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In this issue

SPC activities

News from in and around the region

Feature articles

Editorial

On Asian markets, the difference in price between a well processed and a badly processed sea cucumber (beche-de-mer), can be 5–10 fold. With sea cucumber stocks rapidly declining, it is important that fishers receive the highest possible financial return from the limited number of animals they are able or authorised to catch. In their article, Ram and coauthors (p. 22) describe a processing technique for two high-value species in Fiji that results in high-end products. The authors believe that fishers who need fewer sea cucumbers to make the same income should be more inclined to comply with management measures (e.g. quotas or closed seasons) that are implemented to release pressure on wild stocks.

The stock structure of exploited species is an important piece of information needed by fisheries managers to properly manage fisheries. There is currently very limited information on the stock structure of deepwater snappers in the Pacific Ocean. Goldstien and coauthors partly fill this information gap (p. 30) with their examination of the genetic diversity of three important deepwater snapper species: the flame tail, the ruby and the pygmy ruby snappers.

The European Union has established a system to prevent, deter and eliminate illegal, unreported and unregulated fishing, known as the 'EU IUU Regulation'. In his article on page 35, Francisco Blaha details some of the disruptive consequences of this regulation for Pacific Island tuna fisheries. He reports that the strict observance of this regulation is extremely challenging for small country authorities, leading to more warnings (yellow cards) being issued in the Pacific than in any other region in the world.

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Transshipping in Papua New Guinea (Image: Francisco Blaha)

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

Fishing for diamondback squid in Tahiti: Adapting gear for small boats

*Another round of diamondback squid (*Thysanoteuthis rhombus*) fishing trials was recently completed in Tahiti. This was a collaborative assignment between the Pacific Community (SPC) and French Polynesia's Direction des Resources Marine et Minières (DRMM). Previous trials, carried out by SPC in New Caledonia, Cook Islands and Fiji, were done from ships designed to spend several days at sea. This time, the mission had three objectives: 1) to confirm, or more accurately to advertise, the presence of diamondback squid in the waters off Tahiti; 2) to assess the possibility of using a smaller boat for fishing operations; and 3) to try out an electric reel modified to be used for commercial diamondback squid fishing off small boats.*

A similar trial to catch diamondback squid from small boats was successfully conducted in the waters around Aneityum Island in Vanuatu as part of a Japan International Cooperation Agency-funded programme to support Vanuatu Fisheries Department's coastal fisheries development strategies, as detailed in the SPC *Fisheries Newsletter* #144.[1] A 7-m fibreglass skiff was used, and a giant squid was successfully caught using a manually operated hand reel. This gave Vanuatu fishermen an alternative fishing method to complement the fishing activities they were already doing, using the methods they were accustomed to: using wooden hand reels and hand-hauled lines.

French Polynesia has a large fleet of powered boats, called *poti marara*, operated by small-scale commercial

Figure 1. Vessel used for the diamondback squid trials (image: William Sokimi).

[1] See : http://www.spc.int/DigitalLibrary/Doc/FAME/InfoBull/FishNews/144/FishNews144_48_Nimoho.pdf

fishermen that carry out day fishing for tuna and other pelagic species. The use of an adequately sized electric reel on these boats fits in well with improving fishing efficiency, and provides the means to fish for diamondback squid with relative ease compared to hand hauling or manual hand-winding reels.

From 22 June to 3 July 2015, SPC's Fisheries Development Officer, William Sokimi, worked with DRMM's Manager for Projects and Development Programmes, Mainui Tanetoa, to carry out the Tahiti diamondback squid fishing trials.

Boat used

A modified version of the Tahitian *poti marara* boat design was used as the platform for the trials. This vessel was built for DRMM's offshore activities. It is constructed from aluminium, is 6.7 m in length, and has a maximum beam of 2.50 m. It is powered by a 2-stroke Mercury Optimax 225 hp outboard engine. The design is meant for high speed and manoeuvrability on the open ocean. The deep V-shaped forward hull, which tapers to a shallow V at the aft end, is well adapted to large swells, choppy seas and rough weather conditions. The boat's stiff hull form (which provides stability) results in jerky and bobbing movements in choppy seas, although the boat still maintains a safe centre of gravity, thus making it a good working platform. The boat has more than sufficient space to conduct fishing operations (Fig. 1).

Figure 2. 12-V electric reel used during squid fishing trials (image: Pacific Ocean Producers Hawaii catalogue).

Electric reel and mainline spools

A POP (Pacific Ocean Producers) Hawaii ¼ hp, heavy-duty electric reel was used during the trials. This reel was initially installed for vertical longline and deep bottom fishing, and came with an aluminium spool with a holding capacity of 750 m of 300-lb test monofilament line, and driven by a 12-V, high torque, low-amp motor (Fig. 2). Other features of the reel included a 6 mm x 64 mm heavy duty fiberglass davit or boom, 32 mm stainless steel pipe stanchion with a welded foot mount, stainless steel gunwale mounting bracket, adjustable drag system, and manual backup winding capability.

The reel had only a single speed but the drag could be adjusted to avoid rigid hauling. The flexible davit and elastic cord in the mainline system assisted with reducing harsh haul-back force. The reel performed beyond expectations during the trials.

Figure 3. An Alvey hand-cast spool used for holding a single stainless steel mainline (image: William Sokimi).

In order to set 15 diamondback squid vertical longlines, the reel was modified to fit interchangeable plastic, hand-cast spools (254 mm outside diameter and 150 mm inside diameters). The Alvey hand-cast spool (Fig. 3) was found to be better suited for this type of operation than other plastic spools found on the island because it is thicker, non-brittle and stronger. It could also comfortably hold 500 m of 1.05 mm stainless steel wire with room to spare. The spool was changed after each line was set.

Aluminium coupling was machined on a lathe (Fig. 4) to specifically fit the dimensions of the Alvey plastic spools (Fig. 5). This coupling replaced the aluminium reel on the winding shaft. The same principle can be applied when adapting to other types of spools.

The plastic spool is locked to the coupling by two levers screwed tight by 6 mm butterfly screws (see Fig. 4). These butterfly screws should be increased to 13 mm or more to make it easier to tighten and loosen.

Electric reel work rate

On average, it took 10 minutes to deploy a vertical longline, including the time taken to move to the next location.

It took around 15 minutes to haul back each line, including the transit time between lines.

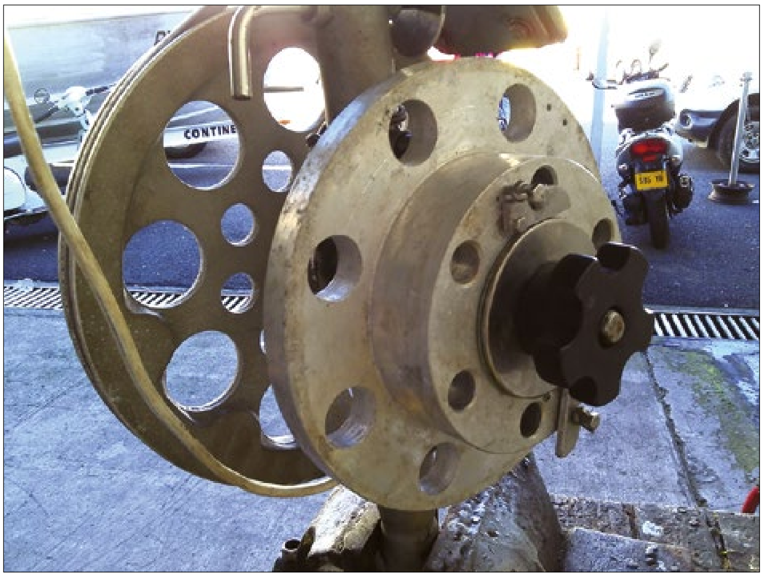

Figure 4. Coupling constructed especially to hold the Alvey hand-cast spools (image: William Sokimi).

Figure 5. A plastic spool fitted onto the coupling and locked in (image: Mainui Tanetoa).

Gear and rigging

The fishing gear for this trial, excluding the electric reel, was shipped from Noumea, New Caledonia to DRMM for the fishing trials. A complete set of new diamondback squid fishing gear was stored at SPC in anticipation of fishing trials around the region. The electric reel and additional plastic spools were provided by DRMM.

Fifteen diamondback squid vertical longline units were rigged for the trials. Each unit consisted of a flag marker, 450 m of mainline (1.05 mm #29 stainless steel wire) + 20 m red monofilament (#100 1.65 mm, 280-lb test), a trunk line consisting of 5 m x 4 mm elastic line + 3 x 5 m red monofilament sections, 3 bulb lures with 23-cm squid hooks, and a 1.2 kg silver sinker with 23-cm squid hooks.[2]

Fishing trips

Fishing was planned for day trips only, beginning at dawn and returning before dusk. However, due to logistical constraints, actual fishing times always started later than dawn.

The fishing grounds were between 10 nm and 20 nm directly off Papeete, the capital of French Polynesia.

During Day 1, eight vertical longlines were deployed to test the gear, and also to record the setting and hauling times for the electric reel. This provided an idea of the working rate of the reel, which was useful for planning how many vertical longlines to deploy during the next two fishing trips so that it would be possible to complete the full fishing operation within the planned schedule for the fishing trip.

[2] See illustration at : http://www.spc.int/DigitalLibrary/Doc/FAME/InfoBull/FishNews/144/FishNews144_14_Sokimi.pdf

The units were deployed independently, with no line of connection between them. The lines were set in a linear sequence, 300 m and 500 m apart (Fig. 6). This method was faster and less labour intensive than the usual method of using connected vertical longlines, which require a horizontal longline reel system on the boat. The boat used in Tahiti was too small for an additional hauling reel system, which, additionally, would introduce a substantial cost that may dissuade small-scale fishermen from taking up the fishery.

Squid catch

Catching large volumes of squid was not a priority for this project; rather, the main objectives were to train a local counterpart in using the fishing method and verify the presence of "giant" squids (diamondback and the less-valued neon flying squid).

Nevertheless, 8 lines were set on Day 1, 10 on Day 2 and 15 on Day 3:

- No squids were caught on Day 1, but a neon flying squid tentacle was attached to one of the lures, indicating the presence of this targeted squid species.
- Two diamondback squids were caught on Day 2 (total weight: 23 kg).
- Four diamondback squids (27.5 kg total) and one neon flying squid (8 kg) were caught on Day 3.

The average overall catch was only 0.045 squids per hook set, which is less than a third of the average catch of preceding SPC experiments (see table below). The fact that this campaign was mainly aimed at validating the use of a small boat for squid fishing and experimenting new hauling gear, combined with the very short period during which the fishing took place (three days) and the small number of lines set in total (33), could explain low catch rates. DRRM is planning other fishing trials to fine-tune the equipment and establish more robust catch statistics. It would not be surprising to see increases in catch rates with future trials.

Comparison of results obtained during the four experimental squid fishing campaigns conducted by the Pacific Community

While fishing trials in New Caledonia, Cook Islands, Fiji and French Polynesia were all conducted around the same time of year (i.e. June to August, the Southern Hemisphere's cool season), and the gear and fishing methods used were comparable, the varying catch rates obtained at the four sites do not necessarily imply similar differences in stock sizes of squids. The sample size was too small to be statistically representative and the moon phase is likely to have an impact on squids' feeding patterns; hence, the need to undertake fishing trials over a much longer period if meaningful catch data are to be obtained. It is hoped that the exploratory squid fishing trials will continue in these four countries with some parallel marketing trials conducted. Such efforts, if well monitored, would allow interesting analyses of both the squid resource and its potential development in the region.

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Summary of SPC squid fishing experiment catches

Location	Date	Total no. of hooks set	Total catch (no. of squid)	CPUE* (no. of squid per line)	CPUE* (no. of squid per hook)	Ratio of diamondback squid	Ratio of neon flying squid
New Caledonia	21–31 August 2012	560	70	0.50	0.125	50%	50%
Cook Islands	20–30 July 2013	180	15	0.33	0.083	53%	47%
Fiji	30 June–4 July 2014	252	59	0.90	0.230	95%	5%
French Polynesia	22 June–3 July 2015	132	6	0.18	0.045	83%	17%
All experiments combined		1124	150	0.53	0.133	69%	31%

* CPUE = catch per unit of effort

Fish cage racing in Satoalepai Village, Samoa!

There was considerable action in Samoa in November 2015 when the first fish cages were built and deployed as part of the Australian Centre for International Agricultural Research (ACIAR) project "Improving Community-based Aquaculture in Fiji, Kiribati, Samoa and Vanuatu". Staff from the Aquaculture Section of the Pacific Community (SPC) — Tim Pickering, Beero Tioti and Michel Bermudes — travelled to the village of Satoalepai on the island of Savaii to work for one week with communities and Samoa's Fisheries Division staff in building and deploying fish cages. This was the first small cage aquaculture project in Samoa, and it was critical that work was properly carried out so that the first site would rapidly become operational and could be used as a demonstration farm. In other Pacific Island countries where the project operates, the focus is on ponds for producing tilapia, but the volcanic soil in Samoa precluded the use of ponds for growing fish. Therefore, the Samoa component of the ACIAR project focuses on introducing local communities to cage technology to take advantage of the fresh and brackish water bodies available on the islands of Upolu and Savaii.

Releasing tilapia fingerlings at the nursery site so they can acclimate to local conditions (image: Michel Bermudes).

The week was expertly orchestrated by Ulusapeti Tiitii, Principal Fisheries Officer of the Samoa Fisheries Division. After working well into the night on the first day to get equipment organised, the fisheries crew and SPC staff sailed to Savaii with two truckloads of gear and live fish. Community consultation and ownership of the project are key to the success of any community-based project, so the very first step was a meeting with community chiefs close to the planned farm site. During the meeting, the project was explained, and the location of cage deployment was discussed. The chiefs suggested sites close to the village so that the community could keep an eye on the cages. From then on, cage building started in earnest, with fisheries staff and villagers working together. Remarkably, the first cage was completed in half a day.

While cages were being built, the lake area around Satoalepai was surveyed for salinity to determine the best place for the cages given that young tilapia do not tolerate high salinities. It was a case of science meets community knowledge as the sites suggested by the community chiefs to deploy the cages also turned out to have the best salinity conditions for tilapia. Once two cages were completed, transport to the deployment sites was organised. Samoa fisheries staff and Satoalepai villagers formed two teams and paddled, pushed and raced the cage rafts to the deployment site in a lively display of Samoan sportsmanship.

To finish, the cages were moored and some test fish were used to see how they would perform over the following weeks. In the following month of December, coinciding with the Savaii Agricultural Show, each cage was stocked with 1,000 tilapia weighing about 2 g, in a fine-mesh nursery net. The fish will be reared to 50 g before thinning them out to 50 fish per cubic meter in a grow-out net. In the 3 m x 3 m x 1 m cages that were built, this will mean about 500 fish per cage, reared to 300 g. The time it will take is not known yet, because it is the first trial at this site and the water is brackish. But, it is hoped that the fish will be ready to harvest after six months of rearing. With an estimated 80% survival rate, the cages could provide 120 kg of fish each.

Villagers learned about the whole process: building the cages, deployment, mooring, and stocking and feeding of fish in the cages. Samoa fisheries and SPC staff felt that the week was a success.

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A cage structure built by Satoalepai villagers and Samoa fisheries staff in just half a day (image: Michel Bermudes).

A race to the finish line (or in this case, the deployment site)! The Samoa fisheries team wins the first Satoalepai fish cage race (image: Michel Bermudes).

SPC and EU-IACT assist commercial tilapia farmer with floating-feed mini-mill in PNG

The Pacific Community is assisting Agro Business Consultant Ltd (ABCL), a commercial tilapia farming enterprise based in Goroka, Papua New Guinea (PNG), in purchasing and installing a feed mini-mill. This will enable the company to locally produce floating-feed pellets for farmed tilapia fish. This assistance is funded by the European Union's Increasing Agricultural Commodity Trade (EU-IACT) project. SPC provided part of the feed machinery, including a hammer mill, an extruder and a drier, while ABCL purchased a mixer and paid for installation costs. It is expected that the machinery will allow ABCL to produce 1,000 kg of feed per day.

Feed is one of the major costs in a tilapia farming business, and the regular supply of feed is critical to the growth of this business. ABCL plans to utilise locally available ingredients such as cassava and corn to make floating feed for tilapia cage culture. The company intends to use the feed for its own farm, but also to produce a surplus of feed for sale to other tilapia farmers, giving them access to a resource that is currently hard to acquire in PNG.

The advantage of floating feed is that the pellets can remain intact for several hours on the water's surface, giving fish ample time to find the feed, while also allowing the farmer to see how much feed the fish actually consume. At present, sinking feeds are the most commonly used feed in PNG and these can become buried in the mud of earthen ponds or washed out of cages, causing significant losses to farmers. Floating feed will result in greater efficiency for fish farmers and reduce waste.

Although floating feed is available on the international market, the cost associated with purchasing feed, shipping, duty and clearances — especially considering the geographical isolation of many farmers in PNG — does not make it accessible to most PNG farmers. In addition, many small-scale farmers would find the cost of purchasing in bulk to be a major financial burden. Having access to a local supply of feed will allow farmers to purchase just what they need from the feed mill in Goroka. There are many hundreds of tilapia farmers within the Eastern Highlands Province alone, and more than 50,000 in PNG as a whole.

The EU-IACT project, along with PNG's National Fisheries Authority, has been assisting ABCL since 2014 to develop its tilapia business through targeted actions such as training in hatchery and cage grow-out techniques, constructing a small-scale hatchery and nursery system to overcome seed supply constraints, and providing material and techniques to make local feeds. By encouraging production of tilapia feed and seed, the project also aims to support business growth through the provision of similar services to other farmers, thereby contributing to the development of the whole tilapia aquaculture industry in PNG.

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Agro Business Consultant Ltd Director, Steven Pupune, stands next to the newly installed feed extruder machine (image: Avinash Singh).

Fish pond construction workshop held in Fiji

In the first half of December, extension officers and aquaculture farm development teams from Fiji's Ministry of Fisheries and Forests (MoFF) took a week-long hands-on refresher training course on fish pond site selection and construction techniques.

Fisheries extension officers experience pond construction first-hand, doing it the old-fashioned way with spades and wheelbarrows.

We say 'solid' because the ground was solid – solid clay. The workshop emphasised experiential learning, or 'learning by doing', as participants were taken through all of the steps involved in designing, marking-out and constructing both a machine-dug commercial tilapia pond and a hand-dug subsistence tilapia pond. The ground was hard, the sun was hot, and body hydration was a challenge. Participants could enviously watch the speed of construction for a machine-dug pond, while we toiled nearby to dig by hand using spades the type of pond used by household-scale tilapia farmers. The hard work was worthwhile, because it is easy to think you understand how to do something by watching someone else, but when you have to do it all by yourself, then you really know it!

Pond construction was identified by MoFF as a training need for 2015 because new staff extension officers were being hired. The job of these officers will be to advise and supervise fish pond construction throughout Fiji, and help farmers to avoid common and costly mistakes such as constructing ponds in leaky soil. A hole in the ground seems like such a simple thing, but there is a right way and a wrong way to dig it if its purpose is to grow fish.

Facilitated by the Aquaculture Section of the Pacific Community (SPC), Tim Pickering, SPC Inland Aquaculture Advisor, and Avinash Singh, SPC IACT (Increasing Agriculture Commodity Trade) Aquaculture Officer, were joined by Prof. Peter Edwards of the Asian Institute of Technology, Bangkok, Thailand, as a resource person. Prof. Edwards led participants through classroom work on the underlying principles of fish ponds, and presented global case studies of good and bad pond situations.

The workshop was attended by 27 enthusiastic participants, including aquaculture farm development team officers or fisheries extension officers from throughout Fiji, two commercial fish farmers and two tilapia entrepreneurs. The workshop was opened by Fiji Fisheries Department's Acting Director, Suresh Chand, whose opening remarks reminded officers of the importance of their role to advise farmers correctly.

A real farm was selected as the site for the practical aspects of the workshop, by arrangement with Chandra Sen who owns a commercial tilapia farm at Baulevu on the banks of the Rewa River in Tailevu Province. In addition to digging their own 3 m x 5 m pond by hand, workshop participants witnessed all aspects of machine-dug pond design and construction. They also engaged in some of the steps involved in constructing a large 22 m x 33 m commercial pond, such as laying out the borders of the pond with marker pegs and tapes, setting a level-indicator line for the digger's reference, laying the outlet drain pipe through the dike, and correctly compacting the soil in the critical outlet-drain area.

Because pond construction conditions were, in many ways, perfect at the Chandra Sen farm (i.e. flat topography and excellent clay content in the soil), a field visit was made to see a leaky pond site on hilly topography at Homes of Hope, Wailoku, a rehabilitation centre for disadvantaged single mothers. Because the organisation wanted to farm fish to provide food and to teach female residents about aquaculture as a possible livelihood option, a plastic liner donated by a non-governmental organisation in the USA had been used to seal another pond, although this was recognised as being a very expensive solution to pond water retention. Other options to seal leaky ponds were discussed in detail, such as the heavy application of manure to clog leaky soil, or the use of products such as bentonite clay dam-sealer.

A plenary discussion was held on the final day about costing time, labour and the volume of earth required to dig ponds manually and by machine. The aim of this was to equip participants with skills to negotiate future pond construction contracts based on realistic appraisal of the volume of earth to be moved, and the time expected for a digger or hand-spades to move it. This was a revealing exercise because it showed that a machine-dug pond cost only about USD 2.50 per cubic metre to construct, whereas a hand-dug pond cost much more, about USD 12.5 per cubic metre. The conclusion was that, wherever possible, fish farmers in Fiji should employ machines to dig ponds if access roads allow for it.

Putting the finishing touches to our hand-dug, household-scale fish pond by planting grasses on the dykes.

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Extension officers also gained experience in the new way, supervising pond digging by machine (all images by Tim Pickering).

Supporting fishers' mechanical skills in Tuvalu

In December 2015, 24 members of the Funafuti Fishermen's Association participated in the Outboard Motors Servicing and Maintenance Training Workshop in Funafuti, Tuvalu. The workshop was jointly organised by the Tuvaluan government and the European Union (EU)-funded Development of Tuna Fisheries in the Pacific (DevFish2) project, which is implemented by the Pacific Community (SPC).

"The Tuvalu National Master Plan for Fisheries Development identifies training in outboard maintenance for local artisanal fishers to be a priority. It is very welcoming that the EU DevFish project can offer support in implementing this priority in the 2015 annual work plan," remarked the Acting Director of Fisheries, Fulitua Tealei, at the workshop's opening.

Ms Tealei stated that small-scale fisheries is a lifeline for local communities in Tuvalu. "Artisanal fishermen provide much of the fish supply for food security for the island population. Further, the artisanal fisheries sector is the predominant sector in which most of the locals on atolls like Funafuti engage in self-employment, and such training ensures the sector is self-sustainable".

The two-week training began with three days of classroom sessions that covered topics such as safety at sea, outboard motor operations, troubleshooting, and maintenance. These were then followed up with practical sessions.

The training was led by Ioapo Tapu, the Yamaha outboard motor engine dealer in Tuvalu, who is a certified marine engineer whose business includes outboard engine repairs and maintenance. Ioapo conducted the training in the local language to ensure that all participants could easily understand and "digest" the information in the training.

However, a major problem is the short supply of engine parts in Tuvalu. Anticipating this, some spare parts were bought at ASCO Motors in Suva, Fiji, and brought to the workshop.

"The local population on Funafuti relies on these fishermen for food, and for most of these fishermen, fishing is their primary source of income. Therefore, their safety when going out to sea is critical," explained SPC's DevFish2 Officer, Jonathan Manieva. Manieva added that in the Pacific, "Many lives have been lost at sea in small fishing craft, and very often due to engine malfunctions. The mechanical skills that trainees have acquired will enable them to undertake regular servicing and minor repairs to their outboard engines, which will help them return safely from their fishing trips."

To further reinforce safety-at-sea practices, 30 emergency grab bags were provided to the Funafuti Fishermen's Association. The emergency grab bag concept ensures that fishers and small craft operators have convenient access to basic sea safety equipment that is easy to carry and transport onto small vessels. Each bag contains a personal locater beacon, strobe light with batteries, compact medical kit, a signalling mirror and whistle, a rescue laser and sea rescue streamer, a marine radio with support pack, a sea anchor, two manual inflatable lifejackets, a directional compass and two emergency thermal blankets.

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Contributing to food security in post-cyclone Vanuatu and Federated States of Micronesia

Two 20-foot containers filled with materials for constructing fish aggregating devices were sent from Taiwan to Port Vila, Vanuatu in support of the Cyclone Pam Recovery Program, and to Chuuk, Federated States of Micronesia, in support of Chuuk's rehabilitation efforts in the wake of devastating super Typhoon Maysak. The purchase and delivery of the two containers had been made possible by the European Union-supported Development of Tuna Fisheries in the Pacific Project (DevFish2) project, which is implemented by the Pacific Community (SPC).

A hand shake to celebrate the delivery of 20 FADs to Vanuatu.
From left to right: Moses Amos, Director of SPC Fisheries, Aquaculture and Marine Ecosystems Division, Kalo Pakoa, Director of Vanuatu Department of Fisheries and Eric Festa, Chairman of the National Fishermen Association

Vanuatu

In April 2015, Cyclone Pam left a swathe of destruction across the western Pacific, with Vanuatu being hit the hardest. The Vanuatu government estimated that half of the country's population – about 166,000 people – were affected by the cyclone. Across the country, 50–90% of homes were damaged, leaving 65,000 people in need of shelter, food, water and medical care.

Following the devastation, SPC's Division of Fisheries Aquaculture and Marine Ecosystem dispatched a team who collaborated with the Vanuatu Fisheries Department to undertake a post-cyclone needs assessment for the fisheries sector. Through that assessment, a recovery strategy for Vanuatu was developed, identifying priority areas for intervention support and potential sources of assistance. The Vanuatu fisheries FAD programme is part of the Cyclone Pam food security measure and recovery programme.

The EU-funded DevFish2 project focuses on assisting small-scale fisheries development, and acknowledges that this sector plays a significant role supporting rural community livelihoods.

With coastal marine resources severely impacted by Cyclone Pam, the deployment of FADs – which help small-scale fishermen to access offshore resources such as tunas – was hoped to be an efficient way to quickly "bring some food to the table". Furthermore, the 20-foot container in which the materials were shipped was purchased by the DevFish2 project. In Vanuatu, the container now serves as a temporary storage facility for the Fisheries Department, and replaces some of the storage sheds destroyed during the cyclone.

Chuuk

In December 2015, 20 FADs — worth USD 23,400 — were delivered to the Chuuk State Department of Marine Resources in Chuuk to assist with rehabilitation efforts in the wake of devastating super Typhoon Maysak.

Chuuk State, which is home to about 50,000 people, was hit the hardest of the four states within the Federated States of Micronesia. Typhoon Maysak affected most of Chuuk's lagoon resources and habitats, which communities depend on for food and livelihoods.

"These FADs are the result of an ongoing collaboration between SPC and the Chuuk State Department of Marine Resources and FSM's Department of Resources and Development (DRD) to help rebuild and bring back to normal what was destroyed by super Typhoon Maysak in April," said SPC's Fisheries, Aquaculture and Marine Ecosystem (FAME) Division officer, Etuati Mangele Ropeti.

EU-funded DevFish2 project support was in response to recommendations of a post-typhoon needs assessment carried out between FSM's DRD and SPC's FAME shortly after the category 5 super typhoon struck FSM in April 2015. The rehabilitation plan identified the securing of food sources from the fisheries sector as one of the first actions to be taken. Following consultations with Chuuk State, non-governmental organisation partners, and local communities, a strategy for immediate action was put into place to direct fishing effort away from the heavily distressed inshore and reef habitats, as these areas needed time to recover.

"Fisheries contribute to food safety and play a vital role in rural economies. One primary objective of the community-based ecosystem approach to fisheries management is to balance the pressure on the fish stocks and the aquatic habitat that is under distress caused by the effects of the typhoon. This requires innovative solutions and alternatives in the dynamics of fisheries management so the balance is reached between marine habitats under pressure and peoples' requirements for fish for food and nutrition security," said Valentin Martin, Deputy Assistant Secretary, Marine Resources Unit, DRD.

Sorting out and assembling two of the 20 FADS delivered to Chuuk.

Chuuk State government estimates that while FADs will provide immediate benefits to the community fishers who were affected by the climatic disaster, a greater secondary impact can be expected for the rest of the island population through landings of fish at local markets.

FADs will be rigged and deployed at locations outside of the lagoon, and will help to attract pelagic fish that Chuuk fishermen can more easily access.

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Capacity development in the Pacific tuna processing sector

In order to develop capacity in the Pacific tuna processing sector, two training sessions were held in late 2015 in both Fiji and Papua New Guinea (PNG). The trainings were facilitated by the European Union (EU)-supported Development of Tuna Fisheries in the Pacific (DevFish2) project, which is implemented by the Pacific Community (SPC). The first training, which took place in Levuka, Fiji, involved 18 cannery and national fish inspectors from Fiji, PNG and the Solomon Islands. The second training took place in Lae, PNG, and involved nine students from the Department of Applied Sciences – Food Technology Section at PNG's University of Technology.

Image: Malo Hosken

Thermal processing and regulatory audit training

This training was aimed at ensuring that the production of canned tuna in the region meets the required standard for safe human consumption. In welcoming training participants, Lomaiviti Provincial Administrator, Ekimi Rokoduru, stressed the importance of the training for Fiji's tuna processing plant and the local economy.

"Such SPC regional training adds value to the Pacific Fishing Company Limited's operation in Levuka, in terms of supporting the skills of locals who are employed by the factory," said Rokoduru. "After initial plans to move sites, we're pleased that the tuna factory will remain in Levuka because it is the mainstay of the local economy and the largest employer on the island," he added.

The two-week intensive training involved the increasing the skills of participants to ensure that the process of canning fish under high temperatures is observed and maintained so that the end product meets prescribed quality standards.

SPC's DevFish Officer, Jonathan Manieva, said the training was both timely and critical because the tuna processing industry in the Pacific Islands region is experiencing growth.

"As the industry grows, the need for human resources in key specialised areas of the production line also grows. The EU-funded DevFish2 project contributes its support for such technical and specialised training to enable and enhance the skill sets of our nationals so that they can fill these roles that would otherwise would be occupied by specialists from overseas," Manieva said.

"The safe production of canned tuna fish is a critical component of the nutritional contribution of fish to food security for our people. And, enhancing employment opportunities of our nationals in the sector contributes to individual and household incomes."

In collaboration with the Pacific Fishing Company Limited, the 18 workshop participants also had the opportunity to undertake practical training sessions at the tuna processing plant's factory floor.

"The need for such technical training is critical because the canned products are exported to overseas markets such as the EU and USA, which requires the technical thermal processing of cans to meet required standards," said the Pacific Fishing Company Limited's General Manager, Brett Carter.

"Thermal processing in canned fish is classified as a high risk operation, and personnel must be technically qualified and aware to engage in the canning process to meet standards that ensure canned fish is safe for public consumption," he added.

PNG students benefit from a training attachment with local tuna processing companies

In November 2015, nine students from the Department of Applied Sciences – Food Technology Section at PNG's University of Technology started a 10-week industrial training attachment with four tuna processing and canning companies based in Lae and Madang in PNG.

As with the Levuka training, this training attachment was facilitated by the DevFish2 project.

"The project's assistance to the department in supporting the industrial attachment programme over the last few years has been very helpful. The project support enabled our students to gain exposure to the real work environment in the factories and also mentorship in other industrial specific areas," the Department of Applied Sciences – Food Technology Training Coordinator, Ms Sogoing Denano remarked.

Third-year students have undertaken prerequisite courses in food technology in the areas of seafood safety, regulatory requirements, sanitation, sensory analysis, and other areas of food processing.

The industrial training placements enable students to gain hands-on experience on a factory floor and in laboratories to increase their professional skills in seafood quality assurance and control.

PNG is experiencing a growth in investments within the domestic tuna industry, particularly in onshore factories. Because processed tuna products from nearly all of PNG's factories are destined for the European market, they are subject to tough requirements and high standards in fish processing and packaging.

"A training needs analysis undertaken for the fisheries sector revealed that there is a gap in capacity in both technical and specialised areas of food processing," SPC's DevFish Officer, Jonathan Manieva said.

Hands-on training for students from the Department of Applied Sciences – Food Technology Section at Papua New Guinea's University of Technology (image: J. Manieva).

"Based on this finding, the project has been lending its support to this area of the growing industry. PNG is witnessing the continuing growth in the tuna processing industry, and the demand for technical and specialised skills from within PNG will also continue to rise."

The nine students were placed with Frabelle, International Food Corporation, Majestic Seafoods and RD Tuna Canners in Lae and Madang.

"Most of these students who undertook the internship will eventually be the local human resource capacity in the specialised area of food processing, and will ultimately support the domestic processing sector growth," Ms Denano added.

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Several FFA member priorities were met at WCPFC12

Source: FFA Trade and Industry News, volume 8, issue 6, November–December 2015 (http://www.ffa.int/node/1618)

From 3–8 December 2015, the Twelfth Regular Session of the Western and Central Pacific Fisheries Commission (WCPFC12) was held in Bali, Indonesia. Over 500 delegates attended, representing 25 Commission Members, 6 Participating Territories, 7 Cooperating Non-Members, 8 Inter-Governmental Observers and 22 NGO Observers. This was the first regular session under the new leadership of Ms Rhea Moss-Christian (Chair) and Mr Feleti Teo (Executive Director).

Three of the Forum Fisheries Agency (FFA) members' identified four top priorities were achieved at the meeting. First, WCPFC12 yielded adoption of a target reference point for skipjack of 50% of unfished spawning biomass, which is in line with current catch and effort levels. To reach consensus, FFA members and Japan compromised on language in the text of the measure to address Japan's concerns about range contraction and localized depletion, which they believe is negatively impacting on Japan's coastal skipjack tuna fishery. This outcome is a positive step forward for management of WCPO's skipjack resources and is also critical for the Parties to the Nauru Agreement (PNA)'s Marine Stewardship Council (MSC) certification for free-school skipjack, which requires a target reference point for skipjack to be adopted as a condition of certification by end 2016.

Second, the Conservation and Management Measure (CMM) 2014-06 tasked WCPFC12 to establish a formal framework (i.e. a work plan and indicative timeframes) for the development of harvest strategies for the Western and Central Pacific Ocean (WCPO)'s key fisheries and stocks. While WCPFC12 adopted a work plan, given several concerns raised by China and Japan, some elements of the work plan that were not agreed upon will be carried forward for re-consideration at WCPFC13 (2016).

Third, a new two-year compliance monitoring measure – designed to assess the level of implementation and compliance of members – was adopted and will be independently reviewed at the end of 2017. Given the Charter Notification Scheme (CMM 2012-05) expired at the end of 2015, WCPFC12 agreed to extend the scheme for another three years with no changes to the existing arrangements (now CMM 2015-05).

FFA members' fourth priority area, a target reference point for albacore, was not achieved. Strong opposition was voiced by China and Chinese Taipei to FFA Members' proposal to establish an interim target reference point for South Pacific albacore of 45% of unfished spawning biomass. While the 2015 stock assessment for albacore indicates that stocks are still not biologically overfished, FFA members have called for strengthened best practice management which will not only maintain the biological health of the fishery, but economic viability as well. A number of FFA members have domestic South Pacific albacore longline industries that have suffered significantly over the past several years due to competition from a large influx of subsidised Chinese longline vessels. China and Chinese Taipei opposed the 37% reduction in albacore catches required to achieve the 45% target reference point, on the grounds that there is no biological or scientific rationale for cutbacks. The only positive outcome for albacore was a minor revision to the current conservation and management measure (CMM 2010-05) with members agreeing to provide vessel-level data by species for 2006-2014 for all fleets operating in the South Pacific albacore fishery. These data will be useful for future stock assessments and assessing the effectiveness of CMM 2010-05 (now CMM 2015-02). No agreement was reached on FFA members' proposal to strengthen the measure to ensure that the number of fishing vessels operating in the fishery does not exceed the 2000–2004 average (or 2005) levels (as per CMM 2010-05) and so that compliance with the measure can be effectively assessed.

Little to no progress was made on other substantive issues, most notably, the conservation and management measure for tropical tunas (skipjack, yellowfin and bigeye). Despite bigeye's continued precarious stock status (overfished and overfishing occurring) and a scientific recommendation that additional or alternative measures for purse seine and longline are required to reduce bigeye mortality by 36% to bring the stock back in line with maximum sustainable yield (MSY), there was no consensus on revisions to CMM 2014-01 to further strengthen management measures. Strongly ingrained positions were maintained between the purse seine/longline sectors and coastal states/distant water fishing nations. PNA and Tokelau (PNA+) tabled a proposal along similar lines to that in 2014, which presented a 'package' of purse seine and longline measures.

PNA+ firmly maintains that the purse seine sector has borne a disproportionate conservation burden for bigeye through FAD measures already adopted, and that additional purse seine measures will only be agreed if additional longline measures are also put in place. However, distant water fishing nations with strong longline fishing interests (i.e. Taiwan, US, Japan, China) maintain that they will not accept additional measures as they have already implemented a 30% cut in longline bigeye catches in line with scientific advice, while purse seine bigeye catches continue to increase.

Despite the Chair and Executive Director stressing that status quo was not an option for tropical tunas (and other issues), plus strong efforts by the Chair during several small working group sessions including proposed textural revisions to progress discussions, no agreement was reached. In 2016, 2015 measures will be rolled-over, including the three month-FAD closure and fourth month FAD closure/total limit on FAD sets for the purse seine fishery, as well as bigeye catch limits for the longline fishery (CMM 2016-01). PNA members have reiterated that given failure of WCPFC to reach agreement they will continue to apply their own measures within PNA waters including a FAD monitoring and charging scheme as well as the Longline Vessel Day Scheme in 2016.

Observer safety was a key discussion point during the course of WCPFC12, with FFA members stressing that observer safety is of paramount importance. WCPFC12 agreed that a conservation and management measure should be drafted for consideration by the Technical and Compliance Committe 12th Meeting (TCC12) and WCPFC13 on flag state responsibilities for observer safety incidents. WCPFC12 also adopted a process whereby coastal states' observer providers will pre-notify flag states of possible alleged infringements by their vessels, as well as new fields in WCPFC's Minimum Fields for the Regional Observer Program for observer safety at sea and emergency action plans.

Once again, consensus was not reached on strengthened management of enclosed and semi-enclosed high seas areas, port state measures for monitoring, control and surveillance or replacement of the 5% fin:carcass ratio for sharks, with fins required to be attached.

Release of a bigeye tuna fitted with an archival tag. Despite bigeye's continued precarious stock status (overfished and overfishing occurring), there was no consensus at WCPF12 to further strengthen management measures for this species (image: Bruno Leroy, SPC).

Pacific nations aim to resolve US default on USD 89 million tuna treaty

Source: Latest news column from FFA website: 21 January 2015 (http://www.ffa.int/node/1619)

Impacts and projections, revenues and losses are words that will feature heavily for the 17-member nations of the Pacific Islands Forum Fisheries Agency, FFA as they convene special sessions aimed at resolving the default and withdrawal notice by the US on a tuna treaty that has allowed US access to tuna fishing in the Pacific for almost three decades.

The US treaty, a unique tuna licensing access and development funding agreement between the US government and 17 Pacific nations, has been administered by the Forum Fisheries Agency since its inception almost 30 years ago.

Over the last few years a series of annual negotiations have locked in agreed payments for the coming 12 months. For 2016, that amount was agreed last August as USD 89 million – but in November the US advised that its fishing vessels would not be meeting the terms of that agreement, due on Jan 1 2016

"As treaty administrator, we've notified our Forum Fisheries members of the current situation and we look forward to following through on what regional positions can realistically be taken," says the FFA's acting Director-General, Wez Norris. "We have a clear directive and wish from the Pacific to resolve the issue, on terms that do not compromise their fisheries and economic objectives, or the spirit of a treaty which has delivered benefits for both the US and Pacific nations."

Norris acknowledged the "high level of frustration from Pacific nations where budgets are being skewered by this news, especially as US and Pacific delegations held three specific formal negotiations in the last 12 months to reach a hard-won agreement achieved through compromise, effort, and good faith from all sides."

"As the US Treaty Administrator, the secretariat recognises the impacts of this decision by the US on our members and remains committed to identifying available options and continued communication with the US to seek resolution," says Norris.

"We now have two immediate priorities – to find a resolution for the 2016 impasse that will represent the best outcome for the Pacific; and to continue our work to restructure the Treaty. On the latter, we recognise the issues of inflexibility that the US is now grappling with, and Pacific countries have struggled with the exact same issues over the last few years."

Pacific fisheries ministers were very clear in their desire to uphold the regional benefits and cooperation embodied within the treaty when they met in a special session in October last year, "and to start 2016 on this note was not something any of them wished for."

During the third week of January, the agency circulated advice to members on the current default status of the treaty payment, along with a letter from the US Government advising of its intentions to withdraw. The US has apparently sent formal notification to Papua New Guinea as the treaty depository. Withdrawal would become final by January 2017.

Depending on how the Pacific Island nations and US move on restructuring the treaty, the notice of withdrawal can be revoked if a resolution to the current impasse can be reached.

Urgent regional meetings are being convened on the future role for the government-to-government Treaty, while also allowing for more flexible and direct commercial arrangements between vessel operators and the individual countries in whose waters they fish. Says Norris: "The US have indicated they remain open to this discussion so we will continue to progress towards mutually beneficial outcomes for 2017 and beyond."

Onwards and upwards for Papua New Guinea's National Fisheries College

Jeff Kinch, Principal

The National Fisheries College (NFC) of Papua New Guinea (PNG) had a successful year in 2015, resulting in various achievements and advancements, some of which are described below.

To support fisheries training across PNG, NFC has been providing valuable training materials and capacity building opportunities to Technical and Vocational Educational Training (TVET) institutions in PNG's maritime provinces. This programme has been developed and implemented by NFC's Deputy Principal, Matia Rikis, and assists TVET institutions by providing training opportunities to students who want to obtain employment in PNG's fisheries sector. A similar programme will be implemented in 2016 for both post-harvest operations and aquaculture training.

To support capacity building in the Pacific Islands region, NFC hosted Ratu Apenisa Sauturaga from Fiji, who was attached with NFC's Pacific Island Regional Fisheries Observer (PIRFO) Training Program for six weeks, to complete an ongoing PIRFO trainer development attachment programme that was supported by the European Union's DevFish2 project and the Forum Fisheries Agency. In addition, two Tuvaluans, Uni Satalaka and Taula Kaio, from the Tuvalu Maritime Training Institute were also trained.

The Head of Fisheries Training at the Kiribati Maritime and Fisheries Training College, Ritang Ubaitoi along with one of his instructors, Bauro Uerem, visited NFC to observe the delivery of the college's Purse-seine Deckhand Course. NFC also provided training to two South Koreans from Dongwon Ltd, Sangwoo Park and Ah Ram Yoo. NFC Instructors also delivered trainings for other Pacific Island neighbours, with the delivery of post-harvest operation courses in the Solomon Islands for SolTuna and National Fisheries Development Ltd, which was supported by DevFish2. The college also provided post-harvest operation training in Samoa in conjunction with SPC.

In order to improve post-harvest operation courses at NFC, a consultation workshop on the Post-Harvest Training Package or Curriculum was conducted, and was attended by quality assurance managers, production managers and human resource managers from various processing companies in PNG. The purpose of the consultation workshop was to agree on the final competencies or units required for certificates 1, 2, 3 and 4, and for a diploma in post-harvest operations.

The National Fisheries College fisheries training vessels FTV Pokajam *and* FTV Maliu *(image: Jeff Kinch).*

Following several audits by the National Maritime Safety Authority (NMSA), NFC now has approval to conduct training in the mandatory requirements for safety familiarisation (STCW-VI/1) and security (STCW-VI/6). NFC is also hoping to gain approval to conduct Standards of Training, Certification and Watchkeeping for Fishing Vessel Personnel compliance in 2016. Staff in the Commercial Fisheries Operations programme also obtained their Safety of Life at Sea (SOLAS) certificates, which means that SOLAS courses can now be run at NFC. A Fire Fighting Complex and Sea Safety Survival Centre have been built at NFC, and the college has been upgrading its facilities, including two new buildings: one for Student Services and the other one to house NFC's new library.

NFC has been assisting NMSA with the newly developed Marine Order concerning Fishing Boat Operations and Qualifications. Once this legislation is approved, NFC will be in a strong position to continue providing quality training for people wishing to be part of PNG's fisheries sector, and thus contributing to the aspirations of Vision 2050 and other development policies implemented by the national government.

Disaster Relief Fund from the US compensates fishermen and funds priority projects in American Samoa

Mary Cheung-Fuk,[1] Dr Domingo Ochavillo [1] and Dr Ruth Matagi-Tofiga[1]

In 2014, the United States Congress allocated USD 1 million to the Disaster Relief Fund to help revive American Samoa's bottomfish fishery, which collapsed after a tsunami in September 2009. Based on damage assessment reports conducted by American Samoa's Department of Marine and Wildlife Resources (DMWR), the Western Pacific Fishery Management Council (WPFMC), and the Pacific Islands Regional Office of the National Oceanic and Atmospheric Administration (NOAA), the US Congress declared that a commercial fishery failure had, in fact, occurred with the territory's bottomfish fishery. NOAA released monies to DMWR, under director Dr Ruth Matagi-Tofiga, in order to provide shoreline fishery infrastructure, financial assistance, and job training for the affected fishery.

The American Samoa *alia* bottomfish fishery, which targets snappers and groupers, had been a productive and profitable fishery since 1988. Some *alia* boats also troll for skipjack tuna for bait. According to a WPFMC report, revenue from the fishery averaged about USD 134,000 per year in 2007 and 2008. For 2009 alone, the revenue generated from the fishery totalled USD 190,000. By 2010, revenue had sharply decreased to USD 42,000, suggesting a loss of 80%. Clearly, the tsunami had a large, negative impact on the fishery.

The WPFMC report also indicated that 17 *alia* bottomfish vessels, which accounted for 50% of the fleet, were damaged or destroyed. Of these vessels, 35% were

On 29 September 2009, a tsunami left a mix of damaged boats, broken trees, electric cables and other assorted debris in its wake (image: Telemal, FlickR).

[1] American Samoa Department of Marine and Wildlife Resources

declared a total loss, 42% were declared in need of major repairs, and 23% sustained only minor damage. Lost income is difficult to quantify but were estimated to be around USD 200,000 (pers. comm., Chris Hawkins, WPFMC staff member).

The bottomfish fishery was declared a disaster following criteria defined under the Magnuson-Stevens Fishery Conservation and Management Act, and the Interjurisdictional Fisheries Act. The bottomfish fishery failure determination was the basis for the US Congressional disaster relief funding and for NOAA's National Marine Fisheries Service to provide assistance to American Samoa's affected communities.

In an effort to identify specific projects that would help revive the affected fishery, DMWR conducted a survey among local *alia* boat owners and fishermen, and found that the top priorities were:

- direct compensation for damaged or lost *alia* vessels;
- building a new boat ramp in Malaloa to provide a convenient access point near the floating docks;
- building an *alia* boat maintenance, repair and fishermen training facility; and
- purchasing an ice machine.

In addition to these projects, the Disaster Relief Fund's other main objectives included purchasing fishing gear and other related supplies, and conducting training for fishermen on boat repair.

A coordinator has been hired to initiate projects outlined in the grant. To date, 13 *alia* boat owners have been compensated for their damaged or lost vessels for a total of USD 250,000. DMWR is collaborating with the Department of Public Works in the design of the boat ramp. Moreover, DMWR is also coordinating with NOAA Sustainable Fisheries, and is organizing documents for US Army Corp of Engineer permits to repair the Fagatogo floating docks. Land use permits and site plans for construction of the boat ramp and fishermen training facility have been submitted to the American Samoa Department of Commerce's Project Notification and Review System. Additionally, site visits for the two projects have been completed and DMWR is working on obtaining quotations for ice machines, air compressors, and other related supplies.

Dr Ruth Matagi-Tofiga, DMWR Director, has noted the large amount of paperwork and tedious permitting process involved in getting approval from federal and local regulatory agencies, but hopes that construction of the boat ramp, fishermen training facility, and repairs of the Fagatogo floating docks will take place in 2016.

The tsunami carried this boat well away from the harbor (image: US Navy 091001-F-3798Y-093).

Processing techniques for white teatfish *Holothuria fuscogilva* and black teatfish *H. whitmaei in* Fiji

Ravinesh Ram[1], Roveena V. Chand[2] and Paul C. Southgate[3]

Introduction

The sea cucumber fishery is an important source of income for coastal communities in the Pacific (Conand 1989). Holothurians or sea cucumbers are consumed as a delicacy and for their perceived medicinal properties, and are particularly sought after in Southeast Asian markets (Bordbar et al. 2011; Esmat et al. 2013). The global trade in sea cucumbers is based on whole, gutted and dried sea cucumbers, commonly known as beche-de-mer (*iriko* in Japanese, *hai – som* in Chinese or *trepang* in Indonesian) (Bumrasarinpai 2006; Ferdouse 1999; McElroy 1990). From approximately 1,200 known species of sea cucumbers, around 58 are traded on Asian markets (Li 2004; McElroy 1990). The majority of commercially exploited species belong to the genera *Actinopyga*, *Bohadschia*, *Stichopus, Thelenota* and *Holothuria*, with Asian buyers particularly targeting species from the genus *Holothuria* (Li 2004). Sandfish (*Holothuria scabra)*, white teatfish (*H. fuscogilva)* and black teatfish (*H.* nobilis in the Indian Ocean or *H. whitmaei* in Asia Pacific) are among the highest value species (Holland 1994) in Asian markets where well-dried 'A' grade product commands prices of around USD 70–190 per kg according to size and quality (McElroy 1990).

Beche-de-mer processing entails an uncomplicated sequence of actions resulting in a product that is non–perishable if stored in dry, dark conditions. The processing techniques currently used for beche-de-mer in Fiji were developed in the 1800s and have changed little since then. Post-harvest steps include first boiling, slitting and gutting, second boiling, smoking and finally sun drying (Holland 1990; Kinch 2002; Li 2004; McElroy 1990; Purcell 2014b; Sachithananthan et al. 1985; Seeto 1999; SPC 1994). Although these steps are uncomplicated, they require continuous attention to obtain a standardised dry product, and failure to do so can result in reduced quality and value of the final product (Purcell 2014b; Sachithananthan 1985; SPC 1994).

Processed white teatfish (*H. fuscogilva*) is ranked as the most valuable and superior product from Fiji's sea cucumber fishery, with a value of more than USD 140 per kg dry in Asian markets (Purcell et al. 2012). White teatfish replaced sandfish (*H. scabra*) as the dominant and most valuable product from the Fijian beche-de-mer industry in 1989, when Fiji's natural sandfish stocks collapsed because of overexploitation. Black teatfish (*H. whitmaei*) is currently the second most valuable product from Fiji's sea cucumber fishery in Asian markets. It is favoured for its relatively thick tegument (~12 mm).

A number of studies have reported the general processing methods used for sea cucumbers (Ram et al. 2014a) but there is limited literature reporting on specific processing methods used for individual sea cucumber species (Sachithananthan et al. 1985). Factors affecting the quality of beche-de-mer have been poorly studied. There is a particular lack of information relating to the influence of processing methods on the value of beche-de-mer in Asian markets (Battaglene and Bell 2004; Conand 1990 and 2004; Li 2004; Purcell 2014b).

Sea cucumber harvesting and trading are increasingly becoming restricted in the Pacific Islands region because of overexploitation. Even where stocks are still healthy enough to keep sea cucumber fisheries open, it is important to make sure that the value of the catch is maximised by proper processing techniques. This paper details for the first time the proper processing technique used by some processors in Fiji for white teatfish and black teatfish. If standardised, this method will help processors increase the value of their white and black teatfish products. They should then be able to give a better price for these sea cucumber species to fishermen, who will therefore need fewer sea cucumbers to make the same income. Hopefully, the end result will be less pressure on wild stocks.

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Processing methods for teatfish

Information for this paper was collected online and through personal observations at the processing stations of local sea cucumber processors and beche-de-mer exporters in Fiji.

Harvesting

White and black teatfishes are found as deep as 30–40 m (Reichenbach 1999) in Fiji and generally deeper than the majority of commercially collected sea cucumber species. Fishers collect the two species by free diving and by using scuba, despite the fact that it is an illegal sea cucumber fishing method in Fiji (Carleton et al. 2013; Pakoa et al. 2013). Divers hold harvested sea cucumbers in a porous cotton or polyester sack and, because of their relatively high value, both species are held separately from other species that are harvested from the same site (Ram et al. 2014c).

Once the divers return to the surface and to the vessel from which they operate, harvested sea cucumbers are kept alive in containers filled with seawater; they are maintained separately from other harvested seafood items such as crustaceans. This reduces potential damage to harvested sea cucumbers (i.e. skin scratches and cuts), which would affect the quality and value of processed sea cucumbers. Before processing, white teatfish and black teatfish are laid on a flat surface to obtain a cylindrical shape and to relax the muscles in the body wall (Fig. 1). This relaxation is important for the subsequent cooking step, because if sea cucumbers are put in hot water immediately after being harvested, the body wall can burst open and this would have a major impact on the product quality and value (Ram et al. 2014a). The relaxing process generally takes about 15 min.

First cooking

Sea cucumbers are sorted before cooking to ensure that all sea cucumbers of the same size are cooked together. A large pot of fresh water is generally heated above an open fire. The temperature of the water must be 40–50°C before sea cucumbers are immersed individually (Fig. 2A). A wooden stirrer is used to prevent damage to the sea cucumbers during the cooking process and to assist with their even cooking.

The skin of both white teatfish and black teatfish are very fragile and wrinkles quickly if immersed in very hot water. Immersing sea cucumbers slowly and one by one also reduces the water temperature and the fire must be intensified for the water to maintain the suitable cooking temperature. The sea cucumbers are cooked at 40–50°C for 15–20 min. with occasional stirring. After this cooking period, the fire is intensified and the water

Figure 1. Freshly harvested white teatfish and black teatfish (A) laid on a flat surface to obtain a cylindrical shape and to relax the muscles in the body wall (B) before processing.

Figure 2. Initial cooking of white teatfish and black teatfish (A) and products after the first cooking (B).

temperature is increased to 80–90ºC. Sea cucumbers are then cooked until they begin to swell, attaining a cylindrical shape and becoming harder and less rubbery. The whole 'first cooking' process takes approximately 30 min. to complete.

Cutting and gutting

After completing the first cooking, sea cucumbers are removed from the cooking pot and arranged on a clean dry surface to cool for around 30 min. (Fig. 2B). Using a sharp knife, a neat cut is made on the dorsal surface of the cooked sea cucumbers, ending around 25 mm from the mouth and the anus at either end (Fig. 3). Once the cut is complete, the viscera are removed and the resulting cavity is cleaned. In Fiji, a faulty cutting step in sea cucumbers processing is a major contributing factor to quality and revenue losses (Ram et al. 2014b). For example, for both white and black teatfish, Fijian fishers often cut from the anterior to posterior end thus opening the entire gut cavity.

Figure 3. Slitting and cutting white teatfish and black teatfish on the dorsal surface. Note: the space left from the mouth to the slit on one side and from the anus to the slit on the other side.

Salting

The salting step is used to speed up the drying process and to preserve sea cucumbers from spoiling. In Fiji, a bag of salt costs around FJD 30.00, which is expensive for local fishers. As a result, sea cucumber fishers rarely use salt for the high value species they collect. After cleaning and gutting, salt (Grade 11, coarse solar salt) is pushed into the gut cavity (Fig. 4A) and into the two ends near the mouth and anus until there is no exposed surface that could be prone to spoilage. Teatfish are then turned upside down with the ventral surface facing upwards (Fig. 4B) and covered in salt. The sea cucumbers are spaced so that salt can be packed tightly between them before they are covered entirely with salt. Salting is done in containers that have tiny holes to allow moisture to drain from the sea cucumbers during the dehydration process. The salting container is held in an inclined position to facilitate drainage and is covered with a polyester cover to prevent external moisture entering the container. Teatfish are kept in salt for 48–60 h.

Figure 4. The salting procedure used for teatfish showing salt being pushed into the gut cavity (A) and individuals covered with salt (B).

Second cooking

After salting, teatfish are boiled a second time and the 'second cooking' is of a longer duration than the 'first cooking'. Salted sea cucumbers are washed free of salt using running fresh water and then immersed one by one into a cooking pot containing hot water at 40–50ºC.

They are left at this temperature for around 10 min. and then the water is brought to the boil for a further 10–15 min. Introducing salted teatfish to boiling water directly damages their skin and reduces the quality of the final product. The skin of teatfish is fragile after salting. After the boil, teatfish become hard and attain a cylindrical shape (Fig. 5), indicating that the second cooking is complete. The products are then prepared for sun drying.

Figure 5. White teatfish cooked twice with a perfect shape.

Figure 6. Sun drying white teatfish and black teatfish. Note: small lengths of wood are used to hold open the gut cavity to facilitate the drying process.

Sun drying

To facilitate sun drying, a small stick of wood, around 50 mm long, is used to hold open the cavity of each sea cucumber (Fig. 6), which is then left in the sun with the dorsal slit surface facing upwards. The drying process continues for 5–6 days (with warm sunny days) or may take longer with less favourable weather. During the night, the products are stored in an enclosed room with fans. During the drying process, the teatfish become shorter and the tegument thickness shrinks from around 12 mm to 6–8 mm. As the product dries, a salt crust forms on the skin surface and this must be removed with fresh water before drying continues. If this salt crust is not removed, it attracts external humidity and compromises the drying process. After washing, the length of the pieces of wood holding open the gut cavity is reduced to around 25 mm so that the cavity can be closed properly after the final cooking. After about 5–6 days of drying, the sea cucumbers become hard with a tough texture, indicating that the product is ready for the final cooking. Once the gut openers are removed, the teatfish are returned to the pot for the third and final cooking.

Third cooking

The third cooking is done primarily to assist with straightening the sea cucumbers and maintaining a cylindrical shape, which maximises their quality. During the third and final cooking, the gut cavity closes and the product attains a neat cylindrical shape (Fig. 7B). The final cooking last for only 5–10 min at a temperature of 60–96°C before a final sun drying with the gut cavity closed (Fig. 7B).

Figure 7. Final drying of teatfish in an oven (A) and in the sun until the final product is very hard (B).

Final drying

Drying of the final product is further enhanced using an oven at night to prevent spoilage until the product has lost a considerable amount of moisture. Sea cucumbers in their driest state have only 8–10% moisture (SPC 1994). To monitor the drying process, beche-de-mer processors apply pressure to the outer skin of the product. Sea cucumbers that are not fully dried emit a 'squeaky' noise and are left to continue drying. Properly dried sea cucumbers make no noise when pressure is applied and have a very hard outer surface. This indicates that the product is fully dried and can be packed after grading.

Packaging and grading

Before packaging, the final products are graded according to size, shape, quality and appearance (Table 1). They are then stored in polyester sacks (Fig. 8) that are sealed and stored in a cool, dry place. The dried sea cucumbers are hygroscopic and absorb moisture if exposed to high levels of atmospheric humidity.

Figure 8. Packaged sea cucumbers.

During the processing of sea cucumbers accidents do occur, particularly when processing large batches. Common problems include over-cooking or over-drying, depending on the size of the sea cucumbers. These incidents have a significant effect on the final product quality and value. High value species, including teatfish, are graded into four categories or grades before packaging (Fig. 9).

'A' grade beche-de-mer generates the highest revenue while 'D' grade product generates only a fraction of this revenue (Table 1). 'C' and 'D' grade beche-de-mer can also be produced by marine products agents, particularly

Table 1. Grading system used for processed white teatfish (WT) and black teatfish (BT) in Fiji, and their approximate values.

Grade	Product description for grading	Price per kg of dried WT*	Price per kg of dried BT *
A	Very large size, straight in shape, neat appearance, neatly cut, white and brown spot coloration, teats intact, odorless and cylindrical	USD 141–274	USD 106–139
B	Medium size (≥7.62 cm or 3'), little distortion to shape, gut cavity open, may contain debris (sand and viscera), zigzag cut, teats damaged, white and brown spot coloration	USD 60–90	USD 45–53
C	Smaller size (<7.62 cm or 3'), shape distorted, debris present (sand and viscera), gut cavity open, skin wrinkled, cuts made from mouth to anus, teats damaged, faded colours	USD 40–60	USD 30–45
D	Very small size, shape distorted, presence of debris (sand and viscera), irregular cut, holes in tissue as a result of over cooking and burst, skin wrinkled, teats damaged, faded colours	USD 15–40	USD 15–30

* Prices from Purcell et al. (2012) and Pakoa et al. (2013).

Fig 9. Different grades of beche-de-mer processed from high value species of sea cucumbers. A): Grade A; B): Grade B; C): Grade C and D): Grade D.

if processing is done on a large scale, and white teatfish and black teatfish are cooked with no prior sorting of different sizes. This often results in larger animals being cooked properly while smaller animals are over-cooked and become distorted during the drying process. Where processing is done by the sea cucumber fishers themselves in remote areas where resources such as salt are unavailable, the resulting product is generally reprocessed by marine product agents resulting in C–D grade products (Fig. 9) of low value (Table 1).

Conclusions

White teatfish and black teatfish are the two dominant high value species of sea cucumbers utilised for beche-de-mer production in Fiji. This study outlines in detail for the first time the processing procedure for these species in Fiji. This process takes up 3–4 weeks to obtain a high-grade product, and lack of attention during processing can have a significant negative impact on product quality and value (Ram et al. 2014a). Processing manuals are available to assist fishers and processors to maximise the quality and value of the beche-de-mer that they produce (Purcell 2014a). However, the information provided is often generic and does not fully cover species-specific requirements relating to the sequence, conditions (e.g. boiling temperature) and duration of processing steps that are required to produce the highest quality beche-de-mer from white teatfish and black teatfish. The results of this study fill this knowledge gap. It is hoped that the method described here will be widely adopted in Fiji to improve product quality and increase revenues generated by this important coastal livelihood activity and export industry.

Acknowledgements

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The genetic distribution of three deepwater snappers in the western and central Pacific Ocean

Sharyn Goldstien,[1] Ashley Williams,[2] Simon Nicol ,[2] Simona Kraberger,[1] Daisy Stainton[1]

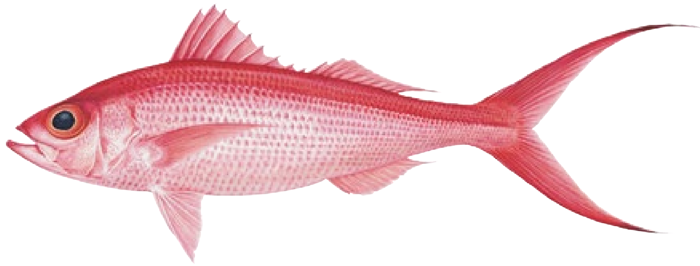
Introduction

Effective management of fisheries requires information on the stock structure of exploited species. Knowledge of the connectivity and gene-flow of exploited species among regions allows managers to delineate stock boundaries and identify whether stocks are shared with other jurisdictions. There is currently very limited information on the stock structure of deepwater snappers in the Pacific Ocean.

Gomez et al. (2015) suggested that the potential for expansion of existing deepwater snapper fisheries may be limited for many South Pacific countries due to the relatively small area of habitat predicted to be suitable for the major fishery species. The vulnerability of a fishery that relies on limited habitat is high, and there is potential for increased reduction in the gene-pool if mixing of fish among these limited habitats is low. It is, therefore, essential that we understand the diversity and distribution of the gene-pool and the potential mixing that is occurring among fished locations.

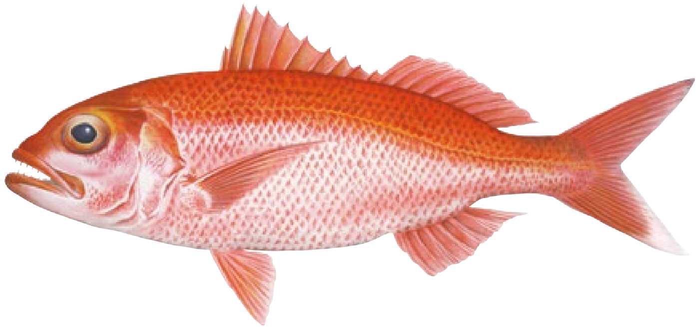
Numerous studies now use genetic tools to determine fishery stock units and to assess the level of gene-flow throughout a fishery. Unfortunately, many of these studies are restricted to local areas, or use very small sample sizes from a wide range of local areas, both of which have the potential to under-sample the true genetic variability and to suggest extensive recent mixing when historical mixing of the stock may instead be causing the observed patterns. There is a need to expand on these preliminary studies to examine the stock structure of deepwater snappers.

In this study, we used a large number of samples collected across the western and central Pacific Ocean. This strategy ensured that samples were representative of the local regions that comprised the total sample. We examined the genetic diversity for three deepwater snapper species that are most important to Pacific Island countries and that are currently being reassigned as different species: flame tail snapper (*Etelis coruscans*), ruby snapper (*E.* sp.) and the pygmy ruby snapper (*E. carbunculus*). The ruby snapper was previously known as *Etelis carbunculus*, but it is now known to be a different species and is currently being assigned a species name. It is referred to here as an unassigned *Etelis* species (*Etelis* sp.)



Flame tail snapper - *Etelis coruscans*
(image Les Hata).

Pygmy ruby snapper - *Etelis carbunculus*
(image Les Hata).



Ruby snapper - *Etelis* sp.
(image Les Hata).

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Methods

We extracted DNA from 2150 samples (*Etelis coruscans* (1249), *Etelis* sp. (494) and *Etelis carbunculus* (217)) (Table 1). Each sample consisted of approximately 5 mm^2 of fin or muscle tissue collected during fisher-dependant and fisher-independent trips throughout the western and central Pacific region. Samples were either frozen or preserved in 70% ethanol depending on on-board or at-port facilities. We extracted DNA from the tissue using Extract-N-Amp™ Tissue PCR kit. We then sequenced a single gene (cytochrome b) from the mitochondrial DNA to investigate the genetic diversity among regions. The quality of the product was tested using standard procedures.

We identified differences among the sequences (variants, also known as haplotypes), and mapped the distribution of the variation through the western and central Pacific Ocean. In addition, we investigated the relationship between the variants using the number of changes between them and graphed these as a network of changes to show how related the different regions were.

Results

We successfully extracted DNA and sequenced 1670 samples: 1165 samples of *E. coruscans*, 332 samples of *E.* sp., and 173 samples of *E. carbunculus*. We also identified 209 variations (genetic diversity) in the samples, which were shared across the regions: 134 variations (*E. coruscans*), 53 (*E.* sp.), and 22 (*E. carbunculus*).

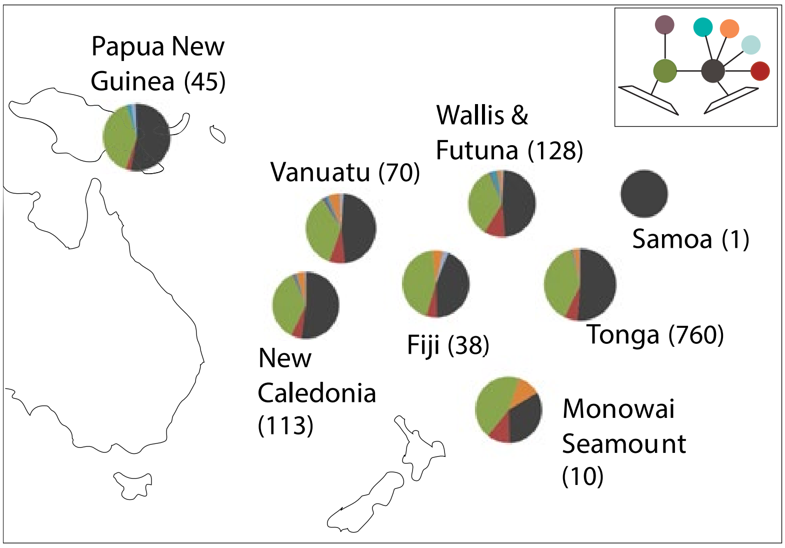
The number of variations for each species was similar when you consider the sample sizes used in the study. Similarly, the number of single changes in the sequences creating the variations was low at 1–7 changes (*E. coruscans*), 1–12 changes (*E.* sp.), and 1–5 changes (*E. carbunculus*). This low number of changes was reflected in networks that have very few connections among the variations. The most complex network and the highest change were observed for *E.* sp.

There were no significant differences in the genetic

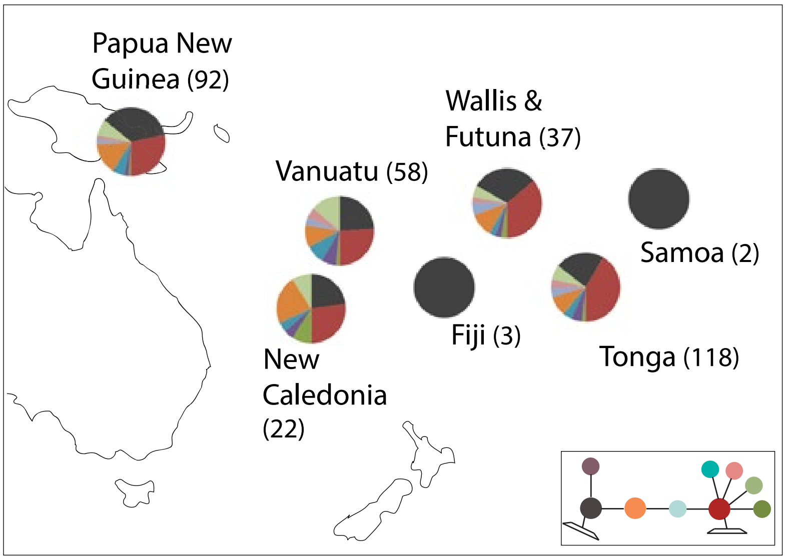
Table 1. Locations where genetic samples were collected from Etelis coruscans *(1),* Etelis *sp. (2), and* Etelis carbunculus *(3).*

Region	Fished location	Species collected
Fiji	Colwyn Ridge	1,2
	Conway Reef	1,3
	Lau Ridge	1,3
	Moore Ridge	1,3
International waters	Monowai Seamount	1,3
New Caledonia	Loyalty Islands	1,2,3
	Hienghene	1,2,3
	Thio	1,2,3
	Touho	1,2,3
Papua New Guinea	Kavieng	1,2,3
Samoa	Field Bank	1,2,3
Tonga	Rochambeau Bank	1,3
	Zephyr Reef	1,3
	Zephyr Reef Seamount	1
	Tonga	1,2,3
Vanuatu	Efate	1,2,3
	Santo	1,2,3
Wallis & Futuna	Arabis Seamount	1,2,3
	Combe Bank	1,2,3
	Foss Bank	2
	Rotuma Shoal	1,2,3
	Siafiafi Bank	1,3
	Lalla Rookh Bank	3

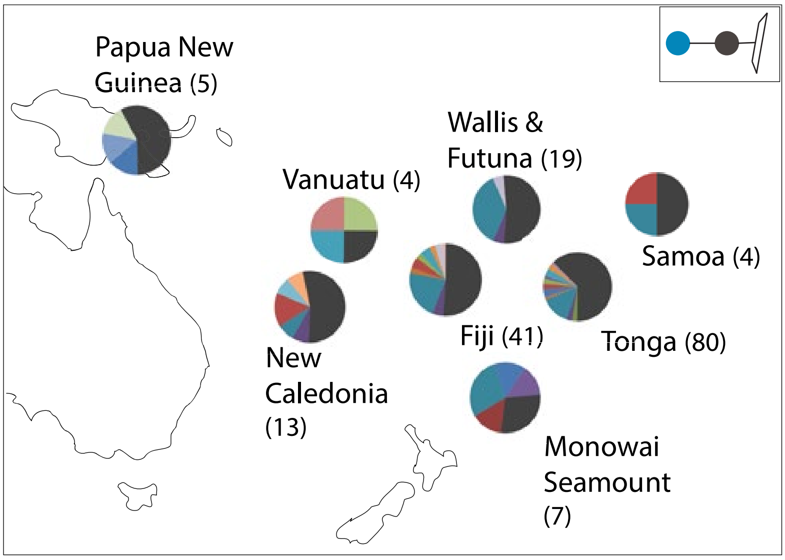
(a) *E. coruscans*



(b) *E.* sp.



(c) *E. carbunculus*



diversity among the regions for any of the species. This means that all regions shared the genetic variation and they cannot be easily distinguished from each other. However, the network suggests that there are closely related groups of variation that occur in many of the regions, but not all, and these warrant further investigation at more local scales (Figure 1a-c inset). The genetic diversity shared among the regions was mostly restricted to one or two core variations that were widespread and occurred in high frequency in all regions. *Etelis coruscans* and *E.* sp. both had more complex networks coming from these cores (Figure 1a-c inset). The distribution of the genetic variation did not show an obvious pattern of isolation for any of the regions, creating a mosaic of genetic variation that varies in the number and frequency of occurrences among regions (Fig. 1a-c). A unique variation was found in Samoa for *E.* sp. and in Papua New Guinea for *E. carbunculus*. These are interesting as they were present in regions where the sample sizes are very small – 3 and 7 respectively – suggesting they may be in high frequency in each of these regions. In comparison, the occurrence of many variations in Tonga was found within a sample size of 760 individuals (*E. coruscans*) representing single individuals.

Conclusions

The widespread genetic diversity for all three species suggests widespread mixing and connectivity. However, these results also suggest local patchiness that requires further investigation with additional analyses. A previous study on another deepwater Lutjanid, the crimson jobfish *Pristipomoides filamentosus*, also revealed little to no genetic structuring for this section of DNA across the Indo-Pacific, except when Hawai'i was included (Gaither 2011), and a similar number of changes was observed in that species as observed in our study for the eteline species. Similarly, two recent localised studies on the genetic diversity of *E. coruscans*, *E.* sp. and *E. carbunculus* in New Caledonia (Loeun et al. 2014) and Hawai'i (Andrews et al. 2014) both produced genetic diversity results consistent with those obtained here, although the study in New Caledonia was based on a different section of the DNA (mtDNA control region).

The striking similarity in the networks for *Etelis coruscans* and *E. carbunculus* from the western and central Pacific samples and from Hawai'i suggests that unlike *P. filamentosus*, the gene-pool may be more extensively mixed than captured by each study, and integrating these results should provide deeper understanding of the whole region. Furthermore, to fully appreciate the role of local habitat and fishing pressure on the gene-pool, additional partitioning and more advanced statistical enquiry for the distribution of genetic diversity within each region is an essential next step.

There is likely to be a need to collaborate with other countries to optimise management of these fisheries. Managers should take a precautionary approach to management at the local level and should be aware that the stocks they are fishing likely overlap with other jurisdictions across the western and central Pacific.

If the genetic diversity is being maintained from many different areas, it is essential to keep the full level of diversity by ensuring sustainability of the mixing. Mixing is more likely to occur in large populations where local stocks are not depleted and isolated from other areas. The genetic diversity identified for all three species in this study was low and it is, therefore, important to maintain this level to ensure the species are less vulnerable to change in the future.

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Impacts of the European Commission yellow cards in the Pacific[1]

Francisco Blaha[2]

The European Commission (EC) is the executive arm of the European Union (EU), and is responsible for proposing legislation, implementing decisions, upholding EU treaties, and managing the EU's day-to-day business. As such, it defines import conditions and certification requirements for the EU. There are two main EC regulatory frameworks that affect fish and fishery products coming into the EU: 1) the sanitary standards that seek, among other objectives, to protect EU consumers' health; and 2) the regulation that seeks to close the EU market to fishery products originating from illegal, unreported and unregulated (IUU) fishing activities. Under these two regulations, all fishing products must be captured, handled, transported and delivered following standards that are established by European legislators.

In order to enter the EU, fish consignments must: 1) come from an authorized country that meets sanitary standards, 2) have been processed in a registered establishment under EU sanitary rules, 3) have the proper catch and health certificates, and 4) pass the EU's border inspection.

The European Council Regulation (1005/2008) — which established a community system to prevent, deter and eliminate IUU fishing — entered into force in 2010, and is known as the "EU IUU Regulation". Only those fisheries products that have been certified as having been legally caught by the flag State concerned are allowed access to the EU market.

The implementing tool of this regulation for non-EU countries is the Catch Certification Scheme (CCS), which is commonly known as the "EU IUU CCS", and its output is the "EU Catch Certificate" , which the regulation uses to determine the legitimacy of a catch.

The EC instituted a "game changer" with its IUU regulation by denying market access to any fishery product that does not arrive at its borders with an "official guarantee" from the flag State, attesting to the legality of the catch.

When the EC feels that a country is not living up to its obligations under its regulation, it starts a "dialogue" process with that country, and sends a delegation of officers in order to assess the human capacity, regulatory framework and compliance evaluation system that the country has in place to control its fisheries. If the EC is not convinced that the country is doing what it should, then it issues a warning (also known as a "yellow card"), insisting that the country improve its legal and operational frameworks with regard to fisheries compliance and management. If these issues are resolved, the country is then issued a "green card"; if issues are not resolved, a "red card" is issued. A red card leads to a trade ban where the EU refuses to accept any fish coming from vessels flagged to the red card State.

Pacific Island countries (PICs) have experienced the effects of the EC's role as the world IUU fisheries evaluator. More yellow cards have been issued in the Pacific than in any other region in the world, in relation to population and development status.

Fiji and Vanuatu were the first PICs to be issued a yellow card, followed by Papua New Guinea (PNG), Solomon Islands and Tuvalu; while Kiribati, the Federated States of Micronesia (FSM) and the Republic of the Marshall Islands (RMI) are in a dialogue process with the EC. While the EC regulation legally concerns itself only with fish being imported into the EU, it is interesting to note that Vanuatu, Tuvalu, Kiribati, FSM and RMI do not trade with the EU because they do not meet the necessary sanitary authorization requirements; nevertheless, these countries have been visited by EC officials who have requested changes in these countries' practices and legislation. In the case of Kiribati, RMI and FSM, however, this was done without issuing a yellow card.

Other small countries outside the Pacific Islands region have also received a yellow card, and some countries have even received a red card (e.g. Belize, Togo, Sri Lanka). It is worth noting that some larger countries

[1] Based on an article published on the author's blog (http://www.franciscoblaha.info/blog/2015/9/25/the-impact-of-the-eu-yellow-cards-in-the-pacific), and a presentation made by the author at the Pacific Tuna Forum 2015 (22–23 September 2015, Fiji)

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with weak compliance records (e.g. the Philippines and Korea) have received a yellow card as well, but these warnings were soon removed, even if the level of information contained in their catch certificates did not seem to have improved.

The latest countries under this process are Taiwan and Thailand, but interestingly, even if Thailand receives a red card, the impact on the tuna world will be minimal because the ban of Thai fishery-related exports to the EU will only affect tuna caught by Thai-flagged vessels, and paradoxically there are none. The largest exporter of canned tuna in the world does not operate a tuna fleet.

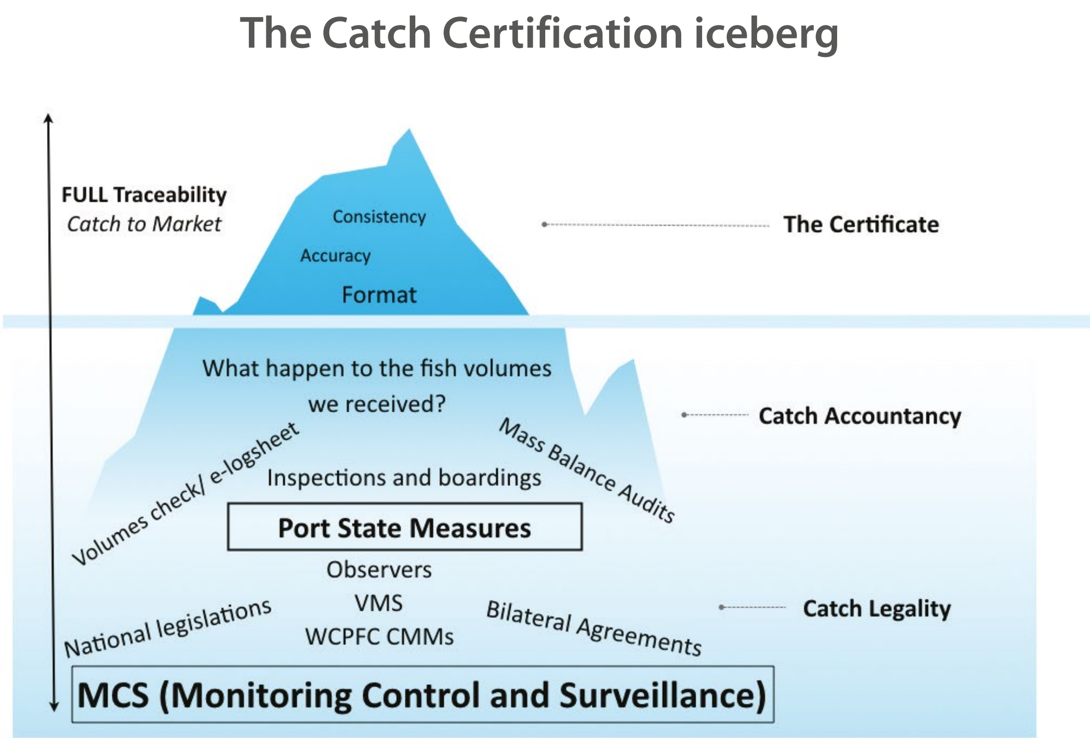
While I recognise and support the principle behind the EU IUU Regulation, my main issue with it is the practicalities of the CCS. Fishery consignments sent to Europe are certified retroactively, just before the export of the processed products to the EU market. In some cases this can be several months after the harvest has been unloaded; hence, authorities in the flag State must work backwards to find the information of the landing and its volumes, which in many cases could have occurred in a different country (e.g. PNG-flagged vessels transhipping in the Solomon or the Marshall Islands, and the fish sent to PNG for processing). And here is where the system is both open to abuse and very resource and time consuming for small countries. In addition, the scheme is paper-based instead of being electronic, so the system is based on photocopies, which are easy to tamper with.

The tuna industry's complex dynamics and operations were in existence long before the 2010 implementation of the IUU regulation. The legislation would have benefited greatly from an in-depth study and understanding of the realities in the region *before* enacting it under a substandard CCS.

Nevertheless, my work aims to improve the CCS from an operational perspective for PICs. In fact, for the last six years I have been helping countries to comply with the CCS, by working around many of the operationally frustrating challenges of the scheme while at the same time strengthening each country's capacity so that the EC legislation's key objective — to minimize IUU fishing — is not lost.

I have suggested to countries to not dwell on the perceived politics of the situation, but rather to focus constructively on the changes that these yellow cards require, in terms of monitoring, control and surveillance (MCS) and related control systems, particularly in regard to strengthening the EU CCS.

Transhipping tuna in the Solomon Islands (image: ©Francisco Blaha).



Incorporating elements of the Food and Agriculture Organization's Port State Measures Agreement could lead to a Pacific-wide catch certification scheme as a tool to offset PICs' administrative and economic burden from complying with the EU regulation and CCS.

The first step was to raise awareness of the EU IUU Regulation, its sections, the CCS product flow scenarios foreseen by the regulation, and the responsibilities it places on the fisheries authorities of the Pacific Island flag and port states. In reality, most fishers, processors and government officials in PICs (or in the rest of the world for that matter) do not fully understand what the legislation requires them to do.

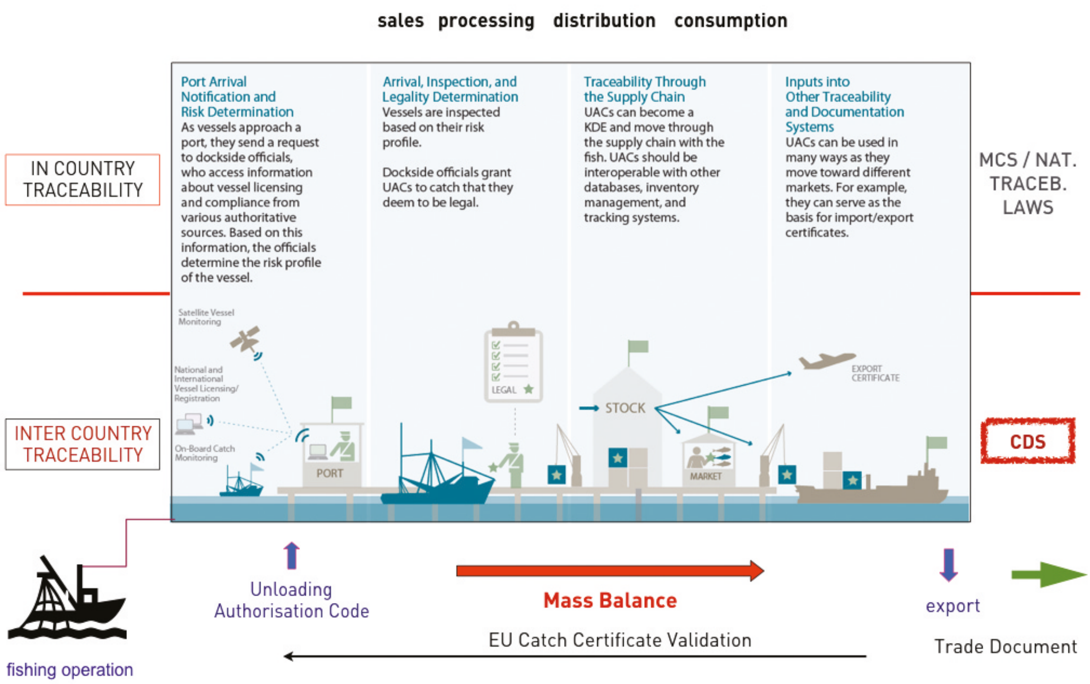
As a former fisherman, I like to think in simple images. Therefore, the analogy of an iceberg seems apt. What we see is only the tip: the certificate, which unfortunately is just a piece of paper. But what really matters is what is below the waterline, two concepts that I call "fish legality" and "fish accountancy". These two areas need to be strengthened and systematized to make the visible tip meaningful. I was contracted by the EU-funded Development of Sustainable Tuna Fisheries in Pacific ACP Countries – Phase II (DevFish2) project to develop and standardize a training programme aimed at the Pacific Island fisheries sector that first explained the regulation's conceptual issues, and later described the certification scenarios that the regulation generates, and assisted countries that have received a yellow card to implement the changes required by the EC.

The catch certificate itself is a complex document with a multi-layered structure of responsibilities that do not always correlate chronologically with reality. Therefore, a detailed explanation of the certificate, and standardizing the way the information in it would be written, was required. These explanations also had to be expanded indirectly to include foreign flag States that operate in the region so as to maintain a system that is homogenous through the operational chain.

The technical content of foreign catch certificates was a constant source of frustration for many of the fisheries officers I worked with. "How come the fisheries authorities of distant water fishing nations send us these incomplete and untruthful certificates, yet they are not yellow carded?" was a frequent question for which I had no answer.

The next element was to explain the content of the regulation and possible certification scenarios under the CCS, and to explain which ones applied to each case in each island country. This was not easy because of the differences between the industries in each PIC as well as the interactions between the catch certificate, the health certificate (normally provided by health authorities) and the certificate of origin (normally provided by customs officers).

Unloading Authorisation Code and Catch Certificate



Furthermore, I also took into consideration transhipment countries, because while these countries are part of the system, they are not initially taken into account (i.e. they are not "notified"). Transhipment countries have an important role but receive no direct benefits, other than receiving fees for use of their ports because they are not allowed to trade fish with the EU because they lack sanitary authorizations. Presenting the EU IUU Regulation and the CCS in a way that could be easily understood was a challenge.

Initially, it was necessary to re-structure the traditional concept of MCS into a more holistic view. An illegal fish does not become illegal during processing; it is illegal from the moment it is caught. Therefore, if the illegally caught fish is not allowed to be legally unloaded, then a big part of the problem is solved, although it is still necessary to stop the potential "laundering" of illegally caught fish (originating from illegal landings), through the mixing with legally caught fish.

In order to be able to "track and account" the volumes legally landed, I created the concepts of an "unloading authorization code" (UAC) and "fish accountancy" to link legal unloadings and mass balance with traditional fisheries MCS activities.

The UAC concept combines two basic elements: the requirements of the Port State Measures Agreement (PSMA) and a key data element that follows a landing all the way through the value chain. Under the PSMA, vessels must seek advance approval to enter a port in order to allow sufficient time for the port State's fisheries authorities to examine the information the vessel provides. Hence, the required information needs to be provided in advance so that a decision can be made regarding whether or not to grant entry to the vessel. When an authorization is given, the vessel's master or representative presents the authorization to the authorities when the vessel arrives in port.

This authorization needs to be coded so that it can be recorded, accounted for, and cross-checked if necessary. I proposed to use this UAC as the tool for the initial key data element, which is required for any catch documentation scheme or traceability analysis along the value chain, from landing to consumer.

Furthermore, most fishing vessel operators (company-owned or independent) maintain a trip or voyage coding system in order to monitor logistics, fuel consumption, crew rosters, general costs and, more importantly, "final payments" to crew (which are in the form of a percentage of catch volumes, species composition and values). These final payments to crew are usually based on landings values and fixed costs. Because the concept already exists in the sector, using the UAC would be a better use of an existing concept.

The UAC process

Arrival notification

Authorization for a vessel to land is granted by the fisheries authority in the port of arrival, according to a series of requirements set forth by the port State's own legislation and by those of a regional fisheries management organisation (RFMO) or international agreements. The scope of the requirements can be arranged in accordance to a pre-determined risk index based on the characteristics of the vessel that requires port access.

For example, domestic-flagged vessels fishing in a port State's exclusive economic zone (EEZ) with a local vessel monitoring system (VMS) and observers are considered to be low risk vessels. Foreign vessels with local licenses, foreign charter vessels, domestic vessels fishing in other EZZs or on the high seas, fish carriers, vessels with patchy observer coverage and indirect VMS access are considered to be medium risk vessels. Finally, foreign-flagged vessels with no direct VMS access by the coastal or port State, with no observer coverage, or are vessels that have been identified as a Vessel of Interest by any country or RFMO, are singled out as high-risk vessels.

As noted, the risk profile of the vessel defines the required time for arrival notification (i.e. 12 hours in advance, 24 hours in advance, or 48 hours in advance, depending on the vessel's risk) and takes into account the amount and depth of the information provided by the vessels. When an assessment has been made, a UAC can be provided and the vessel is allowed to dock with the intention to unload. In instances where the UAC is not provided, the vessel may be allowed to dock for humanitarian or *force majeure* reasons but it cannot unload.

It is up to the port State or RFMO to determine the structure and nature of the UAC, but it is important that it be inclusive in the information it requires. In principle, it should be an integral part of a relational database such as a Fisheries Information Management System (FIMS).

The UAC design should include elements such as country identification, trip and port traceability, VMS, e-logs, and observer reporting, and be interoperable with vessel operator trip and/or voyaging coding systems, if needed, with maritime authorities.

Inspections

The decision of whether an inspection should take place should be based on the vessel's risk profile, the number of inspections it has already been subject to, and any issues arising from the documentation presented to port authorities. If an inspection is performed, then the UAC is recorded in the inspection forms for future verification, if required, and for compliance performance monitoring. Ideally, the inspection forms are digitized on a tablet-type device with the data entered into an FIMS in real time under the specific UAC of that operation. If an inspection indicates inconsistencies or non-compliances, the landing may be authorized under bond or denied. Then the UAC associated with that landing is flagged in the FIMS in order to interrupt any further movements or transactions associated with that landing until the issues are resolved.

Unloading

If port authorities decide that an inspection is necessary, and the vessel is found to be compliant, then permission will be granted. This landing could be conditional (under bond) as explained before. If an inspection does not take place, the Landing Authorization Code becomes the *de facto* authorization for unloading.

In the case of transhipments, the UAC is associated with the measured catch (if hanging scales are used) or with catch estimates (from logsheets), and reflects the captain's or mate's receipt of the documents related to volumes being transhipped. The UAC will then accompany the transhipping documentation (printed), and if the receiving country has a memorandum of understanding with the port State, or is part of the same RFMO, then it can potentially log in to a common FIMS to cross-check the legality and estimated volumes of the landing, and to add their own information. If landings or transhipments are partial (and this practice should be discouraged) then the UAC need to be partitioned into lots associated with the original UAC, which is retained as the main reference. Each lot can then be incorporated into the FIMS. Any volumes not landed should be considered as a "lot" in the same manner as the landed ones.

Reception or weight in

At the cool store or processing facility, or wherever the official sorting and weighing of the fish is done, the UAC marks the volumes in the FIMS and into the receiving operator's inventory system. If whole fish are loaded into containers for direct export, then the weight is recorded under the UAC in the FIMS, and the volumes containerized must be discounted from the total volumes recorded for that landing. That exported lot would still be associated with the UAC as in the case of partial landings or transhipments.

Private operators receiving the fish could either enter all of the data into an FIMS portal or maintain their own inventory and traceability system that could either be absorbed by the FIMS or audited by fisheries authorities. In any case, final volumes by species would be incorporated into the FIMS for the UAC. Companies typically use lot systems based on the species, size and vessel of origin. All of these parameters can be linked to the UAC under the FIMS or their own inventory and traceability management system.

Processing establishments and cool stores

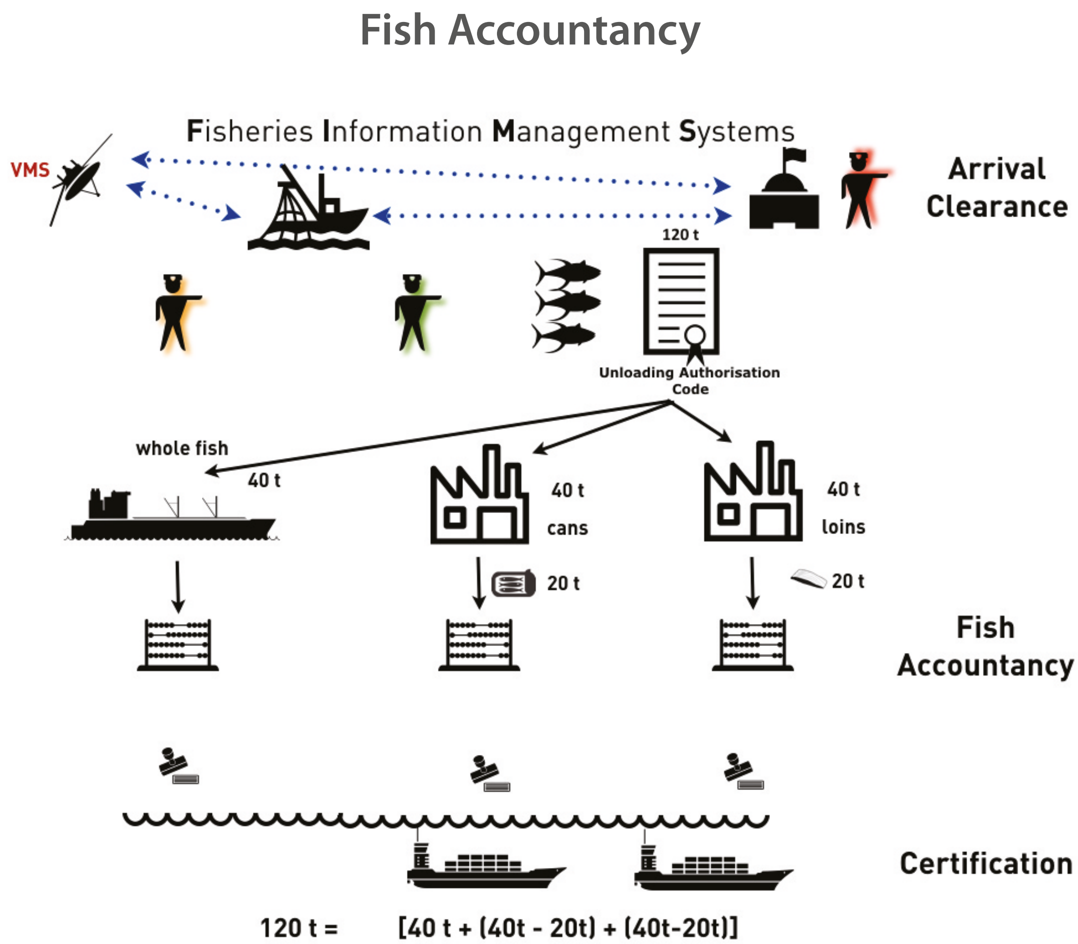
Most responsible MCS systems include a mass balance evaluation (fish landed = fish in storage + fish processed or sold) recorded by the fisheries authorities. This evaluation starts with the UAC of all fish received for a period of time and what is presently in the inventory.

Volumes withdrawn from storage for processing are discounted from the original landed volumes in relation to the UAC; hence, each withdrawal leaves a smaller volume of the original landing until it is exhausted. Obviously, the same principle applies to whole fish withdrawals. Processed product volumes are inventoried under the same UAC, taking into consideration the processing ratios (conversion factors) associated with that type of products.

Final product sales and exports — catch certificates

Prior to the product leaving the premises, a catch certificate (domestic- or market-specific) is prepared, based on all of the operations relating to the original UAC (or UACs in the case of products originating from mixed unloadings). The referencing and traceability of the specific UAC, plus the fish volumes accountancy through the value chain, become the basis and *sine qua non* for the delivery of a catch certificate, whether it be paper or electronic.

The next big issue relates to fish lots movements, which I referred to earlier as "fish accountancy"**.** The quantification of volumes landed, transhipped, traded and processed has two main benefits: 1) it is known how much is being caught, which is important for fish stock management; and 2) the volumes can be recorded as the "initial deposit", and from this it is possible to avoid chances of "fish laundering" from any potential illegal landing (just as any financial systems deals with money laundering).



The volumes unloaded can be used as the initial deposit from which extractions will be made, and the different species unloaded become "different currencies" from the same deposit. A traceability scheme in the system then makes it possible to follow the "extractions" of different currencies trough time, either by whole fish sales or processing. Furthermore, processing losses can be dealt with by the system using a "currency converter" (e.g. 1 kg of fish = 400 g of loins).

Finally, each sale or export is "mass balanced" against the original deposit until the volume is exhausted (i.e. when no more fish can be attributed to that unload). If someone wants to export fish that he did not land, it is obvious that something is wrong and inspectors can focus on figuring out the problem.

Discussion

There is considerable developmental and technical complexity behind these systems. PNG took the lead in developing them, and it was one of the key factors that impressed the EU during its September 2015 visit to assess the changes in PNG's systems. PNG was issued a green card one month later.

Staff of PNG's National Fisheries Authority worked hard to get make the necessary changes to meet the EC regulation, and it is deservedly proud, willing to share its experience with other PICs. Presently, a similar system is being implemented in the Solomon Islands, which faces the prospect of a red card if it does not improve its legal and operational frameworks with regard to fisheries compliance and management.

But the reality is, small island developing states are always playing a "catch up game" when it comes to meeting compliance and market access requirements. The rulebook is being read while playing the game with distant water fishing nations.

Ultimately, the decisions are made by people and justified by paper, and many entrenched positions (e.g. attacker vs attacked, colonial vs independent) were taken when the EC regulation first came into force, but these only served to slow down the process.

The situation is better now and PICs have responded with more than words, they have responded with action. Much of the world's tuna is caught in the western and central Pacific Ocean, but PIC-flagged vessels only catch a small portion of the global catch. Therefore, it seems logical that the catch certificates of distant water fishing nations vessels be examined with the same scrutiny that PIC-flagged vessels are.

Finally, I must make this point: While the EU has imposed the IUU Regulation, it is also providing funding assistance to help countries comply with the measure. Most of the work I have done to date and refer to in this article was done with funding support from the EU.

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