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## Editorial

Overall, tuna catches in the waters surrounding Pacific Island countries (the exclusive economic zones) have increased by 150% since 1990. And, according to data gathered and analysed by SPC's Oceanic Fisheries Programme, a significant portion of this catch is taken less than 100 nautical miles from the shores of individual countries. At the same time, tuna numbers are estimated to have significantly decreased in the last 30 years, by up to 65% in the case of yellowfin tuna.

While tuna stocks are still considered to be in relatively good shape, or at least, above the level required for a maximum sustainable yield, this decline in stocks might not affect industrial and artisanal fishers the same way. The reduction in stocks is not evenly distributed throughout the Pacific Ocean and some localised depletion may occur, mainly affecting local artisanal fleets that are not capable of chasing tunas over great distances the way that industrial fleets can.

Several solutions have been proposed to reduce the impact of industrial tuna fishing on artisanal fisheries (see article by Harley on p. 6). And several articles in this issue are related to the solutions proposed: gaining a better knowledge of tuna (p. 2) and their stocks (p. 4); promoting management measures that specifically address the needs of artisanal fisheries, both at national (p. 21) and international levels (p. 22); and setting fish aggregating devices close to shore to give artisanal fishers easier access to offshore species (p. 23).

"Balancing the needs" seems to be as difficult to do in fisheries management as it is in our everyday life, doesn't it?

**Aymeric Desurmont**

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*FAD fishing in Tahiti, French Polynesia (image: Mainui Tanetooa).*



### Understanding the vertical movement of tropical tunas



*Although the majority of new research on tuna fisheries tends to focus on populations and fishing fleets, there is still much to learn about the individual behaviour of these remarkable animals. In particular, individual movement through the water column is of interest to fisheries scientists because this movement determines how tunas are affected by different types of fishing gear.*

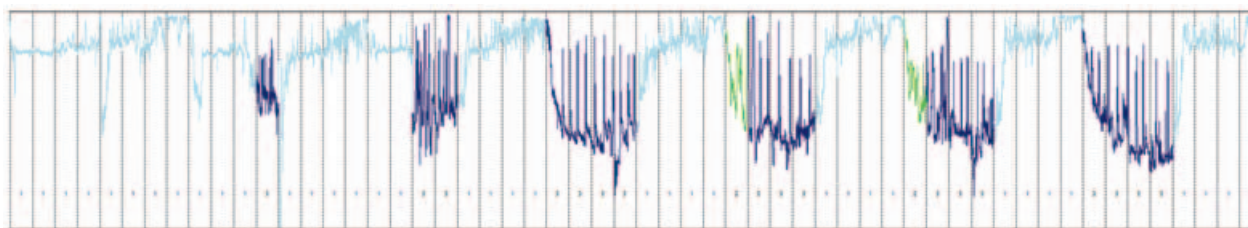
Since 2006, as part of the Pacific Tuna Tagging Programme, SPC has been inserting electronic archival tags into the bellies of tunas in order to obtain information on their vertical movements within the tropical western and central Pacific Ocean. These tags, which are surgically implanted, are electronic devices that record data on the light intensity, depth and temperature that an individual fish experiences, as frequently as every 10 seconds. When tunas are caught by fisherman, the implanted tags are returned to SPC for analysis. To date, the PTTP database (held at SPC) contains data on over 130 returned tags for three different tuna species, spanning a wide range of fish sizes, regions and time periods, and equating to over 130,000 days of data, each with up to 14,000 observations of depth, temperature and light!

The individual behaviour patterns observed from these tagging data are sometimes very consistent, and sometimes extremely irregular. Some fish exhibit very clear patterns day-in and day-out for many months at a time. For example, bigeye (*Thunnus obesus*) and yellowfin (*Thunnus albacares*) tunas often remain in shallow water at night and move deeper within the water column during the day. This is believed to be due to tunas feeding on smaller fish and invertebrates that

occupy these different depths throughout the course of a day. However, striking deviations from these patterns are sometimes observed. An individual tuna may abandon its deep-diving behaviour for weeks at a time, and then undertake sudden deep dives down to many hundreds of meters, or spend time moving constantly through the water column, rarely staying within one layer of water for more than a few minutes. The challenge in analysing these data has always been in objectively characterising these patterns and understanding how they change, and how those changes may be influenced by other factors such as the biological development of the individual, the availability of local food, or the effects of floating objects.

As a PhD attachment to SPC, I have been developing new analytical approaches to address these problems alongside SPC's Oceanic Fisheries Programme staff. We have been developing computer models that discern patterns of vertical behaviour from archival data tags and attribute these identified behaviours (and the switching between them) to factors such as location, time or size of a fish. We can then quantitatively compare the differences in the behaviour of individual tunas or the same tuna over time. In particular, this approach will





*Dive data from a large bigeye tuna, classified using the Hidden-Markov model. This individual tuna alternates between shallow behaviour (light blue) and very deep behaviour (dark blue), occasionally exhibiting short periods of high amplitude diving (green), particularly during the hours before and after sunrise.*

be used to examine some of the specific effects of how tunas may become more vulnerable to fishing gear when they gather near floating objects such as fish aggregation devices, or FADs. This is of particular interest given the increasing use of FADs in the Pacific Islands region, and given their perceived negative impact on certain tuna stocks and smaller tunas. Identifying when associations occur and characterising their effects across size classes of tunas is a goal of this project.

These independent descriptions of vertical behaviour are useful not only for unravelling the life history of tunas, which is very difficult to observe in the wild, but can also inform scientists of important behavioural changes that affect the advice provided to fisheries managers. For example, it has been observed for some time that larger tunas spend more time diving to greater depths than smaller individuals, due to physiological developments as they grow older that allow the fish to feed and hunt in colder, less oxygen-rich water. Such vertical behaviour is referred to as habitat use, and is a critical component to understanding how susceptible tunas are to fishing gear. However, when these biological changes occur, the speed at which they happen, and the degree to which these developments differ by species and location, is not well understood. In preliminary analyses, we observed that bigeye tunas have a very clear, “deep” behavioural state that often occurs during the day. However, in some individuals measuring 60–70 cm, the depth associated with this behaviour actually becomes deeper over time, while the frequency of occurrence stays the same. It appears that these fish do not change their preference for diving deeper during the day, but rather gradually develop this already present “deep” behaviour by simply diving to even greater depths as they grow.

Methods such as these allow scientists to gain new knowledge from

the excellent data that have been collected by SPC, its member countries and fishing companies, not only for describing and understanding the behaviour of tunas and other important species, but also to improve the models that are used to support scientific advice and provide information on the status of stocks. The impressive amount of data gained from archival tagging has provided a window into a world that has been previously hidden from us. However, the fact that we directly observe neither behaviour, nor the context that drives it, means that archival data will remain just that: a window. Further developments in this project and beyond will allow us to extract the maximum amount of useful information from this hugely valuable resource.

### For more information:

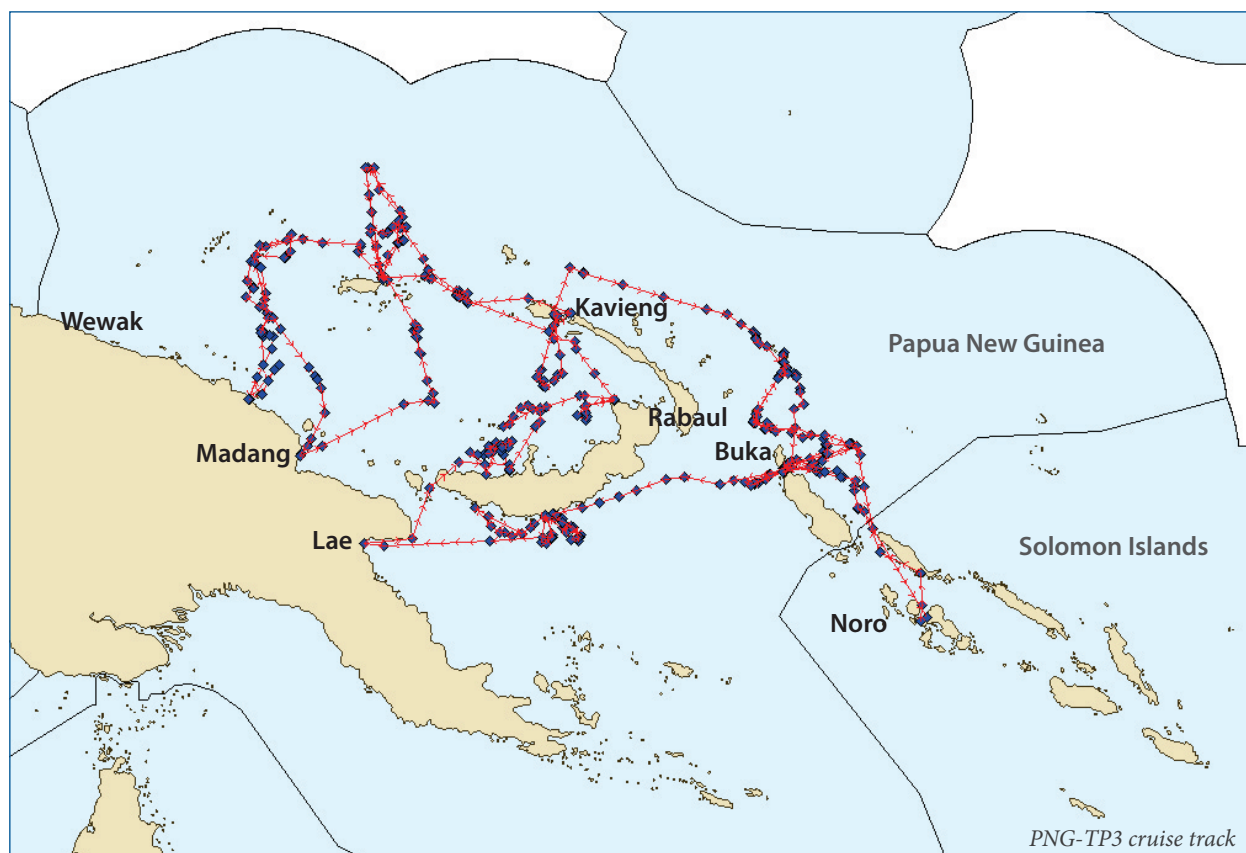
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*Inserting an archival tag in a yellowfin tuna belly (note the green tag antenna sticking out).*

## Last PNG tagging cruise concludes the end of an era



*When the F/V Soltai 101's main engine was turned off at Noro base in the Solomon Islands on 6 June 2013, crew members and others who have been involved in the tagging programme run by the Oceanic Fisheries Programme of the Secretariat of the Pacific Community (SPC) since August 2006 had mixed feelings. The 2013 cruise tagged 29,920 tuna in Papua New Guinea (PNG) waters in two months and the PNG tagging project successfully reached its target goal with 110,501 releases.*

But this cruise meant the conclusion of seven years of almost continuous (no cruise in 2010) tuna tagging in the western and central Pacific Ocean region using pole-and-line boats from the Solomon Islands National Fisheries Development company. More than 360,000 tuna have been tagged onboard the fishing vessels *Soltai 6*, *Soltai 105* and *Soltai 101*, and the success of what could be considered the biggest ever tuna tagging programme is largely due to the efficiency, professionalism and dedication of the crews of these boats and the company they work for. A big thank you to all of you. No doubt this work will contribute to the better management of our tuna resources.

Nearly 15,000 tagged fish have been recaptured from the PNG tuna tagging project and recoveries are expected to continue for several years, providing a full-time job for tag recovery officers who are placed in key tuna unloading points in PNG (Lae, Madang, Rabaul and Wewak).

The tag recoveries officers are now entering data into a specialised database that allows the importation of recovery information directly into SPC's database on a monthly basis. These data will be used primarily to assess the status of tuna resources in PNG for national fisheries management, and will contribute to the regional assessment of tuna stocks. A number of analyses are being undertaken to use tagging data to estimate movements and mortality rates within stock assessment models. Before being used, the data (especially position and date of recapture) need to be verified and corroborated with logsheets (declarations of captures by the fishery), and vessel monitoring system matching is an ongoing task. Close to 70% of recovery records (from the entire Pacific Tuna Tagging Project) have been verified and the remaining is expected to be completed in 2013.



*Tagging yellowfin tuna on F/V Soltai 101.*

*PNG total release summary.*

Time period	Tagging vessel	Number of releases
Apr–Jul 2011	<i>Soltai 105</i>	40,655
Jan–Mar 2012	<i>Soltai 105</i>	39,926
Apr–Jun 2013	<i>Soltai 105</i>	29,920
<b>7 months</b>		<b>110,501</b>

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*The contents of this publication are the sole responsibility of SPC and can in no way be taken to reflect the views of the European Union.*



## Balancing the needs

*In 2011, the delivered value of the industrial tuna catch from the waters of Pacific Island countries and territories (PICTs) was USD 3 billion.*

*PICTs gain up to USD 150 million a year by selling licences to foreign fishing fleets to operate in their national waters, and fleets based in PICT waters contributed over USD 300 million to the region's gross domestic product.*

*At the same time, urban and rural communities rely on small-scale local or “artisanal”<sup>1</sup> fisheries for food security and livelihoods, and there is a growing risk of conflict between the interests of these artisanal fishers and industrial operations.*

### Industrial tuna fishing vs artisanal fisheries

Since the early 1990s, the total industrial catch of all tropical Pacific tuna species has increased by around 60% (Fig. 1). This increase in catch has largely taken place within the exclusive economic zones (EEZs) of PICTs. The overall catch within these waters — from both commercial and artisanal fishers — has increased by 150% since 1990 (Fig. 2).

A significant proportion of the catch within Pacific Island EEZs is taken close to the shores of individual countries — less than 100 nm from the low-water mark. According to a Secretariat of the Pacific Community (SPC) study undertaken in seven PICTs, this amounts to between 5% and 25% of the total industrial catch, which brings industrial fishing operations directly into competition with artisanal operations.

### Impact of industrial tuna fishing on fish stocks

In tropical waters, industrial and artisanal fishers may compete over the tuna species targeted by purse-seine vessels (skipjack and yellowfin tunas). The use of floating fish aggregating devices by industrial fleets also results in the bycatch of some species that are important to artisanal fisheries, such as mahi mahi, wahoo and rainbow runner.

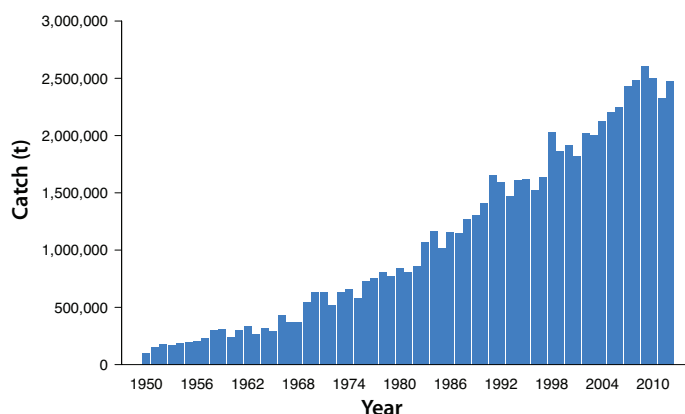


Figure 1. Long-term (1950–2012) tuna catches in the western and central Pacific Ocean .

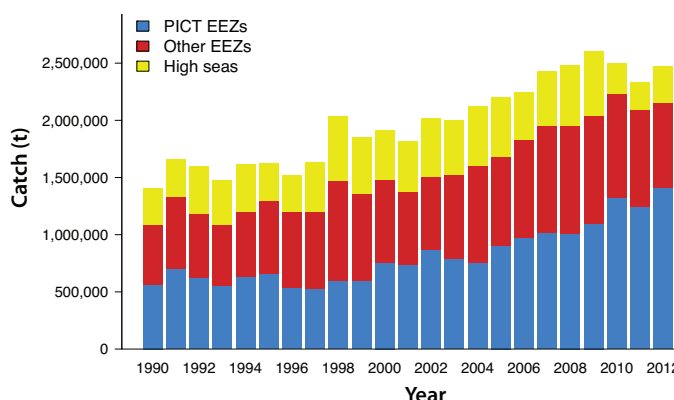


Figure 2. Recent (1990–2012) tuna catches in the western and central Pacific Ocean by area .

<sup>1</sup> Pacific Island governments refer to local tuna fisheries as “artisanal”, “small-scale” or “nearshore”. In this article, the terms “artisanal” and “small-scale” are used to distinguish fishing by small, semi-commercial or non-commercial vessels. In contrast, industrial fisheries are fully commercial, using vessels capable of staying at sea for weeks or months. For more information on definitions, see the Food and Agriculture Organization of the United Nations publication “International Guidelines for Securing Sustainable Small-Scale Fisheries”, available at: [www.fao.org/fishery/ssf/guidelines/en](http://www.fao.org/fishery/ssf/guidelines/en).

In subtropical areas, the competition mainly involves species caught as bycatch (in particular, yellowfin tuna and wahoo) by industrial longline vessels targeting albacore tuna.

Tuna numbers in the Pacific are much lower than they were 30 years ago, primarily due to industrial fishing operations. Declines range from 8% (for skipjack tuna) to 65% (for yellowfin tuna), as seen in Figure 3.

All tuna stocks are estimated to be above the levels required to support the maximum sustainable yield and are, therefore, deemed “biologically healthy”. However, these reduced populations may not be sufficient to sustain the necessary catches and catch rates required by artisanal fisheries. Furthermore, while industrial fleets are highly mobile and can follow the remaining fish, artisanal fleets do not have this mobility, and normally operate within a range of 50 km from their base. Artisanal fleets are, therefore, vulnerable to localised depletion of fish stocks.

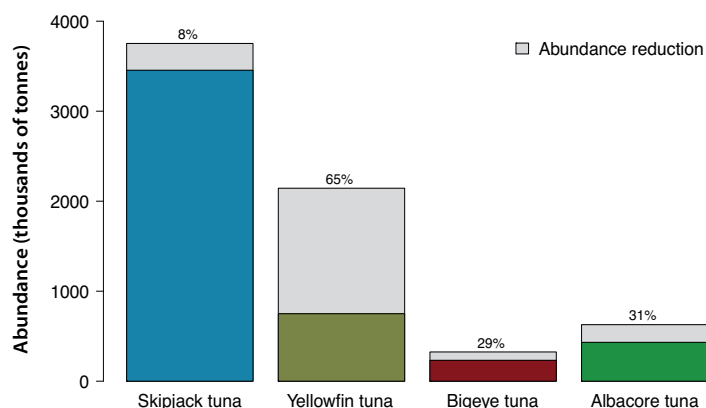


Figure 3.  
Reduction in abundance since 1980.

## Effects of industrial fishing operations on artisanal fisheries

Industrial tuna fishing is affecting artisanal fisheries in three main ways:

1. There are fewer tuna in the water to catch.
2. More tuna are being caught than ever before by industrial fleets.
3. More of the industrial catch is being taken closer to artisanal fishing grounds than ever before.

In some countries, where industrial and artisanal fishers compete for the same fish in the same areas and at the same time, the problems are more acute.

In deciding on what actions to take, each country will need to analyse how its waters are used by industrial and artisanal fishers.

Figure 4 illustrates the increasing impact of industrial fishing on artisanal fisheries, depending on how many factors are found to be significant. If artisanal and industrial fisheries take different species in different areas or seasons, there is likely to be little impact from industrial fishing on artisanal fisheries. But, if industrial fisheries take large numbers of a species that is important to artisanal fisheries, particularly from the same area, there is a much higher risk of negative impacts on artisanal fisheries and a greater need for precautionary actions.

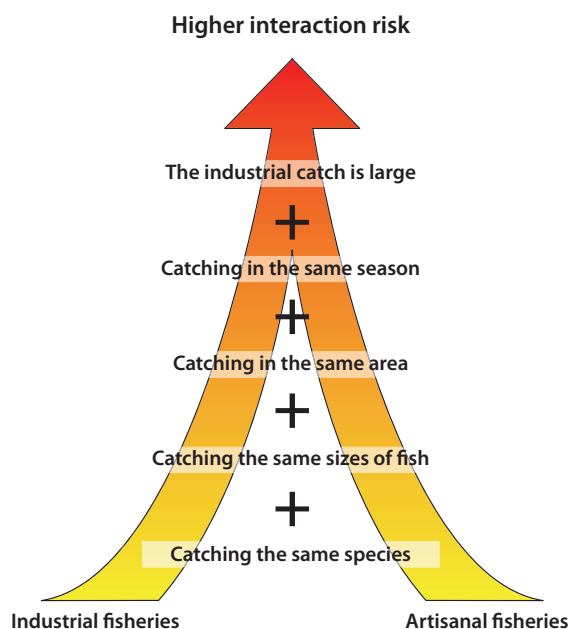


Figure 4.  
Important factors influencing the nature and extent of impacts from industrial fisheries on artisanal fisheries.

### Possible solutions

The appropriate solution will not be the same for every PICT, and will depend on the nature and extent of the likely impacts from industrial fisheries.

Knowledge of the contributions of artisanal fisheries to food security and livelihoods is critical for identifying the best way to manage national tuna resources and to allocate them between industrial and artisanal fisheries. Such analysis needs to look at both socioeconomic and biological factors (e.g. trends in the abundance of fish and their mobility).

Managers should take the following actions, when appropriate:

- Establish industrial fishing exclusion zones to reduce direct competition between industrial and small-scale fisheries.
- Install nearshore anchored fish aggregating devices to increase the accessibility of tuna and other oceanic fish species for artisanal fisheries and to help mitigate declines in local fish populations.
- Improve national knowledge about the catch and catch rates from small-scale fisheries and, particularly, how these change over time.
- Strengthen small-scale fishers' associations, and increase their participation in national tuna management planning forums.
- Promote management measures through the Western and Central Pacific Fisheries Commission that account for the special needs of artisanal fisheries, particularly those where local communities are dependent on such fisheries for their food and livelihoods.

### How SPC will help

SPC will work with each PICT to identify the extent of the challenge to its industrial and artisanal fisheries. It will also work with other relevant regional organisations to determine a set of management actions that will address the impacts of industrial fishing on artisanal fisheries.

### Further reading

Harley S.J., Williams P.G., Nicol S. and Hampton J. 2013. The western and central Pacific tuna fishery: 2011 overview and status of stocks. Noumea, New Caledonia: Secretariat of the Pacific Community. [www.spc.int/DigitalLibrary/Doc/FAME/Reports/Harley\\_13\\_Western\\_Tuna\\_2011\\_overview.pdf](http://www.spc.int/DigitalLibrary/Doc/FAME/Reports/Harley_13_Western_Tuna_2011_overview.pdf)

SPC. 2009. Fish and food security. SPC Policy Brief 1/2008. Noumea, New Caledonia: Secretariat of the Pacific Community.

SPC. 2012. Fish aggregating devices (FADs). SPC Policy Brief 19/2012. Noumea, New Caledonia: Secretariat of the Pacific Community.

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Images: Siosifa FukoFuka and Jacob Appelbaum.





## Giant squid trials in the Cook Islands

*Fishing trials were carried out in July to determine whether giant squid are present in the waters of the Cook Islands. This revelation could provide small-scale fishermen an alternative offshore fishing activity, besides tuna fishing around FADs and offshore, which could help ease the pressure on reef and lagoon resources. The project was a follow up to trials that were carried out in New Caledonia in 2012.*

SPC's fisheries development officer, William Sokimi, of the Nearshore Fisheries Development Section worked with the Cook Islands Ministry of Marine Resources (MMR) to train two MMR staff, Captain Saiasi Sarau and Richard Story, and a local tuna longline masterfisherman, Mark Baxter, in the fishing method used to catch various species of giant squid.

The primary target species was the diamondback squid, *Thysanoteuthis rhombus*, which has a mantle length of up to 100 cm and can weigh as much as 30 kg, although the average weight is around 20 kg. The secondary target species was the neon flying squid, *Ommastrephes bartramii*. This is a smaller squid with a mantle length of up to 70 cm and weight ranging from 5–18 kg. Both species are believed to be present throughout tropical and sub-tropical waters.

During the trials, bad weather restricted fishing efforts and affected catch results. Instead of carrying out eight days of fishing trials as planned, only four fishing days were achieved. Fishing could only be carried out on the west (leeward) side of Aitutaki Island. Plans to continue fishing off Rarotonga were scrapped because it was unsafe to make the crossing from Aitutaki to Rarotonga. Even still, the final outcome of the trials was satisfactory and sufficient enough to confirm that diamondback and neon flying squids are present in Cook Islands' waters.

The fishing gear used was a vertical longline with a blue light and four lures set at a depth of 500 m. Several longlines were set above the 2,000-m contour although they drifted between shallower and deeper depths of 800–3,000 m. Setting was carried out from between 05:00 to 07:00 and usually took one and a half hours. Hauling started between 13:00 and 15:00 and took four hours.

During the trials, 45 vertical longlines were set during four fishing days, with a total of 180 hooks set. The final catch resulted in 14 giant squid: 7 diamondback squid and 7 neon flying squid. The catch consisted of 119.5 kg of diamondback squid and 53.5 kg of neon flying squid, or 173 kg in total. However, when counting tentacles and the mangled remains of squid left on the hook, there were actually 28 hook-ups; double what was caught. The most probable cause of squid being ripped off the hooks was attributed to the rough seas and sudden high swells. Even though the drag of the reel was set as low as possible, it was still insufficient to counter the sudden upsurge when



Mark Baxter (left) and William Sokimi with freshly caught diamondback squid.

a high swell passed. Swordfish were observed attacking three of the squid that were eventually landed.

Because this is a new fishery to the Cook Islands and the region, considerable promotion needs to be carried out to trigger demand for the product and create a local market. Preliminary work was already done in Aitutaki and Rarotonga to promote both squid species. A booklet with 53 recipes, authored by Mitsuhiko Ishida, produced by the Japan International Cooperation Agency, and published by the Dominica Fisheries Division, was distributed along with chunks of squid samples to local restaurants and hotels to try out and to comment on.

It will be necessary to determine how best to manage this new fishery. The diamondback squid in particular needs to be managed carefully. Unlike other squid, diamondbacks pair up and live as a couple. Further development of the fishery can only benefit the fishermen in the long term if it is carried out sustainably.

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## Sea safety “grab bags” for PNG maritime safety officers

*Thirty small-craft, sea safety grab bags were presented to the Papua New Guinea National Maritime Safety Authority (PNG NMSA) by SPC’s DevFish2 Project. Each grab bag kit includes a rescue laser light (replacing flares), sea anchor, portable GPS, life jacket, mirror, whistle, and waterproof mobile phone pouch.*

Many lives have been lost at sea in PNG’s waters due to bad weather, ignorance or negligence on the part of boat operators who have no basic safety equipment on board. PNG NMSA is emphasising the importance of protecting lives while at sea and the need for simple safety precautions to be followed.

NMSA is in the process of introducing the “PNG Small Craft Act 2010”, which will regulate vessels 10 m and less due to the increasing number of accidents and incidents occurring at sea. This Act provides for the safety of people using small crafts in PNG, and provides standards for their construction, registration and operation. Under this legislation, small craft operators will be required by law to have minimal safety training and a range of safety equipment on board their craft.

The EU-funded DevFish2 Project focuses on assisting with small-scale fisheries development, and acknowledges that safety at sea for small-scale artisanal fishers is a critical priority in all of PNG’s 15 maritime provinces.

The SPC DevFish2 Project is providing this support to enhance NMSA’s capacity because they have a regular

provincial programme for awareness and training, which targets small boat operators and seafarers.

NMSA Project Officer, Peter Bell said; “These safety kits will be distributed to maritime provincial safety officers to assist with their training and awareness activities and with the new safety equipment requirements when travelling on small craft themselves.”

The timely support with these small craft safety kits will assist NMSA in their current programme of the PNG Small Craft Act in all 15 maritime provinces. “During this exercise, the grab bag kit of individual life saving safety equipment will be promoted to coastal communities as a cost-effective means for that community to both improve safety and comply with the law,” commented Chris Rupen, NMSA’s Chief Executive Officer.

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Jonathan Manieva (centre) presenting the various elements of the sea safety grab bags to Mr Chris Rupen, NMSA’s CEO (right) and Mr Ulea Waroi, NMSA Education and Safety Officer (left).



### Learning about biosecurity to better protect natural resources



*An enormous amount of goods and passengers are regularly transported by air and by sea to, and among, the countries within Micronesia. These countries are considered to be “hot spots” of biodiversity, and therefore, the accidental or deliberate introduction of diseases and/or invasive species (through the movement of people and products) could have an extremely negative impact on these fragile island environments.*

To help Micronesian countries prevent the accidental import of invasive species, a special training session is held each year for quarantine and biosecurity officers. This year, the 11<sup>th</sup> subregional training on “Quarantine and biosecurity for Micronesian countries” was held in Guam. The training was organised by the University of Guam, the Secretariat of the Pacific Community (SPC), the United States Department of Agriculture – Animal Plant Health Inspection Service (USDA APHIS), and the Guam Department of Agriculture. The trainings, which specifically target quarantine and biosecurity officers within Micronesia, were initiated in 2002 and have been held on annual basis since then.

This year, 26 quarantine and biosecurity officers from the Commonwealth of the Northern Marian Islands, Federated States of Micronesia, Guam, Kiribati, Marshall Islands, Nauru and Palau attended the training. It was the first year that quarantine officers from Kiribati and Nauru participated. Theoretical training sessions were held at the University of Guam, while practical sessions were conducted in various locations, such as the plant inspection facility of USDA-APHIS, the entomology laboratory of the University of Guam, and at rhino beetle eradication and control areas around Guam.

Participants improved their knowledge of major exotic plant pests and animal diseases, and the strategies to control their entrance and spread. Quarantine protocols for plants and terrestrial and aquatic animals were presented. Animal transboundary diseases, major trading partners, agreements and consumer aspirations were also topics covered during the training. One of the

major achievements of this programme is the exchange of ideas and information among quarantine and biosecurity officers. Organisers have noticed that over the years, this training programme has established a large biosecurity “family” within Micronesia, and members are in contact with each other and discuss and help solve problems and learn from each other’s experiences.

The inspection and acceptance of potentially high to medium risk goods within Micronesia are carried out by these well trained quarantine and biosecurity officers. Most Micronesian countries and territories have a good record with regard to plant and animal health (for both terrestrial and aquatic animals) and this reputation should be maintained and preserved through trainings such as this.

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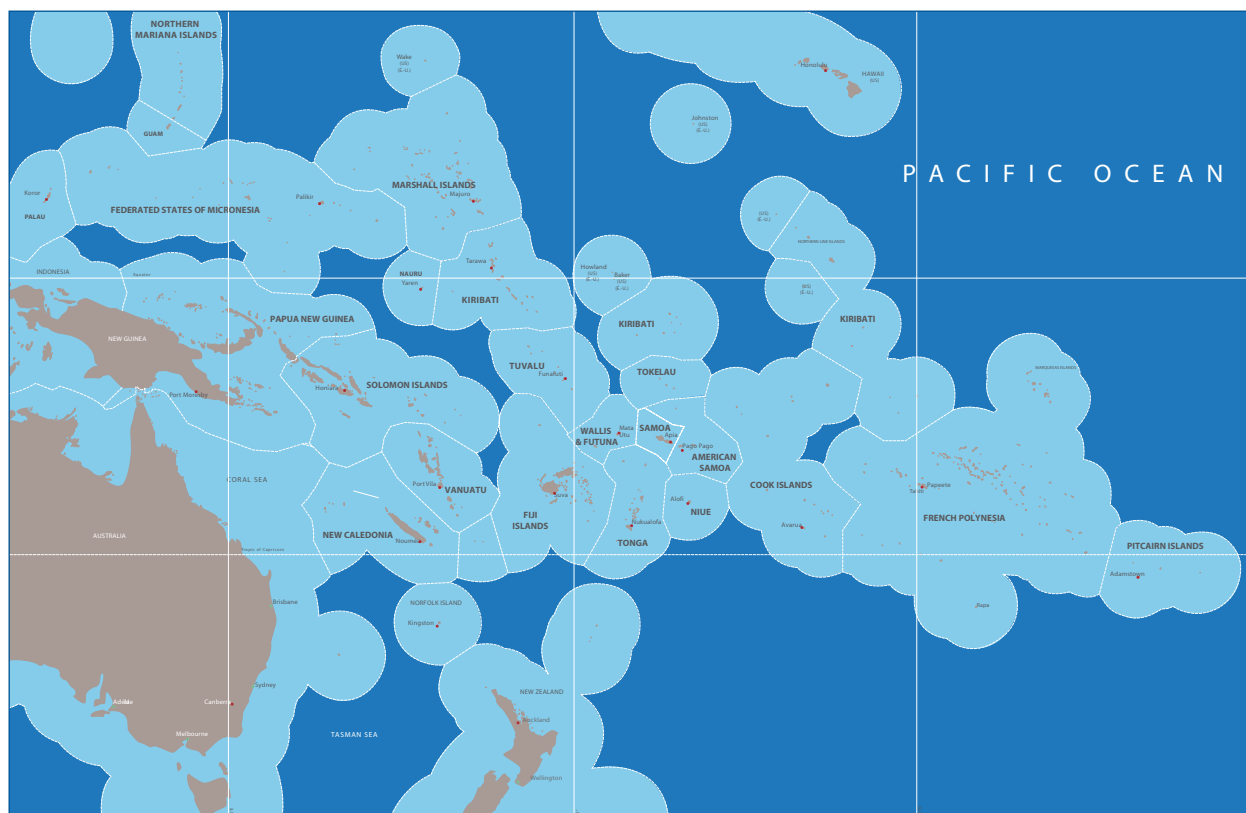
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## The future of Pacific fisheries: The stakes and the prospects



*In the future, what will fisheries contribute to the economic development, livelihood and food security of the Pacific Islands region? This is a crucial issue for the Secretariat of the Pacific Community's Division of Fisheries, Aquaculture and Marine Ecosystems and for the 22 member states and territories of the oldest regional organisation in the Pacific (founded in 1947).*

Pacific Island communities are highly dependent on marine resources. Many countries in the region gain great economic benefit from the sales of fishing licences to industrialised fishing nations such as China, Korea, Japan, Taiwan, USA and, more recently, the European states. This indirect way of exploiting their tuna resources represents a significant percentage of annual government revenue for several Pacific Island countries — as much as 50% for Kiribati. Tuna are a migratory species and managing this resource requires a regional approach. Pacific tuna stocks are in relatively good health, especially skipjack tuna (*Katsuwonus pelamis*), which accounts for 70% of the 1.4 million tonne average annual tuna catch within the exclusive economic zones of Pacific Island countries. Bigeye tuna (*Thunnus obesus*) is, however, now subject to overfishing and future catches of this species, which is very popular with the Japanese, need to be reduced. Most of the regional industrial tuna fishery catches are exported for processing outside the region, in particular by Southeast Asian canneries.

Subsistence and artisanal coastal fisheries are also important to the Pacific Islands, with catches being consumed locally by rural communities (subsistence fishery) or sold in rural and urban markets (artisanal fishery). These fisheries provide many coastal communities with their main livelihood and play an essential role in food security, with seafood accounting for 50–90% of the animal protein consumed in rural areas. With an average annual consumption of 50 kg of fish per person across the region (and at least 70 kg per person in some countries), people in the Pacific eat much more fish than the world average of 18 kg per person per year.

The coastal fisheries used for food security and livelihoods are made up of many species of fish and invertebrates. For example, 1,200 species of reef and lagoon fish have been recorded in New Caledonia alone, including around 150 caught by subsistence and artisanal fishers.

In addition to the very high dependence on coastal fisheries resources for food and livelihoods, two other factors influence the availability of seafood in the Pacific:

population growth and the impacts of climate change. SPC's Statistics for Development Division forecasts a population increase of 45% by 2035 (from 11 to 16 million) in the Pacific Islands region. The increase will be significant in each of the three subregions (Melanesia, Micronesia and Polynesia) but especially in Melanesia where both urban and rural populations are growing. The trend in Micronesia and Polynesia is different: in both areas, increasing urbanisation is causing the rural population to decline. The larger overall population will need more fish.

Climate change is expected to have negative effects on coastal fisheries, largely because higher sea surface temperatures, ocean acidification and increasingly powerful cyclones are likely to degrade the coral reef ecosystems that support much of the coastal fisheries production.

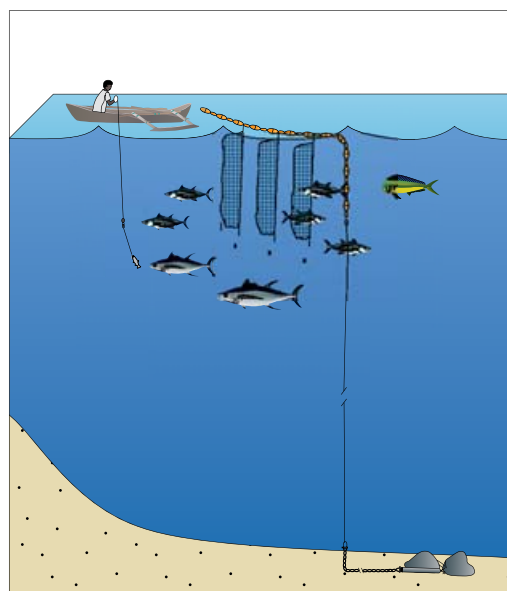
In order to provide the fish recommended for good nutrition (35 kg per person per year), or maintain the traditionally higher levels of fish consumption, an extra 115,000 tonnes of fish per year will be needed by 2030. However, increasing the production of fish from coastal habitats will not be possible for many of the countries in the region, either because they have limited areas of coral reef or because systems for transporting fish from rural to urban areas are non-existent or too expensive.

How then can the supply of fish and invertebrates for food security and livelihoods in the Pacific Islands be increased? First, existing coastal fisheries resources must be well managed. In contrast to agriculture, fisheries depend on finite resources that are often slow to regenerate after disturbances. If overfishing occurs, these resources shrink (or even disappear from some areas) and do not yield their full potential. Unfortunately, this has already occurred around the region in the case of some invertebrates (sea cucumbers, trochus). Coastal fishing effort must, therefore, be controlled to maintain the potential for stocks to be replenished regularly, and to minimise the gap between how much fish is needed for food and the harvests that can be sustained from reefs. SPC recommends participatory management systems in which communities themselves manage the resources they use, and assists member Pacific Island countries with implementing such systems. Where it is necessary to restrict coastal fishing effort, alternative ways of producing food and earning income must be offered to the communities concerned. Certain marine resources can provide some of these alternatives, but other sectors, such as ecotourism or agriculture, also offer opportunities.

One practical approach is to give urban communities easier access to seafood by arranging for some of the fish caught by industrial tuna fleets to be landed at urban centres. The transshipment of catches from purse-seine vessels to refrigerated cargo vessels ("reefers"), which takes place in several of the region's larger

ports, provides the opportunity to do this. Undersize tuna and bycatch — such as rainbow runner, mahi mahi and wahoo — which cannot be processed by the canneries, can be landed and sold in urban markets. These fish transshipment operations should be encouraged by governments and supervised to ensure that the quality of fish is maintained throughout the process. The interests of local small-scale fishers supplying fresh fish will also need to be considered so that their livelihoods are not adversely affected by the increased supply of fish stored in brine from industrial vessels.

Another solution is to assist coastal fishers to transfer more of their fishing effort from reef and lagoon species to tuna and the other large and small pelagic fish that are more resilient to fishing pressure. SPC promotes the use of nearshore, anchored fish aggregation devices (FADs), for this purpose.



*FAD canoe fishing (illustration: Boris Colas).*

These two main alternatives, combined with more efficient management of coastal fisheries resources, development of sustainable aquaculture, and new opportunities offered by the agriculture and tourism sectors, should help Pacific Island countries and territories to address the demographic, socioeconomic and climate change challenges in the 21<sup>st</sup> century.

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### Reviewing Fiji's fisheries laws

*Fisheries are very important to Fiji's economy, making an important contribution to the country's gross domestic product (2.8% in 2011) with export earnings of over FJD 150 million (or 17.5% of domestic exports) for the country. Both capture fisheries and aquaculture are also important for employment and livelihoods, and supply an important source of animal protein. Nevertheless, as in most other Pacific Island countries and territories, Fiji's inshore capture fisheries of multi-species finfish and marine invertebrates, and aquaculture, have developed at a gradual pace and there is significant potential for further development.*

However, Fiji's fisheries sector faces many challenges. These constraints are recognised by the Department of Fisheries and other relevant agencies within Government and are gradually being addressed through various policy developments and project initiatives.

While no single comprehensive strategy has been formally adopted for the fisheries sector, and while the objectives of fisheries management in Fiji do not appear in the current fisheries legislation, the general objectives for the fisheries sector emerge through various policy documents. These include developing fisheries in Fijian waters through government inputs into infrastructure development, such as multi-species hatcheries to boost freshwater and brackish water aquaculture and mariculture, and the introduction of exotic shrimp species resilient to adverse weather conditions due to problems associated with climate change.

Proper management — including adequate regulation — is a fundamental requirement for Fiji if the potential of the fisheries sector and the aspirations of its people are to be fully realised. In this context, the drafting of three new fisheries decrees is an integral and significant component. The Pacific Islands Forum Fisheries Agency (FFA) assisted Fiji in this task. The previous fisheries law, while revised on a number of occasions, dated back to 1942 and was in serious need of updating. Moreover, the 1942 Fisheries Act, even as amended, did not address the conservation and management of aquaculture, despite the rapid growth of this sector in Fiji.

To date, there are two new decrees: the Offshore Fisheries Management Decree, which was officially passed in January 2013, and the Aquaculture Decree, which is expected to be promulgated by the beginning of 2014. A third decree — the Inshore Fisheries Management Decree — has been drafted but is still being reviewed and is subject to further consultation with stakeholders.

These two new decrees give the Government of Fiji a comprehensive range of duties, responsibilities, functions and powers to regulate and sustainably manage offshore fisheries and aquaculture. They are based on modern standards and principles with the overriding aim of conserving, managing and developing Fiji's fisheries and aquaculture operations in order to ensure the long-term sustainable use for the benefit of the people of Fiji.

These are not just words: the objectives and principles lay the framework for the content of the decrees and must be considered and applied by the Minister responsible for Fisheries and Forests and the Fisheries Department when making and implementing policy, and when making decisions under the decrees or regulations.

Under the new decrees, robust licensing systems have been established, which reflect international best practice. Decision-making duties are defined, and the conditions for allocating, refusing or suspending licences are described. Applicants may appeal against unfavourable decisions.

The Offshore Decree addresses many of the legal gaps created by the old law, and provides the government with a broad range of extensive powers to manage, regulate and control offshore fisheries, including activities in support of, or in preparation for, fishing activities.

The decree envisages that the most important fisheries will be managed through Fisheries Management Plans. The government has obligations to designate important fisheries and to adopt comprehensive management plans for them, following criteria set out in the legislation. Specific regulations can be adopted to implement management measures. The allocation of fishing rights under customary marine tenure must also be consistent with the management plans and take into account whether such allocations would advance the development of the fishing industry in Fiji.

There are also detailed monitoring, control and surveillance provisions that not only describe the powers of fisheries officers and the government, but also contain protection for fishers to ensure that the procedures are applied fairly. There is a provision for the establishment of an observer programme, in which fishing companies may be obliged to participate and to which they must contribute costs.

The decree enables the government to implement international and regional rules on port State control. In particular, it allows the Government of Fiji to ban vessels on the black lists of the Pacific Islands Forum Fisheries Agency (FFA) and other regional fisheries management organisations.



The Aquaculture Decree creates many new obligations for potential fish farmers, and extensive attention will need to be given to building capacity to meet these new requirements. It also allows the government to designate areas that are important for aquaculture and to adopt management and development plans to encourage and manage the sector in those areas.

This new legislation promotes improved governance. The functions and responsibilities of the Minister responsible for Fisheries and Forests and the Fisheries Department are clearly defined and — most significantly — new advisory councils and committees are established to provide opportunities for stakeholders to participate in decision-making, ensuring a better understanding and respect for the policies, bylaws and guidelines. Opinions and recommendations made by these bodies must be taken into account by the government.

Another important feature of the new legislation is the Fixed Penalty Notice. These on-the-spot fines can be issued by fisheries officers, and will enable the Fisheries Department to apply sanctions more easily.

A project supported by the European Union, under the ACP Fish II programme<sup>1</sup>, has worked to complement FFA's initiative by supporting an information campaign to raise stakeholder awareness about the content of the new fisheries legislation, and by providing high-level training to officers of Fiji's Fisheries Department to build the department's capacity to implement the new decrees. The campaign took the form of information sessions — aimed at the main stakeholders — that were held in various places for Fiji's Northern, Western and Central divisions, and a training workshop for Fisheries Department staff in Suva.

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<sup>1</sup>. The ACP FISH II Programme is a 4.5-year programme financed by the European Development Fund on behalf of ACP (African, Caribbean and Pacific Group of states) countries. The aim of the programme is to improve fisheries management in ACP countries so as to ensure that fisheries resources under the jurisdiction of these countries are exploited in a sustainable manner.



Aquaculture stakeholders information session in Savusavu, Fiji (image: Peter Thorpe).

## Tuvalu releases the first inventory of its vital marine resources

*Tuvalu, which lies about halfway between Hawaii and Australia, is an archipelago of nine low-lying islands, spread over 900,000 km<sup>2</sup>. With a total landmass of 26 km<sup>2</sup> (about a quarter of the size of Paris) and a population of over 11,000, this young island nation finds itself at the forefront of a planetary issue: climate change. And unless existing trends are addressed immediately, the very future of Tuvalu is at stake.*



Changing and increasingly erratic weather patterns, flooding due to sea level rise, increasing ocean temperatures, and longer periods of drought are already putting Tuvalu's vulnerable environment under pressure, affecting the country's freshwater supply as well as its local food production. Traditional root crops have become difficult to cultivate due to the infiltration of saltwater into the ground water supply. Providing the nation's nutritional base, marine resource are, more than ever, vital for Tuvalu.

### The first marine biodiversity inventory of the archipelago

The publication "Tuvalu Marine Life" was coordinated by the nongovernmental organisation "Alofa Tuvalu" as part of its 10-year "Small is Beautiful" plan to document the island nation's unique marine life, taking into

consideration global warming and paying special attention to endemic species, fishing methods, tides and spawning sites. The project was selected by the United Nations Educational, Scientific and Cultural Organization (UNESCO) as one of the "Remarkable Actions for the Decade of Sustainable Development".

In early June, at the Paris Tropical Aquarium, Alofa Tuvalu, a French-Tuvaluan non-governmental organisation, presented copies of the publication Tuvalu Marine Life to Tine Leuelu, Ambassador of Tuvalu to Belgium, and to the International Union for the Conservation of Nature, UNESCO, The Fondation d'entreprise Total, and the Agence française pour le développement.

For the first time ever, data have been collected on hundreds of fish species, and at least 79 of these are of interest and are listed in the International Union for the Conservation of Nature's Red List, and 29 of species are considered to be "Near Threatened" or "Threatened".

For Tine Leuelu, Ambassador of Tuvalu to Belgium: "Alofa Tuvalu has been very instrumental in several projects (e.g. relating to renewable energy, conservation) that help Tuvalu because of the reality of what is going to happen to us. I am very grateful to receive 'Tuvalu Marine Life'... because the richness of Tuvalu is its marine life... and we need to conserve it."

### Tuvalu Marine Life is a starting point — not a conclusion

While it contributes critical new knowledge to the international community, Tuvalu Marine Life also aims to help Tuvalu manage its marine resources. The publication represents a unique history and testimony of Tuvalu's marine environment as of 2013.

The publication is also the start of environmental awareness campaigns toward a wide audience especially young people. A first pictures exhibition and children's workshop began on June 4th at the Tropical Aquarium, and the "Tuesday for Environment" monthly event addressed Pacific and biodiversity-related subjects. Two weeks after it was made available online, Tuvalu Marine Life had been downloaded over 5000 times. At the end of September it had been downloaded 25,000 times!



### A worldwide endeavour

The publication “Tuvalu Marine Life” represents seven years of work. It was made possible by The Fondation d'entreprise Total, AFD/CRISP (Agence française pour le développement/Coral Reef InitiativeS for the Pacific), Sue Devitt Beauty, Tuvalu Fisheries and Kaupule's, Alofa Tuvalu and numerous other gracious support from around the world.

In mid-July, in Tuvalu, Alofa Tuvalu hand delivered the publication to Willy Telavi and Apisai Ielemia, who were the Prime Ministers in charge during the project implementation. Electronic copies were provided to the Tuvalu Fisheries Department and Funafuti Kaupule (Town Hall) as well.

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### Links to various related resources:

#### Preamble

[http://www.alofatuvalu.tv/US/05\\_a\\_tuvalu/05\\_page\\_tml/05\\_tml\\_preamb\\_us.pdf](http://www.alofatuvalu.tv/US/05_a_tuvalu/05_page_tml/05_tml_preamb_us.pdf)

#### Synthesis report

[http://www.alofatuvalu.tv/US/05\\_a\\_tuvalu/05\\_page\\_tml/livret2light.pdf](http://www.alofatuvalu.tv/US/05_a_tuvalu/05_page_tml/livret2light.pdf)

#### Scientific report

[http://www.alofatuvalu.tv/US/05\\_a\\_tuvalu/05\\_page\\_tml/livret4light.pdf](http://www.alofatuvalu.tv/US/05_a_tuvalu/05_page_tml/livret4light.pdf)

#### Fieldwork report

[http://www.alofatuvalu.tv/US/05\\_a\\_tuvalu/05\\_page\\_tml/livret3%20light.pdf](http://www.alofatuvalu.tv/US/05_a_tuvalu/05_page_tml/livret3%20light.pdf)

#### Photos

[www.flickr.com/photos/alofatuvalu](http://www.flickr.com/photos/alofatuvalu)

#### Videos

[www.youtube.com/user/alofatuvalu](http://www.youtube.com/user/alofatuvalu)



*Sebastapistes cyanostigma, one of the species never recorded before in Tuvaluan waters  
(image : Thomas Vignaud, ©Alofa Tuvalu).*



## Commercial marine ornamental fish surveys in Kavieng, Papua New Guinea



White-bonnet clownfish (image: Colette Wabnitz).

*The newly established Nago Island Mariculture and Research Facility (NIMRF) is a fully operational aquaculture research and marine science centre within Kavieng Lagoon in Papua New Guinea (PNG). NIMRF was established by PNG's National Fisheries Authority (NFA) and is co-managed by NFA's Aquaculture Unit and the National Fisheries College (NFC). Currently, NIMRF, in conjunction with James Cook University (JCU) in Australia, is implementing a project focused on mariculture development in PNG's New Ireland Province that is funded by the Australian Centre for International Agricultural Research (ACIAR).*

The ACIAR project's main objective is to promote the production of marine species that are technically feasible and socially acceptable to local communities within the region. The species on which the project will focus are sea cucumbers (sandfish), edible oysters, and marine ornamentals (the exports of which could be supplanted with wild species collection), including hard and soft corals. As part of the ornamental component of the project, a commercial ornamental fish survey and viability assessment was conducted with support from industry experts, SPC's fisheries scientist responsible for aquarium trade activities, a JCU PhD student who will focus on rearing white-bonnet clownfish (*Amphiprion leucokranos*), and staff from NIMRF, JCU and NFC.

As well as looking for potential ornamental species to culture, the commercial survey centred on species located in the depth range from which fish are typically

safely collected (0–40 m). During this assessment, all ornamental species of potential interest for the marine aquarium trade were recorded and placed in one of three categories.

1. Species of targetable size and high abundance. In situations where an industry can be developed, these species would constitute the main target species.
2. Species with some market value but not viable for export (and for which some were observed in low abundance). Such species would not be targeted per se but would be collected if encountered during a dive.
3. Species with low or virtually no market value (thus not viable for export). Individuals observed on the reef are typically observed at too large a size or at too low an abundance, for example.

Dives allowed the identification of four distinct areas.

1. Partially enclosed lagoon with low current levels and no direct passes to the open ocean.
2. Lagoon with numerous passes to the open ocean along with high current levels.
3. The western side of the island in the Bismarck Sea.
4. The eastern side of the island.

A large numbers of species of interest were recorded, with good abundances noted for targetable sizes. No endemic or new species were observed however, and there were no colour variations found that would bring a premium on the market. A few organisms did stand out though, such as white-bonnet clownfish, which are unique to the region and not readily available on the market. This is why this species is targeted for further research for aquaculture potential.

While available flights would, in theory, allow the export of high-quality fish to a variety of destinations, in practice, a number of issues, mostly related to the high cost of freight, would make the development of a viable ornamental export operation very challenging. These challenges include:

- non-competitive freight costs from Kavieng to Port Moresby and onward;
- limited freight capacity from Kavieng to Port Moresby;
- difficulty in negotiating competitive freight rates between two carriers (because companies operating flights within PNG and onward are likely to be different and the carrier operating the longest leg determines the overall freight rate);

- frequent cancellations and delays both at Kavieng and Port Moresby airports;
- increased risk of missed transfers at international airports when operating with multiple carriers; and
- price-sensitive markets in most accessible markets (Singapore, Japan, and Hong Kong).

Overall, NIMRF is in a unique position to develop mariculture activities and further research on other organisms that may have a place in the ornamental market. The current survey has helped in this regard, particularly with work beginning soon on culturing white-bonnet clownfish.

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Some members of the team (from left to right): Colette Wabnitz, Antoine Teitelbaum, Kaspar, Tony Nahacky, Thane Militz, Jeff Kinch.



## Mangroves can cope with sea level rise by increasing soil height

*A new report<sup>1</sup> by The Nature Conservancy and Wetlands International shows that mangroves can adapt to rising sea levels by building up soils in some locations, allaying fears that mangroves may be lost as sea levels rise. This is important because mangroves provide risk reduction services against coastal hazards such as waves and storm surges.*

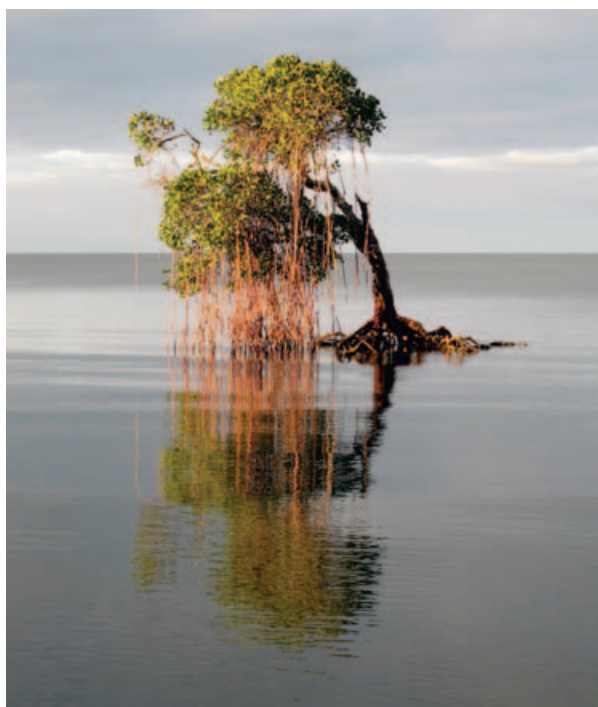


Image: Aymeric Desarmont

Mangroves can protect human lives and property by reducing the impacts of storm surges and waves. However, a major concern has been that mangroves may be lost as sea levels rise, leaving communities more exposed to coastal hazards. This review conducted by The Nature Conservancy and Wetlands International shows that under some circumstances, mangrove soils can build up at similar rates to local rises in sea level, allowing mangroves to survive in situ.

“We need to understand how mangrove soils build up, so that we can maintain suitable conditions for them to do so into the future,” says Nyoman Suryadiputra, Director of Wetlands International Indonesia. “Protecting mangroves is vital for many coastal communities who rely on them for their livelihoods as well as the coastal defence benefits they provide.”

Past evidence suggests that some mangrove soils have built up at rates between 1 mm and 10 mm per year. Currently, global mean sea level is rising at a rate of 3 mm per

year. This suggests that in some places, mangrove soil surfaces will be able to keep up with rising sea levels. This is key, as mangrove trees cannot survive if their aerial roots are submerged for long periods of time.

This latest report highlights the need to maintain, restore or enhance sediment supplies to mangrove areas. The sediments contribute to the build-up of soils, but the supply of sediment to many mangrove areas has been reduced because of dams built on rivers. Mangroves also need protecting from pollution and the felling of trees: the underground roots of healthy trees can push the soil up, while the roots of trees weakened by habitat degradation are less able to hold soils together, potentially leading to erosion and loss of surface soils. Restoring mangrove areas and safeguarding the health of trees can help mangrove soils to build up and so keep pace with sea level rise.

“In some areas, however, mangrove soils may not be able to build up fast enough to keep pace with sea level rise”, alerts report lead author Dr Anna McIvor of The Nature Conservancy. “In these areas, local planners should allow space for mangroves to colonise landward areas as sea levels rise. This will help to ensure that mangroves continue to reduce risks from coastal hazards into the future, benefiting local communities”.

Some mangrove forests have survived in the same location for thousands of years by building up soils beneath them as sea levels rose. In Twin Cays in Belize, mangroves have created a layer of old roots and sediments that is up to 8 m thick in some places. By building up soils, mangroves also help to lock up greenhouse gases such as carbon dioxide, and this provides another reason for protecting mangroves and their soils from degradation and loss.

Dr Mark Spalding, senior marine scientist at The Nature Conservancy said, “It is essential that we protect mangrove forests as they provide many vital services, not just coastal defence, but also fisheries and carbon storage.”

**Source:** [www.wetlands.org/News/tabid/66/articleType/ArticleView/articleId/3412/Default.aspx](http://www.wetlands.org/News/tabid/66/articleType/ArticleView/articleId/3412/Default.aspx)

<sup>1</sup> <http://www.wetlands.org/WatchRead/Currentpublications/tabid/56/mod/1570/articleType/ArticleView/articleId/3517/Default.aspx>



## Local focus may maximize Hawaii's yellowfin tuna stock

*The 2006 re-authorized Magnuson-Stevens Fishery Conservation and Management Act requires federally managed species to be regulated under annual catch limits. Highly migratory species, such as tuna and billfish, are exempted if they are subject to conservation and management measures by an international regional fishery management organization. Recent research, however, has led some Hawaii folks to question the "highly migratory" nature of yellowfin tuna caught locally.*

The tagging studies indicate that nearly 90 percent of the 1- to 2-year-old yellowfin tuna (i.e. those weighing 15 to 30 pounds<sup>1</sup>) sampled in Hawaii were locally spawned. They also show that the vast majority of the yellowfin do not leave Hawaiian waters throughout their lifetime.

This research suggests that Hawaii's fishermen cannot rely on large influxes of yellowfin tuna from other regions to maintain their catch rates and replace harvest stocks. So maximizing the production from the "local stock" makes sense. How can this be done?

One option is to increase the minimum harvest size of commercially landed yellowfin. The current legal size for sale is 3 pounds. Yellowfin at this weight are about 16 inches in length and eight months old. They are not sexually mature, and their natural mortality rate (i.e., mortality not related to fishing) is quite high.

Natural mortality rates of Hawaii yellowfin drop to their lowest levels when the tuna are about 10 pounds (about 24 inches). If not caught by fishermen, many of the yellowfin at this size will survive and grow. They will not be lost to natural mortality nor will they migrate.

Once they reach two years old (30 pounds), they will quickly grow to reproductive size and contribute to local spawning and stocks.

The Western Pacific Regional Fishery Management Council (WPRFMC) conducted an informal poll at the Hawaii Fishing and Seafood Festival and the Fishermen's Forum held in conjunction with the 155<sup>th</sup> Council

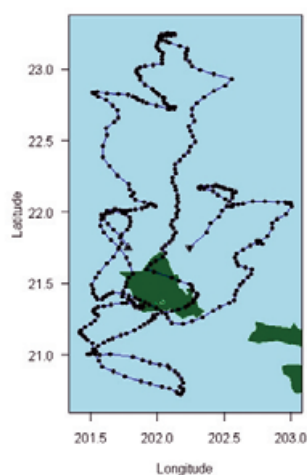


Satellite tagging of a 90-pound yellowfin tuna  
(image: Bruno Leroy).

meeting in October 2012 in Honolulu. People cast their vote on their preferred minimum commercial harvest size for yellowfin tuna. During the Fishing Festival, 259 votes (mostly from the general public) were cast. At the Fisherman's Forum, 63 votes (mainly from fishermen) were cast. Both groups agreed that the 3-pound minimum commercial harvest size is too small and that a larger size category should be used as the standard in Hawaii.

During the first half of 2013, the Council has worked in collaboration with National Marine Fisheries Service staff and a video filmmaker to draft a script for an educational video on yellowfin minimum size. The video will likely be developed in collaboration with the State of Hawaii's Department of Land and Natural Resources, as this agency develops the policy and rules for local fishery landings in Hawaii. In the interim, the Council re-affirmed its commitment to facilitating discussions on yellowfin minimum size and the science behind a potential increase in the minimum landed weight for commercial fisheries.

**Source:** Pacific Islands Fisheries News, Summer 2013 <http://www.wpcouncil.org/2013/09/17/summer-2013-pacific-islands-fishery-newsletter/>



Tagging and tracking studies show that most yellowfin tuna do not leave Hawaiian waters throughout their lifetime.

<sup>1</sup>. 1 pound = 0.45 kg; 1 inch = 2.54 cm

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## The Western Pacific Regional Fishery Management Council offers options to end bigeye tuna overfishing

*Since the late 1990s, bigeye tuna in the western and central Pacific Ocean (WCPO) has been experiencing overfishing. Tuna fisheries operating in the WCPO include longliners and handliners targeting adult bigeye and purse seiners targeting skipjack and incidentally catching juvenile bigeye.*

International management of tuna and other highly migratory pelagic fisheries in the WCPO is conducted by the Western and Central Pacific Fisheries Commission (WCPFC). This regional fishery management organization was formed by an international agreement to which the United States is a party. Despite years of negotiation and adoption of conservation and management measures (CMMs), the WCPFC has been unable to find a solution to end bigeye tuna overfishing that will satisfy both the longline and purse-seine fleets.

At its 9<sup>th</sup> regular session in December 2012, the WCPFC agreed on CMM 2012-01, which established a goal of reducing bigeye mortality to a level no greater than  $F/F_{MSY} \leq 1$ .<sup>1</sup> CMM 2012-01 maintained bigeye tuna limits for longline fleets, including the US/Hawaii limit of 3,763 metric tons, but did not provide annual longline bigeye catch limits for any of the participating territories or small island developing states. CMM 2012-01, among other things, also increased the fish aggregation device (FAD) closure by a month, requiring a four-month purse-seine FAD closure or equivalent reduction in purse-seine FAD sets. CMM 2012-01 directed WCPFC members to cooperate on developing a more comprehensive measure.

The Western Pacific Regional Fishery Management Council at its 157<sup>th</sup> meeting, held in Honolulu, June 26–28, 2013, addressed the prolonged overfishing of WCPO bigeye tuna. It recommended that NMFS, in consultation with the Council, develop management options that would end bigeye tuna overfishing by restricting FAD use, using spatial management and reducing fishing capacity and to propose these options to the WCPFC. The Council and NMFS are members of the US delegation to the WCPFC, which will hold its 10<sup>th</sup> regular session (WCPFC10) December 2 to 6, 2013, in Cairns, Australia.

The options the Council is promoting address the increasing impact the purse-seine fishery has had on the stock. Purse seines account for approximately 67 percent of WCPO bigeye tuna overfishing, according to the WCPFC Science Committee. Purse-seine effort on FADs in 2011 was at an all-time high, up 43 percent from 13,000 FAD sets in 2010 to approximately 21,500 observed FAD sets in 2011, not including Philippines and Indonesia domestic tuna fisheries. The result was



*Bigeye caught by the Hawaii longline fishery at the Honolulu fish auction (image: Sylvia Spalding).*

a record incidental catch of bigeye tuna by purse seiners. By comparison, the targeted catch of bigeye by the longline fishery was below its 10-year average. The purse-seine catch occurred primarily around FADs and equaled the targeted fisheries' bigeye catch in weight but was 10 to 20 times higher than the targeted fisheries' haul in the number of individual bigeye caught.

If the purse-seine fishery were held to the 2010 number of total annual FAD sets and longline catches were maintained at current levels, overfishing of bigeye would be eliminated within 10 years, according to stock assessment models by the Secretariat of the Pacific Community.

While the Hawaii and American Samoa longline and handline fisheries combined account for only 3 percent of the total WCPO bigeye catch, the bigeye tuna fishery is of extreme importance to the Council and the fishermen and consumers it serves. Honolulu consistently ranks among the nation's top 10 fishing ports in value landed because of its longline landings of sashimi-quality bigeye. Eighty percent of the Hawaii longline catch stays in the State, where tuna tops the list of seafood consumed with an annual average of 12.72 pounds<sup>2</sup> per capita. By comparison, shrimp ranks first for the rest of the nation (4.08 pounds per capita) and canned (principally skipjack) tuna ranks second (2.80 pounds per capita).

**Source:** *Pacific Islands Fisheries News, Summer 2013* <http://www.wpcouncil.org/2013/09/17/summer-2013-pacific-islands-fishery-newsletter/>

<sup>1</sup>  $F$  = Current fishing mortality;  $F_{MSY}$  = fishing mortality at maximum sustainable yield (MSY).

<sup>2</sup> 1 pound = 0.45 kg.

# Pacific Islands Region FAD Issues and Priorities Workshop

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United States National Oceanic and Atmospheric Administration*

## Introduction

In many areas of the Pacific Islands, coastal fish aggregation devices (FADs) have been used to divert fishing effort away from slow-growing coral reef and bottom-fish species, towards faster-growing and more abundant pelagic species such as mahi mahi, wahoo, skipjack tuna and yellowfin tuna. SPC's Coastal Fisheries Programme has led the way in developing FAD mooring systems and has been investigating ways to reduce costs while improving the efficiency of FAD programmes.

In order to take advantage of these studies and to learn from other FAD programmes, the Pacific Islands regional office of the United States National Oceanic and Atmospheric Administration (NOAA) has worked with the Western Pacific Regional Fishery Management Council (WPRFMC) to host the Pacific Islands Region FAD Issues and Priorities Workshop earlier this year.

Meeting participants included FAD experts from American Samoa, the Commonwealth of the Northern Mariana Islands (CNMI), Guam, the Hawaiian Islands, and other areas of the central and western Pacific. WESPAC staff member Eric Kingma chaired the meeting and directed discussions in collaboration with David Itano, Recreational Fisheries Specialist with NOAA's Pacific Islands regional office.

Meeting objectives included reviewing existing FAD programmes in the Pacific Islands region, discussing new developments and technology in anchored FAD designs, and examining ways to reduce programme costs while increasing the length of time FADs remain on site. Issues relating to the collection of catch and effort data on FADs, associated FAD research, and community FAD programmes were also discussed.

Anchored FADs have been deployed in Hawai'i, American Samoa, Guam and CNMI since 1979 to assist small-scale fishermen with reducing fuel costs and improving catch rates of popular pelagic fish. Several types of FADs are currently in use throughout the region. Figure 1 illustrates the difference between drifting and anchored FADs used by commercial fishing fleets, and anchored FADs used by small-scale fishermen near islands and even inside bays and lagoons. The workshop centred on anchored offshore FADs used to assist small-scale fisheries.

FAD programme managers from American Samoa, CNMI, Guam and Hawai'i provided detailed descriptions of their domestic FAD programmes, including historical overviews, current FAD sites and mooring systems, deployment procedures, data collection procedures, catch efficiency, expenses and significant issues and constraints that may impact the future of

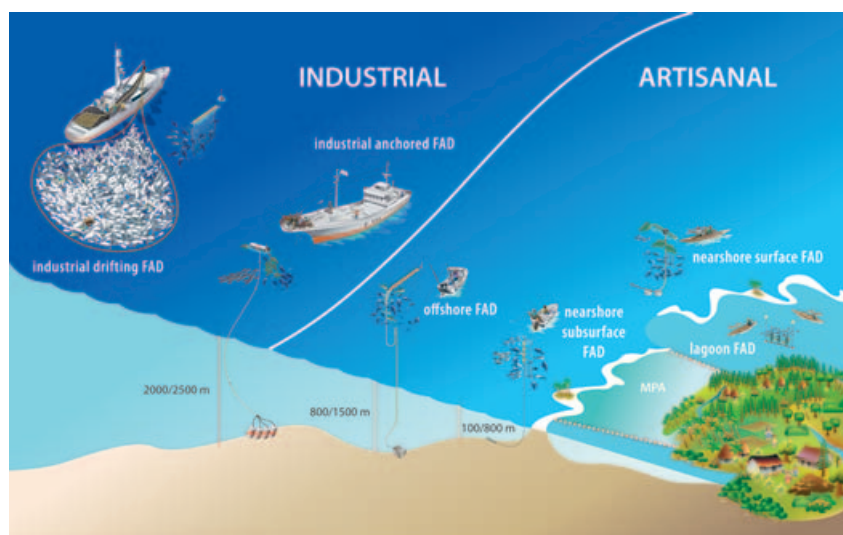


Figure 1.  
Types of fish aggregation devices  
(FADs) to support commercial,  
recreational and subsistence fisheries  
(illustration: Jipé Le-Bars, SPC).



their programmes. The workshop benefited greatly from the participation of William Sokimi, SPC's Fisheries Development Officer, who provided an overview of artisanal FAD developments throughout the western Pacific. Mainui Tanetoa, FAD programme manager for French Polynesia, also informed participants about innovative FAD technology and mooring systems used in his country.

## Inverse catenary spar-style FAD

Figure 2 shows the FAD mooring system that has been used in Hawai'i and the US territories for over two decades. It consists of a concrete anchor (or anchors) with a length of chain shackled to a combination mooring system of floating polypropylene rope on the bottom spliced directly to nylon rope, and shackled to a surface chain that stabilises a large steel or fiberglass float.

This is the original "inverse catenary" mooring design promoted by SPC, which uses poly line to float the anchor chain off the bottom and is spliced to a shorter section of sinking nylon line that stabilises the FAD float. Not much has changed in this system over the years, although some regional FAD programmes have adopted larger-diameter swivels and shackles in the upper system, and use more streamlined FAD floats.

## Indian Ocean-style FAD

William Sokimi described two approaches for reducing FAD costs while increasing the lifespan of anchored FADs. Both systems reduce surface drag and wear and tear on the mooring system at the sea surface where most FAD breakage and losses occur. The Indian Ocean FAD system replaces large steel or fiberglass spar buoys with a series of purse-seine floats strung directly on the mooring line. In many areas of the western Pacific, purse-seine floats can be found at little or no cost where net repairs are conducted. The low profile and visibility of this style FAD should be marked with the addition of a vertical flag buoy with a light and radar reflector. Figure 3 shows an Indian Ocean-style FAD currently used in French Polynesia where they have completely replaced heavy steel spar buoys.

SPC has been evaluating FAD and mooring designs for several years, and some problem areas and solutions have been identified. Most problems that result in FAD loss occur in waters within 150 m of the surface. Problems identified with spar buoy and Indian Ocean-style FADs and mooring systems include:

- corrosion of surface hardware;
- breakage at flexing areas (Indian Ocean-style);
- breakage due to chafing;

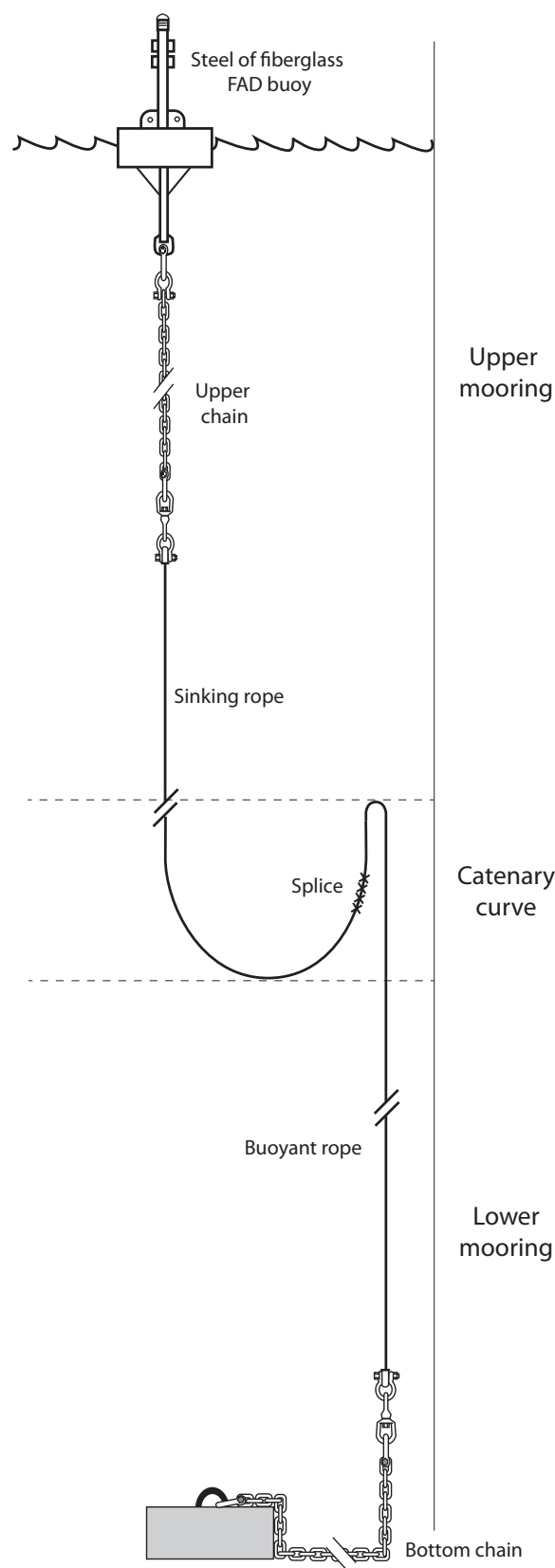


Figure 2. Inverse catenary SPC-style FAD spar buoy mooring system currently used in the Commonwealth of the Northern Mariana Islands.



Figure 3. Indian Ocean-type FAD set close to shore in French Polynesia. It uses purse-seine (soft) and pressure (hard) floats (image: Mainui Tanetoo).

- breakage at upper splice;
- hooks and fishing gear in mooring line;
- shark damage;
- use of wire in some mooring designs; and
- tangling and fouling of swivels.

In order to address these problem areas, the Indian Ocean FAD has been redesigned with the following characteristics:

- use of multi-strand plaited line for mooring system;
- removal of all metal hardware (shackles, chain, swivels) from upper system;
- nylon line put directly through the surface floats to eliminate multiple splices and connections;
- insulation hose used inside floats to minimise wear; and
- use of insulation hose below floats to protect mooring line from hooking and shark damage.

## Subsurface FAD designs

Subsurface FADs tend to last longer because there is less impact on and wear of surface components resulting from wave action at the surface. They are also safe from boat strikes and vandalism. However, mooring line length, stretch or shrinkage of the rope in the mooring system, and the buoyancy ratio of the float-to-anchor weight must be calculated precisely for a successful deployment.

Subsurface FADs have proven to be very successful aggregators of pelagic and lagoon fish in many areas, particularly in shallow depths of less than 500 m.

It was recommended that subsurface FADs be deployed so that surface floats rest at around 20 m below the



Figure 4: An experimental subsurface FAD flotation device modified from a Japanese design (image: Aymeric Desurmont).

surface and constructed with pressure floats rated to 300 m. SPC is now promoting a combination surface and subsurface FAD that has floatation added to the mooring system below an Indian Ocean-style float that provides added buoyancy and security in the event that the surface floats lose buoyancy over time or are lost.

Subsurface FADs were trialled early on in Hawai'i, but were not popular because they were difficult to locate. Now, however, they can be marked with a surface flag marker and are easily located using a global positioning system (GPS). The most common subsurface design currently in use resembles an Indian Ocean FAD that does not quite reach the surface. Figure 4 shows a low-cost experimental subsurface FAD that was built in Vanuatu.

### Aggregators beneath FADs

Suspending coconut fronds beneath anchored FADs has been standard practice in the Philippines where FADs (locally called *payao*) were first developed on a large scale to assist coastal and pelagic fisheries. Many different natural and synthetic materials have been used by FAD programmes in the belief that they enhance the attraction of baitfish, tunas and other gamefish to FADs. There is no scientific proof that aggregators improve fishing on FADs, but many fishermen strongly support their use and they are routinely deployed in many FAD programmes.

After much discussion at the workshop, there was some agreement that if aggregators are used, they should be: 1) designed to create low drag, 2) easy to deploy and replace, and 3) constructed of natural materials that will not contribute to plastic pollution of the oceans. Figure 5 shows an aggregator line attached to a Philippine

anchored *payao* that is constructed of biodegradable palm leaves in bundles attached to a weighted rope that can be added or removed from the surface.

### Improvements to FAD deployment

Deployment costs account for one of the largest expenses for many FAD programmes due to the need to contract large vessels to carry the anchors, FAD floats and volume of rope to the deployment site. The French Polynesian FAD programme demonstrated how they are able to deploy FADs in remote, small island communities using a portable aluminium catamaran and Indian Ocean-style FADs. The catamaran float is transported to a remote area by the interisland ferry where two small boats are then used to carry the rope and floats and tow the catamaran that is loaded with the FAD anchor (Fig. 6). The FAD anchor is towed by one boat to the deployment site where the other vessel lays out all the mooring line attached to the concrete FAD anchor. A single person can then shift weight to the back of the catamaran that allows the anchor to slide off the back of the catamaran. Most of their deployments are conducted at little or no cost through the use of the anchor catamaran and volunteer services from fishing associations and clubs.

### Community FAD programmes

Hawai'i may be unique in that individual commercial fishermen have been known to self-fund their own anchored FADs and maintain their existence and position for proprietary use. These buoys are set in deep water farther offshore than the FADs deployed by the State of Hawai'i. High catch rates on "private FADs" have contributed to user group conflicts and management (of people) concerns.



Figure 5. A Philippine-style aggregator line suspended from an anchored fish aggregation device (FAD) made of biodegradable materials (images: David Itano).





Figure 6. A small aluminium boat used to carry the FAD floats and mooring line (a) and the aluminium catamaran platform (b and c) used to carry the anchor block (images: Mainui Tanea).

WESPAC has developed a community FAD programme that assists with food security for isolated fishing communities, and mitigates user group conflicts over access to private FADs. The programme was designed to supplement, rather than to compete with, the state FAD programme by providing publicly accessible FADs in different areas, testing and developing new FAD designs and technology, and supporting FAD data collection efforts and cooperative research. Figure 7 shows a WESPAC community FAD that was set north of Maui that proved to be a highly productive fishing location for tuna and mahi mahi. This FAD uses a foam-filled, boat-shaped float with a stabilising keel, solar-powered light mast, and GPS positioning buoy. Workshop participants strongly supported the continuation of the WESPAC community FAD programme.

### FAD maintenance programmes

Workshop participants recommended FAD maintenance and inspection programmes would help increase the amount of time that FADs remain on site and would make the most of each deployment. For example, the French Polynesia FAD programme supports the regular

and scheduled visual inspection, cleaning and repair of the upper portion of FAD mooring systems by fisheries personnel (using scuba gear). Vertical longline gear is popular in French Polynesia, and large amounts of heavy monofilament line can become entangled in the mooring systems. Without regular maintenance, the build-up of entangled gear can cause significant drag and submerge Indian Ocean-style buoys, and contribute to FAD loss. Divers also inspect and install aggregators, reinforce damaged rope, and remove coral build-up on hardware and ropes. Damaged upper mooring systems can be replaced at sea by a support vessel and a team of divers using lift bags or lines to winch up the upper portion of the mooring system. A similar FAD maintenance system was in place in American Samoa during the 1980s.

Unfortunately, this type of system is not possible in Hawai'i due to regulatory and liability issues that govern personnel and safety in accordance with state and federal regulations. For these and other pragmatic reasons (e.g. lack of trained divers, suitable support vessels), most FAD programmes have adopted heavy-duty "maintenance-free" systems with high buoyancy and wear characteristics.

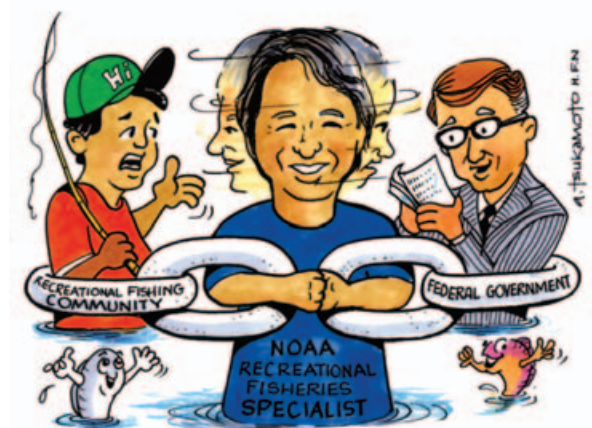


Figure 7. Western Pacific Regional Fishery Management Council community FAD float. Note the GPS buoy mounted in the stern of the foam-filled, boat-shaped float (image: Eric Kingma).

## FAD research and scientific buoy programmes

The Hawai'i State FAD Programme deploys FADs to assist small-scale fishermen. The FADs are also used as a living laboratory to study the behaviour of tunas and other species that gather around floating objects. The information gained is applicable to fisheries management at all scales. Dr Kim Holland of the Hawai'i Institute of Marine Biology administers the research side of the FAD programme. Using funding from the University of Hawai'i Pelagic Fisheries Research Programme, Dr Holland and colleagues have monitored the behaviour of tagged tuna, sharks and billfish at FADs around the island of O'ahu since 2002 using acoustic transmitter tags and FAD-mounted acoustic receivers. Results have demonstrated that FAD residence times for yellowfin and bigeye tunas can vary between a few hours to several months, with most residence times averaging closer to one week. Yellowfin and bigeye tunas associate closely with a FAD, seldom leaving it for more than 12 hours during a continuous FAD "stay", and appear to be capable of directed movement between neighbouring FADs. In general, yellowfin tunas stay longer and feed more successfully at FADs than bigeye tunas, which apparently must venture away from FADs to feed. Schooling behaviour and timing with regard to arrival and departure from a FAD has also been observed in both species, often linked to size-specific groups. FAD aggregations appear to be a mix of different species-specific schools that gather together at the FAD, but each having a different aggregation history that determines different residence times.

Depth-reporting acoustic tags have verified that FADs have a strong influence on the vertical movement of yellowfin and bigeye tunas, making them easier to target and catch. Although vertical behaviour varies significantly by fish size, it is surprising how deep small tunas will swim, suggesting that predator avoidance as well as temperature may keep smaller tunas above the larger fish, and in shallow waters.



## Recommendations

The workshop made several recommendations for improving FAD systems and ways to reduce FAD programme costs. Recommendations for improving Indian Ocean-style FADs have already been mentioned. A summary of additional recommendations is included below. Note that some recommendations will apply only to certain areas, depending on local availability of materials and regulations.

- Develop and test locally constructed fibreglass floats (tapered) that reduce drag and shock load of wave action, are easier to transport and deploy using small vessels, and avoid time and expense of importing buoys.
- Use modular steel anchors that are more efficient than concrete, and allow the use of smaller deployment vessels.
- Consider the use of Indian Ocean-style or subsurface FADs where appropriate.
- If aggregators are used, consider low-drag characteristics, ease of installation and removal, and construction with natural and/or biodegradable materials.
- Develop a maintenance programme to visually inspect, clean and repair FADs if compatible with local regulations and overall programme structure.
- Increase the size or thickness of galvanised steel hardware in upper mooring system for spar buoys, especially if monitoring programmes are implemented.
- Construct and use a portable anchor platform to allow low-cost FAD deployments in remote locations.
- Use volunteer labour, expertise and fishermen's cooperatives and fishing clubs to assist in FAD fabrication and deployments.
- Develop community FAD programmes and encourage communities to raise funds to support their FAD(s), which will promote stewardship, maintenance, longevity and the respectful use of FADs.

Detailed information on FAD designs and technology used in the Pacific Islands region can be found online at: <http://www.spc.int/coastfish/en/publications/technical-manuals/fads.html>

The full report of the workshop is on NOAA's recreational fisheries website at: [www.fpir.noaa.gov/SFD/SFD\\_rcf\\_index.html](http://www.fpir.noaa.gov/SFD/SFD_rcf_index.html)

# Economic monitoring study: The fisheries sector in New Caledonia

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## The importance of fish in New Caledonia

Seafood products account for more than 40% of the protein intake of people in New Caledonian, with lagoon fish, which is mainly sold through “unofficial channels”<sup>1</sup>, being the main source of protein (see Fig. 1).

Fishing in New Caledonia is characterised by the co-existence of artisanal fisheries — which are fairly informal and so are poorly documented, largely unsupervised and subject to little control — and semi-industrial

fisheries, which are based on fleets using different operating methods and with various levels of knowledge about the resources they target.

In New Caledonia, subsistence fisheries account for 78% of all lagoon fish catches and 30% of all offshore catches. This fishery is extremely important to Melanesian communities because it provides a vital source of protein. The subsistence portion of lagoon fisheries accounts for as much as 80% of production in the Northern Province, and even more in the Loyalty Islands. It also provides additional income. Many fishers work at a variety of jobs.

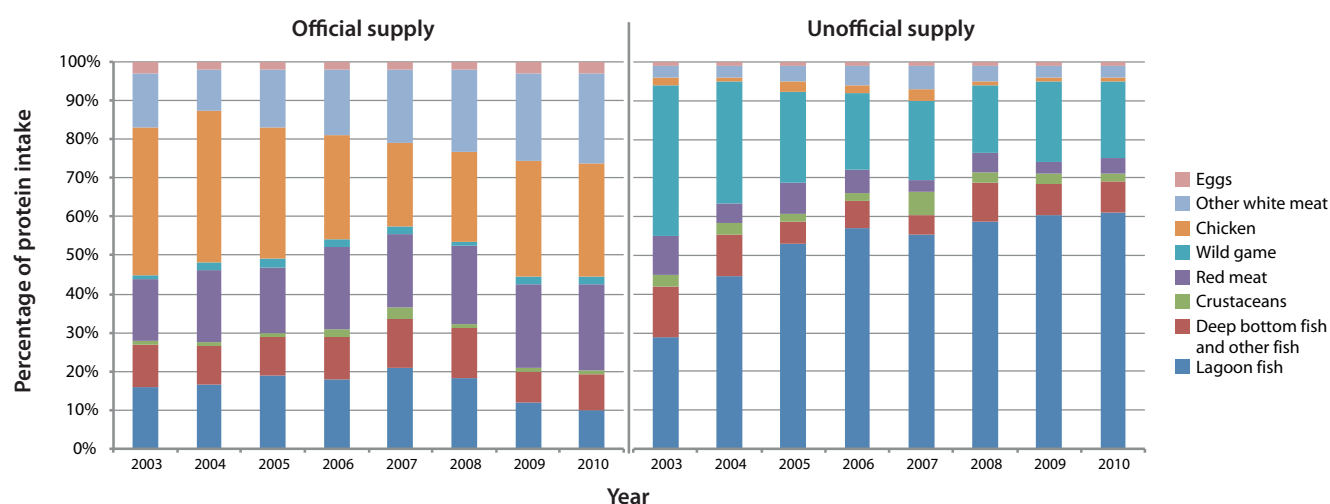


Figure 1. Contribution of various foods to the protein intake of New Caledonian population. Source: TNS, 2010.

## Economic data

In 2010, the fisheries sector had a reported revenue<sup>1</sup> at first sale of XPF<sup>2</sup> 1.85 billion, which put it at the top of the agriculture and fisheries sector, ahead of both the beef and poultry sectors, which each had a revenue of XPF 1.5 billion, and were followed by the aquaculture sector at XPF 1.2 billion.

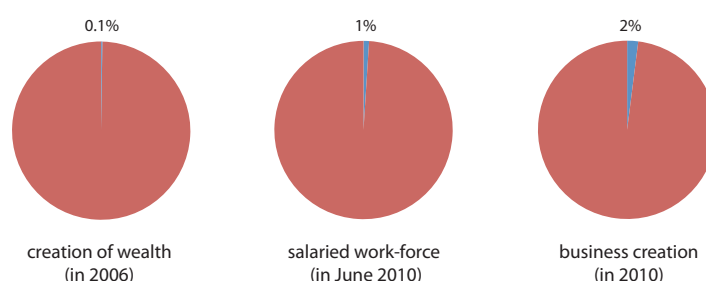


Figure 2. The significance of New Caledonia's fisheries and aquaculture sectors in the creation of wealth, salaried work force and the creation of businesses. Source: Institut de la Statistique et des Études Économiques (ISEE).

<sup>1</sup> An “unofficial channel” refers to non-licensed fishermen who sell their catch to neighbours, restaurants and shops, and includes all of the subsistence catch that is self-consumed or distributed. An “official channel” refers to licensed fishermen who are the only ones allowed to sell their catch, and all of their sales must be reported (yearly). Official, therefore, refers to the professional fishing sector.

<sup>2</sup> The figure for this revenue is before the cost of fuel, wages and other expenses are taken into consideration.

<sup>3</sup> XPF 100 = USD 1.10 as of September 2013.



## Commercial fisheries

Commercial fisheries consist of fishing activities carried out on vessels that have yearly commercial fishing permits issued by one of the provinces. There are three types of commercial fisheries in New Caledonia (Table 1):

1. **Offshore fisheries** take place within the exclusive economic zone, which extends from 12–200 nautical miles out from the reef into international waters, and which target tuna species using horizontal longlines. The Japanese introduced this fishing technique to New Caledonia in the early 1960s. On average, fishing trips last from 10–12 days.
2. **Coastal fisheries** are carried out by multi-purpose vessels outside the lagoon, and up to 12 nautical miles from the reef. This type of fishery targets deep-sea fish such as snappers and pelagic species. Fishing trips last from one to several days and catches are sold at the local market.
3. **Lagoon fisheries** are carried out on foot or in vessels less than 10 metres long. The gear used by this fishery includes nets, lines, and cages to catch finfish, crustaceans (crabs and rock lobsters) cephalopods (octopus, squid, cuttlefish) and shellfish. This is generally done at a subsistence level. The part of the catch that is not eaten is redistributed to family members and the surplus sold. Catches for export involve sea cucumbers and trochus shell (about 70 tonnes a year) that are sold to make buttons and jewellery.

It should be noted that in many fisheries economic reports, coastal and lagoon fisheries are placed into a single category (i.e. reef and lagoon fisheries).

## The fleet

In 2010, the commercial fishing fleet consisted of 332 registered vessels: 311 for reef and lagoon fishing with vessels weighing less than five tonnes, and 21 for offshore fisheries with ships more than 20 metres long.

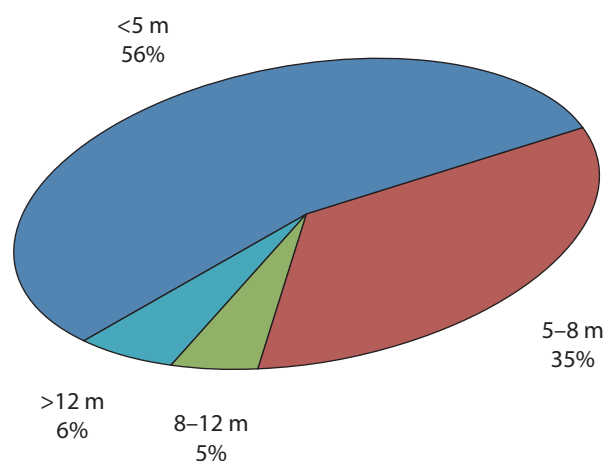


Figure 3. Composition of New Caledonia's fishing fleet by vessel size.  
Source: Service de la Marine Marchande et des Pêches Maritimes, 2009.

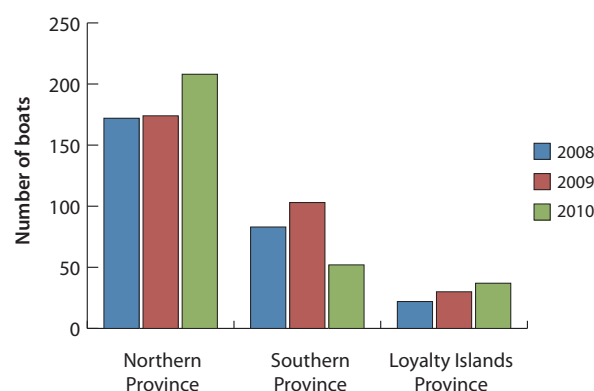


Figure 4. Number of boats in the lagoon fishery.

Table 1. The three types of commercial fisheries in New Caledonia.

	Fishing zone	Technique(s) used	Fishing trip length	Vessel characteristics	Main species caught	Marketing
<b>Offshore fisheries</b>	Exclusive economic zone	Longlining	1–2 weeks	Ships 16–29 m long; target fresh fish	Tuna and related species	Tuna: 50% exported, 50% sold locally
<b>Coastal fisheries</b>	Outside the lagoon, up to 12 nm from the reef	Trolling, longlining, reel, fishing around FADs	1 day to 1 week	Multi-purpose vessels with an average gross tonnage of 16 tonnes	Coastal deep-sea and pelagic species	Sold locally
<b>Lagoon fisheries</b>	Inside the lagoon (barrier reef included)	Gill netting, trolling, handlining	1 day	Less than 10 m, with outboard motors	Reef fish, trochus, sea cucumbers	Sold locally, except for sea cucumbers and trochus, which are exported

Source: Institut de la Statistique et des Études Économiques (ISEE), 2005.

## Processing units

The five large industrial fish processing plants mostly process offshore catches.

- **Pescana** — Produces loins and fillets from offshore species destined for the local market and for Europe.
- **Pêcheries du Nord** — The unit is not currently operating. A large range of offshore products were cut from this unit (e.g. loins, prime filets, cubes, steaks, most of which were destined for the local market, including wholesalers and caterers). A significant portion of the modified-air-packaged fresh loins was exported to Europe. The future of this processing unit is currently under discussion.
- **Pacific Tuna** — This unit, which was built by Navimon<sup>4</sup> in 2006, was initially used by Pêcheries de Nouvelle-Calédonie (PNC) to process deep-sea fish. In 2007, PNC stopped using this unit. The unit was completely renovated in 2008–2009 and now currently produces mainly fresh products from initial processing and some frozen products for the local market.
- **Sodefish** — Exclusively supplies the local market with fresh cuts from both offshore and lagoon catches. In 2010 and 2011 it was the largest producer of frozen tuna steaks.
- **Albacore** — Operates a factory ship that meets European standards and which, up to this year, produced frozen loins destined for local and European markets. An onshore processing unit was created in 2011 on the wharves of the port in Nouville, which will soon begin processing offshore catches for the local market.

There are also several small units (such as Kiwada, Grand Large, La Cigogne) that mainly process offshore products (e.g. loining, filleting, smoking, breeding).

## Jobs and training

In 2010, 767 commercial fishing crew members were recorded in New Caledonia: 613 for artisanal fisheries and 154 for offshore fisheries.

The “fisheries processing and marketing” sector employed 67 people in 2010 in the units that process offshore catches, and 18 people who worked for wholesalers.

There were an estimated 28 subcontractors working in the sector on a daily basis and another 8 people involved in economic and scientific monitoring.

The number of indirect jobs in 2010 was estimated at nearly 200 by New Caledonia’s l’Observatoire économique, which monitors the economic evolution of various economic sectors within the country.

Table 2. Number of jobs related to New Caledonia’s commercial fisheries sector.

Employment area job	Number of people employed
Registered fisher	767
Processing unit	67
Marketing	18
Subcontractor	28
Economic and scientific monitoring	8
<b>Subtotal</b>	<b>888</b>
Indirect jobs	200
<b>TOTAL direct &amp; indirect</b>	<b>1088</b>

Source: Institut de la Statistique et des Études Économiques (ISEE), 2010.

The fisheries sector’s current labour force has the following characteristics:

- Comprises mostly men with an average age of 36.5.
- The majority of salaried employees work in the Southern Province.
- Most companies (70%) have one to four salaried employees.
- Most companies have the legal status of “sole trader”, indicating the high percentage of self-employed fishers.
- The offshore fisheries sector experiences very high employee turnover, particularly of trained people.

## Characteristics by sector (DFPC<sup>5</sup> study)

Commercial offshore sector:

- 98% salaried employees
- 88% of salaried employees have open-ended contracts
- 93% of employees work full time
- The average age of employees is 35 (excluding managers) with 2.6 years of seniority on average
- Just over 70% of employees have qualifications.

<sup>4</sup> Navimon is a domestic tuna longline fishing company.

<sup>5</sup> DFPC : Direction de la formation professionnelle continue (Directorate of continuous training for professionals)

#### Artisanal lagoon and coastal sector:

- 94% of employees are self-employed skippers, 6% are salaried employees
- Salaried employees have open-ended contracts
- 68% of employees work part time,
- The average age of employees is 46 (excluding managers) with 8.5 years of seniority on average
- About 10% of employees have qualifications.

Average annual staffing needs of the fisheries sector are about 50 positions, a full 30 of which are for crew (including needs linked to turnover).

On all boats, crew members are supposed to have seafaring qualifications. Currently, the exemptions that maritime authorities have granted to companies allow them to operate, but the result is a lack of qualified labour (e.g. deckhands, engine room and officers).

In New Caledonia there is no “collective agreement” for the fisheries sector that sets specific rules regarding contracts, wages, or hours worked although a draft agreement is being studied.

## Fisheries training programmes

The Fisheries Training Institute (École des métiers de la mer) is the only marine training agency in the country, and is run by the government. In 2011, the Institute hosted 250 trainees and offered 67,000 class hours of certified courses, with a 92% success rate in the sectors of business, fisheries and recreational boating.

## Production and marketing

### Reef and lagoon production

The reported production for reef and lagoon fisheries for 2010 was 526 tonnes (as compared to 554 in 2009, which was a record year). This figure does not cover all catches because it is simply the total of the reported catch figures. The 2011 figures were not available at the time this report was written. On average, each ship offloads slightly less than 1.2 tonnes of reef and lagoon fish each year.

Unofficial fisheries also account for a very large share of fish consumption in New Caledonia. Some studies estimate that they account for several thousand tonnes each year, most of which is sold through unofficial channels in direct competition with commercial fisheries.

Reported data have shown that parrotfish catches are increasing (31 tonnes reported in 2010, or +37%). Mullet, emperor and grouper catches have also reached

record levels (14–20 tonnes above the average for the period 2005–2010). In contrast, Spanish mackerel (*Scomberomorus commerson*), mackerel, unicornfish (*Naso unicornis*), deep bottom snapper (Etelidae) and yellow-banded snapper (*Lutjanus adetii*) catches have decreased.

In terms of crustacean harvests, reported production increased from 15 tonnes in 2005 to 112 tonnes in 2010, with the majority of harvests consisting of crabs.

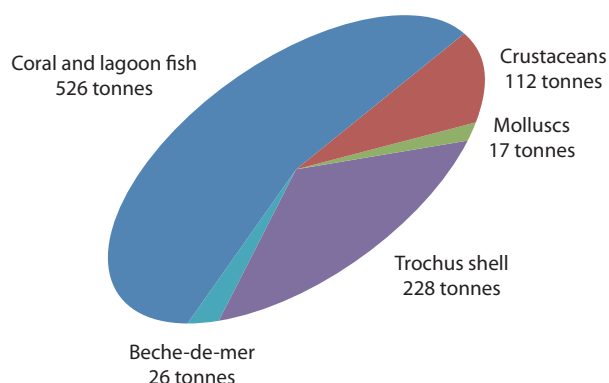


Figure 5. Reef and lagoon catches in 2010.

Reef and lagoon fisheries are a very important source of economic activity outside the Noumea urban area and in the outer islands, accounting for a reported revenue of XPF 555 million in 2010.

### Marketing reef and lagoon products

Several features of lagoon fisheries product marketing in New Caledonia can be noted:

- Landing areas are scattered throughout the territory.
- There is no fish auction or other place where production is sent to be sold.
- Middlemen play a significant role in the “official” channel, making it difficult for many fishers to gain direct access to the market.

The distribution circuit of the lagoon fisheries products (imports and exports not included) is detailed in Figure 6.

### Offshore fisheries production

The species caught by offshore fisheries include the following:

- Albacore tuna (*Thunnus alalunga*), which accounts for more than 60% of all catches, are sold on the local



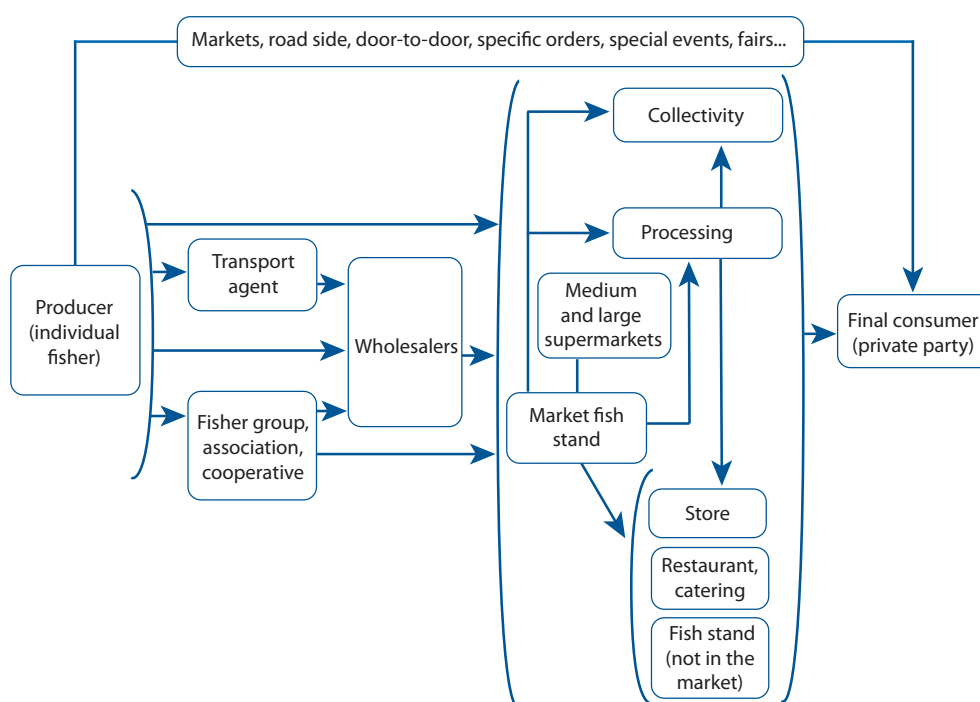


Figure 6. Distribution circuit of the lagoon fisheries products (imports and exports not included).

Source: Marty et al. 2005.

market or sent fresh, by airfreight, to metropolitan France and Japan or as frozen cargo to canneries in American Samoa. Scientists consider that this resource is not overexploited.

- Yellowfin tuna (*Thunnus albacares*), which accounts for about 20% of all catches, are mainly sold on the local market. The best-quality fish are airfreighted fresh to the Japanese sashimi market.
- Bigeye tuna (*Thunnus obesus*) are sold in part on the local market. This is the least common tuna species in New Caledonian waters and the one that is the best selling in Japan, where high-quality specimens are exported fresh by airfreight for the sashimi market.
- Other species, including marlin, swordfish and mako sharks are seasonally and almost exclusively sold on the local market. A few marlins are exported to Japan.

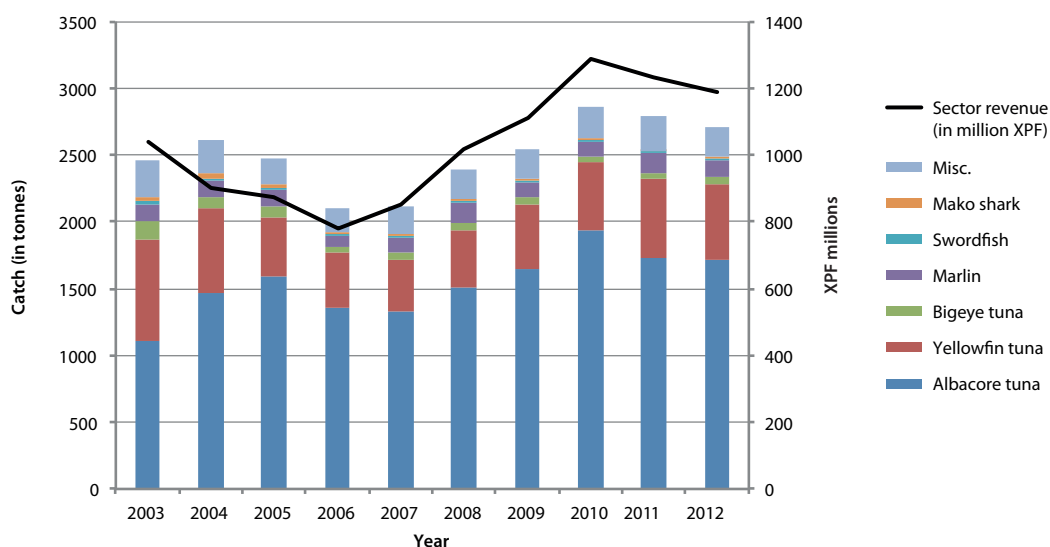


Figure 7. Catch trends by species and revenue for the offshore fisheries sector.

In contrast to some Pacific Island countries and territories, New Caledonia has under-utilised the exploitable resources and the logistical infrastructure that are available. According to scientists at the Secretariat of the Pacific Community, catches for those species that can be taken with longlines could increase to 10,000 tonnes without overfishing the resource.

### Marketing offshore fisheries products

#### Albacore tuna (70% of the catches)

Nearly 1,900 tonnes of albacore tuna were caught and sold in 2010. About 1,200 tonnes were sold on the local market via the channels described in Figure 8.

The remaining 700 tonnes were sold for the export market, and distributed as follows:

- 100 tonnes of whole fresh fish were air freighted to Japan. This market has benefited lately from a favourable yen exchange rate and the recognised quality of New Caledonian products.
- 100 tonnes (whole fish equivalent) were divided between frozen and fresh loins; this has increased in terms of the prices offered but volumes are still quite low and logistics are very complex.
- 300–500 tonnes were sent to destinations such as canneries in Samoa and Thailand.

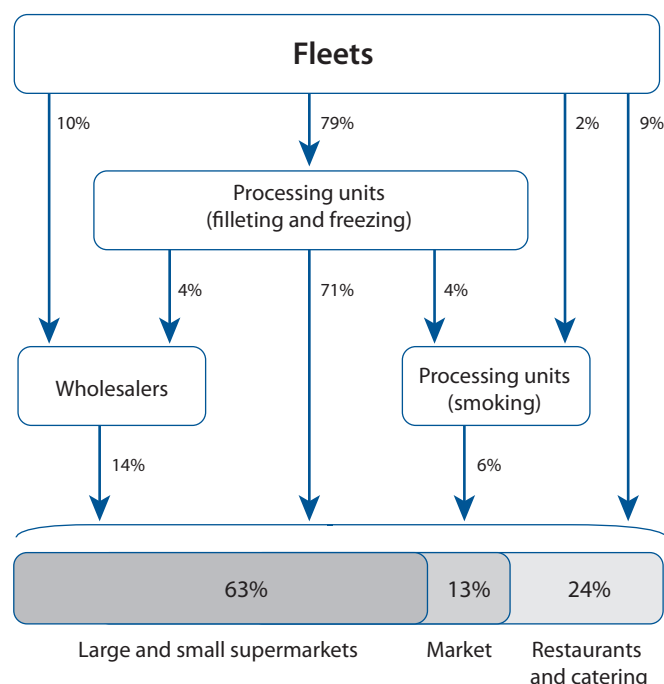


Figure 8. Marketing of the offshore fisheries products in the greater Noumea area. Source: Institut de la Statistique et des Études Économiques (ISEE), 2005.

Efforts made since 2009 to develop the local market via fish processing, with ERPA's assistance, has made it possible to both maintain the balance of the local fresh fish market (stable sales prices), and to "limit" exports to canneries (Figure 9).

The analyses conducted by New Caledonia's l'Observatoire économique (ISEE) for this sector in 2010 seem to confirm a trend towards improved economic outcomes, which began in 2007.

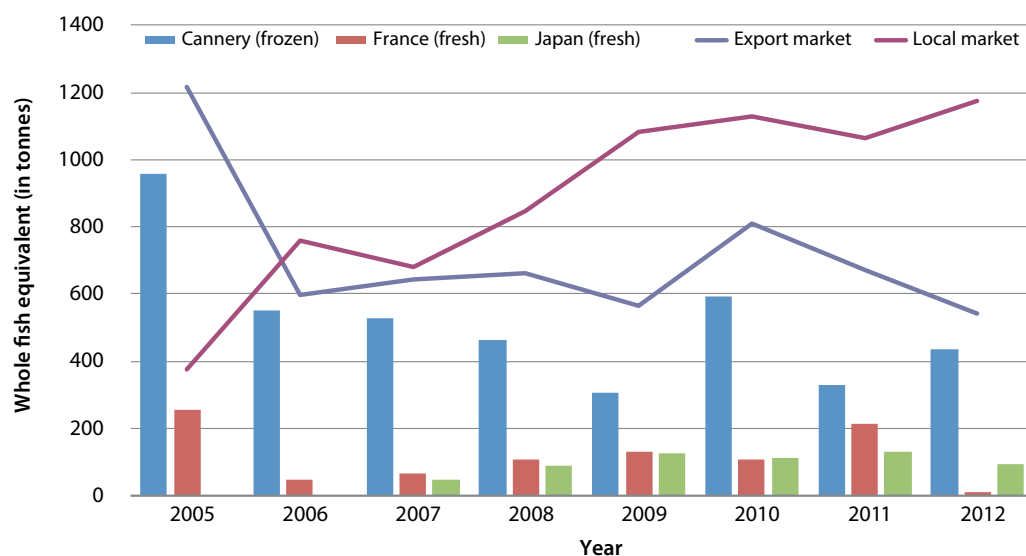


Figure 9. Albacore tuna market trends. Source: ERPA, using New Caledonia Customs data.

## Shrimp production

New Caledonia's shrimp production sector is a key factor in the country's social and economic development. Shrimp farms employ roughly 300 workers, which is significant for a relatively small country. In addition, the shrimp farms are situated in somewhat remote areas where employment is scarce, thereby helping to balance the economic development between the developed and less-developed areas of New Caledonia. The shrimp production sector is organised as described in Figure 10.

### Jobs

This sector provides jobs for 880 people, including 278 permanent jobs and 602 seasonal jobs (Table 3).

Table 3. Jobs in the shrimp production sector.

Job area	Permanent jobs	Casual jobs
Farm	130	220
Processing units	63	370
Feed suppliers	30	12
Research	27	
Hatcheries	23	
Groups & associations	5	
<b>Total</b>	<b>278</b>	<b>602</b>

## Production

Production has fluctuated a great deal over the past few years, with sharp drops in production for four consecutive harvesting periods, followed by increasing production in 2011 and 2012 (Fig. 11).

The observed decrease can be explained, in part, by deficits in post-larval production, which seriously penalised grow-out farm production. Some tanks remained empty and others were seeded at low densities. At the same time, a gradual drop in farm productivity was noted with lower yields and survival rates.

In fiscal year 2010/2011, the volumes produced increased by 29% with a production of 1,476 tonnes as compared with 1,147 tonnes in fiscal year 2009/2010. This increase can, in large, be part explained by improved yields in tonnes per million of seeded post-larvae (MSPV), which went from 9.2 tonnes per MSPV in 2009/2010 to 11.7 tonnes per MSPV in 2010/2011 (+27%). On the other hand, for the fifth consecutive harvest period, significant difficulties in post-larvae production were noted at the hatcheries (deficit estimated at 42 million post-larvae, or 25% of the initial need), which had a strong impact on the sector's production level.

In fiscal year 2011/2012, in spite of correct post-larvae production levels and higher volumes, production levels remained below theoretical objectives (low survival, decreased growth rates and a very high feed-conversion index). This did not allow the sector to reach financial equilibrium, even though deficits were more acceptable than in previous harvesting periods.

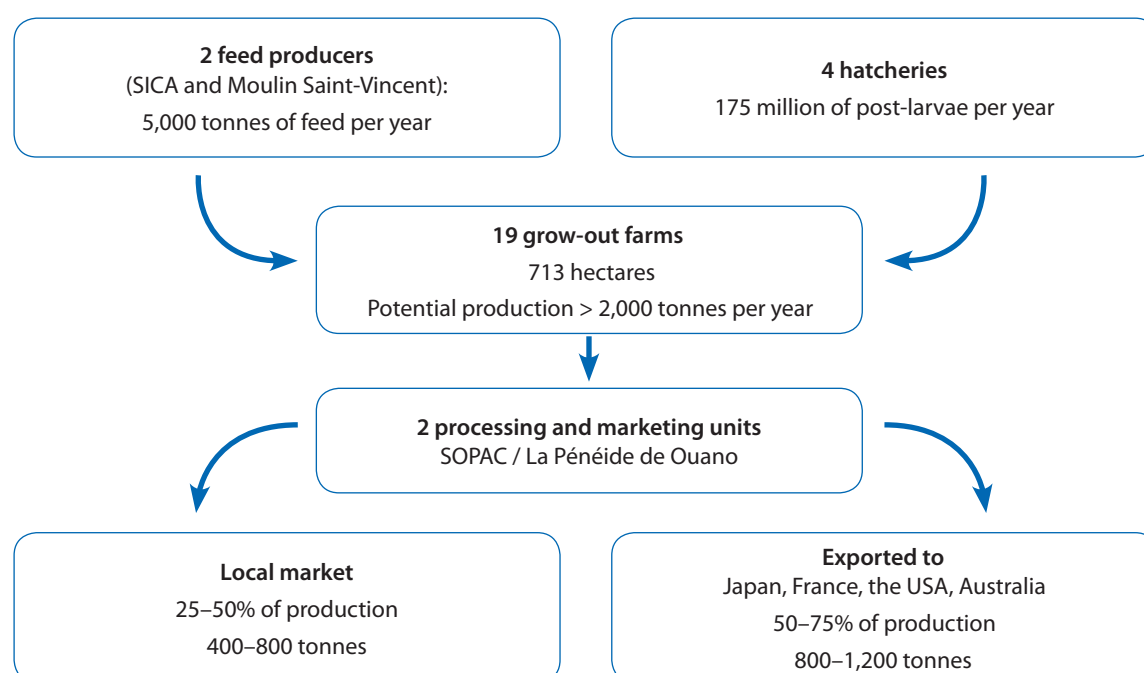


Figure 10. Organisation of New Caledonia's shrimp production sector.



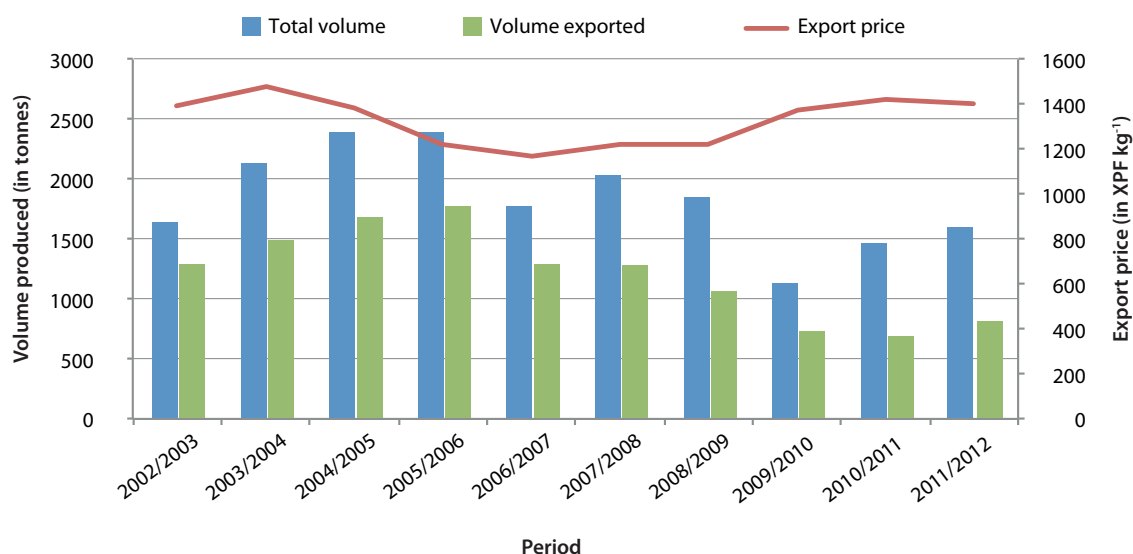


Figure 11. New Caledonia's shrimp production and export trends.

## Markets

Due to very high production costs, the New Caledonia shrimp sector tries, wherever possible, to go outside standard pricing by targeting very well-defined niche markets (e.g. Japan, top-end restaurants in Europe). Following the sharp decrease in production, export volumes have dropped significantly over the past few years (713 tonnes exported in 2011 compared with 1,785 tonnes in 2006) but the average export sales price has increased (XPF 1,421 per kilo in 2011 as compared with XPF 1,219 per kilo in 2006), encouraging exports to the highest-paying markets.

The local market is very attractive for the sector given its significantly lower marketing costs. Each year it absorbs 700–800 tonnes of shrimp, placing New Caledonians among the largest consumers of shrimp in the world.

## Prospects

ERPA funded an overall audit of the sector in late 2011, which made it possible to implement a plan to reactivate the sector so as to allow it to return to financial equilibrium and have prospects for development over the next five years. Today, the sector is still receiving considerable support from public agencies, particularly through ERPA, which provides significant assistance to exports to allow the sector to keep its very exacting niche markets for some of the most expensive farmed shrimp in the world.

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# The marine aquarium trade in Papua New Guinea: Historical context and current activities

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## Introduction

The Papua New Guinea (PNG) National Fisheries Authority (NFA) has been interested in developing its aquarium fishery since 2004. In the second half of 2007, with the approval of its board, NFA commissioned EcoEZ Inc., a consulting company based in Alexandria, Virginia, USA, to conduct a rough assessment of marine species with potential for export as ornamentals. The project, then named as the Papua New Guinea Sustainable Marine Aquarium Resources Trade was given a substantial start-up budget over a six-week period. Following this initial resource assessment, a one-year technical services contract was then awarded to EcoEZ Inc. in January 2008. The project was re-named the SEASMART Programme (Sustainable Enterprise Advancement through the Market Advantages of Responsible Trade) and its objective was to provide technical and project management services for the development of a sustainable marine aquarium trade industry in PNG. At the end of its first year, the programme was extended for another two years.

Key achievements of the programme over these three years include:

- a number of export trials;
- training men and women in eight Central Province coastal communities in the collection and handling practices according to the Marine Aquarium Council<sup>4</sup> certification standards of fish, coral and invertebrates (see Table 1); and
- the establishment of a state-of-the-art export facility in central Port Moresby.

Although laudable, it should be noted that these achievements were accomplished at significant expense — nearly PGK 15 million (~ USD 5 million) over a three-year period ending in 2010. At the request of NFA, a formal review of programme outcomes was undertaken by SPC in October 2010, with the following findings and conclusions.

- The resource assessment, community training and extension work part of the project have been successful at providing good quality fish, and setting a good management and monitoring framework in place.
- A full baseline inventory of potential marine aquarium fish species and invertebrates, their densities, estimated stocks and total allowable catch by species for each of the eight fisheries managements areas (FMAs) already surveyed has been produced.
- The holding facility constructed is world class and is to MAC certifiable standards, but operational costs are very high, and have contributed to the lack of commercial viability of the project.
- Poor species mix probably contributed to poor economic performance.

Given the overall non-commercial viability of the project, poor communication between project operators and NFA, and the failure to deliver on several key project deliverables (including a finalised management plan and fully functional export monitoring software), operations were shut down in December 2010.

*Table 1. Number of fishers trained under SEASMART in eight Central Province communities in Papua New Guinea.*

Community	Number of fishers trained
Fishermen Island	22
Roku	18
Kouderika	12
Gaire	18
Gabagaba	18
Pari and Tarauama	30
Keapara	27

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<sup>4</sup>. Note that this programme is now defunct.

## EcoAquariums

Capitalising on the resource assessments and community training portion of the work undertaken by EcoEZ, and addressing some of the issues raised by SPC in its review, a private entrepreneur submitted a proposal to NFA in 2011 to establish a smaller entity. In early 2012, the proposal was accepted and a trial license granted to EcoAquariums to export marine ornamentals from the FMAs around Port Moresby and Central Province. The company established its holding and packing facility on Fishermen Island<sup>5</sup> — traditionally known as Daugo Island — and fish collection centred mainly around the island itself; although fish provision toward shipment originally was meant to be allocated on a rotational basis between Fishermen Island, Pari and Taurama villages, with all collectors trained under SEASmart. The company's main objectives were to ensure that fish were collected at sustainable levels and were of high quality, and that activities promoted equitable trade. However, in early 2013, after 30 shipments were made between 2011 and 2012 (to the US, Europe, and Asia), the company ceased operations due to its economic non-viability. Freight costs, the high price per fish paid to collectors, the difficulty in keeping collectors (at Fishermen Island in particular) engaged in the trade due to other more lucrative opportunities (e.g. tuna fishing) all seem to have significantly contributed to this outcome. At present, the future of the company is unclear.

## NFA Marine Aquarium Programme

After closure of SEASmart in 2010, NFA integrated the resources assessment and training component of the programme into its fisheries management unit, with the objective at the time to undertake resources monitoring and collectors training in the event that a private sector for marine ornamentals develops.

The NFA Marine Aquarium Programme currently consists of three core divisions:

1. Resource Assessment and Management — Staff are responsible for conducting regular biological surveys and monitoring of key species typically traded for the marine aquarium trade at predefined sites within the eight FMAs.
2. Fishers and Fishery Division — Staff are responsible for training local aquarium fisher folks on proper collection, handling and packing methods.
3. Management Area Planning — Staff deal with the social component of the programme, which includes engaging with community stakeholders and raising awareness about the marine aquarium programme, conducting socioeconomic monitoring surveys, and assisting village members in developing a committee that will regulate aquarium fishing activities within their respective communities.



Women from Fishermen Island preparing live coral pieces for grow out (image: Colette Wabnitz).



In 2011, detailed surveys of Fishermen Island collection areas were conducted to assess fish, coral and invertebrate population abundance after marine collection activities ceased. Findings indicated that there were no significant differences between collection years and the 2011 assessment, seemingly indicating that collection areas are in good condition. Concern was raised at one point during the programme because of the many sea anemones spotted without their resident host percula clownfish (*Amphiprion percula*). However, recent surveys seem to indicate that the population has recovered. Unfortunately, there has been no follow up assessments since then.

In 2012, ecological surveys conducted around Pari and Tarauma, two communities meant to contribute fish toward EcoAquariums' shipments, showed stocks to be in good health. However, the study cautioned that the overall reef area available for collection is relatively small, with all three FMAs sharing the same reefs and collecting ornamentals from these interchangeably.

Fishermen Island, Pari and Tarauma were also chosen as key sites for socioeconomic assessments. Their aim was to identify any social impacts linked to the aquarium programme, and how NFA can best address issues, if any, when they arise. Findings showed that in Pari and Tarauma, the impact of the trade was minimal due to the inconsistent or lack of collectors' employment. However, fishers in these villages retain a keen interest to be involved in the trade and at their request undertook a refresher training, led by the NFA Fishers and Fishery Division team, on species identification, as well as collecting and handling techniques. At Fishermen Island, where fishers have been involved in collection since 2008, the surveys highlighted several concerns, including issues associated with ownership rights, prices paid for different species, collection gear maintenance, company partnership, and neglect of promised benefits to the community by EcoAquariums. Nevertheless, several community members, especially women, highlighted that collection activities provide an important source of income to those actively involved in the trade.

To date, other activities undertaken by the Marine Aquarium Programme team have included:

- Attempts to revive Management Area Planning committees at Fishermen Island, Pari and Tarauma villages. The committees, made up of appointed community stakeholders, were originally established to give a sense of ownership and responsibility over collection activities and manage these as well as any issues that may arise among villagers. However, these remained largely ineffective because members expected to be financially rewarded for their time.
  - Given the overall reduced level of marine aquarium activities since 2011, a number of the Marine Aquarium Programme staff were also recruited to participate in other inshore fisheries activities, such as beech-de-mer stock monitoring (8 out of the 14 maritime provinces in PNG); Inshore Fish Aggregating Device (IFAD) programme; Port Moresby Clean Seascape Programme; fish market surveys; and giant clam hatchery development work.
- With Marine Aquarium Programme activities currently on hold, all officers working for the programme have been made staff of NFA's inshore fisheries.
- Based on experiences thus far, the following activities are recommended:
- Conduct a detailed economic viability assessment for aquarium trade activities. Freight within and out of PNG is extremely expensive and presents a major (together with operating costs) hurdle to the establishment and development of commercially viable marine ornamental trade activities in PNG. Some of this work is currently being undertaken for potential operations out of Kavieng (partly based on Kinch 2008<sup>5</sup>), as a collaborative effort among SPC, the National Fisheries College, and researchers from the Australian Centre for International Agricultural Research.
  - Individuals expressing an interest in developing collection activities should put forward a solid business plan, indicating proven experience in the field and the capacity to run an independently run commercial enterprise (i.e. fully self-financing or at the very least capable of covering the majority of set-up costs; clear price structure and breakdown of how shipments will cover operating costs and allow for income generation). Such a set-up would demonstrate clear commitment to run as a fully independent commercial enterprise, and given that their own funds are at stake, individuals would have a greater responsibility and motivation to ensure the business succeeds.
  - Finalise the management plan and accompanying regulations and licensing conditions; these should also be gazetted to provide the required and adequate control and support for the sustainable management of the industry. This is particularly important with regard to potential farmed coral exports. Indeed, from the outset, marine ornamental trade activities in PNG included coral farming of both soft and hard corals. Yet no hard corals were ever shipped, due to the lack of adequate regulations (i.e. management plan and monitoring framework to fulfil CITES<sup>6</sup>

<sup>5</sup> Kinch 2008, A preliminary assessment of the viability of the development of the marine ornamental aquarium fishery in Papua New Guinea. Report prepared for EcoEZ Inc. and the National Fisheries Authority. 13 p.

<sup>6</sup> CITES = Convention on the International Trade in Endangered Species of Wild Fauna and Flora.

non-detriment finding) did not allow for the Department of Environment (local management authority) to issue permits for their export. These steps should be taken before the establishment of any new enterprise. The Secretariat of the Pacific Community has offered to work with relevant staff to finalise the plan for its submission to the NFA board by the end of this working year.

- If and once collection and export activities resume, emphasis should be placed on reliability, good species mix, quality, and consistency of production to maintain a competitive advantage. Volume and pricing at the market along with the aforementioned may also account for profitability.

The Marine Aquarium Programme should further capitalise on the momentum generated from past initiatives and the current lull in activities to standardise

and compile all marine aquarium survey data, export data, and fishery reports for storage in the NFA database. These data should then be analysed, linked to the socioeconomic context of PNG, and findings written up for publication. Considerable time, effort and resources have been expended toward developing an aquarium trade activity in PNG. It is unfortunate that this has not been a successful venture as yet. Key aspects of the groundwork laid down during the time of the various initiatives were constructive and positive at a wide number of levels, including from a resource assessment, educational and capacity building perspective. Presenting a summary of these experiences, together with data analyses and showcasing lessons learned from the initiatives would be interesting and valuable to PNG, its partners in the region, and the marine ornamental community at large.



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