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Reporting to reusing: How satellite buoys from the purse seine fishery can benefit local communities

Jennyfer Mourot and Lauriane Escalle

Industrial fishing is often singled out when it comes to issues of sustainability and responsible management of natural resources. More and more projects and laws are being put forward to reduce environmental impact and encourage industries to use more responsible practices. Satlink's Project ReCon, which enables recovered Satlink satellite and echosounder buoys used in the purse seine fishery to be reused, is part of a drive to reduce the impact of this fishery on the environment and to support local communities in the development of local projects. The roots of the project lie in the data collected by the inhabitants of Pacific countries on fish aggregating devices (FADs) stranded in coastal areas.

The western and central Pacific Ocean (WCPO) is the largest tuna fishery in the world and provides half of the global tuna catch (54%) (Williams and Ruaia 2023) using different fishing techniques and for which the purse seine fishery provides 70%. The economic importance of the tuna purse seine fishery to Pacific Island countries and territories (PICTs) cannot be understated, with up to 98% of government revenues coming from fishing licences (Bell et al. 2021).

Extensive use of FADs

In the WCPO, almost half of the catch by the purse seine fishery is made using drifting fish aggregating devices (dFADs) (48% in 2022), while industrial anchored FADs (aFADs) make up roughly 1% of the sets (Williams and Ruaia 2023 Jul). FADs are therefore a key component of the purse seine fishery in the WCPO and worldwide. Recent estimates of dFAD buoy deployments are 30,000–40,000 per year in the WCPO only, and 46,000–65,000 for the whole Pacific (Escalle et al. 2021; Lopez et al. 2021). However, this extensive use leads to several environmental impacts. Abandoned, lost, or otherwise discarded fishing gear is a growing concern for sustainable fisheries in terms of environmental, social and economic impacts (Burt et al. 2020; Gilman et al. 2021; Giskes et al. 2022; Richardson et al. 2019) and represents a substantial part of the global marine debris (10%, according to Macfadyen et al., 2009). In the case of FADs, dedicated assessments of their loss, abandonment and related consequences are still lacking (Macfadyen et al. 2009; Richardson et al. 2019).

Photo of ReCon buoy deployed on aFAD in New Caledonia in December 2023.



FAD design and environmental impacts

Generally, dFADs consist of a floating raft structure made of bamboo, purse seine float and/or PVC tubes, and are often wrapped up in nets to avoid detection from other vessels. They also have submerged appendages commonly made of old purse seine nets (Abascal et al. 2014; Bromhead et al. 2003; Dagorn et al. 2013) that are used to slow down dFAD drift and create volume to attract fish (Dagorn et al. 2013). In both the raft and the submerged appendages, dFADs commonly include some netting and/or other synthetic materials in their construction (Escalle et al. 2023). Satellite and echosounder buoys are also attached to dFADs, allowing fishermen to track their location and biomass underneath at any given time (Lopez et al. 2014). The extensive use of dFADs and their current design pose serious risks of marine life entanglement of sensitive species such as turtles or sharks, but also threaten fragile ecosystems like coral reefs, benthic habitats and mangroves. Industrial aFADs, on the other hand, are usually a wide metal or fiberglass drum, attached to the sea floor at over 1000 m depth and used in the western part of the WCPO only. While they are deployed in lower number than dFADs, they are commonly lost and, when they reach coastal areas, their stranding events can have large environmental consequences and are very difficult for local communities to remove.

Stranded FADs data collection programmes

With the aim of quantifying the number of FADs (drifting and anchored) reaching coastal areas, strandings, and the impacts they may cause on coastal ecosystems, programmes to collect data on stranding events have been implemented in 11 PICTs (Figure 1 and Table 1): Australia, Cook Islands, Federated States of Micronesia, Hawaii, Marshall Islands,

New Caledonia, French Polynesia, Palmyra Atoll, Tonga, Tuvalu, and Wallis and Futuna. These programmes are collaborations between SPC, national fisheries departments, or non-governmental organisations (NGOs). When a FAD and/or satellite buoy is found, a report is made to the local partner who enters the information into a database managed by SPC. They retrieve information on the type of stranding event, the location, the date, the materials present in the case of a FAD and the impacts it has caused. So far, 2,513 stranding events have been reported through these data collection programmes, mostly since 2019, although some programme reports have been made as far back as 2004.

These data-collection programmes on stranded FADs and satellite buoys highlighted that a lot of reports were coming from local communities that have been recovering these objects over several years and sometimes re-using them in their gardens or houses. For PICTs, objects from the sea are often valuable because some materials are hard to find or expensive to import. For instance, electronics and solar panels can be used to make phone chargers, and netting and bamboo can be used to build fences.

Project ReCon

In this context, Satlink recently developed Project ReCon, a global circular economy initiative that works with a network of partners and a large part of the fishing industry with the aim of reusing shore-stranded buoys found by local PICT communities. Given SPC's efforts in collecting data on these stranding events, SPC recently signed on to be a partner for Project ReCon in many of the PICTs in its network. The objective is to mitigate the potential environmental impact and marine pollution caused by buoys that are stranded on shores, far away from the fishing grounds where they were originally deployed. Since many of the buoys found are in

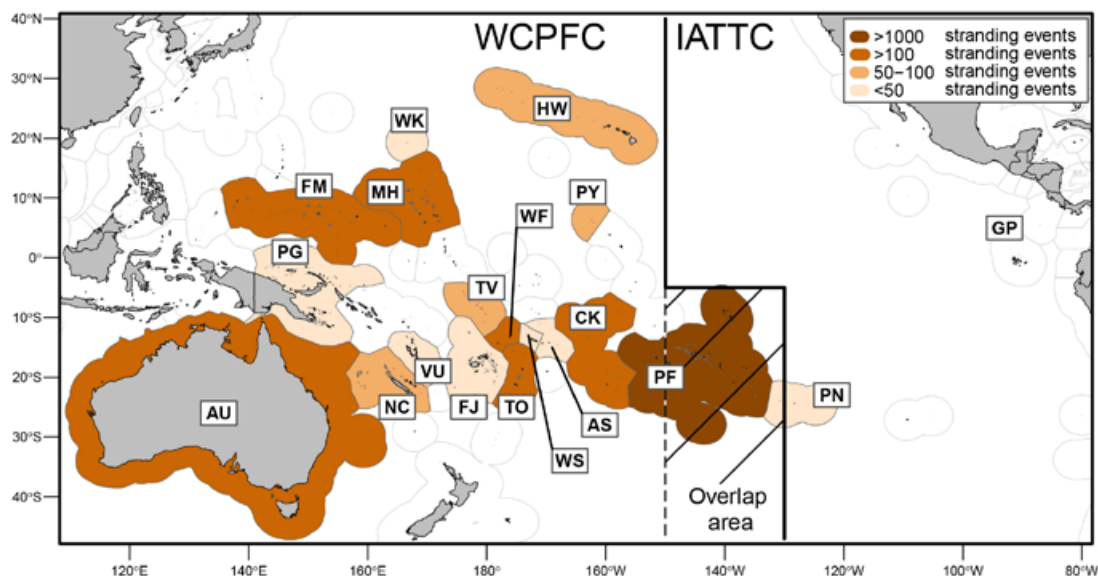


Figure 1. Number of stranding events reported in PICTs involved in the stranded FAD data collection programmes. This area includes the Inter-American Tropical Tuna Commission [IATTC] region.

Table 1. Summary of data collected through stranded FAD data collection programmes in the Pacific Ocean and number of events recorded since the beginning of each programme.

| PICT | Programme | Start of the programme | Events recorded |
|--------------------------------|--------------------|------------------------|-----------------|
| French Polynesia | Independent | 2019 | 1050 |
| Cook Islands | SPC | 2020 | 288 |
| Australia | Independent | 2004 | 275 |
| Wallis and Futuna | SPC | 2020 | 179 |
| Federated States of Micronesia | SPC | 2021 | 168 |
| Tonga | SPC | 2023 | 115 |
| Marshall Islands | SPC | 2021 | 103 |
| Hawaii | Independent | 2014 | 100 |
| New Caledonia | SPC | 2022 | 71 |
| Palmyra Atoll | Independent | 2009 | 63 |
| Tuvalu | SPC | 2022 | 58 |
| Galapagos Islands | Independent | 2024 | |
| Vanuatu | Under discussion | | 20 |
| Papua New Guinea | Under discussion | | 1 |
| Samoa | Under discussion | | 1 |
| American Samoa | Under discussion | | 4 |
| Solomon Islands | Under discussion | | 0 |
| Palau | Under discussion | | 0 |
| Wake Island (US) | Opportunistically* | | 8 |
| Pitcairn | Opportunistically | | 7 |
| Fiji | Opportunistically | | 1 |
| TOTAL | | | 2513 |

* PICTs with a programme presented as “opportunistically” means that there is no programme implemented but some reports have been made nonetheless.

good condition and have great potential to be reused in local projects and benefit Pacific communities, through Project ReCon this valuable technology that would have been waste now becomes an asset for the local communities finding them.

When a buoy is found by a community, it is first reported to the local partner, such as the fisheries department or the NGO (Table 2). They then collect information related to the stranding event, including buoy condition. When the buoy is deemed to be in good condition and if the person who found the buoy agrees to give it to the programme for re-use, Satlink liaises with the buoy’s owner to see if they agree to transfer ownership of the buoy so that it can be re-used in local projects. If ownership is transferred, the local partner and Satlink agree to carry out various tests to assess the state of the buoy’s functions. The buoy can be re-used for

its GPS function to track marine debris or the position of an aFAD; its flashing light can mark a channel or a fishing spot; or its echo sounder can be used to estimate the quantity of fish aggregated under a local anchored FAD. Once the tests are complete, there are several possible scenarios:

- If all or some of the functions work correctly, then the buoy is reusable and ready for a second life, provided a local project has a use for it.
- If nothing works, or there is no project available, then Satlink and SPC will work together to find the best way to dispose of it responsibly, which could be either through a local channel if one exists, or by sending it to Satlink’s head office in Spain so that all the components can be recycled.

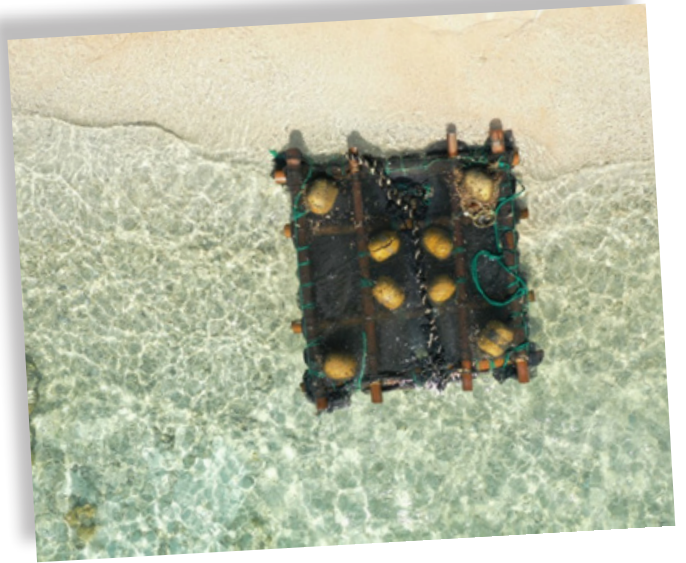


Figure 2. Photos of stranded FADs and/or buoys (© Federated States of Micronesia, French Polynesia and New Caledonia databases)

New Caledonia – case study

In New Caledonia, a programme to collect data on stranded FADs and satellite buoys has been in place since 2022 in partnership with the Service du Parc Naturel de la Mer de Corail et de la Pêche (SPNMCP) and has collected more than 26 stranded FADs (22 dFADs and 4 aFADs) and 54 stranded buoys. From this programme, five of those recovered so far could be potential candidates for Project ReCon. One of the buoys has just been redeployed on a New Caledonian anchored FAD in December 2023; and a second is likely in the coming weeks. This could have several benefits, direct and indirect, for local communities and fishing associations such as:

- i) guaranteeing safe access to food resources,
- ii) observing the ocean in real time and contributing to the improvement of forecasting and warning systems for safety at sea, and
- iii) observing the effectiveness and effects of aFADs in terms of the concentration of target and by-catch species. In the event of the aFAD becoming detached from its location, the buoy will make it possible to track its GPS position and send an alert to parties onshore. Not only does this limit the environmental impact, but also the cost of manufacturing a brand-new FAD, which can be in the region of more than USD 2500.

Table 2. Contact details for partners involved in the stranded FADs programme

| Country | Institutions | Contact |
|--------------------------------|--|---|
| Australia | Australian Fisheries Management Authority (AFMA) | Dutyofficer@afma.gov.au |
| | Tangaroa Blue Foundation | heidi@tangaroablue.org lincoln@tangaroablue.org https://apps.apple.com/us/app/amdi-data-collection/id1408112211 |
| Cook Islands | Ministry of Marine Resources | rar@mmr.gov.ck Tel. 28721 |
| Federated States of Micronesia | NORMA | jamel.james@norma.fm donaldd@spc.int 320-2700 |
| | Pohnpei – Office of Fisheries and Aquaculture (OFA) | 320-2795 |
| | Chuuk – Dept. of Marine Resources (DMR) | 330-6724 |
| | Yap – Division of Marine Resources Management (DMRM) | 350-2350 |
| | Kosrae – Division of Fisheries & Marine Resources (DFMR) | 370-3017 |
| Hawaii | Hawaii Pacific University Center for Marine Debris Research | sroyer@hpu.edu jennifer.lynch@nist.gov |
| Marshall Islands | Marshall Islands Marine Resources Authority (MIMRA) | reports@mimra.com +692 625-8262 |
| New Caledonia | Service du Parc Naturel de la Mer de Corail et de la Pêche (SPNMCP) | merdecorail@gouv.nc 27 99 74 |
| French Polynesia | Direction des ressources marines | dcpech@drm.gov.pf http://www.ressources-marines.gov.pf/dcpech |
| Palmyra Atoll | The Nature Conservancy | kydd.pollock@TNC.ORG |
| Samoa | Ministry of Agriculture and Fisheries – Fisheries Division | moli.iakopo@maf.gov.ws fisheriesmsc@maf.gov.ws +685-7654571 |
| Tonga | Ministry of Fisheries | info@tongafish.gov.to +676 7401200 +676 7401201 |
| Tuvalu | Tuvalu Fisheries | tfd@tuvalufisheries.tv +688 20343 |
| Wallis and Futuna | Directions des services de l'agriculture, de la forêt et de la pêche | service.peche@agripeche.wf 72 26 06 |

Overall, the current projects have the potential to bridge the gap between high sea tuna fishing and coastal communities throughout the Pacific. First, the data collection programmes provide crucial information about abandoned, lost, or otherwise discarded fishing gear from the tuna fishing industry and the ecosystem impacts that derive from it. Second, through Project ReCon, it reduces coastal pollution and the burden to local communities, while enabling Pacific communities to benefit from it locally. The buoys that are reused support the development of artisanal fisheries and/or conservation projects. Project ReCon develops a circular economy, supports community development and reduces the impact of stranded buoys on Pacific coastlines.

The regional data collection programme is continuing its extension, with a likely start in Papua New Guinea, Samoa and Solomon Islands in 2024. The objective is to have this ongoing programme as a sentinel to monitor FAD loss and associated impacts, while the purse seine fishery evolves with new management measures implemented. Similarly, thanks to the partnership with SPC, Project ReCon will also start in the Federated States of Micronesia, the Cook Islands and the Marshall Islands in the next few weeks, allowing more buoys to be reused through this project.

Contact details for partners involved in the data collection of stranded FADs in several PICTs are shown in Table 2. For PICTs that do not appear in the list, there is no data collection programme implemented yet. However, in case of finding a FAD and/or a buoy, please refer to your fisheries institution or send an email to Jennyfer Mourot (Research Assistant - FADs, jenniferm@spc.int) or Lauriane Escalle (Senior Fisheries Scientist - FADs, laurianee@spc.int).

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Getting the band back together – outcomes of the 19th annual WCPFC Scientific Committee

Dr Graham Pilling¹ and Dr Paul Hamer²

After three years of online meetings, this year's in-person Western and Central Pacific Fisheries Commission's (WCPFC) nineteenth Scientific Committee (SC19) meeting was a chance to push forward work items that were not well-suited to the virtual format. And of course, a chance for attendees to meet up and dive into productive discussions and small group sessions. Here are some of the key outcomes from SC19.



The SPC Oceanic Fisheries Programme team

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

The Pacific Community's Oceanic Fisheries Programme (SPC OFP) has been the Commission's Scientific Services Provider and Data Manager for almost 20 years now, which means that the Scientific Committee meeting is a key time for us to present all our analyses and inform the scientific advice from the SC that underpins fishery management decisions taken by the Commission. This year OFP scientists were involved in nearly 60 papers providing information and recommendations to the 19th Scientific Committee meeting³ across the different issues covered.

A face-to-face meeting

The SC19 meeting was held at the Ngarachamayong Cultural Center, Koror, Palau over eight days – from 16 to 24 August 2023. With international borders now reopened, the chance to have a physical meeting with familiar (and new) faces and present our latest scientific analyses was refreshing. The team found it was very productive to be able to meet in small working groups and informal huddles to discuss and work through issues.

Review of the latest stock assessment results

A key element of this year's SC was the review of our latest stock assessments for western and central Pacific Ocean bigeye and yellowfin tuna. The previous (2020) yellowfin assessment was subject to a review by external experts in 2022, and many of their recommendations were implemented in

¹ Head of FAME's Oceanic Fisheries Programme - SPC

² Head of the Stock Assessment and Modelling Section - SPC

³ 19th annual WCPFC Scientific Committee - <https://meetings.wcpfc.int/meetings/sc19>



All aboard! The SPC crew on their way to the SC19 meeting in Koror, Palau.



Rajjeli Natadra, Pacific Island Fisheries Professional with the SPC Oceanic Fisheries Programme, at the SC19 meeting.

this year's yellowfin assessment, which also benefited the bigeye assessment. Both bigeye and yellowfin were assessed as being 'in the green' (i.e. not overfished nor subject to overfishing). SC reviewed and accepted these 2023 assessments as the best scientific information available for stock status and used the results to craft advice for consideration by fisheries managers at the Commission meeting.⁴ Further work on the most recent WCPO skipjack stock assessment that was agreed in 2022 was also presented, addressing some of the areas of work that the SC identified last year.

Research plans

The tuna assessment research plan⁵ ('TARP') was presented and discussed for the first time. This living document captures the key research and development recommendations and the needs arising from stock assessments and work being undertaken by all Commission members in the region. The TARP is important for prioritisation of future work and funding needs and the identification of key projects for SC consideration. A research plan for billfish⁶ was also developed and discussed for the first time, along with a mid-term review of the shark research plan⁷. Both these plans were recommended to continue to 2030 to provide greater opportunity to implement and complete research and include multiple stock assessments.

Progress for tuna harvest strategies

Beyond the assessments and research plans, 2023 was the first year in which the skipjack management procedure (MP), adopted at WCPFC19 in December last year⁸, was run. A milestone for the development of harvest strategies in the WCPFC, SC accepted the output of the MP which indicates the desired overall maximum level of fishing in key skipjack fisheries for the next three years. As part of this process, SC also discussed a proposed monitoring strategy⁹ that tracks the performance and implementation of the MP and will allow the Commission to check that it's working as expected and achieving the desired benefits. The SPC's harvest strategy team had more on their plate than just the skipjack MP and presented several other plenary papers, relating to the development of a management procedure for South Pacific albacore and the approach being tested for incorporating mixed fishery interactions into tuna harvest strategies.

⁴ 20th Regular Session of the Commission - <https://meetings.wcpfc.int/index.php/meetings/wcpfc20>

⁵ Tuna Assessment Research Plan (TARP) for 'key' tuna species assessments in the WCPO, 2023–2026 (25 July 2023) - rev.01 - <https://meetings.wcpfc.int/node/19363>

⁶ Billfish research plan 2023–2027 (13 July 2023) rev. 01 - <https://meetings.wcpfc.int/node/19364>

⁷ Shark research plan 2021–2025 mid-term review (Project 97b) (15 July 2023) – rev. 01 - <https://meetings.wcpfc.int/node/19396>

⁸ See WCPFC19 Summary Report - <https://meetings.wcpfc.int/node/18547>

⁹ Monitoring the WCPO skipjack management procedure - <https://meetings.wcpfc.int/node/19376>



An appropriate mural on the wall of a local school in Koror, where the meeting took place.

Research into drifting FADs and reducing their environmental impacts

Finally, given the growing pressure to reduce the environmental impacts of drifting fish aggregation devices (dFADs) used by the industrial purse seine fishery, SPC's various collaborative research and monitoring activities on dFADs received considerable attention. Plenary presentations and discussion¹ involved the work trialling biodegradable and non-entangling dFADs, the regional database on stranded FADs, analysis of FAD numbers and trends in the materials used to construct FADs. The latter topic was particularly relevant given that the ban on mesh netting in dFADs in the WCPO is coming into effect in 2024.

Celebrating the inputs of one of OFP's SC veterans

We should also take the opportunity to mention that this Scientific Committee was most probably the last one that SPC OFP's Peter Williams will attend in person, and he has probably been to them all. His immense contribution to the work of the Science Committee, the WCPFC and the regions' tuna fisheries data, science and management support was warmly acknowledged.

Up next

Post SC, the work level does not ease up. At the time of writing, we've already supported the 4th Tropical Tuna Management Workshop¹⁰ in September, presenting the results of requested scientific analyses based on the new big-eye and yellowfin assessments, with more to do prior to the Commission meeting in December¹¹ in Rarotonga, Cook Islands. That meeting, which will have taken place by the time of publication of this article, will review key elements of the current tropical tuna Conservation and Management Measure, with the goal to agree on a new measure to start in 2024. OFP will be there to present the results of analyses and to inform member's decision-making.



Peter Williams, SC veteran, WCPFC data guru, and Principal Fisheries Advisor to the Oceanic Fisheries Programme Data Management section, enjoying one last SC.

¹⁰ Development of a Revised WCPFC Tropical Tuna Measure Workshop 4 - <https://meetings.wcpfc.int/meetings/ttmw4>

¹¹ 20th Regular Session of the Commission - <https://meetings.wcpfc.int/meetings/wcpfc20>

Capacity building on harvest strategies: Progress and areas of improvement

In pursuit of sustainable tuna fisheries in the western and central Pacific Ocean (WCPO), the Western and Central Pacific Fisheries Commission (WCPFC) members agreed in 2015 to a workplan for the adoption of harvest strategies for WCPO skipjack, bigeye, yellowfin and South Pacific albacore tuna. A critical element of this initiative is capacity building, where stakeholders play an important role in leading the development process by making key decisions. The Pacific Community (SPC), serving as the science provider of WCPFC, has been supporting this effort and since 2018 has provided training on harvest strategies through regional and national workshops. In order to assess the use and application of the information and knowledge provided to participants through these workshops, a tracer survey was deployed in 2023. This article presents some of the findings of this survey, shedding light on the challenges that are present after the facilitation of a workshop and why, even though knowledge increases with training, this does not necessarily mean that application of learnings will follow.

Sustainable management of tuna: why adopt a harvest strategy?

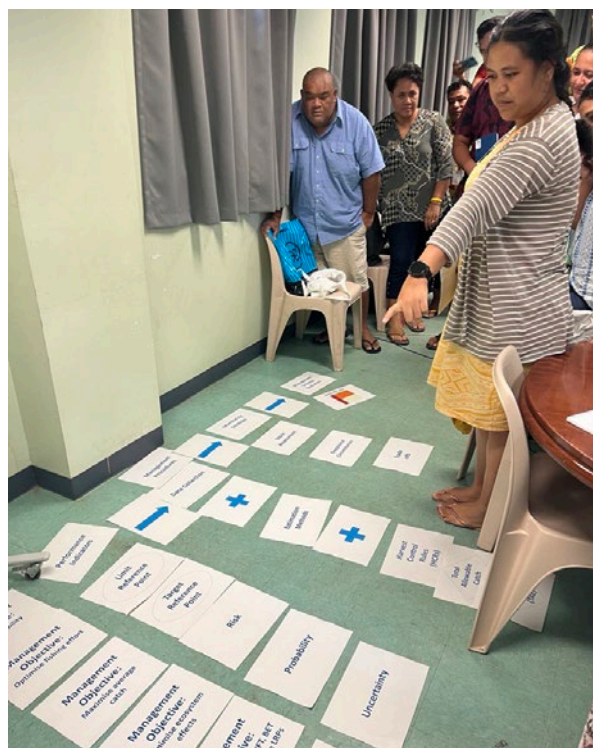
The WCPO region hosts the world's largest tuna fisheries industry, which contributes significantly to the economy and the livelihoods of PICTs. Despite its vital significance, the existing management systems employed in the tuna fisheries appear to be reactive, and with short-term objectives, which jeopardises the sustainable management of such a large-scale industry.

The deficiencies of the current management systems indicate that there is a pressing need for a structured system that can provide clear guidelines and focus on long-term objectives encompassing all stakeholders. Responding to this urgent need, the WCPFC has introduced a harvest strategy approach to better manage the tuna stocks in the region. A harvest strategy is a formalised and pre-agreed framework for guiding decisions on the management of a fishery. It aims to shift from short-term, ad hoc decision-making to a longer-term proactive approach to achieve defined management objectives. This shift in approach is crucial to effectively address the challenges posed by the scale and complexity of the industry, ensuring sustainable practices and equitable benefits for all involved parties in the WCPO region.

SPC delivery approach of harvest strategy training

A key component to the adoption of the harvest strategy approach is to conduct stakeholder engagement and capacity-building activities. Across the development process, stakeholders are expected to take the lead by making a variety of data-driven and science-based decisions. Many of these decisions require a two-way dialogue between scientists and decision makers from PICTs.

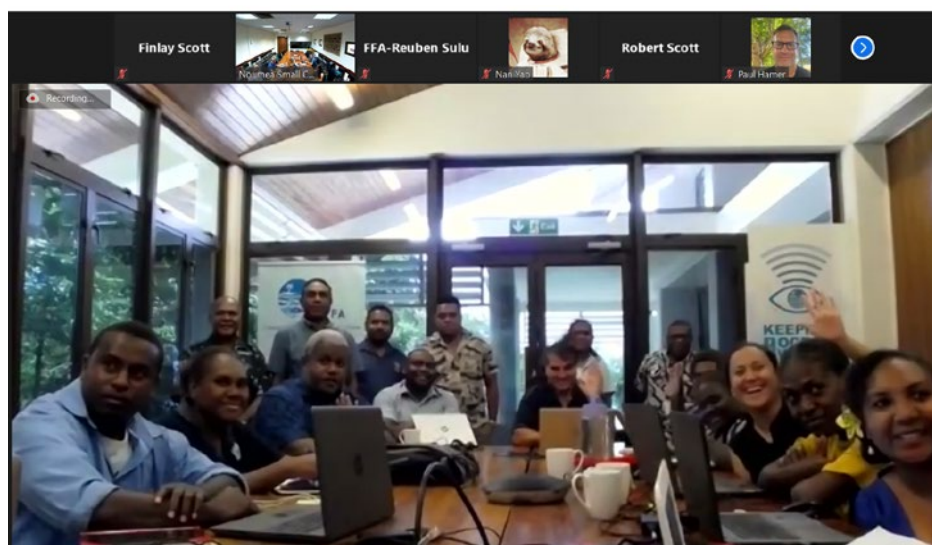
SPC facilitates the capacity-building process by organising 2–3-day national workshops, offering participants a comprehensive overview of the harvest strategy approach.



Participants at Samoa harvest strategy workshop engaging in practical activities to understand the harvest strategy development process.

The objective of these workshops is to equip participants with the knowledge needed for effective decision-making throughout the process. Additionally, they serve as a valuable platform for stakeholder communication.

Since 2018, 18 workshops on harvest strategies have been conducted by SPC. At least 400 participants have been trained during these workshops, coming from 12 PICTs (Cook Islands, FSM, Fiji, French Polynesia, Kiribati, Marshall Islands, Palau, PNG, Samoa, Solomon Islands, Tokelau and Tonga). Some of the workshops have been done in collaboration with the Pacific Islands Forum Fisheries Agency (FFA), delivered at both national and regional levels. In addition, SPC's Fisheries, Aquaculture and Marine Ecosys-



Group photo from online Solomon Islands national harvest strategy workshop



Participants from New Caledonia selecting their fisheries management objectives in the harvest strategy workshop.

tems has also facilitated three informal two-hour on-line workshops on national-specific topics with French Polynesia, New Caledonia and China in 2023.

The provision of the harvest strategy workshops has increased the understanding of this approach among PICTs. The workshops have been a valuable step that contributed to the adoption of the interim skipjack management procedure (MP) at the WCPFC meeting in December 2022. This marks the first instance of a harvest strategy approach being adopted in such large-scale fisheries. It stands as a significant decision to ensure the ongoing sustainability of the stock while improving the transparency and effectiveness of management.

Methodology of the tracer survey

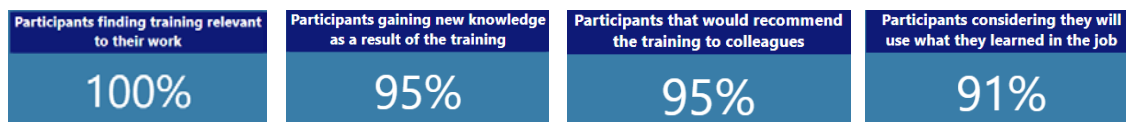
Having considered the significant efforts that SPC has made to engage members in developing harvest strategies, we employed a tracer survey with participants to assess the potential application of knowledge of harvest strategies, and to under-

stand the challenges they have faced in the use of this fisheries management approach. Tracer surveys are conducted with participants after some time (six months, a year, two years) has elapsed since the completion of the training. These are tools to capture data on the potential use of the learnings gained from a training workshop or how the context/situation changed following the completion of the workshop.

Four training events on harvest strategies were selected (two in 2022 and two in 2023), targeting 44 unique participants. These training workshops were held in Brisbane, Kiribati and Samoa (in person) and one was delivered online with participants from French Polynesia. We implemented a mixed-methods approach: most participants (82%) were invited to fill in the survey directly (self-administered survey) while the remaining 18% of participants were invited to receive a call with the surveyor to go through the questionnaire with them (assisted/guided survey). The harvest strategy tracer survey was deployed on 2 November 2023 and reminders were sent on both 13 and 22 November 2023.

From increasing knowledge to applying learnings – the missing link

A first review was done on the data collected from the post-training survey, which tends to be conducted immediately after the training is delivered. This initial survey collects information on the participant's impressions of the content, perceived increase of knowledge, relevance to the participant, and overall satisfaction with the training.



Response rates for post- training survey questions measuring reaction/satisfaction levels immediately after the training

The aggregate response ratio was 48%.¹ As tends to be the case with training and capacity-building activities, the immediate feedback from participants was mostly positive. On average, the training content was rated 4.6 out of 5, all respondents found the training relevant to their work, and 95% of them gained new knowledge as a result of the training.

The initial positive reaction contrasts with the actual responses received six months or more after attending the training via the results of the tracer survey. SPC received 16 responses to the harvest strategy tracer survey, representing a 36% response ratio to the total participation in the selected training to be assessed.² Out of the total respondents, 31% indicated they had applied the learnings on harvest strategies in their work. This figure represents a substantial drop from the increase in knowledge reported immediately after the training.

“Our ministers are very revenue-generated thinkers, so it had a clash with conservation and fisheries development, that’s the current discussion” Female participant from Samoa.

Participants were asked about the challenges they faced in the application of the knowledge of harvest strategies; responses reported included:

- lack of policy and regulations in place to advance the use of the knowledge at the national fisheries sector,
- trade-offs faced by decision-makers,
- need to develop long-term objectives,
- lack of general understanding of the importance to sustainable management practices, and
- specific components of the strategy (model complexity, validation, generalisation and uncertainty).

“Lack of awareness and understanding about the importance of sustainable harvesting practices can lead to unsustainable resource use. Public education and outreach are crucial components of effective harvest management” Female participant from Kiribati.

Despite participants reporting an increase in the understanding of the harvest strategies, the responses relating to the challenges seem to indicate that this is not always shared. Within the context of the respondents’ work, it is possible

that decision makers and other stakeholders do not necessarily have the same understanding or prioritise the subject. This gap in knowledge affects the capacity of the training to have an impact in the application level after the provision of the workshops.

“I believe it’s educational [the training] for all existing and new recruits of fisheries officials and to better provide technical advice for decision makers, because without understanding the science behind the fisheries, I don’t think you can provide better advice and it will go against our overall long-term objectives of the ministry” Female participant in the harvest strategy training in Samoa.

Furthermore, almost three quarters of respondents (73%) reported facing learning difficulties during the workshops, most of them linked to the technical terminology and concepts, the background preparation needed and the length of the training.

“The timeframe for the training was not enough. Needs more time to understand the technical and scientific models and content of the harvest strategy” Female participant from the Solomon Islands.

The facilitators provided supplementary materials after the completion of the training. However, less than half of respondents (40%) reported that they had consulted them. Addressing the reported learning difficulties in future training can be done by making a thorough review of the materials to be used before, during and after the workshops. Ahead of the training, the facilitators could liaise with the participants to get a general idea of their profiles so they can tailor the level and contents of the workshops accordingly. Despite the need to use technical words, the facilitators could still deliver the training to fisheries officers with

¹ For individual workshops: Brisbane, no responses as the survey was not deployed, French Polynesia: 14% (1 of 7 participants responded). Samoa: 92% (11 of 12 participants responded) and Kiribati (100%, all 10 participants responded)

² Response ratio to tracer survey per workshop selected: Brisbane: 18%, French Polynesia: 0%, Samoa: 67% and Kiribati: 50%.

diverse roles in the ministries by adapting the materials and delivery method. Furthermore, the supplementary materials could be more practical, user friendly and dynamic to inspire more participants to consult them after the training. Participants could also be encouraged to review the posters, videos or presentations by following up with them in case they have any questions on these additional materials, or any other post-training queries they might have.

The ABC of lessons learned on delivering and assessing the harvest strategy workshops

The capacity-building experience and the post-training survey have provided valuable lessons. These insights serve the team as a foundation for further refinements to the capacity-building strategies, enabling more effective communication with the target audience, and increasing the use and application of the learnings provided in the training. The key lessons, summarised by thematic area, are listed below.

A From conducting the training workshops

- a** Keep combining the regional with the national level training.
- b** The one-on-one country-specific conversations have proven useful to grasp more of the current situation and context of each PICT that enhance the provision of support around the harvest strategy.
- c** Maximise the advantages of building strong advocates and influencers during the workshop.
- d** Follow-up is essential for sustaining PICT engagement.

B From data collected in the survey

- a** The terminology, participant profiles, training duration and timing, and agenda, are items of the training preparation to be reviewed by the team based on the feedback collected.
- b** There is a need to potentially review the context and setting in which the decision-makers on harvest strategy and teams operate to address it further in the training planning.
- c** Less than half of the participants consulted the supplementary materials. These could be improved by making them more practical, user friendly and dynamic and by using them as a reference for follow-up with participants.

C From deploying a tracer survey

- a** The training facilitators and the monitoring, evaluation and learning (MEL) teams must work more closely together to enhance data completion and accuracy.
- b** During the training, it is important to inform participants about SPC's interest in assessing the lasting impact of the training workshops to enhance contact information and responsiveness to surveys.
- c** Tracer surveys should be co-designed with facilitator teams to tailor the application of knowledge questions to the context of the training subjects.

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Participants engaging in a harvest strategy capacity-building workshop in Kiribati (left); Graham Pilling discussing the harvest strategy approach with participants in the Papua New Guinea national workshop (right).

Data balancing acts: The coexistence of offshore tuna and artisanal fisheries in French Polynesia

French Polynesia, a paradise of azure waters and pristine beaches, has been facing a complex challenge in recent years – the coexistence of its growing offshore tuna fishery and the existing artisanal fishery sector. This delicate balance requires a nuanced understanding of the interactions between these two vital components of the region's economy, ecology, and subsistence.

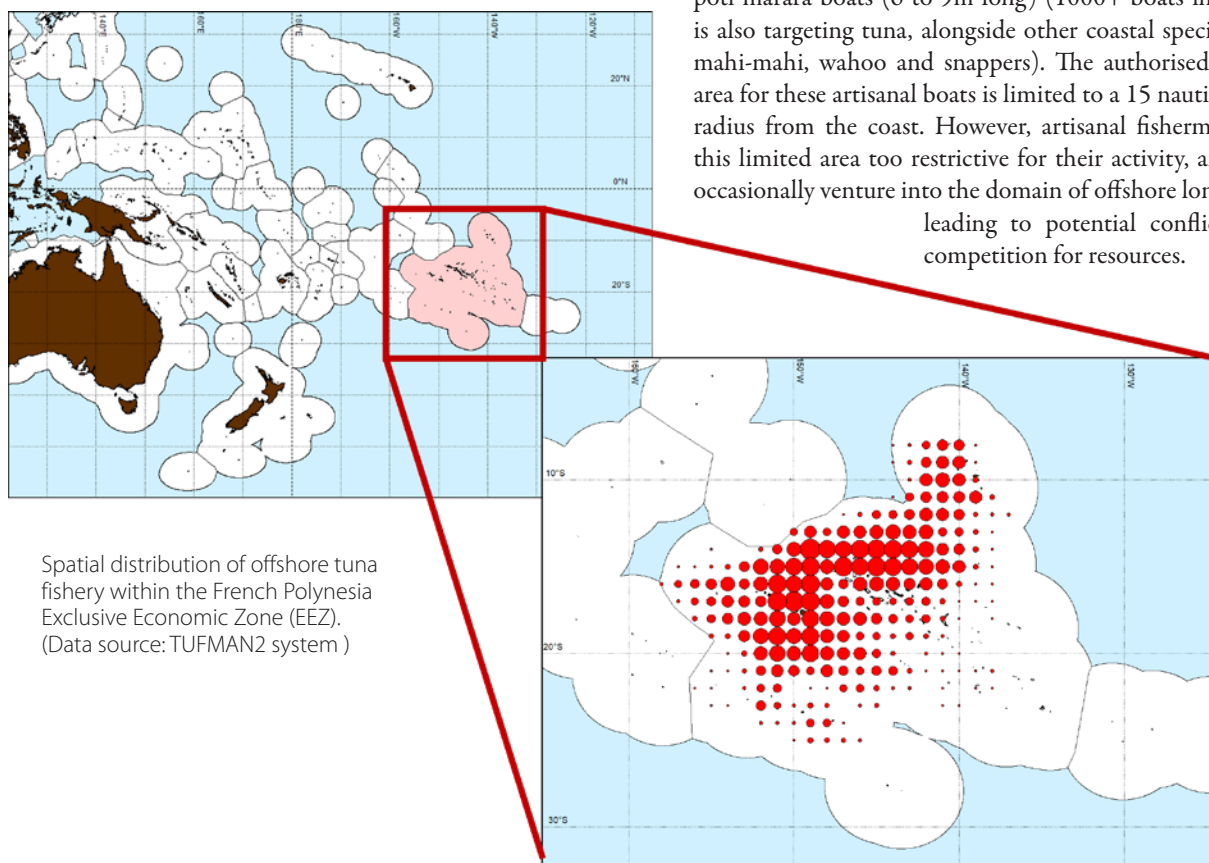
The growth of the offshore tuna fishery

French Polynesia has witnessed a steady increase in the number of offshore longline fishing boats (from 40 in 2000 to 80 vessels nowadays). These vessels are primarily deployed to target tuna, highly sought-after species for global seafood markets. Although there are no fishing area limitations for

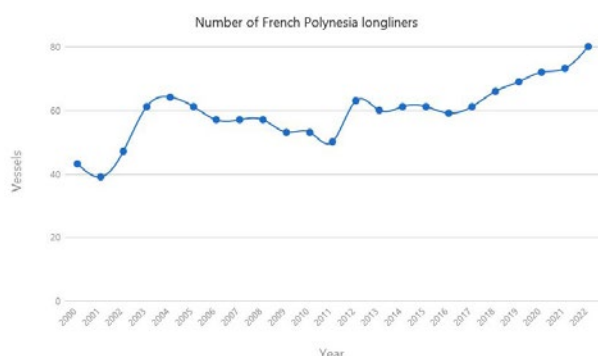
the offshore fleet, they generally fish beyond 15 nautical miles from shore. This industry plays a crucial role in providing economic opportunities and supporting local livelihoods.

Artisanal fishery: smaller boats, bigger impact

On the other hand, the artisanal fishery sector, consisting of smaller boats such as bonitier (10 to 13m long) and poti marara boats (6 to 9m long) (1000+ boats in 2022), is also targeting tuna, alongside other coastal species (e.g., mahi-mahi, wahoo and snappers). The authorised fishing area for these artisanal boats is limited to a 15 nautical mile radius from the coast. However, artisanal fishermen find this limited area too restrictive for their activity, and they occasionally venture into the domain of offshore longliners, leading to potential conflicts and competition for resources.



Spatial distribution of offshore tuna fishery within the French Polynesia Exclusive Economic Zone (EEZ). (Data source: TUFMAN2 system)



Conflicts and calls for expansion

The interactions between offshore longliners and artisanal fishers have sometimes escalated into conflicts within the 15 nautical mile zone. There have been instances where artisanal fishers discovered longliners operating in their designated zone and resorted to cutting their lines out of frustration and the need to protect their livelihoods. These confrontations underscore the complexities of shared fishing territories. In response to these challenges, artisanal fishers are now advocating for an extension of their current



Poti marara fishing boat. Photos © Steven Hare and Manu Schneider (SPC)



15-mile zone to provide them with more exclusive access to these nearshore waters. This call for expansion reflects the pressing need for effective regulations and compromise to ensure the coexistence of both fishing sectors while safeguarding their interests.

Government's call for analysis

Recognising the need for effective resource management, the French Polynesian government has been actively involved in understanding the dynamics between the two fishing sectors. They have previously requested the support of SPC to carry out a bio-economic analysis of the longline fleet. However, the current focus has shifted towards evaluating the extent of interactions between offshore and artisanal fleets in shared fishing zones. The key aspects to be examined include the area of fishing, the species caught, and the feasibility of introducing zone-based regulations for offshore vessels.

Challenges in data management

Analysing the historical fishing activity (and associated data) is essential for a better understanding of the interactions between these fleets. One of the significant hurdles in conducting these analyses is the state of artisanal fishing data in French Polynesia. While there is a wealth of historical data, the quality/state of the information is insufficient to address the questions being asked by the government. To address this issue, a collaborative effort, involving an in-depth data cleaning process, was undertaken by the Marine Resources Department (Direction des Ressources Marines – DRM) and SPC staff.

The historical dataset that was reviewed during this process, originally available from an MS Access database, contained fishing records from 1997 to the present day. The cleansing process, which took one week and involved close collaboration with several DRM staff, attempted to standardise some of the data sets (e.g. fishing areas and

species, originally recorded as free text), identify and address missing information (e.g. vessel definitions and landing sites), and ultimately import the artisanal data into the SQL Server based TUFMAN 2 system to ensure usability.

This effort is critical for subsequent studies, as the improved precision of fishing locations, the rationalisation of species codes and fishing techniques, and the availability of these data in a standardised way, will provide a useful history of the temporal and spatial dynamics of artisanal fishing activities, offering valuable insights into trends over time.

The coexistence of offshore tuna fishing and artisanal fisheries in French Polynesia represents a delicate balance between economic progress, ecological sustainability, and cultural livelihoods. The growth of the offshore tuna fishery, catering to global markets, has brought economic opportunities to the region, but it has also interacted with the traditional artisanal sector, causing friction and competition for the resources.

SPC involvement in analysing these interactions signals a commitment from the French Polynesian government to finding a balanced solution for achieving harmony between these fishing sectors' demands. Only through such comprehensive efforts can French Polynesia sustainably navigate the coexistence of these vital components of its marine ecosystem and economy.

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Data collectors in French Polynesia: Vaiana Joufoques, a committed enthusiast

An interview reveals the challenging and fascinating work of data collectors in French Polynesia, shedding light on the inspiring journey of Vaiana Joufoques.



Vaiana Joufoques, head of the Statistics Office under the Directorate of Marine Resources in French Polynesia. Image: T. Rasoloarimanana, ©SPC

French Polynesia is renowned for its picturesque landscapes and turquoise waters teeming with marine life. Beyond the idyllic beauty lies complex and crucial work carried out by dedicated individuals to support marine conservation; efforts that help protect the beauty of this region. Among them is Vaiana Joufoques, a passionate and committed woman who plays a vital role in the collection of fisheries data. Her personal story, intimate connection to the region, and dedication to marine resource conservation have culminated in her emerging as an invaluable leader in this field.

The inspiring journey of Vaiana Joufoques in fishery data collection

Vaiana Joufoques was born and raised in Tahiti, within a multicultural family, combining her father's Chinese origins and her mother's European heritage. After pursuing studies in biology at the University of Tahiti, she obtained a master's degree in aquaculture, marking the beginning of an accomplished and diverse career. For nearly a decade, Vaiana worked in the field of aquaculture before shifting her focus to statistics and fishery monitoring.

After years of working in the field of aquaculture, Vaiana decided to change the trajectory of her career to develop new

skills and diversify her experience. She then seized the opportunity to join the Statistics Office under the Directorate of Marine Resources, based in Papeete, Tahiti. This position exposed her to different fishery sectors and a comprehensive perspective on the state of the resources. An essential aspect of her teamwork involves raising awareness among Polynesian fishers about the protection of regulated fishing areas and the importance of establishing quotas in order to protect certain species from overharvesting.

For the past decade, Vaiana has been dedicated to data collection, working closely with the Pacific Community (SPC) and their Data Management team. This collaboration has significantly improved the uptake of electronic reporting tools, such as OnBoard,¹ and improved the quality of the data collected by fishers.

Vaiana's days are demanding. As a mother of three children, she wakes up at 5 a.m. to take care of her family before immersing herself in her work. As the head of the Statistics Office, she supervises nine staff, including two women and seven men. One of her main responsibilities is the analysis of the data she collects. These analyses are crucial for providing the information necessary to monitor and assess the status of marine resources in the waters of French Polynesia. In addition, the information generated is reported to

¹ <https://fame.spc.int/data-management-tools/onboard-application>

² <https://fame.spc.int/resources/tools/tufman2>



Building a good rapport and trust is key to ensuring active participation from fishers. Image © Vaiana Joufoques

A morning trip to the port to engage with the fishers and collect fishing data. Image © Vaiana Joufoques



international fisheries commissions such as the Western and Central Pacific Fisheries Commission (WCPFC) and the Inter-American Tropical Tuna Commission (IATTC), to inform regional assessments and management of these marine resources. As French Polynesia is a member of both the WCPFC and the IATTC, Vaiana and her team must ensure they are meeting their reporting requirements within the specified deadlines, thus providing essential data to support sustainable fisheries management in her country and throughout the broader region.

Challenges and technological advances in fisheries data collection

The volume of data collected by Vaiana's team is impressive. In 2022, French Polynesia had a fleet of 80 active longliners, as well as a large artisanal fishing fleet comprising 400 boats spread across the five archipelagos. Each year, around 1100 longline fishing campaigns are managed, representing 7500 tonnes per year and around 12,000 fishing days. Small-scale fishing represents 2300 tonnes per year and 35,000 fishing days.

Vaiana and her team have adapted their data collection methods through the years, as newer technologies, such as electronic reporting, have begun to replace the more traditional data collection methods or recording data with pencil and paper. In 2017, they took the initiative to adopt an electronic reporting system with the support of the SPC team, becoming pioneers in the use of SPC's OnBoard application in the region. OnBoard, which is used by longline fishing vessel captains to report their fishing catch information, allows direct transmission of the collected data into SPC tuna data management software, TUFMAN 2.²

The introduction of TUFMAN 2 has been a true revolution for Vaiana and her team. This web-based tool allows data collectors to optimise their work since it incorporates a comprehensive data quality control engine that can highlight all potential errors, such as misreporting or missing information. The integrated interface also enables the team to cross-reference various data sources more efficiently and therefore improve the overall quality of collected information

Convincing fishers and captains to transition from paper-based systems to electronic tablets was not easy. Some captains, often older individuals, resisted this technology. But with perseverance, after five years they successfully equipped 100 per cent of the vessels with tablets, significantly improving data collection coverage and reliability.

The importance of human relationships in Vaiana's work with fishers

Beyond the technical aspects, Vaiana attaches great importance to human relationships. She and her team build trust with fishing captains, seeking to understand and support them. She encourages active participation from fishers, urging them to accurately report their bycatch, an important task in the management and protection of non-target species such as sharks and rays. Her team maintains close ties with the fishers, even going to the port every morning to engage with them and gather their feedback.

Passion for the ocean as a way of life

Outside her work, Vaiana nurtures a passion for fishing, a tradition passed down by her grandfather and uncle. When she is near the sea, she explores every nook with curiosity, already instilling in her children a respect for the ocean and its inhabitants.

Vaiana Joufoques embodies the dedication and passion of fishery data collectors in French Polynesia. This work is more than a job, it is an opportunity to be a steward of the place they call home. Her journey and extensive experience in the maritime sector have made her an important figure and role model in the preservation of marine resources and the sustainability of fishing in her community.

To all the women passionate about the ocean

The fishing industry and fisheries sector has long been male-dominated. Vaiana has been helping to remove gender barriers and inspiring other women to enter the fisheries field. She is convinced of the importance of women's contribution alongside men to foster team spirit. Gender roles in the Pacific have long shaped expectations placed on women and men. While women have experienced greater limitations in exploring roles and jobs that are often associated with men, she thinks that women should not shy away from embracing their full potential. For her, this means using her refined instincts and eye for detail in reporting bycatch, leveraging her empathetic ways and her ability to establish trust in order to build relationships, and connect and network with fishers and other stakeholders in the sector. For Vaiana, it is a matter of harnessing her individual talents and skills as opposed to being limited by them because they are associated with being weak, female or 'too soft'.

As a mother of three children, Vaiana dreams of a future where her children can pursue their studies and return to contribute to the development of their country. She works hard to provide them with this opportunity and already raises their awareness about ocean and environmental preservation. Her commitment to protecting marine ecosystems is deeply rooted in her Polynesian culture, where turtles, birds and cetaceans also hold a special place.

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Growing up island-style: Vaiana's children exploring the ocean and learning how to protect it. Image © Vaiana Joufoques



Sixth Regional Technical Meeting on Coastal Fisheries and Aquaculture: Sharing experiences in person

The Sixth SPC Regional Technical Meeting on Coastal Fisheries and Aquaculture (RTMCFA6), including the Third Community-Based Fisheries Dialogue (CBFD3), was held from 13 to 17 November 2023 at SPC Headquarters in Noumea, New Caledonia. The RTMCFA6 was the first fully in-person meeting held since 2019 (RTMCF3) and brought together coastal fisheries officers, scientists, technical experts and partners in the Pacific to share experiences and to discuss priority coastal fisheries and aquaculture technical needs, challenges and opportunities. Twenty-three SPC member countries and territories participated, with over 96 participants (60 male, 36 female) from members, observers, civil society organisations (CSOs), non-government organisations (NGOs) and other non-state actors (NSAs). The meeting was also streamed online with more than 35 registered listeners. The meeting was chaired by New Caledonia, under the guidance of Mr Manuel Ducrocq, Head of the Fisheries Department, Government of New Caledonia.

RTMCFA6 was the third meeting to include the Community-Based Fisheries Dialogue which ran over two days, where representatives from fishing communities, CSOs and other NSAs provided input and shared their experiences on key issues and challenges, offering solutions on inclusivity, communication, and collaboration in community-driven coastal fisheries management. The CBFD provides information and advice on key community-based fisheries needs, through the RTMCFA, to the Heads of Fisheries and the Regional Fisheries Ministers Meeting, to assist with informing Pacific leaders on priority issues associated with the sustainable use of coastal fisheries resources.

The overarching theme of RTMCFA6 was to discuss and address some of the main technical issues affecting coastal fisheries and aquaculture in support of better evidence-based resource management, equitable access to resources and the sustainable development of fisheries and aquaculture and nearshore livelihoods.

SPC FAME identified a range of possible priority topics for the meeting's technical sessions by reviewing the outcomes of the 15th Heads of Fisheries meeting, the 3rd and 4th Regional Fisheries Ministers Meetings, the 5th RTMCFA, the Regional Aquaculture Assessment Report¹, and SPC Member requests to SPC FAME during 2023. SPC members were asked to prioritise the proposed topics based on their national needs and priorities. While only nine responses were received, the identified priorities were closely aligned and informed the meeting's technical sessions.

The meeting focused on a range of areas, including:

- assessing aquaculture feasibility;
- reviewing coastal fisheries, aquaculture and biosecurity legislation;
- identifying the challenges to aquaculture development;
- supporting the delivery of data for management through innovative technologies;
- developing coastal fisheries livelihoods; and
- understanding economics and socioeconomics in coastal fisheries and aquaculture.

The RTMCFA6 *Outcomes and actions report*, along with all the working and information papers and the presentations, are available on the SPC FAME RTMCFA6 website (English: <https://fame.spc.int/events/RTMCFA6> and French: <https://fame.spc.int/fr/events/RTMCFA6>). The RTMCFA6 *Outcomes and actions report*² includes the agreed priority issues and needs that are to be actioned by SPC members, provides guidance to the SPC Fisheries Aquaculture and Marine Ecosystems (FAME) Division and the Coastal Fisheries and Aquaculture Programme (CFAP), and identified the key recommendations to be taken to the 16th Heads of Fisheries (HoF16) meeting in late April 2024.

¹ HoF 14: Information Paper 12 Assessment of the aquaculture needs, priorities and future direction in the Pacific Islands region. Draft final report, 8 May 2022. <https://purl.org/spc/digilib/doc/z39wz>

² Outcomes and actions report from the 6th SPC Regional Technical Meeting on Coastal Fisheries and Aquaculture. Sixth SPC Regional Technical Meeting on Coastal Fisheries and Aquaculture: 13-17 November 2023, Noumea, New Caledonia. 28 p. <https://purl.org/spc/digilib/doc/5o6ab>



Member priorities

Prior to RTMCFA6, SPC member Pacific Island countries and territories (PICTs) were sent a presentation template to capture their current priority technical needs, issues and challenges in coastal fisheries and aquaculture and any actions taken since the previous RTMCFA5. SPC Member PICTs presented these to the meeting.

The members' presentations highlighted critical priority areas for the sustainable development of the region's coastal fisheries and aquaculture sectors. The common priorities included:

- ◆ *Strengthening data management:* Enhance data collection, analysis, and utilisation to support evidence-based decision-making and the development of effective management plans.
- ◆ *Empowering fisheries agencies:* Build the capacity and capabilities of fisheries agencies through technical training and support, in particular, enhance monitoring, control, and surveillance capabilities.
- ◆ *Exploring supplementary and alternative livelihoods:* Investigate fisheries development, supplementary and alternative livelihood opportunities to enhance economic resilience and food security.
- ◆ *Policy and legislation review and development:* Review and update, or draft new policies, legislation and regulations relevant to fisheries and aquaculture.
- ◆ *Human resources and technical skills:* Invest in developing appropriate human resources and technical skills within the coastal fisheries and aquaculture sectors.
- ◆ *Strengthening Marine Protected Areas (MPAs) and Special Management Areas (SMAs) monitoring:* Enhance the effectiveness of monitoring MPAs and SMAs.
- ◆ *Value adding, post-harvest processing and improved marketing:* Focus on value adding in fisheries products, optimising post-harvest processing to maximise economic benefits, including through enhanced marketing channels.
- ◆ *Resilience to climate change:* Evaluate and address climate change impacts through reef monitoring, expanding ecosystems knowledge and impacts on fish distribution and behaviour and assessing the impacts of natural disasters.
- ◆ *Enhancing aquaculture:* Enhance aquaculture through improved infrastructure, brood stocks, local feed processing, hatcheries and market access. This includes conducting feasibility studies in seaweed, milkfish cage culture, among others, as well as feed production and cultivation of species (e.g. trochus, sea cucumber, giant clams and oysters).

New SPC FAME website

The SPC FAME website (<https://fame.spc.int>) has been updated to improve access to information, resources and tools. The meeting received a brief introduction to the new website and a short tour of the important new features to help users access available information and knowledge products. One of the highlights was the new platform for community-based fisheries management (CBFM) knowledge: *Echoes of Oceania* (<https://cbfm.spc.int>).

Aquaculture technical sessions

Assessing aquaculture feasibility: technical, economic and social factors

Case studies from New Caledonia and Fiji were presented, demonstrating the incorporation of technical, economic and social factors into aquaculture feasibility assessments that enhanced the sustainability and investment in aqua-



culture development. The meeting agreed on actions to strengthen the capacity and capability of PICTs in conducting integrated feasibility studies in the context of sustainable aquaculture development, including identifying and prioritising species that could be assessed in a feasibility study, training staff from member PICTs to conduct feasibility studies, taking into consideration lessons learned from past successes and failures, and developing economic models at the national level for decision-making.

Update on progress of the Pacific regional aquaculture strategy

Members were updated on the next steps in the development of a new *Pacific regional aquaculture strategy* and the related mid-term review of the *Regional framework on aquatic biosecurity*. The process will include three sub-regional virtual workshops and one regional workshop in the first half of 2024.

Review of aquaculture and biodiversity legislation: findings and recommendations

An update was provided on the review of the status of legal frameworks for aquatic biosecurity in PICTs against international standards. The review examined five key areas: authority, aquaculture, disease control, fish movement and pest management. It revealed that, while primary legislation generally addresses critical biosecurity concerns and allows for the establishment of specific regulations on aquatic biosecurity, effective implementation still hinges on the precise delegation of powers to relevant agencies. SPC members and partners discussed the findings of the review and identified key national and regional priorities. This analysis will also inform the update of the *Regional framework on aquatic biosecurity* and contribute to the development of the *Pacific regional aquaculture strategy*.

Increased effectiveness of mariculture hatchery systems

SPC FAME presented the operational requirements needed by Pacific mariculture hatcheries, including the need for expertise in biological management, aquaculture engineering, personnel and financial management. These requirements are further emphasised by supply chain vulnerabilities and tropical climate effects on infrastructure. Despite these needs, mariculture hatcheries offer promising opportunities for efficient genetic improvements to address issues such as disease susceptibility, and promotion of desirable traits such as rapid growth. The meeting agreed on 13 actions for SPC FAME, members and private sector organisations to work on to address bottlenecks, risks and the identified problems, to increase the effectiveness of mariculture hatchery systems in the Pacific.

Addressing challenges to aquaculture development

SPC FAME presented on the common worldwide challenges affecting aquaculture development, encompassing market access, sustainable feed sources, disease control, regulatory and tenure complexities, financial capital access, environmental impact oversight, labour availability, water quality management, supply of juveniles, species domestication, technology uptake, and competition for land and water resources. A prime illustration of these interdependencies is the impediment posed by inadequate regulation and complex marine tenure restricting access to formal financial channels. To address these challenges faced by PICT governments and the aquaculture private sector, the meeting agreed on the following points and actions:

- Members are to consider these challenges in developing or updating their aquaculture development plans.

RTMCF6 participants enjoying the social side of the event as well as the technical discussions! Image: Josaia Nanuqa © SPC PEUMP



- Members should ensure laws and regulations enable aquaculture development, while ensuring environmental conservation (e.g. unfed and restorative aquaculture).
- SPC FAME is to work with members and private sector organisations to undertake community surveys to determine areas that are suitable for aquaculture development in order to guide the establishment of appropriate aquaculture systems.
- A regional mariculture hatchery would be of use to improve supply chain issues for both seedstock and engineering components that currently are difficult to source in the region.
- A variety of species and commodities remain of interest to members, and the consolidation of species for regional production remains a nascent idea, but sea cucumbers may be one group that the region may associate with its regional identity.

Coastal fisheries technical sessions

How technology is supporting the delivery of better data for informed management of coastal fisheries

An update was presented on the advancements made by SPC FAME's CFAP Science and Database teams in developing e-data tools for enhanced collection and management of coastal fisheries data. Members also shared their experiences and discussed the use of these tools, and upcoming capabilities being integrated into the system were noted. A number of actions were agreed by the meeting to further enhance the development and the scale-up of the roll-out of the tools.

Coastal fisheries management – Reviewing and updating legislation and policy.

The role of sound fisheries management in ensuring the economic prosperity of Pacific Island communities that rely on marine resources was highlighted. Recognising the critical nature of policy and legislation in the sustainable development of small-scale coastal fisheries, continued support to PICTs through comprehensive guidance on regulations, management plans, and fisheries law and policy training will continue. The new SPC *Legal guide to enabling coastal fisheries co-management in the Pacific*³ and the availability of law and policy resources on the SPC REEFLEX database⁴ were noted.

The meeting recommended the development of a toolbox for training on coastal fisheries law and policy for PICTs fisheries agencies, covering all relevant topics and bringing together fisheries and legal experts. The meeting also requested that SPC FAME explore the opportunity for a dedicated workshop on the development and review of fisheries management plans.

Coastal fisheries livelihoods – diversification and food security

SPC FAME presented the latest publications on nearshore fishing techniques, and fishing techniques training videos, and briefed the meeting on past livelihood diversification and food security activities. While small-scale fisheries projects in PICTs have achieved remarkable successes with the support of international and regional organisations, NGOs, and donors, the lack of comprehensive data has hampered in-depth analysis of the factors contributing to the success or failure of some livelihood diversification initiatives.

³ O'Connor S., D'Andrea A., Recio-Blanco X., Devez S. 2023. Legal guide to enabling and strengthening coastal fisheries co-management in the Pacific. Noumea, New Caledonia: Pacific Community. 212 p. <https://purl.org/spc/digilib/doc/s5b7j>

⁴ The Pacific law and policy database on coastal fisheries and aquaculture: <https://www.spc.int/CoastalFisheries/Legislation/main>



RTMCFA6 participants enjoying the social side of the event as well as the technical discussions! Image: Josaia Nunuqa © SPC PEUMP

The meeting recognised the limitations faced by SPC FAME in providing comprehensive development, livelihood, social, and economic support due to staffing constraints and lack of funding for support to PICTs. The meeting considered livelihood opportunities across three key dimensions: marine-based extractive alternatives, non-extractive alternatives in the coastal/marine sector, and land-based alternatives. PICTs shared their livelihood diversification trials and ongoing activities to enhance food security, income sources and to alleviate pressure on vulnerable habitats and species.

Coastal fisheries livelihoods – Anchored FADs and nearshore small-scale fisheries

There is a significant demand from member countries for comprehensive support in enhancing coastal fisheries livelihoods and food security. Key areas of focus include the deployment of traditional and highly-instrumented/smart' anchored fish aggregation devices (HI-FADs), specialised training for artisanal fishers, diversification of livelihoods, and ensuring maritime safety. The need to address critical data gaps in new fisheries development, conduct thorough cost-benefit analyses, and provide broader support to fishers was also emphasised. A number of actions were identified, including:

- the importance of anchored FAD initiatives as a strategy in the development of nearshore small-scale fisheries in the region and the accompanied challenges that need to be addressed, such as inadequate data collection, lack of management plans, limited maintenance, absence of adequate documentation on FAD longevity, depredation of catch, competition between sectors, environmental impacts, catches, performance, and overall usefulness;
- the further investigation of biodegradable materials for FAD construction;
- investigation and consideration of a regional technical workshop on FADs every 18 to 24 months to share lessons and experiences amongst PICTs and ensure that best practice prevails.

Cross-cutting sessions

Coastal fisheries and aquaculture climate change vulnerability

An update on the *Vulnerability of tropical Pacific fisheries and aquaculture to climate change* assessment was presented, emphasising the urgent need to understand the evolving impacts of climate change. Employing a 'cascade of effects' framework, the assessment encompasses all 22 PICTs, aiming to map out the direct and indirect consequences of climate change on various habitats and the fisheries they sustain, along with freshwater and marine aquaculture. It will project how these ecological shifts might affect blue food (food from marine or freshwater animals, plants and algae) systems, livelihoods, and economic revenue in the face of

current and future climate scenarios. The final report and relevant products will be available towards the end of 2024.

Value of understanding economics and socioeconomics in coastal fisheries and aquaculture

This session highlighted the interconnectedness of biological, socio-economic, and commercial factors in the sustainability of coastal fisheries and aquaculture, and underscored the imperative of balancing ecological conservation with the food security and well-being of dependent communities. Members emphasised the critical role of economic and socio-economic analyses, such as cost-benefit and value chain analyses, in driving evidence-based policy development. The meeting agreed to a range of actions to enhance the understanding of social aspects and economics in coastal fisheries and aquaculture management.

Recommendations for the 16th SPC Heads of Fisheries meeting

The meeting discussed and agreed to 17 recommendations to be transmitted to the 16th Heads of Fisheries meeting for their consideration in late April 2024. These are included in the RTMCFA6 *Outcomes and actions report*.⁵

Feedback

The participants were asked to complete a post-RTMCFA6 survey to rate aspects of the meeting. Forty-four participants responded to the feedback survey, constituting a 45% response rate. Compared to previous post-meeting surveys, the RTMCFA6 received the highest number of post-meeting responses. Participants were asked to rate meeting content, opportunity for feedback, participant engagement, time allocated for the sessions, meeting organisation and breakout group facilitation. The most highly rated item was the meeting content (4.6 out of 5) while the lowest rating was given to the time allocated for the sessions (4.1 out of 5) which is consistent with the feedback provided by participants on requesting more time for breakout group sessions.

Snapshot

- Most respondents considered the purpose of the sessions were clear (95%, 42 of 44).
- Respondents rated highly the RTMCFA6 sessions on Anchored FADs and the Community-Based Fisheries Dialogue report.
- A high number of respondents (90%, 38 of 42) reported the sessions addressed topics relevant for their countries/territories.
- 91% of respondents (39 of 43) considered they gained new knowledge as a result of their attendance at RTMCFA6.

Most useful: There was a diverse range of responses on the most useful aspect of RTMCFA6. Many participants indi-

⁵ Outcomes and Actions Report from the 6th SPC Regional Technical Meeting on Coastal Fisheries and Aquaculture. Sixth Regional Technical Meeting on Coastal Fisheries and Aquaculture. Noumea, New Caledonia: Pacific Community. 26 p. <https://purl.org/spc/digilib/doc/5o6ab>

cated everything was useful. However, the two most common aspects of the meeting that were found most useful were the sessions and information shared on aquaculture feasibility, challenges and development considerations (8 responses) as well as countries sharing experiences and providing updates on their national work (7 responses). Furthermore, respondents highlighted the value of having the Community-Based Fisheries Dialogue (3 responses) as well as knowing about the emerging works areas and new initiatives and the SPC-developed applications.

Least useful: Most respondents identified no parts of the meeting as being not useful. Despite Aquaculture sessions and topics being highlighted by some as the most useful, some (2 responses) mentioned it was not very useful for them, and was explained by respondents not working directly in the topic.

Participants were asked to provide topics that they would like to be discussed in future RTMCFA meetings. Some of the topics noted were:

- Alternative livelihoods (eco-tourism, post-harvesting)
- Aquaculture research systems and database
- Climate change-associated risks
- Coastal fisheries management

- Community-based monitoring, control and surveillance
- Data collection with artificial intelligence
- Deep water fisheries
- Economics of small-scale fisheries business
- Establishing aquatic biosecurity measure
- Ika savea use, success and challenges
- National challenges on implementation of activities
- Policy or legislation in regard to land-based activities that are affecting coastal fisheries
- Recreational game fishing and its importance to communities' livelihoods
- Sea safety
- Socio-economics in coastal fisheries and aquaculture
- Training and capacity-building needs
- Value adding for sea products.

The next RTMCFA meeting (including the CBFD) is scheduled to be held in late October 2024, funding permitting. An official announcement will be sent out after the 16th Heads of Fisheries meeting in late April 2024.

For more information

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Inclusion takes central stage during CBF3

Aurélie Delisle¹, Natalie Makhoul², GESI session participants (Teri Tuxson³, Siueli E. Mone², Mele Weilert⁴, Dua Rudolph⁵, Tarusila Veibi⁶, Leisavi Joel⁷, Rose Gere⁷ and Esther Umu²)



The coastal environment has long shaped Pacific people's sense of belonging and identity. Marine resources and ecosystem services are vital for women, men, children, youth, or other social groups of each and every community in so many ways.

A fisherman's catch of the day is a community's asset and a woman's full fish basket is a family meal with a wide reach to the extended family.

Knowing that one's social identity and gender can determine access to, and use of marine resources makes it crucial to shift attention to better understand these social categories that shape people's roles and behaviour in the fisheries sector. Women and men occupy different marine spaces, use different gear and techniques, hold different traditional knowledge, and target different species – but how do we factor this into community-based fisheries management (CBFM)?

The *Pacific framework for scaling up CBFM (2021–2025)* introduced a people-centred approach aiming to assist community leaders, community representatives and fisheries of-

ficers to achieve the most desirable outcomes for all in community fisheries management.

The Framework has been implemented for a few years across the region. But what have been the strategies used by communities and countries to ensure equity and inclusion in the scaling-up efforts?

As part of the 3rd Community-based Fisheries Dialogue held in Noumea from 14–15 November, a special session titled “Casting nets of inclusion” endeavoured to get participants to reflect on inclusion in national CBFM initiatives.

The session was a blend of short presentations and videos to set the scene, followed by a panel study and talanoa session to allow Pacific voices and experiences to be shared. The panel was facilitated by Teri Tuxson from LMMA Network International and allowed participants from across the three Pacific sub-regions to share their experiences and reflect on risks, and opportunities for inclusion into CBFM processes. Four panel participants – Siueli Mone and Mele Weilert from Tonga, Dua Rudolph from the Republic of Marshall

¹ Australian National Centre for Ocean Resources and Security, University of Wollongong, Australia

² Pacific Community

³ LMMA Network International

⁴ Ha'atafu SMA Committee, Tonga

⁵ Marshall Islands Conservation Society

⁶ Fiji Locally Managed Marine Area Network

⁷ Havana Tasivanua Environment and Climate Action Network, Vanuatu



The CBFD3 provided an opportunity for Pacific voices to be heard at an international forum. Image © Josaia Nanuqa (SPC PEUMP)

Islands and Tarusila Veibi from Fiji – gave an honest account of their stories, the struggles they faced or witnessed along the way, but also their wins and their hopes.

During a talanoa session, participants heard from ni-Vanua-tu ladies Leisavi Joel and Rose Gere who discussed concrete examples from their lives in Vanuatu, moving from being fish vendors to advocating for inclusion and consideration of women's roles in supporting community fisheries management initiatives. The session felt so real, and Leisavi and Rose's activities showed how much women in the communities can progress, move and lead if we acknowledge them, lift them up and give them the recognition, space and support.

The entire 'Casting the nets of inclusion' session was charged with emotion and the audience listened with intensity. Words were spoken from the heart and rang true for everyone. A strong positive experience was felt by all participants of this special session and their audience.

Overall, the special session on 'Casting the nets of inclusion' emphasised for CBFD participants and the audience from

RTMCF6 that there is still much to do to achieve inclusive CBFM processes, but that progress is happening around the region, and advocates are present in communities, civil society organisations and national agencies. Allowing sessions such as this one to take place in main regional and national fora on fisheries allows further recognition of these efforts and provides a space to share lessons and devise national and regional strategies to support inclusion of marginalised groups.

Further recognition was acknowledged by participants of the 6th Regional Technical Meeting on Coastal Fisheries, who noted the following items in their final outputs:

- The CBFD3 acknowledged the challenge of including women, achieving equal representation of marginalised groups, and considering women's voices in decision-making for fisheries resource management.
- The CBFD3 acknowledged the role of women in fisheries management advocacy, as they play a crucial role as teachers in their families and communities, influencers in local women's groups, and leaders in the communities.
- The CBFD3 noted and agreed on the following:
 - The need to include marginalised community groups in fisheries management committees, to empower them to actively participate and to contribute to the decision-making process.
 - The inclusion of women enforcement officers to encourage reporting of offences committed by women and other marginalised groups.
 - Conducting more awareness and capacity development training on gender and social inclusion in the communities, including targeted empowerment initiatives for GESI advocates and champions in the communities.
 - Encouraging more women and youth champions to advocate for fisheries resource management.
 - Encouraging programmes in communities for livelihood diversification and supplementation to increase resilience and ensure equal benefit-sharing among women, youths, and people with special needs, with the special intention to reduce poverty and hardship for people relying heavily on marine-based livelihoods.

Acknowledgements:

We would like to thank all participants and SPC staff who assisted in preparing this special session during CBFD3. We would like to also acknowledge financial support from the PEUMP programme and the Australian government-funded CBFM project ACIAR FIS-2020-172.

Political support paves the way to scaling community-based fisheries management in Kiribati

Tarateiti Uriam Timiti¹, Toaiti Vanguna¹, Beia Nikari¹, Maaria Henry¹, Katirube Nakabuta¹, Iutita Karekennatu¹ and Tooreka Teemari¹

During 14–16 August 2023, representatives from communities engaged in and implementing various forms of coastal fisheries management, together with the community-based fisheries management project (CBFM or Nei Tengarengare in Kiribati) of the Kiribati Ministry of Fisheries and Marine Resources Development (MFMRD) held a national Kiribati CBFM Community Stakeholder Meeting. This was the first inter-islands gathering held in four years, owing to COVID-19 related travel restrictions.

CBFM communities had long asked for a stakeholder workshop to be held outside the urban centre of Tarawa, where limited CBFM takes place. The collective decision was made to organise a gathering in the outer islands where CBFM occurs, to acknowledge everyone's efforts. Butaritari Island, one of the outer islands in the Northern Kiribati Group, offered to host the meeting and its participants. More than 140 representatives from CBFM communities across 10 islands gathered in Butaritari, the first CBFM-related meeting of this scale to be held on an outer island. The meeting provided communities with the opportunity to share their respective and unique experiences, discuss their challenges and solutions and provide their opinions on ways forward in the context of scaling CBFM in the country.

The meeting was attended by His Excellency President Taneti Maamau and his delegation, consisting of the

Secretary to Cabinet, Minister for Environment, Directors from Agriculture Division and Environment and Conservation Division. President Taneti Maamau congratulated the communities for the commitment they have made towards creating sustainable fisheries, and strongly encouraged them to continue with the great work: "To echo the words of Minister Tiwau, our ocean acts as a cupboard for our food. When we need to eat, our ocean provides us with our daily protein. But we are faced with new challenges that need diverse solutions and need people working together. The Nei Tengarengare/Community-Based Fisheries Management programme has brought so many people together, from our communities and government departments to reach our common goal of sustainable and healthy fisheries ... The people gathered here have all committed to work towards protecting our marine coastal fisheries for our children and all future I-Kiribati generations ..." President Taneti Maamau

President Taneti Maamau also thanked the Australian Government for its continuous support, and the New Zealand Government for the fisheries institutional development and management programme framework, Tobwan Waara. The Australian High Commissioner, Karen Bray, the New Zealand Deputy High Commissioner, Marni Gilbert, and Members of Parliament from Butaritari were also in attendance at the meeting.

¹ Ministry of Fisheries and Marine Resources Development, Coastal Fisheries Division, Kiribati

His Excellency President Taneti Maamau, distinguished guests and leaders of CBFM communities gather in Butaritari to attend the national CBFM stakeholder meeting - Image © MFMRD



Sharing CBFM lessons

During the community stakeholder meeting, community leaders and representatives shared their experiences with CBFM. The dialogue was a learning opportunity for communities new to CBFM, as well as those with more experience, to learn from islands with strong governance and island-wide support for the management of their fisheries. Some villages spoke about how their efforts were strengthened by support from island institutions such as the Council of Elders and Island Council. This discussion highlighted to many that the keys to scaling were being able to be confident in their island institutions, and the willingness for representatives to take an active, leading role as advocates for CBFM to neighbouring communities in their islands. Another lesson, applicable to all communities, was the importance of having a legalised community plan, since all management is currently operationalised informally through local governance. There was also much discussion about how communities can participate in, or support the monitoring of, their marine protected areas (MPAs), and ensure compliance with other fisheries management tools applied in their communities. It was proposed that some of these challenges might be met by developing resources designed to help community members monitor their fishing activities more closely, reducing the need for involvement from the Ministry of Fisheries in remote areas.

Hearing women's voices

To ensure women's voices were heard, a two-day dialogue was held specifically for women in a separate location, so that women had a safe space to discuss their issues, concerns and needs regarding CBFM. Forty-nine representatives from communities that have established community women's groups, as well as female representatives from all communities in Butaritari were invited to this dialogue. The meeting was facilitated by the CBFM team and Ministry

of Fisheries staff, supported by the representatives from the Ministry of Women and Ministry of Commerce. To set the scene, the Ministry of Women delivered a short presentation on the National Policy on Gender Equality and Women's Development that enlightened participants on the government's commitment to supporting and empowering women and promoting gender equality across all sectors and at all levels. The Pacific Region Oceanscape Program (funded by the World Bank) showcased the current support for this project supporting community marine-based livelihood initiatives. The meeting provided many opportunities for women to learn about the government support available to them and how they could access it. Examples included financial literacy training led by Ministry of Finances, and training led by experts for marine-based income-generating activities that require little initial start-up funds, such as making baskets with seashells, and seaweed ice-cream making. This was an excellent moment for women to share and discuss issues, challenges and limitations that prevented them from working on their income-generating activities. Some major challenges that were raised by many women were the lack of spousal support, lack of equipment, and limited knowledge and skills in marine-based livelihood opportunities and how to access a market.

Competitions, crafts, and quizzes

In ensuring that children, youth and men are involved there were competitions organised for each category. Children from all primary schools participated in a quiz and drama competition based on the theme of the event. It was an exciting opportunity for children to dive more deeply into the science of fisheries resources, and how human behaviours affect the health of the marine resources in terms of pollution, destruction of marine habitats, and the effects of using destructive fishing methods and fishing gears. Students who participated learned what the community-based fisheries management approach is, and

Women representatives take part in a tailored two-day women's dialogue during the CBFM stakeholder meeting - Image © MFMRD





Children take part in a drama and quiz competition about sustainable fisheries
Image © MFMRD

the essential roles that people in the community play to work together and protect and manage fisheries resources. Learning the concept of managing people's actions to ensure sustainable fisheries is a great way to brighten the minds of the young generation and encourage them to become responsible citizens.

A training workshop for making scoop nets was run for youths and people with disabilities. Scoop-net-making is an extremely important skill, because they are a commonly used fishing gear, which is good for both fishing and selling. One of the participants mentioned that he was fortunate to be part of the training, because making scoop nets was a skill he had always wanted to learn, since he did not own one.

To engage the fishers of Butaritari and raise awareness of minimum size restrictions for the local fish species, a fishing competition was run. The rules were that fishers could only fish for four hours, employing only handlines, and that all fish needed to exceed the minimum size as per the Fisheries Regulation 2019.

Ecotourism packages

The last day of the event was dedicated to showcasing three communities' trial ecotourism packages. The three villages presenting were the first to pioneer CBFM in Kiribati – Kuma, Tanimaiaki and Bikati. All three villages have established MPAs. A few months prior to the event, each village received training on ecotourism package development from the Tourism Authority of Kiribati. MFMRD had been liaising with the Tourism Authority as part of an effort to explore innovative income generation that could support the scaling of CBFM. During the third day of the event, village representatives presented their packages to all participants and diplomatic guests of the meeting. The tourism packages included MPA tours, cultural performances, and traditional local food.

This stakeholder meeting was a testament to the commitment that the people and government of Kiribati have towards the mission of sustainability that is CBFM, and their gratitude for support from within Kiribati and overseas.

"The people gathered here have all committed to work towards protecting our marine coastal fisheries for our children and all future I-Kiribati generations. It is heartwarming to hear from you all that the programme has helped sustain your marine resources. I was glad to hear that some islands shared the positive impacts of the programme and have started to witness the increasing health of their fisheries. It would have taken patience and resolve to work towards this goal and I hope that the lessons shared from those islands will inspire new islands who have joined the programme to continue on their journey."

His Excellency President Taneti Maamau

Acknowledgements

Thank you to His Excellency President Taneti Maamau and his delegation, who gave such gravitas to the stakeholder meeting.

We are grateful to the Mayor and the people of Butaritari for going above and beyond, supporting a meeting of this scale on their home island. We are also grateful to all attendees and distinguished guests of the meeting, without whom none of the progress made would be possible.

The event was funded by the Australian Government through the Community-based Fisheries Management project (ACIAR FIS-2020-172), New Zealand Government (Tobwaan Waara Programme), World Bank (Pacific Regional Oceanscape Program) and the FAO Ridge to Reef Project.

Tautai Samoa Association Roadmap – A milestone for Samoa small-scale fisheries

Maria Sapatu-Kennar and Jeffrey Kinch¹



Figure 1: Members of the Tautai Samoa Association with Hon. Minister of Agriculture and Fisheries, the ACEO Fisheries Division, and the FAO Sub Regional Coordinator for the Pacific

The Tautai Samoa Association consists of small-scale fishing fleet members across Samoa who use ‘alia’, a type of fishing catamaran. On 28 September 2023, its members gathered at the Fisheries Division of the Ministry of Agriculture and Fisheries (MAF) conference room in Apia, Samoa, to launch its roadmap.

The roadmap has been a long-standing activity for the Tautai Samoa Association that started in late 2021 and was funded by the Food and Agriculture Organization of the United Nations (FAO). The activities and interventions undertaken through this project are aligned with the United Nations Decade of Family Farming, which supports food security and sustainable small-scale rural fishing activities. Due to the COVID-19 pandemic, the project moved into a second phase in 2022, reflecting delays in the implementation of some activities due to the pandemic.

Milestone achievement

It was consequently a great day of celebration and an important milestone for the Association as well as MAF who worked closely to support the initiative to officially launch and kick start implementation of the roadmap.

As the Minister of MAF, Hon. La’aulialemalietoa Leuatea Polataivao Fosi Schmidt expressed it, “The Samoa Tautai Association takes ownership of this roadmap so as to guide their activities towards better management and sustainable fishing in our waters which is a great achievement for our



Figure 2: Covers of the Tautai Samoa Association Roadmap 2023–2026

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island nation. The roadmap will be a stepping stone of our further collaboration with the Association in tackling together upcoming challenges such as illegal fishing activities, depleting fish stocks, and climate change.”

Seven strategies

The roadmap describes the intent of the Association to sustainably manage and develop its activities for the welfare of its members as well as to provide food security and economic growth for Samoa over the next four years from 2023 to 2026. It looks at seven strategies to achieve its overall goal of maintaining and strengthening the viability of Samoa’s domestic fishing sector to provide long-term economic, social, ecological, and food security benefits to Samoa. These seven strategies are listed below.

- Building the capacity and knowledge of its members for the effective running of the Association which requires a range of different skills, and hence continued capacity-building is needed as well as having the members upskilled with new sustainable fishing technologies.

- Strengthening market access and develop mechanisms that would improve connectivity to domestic and overseas markets.
- Ensuring internal funding and stability and viability of the Association to support association activities, priorities, and long-term plans.
- Developing financial sustainability by diversifying sources of external funds to support the Association.
- Marketing the Association’s brand and identity to establish recognition and expansion of the Association.
- Ensuring effective collaboration and coordination with the Government of Samoa and other key stakeholders.
- Promoting compliance and stimulating a sense of responsibility and voluntary compliance with Samoa’s Fisheries Policies and Regulations.

The Association will implement its planned activities as detailed in the roadmap in the next four years and looks forward to further collaboration with MAF, FAO, the Pacific Community, other development partners and most importantly, new members of the Association.



Figure 3: Members of the Tautai Samoa Association from Savaii with FAO Samoa National Fisheries Consultant

Strengthening small-scale fisher organisations in the Pacific: Outcomes and lessons from the region

Joelle Albert, Maria Sapatu-Kennar, and Jeffrey Kinch¹ (with contributions from participants of the Fisher Organization Lessons Learned Workshop).

Working together is part of the social-cultural system of many Pacific Island countries (PICs). Across the Pacific Islands region, there are numerous groups of people working together within the fisheries sector, both in an informal and formal capacity. Such collective action provides the basis to strive for common goals and mutual benefit to those involved. Over recent years, there has been a movement for the formation of fisheries-based organisations, both as a mechanism to improve food security and livelihood benefits, to provide an organised system to engage with national fisheries agencies, and as a vehicle to harness fisheries development and management support.

FAO project partnerships with Fiji, Palau, Tuvalu, Samoa, and Vanuatu

To enable fisher organisations to be more functional, and effective, and to become key partners in developing fisheries and associated sectors' agendas, the Food and Agriculture Organization of the United Nations (FAO) has been working in partnership with selected PICs through the *Mapping and Characterization of Fishers and Fish Workers Organizations* project. This project was implemented in five PICs which included Fiji, Palau, Tuvalu, Samoa, and

Vanuatu. The project was implemented in two phases; Phase I focused on understanding the context of fisher organisations across the five participating PICs and the legislative frameworks that govern registered groups, while Phase II focused on delivering targeted assistance.

Fisher organisation diagnosis

The initial assessments of fisher organisations, including the function, objectives, operation and services, status, and capacity needs were undertaken to gain a comprehensive understanding of the different contexts of fisher organisations in the five PICs. This was carried out by in-country partners with members of the respective fisher organisations using a diagnostic survey tool developed specifically for the project. In total, 47 fisher organisations participated in these assessments. In addition, national fisher organisation diagnosis reports, including a summary of the legislation relating to the registration of such organisations, were developed based on the analysis of the findings and provide key recommendations for national fisheries agencies to strengthen fisher organisations in their respective PICs. A Regional Guideline for Strengthening Fisher Organizations was also developed based on a review of existing information and the results from the assessments.

Figure 1: Training by the Cooperative College of Fiji in Fiji.



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Differences and similarities between the fisher organisations

The diagnosis highlighted diversity within and across PICs in terms of fisher organisations' size (ranging from less than five to over 300 members) and geographical scope (ranging from village level, multiple villages, or whole of island). The fisher organisations' function and ambitions ranged from working together for the common benefit, the desire to enhance fisheries management, food security, and livelihood benefits, and the need for income generation through improved market access. The fisher organisations that were assessed were at different stages of development; as such there was diversity in the services that such groups provided to their members. The more developed organisations were generally formalised groups, registered as an association or cooperative, and typically offered services to members such as provision of ice or fish storage, vessel hire, fish marketing, and to a lesser extent, fish processing. Informal or newly established groups were typified by a collective of people working together with limited services provided to members, except for the provision of fish storage or selling ice which often involved the provision of equipment (e.g. solar/chest freezers) through external assistance.

Despite the differences in the context and stage of fisher organisation development, the diagnosis identified similarities across fisher organisations in their organisational operation and management capacity and skills. In particular, financial management, record keeping, business management, and leadership skills were common aspects that require strengthening across most of the fisher organisations assessed. Of the 47 fisher organisations assessed, 98% stated that they had limited or only some financial management skills, 85% had limited to some small-business management skills, 82% had limited to some record-keeping skills, and 68% had limited to some leadership skills.

Training modules developed

Financial management, record keeping, governance, and business management are core underlying skills that can enable fisher organisations to be more functional and effective. Such areas of capacity development are beyond the usual knowledge realm of fisheries officers, and there are limited fisheries-specific training packages available in the Pacific Islands region. As such, in partnership with the Fiji Ministry of Fisheries and Ministry of Trade, Cooperatives, Small and Medium Enterprises and Communication (MTCSMEC), small-scale fisheries training modules were developed for training and capacity development of fisher organisations. The training modules cover governance, service provision, financial management, business planning, and marketing – key areas of need identified in the diagnosis. While focused on cooperatives and the Fiji context, these modules are available for use and can be requested from MTCSMEC.

Cooperative capacity development in Fiji

During the second phase of the project, efforts focused on delivering targeted assistance to fisher organisations, based on their PIC's priorities, situation, needs, and context. In Fiji, activities focused on capacity development training. Utilising the training modules developed, the Cooperative College of Fiji trained 363 participants from 12 fisher communities which had been identified by the Fiji Ministry of Fisheries (Figure 1). The successful delivery of training resulted in the registration of eight fisher cooperatives and interest from many more. The collaboration fostered between the Fiji Ministry of Fisheries and the MTCSMEC was the first of its kind and highlights the importance of cross-sectoral partnerships for the collective outcome.

Figure 2: Participants of the Regional Fisher Organization Workshop in Nadi, Fiji.



Samoa Tautai Association Roadmap

In Samoa, the project supported the Samoa Tautai Association to develop a roadmap. The Samoa Tautai Association is a group of fishers operating a catamaran domestic fleet, known as 'alia'. The roadmap, which runs from 2023 to 2026, describes the intent of the Association to sustainably manage and develop its activities for the welfare of its members as well as to provide food security and economic growth for Samoa. The development of the roadmap was a milestone for the Association as two separate fisher associations (from the two main islands of Savaii and Upolu) came together under one umbrella association to develop strategies to guide their activities towards maintaining and strengthening the viability of Samoa's domestic fishing sector. The roadmap was signed off by the Minister of Fisheries and Agriculture and officially launched on 28 September 2023.

Improving access to markets in Vanuatu

The focus for many fisher organisations in Vanuatu is increasing access to markets and reducing post-harvest losses. As most fisher organisations are located on remote islands and markets are located in provincial or urban centres, maintaining the cold chain is deemed essential to ensure a good and safe quality product is delivered to markets and end consumers. In partnership with Vanuatu Fisheries Department, freezers were provided to fisher organisations to enable such groups to store fish and produce ice to transport their fish to markets. Building on the findings from the fisher organisations' diagnosis, Vanuatu Fisheries Departments in partnership with the Vanuatu Ministry of Trade and Cooperative Department are developing strategies to strengthen and support the development of fisher organisations.

Wrap-up workshop and recommendations

The *Mapping and Characterization of Fishers and Fish Workers Organizations* project wrapped up with a Fisher Organization Lessons Learned Workshop which was held in Fiji on 12–13 October 2023. The workshop brought together the PICs involved in the implementation of the project and included representatives from national fisheries agencies (Fiji and Samoa), Trade Ministries (Fiji MTCSMEC - Co-operative College of Fiji, the Vanuatu Department of Industry and Department of Cooperatives), the Pacific Community (SPC), the Nature Conservancy (Palau), and core project staff from FAO (Figure 2).

The workshop provided the opportunity to discuss different stakeholder perspectives, covering aspects such as establishment, capacity needs analysis, capacity development, and scaling strategies to further strengthen fisher organisation in the Pacific Islands region. Key lessons learned across the participating PICs of what has worked in

engaging with fisher organisations highlight that formalising fisher organisations, particularly through cooperatives, builds public recognition, vested interest for returns, and access to finance, facilities and support. At the same time, it gains legal recognition of fishers and enables opportunities for a voice in decision-making in fisheries regulations and policies. In addition, continuous capacity-building support from government and partner organisations (through cross-sectoral partnerships) is essential to continuously build skills and capacity in aspects such as fish processing, sustainable fishing practices, financial management and small-business management.

Some of the shared recommendations that would help improve some of the challenges faced included mainstreaming fisheries data collection within fisher organisations; continuous support in capacity building particularly on organisational leadership development and entrepreneurial capability; having inclusive and collective approaches in partnerships; exchange programmes between cooperatives to share their experiences; seeking sustainable funding mechanisms that are appropriate to support fisher organisations and ensure ownership; and improvement of infrastructure, facilities and market access.

The project's legacy

Even though the project has ended, the movement for establishing and strengthening fisher-based organisations in the Pacific Islands region remains in its infancy. The partnerships fostered through the implementation of the project and the lessons and experiences shared highlight the need for on-going support to build and foster the capacity of fisher organisations, based on their needs as they grow and develop. Collective action, clear and open communication, and recognition of our achievements will result in stronger, more effective fisher organisations and contribute to the well-being of Pacific people and the sustainable use of marine resources.

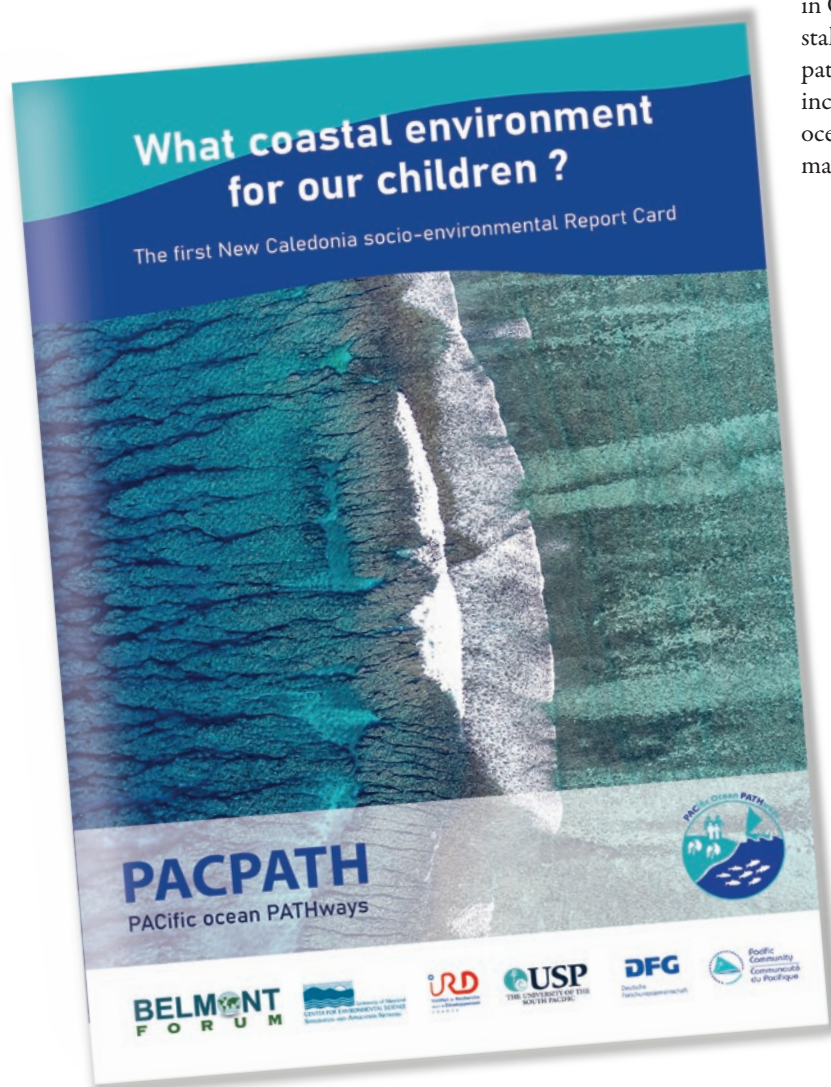
Contributions

The lessons learned and recommendations summarised in this article are an output from the Fisher Organization Lessons Learned Workshop held in Fiji in October 2023. We thank the following people for their contribution to the workshop and project implementation: Serafina Ah Fook, George Amos, Tevita Apulu, Ajay Arudere, Lameko Asora, Neelam Bhan, Beniamine Bulilevuka, Betsy Charlie, Lindsay Chapman, Sylvester Diake, Sammy James, Faizal Khan, Dean Kloulechad, Victoria Mauvae, Zafiar Naaz, Kolinio Naivalu, Tomasi Peckham, Neomai Ravutu, Ateca Rounds, Mike Savins, Anne-Maree Schwarz, Fabio Siksei, William Sokimi, Saimoni Tauvoli, Jessica Tasale, Autalavou Taua, Sapeti Tiitii, Katangatemman Tokabwebwe, Senele Tualalelei, Yvonne Ueda, Mere Vere, Leintz Vusilai, Kuini Waqasavou, and Joanne Young.

PACPATH: A transdisciplinary approach to developing Pacific Ocean sustainability pathways

Alexandre Ganachaud and Mathilde Landemard

The PACPATH project¹ is an initiative that focuses on New Caledonia and Fiji. The goal of this ambitious project is to address the impacts that climate change has on the ocean and coasts through joint design of sustainability pathways, by promoting a shared vision and collaboration between the different stakeholders in these areas.



New Caledonia socio-environmental report card

1. Sustainability pathways: Importance of joint design

The first phase of the project focused on the creation of a multidisciplinary consortium that brought together scientists and stakeholders from both New Caledonia and Fiji. Through workshops held in Noumea, New Caledonia in October 2022 and in Suva, Fiji in February 2023, project stakeholders collaborated on jointly designing sustainability pathways. These workshops addressed a wide range of issues, including sea-level rise, coastal erosion, marine heatwaves, ocean acidification and deoxygenation, reefs, food security, marine resources, health, the economy and cultural heritage.

2. A social and environmental map of New Caledonia

The outcomes of the workshops and this in-depth collaboration led to the publication in April 2023 of a social and environmental map of New Caledonia that had been drawn up during the workshops at the Pacific Community in Noumea in October 2022. This social and environmental map², the fruit of a collective effort by stakeholders, comprises indicators on the health status of New Caledonia's marine and coastal environment.

3. Fiji workshops

The workshops held in Suva, Fiji in February 2023 brought together a targeted range of participants, including researchers, provincial representatives, NGOs, associations, and members of the Fijian Government's Ministry of iTaukei Affairs. Working sessions allowed stakeholders to identify key values and threats and then identify indicators to assess climate change's impact on Fiji's coastlines. The country was mapped through participatory mapping exercises and brainstorming sessions to locate and assess the various indicators.

¹ <https://pacpath.org/>

² https://pacpath.org/wp-content/uploads/2023/06/New-Caledonia_ENG.pdf
<https://pacpath.org/wp-content/uploads/2023/11/Fiji-Report-Card-22.11.2023-planches.pdf>

Following the workshops, a drafting retreat was held in Tailevu Province, which also allowed observation of the impacts of erosion and coastal inundation in the villages of Silana and Vatani. The outcomes of this work led to the formation of three working groups to continue to develop a scientific research project on the following topics: coastal erosion, marine habitats and governance.

4. A social and environmental map of Fiji

Following the workshops in Fiji, a socio-environmental map³ was finalised that provides an assessment of the health status of its territory. The map underwent a review process involving stakeholders at the workshops before it was distributed electronically and in print form. A version in iTaukei will also be available soon, in order to optimise inclusion as part of the document's distribution.

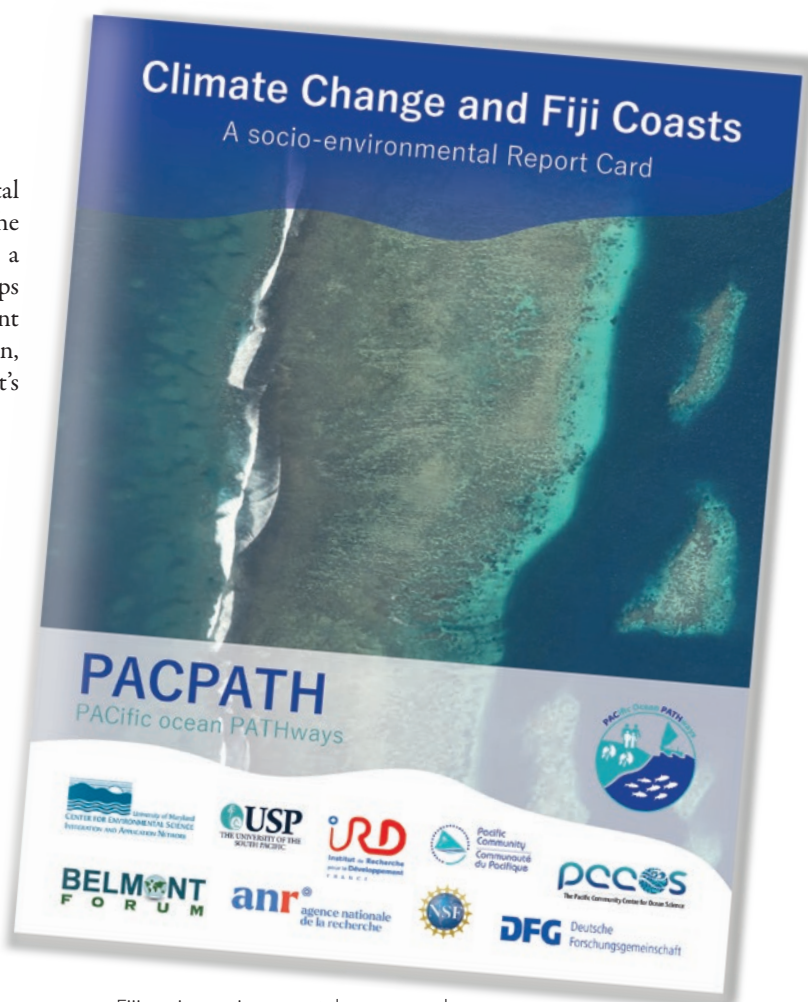
5. A tool for future action

The map reflects stakeholders' expertise and is intended to support future actions in the areas of monitoring, research and adaptation. This document can be used to support calls for projects by demonstrating the status of indicators, propose solutions identified by stakeholders, and assess territorial indicators.

The map's strength lies in its joint creation by a multitude of actors who represent a wide range of viewpoints from various fields of research, communities, and local authorities. These indicators are evaluated based on the actual assessment of stakeholders on site, which gives the map a legitimacy rooted in local experience.

6. Developing PACPATH-2

The upcoming phases of the project, for 2024, will focus on developing research projects to meet the needs expressed during the workshops. As part of the Belmont Forum's Climate Environment and Health 2 call for projects, a panel of researchers from New Caledonia and Fiji but also more broadly from the Pacific, Europe and the United States, will work on developing the project and taking into consideration the recommendations from the Noumea and Suva workshops.



Fiji socio-environmental report card

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SEM-Pasifika¹: Join our socio-economic network!

Carolina Garcia, Julie-Anne Kerandel and Esther Umu

What is the SEM-Pasifika network?

The SEM-Pasifika network is a group of like-minded people interested in advancing the use of social and economic sciences in the Pacific Island region to improve resource management for the benefit of communities, through an ethical and inclusive process of mutual learning led by Pacific Islanders.

What has happened so far?

- SEM-Pasifika guidelines were launched in 2008.
- In August 2023, 24 people from a diversity of backgrounds and organisations across the region got together in person to draft an action plan for this community. A further 15 people contributed from afar to this process.
- In December 2023, over 30 people got involved in an online meeting, where the action plan was reviewed and edited, and some ground rules were discussed to better structure the community. The final draft of the action plan² is available for comments until the end of January 2024, and it will be finalised in February 2024.

Who should join?

Not only social and economic experts should join the community of practice, but also those interested in social and/or economic studies in the region:

- research organisations and universities, including students
- natural resource managers and practitioners
- biophysical scientists working in the field of natural resource management
- national and local governments, policy developers, decision-makers
- non-governmental and community organisations
- regional and international organisations.

¹ SEM-Pasifika was the name given to the guidelines developed by The Global Socioeconomic Monitoring Initiative for Coastal Management (SocMon) for coastal managers to conduct socioeconomic monitoring (and assessments) in the Pacific Island region. <https://icriforum.org/socmon-resource/sem-pasifika-socio-economic-monitoring-guidelines-for-coastal-managers-in-pacific-island-countries/>

² <https://docs.google.com/document/d/1g2FS59UHrpzvOhycrdS8TMFGEB2KBjWQIw4Q37fqLc4/edit>



Why should you join?

Joining the network will allow you to better understand and steer interventions to enhance human well-being, resource management and ecosystem health in the region.

You can boost your professional life by:

- connecting with other people and organisations
- sharing knowledge and experiences
- better understanding local or national contexts
- understanding which methodologies to use
- accessing publications, courses, templates and other socio-economic tools, and information about grants and jobs.

You can also contribute to the development of the Pacific region by:

- sharing your knowledge and resources (local, traditional, technical, etc.)
- mentoring non-experts and early-career students and professionals
 - collaborating with a diverse group of stakeholders for more holistic interventions
 - having fun during face-to-face meetings!

What's next?

- Soon we'll be setting up an online platform to share key resources, and a social media group to share news and opportunities.
- We're also organising low-cost activities, as laid out in the action plan, and fundraising to implement more costly ones!

Acknowledgements:

SPC, as the temporary secretariat to the network, would like to acknowledge all participants of the planning workshops conducted in 2023, as without their contribution we would not have a draft action plan to bring this network to life.

How can you join?

To join the network and keep up to date with our activities, send an email to:

secopsecretariat@gmail.com

carolinag@spc.int

julieannek@spc.int



Working session © Julie-Anne Kerandel (SPC)



Three years of efforts to promote more sustainable coastal fisheries in Wallis and Futuna: Taking stock

Baptiste Jaugeon, Matthieu Juncker, Chloé Faure, Céline Muron, Angèle Armando, Lotolelei Manufekai and Savelina Taiava.

To ensure that Wallis and Futuna has a sustainable supply of coastal marine resources, in 2020 the Fisheries Service of the territory's Agriculture, Forestry and Fisheries Services Department (DSA) developed a strategy for the sustainable and participatory management of coastal resources. This strategy was implemented in several phases, which included building public awareness, establishing management measures, and supporting local initiatives.

Three years after launching this strategy, an evaluation has shown its success. Awareness of the issues involved in sustainable fisheries has increased and a significant share of the population have changed their fishing practices and consumption patterns.

However, the DSA has not yet succeeded in implementing the sustainable management of coastal fisheries in Wallis and Futuna over this time. Three years of effort have not been enough to radically change thinking and poor fishing practices. There are still barriers to action, and disparities have appeared between the territory's two islands. Seven Recommendations are proposed to strengthen the DSA's efforts: continue awareness initiatives; maintain the fisheries observatory; establish an effective control system; support local initiatives; allocate more human resources to fisheries; help build cooperation through the Fisheries Committee; integrate actions into local development plans; measure the efforts made ; and disseminate the knowledge.

Introduction

Decline in fishing

Coastal fisheries are central to the cultural identity of Wallis and Futuna. In the past, residents had to live off marine resources. Those resources also structured the society. However, a significant change has taken place in recent decades: the share of households involved in fishing has declined sharply, and fresh fish consumption has followed a similar trend (Bouard et al. 2021). This decline is linked to several

factors, including a change in residents' dietary habits, but may also be related to a decrease in coastal resources and degradation of coastal habitats (Jaugeon and Juncker 2021; Jaugeon et al. 2023a).

Ensuring a sustainable supply of marine resources

This dependence on marine resources could rebound in coming years, however, as a result of the increased costs of raw materials and maritime transport. In addition, a policy encouraging a healthier, local diet could re-establish fish

Sustainable fisheries day 2022 on Nukuteatea, Uvea island.



as central to households' dietary concerns. In this context, ensuring a sustainable supply of coastal marine resources has become a priority for national governments, as various regional declarations and policies demonstrate (FFA and SPC 2015; SPC 2015; SPC 2021). Fisheries co-management methods are preferred to achieve this sustainability objective for fisheries resources. While Wallis and Futuna does have a body of legal provisions for managing fishing, no management measures are actually implemented. Despite several initiatives targeting the integrated coastal zone management (Egretaud et al. 2007a, 2007b; Verducci and Juncker 2007; Moncelon 2017a, 2017b; INTEGRE 2018), a sustainable framework for reef and lagoon resources has not been developed.

Fisheries regulations previously unknown or rejected

In 2020, with support from then European-Union-funded PROTEGE¹ programme and the Pacific Community (SPC) as its implementing agency, the DSA's Fisheries Service prepared a stocktake to identify the prerequisites to establishing participatory coastal resource management in Wallis and Futuna (Aubert and Vieux 2021). A major challenge arose: how to promote this management method when the majority of the population does not consider it a priority. Existing fishing regulations were little known, poorly understood and largely rejected. In addition, unsustainable fishing practices persisted without challenge.

Given that context, the DSA's Fisheries Service developed an innovative strategy to launch a paradigm change in fisheries management in Wallis and Futuna with the strategic, technical and financial support of SPC via the PROTEGE project.

This paper reviews three years of actions, an unprecedented communications campaign, and the creation of a fisheries observatory. It evaluates the impact these actions had on the community's perceptions of their fisheries and fishing practices and examines how fisheries became a central concern once again. We conclude by looking towards the future, anticipating the next steps to ensure a continuous supply of fish to the local community in the face of the challenges of climate change.

Artistic expressions to raise awareness of sustainable fishing. ©DSA



PROTEGE – Sustainable coastal resource management action strategy

Developing a strategy, together with support from the “Trajectoires” and “Hope” consulting firms, made it possible to create an inclusive approach from the outset. Through the use of individual surveys, a comprehensive assessment, and working groups with all representatives of Wallisian and Futunan society, we designed an effective strategy, coupled with a high-impact communications strategy.

Challenges facing sustainable management of coastal resources in Wallis and Futuna

The situation in Wallis and Futuna does not favour implementation of a sustainable coastal-resource-management approach. While population decline offers benefits in terms of pressure on fisheries, it poses an obstacle to involving local communities, leading to a decline in traditional knowledge and social cohesion. Dependence on government subsidies reduces local communities' investment in fisheries management. Complex institutional arrangements make it complicated to coordinate management efforts, and governance conflicts among the various entities impede the decision-making process. Regulation of existing fisheries is characterised by a lack of participation, and decisions are often made without adequate stakeholder consultation. Certain unsustainable fishing practices persist (such as night spear-fishing, misuse of nets and the harvest of protected species), exerting a selective pressure on certain resources. The lack of awareness is obvious, with widespread ignorance of the impacts such practices have on resource sustainability. Consequently, in 2023, the community still does not perceive coastal resource management to be a concern and no effective management measures or regulations have been implemented. Coordination among the actors is needed to ensure effective and sustainable management (Jaugeon and Juncker 2021; Aubert and Vieux 2021).

Young women from Wallis and Futuna were key players in the campaign.
©Patrice Terraz



¹ The PROTEGE programme webpage in English - <https://protege.spc.int/en>

Strategic approach

In the face of these challenges, participatory workshops were held in 2020 to develop a common strategy. The goal of this three-year strategy was to promote a shared perception of the status of the resources and promote sustainable fishing. It was based on three pillars:

- improved knowledge of fisheries and fishers, particularly subsistence fishers;
- development of tailored communications; and,
- phased implementation of management measures.

Several indicators were designed to evaluate the strategy's effectiveness. They included the number of individuals familiar with good practices; the number of individuals who changed their practices; the number of communication tools and materials developed and disseminated; and the existence of new regulations.

Learning and capacity building

It was also important throughout the process to encourage capacity-building among technical service staff and communities. The DSA provided specific participatory management training to 16 service staff. The training's objectives included understanding the importance of participatory management, learning techniques to promote stakeholder commitment, and learning to provide effective facilitation for participatory processes.

Key role of external support

It is important to note that this intervention strategy for the sustainable management of marine resources falls under the EU-funded PROTEGE project and that it is aligned with the objectives and regional sustainable fisheries policies in the Pacific region (FFA and SPC 2015; SPC 2021). The DSA's Fisheries Service worked closely with the PROTEGE project team from both SPC's Climate Change and Environmental Sustainability Programme (CCES) and the Fisheries, Aquaculture and Marine Ecosystems Division. Thanks to the latter collaboration, additional funding was obtained from New Zealand's Ministry of Foreign Affairs and Trade (MFAT) and Australia's Department of Foreign Affairs and Trade (DFAT). This technical and financial support was critical to launching our awareness campaign.

Knowledge and monitoring of stock status and sampling

Even if the community did not feel an urgent need to manage the fisheries, further knowledge of the status of resources and the pressures exerted on them was crucial. Obtaining and disseminating objective information on fisheries and the status of coastal resources was essential to establish a shared perception, develop interest in resource management, and inform decision-making. These concerns led to the creation of the Wallis and Futuna Coastal Fisheries Observatory (Jaugeon and Juncker 2021, Jaugeon et al. 2023b; Virly et al. 2023).



With the development of a community-based marine monitoring toolkit, the campaign sought to engage all fishermen in data collection. ©DSA

Decline of fisheries in Wallis and Futuna

During 2019 and 2020, Wallis and Futuna's Territorial Statistics Service conducted a detailed family budget survey. It both contributed to large-scale data collection and enabled an in-depth analysis of this information in order to identify relevant indicators (Bouard et al. 2021). The survey revealed that the community had undergone a profound transformation over the previous 15 years. In Wallis, fishing and the consumption of fresh fish had declined significantly, with only 9% of households fishing in 2020, compared to 35% in 2006. Futuna experienced a similar, although less pronounced, shift, with 35% compared to 51% previously (Jaugeon et al. 2022). The total quantity of marine products consumed in Wallis and Futuna also declined, from 961 tonnes (t) in 2006, to 825 t in 2014, and 273 t in 2020 (Jaugeon et al. 2022). Average annual consumption on both islands was 27 kg/inhabitant in 2020, compared to 75 kg/inhabitant in 2006. Futuna consumes more seafood than Wallis, at, respectively, 34.6 kg/inhabitant compared to 19.4 kg/inhabitant in 2020. Multiple causes are responsible for this drastic reduction in fishing and seafood consumption, but they may also be linked to reduced coastal resources and degraded coastal habitats. This raised important questions in terms of strategy because this weak reliance on marine resources does not encourage taking action in response.

Implementing strategic communications – The sea, our source of life

Phase 01: Rallying communities around sea and fisheries culture

[illegible]

SPC Fisheries Newsletter #172 - September–December 2023



A multimedia stand is used to play awareness videos at local events to promote sustainable fishing. © DSA

fishers through field visits and a social networks campaign. A communications officer was hired specifically to support the campaign. The Fisheries Service also reached out to external service providers to design a brand platform.

Phase 02: Encouraging discussion

In 2022, the DSA stepped up discussions on fishing practices. These conversations were held on the awareness campaign's Facebook page and during meetings and events with various audiences. To encourage these exchanges, the DSA produced eight videos to stimulate discussion about fishing practices and management measures. Each video is available in the local languages and in French, combining statements from the population and portraits of experts, and disseminated over social networks. Using the local languages of Wallis and Futuna was a strategic choice to strengthen community ownership of the areas of discussion.



Cover of one of the booklet of the awareness campaign toolkit. A genuine awareness-raising tool, this booklet tells the story of fishing on Wallis and Futuna through a selection of photographs, children's poems and proverbs from the stories of the elders.



The fisheries department was there at every important event. © DSA

Phase 03: Promoting good practices

The key aspect for 2023 was communications focused on regulations. The objective was to create public awareness of existing regulations and stimulate discussion of the practices to adopt. The campaign supported enforcement of the regulations by providing information and support to ensure they would be understood and implemented.

A range of multilingual communications tools serving the campaign

Te tai matapuna o te maui campaign communications kit

A communications kit was designed at the start of the project to introduce the campaign, its objectives and its key messages. It included a visual identity, animated clips, a Facebook page, exhibition panels, posters, and collections of poems and statements from elders. Four dissemination channels were used to engage target audiences in support of sustainable fishing.

Channel 1: Mass media

The campaign was disseminated widely through television and radio, thanks in particular to statements by traditional leaders, fishers, associations, fisheries service technicians, and merchants. Facebook was also an important campaign medium, with more than 2000 people subscribing to the page "The sea, our source of life"². Several competitions were organised on the social network to engage civil society and fishers.

Channel 2: Outreach events

The Fisheries Service participated in more than 10 events, such as the forum on maritime and fisheries careers, open house days at the agricultural high school, and the Christmas Fair. More than seven "Sustainable Fishing Days" were held, with up to 400 people participating daily. These days were integrated into the communications strategy from the outset because they provided unique opportunities to spread the word about the campaign and introduce it to the public. An event booth was designed to promote dialogue with the community. It included wall hangings with key messages, display stands and brochures, and an interactive terminal showing videos.

² facebook.com/pecheurswf

Channel 3: Targeted awareness-raising in the field and stakeholder network

The campaign was based on informal encounters with the community, thanks primarily to the village assessments conducted by the Environmental Department. Connections were established with the traditional leaders, who played an important role in the campaign. A programme to collect data on landed fish catch was also set up. This resource assessment method helped to create awareness among fishers of the impact of their practices. The DSA also created partnerships with local associations, such as *Les enfants du lagon* (children of the lagoon) and *A vaka beke*.

Channel 4: Building skills among stakeholder networks

The DSA developed a community toolkit for monitoring the marine environment. It enables communities to conduct their own resource and habitat monitoring.

Potential to be tapped

The tools developed proved that they were relevant to meeting the campaign's objectives. However, the time required to design, produce and translate sometimes meant that their deployment was delayed, which limited the time available to implement the campaign in the field. Despite the team's enthusiasm, these tools have not yet been used to their full potential. For example, the videos on fishing practices have not yet been shown on television. The educational resource kit, community toolkit for marine environment monitoring, and the merchant communication tools have not yet been deployed.

Coastal Fisheries Observatory

The Fisheries Observatory created a complementary communications strategy, with a distinct visual identity. An annual report and a quarterly newsletter are published.

Three-year evaluation

Three years after introducing the intervention strategy, it was important to assess its impact. To do that, the DSA service, with consulting support, conducted surveys with various groups on the islands of Wallis and Futuna, including commercial and non-commercial fishers, managers, territorial elected officials, traditional leaders, merchants and consumers. The authors gathered data from a total of 109 people in Futuna and 197 people in Wallis. Based on a population of 11,558, this sample is representative, with a 90% confidence interval and a 5% margin of error. It should be noted that the evaluation questionnaire was not launched until 2023. The information collected during the 2020 initial assessment did not provide information on all of the strategy's indicators. For this kind of evaluation, it is particularly important to start with a solid baseline for comparison with the evaluation data.

The Fisheries Services' actions are known and recognised

At the outset, the population lacked a solid understanding of the concept of sustainable fishing and its implications. The public was not yet aware of the issue of the sustainable management of coastal resources. Our results suggest that the DSA's actions and information campaigns enjoyed wide visibility and did transmit their messages. In Wallis, 81% of respondents stated that they considered the Fisheries Service to be useful and more than half retained the campaign's messages (for example, regarding the status of the resources and fishing practices). In Futuna, the figures were, respectively, 62% and 13% (Faure, 2023). The campaign's low penetration there may be explained by the fact that the campaign could not be carried out on-site.



Screenshot from one of the eight videos that the DSA produced to stimulate discussion about fishing practices and management measures. In this video, Saleina Taiava, a staff member from the Fisheries Service, interviewed members of the Wallis community about net fishing practices.

Effective communications campaign

The surveys also helped to assess the relevance of the tools used. In Wallis, the multichannel approach proved to be effective as all of the tools were mentioned in the survey. In Futuna, the messages were transmitted to the population primarily through Facebook, television and posters. Respondents on both islands expressed a desire for more interventions in the field, such as village meetings and public events. There was also significant demand for radio and TV broadcasts.

Gaining awareness of diminishing resources and impact factors

One of the campaign's key impacts was the change in perception regarding the status of the resources and environmental pressures. During the initial assessment, the perception of resource status – specifically in Wallis – was vague and any reductions were often attributed to external factors, such as climate change or foreign vessels (Jaugeon and Juncker, 2021). Today, 65% of fishers questioned in Wallis noted that the resources had diminished, compared to 23% in 2019–2020. In Futuna, a majority of respondents had already noticed that resources were diminishing. This did not change significantly over the course of the campaign, that is, 81% compared to 89% in 2019–2020 (Bouard et al. 2021; Faure 2023). This change in perception was particularly marked among commercial fishers, since 89% of respondents in Futuna and 73% in Wallis stated that resources were diminishing in 2023, compared to 50% in 2020 for Wallis and Futuna combined (Aubert et al. 2021; Faure 2023).

In Wallis, the main cause of diminishing resources now identified is the use of destructive fishing techniques, followed by climate change and overpopulation. In Futuna, the main cause identified is an increase in the number of fishers. However, this perception does not reflect reality because the 2019–2020 family budget survey showed that the number of fishers had declined. On the other hand, fishers are better equipped. Climate change and destructive fishing techniques are also mentioned.

Customary leaders were key players in the campaign, as seen here with Ului Monua, the minister of primary sector of the kingdom of Uvea. ©Patrice Terraz



A programme to collect data on landed fish catch was also set up. ©DSA



These new perceptions regarding causes and the status of the resources show a greater awareness among the population of the consequences of poor fisheries management and environmental pressures, which is probably the result of the information campaign. The declining species mentioned in Wallis are the parrotfish, surgeonfish, deepwater snappers and sea cucumbers. In Futuna, the species in decline are lobsters, parrotfish, trochus, giant clams and blue sea chubs.

Most of the community is familiar with and accepts the regulations

One change attributable to the campaign is increased knowledge and acceptance of fisheries regulations. At the start of the campaign, the population had a striking lack of knowledge of and rejected certain fisheries rules (Aubert et al. 2021; Jaugeon and Juncker 2021). In 2023, in Wallis and Futuna, the majority of respondents expressed support for adopting minimum size limits, protecting vulnerable species, prohibiting night spearfishing, and setting up marine reserves.

A measured change in practices, influenced by the campaign

The survey showed a measurable change in fishing practices and seafood consumption, influenced by the campaign. For example, in Wallis, 35% of respondents reported that they had changed their fishing practices, and 34% had changed their seafood consumption habits. Some 45% of those surveyed stated that they had changed their behaviour as a result of the campaign.

Lessons learned and areas for improvement

To summarise, the evaluation of the strategy revealed a strong knowledge of the campaign and a recognition of its value, particularly in Wallis, where activities were undertaken in the field. The population has begun to change its behaviours, perceive the usefulness of the fishing rules, and understand the status of marine resources and the reasons for their decline. The campaign certainly encouraged several initiatives, such as the customary marine area project, the SOS turtle project, the *A Vaka Heke* club's awareness-raising activities, and the *Mala'efōu* educational managed marine area.

To encourage fishermen to participate in data collection, the campaign offered gift cards that could be used to purchase fishing gear or maintain boats. This incentive was successful in increasing participation in the data collection effort. ©DSA



We also observed a shared interest in continuing to raise awareness and promote sustainable management of marine resources in both Wallis and Futuna. This work should involve all local actors, including traditional leaders, the Fisheries Service and fishers. The Fisheries Committee could be an excellent governance tool for achieving these objectives.

There is no doubt that the campaign is working, but achieving the expected behavioural changes – specifically, implementation of the regulations – will require extending it into coming years.

Setting up relevant management measures

The efforts of the Fisheries Observatory and the communications campaign have helped to guide and support marine resources management initiatives in Wallis and Futuna. Three strategic initiatives have emerged:

Fisheries Advisory Committee

The Fisheries Advisory Committee was created in 2022. Its members include representatives of governments, elected officials, traditional leaders, commercial fishers, and civil society. The committee has already supported the DSA in several approaches, specifically, the need to implement fisheries regulations, the need for financial and human resources to conduct fisheries monitoring, and the need to review current regulations in consultation with fishers.

Customary marine area project

The commercial fishers' association in Wallis proposed creating a 2 km² customary marine area in Hihifo district. The project has the traditional leadership's support and was formally inaugurated in October 2023.

Environmental warden team

A team of environmental wardens was set up in 2023. Its mission is to inform and create awareness among fishers and the general public regarding the regulations in force. The first activities focused on night fishers. Surveys show that fishers who practise this activity are familiar with regulations, but do not comply with them.

Conclusion

The PROTEGE project has triggered a pro-change momentum in terms of both the perception of the status of the resource and an understanding of the importance of resource-friendly practices. The strategy used has helped create a collective awareness of the need to manage marine resources.

This strategy has given rise to some promising initiatives, such as the Fisheries Committee, the Hihifo marine area, and the nature wardens. However, these initiatives are still being developed and are fragile at this stage. They need support if they are to be maintained and to have a significant impact on the resources.

To date, the DSA's efforts have not brought about sustainable coastal resource management in Wallis and Futuna. Despite growing awareness of the fragility of the marine resources, the transition to action has encountered serious obstacles that the awareness-raising campaign alone cannot overcome. In addition, disparities have appeared between the territory's two islands in implementing the actions related to the participatory coastal resource management under the PROTEGE project. The lack of a local intermediary in Futuna meant that the same level of enthusiasm generated in Wallis could not be achieved there.

Clearly, much remains to be done. Today, it is critical to strengthen and pursue the existing initiatives to ensure that all these efforts are not wasted. The following recommendations are intended to strengthen the efforts already deployed.

- Continue and step up the awareness-raising and communication initiatives to promote collective awareness of the need to manage the coastal resources.
- Maintain the Fisheries Observatory to monitor fishing, the status of the resources, and the impact of management measures.
- Set up an effective control and surveillance system to deter non-compliance and sanction violations.
- Support local initiatives and build local skills.
- Allocate new human resources to the Fisheries Service to create a dedicated marine resources management team.
- Strengthen cooperation among the actors by facilitating the Fisheries Committee.
- Integrate actions in local development plans.
- Monitor and evaluate the actions.
- Safeguard and disseminate the knowledge acquired.

By implementing these measures, the DSA can sustain the momentum initiated by PROTEGE and ensure that fisheries resources remain sufficient to feed the local communities and enable fishers to earn a living.

For more
information :



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Developing coordinated management of the sea cucumber sector in New Caledonia

Solène Devez, Ariella D'Andrea and Denis Labiau

New Caledonia's sea cucumber sector

Twenty species of sea cucumber are harvested in New Caledonia, of which around ten are especially sought-after due to their market value, in particular the black teatfish (*Holothuria whitmaei*), white teatfish (*Holothuria fuscogilva*), sandfish (*Holothuria scabra*) and golden sandfish (*Holothuria lessoni*). Among these locally harvested sea cucumbers with high market value, the black teatfish and white teatfish were listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 2020¹. In 2019, the catch volume for both CITES species combined was lower (41.2 tonnes by fresh weight) than for some other species such as leopardfish (*Bobadischia argus*), which alone accounted for a reported volume of 71.5 tonnes (see Figure 1). Nevertheless, these two species generated just over 50% of the sector's turnover in 2019 (Observatoire des pêches côtières de Nouvelle-Calédonie 2022).

In response to the two sea cucumber species' listing in CITES Appendix II in 2020, as well as the addition of two other significant species for New Caledonia in 2022 (*Thelenota ananas* and *Thelenota anax*)² public authorities

and private operators in the sea cucumber sector began working towards developing integrated management across the entire territory. This sustainable and integrated management of resources listed in Appendix II of CITES is a prerequisite to proving that trade in the resource does not harm the species. Before issuing an export permit for species listed in CITES Appendix II, the management authority of the exporting country must determine that the specimens were legally obtained (known as a legal acquisition finding, LAF). It must also seek the scientific authority's assurance that export will not be detrimental to the survival of the listed species (known as a non-detriment finding, NDF) (Nakamura et al. 2020).

The New Caledonian context is specific in that responsibility for management is spread across several levels. The provincial authorities in each province are in charge of regulating fishing, distributing and processing activities while the Government of New Caledonia is in charge of regulating exports. As a result, the sector's stakeholders deemed it a priority to establish a technical committee on sea cucumbers to structure, coordinate and effectively manage sea cucumber resources.

SEA CUCUMBER CATCHES (FRESH WEIGHT IN TONNES) IN NEW CALEDONIA IN 2019.

The seven species for which less than 2 tonnes were caught are not represented on this graph.

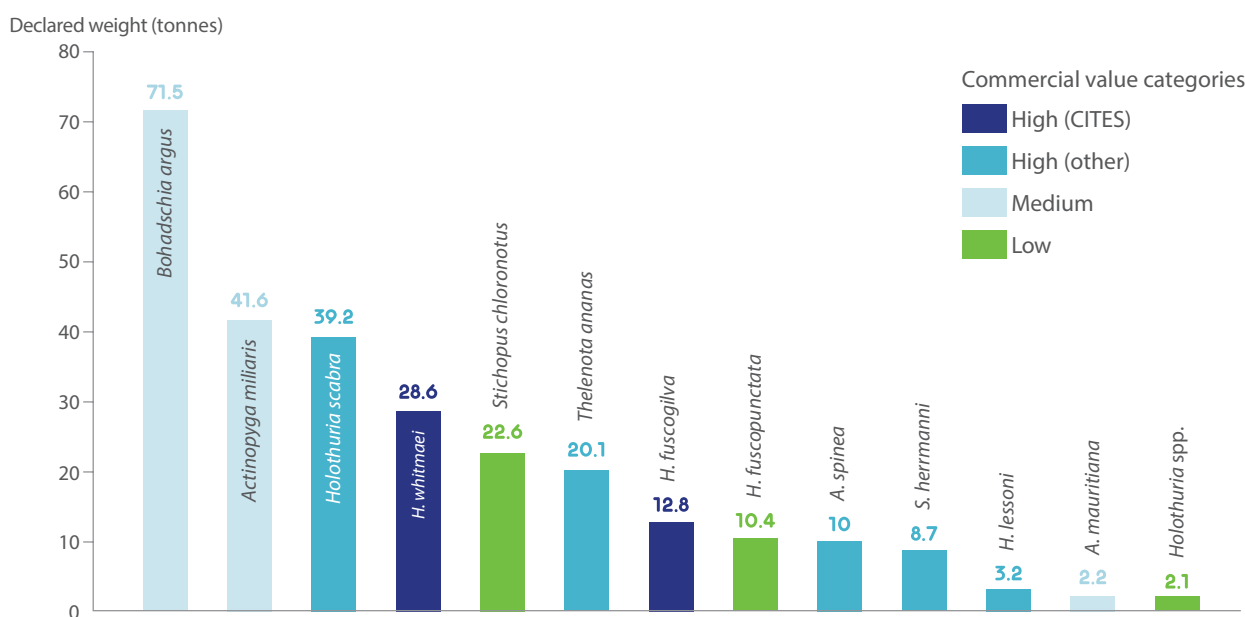


Figure 1. Sea cucumber catches by species in 2019 in New Caledonia (Source: Observatoire des pêches côtières de Nouvelle-Calédonie 2022)

¹ In the same year, a third species was listed in CITES Appendix II, but it does not concern the Pacific Ocean (*H. nobilis*).

² For the two species *Thelenota ananas* and *Thelenota anax*, as well as a third that does not concern the Pacific Ocean (*T. rubrilineata*), their inclusion in CITES Appendix II is due to enter into effect on 25 May 2024. New Caledonia's reported catches of *Thelenota ananas* amounted to 20.1 tonnes in 2019 (Observatoire des pêches côtières de Nouvelle-Calédonie, 2022).

Authorities involved in managing the sea cucumber sector

The fisheries management role of provincial authorities

In order to harvest sea cucumbers, commercial fishers must apply for a special licence (Article 341-2 of the Northern Province's Environment Code) or a specific licence (Article 341-2 of the Southern Province's Environment Code). In 2021, 178 fishers applied for a special or specific licence to harvest sea cucumbers, with 71% in the Northern Province and 29% in the Southern Province (Laplante et al. 2023). As the licensing authorities, the provinces are responsible for controlling fishing licences as well as ensuring compliance with minimum sizes (live and dry specimen length) and implementing temporary harvest bans. Distribution and processing also fall under provincial jurisdiction and although there is no cap on the number of distributors and processors, a special permit is required for transporting and marketing. This permit had already existed in the Northern Province since 2019 and was added to the Southern Province's Environment Code in 2022 to harmonise the regulation of all activities under provincial jurisdiction.

The minimum sizes of live and dried sea cucumbers were also amended in 2021 to align them in the Northern and Southern Provinces. Disparities in the size of sea cucumber species persist between provinces, particularly for certain CITES species (see Table 1). Harmonising these sizes is essential for ensuring integrated management of provincial fisheries. Regulating and enforcing minimum sizes is one of the most important drivers, not just of sustainable fisheries but also of maximising economic benefits for fishers (Lee et al. 2018).

For the sustainable exploitation of sea cucumber species listed in CITES Annex II, the ultimate goal is to allocate

New Caledonia is made up of three provinces: the Northern, Southern and Loyalty Islands Provinces. They are responsible for managing coastal fisheries. The provinces' regulatory jurisdiction over the management and conservation of biological and non-biological natural resources up to 12 nautical miles from the baseline stems from Article 46 of Organic Law No. 99-209 of 19 March 1999 relating to New Caledonia. The various environment codes of 2008, 2009 and 2016 respectively specify the provincial procedures for fisheries resource management.





quotas by geographical area throughout New Caledonia as a whole, and then determine quotas by province.

Thus, the provinces play a crucial role in sustainable management of sea cucumbers listed in CITES Appendix II, including by supporting the French Institute of Research for Development (IRD), which is the scientific authority locally designated to prepare NDFs and provide input to the fisheries management part of the NDF assessment.

The role of the Government of New Caledonia in managing sea cucumber exports

In New Caledonia, exports fall under the jurisdiction of the Government of New Caledonia, and controls for the entire territory are conducted by governmental authorities in the Southern Province. The Animal Health, Food and Phytosanitary Inspection Service (SIVAP) is responsible for export controls and in particular for verifying both the legality of catches and compliance with quotas and tolerance thresholds for undersized specimens. As such, SIVAP was designated as the focal point for management of species

Table 1. Minimum sizes for four sea cucumber species listed in CITES Appendix II

| Species | Minimum live length of animal in Northern Province | Minimum dry length of animal in Northern Province | Minimum live length of animal in Southern Province | Minimum dry length of animal in Southern Province | |
|--|--|---|--|---|---|
| <i>Holothuria whitmaei</i> Black teatfish | 30 cm | 14 cm | 30 cm | 16 cm |  |
| <i>Holothuria fuscogilva</i> White teatfish | 35 cm | 16 cm | 35 cm | 16 cm |  |
| <i>Thelenota ananas</i> * Prickly redfish | 45 cm | 14 cm | 45 cm | 14 cm |  |
| <i>Thelenota anax</i> * Amberfish | N/A | N/A | 55 cm | 25 cm |  |

*Entry into effect of this listing delayed until 25 May 2024.



Diver measuring a sea cucumber during a stock assessment. © Matthieu Juncker (SPC)

listed in CITES.³ As the management authority, SIVAP prepares the LAF, examines any CITES export permit applications⁴ and ensures compliance with existing regulations on CITES species.

The Government of New Caledonia selected IRD to be the scientific authority tasked with issuing findings as to whether exports would be detrimental to the conservation status of the resource based on available scientific evidence.⁵ On the basis of these scientific findings, the IRD issues export quotas for CITES species in the NDF.

For the black teatfish and white teatfish included in Annex II, SIVAP is responsible for drafting the export part of the NDF assessment. Currently, the export market for all species across the entire territory is shared between two exporters. Implementing export quotas has helped trigger a process of structuring the sea cucumber sector by involving all actors in its management (Observatoire des pêches côtières de Nouvelle-Calédonie 2023).

Existing provincial advisory committees under current regulations

Article 341-1 of the Northern Province's Environment Code established a committee to monitor sea cucumber

regulations (CSRH-PN). This committee, which was further defined by an order⁶, supports management of the sector in the Northern Province by issuing advice on any proposed amendments to sea cucumber fisheries regulations and may make management proposals. It is composed of provincial elected officials, provincial technical departments, commercial fishers from the Northern Province, processors and exporters, but also the fisheries departments of the Southern and Loyalty Islands Provinces, customs authorities, the gendarmerie and the Maritime Authority. By bringing administrative authorities and the sector's various stakeholders together, the committee's membership ensures integrated management of the sea cucumber sector in the Northern Province.

There is no equivalent body provided for in the Southern Province's Environment Code, but the Southern Province Environmental Protection Committee was set up to advise on resource management provisions, including on sea cucumbers.

For this reason, with the introduction of export quotas and the PROTEGE project in 2020, a territory-wide technical committee on sea cucumbers was established to bring together more broadly all the actors in the sea cucumber sectors of the Northern, Southern and Loyalty Islands provinces.

³ Resolution No. 147 of 11 August 2016 on implementation of the Washington Convention (CITES) in New Caledonia

⁴ Order No 2019-1177/GNC of 30 April 2019 designating the competent administrative agency for examination of CITES permits and certificates in New Caledonia

⁵ Order No 2019-1179/GNC of 30 April 2019 designating the CITES Scientific Authority for New Caledonia

⁶ Order No. 2020-448/PN of 28 September 2020 establishing the Monitoring Committee for Sea Cucumber Regulations in the Northern Province

A territory-wide technical committee on sea cucumbers for a co-management approach

The Technical Committee on Sea Cucumbers is an advisory body whose role is to coordinate the various stakeholders in the sea cucumber sector, combining its members' respective areas of expertise in order to make recommendations. This committee, established on 9 March 2023,⁷ met four times during the year. The last meeting was on 29 November 2023.

Membership of the Technical Committee on Sea Cucumbers at its meeting of 06 April 2023 is listed here (Chambre d'agriculture et de la pêche de Nouvelle-Calédonie, CAP-NC 2023):

| Administrative authorities | Professionals |
|---|---|
| 1 representative of SIVAP | 1 representative of the CAP-NC Fisheries section |
| 1 representative of the Coral Sea Natural Park and Fisheries Department | 1 representative of each of the two exporters |
| 1 representative of the Southern Province | 1 representative of commercial fishers in the Southern Province |
| 1 representative of the Northern Province | 1 representative of commercial fishers in the Northern Province |
| 1 representative of commercial fishers in the Loyalty Islands Province | N/A |

The Technical Committee on Sea Cucumbers relies on the Coastal Fisheries Observatory for data collection and identifying indicators for real-time monitoring. The committee has also retained a scientific expert, who works with the Southern Cross University of Australia, to advise on any proposals or amendments to quotas mentioned in NDFs and in annual NDF reports. Its members may invite any qualified individual to provide insight on targeted issues, such as scientists, elected officials, non-governmental organisations, experts, customs authorities, maritime police, the Government of France, Department of Economic Affairs, traditional leaders, and so on.

Thus, as well as coordinating actors in New Caledonia's sea cucumber sector, the Technical Committee on Sea Cucumbers serves to empower these various stakeholders. By its balanced distribution of the number of seats among all organisations, including commercial ones, in particular the export sector, the committee ensures that professionals are involved in managing the sector. This balanced distribution is one of the keys to structuring and empowering all stakeholders in the sector (Lee et al. 2020). The role of the Technical Committee on Sea Cucumbers is to:

Ensure the coordination of the sea cucumber sector in New Caledonia by communicating and by supporting all actors in an optimal and concerted manner, taking account of the issues they face.

The meeting of 6 April 2023 agreed that the Technical Committee on Sea Cucumbers would temporarily pursue the following tasks:

1. present projects and concerted opinions on the sector's management to elected officials and decision-making bodies;
2. discuss and submit a strategic management plan with those involved in sea cucumber management and follow up on this plan with managers; and
3. issue opinions and recommendations on sea cucumber management at the territory level.

In the future, the committee's operations and mandate may be reinforced by an official order.

The Technical Committee on Sea Cucumbers comes under the fisheries section of the Chamber of Agriculture and Fisheries (CAP-NC), which coordinates and manages it. The CAP-NC was selected to organise the committee in its capacity as a sectoral chamber with a territory-wide scope. The CAP-NC's role is to represent commercial fishers with regard to public authorities and to support them, while also coordinating projects for the development and structuring of the fishing sector. The Technical Committee on Sea Cucumbers plays a key role for CITES species by rigorously monitoring harvests and exports, and by preparing the assessment for each NDF in a coordinated and consultative manner.

What future for New Caledonia's sea cucumbers?

For the sustainability of sea cucumber resources, there are many benefits to professionals and public authorities meeting and working together. These include:

- improving sea cucumber stock management in New Caledonia
- targeting catches according to species abundance and to their market value
- exporting quality products sourced through sustainable management
- developing mechanisms for inter-institutional co-operation

⁷ The PROTEGE project helped to further promote the Technical Committee on Sea Cucumbers, in particular via the recruitment of a facilitator and the completion of a legal study on developing a favourable legal framework for sustainable sea cucumber management in New Caledonia.

- preventing regulatory gaps in the management of export fisheries, and
- providing a mechanism for participating in decision-making and a platform for discussion and exchange of information.

In the medium term, a multi-year management plan will instate sustainable sea cucumber management in New Caledonia and improve biological knowledge for the survival of a species seen by SPC member countries and territories as iconic⁸ and providing many ecosystem services on which the health of our oceans depends.

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⁸ SPC member countries and territories asked SPC's Fisheries, Aquaculture and Marine Ecosystems Division to "examine sea cucumber production as an iconic Pacific taxon that could be developed by the region" (Outcomes and actions report from the 6th SPC Regional Technical Meeting on Coastal Fisheries and Aquaculture, paragraph 24.b.ii).

The evolving relationship between humans and sharks

A review and discussion of current shark hazard management strategies to foster co-existence

Jed Macdonald¹ and Lauriane Escalle²

Introduction

As the human footprint on the planet grows ever larger, wildlife in both terrestrial and aquatic realms is facing unprecedented challenges, sometimes existential in scale (Ripple et al. 2014; Juan-Jordá et al. 2022; Sherman et al. 2023). These challenges can take a variety of forms. Habitat loss, brought about, for example, by land clearing for agricultural needs (Green et al. 2005), river regulation for power generation (McClure et al. 2008), or through the impacts of human-induced climate change (Hoegh-Guldberg et al. 2017), can strongly affect wildlife, eroding species' resilience and genetic diversity (Laurance et al. 2002; Aguilar et al. 2008; McClure et al. 2008) and constraining foraging, breeding, and dispersal opportunities (Fahrig 2003). Overharvesting of wild marine resources is another serious challenge. This can disrupt demographic processes, force population declines and raise extinction risk (Dulvy et al. 2003; Field et al. 2009; Juan-Jordá et al. 2022), as can the removal of wildlife perceived by humans to pose a threat to the environment or to humans themselves. At the heart of all these challenges lies some 'interaction' between humans and wildlife. When such interactions are deemed adverse to either party, they are often referred to as 'human-wildlife conflicts' (HWCs) (Conover 2002). This definition implies that wildlife is able to consciously engage in conflicts (Peterson et al. 2010). Indeed, recent calls have been made to redefine HWCs more broadly, consisting of two elements: (i) biodiversity 'impacts' that deal with direct interactions between humans and wildlife; and (ii) biodiversity 'conflicts' that centre on human interactions – that is, between those seeking to conserve species, and those with other goals (Young et al. 2010; Redpath et al. 2013).

With the rate and diversity of biodiversity impacts and conflicts predicted to increase globally (Young et al. 2010; Kansky and Knight 2014), solutions are needed that promote coexistence between humans and wildlife while fostering engagement and the willingness for compromise among the human actors involved (Carter and Linnell 2016; Gallagher 2016). Though much of the work on HWCs and their solutions to date has focused on terrestrial systems (e.g. Redpath et al. 2013; Chapron et al. 2014; Kansky and Knight 2014; Carter and Linnell 2016) a marine example involving interactions between humans and sharks poses an intriguing and ongoing challenge for balancing conservation and human safety outcomes, tapping into both the 'impact' and

'conflict' elements of HWCs (Neff 2012; Sabatier and Huveneers 2018; Simpfendorfer et al. 2021).

Human-shark interactions are always multidimensional and often emotional affairs comprising different ecological, social and economic elements. Sharks are unique among marine wildlife in that they can predate upon humans, compete with humans for marine resources and are preyed upon by humans in fisheries (Simpfendorfer et al. 2021; Sherman et al. 2023). Given this multifaceted role that sharks play, their iconic nature, in conjunction with the globally threatened conservation status of many shark and ray species (Dulvy et al. 2021; Pacoureau et al. 2021; Sherman et al. 2023), the complexity, conflict and controversy that often surround decisions on how best to manage human-shark interactions and their consequences are hardly surprising.

We focus on this issue further here, motivated by a recent spate of human-shark interactions in New Caledonia, and the actions taken by local authorities to reduce the risk of further negative interactions. We first provide some background into the various roles that sharks play as ecosystem sentinels and cultural totems. Next, we dig deeper into the world of human-shark interactions and chart the evolution of thinking around methods to minimise negative outcomes. We then provide an evidence-based overview of current strategies available for mitigating the risk of negative human-shark impacts in nearshore environments, and conclude with a call for further research into solutions centred around understanding and coexistence between humans and sharks.

Sharks as ecosystem sentinels and cultural icons

Sharks and rays (Class: Chondrichthyes, Subclass: Elasmobranchii) are an ancient, remarkably diverse group of slow-growing predatory fishes that reside in all aquatic environments, from rivers and estuaries, to coastal, pelagic and demersal marine habitats. While the trophic roles of the over 1200 extant shark and ray species are often varied, system-dependent and challenging to assess (Heupel et al. 2014; Roff et al. 2016), their importance as key predators in aquatic ecosystems is universally accepted. Sharks can impart strong top-down effects on ecosystems via direct predation or by inducing behavioural changes in prey taxa (i.e. risk effects – Creel and Christiansen 2008; Heithaus et al. 2008) (e.g. Frid et al. 2007; Heithaus et al. 2007), and

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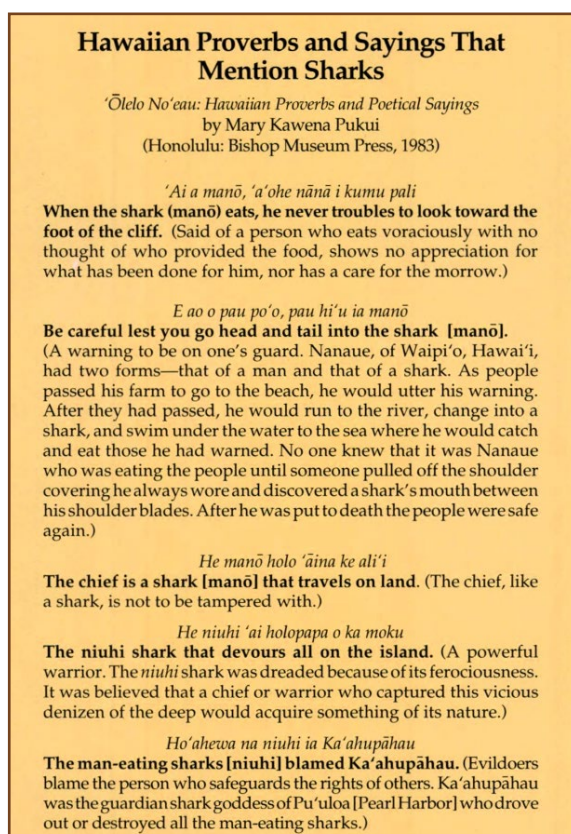


Figure 1. Panel of Hawaiian shark-related proverbs (drawn from Pukui 1983)

have the capacity to shape aquatic community structure and function across broad spatial and temporal scales (Ferretti et al. 2010; Roff et al. 2016). There is now compelling evidence that the loss of sharks from ecosystems can have dramatic impacts on food web dynamics, releasing mesoconsumers and affecting the abundance and/or distribution of primary consumers and producers (Myers et al. 2007; Ruppert et al. 2013; Rasher et al. 2017). Wide-ranging sharks also act as important nutrient transfer agents and provide energetic linkages among habitats, as was neatly demonstrated recently for grey reef (*Carcharhinus amblyrhynchos*) and black tip reef (*C. melanopterus*) sharks on Palmyra Atoll (McCauley

et al. 2012; Williams et al. 2018). Such results highlight that the impacts of even localised declines in shark populations are capable of extending far beyond the local ecosystem (Simpfendorfer et al. 2021).

In attempting to quantify sharks' roles and place within aquatic ecosystems – ecosystems also used, inhabited and increasingly affected by humans – comparing the cultural status of sharks in different societies may help us to contextualise the longstanding and ongoing debate around how best to manage human–shark interactions (Muter et al. 2013; Neff 2012; McCagh et al. 2015; Hammerton and Ford 2018). In many Pacific Island countries and territories, sharks are revered as deities and guardian spirits, seen as a manifestation of ancestors, a guide to travellers, as a source of food and the subject of countless tales and proverbs (Pukui 1983; Magnuson 1987; Taylor 1993; Hutching 2012; Ames 2013; Kane 2014) (see Fig. 1).

Through this framing, Pacific Island peoples' traditional attitudes towards sharks arguably appear to revolve more around reverence and respect rather than fear (Pukui 1983; Magnuson 1987; Hammerton and Ford 2018). Viewing sharks through this cultural lens can, in many cases, align with conservation objectives, for example, when the hunting and consuming of threatened species or particular specimens is taboo (Ames 2013; Kane 2014). Yet, certain customs might also hamper current conservation goals, for instance, where sharks and shark products have value as food, traditional medicine, art or jewellery (Vannuccini 1999), or contribute to past losses of specimens harvested for characteristic weapons like the *te unun* (shark's tooth spear) (Fig. 2) and the *tetoanea* (shark's tooth sword club) of the Gilbert Islands, Kiribati (Murdoch 1923; Drew et al. 2013).

In contrast to many Pacific Island and indigenous cultures, fear has been a dominant force in traditional western thinking around sharks (Philpott 2002; see Neff and Hueter 2013 for a brief yet comprehensive history). The media and film industry are widely credited with perpetuating the negative perception of these animals, playing on our 'terror of the unknown' (Magnuson 1987; Neff and Yang 2013) and

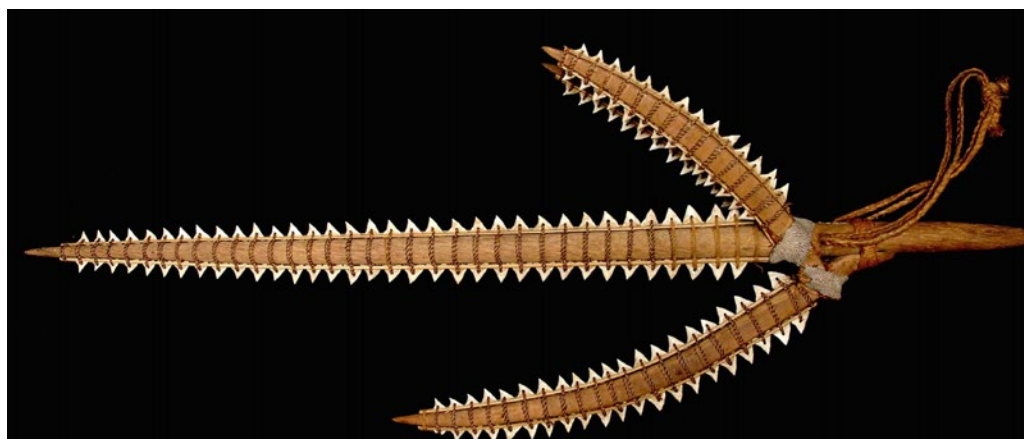


Figure 2. A *te unun*, traditional weapon from the Gilbert Islands, Kiribati (courtesy: National Geographic).

often intensifying public hostility towards sharks through coverage emphasising the risks they pose to humans (Muter et al. 2012). This portrayal has often been associated with suboptimal outcomes from the shark's perspective. The case of the Western Australian (WA) response to a spate of seven fatal shark bites between 2010 and 2013 provides a useful example of how legitimate concerns for human safety and a powerful media influence on public discourse can still override ecological or sociological data and lead to policy decisions with lethal endpoints (e.g. Gibbs and Warren 2015; McCagh et al. 2015; Neff 2015; Gallagher 2016). However, this example also highlights that public sentiment towards sharks and approaches to shark hazard management in Australia (and other Global North nations) is gradually shifting away from traditional themes around fear and the need to control nature towards understanding and celebrating it (Simpfendorfer et al. 2011; Whatmough et al. 2011; Neff and Yang 2013; Dorling 2014). This was evidenced by strong public and scientific opposition to the WA Government's implementation of a baited drum line programme targeting white (*Carcharodon carcharias*), tiger (*Galeocerdo cuvier*) and bull (*Carcharhinus leucas*) sharks following these seven fatalities (see Cressey 2013; McCagh et al. 2015). In 2013, over 100 of the world's leading shark experts wrote an open letter to the WA Government against the drum line proposal¹ that questioned the effectiveness of such programmes in terms of increasing human safety, cited scientific recommendations against its implementation in WA waters (McPhee 2012), and promoted the use of alternative, non-lethal strategies coupled with enhanced public education and awareness as better ways forward. Despite the letter's publication, together with an online petition opposing the programme that collected 34,000 signatures, the programme went ahead, capturing 172 sharks in total, including 50 tiger sharks, which were destroyed, and no white sharks, the primary target of the cull (McCagh et al. 2015; Gallagher 2016). In mid-2014, the WA Government submitted a proposal to the state's Environmental Protection Authority (EPA) to extend the programme for three years (EPA 2014a). During the seven-day period for public comment on the proposal, the EPA received over 20,000 public submissions, most of which opposed the proposal and requested that the EPA undertake a formal assessment (EPA 2014b). Finally, in September 2014, the EPA recommended against the proposal, ending the programme and citing the 'high degree of scientific uncertainty about impacts on the viability of the south-western white shark population' (EPA 2014b).

While just one example covering the initiation, implementation and outcomes of a shark hazard management strategy (see Dudley and Cliff 1993; Wetherbee et al. 1994; Neff 2012; Lemahieu et al. 2017; Gibbs et al. 2020 and Table 1 for others), this Australian case study does illustrate the changing perception of sharks in the western public eye.

Criticisms of lethal approaches to managing human–shark impacts are growing in concert with (1) appreciation of the global conservation challenges sharks face, (2) new scientific discoveries in shark biology, behaviour and their roles in maintaining ecosystem health, and raised public awareness of these discoveries, (3) concerns around the environmental consequences of approaches with lethal endpoints and their effectiveness for improving human safety, and (4) the proliferation of effective non-lethal alternatives (see McPhee et al. 2021 and Table 1 for examples). However, as highlighted recently by Simpfendorfer et al. (2021), the concept of the shark remains a divisive force, both among and within societies, and biodiversity conflicts around what these creatures represent, how we value them, and how best to manage human–shark interactions are unlikely to cease in the near-term.

Human–shark interactions – the how, the threats, the opportunities, the solutions

Humans and sharks can interact in at least five different ways: (1) through fishing and fishing-related industries, (2) through science, film and other media, art, customs, folklore or imagination, (3) through underwater, land- or vessel-based encounters with no direct contact, (4) through direct biodiversity impacts from shark bites on humans, and (5) through shark hazard management programmes. Interactions arising via 1, 4 and 5 can pose direct threats of physical harm to one or both parties, though humans stand to gain socio-economically (i.e. through 1), politically and health-wise (i.e. through 5) in some cases. Interactions arising via 2 and 3 might cause psychological distress to people (and sharks too perhaps), embed a negative image of sharks and evoke the 'Jaws Effect' as a political instrument in policy-making (Neff 2015). Yet, such interactions can also bring financial benefits through ecotourism (e.g. Huvneers et al. 2017) and foster human understanding and interest in shark behaviour and current conservation concerns (Apps et al. 2018) that may translate to better physical outcomes for sharks in the long run (Topelko and Dearden 2005). We now delve a little deeper into the threats and opportunities arising from human–shark interactions before presenting some possible solutions in the next sections.

A large number of shark and ray species are currently at high risk of extinction (Dulvy et al. 2021; Pacoureau et al. 2021; Juan-Jordá et al. 2022; Sherman et al. 2023). Indeed, recent analyses based on global biodiversity indicators including the International Union for Conservation of Nature (IUCN) Red List Index, which charts changes in the relative extinction risk of taxa, have shown that three quarters of oceanic species (Pacoureau et al. 2021) and 59% of coral reef-associated species (Sherman et al. 2023) are threatened with extinction. Overfishing is widely accepted as the number one cause (Dulvy et al. 2021). Since 1970, the

¹ <https://www.southernfriedscience.com/more-than-100-shark-scientists-including-me-oppose-the-cull-in-western-australia/>

global abundance of oceanic sharks and rays has decreased by 71%, with the 18-fold increase in relative fishing pressure observed over the same period being identified as the key driver of the decline (Pacoureau et al. 2021). Populations of coral reef-associated species have also undergone marked declines over the past 70 years approximately, primarily as a result of fishing, but also compounded by the effects of climate change and habitat loss (Dulvy et al. 2021; Sherman et al. 2023). Shark and ray species are mostly 'K-selected', exhibiting low lifetime reproductive potential and reaching maturity late (Conrath and Musick 2012). Hence, many species are both highly susceptible to overfishing (Dulvy et al. 2008, 2021; Feretti et al. 2010; Gallagher et al. 2012) and recover slowly from it (Smith et al. 1998).

Despite these well publicised declines, sharks and rays continue to be heavily harvested across the world's oceans (Clarke et al. 2013; Davidson et al. 2016; Peatman et al. 2023). In the western and central Pacific Ocean (WCPO) annual elasmobranch (sharks, rays and skates) catch from the tuna fishery estimates have been trending up since 2015, with the most recent estimate (for 2019) approaching 100,000 individuals per year (Peatman et al. 2023). This is a small (yet still significant) quantity of animals compared with global landings, which peaked at between 63 and 273 million individuals per year in the early 2000s, with more recent estimates of around 780,000 tonnes caught per annum (Davidson et al. 2016). It is important to note also that these figures are likely to be underestimates of the true catch, given that shark catches are often underreported in fishery statistics (Clarke et al. 2013) and fisheries observer records (Forger et al. 2021; Peatman et al. 2023).

Shark catches contribute to a lucrative global trade in shark products, including meat, fins, gill plates, skin and liver oil (Dent and Clarke 2015; McClenachan et al. 2016; Wu 2016; HSI 2021) which in turn supports livelihoods, economies and food security in many countries (Dent and Clarke 2015). Of all shark-derived products, fins provide the greatest economic value at all levels of the supply chain (Simpfendorfer and Dulvy 2017; Human Society International (HSI) 2021; Hasan et al. 2023). With continuing high demand across the Global South and North (HSI 2021; but see Eriksson and Clarke 2015), coupled with poor traceability and industry regulation, fishing for, and trade in, shark fins is seen to represent one of the key global threats to shark populations (Hasan et al. 2023). These issues again highlight the tension between socio-economic needs of some groups of humans and the conservation objectives of others, with sharks sitting squarely in the middle. That said, a focus on improving industry transparency, product traceability and a better integration of science-based management, by leveraging the power of international treaties such as the Convention on Migratory Species and the Convention on International Trade in Endangered Species (CITES), may be one path towards more sustainable shark fisheries and the ethical use of products they provide (Vincent et al. 2014; Simpfendorfer and Dulvy 2017; Hasan et al. 2023).

Ecotourism based around shark observation offers an alternative way for humans and sharks to interact. Since the early 1990s, shark tourism, commonly involving diving, snorkelling or other forms of visual engagement with sharks, has grown in popularity internationally and is now highly profitable (Anderson and Ahmed 1993; Dicken and Hosking 2009; Cisneros-Montemayor et al. 2013; Huveneers et al. 2017; Gonz  les-Mantilla et al. 2021). In a global survey of the distribution and economic value of shark-based ecotourism operations up to 2010, Gallagher and Hammerschlag (2011) identified 376 established operations in 83 locations across 29 different countries. Soon after, Cisneros-Montemayor et al. (2013) evaluated the global economic benefits associated with shark 'watching', which they defined as "... any form of observing sharks in their natural habitat without intention to harm them". They estimated that around 590,000 divers partake each year internationally, contributing greater than USD 314 million per annum and supporting 10,000 jobs. These figures were predicted to more than double by the early 2030s (Cisneros-Montemayor et al. 2013), a prediction supported recently by Healy et al. (2020) who documented shark tourism operations occurring across at least 42 countries as of November 2017. Shark tourism also represents an important tourist sector for small island nations (e.g. Anderson and Ahmed 1993; Anderson et al. 2011; Gonz  les-Mantilla et al. 2021), including PICTs, with several studies confirming its socio-economic value to Fiji (Brunnschweiler 2010; Vianna et al. 2011), French Polynesia (Clua et al. 2011), and Palau (Vianna et al. 2012), among others. Palau designated the world's first shark sanctuary in 2009, and a 2010 socio-economic survey of divers, dive operators, guides and fishers indicated that shark-diving was the third largest contributor to the Palauan gross tax revenue, contributing USD 18 million per year to the economy and 8% of annual gross domestic product (Vianna et al. 2012). It was estimated that if the approximately 100 sharks regularly visited by tourist operators at that time were captured by fishers, their economic value would represent a fraction of what these animals were worth as a tourist drawcard (Vianna et al. 2012).

Aside from the economic benefits, there is also evidence that shark tourism can impart important community and conservation benefits, providing value to humans and to sharks through strengthening our connection with nature and raising our awareness of sharks' important roles within it (Apps et al. 2018). Even so, the industry can pose risks to target species, environments and humans if human-shark interactions are poorly handled or in the absence of appropriate management controls (see Clua 2018; Healy et al. 2020 for examples).

It is clear that humans and sharks can interact in diverse ways, but few interactions present a more challenging social and environmental conundrum than when a shark bites a human (Gibbs et al. 2020). Each year across the world, a small number of interactions between humans and sharks result in human injury or death. These interactions are commonly referred to as 'shark attacks' or 'shark bites'. The

most recent data from the Florida Museum of Natural History's International Shark Attack File (ISAF)² highlights the strong year-to-year, decadal and regional variability in both the numbers of unprovoked shark attacks recorded globally (Fig. 3) and the rate of attacks (Midway et al. 2019). Though some caution is warranted in interpreting this data due to changes in reporting rates through time, a general decrease in annual numbers of shark-bite incidents since 2015 is evident. Moreover, the fatality rate from these incidents continues its longer-term decline (Fig. 3; ISAF 2023).

These declines in part reflect advances in beach safety, medical treatment and public awareness (ISAF 2023). Interestingly, in some regions where the incidence of attacks has risen through time (e.g. white shark attacks in California), the attack risk for individual ocean users has declined, a pattern exposed after accounting for human population growth and trends in ocean use (Ferretti et al. 2014). Attack risk is often linked with human population size, though other factors like the level of coastal development, local- and broad-scale environmental conditions, and changes in behaviour and spatial distribution of humans and sharks are emerging as important (West 2011; McPhee 2014; Chapman and McPhee 2016).

While the mechanisms influencing shark attack risk are still under study, we do know that shark attacks pose a low chance but high consequence risk for humans, one that can impart substantial physical and psychological damage to individuals and potentially affect the economies of beach communities (McPhee 2012). Rather unsurprisingly then, how best to manage and mitigate this risk remains a complex, emotionally charged, hotly debated topic. Neff (2012) neatly captures the complexity:

“There are no simple government solutions when sharks bite people. These rare and sometimes fatal incidents are fraught with uncertainties regarding what happened, why it occurred, and how best to respond. Shark bites represent an unresolved puzzle for coastal managers, scientists, policymakers, and conservationists, who attempt to balance the protection of endangered predatory marine animals with the harm the public can experience from human–marine life conflicts. This dilemma is complicated by the low probability and dreadful consequences of these events, the high degree of public emotion they elicit, and policy responses that can deplete endangered species' populations. Yet, shark bite incidents are reported annually in nations across the globe, usually without policy changes. It is when human behaviours or perceptions change, not shark behaviour, that problems are observed and government action is requested.”

Logic dictates that on a global scale, developing solutions to support human and shark coexistence is necessary for conservation of sharks and minimisation of risks to humans (Gallagher 2016; Simmons and Mehmet 2018; Gibbs et al. 2020). This need is particularly pressing, given the increase in anthropogenic activities in coastal areas and current threats faced by shark populations. A substantial body of research now exists into methods aimed at minimising the chance of negative human–shark encounters, with substantial progress made in recent times due to the interplay of technological advances and improved scientific and public understanding of shark behaviour (e.g. McPhee 2012; DeNuzzo 2019; Gibbs et al. 2020; McPhee et al. 2021, 2022). Therefore, in defining the most appropriate action to take to mitigate the

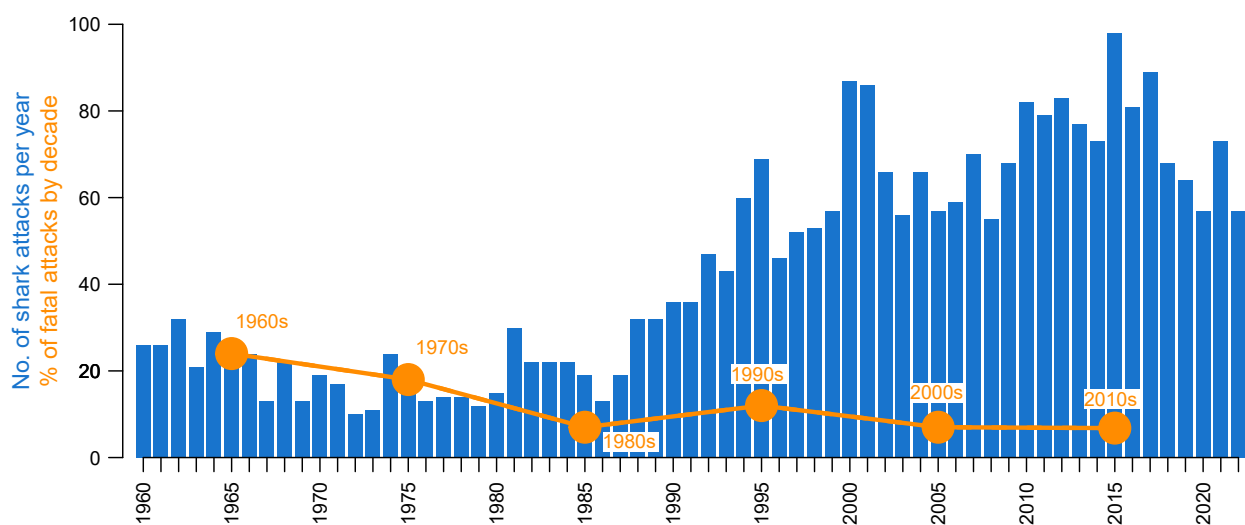


Figure 3. Number of unprovoked shark attacks per year worldwide between 1960 and 2022 (blue bars) and the percentage of attacks that were fatal by decade (orange circles) (Data sourced from the ISAF <https://www.floridamuseum.ufl.edu/shark-attacks/trends/frequency-rates/world/> [accessed 12 December 2023])

² <https://www.floridamuseum.ufl.edu/shark-attacks/>

risk of attack by a particular species and/or in a particular locality, it might be prudent to look at examples from elsewhere to gain the most objective, evidence-based views on the appropriate strategy or strategies to employ.

To this end, in Table 1 we list the current shark hazard management strategies available for mitigating risk of negative human–shark impacts in nearshore environments. By

providing information on the key benefits and drawbacks of each strategy, linked to relevant scientific literature, the table aims to provide a reference to managers and policy-makers faced with decisions around how to balance social, economic, environmental and political values to achieve optimal outcomes for sharks and humans. Strategies are classified under ‘lethal’ and ‘non-lethal’ subheadings, reflecting the endpoint from the shark’s perspective.

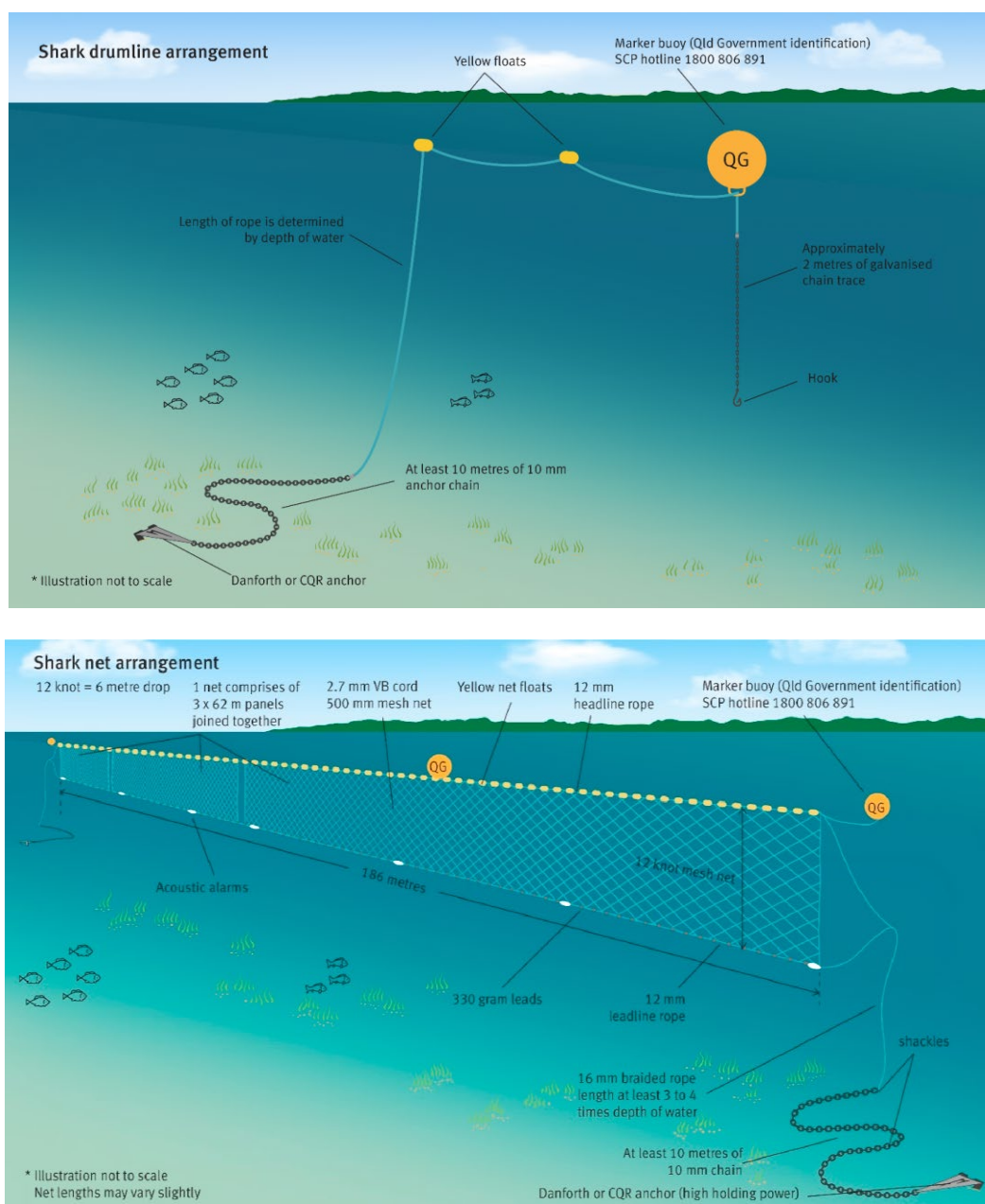


Figure 4. Lethal shark hazard management strategies - shark nets and shark drumline (redrawn from McPhee et al. 2021)

Table 1. Available strategies for mitigating risk of negative human–shark impacts in nearshore environments

| Management strategy | Positive consequences | Negative consequences | Notes | References |
|---|---|---|--|--|
| Lethal strategies | | | | |
| <i>Shark culling</i> | | | | |
| <ul style="list-style-type: none"> • Several methods: gillnets (a.k.a “shark nets”), baited drum lines, longlines. • Active and passive gears. • Lethal control methods. | <ul style="list-style-type: none"> • Decreased perceived level of risk to public. • Public feel that action is being taken to reduce shark bite/attack risk. • If implemented in collaboration with scientists, could provide opportunities for collection of biological samples from captured animals to better understand shark biology, ecology and genetics. | <ul style="list-style-type: none"> • Lethal end point for sharks. • Contributes to global trends of elasmobranch (sharks, rays and skates) population decline. • Extremely challenging to objectively quantify success or failure of culling efforts. • Unpredictable effects of removal of top predators on ecosystem dynamics and functioning. • Potentially high non-target, by-catch species entanglement and/or mortality (depending on gear type used for culling). • The two main targeted species in New Caledonia, the tiger shark (<i>Galeocerdo cuvier</i>) and bull shark (<i>Carcharhinus leucas</i>), are classified as ‘Near Threatened’ internationally on the IUCN Red List. • Growing public concerns about the environmental impacts of culling exercises. • Uncertainty around their effectiveness for improving human safety. • Poor public approval – inconsistency with contemporary societal values in the face of effective non-lethal technologies becoming available. • Approach ignores the potential for long-range movement of these species and immigration back into previously fished areas. • Set up and operational costs: high: approx. AUD 1,000,000 per year for large programmes. | <ul style="list-style-type: none"> • Lack of scientific evidence for culling activities measurably decreasing attack rates from tiger or bull sharks (see case studies in Hawaii, South Africa, and Queensland and New South Wales, in Australia). • No correlation found between the abundance of sharks in the local area and the risk of a shark attack (see results from the 2014 tiger shark drum line programme in Western Australia). | <p>Wetherbee et al. 1994</p> <p>Treves et al. 2006</p> <p>Gibbs et al. 2020</p> <p>Feretti et al. 2010</p> <p>Burkholder et al. 2013</p> <p>Ruppert et al. 2013</p> <p>Ripple et al. 2014</p> <p>McPhee 2012</p> <p>McPhee et al. 2021 (Fig. 4)</p> <p>Administrative Appeals Tribunal of Australia, 2019*</p> |

| Management strategy | Positive consequences | Negative consequences | Notes | References |
|--|--|---|--|--|
| Shark nets | | | | |
| <ul style="list-style-type: none"> • Not a physical barrier. • Rather, aimed at reducing shark populations. • Passive gear. • Lethal control method. | <ul style="list-style-type: none"> • Decreased perceived level of risk to public. • Public feel that action is being taken to reduce attack risk. | <ul style="list-style-type: none"> • High mortality of sharks and high potential risks to threatened, vulnerable and endangered non-target species (including other sharks, rays, turtles, dugong, dolphins). • Potential negative consequences for tourism (bad publicity and impact on iconic species populations). • Low support from public due to conservation ethics. • Effectiveness unproven: attacks still occurring in areas where nets have been long established. • Need effective data collection and monitoring systems in place. • Potential environmental cost: large. • Set up and operational costs: high. • Nets need to be checked regularly. | <ul style="list-style-type: none"> • Need to be differentiated from physical shark barriers | <p>Curtis et al. 2012 Marsh et al. 2001 McPhee et al. 2021 (Fig. 4) Green et al. 2009 Brazier et al. 2012 Atkins et al. 2013; 2016 Daly et al. 2021 Worm et al. 2013 Gibbs et al. 2020 DeNezzo et al. 2019</p> |
| Non-lethal strategies | | | | |
| Shark barriers | | | | |
| <ul style="list-style-type: none"> • Physical barrier from sharks. • Often enclosures for swimmers. • Non-lethal control method. <p>e.g. Fish Hoek exclusion net (South Africa) (Davison and Kock 2014) (Fig. 5)</p> <p>e.g. Global Marine Enclosures - Aquarium Gen 2 Barrier** (Fig. 5)</p> | <ul style="list-style-type: none"> • Proven very effective at excluding sharks in swimming areas, though from limited trials. • Non-lethal method for sharks. • Very limited by-catch, especially if temporary. • Public safety perceived, and increased public support for government action. • Good publicity for the government/tourism, as non-lethal option. • Not dependent on water clarity. • Set up cost: medium. • Operational cost: low. • Some light barriers are easily removed for cleaning or during lower beach use or storm season | <ul style="list-style-type: none"> • For swimmers only (small enclosure close to beach): not appropriate to surfers, kite-surfers, etc. • Further trials needed to test efficacy. • Not designed to cover large areas (max ~500m). • Need to be deployed in calm waters only. • Damaged by storms or strong waves if permanent. • Biofouling decreases longevity. • If temporary: high operational needs • Potential conflict with other human use of the area. • If permanent, need to be inspected by divers regularly. • Uncertain community attitude. • Set up cost: medium. | <ul style="list-style-type: none"> • More rigid than a shark net, from bottom to surface and large mesh to let other marine life swim through. • Flexible deployment strategy: can be permanent or temporary (the latter reducing potential damage from storms, waves, biofouling) | <p>McPhee 2012 (Fig. 5) McPhee et al. 2021 Kock et al. 2012 Davison and Kock 2014 Simmons and Mehmet 2018 Green et al. 2009 DeNezzo et al. 2019 Hydrobiology 2014</p> |

| Management strategy | Positive consequences | Negative consequences | Notes | References |
|---|---|---|-------|---|
| SMART (Shark Management Alert in Real Time) or Catch-Alert drum lines | | | | |
| <ul style="list-style-type: none"> • Non-lethal control method. • Drum lines with the addition of an alert system to ensure the relevant parties are notified when something is hooked. | <ul style="list-style-type: none"> • Non-lethal. • Works in all sea states and water clarity conditions. • Allows tagging and relocation of targeted sharks and release of bycatch at the capture location. | <ul style="list-style-type: none"> • Catches non-target species. • Need to be reactive, with a team ready to free and relocate sharks. • Set up cost: moderate. • Operational cost: high. • High human resource needed. | | <p>McPhee et al. 2021</p> <p>McPhee et al. 2022</p> |
| 'SharkSafe' and similar exclusion barriers | | | | |
| <ul style="list-style-type: none"> • Visual and/or electromagnetic stimuli. • Non-lethal control method. | <ul style="list-style-type: none"> • Non-lethal and no bycatch • SharkSafe barrier effective in small spatial scale experiments. • Improved performance of newer designs at larger spatial scales. • Limited operational costs • Not dependent on water clarity. | <ul style="list-style-type: none"> • Technology is still under development/testing and is not commercially available. • Not designed to cover large areas. • Potential conflict with other human use of area. • Set up cost: medium. | | <p>McPhee et al. 2021</p> <p>O'Connell et al. 2014</p> <p>O'Connell et al. 2022</p> |
| Detection methods | | | | |
| Aerial detection: blimp | | | | |
| <ul style="list-style-type: none"> • Pre-emptive, non-lethal control method. | <ul style="list-style-type: none"> • Effective method with very high detection probability (>90% on sunny day; and >75% on cloudy days; in shallow waters). • Non-lethal method, no bycatch. • Non-invasive. • Continuous detection throughout the day. • Good publicity for the government/tourism. • Most efficient in swimming areas (vs surf or other water sports). • Detection can be automatic (AI). • No noise pollution. • Environmentally friendly with no battery power. • Commercially available. • Operational cost: low. | <ul style="list-style-type: none"> • Needs to be paired with lifeguard surveillance and alert system. • Could increase safety across all water-based activities in a location. • Water clarity needs to be high to moderate. • Set up cost: moderate. | | <p>McPhee et al. 2021</p> <p>Adams et al. 2020</p> |

| Management strategy | Positive consequences | Negative consequences | Notes | References |
|---|--|--|-------|--|
| Aerial detection: drone or helicopter | | | | |
| <ul style="list-style-type: none"> • Pre-emptive, non-lethal control method. | <ul style="list-style-type: none"> • Non-lethal method, no bycatch. • Non-invasive. • Most efficient in swimming areas (vs surf or other water sports). • Set up cost: low. • Operational cost: low (drone) to expensive (helicopter). | <ul style="list-style-type: none"> • Detection probability high in good weather conditions and with good water clarity. • Transects rather than providing visibility over whole area. • Needs to be paired with lifeguard surveillance and alert system (re: drone) • Noise pollution issues. • Potential negative response from public due to noise or privacy issues. | | <p>McPhee et al. 2021</p> <p>Simmons and Mehmet 2018</p> <p>Robbins et al. 2014</p> <p>McPhee et al. 2022</p> |
| Aerial detection: towers, beach level or headlands (shark spotters) | | | | |
| <ul style="list-style-type: none"> • Pre-emptive, non-lethal control method. | <ul style="list-style-type: none"> • Non-lethal method. • No bycatch. • Non-invasive. • Set up cost: low • Operational cost: moderate • Most efficient in swimming areas (vs surf or other water sports). | <ul style="list-style-type: none"> • Detection probability only high in good weather conditions and with good water clarity. • High human resource needed. • Needs to be paired with lifeguard surveillance and alert system. • Potential negative response from public due to privacy issues. | | <p>McPhee et al. 2021</p> <p>Simmons and Mehmet 2018</p> <p>Robbins et al. 2014</p> |
| Sonar (detection of sharks in water) | | | | |
| | <ul style="list-style-type: none"> • Non-lethal method. • No bycatch. • Works in all sea states and clarity. | <ul style="list-style-type: none"> • Detection can be limited, or needing to cover large areas. • Still needs to be tested in terms of effectiveness. • Set up cost: high. • Operational cost: high. | | <p>McPhee et al. 2021</p> <p>DeNezzo et al. 2019</p> |
| Deterrence methods | | | | |
| Individual shark deterrent (e.g. "shark shields") | | | | |
| <ul style="list-style-type: none"> • Pre-emptive, non-lethal control method. | <ul style="list-style-type: none"> • Different types: electrical, magnetic, semio-chemical, visual. • Electrical personal risk-reduction technology. • Easy to implement. • First-line-of-protection. • Take-up easily encouraged with govt tax exemptions. | <ul style="list-style-type: none"> • Not a stand-alone complete deterrent. • Effectiveness varies with model and activity of the user • Not 100% effective. • May encourage lax behaviour due to incorrectly assuming total protection is offered. • Set up cost: high for individuals USD 300-600 for electrical (XPF 33,000-66,000). | | <p>Huveneers et al. 2012</p> <p>Huveneers et al. 2018</p> <p>DeNezzo et al. 2019.</p> <p>O'Connell et al. 2014</p> |

*<http://www8.austlii.edu.au/cgi-bin/viewdoc/au/cases/cth/AATA//2019/617.html>

**<https://www.globalmarineenclosures.com/aquarius-barrier-gen-2>

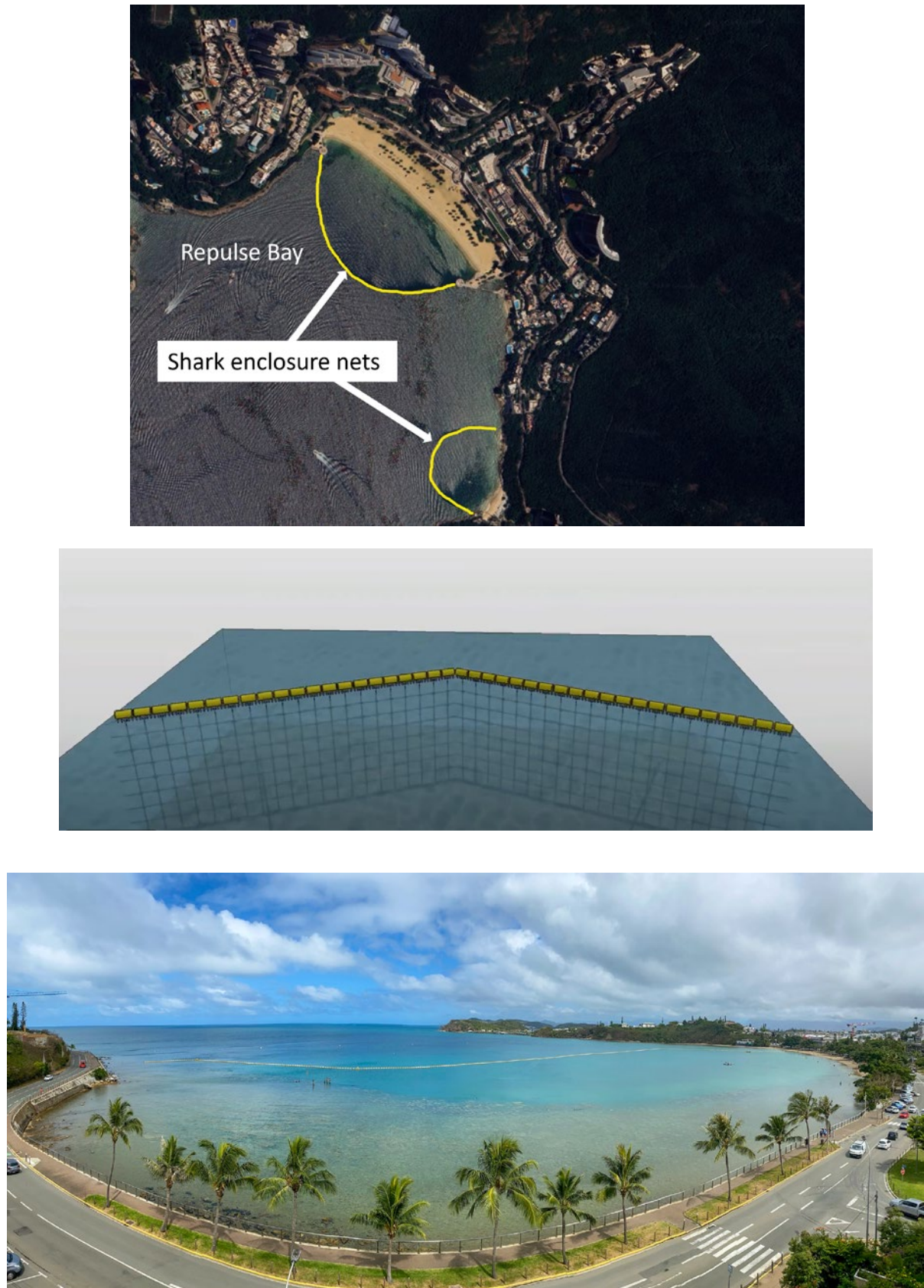


Figure 5. Examples of shark barriers for swimming enclosures.

Top: swimming enclosures in Hong Kong (adapted from McPhee 2012; Map data: Google, © 2023 Airbus);

Middle: Aquarius Gen 2 Barrier (<https://www.globalmarineenclosures.com/aquarius-barrier-gen-2>);

Bottom: newly-installed shark barrier enclosure at Baie des Citrons in Noumea, New Caledonia. ©Sophie Garioud

The need for continued research

While not an exhaustive list, Table 1 does illustrate the diversity of options available for minimising the risk of negative human–shark encounters. It is clear that shark hazard management strategies are evolving in concert with new technological developments and a greater public awareness of and support for conservation and non-lethal responses. That said, our literature review also indicated that a still often missing piece of the puzzle relates to our understanding of shark behaviour and biology, and the underlying causes of negative human–shark encounters. As programmes to reduce negative human–shark encounters are typically expensive, government priorities often appear to have been placed on the implementation of the management strategy itself, rather than invested in scientific programmes to understand the root cause of the encounters or to evaluate the environmental, social and political consequences of the different strategies.

This feels like an opportunity lost, since the implementation of shark hazard management strategies, either with lethal or non-lethal endpoints, can theoretically provide the perfect platform for gathering biological and ecological data on shark populations. For instance, despite little evidence of success in terms of reducing attack rates, and some shortcomings in scientific focus, the Hawaiian shark control programmes that ran between 1959 and 1976 generated crucial new information on the diet, reproduction and distribution of sharks around Hawaii (Wetherbee et al. 1994). Through science-led initiatives, taking advantage of recent advancements in electronic tagging technology, genetic methods, sonar and baited remote underwater video cameras (BRUVs), additional detailed data can be collected on site fidelity, large-scale movements, and population size and structure (Blaison et al. 2015; Taglioni et al. 2019; Drymon et al. 2021; Barnett et al. 2022). This information is doubly useful. First, it can help us better understand the drivers of human–shark interactions, and second, it can be fed back to update and optimise the design of the shark management strategies that generated the data in the first place.

In addition to the biological and ecological factors, the examples listed in Table 1 also reinforce the importance of considering the human dimension of human–shark interactions. They highlight in particular how engaging all stakeholders through effective education and communication programmes is a necessary ingredient in developing a “SharkSmart” understanding (<https://www.sharksmart.nsw.gov.au/>) among the general populace. This in turn allows management agencies to make the most informed, evidence-based policy decisions around what action to take to best mitigate risk, no matter if these decisions are made at local, state or national levels. The success of the current New South Wales Shark Management Strategy and Shark Program (McPhee et al. 2022) provides a good example of the advantages of this type of integrated approach, one that

is adaptable to changing social perceptions around human–shark interactions and open to integrating new data as it comes to hand. Such programmes are increasingly acknowledging that humans and sharks will always share oceanic environments, and that strategies that promote coexistence rather than dominance will ultimately benefit both parties.

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