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SPC
activities



Regional
news



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Dr Antony David Lewis

by John Hampton and Peter Williams



Dr Antony David Lewis – alternatively and affectionately known as Dr Fish, Yoda, ADL, or simply Tony – passed away on 23 September 2022 after a short illness. Tony was a fisheries legend in the Pacific, and his passing will be deeply felt by his many friends and colleagues in Australia, the Pacific, Southeast Asia and elsewhere in the world.

Tony grew up in Brisbane, Queensland, with a passion for fish and fishing. Always a gifted student, it was no surprise that he attended Queensland University and studied fisheries science, obtaining a BSc with First Class Honours in 1971. From there, Tony's journey in the Pacific began, as he took on the role of Principal Biologist in the Ministry of Agriculture, Stock and Fisheries in pre-independent Papua New Guinea. There, his interest in the burgeoning pole-and-line skipjack tuna fishery began, and he was instrumental in developing the first large-scale tagging programme for skipjack in PNG. The early results of that work, in particular the wide distribution of skipjack tag recaptures outside of PNG, stimulated his interest in larger questions around skipjack stock structure and regional productivity. His great friend and mentor, Bob Kearney, brought Tony to SPC Noumea for the first time in 1977, where he played a major role in setting up and implementing the first SPC-region-wide tuna tagging experiment, the Skipjack Survey and Assessment Programme. Tony's interest in all-things-skipjack continued, along with his other passion, scombrid taxonomy, which was the topic of his PhD at the Australian National University from 1978–1981.

With his newly minted PhD in the pocket, Tony then took on the role of Principal Fisheries Officer (Resource Assessment and Development) at the Fiji Fisheries Division in Suva, covering the gambit of coastal and offshore pelagic fisheries in Fiji. He continued his regular association with SPC during these years, attending all the regular fisheries meetings in Noumea before eventually being convinced to re-join the staff of SPC as Manager/Chief Scientist of the Oceanic Fisheries Programme (OFP) in 1988. This was a period of re-building and refreshment of OFP, and Tony brought his unique approach to leadership wholeheartedly to the task. A large new tagging programme focusing again on skipjack but now also on yellowfin tuna commenced, with substantial EU funding. Managing large field programmes such as this was Tony's forte, and he easily straddled the complex issues of scientific design, finance and administration, donor liaison and, importantly, motivating and encouraging the onboard team of scientists, technicians and the Tuvaluan crew of the chartered pole-and-line vessel *Te Tautai*.

During his 14 years at SPC, Tony shepherded many changes in OFP, including a broadening of the focus of the programme from primarily skipjack and yellowfin to also include the other species of tunas (bigeye and albacore), as well as billfish, sharks and other pelagic species impacted by the fisheries. Under his watch, the first forays into developing a regional observer programme were made, as well as large investments in data management and the application of cutting-edge stock assessment methodology to meet the emerging needs of regional fisheries management.

Such major programme development, of course, required substantial donor support. And bringing the donors onside and convincing them of the value of investing in OFP was an area in which Tony truly excelled. His "donor lunches" and early-morning fishing trips for representatives of the various donor agencies were the stuff of legends, and no doubt made a substantial contribution to many productive donor relationships that SPC, in particular OFP, enjoyed during this time.



Tony left SPC in 2002 to take up the Managing Director position at the Papua New Guinea National Fisheries Authority (PNG-NFA), which lasted until 2004, when he then served as a technical advisor (in a small team) that assisted the new Executive Director and Secretariat of the Western and Central Pacific Fisheries Commission (WCPFC) in its formative years.

From 2005 onwards, Tony remained very active in the region through a range of consultancies (including several tuna supply chain studies), serving on scientific committees (e.g. the Threatened Species Scientific Committee in Australia), often playing a pivotal role in a range of regional and international fisheries and seafood meetings, and serving as technical advisor to industry associations.

As the Pacific Tuna Tagging Project (PTTP) Project Consultant/Coordinator, Tony brought his vast experience to assist with planning and provide overall coordination of this third major SPC-led tagging project over the period 2006–2019. During this time, he also achieved a significant milestone of personally tagging his 100,000th tuna, a record that is never likely to be broken.

From his exposure to the domestic fisheries in Indonesia, the Philippines and Vietnam, particularly during the years of the SPC tagging projects, Tony recognised the importance and magnitude of catches from these fisheries and the potential impacts to WCPFC tuna stocks and the tuna fisheries of SPC member countries. He was significantly involved in developing the initial project documentation for the West Pacific East Asia Project (WPEA) that aimed to improve the monitoring and management of the domestic tuna fisheries of these countries.

The WPEA project began in 2010 and continues to be administered by WCPFC today with SPC contracted to provide ongoing technical assistance. Tony played a key active role in the WPEA project from the outset, with his technical expertise covering a range of areas, including the provision of expert advice on establishing capacity around species identification, technical advice on the annual catch estimation process, establishing observer and port sampling programmes, advice on rationalising import/export data, and advice on improving onboard fish handling and storage for the Vietnam handline fishery.

An example of the significant contribution he made through the WPEA project was the award of an official government medal from the Vietnam Minister of Agriculture and Rural Development in 2013 for his services to improving the monitoring of Vietnam fisheries.

Tony was also a technical adviser of the International Pole and Line Foundation, an organisation dedicated to developing sustainable and equitable pole-and-line fisheries. One of his key roles in the organisation was co-chairing their Scientific and Technical Advisory Committee.

During his life, Tony was an acknowledged expert in fish identification throughout the Pacific. His passion for ichthyology was mostly undertaken in his own personal time and he was responsible for acquiring and compiling various information that resulted in the formal acceptance of several new fish species. He had the keen eye of a naturalist that allowed him to discern new species that were hiding in plain sight. His work in this area was acknowledged with several new fish species bearing his name, for example, Lewis' round herring (*Spratelloides lewisi*).

Tony is survived by his brother Geoff, six nieces and nephews and his son Arnaud. Arnaud, who lived close to Tony in Brisbane for the past 10 years, has inherited his dad's love of fishing, his good humour and love of a good time. All with a delightful French accent. Can you imagine!

Adopting a WCPO skipjack tuna harvest strategy: A big step forward at the 19th Western and Central Pacific Fisheries Commission meeting

Viet Nam's vibrant city of Da Nang was the venue for the 19th Western and Central Pacific Fisheries Commission annual meeting (WCPFC19) between 27 November and 3 December 2022. A major topic of discussion at the meeting was a harvest strategy for western and central Pacific Ocean (WCPO) skipjack tuna.

The beginning

Members of the WCPFC agreed to the development and implementation of harvest strategies back in 2014, when they adopted conservation and management measure (CMM) 2014-066,¹ which was an agreement to develop and implement a harvest strategy approach for key fisheries and stocks in the WCPO. A harvest strategy is a set of pre-agreed management actions regarding a fishery that will achieve agreed on management objectives such as stock sustainability, economic benefits, and social outcomes such as employment levels. The pre-agreed actions to be taken are dependent on the status of the stock and are defined through a management procedure. A harvest strategy should improve fisheries management by increasing the speed and transparency of decision-making, and ensuring that actions are robust to the uncertainties inherent in fisheries science and management.

Harvest strategies represent best practice in fisheries management and are critical to the ongoing certification of tuna fisheries to global standards for sustainable fishing. Their implementation would represent a notable change in the way WCPO fisheries are managed; moving to the new system is a significant step forward. At its heart, the harvest strategy approach is a stakeholder-driven process in which members identify their collective goals and objectives for the fishery, and select the preferred management procedure to achieve them.

The road to adoption

Over the last eight years, the Pacific Community's Oceanic Fisheries Programme (SPC-OFP) has supported the harvest strategy approach, undertaking the technical work to evaluate candidate management procedures and provide results to WCPFC members on potential outcomes. This work has been featured in over 50 papers to the WCPFC's Scientific Committee and other regional meetings. In turn,

we have undertaken a series of capacity building workshops in more than 14 countries, and provided broader regional capacity building through seminars, workshops and films to WCPFC members, with the aim of ensuring that the results of evaluations can be understood. It is essential that members feel comfortable in taking the decisions necessary to drive the process forward, ensuring that the outcomes meet their objectives and continue the responsible stewardship of the critically important fish resources of the region.

As part of the harvest strategy development, the WCPFC held its first Science Management Dialogue (SMD) meeting in August 2022, with a focus on the WCPO skipjack fishery. This forum enabled scientists and managers to interact, build capacity and provide key input into the harvest strategy process. Successful discussions at the SMD narrowed down the number of candidate management procedures under consideration and defined the final analyses to be performed to support discussions at WCPFC19.

The Parties to the Nauru Agreement (PNA) and Pacific Island Forum Fisheries Agency (FFA) carried the momentum from the SMD and continued to drive the process. The WCPFC19 meeting had a dedicated agenda item focused on the skipjack harvest strategy. Feeding into this agenda item, the FFA membership had put forward their preferred harvest strategy for skipjack based upon the outcomes of the SMD and FFA members' discussions. This was in the format of a candidate CMM², which formed the basis for WCPFC discussion and negotiation.

In our role as the independent scientific services provider to WCPFC, SPC-OFP presented the results of analyses requested by the SMD to WCPFC19's plenary. We were also deeply involved in the three small working group meetings held during the week, answering questions, providing new papers, responding to requests from members, and developing new presentations to clarify issues. We also provided information to the side-meeting negotiations that were necessary to finalise the draft harvest strategy. Throughout

¹ Conservation and management measures to develop and implement a harvest strategy approach for key fisheries and stocks in the WCPO. <https://www.wcpfc.int/doc/cmm-2014-06/conservation-and-management-measures-develop-and-implement-harvest-strategy-approach>. WCPFC's conservation and management measures (CMMs) describe binding decisions relating to conservation and management measures.

² <https://meetings.wcpfc.int/node/17862>



Catching skipjack during a tagging campaign. Image: ©Bruno Leroy, SPC

this process, the unfortunately named online PIMPLE app³, designed and developed by SPC-OFP, proved invaluable for presenting and explaining the results of scientific analyses that supported the negotiations.

A milestone

The good news is that on the last day of the meeting, the WCPFC19 plenary adopted the negotiated interim harvest strategy for WCPO skipjack tuna, containing an agreed-on management procedure that will define future levels for the key fisheries catching this stock. The interim nature of the harvest strategy allows WCPFC members to become comfortable with the approach and familiar with how it operates, while allowing the Commission process to adjust to this new way of working.

This adoption is a landmark for the Commission that reflects over eight years of collective effort. It paves the way for the adoption of harvest strategies for the other key tuna stocks – South Pacific albacore, WCPO bigeye and yellowfin – over the coming years.

What happens next?

There is still work to be done. Over the next seven years a schedule of analyses and monitoring has been agreed to as part of this harvest strategy, which will involve running the management procedure for the first time in 2023 to define future fishing levels. That will feed into discussions on the tropical tuna CMM, due to be re-developed by the end of

2023, as the mechanism through which the skipjack harvest strategy will be made operational. In turn, approaches to monitor the harvest strategy and check that it is performing as expected are to be agreed on in the next couple of years.

After this, work to support the harvest strategies for the other key tuna stocks will keep WCPFC members and ourselves busy for a few years to come!

We sincerely thank the European Union for their funding to support early activities, and the New Zealand Foreign Affairs and Trade Aid programme for their long-term funding under the “Pacific tuna management strategy evaluation” project, which has been pivotal to the success of this work.

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³ Performance Indicators and Management Procedures Explorer (PIMPLE) - https://ofp-sam.shinyapps.io/PIMPLE_WCPFC19/
 See also Scott F. 2022. Hitting the spot! Behind the scenes of the PIMPLE training videos. SPC Fisheries Newsletter 168:17–18. <https://purl.org/spc/digilib/doc/he7t2>

An ode to ear stones: A summary of activities around IPWoFA 22

The Indo-Pacific Workshop on Fish Ageing 2022 (IPWoFA22) kicked off at the end of November 2022, and included 28 participants from 13 institutions and 7 countries. The workshop was organised as part of a “Funding with Intent”¹ project to generate epigenetic clocks² for a suite of commercially important deep-water snapper species, and support fish ageing capacity across the region via otolith reading or epigenetic methods.

That is a lot to unpack! Here is the long story. Fish ageing is an important element of fishery management because the age structure of a fish stock has major implications for its sustainability. For example, if a species has a life cycle whereby it becomes disproportionately more reproductively successful with age, it is important to ensure that the oldest fish in a stock are not selectively depleted by fishing efforts. Therefore, fisheries management requires an accurate way to assess the age of fish.

The most common and traditionally enshrined way to age a fish is by counting the growth rings that form on little “ear stones” located on either side of the fish’s head, known as otoliths. The concept is the same as counting tree rings; throughout its life, a fish lays down translucent or opaque material at the edge of the otolith, depending on environmental conditions, creating daily and yearly growth rings. Extract the otolith, count the rings, and you will know how many winters the fish has seen. In species that do not lay down nice, clear growth rings (e.g. tropical species that do not experience significant seasonal environmental shifts), otolith chemistry can also be used to infer age. The sexiest version of this type of analysis is bomb radiocarbon otolith ageing. Specifically, the atomic bombs that exploded in the 1940s and beyond fundamentally changed the ratio of carbon isotopes in the atmosphere and, consequently, in fish otoliths. By measuring the carbon isotope ratio along the length of an otolith, it is possible to calibrate the absolute values and change over time with the historical atmospheric levels in order to estimate the year a fish was born and when it died.

Otoliths have been the gold standard for fish ageing for decades. There are some limitations, however, most notably that it does not work in some species, and that a fish must be dead in order to extract its otoliths. Another option is using length vs age growth curves that plot the length of a fish against its (otolith-validated) age, and then apply the resulting pattern to a non-aged fish. It would be great to need nothing but a fish’s length to know its age, but individual variation in growth and growth cessation after a certain age can introduce considerable inaccuracy in the resulting estimations.

Enter epigenetic ageing. The basic concept is that any living organism has DNA that begins degrading as soon as it is born, particularly by the increased methylation of key areas in the genome. For those of you who are molecular biology and chemistry enthusiasts: methylation happens when an

extra methyl group (CH₃) attaches to the phosphate groups that make up the backbone of DNA molecules, and results in reduced expression of certain genes. The relative amount of methylation of an individual’s DNA can, therefore, be calibrated to its age, with some technical discussion of biological age vs chronological age. The same applies to some humans who are more vital at age 70 than others who are 60. Developing epigenetic clocks also requires a validated ageing method (i.e. otolith reading) in order to make the initial calibration. However, after a lot of prerequisites and upfront work, epigenetic ageing allows for reasonably precise, cheap and non-lethal ageing of an organism.

All of the above was covered in IPWoFA22. The fundamental goal was to draw together fisheries scientists, fisheries professionals and geneticists (who sometimes happen to work on fish) from across the Indo-Pacific region to showcase and share knowledge on current and emerging fish ageing methods, and to demonstrate why accurate age estimates are important for stock assessments. At the workshop, there was also plenty of shop talk among fish agers from around the Pacific and beyond, and practical lab time where everyone who cared to could practice otolith extraction (and, later, ring counting), genetic sampling using biopsy punch tools, and even an off-the-cuff demonstration of extracting a fish eye lens (which is another organ that can be used for age validation).

The workshop covered an ambitious amount of material, and no one walked away without some expansion of their knowledge base. Ultimately, it is hoped that IPWoFA22 and its outcomes will help foster an Indo-Pacific network that is skilled in the latest fish ageing techniques, and with the capacity to coordinate and apply these techniques in future work across the region. Cheers to IPWoFA22, its organisers, and to the many collaborations in fish ageing to come!

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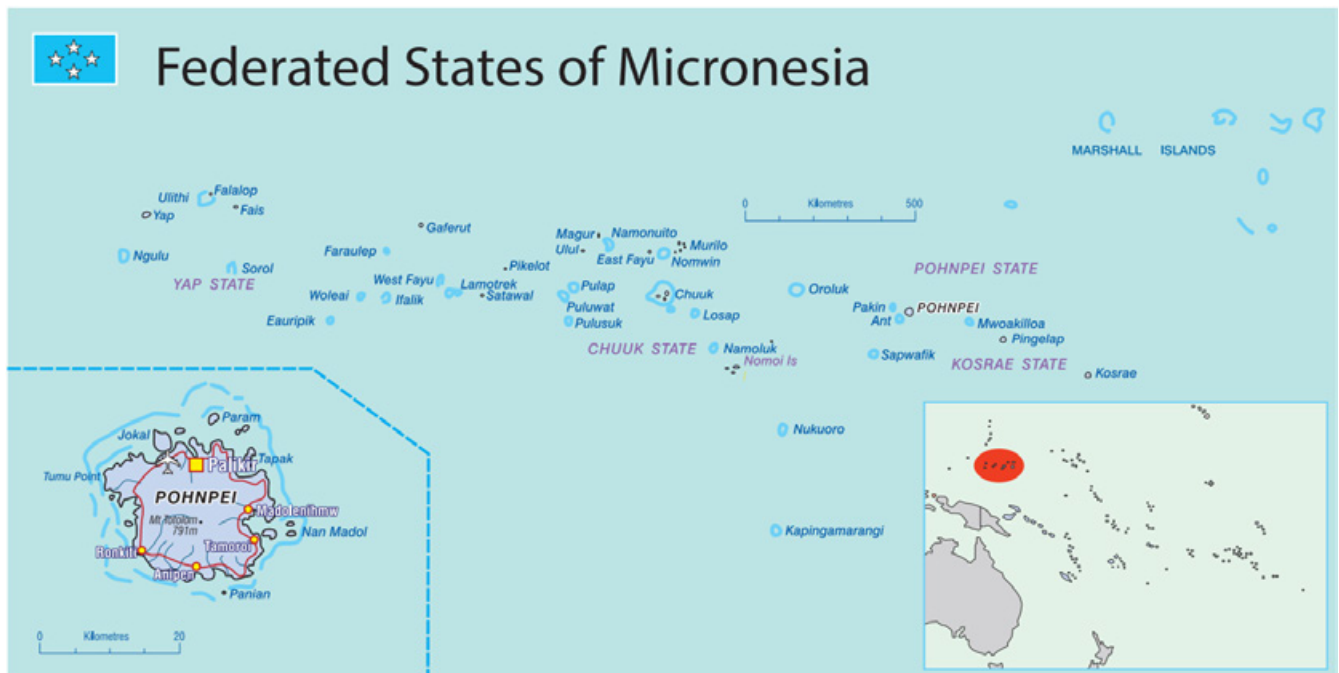
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¹ “Funding with Intent” is a research grant intended to increase capabilities in innovation, capacity development, and applying integrated, multi-sectoral approaches to development challenges across Pacific Island countries and territories. It is supported by New Zealand’s Ministry of Foreign Affairs and Trade, as part of the broader New Zealand-SPC partnership. This epigenetic ageing project received additional funding support from the Pacific Community Centre for Ocean Science.

² An epigenetic clock is a tool to estimate the age of an organism based on biophysical properties of its DNA.

Better safe than sorry: Raising awareness about sea safety in Pohnpei

In a region where many coastal communities depend on the sea for food and livelihoods, being safe at sea is paramount. Yet tragedies at sea have revealed a lack of basic safety equipment on board artisanal and small-scale fishing vessels. A sea safety awareness and grab bag programme that began in 2021, has been well received in Pohnpei, and offers benefits to other communities in the Federated States of Micronesia (FSM).



In FSM, coastal fisheries play a key role in the livelihoods of coastal communities. It has been estimated that the average amount of fish consumed per person per year in FSM is 69 kg (with the majority provided by subsistence fishing), and more than 50% of households derive their primary or secondary incomes from catching and selling fish (Gillett 2016).

Image: ©Bill Janes, Kaselehli Press



Sea safety in FSM – the situation

Enhancing sea safety for all local fishermen in FSM is critical for fishermen, their families and communities. FSM does not yet have an established maritime safety code, which can lead to local communities not feeling the need or the support for any safety practice responsibilities at sea. A pervasive attitude is, “If you can drive a boat, you’re good to go!”

In recent years, however, numerous mariners have lost their lives at sea in the waters around Pohnpei. Most of these cases later revealed a lack of basic sea safety equipment on board, such as lifejackets, a communication device and a personal locator beacon (PLB). In an emergency situation where a PLB has been activated, the coast guard instantly sends out a continuous 24-hour satellite signal on the PLB’s location to assist potential rescuers.

Sea safety programme developed in Pohnpei

An integrated programme was started in Pohnpei in 2021 – a partnership among the Pacific Community, FSM’s National Oceanic Resource Management Authority (NORMA), and the Office of Pohnpei State Fisheries and Aquaculture (OFA). The programme focuses on the development and monitoring of artisanal FADs (FADs), data collection on artisanal catch and effort (and non-FAD related), data collection on stranded or lost drifting industrial FADs, and sea safety for small boats. This article focuses on sea safety, which has several components: communications and awareness related to sea safety; safety grab bags; and distributing boat stickers and painting small vessels bright orange.

Sea safety awareness and communication

Through the support of various Pohnpei partners, various awareness activities were carried out to ensure that our message on sea safety was well heard and understood. Activities included:

- **Community outreach** – Special awareness meetings were held with communities, village leaders, and title holders on sea safety related to small boats, and other components of the programme.
- **Billboards** – Two sea safety billboard signs were erected; one between a major boat ramp in the heart of town and another at a popular fish landing site on the other side of town.
- **School visits** – Several school visits were organised by NORMA and OFA.
- **Events** – Awareness activities were held during special events and functions such as World Tuna Day and International Women’s Day.
- **Fishing club** – With support from the local fishing club through its regular monthly fishing tournaments, we spoke with fishers about sea safety.
- **Island visits** – Travel to Pohnpei’s surrounding islands with the OFA team helped to deliver our important message about sea safety.
- **Radio** – A radio announcement was developed and included a two-minute message about sea safety, which was announced five times a day.

Promoting sea safety awareness through a variety of activities.



• SPC activities •

- ◆ **Newspaper** – Several newspaper articles were written regarding the launch of the programme, as well as important safety workshops and the delivery of safety grab bags.
- ◆ **T-shirts** - T shirts with sea safety messages were printed and distributed.
- ◆ **Local workshops** - Working closely with business owners and fishers, the programme provided basic outboard motor workshops as another opportunity to deliver the message regarding sea safety, and to ensure fishers know how to maintain and service their engines properly.

Sea safety grab bags

In September 2021, 86 safety grab bags – containing a PLB, lifejacket, compass, flashlight, mirror and whistle – were distributed to Pohnpeian fishers who had to meet the following criteria to qualify for this free giveaway:

- ◆ Own a boats with a single 60 hp engine or less; the assumption being that owners of boats with larger engines can afford their own safety equipment.
- ◆ Boats must have visible boat names on the sides, and must support the color of the municipality it is moored in. For example, Kolonia municipal's colour is black, Kitti municipal is white, Sokehs municipal is yellow, Nett is purple, U is blue and Madolenihmw is red. This will also assist with the Pohnpei vessel identification process.
- ◆ Every boat captain must undergo a short training session on how and when to operate each sea safety device.
- ◆ Must be willing to assist in search and rescue operations.
- ◆ Fishers who received a sea safety grab bag were required to provide their catch effort data to OFA, in support of the Pohnpei State data collection programme for coastal fisheries.

In addition to safety equipment, over 100 orange watertight buckets with lids for holding sea safety equipment and keeping personal items dry were also distributed, along with boat name stickers to help identify boats.



Orange bucket initiative for fishers to keep important things dry such as a cell phones, safety equipment, and food and water.

Fishers receiving sea safety kits and equipment.





Assisting fishers with boat registration – Fishers receive a sticker of their boat's name.

Distribution of boat stickers and boat painting operations

Orange paint – Tins of safety orange paint were purchased to improve visibility on boats to aid maritime search and rescue operations, as encouraged by the United States Coast Guard, which states that “A white or blue coloured boat in the middle of the ocean will look just like a white chop of waves”. Over 50 boats have since been painted and this initiative has shown other fishers who were not directly involved with this programme to also paint their boats with some amount of orange so they are more visible. One group (URMWAKA Inc) in Pohnpei took advantage of this opportunity and applied it towards their community by organising an event by the sea, where communities painted boats together.

Boat stickers – Recognising the challenges of fishers putting boat names on their boats, over 100 boat stickers were also printed and distributed to these boat captains and boat owners to assist with boat registration efforts.



Orange paint provided by SPC for the sea safety programme increases the visibility of boats during search and rescue operations.

In summary

This two-year sea safety programme can be considered to be positive, due to the following.

- The 86 sea safety grab bags provided by SPC, plus ongoing support from local donors and embassies, has meant a huge cost reduction in search and rescue operations in Pohnpei. Based on the latest data provided by a local sea safety distributor in Pohnpei, there was a noticeable increase in the sale of PLBs and EPIRBs (emergency position indicating radio beacons) from 36 units in 2020, to 222 units between 2021 and 2022.
- Each of the five islands of Pohnpei have now received the SPC grab bag three to five units based on the number of fishers on each island. One island in particular, Mwoakilloa, has created its own sea safety awareness campaign, and initiated its own community fundraising programme for the purpose of providing each of its active fishers living on Mwoakilloa and on Pohnpei with sea safety equipment.

Recognising that the success of this programme means there are now more sea safety-affiliated fishers in Pohnpei, a similar programme would definitely benefit other communities within the FSM states of Chuuk, Yap and Kosrae where sea safety for small boats is lacking.

Reference

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All photos in this article are by James Wichman, ©SPC, unless otherwise stated.

All Mwoakilloa Island boat fishers were equipped with sea safety gear, following a dedicated fundraising campaign.



Giving diamondback to the community: Nauru small boat fishers learn to target alternative species safely

Plans for this assignment were initially laid in mid-2016 as part of the Global Environment Facility's Ridge to Reef project to help community fishers cope with changes in fisheries development issues that affected their livelihoods. It got underway with community-based fisheries management consultations to educate communities so that they better understand their fisheries resources and can utilise them sustainably. The goal was to train community fishers and staff of the Nauru Fisheries and Marine Resources Authority (NFMRA) in fish aggregation device (FAD) work, safety at sea procedures on small boats, small fishing operations procedures, midwater fishing methods, and targetting alternative species such as diamondback squid and loligo squid. It took time to get the funding and logistics organised for the practical fishing component, but by mid-2019, everything was in place. With the advent of COVID, however, and the uncertainties thereafter, the assignment was delayed until September 2022.

Small fishing operation and small boat safety training

The small fishing operation and small boat safety training was housed in NFMRA's new coastal fisheries workshop and office building, with 20 representatives from eight districts in attendance: Aiwo, Anetan, Baitsi, Boe, Denig, Meneng, Uaboe and Yaren. But as word got around about the content and training, about 60 more fishers asked if they could join during the later stages. They were advised to wait until the next round of training as they had missed crucial information during the first two days and the format of the workshop was not conducive to large numbers of participants.

The training was structured in two parts over two weeks:

Week 1 - Introduction to what will be undertaken during the training; safe operation plans, procedures, and checklists; safe fishing practices; dealing with emergencies at sea; rigging fishing gear for the various fishing methods; and book-keeping.

Week 2 - Preparing boats for sea; loading and arranging gear for fishing operations; practical fishing; onboard handling and storage of catch; fish quality for the markets; and recording the catch.

Two practical fishing trips were conducted on separate days, both beginning with setting 6 vertical longlines then setting 10 mid-water chum drift lines and moving on to trolling and jigging. All of the various fishing methods used produced catches. Small yellowfin tuna and skipjack were caught with the double lure trolling method; marlin was caught using a single troll with a shock absorber; yellowfin tuna, rainbow runner, trevally and bohar snapper were caught with the dropstone, cloth and chum methods; rainbow runner and small yellowfin tuna were caught with spreader rod jigging; and vertical longlines had some misses but caught several sharks that were released.





A freshly caught diamondback squid and the type of lure used during the trials. Image: ©William Sokimi, SPC

Diamondback squid trial

Diamondback squid (*Thysanoteuthis rhombus*) is a large oceanic species that has been relatively unexploited in the Pacific Islands region. As such, it offers a potential new resource for Pacific Island countries and territories. Trials confirming the presence of diamondback squid in other Pacific Islands – Cook Islands, Fiji¹ and New Caledonia – have previously been conducted, and now also in Nauru. This latest trial confirmed the presence of the species in Nauru's nearshore and offshore waters and publicised its presence and use as a potential food source. Carried out over four days on Nauru's west side, the NFMRA team were also trained in how to conduct additional trials and to train local fishers in how to catch diamondback squid.

The fishing gear used to catch diamondback squid includes a dropline to which are attached a waterproof light and three lures with two crowns of tiny barbless hooks at one end. The light and lures are dropped to depths of 450 m and more and the line is either jigged from the boat or left drifting attached to two floats on the surface.

Interestingly, the fishing gear used for the Nauru trial differed from the gear used for trials conducted around the region.¹ Usually, the reel used for small-scale diamondback fishing is a hydraulic or electrical reel specifically built for this purpose. The reel used in Nauru was ordered for multiple purposes such as to serve as a winch to haul vertical longlines and to conduct other trials should NFMRA wish to explore other prospects (e.g. deep-water snapper). Furthermore, a monofilament dropline was used instead of the much-preferred braid and wire dropline. As a cheaper option, the monofilament line has several limitations compared to wire and braid lines, such as taking up more space on the reel, thus reducing the number of mainlines that can be loaded on a spool, being susceptible to faster drift rates, arching of the midsection of the line under strong currents, and stretching under load.

Loligo squid trial

While Nauruan fishers have long been aware of the large numbers of loligo squid (*Loligo vulgaris*) in their waters, they are mostly caught randomly when targeting other species. There is a lack of knowledge regarding catch methods and fishing season, yet there is an interest in diversifying, and loligo squid offer market potential because imported squid is sold locally in eating houses and supermarkets. Understanding what species populate the waters, their respective seasons, and whether they can be caught in sufficient volume to satisfy local demand, remains to be determined.

The fishing trials were carried out on two nights, from 18:00 h to 24:00 h. Unfortunately, this was the wrong season to conduct loligo squid trials in Nauru but because the SPC team and the gear were in place, it was decided to at least familiarise the NFMRA team with the methods for when the season comes around. The weather was not suitable for fishing on the first night, with choppy seas and 15–20 kt winds blowing but the team set and hauled the lines anyway to test the gear. On the second night, only a single squid was caught. Despite trialling this method during the squid off-season, the NFMRA team got a chance to practice how the method works, how to set up the lights, set the sea anchor, and how to rig gear.

What's next?

While the participants benefitted from a practical training session on the principles of FAD rigging and deployment, weather conditions were not favourable for an actual deployment. So, this will take place in 2023 with a future visit to Nauru to complete this part of the training.

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¹ Sokimi W. 2014. Successful diamondback squid fishing trials in Fiji. SPC Fisheries Newsletter 144:14–16. <https://purl.org/spc/digilib/doc/42ck6>

Vhalik: Young Pacific Island students take the mic to preserve fisheries

“Sustainable fishing”: What does that mean today in New Caledonia?

Students from the University of New Caledonia (UNC) explore this question in a 20-part series of creative, lively and sensitive audio broadcasts. They’re produced through a partnership among UNC, the Pacific Community¹ and New Caledonia’s “La 1ère” media network.

Connecting science and culture

The students who participated in the project are enrolled in a research and mediation class as part of their bachelor’s degree programme in literature, languages and the humanities at UNC. Non-commercial fishers are responsible for 75% of New Caledonia’s fish production, so the social aspect of fishing is uniquely important there. Thanks to the students’ passion for the Pacific cultures and local languages, and to their training on awareness and legal aspects of coastal fisheries, they can now tell these stories from a unique perspective, connecting marine environmental management and culture.

“Did you know that New Caledonia is home to the world’s biggest lagoon?” one student asks in a mischievous tone. Another, discussing the trochus snail, explains, “If they’re caught when they’re too small, they won’t be able to reproduce.”

With each episode of the *Vhalik*² radio series on sustainable fishing, listeners are introduced to species such as parrotfish, Spanish mackerel or octopus, different ways to fish for them, and the clever tips that elders used to catch them not so long ago. And every episode has a common thread: to tell the story of fisheries, their importance in the daily lives of Pacific societies, and the need to preserve them for future generations.

Rich and personal stories

To produce their radio programmes, the students interviewed fishers from every corner of New Caledonia and Futuna. They asked about changes in the fisheries resources, the regulations in force, and fishing practices. In consultation with fishery authorities, SPC’s sustainable fishing specialists then helped them deepen the technical and scientific content of their broadcasts.

The result: rich and unique audio accounts that are also profoundly human. That’s because the fishers they interviewed are uncles, brothers, friends, family members and close friends. As children, some of the students used to go out on fishing trips with their elders.

Vhalik isn’t just a university assignment, it is also an authentic and appealing radio project. Speaking into the microphone, these young people finally recount a piece of their history.

Reaching a wide audience

Broadcast over the radio – a very popular medium in New Caledonia – the series also seeks to involve younger generations in building and disseminating a tool that can create awareness of sustainable fishing practices. The episodes are heard during primetime weekday hours and re-broadcast on summer weekends in 2022–2023. Each one includes a reminder about local regulations or a conclusion about sustainable fishing. Available as a podcast, this series can also be used for teaching and can help create awareness among young audiences about the sustainable management of marine resources.



Students refine their topics and look for contacts as they write their stories about fishing on foot for mangrove oysters and crabs, or fishing from a boat for groupers or snappers. Image: ©Céline Muron, SPC

¹ Division of Fisheries, Aquaculture and Marine Ecosystems, in collaboration with the Pacific Territories Regional Project for Sustainable Ecosystem Management (PROTEGE)

² *Vhalik* means “speech” in Fwâi and Pije, two Kanak languages that are spoken primarily in Hychen and nearby areas of New Caledonia.

Extracts

Trochus snail



©B. Preuss

“Better to be good than beautiful.” I know one creature that doesn’t have to choose between the two. It’s the trochus snail, with its beautiful mother of pearl shell. The trochus is popular with New Caledonians for its delicious flavour, whether in salads, pickled, or sauteed. Today, in the Southern Province, they can be only harvested if they are between 9 cm and 12 cm.

... If they’re caught when they’re too small, they won’t be able to reproduce. And if they’re caught when they’re too big, they won’t be able to reproduce when they’re in peak form. So think twice about that the next time you go fishing!



Solène Prigent

Parrotfish



©M. Juncker

Put your cellphone and tablet down. I’m going to take you fishing for parrotfish. It’s an herbivorous fish that spends most of its time scraping the surface of the coral to feed off the algae that hides there. This restricts the growth of the algae that keeps our coral reefs from growing well. ... Now that you’re an expert, I’ll let you take your spear and catch some of this delicious fish. But make sure to leave enough of them in the water for future generations so that they can fill their plates, too. And we want to make sure that we can continue to enjoy our beautiful fine sand beaches. Parrotfish excrete ground-up coral and an adult can create approximately 80 kg of sand/year.



Elepe Jiane



Divided into groups, the students worked with mentors who are experts in sustainable fishing (left-hand photo, centre) Bernard Fao (Southern Province); right-hand photo (r.) Thomas Wayaridri (Pacific Community). Images: ©Céline Muron, SPC



Today, I'm going to take you atule fishing on Futuna, where I live. Over there, on the ocean-going canoe, do you see them? Yes, they're women. Sit down and I'll explain what they're doing. ... Only women from the village practise this fishing technique. It's called "fai atule" and they've been doing it for generations. ... It's a seasonal fishery and there are several restrictions. You and I can't participate unless we're from the village because that could cause the fish to flee.

 *Velania Savea*



From generation to generation, our elders have taught us the right way to fish for them. Take only the adults and only what is absolutely necessary so that the sea can adjust on its own ... My grandmother used to fish for octopus with my mother and I used to fish for octopus with my mother. Will I be able to do the same with my own children?

 *Mirella Abdelkader*



Today, I'm taking you to one of New Caledonia's beautiful mangroves to gather a shellfish that I adore: the mangrove oyster... Did you know that the oyster does us a huge favour? Throughout its life, it filters the water from the mangrove and cleans out the tiny bits of organic waste. Whether you eat them as oyster tartare or on a seafood plate, they're a real treat. But don't eat too many - if they're over-fished, they could disappear from the mangroves ... and from our plates!

 *Marcellina Rory*

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Resources, courses and coordinated forces: Tackling illegal, unreported and unregulated fishing in the Pacific

One person taking one small fish for their breakfast might not seem like a problem, or a crime, but when that one person becomes many people doing the same thing, it becomes a major problem. From large-scale export companies operating without a licence, to individual subsistence fishers catching undersized fish, illegal, unreported and unregulated (IUU) fishing has many faces.



Monitoring Aitutaki lagoon, Cook Islands. Image: ©Aymeric Desurmont, SPC

Importance of small-scale fisheries in Pacific Island countries

Although offshore industrial fisheries harvest over 10 times more fish than small-scale coastal fisheries in the Pacific Islands (Gillett and Tauati 2018), coastal communities depend heavily on small-scale fisheries for their economies, food security, social well-being and livelihoods. Small-scale coastal fisheries are broadly divided into two main categories: 1) commercial fishing, which is generally subject to licencing and reporting obligations; and 2) subsistence fishing, for which no licencing or reporting is generally required.

Subsistence fishing, in particular, plays a significant role in the rural economies of Pacific Islands, and accounts for around 70% of fisheries production from coastal areas (Gillett and Tauati 2018). Management of these fisheries is challenging, especially when population growth, pollution and more efficient fishing techniques are already increasing the pressure on local resources. Added to this is the increased burden on coastal resources resulting from the COVID-19 pandemic. As tourism and associated industries closed

down, people who were no longer able to support themselves in the urban environment returned to rural communities where they could fish and grow crops.

IUU fishing – What is it?

IUU fishing activities can have a huge negative impact on the livelihoods, food security and marine ecosystems of small fishing communities. IUU fishing is not the reserve of large-scale export merchants, but may include local fishers who exploit their own resources by fishing unsustainably; for example, using destructive fishing methods (such as poison or explosives), targeting prohibited species, or disregarding the legal size limit for each species.

Management plans and regulations to protect vulnerable marine resources can easily be undermined by someone exporting species that have been caught without a licence or permit if the legal framework and capacity to enforce regulations is not well supported. Coastal fisheries in the Pacific are often informal, either because they are unregulated (and,



A fisheries officer checks the catch of a fisher near Suva market in Fiji. Image: ©Ariella D'Andrea, SPC

therefore, unreported), or due to a lack of enforcement, such as when subsistence fishers, who are not subject to licensing requirements, sell their catch on the local market, although it is generally prohibited by law.

Impacts of IUU coastal fishing are largely unknown

In coastal areas, IUU fishing appears to impact Pacific Island communities by contributing to overexploitation of vulnerable marine resources and depriving (human) populations of associated benefits. Coastal fisheries, in particular, provide a wide range of tangible and intangible benefits, including key contributions to income, health, food security, culture and resilience (Béné et al., 2016; Petrossian et al., 2015). It is difficult, however, to assess the extent to which IUU fishing impacts economies in the Pacific Islands region because by their nature, these clandestine or informal activities go largely unseen. An update to a study conducted in 2020 (MRAG Asia Pacific 2021), which quantified IUU fishing in the Pacific, focused on offshore fisheries that target tuna and tuna-like species, and noted that there is a high level of uncertainty in catch estimates. Small-scale IUU fishing is even more difficult to evaluate in the coastal sphere because that sector is quite data-poor.

Coastal fisheries can be considered to be illegal fisheries if existing regulations are not implemented effectively, and sustainability is jeopardised. Coastal fisheries can also be considered as a form of unregulated fishing if traditional and customary rules are implemented in practice, but are not recognised by law. Understanding the specificities of IUU coastal fishing is crucial to avoiding the risk of criminalising small-scale fishers (Song et al. 2020).

Pacific context

In the Pacific Islands, IUU fishing is a significant issue because coastal communities are geographically spread out and often lack the resources for monitoring, control and surveillance. The Pacific coastal fisheries sector is typically small in scale and often informal in nature. Fisheries management in the coastal areas of Pacific Island countries and territories (PICTs) is largely based on traditional management, particularly around reef areas and in lagoons. In most PICTs, small-scale commercial fisheries are managed by fisheries agencies through licensing and registration, although difficulties may exist in controlling fishing activities in outer islands. Similarly, fisheries agencies may not have enough resources to monitor all subsistence fishing activities occurring in a country's or territory's waters. The

Pacific's response to IUU fishing in coastal fisheries relies heavily on local communities being involved in marine resource management, thus highlighting community members' role as stewards or guardians of marine resources.

What can be done?

Community-based fisheries management

Community-based fisheries management (CBFM) is an approach to managing fisheries in which communities take a leading role. Using local knowledge, the CBFM approach aims to empower stakeholders in coastal communities and ensure that fisheries are managed sustainably and in a way that is appropriate for the local or national context. Under the CBFM approach, local communities are actively involved in the process of planning, rule-setting and determining how these rules can be enforced.

CBFM has garnered strong support across the region. *A New Song for Coastal Fisheries – pathways to change: The Noumea Strategy* (SPC 2015) was developed by PICT representatives and endorsed by fisheries ministers in 2015. With this strategy, PICTs agreed to scale-up coastal fisheries management by incorporating a community-based ecosystem approach to meet domestic development aspirations. The resulting workshops and consultations in response to this strategy led to the Pacific Framework for Action on Scaling up Community-based Fisheries Management (SPC et al. 2021), which was endorsed by fisheries ministers in 2021.

Collective engagement in rule-setting

Engaging communities in establishing rules and determining how to enforce them can help with combating IUU fishing because awareness and a sense of ownership is increased, which ideally creates a feeling of collective responsibility among community members. How this is done, however, is crucial. Consider that for many communities, tackling IUU fishing could mean a community enforcement officer having to take a close relative to task for catching an undersized fish. The officer's job is even harder if the individual was unaware of the rules because they had not been involved in making them. Awareness needs to be a primary consideration before the enforcement stage, and getting everyone to agree on the regulations is one way of doing this.

Sharing successful models of management

Awareness also includes recognising good management practice, and where this has had a real benefit, in terms of resource abundance, and economic and ecological benefits. Tonga, for example, has used the special management area

(SMA) tool of fisheries management since 2006 (Smallhorn-West et al. 2020). In this arrangement, communities have preferential access to a specified marine area and have the responsibility of looking after it for their own use, as well as for future generations. This long-term vision has had some evidence of success as witnessed by the rapid expansion of the SMA programme as more Tongan communities have become involved. There needs to be, however, data to verify the tangible benefits (e.g. stock status improvements, economic growth), as well as be a monitoring programme. Coastal fisheries monitoring involves gathering data on species inside and outside of managed areas, which requires local knowledge, survey design capacity and resources.

Strengthening monitoring, control and surveillance

Effective monitoring, control and surveillance (MCS) needs capacity, capability and equipment, all of which require investment. A recent survey of 11 countries in the region¹ indicated that some lacked the basic equipment needed to conduct MCS (see Table 1 below). The equipment does not include boats and vehicles, which are also required, and in short supply, in these countries. If an adequate level of enforcement is not supported, then IUU will continue to occur and all other efforts to manage the fishery will have been undermined. Addressing this gap is of utmost importance and will require funding and cooperation from invested stakeholders in the region.

Table 1. Monitoring, control and surveillance capital assets required for coastal fisheries by number of countries out of 11 surveyed.

Equipment	Total countries in need
Safety equipment	9
ID badges or authorisation cards	7
Binoculars	7
Note taking for evidence collection	7
Camera	6
Official uniforms	5
Mobile phones	5
Coolers or freezers for evidence storage	5
Measuring devices	4
Tablets	2
Drone for effective surveillance	2
Vernier caliper	1
Torch	1
Exhibit tags and labels	1
Reef walking shoes or boots	1

¹ Conducted by SPC to provide baseline information on the capacity of fishery authorities to undertake effective deterrence of IUU fishing activity in coastal fisheries.

While considerable effort has gone into mitigating IUU fishing in Pacific tuna fisheries, coastal fisheries have historically lacked the investment for this. There is very little in the way of coordinated regional activity to address IUU fishing in coastal fisheries in the region. This is a critical area that requires more dialogue between countries, stronger coordination between CROP² agencies, and collaboration between supporting regional partners.

As the key CROP agency working in the coastal fisheries sector, the Pacific Community (SPC) has a significant role in supporting members to address IUU fishing in coastal fisheries, particularly through MCS capacity building. SPC works closely with the New Zealand Ministry for Primary Industries' Te Pātuitanga programme,³ the Pacific Islands Forum Fisheries Agency,⁴ the Australian Fisheries Management Authority,⁵ and other agencies to provide support for its members' national fisheries authorities. SPC, in cooperation with the Te Pātuitanga programme, has provided training and capability building in MCS concepts and skills in Kiribati, Marshall Islands, Solomon Islands and Vanuatu to enhance members' ability to address IUU fishing in coastal waters. These workshops have included practical market inspections, and in every country, some level of illegal activity has been discovered.

To support capacity building, SPC and partners have developed a series of online learning programmes to help its members improve MCS and address IUU fishing in coastal fisheries. These include:

- Certificate IV in Coastal Fisheries and Aquaculture Compliance, accredited by the University of the South Pacific at the regional level, and delivered online as a full year course;
- Professional Certificate for Community Compliance Officers, at the national and regional level, delivered online and face-to-face as a three-month course;
- National training workshops run in partnership with Te Pātuitanga, and tailored to each country's needs and delivered virtually, including several practical market inspections;
- Assistance with developing national compliance strategies and MCS and enforcement policies for coastal fisheries; and
- Assistance with drafting of a set of standard operating procedures for routine MCS and enforcement work.

To enhance members' capacity in policy and planning for effective coastal fisheries management, SPC has been providing support in three broad focus areas:

- 1) Development of anchored FAD Development and Management plans that are fundamental for developing sustainable national FAD programmes.
- 2) Review of existing, and development of new, management plans and policies that support members in implementing measures for the sustainable management and development of coastal fisheries.
- 3) Provision of advice to members on specific issues pertaining to coastal fisheries management and development.

SPC has also been exploring the potential to develop and deliver training through web streaming. As part of this work, an e-training workshop on fisheries management planning was developed, in partnership with New Zealand's Ministry of Primary Industries. The first e-training workshop – Developing Fisheries Management Plans – was successfully delivered to government officials from Polynesia and Melanesia. This effort is expected to improve members' capacities in sustainable and effective coastal fisheries management.

The United States Agency for International Development-funded Pacific Coastal Fisheries Management and Compliance project⁶ aims to strengthen governments' capacities to implement and improve MCS in 12 Pacific Island countries: Federated States of Micronesia, Fiji, Kiribati, Nauru, Palau, Papua New Guinea, Marshall Islands, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu. This USD 6 million, five-year project (2021–2026) will address some of these gaps for these countries and improve coastal fisheries management and data systems.

The larger-scale problem of IUU fishing is still a big issue

There are still instances of IUU fishing that are conducted knowingly and deliberately, such as the harvesting of illegal marine products (e.g. beche de mer) to export to foreign markets, or foreign fishing vessels operating illegally in coastal waters. This type of IUU fishing is particularly difficult to combat because the offenders often work for large companies with the wealth and power to influence decision-makers and fishers alike. The limited resources available for MCS in many Pacific Island countries makes coastal areas more attractive and more vulnerable to these kinds of operations.

² Council of Regional Organisations of the Pacific

³ <https://www.mpi.govt.nz/fishing-aquaculture/fishing-aquaculture-funding-support/te-patuitanga-ahumoana-a-kiwa/>

⁴ <https://www.ffa.int/>

⁵ <https://www.afma.gov.au/>

⁶ Pacific Coastal Fisheries Management and Compliance programme

A wider responsibility

While PICTs are working on these issues from their side, there needs to be recognition from the market states – where fish are exported to – in order to avoid imposing harsh trade restrictions on small-scale fishers. Market states that impose trade sanctions on countries that fail to comply with their flag state duties should consider the impact that such blanket bans would have on the livelihoods of small-scale fishers. Allowing such fishers to continue to trade in species and products that are considered to be sustainable (e.g. under formal CBFM arrangements) would not only be beneficial for those small operations, but could also work as an impetus for public participation in management and awareness.

The letter of the law

In order for local communities to have specific rights to manage coastal areas – in collaboration with the national fisheries agency and local authorities – the legal framework should be clear.

For example, in Solomon Islands, community fisheries management plans can be drafted by, or on behalf of, customary rights holders. The management measures, fines, penalties and sanctions, as well as the licensing and enforcement authorities, described in the plans are “deemed to have legal effect of a by-law” on adoption and publication (Fisheries Management Act 2015, Section 18⁷). In Samoa, village fisheries management areas, established by the government (Fisheries Division of the Ministry of Agriculture and Fisheries) in consultation with village *fono* (councils), are managed by village communities (Fisheries Management Act 2016⁸). Village *fono* can also make village fishery by-laws (Village Fono Act 1990⁹). In Tonga, the government (Ministry of Fisheries) can declare any area a special management area for the purpose of coastal community management, and the coastal community designated for the management “shall organise itself and its operations or administration in a manner that is conducive to the effective conservation and management of fisheries resources” (Fisheries Management Act 2002, Section 14¹⁰). A community management committee helps the coastal community manage the area, including by drafting and enforcing its management plan (Fisheries [Coastal Communities] Regulations 2009¹¹).

If traditional practices are recognised under the law, then it is possible to take decisive measures to combat IUU fishing in ways that are appropriate to the local culture and context. SPC has also been providing remote support to members

in the review and development of laws and regulations for sustainable and equitable coastal fisheries management. In particular, the following activities have been carried out:

- Assistance was provided to fisheries agencies in drafting laws and regulations on coastal fisheries and aquaculture, via email and other available communication platforms.
- Virtual workshops on gender and human rights in coastal fisheries legislation were successfully held in August 2020 and July 2022, followed by the preparation of legal reviews for nine PICTs and the publication of a Policy Brief (Graham and D’Andrea 2021).
- To enhance the legal writing skills of government staff, SPC has developed an online training course for legislative drafting in coastal fisheries, in collaboration with the University of California. The online course will provide tips and methods to draft laws, regulations and other supporting documents that are key to sustainable coastal fisheries management.
- To increase awareness and facilitate access to relevant information, legal resources are also made available on REEFLEX (Pacific Law and Policy Database on Coastal Fisheries and Aquaculture).

To support the implementation of the Pacific Framework for Action on Scaling up Community-based Fisheries Management, SPC has also prepared a legal guide to identify enabling provisions for community-based fisheries management. The guide, developed in collaboration with the Environmental Law Institute, a Washington DC-based non-profit organisation, is intended to assist Pacific Island fisheries agencies in implementing CBFM on a larger scale by assessing and improving their legislative framework. A variety of examples of legal provisions illustrate national legal frameworks for CBFM in the Pacific and outside the region. The main objective of the guide is to allow PICTs to select among different approaches and develop a CBFM framework that is adapted to their national context.

Better coordination with participating partners

As mentioned earlier in this article, resources and funding are crucial to enabling communities to manage their fisheries and combat IUU fishing, and these must be managed carefully to be put to efficient and effective use. Donors and implementing agencies who are involved in capacity building for effective coastal fisheries management could

⁷ Fisheries Management Act 2015, Section 18 <https://purl.org/spc/fame/cfp/legaltext/msm82>

⁸ Fisheries Management Act 2016 <https://purl.org/spc/fame/cfp/legaltext/r563p>

⁹ Village Fono Act 1990 <https://purl.org/spc/fame/cfp/legaltext/z2cvx>

¹⁰ Fisheries Management Act 2002, Section 14 <https://purl.org/spc/fame/cfp/legaltext/jxm55>

¹¹ Fisheries (Coastal Communities) Regulations 2009 <https://purl.org/spc/fame/cfp/legaltext/xmeao>

coordinate their activities to ensure that there is no duplication of effort. New Zealand's Ministry of Foreign Affairs and Trade has provided support to address capacity building for MCS and resource management over many years. One example is the Effective Coastal Fisheries Management Project,¹² which has been extended for a further five years as the Sustainable Coastal Fisheries and Aquaculture for Pacific Livelihoods, Food and Economic Security,¹³ and provides technical assistance and training alongside awareness raising to promote compliance.

Currently, there appears to be no mechanism for capturing all that is happening in this area, and this relies on people knowing what's happening through their personal networks. Developing more project coordinator roles to provide a focal point and to integrate workplans is one idea towards increasing the efficiency of the projects at play. The Pacific is vast, but effective collaborations can enable a speedier response to IUU activities in coastal fisheries.

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¹² The Effective Coastal Fisheries Management Project aims at strengthening governance structures and processes for effective management of coastal fisheries and aquaculture, both at national and subnational level. <https://fame1.spc.int/en/projects/mfat>

¹³ Sustainable Coastal Fisheries and Aquaculture for Pacific Livelihoods, Food and Economic Security project brief. <https://purl.org/spc/digilib/doc/bhacu>

Can new tech help to reduce illegal activities in Pacific coastal fisheries and aquaculture?

SPC global study on new tools and technology

In 2021, the Pacific Community (SPC) commissioned a study on emerging technologies and their suitability for the monitoring, control and surveillance (MCS) of coastal fisheries and aquaculture. The study was conducted in response to SPC members' increasing interest in drones, small craft tracking systems, hydrophones, and automated cameras to assist with their coastal fisheries MCS operations.

The proverbial “net” was cast wide for this study so as to capture as many potential tools and technologies as possible. The findings come from an assessment of over 175 tools from over 135 companies around the world. Most of the research was done online using web resources. The consultant for this study contacted (via video conferencing) 75 different companies to better understand their offerings for the Pacific context.

A copy of the report from the study is available on SPC's digital library¹ for those members who express an interest in more information on emerging technologies or wish to undertake a trial with SPC's assistance.



Hydrophone ready for installation in Niue. Image: ©Ian Freeman, SPC

Key findings

Fancy tools and technologies are not a panacea for coastal fisheries and aquaculture MCS everywhere in the world, including the Pacific Islands. Effective MCS comes from suitably skilled and resourced fisheries officers working with a clear mandate and authority to regulate fisheries rules and regulations. This work is made much easier if the rules and regulations are based on good science, fisheries management, and community involvement and awareness.

The findings of this report may not apply to every Pacific Island country and territory in every circumstance. All MCS solutions need to be tailored to the specific situation on the ground, taking into account resources, capacity and actual needs and circumstances. A number of key findings that are likely to have application in the Pacific Island context are presented below.

¹ <https://purl.org/spc/digilib/doc/jif2s>

² The AIS coastal or base station is the primary component in an AIS physical shore station, and the most important component in a coastal AIS network. The AIS base station receives and communicates AIS data from all AIS sources (e.g. AIS mobile stations, other AIS base stations, AIS aids to navigation units) within the coverage area.

³ A geofence is a digital, or virtual, boundary established around a geographical area in an information system.



Long range robotic camera being set up in Niue.
Image: ©Ian Freeman, SPC

- **Baseline MCS tools and capacity** – Key equipment for field officers includes: 1) safety gear such as a first aid kit and protection from the natural elements; 2) a torch/flashlight; 3) multi- tool; and 4) a smart phone with a good digital camera. Access to binoculars, gauges and measuring devices should also all be included in fisheries officers' basic MCS kit. Participation in fisheries officer training, such as the Certificate IV in Coastal Fisheries and Aquaculture Compliance, is encouraged along with specific training in the deployment and use of tools and equipment used to gather evidence of an infringement. Access to awareness-raising material and presentations to give to communities on the importance of following rules and regulations is also critical for an officer working in the field.
- **Vessel tracking** – There are several small vessel monitoring systems (VMS) and solar VMS units on the market now, or in development, that target smaller artisanal vessels. Costs to purchase the devices have come down significantly, along with the cost of monthly cellular or satellite services that support the VMS. There is a range of features that increase the efficiency of a VMS, such as the ability to send emergency messages to authorities, warning signals that alert a fisher when they are entering closed waters, and the ability to report catch and effort data via a cell phone or internet connection. These features can help drive the uptake of VMS among fishers.
- **Automatic identification system (AIS)** – This technology offers a simple and inexpensive alternative to traditional VMS systems, which need cell or satellite access to work. AIS works on VHF radio signals that require line of sight for functionality. The coastal station or base station is generally located up high to cover the most area at sea. If the base stations² can be located around island areas for maximum coverage and/or vessels can relay signals via each other to a coastal station, there is very little in the way of running costs, other than retrieving data from coastal stations. The benefit of a simple solution for fishers that can alert them of geofences³, send distress messages, and send or receive other messages makes this an interesting solution.
- **Shore-based monitoring**

 - ✧ **Active radio frequency identification** – This uses a system of sensors to count vessels as they move to and from port and launch sites. It is a relatively inexpensive and low-tech way of monitoring vessels.
 - ✧ **Cameras** – There are many camera options to choose from that have the capability of monitoring vessel movements and detecting infringements (or other illegal activity) in closed waters. Cameras can be miniaturised and fixed at specific locations where they are unlikely to be detected.
- **Radar and other systems** – Radar-based systems with commercially available components have good potential in the Pacific Islands, and are being trialled and/or used in American Samoa, the United States (Hawaii), Palau and Tuvalu. They may be good solutions for monitoring remote areas such as marine protected areas because they are multisensory systems with radar detection (Furuno), forward looking infrared, AIS identification, camera and weather sensors.

◆ **In-water monitoring**

- ✎ **Unmanned surface vessels** – These may have an application for coastal fisheries monitoring if they can be operated in collaboration with other users to defray or minimise costs. They have long-range capability and are relatively undetectable, given their low profiles. But, due to their significant cost, they would also likely need to be deployed with other air/vessel assets at the same time to get the most benefit of their use.
- ✎ **Hydrophones** – Acoustic sensors could give valuable insights into vessel or fisher activity patterns in remote areas. Acoustic sensors linked to cameras or other devices, such as auto learning processors, can determine if the sounds are vessels, explosives and potentially even spearfishing. Fisheries officers could use this information to get an idea of the amount of activity – such as number of boats, or number of spears shot – in a particular area and can even help to determine if there are patterns to this activity. For example, if it can be determined that there is a recurring time and/or day that the area is being accessed, this would give fisheries officers an idea of when they should go to the site or area in person to investigate.

- ◆ **E-reporting solutions** – There are many free and open-source e-reporting solutions on the market that collect catch and effort and location data, which is then transmitted to a central repository, either directly as it is collected or once the collector has internet or cell phone connectivity. There are two approaches to collecting catch data in coastal areas that have had some success: 1) training either local hires or volunteers to collect data at points of landing, and 2) using fishers to collect data, which would also give them more control over the data for their own use.

- ◆ **Fisheries officer field work solutions** – Two complementary and linked systems – Earth Ranger and SMART – were initially developed to support rangers working in Africa. Both systems are free and open source. The scope of these systems has since been expanded to support coastal fisheries officers, particularly in managing marine protected areas, and they have a very good potential as a tool for coastal fisheries management in the Pacific. Key potential benefits are that they can work as a quasi-intelligence solution over time and can help managers better target where fisheries officers should be operating.

- ◆ **Community engagement solutions** – There are several software packages that are used extensively elsewhere in the world that offer easy-to-use monitoring solutions that can be undertaken by communities. The range of these solutions is only limited by one's imagination and the complexity of the system being monitored. ODK Cloud is one such data collection system, and is used across a multitude of fields by organisations such as the Commonwealth Scientific and Industrial Research Organisation, World Health Organization and Red Cross.

- ◆ **Traceability solutions** – A significant number of traceability solutions exist that can track fish and invertebrates – from initial capture, right through to the end purchase (also known as “bait to plate”). These are currently used in the offshore tuna fishery to verify that tuna have been caught from sustainable fisheries. These have good potential for use in coastal fisheries as they can also be used for MCS purposes.

Field trials

Many of the emerging technologies have yet to be proven in the coastal fisheries context, and most will work best as part of an integrated package – rather than as stand-alone solutions – to address MCS issues in coastal waters. SPC is keen to undertake field trials to evaluate the effectiveness of the various emerging technologies and assist countries in strengthening their coastal fisheries and aquaculture MCS capacity at the community, national and, ultimately, regional level.

Several suppliers and vendors of some of the emerging technology equipment have indicated a willingness to participate in trials, and some have offered to trial their equipment free of charge. SPC has funding available that could go towards supporting the logistics and monitoring of the trial, rather than providing the equipment, so cost-effective pilot studies can be undertaken.



SPC members who are interested in further information and being part of these trials should contact:
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Factors that assist and constrain the careers of Pacific Island fishery professionals

Robert Gillett,¹ Barbara Hanchard² and Esther Wozniak³

Pacific Islanders now make up much of the staff of the regional organisations involved with fisheries, although most bilateral donors, foundations, development banks and other agencies doing advisory fishery work in the region rely almost exclusively on people from outside the region. This is surprising considering that tertiary education institutions in the Pacific Islands have been producing graduates in marine-related fields for over five decades. Recently, there has been a greater shift of Pacific Islanders to senior roles in those agencies in specific fisheries subsectors (e.g. law), and less so in other fisheries subsectors. To understand this shift, this article seeks to understand the factors that promote and constrain career advancements.

For the purposes of this article, the following terminology applies unless otherwise specified.

- A Pacific Island fishery professional (PIFP) is a Pacific Islander who is an officer of a national government fisheries division, department or ministry. The term also includes Pacific Islanders who are employed to carry out fisheries work at a Pacific Islands regional organisation, international agency, foundation or non-governmental organisation. The categories “PIFP leaders” and “emerging PIFPs” are considered subsets of all PIFPs.
- A PIFP is considered to be successful if the following attributes apply to them: have a positive career trajectory; have regularly been promoted; are respected by

their peers and supervisors; have done well in collaborative efforts with outside teams (e.g. projects, regional organisations); have been productive; and have some major accomplishments, such as securing a job based on merit with the regional organisation or a position of responsibility in a regional or international forum.

- A mentor is someone who shares their knowledge, skills and/or experience to help another person develop and grow professionally. This is somewhat different from a coach who provides guidance to a client on their goals. Having stated that, in the region the terms are sometimes used interchangeably, and several people interviewed equated a “formal mentor” to a “coach” because both are thought of as being paid positions.

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Pacific Island fishery professionals with some mentors, regional organisation officers, and others at an SPC fisheries meeting. Image: © Jean-Pierre LeBars, SPC

Methods

Considerable work has been done in the region on staff capacity development of national and regional fisheries agencies. Therefore, an initial priority for this study, which was sponsored by Pew Charitable Trusts, was to speak to the people who are familiar with that work and the issues relating to capacity development in the fisheries sector. Early discussions with 16 individuals who are knowledgeable about capacity development in the fisheries sector indicated that there were some fundamental considerations to take into account:

- The entire subject of capacity enhancement for PIFPs by all varieties of institutions is too large to be handled by a small study.
- While considerable work has been done in the area of capacity enhancement, there are major gaps.
- One of the largest gaps is what PIFPs themselves think are the major factors that have assisted and/or constrained their careers.
- The study should focus on both successful mid-career PIFPs and those who have been highly successful and are in leadership positions.

Additionally, those discussions revealed that it is difficult to distinguish efforts on what should be done to enable fishery professionals to move into advisory roles from many other kinds of development efforts, such as promoting Pacific Island fisheries consultants, hiring more Pacific Islanders at regional organisations, regional organisations enhancing the capacity of their Pacific Island staff, and efforts made at the national level to enable the advancement of staff within a government fisheries agency. All are part of the large subject of increasing the capacity of Pacific Islanders in fisheries, and it is difficult to draw boundaries between these areas.

Based on this preliminary scoping, the study consultants – in collaboration with Pew staff – formulated specific research questions that the study should address.

1. What are the important factors that have assisted or constrained the careers of PIFPs?
2. What are the important root causes of the factors that have assisted or constrained the careers of PIFPs?
3. What are the important aspects of the assisting and/or constraining factors, such as an exploration of the relevance across the region, how beneficial or severe, and any historical context?
4. How can the constraining factors and root causes be addressed?
5. What are the major lessons learned in past efforts to address the assisting and constraining factors and root causes?
6. To improve the situation (i.e. enhancing PIFPs' careers), what are the appropriate and necessary contributions that should be made by national governments, regional organisations, donors, foundations and PIFPs themselves?
7. How can national governments, regional organisations, donors, foundations and PIFPs take advantage of the new insights gained from the study?

These research questions were modified into questionnaires for interviews. The content of the questionnaire was a balance between thoroughness and length, so as to prevent “fatigue” of those being interviewed.

Three categories of people were interviewed for this study: 1) emerging PIFPs in mid-career who appear to be successful and are respected by their peers; 2) PIFP leaders who have been highly successful in their careers and risen to leadership positions in regional and international organisations; and 3) people who have been mentors to PIFPs or who are familiar with the issues

The study consultants – in consultation with relevant regional experts – determined which PIFPs would be appropriate for the three categories. In the selection process, efforts were made to: 1) pick people from the majority of countries in the Pacific Islands region; 2) obtain an appropriate gender balance; and 3) cover many of the fishery sub-sectors. Also considered in the selection process was the ease of contacting PIFPs and their willingness to participate in interviews. It should be noted that those interviewed represent a subset of individuals in the three categories (i.e. there are many more emerging professionals than those interviewed).

Because the information sought can be considered sensitive, it was agreed with the PIFPs interviewed that:

- information presented in the report would not be identified as being from specific individuals and, accordingly, when a response obtained during an interview could lead to the identification of an individual, it was anonymised and made more general;
- if the interviewees did not wish to answer a question for whatever reason (e.g. because of confidentiality, or no thoughts) there would be no pressure to do so; and
- answers to specific questions by specific individuals would be known only to the study consultants.

It is important to explain some of the limitations of this study. For practical reasons, not all types of PIFPs were interviewed. The study focused only on mid- to seasoned level career professionals with clear advancement opportunities, and not those people who, for various reasons, chose to emigrate out of the region. Therefore, it is difficult to generalise from the results of the study. In the selection of successful

PIFPs to interview, the study relied, to a large degree, on the knowledge of the two consultants (i.e. contacting fishery professionals known to them as being successful), which may have introduced a bias against the type of PIFPs unknown to them. Another limitation was that the small sample size resulted in the inability to do some planned comparisons, such as comparing differences among countries. The small sample size is an important reason why this research was undertaken. Understanding why so few PIFPs have reached higher career levels is one of the specific goals of the study.

Results

The complete results of the study are contained in a report submitted to The Pew Charitable Trusts. A summary of the results is given here.

<p>Factors that have assisted careers</p>	<p>Each PIFP interviewed provided 3–7 factors that assisted their careers. Factors that were cited by more than one interviewee were (in decreasing frequency):</p> <ul style="list-style-type: none"> • having a mentor • participating in short-term training, internships and attachments • having a postgraduate degree • having a deep interest in fisheries • having had a positive upbringing and home environment • attending workshops • having good supervisors • having family support • having luck • attending fisheries meetings <p>In terms of gender differences in the identified assisting factors, the major disparities were in the importance of a postgraduate degree (more important to women), interest in fisheries (men), good supervisors (men), family support (women), and luck (women).</p>
<p>Factors that have constrained careers</p>	<p>Each PIFP interviewed provided up to 4 factors that constrained their careers. Factors cited by more than one interviewee were (in decreasing frequency):</p> <ul style="list-style-type: none"> • not possessing writing skills • having family and/or community commitments • not having public speaking experience • inability to do continue studies • cultural restrictions on being assertive • no constraints <p>In terms of gender differences in the identified constraining factors, the major disparities were that the writing skills and public speaking constraints were cited much more often by men than women. Cultural restrictions on being assertive and family and/or community commitments were the factors most cited by women.</p>
<p>Mentoring</p>	<p>Mentoring was cited by more interviewees than any other assisting factor; therefore, the subject was further explored. Some of the features on mentoring that emerged in specific areas were:</p> <ul style="list-style-type: none"> • Mentorships in the past: All PIFPs interviewed had experience with mentors and most had experienced several. • Types of advice from mentors that were valued: The valued types of advice cited included both career and technical advice. In general, there was considerable diversity in the types of advice that was appreciated by the interviewees. • Advice to be given to student and young PIFPs on the value and need for a mentor: all expressed value in having a mentor, and many PIFPs were very enthusiastic. • The appropriate relationship with a mentor: The most common response was that the relationship should be one of trust. • The attributes and background of an appropriate mentor: The most common response was that the age, gender and culture of the mentor did not matter much, but some interviewees did not agree with this view. • The involvement of the regional organisations in mentoring: Most PIFPs thought that this was a good idea, but a few either had no opinion or could not see how it could happen.

Writing skills	<p>Because interviewees cited writing skills more than any other constraining factor, the subject was further explored. Some of the features regarding writing that emerged in specific areas were as follows:</p> <ul style="list-style-type: none"> • 19 of the 21 emerging PIFPs interviewed (95%), indicated that writing was an important part of their job. • Eight of the emerging PIFPs interviewed (38%) indicated that poor writing skills was negatively affecting their careers, and was either a constraint, sometimes a constraint, or a constraint early in their careers. • The most often cited way for improving writing skills was practising, emulating good writers, reading, assistance from a supervisor or mentor, and feedback from colleagues and /editors. Only four interviewees (19%) had a formal writing class since completing university studies. • The gender disaggregated responses on writing show considerable differences. All female respondents (100%) indicated that their writing skills were such that they were either helpful in their careers, helpful after training, or sometimes helpful. Of the 12 male respondents that supplied information on this question, only four (33%) indicated their writing skills were helpful or sometimes helpful.
Differences in responses between PIFPs in coastal fisheries and in offshore fisheries	<p>The responses showed that: 1) coastal fishery specialists seem to be more constrained than offshore specialists by a lack of opportunities for further training and studies; and 2) offshore specialists seem to be more constrained by family and social obligations. Although this could easily be an artifact of the small sample size, there is some logic in these results. Many countries in the region focus more resources on offshore fisheries, and often those extra resources include opportunities for advanced study. Offshore specialists' constraint due to family and social obligations could be related to the remarkably large amount of duty travel undertaken to the many meetings related to offshore fisheries.</p>
Could outside agencies address the assisting and constraining factors?	<p>When PIFPs were asked if the assisting factors could be transferred to other PIFPs (i.e. promoted by an outside agency), the responses were that factors such as experience and the drive and will to do the job would be difficult to promote to others. By contrast, PIFPs interviewed indicated that other assisting factors such as mentoring, scholarships, English courses, and attendance at workshops and meetings could conceivably be replicated.</p> <p>Of the 5 major constraining factors cited, PIFPs indicated it would be difficult for an outside agency to deal with two of them: family commitments, and cultural restrictions on being assertive. It is conceivable that an agency could deal with three other constraining factors: writing, further studies and public speaking.</p>
Going forward	<p>Rather than the study consultants deciding on the institutionalisation of the study findings, a more appropriate approach would be to convene a small meeting of regional stakeholders (especially regional organisations) to validate the study's findings and explore the interest by entities in the region in taking on some of the recommendations.</p>

Recommendations

Two types of recommendations are given below: process-type recommendations and recommendations for specific interventions.

Process-type recommendations

1. After the full study report is released to the management of the regional organisations involved with fisheries, determine if the management of those organisations have an interest in their organisations being part of a small meeting that would include selected organisation officers and study consultants to validate the results and determine their interest (or reluctance) in carrying forward some of the suggestions.
2. If the regional organisations express interest, hold a meeting (either virtually or in-person) to articulate what can and should be done to institutionalise the recommendations of the study, and the interest of the various organisations in taking on some of the work.
3. The meeting should validate (or modify or refute) the following study recommendations:
 - Mentorships, short-term training, internships and attachments, and postgraduate degrees should be recognised as being important and appropriate for promotion by an outside agency.
 - Writing skills, public speaking and the inability to continue studies should be recognised as being important constraints and appropriate for mitigation by an outside

agency. Because of the prevalence of writing as a constraining factor, it should receive additional attention, including the potential for writing workshops or communication training.

- It should be recognised that family and community commitments and cultural restrictions on being assertive, although important constraints, are not amenable for addressing by an outside agency.
- In the interventions to enhance the assisting factors and mitigate the constraining factors, there should be a realisation that the requirements are different for men and women, with examples being that postgraduate degrees are especially important for women, and improvements in writing skills are especially important for men. In general, addressing c will be more difficult and/or expensive for women. Such considerations must be taken into account during capacity building efforts.
- Regional organisations should acknowledge the value that PIFPs place on short-term training, internships and attachments, and continue their roles in these areas.
- It should be recognised that addressing the assisting and constraining factors (i.e. enhancing PIFP tools) is a large departure from the common practice of regional organisations in human resource studies of focusing on technical skills and knowledge in specific fishery subsectors.
- Action by outside agencies on the factors that assist and constrain should be considered as mainly small interventions to bolster, rather than replace, personal drive and determination.

Specific interventions (to be discussed at the regional meeting). These are, roughly, in order of priority.

1. Publicise the relevant results as advice to young PIFPs: a brochure, poster or social media article giving career advice based on this study to university students and young PIFPs, with attention to mechanisms for getting the messages to those people.
2. Future fisheries-related human resource studies in the region (i.e. training needs analysis) should pay particular attention to the perceptions of PIFPs, and what they feel are the major issues related to assisting and constraining factors.
3. Promote the assisting factors identified in this study, with the idea that mentoring, scholarships, English courses, and attendance at workshops and meetings are common assisting factors that can be externally promoted.

4. Mitigate the constraining factors identified in this study, especially recognising that a) writing skills, public speaking and the inability to continue studies are common constraining factors that can be externally addressed; and b) most of the common constraints could be addressed by mentoring or targeted training courses.
5. The New Zealand Ministry of Primary Industries has had some successful experience in enhancing the writing skills of Pacific Islanders; therefore, it is worth exploring their interest in sponsoring national or subregional fisheries-oriented writing workshops.
6. Explore the cost-effectiveness and suitability of online writing courses for PIFPs.
7. Explore the interest of the universities in the region in enhancing their efforts in the area of technical report writing.
8. Recognise that addressing the “root causes” of the constraints (e.g. family or social obligations, poor schools, lack of money) would probably be more appropriate for addressing by national governments across all sectors, and not just fisheries agencies or donors focused on the fisheries sector.

Concluding remarks

With respect to the study’s findings, the top identified assisting factors and constraining factors are not surprising. They are well known to most people who are intimately familiar with Pacific Island fisheries. What is noteworthy is that significance factors have received scarce attention from regional organisations and other agencies involved in human resource development in fisheries in the Pacific Islands region.

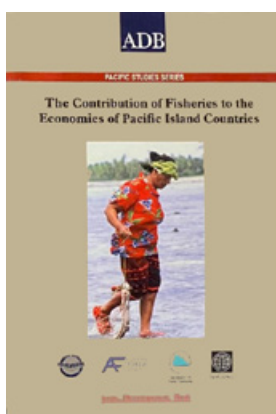
The findings point to the opportunities and need for outside agencies to help address many of the identified assisting and constraining factors in the careers of PIFPs. A priority type of support would be for the “low hanging fruit”: interventions to promote mentoring and improve writing skills. Regional stakeholders (especially regional organisations involved with fisheries) need to assess the extent to which they are willing and able to provide various types of identified support to the careers of Pacific Island professionals.

A study of the benefits from fisheries in the region

*In 2001, 2008 and 2016, the Pacific Community (SPC) and various regional agencies and donors were involved with studies that brought together various types of information on the benefits from fisheries to Pacific Island countries and territories. This work, known as “Benefish”, was written up into a series of three books: 1) *The contribution of fisheries to the economies of Pacific Island countries* (2001), 2) *Fisheries in the economies of Pacific Island countries and territories* (2008), and 3) *Fisheries in the economies of Pacific Island countries and territories* (2016).*

Each book has a chapter for each Pacific Island country and territory covering the following topics:

- Recent annual fishery harvests: values and volumes covering six fishery production categories.
- Fishing contribution to gross domestic production: the current official fishing contribution, how it is calculated, and a production approach recalculation based on annual harvest levels obtained during the study.
- Fishery exports: amounts, types, and the ratio to all exports.
- Government revenue from the fisheries sector: access fees and other revenue.
- Fisheries employment.
- Fisheries contribution to nutrition.



A digital copy of the 2016 book is available at:

https://www.spc.int/sites/default/files/word-presscontent/wp-content/uploads/2016/11/Gillett_16_Benefish-fisheries-in-economies-of-pacific-countries.pdf

Some of the more surprising facts to emerge from the 2016 Benefish study were:

- The 2014 tuna catch in the Kiribati was 40.7% of the regional total and was valued at about USD 1 billion.
- 52.7% of all employment in the region directly related to the tuna industry occurs in Papua New Guinea.
- The volume of production from the coastal commercial fisheries of Samoa in 2014 approached that of PNG. The volume of production from the coastal commercial fisheries of Fiji is almost twice as much as that of PNG despite having a population almost 9 times greater than Fiji.
- 93% of the value of all aquaculture in the region is produced in two French territories, French Polynesia and New Caledonia.
- In only 6 countries of the region is aquaculture significant (i.e. production value is greater than 5% of that of coastal fisheries) – all but one of those countries (Cook Islands) are territories.
- American Samoa's fishery exports are about 47% of the fishery exports from all the other countries and territories combined. PNG's fishery exports are valued at about 41% of all the fishery exports from all the other independent countries combined.
- The total amount of fishery exports from the region fell about 42% in real value in the 2007–2014 period. The fall in the value of canned tuna exports from American Samoa was responsible for about 37% in the total regional decline.
- In just the period 2007–2014 (which coincided with the period when the Vessel Day Scheme was introduced and became fully operational) access fees for foreign fishing increased 279%.
- Four countries of the region received access fees in 2014 that equated to more than USD 1,000 per capita.

Following recommendations from members to SPC at various regional meetings, SPC is supporting an update of the Benefish work. This study will be similar to the previous studies, but a few changes have been made based on lessons learnt from the last study. A Pacific Islander has been recruited to work with the main consultant, with the idea that the person will learn how the study is carried out and will hopefully be able to do similar work in the future. Information will be collected and analysed on the impacts of COVID and climate change on fisheries in the region.

This work is expected to be published in mid-2023.

The “Pacific Way” of coastal fisheries management: Status and progress of community-based fisheries management¹

Hugh Govan² and Watisoni Lalavanua³

Introduction

The ocean area that most Pacific Island citizens interact with and rely on for daily food are coastal waters, which comprise less than 1.25% of the total ocean area under national jurisdictions⁴. Yet, these coastal fisheries provide most of the seafood contribution to nutrition and nearly half of the fisheries-related contribution to the gross domestic product of most Pacific Island nations (SPC 2021a).

For several decades, Pacific Island countries and territories (PICTs) have warned that coastal fisheries are threatened (King et al. 2003; SPC 2008). The emerging threats of ocean warming and acidification are likely to exacerbate previously identified challenges of coastal urban development, population growth, coastal pollution, overfishing, erosion and siltation of coastal ecosystems from logging and mangrove clearing. All of these activities are causing a decline in catch potential (Bell et al. 2018) and are threatening food security and livelihoods.

Challenges facing the management of coastal fisheries include the diversity among PICTs in terms of geographical size, population, culture, development status and economy; dispersed and rural populations (77% live in rural areas) that rely heavily on fish among other natural resources⁵; and a lack of political will to make appropriate management decisions (Munro and Fakahau 1993; Naqali et al. 2008; CCIF 2013). These combined with low levels of capacity, transparency and accountability further exacerbate the problem (Gillett and Cartwright 2010; Coastal Fisheries Working Group 2019; Tuxson 2018).

The potential for effective coastal fisheries management to be based on traditional marine tenure and ecological knowledge has always been apparent to Pacific Islanders and was documented nearly half a century ago (Johannes 1978). Regional policy has increasingly highlighted community-based approaches as being core to coastal fisheries management (Box 1) in parallel with national experiences led by governments (e.g. Vanuatu, see Amos 1993; Samoa, King

Box 1. Regional declarations and policies concerned with the state of Pacific Island coastal fisheries.

- Strategic plan for fisheries management and sustainable coastal fisheries in Pacific Islands (King et al. 2003)
- Vava'u Declaration on Pacific Fisheries Resources (2007)
- Pacific Islands regional coastal fisheries management policy and strategic actions 2008–2013 (Apia Policy, SPC 2008)
- Melanesian Spearhead Group roadmap for inshore fisheries management and sustainable development 2015–2024 (MSG 2015)
- A New song for coastal fisheries – pathways to change: The Noumea strategy (SPC 2015)
- Future of fisheries: A regional roadmap for sustainable Pacific fisheries 2015 (FFA and SPC 2015)
- Pacific Framework for Action of Scaling-up CBFM: 2021–2025 (SPC 2021b)

and Fa'asili 1999; Tonga, Malimali 2013) or non-governmental organisations (e.g. Fiji, Papua New Guinea, Solomon Islands, Govan et al. 2009).

Despite the impressive coverage and progress in some countries, *A new song for coastal fisheries – pathways to change: The Noumea strategy* (SPC 2015) acknowledged the clear local, subregional and regional differences in the circumstances of coastal fisheries, and highlighted that site-based, community-based fisheries management (CBFM) alone will not be sufficient to meet future national and regional food security challenges, and will need to be supplemented with other approaches and mechanisms. Scaling-up was identified as the main strategy for moving towards sustainable coastal fisheries (SPC 2015), and so SPC developed, with its members and partners, the Pacific Framework for Action on Scaling-up CBFM: 2021–2025 (hereafter referred to as the Framework for Action; SPC 2021b).

¹ This article draws from a report (Govan and Lalavanua 2022) available from: <https://purl.org/spc/digilib/doc/ocw6w>

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⁴ Inshore Fishing Area defined as the area up to 50 km from shore or 200 m depth, whichever comes first (Chuenpagdee et al. 2006). Sea Around Us 2015. Data provided 15 January 2015. <http://searoundsus.org/>

⁵ [https://stats.pacificdata.org/vis?lc=en&df\[ds\]=SPC2&df\[id\]=DF_KEYFACTS&df\[ag\]=SPC&df\[vs\]=1.0&pd=2021%2C2021&dq=A..&ly\[cl\]=INDICATOR&ly\[rw\]=GEO_PICT](https://stats.pacificdata.org/vis?lc=en&df[ds]=SPC2&df[id]=DF_KEYFACTS&df[ag]=SPC&df[vs]=1.0&pd=2021%2C2021&dq=A..&ly[cl]=INDICATOR&ly[rw]=GEO_PICT)

The Framework for Action identifies actions relating to information, awareness, communication, policy and legislation, organisational and individual capacity, and inclusive and ecosystem approaches as key strategic actions for scaling in order to supplement the support for site-based approaches.

Status of community-based fisheries management

The Pacific Community (SPC) commissioned the authors of this paper to carry out a survey to assess the status of CBFM and coastal fisheries management in 22 PICTs as well as Timor Leste (Govan and Lalavanua 2022). The overall purpose of the survey was to assess to what extent communities in the PICTs are supported to achieve sustainably managed coastal fisheries, including support for site-based and community-driven CBFM as well as provision of an enabling environment in the areas of information, policy and legislation and capacity.

The survey contributed to the regional CBFM website, currently under development by SPC's Fisheries, Aquaculture and Marine Ecosystems Division, which will provide management information suitable for local communities and CBFM practitioners. The full results are provided in the [full report](#), and the main results are discussed below.

Recording and tracking CBFM

The survey explored whether PICTs had public inventories of sites receiving CBFM support, as well as whether these were used to track progress. The Republic of Marshall Islands (RMI) and French Polynesia (Box 2) have public registries of CBFM sites but no other PICTs have such registries. Although most PICTs were able to produce site inventories (usually by the fisheries agency), the majority did not have these readily available, nor were they up to date. It is notable that the two largest countries do not appear to have government listings of CBFM interventions (Papua New Guinea and Fiji).

RMI provides an example of a simple approach that provides public information on the status and progress of CBFM sites (Fig. 1). Although not publicly available, Tonga, Samoa, Solomon Islands (see Box 3), and, more recently, Vanuatu, appear to be maintaining national inventories that also serve as tracking mechanisms. The last two countries are also tracking other community support contemplated under the Framework for Action, including information and awareness provision.

The lack of national registries or the ability to track CBFM interventions in the majority of PICTs, increasingly poses an obstacle for the efficient support of CBFM at national

Box 2. Example of publicly available online databases and maps for CBFM sites (Zones de pêche réglementées) in French Polynesia

The screenshot shows the website of the Direction des Ressources Marines (DRM) of French Polynesia. The header includes the DRM logo and navigation links: Accueil, Pêcheurs, Perculteurs, Aquaculteurs, Cartes thématiques, Supports de communication, and Prévention et sécurité en mer. A search bar is visible on the left. The main content area displays a message in French: 'Les cartes des Zones de Pêche Réglementée (ZPR) des Tuamotu, sont disponibles ci-dessous. Vous pouvez consulter les textes réglementaires en cliquant sur les liens suivants :'. Below this, a list of fishing zones is provided with links to their respective PDF maps: Tatakoto, Rangiroa, Mataiva, Manihi, Reao, and Anaa. The date 'Mise à jour octobre 2020' is noted. At the bottom, three map thumbnails are shown with labels: 'ZPR de Anaa', 'ZPR de Rangiroa', and 'ZPR de Manihi', each with a 'Télécharger le PDF' link.

Source: http://www.ressources-marines.gov.pf/cartes-sig/cartes-thematiques/zone_de_peche_reglementee/

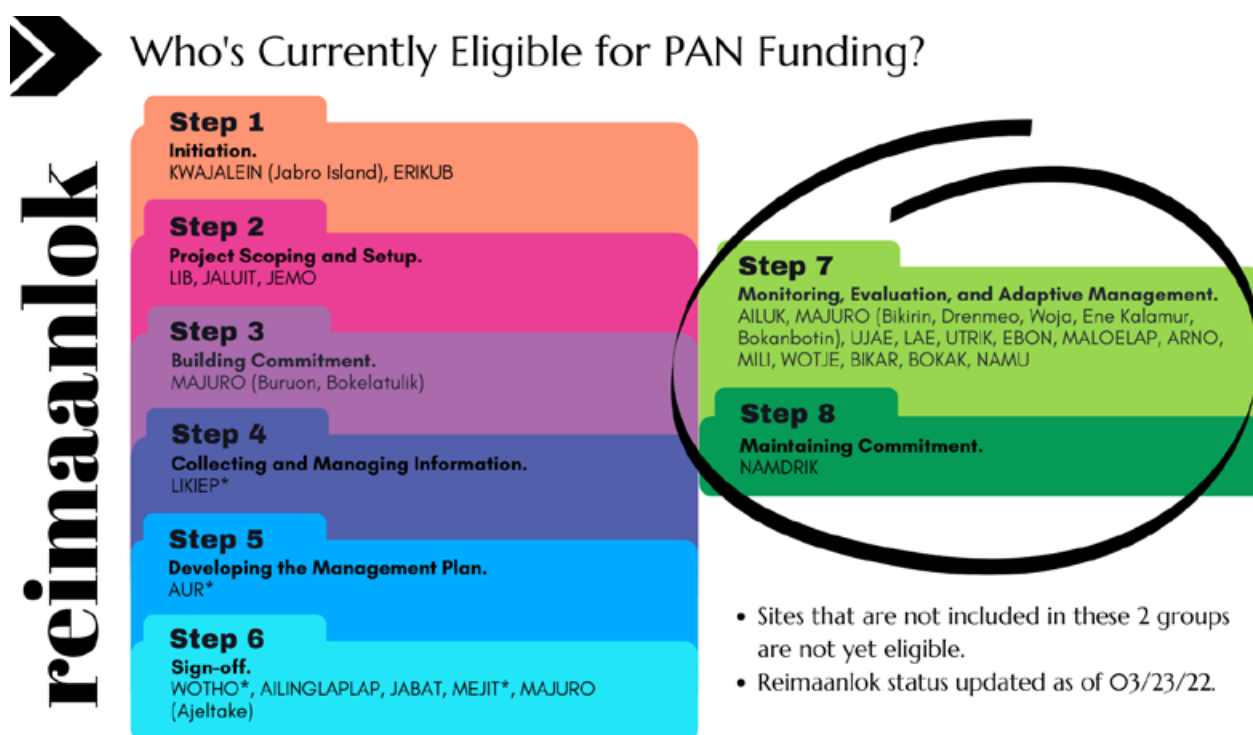


Figure 1. Graphic representation of the status of different CBFM sites in the Reimaanlok process under the Protected Areas Network (PAN) within the Republic of the Marshall Islands. Source: <http://www.rmimimra.com/index.php/about-us/rmipan>

Box 3. Tracking tool for scaling-up community-based resource management (CBRM) outreach by Solomon Islands' Ministry of Fisheries and Marine Resources

Solomon Islands has long identified the challenge of providing support for CBRM to more than 3000 coastal communities (MECM/MFMR 2009) and has been working to ensure the best support coverage subject to the modest budgets and staffing available. In 2016, a CBRM section (with six dedicated staff) was established within the Inshore Fisheries Department. Partnership and collaboration with non-governmental organisations are important tools, and given the size of the country, it is vital to work in a decentralised manner through close support of provincial fisheries offices.

Awareness raising – using radio and mass media – forms a strong basis at the national level, while at provincial level, approaches try to ensure widespread coverage through any other means available. Driven by village requests or expressions of interest, visits may be arranged to provide more information; these awareness activities are termed Level 1. Communities that express further need and interest may qualify for Level 2 support and receive more training or capacity building, subject to available staff and finance. Further assistance for the most advanced or needy sites involves technical assistance in developing management plans – Level 3.

MFMR description of levels

Expressions of interest, names of communities and contacts, as well as the delivery of Level 1 and higher levels of support are recorded in a national and provincial tracking tool as an Excel spreadsheet and regularly updated.

Level of Awareness				
Level.1	General Awareness (importance of resources)			
	<ul style="list-style-type: none"> Awareness Disseminate materials 			
Level.2	Follow up - provoked by Level 1			
	<ul style="list-style-type: none"> Simple management rules M&E Trainings/capacity building 			
Level.3	Technical Assistance			
	<ul style="list-style-type: none"> Management Plans 			

Level 1:										Level 2:	Level 3:
Communities	EOI (Date)	Current status	Person in charge	Contact	1-1. Material dissemination	1-2. Face-to-face awareness	2-1. Monitoring, tracking and evaluation of materials	2-2. Community training and capacity building	3. Community Fisheries Management Plan		

Data fields recorded in provincial and MFMR tracking tool. (Source: MFMR Inshore Team, David Aram)

and subnational levels. Without timely and regular tracking of the reach of CBFM support, together with estimations of the number of communities or geographical areas covered, it will be hard to gauge the extent, let alone the impact, of CBFM support efforts.

The survey did provide an update of the number of coastal protected and managed areas (MPAs) (cf. Huber and McGregor 2002; Axford 2007; Govan et al. 2009; Govan 2015 a,b) because most PICTs consider CBFM sites as qualifying as MPAs, and at some stage have included these in conservation reporting. The survey should be of interest to the wider conservation community as it is almost certainly more complete and up to date than others for the Pacific Islands at the date of reporting.

The World Database of Protected Areas (WDPA), as used in the latest Status of Protected Areas of the Pacific (Nimwegen et al. 2022), could provide an alternative public source of information as most countries include CBFM sites in their lists of coastal MPAs. But the quality of data across countries and territories was found to be highly variable, and known to be problematic both in content (Smallhorn-West and Govan 2018) and consistency and timeliness in the updating process (Nimwegen et al. 2022). Although it was not possible to carry out a site-by-site comparison, we show the national totals for CBFM sites and MPAs with community involvement in Annex 1.

Coverage of CBFM

In contrast to the coverage by information, awareness or other enabling types of support, data do exist for most PICTs on the number of CBFM sites. Site-based CBFM takes many forms across the region, with island, state and district clustered, and community level approaches recorded. For many of these sites, participatory community plans are developed to achieve area-based coastal fisheries management.

Site area is not consistently or comparably reported, nor are the number or areas of reserves or no-take zones. Of the 10 PICTs that reported CBFM areas, the sites totalled around 1.45 million ha; of the 7 PICTs that reported the area of no-take zones or reserves, the sites totalled 142,000 ha. More than half of these figures are derived from non-governmental organisation (NGO) data from Fiji.

In a number of cases, it is evident that no-take zones or closed areas are reported as CBFM sites, without reference to clear fisheries objectives or community management or rules in the fished areas. This issue is particularly acute where MPAs have been developed with more focus on biodiversity conservation or with support from foreign NGOs.

The CBFM approaches used in different PICTs are highly diverse. One variable is the number of communities covered by a single site; in some cases, a single site comprises a single community, but in others, multiple communities are covered. For the purposes of estimating coverage of CBFM approaches to coastal fisheries management, we assessed the number of communities that participate in CBFM (i.e. making coastal fisheries rules to meet their needs) as a more useful indicator than the number of sites.

Overall (see Table 1), 661 active CBFM sites serving 1032 communities⁶ are reported in 15 PICTs, or 10% of the total possible communities reported or calculated for this survey. A further 193 sites are reported to be in progress, which could raise the coverage to 12%, if successfully concluded. The present study discounted 170 sites considered inactive, mainly in American Samoa, the Federated States of Micronesia, Samoa and Solomon Islands.

The community coverage by site-based CBFM has increased overall from the 8% reported nearly 10 years ago (Govan 2015a), to approximately 10% of the estimated total communities (Table 2), an increase of 96 communities since the endorsement of the Noumea Strategy. Given the differences in surveys, the changes that most likely reflect real increases



Image: ©Watisoni Lalavanua, SPC

⁶ In many cases this equates to villages or settlements but the governance unit predominantly used by the specific or national CBFM approach was used for each country or territory. This means, in practice, that villages, settlements, districts, states, communes, island councils or municipalities, depending on each PICT.



Image: ©Jan Van der Ploeg

are those in Kiribati, Samoa, Tonga and Vanuatu. Coverage has decreased in Papua New Guinea (PNG) and American Samoa, and has stalled in Fiji and Palau.

These numbers mask the high variability between countries. For instance, coverage of 50% or more in Cook Islands, Fiji, RMI, Tonga, Tuvalu and Samoa, contrasted with less than 5% in the countries with the largest numbers of communities and/or highest populations (PNG, Solomon Islands and Vanuatu), and less than 17% of Kiribati, Palau and Timor Leste.

Examining the historical evolution of CBFM coverage suggests two broad categories of countries that should be considered by conservation and fisheries management planners.

1. Potential of site-based approaches is limited. Site-based CBFM, management plans and MPAs are very unlikely to achieve significant coverage of coastal communities. Despite the impressive progress in some cases (e.g. Kiribati, Timor-Leste and Vanuatu), or the substantial number of sites achieved (Solomon Islands), it seems unlikely that a large enough proportion of coastal communities will be able to participate in site-based approaches of management planning for this to be the main fisheries management strategy, nowhere more so than PNG. For the five PICTs mentioned, the cost-effective and enabling environment aspects of the Framework for Action will likely be of most relevance in the development of their CBFM scaling-up strategies. Solomon Islands and Vanuatu are making notable progress in this regard.

2. Site-based approaches at the core of CBFM. High coverage of site-based CBFMs have been achieved already or likely to be soon (Cook Islands, RMI, Samoa, Tonga and Tuvalu). In these cases, future strategies may be able to focus on improving aspects of effectiveness and sustainability.

In addition, there are special cases affecting a few countries and most of the territories.

3. Potential for high coverage of site-based CBFM: High coverage could be achieved but progress has slowed or stopped. Future strategies require a review of experiences and objectives in order to better define strategic approaches to achieving sustainable coastal fisheries management through CBFM (Fiji, FSM and Palau). Conservation agendas may be undermining clear thinking on fundamental resource management strategies.

4. Territories with specific needs or emerging opportunities. Niue, Pitcairn and American Samoa are initiating promising site-based or community approaches. French Polynesia is making good progress implementing zone-based and traditional approaches. The Commonwealth of the Northern Mariana Islands, Guam, New Caledonia, and Wallis and Futuna may have varying roles (or none at all) for CBFM approaches.

*The “Pacific Way” of coastal fisheries management:
Status and progress of community-based fisheries management*

Table 1. Coverage by site-based, community-based fisheries management approaches in PICTs. Total number of coastal communities was determined by each jurisdiction. Colour coding ranges from low coverage (red) to high coverage (green).

	Name of model or programme	Number of sites active	Sites in progress	Sites inactive	Communities covered	Total coastal communities	Community unit	Coverage	+in progress
American Samoa	Community based Fisheries Management Program (CFMP)		6	7		74	Villages	0%	8%
Cook Islands	Ra'ui and marine managed areas	23		9	40	41	Districts	98%	98%
Federated States of Micronesia	Marine protected areas (MPAs) and community-based fisheries management (CBFM)	20	4	9	21	75	Municipalities	28%	33%
<i>Fiji Islands NR</i>	<i>Locally-managed marine areas (LMMA)</i>	89			437	850	Villages	51%	51%
French Polynesia	ZPR and rahui	36	5	4	20	116	Communes and commune associée	17%	22%
<i>Guam NR</i>	<i>No co-management</i>					13	Village	0%	0%
Kiribati	Nei Tengarengare CBFM, island and zone approaches	27	40	5	29	184	Villages*	16%	38%
<i>Marshall Islands</i>	<i>Reimaanlok</i>	14	13		14	27	Atolls	52%	100%
Nauru	Community fisheries management areas		3			14	Districts	0%	21%
<i>New Caledonia</i>	<i>Consultative and traditional management</i>					33	Communes	0%	0%
<i>Niue</i>	<i>Community management plans/RMACs</i>		13			14	Communities	0%	93%
<i>Northern Mariana Islands NR</i>	<i>No co-management</i>					12	Villages	0%	0%
<i>Pitcairn Islands</i>	<i>Coastal conservation areas</i>		1			1	Island	0%	100%
Palau	Protected Area Network (PAN) with a marine component (2)	1	3		2	16	States	13%	31%
<i>Papua New Guinea NR</i>	<i>Community, ward or customary plans</i>	32			37	4000	Village	1%	1%
Samoa	Village management/bylaws	111	97	14	123	253	Village	49%	87%
Solomon Islands	Community-based resource management (MFMR and NGOs)	158	unk	121	158	3000	Villages	5%	5%
Timor-Leste	Tara bandu	15		1	16	98	<i>Sucos</i> or districts**	16%	16%
<i>Tokelau NR</i>	<i>Traditional and village rules</i>	3			3	3	Villages	100%	100%
Tonga	Special management areas (SMAs)	59	5		54	111	Village	49%	53%
Tuvalu	Locally-managed marine areas (LMMA)	9			9	9	Councils	100%	100%
Vanuatu	Community-Based Fisheries Management programme	65			65	1400	Communities/settlements	5%	5%
Wallis and Futuna	Marine protected areas (MPAs)		2			36	Village	0%	6%
TOTALS		662	192	170	1028	10,380		10%	12%

* Also includes island and zone initiatives

** Total number of communities not known. 7 of 98 *sucos* (districts) have at least one community with a *tara bandu* (traditional prohibition).

Italics denote data without final validation from the relevant authority, and NR indicates no data provided or no response received.

Table 2. Comparison in community coverage of CBFM for 2015 (Govan 2015a) and this survey. Methodology and response rates varied between the two surveys, so results are only indicative. Orange denotes a significant decrease since 2015, green denotes a significant increase.

	Number of sites active 2022	Sites in progress	Sites inactive	Communities covered 2022	Communities covered 2015	Total coastal communities	Community unit
American Samoa	0	6	7	0	13	74	Villages
Cook Islands	23	0	9	40	6	41	Districts
Federated States of Micronesia	20	4	9	21	10	75	Municipalities
<i>Fiji Islands NR</i>	89	0	0	437	448	850	Villages
French Polynesia	36	5	4	20	27	116	Communes
<i>Guam NR</i>	0	0	0	0	0	13	Village
Kiribati	27	40	5	29	5	184	Villages*
<i>Marshall Islands</i>	14	13	0	14	13	27	Atolls
Nauru	0	3	0	0	0	14	Districts
<i>New Caledonia</i>	0	0	0	0	1	33	Communes
<i>Niue</i>	0	13	0	0	1	14	Communities
<i>Northern Mariana Islands NR</i>	0	0	0	0	0	12	Villages
Palau	1	3	0	2	5	16	States
<i>Papua New Guinea NR</i>	32	0	0	37	86	4000	Village
<i>Pitcairn Islands</i>	0	1	0	0	0	1	Island
Samoa	111	97	14	123	102	253	Village
Solomon Islands	158	NR	121	158	184	3000	Villages
Timor-Leste	15	0	1	16	NR	98	Sucos **
<i>Tokelau NR</i>	3	0	0	3	3	3	Villages
Tonga	59	5	0	54	10	111	Village
Tuvalu	9	0	0	9	9	9	Councils
Vanuatu	65	0	0	65	13	1400	Communities
Wallis and Futuna	0	2	0	0	0	36	Village
TOTALS	661	193	170	1032	936	***10,380	

* Also have island and zone initiatives

** Total number of communities not known. 7 of 98 *sucos* (districts) have at least one community with a *tara bandu* (traditional prohibition)

***The 2015 report summed 11,422 communities and, since, some PICTs have refined their estimates.

Italics denotes data without final validation from the relevant authority, and NR indicates no data provided or no response received.

Who drives CBFM?

Determining who initiated CBFM at particular sites is often not straightforward, let alone determining the motivation and who currently drives the sites identified in the survey. Subjective categorisations by respondents suggest the majority of active sites in the region are either “community driven” or “community initiated jointly driven with government or NGOs”.

In many PICTs, particularly those in the northern Pacific, there is lack of clarity relating to whether MPAs had been initiated or designated as part of CBFM or fishery strategies, and whether their primary motivation was biodiversity conservation with unclear considerations for fisheries outcomes or community enforceability.

The two US territories of CNMI and Guam, and the French territory of Wallis and Futuna rely on relatively long-established systems of top-down fisheries management, and do not practice CBFM or co-management at present, although Wallis and Futuna is exploring such options. All other PICTs had implemented, or were planning on implementing, CBFM approaches although notably the two largest countries, PNG and Fiji, did not report any information relating to CBFM or coastal fisheries management in general. New Caledonia reported that CBFM or traditional approaches were used in two provinces, and Province Sud reported elements of fisher involvement in a generally Western style fisheries management system.

Government finance and staffing

One way of assessing the extent to which CBFM is currently supported and could feasibly be scaled up is by examining government financing of coastal fisheries management and CBFM. This could not, however, be reliably achieved (Marre et al. 2021). Responses regarding fisheries agency staffing were easier to obtain (Table 3) and give some indication of the support and priorities allocated to coastal fisheries. Twenty PICTs reported a total of 488 coastal fisheries staff, representing about a third of total fisheries agency staff numbers reported (n=18) but ranging from 12% to 67%. Ten PICTs reported 136 staff dedicated to CBFM, with a further three reporting part-time staff. Five PICTs reported the existence of mechanisms equivalent to community authorised officers (i.e. community members empowered to enforce fisheries rules). It is important to note that complete data were not available for New Caledonia, PNG and Vanuatu.

Despite mixed or unclear trends in coastal fisheries management budgets at the national level (Marre et al. 2021), there are good indications that staffing has increased in 10 PICTs, even possibly indicating in 6 or 7 cases an increase in support for coastal fisheries management and, explicitly, CBFM (Table 4). The reduction in staff observed in four PICTs may be cause for concern and should be further explored. While staffing could be a good indicator of national support for coastal fisheries (Marre et al. 2021), it is hard to assess what numbers would be adequate to the tasks at hand or whether staff are sufficiently supported by operational budgets to perform the tasks.

Fisheries agencies are often initially, and almost always ultimately, responsible for coastal MPAs in nearly all PICTs, including those with conservation objectives. Yet, low government fisheries management budgets stand in stark contrast to the large budgets of many fisheries and conservation projects implemented by third parties (e.g. NGOs, consulting firms, academia), the majority of which do not integrate their funding mechanisms into national agency financing structures.

Commitments to substantially increase philanthropic funding for marine protection, such as 30% coverage of MPAs by 2030 (Bezos Earth Fund 2022), present an opportunity, but also a considerable risk. Given the specificities of PICTs and the lessons learned (Nimwegen et al. 2022), achieving substantial increases in MPA coverage will rely on CBFM approaches. Fisheries agencies are already over-stretched and have identified the lack of recurrent budgets as a primary challenge (SPC 2021b). Additional support aligned with CBFM strategies and addressing recurrent government budget shortfalls could be a gamechanger, achieving both coastal fisheries management and conservation. But the influx of substantial funding promoting unproven approaches and increasing the burden of fisheries agencies without careful consideration could be extremely detrimental to both the environment and people’s livelihoods.

Table 3. Staffing at coastal fisheries management agencies in PICTs. (Sources: this survey and Marre et al. 2021)

	Agencies in charge	Staff TOTAL	Staff in coastal	Staff full time on CBFM	Staff part time on CBFM	MCS officers in support	CAOs*
American Samoa	American Samoa Department of Marine and Wildlife Resources (DMWR)	18	4	4	0	6	0
Cook Islands	Ministry of Marine Resources (MMR). Island Councils, Vaka Councils, National Environment Service (NES).	60	29	0	10	21	0
Federated States of Micronesia	Division of Marine Resources (DMR), Division of Fisheries and Marine Resources (DFMR), KIRMA, Kosrae Conservation & Safety Organization (KCSO), Office of Fisheries and Aquaculture (OFA), FSM Department of Resources and Development (MRMD)	26	NR	23	12	10	7
Fiji Islands NR	Ministry of Fisheries	365	50	0	5	NR	60
French Polynesia	Direction des Ressources Marines (DRM) pour les ZPR uniquement	94	11	1	3	7	0
Guam NR	Department of Agriculture (DA) - Division of Aquatic and Wildlife Resources (DAWR)	NR	7	0	0	0	0
Kiribati	Ministry of Fisheries & Marine Resource Development (MFMRD)	169	88	0	18	NR	NR
Marshall Islands	Marshall Islands Marine Resource Authority (MIMRA)	90	60	NR	NR	NR	NR
Nauru	Nauru Fisheries and Marine Resources Authority (NFMRA)	58	22	22	10	NR	0
New Caledonia		NR	NR	NR	NR	NR	NR
Niue	Department of Agriculture, Forestry and Fisheries (DAFF) - Fisheries Team	4	2	NR	NR	NR	NR
Northern Mariana Islands NR	Department of Lands and Natural Resources (DLNR)	17	11	NR	NR	NR	NR
Palau	Ministry of Agriculture, Fisheries and the Environment, Bureau of Fisheries, Bureau of Environment – Protected Areas Network (PAN)	29	10	0	0	0	0
Pitcairn Islands	Government of Pitcairn Islands, Environmental, Conservation & Natural Resources Division (ECNRD)	2	1	0	1	NR	NR
Papua New Guinea NR	National Fisheries Agency (NFA) Provincial fisheries departments	NR	NR	NR	NR	NR	NR
Samoa	Ministry of Agriculture and Fisheries (MAF) – Fisheries Division	62	26	26	0	Yes	Yes
Solomon Islands	Ministry of Fisheries and Marine Resources (MFMR) and Provincial Fisheries Departments	151	52	5	32 + 18 Provincial Fisheries Officers	NR	0
Timor-Leste	Ministério da Agricultura e Pescas, Departamento do pescas https://www.maf.gov.tl/	103	NR	NR	NR	NR	NR
Tokelau NR	Fisheries Management Agency (FMA), Taupulega	NR	4	NR	NR	NR	NR
Tonga	Ministry of Fisheries, Community Development and Advisory Section (CDAS)	92	22	12	5	10	12
Tuvalu	Tuvalu Fisheries Department, Falekaupules	60	20	20	NR	NR	NR
Vanuatu	Vanuatu Fisheries Department (VFD)	NR	38	18	20	10	22
Wallis and Futuna	Direction des Services de l'Agriculture, de la forêt et de la Pêche (DSA)	5	5	5	0	NR	NR
TOTALS		1396	488	136	84	64	101
Countries reporting		18	20	16	14	8	10
Countries reporting > 0		18	20	10	9	6	4

* CAO: Community authorised officers

Italics denotes data without final validation from the relevant authority, and NR indicates no data provided or no response received.

Table 4. Indicative total and coastal fisheries staff levels comparison over approximately 10 years – recent data from this survey and Marre et al. 2021, and pre-2015 data from Govan (2015). Green shading indicates notable increases; red numbering indicates substantial decreases.

	Staff total	Staff in coastal	Staff full time on CBFM	Total staff (pre- 2015)	Coastal staff (pre- 2015)
American Samoa	18	4	4	31	31
Cook Islands	60	29	0	65	17
Federated States of Micronesia	26	NR	23	66	37
Fiji Islands NR	365	50	0	147	73
French Polynesia	94	11	1	51	7
Guam NR	NR	NR	NR	NR	NR
Kiribati	169	88	0	103	72
Marshall Islands	NR	NR	NR	NR	NR
Nauru	58	22	22	46	18
New Caledonia	NR	NR	NR	35	24
Niue	NR	NR	NR	NR	NR
Northern Mariana Islands NR	NR	NR	NR	NR	NR
Palau	29	10	0	32	11
Papua New Guinea NR	NR	NR	NR	290	129
Pitcairn Islands	NR	NR	NR	NR	NR
Samoa	62	26	26	57	19
Solomon Islands	151	52	5	79	47
Timor-Leste	NR	NR	NR		
Tokelau NR	NR	4	NR	7	3
Tonga	92	22	12	50	12
Tuvalu	60	20	20	43	10
Vanuatu	NR	38	18	54	21
Wallis and Futuna	5	5	5	3	3

Italics denotes data without final validation from the relevant authority, and NR indicates no data provided or no response received.

Legislation, policy and rights

There has been substantial progress in legislation and policy development supportive of CBFM in PICTs over the last 5–10 years (Table 5). Five PICTs have developed new primary legislation and five others have developed relevant legislation on protected areas (or similar) since 2014 (cf. Govan 2015a). Thirteen PICTs have fisheries policies that provide at least some mention of community or traditional fisheries management approaches, 10 of these since 2014. Elements contributing to support for scaling-up of CBFM as envisaged in the Framework for Action (SPC 2021b) are present in existing strategies or under development in five PICTs.

User rights and tenure arrangements were explored during this survey but the variety of situations, and the challenge of discussing complex, contextual matters without site visits

meant that only preliminary impressions could be gathered (Govan and Lalavanua 2022). Several countries appear to have tenure arrangements strongly favouring traditional communities (e.g. Solomon Islands and Vanuatu) and other PICTs seem to have been able to achieve practical solutions that enable community rights to manage and have exclusive access to nearby fishing grounds (e.g. Samoa and Tonga). However, in most PICTs, it is impossible to assert that there are “clear user rights” as called for by leaders in the *Future of Fisheries Roadmap* (FFA 2015), and almost all presented some grounds for concern or need for clarification in terms of user rights (access, exclusion, management) or empowerment (cf. coastal fisheries report card⁷). User rights and tenure arrangements need deeper analysis and most likely the development of a conceptual approach and methodology suited to the context of PICTs.

⁷ <https://fameresults.org/cfreportcard/>

Table 5. Legislation and supporting policy for coastal fisheries in PICTs. Sources: this survey is based on O'Connor et al. in press

	Legal framework	CBFM supporting policy
American Samoa	A.S.A.C §24.1001 Title 24: Ecosystem Protection and Development; American Samoa Administrative Code 24 CAP.10 (Community-based Fisheries Management Program) 2008	American Samoa Administrative Code 24 CAP.10 (Community-based Fisheries Management Program) 2008
Cook Islands	Marine Resources Act 2005. Environment (Atiu and Takutea) Regulations 2008. Island Government Act 2012–2013	Ministry of Marine Resources (MMR). Policy for Coastal Fisheries Resources 2014. Acknowledges “knowledge of our ancestors, develop laws to protect and conserve our coastal fisheries”
Federated States of Micronesia	State level	No
Fiji Islands NR	Fisheries Act 1942	No
French Polynesia	Délégation n° 88-183 on fisheries (ZPR) 1988 Délégation n° 88-184 on fisheries 1988 Deliberation n° 2004-34 on public domain 2004 Code de l’environnement, art.LP.2122-1 (Rahui) 2017 Arrêté n° 2009 CM du 10 septembre 2021 approuvant le plan de gestion de l’espace maritime (PGEM) révisé de l’île de Moorea, commune de Moorea Maiao	No
Guam NR	U.S. Code of Federal Regulations 50 CAP.6 Part.665 (Fisheries in the Western Pacific) Guam Code Annotated 5 CAP.63 (Fish, Game, Forestry and Conservation) Guam Administrative Rules and Regulations 9 CAP.12 (Fishing Regulations) Marine Conservation Plan 2017	unk
Kiribati	Local Government Act 1984 Incorporated Society Act 2002* Fisheries Act 2010 Fisheries (Conservation and Management of Coastal of Marine Resources) Regulations 2019	National Coastal Fisheries Roadmap 2019–2036 (S, I) https://purl.org/spc/fame/cfp/legaltext/ba2ot Kiribati National Fisheries Policy 2013–2025
Marshall Islands	Protected Areas Network (PAN) Act 2015 Protected Areas Network (PAN) Act 2018 Protected Areas Network Regulations 2020 Management and Development of Local Fisheries Act 1997	RMI Fisheries Policy https://purl.org/spc/fame/cfp/legaltext/cadb7 PAN Strategic Action Plan Reimaankok: Looking to the Future. National Conservation Area Plan (S)
Nauru	Coastal Fisheries and Aquaculture Act 2020	Nauru Fisheries and Marine Resources Authority Corporate Plan 2015–2020
New Caledonia	Organic Law n° 99-209 1999 (New Caledonia) North Province Deliberation n° 2014-316/APN (Kan-Gunu) 2014 Loyalty Islands Province Environment Code 2016	unk
Niue	Domestic Fishing Act 1995 Village Council Act 2016	National Coastal Fisheries Management and Development Plan 2017–2022
Northern Mariana Islands NR	Commonwealth Code. Title 2: Natural Resources http://www.dfwcnmi.com/laws-regulations.php The Fair Fishing Act of 2000 http://www.dfwcnmi.com/fishing-rules.php	No
Palau	Palau National Code 24 (Environmental Protection) 1997 Palau National Code 27 (Fishing) 190	MAFE Strategic Plan Palau 2021–2024
Papua New Guinea NR	Fisheries Management Act 1998 Fisheries Management (Amendment) Act 2015. Organic Laws: on Provincial Boundaries 1998 / on Provincial Governments and Local-level Governments 1995 Customary laws and tenure	A Roadmap for coastal fisheries and marine aquaculture for Papua New Guinea 2017–2026 (S,I) A roadmap for the management and development of coastal fisheries for New Ireland Province 2021-2029
Pitcairn Islands	Pitcairn Islands Marine Protected Area Ordinance 2016 and Marine Conservation Regulations Pt V s14 (MCR) http://www.pitcairn.pn/Laws/index.php	The Pitcairn Islands Marine Protected Area Management Plan 2021 to 2026 (PIMPAMP). http://www.pitcairn.pn/environment.php
Samoa	Fisheries Management Act 2016 Village Fono Act 1990	Coastal Fisheries and Development Plan 2013-2016. Village Fisheries Bylaws and Village Fisheries Management Committee (Fisheries Management Act 2016, ss. 19, 41 & 86-89; Village Fono Act)
Solomon Islands	Fisheries Management Act 2015 Provincial Government Act 1997 Local Government Act 1964	Solomon Islands National Fisheries Policy 2019–2029 Solomon Islands Community Based Coastal and Marine Resource Management Strategy 2021–2025 (S) Standard Operating Procedures (CBRM SOP)
Timor-Leste	Decree Law No 26/2012 of 4 July 2012 Environment Basic Law – Art. 8 [Tara bandu] Diploma Ministerial No. 01/ 167/Gm/Vi/2007 Altera O Diploma Ministerial No. 01/03/Gm/I/2005 Definição Das Zonas De Pescas [6nm] Decree-Law No. 6/2004 of 21 April 2004 Government Decree No 5/2004 of July 2004	No, but CBNRM mentioned in Plano Anual de 2019 – Ministério da Agricultura e Pescas https://www.maf.gov.tl/tl/dokumentu/send/6-plano-no-programa-map-pedn/155-plano-asaun-anual-map-2020
Tokelau NR	Tokelau Village Incorporation Regulations 1986	No
Tonga	Fisheries Management Act 2002; Fisheries (Coastal Community) Regulations 2009	Tonga Fisheries Sector Plan 2016–2024 Tonga National Fisheries Policy 2018 [covers Coastal Fisheries and reformed SMA approach] (S)
Tuvalu	Falekaupule Act 1997 Conservation Area Act 1999 Marine Resources Act (2006), revised 2008, amendments 2012, 2017	No
Vanuatu	Decentralization Act 1994 Environmental Management and Conservation Act 2002 Fisheries Act 2014	Vanuatu National Fisheries Sector Policy (2016–2030) Vanuatu National Roadmap for Coastal Fisheries: 2019–2030 (S)
Wallis and Futuna	Law n° 61-814 of 29 July 1961 Deliberation n°73/AT/05 on marine fisheries	No

Italics denotes PICT yet to provide final validation from authority, and NR indicates no data provided or no response received.

(S) CBFM Scaling up strategy partially addressed in this policy

(I) CBFM Information Strategy partially addressed in this policy

The progress in legislation and policy development is impressive and suggests that the focus of donors and regional agencies can usefully shift more towards implementation, especially with regards to national strategies and workplans, while also improving simple monitoring and evaluation so that progress can be monitored over time.

Some donors base their support on regional and national policies in development aid planning but, in general, the large international conservation programmes have not tended to support the implementation of regional and sub-regional CBFM policies. The envisaged increase of initiatives supporting MPAs may aim to support fisheries and livelihoods priorities, but it is unclear that this would be achieved if not carefully aligned with regional and national policies, strategies and ongoing efforts to support coastal fisheries management frameworks and achieve scaled-up CBFM.

Conclusions and recommendations

Over the last few decades, CBFM has come to be recognised as normal, not exceptional nor a historical relic (Adams 2022). This shift has seen a recent increase in CBFM enabling conditions in most PICTs while, at least for some of the larger countries, increases in site-based management areas are slowing or stagnating. The increasingly satisfactory status of enabling conditions suggests the need to shift towards implementation and ongoing operational support for CBFM in the forms of budget, adequate staffing, and workplans and strategies. Public awareness and information strategies require consistent attention in most PICTs.

CBFM site coverage

Careful consideration is needed – depending on the particular PICT context – as to the optimum way to work with communities to achieve sustainable coastal fisheries. Two principal scenarios are evident: one where high coverage of site-based CBFM has been achieved already, or likely to be soon (Cook Islands, RMI, Samoa, Tonga and Tuvalu). In these cases, future strategies may be able to focus on improving aspects of effectiveness and sustainability.

For the larger countries, however, the site-based approaches, at least as currently framed, will be unlikely to reach a large enough proportion of coastal communities for site-based approaches to be the main fisheries management strategy. In these cases, the cost-effective and enabling environment aspects of the Framework for Action will likely be of most relevance in the development of their CBFM scaling-up strategies. The two largest countries present particular challenges relating to the implementation of CBFM that potentially affects half the coastal population of PICTs.

The interplay of conservation and sustainable fisheries management in CBFM

Most PICTs need discussions and clarification of the synergies and different needs of area-based management for coastal fisheries and biodiversity conservation in order to achieve overall coastal fisheries management and livelihood aims. Useful starting points for discussion in several PICTs would include integrating traditional management in the development of scaling-up strategies for coastal fisheries resource management, and resituating biodiversity conservation as an integrated outcome rather than a confusing and, sometimes, counterproductive driver. It is important to note that whether the sites are coastal MPAs or CBFM, most are under the remit of fisheries agencies.

Recording, tracking and evaluating CBFM

Ascertaining the number of sites and community coverage of CBFM is still a challenge in many PICTs. National and sub-national agencies should consider improved documentation and tracking of CBFM interventions, such as information, awareness, livelihoods projects, as well as CBFM and MPA sites (Solomon Islands may be a useful example). Publicly available registration or databases would ensure improved co-ordination, support and transparency. This would be a crucial step towards more comprehensive evaluations of the effectiveness and impact of CBFM on fisheries, ecosystems and livelihoods. More attention should also be paid to the quality of “user rights” that are necessary for scaling-up CBFM in each PICT and the means to assess and monitor these rights.

Challenges of adequate long-term operational funding

Although the strategic approaches proposed by the Framework for Action to maximise the strengths of community rights and empowerment should increase cost effectiveness; the fact remains that coastal fisheries management does not receive the budgetary support it requires. In addition, fisheries agencies are usually responsible for coastal MPAs, including those with conservation objectives.

Future support for CBFM that achieves substantial livelihood and conservation objectives will need to develop approaches that are appropriate and commensurate to the capability and recurrent budgets of the implementing government institutions. The envisaged increase in philanthropic funding for marine protection must avoid distracting fisheries agencies and governments from consolidating and building on the progress in coastal fisheries management systems and local management areas.

There is an urgent need to open the debate on the possibility that aid funding could supplement in the long term the annual government operational budgets to ensure that the livelihood and conservation objectives of scaling-up CBFM. Trust funds or direct sector support could be starting points for discussion, and the regional and subregional policies would be the logical framework for design.

While bilateral donors do use regional coastal fisheries policies in programming aid, large international conservation programmes tend not to. This is of concern given the emerging momentum to leverage relatively large amounts of funding to global visions of MPAs. Support of fisheries and livelihoods priorities, in tandem with coastal conservation, will be hard to sustain if it is not carefully aligned with regional and national policies, strategies, and efforts to support coastal fisheries management frameworks and achieve scaled-up CBFM.

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Annex 1 – Comparison with the World Database of Protected Areas

The WDPA accessed 26 January 2022 (<https://www.protectedplanet.net/en/thematic-areas/marine-protected-areas>) provided a registry of national data on protected areas. Data were tabulated for marine or partly marine sites as well as sites that had evidence of being co-managed i.e. Categories V or VI, governance types local, indigenous, collaborative or joint. For most categorizations a predominant number of sites were not classified at all. Thus, for a total of 557 sites; 80 sites were Category V or VI out of 189 reporting, 269 had some form of indigenous or collaborative governance out of 420 reporting and 248 out of 554 designations indicated co-management or local management. The most common designations were LMMA (115), marine managed area (32), Community based fishery (29), Tabu/MPA (21), and community conservation area (17).

	Number of sites active 2022 – this study	WDPA Total Protected Areas with marine component	WDPA Marine component and Category V, VI, or collaborative governance
American Samoa	0	15	8
Cook Islands	23	11	8
Federated States of Micronesia	20	4	0
<i>Fiji Islands NR</i>	89	118	101
<i>French Polynesia</i>	36	7	0
<i>Guam NR</i>	0	10	0
Kiribati	27	11	0
<i>Marshall Islands</i>	14	16	12
Nauru	0	0	0
<i>New Caledonia</i>	0	53	8
<i>Northern Mariana Islands NR</i>	0	25	4
<i>Niue</i>	0	2	0
Palau	1	49	10
<i>Papua New Guinea NR</i>	32	18	14
<i>Pitcairn Islands</i>	0	2	0
Samoa	111	47	29
Solomon Islands	158	79	74
Timor-Leste	15	10	8
<i>Tokelau NR</i>	3	3	2
Tonga	59	43	27
Tuvalu	9	18	8
Vanuatu	65	15	3
Wallis and Futuna	0	0	0
TOTALS	661	556	316

Research perspectives on Pacific Island coastal fisheries

Pita Neihapi,¹ Faye Siota,^{2,3} Rolenas Tavue,⁴ Tarateiti Uriam,⁵ Aurelie Delisle,⁶ Hampus Eriksson^{2,6} and Dirk J. Steenbergen^{6*}

In 2019, four coastal fisheries staff members from across the Pacific won scholarships to complete a Master of Fisheries Policy at the University of Wollongong in Australia. Faye Siota from Solomon Islands, Tarateiti Uriam from Kiribati, and Pita Neihapi and Rolenas Tavue from Vanuatu completed their degrees remotely over a two-year period while continuing their jobs in coastal fisheries in their respective countries. COVID-19 made this a tough challenge, but studying this way meant they could continue working while pursuing their studies.

The following research perspectives mark the completion of their research training journey and brings together insights and findings from their research “capstone” projects submitted as a component of their degrees.

All candidates brought a wealth of experience in community-based fisheries management. Coursework supplemented this experience with teachings on broader policy processes and academic insights of management. The study programme also provided an opportunity for candidates to complete and defend a research project before an examining board on a topic of their interest.



Figure 1. Pacific Island researchers are increasingly playing key roles in determining the focus of research projects, planning and design, and championing place-based and people-centred approaches. Image: © Eleanor McNeil

As coastal fisheries management capacity in the region grows, there are increasing avenues emerging for Pacific Islander-led research to become mainstream in knowledge creation, setting research agendas, and in designing and coordinating research implementation (Fig. 1). This is undeniably a welcome transition in how the science community in the Pacific operates. Place-based and people-centred approaches

to science in the Pacific will increase. As evident from these capstone projects, prospects for continued Pacific research leadership in coastal fisheries are promising. It is notable that this research has utility in mind and is informed by demands within departments, communities and countries.

In the following four short articles, the students summarise their research projects, highlighting objectives, key results and lessons learned for policy and practice. Given the students’ background and expertise, all projects shared a common thread – a focus on community-based fisheries management. Faye Siota summarises her review of national fisheries policy, strategies and operational work plans in order to understand what the gaps are in mobilising provincial fisheries officers to achieve national and subnational development targets in Solomon Islands. The research by Tarateiti Uriam seeks to understand how gender equality is presented and pursued in six Kiribati national natural resource policies. Pita Neihapi’s research addresses community resilience in Vanuatu, and outlines what the major challenges and opportunities are for resource-dependent coastal communities living in disaster-prone environments. Rolenas Tavue’s research investigates the processes of boundary formation and how these reveal the way multiple governance systems overlay one another in coastal waters. The views presented are those of the students and not necessarily those of their supporting institutions. We invite those interested in the different research projects to contact the respective researchers for more details.

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Understanding the capacity of provincial fisheries officers in order to support the scaling-up of community-based fisheries management in Solomon Islands

Faye Siota⁷

Supporting coastal resource management across many dispersed islands and communities is a major challenge for fisheries authorities in the Pacific, particularly where islands are large and highly populated, such as in Melanesia. Decentralised government structures provide channels by which support is delivered from national to local constituencies (Cohen and Steenbergen 2014). In Solomon Islands, officers from the Ministry of Fisheries and Marine Resources (MFMR) are seconded to provincial offices to implement the national Fisheries Management Act (Solomon Islands Government 2015), and any provincial fisheries ordinance or by-laws. Provincial fisheries officers (PFOs) are supported by the provincial government to ensure integration of fisheries support to communities and individual fishers through broader service delivery in the province. With ongoing support from internal and external partners, PFOs promote the sustainable use and management of fisheries resources in provincial waters (Fig. 2). They are, therefore, critical agents to achieving sustainable development targets under the various national fisheries management policies and strategies.

In the context of national ambitions to scale-up community-based fisheries management (CBFM), it is critical to understand the challenges and opportunities across the different provinces of Solomon Islands, and to evaluate how the Fisheries Management Act 2015 and provincial level policies can be adequately reflected in national workplans (e.g. MFMR Corporate Plan 2020–2023) and strategies (e.g. National

Community-based Resource Management Strategy 2022) (MFMR and WorldFish 2022). The objective of this capstone research project was to understand the factors and enabling conditions that support and empower PFOs to implement CBFM initiatives at the provincial level. Three provinces were examined in depth: Isabel, Malaita and Western.

The study reviewed national fisheries policy, strategies and operational work plans current as of 2021 (e.g. the National Fisheries Policy 2019–2029, MFMR Corporate Plan 2020–2023, Fisheries Management Act 2015, SI Coral Triangle Initiative National Plan of Action), and was supplemented by observations from discussions with PFOs and stakeholders during network meetings and workshops.

Coastal fisheries infrastructure available to PFOs differed among provinces, as did their capacities to lead the implementation of CBFM. Priorities differed among activities by the provincial governments and in how many external partners (e.g. non-governmental organisations) were implementing work (Table 1). These conditions contributed to influencing how PFOs viewed their roles and responsibilities as focal points for CBFM programmes in the provinces.

Financial and geographical issues in implementing CBFM is a long-standing limitation for national and provincial fisheries officers alike (WorldFish 2014). MFMR has addressed these challenges through, for example, recruit-

ment and training as well as the establishment of a CBRM section within MFMR's Inshore Division. In recent years, MFMR has worked with partners to address historically low operating budgets through seeking better alignment of NGO activities and by creating opportunities for PFOs to access funding for provincial-level activities from donor-funded projects in MFMR (MFMR 2021). Since 2021, *Mekem Strong Solomon Island Fisheries* (MSSIF) has provided funding to mobilise PFOs, which has better prioritised activities for CBFM scaling. Nevertheless, additional financial and human resources will be required if the aspirations of the CBFM scaling strategy are to be achieved.

OLKETA FISH WEA HEM TAMBU FO SELEM OR BAEM	
DUGONG	HEM TAMBU FO SELEM AN KATSIM DUGONG PENOLTI HEM \$40.000 OR 4 MANIS LO PRISIN
TURTLE	HEM TAMBU FO KATSIM AN SELEM ENI TOTEL HEM OLSO TAMBU FO TEKEM EGG BLO HEM PENOLTI HEM \$40.000 OR 4 MANIS LO PRISIN
MUD CRAB	HEM TAMBU FO KATSIM AN SELEM OLKETA SMOLA CRAB DAN 12cm OR MERE CRAB WEA STILL GAREM EGG PENOLTI HEM \$30.000 OR 3 MANIS LO PRISIN
HUMPHHEAD PARROT FISH	HEM TAMBU FO KATSIM OR SELEM ENI PARROT FISH WEA SAES BLO HEM SMOL MINIM 65cm PENOLTI HEM \$30.000 OR 3 MANIS LO PRISIN
TROCHUS	HEM TAMBU FO HAVESTIM AN SELEM OLKETA TROKAS WEA SAES BLO OLKETA SMOL MINIM 8cm OR BIG MINIM 12cm PENOLTI HEM \$40.000 OR 4 MANIS LO PRISIN
MAORI WRASSE	HEM TAMBU FO KATSIM AN SELEM ENI MAORI WRASSE FISH (UME) WEA SAES BLO HEM SMOL MINIM 65cm PENOLTI HEM \$30.000 OR 3 MANIS LO PRISIN
CRAY FISH	HEM TAMBU FO KATSIM AN SELEM ENI CRAY FISH WEA SAES BLO HEM SMOLA DAN 8cm PENOLTI HEM \$30.000 OR 3 MANIS LO PRISIN
COCONUT CRAB	HEM TAMBU FO SELEM ENI KASUSU WEA SAES BLO HEM SMOL MINIM 9cm OLSO HEM TAMBU FO TEKEM WEA STILL GAREM EGG PENOLTI HEM \$40.000 OR 4 MANIS LO PRISIN

Figure 2. Auki market billboard in Malaita Province, provides public information. This was the result of an active collaborative partnership between PFOs and non-governmental organisation. Image: © Faye Siota

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Research perspectives on Pacific Island coastal fisheries

Understanding the capacity of provincial fisheries officers in order to support the scaling-up of community-based fisheries management in Solomon Islands

Table 1. Elements of the enabling environment that drives CBFM activities in the three case study provinces.

	Isabel	Malaita	Western
Infrastructure	3 functioning Provincial Fisheries Centres (PFC) and work stations	1 PFC currently not functioning) and 2 work stations	2 functioning PFCs and 2 work stations
Provincial Fisheries Ordinance	-		✓ (draft)
Partnerships (environmental groups)	<ul style="list-style-type: none"> • The Nature Conservancy • Provincial environment officer 	<ul style="list-style-type: none"> • WorldFish 	<ul style="list-style-type: none"> • WorldFish • World Wildlife Fund • Wildlife Conservation Society • Community-based organisations • Western Province Network for Sustainable Environment
Proportion of PFOs who have been trained to lead CBFM implementation (i.e. "has capacity to deliver")	2 out of 4	4 out of 5	2 out of 4
Provincial priority (PFOs' prime responsibility is to operate and manage the PFCs)	PFC generates high revenue for the province thus priorities are around the operation and management of PFC services.	PFC generates small revenue for the province; however, prioritises other fisheries activities for current implementation. PFC currently under maintenance.	PFC generates high revenue for the province thus priorities are around the operations and management of PFC services.

Lessons

In Solomon Islands, PFOs form the most decentralised, formal fisheries, point-of-authority under MFMR (Fig. 3), and the closest link to communities who retain customary rights to their resources (WorldFish 2014). The stationing of PFOs in the provinces provides a critical bridge between communities and MFMR and partner organisations. Addressing key factors to support PFOs to facilitate CBFM effectively will support provincial governments in prioritising appropriate activities and budgets.

Progressing CBFM requires a combination of structural (e.g. effective policy, procedures, legislation) and agency-based (e.g. skills training, work plans and resourcing of PFOs) support to ensure effective planning and implementation of provincial programmes. The research suggests that existing resources and capacities needed to implement CBFM are not yet equitably distributed across all provinces (and PFOs). In addition, at an individual level, the capability and confidence of PFOs varies widely. Ongoing coordinated efforts by, and for, PFOs will be critical in moving towards consistent leadership and coordination in CBFM activities within provincial waters.



Figure 3. Newspaper article excerpt indicating how PFOs are coordinating with police to enforce regulations in some instances (in urban areas and markets where there is oversight) (Source: Solomon Star, 28/05/2020, "Caught in the Act – shops caught in illegal beche-de-mer").

Integrating gender equality in natural resource policies in Kiribati

Tarateiti Uriam⁸



Figure 4. I-Kiribati family fishing for subsistence needs. Image: ©lutita Karekennatu

Women are involved in all stages of the fisheries value chain, although their contribution is often unrecognised (Kleiber et al. 2013). Gender equality has been recognised in international environmental agreements as a principle of good environmental governance (Lawless et al. 2021) that can ensure policies and programmes deliver equitable outcomes for the well-being of communities.

Understanding how gender equality is integrated in national natural resource policies is crucial to ensure that strategies deliver gender equitable outcomes. Natural resource conservation, management and development is central to the lives of I-Kiribati people for food, income, culture and medicine (MELAD 2021; MFMRD 2012). People use, interact, access and benefit from natural resources differently, particularly marine resources, and this is often based on cultural and gender norms (Fig. 4). It is, therefore, important to understand how guiding natural resource policies take into account gender dimensions to achieve gender equality. In Kiribati, traditional governance is driven by men and elders, and often overlooks certain groups in decision-making. Without meaningful participation, women and youth are

often disadvantaged when decisions are made that insufficiently consider their concerns and voices.

This capstone project addressed these challenges through three objectives: 1) understanding how gender equality is presented and pursued in six Kiribati national natural resource policies; 2) identifying gaps in these policies; and 3) providing recommendations to enhance gender equality in small-scale fisheries and across natural resource management and development.

To address entrenched inequalities and to work around sensitive cultural gender barriers, good guiding strategies are necessary, and staff must be well equipped with necessary knowledge and skills. In evaluating these policies from a gender lens, this study considered how gender is framed, the linkages of these policies to the National Gender Policy, how strategies consider gender equality, and the capacity of staff to deliver and integrate gender aspects.

An in-depth evaluation of Kiribati's national natural resource policies revealed that Kiribati has a long ways to go in terms of

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integrating gender equality perspectives. To understand what *change* may look like in different contexts, the study applied a spectrum of gender equality progress that distinguishes between different levels of progress measured along extents of participation and inclusivity (Johnson et al. 2018; Theis and Meinzen-Dick 2016). This spectrum identifies levels of change progressing from its most basic form, such as that of achieving “reach” (e.g. involving women and men who were not previously involved), to “benefit” (e.g. access and benefits delivered to women and men who could not derive these before), “empower” (women and men have the ability to make strategic life choices they did not have before), and “transform” (e.g. gender norms are redefined; Fig. 5).

Lessons

National policies currently focus on consultation processes to ensure that all gender groups are involved and benefits are equitably shared. Some policies recognise economic empowerment but actions are currently directed at the individual level rather than community level.

Although the policies are gender aware, clear linkages made to the overarching National Gender Equality Policy remain weak. Given that gender equality is a cross-cutting issue, national reporting on progress should be centralised to understand progression of different sectors on gender equality at the national level. Based on this analysis, four main recommendations are suggested to enhance Kiribati’s

commitments towards gender equality at the national level, particularly in the fisheries sector:

1. Development of clear strategies to integrate gender: to guide implementation and integration of gender equality into programs and activities
2. Build capacity of staff (particularly those with direct engagement with communities) on gender, empowerment and social inclusion principles (Barclay et al. 2021)
3. Invest in women’s economic empowerment and promote spousal support: to support women economically and to ensure that spouses render adequate support to their wives.
4. Strengthen the national taskforce to consider gender integration: enable national collaboration and communication between ministries, civil societies and NGOs on gender equality.

This research highlights that Kiribati is starting to integrate gender equality into national natural resource policies, but more work is needed. A coordinated and collaborative approach between national gender agencies and natural resource management agencies would assist in increasing the knowledge and capacity of staff, as well as ensuring that programmes deliver gender equitable outcomes in the natural resources sector, including the fisheries sector.

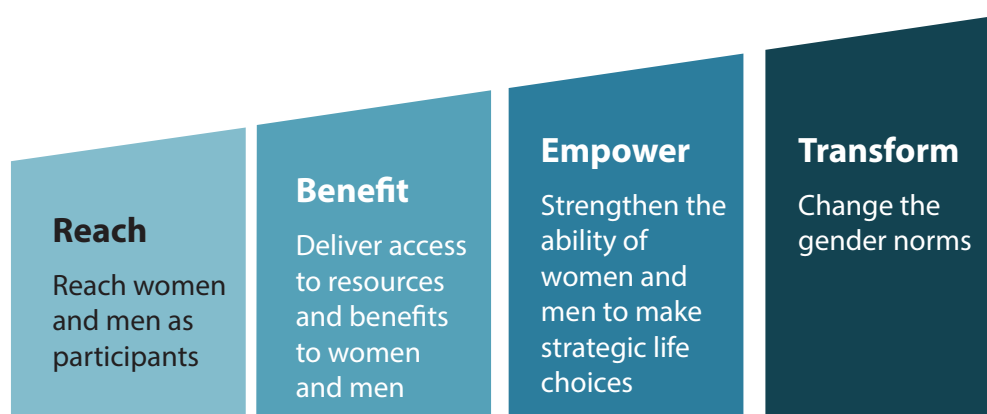


Figure 5. The status of Kiribati on its progression towards gender equality on the Reach – Benefit – Empower – Transform spectrum (Figure adapted from CGIAR Research Program on Fish Agri-Food Systems 2017; Johnson et al. 2018; Kleiber et al. 2019; and Theis and Meinzen-Dick 2016).

Disaster responses in Vanuatu: Local resilience and CBFM

Pita Neihapi⁹

In Vanuatu, as in other Pacific Island countries and territories, natural disasters are a part of life (UNDP 2014; see Fig. 6). Vanuatu is expected to incur, on average, USD 48 million in damages per year due to earthquakes and tropical cyclones (PACMAS 2015). Past events, such as Tropical Cyclone Pam in 2015, have shown how an avalanche of external material aid can overwhelm the country's infrastructure, decentralised governance framework, and relief management system (CARE-Vanuatu 2018). In considering how ill-equipped local groups are to deal with such sudden influxes of aid assets, it is unsurprising that such assistance struggles to reach the communities and individuals in most need. These experiences have resulted in recent calls for a more strategic approach to resilience building – one that is appropriately resourced and better integrated into local practices and institutions (UNDRR 2022). Specific attention is being given to the role that coastal fisheries play as a safety net and source of social protection (Pakoa et al. 2019).

Participatory development – supported by well-coordinated and well-resourced national mechanisms – has been widely demonstrated to contribute to community resilience in Vanuatu (Raubani et al. 2017). Such an approach recognises importance of national processes, but also emphasises the need to build on strengths in existing local institutions and practices, rather than transforming them. The community-based fisheries management (CBFM) programme at the Vanuatu Fisheries Department (VFD) is primed to strengthen communities' resilience in the face of disruptions and national emergencies. Its multi-focused approach involves, for example, establishing community-managed areas whereby co-developed CBFM plans allow the application of regulations around size limits and fishing bans on certain resources and destructive fishing methods (Steenbergen et al. 2022).

This research sought to determine what the major challenges and opportunities are in improving the resilience of resource-dependent coastal communities to disasters, and how coastal fisheries relate to this. To do so, the broader structural systems in Vanuatu that deal with disaster response were examined first, followed by an examination of how local fishery management practices and institutions contribute to resilience building.

Disaster management in Vanuatu

A fair amount of work has been done to improve the country's response to shocks, including policy adjustments, instalment of high-frequency radio networks and the establishment of a national Community Disaster Committee (CARE-Vanuatu 2018). The National Disaster Management Office (NDMO) is the focal point mandated by the Disaster Risk Management Act of 2019 to manage and coordinate emergency responses. The act mandates national, provincial, municipal and community stakeholders with implementation roles and is advised by a National Disaster Committee (Vanuatu Government 2019). Intersectoral planning and coordination occurs across areas of national security, agriculture and fisheries, health, economy and justice, through a series of working group clusters that address different needs, depending on the type and impact of a disaster. Over the last few decades, emphasis has been placed on policy development, rather than practical implementation, which is reflective of how the decentralisation system struggles to cope with managing aid initiatives when events occur.



Figure 6. The aftermath of a landslide that destroyed much of Walowemboeh Village on northern Ambae Island.
Image: © Pita Neihapi

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This research reveals a disconnect between the national and provincial governments, and the area councils, resulting in unclear operational plans and disruptions in distribution of aid assets. The national system is left vulnerable; in some cases to exploitation and accumulation of assets by a powerful few, and in other cases to paralysis in the distribution of assets when no action is taken nor any deployed assets are used (SPC 2016). The local contexts in which material support is meant to have impact, therefore need mechanisms that can effectively distribute along decentralised delivery channels. A cohesive approach that integrates the national and provincial government, area councils and community networks is imperative in cultivating delivery systems that can deal with intensive spikes of material aid (CARE-Vanuatu 2018).

In addition, strengthening grassroots resilience through, for example, resource management institutions is equally critical. CBFM programmes in Vanuatu have been shown to effectively empower local action towards ensuring food security (e.g. access to fish) and improved livelihoods (e.g. ability to sell fish). These co-management arrangements furthermore catalyse collaboration with provincial and area council government extensions to do so. Provincial fisheries officers play particularly important roles in establishing tabu areas, community fish market outlets, aquaculture ponds and skills training. Communities and their leaders also play a key role in determining the extent to which people rebound from disaster events, and whether external assistance is reaching the area it needs to. Social capital (e.g. peoples' relations and community organisation), economic capital (financial assets), cultural capital (customary practices and structures), and natural capital (coastal fisheries resources) provided safety nets by which different community groups were able to engage in collective activities to overcome impacts from COVID-19 lockdown (Neihapi 2021).

Lessons

Community-based initiatives, whether driven by the government or through traditional institutions, play an important role in disaster risk reduction and resilience. CBFM institutions have proven to be critical in ensuring food security in times of disaster, or when access to food is compromised by crippled infrastructure and/or destroyed household gardens (Steenbergen et al. 2020). The coalescing of customary and fisheries-informed practices in community managed fisheries provide reliable avenues of access to protein, particularly in such times. At the same time, systems of benefit distribution and safety nets in communities emerge as amalgamations of customary practices and newer influences through, for example, government support.

The focus on external post-disaster support is often on material aid, although too often uncoordinated distribution means that aid does not reach those most in need when they need it the most. While this study does not contest that material support remains critical, deeper consideration should be given to what material support is appropriate (i.e. finding the right fit within a particular context, culture and needs). Vanuatu maintains two major assets, and therefore two points of entry for investment. First, the Decentralisation Act (Vanuatu Government 2006) provides a platform to establish effective systems of access and distribution for support to grassroots levels. Second, the engrained Ni-Vanuatu *kastom* institutions and practices hold important capital wherein best practices can be integrated. As a final observation, to ensure that people and places are prepared when disasters do occur, this study emphasises the need to invest in strengthening systems and structures in “down times”, as in the case of VFD's national programme.

Bridging legal pluralism: Maritime boundaries and coastal resource management in Vanuatu

Rolenas Tavue¹⁰

Globally, marine spaces have become increasingly busy places. New economic and political interests across public and private sectors have seen a considerable shift in focus towards utilising marine zones and the supposed bountiful resources they offer (Voyer et al. 2021). In the Pacific these developments are seeing boundaries being drawn (and re-drawn) under emerging marine spatial planning initiatives.

Maritime boundaries play important roles in the management of marine resources. It has been widely demonstrated in the literature that “clear boundaries” are a foundational prerequisite for effective collective action at the local level, to resolve conflict, focus management interventions, and ensure equitable access (Agrawal 2001). However, drawing boundaries often reveals contestations among government agencies, sectors and/or community stakeholders over how and why marine spaces are divided (Bennett et al. 2015).

In Vanuatu, the main maritime boundaries divide waters into three zones aligned with the United Nations Convention on the Law of the Sea (UNCLOS; Fig. 7). These zones are the coastal zone, which extends 12 nm from baselines; the contiguous zone, which extends 24 nm from baselines; and the exclusive economic zone, up to the outer boundary, which extends 200 nm from baselines. At the most devolved level, coastal communities claim customary-based (*kastom*) ownership over marine areas, often extending from the shoreline to a fringing reef or edges of the blue water zone. This is enshrined in Vanuatu’s constitution (Republic of Vanuatu 1980). Details of ownership at the lowest levels, however, are most often defined by local *kastom* arrangements, and remain undocumented and poorly understood by outsiders.

This research project investigated how formal boundaries that result from, for example, conservation or resource management interventions often overlay existing local arrangements, which tend to be far more flexible and subject to negotiation. The legal pluralism (Bavinck 2014) that results means that different governance systems operate over the same space. Here the fluidity of *kastom* governance and the fixed nature of administrative governance meet where community-based fisheries function. In order to understand the challenges and opportunities of this overlay for managing coastal fish stocks, this research sought to determine the importance of clear and defined boundaries (e.g. universally standardised definitions of baselines or basepoints), and then outline some of the negative consequences this holds in relation to other boundary forms (e.g. *kastom* boundaries). The research highlights opportunities that can effectively integrate and connect these overlays.

It is often argued that in order for Vanuatu to continue to derive revenue from its fishery resources, delineating boundaries is vital; not only to resolve maritime boundary disputes, but also to ensure effective governance of fishery resources. Migratory stocks, including sharks, pelagic species and sea mammals, require multi-scale perspectives and connected management across different levels. Monitoring, control and surveillances across offshore and coastal fisheries hinges on effectively defining and designating management agencies over marine spaces, such as by delineation. This allows the government to impose rules and regulations for fisheries management. Such boundaries are delineated based on standardised rules and procedures; for example, provincial waters are measured from the current land basepoints extending seaward for 6 nm (Vanuatu Fisheries Division 2014) to enable provincial fisheries management authorities to oversee management of fishery resources there.



Figure 7. Designated maritime boundary baselines of Vanuatu, as defined under UNCLOS.

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However, formalising ways of spatially planning coastal zones through national rules and procedures stands in contrast to communities' often very fluid customary forms of management. Across Vanuatu, traditional owners have delineated boundaries over many generations, using landmarks such as stones and big trees as boundary markers; often agreed to through verbal agreement and sealed by ceremony.

The findings from this research show that there are significant discrepancies in Vanuatu between how fixed standardised rules for maritime boundaries function versus more dynamic customary rules. While national administrative maritime boundaries zones are guided by science and international convention (e.g. UNCLOS standards), smaller-scale customary rules are based on the social histories of people and place. In turn, appropriate delineation is contingent on, for example, appropriate consultation with indigenous people.

Lessons

Vanuatu's customary structures are constitutionally recognised, and function alongside (and with) central state administrative structures at all levels of governance. Depending on context, either system can take precedence in how and what rules and norms are applied to decision-making or conflict resolution. This also extends to discussions around how maritime spaces are used and how boundaries are drawn across them. This study shows that well-defined and collectively agreed on boundaries are critical to securing sovereign ownership and effectively governing access to resources, particularly at larger national scales. However, it also highlights how rigid boundaries are based on very different parameters to how local *kastom* boundaries are defined, which can lead to contestations and conflict.

The nature of decision-making and collective action in the Melanesian context is based largely around local social histories and people's relations. Finding instruments by which this legal pluralism can be bridged is something Vanuatu fisheries authorities, in seeking to effectively govern coastal fisheries, have pursued under their national CBFM programme. Management tools that are co-developed with communities, such as CBFM plans, form a conduit between customary and science-based management approaches. Ultimately, the research argues how critical it is that delineation of any maritime boundary in the coastal zone must take into account both systems.

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The importance of maritime domain awareness in fighting illegal, unreported and unregulated fishing

Moritz K. Lehmann^{1*} with Megan Charley²

Introduction

The fight against illegal, unreported, and unregulated (IUU) fishing (FAO 2001) is a multifaceted activity that reflects a range of harmful fisheries practices. IUU fishing is defined as activities that violate laws or occur outside of existing laws and regulations within the national jurisdiction of a state or on the high seas (Brush 2019). Briefly, “illegal” refers to direct violations of laws and regulations, such as fishing without a licence, fishing with gear that is banned, or fishing for prohibited species. Unreported fishing occurs when fishers report the wrong volume of catch or species to the relevant fisheries management authority. Unregulated fishing includes fishing activities in areas or for fish stocks where there are no applicable conservation or management measures in place.

IUU fishing-related activities at sea are extremely difficult to spot because infringements occur in remote areas and operators actively hide their practices using a range of measures, such as not reporting their positions via automated geolocation devices, making frequent flag changes, and transshipping on the high seas. Ultimately, misconduct has to be proven in order for legal action to be effective, and the evidence for this proof has to be gathered directly by manual inspection of catch volumes, species, logbooks and onboard chartplotters. Furthermore, to be effective, IUU fishing must be fought at large spatial scales, so that perpetrators do not just move on to other regions. Therefore, the most successful operations against IUU

fishing are conducted when nations get together to share intelligence, coordinate the deployment of patrol assets, and work across national boundaries.

In this article, we demonstrate the current tools used in the fight against IUU fishing, and show how different types of information come together and lead to the identification of highly suspicious vessels that make targets for physical interrogation. To do this, we follow the thought processes and methods of Megan Charley, Senior Intelligence Analyst at the Australian Fisheries Management Authority (AFMA). To understand Megan’s work, we first discuss the indicators that are potentially related to IUU fishing activities. Because most of these indicators in and of themselves are not evidence of IUU fishing, Megan must forensically uncover multiple hidden relationships, weigh environmental and geopolitical factors, and collaborate with other analysts to prioritise targets for further investigation. This is illustrated using Megan’s contribution to the successful multilateral anti-IUU fishing Operation Nasse between May and August 2022.

Indicators of IUU fishing

IUU fishing activities are seldom observed directly and unequivocally, and implicating a vessel with suspected nefarious practices requires gathering intelligence. Such intelligence includes illegal or suspicious behaviour at sea, suspicious activities in ports, and a vessel’s onshore ownership structure. One example of illegal at-sea behaviour is the disabling of

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vessel monitoring systems in areas where their operation is mandated. Other at-sea behaviours are not illegal per se, but often also occur during illegal misconduct. For example, two ships encountering one another on the high seas may legally exchange supplies and crews, but in some cases such activity has been linked to the transfer of catch to avoid reporting, labour abuses, and the trafficking of narcotics, weapons and humans (Belhabib and Le Billon 2022).

A vessel's at-sea behaviour is usually assessable from ship tracks of self-reported position transponders of the automatic identification system (AIS) or vessel monitoring system (VMS) (see Box 1). When these are turned off, a vessel "goes dark" and the resulting disappearance from monitoring platforms is a strong indicator of illegal activity (Welch et al. 2022). We describe how dark vessels can be detected using satellites in the case study below and in Box 2.

Box 1. What are AIS and VMS?

Two key sources of vessel position information are automatic identification systems (AIS) and vessel monitoring systems (VMS). What can we expect from each of these for fisheries monitoring, control and surveillance?

Automatic identification systems are required on vessels of 300 gross tonnage and upwards engaged on international voyages, cargo ships of 500 gross tonnage and upwards not engaged on international voyages, and all passenger ships irrespective of size, by the International Maritime Organization (IMO 2015). Boat owners may voluntarily install AIS units and some countries have additional requirements as part of their vessel regulations, so coverage of smaller fishing vessels can vary significantly between flag states.

The primary purpose of AIS is safety at sea, including collision avoidance. AIS transponders provide information such as the ship's identity, type, position, course, speed, and navigational status automatically to other ships and shore stations, and the transmissions need to be received without permission. This availability has led to the common use of both satellite and terrestrial receivers to harvest all available AIS signals, achieving global monitoring of vessel positions. This makes AIS the largest and most significant source of geospatial ship movement data. But because vessel tracking is not its core purpose, it is notoriously messy to work with.

What to watch out for when using AIS data for fisheries monitoring? One of the primary issues with AIS is that it is not tamper proof. That means operators can intentionally manipulate geolocations to appear in the wrong location (spoofing) or turn transmissions off altogether (a vessel going dark). The static vessel data, such as vessel type and size, is also prone to intentional or unintentional misdeclaration. Furthermore, a large number of AIS messages may overwhelm receivers in busy shipping areas, causing some messages to be lost, but because the transmit rate for AIS messages is every few seconds some data usually gets through.

On the plus side, investigation into suspicious AIS data can be used to identify "red flag" vessels that warrant further investigation. AIS data are also reported in near real-time, and provide a high-resolution track of a vessel's journey. When coupled with other information – such as vessel monitoring systems, regional fisheries management organisation vessel lists, lists of IUU vessels, and ownership information – AIS provides a valuable real-time resource for fisheries analysis.

Vessel monitoring systems are a key component for managing national and regional fisheries. They provide a reliable source of vessel position and catch data, and are generally mandated by coastal states or regional fisheries management organisations (RFMOs). However, VMS messages are typically not transmitted as often as AIS, with common intervals from one to six hours.

For commercial fisheries, the requirement for VMS is high and most vessels will be tracked in this way. However, VMS data are owned by the managing nation or RFMO, and are not necessarily shared with others, so there is often a lack of transparency. Organisations such as Global Fishing Watch are encouraging nations and RFMOs to share VMS data publicly.

Positive efforts have also been made to increase the number of fishing vessels tracked by VMS. For instance, in the United Kingdom, an iVMS system using the cellular network has been leveraged to enable the tracking of vessels at a lower cost. Despite these initiatives, expanding VMS tracking into small-scale fisheries in developing countries is still challenging due to the cost of the technology.

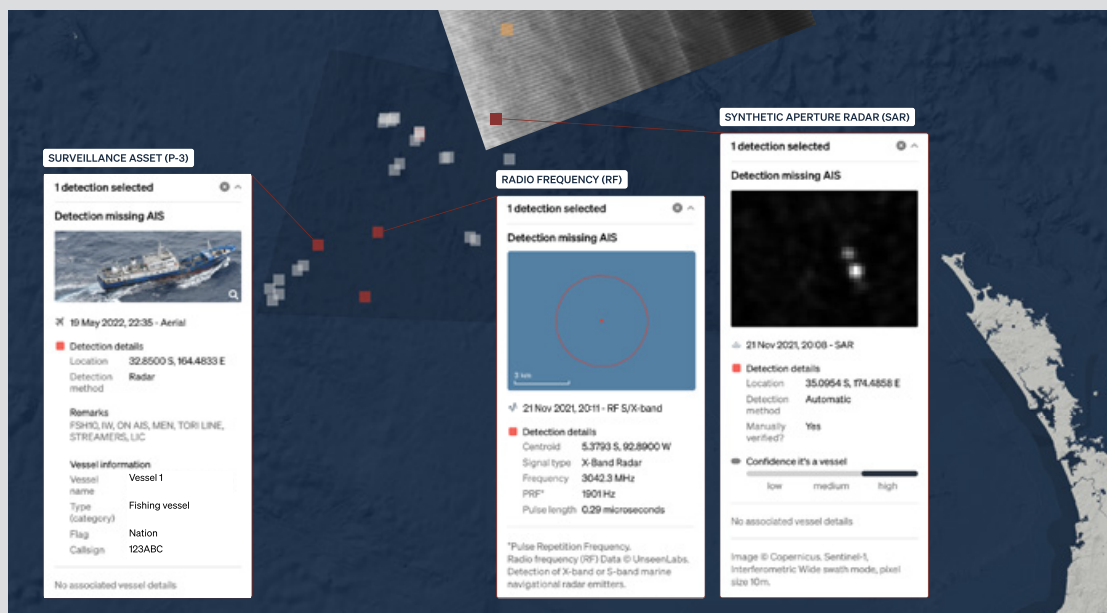


Box 2. Satellite surveillance technologies

Satellite surveillance is a rapidly growing area for the monitoring of fisheries. Dark vessels that do not self-report their positions using automated geolocation systems pose a risk to nations' fishery resource, and are a challenge to maritime domain awareness. Satellite technology enables the monitoring of large areas of ocean for the detection of dark vessels, and different sensor types offer complementary modes of detection with consequences for specific applications. The most common types of space-based sensors used by fisheries analysts include radio frequency emitter detection, synthetic aperture radar, and optical sensors.

- Radio frequency (RF) detectors can scan vast areas of ocean (up to 10 million km²) in a single overpass. Emissions from X- and S-band marine navigational radars and VHF and L-band communication devices can be geolocated from RF sensors. Vessels can only be detected if they are actively transmitting RF signals as the satellite passes overhead, which can reduce the detection rate compared to alternative technologies.
- Synthetic aperture radar (SAR) is an active sensor that locates vessels by transmitting radio signals towards the ocean surface and detecting backscattered energy at the satellite receiver. Using large-area modes, regions up to 225,000 km² can be scanned by SAR, typically detecting vessels over 20 m in length. Higher resolution SAR sensors can be used to detect and, in some cases, categorise smaller vessels, but have a significantly smaller spatial footprint.
- Optical imagery has limited utility compared to RF and SAR technology due to the relatively small footprint provided by these sensors and the requirement for a cloud-free field of view. Under specific circumstances (e.g. constrained areas of interest) optical sensors can provide high-resolution images that can be used to detect and identify vessels.

Results from surveillance operations in the Pacific have demonstrated that satellite technology is an important component of an effective maritime domain awareness tool and the fusion of data from multiple types of satellite technology provides a more complete picture of maritime activity than a single sensor in isolation. Satellite technology should be used in conjunction with targeted aerial and surface patrols which means reducing the time between the satellite data collections and the provision of actionable information to patrol assets is critical to the success of these operations.



Example of vessel detection by SAR and RF satellite scans. Verification of satellite-identified targets by surface or airborne surveillance assets is required for target vessel identification.

At-sea behaviour makes up only a subset of IUU fishing risk indicators. Ultimately, vessel operations are sustained by corporate stakeholders, and vessels conducting IUU activities often have extremely complex ownership structures where shell companies across multiple jurisdictions attempt to hide the ultimate beneficial owner of a vessel (Brush

2019; Carmine et al. 2020). Ownership obfuscation often goes along with alterations and manipulations of a vessel's flag (i.e. the nation where a vessel is registered). For example, an owner may register a vessel in a state with limited regulatory oversight, and not their own home nation, to avoid the scrutiny of catch reporting.

An extensive list of IUU fishing indicators is published in Ford and Wilcox (2022). Top-priority indicators are:

- Captain from different country than crew
- Stopped near another vessel (encounter)
- Last port of call
- Home port
- Country beneficial owner
- Near protected area
- Location last six months
- Most frequent port
- AIS vessel name “Nauticast”
- Crew from country with record of labour abuse
- Area mismatch to activity
- Ship type incorrect
- Navigational status
- Flag from high corruption country
- Change in vessel length or beam

Because any single risk indicator is insufficient to verify whether IUU fishing activity has taken place, analysts must consider multiple indicators simultaneously for several ships.

Practical application of IUU fishing risk indicators

Megan is an analyst at the National Intelligence Unit of AFMA, and her day-to-day role is to uncover the patterns and behaviours of vessels that display risk factors that are consistent with IUU fishing activity. She takes an investigative approach to her analysis, combining as many sources of intelligence as available to gather evidence of vessels that are likely to be engaged in IUU fishing. The more defined the profile of IUU activity becomes, the more targeted enforcement actions can become.

Megan often starts by investigating recorded and real-time ship tracks and identifies movement patterns. Although many movements and characteristics of at-sea activity on their own appear innocuous, patterns and connections over time create a clearer picture of whether a ship is engaged in IUU fishing activities or not. Indicators that raise red flags include:

- Fishing activity in distant high-sea pockets – areas far from exclusive economic zones that are not covered by any nation’s jurisdiction and are hard for authorities to reach;
- Gaps in the vessel location tracking where positional transponders have been disabled in locations that have a history of IUU fishing; and
- Anomalous movement patterns where vessels take unusual diversions or move into an area they are not authorised to fish in.

She explains that analysing IUU risks is not as simple as evaluating the risk indicators listed above. While the indicators in principle are applicable globally (Brush 2019), their expression and relative importance vary by region, target species, gear type, and season. For example, in the western and central Pacific tuna fishery, the biggest IUU fishing risk comes from misreporting (89% of the quantified annual volume of IUU fishing-implicated Pacific tuna harvested or transshipped), while illegal, unlicensed fishing is estimated to account for only 5% (MRAG 2021). Characteristic for this region is the prominence of longline vessels that make up 65% of all active Western and Central Pacific Fisheries Commission (WCPFC) registrations.³ This affects the type of catch, bycatch, and relevant conservation management measures, creating a different risk profile for IUU fishing than, say, a purse-seine vessel-dominated Indian Ocean tuna fishery.

Factors such as climate, economic and market variability also influence the weighting of the risk factors. For example, large-scale ocean–atmosphere variations such as the El Niño–Southern Oscillation (ENSO) dictate where target species of fish are found, and volatility in fuel prices determine how much it costs to reach those areas. Therefore, Megan investigates potential recipients of government subsidies that help offset the high costs associated with fishing in high seas waters, where the lack of oversight increases the risk of IUU fishing.

Encounters and vessel networks

The basic unit for IUU fishing activity is the fishing vessel, but vessels at sea do not operate in isolation. Fleets of ships often fish in the same area, and supply vessels, refrigerated fish carriers, and tankers all form complex interrelationships. Therefore, Megan is particularly interested in fishing fleets and encounters between vessels at sea (Fig. 1) because these can sustain a ship’s operation away from ports and regulatory oversight for a long time. This makes time since last port visit and the length of encounters important risk indicators.

Megan says that, “When I see patterns where ships are coming together, I want to dig deeper and understand what is happening there. With this type of behaviour, I look at what types of vessels are meeting up, who owns those ships, what is the ownership history, and any historical IUU fishing prosecutions connected to this network. Combining that external information alongside geospatial data will give me a much clearer view of what is going on there.”

Considering encounters with other fishers and support vessels adds a whole new dimension to the problem because the number of ships involved grows exponentially. One tool to help analysts to capture and simplify the complex interconnected web of interactions formed by encounters over time is network analysis. Network analysis allows Megan to look deeper into relationships that may at first be hidden (Box 3). For example, it allows her to uncover a connection between two vessels of interest that

³ Analysis of the WCPFC record of fishing vessels <https://www.wcpfc.int/record-fishing-vessel-database>

have not had direct encounters, but can have a relationship via a common carrier vessel that encounters with both. Importantly, inspecting encounter networks also allows her to discount connections between certain vessels, so she can focus the time-consuming investigation of onshore networks on high-risk candidate vessels.

Armed with comprehensive historic and up-to-date vessel tracking information, lists of vessels of good standing and of vessels with a history of IUU fishing, and data science tools, Megan can achieve an effective maritime domain awareness (MDA). This MDA allows her to provide vital intelligence to direct military and civil assets to targets for boarding, inspection, and prosecution in the field. A prime example where these complex layers of intelligence are woven together to result in operative action is “Operation Nasse” (Op Nasse).

Case study: Operation Nasse 2022

Op Nasse is an annual, multilateral maritime monitoring, control and surveillance (MCS) operation to actively fight IUU fishing in the western and central Pacific Ocean (Fig. 2). It is a multilateral effort between Australia, New Zealand, France and the United States. Under the framework of the Pacific Quadrilateral Defence Coordination Group (Pacific Quad), these nations have worked together to conduct Op Nasse on the high seas of the southwest Pacific Ocean each year since 2015, with the United States joining in 2016 (AFMA 2022).

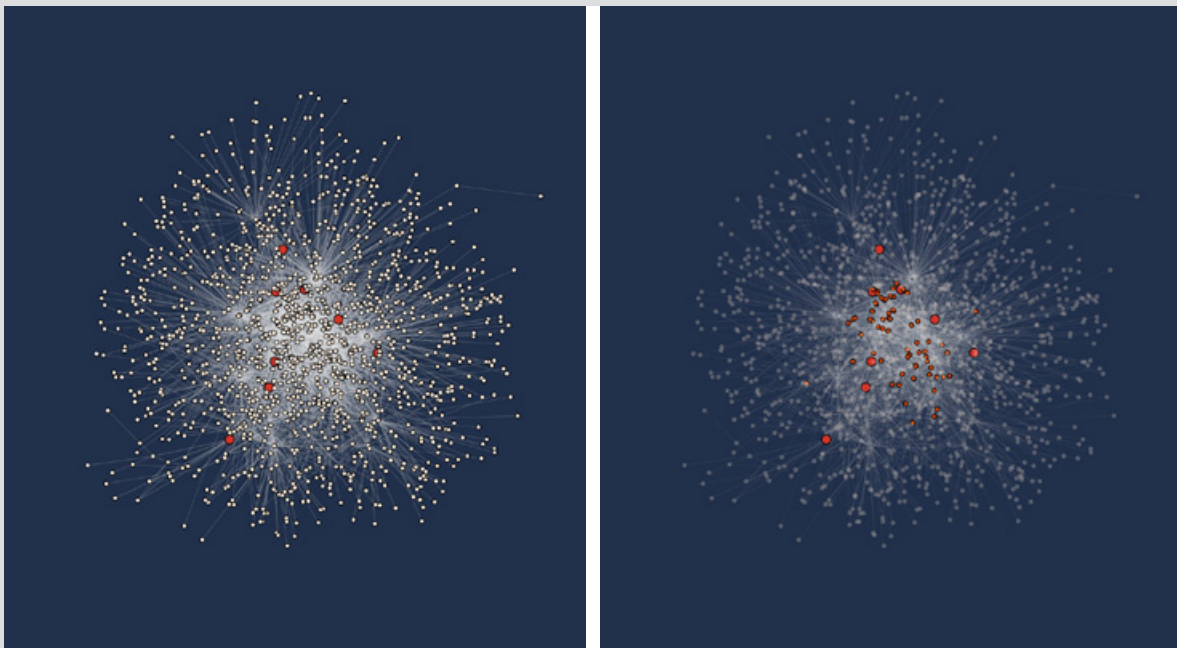
Op Nasse’s aim is to target high-risk fishing vessels for high seas boarding and inspection and aerial surveillance.

Box 3. Network analysis as a tool to capture complex relationships

Network analysis is a mathematical method to analyse a group of objects and relationships between them. A network structure consists of nodes and edges. In the case of at-sea networks, nodes represent the vessels while edges represent vessel encounters. Network analysis using Starboard Maritime Intelligence’s encounter database and a list of 40 vessels currently or historically implicated with IUU fishing, uncovered relationships to 5000 other vessels.

The high yield of related vessels can be reduced by applying weights to edges based on factors such as current versus previous IUU listing, when an encounter occurred, and the number of encounters. Applying these weights to the 5000 linked vessels reveals a more manageable number of 300 closely linked ones. Close links do not necessarily mean that they are involved in IUU fishing, but rather signals that further investigation may be helpful.

Implementing this analysis into a real-time platform means that decaying weights and new relationships appear dynamically and can provide an efficient and objective basis for intelligence gathering.



Visualisation of a network of vessels linked to IUU-listed vessels. The image on the left shows 40 IUU vessels (red dots) and 5000 vessels with a relationship to those (white dots). In the image on the right 300 closely linked vessels are shown as small red dots.

Note: Some dots are hidden in the 3-dimensional structure of the point cloud.

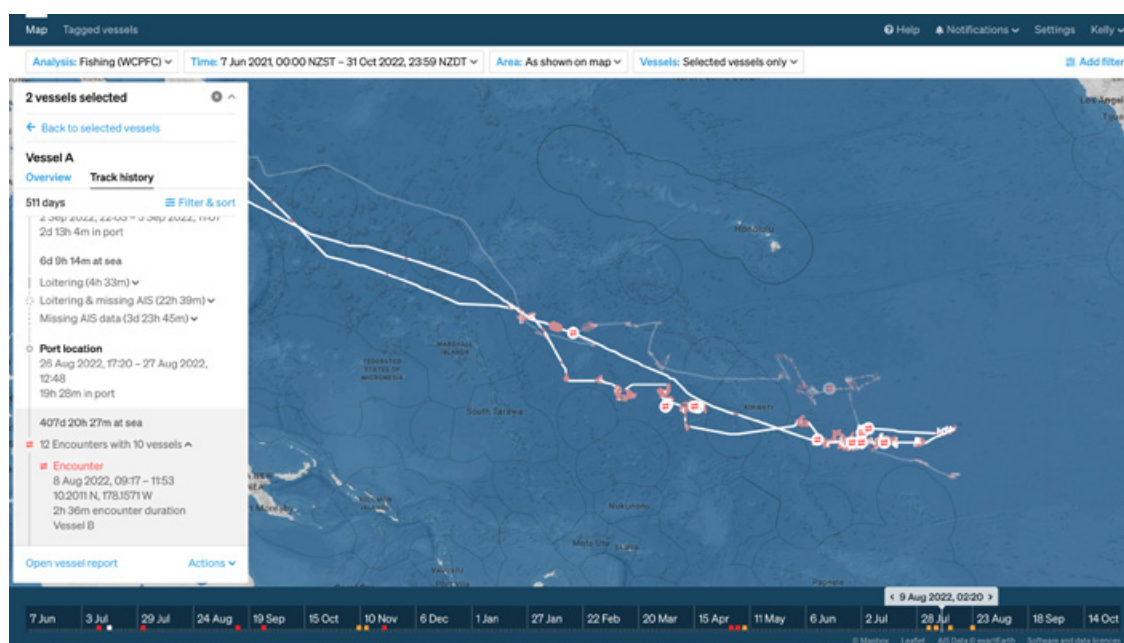


Figure 1. After over 400 days at sea, including fishing in areas of the WCPFC Convention Area, which are generally harder for surveillance to reach, this vessel is returning to port. En route, it encounters another fishing vessel for just over two and a half hours. These potentially high-risk behaviours are clearly identifiable when the extended history of this vessel is visualised.

The goal of the annual operation is to combat IUU fishing activities and better understand the level of compliance among high seas fishing vessels in respect to the WCPFC conservation management measures. The size of the area of the operation and the remoteness of many parts within it necessitate an intelligence-driven approach with effective information sharing and target priorities between the Pacific Quad partners.

During Op Nasse 2022, a joint coordination centre (JCC) was established at the French Armed Forces Headquarters in Noumea, New Caledonia, to coordinate the regional surveillance effort (AFMA 2022). As AFMA's Senior Intelligence Analyst, Megan Charley developed a significant part of the preoperative intelligence and provided recommendations and intelligence to the JCC for operational response.

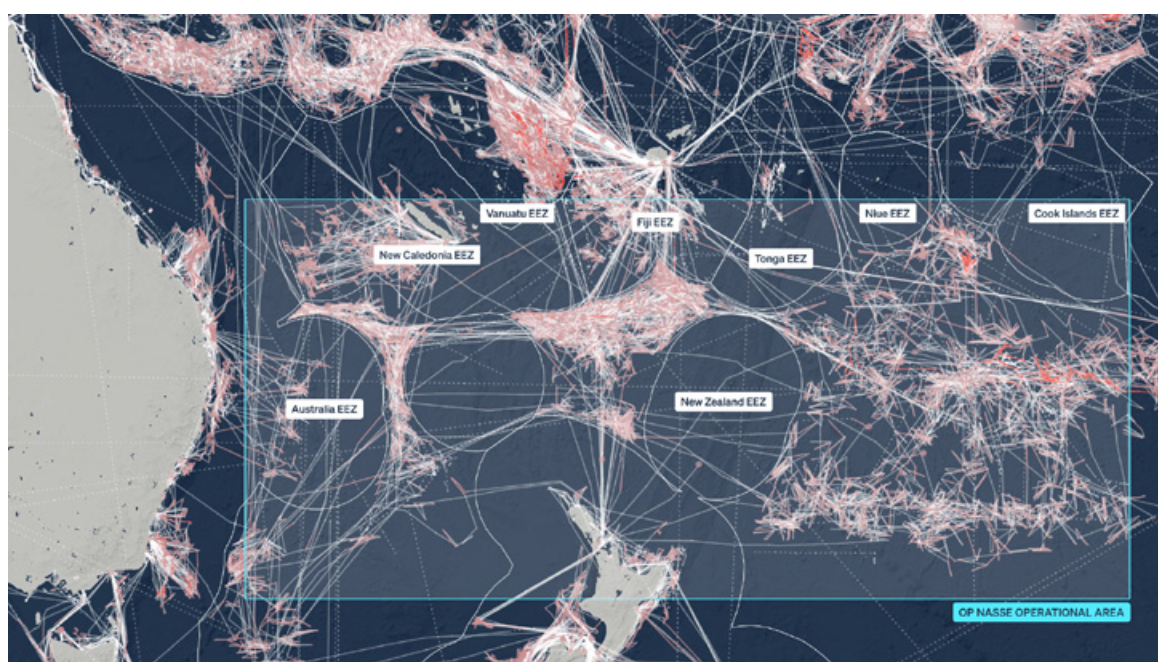


Figure 2. The western and central Pacific with the Op Nasse operational area and national exclusive economic zones. Tracks of 978 fishing vessels from 1 June to 31 July 2022 show intensive fishing activity in the high-seas pockets. Pink tracks indicate active fishing as identified by the Starboard Maritime Intelligence platform's classification algorithm.

Starting with the big picture

Concentrating on the potential of IUU fishing activity in the WCPFC means taking into account over 2700 vessels currently registered and with the authorisation to fish and transship in the region by the WCPFC.⁴ To reduce the number of vessels to just those with potential IUU fishing risk indicators, Megan began by first analysing key environmental and socioeconomic factors in 2022. Specifically, the ENSO climatic pattern was in the La Niña phase during 2022, with strong surface tradewinds piling up warm water in the western Pacific (NOAA 2022). In La Niña years, tuna catches generally shift from east to west (Fig. 3, Zhou et al. 2022).

In addition, Megan focused on distant-water fishing vessels that travel several thousand miles from their home port into remote areas of the Pacific where perceived enforcement efforts may be lower. This may seem a viable business model under government subsidies and reasonable fuel and logistical costs, but the conflict in Ukraine saw fuel prices skyrocketing. As a result, distant-water fishing in the eastern Pacific was likely to incur high operating costs, thus incentivising IUU fishing practices through their potential financial benefit.

Taking into account environmental and geopolitical factors, Megan knew what to look for: a westward shift of fishing vessels that usually target remote areas of the Pacific. She found several such vessels and noticed that their current positions intersected with the Op Nasse area of operations.

Looking deeper into networks

To further validate and prioritise the vessels of interest, JCC analysts investigated several IUU fishing indicators. They sought to identify the beneficial owners, fleet structure, and shareholder networks of the companies, especially where connections may be obfuscated through vague WCPFC records of fishing vessel details, separate ownership listings among shareholders, or using third-party addresses and flags of convenience.

These ownership networks allowed vessels to be grouped into extended fleets that could be analysed for correlations with other potential IUU fishing indicators (Fig. 4). Geo-spatial analysis of AIS data was conducted using the Starboard Maritime Intelligence platform to determine the operational patterns of fleets, transshipment indicators, time at sea, port visits, anomalous movements, and WCPFC registration details. Notable patterns included:

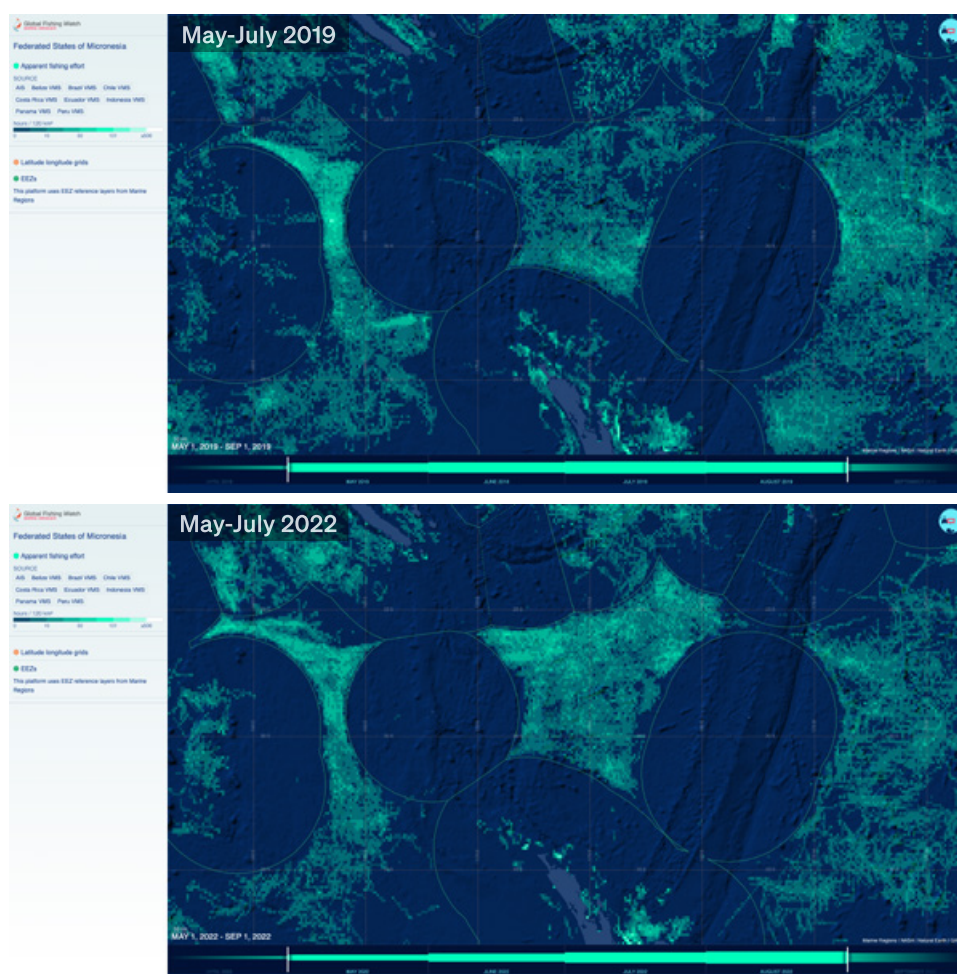


Figure 3. Fishing effort in the western and central Pacific in May–July 2019 (top panel) and the same time period in 2022 (bottom panel) from Global Fishing Watch Marine Manager app. Using such plots, the intensity of distant-water fishing can be correlated against factors such as El Niño–La Niña conditions (2019 versus 2022, respectively) and geopolitical factors.

⁴ Analysis of the WCPFC record of fishing vessels <https://www.wcpfc.int/record-fishing-vessel-database>

- Vessels that routinely travel extensive distances to fishing grounds (Fig. S1), without any identified record of government subsidies or foreign port use. This apparent uneconomic behaviour is an indicator for potential IUU fishing (Brush and Utermohlen 2022).
- Vessels that have a history of:
 - avoiding surveillance areas (Fig. S2) and ports that have robust counter IUU fishing measures in place;
 - making efforts to avoid ports completely, spending long periods at sea (up to two years); or
 - fishing activities such as shark finning, which is illegal.
- Concerns for crew welfare can be inferred from anomalous movements and encounters. Where vessels appear to behave in an abnormal fashion, this will naturally elevate the risk of IUU fishing activity and forced labour concerns (Fig. S3).

Going even deeper, Megan and the analysis team used publicly accessible information, including non-English sources, to discover potential IUU fishing allegations (among other prosecutions) or prior convictions for the vessels, masters, crew, companies, or shareholders. This investigative research

identified some vessels and companies as having both IUU fishing allegations and officially recorded court proceedings in foreign and domestic records. Even fleet constituents that do not operate in the Pacific were identified and noted for future use.

Satellite support of Op Nasse

During Op Nasse 2022, radio frequency and synthetic aperture radar satellite acquisitions were used to identify vessels that were not self-reporting their position (i.e. dark vessels). Satellites have a unique advantage in dark vessel detection because they can scan larger ocean areas more often than any other surveillance technology (Box 1). Several satellite scans were scheduled in advance of deploying patrol aircraft and ships, and the satellite ship detections were matched against known ship locations from AIS transmissions to reveal potential dark vessels for the patrol missions (Fig. 5).

A successful operation

Amassing all this intelligence, the JCC analysis team created a prioritised list of vessels of interest within the Op Nasse area of operations and deployed aerial surveillance and patrol boats to intersect with suspicious vessels.

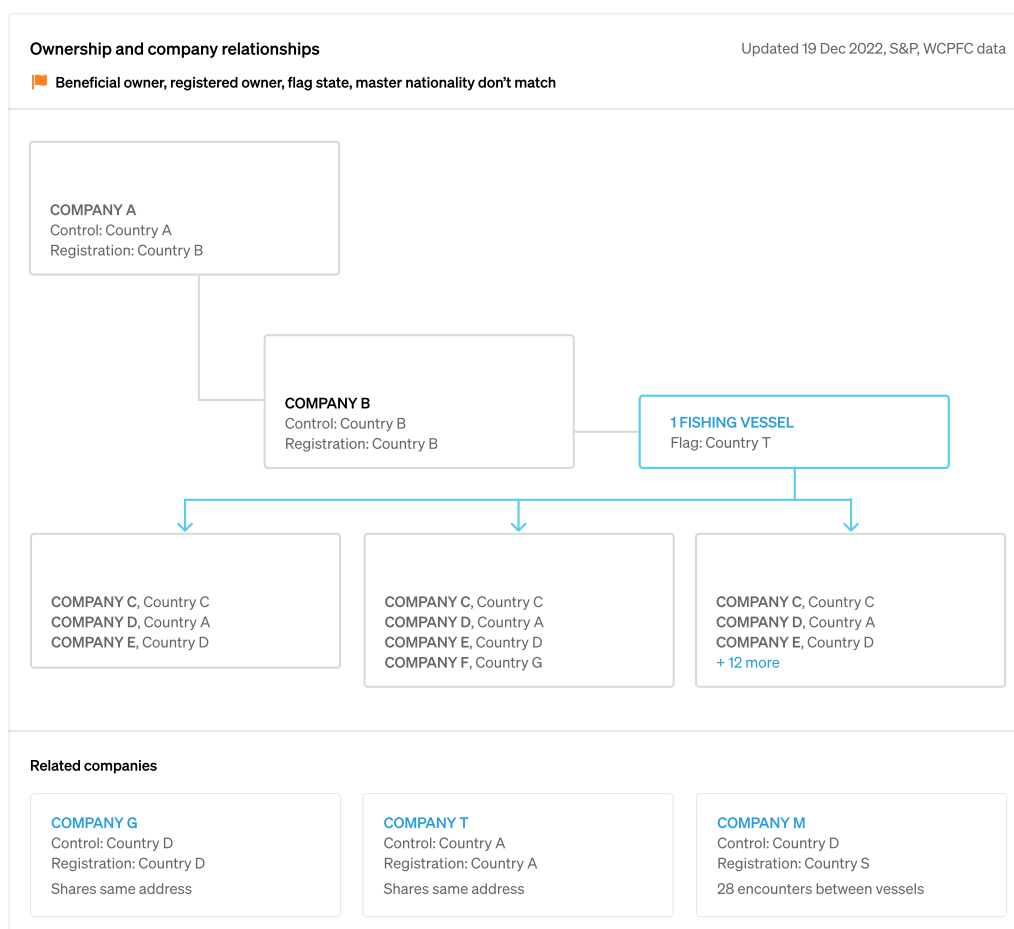


Figure 4. This vessel report prototype from Starboard Maritime Intelligence shows how the inclusion of vessel ownership information in MDA platforms will be able to assist with ownership analysis that incorporates real-time geospatial data.

In total, 18 surveillance flights and 14 high-seas boardings and inspections were carried out. These engagements uncovered 19 potential breaches of WCPFC conservation management measures and at least 8 infringements, with further infringements pending investigations (AFMA 2022).

Infringements included situations where: 1) officers were unable to easily identify shark carcasses and the corresponding fins as required; 2) bycatch mitigation was not deployed correctly; 3) daily catch and effort reporting was not captured accurately; and 4) crew made allegations of poor labour standards (MPI 2022).

Conclusions and outlook

Averaged over the years 2000 to 2003, the global volume of IUU fishing has been estimated to be between 11 and 26 million tonnes of fish taken annually, corresponding to financial losses between USD10.0 billion and USD 23.5 billion (Agnew et al. 2009). The effect of IUU fishing on ecosystem health, the sustainability of fish stocks, and the economy of individuals, communities, businesses, and coastal states can be devastating (FAO 2002). In the Pacific, tuna plays a vital role in economic development and, for many states, food security (Bell et al. 2021; Terawasi and Reid 2017).

The scale and complexity of IUU fishing means that no single institution or nation can fight it on its own. International agreements and cooperation can increase the effectiveness of the fight against IUU fishing as demonstrated by

Op Nasse over the years. In 2022, analysis and intelligence provided by Megan and other JCC analysts meant assets such as patrol boats and defence force aircraft were able to be used very efficiently and effectively, resulting in positive outcomes that demonstrate the coordinated capabilities and collaborative intelligence-gathering across partner nations.

Technology has an important role to play in this fight. Megan stresses the importance of a common operating picture as being the foundation of effective collaboration. A cloud-based MDA platform facilitates information sharing with minimal latency, enabling command centres such as the JCC and their outposts, including patrol asset operators, to operate 24 hours a day, seven days a week.

Cloud computing also allows access to cutting edge data science and machine learning tools, such as network analysis, at minimal requirements for computing resources by the end user. Specifically, the software-as-a-service model allows rapid co-development of platform features and bespoke analyses with experts at agencies such as AFMA and the Pacific Islands Forum Fisheries Agency. Expert analysts like Megan are central to this development. When their knowledge influences the development of shared systems, it can transfer to others and build capacity where it is needed, thereby creating long-lasting benefits. Then, when software performs the mechanistic portion of Megan's work, such as determining IUU risk indicators, she can focus on the investigative research and on interpreting the activities in the context of ever changing IUU fishing practices and environmental change.

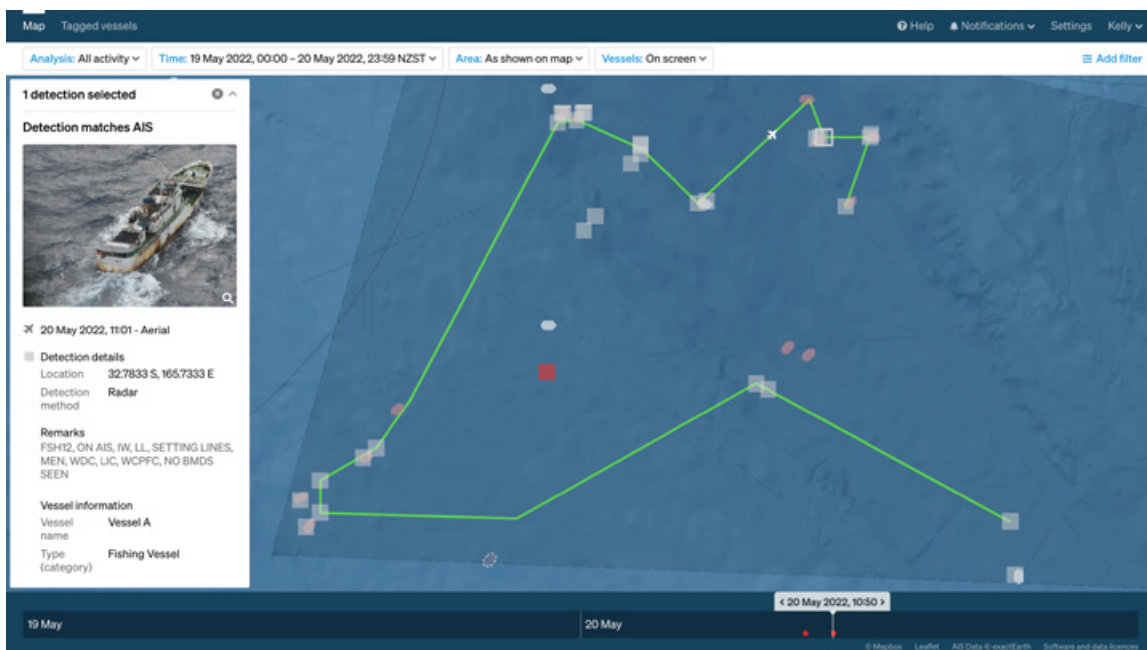


Figure 5. Radio frequency (RF) scan from Unseenlabs shows X- and S-band marine navigational radar detections that matched with AIS positions (white squares). An aerial surveillance patrol flight (green line) validated many of these RF detections and provided photographic evidence of the vessels. The red square identifies a potential dark vessel, a satellite detection that did not match a known vessel position.

Supplementary figures

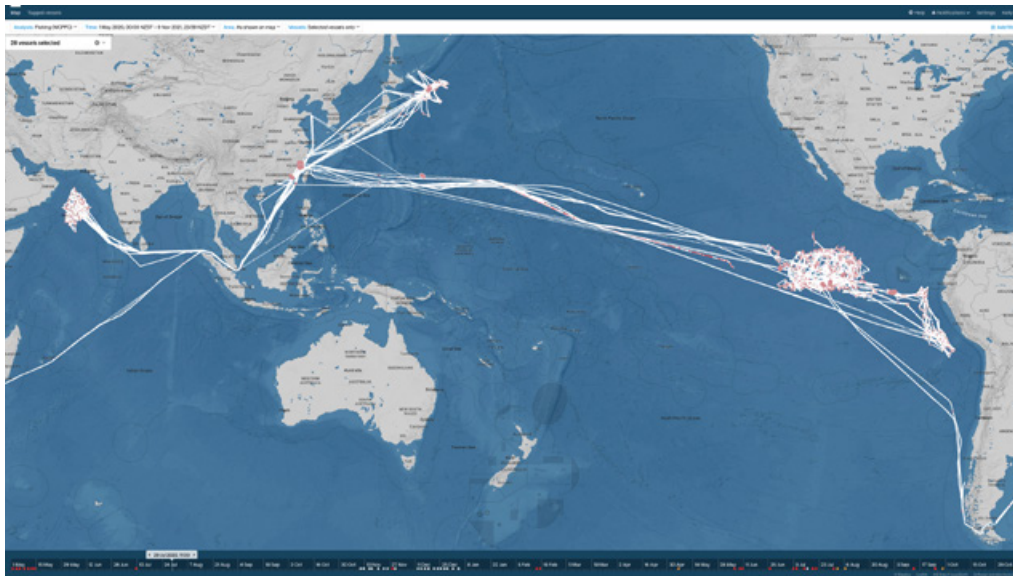


Figure S1. These vessels travelling long distances to fish exclusively in high seas areas are all owned by a single company (Brush and Utermohlen 2022).

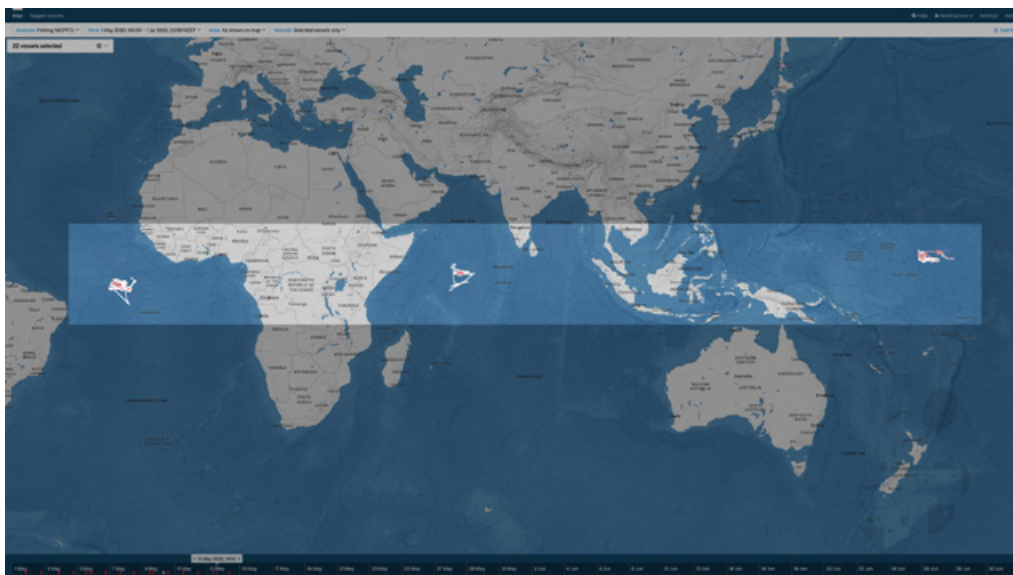


Figure S2. These vessels were all owned by the same company that used banned fishing gear to deliberately catch and illegally cut the fins from sharks in international waters (Jacobson and Gokkon 2022). The vessels' activities prior to discontinuing their operations in mid-2020 were concentrated in distant high-seas locations.

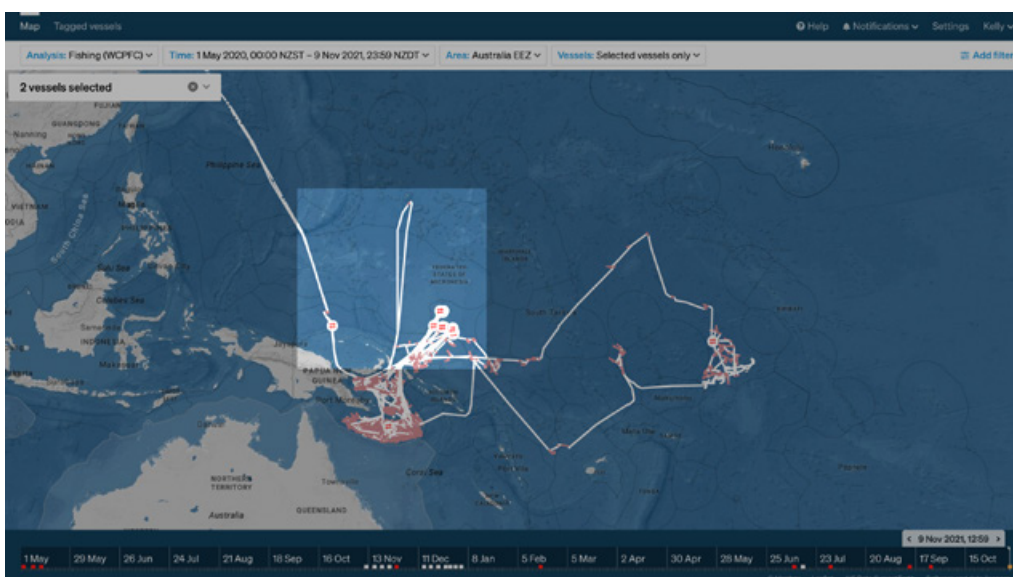


Figure S3. These vessels were identified departing their routine fishing grounds to conduct several fleet encounters in remote areas of the Pacific, while also refraining from further fishing efforts. Subsequent media reporting identified that forced labour was occurring on board the vessels, and that crew members were attempting to contact the local authorities via mobile phone (Jakarta Post 2020). The vessels were forced to depart the region and disembark the crew to avoid detection.

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