitments. Disaggregated budgets with activities, outputs or subprograms focusing on coastal fisheries management is a key first step.
- National fisheries agencies need to ensure the last annual reports and budgets are made readily available on their websites. To the extent possible, the reports should include a monitoring component on expenditures for coastal fisheries management and CBFM.

Recommendations for SPC's Fisheries, Aquaculture and Marine Ecosystems Division

- The FAME Monitoring, Evaluation and Learning team should consider requesting the Coastal Fisheries and Aquaculture Programme (CFAP) staff visiting PICTs or otherwise in a position to obtain relevant staff and budget data to do so regularly. This would facilitate data collection and cross-checking.
- FAME could submit a proposal to the next Heads of Fisheries meeting to gain their approval and procedures for obtaining the relevant staff and budget data, so that fisheries agencies staff can be reassured that the request is approved at a high level.
- The FAME Monitoring, Evaluation and Learning team, in collaboration with relevant CFAP staff, need to update the CFRC questionnaire as it represents a great opportunity to further strengthen the national resources allocation monitoring efforts on a yearly basis. In addition to distinguishing between aquaculture and coastal fisheries, dedicated questions on resources specifically allocated to management and CBFM should be included.
- If deemed appropriate, CFAP needs to establish a methodology for a coastal fisheries management and CBFM national expenditures regional assessment that could be conducted every five years. As part of this methodology, precise steps to calculate operational coastal fisheries budgets for each PICT should be defined and the CBFM 2021 questionnaire should be updated to further clarify some questions and the terminology. Both the bilateral exchanges and the questionnaire should target national coastal fisheries directors or equivalent.

Conclusion

Implementing such recommendations would allow a better assessment of the extent to which current investments are commensurate with coastal fisheries management challenges in the region. It is also key to better assess progress made by PICTs in providing adequate resources to sustainable fisheries management and CBFM as per the New Song for Coastal Fisheries approved and endorsed in 2015 by the Heads of Fisheries and fisheries ministers respectively, and the Future of Fisheries Roadmap endorsed by Forum leaders in 2015.

Improving assessment and monitoring of staffing and financing of fisheries management will be vital in addressing the increasing threats faced by coastal fisheries and the continuous decline of the resources. The options to leverage additional recurrent resources for management should be urgently investigated by regional organisations and PICTs. Such options include: advocating for larger national budget allocation for coastal fisheries (e.g. given the nutritional and socio-economic importance of coastal fisheries to Pacific island people); prioritising staff time and budgets on coastal fisheries management and CBFM as opposed to some fisheries development activities that lead to increased pressure on coastal resources; generating additional revenues from coastal fisheries licensing regimes or other economic instruments (e.g. user fees); and reforming coastal fisheries subsidies (in particular ending the harmful ones). Donors should also consider the importance of ensuring government coastal fisheries management budgets are adequate compared to short-term projects, and support the development and implementation of possible solutions to do so (e.g. trust or sovereign funds).

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An overview of fishing in Wallis and Futuna: Prospects for the sustainable management of coastal marine resources

Baptiste Jaugeon[1] and Matthieu Juncker[2]

Abstract

Participatory management of coastal resources is the method preferred by Pacific Island countries and territories to both ensure a degree of food security and act against overfishing. Wallis and Futuna islands offer a number of similarities with other islands in the Pacific: they have been able to maintain their culture and a traditional system, both still very relevant features co-existing with Western values, in this case, those of the French Republic. Contrary, however, to other regional island countries and territories, the population of Wallis and Futuna is gradually shrinking. This trend can be considered beneficial for their marine resources, which for a long time were under severe pressure. The limited number of scientific studies carried out in Wallis and Futuna have, nevertheless, highlighted the vulnerability of some of these resources, without being able to confirm whether or not they are being sustainably harvested. The fact remains that some fishers report a decline in coastal resources, without necessarily perceiving this as an issue. This would seem to be the consequence of a relative lack of knowledge and awareness around the vulnerability of coastal resources, and of some acceptance that the marine environment could be damaged by persistent unsustainable practices.

There is very little documentation describing any traditional coastal resource management methods in Wallis and Futuna, with the initial arrival of missionaries and then the westernisation of society seeming to have changed the bond that Wallis and Futuna islanders had with the ocean. Although today fishing still plays a major part in the life of the people of both islands, coastal resource management is not seen as a priority by the majority of the surveyed population. Existing regulations on fishing activity are either not understood or fishers have never seen them, and they are not accepted by the community. Unsustainable fishing practices continue without being challenged. On the basis of these factors, the current context in Wallis and Futuna is not the most favourable for introducing a participatory management process. This article sets out some of the preconditions that could favour the emergence of the awareness required to introduce sustainable coastal resource management practices.

[1] Service de la pêche et de gestion des ressources marines, Wallis and Futuna. Email: baptiste.jaugeon@agripeche.wf
[2] PROTEGE Project Coastal Fisheries and Aquaculture Coordinator. Email: matthieuj@spc.int

The island of Uvea, with Avatolu pass, southwest of Wallis in the foreground.
Image: © Matthieu Juncker

Introduction

Coastal fisheries play a vital role in food security and subsistence in Pacific Island countries (Gillett 2016; Johnson et al. 2017). Overfishing, global warming, habitat destruction and ocean pollution are all threats to coastal resources (Bell et al. 2012). The regional forecasting is increasingly worrying with regards to the future of coastal fisheries and their ability to feed Pacific Island communities, unless there is a significant improvement in the management and status of these resources and their habitats (Bell et al. 2009; Gillett and Cartwright 2010; Bell et al. 2012; Johnson et al. 2017; Asch et al. 2018).

An assured sustainable supply of coastal marine resources is a priority for Pacific Island governments, as expressed in a series of regional political declarations, with special reference to the Regional Roadmap for Sustainable Pacific Fisheries (FFA and SPC 2015) and the New Song for Coastal Fisheries (SPC 2015). Community fishery management is one of the preferred management methods for achieving this sustainable fishery goal.

As part of the Pacific Territories Regional Project for Sustainable Ecosystem Management (PROTEGE), and using methods that have proved their effectiveness in other sites around the region, the territory of Wallis and Futuna decided to adopt its own sustainable coastal resource management action strategy.

In Wallis and Futuna, coastal fishing plays a big part in the daily life of the community, which fishes for subsistence and economic reasons (commercial fishing), and for recreation. In the same way as with agriculture, fishing helps to maintain a socioeconomic balance in the islands. The territory's dependency on coastal marine resources makes the way they are managed a major issue.

Compliance, however, is low even with the few resource management measures that do exist. Unsustainable practices could ultimately compromise the sustainability of these islands' marine resources, the relevant balances and also socioecosystem resilience.

In 2007, the Coral Reef Initiative for the South Pacific (CRISP) outlined a "marine space management plan" (PGEM) for Wallis and Futuna (Egretaud et al. 2007a, 2007b; Verducci and Juncker 2007). Subsequently, some one-off integrated coastal zone management activities were introduced (Moncelon 2017a, 2017b; INTEGRE 2018). These actions did not, however, make it possible to bring in a permanent framework for sustainable coastal resource management work.

An understanding and proper consideration of the socioeconomic setting is essential for the success of projects such as this. Contrary to the situation in neighbouring countries that have adopted participatory marine resource management methods, the Wallis and Futuna community does not

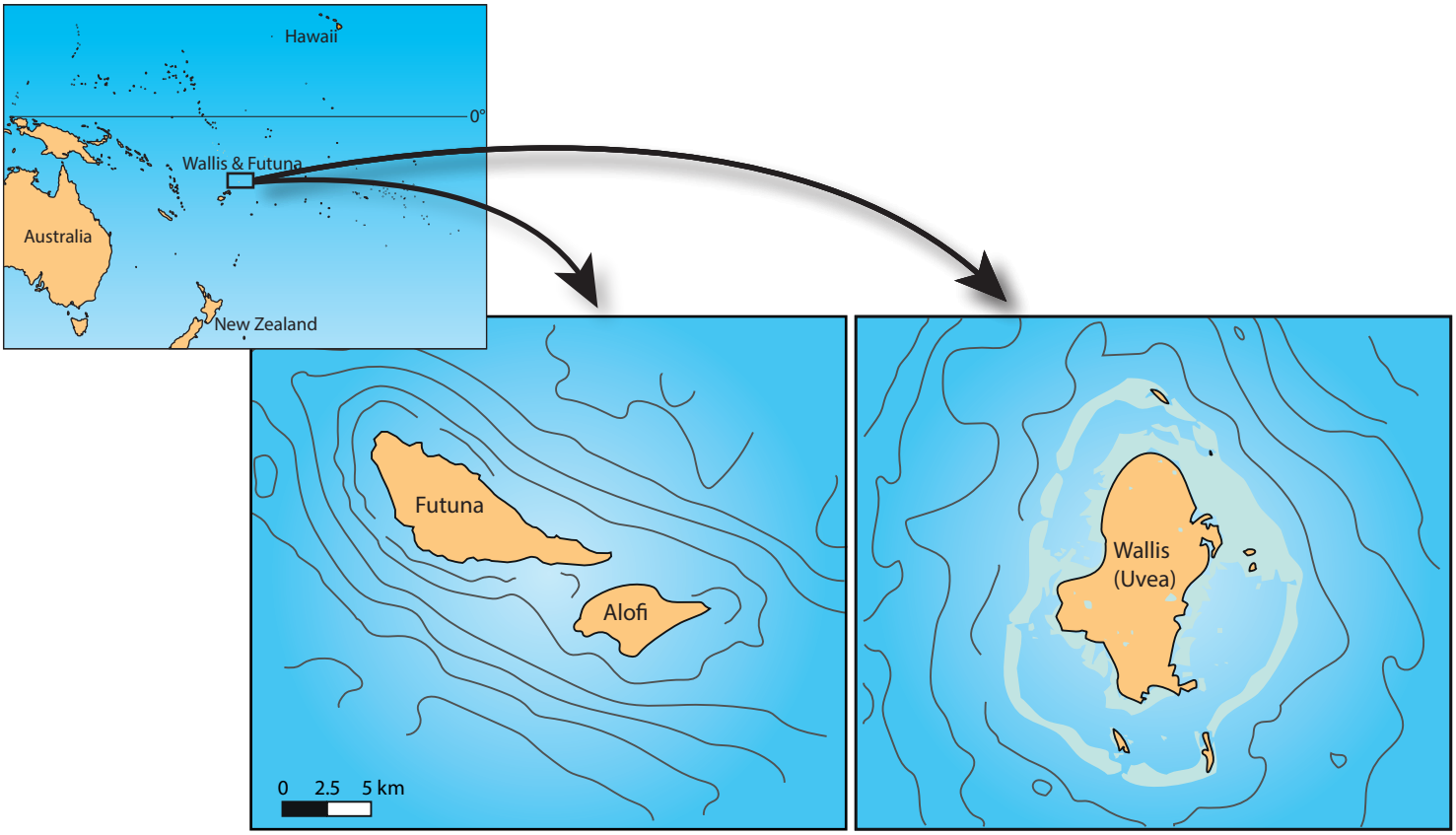

Figure 1. The islands of Futuna and Alofi are situated 230 km southwest of the island of Wallis.

seem to be particularly concerned when faced with a decline in some species and does not see coastal resource management as a priority. This particular contextual component means that it becomes very difficult to involve stakeholders in the introduction and monitoring of management measures (Aubert et al. 2020).

How favourable then is the Wallis and Futuna context for good marine resource management? Are marine resource use and fishing practices sustainable? Were they ever? What is the status of resources and how are they perceived by the community? What are the prerequisites for introducing participatory and sustainable coastal resource management in Wallis and Futuna? What are the conditions required to implement management activities?

Methodology

The information and data assessed for the purposes of this article come from a compilation of 34 studies carried out in these islands, interviews by the Fisheries Department with fishers, stakeholders and decision-makers (traditional leaders, Territorial Assembly members, representatives of the French Higher Administration), and focus group activities among stakeholders.

The Fisheries Department received support from the Fisheries, Aquaculture and Marine Ecosystems Division of the Pacific Community (SPC), the PROTEGE project, and the companies Trajectoires and HOPe ! in performing this situational assessment (Aubert et al. 2021).

A general introduction to the Wallis and Futuna context

Geography

- Wallis and Futuna lies 450 km northeast of Fiji, 345 km west of Samoa, 450 km north of Tonga, 600 km southeast of Tuvalu, and 670 km southwest of Tokelau, thus occupying a central position in western Polynesia (Fig.1).
- The territory comprises three main islands, Wallis, and Futuna and Alofi (the latter two are also known as the Horn Islands).
- Volcanic Wallis Island, 78 km^2 in area, is the biggest in the group. It is a low island, whose highest point reaches an elevation of 151 m. It is surrounded by a lagoon approximately 63 km long and 4 km wide, delineated by a barrier reef with four passages (Richard et al. 1982; Juncker 2005).
- Some 230 km southwest of Wallis, are the islands of Futuna and Alofi, which are both mountainous islands with rugged coastlines and difficult access to the sea. The highest points are Mount Puke on Futuna (524 m) and Mount Kolofau on Alofi (417 m). Futuna (46.3 km^2) has no lagoon but does have rugged relief. Its small, neighbouring island of Alofi (17.8 km^2) is uninhabited and separated from Futuna by a strait 1.8 km in width (Richard et al. 1982; Juncker 2005).

These distinct geographical settings have produced very different fishery practices.

Demography

Between 1969 and 2003, influenced by a high birth rate and relatively low emigration, the population increased by 75%, from 8546 to 14,944 inhabitants. Since 2003, this trend has reversed, with both increasingly high levels of emigration and fewer births. Consequently, the territory lost more than 22% of its population between 2003 and 2018, reverting to its pre-1983 level (INSEE 2019).

In 2018, the population of Wallis and Futuna was 11,558, two-thirds of whom lived on Wallis and one-third on Futuna (INSEE 2019).

This decline inevitably has led to a reduction in fishing pressure, which was a very welcome reversal for the resource, but which has also contributed to a loss of traditional knowledge of fishing.

Cohabitation of a traditional and administered economy

The only data accessible on the subsistence economy date back to 2005–2006: households at that time produced, on average, for their own consumption goods with a monetary value of EUR 530[3] per month. Subsistence consumption, therefore, represented a significant proportion of total household expenditure (26%) (Buffière et al. 2006).

The "formal" economy is highly regulated. Almost 56% of the total value of salaries comes from government jobs (IEOM 2020). The territory is additionally highly dependent on the outside world for other food products and fuel for energy. In contrast, exports are virtually non-existent.

In 2005, the gross domestic product per inhabitant was approximately EUR 10,117 per annum, placing the island group in a leading position among Pacific Island states and territories in terms of standard of living.

From our assessment we have found that the comfort of an administered economy and a context of acceptance of external dependency are not favourable to increased awareness regarding marine resource vulnerability.

Institutional organisation

While the islands of Wallis and Futuna share a common history and culture with other Polynesian islands, their status as a French territory since 1961 (after being a French protectorate since 1888) has resulted in a unique development history.

The islands have been able to maintain their royalty systems, which distinguishes them from the other French Pacific territories of French Polynesia and New Caledonia. Responsi-

[3] The local currency in Wallis and Futuna is the French Pacific franc (XPF). EUR 1.00 = XPF 119.33.

Gleaning is mostly done by women in Wallis and Futuna. Image: © Baptiste Jaugeon

bilities are shared between the representative of the French state, known as the Prefect, traditional authorities and the Territorial Assembly, which is the territory's deliberating chamber. The hybrid status of Wallis and Futuna is based on a balance between French state law and the recognition of the customary authorities' legitimacy, to which should be added the strong influence of the Catholic Church.

Community organisation is still a very strong factor when it comes to traditional customary and religious events but is losing traction in its influence on daily life. In the same way as in modern societies, individualism is also gaining ground in Wallis and Futuna (van der Grijp 2002) and relates the answer to indigenous representations of work and to cultural constraints on leadership. It should be noted that the customary system on Wallis has been in crisis since 2005, with two chiefly houses claiming and sharing the same territory. These periods of instability are apparently fairly common in the Pacific (Blanchet et al. 2001). The coexistence of two sources of traditional authority on the same territory is a hindrance to management and development projects, and especially the implementation of a fishery management strategy.

Fishery managers

Traditional fisheries management long involved organising collective fishing activities as part of celebrations or customary exchange practices. It involved managing fishing practices by regulating access to certain zones or by setting a fishing ban (tapu) at certain times of the year on some fish species or certain techniques (Burrows 1936; Gaillot 1961; Rozier 1963; Blanchet et al. 2001). Today, apparently, there are no more iconic marine species or tapu areas (apart from the places where fishers have perished at sea). The ocean is a free space where any form of regulation seems to be seen as a deprivation of rights.

"Without fishing there is no way to live" Soane Katoa, day and night underwater fisher, Futuna. Image: ©Baptiste Jaugeon

Administratively speaking, fishing is under the authority of the Fisheries Service within the Agriculture, Forestry and Fisheries Department of Wallis and Futuna. The department's job is to support fishing activities and improve the population's living standards by making access to the resource easier through the acquisition of new techniques. Its job is also to implement a sustainable fishery development policy. The Wallis and Futuna Fisheries Service is trying to support fishers to become more professional, and it is the guarantor of the status of professional fishers: licensed fishers can obtain fuel subsidies if they hand in their fishing logs; they can also claim investment support.

Fishing activities began to be regulated in Wallis and Futuna's territorial waters (<12 nm from land) by the territorial government from 1994 onwards. A number of orders were adopted to ban fishing practices such as using explosives, crowbars and poison, and night spearfishing and fishing with scuba gear. The use of nets is also regulated, with minimum catch sizes for species such as lobster, coconut crab and trochus being introduced. From 2005, these regulations were supplemented through a resolution to modernise the regulations governing the status of professional fishers. The resolution contains provisions regarding the protection of endangered species (cetaceans and sea turtles), as well as setting limits on catches and outlawing sales by non-professionals. In addition, in 2020, the territorial Environment Department secured the adoption of a list of protected species, banning the capture of turtles, humphead wrasses and some invertebrate species (e.g. sea cucumbers and giant tritons).

While such regulations can be seen as a vital tool in marine resource management, in reality they are not applied. There are no checks and there have never been any administrative penalties. Some professional fishers are familiar with the regulations, but this is not the case for most fisherfolk or the community at large. In addition, some bans such as those on underwater spearfishing at night and catching humphead wrasses and marine turtles, are rejected by most fishers, including professionals.

There is also the issue of monitoring, control and surveillance of fishing activities. In the opinion of traditional leaders and elected representatives, the enforcement of regulations must be done in cooperation with the customary chiefs, who would need to support it. Operationally speak-

ing, different views prevail: some people think this is a job for the gendarmerie, while others believe it should be in the hands of the chiefs. At the present time, the regulations and the territory's status do not make it possible to introduce "community" management because they do not enable the empowerment of local communities. The territorial management agencies are favourable to this transition so that the traditional leadership can be included in the arrangements and communities can be given responsibilities.

Who does the ocean belong to?

Management of the maritime space raises a governance issue. The management of territorial waters (<12 nm from land) is the responsibility of the Territorial Assembly. Management of the exclusive economic zone (12–200 nm from land) comes under the responsibility of the French government. In customary terms, the maritime domain is not territorialised, and its use is available to everyone for free.

In a future sustainable coastal resource management project, these governance contradictions could generate conflicts over legitimacy in terms of surveillance and management measure enforcement.

Profile of fishing and fishers

Fishing in Wallis and Futuna is an exclusively coastal activity, with almost all fishing effort focused on an area from the fringing reef to a few nautical miles offshore

Fishers generally do not use mechanised fishing gear. Most boats are small (4–6 m in length) and have outboard motors of between 15 and 80 hp. Very few fishers own a global positioning device or echo-sounder, and safety equipment is often lacking. Most people net fish (50%), underwater spearfish (44%), troll (21%) or handline (26%). Some 35% of fishers also collect shellfish and crustaceans. Taking all the techniques together, fishers tend to go out once or twice a week for periods varying from two to eight hours, and targeting a very broad range of species. Professional fishers target more than 300 species of fish and invertebrates (Wallis Island is free from ciguatera), and about 30% of these catches consist of tunas and associated species.

At the last general agricultural census in 2014, 29% of households on Wallis (395) and 40% on Futuna (263) stated that they actively fished; thus, there are 2632 fishers, 736 on Futuna and 1896 on Wallis, and a total of 81 boats used in fishing activities.

Annual production was estimated at 825 tonnes, with 150 tonnes for sale and 675 tonnes for home consumption. Local fish consumption per inhabitant was subsequently estimated at 68.7 kg/year (Sourd and Mailagi 2015).

Fish landings are mostly intended for family consumption and customary exchanges, with sales being quite limited (27% of fishers state that they sell their catches from time to time). A small proportion of fishers attempt to generate significant income from their activity but generally speaking have no management knowledge (regarding depreciation in particular), their equipment is often badly maintained, and their fishing trips are conducted on an irregular basis, generally determined by immediate financial needs. Only a limited number of fishers, holding licences issued by the Fisheries Service, can be truly considered as professionals.

Catches are mainly sold when the boats return from trips or in commercial outlets, at between EUR 7.50 and EUR 12.50/kg.

While there can be no doubt that fishing still plays an important part in the culture and life of the people of Wallis and Futuna, and while seafood consumption remains high, the community's dependency on marine resources remains a relative one. Few households report fishing as their main source of income (Buffière 2006). For example, in the two

Mikaele Moleana, experienced net fisherman, Mua, Wallis.
Image: ©Baptiste Jaugeon

Ark clams (*Anadara* sp.) collected from Wallis lagoon.
Image: © Baptiste Jaugeon

villages considered to be fishing villages 15 years ago, only 38% of the households in Halalo and 19% in Vailala drew their main income from fishing (Kronen et al. 2006). To this background, interest in the state of marine resources does not emerge as a major factor.

Unsustainable fishing practices and other pressures on marine resources

Fishing effort may appear to be relatively low with the decline in the population and the number of fishers, but some unsustainable fishing practices still prevail.

- Underwater spearfishing is carried out both at night and in the daytime. At night, spearfishers tend to target sleeping surgeonfish and parrotfish.
- Another technique used by fishers in Wallis and Futuna is the drift net. Not many use this method, but it can lead to dramatic consequences when the nets are set to catch fish migrating towards a spawning ground. Some fishers report catching more than 200 kg of mullet in their nets.
- Fishers mainly target spawning periods and sites. Some species such as groupers, emperorfish and surgeonfish congregate in reef passages during breeding seasons around a full moon or new moon.

'Alu 'alu i mala tau ki monu. Persevere, the fish will eventually bite.
Image : © Leone Vaitanoa, Wallis

- Fishers are not very selective, either with species or catch sizes. This may be advantageous in terms of fishing activity because the fishing pressure is spread over a large number of resources, but catches of juveniles and very large specimens can also affect stock reproduction potential.
- Fishing on foot, repeated trampling of the reef, and random anchorage choices may lead to serious damage to reef and lagoon habitats.

To this should be added other current pressures: massive terrigenous deposits from landslides; domestic pollution sources, including pig effluent, sand and coral extraction; land reclamation; and coastline and lagoon current changes. These sources of damage have been observed qualitatively in the field (Gabrié 1995; Verducci and Juncker 2007; Chancerelle 2008).

The impact of these pressures remains difficult to fully assess, particularly in the coastal zone along seagrass beds and mangroves, which are essential habitats in the life cycle of many marine species. The threat of climate change also increases the vulnerability of these resources and their habitats.

The state of Wallis and Futuna's marine resources

Perception of the state of various resources

The main hindrance to implementing participatory and sustainable coastal resource management appears to reside in the lack of social demand. This topic, however, is not perceived as a priority.

In 1969, underwater spearfishers had already been reporting that the number of large groupers, parrotfish and humphead wrasses had diminished considerably. Spearfishers readily admitted that this was due to the increasing number of spearguns sold and to the poor practice of going out underwater spearfishing at night using waterproof electric torches (Hinds 1969).

In 2007, as part of the projected marine space management plan, the majority of people surveyed testified to a decline in resources (Egretaud et al. 2007a; Verducci and Juncker 2007).

In 2018, 2019, 2020 and 2021, surveys conducted with some 50 professional and subsistence fishers revealed differing opinions about the state of resources.

On Wallis, a number of professional fishers expressed a clear perception that lagoon resources were shrinking. This decline required fishers to dive to greater depths (more than 20 m) and spend more time at sea to bring home the same quantity

of seafood. They implicated unsustainable practices, especially underwater spearfishing at night, or nets left in the sea for too long or of excessive length. Other fishers had a completely different perception, claiming that there is still enough fish to meet people's needs. They also queried the destructive nature of underwater spearfishing at night. Female fishers consulted on Wallis perceived a reduction in fish and ark clams (*Anadara* sp.) in the lagoon. The reasons given included night-time underwater spearfishing, beach width shrinkage and uncontrolled garbage dumping (Aubert et al. 2020).

On Futuna, some fishers reported declines in recent years of unicorn fish (*Naso unicornis*) and green jobfish (*Aprion virescens*). There are also fewer large giant clams and fishers now have to go farther offshore to find them. Other fishers felt there has been no significant change over their lifetime. Female fishers on Futuna did not, as a whole, perceive there to be a problem with a decline in resources on the reef that they exploited. After specific questioning, however, they produced a list of everything that had disappeared or virtually disappeared (e.g. green snail, trochus, giant clam, octopus, sea cucumber and mussel) (Aubert et al. 2020).

There does not seem to be any dominant discourse within the fishing community surveyed, including both men and women, regarding the perception of the state of local resources varying from person to person. Some fishers do report a decline in catches and the size of fish and some invertebrates, which they say are harder to find than in the past. This observation is, however, only infrequently seen as a problem and often comes with a degree of fatalism not requiring any action to be taken. For most of the stakeholders surveyed, there is no cause-and-effect relationship between fishing practices and a possible decline in coastal resources. External factors, such as climate warming and foreign fishing vessels, are often referred to, and the vast majority of people interviewed are quite sure that when challenges such as this arise, providence will always save them.

This fatalism has already been referred to in Wallis and Futuna to describe local community perceptions of natural hazards (Dupon 1984). In similar settings, some authors state that, until such time as communities adopt a more deterministic approach, establishing the cause-and-effect relationship between human action and resource abundance trends, no management initiative will be possible (Foale 2006; McClanahan 2007, 2010; Bruggemann et al. 2012). Improved monitoring and inclusive communication on the relationship between the various pressures and resource abundance trends could, therefore, be an initial source of leverage towards achieving participatory and sustainable coastal resource management in Wallis and Futuna.

Tilita, fisherwoman of Wallis.
"They call me Mrs. Share. I often glean on the flats and I always give away part of my catch because I know that God will pay me back."
Image: © Baptiste Jaugeon

What was and what is the status of the resource?

Before World War II, Wallisian and Futunan society was still very traditional. The first descriptions of fishing practices go back to the writings of the first missionaries, and in 1932, fishing techniques were still very limited (Burrows 1936, 1937).

Wallis and Futuna island society was deeply disrupted in 1942 by the arrival of the American army, the emergence of a market economy, and the abandoning of subsistence cropping in order to provide food for the American military. The presence of 4000 men required the population to mobilise en masse to support the troops. The euphoria was only short lived, with American soldiers leaving behind a collapsed traditional economy when they departed in 1944. The lagoon suffered particularly badly in terms of its fish and crustacean resources through inappropriate fishing methods, especially dynamite fishing (Angleviel 2006).

In 1969, an SPC expert, reported stock shrinkages because of the persistent use of destructive fishing methods, the lack of interest in fishing as a profession, and difficulties in supplying the local market (Hinds 1969).

The first comprehensive inventories, quantified scientific data production activities and ecological studies on the islands' marine environment began in the 1980s.

The first inventory of the underwater fauna and flora of Wallis and Futuna was carried out in 1980 (Richard et al. 1982). This study recorded 330 species of fish in more than 55 families in the lagoons of Wallis, Futuna and Alofi.

Over 20 years later, a new expert study yielded the first quantitative data (density and biomass) and structural information about the reef ichthyofauna of Wallis (Wantiez and Chauvet 2003). Only 194 species of fish (30 families) could be recorded. A spatially less extensive sampling campaign (Richard et al. 1982) could, however, explain the lack of some fish species that were previously recorded. It is also possible that recruitment variations may explain these discrepancies in abundance.

The following year, a major sampling effort made it possible to obtain a relatively comprehensive snapshot of the fish communities (648 recorded species belonging to 79 families) (Williams et al. 2006), and confirmed the existence of major spatial and temporal variations in juvenile and adult populations (Wantiez 2000a, 2000b, 2001a, 2001b) that could possibly be attributed to the unreliable supply of fish larvae to Wallis lagoon (Juncker 2005). At the same time, a reef health status monitoring exercise was carried out by the Island Research Centre and Environmental Observatory. From the results of the first three monitoring programmes (1999, 2002 and 2005), it emerged that the reefs and outer slopes investigated were not showing clear damage (Chancerelle 2008).

The research conducted by Richard et al. (1982), Juncker (2005), Williams et al. (2006) and Chancerelle (2008) was not designed as a report on the status of marine resource stocks but rather to describe the ecology and dynamics of these populations.

A fishery-oriented approach was adopted in 2005–2006 by SPC as part of the regional oceanic and coastal fisheries development programme, PROCFish/C. Surveys and underwater visual census campaigns aimed at collecting reference information on the state of reef fisheries in order to contribute to overcoming the enormous information deficit – an obstacle to good management for these fisheries (Kronen et al. 2006).

Subsequently, reef and lagoon resources have not been subject to investigation, with the exception of commercial invertebrates such as sea cucumbers (Chauvet and Lemouellic 2005; Chauvet et al. 2011; Bertram et al. 2015), spiny lobster and slipper lobster (Bosserelle et al. 2018a), coconut crab (Bosserelle et al. 2018b) and trochus (Chauvet et al. 2004, 2006; Bosserelle and Liufau 2017).

Very recently, an even more thorough inventory was performed by the Institut de Recherche pour le Développement (Institute of Research for Development) as part of the regional strategic analysis performed by the Office Français de la Biodiversité (French Biodiversity Agency).

These many studies pursued a range of objectives, although common elements emerge. There can be no doubt that, in the past, the reef and lagoon resources have been jeopardised, but they seem overall to have been in a good state when the research was performed. Some warning signs were, however, also observed: different variables (abundance, biomass, species size) point to selective and impact-producing fishing pressure, with special reference to the most accessible coastal and intermediate reef formations.

Can we fish more?

When investigating the reef and lagoon resources of Wallis and Futuna, it is important to bear in mind the relative geographical isolation of these islands. Apart from some shallows in the exclusive economic zone, these islands tend to rely on recruitment from their own reefs (Juncker 2005). This isolated status of Wallis and Futuna is thought to hinder access to marine organisms from other reefs. In the event of local overfishing, recolonisation and stock rehabilitation would be a long process, even more so if the habitat has been damaged by poor practices (Blanchet 2001).

Research carried out in 2009 (Bell et al. 2009) categorised Wallis and Futuna as one of the Pacific Island countries and territories for which reef and lagoon fishing could not sustainably supply fish in quantities sufficient to meet community demand. On the assumption that one square metre of reef cannot sustainably supply more than 3 tonnes of fish per

year (Newton et al. 2007) structure, function, and resilience 1, 2. Although it is generally held that coral reef fisheries are unsustainable 3, 4, 5, little is known of the overall scale of exploitation or which reefs are overfished [6]. Here, on the basis of ecological footprints and a review of exploitation status 7, 8, we report widespread unsustainability of island coral reef fisheries. Over half (55%, the authors estimated – from the available spatial assessment data – that the reefs of Wallis and Futuna (including shallows) would not be able to sustainably supply more than 800 tonnes annually.

In 2006, however, fishery production (including tunas) was estimated at 900 tonnes and then at 825 tonnes in 2014. The reefs of Wallis and Futuna were therefore exploited to an extent exceeding their capacity.

Production data from the household budget surveys in 2019 and 2020 are not yet available, but production may have declined because of demographic shrinkage and possibly dropped to a sustainable exploitation level.

These large-scale estimates do not, however, address the impact of certain practices, the exploitation of specific species, habitat destruction or yield drops associated with climate change. There is merit in determining with accuracy the sustainable coastal resource exploitation threshold in Wallis and Futuna.

Conclusion

Is the Wallis and Futuna context conducive to good marine resource management?

Like agriculture, fishing is an activity that helps maintain a socioeconomic balance in Wallis and Futuna. For many people, the sea is a true larder, "a reserve for hard times" and a guarantee of high-quality, healthy and local food. For others, it means they are certain that they will be able to meet their everyday expenses. And for a number of professional fisherfolks, it is their workspace, enabling them to catch fish and supply the local market.

At present, because of declining demography, a relatively high standard of living, a relative degree of dependency on marine resources, a customary system that is losing influence, and an indulgent government administration, the people of Wallis and Futuna enjoy a great deal of freedom in terms of their marine spaces.

Any management measure is perceived as a loss of freedom and a futile effort in light of nature's providence, especially as the majority of fishers do not see any cause-and-effect link between their activities and the decline in resources. This leads to a lack of social demand for marine resource management.

The resources of Wallis and Futuna are, however, not infinite and have limited renewal capacities, especially when it is realised that unsustainable practices continue and place increasing pressure on the marine environment.

As observed by a professional Wallis and Futuna fisherman: "To be free does not mean that you give yourself permission to do what you shouldn't be doing".

What are the prerequisites to the introduction of participatory and sustainable coastal resource management in Wallis and Futuna?

Today the prerequisite for introducing participatory coastal resource management would be to change the sociocultural paradigms associated with natural resource use. Various avenues are under consideration: raise awareness about the vulnerability of reef and lagoon marine resources, demonstrate the causal links between resource harvesting and stock reduction (and between management and sustainability), and strengthen resource monitoring efforts by making this knowledge available and disseminating it.

The sources of motivation that could induce behavioural change are not always rational. The lack of social demand would appear principally to be part of the cultural and spiritual spheres and, therefore, it could be that the solution would not be to create a contrast between coastal resource management and culture, but rather to reconcile these from a new standpoint.

In a future article, the authors will address the strategy that is beginning to be introduced in order to attempt to achieve participatory marine resource management based on knowledge and awareness within local communities.

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Reef and lagoon fishing do not need to be very selective on Wallis, an island free of ciguatera. Image: © Matthieu Juncker