

Editorial

Very large sea cucumbers, as those proudly displayed in the picture to the left, have been named 'Pacific black gold', probably because they fetch very high prices, but most certainly because they are fast becoming as rare as gold in the region.

In 2012, fisheries authorities in French Polynesia decided to close a rapidly expanding sea cucumber fishery until a management plan was in place. Arsène Stein describes in detail (p. 40) the approach taken by the Department of Marine Resources to develop this management plan, which involved communities in the monitoring and control of the fishery. Interestingly, overall beche-de-mer production sharply declined when regulations – including seasonal closures, quotas set per atoll, and minimum sizes imposed for each species – were put in place at the end of 2012, and quotas have not been fully utilised since then. At the same time, however, the declared export value per kilo almost tripled, proving that limiting the catch to large individuals by imposing minimum size limits could have a spectacular effect on the value of the catch. If size limits, used primarily to protect animals until they have had time to reach sexual maturity, have such a positive effect on the value of the catch, they should be used (and firmly enforced) for all sea cucumber fisheries in the Pacific Islands region, particularly where quotas are almost impossible to evenly share between localities and communities, and prove to be extremely difficult to monitor efficiently.

Be reassured, sea cucumbers are not the only topic discussed in this issue. Authors also relate surprising findings about tuna diets (p. 2), describe promising initiatives in the aquaculture sector (p. 9–13), detail the ambitious programme of the new Pacific-European Union Marine Partnership (p. 14), and summarise lessons learned during 40 years of small-scale tuna fishery development (p. 60). This is a large issue, but then there is so much to say.

Aymeric Desurmont, *Fisheries Information Specialist, SPC*

In this issue

SPC activities

- P 2 *A la carte menu for tuna: Kids' dishes, regional and seasonal specialties, or how tuna diets vary in the Pacific*
- P 8 *20,000th Tails logsheet uploaded*
- P 9 *PNG farmers improve their fingerling production skills*
- P 11 *Improving giant clam farming in the Marshall Islands*
- P 12 *The Pacific Community and the Asian Institute of Technology work together towards sustainable aquaculture development in the Pacific*
- P 14 *The Pacific-European Union Marine Partnership Programme now in the implementation phase*
- P 19 *PEUMP Programme Inception Meeting for Key Result Area 3 on Coastal Fisheries*
- P 21 *Outcomes of the second SPC Regional Technical Meeting on Coastal Fisheries*
- P 25 *New course on Coastal Fisheries and Aquaculture Compliance takes off!*
- P 28 *My experience as a Pacific Islander Junior Professional with SPC*

News from in and around the region

- P 30 *Fiji's groupers – valuable but vulnerable*
- P 32 *Tablet-based data collection – a new vision for Vanuatu's aquaculture sector*

Feature articles

- P 34 *Temporal variation in catch composition, fishing gear and time spent fishing in an artisanal coral reef fishery*
- P 40 *Development and application of sea cucumber fishery regulations in French Polynesia*
- P 60 *Forty years of small-scale tuna fishery development in the Pacific Islands: Lessons learned*



Fijian fisherman proudly displaying his catch of white tearfish sea cucumbers. (Image: Kalo Pakoa, ©SPC)

A la carte menu for tuna: Kids' dishes, regional and seasonal specialities, or how tuna diets vary in the Pacific

A young female scientist from New Caledonia is earning her master's degree at the University of Montpellier in France. She came returned to the Pacific for six months as an intern at the Oceanic Fisheries Programme (Fisheries and Ecosystem Monitoring and Analysis Section) and the Climate Change and Environmental Sustainability Division of the Pacific Community (SPC). At SPC, she was trained in studying the diet of tunas in the western and central Pacific Ocean (WCPO) in order to provide knowledge on tuna ecosystem dynamics in the face of climate change.

The Pacific Ocean is the biggest ocean on Earth. It presents a characteristic distribution of sea surface temperature with two different bodies of water (Fig. 1). To the east is the 'cold tongue', a nutrient-rich and highly saline body of water with a high primary productivity and a sea surface temperature of about 20°C. To the west is the 'warm pool', an oligotrophic and warm water body with a sea surface temperature of about 29°C. Where these two bodies of water meet, they form a convergence zone in the equatorial Pacific Ocean. In this region, there is a major climatic phenomenon called the El Niño-Southern Oscillation (ENSO), which is an alternation between a warm period named El Niño, and a cold period named La Niña. This event has effects on the convergence zone that moves eastward during an El Niño period and westward during a La Niña period. This convergence zone impacts the entire ecosystem, especially with regard to the distribution of tunas and, consequently, the productivity of commercial fisheries, which are very important in this region.

This physical environment is host to a very rich ecosystem, where each species is a link in the food web (Fig. 2). The apex predators in these waters include tunas, sharks, marlins and mammals. Micronekton (2–20-cm-long organisms) are part of these top predators' diet. Micronekton feed on the first links at the base of the food web: phytoplankton, that are the primary production of the environment, and zooplankton. Micronekton play a central role in this complex food web.

The aim of the internship was to determine whether climate change is impacting the pelagic ecosystem of the WCPO through the study of apex predators' diet. The results should, in turn, provide a more general overview of the composition of micronekton in the ecosystem, and help to understand and model its dynamics.

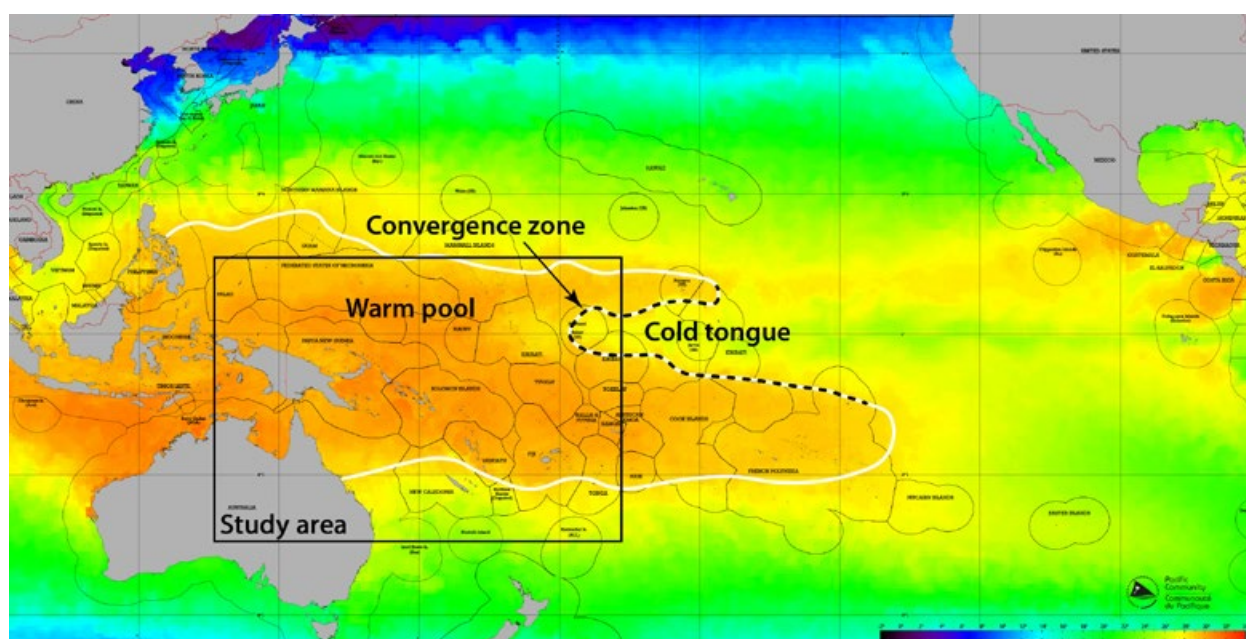


Figure 1. Average distribution of sea surface temperature (15 March 2018) and the area covered in this study. The white line is the approximated 28.5°C isotherm used to define the extent of the warm pool. Sources: SPC for the map and NOAA for the March 2018 sea surface temperature levels.¹

¹ <https://www.ospo.noaa.gov/Products/ocean/index.html>

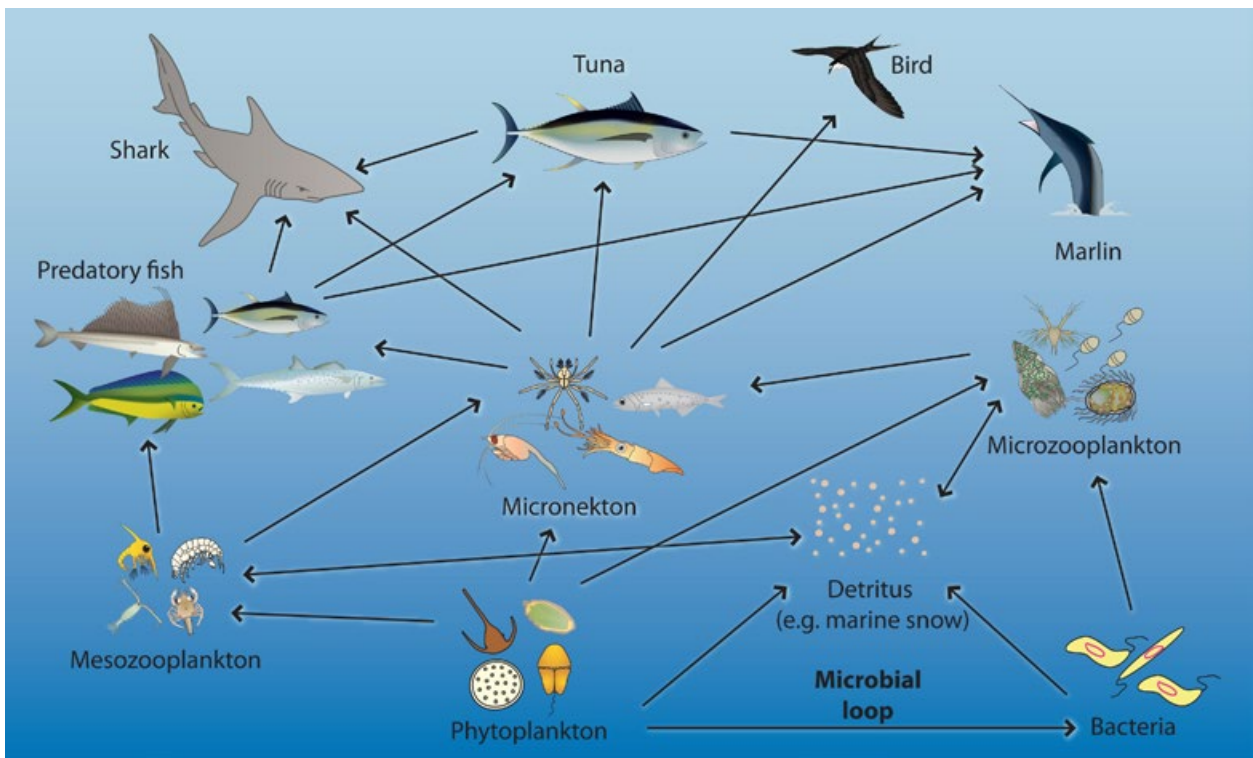


Figure 2. The pelagic ecosystem food web. (illustration: Jipé Le-Bars, SPC)

Scientists and fisheries observers collect biological samples of tuna during SPC’s Oceanic Fisheries Programme (OFP) tagging campaigns, scientific voyages, and from commercial tuna fishing boats. They collect, in particular, tuna stomachs, which are then stored at SPC in the Pacific Marine

Specimen Tissue Bank² to later be analysed. To describe their diet (Fig. 3), we analysed 2,979 stomachs of yellowfin tuna (*Thunnus albacares*), and 1,012 stomachs of bigeye tuna (*Thunnus obesus*), which were collected between 2001 and 2018 in the study area shown in Figure 1.



Figure 3. Examples of prey animals found in the stomachs of tuna: fish, squids and shrimps. (photo: SPC)

² <http://www.spc.int/ofp/PacificSpecimenBank>
See also: http://www.spc.int/DigitalLibrary/Doc/FAME/InfoBull/FishNews/152/FishNews152_43_Smith.pdf

Several types of data were collected during the identification of prey, such as stage of development, stage of digestion, number of specimens and their weight. These data were entered into BIODASYS, SPC’s biological database. Scientists also found macro-plastics in tuna stomachs, which were duly recorded (Fig. 4).



Figure 4. Macro-plastic found in a tuna stomach. (photo: SPC)

According to lab work, yellowfin tuna feed on species within the epipelagic layer (0–200 m depth) such as micronekton, and mainly on the larvae of crustaceans, whereas bigeye tuna feed on species within the upper mesopelagic layer (200–500 m depth) and lower mesopelagic layer (>500 m depth), and feed mainly on fishes.

Classification trees were used to look at variations in the prey composition of the diet of yellowfin and bigeye tunas. Our objective was to try to identify which environmental factors are crucial to diet variability, and to determine if there has been a change in the diet with time between 2001 and 2018 that could be linked to climate change (Figs. 5 and 6).

This statistical method groups together predators with a similar diet and identifies which environmental characteristics best defines the groups. The results showed that the first characteristic that separated predators into two groups with distinct diets is predator length. Small and large tunas have a very distinct diet and the shift occurs at 60 cm long for bigeye tuna and 67 cm long for yellowfin tuna. Of the 1,519 yellowfin tuna examined that were smaller than 67 cm fed mainly on crustaceans, in particular, the pelagic larvae of reef species such as mantis shrimp (Stomatopoda ~30% of

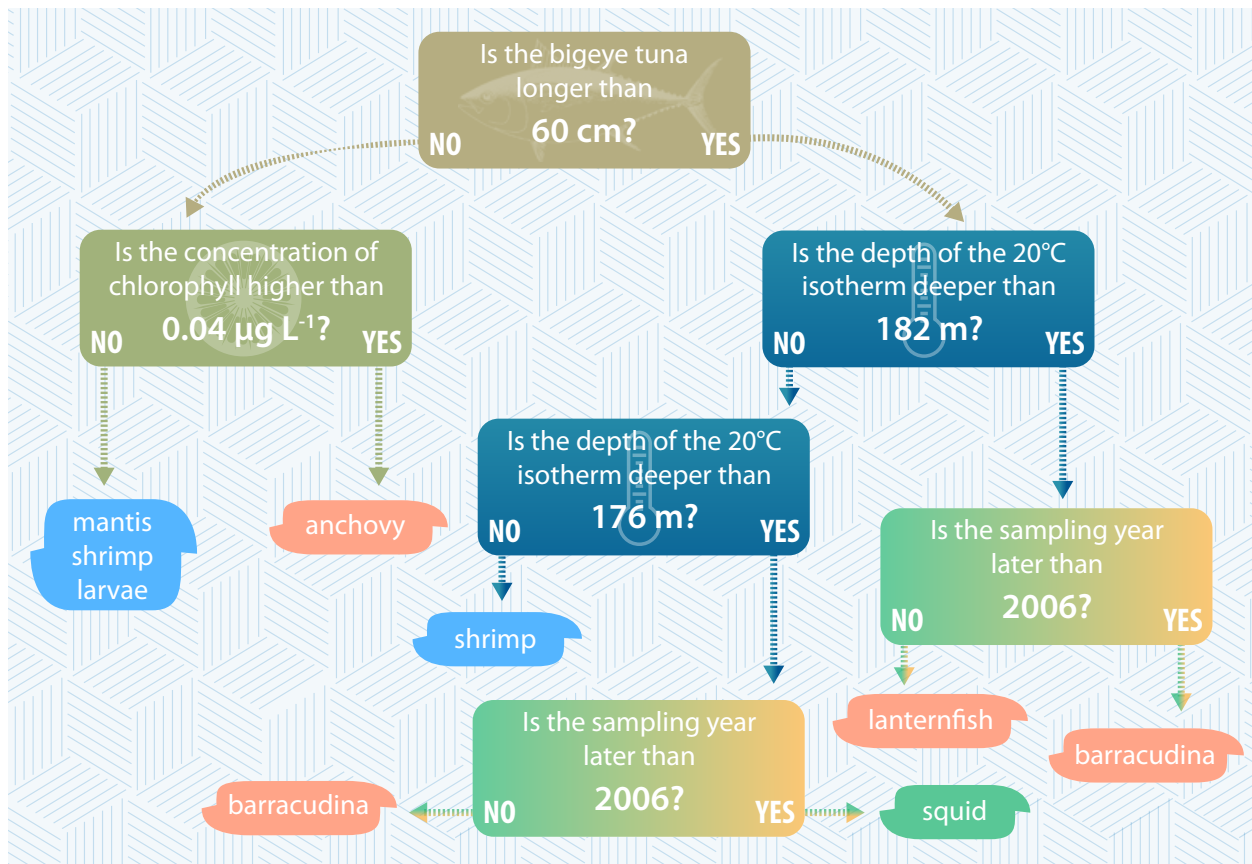


Figure 5. Representation of the classification tree ordering the bigeye tuna predators according to their diet, and identifying the basic environmental factors that influence the classification.



Figure 6. Representation of the classification tree ordering the yellowfin tuna predators according to their diet and identifying the basic environmental factors influencing the classification.

the diet in weight) and crab (*Brachyuran megalopa* ~15%), but also on small 1–2 cm long *Thalassocaris* shrimps (~10%) (Fig.7). Yellowfin tuna also feed on triggerfish larvae (Balistidae ~10%), oceanic anchovies (Engraulidae ~5%) and flying squids (Ommastrephidae ~5%). Of the 627 yellowfin tuna that were larger than 67 cm, all had fed on a wider diversity of prey, with a preference for fish, particularly juvenile tunas (Scombridae ~10%), triggerfish larvae (~10%), oceanic anchovies (~10%), flying squids (~10%), mantis shrimp (~5%) and crab (~5%) larvae (Fig. 7). The 70 bigeye tuna examined that were smaller than 60 cm demonstrate the same appetite as small yellowfin tuna for crustaceans, feeding primarily on mantis shrimp larvae (~35%),

Thalassocaris shrimp (~15%), shrimp (~5%) and 1–2 cm long *Phrosina* crustaceans (~5%) (Fig. 7). They had also fed also on oceanic anchovies (~10%) and small flying squids (~10%). The 384 bigeye tuna larger than 60 cm had a more diverse diet than the small bigeye and fed preferentially on deepsea fish such as barracudina (Paralepididae ~20%), lanternfish (Myctophidae ~10%), pomfrets (Bramidae ~5%) and lancetfish (Alepisauridae ~5%) (Fig. 7). They had also consumed shrimp (~10%) and flying squids (~5%).

The difference in food composition and prey diversity between small and large tunas is explained by the fact that they do not occupy the same vertical habitats: large tuna are

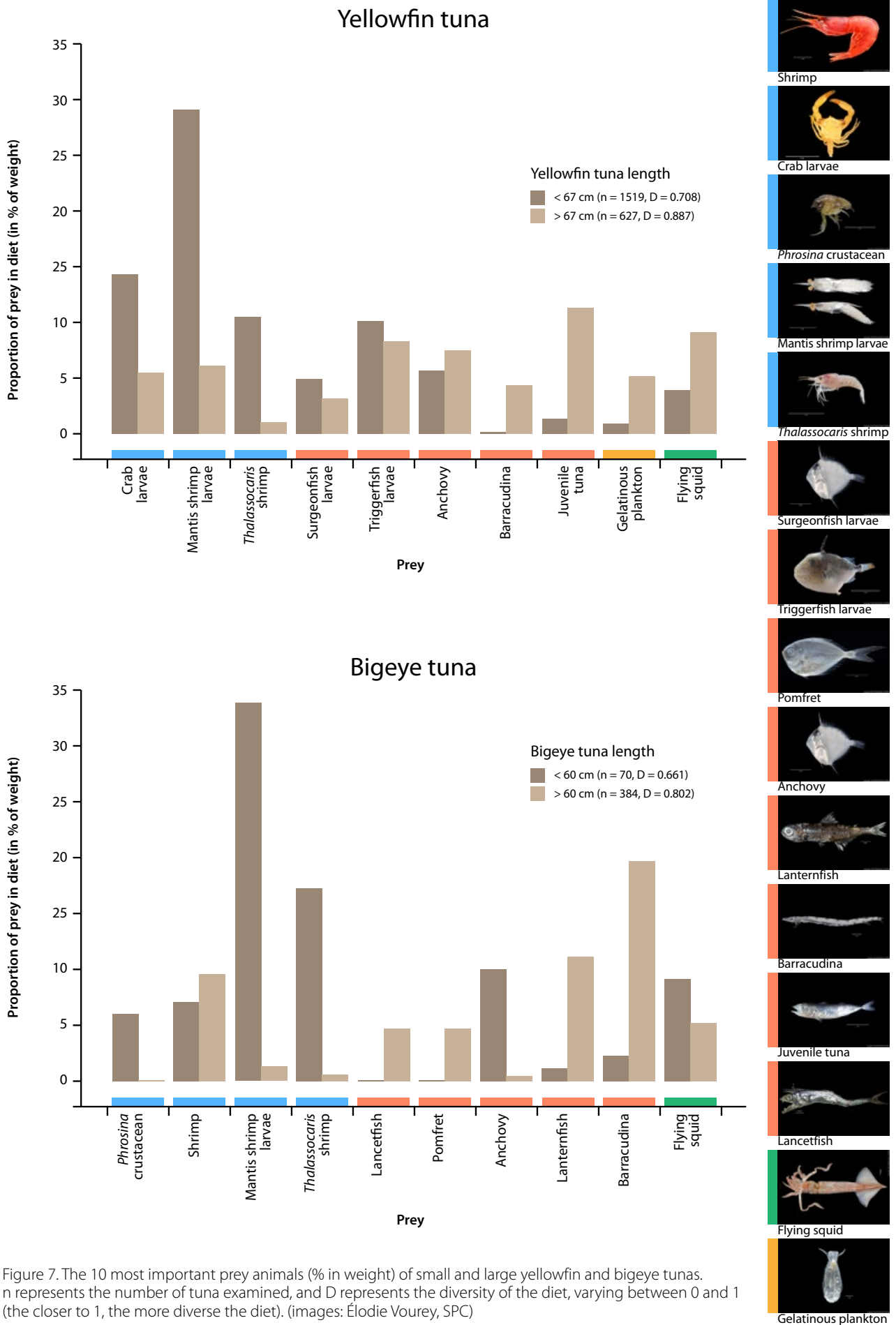


Figure 7. The 10 most important prey animals (% in weight) of small and large yellowfin and bigeye tunas. n represents the number of tuna examined, and D represents the diversity of the diet, varying between 0 and 1 (the closer to 1, the more diverse the diet). (images: Élodie Vourey, SPC)

able to access deeper and larger prey while small tuna are limited to surface waters.

Moreover, the statistical analysis indicates that specimens are grouped together (meaning they have a similar diet), according to the depth of the 20°C isotherm. The 20°C isotherm is a line on a map connecting all of the locations and depths where the sea temperature is at 20°C. This value is used as a proxy for the thermocline, which is the depth where surface waters that are mixed and have the same temperature are separated from deeper waters where the temperature decreases with depth. Exchanges between waters above and below the thermocline are very limited and tend to create two separate habitats. Our results indicate that when the depth of the 20°C isotherm, or thermocline, is deep (>180 m depth), tuna, in particular bigeye, have access to deeper prey items and their diet looks different from tuna that live in waters where the thermocline is closer to the surface. A shallow thermocline limits the vertical habitat of the tunas that only access surface preys, while a deep thermocline allows tunas to expand their feeding range to deeper habitats.

Our primary goal for this study was to investigate whether there was a change in the diet of tunas over time that could be linked to climate change. However, no particular year emerged as a major factor contributing to diet variability. For example, the main prey of bigeye tuna in the equatorial zone was squids (Teuthida) between 2001 and 2006, but changed to barracudina after 2006. We believe that this result may be linked to ENSO, the major climatic phenomenon in the region. The analysis of the yellowfin tuna diet also indicates an impact of ENSO; the main prey of large yellowfin tuna is the flying squid during La Niña periods, but changes to mantis shrimp larvae and juvenile tunas outside this period.

Other environmental factors that can influence the diet of tunas are sea surface temperature and the concentration of chlorophyll-*a*, which indicates the level of phytoplankton, the first component at the bottom of the food web that allows the development of the whole ecosystem.

Our study covers a vast area of ocean with diverse ecosystems, where environmental conditions vary considerably. Tuna in this environment face very diverse climatic conditions and will opportunistically feed on whatever prey is available to them. Their diet varies a great deal and there are many external factors that influence this variability. The system is complex, and it is difficult to interpret complex phenomenon in a simplistic way. Moreover, even if we were lucky to access a fantastic dataset of tuna diet content, we

realised that collecting samples opportunistically does not always allow detailed analyses to be conducted. Filling the gap of knowledge we have on tuna prey (also called micronekton) would also help to interpret changes in tuna diet and determine if tuna diet changes because of changes in the available food within the low and mid-trophic levels of ecosystems, or if tuna diets change due to modifications of tuna behaviour.

The results presented here only relate to a portion of the data collected: there are still many stomach samples in the Marine Specimen Tissue Bank waiting to be examined, and biological sampling by fisheries observer programmes in the region continues. To try to determine when climate change will impact the tuna ecosystem to the point that it shifts³ would require a better sampling design to limit the biases in the analyses (e.g. samples collected from the same place every year). Obtaining fisheries independent data of tuna prey (micronekton) to describe which species are available to predators is also crucial to help understand changes in the ecosystem. Using acoustical data to determine the quantities of micronekton and their spatial distribution, and nets to collect samples of micronekton to determine their diversity and understand their biology, contributes to filling the gap in knowledge on micronekton and better understanding the relationships between tunas and their environment. The BIOPELAGOS⁴ project (BEST 2.0 programme funded by the European Union) – implemented jointly by SPC and the French Institute for Research and Development (IRD) – contributes to fill the gap of knowledge on micronekton with acoustic and net sampling during scientific campaigns in New Caledonia and Wallis and Futuna, and results of those voyages will be available in 2019 at the end of the project.

Finally, besides climate change, it would also be important to study human-caused pressures, particularly the impact of plastics on marine communities, as the examination of tuna stomachs showed that these affect pelagic species.

For more information:

Pauline Machful
Master's student
machful.pauline@gmail.com

Valérie Allain
Senior Fisheries Scientist (Climate Change-
Ecosystem Analysis), SPC
valeriea@spc.int

³ In ecology, regime shifts are large, abrupt, persistent changes in the structure and function of a system (source: Wikipedia).

⁴ See : <http://purl.org/spc/digilib/doc/oo5pn> and <http://purl.org/spc/digilib/doc/j6i4i>;

20,000th Tails logsheet uploaded

On 1 November 2018, the 20,000th fishing trip logsheet was uploaded using the Tails data entry app, marking a significant milestone for tablet-based, small-scale fisheries data collection in the Pacific Islands region. In a serendipitous twist of fate, the same data collector who uploaded the 20,000th logsheet also uploaded the very first Tails logsheet back in 2016 during the first field trials.¹ Looking back over the last few years, there has been significant progress in the region towards improved small-scale fisheries data collection, and a push from Pacific Island countries and territories to use these data for decision-making within fisheries management.



Slade Benjamin (Nauru Fisheries) entering the first Tails logsheet in February 2016. (image: Andrew Hunt, SPC)

Fisheries data management staff at the Pacific Community (SPC) had been running some routine reports and noticed that the number of logsheet uploads via Tails was approaching 20,000. Who would submit the 20,000th logsheet? Would it be sent from a community-based fisheries manager in remote Vanuatu, entering caught yellowfin tuna from a locally designed and built 'vatu ika' fish aggregation device? Would it be submitted from the wharf in Rarotonga, with a fisheries officer sampling a few mahi mahi caught by tourists from Auckland as part of the island's thriving tourist industry? Or could the logsheet be submitted from a data collector in Tonga, entering a catch of wahoo from the local small-scale troll fishery?

As it turned out, the 20,000th logsheet was submitted by Slade Benjamin, a fisheries data collector with Nauru fisheries who assisted with the very first version of Tails, and collected the very first Tails logsheet from a local fisher who had caught a wahoo and snapper while fishing from of a small boat before work. Slade was instrumental in the early testing of Tails and in providing feedback on the first designs and ideas in order to get Tails to where it is today.

Looking back at several years of data collection, and those 20,000 logsheets, gives perspective to the rapid uptake and effort that Pacific fisheries offices have invested into this kind of data collection. These logsheets contain a huge amount of small-scale fisheries data, made possible by the many thousands of hours that data collectors spend waiting at landing sites to collect data, interview fishers and measure catches. An impressive amount of data collection for a tool that was only first tested in 2016.

As the data collection programme matures, and the time series of data increases, these data become more and more useful for fisheries and social purposes. These data inform the coastal fisheries report card,² are used to report total removals of tuna to the Western and Central Pacific Fisheries Commission, and in some cases the collection of reef species has helped inform local fisheries management decisions.

Less than three years after the first Tails logsheet was developed, there are now close to 100 data collectors operating in 10 Pacific Island countries and territories, with 451 unique species logged, and 564,092 kg of fish recorded. These data have been used for important management decisions, as well as tracking nearshore the effectiveness of fish aggregation devices, and reporting small-scale tuna catches to the Western and Central Pacific Fisheries Commission.

For more information:

Andrew Hunt

Data analyst – Trainer, FAME, SPC
andrewh@spc.int

¹ See: https://www.spc.int/DigitalLibrary/Doc/FAME/InfoBull/FishNews/149/FNL149_02_Hunt.pdf

² <http://fame1.spc.int/en/publications/roadmap-a-report-cards>

PNG farmers improve their fingerling production skills

The Sirinumu Dam in the Central Province of Papua New Guinea (PNG), which supplies water and electricity to PNG's capital of Port Moresby, drowned the agricultural valley in the area and created a large lake in the early 1960s. Landowners can use this lake for aquaculture purposes to compensate for lost agriculture activities, but a key issue for them is obtaining baby fish fry (fingerlings) for stocking floating cages so that fish can be grown to a harvestable size.



SPC Aquaculture Technician Jone Varawa (at right) and members of the Sirinumu Tilapia Women's Group with fish breeding equipment sourced from Thailand and delivered during a ceremony conducted on September 2018 at a Sirinumu Tilapia Cluster meeting. (image: Gideon Pama, NFA)

Facilitation by PNG's National Fisheries Authority (NFA) and the Aquaculture Section of the Pacific Community (SPC) has led to the establishment of the Sirinumu Tilapia Cluster and the Sirinumu Women's Group, whose membership currently stands at 76 tilapia cage farmers who have adopted aquaculture activities to increase local incomes and food security. These farmers own a total of 185 fish cages, of sizes 3 m x 3 m x 2 m and 4 m x 4 m x 2 m.

The main constraints identified by these tilapia farmers include:

- inconsistent supply and non-uniform size of tilapia fingerlings; based on the 185 cages now in place, the yearly fingerling need is estimated at 800,000;
- lack of knowledge about tilapia cage management practices;
- poor record keeping;
- lack of financial skills;
- absence of local suppliers of specialized aquaculture equipment, such as cage nets, hapa nets, scoops and scales; and
- need for frequent extension support, advice and monitoring; it has been decided to engage an extension consultant for the farmers' groups at Sirinumu Reservoir.

With the assistance of the New Zealand Government-funded Sustainable Pacific Aquaculture project (PacAqua), SPC and NFA are working with Sirinumu tilapia farmers to prioritise actions addressing these constraints. The project officers are training the lead farmers on basic tilapia fry production methods using hapa nets, and on tilapia cage grow-out management. Because there are no 'aquaculture shops'

• *SPC activities* •

selling equipment in PNG, NFA and SPC have facilitated access to sources of specialised aquaculture equipment in Southeast Asia to establish hapa-based tilapia fry production systems.

The 76 farmers organised themselves into smaller groups of 8–15 farmers, each with a group leader to manage fry production. Seven groups of farmers have so far constructed 10 ponds to operate as hapa-based breeding systems for tilapia fish. The lead farmers and their assistants received hands-on training on tilapia fry production by the project team as the first priority of the project intervention. The six lead farmers are Tom Moduba, John Toina, Arthur Unene, Kevani, Charlie Kone and Kila Bobogi of the Sirinumu Women's Group. The target set by these lead farmers is to produce a minimum of 15,000 fingerlings each per month to supply cage farmers in their area.

Based on the production survey conducted to benchmark farmer performance in 2017, the 185 cages operated by these 76 farmers produced around 20 tonnes of fish in total. While this is certainly worthwhile, these same 185 cages are capable of producing 182 tonnes per year, worth PGK 1.8 million (AUD 760,000). Using the assistance provided through the New Zealand-funded project to increase tilapia fry production, Sirinumu farmers will aim at approaching this figure.

For more information:

Jone Warawa
Aquaculture Technician
jonev83@gmail.com



Jonah Bobogi and John Toina harvesting the first batch of their tilapia fry from a hapa-based breeding system. (images: Jone Warawa, SPC)

Improving giant clam farming in the Marshall Islands

The farming of giant clams is an aquaculture activity that was developed in the Marshall Islands more than 30 years ago, with relatively successful results. Despite the long history of giant clam farming, there is still much to learn about and improve on in order to reach a production that is efficient, viable and sustainable.



Spawning induction of giant clam brooders, using thermal stress. (images: R. Garcia-Gomez, SPC)

Giant clam juveniles have been used in the Marshall Islands for restocking and stock enhancement programmes, and for ornamental export markets in the United States and Europe.

For this reason, the Marshall Islands Marine Resources Authority (MIMRA) formally requested the Pacific Community (SPC), on behalf of the government of the Republic of Marshall Islands, to conduct an in-country training course for MIMRA staff and national private giant clam farmers on giant clam larval culture, nursery and grow-out systems.

In order to respond to this official request, SPC's Aquaculture Section, under the New Zealand-funded project 'Sustainable Pacific aquaculture development for food security and economic growth', engaged a regional expert on giant clam farming, Cletus Oengpepa from Solomon Islands, to provide technical training.

A practical and theoretical training on giant clam farming, including broodstock management, larvae rearing, hatchery and nursery techniques and grow-out protocols was conducted at the government hatchery in Majuro, from 16 to 27 July 2018. Participants comprised government fisheries officers and private hatchery operators.

The training specifically addressed the need to broaden the skills and knowledge of the staff working in the government-operated hatcheries or private enterprises.

Some innovative practises were taught to the participants, such as supplementary feeding of larvae, culture and use of microalgae, establishment of settlement structures, egg counting, fertilisation, and others. Special attention was given to the control of water quality parameters and how these affect breeding and larvae rearing results.

The expert also provided technical advice for a possible extension of the government giant clam hatchery, which could be built in 2019 if national funds are available.

The training was well received by participants, as shown by the post-training evaluations. As one of the first results of the training, MIMRA and the private hatcheries have begun to use concentrated microalgae bases to supplement the feeding of giant clam larvae, as well as to cover the settlement structures.

Close monitoring will be conducted by MIMRA, in close collaboration with the SPC Aquaculture Section team, to assess the real impact of the training and the implementation of the aforementioned innovative practises provided.

For more information:

Ruth Garcia-Gomez
Aquatic Biosecurity Specialist, SPC
ruthgg@spc.int

The Pacific Community and the Asian Institute of Technology work together towards sustainable aquaculture development in the Pacific

The Aquaculture Section of the Pacific Community (SPC) and the Aquaculture Division of the Asian Institute of Technology (AIT) began a close collaboration in the area of sustainable aquaculture development in 2016. Within the framework of the project funded by the New Zealand Government – ‘Sustainable aquaculture development for food security’ – the two organisations have carried out joint training and capacity building exercises on aquatic biosecurity and animal health.



Visiting a typical Nile tilapia farm using floating cages. (image: Ruth Garcia-Gomez, SPC)

AIT promotes technological change and sustainable development in the Asia-Pacific region through higher education, research and outreach. It was established in Bangkok in 1959 and is now a relevant regional postgraduate institution that actively works with public and private sector partners throughout the region.

The SPC/AIT joint training and capacity building activities were carried out at the AIT campus and laboratories in Bangkok, Thailand, with participants from 11 Pacific Island countries or territories (PICTs): Federated States of Micronesia, Fiji, French Polynesia, Marshall Islands, New Caledonia, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga and Vanuatu.

Trainees were fishery and biosecurity or quarantine officers who are responsible for monitoring aquaculture and fisheries activities in their respective countries.

The first joint training was conducted in 2016, and focused on aquatic biosecurity protocols and operations, including quarantine, border control, certification schemes and import/export standards.

Building on the good results obtained during this first training, a second training was organised in 2017, focusing on freshwater finfish diseases, with a special emphasis on diseases affecting Nile tilapia and the common carp (other carps were also considered). These species are the most commonly farmed freshwater fish species in the Pacific Islands region. The objective of the training was to improve the capacities and skills of participants on freshwater fish diseases diagnosis, prevention, control and treatment. The training workshop placed special emphasis on external and internal parasites affecting freshwater fish.

A third training on freshwater finfish parasites was conducted from 26 to 30 November 2018. Participants from 11 PICTs were trained on the most relevant parasitic diseases that affect small-scale freshwater farming. It should be noted that the majority of PICTs are currently involved in freshwater aquaculture. These farming activities vary from small-scale subsistence aquaculture operations to medium- to large-scale, semi-commercial operations.

In addition to these training workshops, SPC and AIT also collaborate in laboratory analyses of diseases of mandatory



A Nile tilapia farm using *hapa* nets was visited during field work in Thailand. (image: Ruth Garcia-Gomez, SPC)

declaration in aquatic animals. The AIT laboratory has been used as a reference laboratory for screening notifiable diseases of shrimp and Nile tilapia specimens from the Pacific Islands, as there no such laboratory capacity exists within the region.

It should be noted that Nile tilapia, although not subject to any notifiable disease listed by the World Organisation for Animal Health, is currently under the radar as a host of an emerging virus called the tilapia-lake virus (TiLV). Nile tilapia from Pacific Islands countries have been screened for this virus at the AIT laboratory using New Zealand funding. All tests have been negative so far.

Building on the success of the three first training workshops, SPC and AIT, as two reference institutions in the Pacific region, intend to continue their close collaboration in aquaculture and aquatic animal health in the future.

For more information:

Ruth Garcia-Gomez
Aquatic Biosecurity Specialist, SPC
ruthgg@spc.int



Taking samples of laminar gills for microscopy examination. (image: Ruth Garcia-Gomez, SPC)

The Pacific-European Union Marine Partnership Programme now in the implementation phase

The Pacific-European Union Marine Partnership (PEUMP) Programme has been designed to improve the economic, social and environmental benefits of 15 Pacific ACP states by stronger regional economic integration and the sustainable management of natural resources and the environment. This will be achieved through supporting sustainable management and development of fisheries for food security and economic growth, while addressing climate change resilience and conservation of marine biodiversity.

With the support of the European Union (EUR 35 million) and Swedish Government (EUR 10 million), the Financing Agreement for this Programme was signed in October 2017, and the Contribution Agreement signed in September 2018. The Pacific Community is the lead agency, implementing in partnership with the Pacific Islands Forum Fisheries Agency (FFA), the Secretariat of the Regional Environment Programme (SPREP) and, through a separate European Union agreement, the University of the South Pacific (USP). Each agency has a number of implementing partners.

The PEUMP Programme has six key results areas (KRAs), targeting gaps in: 1) fisheries science; 2) fisheries development; 3) coastal resources and livelihoods; 4) illegal, unreported, and unregulated (IUU) fishing; 5) ecosystem-based management; 6) biodiversity conservation; and 7) capacity building at the national and community level.

- KRA 1: Scientific advice for management of the oceanic fishery (EUR 4.45 million) – Lead agency: SPC
- KRA 2: Economic development of national tuna industries (EUR 4.4 million) – Lead agency: FFA
- KRA 3: Coastal fisheries science and management (EUR 12.3 million) – Lead agency: SPC
- KRA 4: Enhanced MCS to control IUU fishing (EUR 4.85 million) – Lead agency: FFA
- KRA 5: Ecosystem management and biodiversity conservation (EUR 5.8 million) – Lead agency: SPREP
- KRA 6: Relevant tertiary training (EUR 5.6 million) – Lead agency: USP
- Programme management and communication (EUR 4.2 million + 1.65 million)

With the end of the inception phase (July–December 2018), this four-year programme is now in the early stages of the implementation phase (January 2019 to December 2022), which will be followed by a closing phase (January–March 2023).

The following article reproduces, verbatim, a leaflet that describes the PEUMP programme in more detail. It was produced for the Inception Meeting for Key Result Area 3 on Coastal Fisheries, held in Noumea on 15 November 2018, and is followed by a brief summary of topics discussed during this one-day meeting.





THE PACIFIC-EUROPEAN UNION MARINE PARTNERSHIP PROGRAMME

The Pacific-European Union Marine Partnership (PEUMP) programme is a comprehensive programme that supports sound ocean and coastal governance with a focus on biodiversity protection and sustainable use of fisheries and other marine resources. With European Union and Swedish funding, it was launched in October 2017 and focuses on gaps in fisheries science; fisheries development; coastal resources and livelihoods; illegal, unreported and unregulated (IUU) fishing; ecosystem-based management; biodiversity conservation; and capacity building at national and community levels.

Background

Marine resources are the backbone of the Pacific region's economies and form the basis of men and women's livelihoods in Pacific Island countries.

Economically, oceanic fisheries are vital to the region as a source of a) economic growth and government revenue; b) decent employment for women and men and small business opportunities. The European Union is the main market for the cooked tuna loins produced in Pacific processing plants.

Coastal fisheries are vitally important at the community level, providing food security, livelihoods and income for small-scale fishers with more than 60% of households in coastal areas relying on fishing as a mechanism to increase resilience and reduce vulnerability.

Overall, the PEUMP programme aligns with all regional priorities and strategic documents, including the *Regional Roadmap for sustainable Pacific fisheries* and *The New Song for coastal fisheries – pathways to change*.

Main objectives

The programme's overall objective is to:

Improve the economic, social and environmental benefits for 15 Pacific ACP states (PACPs) arising from stronger regional economic integration and the sustainable management of natural resources and the environment.

The specific objective (outcome) is to:

Support sustainable management and development of fisheries for food security and economic growth, while addressing climate change resilience and conservation of marine biodiversity.

Key result areas (KRAs) and agencies involved

The programme will cover six KRAs, which are detailed on the next few pages. Its overall management will be done by a Programme Management Unit (PMU) based in Suva, Fiji.

Four main agencies will implement six programme KRAs through a multisectoral approach: 1) The Pacific Community (SPC), the programme's lead agency, will be responsible for its overall management; 2) the Pacific Islands Forum Fisheries Agency (FFA); 3) the Secretariat of the Pacific Regional Environment Programme (SPREP); and 4) The University of the South Pacific (USP).

Given the scope and breadth of the PEUMP programme, agencies will work with and through partners in some areas of implementation: The International Union for Conservation of Nature (IUCN), the Locally Managed Marine Area (LMMA) Network, the Pacific Islands Tuna Industry Association (PITIA), and the World Wide Fund for Nature (WWF). Other partnerships may develop during the programme's implementation.

KRAs and objectives

Activities



1 High quality scientific and management advice for oceanic fisheries provided and utilised at regional and national levels

Mala Hasken, SPC

- Analysis of tuna bycatch at regional and national levels
- Ecosystem modelling and development of indicators
- Evaluation of electronic monitoring for purse-seine vessels
- Research to address biological uncertainties in tuna stock assessment models
- Improved modelling of relative abundance using catch per unit effort
- Capacity development through long-term and short-term attachments with SPC

LEAD AGENCY: SPC



2 Inclusive economic benefits from sustainable tuna fishing increased through supporting competent authorities and strengthening private sector capacities to create decent employment

Francisco Blaha

- Establishment of a competent authority support unit to assist PACP government agencies meet sanitary market access requirements
- Support for sanitary and IUU competent authorities to comply with applicable legislation allowing for market access
- Assistance with fisheries development and national policies
- Annual policy dialogue with the European Union
- Assistance to PACP to comply with the Western and Central Pacific Fisheries Commission conservation management measures, and to implement checklist-identified priorities
- Building the capacity and engagement of the regional tuna industry association
- Developing pilot projects for and providing technical assistance to small and medium enterprises in the sector

LEAD AGENCY: FFA MAIN PARTNER: PITIA



3 Sustainable management of coastal fisheries resources and ecosystems improved through better quality scientific information, legal advice, support, mentoring and empowerment at the community level

Johan Van der Pijeg, WorldFish

- Surveys of commercially important invertebrates
- Socioeconomic surveys of coastal communities, including gender-segregated data
- Mainstreaming of gender and rights-based approach, training, and national gender stocktakes
- Coastal fisheries data collection and national database development, including trials of new technology
- Support and mentoring for the community-based ecosystem approach to fisheries management (CEAFM) at national and local levels
- CEAFM management and coordination with non-governmental organisations (NGOs)
- CEAFM activities at subnational and community levels
- Communication activities and production and dissemination of information and materials for communities
- Capacity development through long-term and short-term attachments for national fisheries and NGO staff
- Outreach activities, including adaptation with communities

LEAD AGENCY: SPC MAIN PARTNER: LMMA

Activities

- Support for the review of national legislation to be in line with international principles as well as the implementation of IUU national plans of action
- Training to deal with IUU incidents and assistance with prosecutions and sanctions
- Trials of new technology to assist national and regional monitoring, control and surveillance (MCS) efforts
- Technical assistance with catch documentation systems, electronic monitoring and electronic reporting
- International outreach and advocacy on IUU and control of high seas fisheries
- Capacity building and training of MCS officers, with an emphasis on the enforcement of port state controls and coastal fisheries regulations
- Development of tools and systems to combat IUU fishing activities in coastal waters

LEAD AGENCY: **FFA** MAIN PARTNER: **WWF**

KRAs and objectives



Illegal, unreported and unregulated (IUU) fishing reduced through enhanced monitoring, control and surveillance of both oceanic and coastal fisheries; improved legislation; access to information; and effective marine area management

4

- Support for marine spatial planning in at least two countries
- Integrated ecosystem strategies and coastal zone management planning
- Climate change adaptation strategies integrated into coastal community plans
- Endangered marine species bycatch assessed, and extinction risk evaluated
- Bycatch mitigation strategies developed and rolled-out
- Capacity development through research grant
- Support for community monitoring and protection of endangered species

LEAD AGENCY: **SPREP** MAIN PARTNER: **IUCN**



Sustainable utilisation of the coastal and marine biodiversity promoted through improving marine spatial planning; increasing climate change resilience; and enhancing conservation, mitigation and rehabilitation measures

5

- Comprehensive needs and gap analysis undertaken
- Accreditation and delivery of existing technical and vocational education and training (TVET) courses (e.g. fisheries enforcement)
- Design of continuing professional development and career pathways including business skills
- Development and delivery of additional training courses identified through needs and gap analysis related to coastal fisheries management and sustainable marine development
- Applied research, postgraduate, workplace development training and TVET scholarships
- Outreach, including online delivery of education and training, publications, *Talanoa*, open educational resources and mobile applications

LEAD AGENCY: **USP**



Capacity built through education, training and research and development for key stakeholder groups in fisheries and marine resources management

6

Programme Management Unit

Objectives

Strengthening gender and rights-based approaches across all KRAs through positive change to peoples livelihoods, in particular, women, youth and the most vulnerable groups.

Activities

- Overall reporting and financial management, as well as communications and visibility of the PEUMP programme
- Integrating and mainstreaming gender and human rights-based approaches across the programme
- Providing technical assistance for the delimitation and negotiation of maritime boundaries

LEAD AGENCY: SPC

Programme genesis

The concept of the Pacific-European Union Marine Partnership programme was launched under the 11th European Development Fund in October 2017 on the occasion of the Our Ocean Conference hosted by the EU in Malta, with the signing of the Financing Agreement for the programme. The Contribution Agreement for implementing the PEUMP programme was signed in Nauru on 5 September 2018 at the Pacific Islands Forum Leaders Meeting. The partnership will be implemented in the 15 Pacific-ACP countries with a total budget of EUR 45 million, made up of EUR 35 million from the EU and a EUR 10 million cofinancing contribution by the Swedish Government through their International Development Cooperation Agency (Sida).

Contacts for more information

KRA 1

John Hampton
Deputy Director FAME
(Oceanic Fisheries), SPC
johnh@spc.int

KRAs 2 and 4

Matt Hooper
Deputy Director General, FFA
matt.hooper@ffa.int

KRA 3 and PMU

Andrew Smith
Deputy Director FAME
(Coastal Fisheries), SPC
andrews@spc.int

KRA 5

Stuart Chape
Director - Island and Ocean Ecosystems
Acting Deputy Director-General - Strategic
Policy and Technical Programmes, SPREP
stuartc@sprep.org

KRA 6

Dr Bibhya Sharma
Dean, Faculty of Science, Technology and
Environment, USP
bibhya.sharma@usp.ac.fj

EUROPEAN UNION

Ingrid Swinnen
Team Leader Delegation of the European
Union for the Pacific
ingrid.swinnen@eeas.europa.eu

Funded by



EUROPEAN UNION



Implemented by



PEUMP Programme Inception Meeting for Key Result Area 3 on Coastal Fisheries

The largest component of the PEUMP Programme is for Key Result Area (KRA) 3: Coastal fisheries science and management (EUR 12.3 million), led by the Coastal Fisheries Programme of the Pacific Community (SPC). A key partner in implementing some of the subcomponents is the Locally Managed Marine Area (LMMA) Network.

Immediately after the Second SPC Regional Technical Meeting on Coastal Fisheries, which was held at SPC headquarters in Noumea (12–14 November 2018), the PEUMP Programme Inception Meeting for KRA 3 on Coastal Fisheries was held (15 November 2018).

The purpose of the KRA 3 Inception Meeting was to provide participating countries an overview of the work areas under KRA 3, provide information on the more crosscutting components, and begin seeking countries' priority needs for consideration of support under the PEUMP Programme. The inception meeting was followed by a formal launch of PEUMP Programme in the evening.

KRA 3 – Coastal Fisheries science and management addresses the sustainable management of coastal fisheries resources and the improvement of ecosystems through better quality scientific information, legal advice, support, mentoring and empowerment at the community level.

To achieve results, specific activities will target coastal communities, with a focus on women and youth, national government agencies and local authorities. For work with local communities, a rights-based and gender inclusive approach will be taken at the outset of project design and planning in order to directly address specific community needs and establish better opportunities for sustainable development.

These activities will be implemented at the national level, through local government and local authorities and working directly with coastal communities, with a specific focus on vulnerable groups such as women and youth.

The main work areas and related KRA 3 activities were presented and discussed at the meeting. They relate to four main groups of activities:

Coastal science activities

- Surveys of commercially important invertebrates
- Socioeconomic surveys of coastal communities, including gender-segregated data
- Capacity development through long-term and short-term attachments for national fisheries and staff of non-governmental organisations (NGOs)
- Gender-based and rights-based training, national gender stock takes

Databases and old data activities

- Coastal fisheries data collection and national database development, including trials of new technologies

Community-based ecosystem approach to fisheries management activities (SPC and LMMA)

- Support and mentoring for the community ecosystem approach to fisheries management (CEAFM) at the national and local level (SPC lead)
- CEAFM management and coordination with NGOs (LMMA lead)
- CEAFM activities at the subnational and community level (LMMA lead)

Information and outreach activities (SPC and LMMA)

- Communication activities and production and dissemination of information and materials for communities (tendered out with LMMA lead)
- Outreach activities, including adaptation with communities (SPC lead)

A critical aspect of the PEUMP Programme is the incorporation of the crosscutting issues of gender and human rights-based approaches to programme activities. SPC's Social Development Programme (SDP) and Regional Rights Resource Team (RRRT) provided a session on how to build gender and human rights-based approaches into the coastal fisheries component by applying a people-centred (rights-based and social inclusion) approach. The 'PLANET' conceptual framework was presented as a way to achieve the development goals framed in the PEUMP coastal fisheries component:

- Participation
- Links to rights
- Accountability
- Non-discrimination
- Empowerment
- Transforming social norms

Gender analysis covers four key areas: the gendered roles of men and women; women's participation in decision-making; women's access and control over resources; and women's access to training and learning opportunities. Under the PEUMP Programme, gender mainstreaming stocktakes of fisheries organisations will be undertaken, and will examine political will, funding and resources, technical capacity, and organisational culture to support gender mainstreaming.

RRRT and SDP provide the following suggestions:

- Commit to applying a rights-based approach to coastal fisheries work;
- Conduct social and gender analyses and include communities in these analyses;
- For each project component, determine how it will affect different segments of communities, especially the vulnerable and less-privileged;
- Avoid rights being portrayed as confrontational or non-traditional, and include responsibilities in discussions about rights;
- Train duty-bearers and rights holders in this area;
- Not all rights have to be claimed through the formal legal system in a litigious manner;
- Understand the contents of legislation and policies within the local context; and
- Offer training in self-empowerment for women.

Coastal fisheries management is about managing peoples' behaviour in relation to fisheries resources. Equitable access to fish is one behavioural aspect that needs to be managed. Culture should not be an excuse for not moving forward.

Priority activities

At the inception meeting, SPC requested participating countries to provide their priority needs for consideration of support under the PEUMP Programme KRA 3 on coastal fisheries. While some countries were able to do so at the meeting, others were not, requiring more time to consult in-country officials. As such, in December 2018, SPC sent a circular to participating fisheries agencies requesting that their priority needs for the next 18 months (January 2019 to June 2020) be considered for support under the PEUMP Programme KRA3. Any request for assistance under the PEUMP Programme must relate to one or more of the PEUMP Programme coastal fisheries activity areas and be a specific priority need identified in that country's national coastal fisheries policies, plans and/or strategies.

For more information:

Andrew Smith

Deputy Director FAME (Coastal Fisheries), SPC
andrews@spc.int

Outcomes of the second SPC Regional Technical Meeting on Coastal Fisheries

The Second Regional Technical Meeting on Coastal Fisheries (RTMCF-2)¹ was held at the Pacific Community (SPC) headquarters in Noumea from 12 to 14 November 2018. With funding from the Australian Government, European Union and the Food and Agriculture Organization (FAO) of the United Nations, over 58 participants² from national fisheries agencies of SPC member countries and territories, non-governmental and civil society organisations, partners of the Council of Regional Organisations in the Pacific and other institutions, discussed and addressed some of the main issues affecting coastal fisheries in support of better resource management, equitable access to resources, and the safety of fishers.

The Regional Technical Meeting on Coastal Fisheries (RTMCF) – which focuses on science, management and capacity building – was revived in order to: 1) fill the need for a regional technical meeting on coastal fisheries; and 2) bring together coastal fisheries scientists, managers and technical experts to discuss important technical, management and scientific gaps and challenges. It supports the implementation of the ‘New Song for Coastal Fisheries – Pathways to Change’³ and the ‘Regional Roadmap for Sustainable Pacific Fisheries’⁴ as well as assisting with providing much-needed information for reporting to Leaders under the annual ‘Coastal Fisheries Report Card’.⁵

The format of RTMCF was designed to maximise input through group discussions and plenary sessions. SPC views the RTMCF as essential for longer-term planning, and is of considerable assistance to other agencies, regional non-governmental and civil society organisations, and donors interested in national and regional coastal fisheries issues and sustainable development.

Funding permitting, SPC intends to continue to hold the RTMCF annually so that its Action Plan can feed into the SPC Heads of Fisheries Meetings. To ensure the RTMCF meets members’ needs and expectations, SPC conducted a participant feedback survey at the end of the meeting. The main feedback indicated that delegates rated highly (4.39 out of 5) on the relevance of the meeting to their work.⁶



Participants to the second SPC Regional Technical Meeting on Coastal Fisheries, SPC headquarters, Noumea New Caledonia, 12–14 November 2018.

¹ RTMCF-2 documents and presentations are available from: <http://www.spc.int/fame/en/meetings/241>

² 28 as representatives from 18 member countries, and 30 as partners from development or non-governmental and civil society organisations.

³ <http://purl.org/spc/digilib/doc/b8hvs>

⁴ <http://purl.org/spc/digilib/doc/xnc9f>

⁵ http://coastfish.spc.int/index.php?option=com_content&Itemid=30&cid=467

⁶ <http://purl.org/spc/digilib/doc/y6kse>

RTMCF-2 Action Plan

The following constitutes the agreed Action Plan from RTMCF-2 for SPC, member countries and territories, and collaborating stakeholders.⁷

The agenda for RTMCF-2 was developed in consultation with countries, administrations and non-state actors through the Coastal Fisheries Working Group (CFWG) process. Key issues identified to be addressed at RTMCF-2 include: 1) progress on the RTMCF-1 Action Plan⁸; 2) gender and human rights-based approaches in coastal fisheries and aquaculture; 3) safety at sea; 4) managing sea cucumber fisheries; and 5) identification of issues and priorities for the next RTMCF meeting.

Progress on addressing the RTMCF-1 Action Plan

- **The meeting recognised** the progress made in coastal fisheries governance at the regional, national and local level since the 2015 publication of 'A New Song for Coastal Fisheries – Pathways to Change: The Noumea Strategy',³ which emphasises:
- stronger and more coordinated new regional arrangements, such as the establishment of the annual RTMCF event itself, which now provides for coastal fisheries issues to be discussed at all levels – from officials to ministerial and Pacific Island Forum Leaders;
- an increase in adoption at the country level of stronger institutional arrangements in coastal fisheries; for example, institutional restructures and policy and legislation reviews by governments and administrations; and
- increased engagement in coastal fisheries management at the community and local level.

The meeting advocated that, notwithstanding this progress, effort should be made to address some significant limitations and gaps in data that constrain the region's ability to report progress against several of the output areas of the Report Card in coastal fisheries, which is made annually to ministers and Pacific Island Forum Leaders under the new regional coastal fisheries governance arrangements.

The meeting noted with appreciation the comments by Vanuatu about the efficacy of Vatu-ika fish aggregation devices (FADs), and their offer to share with other Pacific Island countries and territories their knowledge and experience in the deployment of Vatu-ika FADs in coastal waters.

The meeting acknowledged the perspectives provided by civil society organisation representatives, who highlighted a need to:

- establish formal statutory mechanisms for fisher and fishing community participation, dialogue and input into the formulation of coastal fisheries priorities, policy and legislation;
- develop strategies, approaches and tools to mainstream gender and social inclusion into coastal fisheries planning, management and governance;
- ensure transparency and accountability of government agencies and decision-making processes; and
- increase government budgets for coastal fisheries, with special emphasis on community-based resource management.

The meeting noted that more Pacific Island countries are conducting market surveys in addition to collecting catch and effort landing data for coastal fisheries management, and **recommended that** a number of issues be addressed, such as:

- the separation of enforcement and research (survey) roles of fisheries officers;
- bias in market data vs actual landings;
- absence of central locations where fish are sold;
- inconvenience to vendors of data collection;
- the need for standardised statistical methods to collect data;
- appropriate tools that can feed into a central system for the standardised collection and storage of data; and
- increased capacity and training in collection, storage and analysis of fisheries data.

The meeting recommended the acquisition and use of length data for target species in coastal fisheries management, while mindful that data for other parameters are also needed for coastal fisheries management (such as size at maturity).

The meeting also recommended the sharing of data with other countries, subject to data use agreements, and data aggregation to protect the privacy of survey respondents and locations of vulnerable fishing resources.

⁷ Collaborating stakeholders in coastal fisheries include development partners, research and educational institutions, civil society and non-state actors.

⁸ <http://purl.org/spc/digilib/doc/oize9>

The meeting expressed interest in a coastal fisheries law, policies and regulations database for reasons of information and comparison purposes between jurisdictions. However, the **meeting requested** more information about the practicalities of utilising such a database, and **recommended** that it be user-friendly and include a legal analysis of the application context of the documents and regulations.

The meeting noted with interest the results of social research presented by civil society organisations, which highlighted challenging perceptions about coastal fisheries management processes in selected countries, and the information they reveal about the need to further strengthen meaningful consultation and dialogue at the community level.

Gender and human rights-based approaches

The meeting recognised that a people-centred approach to coastal fisheries:

- derives from SPC's commitment to the defence of human rights and promotion of gender equality and social inclusion, to ensure that the needs of the most vulnerable are at the forefront of SPC's work;
- has two main components: a rights-based component, and a gender equality and social inclusion component;
- offers a conceptual framework to promote and encourage the pursuit of initiatives to ensure the attainment of equitable outcomes through the progressive realisation of rights, which then resonates with the key guiding principles reflected in the current governance framework for coastal fisheries under the New Song; and
- will leverage the achievement of developmental goals framed under the New Song, such as the improvement of food security and livelihood rural development.

The meeting highlighted the need for:

- consistency across the use of terminologies when applying a people-centred approach in coastal fisheries;
- ongoing education and awareness at all levels on gender and human rights dimensions relating to coastal fisheries work; and
- research and gender-disaggregated data analysis to inform policy and programmatic interventions.

The meeting strongly encouraged SPC and member countries to work with development partners to secure additional support for applying a people-centred approach to coastal fisheries.

Saving lives: Safety at sea

The meeting took note of the reported success stories about lives saved at sea, which are directly attributable to relatively inexpensive regional initiatives in sea safety such as the Safety Grab Bags promoted by SPC that include a personal locator beacon.

The meeting recommended expanded and longer-term sea safety initiatives, with better coordination that spans other marine sectors and agencies (such as island councils) in addition to fisheries authorities. Elements of future regional safety-at-sea work should include the creation of a Small-boat Safety Officer position, further procurement and distribution of Safety Grab Bags, provision of small boat safety training using a Train-the-Trainer approach, knowledge products in a range of languages, development of sea accident data collection systems at the national level to monitor incidents, and the transfer of useful technologies and initiatives from other regions such as the Caribbean.

The meeting **proposed** that sea safety capacity development be an integral part of post-cyclone recovery efforts for coastal fishing communities in impacted areas.

Managing sea cucumber fisheries

The meeting reaffirmed the high importance of sea cucumber fisheries to the region, **emphasised** the need to reverse the decline in sea cucumber stocks, and **noted** the lack of examples at the national level demonstrating successful management of sea cucumber resources.

The meeting recommended an assessment of approaches and management options to maximise the economic benefits and social values for SPC members of sea cucumber fisheries (e.g. auctions, one-desk selling).

The meeting acknowledged its support for SPC's work to provide members with advice and capacity building in legislation and monitoring, control and surveillance for managing sea cucumber fisheries, and **recommended** that this work be ongoing.

The meeting noted that political interference in the governance of sea cucumber fisheries represents a major hurdle to effective management of this very important fishery.

The meeting proposed that SPC raise the issue of governance, transparency and accountability with Pacific Islands Forum Leaders.

The meeting urged that the best possible science-based information and advice be provided to decision-makers who make visible the implications of their management decisions upon the sustainability of sea cucumber resources.

SPC, its members, and other stakeholders are **encouraged** to fully utilise the opportunities afforded by the newly evolving regional institutional arrangements for coastal fisheries, in which fisheries ministers and Pacific Islands Forum Leaders now annually consider coastal fisheries issues including sea cucumbers.

The meeting further **advocated** that science-based information about environmental impacts of sea cucumber depletion be reviewed and disseminated to increase awareness and modify behaviour of fishers and communities engaged in sea cucumber fisheries.

The meeting recognised the importance of social inclusion for the effective management of sea cucumber fisheries, and **urged** continued efforts to ensure meaningful participation in policy or management processes by disadvantaged or marginalised groups, including women and youth.

The meeting considered the rights vs responsibilities of fishers and exporters to gain access to sea cucumber fisheries resources, and **advocated** that access be limited to those in compliance with management measures. To this end, it is **recommended** that criteria be developed for access, and that intelligence be shared between governments and administrations about the track records of those operating across multiple jurisdictions.

The meeting advocated that alternative livelihoods (e.g. FADs, aquaculture, terrestrial economic activities) be considered to offset any impacts on the food security and livelihood opportunities of people and communities caused by the introduction of sea cucumber fisheries management measures.

The meeting noted the call by Vanuatu for a review of survey methods in sea cucumber fisheries, and a review of sea cucumber survey data and training activities, in order to address scientific needs (e.g. stock status such as biomass estimates, stock assessment methods) to underpin management.

The meeting **encouraged** representatives from national fisheries agencies to liaise with the national agency or council responsible to the Convention on the International Trade in Endangered Species to formulate a national position about the proposed listing of sea cucumber species.

Other issues, and priorities for the next RTMCF meeting

Aquaculture and aquatic biosecurity

The meeting recognised the increasing importance of the role and contribution that sustainable aquaculture is making in the region, either toward national fish production or as an alternative livelihood to fishing activity, and **encouraged** SPC to continue to provide capacity building and advice to members in aquaculture and aquatic biosecurity.

Future RTMCF meetings

SPC members agreed that future RTMCF meetings will be chaired by members, rather than by SPC, on an annual rotating basis.

The meeting agreed that future meetings will be more than three days in duration, subject to the agenda and the possibility of back-to-back meetings, and supported that the meeting format will consider multiple topics in coastal fisheries. Each session will be at least one day long, with more time allocated for group discussions. Participants will be given advance notice of topics and any relevant materials to be considered. SPC will determine the most cost-effective venue to hold future RTMCF meetings.

For more information:

Andrew Smith

Deputy Director FAME (Coastal Fisheries), SPC

andrews@spc.int

New course on Coastal Fisheries and Aquaculture Compliance takes off!

Competency-based assessments (CBAs) were conducted from 6 to 13 November 2018 for Cohort 1 of the new Certificate IV in Coastal Fisheries and Aquaculture Compliance. The course was developed by the Pacific Community (SPC) under the New Zealand-funded Coastal Fisheries Governance project in collaboration with the Pacific Technical and Further Education (Pacific TAFE) Programme of the University of the South Pacific (USP). Fifteen students who are working as monitoring, control and surveillance (MCS) officers at varying levels in the Pacific, three guest lecturers and seven assessors participated in the assessments, which were held in Suva, Fiji. The assessments were a great success and thanks are extended to the assessors and guest lecturers whose assistance greatly helped to achieve a positive outcome.

All 15 students were graded as competent at the end of the CBAs, which was a fantastic outcome considering that 16 enrolled for the course in August 2018. They will graduate in early 2019 with a Certificate IV in Coastal Fisheries and Aquaculture Compliance. The one student who was unable to complete the CBAs had a good excuse – he was involved in rescue and restoration work in Vanuatu following Cyclone Hola, so he will be the first to be enrolled in Cohort 2 in early 2019.

The timeline for completing online components was condensed to three months because all Cohort 1 students had already completed Certificate IV in Fisheries Enforcement and Compliance (Certificate IV FEC, the old Forum Fisheries Agency foundation course) and were familiar with using the Moodle online learning platform. In addition, they had already graduated with a certificate in Operational Planning and Enforcement Processes, one of the mandatory

courses required for the new Certificate IV in Coastal Fisheries and Aquaculture Compliance.

The CBAs assess students' capabilities when dealing with real world situations along with their knowledge and understanding of the topics covered in the course. These topics included: legal issues related to enforcement, coastal fisheries and aquaculture management, inspection and interview procedures, and how to manage stakeholder consultations.

Market inspections were conducted at the Bailey Bridge market and the Suva Central market on Saturday morning. No offences were detected at the Bailey Bridge market, although undersized fish and mud crabs were located and confiscated from vendors during the inspection of the Suva Central Market. One vendor was issued a warning for selling goods without a fish license, while another vendor was selling a brown-marbled grouper (*delabulewa*), which is an



Students and assessors during a visit to the Crab Company. (image: USP)



Vessel inspection in Suva. (image: Ariella D'Andrea, SPC)

endangered species covered under Fiji's Endangered and Protected Species Act of 2002. Because the fisheries officers were not authorised officers under the Endangered and Protected Species Act the incident details were reported to the Department of Environment for further action.

One fishing vessel was also inspected because it was berthed at the small wharf opposite the market, and all of their catch was legal size. The market inspections were carried out very efficiently and the officers were well respected by the vendors and general public, with many asking questions about the purpose of their work. It was pleasing to see the students displaying good social and communication skills and remaining calm when questioned by vendors. Some of the vendors that were interviewed were really excited and thankful to receive a snap-on bracelet ruler that they could use to measure mud crabs and fish when harvesting them to ensure were of legal size.

In addition to market inspections, students undertook two visits to aquaculture ventures – the Kaybee Tilapia Farm and the Crab Company – to increase their understanding of operational aspects of aquaculture farms where vannamei shrimp are grown for the domestic market. Guest lecturers



Fish for sale at a market in Suva. (image Ariella D'Andrea, SPC)

from SPC's Aquaculture Section explained the workings of the aquaculture farms and gave students an insight into what permits and approvals are required for new aquaculture ventures in Fiji.

During the CBAs, we were advised that USP had just accredited the course so, in the future, it will be advertised as a full USP Certificate IV course. SPC will run the CBAs for at least the next two cohorts and provide student scholarships that will cover flights and accommodation for international students and cover their course fees. USP will provide the training venue and the facilitator for the online learning component, and this will include setting up and management of the USP Moodle platform that will be used to deliver the online component of the course. USP will also take over the advertising of the course and it is hoped within two–three years SPC's involvement will be limited to providing assistance during the CBA phase.

Nominations for the 2nd cohort of the Certificate IV in Coastal fisheries and Aquaculture Compliance will be called for in early 2019. If you are interested in nominating for the next course or would like further information please contact Ian Freeman at ianf@spc.int.

For more information:

Ian Freeman

*Coastal Fisheries and Aquaculture Monitoring and Surveillance Specialist, SPC
ianf@spc.int*

Megan Streeter

*Consultant, Fisheries Training Specialist
mapstreeter@gmail.com*



Measuring fish being sold at the market to ensure they are of legal size (bottom); and confiscated fish and other seafood (top). (images: Ariella D'Andrea, SPC).

My experience as a Pacific Islander Junior Professional with the Pacific Community

Sylvester Diake (Junior)¹

I accepted the position of Pacific Islander Junior Professional (PIJP) – Fisheries Management and Policy with the Pacific Community (SPC) in early February 2018. Prior to this, I served as Chief Aquaculture Officer with the Solomon Islands Ministry of Fisheries and Marine Resources (MFMR).

I never dreamed that one day I would join SPC as a Junior Professional. It all began in 2017, when the PIJP position was advertised on the MFMR email circulation list. I thought about the job requirements, the challenges, and its relevance to fisheries and aquaculture development in Solomon Islands, and most importantly about my career path. I lodged my application, was short-listed, interviewed and was very fortunate to have been offered the position.

The PIJP position is a capacity-enhancing programme offered by SPC through its Fisheries Aquaculture and Marine Ecosystems (FAME) Division. It targets young professionals from national fisheries and environmental agencies or non-governmental organisations working in the marine and/or fisheries field in the Pacific Islands region. This 12-month position is an opportunity to enhance capacity in coastal fisheries and aquaculture, and, particularly in fisheries science, management and policy. PIJPs are employed under a contract like other SPC staff but receive more mentoring and coaching as key components for capacity building.

For me, it was an opportunity to experience and work with a team of experts and professionals from the region. One of the expected results of this programme is the impact that junior professionals may have when they are back in their respective countries and contribute to positive changes in fisheries management.

During my term as a PIJP, I have learned a lot about coastal fisheries and aquaculture management, and policy in the region. My learning experiences drew from a variety of work areas, including: reviewing and formulating coastal fisheries and aquaculture policies and management plans; conducting consultations; organising and facilitating workshops and trainings; and visiting member countries to study how fisheries are managed. One of my main achievements was the completion of the Solomon Islands National Aquaculture Management and Development Plan 2019–2024²

and the National Strategy on Aquatic Biosecurity 2018–2023³. I worked under the guidance of policy specialists and marine biosecurity specialists from the time of the consultations to the drafting process. These learning experiences – together with a professional supervising team from SPC's Coastal Fisheries Science and Management (CFSM) Section – enhanced my ability to identify and address key management and development issues and the needs and aspirations at the national and regional level, and how to address them appropriately.

The difficulty of transferring scientific and economic information into national fisheries policies and management frameworks is one of the major limitations to robust fisheries management. Science, economics and management must be seen as complementary, they cannot work independently from one another. By providing convincing policy advices, one can win the political support to influence public policy directions. Management plans are formulated specifically to implement major policy objectives, particularly in fisheries. Fisheries management is shaped by various factors, ranging from legislation, policy, political influences, internal functions and powers at the national and subnational level, traditional and customary systems and the social hierarchy of a community. All of these factors shape the way our fisheries resources are managed, and for me, realising this has been truly a challenge and a worthy learning experience.

In the 12 months of my attachment, I have travelled on duty missions with staff from CFSM and the Aquaculture Section, to Cook Islands, Fiji, Kiribati (Tarawa and Kiritimati Islands), New Zealand, and Solomon Islands. Travelling with the team serves two



Sylvester showing classic catwalk style while 'modelling' a new fisheries officer vest, one of the more unusual tasks he kindly accepted to do for SPC. (image: Ian Freeman, SPC)

¹ Pacific Islander Junior Professional (Fisheries Management and Policy), SPC. Slydiake@fisheries.gov.sb

² <http://purl.org/spc/digilib/doc/mnvrz>

³ <http://purl.org/spc/digilib/doc/4zomz>

purposes: 1) to assist the team with the mission objectives, and 2) to observe and learn. During these missions, I interacted with Pacific Islanders, understanding their issues and aspirations, and experiencing their culture and their way of life. Most importantly, I learned about the importance of fisheries to communities and the various fisheries management systems that exist in those countries.

The PIJP program also provided me the opportunity to build and expand my network within SPC and national fisheries agencies in the region. My interactions in terms of exchanging ideas, corresponding with other fisheries personnel, planning and interacting with other professionals about coastal fisheries management, participating in training (internal and external) workshops, has enabled me to build professional relationships within my expanded network. Building a network of people in different positions in the fisheries sector has certainly helped me to improve my ability to share information and collaborate.

Another unique experience as a PIJP was being part of an SPC interview panel that assessed regional candidates for a PIJP position. It was indeed a challenging task for me, as I had never engaged in interviewing applicants for regional positions. I accepted the challenge, and with guidance and advice from my supervisor, the interview was a success. The knowledge and skills acquired will equip me to deal with a similar situation in the future.

The working atmosphere at SPC is very conducive to learning and achieving objectives. There are no disruptions related to public visits or political requests. For example, at MFMR, people come to the office and expect you to immediately take the time to discuss their fishing or aquaculture issues. The serenity of the SPC office environment helped me to focus more on my work and, most importantly, allowed me to do research.

The beauty of working with the CFSM team is that they are always available and ready to help despite their busy work schedules. Staff members always demonstrate professionalism and are willing to help in any way they can from giving advice, providing guidance and direction, or simply answering any question. From my point of view, expecting the supervisors to know your problems and needs may be the only weakness of this programme. As long as I did not ask for help, my superiors assumed I did not have a problem. To overcome this, I evaluated and identified areas where I was confident and areas that needed development, and took the initiative to seek assistance from the CFSM staff in addressing those development areas.

The PIJP programme is truly a rewarding experience. It has given me a rare opportunity to expand my knowledge and build my skills in regional coastal fisheries and aquaculture. In terms of career development, it has given me a lot of clarity and confidence to look to higher challenging positions.

The encouragement and support I received from the CFSM team has empowered and motivated me to continue to improve professionally beyond the PIJP programme.

The programme has impacted me a lot in terms of my career as a fisheries and aquaculture manager and how I view coastal fisheries and aquaculture management and development at the national and regional level.

As I have now successfully completed my contract as PIJP, I want to encourage aspiring individuals to take advantage of this opportunity, and I would like to provide some recommendations for future aspiring young professionals and SPC to ponder upon.

I urge SPC to continue offering this programme and developing the capacity, knowledge, skills and courage of young professionals of national fisheries agencies.

Young professionals, my recommendations for you are to:

- challenge yourself and apply for a PIJP position;
- set your objectives and focus your efforts to achieve them;
- discuss your goals with your supervisor;
- build your capacity and use what you have learned to manage fisheries in your country and advance your career; and
- develop your self-confidence to aim for higher positions.



Sylvester at work under the supervision of Jacob Raubani, SPC Coastal Fisheries and Aquaculture Management and Policy Specialist. (image: Ariella D'Andrea, SPC)

Fiji's groupers – valuable but vulnerable

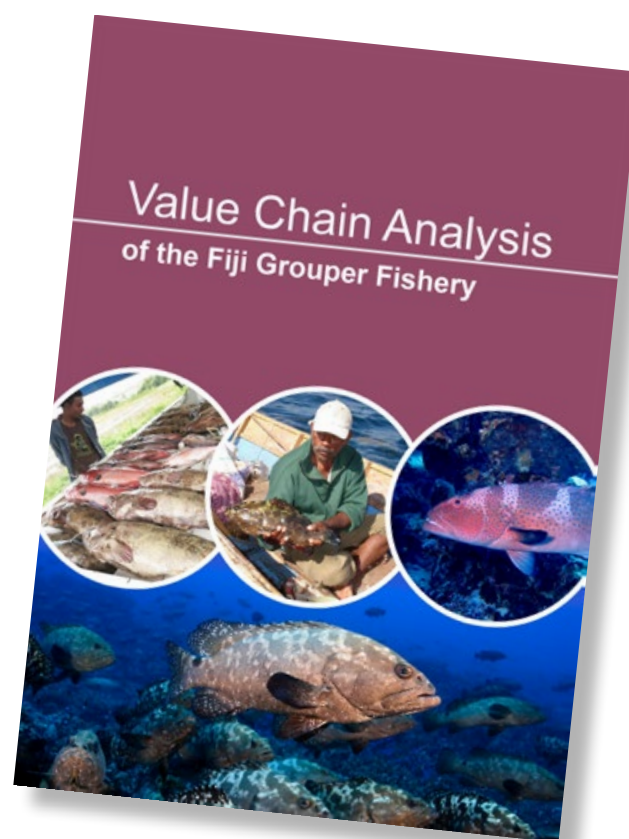
Yvonne Sadovy de Mitcheson¹ and Sangeeta Mangubhai²

Groupers (family Epinephelidae) are among the most highly valued (Grade 1) fish in Fiji's coral reef coastal fishery. The kawakawa (camouflage grouper, Epinephelus polyphekadion), in particular, is very much appreciated in Fiji's domestic markets, and several other groupers are especially valued for export markets to China. Recognising the increasing value of, and demand for, groupers generally, in parallel with declines in some grouper populations both in Fiji and in other countries of the region (Lee et al. 2018), we were interested to learn more about the marketing of grouper. We had noticed that fishers in some parts of Fiji were catching fewer and sometimes smaller groupers than in the past, a matter of concern for the resource itself and for fisher incomes (Sadovy de Mitcheson and Ramoica 2015).

To learn more about the grouper trade in Fiji, we conducted a value chain analysis to examine the distribution of value gained from groupers along the trade chain – from fisher to consumer – between September 2016 and April 2017. Our intention was to inform policy-makers on how higher economic benefits can be derived from groupers for value chain actors, particularly fishers, without compromising the resource base, considering that groupers are known to be particularly susceptible to overexploitation (Sadovy de Mitcheson et al. 2013). We also examined the implications for Fiji of exporting this limited and valuable resource and whether exports were of benefit to Fiji, given the declining availability of groupers in domestic markets and the lack of export tariffs.

Based on socioeconomic survey questionnaires with fishers, middlemen and middlewomen, hotels, restaurants, and exporters involved in grouper fishery and trade, and referring to the literature, we describe the trade chain as it applies to both the domestic and export trade. We gauged perceptions of resource status and evolution and gathered opinions on possible management approaches. Groupers were once exported live from Fiji to China but concerns about overfishing led to an assessment of sustainable catches and recommendations for monitoring and management (Yeeting et al. 2001): the live export trade ceased shortly after this report. Now that chilled or frozen groupers can attract high prices, similar concerns are emerging for the viability of this export trade, which should either be controlled by a quota system, or eliminated due to concerns about overfishing and competition with domestic markets.

Because most fishers catch groupers for both food and income, and given the interviewees' perception of declining



Cover of the report written by Yvonne Sadovy de Mitcheson, Sangeeta Mangubhai, Allison Witter and Rashid Sumaila, in cooperation with the Fiji Ministry of Fisheries. Funding was predominantly from the David and Lucile Packard Foundation.

grouper resources, prioritisation of local food security and sovereignty could help shape the management of Fiji's grouper fisheries and trade. Interviewee responses were consistent with independent studies that suggest that grouper catches have declined several-fold in recent decades (Lee et al. 2018). Due to such concerns, fishers identified appropriate management options, including spatial, temporal and gear controls, while most other players along the value chain were supportive of the seasonal (i.e. June–September) fishing ban that protects key groupers when aggregating to spawn, introduced in 2018.

To achieve higher values from groupers and reduce risks of overfishing when unit prices vary by season, species and sales outlets, it is important that market prices and needs are better understood, and that grouper resources are adequately monitored and managed. For example, fishers receive similar prices for all grouper species caught, yet the price differentials downstream can be considerable. For example, leopard coral trout *Plectropomus leopardus* (red donu) prices are often double those of other grouper species, while size (certain sizes fetch higher export values),

¹ University of Hong Kong, Science and Conservation of Fish Aggregations. Email: yjsadovy@hku.hk

² Wildlife Conservation Society, Fiji Country Program, 11 Ma'afu Street, Suva, Fiji. Email: smangubhai@wcs.org

condition (freshness and appearance) and availability (scarcity versus market gluts) can all substantially influence prices. Other valued species are camouflage grouper and tiger grouper (*E. fuscoguttatus*). To improve prices to fishers, the formation of producer groups to share resources for marketing could be beneficial, while a better understanding of market pricing could enhance bargaining power. Training could help to add value to catches by improved handling, processing, transportation and storage.

A full copy of the report 'Value chain analysis of the Fiji grouper fishery' is available from: WCS Fiji's website.³

References

Lee S., Lewis A., Gillett R., Fox M., Tuqiri N., Sadovy Y., Batibasaga A., Lalavanua W. and Lovell E. 2018. Fiji Fishery Resource Profiles. Information for management on 44 of the most important species groups. Gillett, Preston and Associates and the Wildlife Conservation Society, Suva. 240 p.

Sadovy de Mitcheson Y. and Ramoica M. 2015. Grouper spawning site and trade study, July 2015: Northern Fisheries Division, Fiji. Completion Report. Fiji Fisheries Department and Science and Conservation of Fish Aggregations (SCRFA).

Sadovy de Mitcheson Y., Craig M.T., Bertoncini A.A., Carpenter K.E., Cheung W.L., Choat J.H., Cornish A.S., Fennessy S.T., Ferreira B.P., Heemstra P.C., Liu M., Myers R.F., Pollard D.A., Rhodes K.L., Rocha L.A., Russell B.C., Samoilys M.A. and Sanciangco J. 2013. Fishing groupers towards extinction: A global assessment of threats and extinction risks in a billion dollar fishery. *Fish and Fisheries* 14:119–136.

Yeeting B.M., Labrosse P. and Adams T.J.H. 2001. The live reef food fish of Bua Province, Fiji Islands: A first assessment of the stock potential and guidelines for a management policy. Noumea, New Caledonia: Secretariat of the Pacific Community. Reef Resources Assessment and Management Technical Paper 1. xi, 30 p.



Fisher weighing his catch before pickup by middleman in northeast Vanua Levu, Fiji. (image: Yvonne Sadovy de Mitcheson)

³ <https://fiji.wcs.org/Resources/Reports.aspx> and <https://fiji.wcs.org/Portals/82/reports/WCS%20Grouper%20VCA%20Report%20081018%20WEB.pdf?ver=2018-10-31-023525-590>

Tablet-based data collection – a new vision for Vanuatu’s aquaculture sector

The Vanuatu Fisheries Department (VFD) considers information and communication technology, and data collection as the way forward in strengthening aquaculture development in Vanuatu. A recent two-day workshop was organised by Lucy Joy from VFD’s National Data Unit and aquaculture team to select a provider for tablet-based aquaculture data collection.

Vanuatu continues to struggle to find efficient ways of capturing coastal fisheries and aquaculture data, and to interpret them for fisheries management purposes. The philosophy of ‘quality data, good management’ is the reason why Vanuatu sees the need for improving its data collection. For many years now, Vanuatu has used paper forms for recording data and, most of the time, when the data forms reach VFD to be analysed, the management advice is no longer relevant. In other cases, the forms never reach the office and the data are lost.

In 2015, the Vanuatu Government made its first foray into electronic reporting. VFD, with the assistance of the Pacific Community (SPC) and some external donor partners, decided to implement the use of the SPC-produced Tails mobile app to record coastal fisheries production data. After this successful transition to electronic reporting, Vanuatu decided to further push for a tablet-based system to collect aquaculture data.

Vanuatu aquaculture sector

Aquaculture in Vanuatu is new and less developed than in some other Pacific Island countries, such as Fiji, French Polynesia, New Caledonia and Papua New Guinea. There are seven freshwater and marine commodities cultured in Vanuatu for the purposes of food security, sustainable livelihood, wild stock enhancement and resource management programmes, and entrepreneurial activities. The commodities include introduced freshwater prawn species (*Macrobrachium rosenbergii*), GIFT tilapia (*Oreochromis niloticus*), red tilapia (*Oreochromis* sp.), giant clams (*Tridacna* spp.), green snail (*Turbo marmoratus*), trochus (*Tectus niloticus*), and marine shrimp (*Litopenaeus stylirostri*).

Apart from marine shrimp culture by a large-scale operator, all aquaculture activities are operated at a small-scale, community-based level. This is being promoted and supported by VFD as an alternative food source, which helps support coastal resource management by decreasing fishing pressure on nearshore reefs.

Pacific Islanders rely heavily on marine products as a source of animal protein, and given the rapid population growth rate in the region, it is expected that to maintain the current level of protein intake per capita, an additional 115,000 tonnes of fish will be required in 2030 (Bell et al. 2011).

According to Gillett (2016), in the Pacific Islands region, inshore fisheries production (subsistence, commercial and freshwater) accounts for 15% of total marine and freshwater production in volume, with offshore fisheries accounting for 81% (the vast majority of which is exported to markets outside the region) and aquaculture production accounting for only 4%. While reserving a larger share of offshore production for domestic markets seems to be a logical solution to partially close the expected marine products gap, the development of the aquaculture sector should definitely have a role to play in the equation.

In Vanuatu, about 1,627 households and 200 farms are engaged in freshwater aquaculture, either for subsistence or semi-commercial purposes. The combined total annual production from these activities is estimated to be 10 tonnes, with an estimated value of VUV 6.2 million (USD 56,000). However, the absence of an established data collection system that could provide a more accurate picture at the farm level remains one of the key challenges faced by fisheries managers. Such a system would be very useful for prioritising aquaculture commodities that are of importance to farmers, taking into account the sustainability of markets, the cost of operations, the risks induced and the potential economic benefits. VFD has been looking for solutions to address this lack of aquaculture data issue.

Choosing the proper data collection system

Lucy Joy, Senior Data Officer at VFD, drove the process of selecting and assessing an appropriate solution for aquaculture data collection, and identifying potential vendors via a consultative workshop held in Port Vila with various aquaculture stakeholders. Lucy partnered with SPC aquaculture staff who provided scientific advice on the technology required, specific aquaculture expertise, and vendors’ assessment. Lucy recently spent one year with SPC’s Oceanic Fisheries Programme – Data Management Section as a Pacific Islander Junior Professional, which gave her the opportunity to gain a wealth of knowledge about database management. She developed skills in the area of tuna and other coastal fisheries data collection, management and dissemination, which were useful in the vendor assessment.

Mobile devices have become successful and widely used data collection tools. Following the success of the Tails



Vanuatu Fisheries Department officers Lucy Joy (left) and Lency Dick (middle) rolling out the Aquanetix system to the Onesua Presbyterian College fish farm, and providing training to the farm manager and college principal, Graham Kalmar.

app in Vanuatu, it was decided to adopt a cloud-based fish and shrimp farm software named Aquanetix because of its simplicity and user-friendliness. Aquanetix was designed to provide useful analytical information to the aquaculture industry and help improve farm productivity and profitability. It is efficient in that it assists farm managers in reducing production costs by improving their daily management operations (e.g. by calculating the exact amount of feed needed so that fish are not overfed or underfed). The system operates a friendly interface on a mobile app where some operations can be automatically performed by the app when the data are entered, and where it is possible to customise reporting. The system also provides quick insights for farm administrators through a web dashboard.

With this new tool, hatcheries and farms will have access to timely and updated information, a prerequisite to the proper management of their operations.

The rollout

VFD, with SPC's assistance, has provided digital tablets, with the Aquanetix app already installed, to its first farms operating at a semi-commercial scale, and will monitor and assess the results with a wider deployment planned at a later stage.

The Aquanetix system rollout targeted two pilot tilapia fish farms on the island of Efate: one is operated by the Onesua Presbyterian College located at the north end of Efate, and has two ponds with a carrying capacity of 1,500 juvenile fish (fry) each; the other one is the Vanuatu Fisheries Department hatchery and grow-out farm, situated outside of Port Vila, which consists of two ponds and a holding capacity of over 4,000 juvenile fish in total. The system was rolled out to the farms after a series of online training sessions organised by the Aquanetix system trainers for VFD aquaculture officers. Officers were trained in how to use both the mobile app and the webtool system. The trained officers then rolled out the tool to the two farms, and trained the farmers and feeders in charge of the fish farms in how to use the app for their daily operations. As an incentive to support the rollout, mobile credit top-ups are provided to the farmers on a monthly basis to support the cost of daily uploading data into the system. This will continue until the fish are ready to be harvested and sold.

VFD will continue to support the farms and assess the results collected from the initial rollouts with the aim of widening the deployment of the app to more farms in the coming months.

References

- Bell J.D., Johnson J.E. and Hobday A.J. 2011. Vulnerability of tropical Pacific fisheries and aquaculture to climate change. Noumea, New Caledonia: Secretariat of the Pacific Community. 925 p.
- Gillett R.E. 2016. Fisheries in the economies of Pacific Island countries and territories. Noumea, New Caledonia: Pacific Community. 684 p.

For more information:

Sompert Gereva
Manager for Research and Aquaculture, VFD
sgereva@vanuatu.gov.vu

Lucy Joy
Senior Data Officer, VFD
ljoy@vanuatu.gov.vu

Temporal variation in catch composition, fishing gear and time spent fishing in an artisanal coral reef fishery: An assessment through fishers' perceptions and experiences

Watisoni Lalavanua^{1*}, Jeremy Prince², Epeli Loganimoce¹, Jone Tamanitoakula¹, Mosese Naleba¹, Waisea Naisilisili¹ and Sirilo Dulunaqio¹

Introduction

Overfishing by small-scale fisheries has been recognised as a key threatening process for coastal fish stocks and biodiversity, both globally and across the Pacific Islands region (Sadovy de Mitcheson et al. 2013; Andrew et al. 2007; Newton et al. 2007; Sadovy et al. 2005). Surprisingly, our discussions with communities in several Pacific Island countries reveal that while local communities are generally well aware of, and worry about, the decline of local fish stocks, they rarely attribute it to their own fishing activities. Instead, they are most likely to attribute stock declines to changes they observe occurring in the natural environments around them, such as coastal development, mangrove cutting, coral bleaching and climate change. While these factors certainly contribute to the decline of coastal fish stocks, the length-based assessments we have been conducting reveal the major cause is depletion of reproductive potential through overfishing (Prince et al. 2015; Prince et al. in press), to the extent that even without environmental factors, we would expect these resources to be declining.

Our discussions also reveal a general lack of awareness, particularly among people young enough to be still actively fishing, about how much fishing has changed over time. Perhaps communities fail to recognise overfishing because they perceive their fishing practices to be one of the few aspects of life that have remained constant over many generations, and do not understand why it would have an effect now.

Worldwide it is recognised that human populations struggle to transfer information between generations, so that changes that occur slowly (over approximately 40-year intervals) are forgotten by successive generations. Instead, each generation presumes that the conditions they initially experience are the way things have always been, and so only take into consideration change that occurs during their own lifetime. In fisheries, this has been called the 'shifting' or 'sliding' baseline syndrome (Pauly 1995). It is recognised as impeding fisheries reform by preventing the full extent of fisheries depletions being appreciated, thus reducing the sense of urgency for management reform, as well as expectations for the long-term benefits to be derived. Correctly recognising the central role of local overfishing in the decline of coastal resources is important and can be empowering for Pacific communities. Armed with basic fisheries knowledge, communities can hope

to directly address their own local overfishing by implementing fisheries management. In contrast, they can only hope to play small in-direct roles in solving the pressing national and global environmental degradation issues stemming from poor land-use policies and global warming.

With the aim of counteracting the shifting baseline syndrome among Pacific communities, this short paper documents the results of facilitated community discussions, describing changes in fishing practices and catches that have occurred over the last 50 years on Koro Island in the Lomaiviti Province of Fiji.

Method

The Wildlife Conservation Society (WCS), together with the Lomaiviti Provincial Office (LPO), implemented a two-day, community-based fisheries management training in Tuatua village on Koro Island, Lomaiviti, Fiji. The training was attended by community representatives from 11 out of the 14 villages on Koro Island (Fig. 1). The objectives of the training were to raise awareness about and train community members in the various fisheries management tools (Fig. 2) that the community could adopt in order to support their efforts in community-based fisheries management.

Within their respective villages and irrespective of gender, fishers were divided into two groups: old and young. Both groups were given the same topics to discuss, which included:

- the period of years during which they were (or are) most actively fishing (based on their year of birth);
- the amount of time they normally spent fishing each day;
- the type of fishing gear and fishing methods used;
- the types of boats used and the availability of fishing gear;
- the number of fishers participating in a normal fishing party; and
- the catch composition in terms of species, size and number.

At the end of the 45-minute discussions, groups were asked to present a summary of their discussions.

¹ Wildlife Conservation Society – Fiji County Program, 11 Ma'afu Street, Suva, Fiji Islands

² Biospherics P/L South Fremantle, Western Australia, Australia

* Author for correspondence: watisonil@spc.int

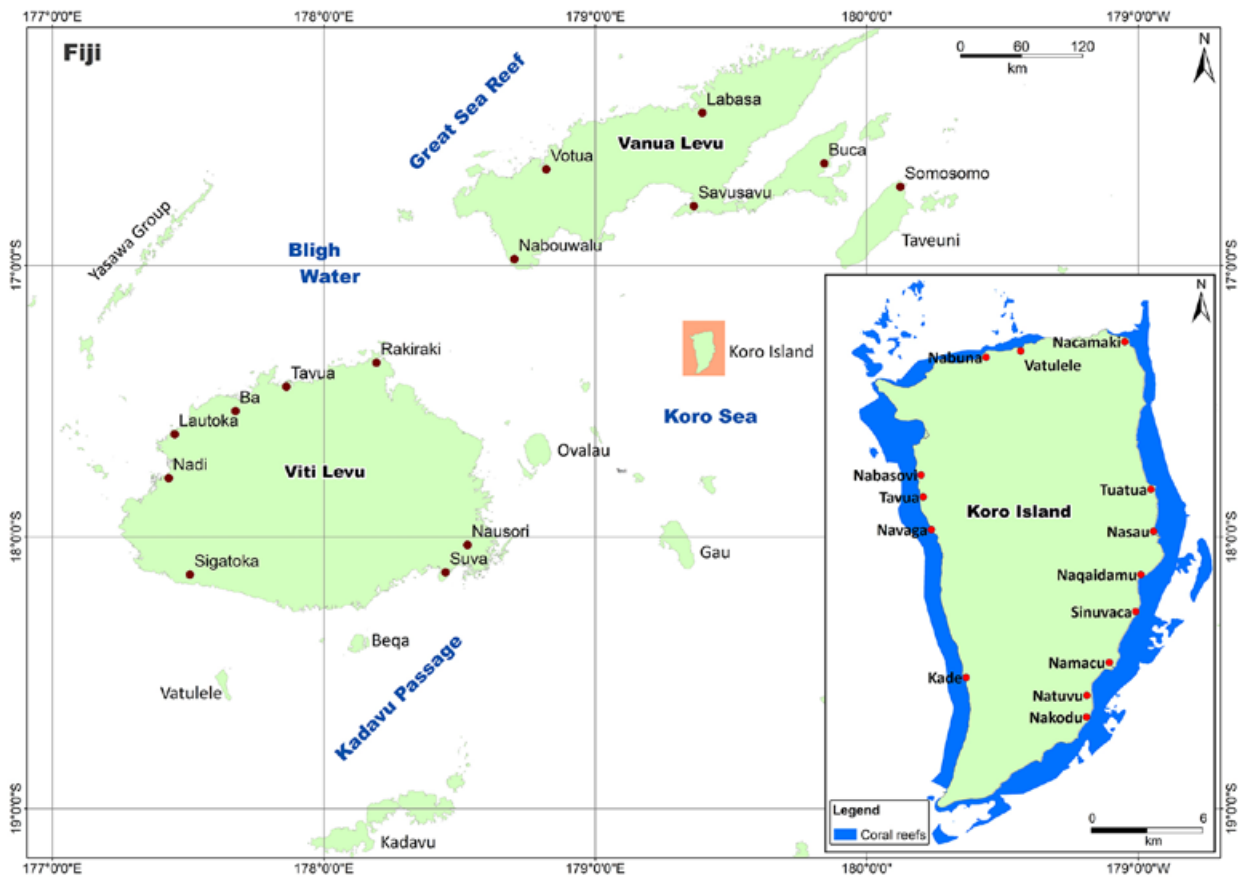


Figure 1. The location of Koro Island within Fiji, and an insert map showing the 14 coastal villages.

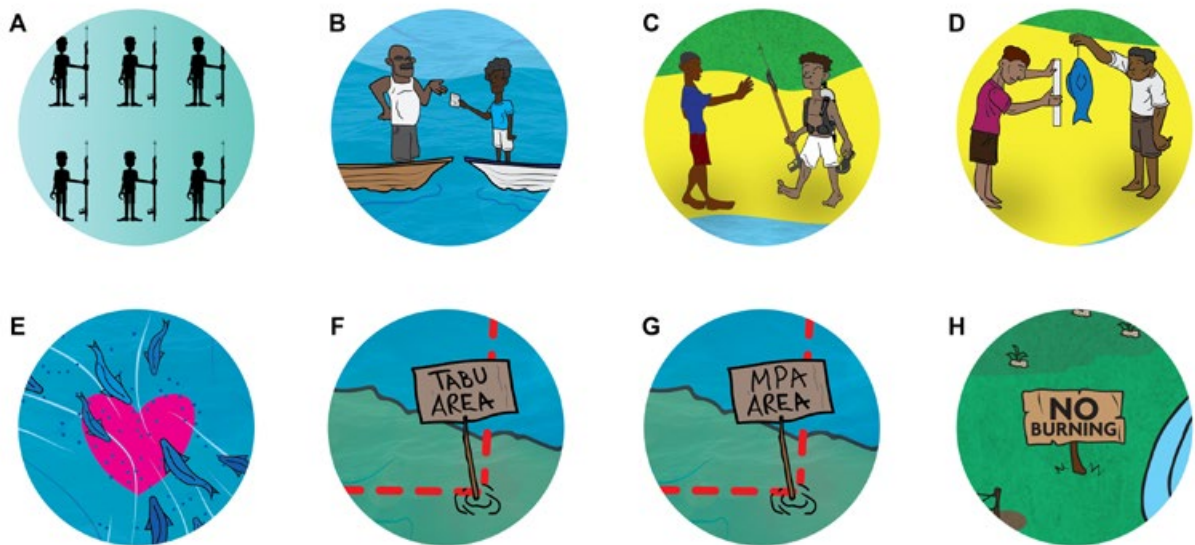


Figure 2. Fisheries management tools include: A) limiting the number of fishers, B) limiting the number of licenses granted, C) gear restrictions, D) minimum size limits, E) protecting spawning aggregation sites and/or species through seasonal bans, F) tabu areas, G) permanent no-take zones, H) rules for land use. ©cChange

Results

The results of the facilitated discussions provide a detailed insight into the changes to fishing that have occurred over the last 50 years (Table 1).

Traditional fishing methods

Older fishers reported that they fished from simple hand-propelled bamboo rafts (*bilibili*), canoes or punts without engines, which carried only 1 or 2 fishers. Older fishers also only fished for a couple of hours per fishing trip, and used a range of traditional techniques and gear types made from locally available materials: hand spearfishing (*cocoka*), fish weirs (*moka*), fish drives (*yavirau*) and cast nets (*lawa sua/lawa viri*). These techniques are rarely used today.

Hand spearfishing

Hand spearfishing (*cocoka*) involved throwing or thrusting a particular spear known as the '*moto saisai*' through the

surface of the water. This method was used in rivers, intertidal areas, mangroves, reefs and even open water. Fishers typically caught jacks (Carangidae), emperors (Lethrinidae), rabbitfish (Siganidae), mullets (Mugilidae) and needlefish (Belonidae) with this method. Some hand spearfishing still continues, although over time, spears have been modernised so that today different types are used; some are still made from traditional materials of wood and coconut vine known as '*magimagi*' and others by combining a wooden handle with a pointed metal tip.

Fish weir/trap

Another traditional fishing method involved the permanent construction and maintenance of a horseshoe-shaped, boulder-walled trap or weir, locally known as '*moka*', which was used in the intertidal zone. For structural stability, a weir required a hard-bottomed shoreline, and the rocky shorelines of Namacu and Tuatua villages provided an excellent setting for these structures. To be effective, the weir had to be constructed with correctly angled stonewalls that helped

Table 1. Difference in fishing as experienced by old and young fishers.

Topics	Old fishers	Young fishers	Changes observed
Fishing period	1960s–1980s	2012–to present	1960s–present
Hours of fishing per day	1–2 hours (day fishing)	10–12 hours (day and night fishing)	Many more hours spent fishing per day
Fishing gear used	<ul style="list-style-type: none"> ⊗ <i>moka</i> (fish weirs) ⊗ <i>cocoka</i> (thrust spearfishing) ⊗ <i>lawa sua/lawa viri</i> (cast net) ⊗ <i>qoli walai/yavirau</i> (fish drive) ⊗ <i>cina coka</i> (night thrust spearfishing) ⊗ <i>kilivati</i> (Hawaiian sling) ⊗ <i>duva</i> (fish stun) 	<ul style="list-style-type: none"> ⊗ <i>nunu</i> (spearfishing) ⊗ <i>nunu bogi</i> (night spearfishing) 	Fewer fishing methods practiced
Boat used	<i>bilibili</i> (bamboo raft) Boats without engines	Boats with engines	Nowadays, productive fishing grounds are farther away and require motorised boats
Availability of fishing gear and boat	Few fishing gear types and boats	Many types of fishing gear and boats with engine	Few fishing gear types available in 1960s–1980s compared to now
Main fish species caught	<ul style="list-style-type: none"> ⊗ <i>kawakawa</i> (grouper) ⊗ <i>donu</i> (coral trout) ⊗ <i>varivoce</i> (humphead wrasse) ⊗ <i>kalia</i> (bumphead parrotfish) ⊗ <i>saqa</i> (giant trevally) ⊗ <i>derekeni/sevaseva</i> (sweetlips) ⊗ <i>ogo</i> (barracuda) ⊗ <i>walu</i> (Spanish mackerel) 	<ul style="list-style-type: none"> ⊗ <i>kabatia and sabutu</i> (emperors) ⊗ <i>cucu</i> (goatfish) ⊗ <i>balagi</i> (surgeonfish) ⊗ <i>nuqa</i> (rabbitfish) 	Old fishers' catch was mostly composed of larger-bodied and A-grade fish species. At present, catch is mostly composed of fewer and smaller fish species
Size of fish caught	Large	Small	Smaller fish are caught nowadays than in the past
Number of fishers	Few	Many	Fewer fishers in the 1960s and 1980s compared to now

to guide fish moving along the shoreline into a retaining area. The top of the wall was built up to a level that would be covered by at least 0.5–1.0 m of water at spring high tide, thus allowing fish to enter, but be above the surface of the water during low tide so as to trap the fish within the weir. The landward face of the weir tended to be vertical, thereby providing fish inside with reassuringly deeper water close to shore, while the seaward face sloped gently to seaward minimising turbulence from incoming waves and easing access into the weir. Entrapped fish were speared at low tide. The species commonly caught with this method were: thumbprint emperor, *kabatia* (*Lethrinus harak*), bluefin trevally, *saqa ni vatu* (*Caranx melampygus*), Picasso triggerfish, *cumu* (*Rhinecanthus aculeatus*), honeycomb grouper, *senikawakawa* (*Epinephelus merra*), crescent-banded grunter, *qitawa* (*Terapon jarbua*) and blacktip silver biddy, *matu* (*Gerres oyena*).

Remnants of fish weirs are still present in many locations as some communities were using them up until Tropical Cyclone Winston, although other communities in our study area stopped using them earlier, when fishing *tabus* which extended from the shoreline to the outer reef, were implemented.

Fish drives

In Koro, fishers traditionally used community fish drives, known as *yavirau* or *qoliwalai*, which required cooperative prior planning of intended target species and employed a rope sweep, which was used on the agreed day and at the right part of a tidal cycle. The sweep was made with coconut fronds and vines that were woven together to form a long rope. The coconut fronds were wrapped around the rope to form a hanging skirt-like structure for sweeping across the coral shallows. Using the sweep, fish were herded through the coral shallows into a small area where they could either be scooped up with traditionally made nets (now monofilament gillnet is used), or by hand spearing. Depending on the number of people available to assist with the drive, a greater or lesser amount of coconut fronds would be wound into the rope. The more people and pairs of legs along the rope, the fewer the gaps that need filling with coconut fronds so that the fish can't escape.

The main species caught include with the rope sweep were: bluefin trevally, leopard coral grouper, *Plectropomus leopardus* (*donu damu*), and grouper (*kawakawa*), longface emperor, *L. olivaceus* (*dokonivudi*), thumbprint emperor and Pacific yellowtail emperor, *L. atkinisoni* (*sabutu*), steep-head parrotfish, *Chlorurus microhinos* (*ulurua*), rivulated parrotfish, *Scarus rivulatus* (*kakarawa*) and bullethead parrotfish, *C. sordidus* (*kakarawa*), Achilles tang, *Acanthurus achilles* (*dridri*), yellowfin surgeon fish, *Acanthurus xanthopterus* (*balagi*), orangeband surgeonfish, *A. olivaceus* (*balagi nawa*) and lined bristletooth, *Ctenochaetus striatus* (*meto*), vermiculate rabbitfish, *Siganus vermiculatus* (*volaca*) and streamline spinefoot, *S. argenteus* (*nuqa*), humphead wrasse,

Chelinus undulatus (*varivoce*), Picasso triggerfish and yellow margin triggerfish, *Pseudobalistes flavimarginatus* (*qau*) and mangrove red snapper, *Lutjanus agentimaculatus* (*damu ni veidogo*), two spot red snapper, *L. bobar* (*bati*) and humpback red snapper, *L. gibbus* (*bo*).

In Koro the *yavirau* is still employed one or two days before Christmas and New Year's, specifically for villagers returning to the village for the holidays.

Fish poison

Fish poison or *duva* is carried out using either *vutu* fruit (*Barringtonia asiatica*) or the roots of a certain vine (*Deris* spp.). Both plants contain a poison strong enough to stun or kill fish. The plant material is pounded before being wrapped in a cloth and then squeezed into tidal pools or under a rock or coral head where the poison leaches out and stuns the fish. Stunned fish then float to the surface where they can be easily collected. A wide range of species are caught using this method.

Modern fishing gear and methods

Younger fishers engage most intensively in speargun fishing, particularly at night (*nunu bogi*) and also in gillnetting and trolling, techniques that were not used 50 years ago (S. Kasanibuli, elder fisherman, pers. comm.). Fishing is mainly carried out in vessels powered with 15–60 hp outboard motors, which typically now carry about four fishers per fishing trip, which generally last up to about 12 hours, either a whole day or an entire night.

Speargun fishing

Spearguns are mostly used by fishers who breath-hold dive with a mask, snorkel and fins in shallow water. With a clear view of fish underwater with a face mask, and the enhanced capacity for stalking fish, speargun fishing is much more efficient than traditional hand spearing. The main target species with this method included snappers, emperors, parrotfish, jacks, surgeons and groupers. Speargun fishing is practiced almost exclusively by young male fishers.

Night diving

Speargun fishing was initially practiced exclusively during daylight hours. As fish have become scarcer and warier of divers, daytime speargun fishing has been almost entirely replaced by night-time speargun fishing. With the assistance of an underwater torch, fishers are now able to search for fish sleeping among the corals at night.

Gill nets

Monofilament gill nets, held vertically in the water by a series of floats attached to the upper edge of a rope and lead weights along the bottom, are anchored in shallow water to

catch a range of species, including mullet, emperors, rabbitfish, parrotfish, goatfish and snappers. Gill nets have a mesh size designed to catch a specific size range of particular fish.

Trolling

Trolling mainly targets jacks, snappers and other pelagic fish species. It involves towing bright or reflective fluttering lures made of feathers or plastic along the surface behind slowly motoring boats.

Changes in catch composition

Through our facilitated discussions the older fishers bragged about their catches in the past, which comprised large-bodied groupers (*kawakawa*), coral trout (*donu*), humphead wrasse (*varivoce*), bumphead parrotfish (*kalia*), Spanish mackerel (*walu*) and barracuda (*ogo*) (W. Tora, elder fisherman, pers. comm.). Young fishers' catches comprise mostly smaller-bodied emperors (*kabatia* and *sabutu*), goatfish (*cucu*), surgeonfish (*balagi*) and rabbitfish (*nuqa*). Older fishers claim that catches of 270–750 kg per fishing trip were common, while younger fishers estimate current catches at 12–120 kg per fishing trip.

While it is worth noting that the historic figures are based on reminiscent community perceptions and may well be exaggerated to some extent, they still indicate the magnitude of change that has occurred over a relatively short time (30–50 years).

Discussion

The community discussions highlighted several key ways that fishing has changed.

From the 1960s to 1980s, modern fishing gear was not as commercially available as it is today, and was generally constructed with locally available materials. Not all community members had the skills required to making and use these traditional techniques. Older fishers emphasised that the combination of motorised vessels, underwater torches, spearguns, snorkelling gear and underwater breathing apparatuses have made fishing much more effective than traditionally made fishing gear. While a wider range of traditional fishing techniques were used in the past, they all tended to be more 'passive', in that fish could not be so actively pursued throughout their life cycle, depth range and habitats. To successfully deploy traditional methods, fish behaviour had to be known and understood, and taken advantage of in places and times of particular vulnerability. For example, fish weirs and drives only caught fish in particular shallow locations and certain tidal cycles, while hand spearing relied on being able to approach within very close range of shallow swimming fish. In contrast, outboard motors, spear guns and underwater torches, enable fishers to hunt and catch fish on almost every reef, throughout

almost their entire depth range, and even while they are sleeping at night hidden among corals and rocks.

The facilitated discussions suggest that the observed shift in fishing techniques towards more effective but expensive fishing gear has been driven by a cascade of factors. Participants repeatedly observed that fishing increasingly yields fewer and smaller fish, and that bigger-sized fish have become extremely hard to find within customary fishing grounds. At the same time, the number of households per village continues to grow, meaning there are more mouths to feed and more income required. These trends have led to an increasing number of community members going fishing, and driving fishers to invest in more sophisticated fishing gear and fish for longer periods during each fishing trip, so as to maximise their catches in the face of declining resources.

Community participants often attributed the changes they observe in fish stocks to climate change, which they perceive as having an impact on every species group within the fishery. This in turn forces fishers to respond with new fishing gear, more fishers and longer fishing trips. We acknowledge that climate change is undoubtedly having a negative impact on coastal resources, particularly through the degradation of coral by bleaching and cyclone damage. However, our recently completed assessments of 29 Fijian reef fish species found that more than half (17) currently fulfill <20% of the natural reproductive potential ratio (SPR), the level internationally regarded as the minimum sustainable level, while less than half (14) are fulfilling <10% SPR, the level regarded as indicative of stock collapse (Prince et al. in press). Such low levels of reproductive potential are entirely due to heavy fishing pressure, which is reducing the reproductive life span of fish. In contrast, the signature of stock declines driven primarily by climate change or environmental degradation will be that lightly fished stocks completing relatively high levels of reproductive potential will never-the-less fail to maintain stock levels due to the loss of the productive habitat needed to sustain their populations. With fish currently being caught before completing minimal sustainable levels of reproduction, there is little need to invoke climate change as an additional cause of resource decline, and no evidence to suggest it is the primary cause of declining stocks at present.

Rather, the changes in catch composition described are indicative of the phenomenon observed around the world called 'fishing down the food web' (Pauly et al. 1998), by which fishers or hunters start off targeting the most preferred and largest-bodied species at the top of the food web (Fig. 3) until those species become depleted. Targeting then shifts down the food web, focussing on progressively smaller and smaller-bodied species, as each level of the food web is depleted in turn. It is this phenomenon that results in fishers competing more intensively for fewer and smaller fish with increasingly effective gear and spending more time fishing.

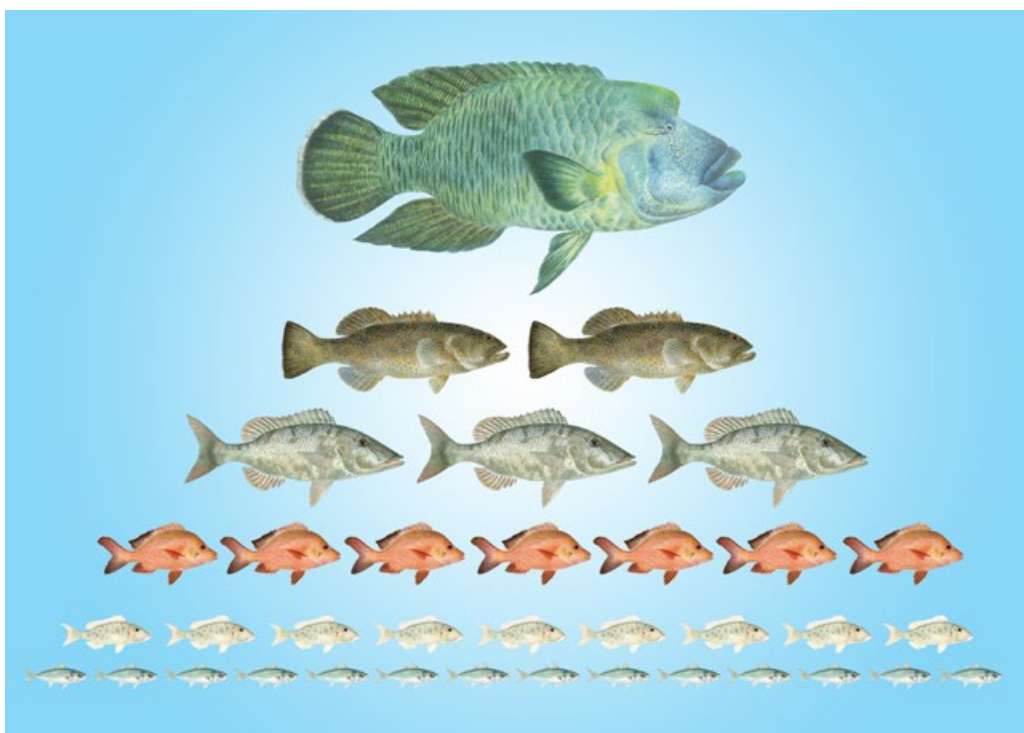


Figure 3. Fishing down the food web. (illustrations: Les Hata, © SPC and cChange)

Acknowledgements

The authors would like to thank the participants of the Koro Island management planning workshop for their contributions during the workshop and to the community of Tuatua village for hosting the workshop. We would also like to thank Dr Sangeeta Manghubhai for her final review of the article. Heartfelt thanks go to cChange for providing awareness materials such as videos, animations and illustrations that are simplified for local communities to understand. Thanks and gratitude are also owed to the David and Lucile Packard Foundation and the John D. and Catherine T. MacArthur Foundation for financial support.

References

- Andrew N.L., Bène C., Hall S.J., Allison E.H., Heck S. and Ratner B.D. 2007. Diagnosis and management of small-scale fisheries in developing countries. *Fish and Fisheries* 8:227–240. doi:10.1111/j.1467-2679.2007.00252.x
- Newton K., Cote I.M., Pilling G.M., Jennings S. and Dulvy N.K. 2007. Current and future sustainability of island coral reef fisheries. *Current Biology* 17:656–658. doi:10.1016/j.cub.2007.02.054
- Pauly D. 1995. Anecdotes and the shifting baseline syndrome of fisheries. *Trends in Ecology and Evolution* 10:430. doi:10.1016/S0169-5347(00)89171-5
- Pauly D., Christensen Villy., Dalsgaard J., Froese R. and Torres F. 1998. Fishing down marine food webs. *Science* 279:860–863 doi:10.1126/science.279.5352.860
- Prince J.D., Victor S., Kloulchad V. and Hordyk A. 2015. Length-based SPR assessments of eleven Indo-Pacific coral reef fish populations in Palau. *Fisheries Research* 171:42–58. doi:10.1016/j.fishres.2015.06.008
- Prince J. D., Lalavanua W., Tamanitoakula J., Loganimoce E., Vodivodi T., Marama K., Waqainabete P., Jeremiah F., Nalasi D., Tamata L., Naleba M., Naisilisili W., Kaloudrau U., Lagi L., Logatabua K., Dautei R., Tikaram R. and Mangubhai S. in press. Spawning potential surveys for 29 stocks of Fijian reef fish reveals the urgent need for effective management. *SPC Fisheries Newsletter*.
- Sadovy Y. 2005. Trouble on the reef: The imperative for managing vulnerable and valuable fisheries. *Fish and Fisheries* 6:167–185. doi:10.1111/j.1467-2979.2005.00186.x
- Sadovy de Mitcheson Y., Craig M.T., Bertonecini A.A., Carpenter K.E., Cheung W.W., Choat J.H., Cornish A.S., Fennessy S.T., Ferreira B.P., Heemstra P.C., Liu M., Myers R.F., Pollard D.A., Rhodes K.L., Rocha L.A., Russell B.C., Samoilys M.A. and Sanciangc J. 2013. Fishing groupers towards extinction: A global assessment of threats and extinction risks in a billion dollar fishery. *Fish and Fisheries* 14:119–136. doi:10.1111/j.1467-2979.2011.00455.x

Development and application of sea cucumber fishery regulations in French Polynesia

Arsène Stein¹

1. The sea cucumber fishery situation in French Polynesia before 2008

In French Polynesia, the trade in sea cucumbers (locally called *rori*) began in the 19th century as a supplement to the trade in pearl oyster shells (nacre or mother-of-pearl). In 1848, sea cucumbers were harvested from 11 atolls in the Tuamotu Islands (Lucett 1851). Official annual statistics on dried sea cucumber exports are not available before the 1930s, but do indicate exports of 59,400 kg in 1931; 36,800 kg in 1932; 7,380 kg in 1933; 1,700 kg in 1934; and 9,800 kg in 1935, probably from the Tuamotus. A long period follows during which statistics on dried seafood products were recorded only for certain years; these figures indicate up to several tonnes, but it is not possible to distinguish between the proportions of fish and sea cucumber.

Some sea cucumber species are also eaten by a portion of the local population, but harvests remain small in comparison to those of other seafood products such as molluscs, shellfish and especially finfish. The inhabitants of three of the Austral Islands – Rimatara, Rurutu and Rapa – are known to be particularly fond of sea cucumbers such as *Actinopyga mauritiana*, *Holothuria atra*, *H. cinerascens*, *H. leucospilota* and *Stichopus horrens*, which they eat both raw and cooked. Polynesians of Asian origin are also keen on teatfish (*H. fuscogilva* and *H. whitmaei*), which they eat cooked.

Because of sea cucumbers' high commercial value, several initiatives were launched by the Fisheries Department in French Polynesia to develop the teatfish fishery so as to create a means for livelihood in rural areas. In the late 1970s and early 1980s, the Fisheries Department carried out teatfish processing trials on Tahiti and Moorea (using artisanal smokehouses) to determine whether there was potential for further development. The trials did not last long, however, because of very low harvest quantities.

Between 1984 and 1986, the Fisheries Department implemented a seafood product processing programme on Apataki Atoll, where the potential for teatfish was considered to be better. Raw materials were provided by Fisheries Department staff initially, and later by the island's fishers,

to supply an experimental smokehouse. Fishers were paid per sea cucumber and encouraged to use 'torpedo spears' or 'dri-bombs', accessories recommended at the time to facilitate deep-water sea cucumber fishing. This programme led to the production of 786 kg of beche-de-mer (also called trepang) over three years, all of which was sold to several Chinese restaurants in Tahiti at an average price of XPF (CPF francs)² 1,141 per kilo (kg⁻¹). This was a considerable amount for that time as in comparison, salted or dried fish produced at the same location sold at XPF 228 kg⁻¹. Despite the favourable purchase prices proposed, fishers from Apataki did not develop this business for themselves, and the experimental programme came to an end.

In 1998, a private company established a processing centre on Fakarava Atoll in the Tuamotus. It was equipped for processing approximately 10 tonnes (t) of finished products per month but ceased activity several months later, after having processed just 1 t of finished products in total.

The above background makes it possible to state that, overall, French Polynesia's sea cucumber stocks were hardly exploited between 1940 and 2008, with the exception of Rimatara and Rurutu Islands in the Australs where subsistence fishing is deeply rooted, and Tahiti, where many people from those two islands live.

2. Commercial fishing from 2008 onwards and the problems that arose

Commercial sea cucumber fishing in French Polynesia started in earnest in 2008, when a local operator who had learned the trade in New Caledonia opened a business. That initiative led to other new operators setting up businesses. Between 2008 and 2011, exports grew exponentially, with 3 t exported in 2008, 28 t in 2009, 56 t in 2010 and 125 t in 2011. In 2012, total exports increased slightly, – despite a fishing season limited to 10 months – to 132 t, some 6.8 t of which was exported in 2013. This residual amount exported in 2013 can be explained by the fact that commercial fishing ended on 1 November 2012 when the sea cucumber fishing regulations came into effect, and a six-month period was established for selling residual stocks.

¹ Project leader, Department of Marine Resources, French Polynesia. Arsene.stein@drm.gov.pf

² XPF 100 = USD 0.95 (16 January 2019)

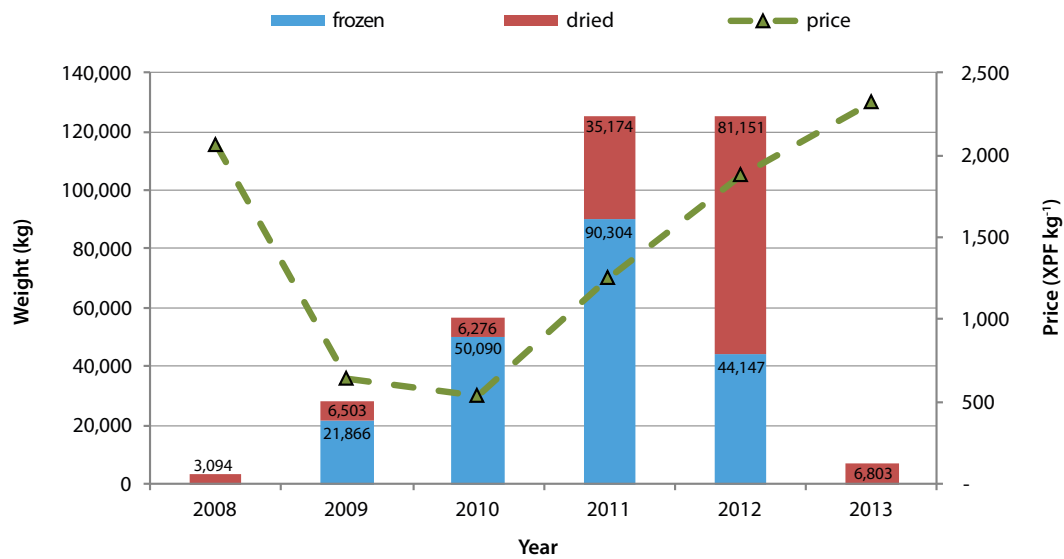


Figure 1. Sea cucumber exports by product type (unit = kg) and average per kilo prices.

Despite the lack of access to operators' statistics on the quantities, species concerned and islands of origin, an analysis of export statistics made it possible to clearly distinguish between two types of products, divided by a price threshold at about XPF 800 kg⁻¹:

- Expensive products, with a price of one to several thousand CFP francs (XPF). These were mainly dried products, usually exported by air. The three species with higher intrinsic value (*Holothuria fuscogilva*, *H. whitmaei* and *Thelenota ananas*) were generally processed in this form. These products were shipped almost exclusively to Hong Kong.
- 'Cheap' products, ranging in price from XPF 300 to 700 kg⁻¹, consisting of raw or semi-cooked products or of less valuable species, such as *Actinopyga mauritiana* and *Bohadschia argus*. These products were exported frozen, by ship, to destinations such as Taiwan and Vietnam.

2.1 Highlights of the 2008–2012 period

In 2008, the sole sea cucumber operator targeted only the two or three species with the greatest market value and exported 3 t of dried products harvested from several lagoons in the Society and Tuamotu islands. As the operator had no competition, the prices he offered to fishers for fresh products were rather low – all the more so because the exporter took care of processing them himself to ensure optimal quality of the exported products. This may explain the relatively low average price declared at the time of export of around XPF 2,000 kg⁻¹.

In 2009, at least two other exporters started up businesses, one of which dealt in low-value sea cucumber species, which were exported frozen. The production of dried products doubled to 6 t, and the production of frozen products

climbed sharply to 22 t. The average value of dried products decreased to XPF 1,700 kg⁻¹, while that of frozen products was limited to XPF 335 kg⁻¹. Because frozen products predominated, the average value of exported products dropped to XPF 636 kg⁻¹. At least six of the Tuamotu Islands were fished for the production of dried sea cucumber products, while most frozen products (*A. mauritiana*) came from Tahaa and Tahiti.

The 2009 scenario repeated itself in 2010, but was characterised by a much greater harvest of species of lesser value, and exports that were dominated by frozen products. Overall production doubled, with an estimated 50 t out of 56 t of sea cucumbers being exported frozen at an average price of XPF 372 kg⁻¹. The quantity of dried sea cucumbers remained stable, however, at 6 t, with slightly improved prices compared to 2009 due to an increase in the number of exporters (to nine) and the beginning of competition. The growing dominance of frozen products brought down the average value of exported products to XPF 540 kg⁻¹. That year, harvesting took place in at least 13 Tuamotuan atolls. Frozen products continued to come mainly from the Society Islands of Tahaa, Raiatea, Huahine, Moorea and Tahiti. 2010 was marked by the efforts of the municipality of Moorea, which already had a maritime area management plan, to set up a regulatory framework for sea cucumber fishing, which led to a charter being established in 2011.

In 2011, overall production doubled once again, in particular because of very strong development in sea cucumber fisheries in Tahiti and Moorea, chiefly for *B. argus*. Production of frozen products reached 90 t for an average value of XPF 700 kg⁻¹. Meanwhile, the quantity of dried products grew six-fold and their overall average value climbed to nearly 2,700 kg⁻¹, while the overall average value of exported

products reached XPF 1,250 kg⁻¹. The increase in price can be explained mainly by heightened competition between buyers who competed for the products on the ground and offered fishers prices that were closer to values on the international market. That year, sea cucumber fishing took place on at least 20 atolls in the Tuamotu Islands. On some atolls, such as Faaite, Fakarava, Arutua, Rangiroa, Kauehi and Amanu, teatfish stocks were considered to have already been heavily impacted. On Bora Bora, the municipality blocked a project by an operator from Tahaa who wished to fish in Bora Bora's lagoon.

2012 was marked by some stagnation in activity, independently of the close of the harvest season on 1 November 2012, when the new regulations came into force. With products exported in 2013 included, overall tonnage reached 132 t, consisting of 88 t of dried products and only 44 t of frozen products. The average value of the products increased from 2011, except for frozen products: XPF 600 kg⁻¹ for frozen products and XPF 2,500 kg⁻¹ for dried products, amounting to an overall average price of XPF 1,900 kg⁻¹.

In Tahiti, a significant reduction in activity for frozen products was observed as early as March, apparently linked to a problem marketing this type of product and price levels that could no longer be maintained. In November 2012, several dozen tonnes of sea cucumbers were still stored in a freezer because they could not be exported as is. Quantities of dried products, on the other hand, more than doubled compared to 2011, due to their being made up mainly of more poorly rated species, such as *B. argus*. There were 15 registered exporters in 2012, some of whom had only just started out in the business. In the Tuamotu Islands, at least 30 atolls were being fished, sometimes only on an occasional basis. Harvesting also spread that year to a few islands in more distant islands, such as Ua Pou and Tahuata in the Marquesas, and Raivavae and Tubuai in the Austral Islands. Finally, 2012 was marked by positions taken by two municipalities: Rangiroa in the Tuamotu Islands issued a ban on commercial sea cucumber fishing in all of its islands, and the Gambier Islands decided not to allow sea cucumber fishing in its lagoons.

2.2 Problems begin to arise

Problems first began in 2010 and increased gradually until the regulations came into force in November 2012. The main grievances registered by the Fisheries Department are detailed below.

Product wastage

This major problem can be broken down into several types.

1. Harvested products were destroyed due to the overly poor quality obtained during processing. These events were more common among new fishers and processors and/or new buyers.

2. One buyer rose up against the practice of traders who bought sea cucumbers whole from fishers, saying that this hindered the renewal of wild populations that would reproduce naturally if their gonads were put back into the ocean after evisceration.
3. The harvest of several species was called into question because of the very low added value of the finished product, or because the species was of minor importance.
4. Most wastage resulted from harvesting a large number of very small sea cucumbers, which dragged down the value of all export catches and threatened certain sea cucumber populations in several lagoons. This problem, which was heightened by night-time fishing, was especially prevalent in the Society Islands.

Poaching

Scuba diving for sea cucumber fishing is illegal in French Polynesia, but it was reported in several islands of the Tuamotus, which is not surprising given that many pearl oyster farms are equipped with scuba gear.

Use of new technologies

The use, or suspicion of use, of ROVs (remotely operated vehicles) or of camera-aided systems for detecting sea cucumbers in deep waters were reported, leading to the fear that their use might become widespread for deep-sea resources.

Harvesting by outside fishers

Many fishers or inhabitants complained that fishers from other municipalities or islands were operating in their geographical areas.

Impression of a 'slaughter'

Some individuals expressed – directly to the Fisheries Department, in the media, or through social networks – their protests against the 'pillaging' or 'slaughter' of sea cucumbers. Pictures of bags filled with sea cucumbers or pickup trucks filled with bags of sea cucumbers made them fear that sea cucumbers would be eradicated.

3 Proposed corrective measures

The author participated in the technical workshop on sea cucumber fisheries held in November 2011 in Nadi, Fiji, organised jointly by the United Nations Food and Agriculture Organization, the Australian Centre for International Agricultural Research, and Southern Cross University in Australia. The problems identified and the lessons learned from the workshop helped design regulations adapted to French Polynesia's geographical situation. The aim of the

regulatory measures was to provide a framework for the sea cucumber fishery, which is economically significant in the islands, so as to eliminate the main problems reported and involve fishers and communities in the daily management of sea cucumber fishing (Table 1).

It should be pointed out that these regulations were not developed via a participatory approach with the fishers. Rather they were based on the experience the Fisheries Department had gained in organising community trochus harvest operations, by incorporating information provided by certain sea cucumber buyers, and feedback concerning problems encountered on the ground.

3.1 - Product traceability

The overall goal was, if not to prevent, then at least to limit fraud among both fishers and traders. The solution was to impose traceability requirements on harvested products, with ongoing monitoring by the Fisheries Department.

This traceability is monitored on the ground by the management committee, which stamps the shipping sheets for each sales transaction between a fisher and trader. The Fisheries Department receives this sheet and enters it into a database, which allows the Fisheries Department to check the origin of the products before approving the trader's export application.

The Pacific Community (SPC) helped the Fisheries Department a great deal in designing and developing the web application used by the department to manage sea cucumber traceability. This application is also accessible, with the use of a password, to the management committees and sea cucumber traders (Fig. 2).

- A management committee can always access the data relating to fishing seasons (period of open season, numerical quotas by species, numerical residual quota by species, list of fishers, contact details of the sea cucumber traders), thus enabling it to verify, if necessary, local management data.

Table 1. List of problems and possible and/or proposed solutions.

No.	Problem to be solved	Possible solution
1	No information on species or island of origin	Set up a procedure requiring that the island of origin and the species involved be reported
2	Imprecise nature of quantities given by weight	Give quantities and quotas in numbers
3	Very low-value species are being fished	Ban commercial harvest of such species
4	Species considered to be rare or at least very uncommon are being fished	Ban commercial harvest of such species
5	Specimens that are too small are being harvested	Introduce minimum size limits – live weight – for each species Ban night fishing
6	A wide variety of processing methods are used	Introduce minimum size limits – dry weight – for each species
7	ROVs and dri-bombs are being used	Make harvesting by hand mandatory
8	Fishers coming from outside the municipality or island	Set up a list of fishers who have been approved by each management committee ³

No.	Legislators' aim	Solution proposed
1	Apply the main administrative requirements to traders rather than to fishers	No permits required for fishers but authorisation to engage in trade should be required
2	Involve local communities	Create a management committee made up solely of local stakeholders The management committee should manage the practical and regulatory aspects on a daily basis
3	Get the best possible prices for fishers	Encourage fishers to take advantage of processing's added-value Promote competition between buyers Encourage the harvesting of the largest specimens
4	Maintain free but supervised trade	Introduce a purchase declaration procedure Introduce trader licensing Provide traders with training on regulations
5	Limit quantities harvested for each species	Introduce per-species quotas
6	Introduce additional precautionary measures	Set up fishing reserves Set up a no-harvest period for each species

³ Management committees are described in detail in section 3.2 'Decentralisation', on next page.

Apataki 2014

- Date d'ouverture : 05/05/2014
- Date de fermeture : 31/10/2014

Lieu de pêche	Espèce	Quota (nombre)	Quantité pêchée	Quota consommé	Quantité expédiée	Stock ouverture	Quota consommé ⁽¹⁾
Apataki	Rori titi blanc	2000	1881	94 %	1921	0	96 %
Apataki	Rori marron de récif	4000	459	11 %	264	0	7 %
Apataki	Rori titi noir	400	258	64 %	310	0	78 %
Apataki	Rori ananas	4000	47	1 %	38	0	1 %
Apataki	Rori vermicelle	8000	893	11 %	943	0	12 %

⁽¹⁾ Le quota consommé pour l'expédition est calculé à partir de la quantité expédiée moins le stock à l'ouverture

Figure 2. Example of a table taken from the web application, which is available to management committees and traders.

- Sea cucumber traders have ongoing access to the open and residual quotas by species, for each lagoon open to fishing, and the contact details of the management committees. This allows them to know where and what type of product it is still possible to buy. Traders can also use this application to fill in and send their export forms to the Fisheries Department in order to get the export certificate that Customs requires.

Sea cucumber trade licences

The licencing procedure for sea cucumber traders makes it possible to identify all of the entities authorised to engage in the purchase and sale of sea cucumbers. Licences are issued by the Minister of Fisheries for a period of two years, and may be revoked in the event of non-compliance with their responsibilities.

Licencing subjects beneficiaries to mandatory reporting requirements for all of the important data on each species sold, such as quantities, weight, type of packaging (frozen, dried, fresh) and island of origin.

For sea cucumber exports, a declaration must be submitted to the Fisheries Department for each operation, including all details relative to the species, number, weight, island of origin and destination. For local sales, a simple monthly report is required.

Because sea cucumber traders must store and handle products that arrive from the outer islands before sorting or finishing up their processing prior to reshipment for export, they must get health permits and follow the current rules on the inspection of foodstuffs of animal origin in French Polynesia.

Specific case of processors

Processors are the individuals who process the fishers' fresh products before sales to a buyer. In most of the islands,

fishers are also processors so that they can take full advantage of the added value that comes from processing their products. Fishers who do not know how, or who do not want, to process their products can make an agreement with a processor to be able to then sell those products to a sea cucumber trader. As a result, some people can work in processing without being fishers and get paid for their work. However, processors strictly speaking do not have the right to sell processed products that are not their own to a sea cucumber trader. As the sea cucumbers are intended for human consumption, processors may be required to obtain a health permit for their processing business. Up to now, health permits have not been made mandatory in the islands, but processors have been provided with a guide to good hygienic practices for processing their products, so that they can prepare for the day when such permits become mandatory.

3.2 Decentralisation

Fishing is organised according to geographical units (islands) or administrative units (municipalities) so as to control the number of participants and provide a concrete solution to the problem of intrusion by people from outside the area concerned.

Management committee

Each geographical unit can set up its own management committee, which may, for example, correspond to a municipality or to one or several islands close to the same municipality, as is often the case in the Tuamotus.

The management committee is chaired by a sea cucumber fisher and is formed by other fishers and representatives of other business sectors operating within the geographical unit, such as finfish fisheries, pearl oyster farming, tourism, and civil society groups that are involved in environmental protection. Municipal employees, who must not be elected officials, have also been included in the committee so that

they can provide logistical and/or administrative support to the committee. Mayors and local officials are not allowed to serve on management committees in order to limit their sphere of influence as to how the management committee operates, especially with regard to drawing up the list of fishers.

The management committee also plays a decisive role on the ground by:

- establishing the initial list of fishers and sending it to the Fisheries Department;
- providing information on any changes to the list of fishers;
- distributing fishing quotas to each fisher and ensuring the fisher is in compliance with them;
- carrying out possible redistribution of fishing quotas in order to optimise the use of the quotas granted;
- ensuring compliance with the general regulations and the rules agreed on at the local level;
- distributing fishing logsheets and shipping sheets to fishers;
- checking the accuracy of the information given on shipping sheets and validating any product movement out of its geographical unit; and
- ensuring that harvests come to a halt at the end of the season.

List of authorised fishers

Only persons registered on a list that has been validated and sent to the Fisheries Department by a duly constituted management committee are authorised to harvest sea cucumbers commercially in a defined geographical zone. These fishers may only sell their catch to an approved sea cucumber trader of their choice. This implies, in theory at least, that sea cucumber traders cannot buy products from someone who is not registered on any of the fisher lists validated by a management committee.

Monitoring agreement

Through a special agreement signed with the Fisheries Department, the management committee undertakes to enforce the fishing rules on the ground and can make specific proposals that then become the community rules for the fishers concerned if they are incorporated into the agreement. Such proposals may, for example, restrict harvests to certain days of the week, or even limit the number of fishing hours or require that sea cucumbers undergo a certain type of processing before they can be shipped to Tahiti. These locally applied rules may not depart from the general regulations, but they make it possible to vary certain practices that most fishers want. For example, ever since the season

opened in 2014, all management committees have decided to ship only processed products to Tahiti.

3.3 Management measures

Subsistence fishing

Because sea cucumbers are part of the diet of some local people, sea cucumber fishing strictly for home consumption, without trade, continues to be allowed for all species. However, the rules on regulated species must be followed, especially in terms of minimum sizes and closed harvest seasons.

Authorised species

Out of the approximately 15 species of sea cucumbers that inhabit the lagoons of French Polynesia, only 5 species are authorised for commercial fishing. These five species have both large enough stocks to be harvested and fetch worthwhile export prices. They are: two teatfish species, *Holothuria fuscogilva* and *H. whitmaei*, *Thelenota ananas*, *Actinopyga mauritiana* and *Bobadscia argus*. *Holothuria atra* is excluded due to its very low purchase price, despite the fact that its stocks are by far the largest. *Thelenota anax* is also excluded because while it obtains relatively good prices, its stocks are low overall, although somewhat more numerous populations exist in certain lagoons.

Minimum sizes

Minimum size limits have been established for each sea cucumber species. The objective of this is, of course, to protect small sea cucumbers, but also to fight waste and to obtain the best export prices.

When a sea cucumber is processed (dried), it shrinks in length and diameter (and in weight), and the level of this change depends on the processing protocol required by the buyer. Setting minimum sizes for dry products encourages processors to use only those protocols that allow them to get dried sea cucumbers of a legal size from fresh sea cucumbers of a legal size. This measure is also in the interest of processors (and fishers), who must select the protocols that, for sea cucumbers of similar quality, lead to more lucrative finished products so as to benefit from their added value.

For example, when sampling was carried out in 2012 on *B. argus*, the number of dried sea cucumbers required to get 1 kg of product was six large ones or up to 62 very small ones. Further, with processing of similar quality, not only does harvesting small sea cucumbers risk compromising the entire value chain in the end, but the per-kilo price offered for small sea cucumbers is also much lower than the price for large specimens. Thus there is a dual benefit to only targeting large sea cucumbers.

The values of the minimum sizes are largely modelled on those that were in force in 2012 in New Caledonia, both

Table 2. Minimum sizes and closed seasons in French Polynesia.

Scientific name	Common local name	Common English name	Minimum live size (cm)	Minimum dried size (cm)	Prohibited months
<i>Holothuria fuscogilva</i>	Rori titi blanc	White teatfish	35	15	Nov, Dec, Jan
<i>Holothuria whitmaei</i>	Rori titi noir	Black teatfish	30	15	Jun, Jul, Aug
<i>Thelenota ananas</i>	Rori euata	Prickly redfish	45	20	Nov, Dec, Jan
<i>Actinopyga mauritiana</i>	Rori papao	Surf redfish	20	10	Nov, Dec, Jan
<i>Bohadschia argus</i>	Rori ruahine	Leopardfish	40	15	Nov, Dec, Jan
Other species			15	10	

for live and dry weights. However, as New Caledonia does not have minimum sizes set for *B. argus*, sampling was done with two exporters to determine the values.

At the request of traders, the minimum size limit of *A. mauritiana* was modified in January 2014, from 25 cm to 20 cm fresh weight and 12 cm to 10 cm dry weight. This measure made it possible to indirectly determine, for all species of sea cucumbers, a range of dry weight sizes, ranging from 10 cm to 20 cm, using intervals of 5 cm that are easier for fishers to remember (Table 2).

Sea cucumber traders made two further demands, one in 2015 and one in 2017, to decrease the minimum length of *Thelenota ananas* from 20 cm to 15 cm dry weight. Those demands have not been accepted to date, as the sample data taken in 2012 from two major exporters are compatible with a minimum length of 20 cm. One of the exporters, whose products came from the Society Islands, recorded lengths of 10 cm to 22 cm, with a mean length of 15.6 cm, but 96% of the catches were less than 20 cm long. The other exporter, whose products came from the Tuamotus, recorded lengths of between 14 cm and 31 cm, with a mean of 21 cm, with 55% of catches over 20 cm long. The sample data show that the minimum length of 20 cm dry weight is achievable if large individuals are harvested and that a species-specific processing method is used that does not result in excessive shrinkage. Processors were, therefore, encouraged to find processing methods that ensured a minimum length of 20 cm because it is, in principle, hard to accept that it takes more than three individuals weighing 3 kg to 5 kg each fresh to obtain 1 kg of dried sea cucumber (beche-de-mer).

Reserves

When the harvest or fishing season begins, an area covering, at the very least, one-third of the surface of each biotope in which the target species live must be declared a reserve. In

practice, because harvesting usually involves all five authorised species, at least one-third of the area, comprising the lagoon, reef crest and outer reef slope, is closed to fishing (see Fig. 3). The area is not marked in any way; the limits indicated on a map correspond to recognizable points suggested by the fishers and are easily identifiable by them; for example, a *motu* (small island), point or channel. The reserve's location can be modified at the start of the following harvest or fishing season.



Figure 3. Example of the geographic division for Apataki Atoll (reef surface area = 735 km²).

The municipality of Fakarava, which comprises seven atolls, is a special case because it forms a biosphere reserve where sea cucumber harvesting is only authorised in zones where all human activities are authorised (called transition zones). Taiaro Atoll is a no-take reserve, but open harvest seasons did take place in the municipality's six other atolls between 2014 and 2017.

Closed seasons

Each commercially harvested species is subject to a three-month mandatory closed season. The season corresponds to the biological cycle of the species determined outside of French Polynesia (i.e. the Southern Hemisphere summer), except in the case of *H. whitmaei* (black teatfish), for which it is the Southern Hemisphere winter. The three-month break serves to separate successive harvests or fishing seasons.

In addition, harvesting is only authorised during daylight hours, from 0600 to 1800. The aim is, above all, to ensure fishers are not tempted to harvest small specimens, which are much more accessible at night. It also serves to limit the risk of diving accidents and makes it easier to monitor catch compliance.

Only harvesting by hand is authorised

Only the harvesting or collecting of sea cucumbers by hand is authorised; this eliminates certain practices deemed to be harmful, such as 'torpedo spears' or 'dri-bombs' (Fig. 4), and to dispel fears – founded or not – about the use of various mechanical harvesting devices. In 2014, one management committee requested that the ban on torpedo spears or dri-bombs be lifted for reasons related to diving safety. The request was not approved and the management committee did not appeal it because fishers were able to take advantage of the vertical movements of teatfish during certain lunar phases. It would seem that the fishers on this management committee are now against authorising the use of torpedo spears. There is still reason to suspect that the technique continues to be used in certain sparsely inhabited islands.

Quotas

Quotas are set by species for a given lagoon, and it is up to the management committee to allocate them to registered fishers; as a rule, the quotas are evenly distributed among all fishers. For that reason, the Fisheries Department monitors only the overall quotas set for a specific lagoon and not the individual quotas attributed to each fisher. Should the quota for a species be reached before the end of the season, the harvesting of that species is closed, regardless of whether some fishers fished more than their individual quota while others didn't reach theirs. In such cases, responsibility lies with the management committee, which is supposed to take the situation into account the next time authorisation to harvest is requested.



Figure 4. Examples of 'torpedo spears' or 'dri-bombs' made of concrete set in tin cans.

The system for setting quotas is normally the trickiest aspect of regulations as it must be based on a robust methodology. Section 3.4 below considers this in detail.

The flow of products, from a lagoon that is open for harvesting to the final purchaser, is shown in Figure 5.

In regulatory terms, two successive pieces of legislation were approved.

1. A resolution by the French Polynesia Assembly, which closed commercial sea cucumber harvesting throughout the territory, introduced sea cucumber trader licensing, and established the general framework of management and conservation measures – this legislation came into force on 1 November 2012.
2. An implementing order issued by the French Polynesia Council of Ministers established management committees and their terms of reference, and stipulated the procedure for opening commercial harvest seasons and the parameters for authorised species, from mandatory sizes to closed seasons. This legislation came into force on 2 May 2013.

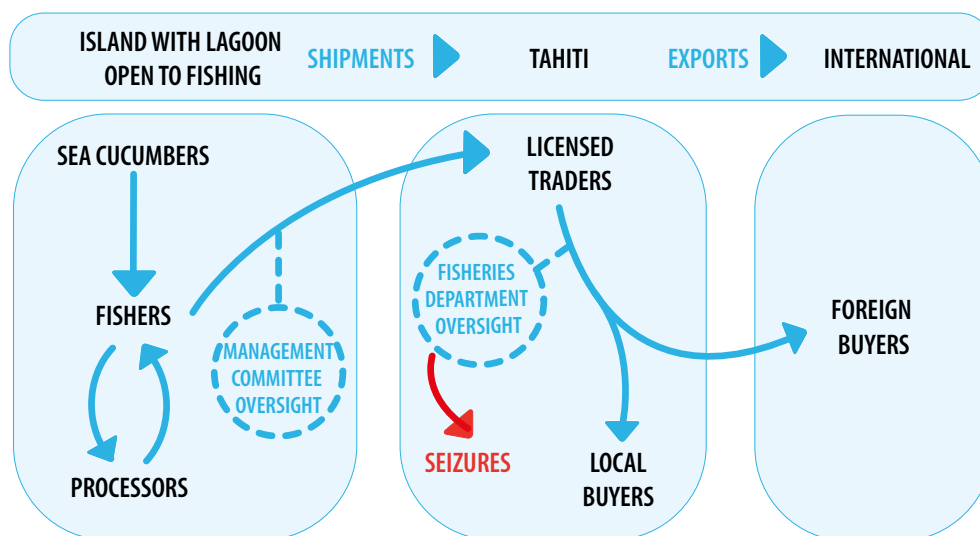


Figure 5. Sea cucumber flow diagram from harvest to export

3.4 Focus on how initial and final quotas were set and subsequent changes

Principle

In the absence of detailed knowledge about the five sea cucumber species involved, the recommended system consists of conducting stock surveys for each species in every lagoon to be harvested. These costly operations usually have to be repeated at the start of each season so as to gauge the impact of the preceding harvest and the numbers of new specimens available for harvest.

The Fisheries Department did not, however, have any statistics on the harvests in each lagoon between 2008 and 2012. It did, however, have some information on the stocks of certain species on certain islands and the intensity of the harvest of certain species on several islands, bearing in mind that stocks and species distribution can vary widely from one lagoon to another.

The Fisheries Department also had access to the following data or information: lagoon surface areas, relative preponderance of species in some lagoons, dry and fresh weight conversion rates, and average number of fresh specimens required to get 1 kg of dry weight.

Studies conducted in the late 1990s in Tahiti and Rangiroa (SNC Pae Tai – Pae Uta Etudes Environnement 1997) have provided estimates of potential harvests for certain species: 4.1 kg ha⁻¹ year⁻¹ for *H. fuscogilva* and *H. whitmaei* combined for Tahiti, and 70.6 kg ha⁻¹ and 4.1 kg ha⁻¹ year⁻¹ for *B. argus* for Tahiti and Rangiroa, respectively.

Those existing data were used to establish a method for setting quotas for the Tuamotus, which remain the main

targets of harvesting campaigns. That approach can be criticised from a scientific point of view, but it has the merit of enabling immediate harvesting while limiting risks – due to the regulatory management measures – and of adapting catch sizes at each new open season in light of results of previous harvests. It has another significant advantage – the acquisition, at little cost, of information about the various sea cucumber populations in the lagoons harvested.

The baseline used to calculate the initial quotas for the atolls is based on a hypothetical harvest of 1.0 kg of sea cucumbers (all species) live weight per hectare of reef surface; the equivalent of 0.1 kg of dried beche-de-mer per hectare. Those are very reasonable amounts when compared to the recommended harvest levels of teatfish or leopard fish (aka tigerfish) for Tahiti or Rangiroa in the late 1990s (SNC Pae Tai – Pae Uta Etudes Environnement 1997).

The surface area considered concerns all sectors of the reef, from the lagoon to the outer slope. Those data are available in the atlas of coral reefs of French Polynesia (Andréfouët et al. 2005). Conventional distribution in terms of the weighted abundance for each species is based on the results of studies previously conducted in French Polynesia (SNC Pae Tai – Pae Uta Etudes Environnement 1997, Biodax Consulting 1998).

The factor for converting the weight into number of specimens varies depending on the species and corresponds to the mean number of specimens meeting the minimum size requirement needed to get one kilo of dried products. Table 3 sums up the different ratios assigned to each species.

The outcome can be weighted, depending on the estimated intensity of harvests before 2013, from 0.5 for lagoons

considered to have been heavily harvested with regard to at least one species, to 1.0 for lagoons considered to have only been lightly harvested, if at all.

The initial quota (Q) – in numbers for each species (sp) in a given lagoon – is set using the following formula:

$$Q_{sp} = S * R * Asp * Csp * P$$

Where:

- *Q_{sp}* is the initial quota of specimens for the species concerned
- *S* is the reef surface area in hectares
- *R* is the total authorised dry weight per hectare = 0.1 kg
- *Asp* is the distribution rate for the species
- *Csp* is the weight/number conversion factor for the species
- *P* is the weighting factor based on the intensity of previous harvests

The final quotas are then set by comparing the initial quotas to the quotas requested by the management committee; the quotas are levelled out, which generally lowers them.

Two numerical examples

The first example concerns Fakarava, a large atoll with a reef surface area of 1,243 km². The quotas in number of specimens for each species for the first year of harvesting in 2014 received a weighting of 60% because of the high pre-2013 harvest estimates for *H. fuscogilva* and *H. whitmaei* (Table 4).

The final dry weight quota recommended for all species combined was estimated at 6 tonnes maximum, whereas the management committee had requested a quota of 50 tonnes. In reality, only 17% of the quota granted was filled on Fakarava in 2014 (Table 5).

Table 3. Ratios used to determine quotas.

Species	Dry weight/ live weight conversion rate	Asp live weight in kg per lagoon hectare	Csp Number of specimens for 1.0 kg (dry)	Mean live weight considered (kg)	Ratio of maximum number of specimens per lagoon hectare
<i>Bohadschia argus</i>	0.1	0.4	4	2.50	0.160
<i>Actinopyga mauritiana</i>	0.1	0.1	10	1.00	0.100
<i>Thelenota ananas</i>	0.1	0.25	3	3.33	0.075
<i>Holothuria fuscogilva</i>	0.1	0.2	2	5.00	0.040
<i>Holothuria whitmaei</i>	0.1	0.05	2	5.00	0.010

Table 4. Sea cucumber quotas for Fakarava Atoll in 2014.

Species	Asp	Csp	Weighting	Initial quota calculated in numbers	Quota requested by management committee	Additional information	Final suggested quota in numbers
<i>Bohadschia argus</i>	0.4	4	0.6	11,933	50 tonnes dry weight without specifying per-species quantities or numbers	Little information	10,000
<i>Actinopyga mauritiana</i>	0.1	10	0.6	7,458		Little information	5,000
<i>Thelenota ananas</i>	0.25	3	0.6	5,594		Little information	5,000
<i>Holothuria fuscogilva</i>	0.2	2	0.6	2,983		Abundance before 2013 but high harvests in the northern pass zone	3,000
<i>Holothuria whitmaei</i>	0.05	2	0.6	746		Little information	500
Total or mean	1	3.85	0.6	28,714			23,500

Table 5. Actual harvests from Fakarava Atoll in 2014.

Species	Quota requested by management committee	Final quota suggested	Actual harvests (numbers)	Actual harvests (kg)	Quota use rate in numbers (%)	Overall use rate of initially requested quota (%)
<i>Bohadschia argus</i>		10,000	587	121	5.9%	2.1%
<i>Actinopyga mauritiana</i>	50 tonnes dry weight without specifying per-species quantities or numbers	5,000	975	116	19.5%	
<i>Thelenota ananas</i>		5,000	72	19	1.4%	
<i>Holothuria fuscogilva</i>		3,000	2,356	797	78.5%	
<i>Holothuria whitmaei</i>		500	*	-	0.0%	
Total		23,500	3,990	1 053	17.0%	

* According to this table, *Holothuria whitmaei* was not harvested at all; harvest data for subsequent years showed that the species, in fact, accounts for about 2% of all teatfish.

The second example concerns the much smaller Aratika Atoll, which has a reef surface area of 171 km². The method for calculating the quotas of specimens for each species was thoroughly revised for this island, which had been spared harvesting before 2013, to take into account additional information and the fact that the harvest area was limited to the reef crest and the outer slope (Table 6).

The results indicate that:

- the *B. argus* quota was substantially reduced because the reef crest and outer reef slope of the atolls are far removed from this species' preferred biotope;

- the *T. ananas* quota was considerably increased, following the information obtained from an exploratory campaign carried out in 2012 by the Khaleb Bin Sultan Living Ocean Foundation, which showed that this species was actually abundant on the outer reef slope; and
- the *A. mauritiana* quota was increased on an exceptional basis and rounded up to the nearest thousand to offset (to some extent) the low quota allocated for *B. argus*.

The theoretical dry weight quota was estimated at about 1700 kg. In reality, only 20% of the total quota was filled on Aratika (Table 7).

Table 6. Quotas for Aratika Atoll in 2014.

Species	Asp	Csp	Weighting	Initial quota calculated in numbers	Quota requested by management committee	Additional information	Final suggested quota in numbers
<i>Bohadschia argus</i>	0.4	4	1	2,736	No specified quota	No information on the species; fishing grounds limited to the reef crest and outer reef slope	600
<i>Actinopyga mauritiana</i>	0.1	10	1	1,710		No information on the species; fishing grounds limited to the reef crest and outer reef slope	2,000
<i>Thelenota ananas</i>	0.25	3	1	1,283		High abundance on outer reef slope	2,000
<i>Holothuria fuscogilva</i>	0.2	2	1	684		No information on the species; fishing grounds limited to the reef crest and outer reef slope	600
<i>Holothuria whitmaei</i>	0.05	2	1	171		No information on the species; fishing grounds limited to the reef crest and outer reef slope	100
Total	1	3.85	1	6,584			5,300

Table 7. Actual harvests in Aratika in 2014.

Species	Quota requested by management committee	Final quota suggested	Actual harvests (numbers)	Actual harvests (kg)	Quota use rate in numbers (%)	Use rate of initially requested quota (%)
<i>Bohadschia argus</i>	No specified quota	600	597	121	99.5%	Not calculated
<i>Actinopyga mauritiana</i>		2,000	462	47	23.1%	
<i>Thelenota ananas</i>		2,000	8	3	0.4%	
<i>Holothuria fuscogilva</i>		600	7	4	1.2%	
<i>Holothuria whitmaei</i>		100	-	-	0.0%	
Total		5,300	1,074	175	20.3%	

Surprisingly, the predominant species in the catches was *B. argus*, with the supposedly most abundant species – *A. mauritiana* and *T. ananas* – accounting for very little. As the preferred biotope of *B. argus* tends to be the inner lagoon, where harvesting was prohibited, it is likely that there was some illegal harvesting.

Quota changes

The big advantage of this method is that it uses data from a past harvest or fishing season to adapt certain suggested quotas for the next. Tables 8a and 8b, illustrates how quotas were adapted over three years, taking into account the results of the previous harvest and the quotas requested.

Table 8a. Adjustments in quotas (in numbers) for Fakarava Atoll from 2015 to 2017.

Island	Species	2014				2015				2016				2017			
		Management committee quota request	Quota set by Fisheries Department	Actual harvest	Use rate (%)	Management committee quota request	Quota set by Fisheries Department	Actual harvest	Use rate (%)	Management committee quota request	Quota set by Fisheries Department	Actual harvest	Use rate (%)	Management committee quota request	Quota set by Fisheries Department	Actual harvest	Use rate (%)
Fakarava	<i>Bohadschia argus</i>	50 tonnes	10,000	587	5.9%	7,000	5,000	55	1.1%	5,000	3,000	662	22.1%	5,000	3,000	2,363	78.8%
	<i>Actinopyga mauritiana</i>		5,000	975	19.5%	5,000	2,000	149	7.5%	3,000	2,000	171	8.6%	3,000	2,000	464	23.2%
	<i>Thelenota ananas</i>		5,000	72	1.4%	5,000	1,000	30	3.0%	1,500	500	32	6.4%	500	500	61	12.2%
	<i>Holothuria fuscogilva</i>		3,000	2,356	78.5%	6,000	3,000	3,000	100.0%	6,000	4,000	4,000	100.0%	6,000	4,000	3,151	78.8%
	<i>Holothuria whitmaei</i>		500	0	0.0%	500	100	56	56.0%	200	200	200	100.0%	1,000	200	71	35.5%
	Total		23,500	3,990	17.0%	23,500	11,100	3,290	29.6%	15,700	9,700	5,065	52.2%	15,500	9,700	6,110	63.0%

Table 8b. Adjustments in quotas (in numbers) for Aratika Atoll from 2015 to 2017.

Island	Species	2014				2015				2016				2017			
		Management committee quota request	Quota set by Fisheries Department	Actual harvest	Use rate (%)	Management committee quota request	Quota set by Fisheries Department	Actual harvest	Use rate (%)	Management committee quota request	Quota set by Fisheries Department	Actual harvest	Use rate (%)	Management committee quota request	Quota set by Fisheries Department	Actual harvest	Use rate (%)
Aratika	<i>Bahadscchia argus</i>	No specified quota	600	597	99.5%	10 tonnes	2,000	42	2.1%	5 tonnes	2,000	5	0.3%	Management Committee did not function No fishing season opened			
	<i>Actinopyga mauritiana</i>		2,000	462	23.1%		1,000	123	12.3%		1,000	46	4.6%				
	<i>Theleota ananas</i>		2,000	8	0.4%		500	0	0.0%		500		0.0%				
	<i>Holothuria fuscogilva</i>		600	7	1.2%		300	3	1.0%		300		0.0%				
	<i>Holothuria whitmaei</i>		100	0	0.0%		100	0	0.0%		100		0.0%				
	Total		5,300	1,074	20.3%		3,900	168	4.3%		3,900	51	1.3%				

4. Outcomes and analysis of harvest from 2014 to 2017

4.1 Production

The gross weights of products shipped from the outer islands to Tahiti are given in decreasing order in Table 9.

Eight atolls shipped more than one tonne of products to Tahiti, all of large dimensions. Two teatfish – *H. fuscogilva* and *H. whitmaei* – accounted for two-thirds of this output, leopardfish (*B. argus*) accounted for one-quarter, and the two other species combined accounted for under 10%.

Table 10 lists the principal characteristics of the harvests or fishing seasons in the different islands of French Polynesia from 2014 to 2017, with the quantities shipped to Tahiti and verified by the local management committees.

Table 10, on pages 54 and 55, shows that certain lagoons that were open to fishing were not exploited. This was because the management committee that had been set up was either uninvolved or even incompetent. In other cases,

the islands are either uninhabited or only visited at certain times of the year, which may be outside of the sea cucumber fishing season. In addition, the lagoons of the Society Islands were not opened in 2014 because they were deemed to have been overfished before 2013. Lastly, a few lagoons in the Tuamotu Islands, because of their crucial importance in providing the pearl industry with pearl oyster spat, would have been turned down by the Fisheries Department had they asked for authorisation to harvest sea cucumbers.

The length of the harvest season also varied widely, from one to seven months, although it could last a maximum of nine months. There were two main reasons for this: 1) late requests for authorisation by the management committee, which itself was formed late; and 2) late issue of the authorisation by the competent authority, owing to the high turnover in the ministers in charge of marine resources between the introduction of the regulations in November 2012 and November 2017.

The true quantities harvested are unknown, as they correspond to the sum of the amounts shipped to Tahiti and an unknown and unreported amount corresponding, at the very least, to those dried products that did not meet the

Table 9. Quantities (in kg) shipped from the outer islands to Tahiti from 2014 to 2017 shown by species.

no	Island	Number of open seasons	<i>Bohadschia argus</i>	<i>Actinopyga mauritiana</i>	<i>Thelenota ananas</i>	<i>Holothuria fuscogilva</i>	<i>Holothuria whitmaei</i>	Overall total
1	Fakarava	4	667.9	191.5	56.2	5,346.1	131.4	6,393.0
2	Apataki	4	145.0	18.6	12.4	4,295.0	650.4	5,121.4
3	Kaukura	3	1,553.9	523.7	4.6	1,836.2	353.1	4,271.5
4	Toau	4	300.7	9.0	75.5	2,338.7	130.2	2,854.0
5	Makemo	4	1,156.5	214.1	6.0	128.3		1,504.9
6	Raraka	2	114.3	20.4	49.4	916.8	239.9	1,340.8
7	Raroia	2	1,267.6	7.0	15.0	4.0		1,293.6
8	Kauehi	3	251.7	19.6	14.4	626.0	96.0	1,007.7
9	North Marutea	2	314.0	139.0	10.0	94.0		557.0
10	Tahanea	1	190.5	36.1	9.7	10.9		247.2
11	Manihi	1	106.0	10.0		110.0		226.0
12	Faaité	4	81.1	81.4		53.6	0.5	216.6
13	Tahaa	2	24.9	14.9	19.4	135.3	12.5	207.0
14	Aratika	3	125.7	65.0	3.0	5.0		198.7
15	Niau	2		69.0	12.0			81.0
16	Vahitahi	2		1.7				1.7
Overall total		43	6,299.7	1,421.1	287.5	15,899.9	1 614.0	25,522.1
%			24.7%	5.6%	1.1%	62.3%	6.3%	

minimum size requirement and so, could not be sold. No one knows what happens to these products, but it seems likely that in islands where the management committees are less aware of the issues, the products were returned to the fishers instead of being seized and destroyed. Once they have been returned to the fishers, the fishers could then either eat them or even ship them to Tahiti, where they may or may not have been offered for sale. If they were placed on the market, the sale price was obviously well below that used for the same species on the legal market because of their small size. What's more, in these sparsely populated islands, it is hard to sell products illegally without it becoming known, so the risk that registered fishers would be tempted to sell products of an unlawful size is considered to be low.

T. ananas is probably the species that is most vulnerable to non-compliance with regard to size limits because processors find it difficult to get a dried product that is at least 20 cm long using the processing methods that traders require. This is also the reason for the previously mentioned trader demand for a lower minimum dry length.

Each island's output also differed widely in terms of catch composition. Catches can be categorised more objectively – and the availability of certain resources gauged and the fishers' strategy assessed – when average annual output is considered.

When it comes to quantity, three islands stand out, each with an average annual output of over 1 t of dried products:

Fakarava, Apataki and Kaukura. These are large atolls with at least 10 experienced and motivated fishers. Their waters had been heavily harvested for certain species prior to 2013.

Three other large atolls, where the fishers are fewer in number but motivated, produced between 500 kg and 1 tonne. Five average to large sized atolls, with a limited number of active fishers, produced between 200 kg and 500 kg. Lastly, except for the special case of Tahaa, which is a high island, the remaining islands registered less than 200 kg and are small atolls with very few active fishers.

The composition of the catches varied widely from one island to another, and reflects not only the actual availability of resources, but also the fishers' preferences for certain species.

In the large atolls producing a total of over 1 t of dried products, and despite the fact that *B. argus* is recognised as being the most abundant and accessible species for harvest, only Makemo and Raroia predominantly harvested that species. In the other atolls, fishers clearly targeted the two most prized species – *H. fuscogilva* and *H. whitmaei*, with Apataki being an extreme case with 82% of fishers exclusively targeting these species.

On average, and after combining the figures for *H. fuscogilva* and *H. whitmaei*, 54% of all fishers harvested a single species, 23% two species and 16% three species. Only 7% of fishers harvested all species.

Table 10. Product shipments (in numbers) from the various islands within French Polynesia to Tahiti from 2014 to 2017.

Year	No.	Island	Fishing effort		Species					Overall total
			Length of opened season (months)	Number of active fishers	<i>Bohadschia argus</i>	<i>Actinopyga mauritiana</i>	<i>Thelenota ananas</i>	<i>Holothuria fuscogilva</i>	<i>Holothuria whitmaei</i>	
2014	1	Apataki	6	31	943	264	38	1,921	310	3,476
	2	Aratika	5	1	597	462	8	7		1,074
	3	Faaite	7	1		83		9		92
	4	Fakarava	7	8	587	975	72	2,356		3,990
	5	Makemo	7	32	2,872	507	10	158		3,547
	6	Manihi	7	8	576	101		190		867
	7	North Marutea	7	3	1,343	492	29	168		2,032
	8	Motutunga	7	0						
	9	Nihiru	7	0						
	10	Taenga	5	0						
	11	Tahanea	7	4	972	226	30	22		1,250
	12	Toau	7	2			102	432		534
Total 2014		9/12 islands active	79	90	7,890	3,110	289	5,263	310	16,862
2015	1	Apataki	4	46				2 167	296	2,463
	2	Aratika	4	1	42	123		3		168
	3	Faaite	2	1	382	237		1	1	621
	4	Fakarava	4	6	55	149	30	3,000	56	3,290
	5	Hiti	4	0						
	6	Kauehi	4	3	196	12	18	104	30	360
	7	Katiu	4	0						
	8	Kaukura	4	48	2,021	2,983		1,329	262	6,595
	9	Makemo	4	23	1,815	521	1	10		2,347
	10	North Marutea	4	2		779				779
	11	Motutunga	2	0						
	12	Raroia	4	0						
	13	Tahanea	2	0						
	14	Tepoto sud	4	0						
	15	Toau	4	4			35	1,500	100	1,635
	16	Tuanaki	4	0						
Total 2015		9/16 islands active	58	134	4,511	4,804	84	8,114	745	18,258
2016	1	Apataki	5	52				2 797	500	3,297
	2	Aratika	2	1	5	46				51
	3	Faaite	1	1		125		120		245
	4	Fakarava	5	7	662	171	32	4,000	200	5,065
	5	Hiti	2	0						
	6	Kauehi	5	4	1,004	153	3	825	160	2,145
	7	Katiu	2	0						
	8	Kaukura	5	28	2,982	1,513	15	1,063	275	5,848
	9	Makemo	5	15	1,192	348	7	52		1,599
	10	North Marutea	5	0						
	11	Motutunga	1	0						
	12	Niau	4	2		400				400
	13	Raraka	4	7	577	47	115	1 032	237	2 008
	14	Raroia	4	4	3,465	95	14			3 574
	15	Tahaa	5	2	178	358	75	253	22	886
	16	Tahanea	1	0						
	17	Tepoto sud	2	0						
	18	Toau	4	8	1,303	93	217	2,045	153	3 811
	19	Vahitahi	1	1		14				14
	20	Tuanaki	2	0						
Total 2016		13/20 islands active	63	132	11,368	3,363	478	12,187	1,547	28,943

Table 10 (continued). Product shipments (in numbers) from the various islands within French Polynesia to Tahiti from 2014 to 2017.

Year	No.	Island	Fishing effort		Species					Overall total
			Length of opened season (months)	Number of active fishers	<i>Bohadschia argus</i>	<i>Actinopyga mauritiana</i>	<i>Thelenota ananas</i>	<i>Holothuria fuscogilva</i>	<i>Holothuria whitmaei</i>	
2017	1	Akiaki	6	0						
	2	Apataki	7	17	17			646	91	754
	3	Aratika	7	0						
	4	Faaité	7	1	189	456		5		650
	5	Fakarava	7	29	2,363	464	61	3,151	71	6,110
	6	Katiu	7	0						
	7	Kauehi	7	5	191		19	359	20	589
	8	Kaukura	7	17	2,448	749		529		3,726
	9	Makemo	7	2	57	230		10		297
	10	North Marutea	7	0						
	11	Motutunga	7	0						
	12	Niau	7	2		311	30			341
	13	Raraka	7	6	57	145	25	740	222	1,189
	14	Raroia	7	2	4,000		26	8		4,034
	15	Tahaa	7	1	19			32		51
	16	Tahanea	7	0						
	17	Toau	7	22	373			1 163	47	1 583
	18	Vahitahi	6	0						
Total 2017		11/18 islands active	118	104	9,714	2,355	161	6,643	451	19,324
Overall total			318	287	33,483	13,632	1,012	32,207	3,053	83,387
		Mean or %	80	115	40.2%	16.3%	1.2%	38.6%	3.7%	

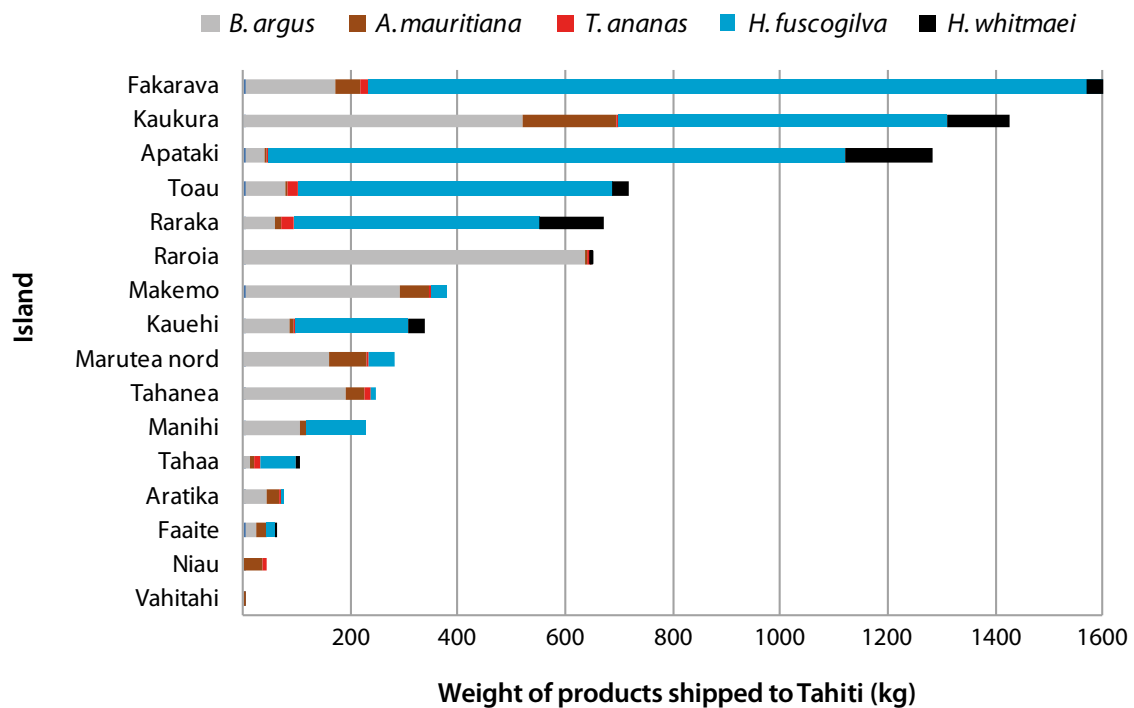


Figure 6. Island ranking by average annual production from 2014 to 2017.

Table 11. Fishers' preferences for certain sea cucumber species in the different islands.

Species	Islands		
	Highly targeted species >75%	Mainly targeted species >50%	Species absent, rare or not targeted < 5%
<i>Holothuria fuscogilva</i> and <i>H. whitmaei</i>	Apataki, Fakarava, Raraka, Toau	Kauehi, Tahaa, Kaukura	Vahitahi, Niau, Raroia, Aratika, Tahanea
<i>Bohadschia argus</i>	Raroia, Makemo	Tahanea, Aratika, Marutea nord	Vahitahi, Niau, Apataki
<i>Actinopyga mauritiana</i>	Vahitahi, Niau		Toau, Apataki, Raroia, Raraka, Kauehi, Fakarava, Manihi
<i>Thelenota ananas</i>	none	none	All the islands except Niau

Table 12. Details of 2014–2017 shipments and final destination (in numbers of specimens per year).

Year	Shipments to Tahiti	Seized	Local sales	Export	Not sold
2014	16,862	235	7	16,610	10
2015	18,258	24	0	18,234	0
2016	28,943	89	191	28,103	560
2017	19,324	32	785	18,507	0
Total	83,387	380	983	81,454	570
%		0.5%	1.2%	97.7%	0.7%

Table 13. Sea cucumber exports from French Polynesia from 2014 to 2017.

Year		Species					Overall total
		<i>Bohadschia argus</i>	<i>Actinopyga mauritiana</i>	<i>Thelenota ananas</i>	<i>Holothuria fuscogilva</i>	<i>Holothuria whitmaei</i>	
2014	number	7,773	3,106	167	5,254	310	16,610
	kg	1,220.1	307.6	43.4	2,227.6	157.5	3,956.1
2015	number	4,511	4,781	83	8,114	745	18,234
	kg	676.8	371.5	25.0	3,350.1	344.8	4,768.2
2016	number	10,679	3 318	459	12 100	1 547	28,103
	kg	1,871	306	121	4,842	648	7,787.3
2017	number	8,988	2,355	138	6,582	444	18,507
	kg	1,684.6	236.0	45.7	2,867.6	208.4	5,042.3
Overall total	number	31,951	13,560	847	32,050	3,046	81,454
	kg	5,452.0	1,221.0	234.9	13,287.3	1,358.7	21,553.9
	% kg	25.3%	5.7%	1.1%	61.6%	6.3%	

4.2 Marketing

Sea cucumbers shipped from the various islands of French Polynesia to Tahiti are then either sold on the local market, exported, seized or not sold. Details of shipments between 2014 and 2017 are given in Table 12.

Exports accounted for almost 98% of output by number and 96% by weight. Between the time sea cucumbers left the outer islands and were exported, the processed products lost some of their mass, either as a result of natural dehydration or because the exporter wanted to improve their processing. *H. fuscogilva*, *H. whitmaei* and *A. mauritiana* lost,

on average, 13–16% of their weight, whereas *B. argus* and *T. ananas* lost 9% and 2%, respectively.

The quantities sold on the local market and the amounts seized following trader inspections are also known, and are presented in Table 14. Sales on the local market concern only two species to date, *B. argus* and *H. fuscogilva*.

With regard to seizures, the existing web application can be used to configure a plausible range of values for the average weight of the various species that were shipped. If the weight is clearly less than the lowest value in the range, there is a strong likelihood that specimens of less than standard size were present, which may trigger an inspection of the trader by the Fisheries Department. The amounts seized between 2014 and 2017 are presented in Table 15.

Accounting differences between the quantities shipped and the quantities previously indicated are the result of products

that were apparently not sold and, thus logically, were eaten in Tahiti. This concerned 570 specimens in 2016, representing a weight of about 90 kg, 92% of which were *B. argus*.

4.3 Exports

The Fisheries Department also collects data on the value of exported products via Customs. The data are compiled monthly for all species. Except for the data on the number of specimens in 2014, when there was a shortfall of 3,673 individuals, very slight differences exist between the data compiled by the Fisheries Department on the products intended for export and Customs data (Table 16).

The entire exported output consisted of dried products (beche-de-mer), all of which were air shipped to Hong Kong. In four years, 21 t of goods, representing a declared customs value of XPF 180 million, were exported by seven sea cucumber traders.

Table 14. Local market sales from 2014 to 2017.

Year		Species		Overall total
		<i>Bohadschia argus</i>	<i>Holothuria fuscogilva</i>	
2014	number	7		7
	kg	3.0		3.0
2016	number	166	25	191
	kg	38.0	12.0	50.0
2017	number	726	59	785
	kg	150.0	28.5	178.5
Overall total	number	899	84	983
	kg	191.0	40.5	231.5
	% kg	82.5%	17.5%	

Table 15. Seizures from 2014 to 2017.

Year	Trader	<i>Bohadschia argus</i>	<i>Actinopyga mauritiana</i>	<i>Thelenota ananas</i>	<i>Holothuria fuscogilva</i>	<i>Holothuria whitmaei</i>	Overall total
2014	1			112			112
	2			3			3
	3	110	4		6		120
Total 2014		110	4	115	6	0	235
2015	1		23	1			24
Total 2015		0	23	1	0	0	24
2016	1		25	19	45		89
Total 2016		0	25	19	45	0	89
2017	1			23	2	7	32
Total 2017		0	0	23	2	7	32
Overall total	4	110	52	158	53	7	380
	%	28.9%	13.7%	41.6%	13.9%	1.8%	

Table 16. Annual exports from 2014 to 2017

Parameter	2014	2015	2016	2017	Total
Number of active traders	5	3	3	3	7
Number of specimens	12,937	18,234	27,913	18,481	77,565
Weight in kg	3,930	4,735	7,639	5,002	21,306
Value in XPF	25,867,755	45,721,623	67,730,159	40,768,193	180,087,730
Average XPF price per kilo	6,582	9,656	8,866	8,150	8,452
Percentage of <i>Hf</i> and <i>Hw</i>	60.3%	77.5%	70.5%	61.0%	68.0%

Source: Customs data



Figure 7. Annual exports from 2008 to 2017. Source: Customs data

Prices vary from year to year, essentially because of the proportions of *H. fuscogilva* and *H. whitmaei*, which account, on average, for 68% of total exports. As those two species are the most highly prized, the average price obtained each year varies in direct proportion to their share of exports.

Prices improved overall between 2014 and 2017 because even though the proportions for the two most prized species remained the same, the average price rose by 24%.

A comparison of the harvests in recent years with those that took place between 2008 and 2013 shows that in addition to the more accurate information obtained on the species and the places they were harvested, there were two major changes (Fig. 7): 1) a steep drop in the number of tonnes harvested, from 132 t (including 88 t of dried product) in 2012 to between 4 t and 8 t of dried product annually between 2014 and 2017; and 2) a substantial rise in declared export prices, which rose from XPF 2,320 kg⁻¹ for dried products in 2013 to between XPF 6,500 and 9,600 kg⁻¹ for the period 2014–2017.

5. Conclusions

The introduction of harvest regulations, which led to the re-opening of certain lagoons to sea cucumber fishing, generally speaking resolved most of the obvious problems observed in 2012, in that it:

- sharply decreased the harvest rate for certain species from islands where harvesting was allowed;
- increased the value of products because of the promotion of dried products;
- enabled all fishers to process the products themselves and, in that way, to benefit from the added value associated with this activity;
- sharply reduced product wastage;
- made it more difficult for both fishers and traders to cheat due to an effective system of product traceability;
- forced processors to adopt more hygienic practices;
- involved the communities in implementing the government's authorised harvest project; and
- restricted the role of public authorities to granting authorisations and their control, directly from Tahiti.

The regulations also served to build up a database on harvested or marketed products by weight and number, species and geographical origin. The main negative effect is, no doubt, the drastic drop in activity for many islands in which harvest authorisations were not renewed, given that the value of exports plummeted from roughly XPF 200 million between 2011 and 2012 to XPF 45 million between 2014 and 2017. Was the 2011–2012 level of exploitation sustainable? Probably not.

While guaranteeing the sustainable development of this fishery, certain islands already involved in harvesting could improve their turnover by more specifically targeting *B. argus*, which predominates in most lagoons, and the harvest season could be extended to other average-sized or large atolls.

References

- Andréfouët S., Chauvin C., Spraggins S., Torres-Pulliza D. and Kranenburg C. 2005. Atlas des récifs coralliens de Polynésie française. Centre IRD de Nouméa. 38 pages + 86 planches.
- Biodax Consulting. 1998. Rapport final relatif à la réalisation d'une étude préalable sur l'exploitation des bèches-de-mer (*rori*). Biodax Consulting R.C 23 760 – A N° TAHITI 336 255. 102 p.
- Lucett E. 1851. Rovings in the Pacific from 1837 to 1849, with a glance at California. London, United Kingdom: Longman, Brown, Green and Longmans. 390 p.
- SNC Pae Tai – Pae Uta Études Environnement. 1997. L'exploitation des holothuries en Polynésie française. Polynésie française, Papeete : Service de la mer et de l'aquaculture. 69 pages + 9 Annexes.

Forty years of small-scale tuna fishery development in the Pacific Islands: Lessons learned

Robert Gillett,¹ Michel Blanc, Ian Cartwright, Mike Batty, Mike Savins, Joelle Albert, Noah Idechong, Mainui Tanetoa, Tricia Emberson and William Sokimi

1 Background

There has been a long heritage of attempts to promote tuna fishing from small boats in the Pacific Islands region. A fisheries specialist visited Fiji in the late 1930s and recommended a better type of small boat and new fishing methods to allow small-scale commercial fishing to expand into offshore areas (Hornell 1940). Following this, at the very first fisheries conference of the (then called) South Pacific Commission (SPC) in 1952, several possibilities for small craft tuna fishing were discussed (SPC 1952). In the early 1960s, SPC produced a manual on tuna trolling (Devambeze 1962). Since that early period, attempts to develop small-scale tuna fishing have proliferated. Box 1 lists the various interventions used to develop small-scale tuna fishing² in the last few decades.

Why has there been so much interest in promoting small-scale tuna fishing? The existence of large tuna resources in the region is certainly a factor but other issues are involved. This includes the thinking that indigenous Pacific Islanders have missed out on the benefits of industrial fishing operations, or that by using small boats and having low entry costs, there is an opportunity for a large number of people to reap benefits. In previous decades, the coastal fishery extension backgrounds of many fisheries officials in senior positions may have contributed to the preference for small-scale development when dealing with tuna. Overall, the governments of all Pacific Island countries feel an obligation to help small-scale fishers, and there has been much enthusiasm for linking this with the large tuna resources of the region.

Only a few of the attempts at small-scale tuna fishery development listed in in Box 1 have been successful and have led to the establishment of new fisheries or the sustained enhancement of existing ones. Reasons for this are complex and likely to vary across locations.

Considering the large number of initiatives to promote small-scale tuna fishing (and plans for more), there has been surprisingly little effort to consolidate what has been learned from past attempts. From a historical perspective, failed initiatives have often been repeated apparently without knowledge of the previous work. Conversely, some successes have

gone unrecognised. It is therefore opportune to review past efforts, determine what has been successful and unsuccessful, and provide guidance for the future to the individuals, organisations, and governments wishing to develop small-scale tuna fisheries in the region

2 Identifying the lessons

During 2017 the Food and Agriculture Organization (FAO) of the United Nations and the Pacific Community (SPC, formerly the South Pacific Commission) discussed ways that the two agencies could cooperate in the development of small-scale tuna fisheries in the region. One of the ideas that emerged was to bring together a small group of people highly experienced in small-scale tuna fisheries development to discuss what has occurred in the past, consolidate the experiences, and focus on common features that emerged, with a view of providing guidance for the future. Accordingly, the SPC/FAO Consultation on Small-Scale Tuna Fishery Development and Associated Value-Chains in the Pacific was convened 2–3 October 2018 in Noumea, New Caledonia.

The consultation was attended by the authors as well as by select SPC staff. During the consultation it was determined that the combined experience of the 10 participants in small-scale tuna fisheries development in the Pacific Islands region accounted for about 300 person years.

The consultation and the experience of the participants were the primary sources of information for this paper. Additional sources included documents assembled for the consultation, fieldwork on small-scale tuna fishery development in August 2018, and further reflection by participants on several issues after the consultation.

To structure the discussions in the consultation, key themes in the development of small-scale tuna fisheries were identified, and some of these were modified and/or consolidated. The resultant list consisted of 10 key themes: 1) FADs, 2) fisher associations, 3) safety, 4) subsidies, 5) interactions with large-scale tuna fisheries, 6) boats, engines and fuel use, 7) post-harvest aspects, 8) the role of women, 9) data, and

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

² In this document 'small-scale tuna fishing' is defined as fishing for tuna from boats without decks or with partial decks.

Box 1: Past small-scale tuna fishery development efforts in the Pacific Islands

Work related to fish aggregation devices (FADs)

- Demonstration of FAD trolling techniques
- Design and construction of FAD buoys
- Improvement in FAD deployment techniques
- Conducting economic studies
- Provision of FAD fishing workshops
- Provision of FAD fishing safety training workshops
- Maintenance of FADs
- Facilitation of FAD materials ordering
- Determining optimum number of FADs in an area
- Encouragement of national FAD programmes

Gear and techniques

- Promotion of vertical longlining
- Promotion of tuna handlining
- Promotion of Maldivian-style tuna fishing
- Revival of traditional small-scale tuna fishing techniques
- Use of plastic pearl shell lures to facilitate the supply of gold-lip pearl shell for lures
- Replacement of Kiribati and Tuvalu tuna fishing in Nauru
- Promotion of pump boat fishing
- Trials involving small-scale pelagic gillnetting
- Promotion of Hawaiian techniques: palu ahi, ika shibi
- Testing capture of bait for tuna fishing: flyingfish, selar
- Trials of small-scale pole-and-line fishing from open boats in Samoa and Tuvalu
- Diversification of canoe tuna fishing

Vessel work

- Design of vessels for small-scale tuna fishing
- Promotion of sail power for offshore fishing
- Promotion of Oregon surf dory
- Testing of outboards: diesel outboards, standardization, fuel-use studies, 4-stroke engines
- Promotion of inboard diesels

Government interventions to protect small-scale tuna fisheries

- Banning the sale of industrially caught tuna and encouraging the sale of catch retention
- Establishing buffer zones
- Banning purse seining or all types of foreign industrial fishing
- Mitigation of range contraction*
- Enshrining in the basic documents of FFA and WCPFC the concept of avoiding adverse impacts on small-scale tuna fishers

Studies related to the Samoan alia vessel

- Study tours to Samoa, visits by Samoan fishers to other countries
- Purchase of an alia in Samoa for use in other countries: Tonga, Samoa, Fiji
- Enlargements of hulls
- Safety improvements
- Ice improvements
- Reviews of the Samoan alia by FFA, SPC, FAO and other organisations
- Study of fuel use
- Design and test of emergency sails

Post-harvest activities

- Piggybacking with larger-scale operations: air transport, wharves, cannery
- Improving onboard icing of fish
- Promoting the use of insulated fish bags
- Organising fish collection in outer islands
- Organising refrigeration in outer islands
- Setting up of fisheries centres
- Promoting alternative tuna products, such as jerky, fish balls, tataki
- Trialling tuna cake recipes
- Promoting fish recipes
- Providing fish handling training

Other

- Vessel construction and operation subsidies
- Supporting associations of small-scale fishers
- Upscaling to longline fishin
- Linking up with the tourism sector (e.g. restaurants and sport fishing)
- Harbour construction and management

* The historical geographic range of a stock of tuna can cover a large area. When that stock becomes overexploited, the geographical area can shrink. Some governments have intervened to reduce the amount of that contraction.

10) government interventions. It was recognised that, while these themes would be considered one-by-one, the reality is there is considerable overlap.

3 Discussion of key themes

In this section each key theme is considered with respect to background and observations, lessons learned, and recommendations.

There is a need to be cautious when trying to identify lessons learned and recommendations. Often, successes or failures are dependent on the local context: in other words, what works well in one village or community, may not work in the next province or even the next village. This comment is particularly relevant to small-scale tuna fishery development, which involves many different drivers (sociocultural, economic, logistical, environmental). Following from this concept, the 'lessons' below are generally applicable to most locations, whereas 'observations' are more limited in scope, much less analytical in nature, and tend to be statements of facts.

3.1 FADs

Background and observations

In reviewing the history of development of small-scale tuna fisheries, one of the most successful initiatives has been, and continues to be, the introduction of FADs. After decades of small-scale tuna development efforts throughout the Pacific Islands, FADs remain one of the few innovations that allow small-scale fishers to economically take advantage of the region's large tuna resources. Overall, nothing comes close

to producing ongoing benefits to small-scale tuna fishers as the FAD. Other important features of FAD use are:

- they can be successfully used at one location in a given country but not necessarily elsewhere in the same country;
- there is very limited information concerning the costs and benefits associated with FAD use (e.g. for each dollar spent on FADs, the amount of extra fish that could be caught);
- SPC assistance to national FAD programmes has been very effective in the past, but it should be recognised that the requirements of those programmes are evolving and there is now a need for assistance in more institutional aspects, such as providing advice on creating good national FAD programmes (SPC 2017); and
- FAD designs and technology will continue to evolve, and technical assistance and research continue to be needed in support of national FAD programmes.

Main lessons learned

- Governments that are serious about developing small-scale tuna fisheries need to be serious about having a well-funded, well-organised national FAD programme. Such a national FAD programme would need to not be reliant on volatile donor or regional organisation funding or expertise, and would need to have mechanisms in place to enhance the status and sustainability of the programme within the government fishery agency.
- Fisher associations can effectively catalyse and drive FAD programmes.



Fish aggregating devices moored close to shore have, in some places, facilitated canoe fishers' access to tuna resources – Nauru, 2007. (image: William Sokimi, SPC)

- Effective stakeholder engagement and local knowledge is required before and after deployment in order to validate deployment location, increase ownership, reduce conflicts and maximise the longevity of the FAD.
- Current FAD fishing is largely limited to surface trolling, but other types of fishing around FADs can be quite productive, suggesting the need for training in, and the promotion of, FAD fishing techniques other than trolling.

Recommendations

To achieve strong and sustainable FAD programmes, national fishery agencies and SPC should analyse existing FAD activities and identify and address gaps. Particular attention should be paid to aspects of staff capacity, management, stakeholder engagement, and ongoing funding mechanisms.

Improved data on FAD performance, including clear identification of social and economic costs and benefits, should be obtained by national fishery agencies and SPC. This should be used to promote national investment in FAD programmes.

3.2 Fisher associations

Background and observations

There are a number of good examples in the region of small-scale fishers associations that facilitate the development of small-scale tuna fisheries. This seems to have occurred by lobbying governments to discourage certain practices (e.g. dumping of fish by industrial fishing vessels) while encouraging other practices (e.g. promoting FAD programmes). In general, fisher associations can improve the relevance of government fishery interventions, although reaching an appropriate relationship between the government and the association can be challenging. In some countries, there seems to be generally a lack of government fishery agency support for fisher associations. This is not surprising in situations where the inclination is to criticise an agency's non-performance. The tendency is to want to exclude government influence from association operations, although the reality is that fisher associations need a pipeline to the fishery agency and other governmental departments to exert their influence. Other features of fisher associations that are relevant to small-scale tuna fishery development are:

- unlike regional agencies and consultants, effective fisher associations can have a constant presence and apply pressure for positive performance;
- many associations for large-scale tuna fishers have received substantial assistance from the regional agencies (e.g. SPC and the Pacific Islands Forum Fisheries Agency), but small-scale associations have not enjoyed such assistance; and

- fisheries specialists know little about the internal machinations of successful small-scale fisher associations, and there is much to be learned from successful (and unsuccessful) associations and from producer associations in the agriculture sector.

Main lessons learned

- In the absence of effective external criticism, government fishery agencies tend to become inward looking and focus on activities that staff feel are important. Associations of small-scale fishers have been effective in getting more attention focused on small-scale tuna fishing, and are often successful in getting improved outcomes.
- Successful fisher associations are very dependent on active individuals who have the support of their peers and fellow fishers, and have pathways to decision-makers in government.
- A fisher association seems to be most effective when governments: a) formally recognise the association, b) have a process for real engagement with the association, and c) include the association in advisory committees.
- Where government fishery agency representatives act as chair and/or drive the agenda for agency outcomes, fisher associations are not usually successful from the fisher's perspective, and it is important that associations are formed around fishers' needs and wants, in order to secure their support.
- In addition to providing constructive criticism to fisheries departments, associations can also be effective in a range of other activities (e.g. promoting safety at sea, organising training activities, and attracting government and non-governmental funding), resulting in significant benefits to members.

Recommendations

Because fisher associations can be effective tools, including for improving the governance of small-scale fisheries, national and international development partners should provide support for establishing and enhancing associations of small-scale fishers. The challenges, however, in organising a collection of competitive, diverse and individualistic fishers should not be underestimated.

Government fishery agencies should recognise that small-scale fisher associations can obtain substantial benefits for fishery stakeholders, and should therefore formulate mechanisms for interacting with these associations, as many fishery agencies have done for large-scale tuna associations.

3.3 Safety

Background and observations

In the Pacific Islands region, most loss of life in small fishing boats is associated with tuna fishing. Both SPC and

FAO have had numerous initiatives during the past several decades aimed at improving the safety of small-scale fishing. Those efforts have involved safety awareness, vessel design, legislation, safety equipment, and other aspects. The cost of small boat safety equipment is falling, but there are still problems of availability and affordability, especially in outer islands. Lately, SPC has been promoting the use of ‘grab bags’, which are waterproof sacks containing essential gear (e.g. flares, beacon, radio) to be used in emergencies at sea, and there are cases in which the bags have obviated the need for expensive search-and-rescue operations. Constraints to improving the safety of small-scale fishing include: a) a scarcity of region-wide data on safety incidents, including those on vessel loss and search and rescue costs; (b) a lack of appropriate small boat regulations in many countries; c) the lack of concern among many small-scale tuna fishers about sea safety; d) inappropriate boat designs and poor construction standards; and e) poor maintenance of outboard motors.

Main lessons learned

- FADs have both positive and negative implications for sea safety. They tend to concentrate fishing effort into discrete locations but the promise of easy access to fish can lure boats into unsafe offshore situations.
- After many decades of interventions by SPC, FAO and other organisations to improve small-scale fishing safety, there remains among many fishers a relaxed attitude towards the risks of fishing offshore in small boats and associated sea safety precautions.
- There has been a remarkable improvement in sea safety in countries where appropriate safety regulations have been introduced and reinforced by ‘big stick’ (very strict) enforcement.

Recommendations

Government fishery agencies should recognise that achieving significant improvements in small boat safety is a long-term endeavour. Measures to increase safety should include the areas of legislation, enforcement, awareness, and promotion of safety equipment and safe boats. The most effective ways of getting the message across should be identified and adopted.

Government fishery agencies, SPC and donors should take steps to ensure that national FAD programmes have sea safety as a major component.

3.4 Subsidies

Background and observations

Governments in the region often use subsidies in their attempts to develop small-scale tuna fishing. Many of these subsidies involve ice making and the provision of boats and engines. These subsidies have variously been successful (resulting in a long-term increase in tuna landings), ineffective (no

noticeable effect on landings), or even disastrous (no increase in tuna but a large increase in inshore fish landings in over-exploited fisheries). In general, those subsidies that involved simply dropping off items for free to individuals or communities appear to be the least successful, while those associated with a long-term development programme seem to be the most successful. Subsidies for ice are a special case: a government role in supplying ice to locations away from urban areas could be justified as a service, but many of the ice facilities were established with the expectation – on the part of governments and recipient communities – that the facilities would be profitable, or at least not be a financial burden, but this was often not the case.

Lessons learned

- In the development of small-scale tuna fisheries, there have been both good and bad subsidies used. Evidence suggests that a good subsidy in small-scale tuna fishing has clear objectives, is transparent (if intended to be catalytic), and has a realistic exit strategy.
- In some cases, the costs of subsidies have far outweighed the benefits, such as the donation of boats to individuals and communities outside of well-planned programmes.
- There is considerable justification for *not* considering certain types of support to fisheries sectors as being subsidies. Examples include: a) support to FAD programmes as being a provision of an essential infrastructure, as roads are on land; and b) free or un-taxed safety gear as being humanitarian assistance, which avoids further costs in search and rescue.
- It is inherently expensive to produce ice and maintain and replace ice making facilities, particularly in remote locations. An operational subsidy is often required, even if the facility has been received through an aid programme. The entities receiving ice making facilities (e.g. communities, island councils) need to be made aware of the extent of ongoing expenses *prior to* agreeing to take on such facilities, which has often not been the case.

Recommendations

Subsidies to encourage small-scale tuna fisheries can be justified in some cases, particularly where they align with the achievement of clearly defined government objectives. Subsidies should be supported by a clear economic rationale, including the expected costs and benefits, and their performance should be periodically reviewed.

3.5 Interactions with large-scale tuna fisheries

Background and observations

Interactions between small-scale and large-scale tuna fisheries take place at the resource and market levels, and at fishing grounds, and these interactions can be either positive or negative. There is less biomass of most tuna stocks in the

region than there was several decades ago because of large-scale fishing (fewer tuna and often lower catch rates for small-scale tuna fisheries). Dumping and the sales of tuna from large-scale fishing in ports of Pacific Island countries can negatively affect the markets for tuna caught by small-scale fishers. On the positive side, small-scale fishing operations often use the facilities, processing establishments and transport owned and operated by large-scale businesses (i.e. 'piggybacking'). Licence fees from large-scale tuna fishers have been used in some countries for small-scale tuna fishery development purposes.

Lessons learned

- There are considerable potential benefits from small-scale operations piggybacking on larger operations, including processing and marketing, transport and refrigeration. In fact, many of the existing small-scale tuna fisheries in the region would not exist without this piggybacking (e.g. the alia fishery in Samoa).
- The reality is that the large-scale tuna fisheries of the region are not going away. The most sensible strategy for dealing with their interaction with small-scale fisheries seems to be taking advantage of the positive interactions, and mitigating the negative ones.

Recommendations

Government fisheries agencies and donors should facilitate piggybacking whenever possible, including in the areas of marketing and processing, ice supply, wharf space, mechanics and technicians, and transport. As to mitigating the negative interactions, the advice given by SPC in 2013 is consistent with historical experience and remains valid today:

- establish industrial fishing exclusion zones to reduce direct competition between industrial and small-scale fisheries;
- install nearshore anchored FADs to increase the accessibility of tuna to compensate for catch declines;
- improve knowledge about the national catch and catch rates from small-scale fisheries;
- strengthen small-scale fisher associations and increase their participation in national tuna management planning forums; and
- promote management measures that address the special needs of artisanal fisheries through the Western and Central Pacific Fisheries Commission.

3.6 Boats, engines and fuel use

Background and observations

Some of the most expensive efforts to develop small-scale tuna fisheries were the long-term FAO projects that designed

vessels, trained people to build them, and taught offshore fishing techniques in Fiji, Tonga, Samoa, Kiribati and Vanuatu. In most of these locations, when the vessel construction subsidies ceased, the building of those boat designs also ceased. But, in Samoa and Kiribati, the building of FAO-designed vessels has continued. In Vanuatu and Tuvalu some locally built designs adopted in development projects also remain popular. The alia catamaran was designed in the early 1980s and has been very popular in Samoa. Despite many study tours by fisheries officers of other Pacific Island countries to Samoa to study the alia, and despite the many positive reviews of the alia, the adoption of that design outside Samoa has not occurred. Another feature of small boats in the region is that some designs are inherently unsafe for tuna fishing.

Within the region's small-scale tuna fisheries, boat propulsion is highly dominated by two-stroke petrol outboard engines. Although the use of outboards is, to some degree, ingrained in the culture of small-scale commercial fishing in the Pacific Islands, the engines are highly fuel consumptive. A World Bank study (Wilson and McCoy 2009) found that, in general, a small-scale tuna fishing boat uses about twice as much fuel per kilogram of fish than a purse seine vessel. Inboard diesel engines use less fuel and are prolific in Southeast Asia and elsewhere, but small-scale fishers in the Pacific currently have a strong preference for outboards, which typically use gasoline, due to their portability and lower capital cost. Opinion is divided on four-stroke outboards: they reduce fuel and oil consumption, and savings can justify the higher capital cost if they are used regularly, but maintenance is more difficult. FADs reduce fuel consumption in small-scale tuna fisheries because tuna and other pelagic fish species concentrate around FADs, thus reducing the need to fish over a wide area.

Lessons learned

- The introduction of new boat designs for small-scale tuna fishing is characteristically successful only when accompanied by long-term technical assistance and subsidies. The preferences and prejudices of fishers can be very strong, and the effective introduction of new vessel designs is usually a long-term process.
- The viability of small-scale tuna fishing operations is strongly affected by the relatively high fuel use of outboard-powered boats. When high national costs for fuel are combined with fuel-intensive fishing, the result can be little small-scale tuna fishing or expensive tuna in local markets.
- There are considerable challenges in introducing inboard diesel engines into the Pacific Islands for small-scale tuna fishing, despite potential advantages, including low fuel consumption.
- Apart from fuel subsidies, one of the few ways in which the high cost of fuel for small-scale tuna fishery can currently be mitigated is through the use of FADs.

Recommendations

When contemplating the introduction of new boat and/or engine designs, government fishery agencies, donors and other development partners should recognise that there is little chance of success unless there is a long-term, well-planned programme of assistance to accompany the introduction, and unless there is support from fishers.

Government fisheries agencies, donors and other development partners should also recognise that yet another positive attribute of the FAD for promoting small-scale tuna fishing is lower fuel consumption.

3.7 Post-harvest

Background and observations

Small-scale tuna fisheries face many difficulties with regard to post-harvest. The cost of skipjack caught by purse-seined vessels (recently USD 1,450–2,300 per tonne delivered in Bangkok) is very low compared with tuna from small-scale fisheries, and small-scale tuna fishers cannot compete in the same markets with commercial fishers. The offloading of fish from large-scale tuna vessels in Pacific Island ports can have negative effects on the marketing of fish from small-scale fisheries. Much of the tuna from small-scale fishing is caught away from urban centres but government fish collection and transport to those centres is often erratic and expensive. The availability of tuna from small-scale tuna fisheries often oscillates between abundance and scarcity. On the positive side, the production of novel fish products in Kiribati, Fiji, and elsewhere suggest there is considerable potential in situations where innovative entrepreneurs work with the production from small-scale tuna fisheries. In several countries there are large tuna catches in the outer islands that sell for very low prices. Other opportunities include:

- piggybacking on the transport, processing and export facilities of larger-scale operations, both inside and outside the fisheries sector;
- producing non-perishable tuna products (e.g. dried or smoked, tuna jerky), especially in remote areas; and
- partnering with tourism and relatively price-insensitive tourists.

Lessons learned

- The low price of purse-seine-caught skipjack, and the complexity and costs associated with the export process, generally constrains the small-scale tuna catch to the domestic market.
- The domestic market for small-scale-caught tuna can be adversely influenced by landings of high-quality, large-scale longline bycatch. The landing of poor-quality skipjack has fewer negative effects on small-scale tuna fishers

and can be an important source of food for impoverished households.

- Piggy-backing on large-scale commercial operations provides a range of opportunities, especially with regards to transport, processing and marketing. However, in situations where the operator of the piggyback facility is also the only buyer of small-scale tuna, prospects can be diminished.
- Government fish collection in the outer islands is mostly erratic, expensive and inefficient. When the transport of products is a major constraint, there are considerable advantages to relying on existing inter-island shipping services (many of which are subsidized) rather than relying on government-organised fish collection operations, which rarely last long.
- The many tuna jerky initiatives in the region have mostly failed except where there has been exceptional managerial talent and determination. High-value domestic markets are limited, export initiatives suffer from daunting logistics, and in many markets there is competition with overseas jerky producers and their associated economies of scale.

Recommendations

Government fishery agencies and development partners should refrain from becoming involved in outer island fish collection schemes unless they are willing to make a very long-term commitment to substantial subsidies.

Those agencies and/or partners should recognise that improved transport, handling and processing (including development of non-perishable products) has considerable potential to add to the viability of small-scale tuna fisheries. Government fisheries agencies and development partners should promote and facilitate the establishment or strengthening of small-scale tuna post-harvest activities.

3.8 Role of women

Background and observations

Small-scale tuna fishing has historically been 'men's business', even though women have a major role in post-harvest activities. Because decisions on actual fishing exert a large influence on post-harvest aspects, women are often excluded from involvement in major decisions associated with the very fishery that affect them. Another important aspect of women in tuna fisheries in the Pacific Islands is the semi-invisible nature of their contribution. As stated by Demmke (2006:42): 'An economic analysis of women in tuna marketing could be carried out to quantify their contribution. In the absence of such data, women's contribution remains invisible and as such, women do not acquire the support they need to improve their employment conditions in marketing.' Examples of women fishing for tuna from

small boats are extremely rare but do exist and there is the contention that no barriers to women tuna fishing should exist; but, it is uncertain how much priority should be given to this issue relative to improving post-harvest aspects where female participation is high.

Lessons learned

- In general, benefits from small-scale tuna fisheries flow mostly to men. While the contribution of women to small-scale tuna fisheries is substantial, the benefits to women have not been as great as those to men.
- In many of the small-scale tuna fisheries of the region, positive changes on the post-harvest side are often positive for women.

Recommendations

Mechanisms should be developed by government fisheries agencies and fisher associations to increase the engagement of women in the two levels of small-scale tuna fisheries: 1) the family or business level, and 2) the policy level, both locally and nationally.

3.9 Data

Background and observations

Collecting data on small-scale tuna fisheries is important for a number of reasons, including determining their national importance, and understanding the impacts of various development efforts and large-scale tuna fishing. Despite this importance, current data are poor or non-existent. Much of the data that does exist comes from relicts of former fisheries statistical systems. Another aspect of the data situation concerns the convention that established the Western and Central Pacific Fisheries Commission, in which Article 30 stipulates: 'the need to avoid adverse impacts on, and ensure access to fisheries by, subsistence, small-scale and artisanal fishers and fishworkers'. In order to 'avoid adverse impacts' there is an assumption that some form of system is in place to detect any impacts, which is typically not the case.

Lesson learned

- Despite the importance of collecting data on the catch of small-scale tuna fisheries, the reality is that most estimates of national small-scale tuna catches are poor, and recent efforts to improve the situation have not been very effective.

Recommendations

Agencies involved with fisheries statistics in the region should focus more attention on improving the methodology of collecting information on the production and associated trends in small-scale tuna fisheries in the region.

3.10 Government interventions to develop small-scale tuna fisheries

Background and observations

Many of the large number of development efforts listed in Box 1 above are government interventions, and some observations can be made about those interventions. In the quest by governments to develop small-scale tuna fisheries over the years, there has been much 're-invention of the wheel' and repetition of past mistakes. The interventions have been both components of well-planned development programmes and short-term ploys to obtain political support.

Lesson learned

- Government initiatives that generally seem to work in the development of small-scale tuna fisheries include: well-funded and well-organised national FAD programmes, safety programmes, provision of critical infrastructure (e.g. wharves, markets), efforts to shield small-scale fishers from the negative effects of large-scale tuna fishing, and maritime school training.
- Government initiatives that generally seem *not* to work: Government fish collection schemes and 'giveaways', especially a) in the absence of a well-designed programme (e.g. the dropping off of a few boats), and b) setting up activities that undermine or conflict with the commercial sector.

Recommendations

Government fishery agencies in their support of small-scale tuna fisheries development should only be involved with, or accept project interventions that, have been subjected to a thorough practical and economic analysis.

Because there is considerable historical experience in small-scale tuna fishery development in regional organisations (especially at SPC), countries should take advantage of that knowledge and seek advice on small-scale tuna fishery development plans to increase the chances of success and lessen the possibilities of repetition of past mistakes.

4 Locations and development potential

Noting the relative success of FADs in small-scale tuna fishery development, an internally funded and well-organised national FAD programme that is effectively institutionalised into the government fisheries agency is of great importance in the development of small-scale tuna fisheries in the Pacific Islands region. Having stated this, FADs are not the complete or total solution to developing small-scale tuna fisheries. Experience shows that there are locations in the region where FADs exist but do not result in significant landings by small-scale tuna fishing (e.g. Ra Province in Fiji), and other areas where there is a substantial small-scale tuna fishery without FADs (e.g. April 2017 to May 2018 at Kadavu Island).

From this example and other experiences, it appears that several features must be present at a location for the development of a small-scale tuna fishery, some of which can be engineered (e.g. a FAD, the teaching of fishing techniques) but some are inherent characteristics of the site itself, such as the availability and/or abundance of fish, favourable geography, a local tuna fishing heritage, and features of the local economy. Because site characteristics cannot be easily addressed by fisheries development efforts, it follows that not all coastal locations have equal potential for the development of small-scale tuna fisheries. Appropriate site selection (i.e. the presence of favourable non-engineerable factors) is, therefore, crucial for the success of a small-scale tuna fishery.

There is also an urban–rural dimension to development potential. Experience shows that small-scale tuna fisheries that are based in urban areas usually have lower prices for fuel, higher fish prices, larger markets, and easier access to repairs and spare parts. But, urban locations do not necessarily have favourable geography or fishers with a strong tuna-fishing heritage.

Following from the above sentiment, in their quest to develop small-scale tuna fisheries, government fishery officials must reconcile two very different concepts: 1) all coastal communities deserve support to develop their small-scale tuna fishery, and 2) some sites have much more potential than others.

5 Concluding remarks

In the development of small-scale tuna fisheries, what have been the most important lessons learned and the strongest recommendations? The most prominent appears to be that developing small-scale tuna fisheries is not an easy process, and that government fishery agencies should not repeat the many mistakes that have been made in the past. Other important key lessons and recommendations that have emerged from this study are described below.

- The FAD is undoubtedly the most important tool for the development of small-scale tuna fisheries; however, sporadically deploying FADs when external resources allow is not a good strategy. Government fishery agencies that are serious about small-scale tuna fishery development should also be serious about a well-funded, well-organised national FAD programme.
- Small-scale fisher associations have the potential to catalyse and drive FAD programmes, identify training

needs, assist in data collection, and contribute to better coastal fisheries governance. Government fishery agencies should recognise that small-scale fisher associations can obtain substantial benefits for fishery stakeholders, and should therefore formulate mechanisms for interacting with these associations. National and international development partners should provide support for establishing and enhancing fisher associations.

- Encouraging small boat owners to venture offshore in search of tuna has significant sea safety implications. Government fishery agencies should ensure that their national FAD programmes have a sea safety component.

The development of small-scale tuna fisheries could result in significant benefits to Pacific Island countries in terms of contributions to both food supplies and cash income. The chances of success of that development would be much greater if attention is paid to the lessons learned from past initiatives in small-scale tuna fisheries development.

6 References

- Demmke P. 2006. Gender issues in the Pacific Islands tuna industry. DEVFISH Project, Pacific Islands Forum Secretariat and Secretariat of the Pacific Community. 51 p.
- Devambe L. 1962. The activities of the South Pacific Commission in the field of fisheries. South Pacific Commission Fisheries Technical Meeting (Noumea, New Caledonia, 5–13 February 1962). 9 p.
- Hornell J. 1940. Report on the Fisheries of Fiji. Government Printer, Suva.
- SPC. 1952. Fisheries conference : Noumea, 14th-22nd May 1952: Report (revised). Noumea, New Caledonia: South Pacific Commission. 46 p.
- SPC. 2013. Balancing the needs: Industrial versus artisanal tuna fisheries. Policy Brief 22/2013, Secretariat of the Pacific Community. 4 p.
- SPC. 2017. Sustainable national artisanal FAD programmes: what to aim for. Policy Brief 31/2017, Pacific Community. 4 p.
- Wilson J. and McCoy M. 2009. The energy costs and fishing study. p. 470–480. In: Fisheries in the Economies of Pacific Island Countries and Territories. The World Bank, Washington. 483 p.

© Copyright Pacific Community (SPC), 2019

All rights for commercial / for profit reproduction or translation, in any form, reserved. SPC authorises the partial reproduction or translation of this newsletter for scientific, educational or research purposes, provided that SPC and the source document are properly acknowledged. Permission to reproduce the document and/or translate in whole, in any form, whether for commercial / for profit or non-profit purposes, must be requested in writing. Original SPC artwork may not be altered or separately published without permission.

The views expressed in this newsletter are those of the authors and are not necessarily shared by the Pacific Community.

Original text: English

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