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In this issue

Editorial

In 2016, scientists from the Pacific Community estimated that bigeye tuna stocks in the western and central Pacific were 'overfished and overfishing was still occurring'. In 2017, according to the latest assessment that was undertaken by the same group of scientists: 'bigeye tuna stock is not overfished and overfishing is not occurring'. Nature can be generous, but such a rapid change in the assessment cannot only be due to good fortune and it requires further explanation. Although Mother Nature did play a role in the increased number of fish that are able to reproduce (the spawning biomass), most of the upturn is due to a change in some of the scientific parameters that were used for the assessment. John Hampton, SPC Chief Scientist (Oceanic Fisheries), explains the situation in detail in his excellent article 'What is going on with bigeye tuna?' (p. 24).

Based on past assessments, the management decisions that were made to reduce fishing pressure on bigeye tuna probably impacted the revenue of tuna fishing companies and those who are responsible for tuna fishery management at the country level will find it difficult to explain the change; however, at least they will be announcing 'good news'.

'On the positive side' as John notes in his conclusion 'it does seem as though the science process has worked as it should'. While some degree of uncertainty always remains with stock assessments, it now seems likely that bigeye is out of the red zone and joined the other three main tuna stocks of the western and central Pacific – skipjack, yellowfin and albacore – in the green zone. Let's hope sound scientific processes followed by wise management decisions will keep them there for many years!

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Juvenile bigeye tuna tagged and ready to be released (image: Jeff Dubosc)

Prepared by the Pacific Community, Division of Fisheries, Aquaculture and Marine Ecosystems, Information Section

The e-volution of fisheries monitoring:

The implementation of e-reporting and e-monitoring tools in longline and purse seine fisheries

Necessity is the mother of invention: We need new tools, let's build them!

Many Pacific Islands countries and territories (PICTs) rely on the harvest of seafood resources for both subsistence and economic growth. Oceanic fisheries monitoring programmes have been successfully implemented over the last five decades in the region. The information resulting from this monitoring has allowed countries to understand the dynamics of their marine resources and to make informed management decisions to ensure its sustainable harvest. The majority of fisheries monitoring data are reported on paper forms and are then manually entered into databases by technicians. The time span between data collection in the field and its availability in a database is variable but generally long (weeks to months).

Recognising the delicate nature of marine renewable resources, especially in the face of climate change and increases in fishing efforts, it is evident that fisheries monitoring programmes need to evolve. Scientists now need rapid and reliable data to ensure management decisions can be taken in as near to real time as possible. Fisheries monitoring tools using electronic technologies are needed to meet this goal. For the past five years, the Pacific Community (SPC) has been collaborating with its member countries, regional fisheries management agencies, the fishing industry, technology providers and non-governmental organisations to design, build and test new electronic fisheries reporting and monitoring tools. This article aims to provide an overview of this electronic evolution.

Electronic logsheets: From trials to implementation

Fishing vessels operating in member countries' exclusive economic zones (EEZs) are required to provide their effort and catch data. This standardised information is conventionally referred to as the logsheet and is essential to fisheries managers. The two main types of fisheries occurring in the region are purse seine and longline fisheries.

In 2013, the computer-based electronic reporting tool eTUNALOG was developed by SPC and initially tested in the Solomon Islands' purse seine fishery. Successful results led to other regional purse seine fisheries using this tool. Concurrently, in Papua New Guinea's purse seine fishery, the tablet-based electronic reporting tool iFIMS was developed with successful trials leading to other associated countries also testing this tool. Today the iFIMS tool is in routine use on most purse seine vessels that are licenced to fish in PICTs' EEZs.

Later on, the eTUNALOG application was also developed to allow longline vessels to electronically report their logsheets. Continued innovation led SPC to develop a new tablet-based application in 2016, OnBoard, which is now being implemented across longline fisheries that target southern albacore tuna.

The implementation of these e-Log tools offers considerable advantages, including in-built data validation processes that ensure high quality data. The data itself is either transmitted to database systems directly from the vessels at sea when they are equipped with satellite connectivity equipment, or when the vessels come back to port and can connect to mobile or Wi-Fi networks. This results in fisheries authorities having quality data submitted in near real time.

Empowering fisheries observers: Connected eyes and ears at sea

Across the region, in the purse seine fishery, it is a legal requirement for each vessel to embark a fisheries observer who is assigned to independently report on effort and catch activities. Such information is also essential to fisheries managers as it is compared with logsheet data for validation. Fisheries observers are the backbone of fisheries monitoring programmes and they deserve to be empowered using modern tools.

Electronic reporting (ER) tools have been developed to allow observers to report their data in near real time by transmitting their data using satellite connectivity systems. These tools not only ensure higher quality data as a result of data validation processes but they also provide safer working conditions as observers are able to communicate with shore parties independently of the vessels' communication systems.

There are 18 PICTs currently implementing electronic reporting tools for fishers or observers. The degree of implementation varies from some countries having started their initial trials and others having committed to full implementation by early 2018.

Video electronic monitoring: A useful complement to existing observer programmes

In 2014, Solomon Islands was the first to experiment on the use of a video electronic monitoring (EM) system installed on-board two longline vessels in collaboration with SPC and the Pacific Islands Fisheries Forum Agency (FFA). Electronic monitoring systems consist of multiple high definition cameras and sensors mounted on the vessel to record effort and catch activities. The records are stored on storage devices, which are removed when the vessels return to port. The records are analysed by experienced observers in order to produce electronic monitoring data. Initial results indicated that video electronic monitoring is a viable tool for producing standardised observer data. While electronic monitoring cannot be used to collect all the data that on-board observers usually collect, when combined with port monitoring programmes it has the potential to increase a country's observer coverage of longline vessels. Electronic monitoring is also being tested on two purse seine vessels this year. While there is 100 per cent observer coverage on purse seine vessels, electronic monitoring has the potential to alleviate observers' tasks so they can focus on collecting more biological data, for example. In 2017, there are 37 longline vessels equipped with electronic monitoring systems across five countries. SPC has been collaborating closely with these countries and the technology provider to ensure national EM data is curated and available for reporting through an online database query system. Electronic monitoring may also offer employment opportunities for female observers who may be uncomfortable embarking on fishing vessels with all-male crews.

New Caledonia Fisheries Officer Thomas Auger (at right) presents the SPC-developed OnBoard electronic logsheet mobile application to longline vessel captain Pierre Heutro (image: M. Hosken).

ER and EM coordinators: Dedicated to the e-volution

Countries that have committed to implementing either electronic reporting or electronic monitoring, and often both together, have established new positions held by staff members who are dedicated to coordinating these new projects. Seven countries have established such positions. Two staff members at SPC are also dedicated to providing regional coordination.

As ER and EM projects continue to expand, so will the amount of data generated. In-country and regional technicians currently tasked with manually entering data into databases will see their roles evolve and their skill sets improve, and they will be able to focus on providing accurate and timely data. There are no jobs at risk of becoming redundant – quite the opposite; new jobs will need to be created to cope with an increasing data load.

Process standards: How do we do it?

In 2014, when recognising the need for countries to implement these new tools as well as the need to establish documented policies and standards for these technologies, the Western and Central Pacific Fisheries Commission (WCPFC) established the ER and EM Working Group.

From left to right: Malo Hosken, from SPC, and French Polynesia captains Moana and Freddy Lucas who are now using the OnBoard e-log application (image: M. Hosken).

This specialised working group has since met once in 2015 and again in 2016. As a result, during the thirteenth regular meeting of the Commission in 2016, the standards, specifications and procedures for electronic reporting in the region were unanimously adopted. Also in 2016, an international workshop held at SPC provided the draft process standards for electronic monitoring for longline vessels. In November this year, a similar workshop will be held at SPC to enhance the longline electronic monitoring standards as well as to draft new standards for purse seine electronic monitoring. These standards aim to guide countries and technology providers in the implementation of these new tools.

Regional implementation: Made possible from support funding

While the core of the development work has been conducted by either SPC or independent technology vendors in collaboration with the countries, major funding has been supported by environmental non-governmental organisations such as the International Seafood Sustainability Foundation, the World Wide Fund for Nature, the Environmental Defence Fund, the PEW Foundation and The Nature Conservancy. Their support has allowed SPC and member countries to establish new positions dedicated to the research and development of new tools and associated database systems, the procurement of hardware (tablets and satellite transmission devices) and the facilitation of regional trainings and workshops.

A brave new world: Towards an efficient transition

The differences between countries that are fully committed to this transition and others that are stepping into it can be attributed to the availability of human and financial resources that are needed to confidently implement these new tools, as well as to the relationships between the fisheries regulators and their fishing industries. The transition from paper-based collection systems to electronic ones also needs to be efficiently managed, including maintaining data collection standards that will ensure data continuity. The implementation of electronic reporting and monitoring tools across the region is a great challenge. This technological e-volution is, never the less, being met by people. They are empowered with imagination, dedication and a will to ensure oceanic resources remain bountiful for our future generations.

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Pacific tuna stock assessment requires regular tagging experiments

Under the auspices of the Pacific Tuna Tagging Programme (PTTP), which has provided crucial data for the assessment of the regional tuna stocks (http://www.spc.int/tagging/webtagging/) since 2006, the Pacific Community (SPC) is implementing a new tagging experiment from September to October 2017. The regularisation of large tuna tagging events on an annual basis was recommended during the last Scientific Committee (SC12 – August 2016) and confirmed at the 13th Regular Session (December 2016) of the Western and Central Pacific Fisheries Commission (WCPFC) as a high priority in order to provide regular data inputs for stock assessment and ecosystem science purposes. This 2017 tagging cruise will focus on skipjack and yellowfin tuna.

To undertake this work, SPC has chartered a pole-and-line vessel from the National Fisheries Development's (NFD) fishing fleet based in Noro, Western Province, Solomon Islands. This vessel, FV *Soltai 105*, has already served as a research platform during a large part of the PTTP and the experience of its crew members represents a major asset in the success of our tagging experiment. Once again, the scientific team reflects the Pacific multi-culturalism with no less than seven different nationalities participating to the cruise.

The research cruise is expected to start from Noro around mid-September this year and last 50 days. It is planned to release tagged tuna in the waters of Papua New Guinea (PNG) during the first three weeks of the charter before moving to the Solomon Islands exclusive economic zone for the remainder or the cruise. The research methods will be identical to previous tagging campaign work, i.e. tuna fishing using pole-and-line techniques to support tuna tagging and biological sampling, and baiting operations using the traditional Japanese bouke-ami technique.

For the in-and-out country clearances, refuelling/provisioning and for crew change, the ports of call will be Buka and Kavieng in PNG and Noro in Solomon Islands.

The Papua New Guinea and Solomon Islands Fisheries Authorities are collaborating on the project, and providing the required research permits, assistance with the vessel in-country clearance formalities, and national scientific personnel for the cruise.

Figure 1. FV *Soltai 105*, Noro fishing base, Western Province of Solomon Islands, July 2017 (image: Bruno Leroy).

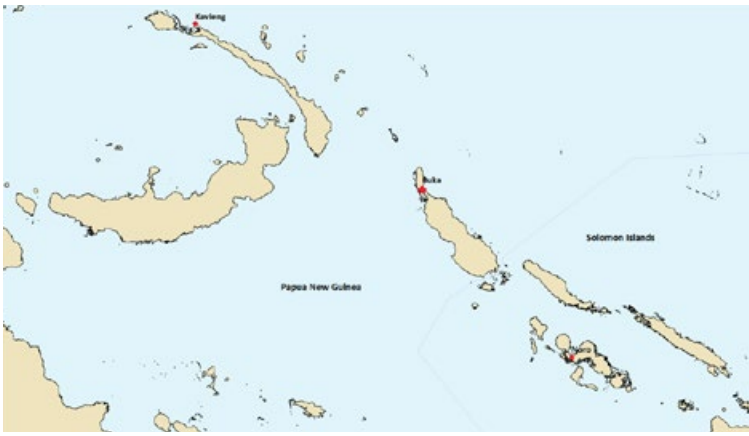

Figure 2. Approximate research area for the cruise.

Tag recovery

For this tagging programme to be successful, the recovery of tags is a priority; therefore, the training of a new Tag Recovery Officer (Patteson Omi Clifford, see Figure 3) was conducted in Honiara. Patteson, a debriefer for the Solomon Islands Ministry of Fisheries and Marine Resources in Honiara, first started as a fisheries observer and has collected data as well as biological samples. He has now become a Tag Recovery Officer and is coordinating tag recovery for Solomon Islands. At Soltuna, in Noro, Tag Recovery Officer Solomon Kakana (see Figure 4) was briefed on new data collection standards.

Figure 3. Solomon Kakana (left) and Patteson Omi Clifford, Tag Recovery Officers from Noro and Honiara, Solomon Islands, respectively.

As focal points for tag recovery in-country, Patteson's and Solomon's contribution to tagging will help better understand valuable tuna stocks. A tag recovery also nets a reward for the finder. A conventional tag is worth USD 10 whereas an archival tag is worth USD 250. Archival tags must be recovered very carefully as there have been incidents of tags being damaged when they are removed. Information pertaining to when, how and where tags were recovered can be difficult to find. Having Tag Recovery Officers who are able to discuss the registering of such information with the finders is therefore essential.

For more information on our tagging projects and to report tags, please visit our website:

www.spc.int/tagging

SPC assists Federated States of Micronesia with a sea cucumber assessment in Pohnpei

Ryan Ladore of OFA surveying a reef benthos transect (image: Pauline Bosserelle).

Sea cucumbers are an important and valuable resource in the Pacific island countries and territories (PICTs). In the face of high global demand, particularly from Asian markets for beche-de-mer, and due to a lack of effective management, sea cucumber resources in many PICTs have become overexploited. In Pohnpei, Federated States of Micronesia (FSM), the fishery has been closed since the early 1990s. However, there is renewed interest in opening the fishery.

Overview of the sea cucumber fishery in Pohnpei

Commercial sea cucumber fishing in the FSM started in the late 1800s, and sea cucumbers were harvested extensively up until the Second World War. Pohnpei State was one of the main producers, and in 1941 exported around 90 tonnes (t) wet weight of sea cucumbers (Smith 1992). World War II did not provide a reprieve for sea cucumbers in the FSM; rather, populations were heavily impacted during the war, as large numbers of soldiers based in the FSM had limited food, and subsequently harvested sea cucumbers to supplement their diets (Kinch et al. 2008). Following the war, commercial exploitation continued until around the late 1980s to 1990s; however, harvests and exports over this time were largely unregulated and poorly documented. In the early 1990s, the Pohnpei State Government realised stocks were depleted and in 1991, the senate declared a moratorium on exports. However, harvest of species – such as brown curryfish, curryfish, dragonfish, sandfish, grey impatient sea cucumber and red impatient sea cucumber – for subsistence use and for sale of processed products – such as guts and shredded body walls at the local markets – is permitted.

One-day harvest of 2016

More than 20 years into the moratorium, Pohnpei State Governments' Office of Fisheries and Aquaculture (OFA) decided to reopen the fishery in 2016.

Many stakeholders protested this decision and took the matter to court claiming that there was not enough scientific evidence to prove stocks have fully recovered and the fishery lacked a management plan and harvest strategies.

After only a day of harvest, the court ordered a temporary restraining order ceasing any further harvesting of sea cucumber until a rigorous assessment of sea cucumber stocks in Pohnpei was completed and a management plan developed.

Accordingly, the Department of Resources and Development of the FSM National Government (FSM DRD) and OFA requested assistance and technical expertise from the Pacific Community's (SPC) Fisheries, Aquaculture and Marine Ecosystem (FAME) Division.

Training and in-water survey

FAME staff travelled to Pohnpei in May 2017 to provide the training and lead the sea cucumber assessment. Before the in-water survey commenced, training on the use of SPC invertebrate in-water survey methods and species identification was conducted at OFA. The survey was conducted by staff members from SPC, OFA, Pohnpei Staff Department of Resources and Development (PS DRD) FSM DRD staff members around Pohnpei and Ant Atoll. The sampling effort was designed to cover a range of habitats within and outside marine protected areas. In all possible instances, stations were placed as close as possible to locations of a previous assessment that was conducted in 2013 by OFA, FSM DRD and SPC. All large invertebrates were counted, measured where possible and recorded using manta tow, reef benthos transect, soft benthos transect and reef front transect survey methods.

Assessment results

The 2017 survey covered an area of over 250 km^2. More than 23,000 individual sea cucumbers were recorded, and belonged to seven genera and 24 species (Table 1). Lollyfish (*Holothuria atra*) was the dominant species, representing almost 69% of all sea cucumbers observed. Other frequently encountered species were pinkfish, greenfish, snakefish, tigerfish and surf redfish.

Densities for all species – except for pinkfish on the reef flat and the coastal fringe and surf redfish on the reef crest – were below regional reference densities for healthy stocks outlined in Pakoa et al. (2014). Densities of high valued species such as white teatfish and sandfish were critically low. Comparisons of this and another recent survey by the College of Micronesia (Bougoin and Pelep 2017) with the 2013 assessment, revealed declines in densities of tigerfish, brown sandfish, black teatfish, hairy blackfish, surf redfish, sandfish and chalkfish. Mean lengths of most species were below regional common lengths, revealing that the populations in Pohnpei were largely made up of juvenile and sub-adult individuals.

Stock estimates and quotas were calculated for pinkfish and surf redfish that exceeded regional reference densities. The pinkfish population was estimated at 1,769,941 individuals, of which the harvestable stock (30% of adult population) represented 39,717 individuals, equating to just under 0.5 t dry weight. The surf redfish population was estimated at 255,354 individuals of which the harvestable stock was estimated at 11,859 individuals, equating to just over 0.5 t dry weight. A preliminary analysis of costs and benefits suggests that exploitation of these two species would be financially unsustainable for most of the parties involved.

Stakeholder workshop

At the end of the in-water assessment, a sea cucumber stakeholder workshop was organised by SPC, OFA and FSMRD on the 26 May 2017, and was held in the Pohnpei State Governor's Conference Room. More than 30 participants attended this meeting, including resource managers from national and state government, representatives from non-governmental organisations, and community leaders and chiefs.

The primary objective of this meeting was to present the preliminary results of the in-water survey of Pohnpei and Ant Atoll and to discuss the possibility of commercially

Table 1. Sea cucumber species recorded at Pohnpei and Ant Atoll during the in-water assessment in May 2017.

Common name	Scientific name	Total counts	Relative composition (%) to total no. of individuals
Lollyfish	*Holothuria atra*	15,968	68.8
Pinkfish	*Holothuria edulis*	2,788	12.0
Greenfish	*Stichopus chloronotus*	1,117	4.8
Snakefish	*Holothuria coluber*	725	3.1
Tigerfish	*Bohadschia argus*	668	2.9
Surf redfish	*Actinopyga mauritiana*	473	2.0
Curryfish	*Stichopus herrmanni*	291	1.3
Brown curryfish	*Stichopus vastus*	282	1.2
Prickly redfish	*Thelenota ananas*	173	0.7
Tiger tail	*Holothuria hilla*	162	0.7
Elephant trunkfish	*Holothuria fuscopunctata*	154	0.7
Flowerfish	*Pearsonothuria graeffei*	136	0.6
Black teatfish	*Holothuria whitmaei*	95	0.4
Red snakefish	*Holothuria flavomaculata*	83	0.4
Hairy blackfish	*Actinopyga miliaris*	32	0.1
Brown sandfish	*Bohadschia vitiensis*	22	0.1
Deepwater redfish	*Actinopyga echinites*	15	0.1
Amberfish	*Thelenota anax*	13	0.1
White teatfish	*Holothuria fuscogilva*	7	<0.1
Sandfish	*Holothuria scabra*	7	<0.1
Deepwater blackfish	*Actinopyga palauensis*	6	<0.1
Chalkfish	*Bohadschia similis*	3	<0.1
Stonefish	*Actinopyga lecanora*	1	<0.1
Spotted-worm sea cucumber	*Synapta maculata*	1	<0.1

Stakeholder meeting group-discussion on management related issues (image: Pauline Bosserelle).

harvesting sea cucumbers from around Pohnpei for export, the management of sea cucumber harvests, and the monitoring strategies for stocks.

Two presentations were delivered to the participants. The first, presented by SPC, provided preliminary findings from the survey. OFA delivered the second presentation, which focused on the 2016 harvest and the management strategies that were adopted. Following the presentations, the participants were divided into working groups to get their views on the 2016 harvest, the management that was in place, and suggestions on how harvests could be better managed in the future should sustainable harvests be deemed possible.

Stakeholders raised several issues with management strategy in the 2016 harvest, namely that there were too many (3500) permits issued, the absence of a management plan and harvest strategies, the lack of transparency when determining species quotas and species available for harvest, a lack of transparency in the selection process for the single export licence, and a lack of tracking of individual fisher permits. Stakeholders proposed several options for improving on these issues, which will be invaluable in formulating the management plan for the fishery.

Next steps

Following completion of survey and data analysis, FAME will produce an assessment report that will include recommendations for management. Furthermore, FAME staff members will coordinate and implement a review of the sea cucumber fishery in all states of FSM. This review is part of the Pacific Islands Regional Oceanscape Programme (PROP) that is administered by the Forum Fisheries Agency (FFA) and will explore options that may assist in regulating the sea cucumber fishery at the sub-regional or regional levels.

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'Blue boats' are a problem!

Blue boats are small wooden fishing vessels that sail from provincial Vietnam. While they are not always blue in colour, the vast majority of these vessels have blue hulls and deck structure as shown in the poster below. These vessels target inshore species that do not require refrigeration or those that can be salted or dried such as sea cucumbers, giant clams or shark's fins. These species also have high value in the Asian market and are very easy to sell. The vessels target isolated reefs and remote islands where their presence may go undetected and not be reported to authorities.

Indonesia has recently taken a tough stance on illegal fishing in its exclusive economic zone (EEZ) and this is having an impact on where the blue boats operate. This has included an extensive campaign of burning boats and there have been reports that the Indonesian Navy has fired warning shots at illegal vessels at sea. These actions, along with the severe depletion of the stocks that blue boats target in their own waters, appear to have led to a transfer of illegal fishing in the Pacific Islands region.

Blue boats have been apprehended or sighted in Palau, the Federated States of Micronesia, Papua New Guinea, Australia, Solomon Islands, Vanuatu and New Caledonia. Given this distribution of blue boats, and noting the vast distance to some of these locations, it is not unreasonable to suspect that they may also be able to reach Kiribati and Tuvalu.

Addressing the blue boats ingress into our region will take a multi-faceted and concerted effort by the affected Pacific Island countries and territories, and their regional support agencies. The Pacific Community (SPC) and the Forum Fisheries Agency (FFA) are working together and sharing information in order to maximise efficiencies and assist in building ways to deter these boats from fishing in members' territorial seas and inshore waters.

SPC has developed awareness and identification posters for outer island communities and remote villages so they can report blue boat activity when sightings occur. The posters are customised for each country and include the phone numbers for the local fisheries agency and local police. So far the posters have been produced for Solomon Islands, Vanuatu and Kiribati. The posters are available in both English and local languages and are produced on plastic coated paper so they can handle the outdoor elements such as rain and sunlight.

In addition, strong penalties that are imposed on these vessels when they are apprehended will be an important deterrent tool. The courts in Solomon Islands imposed penalties exceeding USD 1 million on three Vietnamese fishing captains whose vessels were apprehended in March 2017 for fishing in Solomon Islands archipelagic waters. The court further ordered four years imprisonment should these fines not be paid, which is a very strong message that would-be future offenders may well heed.

This 'blue boat' poster was produced for the Solomon Islands. The same poster can be produced for other countries, and eventually in the local language, upon request.

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MFAT-funded Coastal Fisheries and Aquaculture Governance Project update

In the previous issue of SPC Fisheries Newsletter *(#152) we ran an article on the three new staff members who had been recruited by the Pacific Community (SPC) to undertake a project that will address coastal fisheries governance priorities.[1] The project is funded by New Zealand's Ministry of Foreign Affairs and Trade (MFAT) and focuses on strengthening governance structures and processes – specifically legislation, policy and monitoring, control, surveillance and enforcement (MCS&E), which remain weak for coastal fisheries and aquaculture.*

The project has now been going for six months and here, we provide an update on what the three staff members, Jason Raubani, Ariella D'Andrea and Ian Freeman, have undertaken and discovered so far along with future directions of the team.

Members of the team have undertaken visits to American Samoa, Fiji, French Polynesia, Marshall Islands, Kiribati, Samoa, Solomon Islands, Tonga and Vanuatu. The focus of work in each country has been slightly different but some general findings are provided below.

Ariella reports that the countries that she has visited generally have fisheries legislation in place but it is often dated or missing key relevant sections for today's coastal fisheries and aquaculture requirements. For example, some countries have regulations that support species size limits and limit the use of certain fishing gear but this is not the case in all countries. In other instances, a new fisheries act has been adopted fairly recently but regulations have not yet been adopted or updated for its implementation. Finally, in some cases provisions concerning enforcement of fisheries legislation need to be reinforced. For example, sanctions for fisheries offences may be too low or difficult to apply in coastal fisheries, or the powers of enforcement officers may not be clearly established.

Since the onset of the project, Ariella has been assisting American Samoa, French Polynesia, Kiribati, Samoa and Tonga in strengthening their coastal fisheries legislation. Requests have generally either focused on the overhaul of coastal fisheries and aquaculture legislation, or on the development of specific regulations such as those concerning the exploitation of sea cucumbers. In September, Ariella has hosted a staff member of the Tongan Ministry of Fisheries for a two-week collaboration focusing on improving and updating Tonga's coastal fisheries legislation.

Jason has been very active in assisting with the development of management plans and policy in Solomon Islands, Tonga and Vanuatu. He also notes that many members have management plans and policies for coastal fisheries and aquaculture but these are often dated and infrequently used in the day-to-day management of the coastal fisheries resources.

As part of building capacity of member countries, which is an output under the project, Jason recently hosted four attachments from Solomon Islands and Tonga to progress the review, development and finalisation of aquaculture management and development plans for the two respective countries. While the four officers were at SPC headquarters, assistance was also provided on a Seaweed Management Plan, a Baitfish Fishery Management Plan for Solomon Islands, a Sport/ Game Fishing Plan and an Implementation Plan for the newly approved Marine Aquarium Trade Fishery Management Plan for Tonga.

Ian has also found coastal fisheries MCS&E is lacking in most countries with some inspection work of markets and fish vendors being undertaken but very few prosecutions for illegal activity occurring. Ian has been working with New Zealand Ministry of Primary Industries (MPI) to develop a three-part course in 'Coastal Fisheries MCS&E Proficiency' and has delivered the first two parts of this course to Vanuatu fisheries officers. As part of this collaborative work, SPC and MPI also undertook a series of stakeholder meetings with a private consultant to conduct a review of coastal fisheries MCS&E in Fiji.

Ian recently hosted two attachments from Vanuatu at SPC and provided assistance and advice on the development of standard operating procedures (SOPs) for fish market and vendor inspections along with SOPs for seafood safety inspections. While at SPC, the attendees of the attachments also worked on a series of community awareness and education posters for coastal fisheries that detail size limits for some species and species that are not permitted to be caught.

Christopher Arthur occupies the Junior Professional Officer – Management and Policy position under this MFAT project. While working, he also uses this opportunity to build his capacity in coastal fisheries policy development. He is on a 12-month contract and had been assisting the coastal fisheries team since his arrival to SPC on the devel-

[1] http://www.spc.int/DigitalLibrary/Doc/FAME/InfoBull/FishNews/152/FishNews152_06_Freeman.pdf

opment of a few policies for Tonga, Vanuatu and Kiribati.

He was also part the Pacific Islands Forum Fisheries Agency (FFA)/MPI/SPC team that organised a fisheries policy development and mentoring workshop for the Te Vaka Moana member countries in late May this year at Auckland. In addition, under the SPC/MPI collaboration, a training workshop on fisheries policies was organised in Solomon Islands, and a consultation workshop for the review and update of coastal fisheries management plans was held in Vanuatu.

As part of the integrated approach where coastal fisheries staff members from different funding sources work together, Navneel Singh, a Junior Professional for the Coastal Fisheries Science team works closely with the MFAT-funded team. Navneel joined SPC in February 2017 and is funded by the Australia Department of Foreign Affairs and Trade. He has been working with the Senior Coastal Fisheries Scientist, the Coastal Fisheries Science Officer and the management team, and assisting with in-water surveys, data entry and analysis, and writing technical reports as his primary role. To date, he has worked on the Fiji coastal fisheries and aquaculture implementation plans, done an in-water survey of sea cucumbers in Pohnpei, Federated States of Micronesia, an in-water assessment for finfish in Vanuatu for the RESCCUE[2] project and creel and market survey database training in Kiribati. Navneel's contract will end in February 2018 and he is scheduled to work on projects in Niue and Wallis.

The project team members have a busy schedule for the rest of 2017 with field trips planned in Kiribati, Solomon Islands, Tonga, Samoa and Vanuatu. However, the team commitments are light so far for 2018, so if you would like to discuss assistance for your coastal fisheries or aquaculture programmes then please contact one of the team members.

Fish sampling at the Apia market, Samoa; reliable data collection is crucial for effective coastal fisheries management (image: A. D'Andrea, SPC).

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[2] Restoration of Ecosystem Services and Adaptation to Climate Change project.

Freshwater prawn hatchery master class for Fiji Ministry of Fisheries hatchery staff

For six weeks in May and June of this year, one of the routine Macrobrachium prawn hatchery campaigns – which is operated four or five times each year by Fiji Ministry of Fisheries (MoF) aquaculture staff members – was transformed into a prawn larval rearing 'master class'. This was both a refresher and technological update, in which MoF staff members were mentored in new and emerging international hatchery techniques by staff members of the Aquaculture Section of the Pacific Community (SPC). Due to recent retirements and staff changes within the MoF, it was timely to bring a new group of young and emerging local aquaculturists fully up to speed on the latest in best aquaculture practices.

From left to right: Fiji Fisheries freshwater prawn hatchery staff members Aminio Gaunavou, Mererai Vualeba, Teresia Verekoto, Miriama Delai, Velema Vunivisilevu and Isikeli Odro pose beside a prawn larval rearing tank at Galoa Brackish-Water Hatchery with Avinash Singh of SPC Aquaculture Section (image: T. Pickering, SPC).

The end result of the hatchery campaign was that all farmers in Fiji who had requested prawn post-larvae for pond stocking in 2017 were able to obtain them. The first farmer to benefit in this way was Mr Rajesh Lal of Navua who hosted a ceremonial pond stocking event at his farm, which was officiated by chief guest and Deputy CEO of MoF, Mr Sanaila Naqali. 'Seed production is critical to support industry growth in Fiji aquaculture' said Mr Naqali in his congratulatory remarks to the master class participants at the ceremony. 'Adoption of new innovations and hatchery efficiencies are very necessary because government targets for prawn seed production for the next financial year are going to be increased. Thank you participants for your cooperation, patience and sacrifice of long hours to produce post-larval prawns for commercial farmers'.

The goal of the master class collaboration between Fiji MoF and SPC was to (i) enhance the capacity of hatchery staff members in Fiji in the understanding of the principles behind giant freshwater prawn hatchery seed production, (ii) empower staff members with tools to produce high quality seed, and (iii) increase production efficiencies and learn steps for overcoming constraints. Internationally emerging hatchery innovations that were trialled during the master class included the use of tilapia tank water to stabilise water quality, new recipes for prawn larval food, and a range of improved water hygiene and filtration practices to increase the survival of larval prawns during the hatchery cycle.

Mr Shalendra Singh (Principal Fisheries Officer Aquaculture) explained that the MoF's hatchery team conducts several freshwater prawn breeding cycles each year, in order to supply baby prawns to farmers. 'A lot of money is spent each year on importation of prawns from overseas for Fiji's tourism and hospitality industries' said Mr Singh. 'This is money that needs to be kept here inside our own economy. Providing this kind of support to Fiji prawn farmers is an important part of government policy to boost local production and address import substitution'.

To turn this latest prawn breeding cycle into a 'master class' the MoF aquaculture staff members were joined by SPC prawn hatchery experts. 'New and updated techniques of prawn breeding are emerging in hatcheries overseas, in places like SE Asia and in USA', said SPC's Inland Aquaculture Advisor Tim Pickering during the first classroom session.

'It is SPC's role to network and monitor these emerging trends for technical transfer to our member countries. For example, there is new information available that increases our understanding about the use of natural algae-water in hatchery systems. If adopted through some modifications in hatchery technique, this can lead to healthier prawns and improved results'.

With support from the Government of New Zealand, under a new Sustainable Pacific Aquaculture Project implemented by SPC Fisheries Aquaculture and Marine Ecosystems Division, project staff members Avinash Singh and Jone Varawa worked alongside MoF hatchery operators throughout the major steps of the hatchery cycle in order to provide on-the-job mentoring and guidance in the latest techniques. The new techniques were compared alongside the existing ones.

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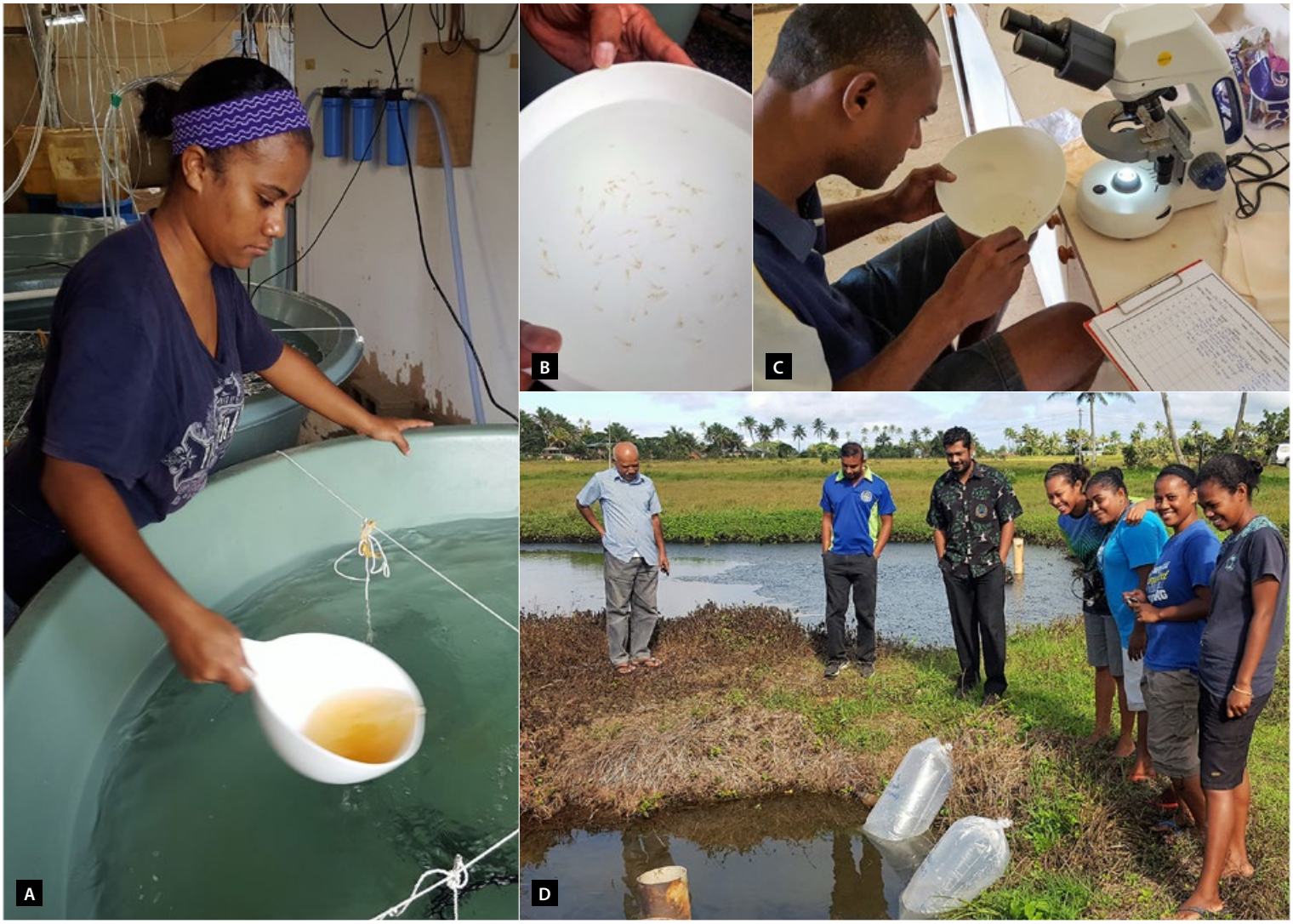

A: Aquaculture trainee Mererai Vualeba of Fiji National University (FNU) feeds out live Artemia brine shrimp to hungry prawn larvae.
B: The end result of the hatchery campaign: Prawn post-larvae ready for pond stocking.
C: Aminio Gaunavou at the microscope, checking various indicators of prawn larval health for entry into the hatchery daily record sheet.
D: The prawn post-larvae packed in plastic bags are being slowly acclimated to pond water temperature by Fiji Fisheries aquaculture staff members prior to release at the prawn farm of Mr Ravin Lal at Navua.

All images by T. Pickering, SPC

A Marshall Islands' successful aquaculture venture

Numerous attempts to develop the aquaculture sector in the region of Micronesia, including in the Republic of the Marshall Islands (RMI), have been relatively unsuccessful in most cases; thereby it is quite encouraging that after all these aquaculture failures the Mayor of Rongelap, James Matayoshi, has even considered starting a fish farming operation in Majuro.

Moi specimens ready for the market (image: J. Matayoshi)

The Rongelap Atoll Local Government (RALGOV) company, managed by Mayor Matayoshi, has been farming black-lip pearl oysters for many years now. In late 2012, the company decided to go into a marine finfish farming pilot project for the production of Pacific threadfin (*Polydactylus sexfilis*) – better known in the region as 'moi' – which is a fish of high commercial value and in high demand in Hawaii.

During the initial steps of the pilot project, Hawaiian fish distributors, researchers and scientists from various agencies and companies showed a strong interest in this venture, which resulted in significant technical assistance being offered to the Marshallese entrepreneurs. As an example, scientists from the Oceanic Institute of Hawaii Pacific University provided technical support in order to fine-tune a fishmeal mix that included products that are locally available in RMI.

The first spawning exercises were implemented at the College of the Marshall Islands in 2012 and early 2013. A survival rate of 17% was achieved. Moi fingerlings were then stocked into small marine floating cages for grow-out for a period of around six months, after which they were harvested. Survival and growth rates obtained during these first farming attempts were evaluated and promised to be enough to pursue the venture.

The company decided to build its own hatchery (the Aquaculture Technologies of the Marshall Islands (ATMI) hatchery), which was to be located in Majuro. The hatchery construction was completed in May 2013, and large marine floating cages were deployed to provide enough space for the new batches of moi fingerlings.

These cages have now been placed on the north shore of Majuro Atoll, next to a small island known as Drirej, which has become the grow-out base for moi farming.

More than 80,000 moi fingerlings were produced at the hatchery in 2015. After around six months of grow-out in cages, moi that were of a commercial size were exported to Hawaii, and obtained quite promising prices and triggered a very high demand for the product.

According to Mayor Matayoshi: 'In 2016 the company has exceeded USD 100,000 in sales as a start-up company. The hatchery production has exceeded the volume available in our sea-cages. This is why we are now installing an additional six sea-cages, as we are expanding into full commercial phases.

A) Moi fry produced at the hatchery; B) Transfer of moi fingerling from the hatchery to the nursery; C) Floating cage for grow-out; D) Harvest of moi specimens at the floating cages; and E) Pellets produced locally as feed for moi (all images: J. Matayoshi).

Our goal is to produce about 50,000–60,000 fish per month to supply the markets in Hawaii, Marshall Islands, and maybe Micronesia and Asia in the near future. High quality feed production is one of the key aspects to be developed.'

This aquaculture business is also getting a boost from the government's utility company, which has installed electricity cables for the first time into the small island of Drirej on the north shore of Majuro, where the new marine floating cages are located. The manager, Mayor James Matayoshi, is expecting to create new job opportunities in the area and he will provide technical training to local fishers and agriculture farmers who are interested in getting involved in what would be a new business for them: aquaculture farming.

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It is hoped that the very encouraging first results of the Marshallese moi farm will be validated when the farm reaches its full-commercial phases. A positive future would not be surprising, considering the number of boxes the project has ticked in the list of pre-requisites for successful aquaculture ventures, including the following:

- The leadership of an enthusiastic entrepreneur, who already had a sound knowledge of aquaculture and the marketing of aquaculture products;
- Access to clean waters and a healthy environment;
- A sound technical and scientific basis, especially in the first experimental phase, thanks to the support of the College of the Marshall Islands and the Oceanic Institute of Hawaii Pacific University;
- The choice of a local species, which requires relatively simple farming techniques;
- The assistance of local authorities for the infrastructure (e.g. electricity and water supply);
- Access to locally-made aquafeeds; and last but certainly not least
- A product in high demand from an accessible market that is ready to pay premium prices for premium quality.

Ruth Garcia-Gomez, SPC

Ecotourism and giant clam community-based nurseries in Samoa

The Samoa Fisheries Marine Multispecies Hatchery has been in operation since early 2014.[1] *Three and a half years after its inauguration, a quick look at its achievements shows that the marine hatchery officers and technicians, who are staff members of the Fisheries Division of the Ministry of Agriculture and Fisheries, have been working hard; if only looking at the giant clam-related activities, the hatchery, based in Toloa, has implemented seven successful spawnings of the smooth giant clam (*Tridacna derasa*).*

Assessment of giant clam nurseries in Savai'i by community members and aquaculture officers (Samoa) (image: Unity Roebeck).

Thanks to these efforts, the Fisheries Division Aquaculture Section has managed to distribute, between 2016 and 2017, more than 5000 farmed giant clam juveniles of 7–12 cm in length to 49 newly-established nursery and grow-out sites, which are managed by local communities. These community-based nurseries and grow-out sites are distributed along the coastlines of Upolu, Mulifanua and Savai'i.

The latest assessment at these 49 nursery and grow-out sites was carried out in July 2017 and has shown a very promising average of a 65% survival rate in giant clam stocks.

Grown-out giant clams are consumed nowadays by the managing communities or marketed locally. Some specimens are retained as future broodstock after a selection process that takes into account grow rates, survival rates, resistance to parasitic infestation and colouration.

An unexpected positive result for the communities involved in giant clam farming has been the additional revenue generated by ecotourism activities that are linked to the 'farm' operations. One of the communities reported during the Community-based Fisheries Management Program review that was carried out in March 2017 that they had received more than WST 20,000 (≈ AUD 10,000) in 2016 from tourists visiting the villages and their giant clam farms as part of island tours.

The community-based clam farm project is already considered a success, but the hatchery staff members do not rest on their laurels and continue to work hard. Unity Roebeck, Senior Marine Aquaculture Officer, in collaboration with Japan International Cooperation Agency (JICA) senior advisers based in Upolu, is currently testing innovative giant clam farming strategies, such as:

- new spawning induction protocols;
- improved feeding and supplementary feeding of giant clam larvae;
- adapted settlement structures for early larvae rearing and larvae settlement;
- innovative nursery cage design and settlement structures; and
- improved site selection that is based on regular assessment of water quality control parameters.

[1] See article in issue #145 of this newsletter at: http://www.spc.int/DigitalLibrary/Doc/FAME/InfoBull/FishNews/145/FishNews145_29_Tiitii.pdf

Long-term involvement of communities in giant clam farming for restocking or stock enhancement purposes is usually difficult to obtain because, apart from a few animals used for domestic consumption, the possible positive effects of stock enhancement take years to be felt. But, if ecotourism is added to the equation, as was done in Samoa, immediate revenues can be directly distributed to the communities that are involved. Samoa has shown that a combination of successful hatchery, nursery and grow-out operations, associated with a strong involvement of coastal communities and alternative income generating activities linked to the clam farming can be key to success.

Checking giant clam health and growth in a community-based nursery (image: Unity Roebeck).

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Giant clams are placed on trays, which are fixed to the seabed (image: Unity Roebeck).

News from the Tuvalu Fisheries Department (TFD)

Total tuna catches in Tuvalu waters in 2016 are provisionally estimated to have been over 110,000 tonnes, which is by far the largest ever recorded and almost double the amount of tuna that is usually caught in these waters. Catch transhipment in Funafuti harbour also reached an all-time high. These record fishing levels are due to a combination of factors including the growing familiarity of purse seine fishing fleets with Tuvalu fishing conditions, environmental factors, and developments in other countries in the region. In addition, Tuvalu has clear fishery rules, which are enforced strictly and without favour or discrimination, so that licensed vessels know the rules and are confident that they will be implemented fairly and reasonably. And of course all fishing in Tuvalu waters takes place according to management measures that are established through national legislation as well as the Parties of the Nauru Agreement, the Tokelau Arrangement, and the Western and Central Pacific Fisheries Commission.

2017 has been a busy year for the TFD so far. Several major events have taken place, including the following:

Industrial tuna development

Tuvalu's one and only tuna purse seiner, the *Taumoana*, will soon be joined by a sister ship, the *Tautaloa*, which will also operate under the Tuvalu Tuna Fong Haur (TTFH) Company. In addition, another vessel, the *Taina*, has just commenced operations under the Tusa Fishing Company Limited. Both companies are joint ventures between the Government of Tuvalu and partners, in Taiwan and Korea respectively. Discussions are also under way with foreign longline companies about the prospects of establishing locally-based operations in order to create onshore processing and eventually exporting of processed tuna products.

Funafuti Reef Fisheries Stewardship Plan (FRFSP)

The TFD is working with the Funafuti *Kaupule* (island council), *Falekaupule* (elders), Fishermen in Funafuti Association (FOFA) and the community, in order to develop a comprehensive plan for the management of stressed fishery resources on Funafuti Atoll. The plan aims to help reef fisheries recover to more productive levels, and will focus on smart use of the already established Funafuti Conservation Area (FCA), avoiding the use of too many complex rules, and preserving and enhancing livelihoods and food and nutrition security for Tuvaluans living in Funafuti.

Outer Island Resource Assessment and Management

TFD staff members have undertaken several trips to Tuvalu's eight outer islands to carry out creel and household surveys, and to discuss fisheries management and development needs and opportunities with outer island residents. This will ultimately lead to the production of fisheries development and management plans for each island, which will then be financed using the Community Vessel Day Scheme (C-VDS), a mechanism under which some of the revenues from foreign fishing in Tuvalu waters are channelled to support outer islands development.

Tala Moana

The Department has been making full use of the Fisheries research vessel *Tala Moana*, which was purchased in January 2016 using Global Environment Facility (GEF) funds available to Tuvalu. The liveaboard vessel can accommodate 15 passengers as well as 8 crew members, and is being used to transport teams of TFD staff members to the outer islands and to carry out fishery patrols in the exclusive economic zone (EEZ). When not in use for official purposes, the *Tala Moana* is made available for charters to private users. The vessel has just undergone major maintenance and refit in Fiji.

Construction of the new TFD headquarters building

Demolition of the old fisheries extension building at Teone commenced in December 2016 and construction work on the new headquarters soon followed. When the new building is completed, it will house the entire TFD, which is

Tala Moana inauguration day.

TFD's new office building should be completed in October 2017 (image: Garry Preston).

currently split among five separate offices. The new facility includes not only office space but also a conference room, vessel monitoring system (VMS) room, dive bay, wet and dry laboratories, and a storage/work area for fish aggregating device (FAD) construction and practical training courses. The building, which should be completed in October 2017, is being funded by the New Zealand government, with IT equipment being procured via World Bank funds, and office furniture being co-funded by the Government of Tuvalu.

Small-scale fisheries development

A major project is currently being formulated to upgrade the vessels and facilities in use by local fishers in Funafuti so that they can make more use of the abundant tuna stocks instead of increasing fishing pressure on reef and lagoon resources. A feasibility study will soon be launched into the technical and financial aspects of establishing a small fleet of seaworthy fishing vessels that are capable of staying at sea for several days at a time, as well as renovation of the fishing jetty and cold store so that catches can be preserved. This project is closely linked with both the FRFSP and the possible development of onshore processing facilities for longline catches.

Marine resources legislation

The Tuvalu Marine Resources Act has been subject to a lengthy period of review and improvement and is now ready to be submitted to Parliament, which should take place before the end of the year. The revised Act strengthens the implementation of international fishery management treaties and agreements to which Tuvalu is a party, and significantly increases the penalties for most fishery offences. Once the new Act is approved, several new regulations will also be promulgated to ensure precautionary management of sensitive resources such as beche-de-mer and sharks.

This is just a small portion of some of the key activities that the TFD has been working on in 2017.

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Kiribati becomes the fourth country in the Pacific authorised to export its seafood to the European Union

Jope Tamani,[1] Saurara Gonelevu[2] and Francisco Blaha[3]

On the 16 June 2017, following the Commission Implementing Decision (EU) 2017/1089, Kiribati became the fourth country in the Pacific region to be included in the list of third countries and territories[4] from which EU imports of certain fishery products for human consumption are permitted. Yet, this does not mean that from now on any fish caught by any Kiribati-flagged vessel can be 'instantly' accessed directly or indirectly by the EU.

The EU's Regulation (EC) 854/2004 provides that products of animal origin can only be imported into the EU from a third country that appears on a list that has been drawn up in accordance with this regulation. In order to be added to this list, a third country must satisfy the European Commission controls and have a Competent Authority (CA) in place, which provides guarantees regarding compliance or equivalence with the relevant EU (health) regulations.

If a country's control systems are considered 'equivalent' to those of an EU member state, then its fishery products are authorised to enter the EU market and the country is added to the Annex II of Commission Decision 2006/766/EC, which lists all the authorised countries. The CA of that country then evaluates the compliance of their factories and vessels (which are called Food Business Operators – FBOs) with EU regulations. If they are up to the standards and expected levels of compliance, the CA 'lists' them by giving them an approval number, which is sent to the EU in order to be added to the list of approved establishments for that country.

At this stage, the first list of five vessels and one factory has been sent to the EU for revision, and once this is done and these FBOs are added to the list, they will be able to access the EU market.

This whole process is quite complex, and it took Kiribati a long time and a lot of effort to get to this point.

The EU obliges compliance with its own requirements, and thus requires the third country to prove that it operates control structures applicable to its seafood exports that are equivalent to those in place in an EU-member country. It means that Kiribati has to prove that it has systems and controls equivalent to those of Germany, for example.

Many Small Island Developing States (SIDS) in the Pacific, like Kiribati, remain in the category of Least Developed Countries (LDC) as recognised by the UN. The three elements that define this status (poverty, human resource weakness and economic vulnerability) can be key obstacles in the establishment and operation of a CA.

Until now, only three Pacific Island countries have been able to meet this requirement – Fiji, Papua New Guinea (PNG) and Solomon Islands. All three are relatively large countries with substantial tuna processing industries. Even these countries face considerable challenges – both Fiji and PNG have been forced to suspend exports to the EU for a while in recent years, and all of them continue to rely, at various levels, on donor involvement to maintain their CA standards.

For SIDS in the Pacific region, the lack of EU sanitary authorisation is a price disincentive for buyers of their fish caught in these waters. It is not the case for the same fish caught in the same waters by vessels from some EU-authorised countries; even if the inspectors of those flag states may have never been on board.

In principle, the processing countries can only provide 'EU Health Certificates' for seafood products that are derived wholly or partly from raw materials that:

- have originated from a third country eligible to export to the EU;
- have been derived from foreign premises eligible to export to the EU (including vessels), and
- are eligible to be exported to the EU.

This 'eligibility' requirement should always be applied, yet this is unfortunately not the case in all canning countries.

A further challenge for Pacific Island countries is that, in many cases, they do not have processing sites – nor the physical area and cost-effective geographical situation to develop them – or, if they do, their operational focus is more on

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[4] Countries and territories that do not belong to the European Union (EU).

regional markets rather than on the EU market. For these countries, the CA needs to be developed and operated in a 'vessel only' oriented manner. This would potentially imply a CA with officers either travelling to foreign landing ports and/or establishing a memorandum of understanding with CAs of offloading countries.

To make things more complicated, in many SIDS, there are a growing number of foreign-owned but locally-flagged vessels (in order to get cheaper access to resources) that operate in their own economic zones and regional waters. And, while these vessels unload locally or in other third countries for processing or shipment to processing facilities with the potential to export to EU markets, there is usually no one on board that has a real link to the flagging state, and language barriers can be problematic. Therefore, some crew on vessels are not particularly keen to have hazard analysis and critical control point (HACCP) plans, records, or training crew on board, or to have inspectors coming to check their records.

Until now, much of SIDS efforts to gain or sustain EU market access has been supported in one way or another by the Forum Fisheries Agency (FFA) and the Pacific Community (SPC), particularly in the areas of training, legislation updates, reciprocal inspections, institutional strengthening, laboratories and control systems development (in many cases funded with EU support).

These inputs have been instrumental in getting Kiribati to become 'EU-authorised'. This process was initiated back in 2012 under the EU-funded and FFA-managed DevFish II project. The process involved using the National Control Plan (NCP) that Francisco Blaha 'invented' for Ecuador in 2007, which had also been adapted to help Fiji regain access to the EU market in 2011, after losing it in 2008 due to lack of compliance.

Francisco went through a process of 'reverse engineering' of all relevant EU regulations. He reorganised the requirements and produced a document in a way that would please inspectors while facilitating the country's compliance.

The NCP sets up the rules for Fiji in which the 'EU system' is to be based. It is meant to provide the 'official assurances' required by EU and to become the basis on which to judge equivalence. The equivalence allows for market access, as well as maintenance of that access.

All methods, procedures and regulatory instruments to be used for conformity assessment, regulatory verification and official guarantees are presented in the NCP, which in turn is presented to EU as required.

Considering that exporting to the EU is a voluntary act on the part of only a few factories and vessels, the idea is that the recognised CA will impose the NCP – and, if eligible, will provide 'official assurances' – only to those establishments and vessels that want to be engaged in trade with Europe.

Communication between inspectors and captains can be difficult due to language barriers (image: Saurara Gonelevu).

Kiribati-flagged longliner offloading tuna (image: Saurara Gonelevu).

Organoleptic assessment of a local fish processing unit by the Kiribati Competent Authority (image: Saurara Gonelevu).

The process is therefore a lot simpler than it would be if official assurances had to be obtained for all of the country's animal processing units.

The operators on their side recognise that maintaining approval and certification privileges – as part of the listing of companies allowed to provide raw material or to export directly to the EU – is dependent on compliance. If an establishment is not in compliance with the requirements, then its market privileges are suspended or removed as necessary.

This approach has the advantage of being cost-effective to implement while upholding the level of compliance required for meaningful official assurances. And it works! Ecuador has maintained its market access to this day, as have Fiji and Solomon Islands, and now Kiribati has the go ahead despite the fact that its application was only based on written documentation.

Since 2014, FFA has taken the lead in assisting countries to gain access to the EU market by employing Jope Tamani (who was the head of the Fiji CA that implemented the NCP) and contracting Cushla Hogarth, a very experienced consultant from New Zealand. Both enhanced the NCP approach and did the massive groundwork that took Kiribati up to the present status, with the local support of Tereere Tioti and Tebeio Tamton from the Kiribati Seafood Verification Authority (KSVA) and Saurara Gonelevu, a former CA officer from Fiji, who is now based in Tarawa and working with KSVA through funding from the New Zealand Ministry of Foreign Affairs and Trade.

Getting to this point was already a long voyage. Yet, as in many other areas, it will take an equal amount of effort to stay at the top as it took to get there. So, the real voyage has just started for Kiribati.

What is going on with bigeye tuna?

John Hampton[1]

*The 13th Regular Session of the Scientific Committee (SC13) of the Western and Central Pacific Fisheries Commission (WCPFC) was held in Rarotonga, Cook Islands from 9 to 17 August 2017. A major topic of debate at SC13 was the new bigeye tuna (*Thunnus obesus*) stock assessment, which was conducted by the Oceanic Fisheries Programme (OFP) of the Pacific Community. This new assessment indicates that the bigeye tuna stock is in a healthier condition than suggested by previous assessments that were carried out in 2011 and 2014. In this article, we outline the changes that were made to the 2017 assessment, why they were done and what they mean for management.*

Previous bigeye tuna assessments

To recap, previous assessments of bigeye tuna conducted by the OFP in 2011 and 2014 had relied on size data – i.e. length frequency and weight frequency samples of catches – to provide information on the rate of growth of bigeye tuna. In those assessments, the mean size of the oldest fish in the population (10 years of age and older) was estimated or assumed to be around 180 cm, which is equivalent to a weight of around 140 kg. This was consistent with available information on growth from the eastern Pacific Ocean, where the Inter-American Tropical Tuna Commission had conducted detailed studies on the age and growth of bigeye tuna. However, while these large bigeye tuna are fairly common in the eastern Pacific, they are relatively rare in the western and central Pacific Ocean (WCPO, west of 150°W). This is shown in Figure 1. For the history of all longline catches of bigeye tuna in the WCPO, <0.1% of the historical catch has been larger than 184 cm or 140 kg, even in the very early days of the fishery, when the presence of larger fish would be expected.

The rarity of large fish in the catch relative to the biological assumptions about the mean size of the oldest fish was attributed to fishery-induced depletion in the stock assessment model. To reconcile the paucity of large bigeye tuna in the catch, the model estimated that few survived to 10 years of age or more. The model did this by estimating high levels of fishing mortality, which greatly reduced the number of bigeye tuna that lived to older ages; thereby, they

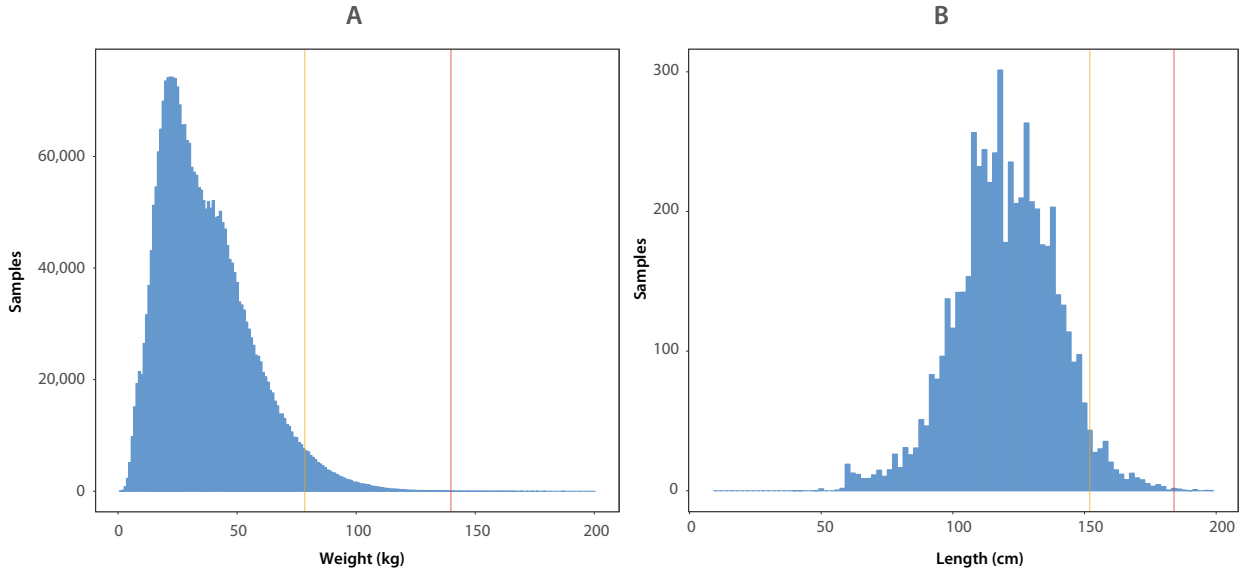

Figure 1. Weight frequency (A) and length frequency (B) distributions of the longline catch of bigeye tuna, 1952–2015, in the western and central Pacific Ocean. The red vertical lines represent the mean size of the oldest fish in the longline catch assumed for the 2014 assessment. The yellow vertical lines represent the mean size of the oldest fish as indicated by the new growth data.

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were not able to grow to these larger sizes. This implied a large fishery depletion effect, and gave rise to the estimate from the 2014 assessment that the ratio of the spawning (adult) biomass in 2012 (the final year of the 2014 assessment time period) to the spawning biomass estimated to occur in the absence of fishing, was 0.16 – i.e. the model determined that the stock was 84% lower than it would have been if no fishing had occurred. As this was below the agreed 'limit reference point' of 0.2 times the unfished spawning biomass, the stock assessment indicated that the stock was in an overfished state.

The 2017 bigeye tuna assessment

The new bigeye tuna assessment presents a considerably more optimistic outlook for the current status of the stock and the impacts of fishing (Figure 2). The assessment updated the data for the past three years and explored a wide range of uncertainty across 72 separate models that made different assumptions about biological characteristics (e.g. whether the new growth information was used, or that used in the 2014 assessment) and assessment model settings. This exploration of uncertainty was the most comprehensive of any WCPFC tuna stock assessment to date. SC13 weighted some of these models higher than others (more on this later), and the overall weighted median ratio of recent spawning biomass to the unfished level was 0.32, with 16% of the model runs falling below the limit reference point of 0.2 times the unfished spawning biomass. The median ratio of recent fishing mortality to the fishing mortality at maximum sustainable yield (MSY) was 0.78, with 23% of the model runs exceeding the MSY level. For this new assessment, it therefore appears that the stock is not in an overfished state nor is it experiencing overfishing. SC13 noted that while this assessment is more positive than previous assessments, it is recommended that fishing mortality should not be increased from the current level.

So what changed in the 2017 assessment?

Four main things changed in the 2017 assessment, and we discuss each of these in the following section.

Change 1: Inclusion of new growth data

As early as 2008, the WCPFC Scientific Committee (SC) recognised that the absence of scientific data on age-at-length represented a key uncertainty in bigeye tuna assessments. The SC also recognised that better biological information was required on bigeye tuna size-at-maturity, so that an accurate definition of 'spawning biomass' could be used in the assessments. This was important, as WCPFC was in the process of

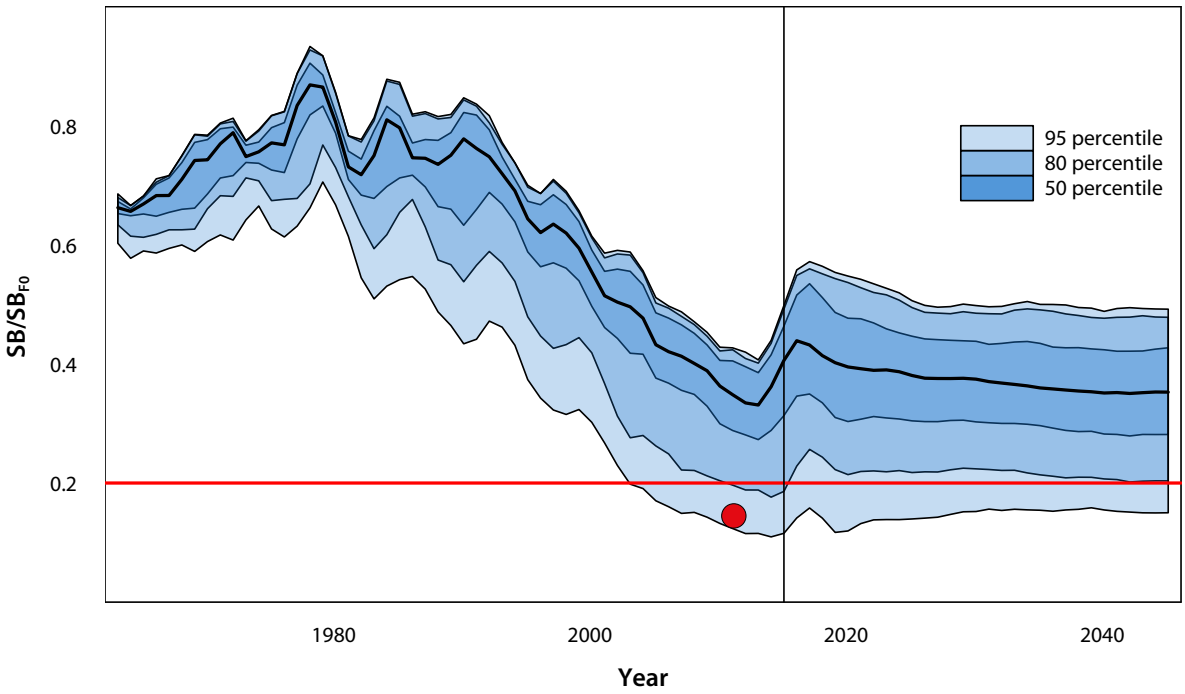

Figure 2. Estimates of historical (to the left of the vertical black line) and projected future bigeye tuna spawning biomass depletion (SB/SB_{F0}) assuming the continuation of recent levels of fishing.[2] The different shading of the trajectory represents the uncertainty in the estimates across 72 model runs that were weighted according to SC13 advice. The horizontal red line represents the limit reference point of 20% of the recent unfished spawning biomass. The solid red circle indicates the estimate of spawning biomass depletion in 2012 from the 2014 bigeye tuna assessment.

[2] SB/SB_{F0}: The ratio of spawning biomass – usually measured as the total weight (in tonnes) of spawners – to the estimated spawning biomass if the stock had never been fished.

moving to the use of spawning biomass depletion as the indicator for reference points. Thereby, the SC proposed and the Commission agreed to fund a major project on bigeye tuna age and growth, and reproductive biology.

During 2009 and 2010, the OFP, with the assistance of national observer programmes around the region, mounted a pilot study aimed at providing initial information to help design a comprehensive sampling programme. The pilot study was completed and reported to SC7 in 2011. The 313 otoliths collected gave the first indications that the size of the oldest bigeye tuna in the WCPO may be smaller than previously thought; however, the samples had been taken from a fairly restricted area of the WCPO, and the SC concluded that a full project, which aimed to collect 2,500 bigeye tuna otoliths and 300 gonad samples from throughout the WCPO and distributed across the size range of the fish, was required before the information could be incorporated into the stock assessment. Thereby, otolith and gonad sampling continued through mid-2016, and the necessary samples were eventually accumulated. WCPFC then committed to funding the processing and analysis of 1,100 otoliths and 300 gonads, which were sent to CSIRO in Hobart, Australia. This work took place in 2016 and early 2017 and the results were presented to SC13 in 2017. The main conclusion was that bigeye tuna grew to a smaller size than had been assumed in previous assessments (Figure 3), which confirmed the preliminary findings of the pilot study. The mean size of the oldest fish in the population, around 150 cm, estimated from these new data is considerably smaller than the size of 184 cm assumed in the 2014 assessment. As evident from Figure 1, there are significant numbers of fish in the longline catch at this smaller size – around 4% of the longline catch.

In the 2017 assessment, half of the 72 models that were considered used the new growth curve that is based on the otolith data, while half used the old growth curve, which had been used in the 2014 assessment. The incorporation of the new growth model had a profound effect on the stock assessment results. These models no longer had to attribute a lack of older fish to high fishing mortality, because greater numbers of older fish in the population could now be predicted by the models. The impact of the change in growth is easily seen in the 'Majuro Plot' of spawning biomass depletion and fishing mortality in relation to MSY conditions (Figure 4). Models that incorporate the new growth generally have moderate spawning biomass depletion and fishing mortality less than MSY; however, those that incorporate the growth assumption that was used in the 2014 assessment mostly have spawning biomass depletion to less than the limit reference point, and fishing mortality above the MSY level. These latter results – that used the old growth – are fairly consistent with the 2014 assessment.

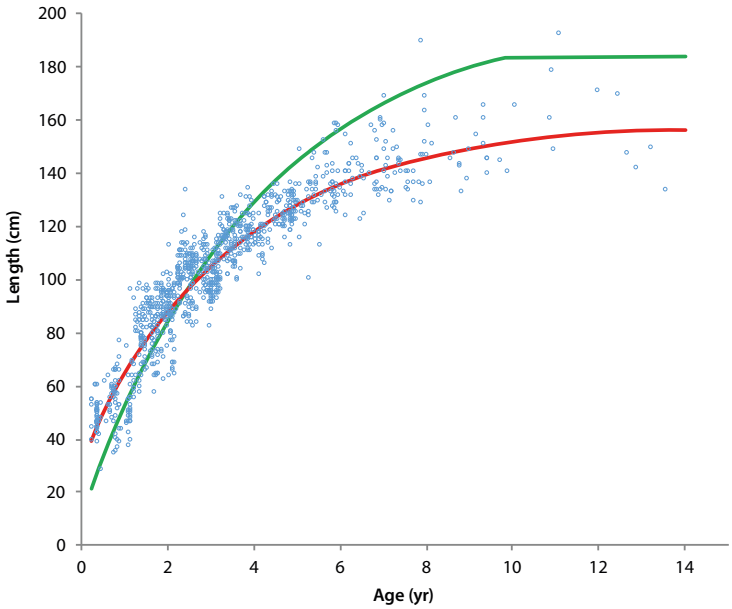

Figure 3. Estimated bigeye tuna growth. The green line represents the growth curve used in the 2014 assessment; the blue circles are the lengths and estimated ages from the otolith samples; and the red line is a von Bertalanffy growth curve fitted to the otolith data.

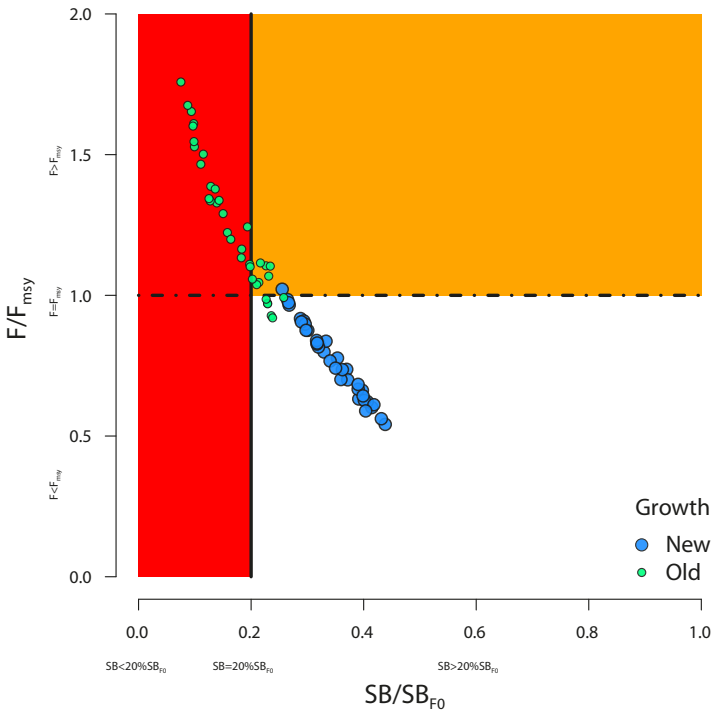

Figure 4. Estimates of recent average spawning biomass depletion (SB/SB_{F0}) and fishing mortality in relation to MSY conditions (F/F_{msy}).[3] The red area of the plot indicates spawning biomass less than the limit reference point of 20% of the unfished level. The red and orange areas above the dashed horizontal line indicate levels of fishing mortality higher than MSY. The blue and green points represent 2012–2015 average spawning biomass depletion from models incorporating the new growth information and old growth assumption, respectively.

[3] F/F_{msy}: Current fishing mortality relative to the fishing mortality that would result in the maximum sustainable yield.

To construct its final scientific advice, SC13 decided to use all 72 models, but gave three times the weight to the new growth models compared with the old growth models. This gave the weighted distribution of outcomes shown in Figure 2.

Change 2: Inclusion of new reproductive maturity data

The same project that SC initiated to acquire new information on bigeye tuna age and growth also obtained new information on size- and age-at maturity. As noted above, this information is important for the definition of spawning biomass in the assessment.

The new data on reproductive maturity resulted in new estimates of reproductive output by age-class that were quite different to those used in the 2014 assessment (Figure 5). In particular, bigeye tuna were found to reach reproductive maturity at a younger age (50% mature at about 3 years of age) than previously assumed (50% mature at 4 years of age). This means that a full additional year-class was added to the spawning biomass as a result of the new information. As younger age-classes are less depleted by fishing than older age-classes, the addition of these younger fish to the spawning biomass means that it is somewhat less depleted overall. So the incorporation of this new information to the assessment also had a positive impact on the estimated stock status.

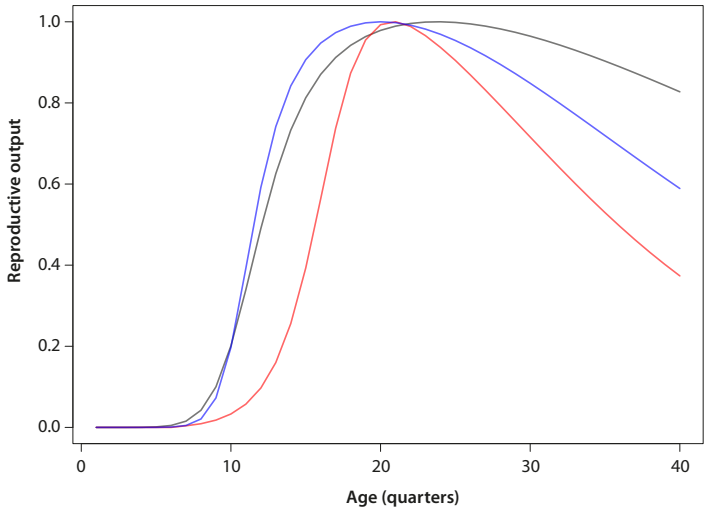

Figure 5. Bigeye tuna maturity-at-age. The red curve is that used in the 2014 stock assessment. The blue curve is based on new maturity-at-length information from the reproductive biology project and converted to maturity-at-age using the growth assumptions used in the 2014 assessment. The black curve is based on the new maturity-at-length information and converted to maturity-at-age using the new growth curve based on otolith data.

Change 3: Spatial structure of the assessment

A considerable amount of bigeye tuna tagging has been undertaken by the Pacific Community and the Inter-American Tropical Tuna Commission in recent years. This work has provided new insights into the extent of mixing of bigeye tuna across the tropical Pacific, both in the E-W and N-S directions (Figure 6). The key observation from these data is that bigeye tuna, at least during their juvenile stage, appear to be tightly constrained within the region from 10°N to 10°S. In previous bigeye tuna assessments, the boundary between the tropical and subtropical regions of the WCPO had been set at 20°N in the North Pacific and at 10°S in the South Pacific. This new information suggested that a boundary of 10°N in the North Pacific would be more appropriate. This boundary would also better demarcate the distribution of the purse seine fishery and better represent oceanographic

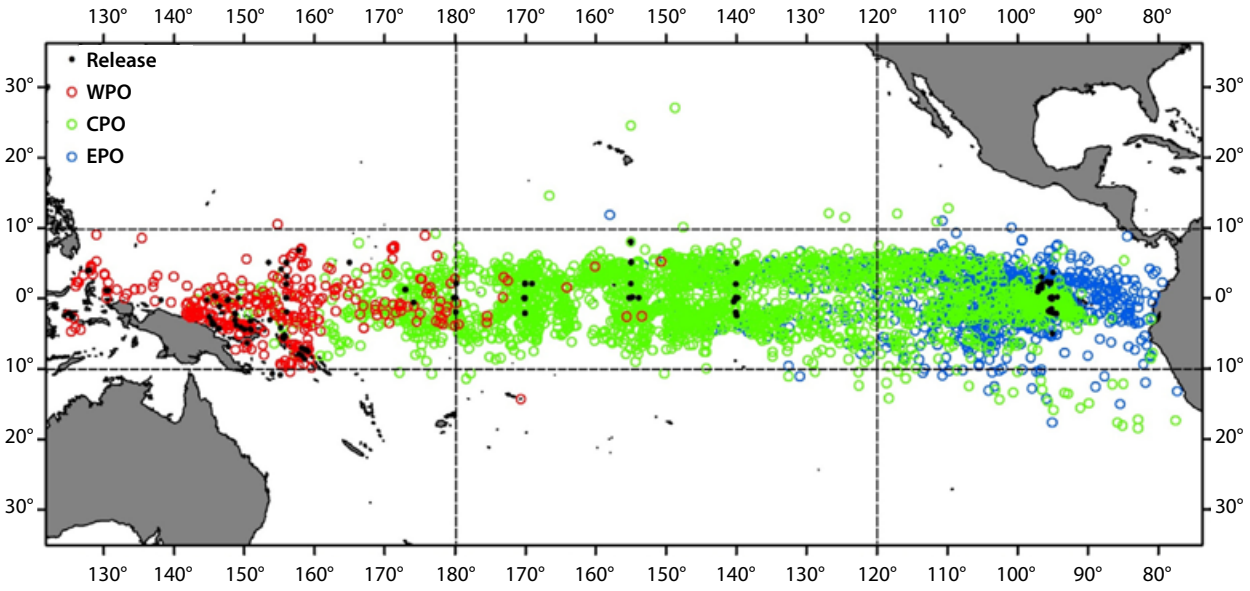

Figure 6. Tag recovery locations of bigeye tuna tagged in the western Pacific (red circles), central Pacific (green circles) and eastern Pacific (blue circles). The small black circles represent the release locations within these areas.

provinces in the Pacific Ocean. Therefore, half of the 72 models used for the 2017 assessment adopted a tropical-temperate boundary in the North Pacific of 10°N, while the other half retained the original 20°N boundary (Figure 7).

The change in regional structure had some effect on the stock assessment estimates by constraining the high exploitation component of the fishery in the equatorial region into a smaller spatial area. Conversely, larger areas were then associated with regions 1 and 2, in which fishing mortality rates of bigeye tuna are lower. This had the overall effect of reducing stock-wide impacts of fishing on the stock. This effect is shown in a 'Majuro Plot' whereby models using the changed (2017) regional structure produce more moderate spawning biomass depletion and fishing mortality in comparison with the previous (2014) structure (Figure 8).

Change 4: Estimated recent increase in spawning biomass

One of the features of the new assessment is an estimated increase in spawning biomass in the final year of the assessment. This increase occurs, albeit with slightly different timing in some cases, for all of the models considered in the assessment. It is consistent with increases in catch-per-unit-effort (CPUE) in many longline fleets and is projected to persist for at least several years in the future (Figure 2). There are several possible reasons for the increase, including: 1) a series of strong recruitments into the population, which is suggested by the recent recruitment estimates in the models; 2) reduced fishing mortality primarily of juvenile bigeye tuna due to management measures implemented by WCPFC and its members; and 3) higher bigeye tuna catchability by longline fleets that was not removed by CPUE standardisation and hence interpreted by the models as an abundance effect. At this point, the first and second reasons appear to be the strongest candidates, and there is some internal consistency for both in the model results. In the case of recruitment, the terminal estimates are consistently high over the period from 2011 to 2013, with these fish now entering the spawning population. Also, there is some evidence of fishing mortality of both adults and juveniles being at least constrained, and possibly slightly decreased, since the introduction of measures such as seasonal closures of purse seine fishing on fish aggregation devices (FADs). In the case of the FAD closures, there is a clear signal of reduced juvenile bigeye tuna fishing mortality in the third quarter since 2010, which coincided with the FAD closure periods, and bigeye tuna catches by purse seine have been estimated to have been reduced by around 35% compared with what they would have been without the closures.

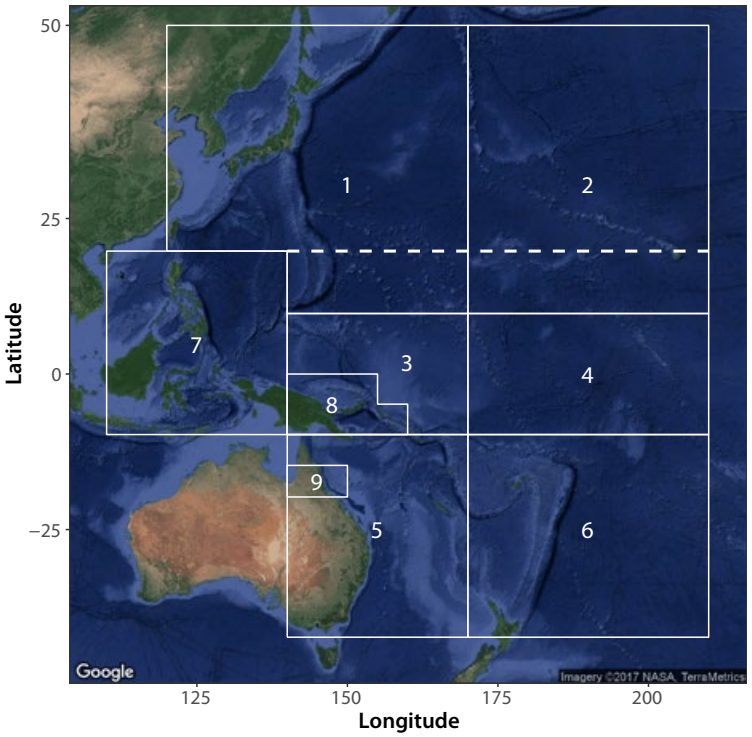

Figure 7. The definitions of spatial structure used in the 2017 bigeye tuna assessment. The dashed white line at 20°N separating regions 1 and 3 and regions 2 and 4 was used in the 2014 assessment. The white line at 10°N is the alternative definition adopted in the 2017 assessment.

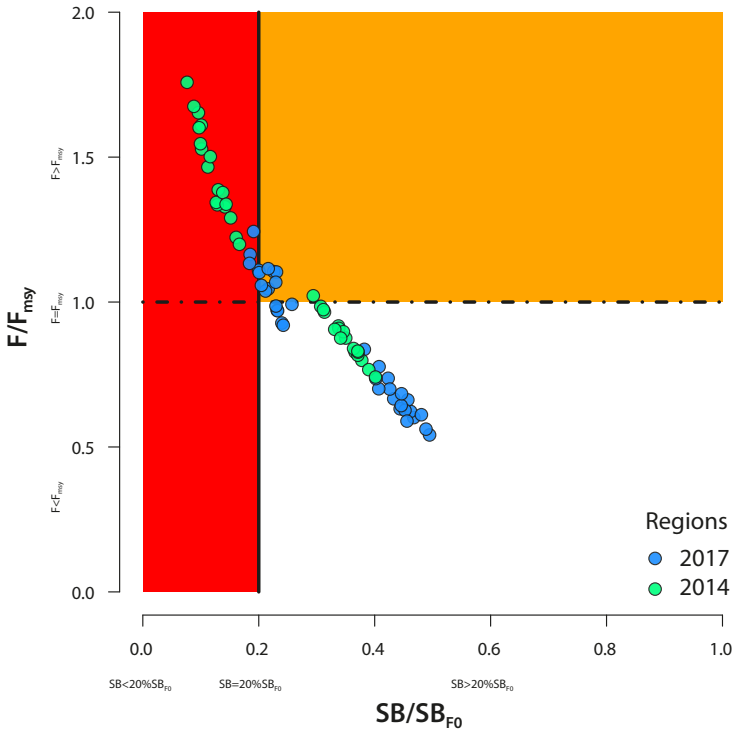

Figure 8. Estimates of recent average spawning biomass depletion (SB/SB_{F0}) and fishing mortality in relation to MSY conditions (F/F_{msy}). The red area of the plot indicates spawning biomass less than the limit reference point of 20% of the unfished level. The red and orange areas above the dashed horizontal line indicate levels of fishing mortality higher than MSY. The blue and green points represent 2012–2015 average spawning biomass depletion from models incorporating the changed (2017) and previous (2014) regional structure, respectively.

Where to from here for the bigeye tuna assessment?

As noted above, SC13 accepted the results of the assessment and made several important recommendations, which are listed below.

1. Use all 72 models that are presented as part of the assessment to characterise the uncertainty in the assessment, with the models that included the new growth curve being accorded three times the weight of the old growth models.
2. Conduct further work to improve the growth data set through the inclusion of additional otolith samples for larger-sized bigeye tuna.
3. Undertake work to indicate which regional stratification is most appropriate for the assessment.

The SC was of the view that the additional work proposed under recommendations 2 and 3, above, should allow the uncertainty in the assessment results to be reduced, ultimately through the use of a reduced suite of models that use the best scientific information on growth and regional structure in particular. It is likely that this question will be re-visited next year at SC14. In the meantime, the OFP will use the weighted model ensemble to conduct evaluations of management alternatives for bigeye tuna, and the other tropical tunas using the latest assessments, for the 14th Annual Regular Session of the WCPFC to be held in Manila, Philippines in December 2017.

Concluding remarks

Rapid and substantial change is rarely comfortable. The changes resulting from the 2017 bigeye tuna assessment have certainly tested the scientists involved in the work. We were acutely aware of the impact that the new assessment would have, and there was pressure on everyone involved to 'get it right' within the limits of the information at our disposal. There was a feeling that our credibility, and that of the science process generally, would be under intense scrutiny. The representatives of WCPFC members participating in SC13 were also tested in interpreting the results and reacting with appropriate recommendations. Many of those representatives will also have to explain to their fisheries managers and industries in their home countries why the assessment has changed and why the outlook now seems to be considerably better. In some cases, this is bound to be a difficult conversation, particularly where difficult decisions were made in the past.

But on the positive side, it does seem as though the science process has worked as it should. Uncertainties in earlier assessments were identified, research to address those uncertainties was designed, funded and implemented, the results of the research were incorporated into a new assessment and appropriate follow-up research and management responses are being formulated – continuing the process of improving assessments and the management decisions that flow from them.

Spatio-temporal interactions between whale sharks, cetaceans and the European tropical tuna purse seine fishery in the Atlantic and Indian Oceans

Lauriane Escalle[1]

Introduction

Various natural and anthropogenic threats impact marine megafauna species worldwide. This denomination for large marine vertebrates includes several taxonomic groups, such as mammals, chondrichthyans (sharks and rays), turtles and seabirds (Lewison et al. 2004). The threats that their populations have to face consist of target and non-target fishing or harvesting, habitat destruction, pollution, ship traffic, pathogens, climate change and non-lethal human interactions (Hoffmann et al. 2010). Yet, in this array of threats from human activities, the major ones are considered to be targeted fisheries and bycatch (i.e. incidental capture of non-targeted species) (Read et al. 2006; Stevens et al. 2000; Wallace et al. 2011). This overall extensive and increasing pressure that is applied by humans has led to the decline of many species, especially species with particular inherent biological characteristics, such as late maturity, low fecundity and high longevity (Musick et al. 2000; Žydelis et al. 2009).

In the open ocean, tropical tuna purse seiners actively search for signs at the surface of the sea that can indicate the presence of tuna schools. These may include flocks of birds, the deformation of the water surface that is linked to tuna feeding behaviour, the presence of floating objects (natural or artificial) or the presence of marine megafauna species (i.e. cetaceans, or whale sharks, *Rhincodon typus*). Indeed, several marine species, including tropical tunas, aggregate under any floating object. Some tuna species may also associate with marine megafauna species – mainly to feed on the same prey species. Fishers use these known tuna behaviours in order to increase their fishing efficiency. For data management purposes, the various fishing modes are classified according to the cues for sighting a tuna school. In the eastern Atlantic Ocean and the western Indian Ocean, most fishing sets are made on free-swimming tuna schools ('free school set'), or associated with a floating object (natural or artificial drifting fish aggregating devices 'FAD set'). In both oceans, sets are also made in association with cetaceans and whale sharks. In the 1980s, these megafauna-associated fishing sets were estimated to represent 8% of the fishing sets in the eastern Atlantic Ocean (Stretta and Slepoukha 1986) but little information existed for the Indian Ocean (Romanov 2002). Nowadays, the whale shark- and whale-associated modes of fishing are considered relatively rare and are not well studied.

In the framework of the ecosystem approach to fishery (EAF) management, the impact of the tropical tuna purse seine fishery on targeted species – but also on incidentally captured and encircled species – should be investigated. In relation to cetaceans and whale sharks, the fact that all these marine species are referenced in international conventions for conservation (e.g. the International Union for Conservation of Nature, or the Convention on International Trade in Endangered Species of Wild Fauna and Flora) led regional tuna fishery organisations (the International Commission for the Conservation of Atlantic Tunas, and the Indian Ocean Tuna Commission), as well as ecological and non-governmental organisations, to call for detailed information on megafauna/purse seine fishery interactions.

The results presented in this newsletter are extracted from my PhD, which was completed at the French *Institut de Recherche pour le Développement* in Sète, France between 2013 and 2016.[2] The aims were to investigate the spatio-temporal interactions (fishing nets set in the vicinity of these species and potentially lead to encirclement) and/or co-occurrences (presence in the purse seine fishing grounds) between whale sharks, cetaceans and the tuna purse seine fishery in the eastern Atlantic and western Indian Oceans, and to assess the potential impacts on the species that are involved. To address these objectives, I have mainly used fishery data from European fleets (France and Spain): i) logbook records systematically filled out by vessel captains since 1980; and, ii) data from scientific observers onboard fishing vessels since 1995 (continuous data collection programmes since 2003). Observers tend to record more detailed and complementary information than captains. However, the number of purse seiners that carried an observer onboard was historically low (<10%), but has increased to 100% in the Atlantic Ocean and ~40% in the Indian Ocean since 2014.

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[2] In March 2017, I joined the Oceanic Fisheries Programme of the Pacific Community. I am now working on sustainable FAD fishing in the Western and Central Pacific Ocean (WCPO). My research focuses on i) identifying factors that lead to high juvenile bigeye tuna catch in FAD purse seine fishing sets; and, ii) investigating, and if possible quantifying, the operational use of FADs to increase our knowledge on FAD fishing dynamics and the ecosystem interactions that they drive.

Interactions between whale sharks and the tropical tuna purse seine fishery in the Atlantic and Indian Oceans

Whale shark sightings have mainly been recorded by captains and onboard scientific observers when directly interacting with purse seine fisheries, i.e. when whale sharks are encircled in tuna purse seine nets. According to these records, ~1,5% of all fishing sets were made in association with whale sharks in both oceans (8650 fishing sets recorded between 1980 and 2011 in the logbook datasets and 180 between 1995 and 2011 in the observer datasets) (Capietto et al. 2014). Whale shark-associated sets were mostly incidental, given that whale sharks were not seen prior to the setting of the net. Distribution maps of sightings per unit of effort (SPUE) highlight main areas of interactions between fisheries and whale sharks: i) in the coastal area from Gabon to Angola in the Atlantic from April to September; and, ii) in the Mozambique Channel in the Indian Ocean between April and May (Figure 1a). The incidence of apparent whale shark mortality due to fishery interaction is low (two of the 145 whale sharks encircled by the net between 1995 and 2011 died, i.e. 1.38%) (Figure 1b). Post-capture mortality rates in the longer term have then been investigated using pop-up archival tags. In 2014 and 2016, eleven large whale sharks (8–12 m in length) that were encircled in tuna purse seine nets were tagged before being released, in the area of the Atlantic Ocean and at the period that had been previously identified as having the highest rates of whale shark encirclements. These whale sharks were released from the encircling purse seine nets using, when possible, a 'good practice' method (see Escalle et al. 2016 for details). Seven individuals survived at least 21 days after release, three tags detached after 3 and 7 days and the fate of these individuals remains unknown, and one tag failed to provide a report. Although the sample size remains limited, the results indicate high post-encirclement survival rates. The tagging of additional individuals, including juveniles, should be pursued worldwide, such as in the Pacific and

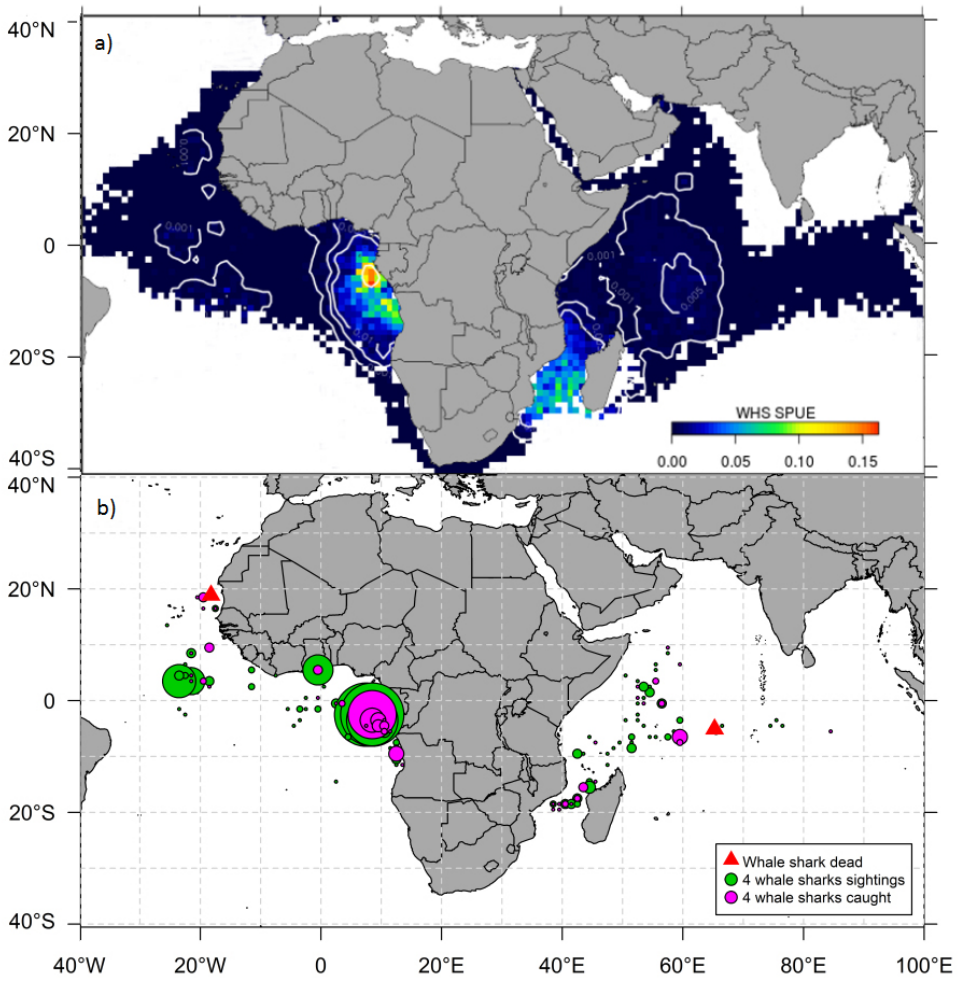

Figure 1. a) Distribution maps of sighting per unit effort (SPUE) of whale sharks in the Atlantic and Indian Oceans from 1980 to 2011 (logbook data) estimated using Poisson kriging. b) Distribution of sightings, encirclements and mortalities of whale sharks in the Atlantic and Indian Oceans from 1995 to 2011 (scientific observers' data). (source: Figure 1 in Capietto et al. 2014).

A whale shark (*Rhincodon typus*) stranded in a closed purse seine (image: L. Escalle, ©Orthongel-IRD, 2014).

Indian Oceans, to precisely assess whale shark post-release survival rates in tuna purse seine fisheries and to develop, if needed, management measures to limit fishery impact on whale shark populations.

Interactions between cetaceans and tropical tuna purse seine fisheries in the Atlantic and Indian Oceans

As was done for whale sharks, the co-occurrence and interaction between various cetaceans species (divided in three groups: baleen whales, dolphins and the sperm whale *Physeter macrocephalus*) and tuna purse seine fisheries has been studied in the Atlantic and Indian Oceans. In these oceans, the majority of cetacean sightings involved baleen whales (94% of the cetacean sightings recorded in the logbook dataset), which are mostly observed during a fishing set and therefore are directly interacting with purse seine fisheries. In both oceans, whale-associated fishing sets represented ~3% of all fishing sets (14,900 fishing sets recorded between 1980 and 2011 in the logbook dataset, and 450 between 1995 and 2011 in the observer dataset) (Escalle et al. 2015). Baleen whales are, however, rarely encircled, as most of the time they escape by themselves by diving before the closure of the net or by going through the net. It should be noted that in the case of whale-associated fishing, the sets are intentional in the way that fishing crews use baleen whales as indicator of tuna schools before setting nets in their vicinity. While dolphins are also present in fishing areas, very few interactions with fisheries were detected (258 and 85 dolphin-associated fishing sets recorded in the logbook and observer datasets), which highlights the striking difference between the eastern Pacific Ocean where half the sets are associated with dolphin pods (Hall 1998). Distribution maps of cetacean SPUE highlighted main areas of relatively high co-occurrence: i) east of the Seychelles from December to March); ii) the Mozambique Channel from April to May; and, iii) offshore waters of Gabon from April to September (Figure 2a). Finally, the mortality of eight pantropical spotted dolphins (*Stenella attenuata*) and three humpback whales (*Megaptera novaeangliae*) has been recorded by observers in the Atlantic Ocean (Figure 2b) leading to relatively low immediate apparent mortality rates following encirclement (Atlantic Ocean: 8%, Indian Ocean: 0%). These high survival rates suggest setting nets close to cetaceans has a low immediate apparent impact on the species involved. It is important to note that the non-lethal impacts of cetacean-associated sets have not been assessed and would be very difficult to measure. Overall, these findings, as those related to whale sharks, should contribute to the development of EAF management and accurate cetacean conservation measures.

Humpback whale (*Megaptera novaeangliae*) encircled in a purse seine (image: L. Escalle, ©Orthongel-IRD, 2014).

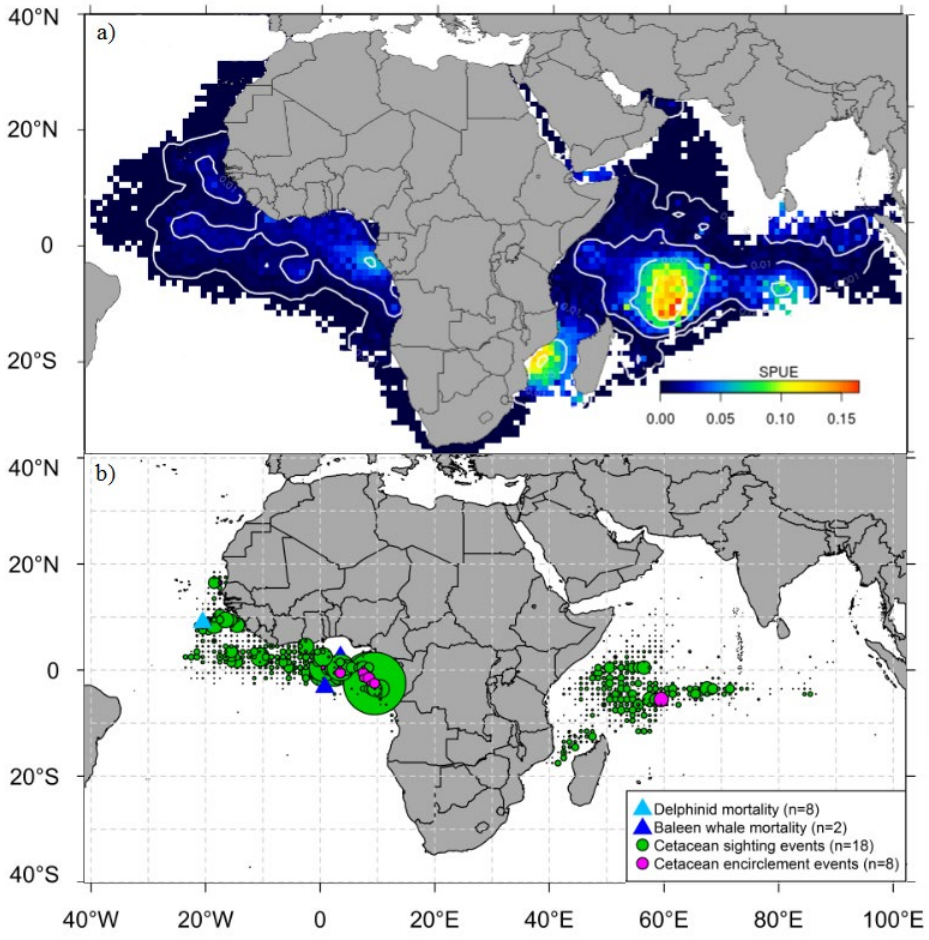

Figure 2 a) Distribution maps of Sighting Per Unit Effort (SPUE) of all cetaceans combined, in the Atlantic and Indian Oceans from 1980 to 2011 (logbook data) estimated using Poisson kriging. b) Distribution of sightings, encirclements and mortalities of cetaceans in the Atlantic and Indian Oceans from 1995 to 2011 (scientific observers' data). (source: Figure 2 in Escalle et al. 2015).

Environmental factors and megafauna spatio-temporal co-occurrence with tropical tuna purse seine fisheries

Following the identification of specific areas and periods with high whale shark and cetacean co-occurrence with purse seine fisheries, it was then relevant to investigate possible links between these main areas of co-occurrence and specific environmental conditions. In fact, various environmental variables such as water temperature or primary production may directly influence the distribution of megafauna species, as well as tuna distribution (and therefore fishery distribution), or indirectly affect them through influences on the distribution of their prey. To investigate these hypotheses, we analysed a ten-year (2002–2011) dataset from logbooks in the Atlantic and Indian Oceans, with the aim of identifying the principle environmental variables under which the megafauna/fishery co-occurrence appears. We applied statistical models (Delta-model approach using Generalized Additive Models and Boosted Regression Trees models) separately by ocean and megafauna group. The variables that contributed most in the models were chlorophyll-a concentration in the Atlantic Ocean, as well as depth and monsoons in the Indian Ocean (Escalle et al. 2016c). It was therefore highlighted that high co-occurrence between whale sharks, baleen whales and tuna purse seine fisheries were mostly observed in productive areas during the particular seasons that are previously mentioned, which was expected as both megafauna groups are filter feeders.

Management considerations

Management conservation measures for whale sharks and cetaceans have been implemented in the Indian Ocean (resolution IOTC 13/04 and 13/05), which prohibit the intentional setting of purse seine nets around these animals. This has been implemented due to the ecological importance and vulnerability of these species, as shown by their inclusion in various conservation lists. It should be noted that as whale sharks are often not seen prior the setting of the net, this measure will have relatively low consequences on the number of encirclements and 'good practice' methods that are carried out to release encircled whale sharks should be mandatory in case of incidental encirclements. On the contrary, no conservation measures toward whale sharks and cetaceans exist in the Atlantic Ocean. To investigate the consequences that such measures may have on the number of megafauna-associated fishing sets, as well as on the tuna catch and bycatch, we simulated the ban of whale or/and whale shark-associated fishing sets in both oceans. These could lead to an increase in the number of FAD and free school sets but no change in the tuna catch, as well as a slight decrease in bycatch (Escalle et al. 2016a). Similarly, management measures toward FAD fishing (no take zones or moratoria, i.e. area and period where all FAD activities are prohibited) have been implemented in both oceans to protect stocks of tropical tunas. However, the fishing effort relocation toward other fishing modes (i.e. free school, whale-associated and whale shark-associated fishing sets) may lead to increasing impacts on encircled megafauna species, but also on bycatch species. The potential side effects and consequences of these FAD fishing management measures were therefore also investigated. Real and simulated (larger and longer than the existing ones) FAD moratoria showed limited impacts on the number of megafauna-associated fishing sets. This is due to the fact that in both oceans the main FAD fishing seasons and areas do no correspond with the areas and periods with higher megafauna-associated fishing sets (Escalle et al. 2016a, 2017). However, the large six-months FAD moratoria that have been simulated in each of the oceans could be beneficial for juvenile tuna and some bycatch species, by highly decreasing the number of FAD-associated fishing sets at the scale of the whole ocean during a fishing year (Escalle et al. 2017). Nevertheless, it should be noted that contrasted results were found depending on the ocean and the fleet considered (i.e. French or Spanish).

Conclusion and comparison with the Western and Central Pacific Ocean (WCPO)

Overall, this study led to an increase in the knowledge on megafauna/fishery interactions, which is essential for the general framework of setting up EAF management in for tropical tuna purse seine fisheries. While megafauna-associated fishing sets were relatively high before 2000 in the Atlantic and Indian Oceans they have become less frequent in recent years. However, whale shark- and baleen whale-associated fishing sets are localised in specific areas and periods that are characterised by highly productive environments. In addition, in the Atlantic and Indian Oceans, purse seine fisheries appear to have a relatively low apparent impact on these megafauna species. In relation to whale sharks, post-release mortality rates also appear low but additional studies are needed to precisely estimate survival in the longer term. In relation to baleen whales, while encirclement and mortality rates appear low, the non-lethal impacts of whale-associated fishing sets have not been assessed. However, given the ecological importance and vulnerability of these species, intentional setting of purse seine nets around whale sharks and cetaceans has been prohibited in the Indian Ocean.

In the Western and Central Pacific Ocean (WCPO), whale- and whale shark-associated fishing sets have also been recorded. Whale shark-associated sets represent 0.3–0.7% and whale-associated sets 1.6–2.5% of the total number of sets performed between 1980 and 2014 (Molony 2005; WCPFC 2010; Clarke 2015). These megafauna-associated fishing sets are mostly located in the Papua New Guinea Economic Exclusive Zone (i.e. Bismarck and Solomon

Seas) (WCPFC 2010). In addition, onboard observers have recorded the mortality of two Bryde's whales (*Balaenoptera edeni*) between 2007 and 2010 (WCPFC 2010) and 88 whale sharks between 2007 and 2014 (WCPFC 2010; Clarke 2015). This corresponds to apparent mortality rates of 6% for baleen whales and 7–14% for whale sharks, which is higher than in the Atlantic and Indian Oceans. This has prompted the Western and Central Pacific Fisheries Commission (WCPFC) to ban the intentional setting of nets on cetaceans and whale sharks since January 2013 (CMM-2011-03) and January 2014 (CMM-2012-04), respectively. In addition, WCPFC has drafted 'good practice' method guidelines on how to release whale sharks that are incidentally encircled.

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Legislating for A New Song: Ensuring effective and up-to-date coastal fisheries laws in the Pacific Region

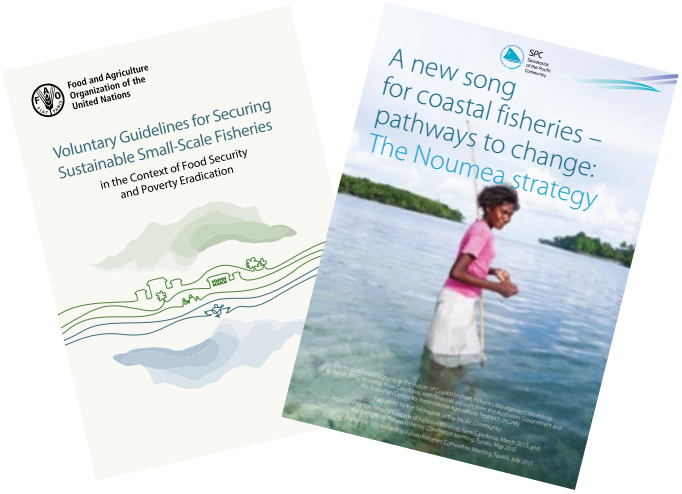
Ruth Davis,[1] Don Gourlie,[2] Hugh Govan,[3] James Marshman,[4] Quentin Hanich[1]*

Background

The significant benefits derived by Pacific Island countries and territories (PICTs) from oceanic fisheries are already recognised in well-developed laws and policies designed to assist PICTs in harnessing the value of commercial tuna fisheries (Gillett 2016). However, to date, coastal fisheries have received far less attention from governments. This is despite the fact that nearshore fisheries play a critical role in many local communities, make a substantial contribution to household income and food security and are declining in many PICTs under the dual pressures of growing populations and unsustainable fishing activities (Charlton et al. 2016; Gillett and Cartwright 2010).

A new song for coastal fisheries – pathways to change: The Noumea strategy ('A New Song') (SPC 2015) presents a broad strategy to deal with the challenges of coastal fisheries management, and works towards the long-term objective of 'improved wellbeing of coastal communities [and] productive and healthy ecosystems and fish stocks'.[5] Insufficient attention to management of coastal fisheries, and outdated planning, policy and legislation are identified in A New Song as key barriers to achieving these goals.[6] A requirement of 'strong and up-to-date management policy, legislation and planning' for coastal fisheries is therefore designated a key outcome area for the strategy.[7]

For many PICTs, this will require new or updated legislation, typically to expand coverage beyond the high value offshore fisheries with their distinct management and policy issues. How might PICTs, then, embark on the task of ensuring that coastal fisheries regulations in each jurisdiction are 'strong and up-to-date'? One approach would be to benchmark existing legislation against a set of 'best practice' guidelines.



The 'SSF Guidelines' and 'A New Song' were both published, respectively by FAO and SPC, in 2015

The study

In a recent study published in *Marine Policy*, this is the task attempted by a group of researchers with a particular concern as to how PICT coastal fisheries legislation could facilitate adaptive and community-based ecosystems approaches to fisheries management in light of climate change (Gourlie et al. 2017). A central conclusion of the study was that the utility of nearshore fisheries laws, in the face of climate change, would depend largely on the ability of the legal regime to support *resilient* coastal fisheries. The paper's consideration of best-practice guidelines for coastal fisheries legislation is therefore of broader relevance to the current question of what criteria to apply when assessing the strength and currency of existing law and policy.

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[5] A New Song, 10.
[6] A New Song, 8.
[7] A New Song, 10.

The authors referred to both A New Song and to the FAO's 2015 *Voluntary guidelines for securing sustainable small scale fisheries in the context of food security and poverty eradication* ('SSF Guidelines') (FAO 2015) to construct a list of benchmarks for use in their assessment of PICT coastal fisheries laws. As with A New Song, the SSF Guidelines also recognise the importance of suitable national legislation as part of the enabling environment for supporting sustainable coastal fisheries.[8] Both policy documents identify a number of considerations that are seen as important – either in improving the management of coastal fisheries directly, or in achieving broader socio-economic goals within the small-scale fisheries sector. From these considerations, the authors derived a set of twelve benchmarks and used these as the basis for assessing coastal fisheries legislation across PICTs.

Coastal fisheries law: Benchmarks

1. Recognition and protection of tenure – in particular does the law ensure that small-scale fishing communities have equitable and socially and culturally appropriate tenure rights to support their nearshore fishing?[9]

2. Recognition and support for local communities and traditional management – remembering that 'Coastal fisheries management is not only about managing fish; it is about supporting people at the community level.'[10] Does the law promote recognition and respect for 'existing forms of organization, traditional and local knowledge and practices of small-scale fishing communities',[11] as these are essential for empowering community stewardship?[12]

3. Long-term conservation policies/sustainable management principles – does the law incorporate such principles? Support for sustainable, well-managed coastal fisheries that provide food security and long-term economic, social and ecological benefits to communities are key concerns of both A New Song and the SSF Guidelines.[13]

4. Adequate enforcement mechanisms – to what extent does the law incorporate these? Compliance, enforcement and variable or inadequate sanctions are identified as a barrier to effective coastal fisheries management in the Pacific context.[14]

5. Support for co-management strategies – to what extent does the law support management cooperation between government and stakeholders (as this is critical in supporting A New Song's central goal of scaling out community-based ecosystem approaches to fisheries management)?[15]

6. Protection for local workers and immigrant fishing communities – to what extent does the law incorporate such protection? While this is not a central concern of A New Song (which does, however, recognise the diversification of livelihoods as a component of coastal fisheries management[16]), this is a major concern in the broader SSF Guidelines[17] and may become more of an issue in the Pacific region as a result of migration and resettlement in response to climate change.

7. Equity for all stakeholders, both pre- and post-harvest, with a focus on women and children – to what extent are equity considerations embedded in the legal framework? A New Song targets the greater inclusion of women and youth in decision-making and more equitable access to the benefits flowing from coastal fisheries.[18]

8. Identification of climate change as a relevant consideration – to what extent is climate change recognised in the law? The potential for climate change to negatively affect small-scale fishing resources and communities is now well-recognised, highlighting the need for adaptation strategies and building resilience in coastal fishing communities.[19]

9. Support for institutional coordination and policy cohesion – to what extent does the law encourage a coordinated approach across agencies and stakeholders?[20] A New Song notes that poor institutional connections at various governance levels have been a key barrier to sustainable management strategies in PICTs, and stresses that successful approaches require stakeholders and policies to 'sing in harmony from the same songbook, or risk being ineffective'.[21]

10. Data, research, and information sharing – to what extent does the law mandate the collection and use of data? Collecting data, conducting research, and communicating knowledge and information effectively amongst stakeholders is an integral part of sustainable coastal fisheries management.[22]

11. Effective monitoring and evaluative mechanisms – to what extent does the law support responsive management using monitoring, evaluation, and adaptation mechanisms?[23]

12. Transparent, accountable, and adequately resourced management structures – to what extent does the law support these? The long-term success of small-scale fisheries management requires strong administrative mechanisms, supported by adequate resources, formal institutions, and cooperation of all parties.[24]

Relevant legislation for 14 PICTs was surveyed to identify provisions that could be regarded as supporting each of

[8] SSF Guidelines, 3
[9] A New Song, 7, 10.
[10] A New Song, 6.
[11] SSF Guidelines, 2.
[12] A New Song, 10, 14.
[13] A New Song, 8; SSF Guidelines, 1.
[14] A New Song, 8, 13.
[15] A New Song, 10, 11.
[16] A New Song, 10, 14.
[17] SSF Guidelines, 8.
[18] A New Song, 6, 14.
[19] A New Song, iii, 7.
[20] A New Song, 7, 10.
[21] A New Song, 6.
[22] A New Song, 8, 12.
[23] A New Song, 8, 11.
[24] A New Song, 10, 13.

Table 1. Abbreviated results of the number of countries (out of 14 total) with legislation that meets, has the potential to meet, or does not meet each of the 12 benchmarks.

	Meets benchmark	Has potential	Does not meet benchmark
Recognition and protection of tenure	3	5	6
Recognition and support for local communities and traditional management	9	2	3
Long-term conservation policies/sustainable management principles	5	7	2
Adequate enforcement mechanisms	11	3	0
Support for co-management strategies	4	8	2
Protection for local workers and immigrant fishing communities	1	5	8
Equity for all stakeholders (gender and age focus)	5	6	3
Identification of climate change as a relevant consideration	2	1	11
Support for institutional coordination and policy cohesion	6	2	6
Data, research and information sharing	3	8	3
Effective monitoring and evaluative mechanisms	0	10	4
Transparent, accountable and adequately resourced management structures	3	8	3

these 12 benchmarks. Legislation was judged against a simple rubric: 'yes' (supports the benchmark); 'no' (does not support the benchmark); and, 'has potential' (i.e., there are provisions that could support this benchmark but further clarification on how the provision is interpreted or supported is required).

Table 1 provides a high-level, region-wide summary of the number of the results for each benchmark. The data corresponds to the number of countries with legislation that falls under each column.

There are three significant limitations with this assessment process. Firstly, the process for selecting the guidelines to use as benchmarks was necessarily imprecise and focused on relatively broad principles; secondly, for practical reasons the assessment looked only at laws from fourteen independent PICTs; and finally, the assessment of legislation against benchmarks was based on a paper reading of those laws and not an analysis of how coastal fisheries regulation is implemented in practice. Despite these limitations, the assessment provides a useful starting point for identifying broad strengths and weaknesses in existing coastal fisheries legislation and its implementation in the region.

Lessons learned

Most PICTs have marine resource and fisheries management legislation in place, supplemented by other statutes for the environment and land use that are relevant to coastal fisheries. However, significant shortfalls come to light when the legislation is measured against the benchmark principles found in A New Song and the SSF Guidelines.

The deficiencies in existing legislation vary considerably across the region. Some countries have legislation directed at offshore fisheries but only limited, or no, regulation of coastal fisheries. Others have legislation directed at coastal fisheries but that legislation is deficient in some key respects.

As Table 1 demonstrates, some benchmarks from A New Song and the SSF Guidelines are strongly represented in existing legislation. Recognition of traditional management and enforcement provisions are frequently found in existing legislation. However, even when the legislative provisions appear strong on paper, the applicability of those provisions is another question altogether. For example, while on paper the enforcement provisions across PICTs rate strongly, in practice compliance and enforcement are identified as significant barriers to effective coastal fisheries management in A New Song.[25]

In other areas, legislation appears are in need of updating. Existing laws frequently lack protection for fishing communities, support for institutional and policy coordination, and effective monitoring and evaluative mechanisms. And while legislation often expresses some degree of recognition for local communities and traditional management interests, the table also suggests that this is often not followed through with mechanisms that could support co-management strategies and ensure equitable participation across stakeholders.

[25] A New Song, 8.

Support for transparency, accountability and resourcing of management structures is commonly in need of attention; so too are the requirements that support effective decision-making in pursuit of sustainable, ecosystem-based management of nearshore fish stocks. In particular, the benchmarks relating to adequate data collection and information sharing and to effective monitoring and evaluation mechanisms – which are essential for supporting informed and responsive decision-making – are not strongly represented in current legislation.

A New Song and the SSF Guidelines will provide a catalyst for many PICTs to review their legal and regulatory frameworks for coastal fisheries. It should be seen as an opportunity to ensure that, so far as is possible, coastal fisheries management is supported by clear and coherent laws that address A New Song requirements. The 12 benchmarks distilled from A New Song and the SSF Guidelines can aid this process, as they are designed to facilitate effective and sustainable management of small-scale fisheries. Legislation can support sustainability of coastal fisheries by requiring the collection of key information for evidence-based decision-making, outlining how such information will be collected and subsequently used. Similarly, statutory provisions can include goals of social, cultural, and economic sustainability, and require that the management scheme accounts for and protects current and future user interests. New administrative structures and funding appropriations via statute can guarantee the long-term viability of decision-making structures and ensure that institutional knowledge and capacity increase over time. However, governments must strive to ensure that legislation can be feasibly implemented under projected capacity and funding levels, and in the context of individual countries. Perhaps most importantly, the study reminds us that it is one thing to have well drafted legislation on the statute books, but the real test is in its implementation and enforcement.

Acknowledgements

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Fishing for octopus, Tarawa Atoll, Kiribati (image: Q. Hanich)

Exploring the use of bylaws as an enabling tool for sustainable community-based fisheries management in Kiribati

Brooke Campbell[1] and Aurélie Delisle[1]

Introduction

The critical importance of coastal fisheries to Pacific Island countries and territories (PICTs), and the urgent need to take more progressive management actions towards safeguarding these resources for current and future generations was formally and collectively recognised in 2015 with the drafting and political endorsement of *A new song for coastal fisheries – pathways to change: The Noumea strategy* (SPC 2015). Central to the proposed pathway to change in the 'New Song' is the use of community-based ecosystem approaches to fisheries management (CEAFM). Situated within a spectrum of possible co-management models, CEAFM[2] sees governments taking on more partnership-based roles while supporting communities to take the lead in local-level participatory resource management decision-making (Pomeroy and Berkes 1997). CEAFM initiatives are not without their challenges and failures; nevertheless, this more participatory and inclusive management approach is considered to be a positive step towards improved coastal resource benefit delivery to the people who are most in need (SPC 2015).

The New Song also recognises that meaningful improvements to coastal fisheries require significant additional governance[3] support, e.g. advocacy, political will, and community empowerment (SPC 2015). In this regard, community decision-makers must feel supported in their chosen management actions – both within and between communities, as well as by local and national governments – in order for community-led strategies to be sustainable in the medium- to long-term. As different models of CEAFM develop, evolve and scale out in their respective local contexts around the Pacific (see e.g. Johannes 2002; Govan 2009; Jupiter et al. 2014), the establishment of an enabling legal environment is an essential dimension of community-led resource management governance support (Pomeroy and Berkes 1997; Fa'asili and Kelekolio 1999; Techera 2009).

An absence of national-level legal backing has not stopped communities from pushing forward to formalise their vision for community-led coastal fisheries management (Fa'asili and Kelekolio 1999; Techera 2009). In the Republic of Kiribati, a country that is relatively new to CEAFM, a handful of villages have sought to harness the power of local bylaws to help their community vision become a recognised reality.

This article briefly describes the introduction of community-based fisheries management (CBFM, a form of CEAFM) to Kiribati, and how bylaws emerged as a potential tool to support village-level CBFM plans. It then describes how the bylaw process in Kiribati was clarified and reflects on the potential impact of bylaws on the sustainability of CBFM initiatives in-country. Finally, it discusses areas of further interest to ensure that village bylaws provide the necessary legal foundations for CBFM success in Kiribati.

Community-based approaches to fisheries management in Kiribati

As in many developing PICTs, coastal fisheries resources provide the people of Kiribati with essential food protein and livelihood benefits, and significant sustainable conservation and management challenges (Bell et al. 2009; Hoegh-Guldberg et al. 2011; GOK 2013). The Kiribati Ministry of Fisheries and Marine Resources Development (MFMRD) Coastal Fisheries Division has the mandate of developing, implementing, monitoring, and enforcing coastal fisheries management and conservation initiatives across Kiribati's 21 inhabited islands. This mandate is challenging not only because of the limited human, financial, capital and technical resources available to the Division to undertake these activities, but also because 'outer' island communities are numerous, remote, spread across vast ocean areas, and are all heavily reliant on coastal fisheries for their daily food and livelihood needs. This makes coastal management outreach, compliance and enforcement critical but also particularly challenging for a ministry that has its headquarters in the capital, South Tarawa.

Aware of the declining health of its coastal fisheries resources, in 2013, MFMRD partnered with the Australian National Centre for Ocean Resources and Security

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[2] A number of terms are actively used around the Pacific to describe CEAFM principles and approaches. Examples include: CBFM=Community-based fisheries management, CBRM=Community-based resource management, CBAM=Community-based adaptive management and LMMA=Locally-managed marine areas.

[3] Governance is defined here as the formal and informal institutions, structures, and processes that shape how power is exercised, responsibilities are allocated, and decisions are made in multi-level, multi-actor systems.

Butaritari Island's Tanimaiaki village works collaboratively on their community fisheries management plan in 2014. (image: A. Delisle).

(ANCORS) at the University of Wollongong, WorldFish and the Pacific Community on the Australian Centre for International Agricultural Research (ACIAR)-funded project *Improving community-based fisheries management in Pacific Island countries* (FIS/2012/074). This 'CBFM project' is a collaboration between local, sub-national, and national governments, with participating communities in Kiribati, Solomon Islands and Vanuatu.

With the exception of a previous draft assessment of CEAFM possibilities for one island, the CBFM project was the first time that CEAFM/CBFM approaches were introduced to Kiribati. The initial participatory diagnosis phase of the project identified and evaluated the social, economic, environmental and governance contexts of five selected pilot communities on two islands, the characteristics of their fisheries, and identified project entry points (Uriam and Delisle 2014; Delisle et al. 2016). Among the issues identified by village communities were perceived declines in local fisheries resources, widespread use of unsustainable fishing practices, a reliance on development-focused projects rather than sustainable management projects, an erosion of respect for customary village-based authority around marine resources use, and a poor understanding of their own decision-making power and available institutional and legal support for fisheries management.

In particular, many community members expressed their concern that unless formal legal recognition was created to honour community-led fisheries resource management efforts, any village-level management plan would ultimately not succeed due to a lack of effective compliance and enforcement mechanisms, especially against potential outside transgressors. Community members noted that in the past, informal village-based and island-based rules were used to regulate specific fishing activities (Teiwaki 1988; Johannes and Yeeting 2001; Delisle et al. 2016). These rules had the backing of traditional customary authority, i.e. the *Unimaane* or council of elders, and were strictly observed within, and sometimes between, villages. However, it was noted during consultations that these rules were no longer a strong behavioural deterrent. Identified reasons for this social shift included the following: changes to cultural values, changes in migration and land ownership patterns, and increases in population-driven resource exploitation pressure from 'outsiders'.

In working collaboratively towards identifying solutions to this issue, community members identified that island councils can create bylaws and noted that these had been used in the past with some degree of success. However, there was a widespread lack of understanding about the mechanisms and processes required to create bylaws,

or of the support available to do so. In response to this stated knowledge gap and request for more information, the CBFM project sought to clarify the process of making bylaws for coastal fisheries management in Kiribati. The aims of this exercise were to respond to community requests to understand the bylaw process, clarify the legal options available to them in support of community-led initiatives, strengthen communication between different actors, and foster an environment where communities felt more supported in making decisions.

Clarifying the bylaw process for coastal fisheries management in Kiribati

Kiribati's small-scale and subsistence coastal fisheries are open-access and to date almost entirely unregulated, with the exception of a handful of species[4]. The national Fisheries Act (2010) makes no explicit mention of coastal fisheries or their management but does allow for coastal fishery designation and management by government, and offers some protection for nearshore customary fishing rights. The relative newness of CBFM concepts and the absence of formally recognised customary marine tenure in Kiribati (although sea tenure rights were important in the past, Teiwaki 1988) mean that no national-level support for community-led fisheries initiatives currently exists in law. However, the pilot implementation of CBFM is a short-term priority strategic action in the Kiribati National Fisheries Policy 2013–2025 (GOK 2013). In addition, Kiribati has a sub-national layer of government called the island council; these island-wide institutions have delegated power over marine resources within their 'area of authority' from the Government of Kiribati through the *Local Government Act 1984* (*LG Act*) and subsequent amendments. It is through this Act that an island council's powers and duties are granted; this includes the creation of local bylaws.

Defining the scope of fisheries bylaws in Kiribati

In 2016, the project team reviewed the content of the *LG Act* in detail to better understand the structural processes involved in creating bylaws and the nature and extent of the powers granted to island councils for coastal fisheries management. The *LG Act* states that an island council's area of authority is determined by the warrant that first establishes the council. Unless otherwise specified in the warrant and in agreement with other national Acts, this area includes waters adjacent out to 3 nautical miles seaward from the low-water line of the lagoon and/or sea.

Bylaws (known locally as 'bye-laws' or *ointua*) are rules with the force of law inside an island council's area of authority. Their primary purpose is to provide formal legal recognition for the rules made by a local government to address the interests, issues and concerns of the community it represents. Bylaws are recognised and supported by the Government of Kiribati, including in the Fisheries Act. Island councils have the option of pursuing legal action against any person who breaches a bylaw in a court of law. Bylaws differ from informal village rules because bylaws are legally enforceable and can apply in one village, across many villages, or across a council's entire area of authority (i.e. island-wide), depending on what a council chooses to specify in their written bylaw. Under the *LG Act*, bylaws can also apply to specific groups of people; for example, people who fish for certain species at certain times of year or use specific gear types. They can dictate who has the authority to enforce bylaws, conditions constituting a breach, and the resulting fine or duration of imprisonment. Appropriate levels of punishment are set in the *LG Act* but the amounts can be increased upon approval by the Attorney General. Island councils have primary responsibility for proposing, drafting and enforcing bylaws.

The *LG Act* provides a foundation for understanding the roles and responsibilities of island councils towards coastal resource management and the structural ways in which bylaws can be used as a local governance support tool. However, the Act's finer points are not widely known in Kiribati and give little insight into how its bylaws component has been operationalised in practice. While bylaw processes are essentially similar around the world, there are contextual differences in practice; it is therefore important to define the local steps, actors, and applications to ensure that bylaws are understood and operationalised appropriately by all stakeholders.

Clarifying the bylaw process

In order to clarify the bylaw process specific to Kiribati, the project team consulted with Ministry of Internal Affairs (MIA), MFMRD, and the Attorney General's Office (AGO) in order to understand how bylaws are created in practice and to specify how the process is applied with regards to coastal fisheries management. MIA has within its mandate the responsibility of supporting island and village-level affairs and employs and trains island council mayors and clerks. MIA is also the lead ministry responsible for facilitating the creation of bylaws through an island council and for approving bylaws into law. The AGO provides advice on the legality of a bylaw and is responsible for ensuring its content is legally sound and does not contradict national Acts. Infrequently, the AGO is asked to draft a bylaw in its entirety. Interestingly, it was discovered that there is currently a minimal official role for MFMRD in the drafting and approval process. Even if a proposed bylaw is coastal fisheries related in content, consultations with the ministry appear to be infrequent and on an ad hoc basis. MFMRD has a legal

[4] MFMRD is currently drafting a new amalgamated coastal fisheries regulation with the Pacific Community support, which will feature specific rules for a number of coastal species.

liaison officer, but it was not possible to clarify their functional role in the bylaw process. The timeframe provided from bylaw proposal to approval was between six months to a year; however the project team has observed that this can take much longer in practice. During the consultation process, it was observed that core knowledge about processes and practices for coastal fisheries bylaws development was fragmented across different key actors. The advice provided by actors also differed with respect to the scope of a bylaw's application (i.e. from village to island-wide) although this information is specified in the *LG Act*.

Prior to the CBFM team's engagement, there were no written guidelines on the bylaw process in Kiribati. Out of this consultation process, the project team produced a guidelines reference document for government departments and a 10-step poster for communities written in both English and the Kiribati language (Figure 1). The poster content was reviewed and approved by MIA's Local Government Unit. This poster was given to a representative from each pilot village in the hopes that it could serve as an easy-to-follow passive communication medium for communities. The community version also included some basic images. The consultation process sparked positive discussion across ministries about the current fisheries bylaw process; as a result, the creation and use of bylaws for community fisheries management was a significant feature of discussion between community leaders and government departments during the project's 2016 annual in-country stakeholder workshop. At this same meeting, alternative options for formalising community fisheries management plans were also identified by the Ministry of Women, Youth and Social Affairs (MWYSA). Noting that the bylaw approval process can be lengthy and has many different steps along the way, MWYSA representatives explained that villages could incorporate themselves as a community organisation through MWYSA (Incorporated Societies Act 2002) and submit their village fisheries management plan as their organisational plan.

Bylaws as an enabling tool for sustainable CBFM in Kiribati

An enabling legal environment is a cornerstone to the successful involvement of communities in the management of their marine resources (Pomeroy and Berkes 1997; Fa'asili and Kelekolio 1999; Techera 2009). Across the Pacific, countries have put in place different legal frameworks to support CBFM initiatives (Techera 2009); including the use of village bylaws in Samoa (Fa'asili and Kelekolio 1999). In Kiribati, bylaws appear to be one of the tools that would support island-wide or community-wide initiatives with regards to coastal fisheries management. This section discusses some of the beneficial outcomes of clarifying the bylaw process but also highlights some of the remaining challenges in providing an enabling legal environment for CBFM initiatives in Kiribati.

As a result of the CBFM project's information collection and sharing, and its fostering of more active lines of communication (Reed 2008) between communities and levels of government, leaders from all pilot communities expressed increased confidence in their ability to push for a formalisation of their community fisheries management plan through the creation of a bylaw. Four villages began taking steps towards drafting a bylaw based on their community fisheries management plan. They are in the process of working with the island council and MIA to determine whether this bylaw can be applied at the village-level only, or if an island-wide bylaw can be created that reflects one village's particular interests in a specific area. At the time of writing, one community in particular is continuing to actively follow up on the proposition made by MWYSA to become incorporated under the Incorporated Societies Act (2002). A fifth village has decided to hold off on plans for plan formalisation for the time being. Instead, they have chosen to consult collaboratively with neighbouring communities and create an informal agreement that acknowledges the open-access nature of coastal fisheries resources but respects their village's desire to meet certain management objectives. Discussions held on the bylaw process highlighted that conflicting advice and miscommunication on the scope of bylaws for use in fisheries management (from village-based to island-based) had created some misunderstandings among stakeholders. This issue is currently being discussed as it will provide all stakeholders and the CBFM team with clear information for current and future CBFM communities in Kiribati. The other aspect that will need to be further explored among stakeholders is the potential differences, advantages and disadvantages of creating a village bylaw through incorporation under the Incorporated Societies Act (2002) or through the standard bylaw process of MIA.

In terms of identifying strengths and gaps in knowledge and communication across the current process, MIA Local Government Unit is the main point of knowledge when it comes to bylaws. They are keen to have stronger engagement with other ministries and with island councils about bylaw issues. The key will be to work towards strengthening direct dialogue habits between MFMRD and MIA in practice, and identify the key points of engagement along the 10-step bylaw process (Figure 1). Status updates on progress of newly written bylaws to island councils would also likely help in maintaining sound lines of communication and in retaining island council's long-term trust in the process. MFMRD's knowledge of the procedure has grown through project activities, but how they engage going forward is yet to be determined.

It is still too early to determine the longer-term fisheries management impact of this ongoing work and whether bylaws will in fact play a positive role in enabling more sustainable CBFM initiatives in Kiribati. A short-term impact is that greater awareness has been raised about bylaws across different levels of government, within communities, and CBFM project support staff, thus creating a better environment for

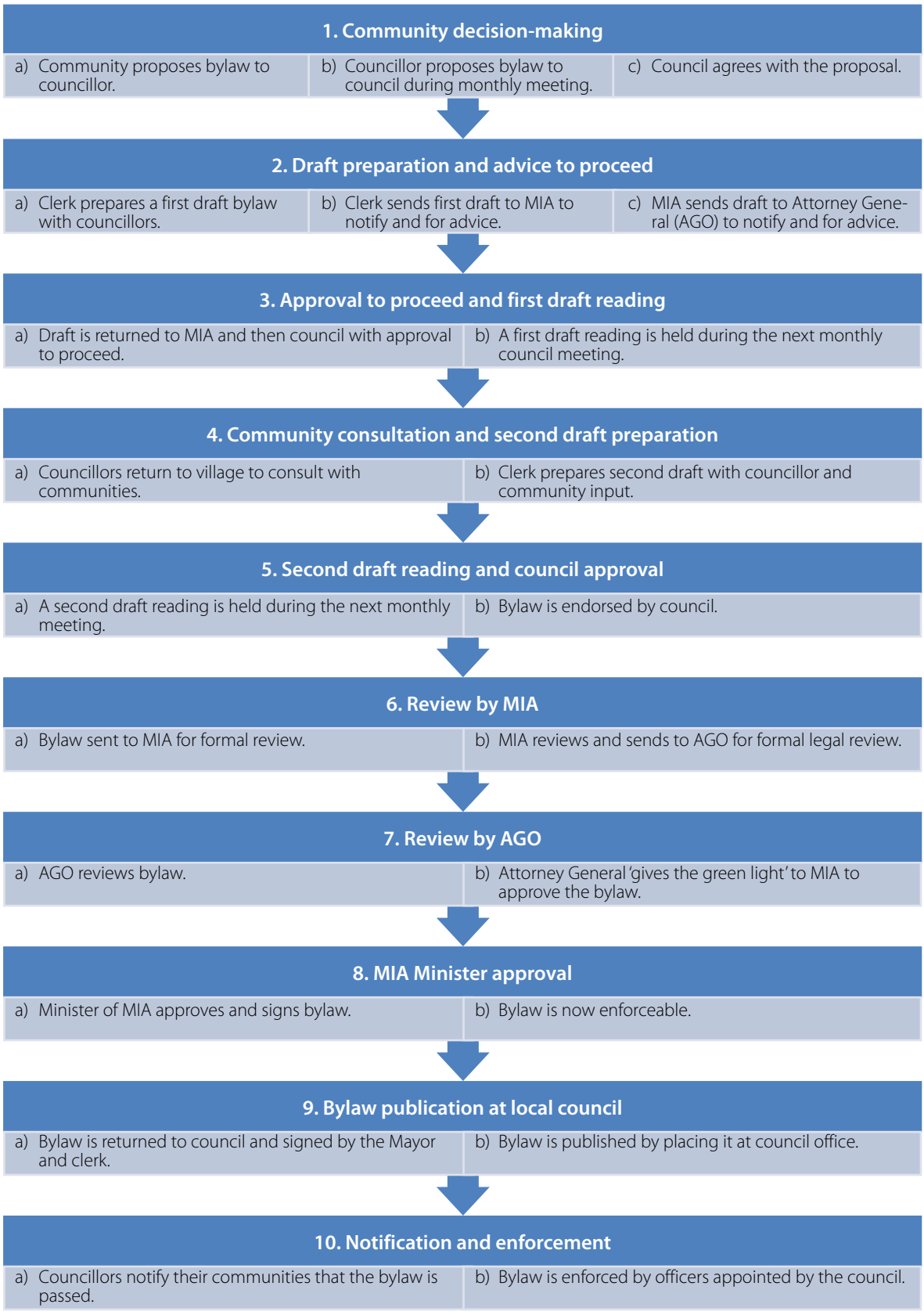

Figure 1: Simplified ten-step process diagram for making a bylaw in Kiribati (English only). This diagram was translated into the Kiribati language and given to pilot village councillors. For clarity, it excludes finer details and assumes bylaw approval. For example, the MIA Minister has the discretion to deny, cancel, create, or amend any bylaw.

continuing participation and engagement. However, the ultimate impact of bylaws as a support tool for CBFM in Kiribati will likely rely on the resolution of three key issues.

The first issue revolves around the determination of boundaries with respect to the marine areas between islands and villages. These boundaries are potentially quite important to have clarified if bylaw breaches occur at the margins between islands or villages. Those boundaries could establish areas of jurisdiction for village-based rules but would not establish ownership over these marine areas. The areas of jurisdiction would give a village the responsibility to monitor, evaluate and enforce village-based rules based on the approved bylaw. At the island level, it is possible that reviewing the island council warrant may assist in clarifying boundaries between islands and out to sea. However, locating copies of these warrants may be a significant undertaking and may not ultimately result in much clarification.

When it comes to defining boundaries between villages, it is evident through the participatory diagnosis work that customary boundaries exist to some extent in the waters immediately adjacent to a village, but there exist no known precedents where nearshore marine boundaries have had to be formally delimited in Kiribati. Rather than deflect the management of coastal fisheries into a bitter argument over boundaries (which has a history of happening for land resources), the most prudent course of action in this regard is likely for the village with the management plan to consult collaboratively with neighbouring villages about their rationale for the rules so as to gain support without having to formalise specific boundaries. Some villages are already using informal agreements with neighbouring communities that are based on sharing and mutual obligations. Regardless, more needs to be done on providing accurate information to villages in order to increase community engagement in coastal fisheries management and in reducing potential conflicts between villagers due to unresolved boundary issues.

A second issue concerns working through the practicalities of monitoring, compliance and enforcement of the formalised village plan. Bylaws can specify who can enforce their content and to whose satisfaction this content must be observed. Villages each have a warden (*Kaubure*) with a traditional 'policing' role that is still generally well respected. However, there is understandably great sensitivity around the social challenge of persecuting your neighbour in a relatively small and close-knit community. It is likely that resolving issues around bylaw breaches will play out very differently in villages that still have a relatively strong sense of community compared with villages where the sense of community is more diffuse due to larger size, in/out migration, and low local land ownership. This is more likely to be the case in villages closer to urban South Tarawa. In practice, bylaws are usually not required for breaches occurring within a village, and village-based rules adopted by a community normally suffice. Any breach is usually dealt with through local mechanisms and fines given by village leaders. Compliance and enforcement becomes more challenging if the offending individual(s) are from another island elsewhere in Kiribati. For example, South Tarawa fishers currently fish in waters adjacent to North Tarawa villages, which is seen as a potential barrier by North Tarawa villagers who only rely on village rules to deal with outside transgressors. If the issue cannot be resolved between island councils with MIA's assistance, the option is then to go to court. At the moment the Kiribati Police does not hold a coastal fisheries enforcement mandate, and it is also not clear if MFMRD do for unregulated small-scale coastal fisheries. Despite the fact that fisheries bylaws have been around for decades, there are no known precedents for taking existing fisheries bylaw breaches to court. Questions could arise as to whether villages that decide to become incorporated can be taken to court and if boundaries could become an issue.

A third issue is the need to sustain lines of outreach, communication, and action beyond one or two key individuals. In particular, there is a need to make sure that community and government officers remain aware of their options as leadership changes. The roles of community leaders need to be clarified while engagement processes between MIA and MFMRD clearly need to be strengthened and sustained. As future bylaws become approved to support CBFM, it will be important that major stakeholders identified in this bylaw mapping exercise ensure that new bylaws are communicated, people are appropriately notified, and the bylaw is published by the island council.

A final consideration rather than a concern is the remaining need for supporting national legislation that recognises community-led fisheries resource management initiatives in Kiribati as legitimate and worthwhile. This may give community leaders a valuable sense of empowerment as part of the management cycle. This may, however, mean that new and more formal processes of co-management engagement may need to be developed between MFMRD, MIA, and island councils. Hopefully, the CBFM engagement model can prove useful in this respect.

Conclusion

In conclusion, the participatory diagnosis of the CBFM project in Kiribati highlighted that considerable confusion existed across government, island council, and community stakeholders with regards to the processes involved in creating and applying fisheries bylaws. Major misunderstandings were around the scope, the steps involved, and procedural roles and responsibilities during the bylaw process. Open discussion and lesson-sharing around the bylaw process allowed stakeholders to reflect on the suitability of bylaws as a potential tool to support village-led coastal fisheries management plans. The differentiated approaches taken by CBFM communities are a reflection of the varied ways in which bylaws are likely to be used in practice for local management support. However, this work highlights

that further efforts are required in order to provide a clear and encompassing enabling legal environment to support community-led fisheries management initiatives in Kiribati. We have also demonstrated a reality of co-management in practice: that effective sharing of management responsibility with communities is involved, ongoing and complex, and that the key to workable solutions lies in continuous positive stakeholder engagement and participatory problem-solving.

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Delivering the *Liomaran*: Honiara to Yap in 1975

Mike McCoy[1]

The Marine Resources Division of the Trust Territory of the Pacific Islands first opened its Yap District office in October, 1973, and hired me as Yap's first Fisheries Officer, but provided me with very little other support. Stepping into the void, the Congress of Micronesia provided a grant to obtain a fisheries research vessel for investigations of the demersal resources of the district's outer islands that stretched nearly 600 miles to the east of Yap proper. Obtaining, delivering, and operating the vessel became the main undertaking for Yap's nascent Marine Resources office and its lone Fisheries Officer from 1974 to 1977.

During the early- and mid-1970s there was very little fisheries development emphasis in the Trust Territory outside of Palau. What interest there was, centred on demersal resources, particularly bottomfish. Very little was known of tuna resources except for skipjack near Palau that were the target of a pole-and-line fishery based at Koror and undertaken by a US company, Van Camp[2]. Although few surveys had been made of the islands and atolls in the Yap District after World War II, Japanese pole-and-line activities prior to the war did not include the central Carolines and it was thus (correctly) believed that insufficient live bait supplies existed to support a fishery such as that in Palau.

Some activity was undertaken in Chuuk (Truk) by the Trust Territory to re-start what had been a Japanese pole-and-line fishery before the Second World War. But no thought or consideration was given by the Trust Territory government to developing a local tuna longline industry. There was little familiarity with the fishery except for the rare occasion when a Japanese longliner called at a Trust Territory port in an emergency[3]. At the time, there was also no knowledge of the extent of tuna fishing activities by foreign fleets in the Territory and no familiarity with markets for longline-caught fish. That situation changed in 1979 when the Federated States of Micronesia declared its 200-mile Extended Fishery Zone and took control of its fishery resources.

After an extensive search for a builder of an appropriate vessel for bottomfishing, Honiara Shipyard and Marina Co Ltd was chosen to build a ferro-cement 16.2 metre, twin diesel vessel with a 900 cubic foot fish hold and blast freezer. Construction of the vessel commenced in late 1974 at the company's boatyard at Ranadi in what was then the British Solomon Islands Protectorate. The vessel was to be named *Liomaran* after the mythical goddess who cast stones into the sea from Yap and created the outer islands.

Construction proceeded slowly and the launch planned for the second quarter of 1975 was set back numerous times. Finally, in June 1975, my delivery crew of four from Satawal Island and I travelled by air from Yap to Honiara via Guam, Majuro and Nauru. At each stopover it was necessary to cajole, plead and beg the relevant airline to allow all the numerous large boxes of equipment to travel with the crew. Fortunately, airline agents were accommodating and everything arrived safely in Honiara. The feeling of relief turned to disappointment when it was found that the vessel was not nearly complete: the refrigeration system, electronics, and deck fittings had not been installed, and other areas such as the fish hold and interior spaces were yet to be finished.

My crew and I were working with an extremely tight budget that did not include funds for hotel accommodation. After a quick search, we found a place for our sleeping mats, mosquito nets and small kerosene stove in a partially-completed and abandoned ferro-cement vessel on the Ranadi foreshore next to the boatyard. Bathing was done in the sea, and the Honiara central market became the source of most sustenance for the next three months. Each day the delivery crew and I helped the shipyard workers with various aspects of fitting out the boat, hoping to speed up the work.

Dewey Huffer, an experienced retired captain from Guam who was hired for the delivery voyage, arrived in Honiara expecting to meet a vessel ready for sea trials. Seeing that was not the case, and not about to sleep in an abandoned boat on the beach, the captain required housing at the Honiara Hotel until the vessel was ready to sail, further straining the delivery budget.

On his first visit to the boatyard the new captain noticed the big padded helmsman's armchair sitting on a pedestal directly behind the helm. His first order was to get rid of it. I

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[2] Foreign companies such as Japanese fishing companies were not allowed to operate in the Trust Territory at the time.

[3] Those vessels were invariably old wooden boats using ice to preserve the fish and nothing at all like the clean, sleek and modern fibreglass or steel longliners that characterised the Japanese longline fleet in later years.

Liomaran, a 16.2 m ferro-cement fishing vessel built in 1974 for the Yap District Office of the Marine Resources Division of the Trust Territory undergoing sea trials at Tulagi, Solomon Islands (image: M. McCoy).

was upset, not only because the chair had cost a considerable amount to purchase and ship to Solomon Islands, but also because I thought it would be a comfortable steering location for the long voyage back to Yap. The captain patiently explained that all steering would be done while standing, as in his experience no helmsman had ever been known to fall asleep while standing up. The captain also insisted that a voice pipe leading to the flying bridge above be moved away from the helm, lest a helmsman rest his forearm on it and become inattentive to the job at hand.

Meanwhile, I had another problem: the Yap government Public Works engineer who had volunteered to participate in the delivery voyage had backed out at the last minute leaving the boat without an engineer. A search for a qualified Solomon Islander in Honiara to serve on the delivery voyage began. Eventually one was found and Nepia 'Bia' Leve from Munda, Western Province of Solomon Islands was signed on. He was later joined by Mathew Peroqolo, a young Solomon Islander from the Guadalcanal Weather Coast who worked as a 'go-fer' for the engine installer and had made friends with the Micronesian crew. There was no provision in the budget for additional crew, but Mathew's wanderlust was such that he offered to work his passage to Yap just to see different parts of the Pacific.

As construction and outfitting progressed, the shipyard owner and I spent one evening at the Honiara Yacht Club discussing the remaining work. One item that had not been completed was a small 40–50-gallon water tank that was to be placed on the deck house so that fresh water could be pumped up manually from the main tank in the hull. It was agreed that the tank would be fibreglass-covered plywood, but on leaving the yacht club the shipyard owner noticed a row of empty aluminium beer kegs stacked behind the club. He quickly threw one of the kegs into the back of his truck and it was soon transformed at the boatyard into the required water tank. Once installed, it remained covered with a tarp until after departure, lest anyone question its origin.

Finally, in early September 1975, the various pieces were in place: a captain, a crew, an engineer, and a boat ready for launching. Although the boat sat on a cradle, it was in a shed about 80 metres from the sea. When the plan for launching was revealed, it became another source of concern to me. I could visualise the entire project collapsing before the boat ever entered the water.

In fact, a collapse in launching was just what the boatyard owner had in mind. The plan was to place a set of parallel rails for the boat on its cradle from the boat shed to the high water mark. Then a series of stacked 44-gallon drums filled with rocks were placed underwater to form a foundation for the continuation of the rails into deeper water. The idea was for the boat and its cradle to pass over the rock-filled drums and rails, which would intentionally collapse, hopefully with enough water under the keel to float the boat. At the appointed time a bulldozer was used to push the boat on its cradle down the rails where it gathered speed until it hit the water stern first and momentarily paused before floating safely away from the now partially submerged cradle.

FV *Liomaran* launching, September 1975 (image: M. McCoy).

Watching the vessel launch in this manner was not for the faint hearted, but in the end the launching was accomplished as planned and without incident.

After a day trip to Tulagi and sea trials, the next chapter in the adventure was the four-day voyage from Honiara to Rabaul. *Liomaran* departed Honiara with a small cargo of local beef (frozen in the fish hold), a deck load of timber for construction of the bin boards and shelves in the hold (which had not been completed), several rattan chairs that were used as deck chairs in good weather, and a considerable amount of Solomons-produced twist tobacco. The twist tobacco was for sale in Yap to help defray delivery expenses.

As the *Liomaran* pulled away from the main wharf at Point Cruz, the tarp was removed from the beer keg water tank to the cheers of the boatyard proprietor and crew who were present to witness the departure. Calm seas prevailed for the next four days and everyone on board was in good spirits. It was declared a good omen when the first fish brought onboard from a trolling line astern was a marlin estimated to weigh 90 kg.

Liomaran arrived in Rabaul at daylight on the morning of 17 September 1975 and was tied up to the Burns Philp wharf. It was the morning after Papua New Guinea's (PNG) independence, and there had apparently been a very large party the day and the evening before, as no one was seen on the streets. There was no response to radio calls to the harbourmaster, and the previously notified Burns Philp wharf agent was nowhere to be seen. Captain Dewey had instructed that the yellow quarantine flag be raised to the masthead anticipating being cleared by the authorities. I was somewhat puffed up in thinking the *Liomaran* was like a larger ship, and should have a PNG courtesy flag to fly as well, even though I had no clue as to what the newly independent country's flag looked like.

Onboard *Liomaran* at the wharf, thought was given to the next steps since both the captain and I wanted to get resupply and refuelling done as quickly as possible. Mathew, the Solomon Islander, volunteered to go ashore and try and find the shipping agent and/or anyone acting in an official capacity. He returned in about an hour and reported not seeing anyone in the town but he did get a big PNG plastic flag to raise on the mast. When asked where he got the flag, he replied that there were hundreds of them hanging from light poles all around the town and he just climbed up and grabbed one.

Eventually the shipping agent showed up, the rest of the town awoke from what must have been a very large collective hangover, and the tasks of refuelling and provisioning were undertaken. The amazing Gazelle peninsula market was visited on several occasions for fresh provisions and the crew took some time to tour around what was at the time a very pretty town.

Edward Olakiman, from Satawal (left), and Mike McCoy with the very first fish caught on *Liomaran*, a 90 kg marlin.

Only one incident marred the hiatus in Rabaul, and it occurred at the local yacht club where the agent had arranged guest passes. After collecting supplies around town on a very hot day, my Micronesian crew and I stopped off at the yacht club for a beer on the way back to the boat. After sitting at a table and ordering, only I was served. The Micronesians had never experienced such a situation and they insisted that the waiter would be coming back shortly with their drinks. After a short while it was obvious that drinks for the Micronesian crew were not forthcoming. I left my untouched beer on the table and exited the premises with my crew, telling them I thought such attitudes would not last long in an independent Papua New Guinea.

Plantation-based economic activity in the area surrounding Rabaul meant there were several shipyards around the harbour, various machine and electrical repair shops, and engine and industrial equipment dealers that catered to the very active inter-island shipping trade as well as the plantations. In fact, almost anything required for maintenance or repair for a small vessel such as *Liomaran* could be obtained in Rabaul at the time. And as it happened, that was to be a very good thing.

Liomaran departed Rabaul in the evening for Chuuk and passed the Duke of York islands before sundown. Later that night strong cross seas were encountered – the first real rough weather of the trip. As the vessel rolled from side to side, an explosion was heard and sparks and smoke were seen in the engine room. All electronics and lights went out but there was no fire. The captain acted quickly and decisively, sending the engineer with a flashlight to check the engine room and report back. He directed others to light the kerosene lamps that had thankfully been brought onboard after

their service in the abandoned boat where the crew and I had slept. Lamps were hung on the mast, and a flashlight was rigged over the compass. The boat slowly made its way back towards Rabaul in the dark without radar, and we awaited daylight before entering the harbour.

Inspection of the engine room found that the boxes containing all the large starting and service batteries had slid off their shelves and shorted out all the alternators (two on each engine) and the electrical service panel. It was quite fortunate there had been no electrical fire. The battery boxes had been placed in angle iron frames well above the bilge, but the shipyard had neglected to weld the frames to the underlying bracket supports. A Lloyd's surveyor was contacted to document the damage and an electrician engaged to repair the electrical system. The delivery budget, already depleted by other unforeseen problems, had been exhausted during the initial visit to Rabaul but the agent agreed to front expenses without a deposit. I anxiously sent daily telex messages to Marine Resources headquarters in Saipan explaining the situation and requesting additional funds.

After another three weeks in Rabaul to complete repairs and receive funds to pay the agent, *Liomaran* finally departed once again for Chuuk. It was an uneventful four-day sail, but upon arrival in Chuuk the captain gave notice and returned to Guam. He said the trip had taken much more time than he had bargained for, and since we were now safely in the Trust Territory we could certainly find someone else for the last 700 miles to Yap. Although I had been practicing celestial navigation under the tutelage of the captain, I was not qualified to take command.

This occasioned another search, this time for someone with a captain's license to take charge of the vessel for the final leg. But Chuuk was not a hotbed of qualified mariners and the only person available was one who had a mate's ticket and was unemployed owing to some dispute or infraction of government rules. The reason for his unemployment was never revealed, but now being in range of Guam's Loran navigation system gave me some comfort that at least navigation on the vessel would have a backup.

After another two weeks in Chuuk waiting out bad weather and dealing with continuing electrical problems, *Liomaran* finally departed for Yap. The first stop was the atoll of Pollap (Pulap) about 120 miles to the west of Chuuk. Pollap lagoon is an exposed anchorage, being open to the sea on one side. A Trust Territory field trip ship was already anchored there servicing the island, and radio contact was made with the ship's captain. He notified me that the latest weather report was that a new storm was brewing in the area and due to *Liomaran*'s size he strongly suggested that shelter be sought elsewhere or to try and run back to Chuuk.

Heading back towards the developing storm was not an option; staying in Pollap was not one either. The only practical option was Puluwat (Polowat) atoll about 30 miles away, but the chart showed it to have a very narrow pass and there was some question as to whether the *Liomaran* could squeeze through. But being the only practical option, a course was set for Puluwat. As *Liomaran* got underway, the engineer came up from the engine room with a concerned look on his face and announced that a hydraulic hose on one of the reduction gears had a leak and there were no spares. The engine was shut down and so instead of racing to Puluwat and possible shelter, *Liomaran* limped along on one engine at about 4 knots while I, the new captain and the crew all felt the increasing wind and watched the black clouds gather on the horizon.

With Puluwat in view, I asked the new captain again if the vessel could get through the pass. He equivocated, saying he was not sure, and in general did not sound at all confident in overcoming the current adversities. I then asked the Satawal crew if anyone had been to Puluwat and, if so, what they thought about the chances of navigating the pass. One of the crew said he had been there once in the past and thought the boat could make it through.

Arriving at the narrow pass just before dark, the crewman who said that he had been there before was sent up on to the flybridge to steer the now one-engined boat through the pass. The wind buffeted the boat as it made its way through the pass, with shallow coral heads visible within inches on both sides of the vessel. After several anxious minutes, the vessel entered the lagoon unscathed. Once safely anchored, the crewman who had steered the boat through the pass said he wanted to go ashore to visit relatives on the island he had not seen for over 15 years. Noting his current age, I asked when exactly it was that he had been to Puluwat and gained his knowledge of the pass. Rather nonchalantly, he said he was 8 years-old the only time he had been there, having come with his father on a canoe from Satawal.

The rest of the Micronesian crew and newly hired captain also asked to go ashore and were not seen again for a week as the now tropical storm became a typhoon and raged outside the reef. The two Solomon Islanders and I manned the vessel during the storm and the engineer managed to repair the leaking hydraulic hose, enabling the use of both engines for the rest of the voyage.

The typhoon finally moved off to the west, but large waves persisted in the pass for more than a week. Finally, *Liomaran* departed through the pass on a high tide on its way to Yap, stopping at several islands along the way. Three of the crew went ashore on their home island and did not return to the vessel to complete the voyage. The full fury of the typhoon was seen at several of the islands visited, where in some cases *Liomaran* was the first vessel to visit after the storm. Quantities of rice and other food were sent ashore at those islands from the ship's limited supplies.

Liomaran finally arrived in Yap on 7 December 1975, nearly three months after leaving Honiara. The substitute

Polowat (or Puluwat) Atoll. The narrow passage to the lagoon is at the very right border of what seems a wide pass, just along the heavy surf; but the most stressful navigation took place while slipping into the inner lagoon of Polowat island, close between the island and the sandbar (image: ©Google Earth – https://www.google.com/intl/en/earth/).

captain returned to Chuuk and a new Micronesian crew was hired, but the Solomon Islanders were not anxious to return home[4]. I travelled to Guam and sat for my US Coast Guard license and also obtained a Trust Territory captain's license. Fishing operations finally commenced in late January 1976 under auspices of the newly constituted Yap Fishing Authority and in late 1976 a qualified Micronesian was identified and given command[5].

I am grateful for the trust shown in me by my superiors, which enabled me to undertake this project more than 40 years ago as a neophyte fisheries officer. I learned many valuable lessons that were put into practice later during my work in Pohnpei, Samoa, and elsewhere in the Pacific islands. I hope that young fisheries officers today are similarly provided with ample opportunities to demonstrate responsibility, adaptability, and a willingness to learn. It will serve them and their countries well in the future.

[4] Mathew stayed in Yap where he learned the language, married, raised a family, and was employed for many years at the Yap Public Works power plant. He is now retired and many people in Yap believe he is Yapese and know nothing of how he first arrived there. Nepia Leve returned to Solomon Islands in early 1977 and worked in various engineering jobs onshore until passing away while working in the Shortland Islands. According to relatives in Honiara he had many tales to tell of his experiences in Yap, some of which more than stretched the truth such as the tale of a later voyage on *Liomaran* to California.

[5] The first year of operations and details of the vessel and its equipment were reported on at the 9th SPC Regional Technical Meeting on Fisheries in January 1977, and can be found in the SPC Digital Library: http://www.spc.int/Digital Library/Doc/FAME/Meetings/RTMF/9/WP32.pdf.

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