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## Editorial

Collecting reliable data on catch and effort is one of the most challenging tasks that coastal fisheries managers face. Reef fisheries cover dozens, if not hundreds, of species, and usually involve large numbers of autonomous operators who use a wide range of fishing techniques. Estimating how much fish is extracted from reefs in a particular area using data collected from commercial fishers at landing or sale sites is all but impossible, because commercial small-scale fishers rarely all land or sell their catch at the same place at a predictable time. Furthermore, even if successful, a survey of commercial fishers omits subsistence and recreational fishing activities, which often represent the largest part of all reef fisheries catches in the Pacific.

Researchers in Moorea, French Polynesia, have sought to evaluate the fishery production of all lagoon fishing activities, beginning in 1985. In their article on page 27, Leenhardt and colleagues compare the results of five studies that were based on two different methodologies: catch monitoring surveys and consumption surveys. Surprisingly, these methods produced widely different results, and fishery production figures obtained from household surveys were almost 10 times higher than those obtained from catch monitoring surveys. The authors conclude that results obtained from consumer surveys are the most accurate.

Long before Pacific Island fisheries managers began surveying fish populations and household consumption, fishers living in the Indo-Pacific were plying the sea for fast-moving fish, mostly likely from boats. Archaeologists working in East Timor have recently discovered a cave with 42,000-year-old bones of tuna and sharks that were clearly brought to the cave by humans (see article by Balter on p. 26). It is a fascinating archaeological find, one that raises intriguing questions about early seafaring. It must also make us stop and reflect whether our practices will ensure there are wild fish left to catch 42,000 years from now.

The issue of whether fishing practices are damaging is raised by Tim Adams, who discusses the pros and cons of fish aggregation devices (p. 36). He notes that FADs are not intrinsically “bad” or “good”. FADs and all other fishing gear simplify the catching of fish, and any gear can become “damaging” given an excess of fishers, gear that is oversized compared with the fish stock, or significant non-fishing impacts.

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*Fishing at dusk, Rabaul, Papua New Guinea (Image: Malo Hosken, SPC)*



### Practical training on milkfish capture-based aquaculture in Fiji

*Milkfish have been identified by the Secretariat of the Pacific Community (SPC), the Japan International Cooperation Agency (JICA) and governments of Pacific Island countries and territories as a fish species that has potential for low-cost aquaculture. If viable in the Pacific, milkfish aquaculture could help meet the projected increased demand for food fish by growing populations, and the demand for fishing bait by tuna longline fleets.*

Attributes that make milkfish (*Chanos chanos*, or *yawa* in Fijian) suitable for low-cost aquaculture include the possibility of capturing fingerlings from the wild for pond stocking, and rearing them on (mainly) natural feeds growing in the pond. This saves money because the cost of running a hatchery is avoided. Milkfish are low in the food chain and can eat naturally occurring sea plants and plankton in addition to low-cost formulated pellet feeds.

Although milkfish aquaculture is well established in Southeast Asia, it is scarcely practiced in the Pacific Islands region. This is mainly because the necessary techniques to capture and culture milkfish have not yet been transferred to the Pacific, with the exception of one or two places. For this reason, the community of Vitawa Village in Fiji's Ra Province, in collaboration with Fiji's Department of Fisheries, JICA, and Japanese company Fisheries and Aquaculture International (FAI Co. Ltd.), has established a milkfish aquaculture project.

The Vitawa project, which has been previously reported on in this newsletter, has reached a stage where it is ready to provide hands-on learning opportunities for people from other parts of the Pacific who are interested in establishing their own milkfish farming projects. Fiji's Department of Fisheries and JICA put forward the idea to organise a training workshop in Vitawa Village for 30 participants from other communities in Fiji.

SPC added a regional component to the workshop by sponsoring the participation of an additional 12 participants from Cook Islands, French Polynesia, Nauru, Palau, Papua New Guinea, Solomon Islands, Tonga and Vanuatu. The WorldFish Center in Solomon Islands funded two of their staff to attend, and Nauru self-funded one extra participant. Interest around the region in milkfish aquaculture is high, with projects either already underway in places such as Kiribati, Palau and Tuvalu, or in the process of being implemented in Cook Islands, Nauru, Tonga and Solomon Islands. Two University of the South Pacific Marine Science Masters students from Solomon Islands, who are beginning milkfish aquaculture studies in Solomon Islands under SPC and WorldFish co-supervision, also attended the workshop in order to learn the techniques needed for their studies.



*Milkfish, *Chanos chanos*, fingerling ready for pond stocking.*

The workshop was designed to have maximum hands-on, outdoor learning experiences and a minimum of classroom lectures. During the first day, resource people such as Mark Napulan from the Philippines and Hideyuki Tanaka from Japan gave presentations on the biology of milkfish breeding and the basis for capture-based culture. Alifereti Senikau summarised the past history of Fiji's experiences with milkfish capture-based culture, and Moana Maamaatuaiahutapu did the same for French Polynesia where milkfish are highly prized on some atolls of the Tuamotu Islands.

After the first day, all learning was done "on the job". Participants manufactured their own bulldozer nets, using materials purchased by the workshop organisers, made

## SPC ACTIVITIES



*Marika Silimaibau of Fiji teams up with Simon Vuto from Solomon Islands to capture milkfish fingerlings using a fine-mesh seine net.*



*Fingerlings are carefully moved from the seine net into buckets with aeration for transport to the fishponds.*

from local materials such as bamboo provided by the Vitawa Village youth. The idea was that, having made their own nets, participants would be able to take the nets back with them to their places of origin and conduct their own trials of milkfish capture-based culture.

The two main methods of fry capture were demonstrated. One method is to capture fingerlings in shallow pools within mangroves. The other is to use floating “bulldozer” nets to catch young fry along beach fronts. Workshop participants using the shallow-pool method successfully caught several thousand fingerlings. This

catch was used to demonstrate the correct techniques for handling and transporting baby milkfish to the farm. Participants worked jointly with the Vitawa milkfish farm youth group to acclimate the fish to pond water, sort the fish according to correct species, and stock them into nursery ponds. In addition to learning the correct methods, workshop participants were able to contribute to the Vitawa fish farm project by stocking several thousand more fish into the fishponds.

Participants practiced the correct way to calculate how much feed to give fish in ponds each day. Water



*Milkfish farming expert Mark Napulan from the Philippines (holding blue basin) demonstrates how to take milkfish fry out of the cod-end of a floating dozer net.*

management regimes that encourage natural food in the pond in order to reduce added-feed costs were demonstrated. Because the Vitawa project had fish that were of a size ready to harvest, one training exercise involved harvesting fish using seine nets. As a result, post-harvest techniques for packing fish in ice, and for de-boning and smoking fish for vac-packing in plastic, could also be practiced by all participants. As a further training exercise, and to assist neighbouring communities at Togavere and Vunitogaloa (also in Ra Province), other possible project sites were surveyed for pond construction. Two new fish farms were designed by participants under the guidance of workshop resource people, then measured and marked out by stakes on the ground ready for pond and channel construction.

Feedback from participants and from the Vitawa community was positive, and centred mainly on the very hands-on nature of the training, which was much appreciated. The warmth of the reception and the hospitality shown to outside participants by the Vitawa community and the women's group was especially commented on. Participants came with knowledge of and experience with milkfish from their own country, which they

shared with their Vitawa hosts in nightly exchanges of information around the kava bowl. The most important aspect of this milkfish training was the Vitawa community setting, which as a learning experience compared better than the usual type of regional training workshop that takes place in air-conditioned meeting rooms in hotel venues. This training was “real life”, done in a way that the benefits of the training experience flowed on not just to participants but also to the host community in ways that were not only technical but also financial and cultural.

Due to renewed interest in milkfish aquaculture in the region, this workshop was timely. Several other communities in Fiji, and other countries in the region, have begun or will soon be starting their own milkfish capture-based culture projects.

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*All pictures in this article are by Tim Pickering.*



*Ken Kikutani of Japan holds a milkfish that has reached a harvestable size.*

### Increasing Agricultural Commodity Trade project calling for expressions of interest

*The European Union (EU)-funded Increasing Agricultural Commodity Trade (IACT) project (housed at SPC in Fiji) has now hit full stride with a call for expressions of interest from enterprises in Pacific Island countries and Timor-Leste. The project invites enterprises such as private businesses, associations, councils and non-governmental organisations to apply for assistance in improving and diversifying agricultural exports. There is also scope for projects that focus on commodities that will aid in import substitution.*

Apart from agriculture, IACT also includes aquaculture and mariculture commodities. The project aims to assist existing aquaculture businesses or producer groups to overcome production constraints, technical capacity, and assessment of market potential through market studies, value chain analyses, food safety certification, and labelling. In addition, projects that develop cluster groups that allow smaller producers to pool together for better economies of scale will be encouraged. This EU-funded project brings closer coordination between two SPC divisions: the Land Resources Division and Fisheries, Aquaculture and Marine Ecosystems Division.

IACT will work on a problem-solving approach whereby enterprises that wish to expand or improve their consistency in supply, market access, quality control and efficiency can request specific interventions. The closing date for the 1<sup>st</sup> phase of expressions of interest was 20 April 2012. However, more opportunities will arise over the next three years.

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Farms such as the milkfish farm above in Timor-Leste stand to gain from IACT interventions (Image: Avinash Singh).

## Outcomes from Eighth Regular Session of WCPFC disappointing

*The Eighth Regular Session of the Western and Central Pacific Fisheries Commission (WCPFC) met in Guam from 26–30 March 2012. This was a much-anticipated meeting that was originally scheduled to be held in December 2011 in Koror, Palau, but was delayed due to electrical power troubles that occurred in Palau. The meeting was attended by SPC's Oceanic Fisheries Programme Manager John Hampton, Principal Fisheries Scientist (Stock Assessment) Shelton Harley and Principal Fisheries Scientist (Data Management) Peter Williams.*

Over 500 participants from member and cooperating non-member countries and territories attended the meeting. There were also many delegates from various non-governmental organisations, who were representing industry and environmental interests.

On the meeting agenda was the new conservation and management measure (CMM) for the tropical tuna fishery. The scientific advice clearly indicated that the previous CMM needed strengthening. Also on the agenda and of interest to WCPFC members were:

- highlighting the recent large increases in South Pacific albacore catches, and seeking ways to give this stock, which is very important to many domestic longline fisheries, better protection;
- taking steps to reduce fishing impacts on oceanic whitetip sharks (where the science indicated some real sustainability concerns); and
- offering protection to whale sharks and cetaceans, which are potentially extremely vulnerable to fishing mortality and impacted on by the purse-seine fishery.

It is fair to say that the outcomes of most of the key issues were very disappointing, and represented a “wake-up call” to the WCPFC. While all members were able to agree that more restrictions were needed for the tropical tuna fishery, they were unable to agree on which fleets were to take on the additional restrictions. A further disappointment was that previously highly contentious measures, such as the closure of the high seas pockets to purse-seine fishing, lapsed and it was impossible for members to agree to keep the closure in place. The final

outcome on the management of tropical tunas was a simple “carry-over” measure aimed to keep most of the same limits in place for 2012 with a view to continue development of a new CMM at the Ninth Regular Session, which will be held in the Philippines in December 2012.

Of particular concern to the more southern countries, the South Pacific albacore discussion was held on the final afternoon. This was also disappointing to some industry and environmental groups who expressed particular concern about South Pacific albacore in the lead-up to the meeting. A new stock assessment is currently being undertaken for this stock and will be reviewed during the annual session of the WCPFC's Scientific Committee, which will be held in South Korea in August 2012.

There were some accomplishments during the meeting, these being an agreement on “no-retention” of oceanic whitetip sharks as an initial step for managing this stock while a new stock assessment is being undertaken (also due for review in August 2012) and potential management options evaluated. Members also agreed on the need for a CMM to protect cetaceans from purse-seine fishing. In addition, some important information on the South Pacific swordfish fishery is now available and there will be concerted research on this stock beginning in 2012.

One outcome of particular interest to those members with fisheries either under Marine Stewardship Council (MSC) certification or currently seeking it, was the agreement to terms of reference and the scheduling of the WCPFC's first workshop on management objectives. This should give WCPFC members the opportunity to discuss what they hope to achieve from the fishery, which should lead to improved negotiations and, more importantly, some discussion of reference points and harvest control rules, which are critical components of MSC-certified fisheries. This meeting is scheduled to be held immediately prior to WCPFC 9 in December 2012, and will feature analyses from SPC's Oceanic Fisheries Programme on reference points and harvest control rules.



*A significant accomplishment of the meeting was the agreement to “no-retention” of oceanic whitetip sharks by tuna fishing boats (Image: Terry Goss Photography USA/Marine Photobank).*

### For more information:

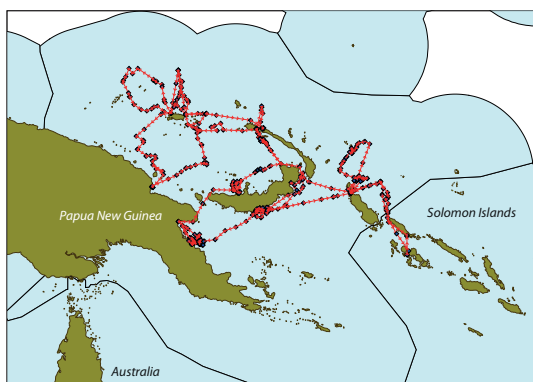
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## Second cruise of Papua New Guinea tagging project successfully completed

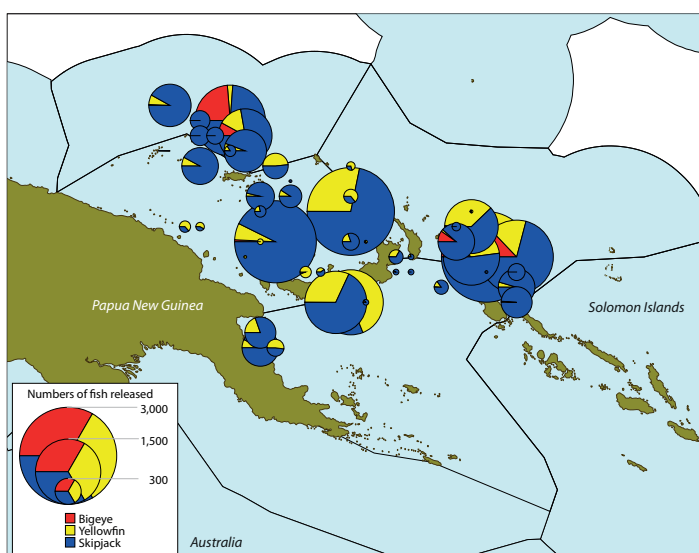
*F/V Soltai 105 returned to its base port on 19 March 2012 after fishing in Papua New Guinea (PNG) waters (see cruise track map). Although the 2012 cruise lasted only two months, nearly the same number of fish were tagged as in the 2011 cruise, which lasted three months: 39,925 fish, including 28,311 skipjack, 9,606 yellowfin and 2,008 bigeye tunas (see release by species map). It is worth noting that the relatively large number of bigeye tagged had never been achieved before in PNG waters.*

Over 6,000 tags have been recovered from the 2011 cruise releases (15%), showing that the tag recovery systems installed in the main PNG tuna catch unloading sites are working well. More than 70% of these tags have been recovered by PNG-based purse seiners.

The third and last PNG tagging cruise will take place in the first quarter of 2013 and will, no doubt, bring the total number of tuna tagged well over 100,000 for the project.



Cruise track of 2012 PNG tagging trip.



Fish releases by species during the 2012 PNG tagging trip.



F/V Soltai 105 in tagging action (Image: Malo Hosken).

## Tuna tag recoveries in Papua New Guinea

*SPC's Principal Tag Recovery Officer (TRO) Caroline Sanchez spent two weeks in Papua New Guinea (PNG) last February to supervise the organisation of tag recoveries in the country. Caroline worked with local TROs Andrew Rahiria, Jacinta Eddie and Priscilla Wrambin in the towns of Wewak, Madang and Lae, respectively.*

These local TROs were trained in 2011 to publicise the tagging project, organise the collection of recovered tags brought in by fishers and provide them with rewards. A reward of USD 10 is given to tag finders when they return a recovered tag and the associated catch information (species, size, date and position of recapture, name of fishing vessel). They can also choose to be rewarded with a t-shirt or a hat bearing the project's logo.

The three TROs in PNG use a custom-designed tag recovery database to complete their work. This computerised interface allows for each returned tag and its associated information to be saved for later analysis. On a monthly basis, the TROs report to Caroline with the data they have accumulated and the data are subsequently integrated into the master tagging database at SPC's headquarters in Noumea, New Caledonia.

Andrew, Jacinta and Priscilla spend most of their time visiting the fishing or carrier vessels that unload their catch in port. They also work with the tuna canneries, where many tags are recovered, and they collaborate with fisheries observers, who embark on fishing vessels to monitor all aspects of fishing activities. This networking role is very important to publicise the tuna tagging project. Observers, fishers and cannery staff are made aware of what a tag is and what information they should record when they find one.

For each recovered tag, a tag recovery form is completed by the finder or the TRO. Tag finders are also asked to provide their name and contact address so they can enter the regular lotteries that are run in the major ports in PNG. During her mission, Caroline and her colleagues ran a lottery in each town. These lotteries were organised with the support of collaborating fishing companies. In Lae, the lottery was drawn at Frabelle PNG Ltd compound. The winner, Elmarson Tolentino, a fishing vessel crew member was at sea but his win was posted on the notice board. In Madang, RD Tuna Canners hosted the lottery draw. The winner, Bernard Nalul, a local unloading crew, was very pleased and announced that his gains

would be used to pay for this son's school fees. Finally, in Wewak, the lottery was run at the South Seas Tuna Corporation refectory, where Eugenio Luzada Sr and Colas Meseo were drawn winners. Each winner was awarded USD 250. Surely this is an incentive to continue reporting recovered tags in the future.

Andrew, Jacinta and Priscilla continue processing tag recoveries and promoting the tuna tagging project. The success of a tagging project is largely based on the quantity and, more importantly, the quality of the data returned. Accurate size measurement, date and position of recapture are particularly important.

Other TROs are based in Honiara, Pohnpei, Majuro and recently Tarawa, some of the major tuna ports in the region.

A tag recovery guide for the general public that details the actions to be taken when a tagged fish is recaptured can be downloaded from the tagging website at this address: <http://www.spc.int/tagging/en/recovery-form/recovery-documents>.

### For more information:

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*Lottery winner Bernard Nalul in Madang surrounded by RD staff and TROs.*

## 50,000<sup>th</sup> tag recovered in Papua New Guinea

*Tag number P199008, deployed on a yellowfin tuna on 15 May 2011, was recovered by a Papua New Guinean fisher in 2012. Johnathan Joul, from Kananam village near Madang, found the plastic dart tag that was attached to the back of the tuna while he was working on a tuna purse-seine vessel, the Dolores 828, when fishing about 140 miles from where the fish had been released in the Bismarck Sea. The tagged fish was spotted during the brailing process when tuna are scooped out from the purse-seine net into the vessel's wells.*

This was the 50,000<sup>th</sup> tag recovered since the start of the Pacific Tuna Tagging Programme in 2006. A special reward of USD 500 was given to Johnathan to celebrate this milestone.

The fish was tagged and released during the first cruise of the Papua New Guinea (PNG) Tagging Project. Fully funded by PNG's National Fisheries Authority and jointly undertaken with the Secretariat of the Pacific Community (SPC), this project aims to establish an "experimental" population of tuna, which can be monitored and modelled as the tagged fish are recaptured.

SPC has been tagging tuna since the 1970s to collect critical information for the assessment of tuna species in the western and central Pacific Ocean, the world's

biggest tuna fishery. Its Pacific Tuna Tagging Programme is an initiative of the Pacific Island community to ensure that the best information is available to manage their oceanic ecosystems. Tagging is currently focused in Papua New Guinean waters. In 2011 and 2012, a three-month and a two-month cruise, respectively, have allowed the deployment of 80,589 tags on skipjack, yellowfin and bigeye tuna.

A short video documenting tuna tagging onboard the chartered pole-and-line fishing vessel *Soltai 105* is available for viewing on YouTube by typing "PNG Tuna Tagging 2012" in the search bar or through this link:

<http://www.youtube.com/watch?v=-get6e202BA>.



The milestone tag finder Jonathan Joul with Madang TRO Jacinta Jacob at left and RD Fishing representative Nilbert Mullet at right.

## How fisheries observers can contribute to the tagging project

*The assistance of fisheries observers is essential to the success of the tagging project. They are often the first ones to see recaptured tagged fish during hauling operations at sea or during unloading and transshipment operations in port.*

Training in tag recovery procedures has been an integral part of observer training since 2006 to ensure that as many observers as possible are made familiar with the project.

We would like to extend our sincere appreciation to all observers who have been assisting in the recovery of tags, either when they find a tag or when they assist crew members to fill in the recovery form and claim their reward.

Observers are strongly encouraged to continue this process. They have access to fishery information for accurately determining the date and position where tagged tuna are recaptured. They also use their callipers or deck tapes to accurately measure the size of recaptured fish. Observers who have not been formally trained should ask their coordinators to be put in contact with the local Tag Recovery Officer. He or she will be able to brief them on tag recovery procedures and provide them with tag recovery materials (guide, recovery forms, publicity posters and envelopes).

Observers can also contact Caroline Sanchez directly if they wish. Again, to all observers, thank you for your valued assistance to the tagging project. Go well!



The tag recovery guide for observers can be downloaded from SPC's Oceanic Fisheries Programme website at: [http://www.spc.int/OceanFish/en/observer-forms/cat\\_view/116-ofp-publications-a-documents/309-fisheries-monitoring/173-observers](http://www.spc.int/OceanFish/en/observer-forms/cat_view/116-ofp-publications-a-documents/309-fisheries-monitoring/173-observers).

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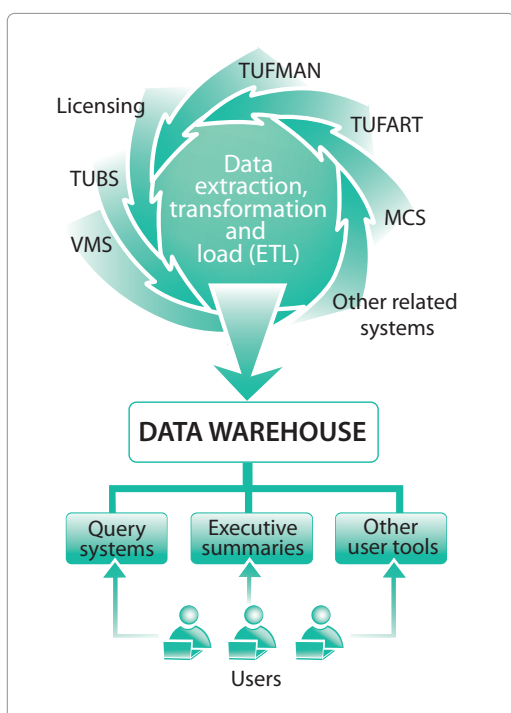
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*The views expressed in this publication do not necessarily reflect the views of the European Commission.*

## Recent developments in regional fisheries information management systems

*Regional fisheries management database systems are being enhanced, with several initiatives looking at the establishment of fisheries information management systems (FIMS). At present, fisheries data in SPC member countries offices are managed through several independent database systems, each developed for a specific need (e.g. TUFMAN<sup>1</sup> and TUBS<sup>2</sup>, for managing tuna fisheries catch data and observer data, respectively).*

The concept of an FIMS is that it uses existing database systems, integrates and enhances them where required, and provides for the addition of new integrated systems to manage data not currently catered for. At the top of the FIMS structure is a suite of reporting systems that will pull all of the information together and provide top-level reports (integrating all of the data sources into data summaries and charts), and allow “drilling down” to see more detail if required. The types of data that may be incorporated into the system will include all tuna fisheries data, VMS (vessel monitoring systems) data, MCS (monitoring, control and surveillance) data, licensing data, and data from other important fisheries, including artisanal (possibly managed by TUFART<sup>3</sup>) and coastal fisheries, but the system will be flexible enough to cater to the specific needs of each country. The systems will also look at streamlining and formalising procedures with specialised software; for example, handling the processing of a license application from start to finish. An example structure of an FIMS is shown in the diagram below.



FIMS developments are currently being undertaken by two separate initiatives. The Papua New Guinea National Fisheries Authority (PNG/NFA) and the Office of the Parties to the Nauru Agreement have engaged an IT consulting firm from Australia (Quick Access Computing) to redevelop their existing software and develop an integrated FIMS that will provide a similar hierarchical structure for these national and subregional organisations, but with additional components specific to PNG/NFA's national database requirements. Work on this system is already well advanced and work is being undertaken to integrate the NFA system with database systems developed and maintained by SPC's Oceanic Fisheries Programme (TUFMAN, TUBS, TAGDAGER).

The second initiative is being undertaken by a group consisting of the Cook Islands, Federated States of Micronesia and Marshall Islands, which have engaged Nesh Petrovic of Taz-E to design the system and coordinate development. This group has invited participation from the Pacific Islands Forum Fisheries Agency (FFA), SPC, and the Western and Central Pacific Fisheries Commission (WCPFC) so that integration with existing systems from these organisations will be planned from the start. The joint vision of this group is to have an FIMS that will integrate relevant sets of information related to fishing, including catch and observer reports, in real time, available at the “press of a button”. The system will be in line with “best practice” using the latest technology to allow fisheries managers to make informed decisions in a timely manner. The FIMS will also allow for electronic exchanges on a national and regional basis, involving partner agencies and the fishing industry itself. The next workshop will be held in Raratonga, Cook Islands in June 2012, and will include participants from PNG and the consultants developing the NFA FIMS, which is expected to generate some collaboration between the two initiatives.

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<sup>1</sup> TUFMAN = Tuna Fisheries Data Management System, a database system for storage, retrieval and integration of tuna fisheries catch and effort, port sampling, unloading, and licensing data.

<sup>2</sup> TUBS = Tuna Fisheries Observer Data Management System, a database system for storage and retrieval of tuna fisheries observer data.

<sup>3</sup> TUFART = Tuna Fisheries Artisanal Data Management System, a database system for artisanal data, mostly tuna-related.

## Communities in the Solomon Islands want effective enforcement of sea cucumber ban

*In the Solomon Islands, the communities of Marau and Sandfly want an improved system of managing the sea cucumber fishery. During a resource assessment training and management consultation in September and October 2011, it was revealed that sea cucumber resources continue to be fished despite the current ban.*

The low numbers of sea cucumbers recorded in the assessment did not correspond with the capacity of the rich reef systems in these areas to support these resources. Sea cucumber numbers inside several marine protected areas (MPAs) were only slightly better. The communities put in considerable effort in setting up the MPAs with the support of non-governmental organisations.

Community leaders in Marau — represented by their tribal leaders and the Resource Owners Association Committee of Ngella and Sandfly (ROA-Ngella) — were concerned but said they expected to hear such results. “Our fishers continue to collect sea cucumbers in open access areas and inside the MPAs for sale to buyers in Honiara despite the ban and we have little power to control our own fishers as we are not fisheries authorised officers,” they said. They also said that “it is the buyers who continue to buy sea cucumbers and we have no power to control these buyers”.

Solomon Islands is the second most important producer of beche-de-mer in the Pacific Islands region, with an annual production of over 700 tonnes. Sales of beche-de-mer provide much needed income to rural communities in Solomon Islands but the overexploitation of resources led to the fishery’s closure in 2005. Two years later, communities in Western and Choiseul provinces — which were affected by a tsunami that struck the area — were allowed to fish as part of the disaster relief effort provided by the government. This later led to nationwide fishing for two years as fishers in other provinces also fished for sea cucumbers, arguing that everyone needs an income and fishing should be allowed for all and not just for a few communities. The ban was re-enforced in April 2009 but the lack of an effective enforcement mechanism — a situation common to many other sea cucumber fisheries — has resulted in illegal fishing, buying and exporting activities.

For the communities of Marau and Sandfly, current illegal fishing activities will continue to deplete their few remaining breeding stocks, making it harder for the resource to recover. Because they are powerless to control the fishery, these communities look to the national ban as the best option to ensure total control and recovery. Leaders from these communities are calling for the extension of the current ban and, at the same time, asking relevant authorities to improve the current management and monitoring system to ensure that enforcement of the ban becomes effective.



*Recording sea cucumber numbers using the manta tow technique (Image: Kalo Pakoa).*

As preliminary results indicate, species diversity remains high in both areas, and remaining stocks are successfully breeding as seen by the presence of young sea cucumbers entering the population. There is potential for the resource to recover if given sufficient time. With regard to livelihood options, community leaders said “there are other opportunities in fish, agriculture, coral farming and forestry but sea cucumbers are an easy way for people to make an income”. Therefore, enforcing a total closure would allow their people to look more seriously at other available options for earning an income.

Meanwhile, the Solomon Islands Ministry of Fisheries and Marine Resources has started a nationwide sea cucumber resources assessment, covering 40 sites in 9 provinces. It is expected to be completed in 2012. SPC is providing technical assistance to the Ministry with field training in resources assessment, as well as training in data management and reporting at SPC main office in Noumea. This support to Solomon Islands is made possible by the European Union-funded SciCOFish Project.

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## Holy mackerel: Small fish, big potential

*Pacific Islanders are heavily dependent on marine resources for food security and income generation, especially in countries and territories with limited arable land. Fish stock depletion and coral reef degradation is creating a need for alternative income and protein sources. New technologies are required to improve access to resilient and sustainable protein sources, such as sardines and anchovies.*

*On Majuro in the Republic of the Marshall Islands, a new fishing technology called bagan is being trialled as a potential tool for enhancing food security, securing livelihoods and assisting with climate change adaptation in the Pacific.*

### Introduction

Small pelagic fish, such as sardines, mackerel and anchovies, are a plentiful and rich protein source that remains relatively underexploited in the western and central Pacific Ocean. Hall (2007) states that we are not overexploiting the ocean's protein resource, but we are overexploiting certain species; in particular, species that are in the upper level of the food chain.

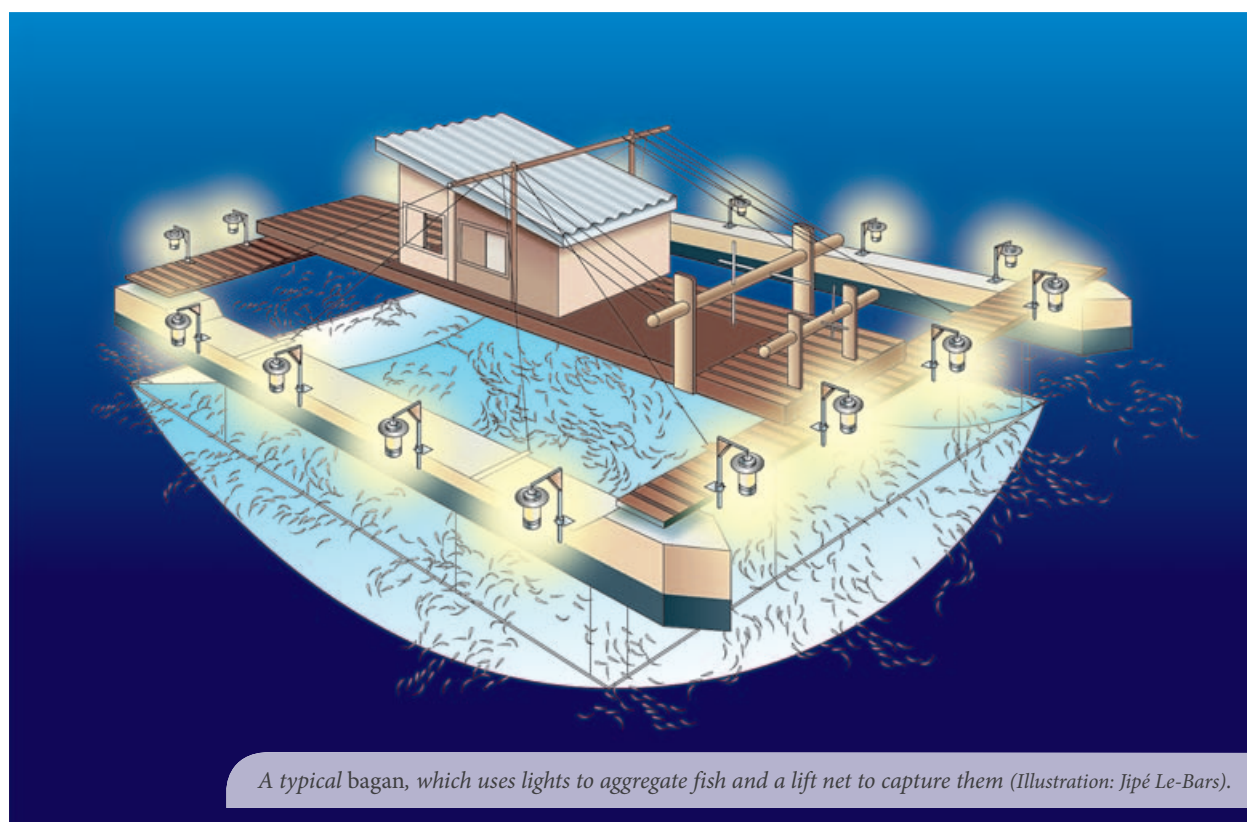
Diverting fishing effort from large predators, reef fish and invertebrates to more robust stocks, such as small pelagic fish, has the potential to rejuvenate overexploited marine resources while continuing to supply the world's growing population with protein.

Increasing fishing effort on small pelagic fish is, within reason, deemed sustainable given the biological nature of these fish: they grow rapidly, have short life spans and high mortality rates (Dalzell 1990). Dalzell (1994) states

that for anchovies in particular, the short life span and high mortality of the population means that they can be fished heavily, have their biomass markedly reduced, and the population will recover in a short time — usually in a few weeks to a few months. As with any fishery, increasing effort must be done with caution and yields must be maintained within sustainable levels.

### Indonesian-adopted fishing technology

As reported by Sokimi (2012), the Secretariat of the Pacific Community — in conjunction with the Pacific Islands Forum Fisheries Agency (FFA) and the Marshall Islands Marine Resource Authority (MIMRA) — is researching the potential of Indonesian-adopted fishing technology, which attracts and captures small pelagic fish using a lift-net platform, or *bagan*.



*A typical bagan, which uses lights to aggregate fish and a lift net to capture them (Illustration: Jipé Le-Bars).*

Fish are attracted to the platform by bright overhead and/or underwater lights. When sufficient numbers of fish have aggregated around the *bagan*, a bag net — one type of liftnet with a bag shape — is lowered inside the platform between the two hulls. The lights are gradually turned off one at a time until only one central light remains on. This light is centred above the net to attract the fish to the entrapment area. Once the school of fish has settled into an orbit beneath the light, a signal is given to lift and close the net to capture the fish.

## Bagan research in Majuro, Republic of the Marshall Islands

The *bagan* bait fishing project aims to research the potential for using a *bagan* to catch small pelagic fish for food. It is planned that the fish will be consumed fresh and in a value-added form (e.g. salted, dried, smoked) on the local market.

The project began in October 2011 when the *bagan* was constructed in Kiribati and transported to Majuro for assembly. The *bagan* was launched in February 2012 and two Indonesian consultants (a pole-and-line specialist and a *bagan* operations specialist) were engaged to conduct fishing and value-adding demonstrations for eight days in March.



*The bagan anchored for the first fishing trials.*

Once a good operations and business model has been defined, and the *bagan* is proving to be successful, MIMRA will transfer ownership and operation of the *bagan* to a community group, who will have the opportunity to operate the *bagan* and market their catch through the Outer Islands Fish Marketing Centre (OIFMC).

If successful, this project will provide an alternative source of food and income from a healthy and robust fish resource that is not currently exploited in the Marshall Islands.

## Fishing trials

Fishing trials were conducted for two nights in March, although due to adverse weather and sea conditions (i.e. moon phase, current, wind and location), catch rates were low.

*Bagan* fishing is a new concept for the fishermen who assisted and were trained by the project. Inexperience in using this type of technology also contributed to fish escaping. This is normal for any new fishing operation where gear must be adjusted and experiments carried out to fine-tune the system. It is envisaged that with practise, catch rates will increase.

The catch mainly comprised sardines, scads and mackerel.



*Scads and mackerel caught on the first fishing trial.*

The catch from each night's fishing effort sold quickly for USD 1.50 per pound on the local market, which indicates that there is demand for small pelagic fish in Majuro.

## Data collection framework

A biological and economic data collection framework has been developed to monitor all aspects of the *bagan* operation. Data collection is an integral component of the research because it provides, among others, information on:

- optimal fishing period — moon, tide, weather, season;
- optimal fishing location — depth and position in the lagoon;
- species composition and catch rate over time; and
- costs used for conducting an economic assessment.

SPC developed logsheets for recording data on catch and effort, processing and sales, and MIMRA's Fisheries Officer, Peter Jaramiel, developed a database to input these data.

## Project opportunities and constraints

The Majuro *bagan* project has a number of opportunities and constraints that are summarised in Table 1.

Table 1. Opportunities and constraints of the *bagan* project in Majuro, Republic of the Marshall Islands.

Opportunities	Constraints
<ul style="list-style-type: none"> <li>Establish retail outlet, cold chain and vessel support for marketing through the OIFMC</li> <li>Supply bait to longline vessels and to fishers</li> <li>Establish value-adding practice, capacity and infrastructure (e.g. smoker, drying racks) at the OIFMC</li> <li>12-month financial commitment from FFA to support fishing trials</li> <li>Ongoing technical support from SPC</li> <li>Commitment from MIMRA to continue fishing trials</li> <li>Seemingly strong demand for small pelagic fish</li> <li>Low-cost fishing method</li> </ul>	<ul style="list-style-type: none"> <li>No capacity for MIMRA staff to conduct frequent fishing trials</li> <li>Uncertainty about fish resources and abundance</li> <li>Uncertainty about the suitability of Majuro's weather for <i>bagan</i> fishing</li> <li>No capacity to accurately record and compile data</li> <li>Uncertainty about the size of the market for small pelagic fish</li> <li>Relatively low-value product (USD 1.50 lb<sup>-1</sup>) — although this is complemented by low-cost fishing method</li> <li>Limited value-adding opportunities (based on the fish that were caught in the trial)</li> </ul>

## Recommendations for the project

- Improve lighting by investing in a generator and underwater lights to more effectively aggregate fish and subsequently, increase catch rates.
- Continue fishing trials in new locations, different moon phases and different weather conditions.
- Invest in some safety gear; night fishing can be dangerous and there is a need for safety gear on the *bagan* (such as fire extinguishers, safety helmets, hand gloves, man overboard life rings with safety line and water activated light attached to each, emergency spotlight).
- Install some safety lights and reflectors so that the *bagan* can be easily seen at night without being hit by passing vessels.
- Allocate a full-time employee or manager to run the *bagan* project.
- Provide additional training in fishing techniques and monitoring and evaluation.
- Explore alternative markets if catch rates improve, such as small-scale value adding, bait.



Towing the *bagan* to the fishing location.

## Discussion

The Majuro *bagan* research project for food security is the first of its kind in the Pacific. FFA has implemented a similar project in the Solomon Islands, although the objective of that *bagan* project is to investigate the potential for supplying bait for small-scale pole-and-line vessels.

From a food security and livelihoods perspective (and assuming that catch rates improve), *bagan* fishing targets an underexploited and sustainable stock, and is a

low-cost fishing technique. Therefore, with further refinement, it is envisaged that this project has the potential to be a biologically sustainable and financially profitable venture.

Further research is required to increase catch rates and to develop a lower cost *bagan* that will contribute to making *bagan* technology an economically viable tool for food security, livelihood improvement and climate change adaption in the Pacific.

### Acknowledgements

The hard work of MIMRA and OFIMC staff in making this challenging project a reality is acknowledged — they are still facing challenges and their perseverance is admirable. Special thanks to: Glen Joseph, Candice Guavis, Peter Jaramiel, Fred Bukida, Tino Debrum and all of the OIFMC team who worked tirelessly during construction of the *bagan* and fishing trials.

Thanks also to our consultants, Anung Widodo and Ajub Dolo, and to the Research Centre for Fisheries Management and Fish Resource Conservation, Ministry of Marine Affairs, Indonesia, for lending their staff for this project.

Financial contribution from SPC, MIMRA and FFA is acknowledged with thanks.

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*All pictures in this article are by Michael Sharp.*



*Hauling the net can be physically demanding. OIFMC staff faced the challenge with enthusiasm.*

## Financial management training for fisheries officers in the Solomon Islands



Fisheries officers during a field trip to Don Bosko Training Centre. From left to right: Alex Carlos, Reuben Vae, James Ngwaerobo, Alan Aba, Sylvester Diake Jnr, James Driver and Ben Buga.

*Too often fishery development projects are implemented without consideration of their financial and economic viability. In many cases, this results in the implementation of a project that requires long-term subsidisation or, without this, results in project failure. The success of a fishery project is dependent on good financial management and planning before, during and after project implementation, and the first step towards this is improving the capacity of project managers.*

Whether fisheries officers manage fish market centres, or work in capture-based fisheries, aquaculture or marketing, they all have a common need to understand basic financial management. The Solomon Islands Ministry of Fisheries and Marine Resources (MFMR), in partnership with SPC and the Mekem Strong Solomon Islands Fisheries Programme (MSSIF), organised a week-long introductory course in financial management for fisheries officers in March 2012. The course was delivered by SPC's Nearshore Fisheries Development Section and facilitated by MFMR's Marketing Section, and had 22 participants.

### Background to the course

This applied course on economic evaluation and project management was designed to introduce fisheries officers to financial concepts, project planning, fisheries economics and business, and included topics on:

- Introduction to financial management;
- Vessel economics;
- Aquaculture economics;
- Project planning and budgeting; and
- Business management, marketing and banking.

The workshop was designed to give a brief overview of fisheries economics and financial management, with the objective of introducing general concepts and evaluation techniques that can be used in day-to-day work and transferred to the private sector.

### Outcome

Increased financial capacity provides an opportunity for fisheries officers to conduct viability assessments in their area of specialisation. Provincial marketing centres, seaweed farmers, the Honiara fish market and small-scale fishing vessels will have improved financial analysis, and the private sector will have access to advice from MFMR's fisheries officers.

### Acknowledgements

Thanks are given to MFMR and, in particular, Ben Buga and David Fatai from the Marketing Section who organised and facilitated the workshop. The authors acknowledge MFMR, MSSIF and SPC for their financial contribution to this national training, and thank Don Bosko Training Centre for hosting us during the aquaculture field trip.

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## Sport fishing training in Niue



*Young Teva Pasisi could well be part of the next generation of fishing guides in Niue.*

*The development of sport fishing tourism has great potential in the Pacific Islands region. On Niue, sport fishing is not in its infancy because fishing charters have been available to visitors for more than a decade. Strengthening this niche industry, and making sure that its economic benefits are spread across the entire community, is the objective of the Niue Tourism Office (NTO), which sought assistance from SPC to conduct a workshop for existing and prospective fishing guides.*

The workshop took place from 13–27 April, following a smooth collaboration and some cost sharing between NTO, the South Pacific Tourism Organization (SPTO), the Niue Island Fishermen's Association (NIFA), SPC's Nearshore Fisheries Development Section, and the EU-DevFish2 project.

The workshop was conducted by SPC's Nearshore Fisheries Development Adviser Michel Blanc, and New Caledonia-based fishing guide Etienne Picquel, with strategic inputs from Graham Marsh (NIFA), Vanessa Marsh and Hayden Porter (NTO), Rusila Drekeni (SPTO), James Tafatu (Niue Fisheries Department) and staff of Niue Telecom. Topics covered in the classroom included SPC's perspective on sport fishing, safety at sea and legal requirements, customer service, VHF radio operations, data collection, modern sport fishing techniques, gear and knots... as well as some casting practice on Niue's golf course! During the following week, 6 fishing trips were organised for 15 people. Local skippers could practice their guiding and boat handling skills, while others (the "customers") fished Niue's fish aggregation devices (FADs) and reef drop offs, under the guidance of Etienne Picquel.

While new to most participants, the fishing techniques explained in the classroom the previous week (casting and jigging) proved successful, especially around two of the nearshore FADs that had aggregators on them.

NIFA's Graham Marsh stated: "This collaboration between local stakeholders and our development partners has made possible a very interesting sport fishing workshop on Niue." He further commented that, "Michel and Etienne were excellent with their assistance and presentations, with Michel's support being invaluable right from the start; participants cannot thank them and SPC enough for this support."

One major outcome of the workshop was the development of a draft accreditation framework for the charter operators who, once they become accredited, will be supported by NTO. To become accredited, prospective guides will need to attend a series of training modules (sea safety and legislation, VHF radio operations, first aid, customer service and safety, fishing techniques) and pass corresponding tests. This accreditation scheme is considered to be a very important step towards the development

of a professional fishing charter sector that NTO is supporting as part of its strategy to attract visitors to Niue.

The results of the sea fishing trials also showed the extreme importance of FADs, not only for sport fishing but also for food security and fuel savings. The casting and jigging techniques that were introduced through the workshop should benefit local charter operators by providing them with an effective and fuel saving alternative to trolling, especially during the wahoo off-season and during periods when fishing is difficult. Those techniques can be a lot of fun and enhance Niue's attractiveness as a sport fishing destination. At the end of the workshop, participants were encouraged to practice and enhance their skills in the key areas of customer service and safety, fishing gear maintenance and boat handling.

SPC's Nearshore Fisheries Development Section will continue to collaborate with NIFA and NTO in the near future: the next idea being the development of a comprehensive data collection system to analyse the socioeconomic impacts of Niue's fishing charter industry.

In its 27 April issue, SPTO's *Pacific Pulse* newsletter stated: "With ongoing support from the Niue Tourism Office and the commitment of local guides to further strengthen their operation, Niue has the potential to become a renowned blue water sport fishing destination."

This workshop was funded by the NTO, SPTO, SPC and the EU DevFish2 project.

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*Top: Etienne Picquel demonstrates how to cast a big popper. This was immediately followed by practical exercises.*

*Middle: The fight. Teva Pasisi using medium tackle at the Aliutu offshore FAD to land a small mahi mahi.*

*Bottom: This fat wahoo crossed the path of Etienne's jig 70 meters below the surface.*

*All pictures in this article are by Michel Blanc.*



### Leatherback sea turtle movements in the South Pacific

*By Scott R. Benson*

*National Marine Fisheries Service, National Oceanic and Atmospheric Administration, USA  
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Sea turtle conservation efforts often focus on protecting hatchlings on nesting beaches, yet foraging and migration behavior in the water may put them directly in the path of fishing boats. Reducing at-sea mortality risk is a priority for endangered Pacific leatherback turtles. In a recent study, leatherback migratory patterns and high-use areas were assessed in an effort to characterize foraging habitat and to minimize the potential for harmful encounters with humans.

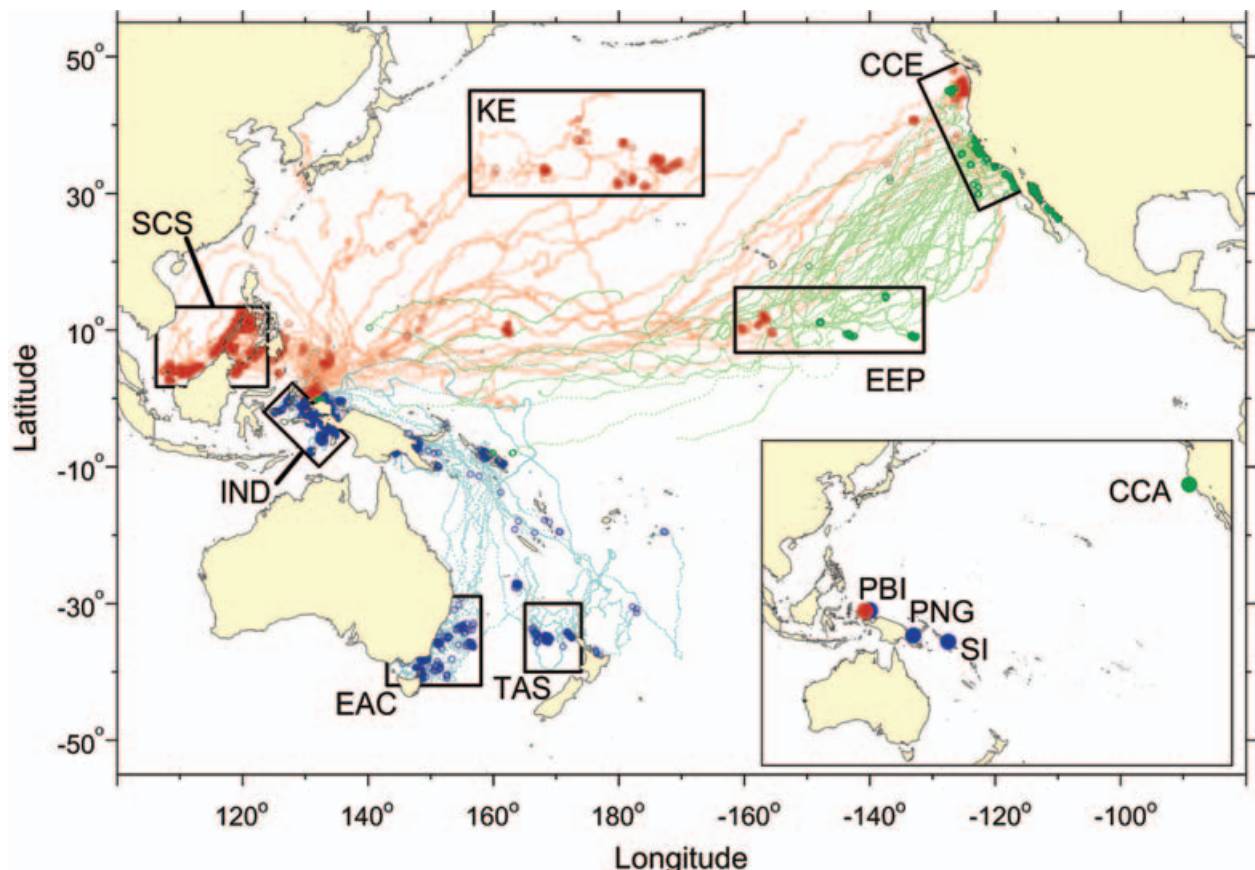
Drawing together scientists from the United States, Indonesia, Papua New Guinea (PNG) and the Solomon Islands (SI), it was possible to produce a large-scale picture of Pacific leatherback foraging and migration behavior in the Southern Pacific. The study focused on the western Pacific leatherback stock that is known to nest in Papua Barat Indonesia (PBI), PNG, SI, and Vanuatu. Satellite-linked transmitters were attached to turtles in 1) PBI on the beaches of Jamursba-Medi and Mermon along the northern Bird Head coast; 2) PNG on the beaches of the Kamiali Wildlife Management Area and Maus Buang along the Huron Gulf; and 3) SI

on beaches in Santa Isabel Island and Rendova Island. The satellite-linked transmitters, which were attached with a flexible shoulder harness, relayed the locations of sea turtles as they moved from their nesting beaches to foraging grounds in the Pacific. Transmitters were designed to provide tracking information for up to two years on each turtle. Location information was collected on 126 leatherbacks from 2000 to 2007.

The study identified patterns of movement and critical foraging habitat for post-nesting leatherbacks nesting in PNG and SI. Analysis of leatherback movements revealed that the turtles in the South Pacific travel to areas with oceanographic features conducive to jellyfish concentrations, the main prey of leatherbacks. Leatherbacks nesting along PNG's Huron Gulf coast used the gulf's waters extensively from December to February while moving between nesting activities. After the nesting season, PNG leatherbacks move southward, swimming through the Coral Sea to access the Tasman Sea or the western South Pacific Ocean. Similar to movements of PNG leatherbacks, turtles nesting in SI remained



*Harness and transmitter fitted on a leatherback turtle (Image: Scott Hansen).*



*Probable transit of 126 tagged leatherback turtles.*

- Large, darker circles indicate area restricted search (ARS) behaviour; small, lighter dots indicate transiting behaviour.
- Colour of track indicates deployment season: red = summer nesters, blue = winter nesters, green = deployments at central California foraging grounds.
- Inset shows deployment locations; PBI = Papua Barat, Indonesia, PNG = Papua New Guinea, SI = Solomon Islands, CCA = central California.
- Black boxes represent ecoregions for which habitat associations were quantitatively examined (see text): SCS = South China, Sulu and Sulawesi Seas, IND = Indonesian Seas, EAC = East Australia Current Extension, TAS = Tasman Front, KE = Kuroshio Extension, EEP = equatorial eastern Pacific, and CCE = California Current Ecosystem.

around the islands from December to February. Upon leaving SI waters, the turtles moved towards the coast-line of southeastern Australia and northwestern New Zealand for foraging.

Mapping the movement of leatherbacks in the Pacific can inform fishers and fisheries managers to help minimize harmful or fatal interactions. During the study, 7 of the 126 tracked leatherbacks were killed either incidentally or intentionally by humans.

Protecting sea turtles across large migratory and foraging areas can be challenging due to demands on resources in these areas. Relatively small time-area closures of the marine areas associated with nesting activities could provide effective protection during nesting periods in PNG and SI. The results of this study can inform the development of conservation measures designed to protect breeding leatherbacks during the nesting season.



*A leatherback turtle taking a breath (Image: Scott Benson).*

## PNA free school skipjack officially MSC certified!

*What we had been hoping for has finally happened: our Parties to the Nauru Agreement (PNA) free school, skipjack fishery has been certified by the Marine Stewardship Council (MSC)!*

We received the official MSC announcement on 9 January 2012, but wanted to wait for this official statement before sharing it with you. In fact, the approval was already sent by the independent adjudicator, Melanie Carter, on 13 December 2011 after a number of objections by the International Seafood Sustainability Foundation and other tuna industry groups.

We want to thank you for all the support you have shown throughout this long process in 2011. Knowing that Pacifical could count on your constant interest gave us confidence throughout the development of the MSC certification to continue working for our purpose. We finally did it!

Within a couple of months, the distinctive blue MSC logo, along with our Pacifical co-brand, will accompany our skipjack tuna cans, indicating that this tuna comes from well-managed and sustainable fisheries.

From now on, MSC certified, FAD-free tuna caught in schools will be a sustainable alternative option to pole-and-line-caught tuna; supplying the world with mature skipjack and reducing bycatch to the maximum level demanded by our PNA nations, and doing away with bait-fish problems. Also, our skipjack are caught by purse seiners; it allows us to serve a much larger group of consumers with sustainable tuna.

With MSC certification, we can start delivering sustainable tuna as well as giving our people the right of getting

benefit from their own resources. “We live in this region, we live and breathe tuna and for many of our members, they have nothing else but tuna,” said Dr Transform Aqorau, director of PNA.

The journey has just begun and after certification there remains considerable work to be done. PNA and Pacifical are now in the process of starting to get fleets organized to fish, based on MSC procedures and chain of custody (CoC). We are also getting appointments with several of our exclusive partners to confirm details in regard to specifications.

It is worth mentioning that in the start-up period, the amount of MSC-certified tuna that Pacifical will have available, will be limited. So we will be able to serve only a select group of highly dedicated retailers, food service and food processing companies. With time, the amount of free school skipjack available will rise as more fishing companies and vessel owners participate in our CoC.

Right now, there are 265 tuna vessels operating in PNA waters. Some of them are already actively working with Pacifical and are enthusiastic about the idea of having separate wells for free school skipjack. We are expecting many more to join within this year.

Eventually we could be catching 500,000 metric tons of free school skipjack within PNA waters, which would fill 1.4 billion 185-g cans of tuna every year, enough to serve 4.2 billion meals, bringing extremely healthy,

### **The Parties to the Nauru Agreement (PNA) controls the world's largest sustainable tuna purse-seine fishery**

- PNA members include the Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Palau, Papua New Guinea, Solomon Islands and Tuvalu.
- Global leaders in tuna conservation and management, many PNA conservation measures are world firsts — such as high seas closures to fishing, controls on fish aggregating devices (FADs), protection for whale sharks and the 100% coverage of purse-seine fishing vessels with observers. No dolphins are caught in PNA waters and the PNA is actively involved in limiting bycatch of other species.
- In 2011, the PNA skipjack tuna caught without using FADs was certified by the Marine Stewardship Council as sustainable, creating the world's largest sustainable tuna purse-seine fishery.
- PNA controls around 30% of the global tuna supply.
- The focus of PNA efforts to sustainably manage tuna is the vessel day scheme. PNA members agree on a limited number of fishing days for the year, based on scientific advice about the status of tuna stocks. Fishing days are then allocated by country and sold to the highest bidder. In this way, Pacific Islanders reap economic benefits from their sustainable management of tuna.

Source: PNA website (<http://www.pnatuna.com/about-us>).

high-protein sustainably-produced food to every corner of the world, at an affordable price and with the least amount of environmental impact.

Unlike beef, chicken or farmed fish, tuna is a purely wild species that requires no farming, no antibiotics, no massive amounts of feeds and water, thereby causing no water or land pollution.

PNA, as guardians for our people and the world, all we need to do is to manage and catch skipjack in a sustainable way — and according to MSC principles — and this highly fecund and fast growing fish will be able to provide us healthy food for generations to come.

We look forward to having the first Pacific MSC-certified skipjack on the shelves in Europe at the start of summer this year!

*Source: PACIFICAL website, 12 January 2012*  
(<http://www.pacifical.com/articles/00020.html>)



Solomon Islands purse seiner (Image: Malo Hosken).

### PNA/MSC chain of custody — Innovating the tuna supply chain

*We are getting closer and closer to the market introduction of Marine Stewardship Council (MSC)-certified skipjack tuna, caught and processed in the pristine waters of our Parties to the Nauru Agreement (PNA) nations. I bet you are curious to know when you can expect to see the first products on your store shelves? Let us update you on that.*

Before an MSC-certified fishery can bring its product to the market, all stages of its supply chain need to be organized and set up to ensure that MSC fish are kept completely separate until they reach the consumer, and the scheme is audited and certified against MSC standards. MSC calls this the chain of custody (COC).

Due to the massive surface area that the PNA skipjack fishery covers (40% bigger than Europe), and the fact that most purse seiners do not land their catch directly at the canneries (but are instead transshipped in PNA port to carrier vessels to the processor), this extension of the COC is a separate challenge. Setting up such a system has required major innovations in procedures on how tuna are handled onboard, transshipped, and landed and how this system is managed and monitored. The PNA has taken up that challenge.

For our PNA free school, skipjack fisheries, that means that we will show to an independent (i.e. third party) that our supply chain, or COC, meets all of the very stringent conditions of the MSC programme: from the moment that the purse seiner leaves port to go fishing, to the moment it has discharged the tuna at the cold store.

Effectively, this requires that we make all of the people involved in this operation — observers, captains, crews and company management — fully aware of what is expected from them in their daily work, and held responsible. Intensive training programmes and

extensive manuals, for each part of the supply chain, have been designed to ensure that everyone involved is well informed, educated and tested. Throughout February, March and April of 2012, the PNA and Pacifical have joined efforts to instruct the PNA fishing and processing companies that have chosen to follow MSC's rigorous COC standards and to fish MSC skipjack in PNA waters for Pacifical customers all over the world.

For the past few weeks, seven major fishing and processing companies have been internally audited, and on the list are still five more to go for the introductory phase. The strengths and weaknesses regarding MSC's COC standards for each of these audited companies have been identified, fishing and processing companies are currently making the necessary adjustments.

Now that the training sessions and internal audits are almost finished, trial trips are being prepared to assess (onboard) the performance of the catching procedure and separation of the skipjack in different wells. The first trial trip was made last year, and now the final trials will follow this coming month, which — with transshipping — will last an average of 45 days.

As always, we will keep you posted!

*Source: Adapted from a PACIFICAL article, May 2012*  
(<http://www.pacifical.com/articles/00031.html>)

## OPRT study echoes PITIA concerns over rapid increase in small tuna longliners

*In late 2011, concerns were raised by the Pacific Islands Tuna Industry Association (PITIA) with Japan's Organisation for the Promotion of Responsible Tuna (OPRT), regarding the rapid expansion in the number of small tuna longliners (50–150 gross registered tonnage). OPRT responded by commissioning a study on the issue, conducted by Japan's National Resource Institute of Far Seas Fisheries. The results of this study were presented at OPRT's fourth annual seminar in Tokyo on 10 February 2012 by Mr Jiro Suzuki.<sup>1</sup>*

An investigation into the state of the industry in all oceans indicated that, with the exception of the Indian Ocean, the real status of the small-scale longline fishing industry is currently not well understood by regional fisheries management organisation. Mr Suzuki estimated that up to 5,400 small longline vessels could be operating globally, with 1,800 of these operating within the waters of the Western and Central Pacific Fisheries Commission. An additional 50–60 Taiwanese small longline vessels with onboard super-refrigeration status are reportedly currently under construction in Taiwan.<sup>2</sup>

According to Mr Suzuki, the burgeoning of small-scale vessel numbers stems from several factors:<sup>3</sup>

- various Pacific Island countries are accommodating additional fishing vessels, in conjunction with their growing drive to develop their tuna fishing industries;
- former Taiwanese shark-finning vessels are converting to albacore vessels due to prohibitions introduced on sharkfin fishing;
- vessel construction and operation of small- and medium-sized longliners is far more economical than operating large-scale longliners, which by comparison are in decline; and

- traditional refrigerated carriers are being gradually replaced with more versatile individual super-refrigerated (-60°C) cargo containers, which are well suited to accommodating small catch consignments; super-refrigerated storage capacity has also been developed on vessels.

Concerns were raised in the study about the sustainability of bigeye and yellowfin stocks — the mainstay species of Japan's sashimi industry and also the target species for longline vessels. The Japanese fishing industry, like PITIA members, are concerned about the growing catch capacity of small-scale vessels and subsequent competition for its already suffering longline industry. In his presentation, Mr Suzuki appealed to the Japanese government to show initiative in regulating the growth of small-scale longliners to protect tuna resources from overexploitation,<sup>4</sup> in the hope that other regional fisheries management organisation members will also follow suit.

*Source: Adapted from FFA Fisheries Trade News volume 5, Issue 1, January–February 2012<sup>5</sup>*



Carefully checking the line being hauled on a small tuna longliner in Vanuatu (Image: William Sokimi).

<sup>1</sup> Suisan Keizai 2012, "Measures required to prevent over-fishing", 14 February 2012.

<sup>2</sup> Minato Newspaper 2012, "Sudden increase in small tuna long-liners", 14 February 2012.

<sup>3</sup> ibid. Suisan Keizai 2012, Minato Newspaper 2012.

<sup>4</sup> Suisan Tsushin 2012, "Refridgerated containers changing the tuna industry", 14 February 2012.

<sup>5</sup> <http://www.ffa.int/node/600>

## Solomon Islands industry supports university training

*In February this year, National Fisheries Developments (NFD) Limited and Soltai Fishing and Processing Limited, the Solomon Island tuna fishing and processing operators, welcomed six Solomon Island students from the University of Natural Resources and Environment (UNRE) in Papua New Guinea to their Noro facility in the Western Province.*

This training opportunity came about through the planning and discussions between the Solomon Island (SI) Ministry of Fisheries & Marine Resources, UNRE and the EU-funded DevFish2 project, which is implemented by the Secretariat of the Pacific Community and the Forum Fisheries Agency. It was deemed sensible and cost-effective to have Solomon Islands students do their industrial work placement in Solomon Islands.

Most of these students are in their third year, and all are enrolled in fisheries and marine science programmes. As part of their programme, they are required to undertake a six-week industry attachment in a real working environment.

NFD and SOLTAI were only too pleased to offer this work opportunity to the local Solomon Island students, two female and four male. NFD Director, Adrian Wickham said, "This opportunity is one that should be encouraged and developed strategically, in collaboration with higher learning institutions like UNRE, where young SI students like these six can learn and benefit from actual work experience before they leave university."

He added, "NFD/SOLTAI have always been receptive to developing the Solomon Island human resource capacity, so that the local private sector in this industry is serviced by skilled locals and, importantly, this is an employment advantage for Solomon Islanders."

All the students said that they would try to get plenty of real work experience from whatever the company managers have them do during the six weeks. They hope to learn not only how applicable their technical fields of study are but also to understand and appreciate the practical and real environment of a work place. All the students hope to enjoy their six weeks at Noro.

The DevFish2 project provided funding support for the students' travel cost and their daily subsistence allowance for the six weeks.

*Source: Solomon Star, 31 March 2012*



*The six UNRE students during their six-week industry attachment at the NFD/SOLTAI facility in Noro.*

### For further information

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## When humans first plied the deep blue sea

*In a shallow cave on an island north of Australia, researchers have made a surprising discovery: the 42,000-year-old bones of tuna and sharks that were clearly brought there by human hands. The find, reported online in Science, provides the strongest evidence yet that people were deep-sea fishing so long ago. And those maritime skills may have allowed the inhabitants of this region to colonise lands far and wide.*

The earliest known boats, found in France and the Netherlands, are only 10,000 years old, but archaeologists know they don't tell the whole story. Wood and other common boat-building materials don't preserve well in the archaeological record. And the colonisation of Australia and the nearby islands of Southeast Asia, which began at least 45,000 years ago, required sea crossings of at least 30 kilometres. Yet whether these early migrants put out to sea deliberately in boats or simply drifted with the tides in rafts meant for near-shore exploration has been a matter of fierce debate.<sup>1</sup>

Indeed, direct evidence for early seafaring skills has been lacking. Although modern humans were exploiting near-shore resources<sup>2</sup> such as mussels and abalone, by 165,000 years ago, only a few controversial sites suggest that our early ancestors fished deep waters by 45,000 years ago. (The earliest sure sites are only about 12,000 years old.) Among the sceptics was Susan O'Connor, an archaeologist at the Australian National University in Canberra. "The evidence was pretty slim," she says.

That is until she excavated a shallow cave called Jerimalai on East Timor, an island nation just north of Australia. In the earliest levels of Jerimalai, dated to 42,000 years ago, about half of the fish are fast-swimming species, such as tuna and sharks, which live in deep waters. O'Connor's team also found a fishhook at Jerimalai made from a mollusc shell and dated to 23,000 years ago, which the team claims is the earliest definite evidence for line fishing. (There are claims for fishhooks in Europe going back about 20,000 years, but the dating is less certain.)

The new evidence "certainly suggests that people had advanced maritime skills" by 42,000 years ago O'Connor says, at least "in terms of fishing technology". The finds indicate that this mastery of the sea "must have been one of the things that allowed the initial colonisation" of East Timor and other Southeast Asian islands, such as Papua New Guinea and Indonesia. But O'Connor cautions that there is still no direct evidence about the maritime skills of the first people who colonised Australia, leaving open the possibility that they drifted there with the tides.

Archaeologist James O'Connell of the University of Utah in Salt Lake City, who has argued that "a broad range of evidence" points to deep-sea fishing between 45,000 and



*Archaeologists have found evidence of deep-sea fishing 42,000 years ago at Jerimalai, a cave on the eastern end of East Timor (Images: Susan O'Connor).*

50,000 years ago, says that the new evidence from Jerimalai "solidifies the case".

But William Keegan, an anthropologist at the Florida Museum of Natural History in Gainesville, points out that the relatively small size of the tuna found at Jerimalai — mostly between 50 and 70 centimetres long — suggests that they were immature, juvenile fish that might have been caught close to shore.

And Geoff Bailey, an archaeologist at the University of York in the United Kingdom points out that East Timor and the other islands in the area have very steep offshore topography, meaning that the deep waters favoured by adult tuna and sharks are very close to land. These species, Bailey says, "would likely come very close inshore and be catchable without necessarily requiring people to set off in boats".

O'Connor counters that even juvenile tuna are "fast moving", adding that "there is no way they could be speared off the beach or the reef". Fishing hooks and other evidence of maritime technology have yet to be found in the earliest levels at Jerimalai, but she and her team plan to continue excavating there in an attempt to find them.

*Source: Article by Michael Balter in Science Now, 24 November 2011<sup>3</sup>*

<sup>1</sup> See: <http://www.sciencemag.org/content/318/5849/388.full>

<sup>2</sup> See: <http://www.sciencemag.org/content/318/5849/377.1.full>

<sup>3</sup> <http://news.sciencemag.org/sciencenow/2011/11/when-humans-first-plied-the-deep.html#>

# Reef and lagoon fisheries yields in Moorea: A summary of data collected

*Pierre Leenhardt,<sup>1,3</sup> Rakamaly Madi Moussa<sup>1,3</sup> and René Galzin<sup>1,2</sup>*

## Introduction

Due to their diversity of animal and plant species, coral reefs are among of the most productive and complex marine ecosystems in the world (Birkeland 1997; Grigg et al. 1984; Letourneur and Chabanet 1994). Covering a surface area of 255,000 km<sup>2</sup> (Spalding and Grenfell 1997), coral reefs support the development of local and national economies and provide a large number of goods and services to island communities through fisheries and tourism (Moberg and Folke 1999).

Exploiting reef ecosystems and their resources, including fisheries, is of major importance to many Pacific Island countries and peoples, especially those in the South Pacific (Ferraris and Cayré 2003; Kronen 2007). These largely small-scale fisheries call on a variety of fishing strategies (e.g. commercial fishing, recreational fishing, subsistence fishing). These multi-species and multi-gear fisheries and their widely scattered landing sites, do not facilitate the task of collecting reliable data to quantify such activities (Ferraris and Cayré 2003). Total artisanal fishery production<sup>4</sup> in the South Pacific has been estimated at 100,000 t, with significant disparities between islands. In addition, some 80% of these landings come from subsistence fisheries activities (Dallzell et al. 1996). The absence of any large single-species stock, the difficulty that fishing vessels have in gaining access to coral reefs, and the possibility of ciguatera on certain islands explain why reef fisheries are mainly artisanal or traditional.

Given that fishing activities in French Polynesia are widely dispersed, it is extremely difficult to get accurate catch figures. Current statistical data are not reliable because these figures cover inter-island air transport but do not include subsistence and recreational fisheries. While only limited statistics exist on lagoon products, French Polynesia's total production can be estimated at about 4,300 t annually (SPE 2006). Production is thought to be distributed as follows: 3,400 t of lagoon

fish, 700 t of small pelagic fish, and 200 t of other types of catch (e.g. molluscs, crustaceans, echinoderms).

Artisanal fisheries are an integral part of the French Polynesian lifestyle. They are roughly divided into three categories: oceanic fisheries, coastal fisheries and lagoon fisheries. Lagoon and/or reef fisheries, which are the focus of this article, can be described as "all the activities that are involved in exploiting biological resources and are carried out on the fringing and barrier reefs, channels, passes and *hoa* (or lagoon in the widest sense) and on the first few metres of the outer slope (depths <80 to 100 m) to the very limits of coral growth" (Galzin et al. 1989; SPE 2006).

Fishing activities on Moorea are important socio-economically because they provide income from fish sales as well as food security<sup>5</sup> (home consumption) (Aubanel 1993). Moorea has experienced very high population growth over the past 36 years. Population census figures for Moorea went from 5,058 to 16,490 between 1971 and 2007 (ISPF 2007) — an annual population growth rate of 2.39%, which is higher than the rate for French Polynesia as a whole (1.57%). In addition, elsewhere in the Pacific Islands, fishing pressure is directly linked to the number of inhabitants (Jennings and Kaiser 1998; Russ and Alcala 1989). Given these demographics and growing urbanisation, it is vital to get a precise picture of Moorea's fisheries activities. A large number of studies since 1985 have attempted to assess fish production<sup>6</sup> (Galzin 1985) or reef and lagoon fisheries yields<sup>7</sup> (Aubanel 1993; Brenier 2009; Vieux 2002; Yonger 2002) on Moorea. As in other coral island settings, quantifying lagoon fisheries here has proven to be a particularly difficult exercise for many reasons. Fishing is often done at night (with or without a boat), is widely dispersed, uses many different types of gear, and landings and sales do not take place at specific sites but rather anywhere along the coast and often even on private stretches of coastline on family properties (Fig. 1).

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<sup>4</sup> Total catches by a fishery over a year (given in tonnes).

<sup>5</sup> Part of the fishery catches are destined for home consumption within the family.

<sup>6</sup> Fish biomass (in tonnes).

<sup>7</sup> Reef and lagoon fisheries yield corresponds to the fishery production of all lagoon fishing activities, which is expressed in the form of yield (i.e. catches in tonnes per surface area unit, or km<sup>2</sup>, over a period of time, generally one year). It is also called fisheries performance.



Figure 1. Lagoon fish sold along the roadside on Moorea (Images: R. Madi Moussa).

Research methodologies used between the times of Galzin (1985) and Brenier (2009) have also evolved considerably. Over the space of 25 years, five different studies attempted to evaluate Moorea's lagoon fishery production (in the form of yield), and only two studies (Aubanel 1993 and Vieux 2002) used the same methodology. Fishery production estimates for Moorea's lagoon vary widely from one study to the next — even more so depending on the methodology used. The goal of this study is to review studies conducted over the past 25 years that describe lagoon fishing activities in Moorea. Special attention is paid to examining the limits of the various estimation methods used in each study so as to decide which lagoon fishery production estimate seems to be the most realistic.

## Materials and methods: Characterising lagoon fisheries activities on Moorea and reviewing the various methods used for estimating fishery production

### Study site

Moorea lies 25 km northwest of Tahiti (17°30' S, 149°50' W). Triangular in shape, the island covers a surface area of 134 km<sup>2</sup>, with a maximum elevation of 1,207 m (Mount Tohivea), and has a 61-km-long coastline (Fig. 2).

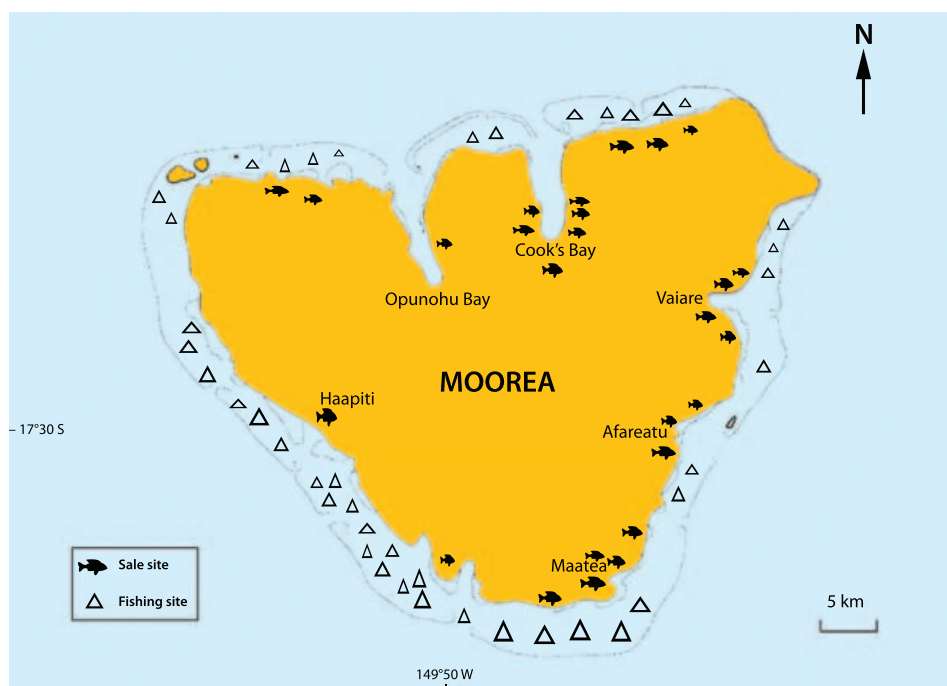


Figure 2. Moorea's fishing and landing sites.

The island is surrounded by a barrier reef that encloses a 49 km<sup>2</sup> lagoon, whose width varies from 500 m to 1,500 m, with depths of 0.5–30 m. The barrier reef has 11 passes that vary in depth (Galzin 1985). The entire coral ecosystem remains submerged at low tide and the tidal range is only about 40 cm. Moorea has a moist tropical climate with two distinct seasons — a hot rainy season from November to April and a cool, less rainy season from May to October. Moorea has a marine area management plan (PGEM), the first in French Polynesia, which applies to the township of Moorea by Order no. 410/CM dated 21 October 2004. The PGEM has four objectives: 1) rational use and development of resources and the area; 2) managing conflicts regarding lagoon use; 3) controlling pollution and damage to marine environments; and 4) protecting marine ecosystems and endangered species.

### Moorea's lagoon fisher population

According to Yonger (2002), Brenier (2009) and Leenhardt (2009), there are three categories of fishers on Moorea: commercial fisher, subsistence fisher and recreational fisher (Table 1).

In all, 23.2% of Moorea's population is involved in fishing: 16% for recreational purposes, 4.6% for supplementary income (subsistence) and 2.6% are commercial fishers (Brenier 2009; Leenhardt 2009; Yonger 2002). While commercial and subsistence fishers are all Moorea residents, a certain number of recreational fishers come from the nearby Society Islands, mainly Tahiti (Leenhardt 2009). It should be noted that more than 70% of the people who fish on Moorea are recreational fishers. None of the catches from this category of fisher appear in the fisheries data collected at landings or at sales sites. Moreover, according to Yonger (2002), subsistence fishing may account for 58% of the catches in the lagoon. Also, a percentage of those catches are never recorded because they are directly destined for home consumption.

### Lagoon fisheries techniques

The extremely wide diversity of lagoon catches explains why there are so many fishing techniques, each adapted to very specific organisms. Given the many different

techniques, fishers often use a multidisciplinary approach, using several techniques depending on their preferences and resources, season, weather conditions, target species, and time of day. The main gear types used in the lagoon are spearguns, nets (gillnets or nets with pot traps), lines (handlines, hook-and-line, trolling, bottom longlines), harpoons, beach seines, cast nets or scoop nets (Leenhardt 2009; Yonger 2002). Fish traps, which are widely used in the Tuamotu and Leeward Islands, and account for 90% of catches in those areas (Galzin et al. 1989), are not used in Moorea's lagoon.

#### a. Net fishing

Net fishing is commonly used on Moorea and takes a wide variety of forms: gillnet fishing; beach seine net fishing (used seasonally on bay floors to catch *ature*, or *Selar crumenophthalmus*); funnel net fishing (*haapua*), which includes a wire net that targets parrotfish, trevalies, surgeonfish and goatfish; cast nets and scoop nets, which are used to catch flyingfish.

#### b. Speargun fishing

This technique is widely used on Moorea, both during the day and at night with a powerful electric torch. When this type of fishing is done at night, it is very effective, providing high yields per fishing trip. This technique accounts for about 29% of lagoon fish production in the Windward Islands as compared with 18% in the Leeward Islands (SPE 2006). This type of fishing is very selective but can lead to local overexploitation of stocks because so many species (80%) are non-migratory and tend to be confined to a specific habitat (Lecaillon et al. 2000).

#### c. Line fishing

Line fishing is done directly from the coastline or from vessels powered by oars or 2–25 hp outboard motors. The different techniques include trolling, bottom longlining, fishing with artificial lures, using lines with one or more hooks, and fishing with natural and live bait.

#### d. Pot and trap fishing

This technique mainly targets fish but also crabs and other crustaceans.

Table 1. Classification and characteristics of fishers on Moorea.

Commercial fisher	Subsistence fisher	Recreational fisher
Two to five fishing trips per week	One to three trips per week	One to four trips per month
Sells catch	Some of the catch is sold and some is kept for home consumption	Catch is for home consumption
Fishing is the main source of income for the year	Fishing is a supplementary form of income	Fishing is primarily a recreational activity

### An overexploited lagoon?

Results of perception surveys by Brenier in 2009 clearly indicate that Moorea has experienced a decline in the abundance and size of food fish species, increased scarcity of giant clams, decreased live coral cover, and increased macroalgae cover. By extrapolating these data, he also estimated the fisher population at 77 fishers km<sup>-2</sup>, with 1,916 ± 530 motor boats and 481 ± 68 fishing trips km<sup>-2</sup> each month. The latter figures show the intensity of fishing pressure on Moorea's coral ecosystems and are potential indicators of overexploitation. Fishing pressure can be considered high with 5 fishers km<sup>-2</sup> (McClanahan et al. 2002).<sup>8</sup> These observations by the local population are potential signals of the overexploitation of lagoon resources.

In addition, in 2005, using underwater surveys Lison de Loma noted a decrease in the size of herbivores. In 2008, several photo identification campaigns involving lagoon fish catches sold along the roadside clearly confirmed a decrease in the size of all marketable fish (Madi Moussa 2010). In addition, most catches are taken with spearguns, a type of gear that is very selective. It would be reasonable to think that each fisher tries to maximise the sizes of catches so as to optimise profits. So the size ranges of the marketable species sold on the roadside represent the maximum size values for fish that can be caught by spearfishing. They are, therefore, good indicators of the maximum fish sizes found in the lagoon. Also, while over the past decade, most fishers say that they are still catching as many fish, they all agree that their fishing effort has increased (Leenhardt 2009). All of these perception indicators and field data tend to confirm the idea that Moorea's lagoon is overexploited.

### Estimation methodologies

The maximum sustainable yield<sup>9</sup> (MSY) calculations that Galzin (1985) used were based on fish production data obtained by monitoring the three main species in Moorea's lagoon — the herbivorous fish *Ctenochaetus striatus*, the omnivorous fish *Stegastes nigricans* and the carnivorous fish *Sargocentron microstoma* — and



Women gillnet fishing in Moorea's lagoon  
(Image: R. Madi Moussa).

extrapolated to total biomass along with the reef and lagoon fisheries production estimate that Munro made in 1984. Even though this MSY figure is more than 25 years old, it is worth using it because it is the only estimate done on Moorea. It served as a comparison for the orders of magnitude of fishery production estimates from the many studies that followed, and allowed comparisons between regions (Labrosse et al. 2000).

In order to assess lagoon fisheries yields, several estimation methods were used on Moorea, including such indicators as catches, tax on fish sold at the Paopao market, counting the number of fish sold on the roadside, and even house consumption data for the island. The results differed from one method to the next, often with very high ranges. However, the data from these methods provided information on fishers' catches and helped discern fishing pressure.

<sup>8</sup> It should be pointed out that the fishers listed were not all commercial fishers, who account for only 1% of the population, as the others were semi-commercial (6% of Moorea's population) and recreational fishers (17% of Moorea's population) (Brenier 2009).

<sup>9</sup> Maximum sustainable yield (MSY) is the largest quantity of biomass that can be removed from a fishery stock on average over the long-term under existing environmental conditions without affecting the reproduction process.

### a. Estimating biomass and MSY

In 1985, Galzin studied the population dynamics (biology, biometry, stock, biomass, growth, production) of the three species and the different trophic levels in order to assess fish production in a reef and lagoon sector in northwest Moorea. These three species account for 74% of the total fish biomass of the fringing reef at the edge of the channel. The total biomass and the biomass for those three species were estimated at 103.4 g m<sup>-2</sup> and 74.2 g m<sup>-2</sup> year<sup>-1</sup>. Those figures made it possible to calculate MSY ( $Y_{MAX}$ ).

$$Y_{MAX} = X (Y + MB)$$

$$Y_{MAX} = \text{maximum sustainable yield (MSY)}$$

$$X = \text{correction factor} = 0.3 \quad (\text{Galzin 1985})$$

$$Y = \text{annual fisheries yield} = 10 \text{ t km}^{-2} \quad (\text{Munro 1985})^{10}$$

$$M = \text{natural mortality}$$

$$B = \text{mean biomass}$$

$$F = \text{fisheries-related mortality} = Y/B \quad (\text{Munro 1985})$$

$$Z = \text{total mortality} = M + F = P/B \quad (\text{Munro 1985})$$

$$P = \text{biological production}$$

$$Z = P/B = 74.2 / 103.4 = 0.72$$

$$F = Y/B = 10/103.4 = 0.09$$

$$M = Z - F = 0.72 - 0.09 = 0.63$$

$$Y_{MAX} = 0.3 (10 + (0.63 \times 103.4)) = 23$$

$$Y_{MAX} = 23 \text{ t km}^{-2} \text{ year}^{-1}$$

### b. Galzin's initial approach in 1985: the PaoPao market tax

Built in 1987, the Paopao market was the single official point of sales where, theoretically, all fishers from the north side of the island had to sell their fish, following an order that no longer authorised the sale of fish from along the roadside<sup>11</sup> (Aubanel 1993). According to observations and studies by Galzin et al. in 1989, total catches were roughly estimated at 7 t during November. This estimate was based on the fact that the township levied

a tax of XPF 10 per kilo sold. Based on total catches for November, excluding pelagic fish, a figure for tonnage per production year was obtained.

### c. Survey of roadside fish sales

In 1993 Aubanel, estimated Moorea's fishery production by inventorying *tui*<sup>12</sup> (Fig. 1) sold along the roadside and at the Paopao market. The weight was estimated by extrapolating the number of *tui* sold each year and multiplying the number of *tui* by 3 kg (the average weight of a *tui*). In 2002, Vieux repeated the same protocol to characterise lagoon fisheries and measure quantitative changes in this activity.

### d. Consumption survey

In 2002, Yonger proposed a study based on a household lagoon-fish consumption survey to assess fishery production. An analysis of seafood consumption can be a good alternative for indirectly assessing fishery production (Gilbert 2006; Labrosse and Letourneur 1998; Labrosse et al. 2000; Loubens 1975; Paddon 1997). To be valid, this method requires that the case study be a well-defined system with low quantities of imported or exported reef and lagoon fish. On Moorea, it can be seen that catch exports are limited to recreational fishers who come over from Tahiti on the weekends. Fish imports are also relatively low and correspond to the sales of some pelagic fish (*ature*) from Tahiti or coolers sent from the Tuamotu Islands (Leenhardt 2009). In general, Moorea can be considered to be a virtually closed system because lagoon fish imports and exports have been deemed negligible (Brenier 2009). In all, 136 households were sampled (i.e. 4.9% of Moorea's household population).

As a comparison, a survey had just been carried on a village on Moorea. In 2006 Kronen conducted a socioeconomic survey in the township of Maatea in southern Moorea for the PROCFish project<sup>13</sup>. Of the 235 households in the township, 28 households (12%) with 112 people were surveyed and interviewed. This sample provided socioeconomic data on 25 fishers in the township (i.e. nearly 8.5% of the total presumed number of fishers in the township). Kronen precisely described the fisher population, particularly its composition (i.e. 18% commercial fishers, 11% subsistence fishers and 71% recreational fishers).

<sup>10</sup> Munro (1985) gave a figure of 15 t km<sup>-2</sup> year<sup>-1</sup> for all fish, crustaceans and molluscs, and Russ and Alcalá (1989) gave yields of 0.4 to 40 t km<sup>-2</sup> year<sup>-1</sup> for fish in small areas of active coral growth (Yonger 2002).

<sup>11</sup> Since 1989, because the order is no longer applied several sales sites have reappeared around the island.

<sup>12</sup> A wreath of fish consisting of one or more species, tied together with plant fibre drawn through their gills and then suspended on a metal holder, which forms the sales unit.

<sup>13</sup> The Pacific Regional Oceanic and Coastal Fisheries (PROCFish) project was funded by the European Development Fund (EDF) and implemented by the Secretariat of the Pacific Community (SPC). The project was initiated in March 2002. The coastal component of PROCFish was designed to enhance management of reef fisheries in the Pacific Islands by providing Pacific Island governments and communities with accurate, unbiased scientific information about the status and prospects of reef fisheries. Seventeen countries and territories were targeted by the project.

### e. Participatory method

Brenier carried out the most recent survey designed to estimate (indirectly) the fishery production of Moorea lagoon in 2009. It was based on participatory monitoring of reef fisheries through household surveys that were designed to collect data on consumption and fishing activity from large sample groups. Fishery production was estimated using surveys by schoolchildren, which provided detailed information on the fishing trips of one fisher in the household over a two-week period.

There were three or four parts to the questionnaire distributed to schoolchildren. The first part was designed to gather general information on the household's fishing activities and fish consumption (e.g. address and size of household, how often fish was eaten, origin of the fish eaten, number of boats, number of fishers). The second part included questions on the number of fishing trips of one fisher in the household over a two-week period (so as to cover one spring tide period and one neap tide period) along with the names, sizes and number of fish eaten at meals over the previous three days. These surveys involved 137 participants (i.e. 4.4% of household population), and the questionnaire return rate was 68%. The schoolchildren received training in how to carry out the survey in their homes using one questionnaire each.

## Results: Overview of various fishery production estimates for Moorea

Reef and lagoon fisheries yield estimates for Moorea vary greatly from one estimation methodology to another (Table 2), and there is considerable differences in their approaches. Yield estimates based on catch data give us relatively low figures for the island's fisheries yields (from 0.7–2.2 t km<sup>-2</sup> year<sup>-1</sup>). On the other hand, data from consumption surveys or participatory surveys estimate fishing yields at between 20 t km<sup>-2</sup> year<sup>-1</sup> and 25 t km<sup>-2</sup> year<sup>-1</sup>.

## Discussion

The significant differences noted between catch monitoring methods and those for socioeconomic surveys incite us to discuss the various limitations of each study so as to give our views on which lagoon fishery production estimate seems to be the most realistic.

### Monitoring catches, landings and sales

An analysis of the methods used by Galzin, Aubanel and Vieux indicate that fishery production was underestimated, mainly because catches from recreational fishing and the quantities commercial and subsistence fishers ate themselves were not counted. In general, these studies demonstrated the difficulty in monitoring fishing activities in peri-urban island settings. The increase in population, the emergence of new markets (e.g. direct sales based on advance orders), and the discontinued use of the Paopao central market make it increasing difficult to monitor fish landings and estimate fishing production using the catch observation method. In fact, the dispersed nature of landings and the importance of lagoon fishing from a socioeconomic point of view do not facilitate the task of quantifying fish catches. On the other hand, monitoring roadside sales can be an excellent way of discerning fishing pressure by noting the sizes of the fish sold (Madi Moussa 2010). The assessment of fishery production that resulted from monitoring the municipal tax (Galzin et al. 1989) was an underestimate because it only took into account the percentage of fish that were sold, whereas, according to Vieux (2002), such catches only account for 40% of the overall quantity caught in the lagoon. In the same way, Aubanel (1993) and Vieux's (2002) studies — two observations a decade apart that used the same methodology — gave yields that were once again underestimated. However, the three studies gave similar yield figures, which is normal because the sample concerned fishers who sold their catches on the roadside and did not take into account home consumption. The entire coastline of Moorea is a potential landing

Table 2. Yield estimates per surface area unit by type of survey.

Yield (t km <sup>-2</sup> year <sup>-1</sup> )	Type of data	Source
24.5	Participatory surveys carried out by schoolchildren on Moorea	Brenier 2007
28.14*	Socioeconomic surveys in the village of Maatea on Moorea	PROCFish 2006
22.9	Direct consumption surveys	Yonger 2002
1.01 to 2.2	Quantities sold on the roadside	Vieux 2002
0.7 to 1.4	Quantities sold on the roadside	Aubanel 1993
1.2 to 1.4	Extrapolation of fishing data	Galzin et al. 1989

\* Reef fishery yield for the township of Maatea only.

area for fishers so it is very difficult, if not impossible, to monitor catches that do not go through conventional sales channels. In addition, this technique ignores recreational fishing catches, which are not counted despite their high levels (Brenier 2009).

### *Consumption surveys and bias*

When you look at the average annual, per capita consumption of fish, French Polynesia is considered to be one of the countries with the highest levels of consumption (Kronen et al. 2006). On Moorea, annual consumption is nearly 110 kg per inhabitant (Yonger 2002), whereas the mean annual per capita figures for the Pacific Islands region are between 4.8 kg and 40 kg, with an average of 23 kg (Labrosse et al. 2006). Even if it is difficult to compare the results of consumption surveys carried out under different circumstances and using different methodologies, the gap between the estimates in French Polynesia and the maximum values for other Pacific Islands countries is intriguing and encourages consideration of possible biases of these methodologies and the context of each survey.

In regards to survey methodology, it can be seen that of the four variables used to collect data during a consumption survey — fish family, origin of fish eaten, quantity eaten at each meal, and weekly frequency of meals — only “weekly frequency of meals” appears to be slightly overestimated (Gilbert 2006). This slight overestimate may be due to a poor interpretation of the term “meal”.

It may be that eating leftovers was reported as a meal, thereby artificially raising the number of meals .

In terms of the context, the “one-off” nature of the surveys was a source of bias for the average annual estimates made. In fact, annual figures were extrapolated from average weekly estimates. This relationship was based on a presumption that eating habits and fishery production remain stable over time (Gilbert 2006). In the same way, quantities eaten were assessed based on the number of fish eaten by species, their sizes or, more rarely (for oceanic species), their weights. Fish sizes were generally estimated with gauges and size and weight conversions used biometric ratios. Size and weight ratios were not always calculated in a precise manner. In fact, when no species ratio existed, the studies used ratios for similar species (Gilbert 2006). So, the information collected from households was more qualitative than quantitative because it was based on perceptions. It called on the short-term memory of the person interviewed and his or her ability to convert an image or a memory into a physical size (Gilbert 2006).

However, indirect studies based on household seafood consumption surveys do offer a good alternative for studying fishery production in these settings. Among other things, they take into account the catches of all types of fishers, including recreational fishers. They have also been subjected to a larger number of studies over the past few years (Kuster et al. 2006; Lagadec 2003; Léopold et al. 2004; Yonger 2002). Léopold et al.



*In Moorea, Brenier trained schoolchildren in how to carry out household fish consumption surveys in their homes. Average per capita consumption of lagoon fish calculated from data collected by these schoolchildren was almost the same as that calculated from data collected by scientists in previous household surveys (Image: A. Brenier).*

(2004) calculated the prediction error for production based on consumption surveys to be 4.5%. Kuster et al. (2006) showed that catch estimates, fishing effort and fish consumption data (using household surveys) were coherent and did not differ statistically from those resulting from direct surveys. As with participatory surveys, there were no differences between average per capita consumption of lagoon fish calculated from the data collected by schoolchildren or from data collected by scientists (Brenier 2009). Other studies where schoolchildren were involved in the collection of scientific data have shown that they can produce reliable data (Au et al. 2000; Delaney et al. 2008; Nicholson et al. 2002).

### Which fishery production estimate is the most reliable?

Based on the obvious signs of overexploitation noted in Moorea's lagoon and the MSY figure of 23 t km<sup>-2</sup> year<sup>-1</sup> calculated by Galzin in 1987, it is reasonable to think that Moorea's current reef and lagoon fisheries yield is higher than that figure, and is probably closer to 25 t km<sup>-2</sup> year<sup>-1</sup>. This would tend to confirm that indirect estimate studies based on consumption and perception surveys are the most relevant for estimating fishery production and yields in Moorea's lagoon.

## Conclusion

Fishery activities in Moorea's lagoon are quite difficult to monitor and assess because they vary greatly and are quite dispersed. Several categories of fishers (commercial, subsistence and recreational) use a wide range of fishing techniques for sales, exchange, and home consumption purposes. Over a period of 25 years, several studies have tried to assess fishery production in Moorea's lagoon, with each study using a specific methodology. There is a wide gap in the estimates of fishery production when using catch monitoring methods (0.7–2.2 t km<sup>-2</sup> year<sup>-1</sup>) and when using consumption or participatory socioeconomic consumer surveys (22.9–24.5 t km<sup>-2</sup> year<sup>-1</sup>). Taking into account the bias found in each estimating method, it seems that methods involving socioeconomic surveys give the most realistic fishery production estimates. In fact, those methods are better at taking into account catches by all fishers in contrast to catch monitoring methods that only consider catches that are sold but not those from recreational fishing. Finally, signs of overexploitation in this lagoon have lead us to think that current fishery production is probably higher than the MSY of 23 t km<sup>-2</sup> year<sup>-1</sup> calculated by Galzin, and this would confirm that Moorea's current reef and lagoon fisheries yield is likely closer to the values estimated by socioeconomic surveys, about 25 t km<sup>-2</sup> year<sup>-1</sup>.

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# FADs – Are they all bad?

*By Tim Adams*

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***An article published in the American Samoan press in 2011 calls fish aggregation devices “Beehives of the Ocean”.<sup>1</sup> It firmly makes a case for having as many fish aggregation devices (FADs) in your waters as possible (at least 200 for each large vessel) and wishes to provide balanced information in the face of the “internal and external forces that wish to ban the use of FADs”.***

***On the other side is a groundswell of popular opinion that “FADs are bad” because fishing around them leads to more unwanted fish (bycatch) and smaller tuna being caught (FADs are a haven for the young and the despised of the fishy world), therefore FADs should be banned.***

Now I can understand someone in American Samoa running the flag up for FADs — after all Pago Pago is where the fraction of the US purse-seine fleet that is US-built and US-owned lands its catch, and these vessels use FADs more than most other fleets — a characteristic they have in common with fleets that started life in the eastern Pacific.

And I can understand environmental lobbyists trying to shoot that flag down. They have seen regional fisheries commissions in other oceans serially unable to agree to measures to effectively curb tuna fisheries when over-fishing occurs. Regional tuna commissions usually lack the legal clout of national fisheries administrations, and their members generally lack unanimity of purpose. Complex, finely-tuned measures designed to maximise yield while minimising the risk of biological harm are difficult to implement under such conditions, and “blunt instruments”, such as complete bans on certain gear-types such as FADs seem to be of more immediate practical benefit.

So is this all rhetoric? On both sides?

My view is this: FADs are no more intrinsically “bad” or “good” than any other piece of fishing gear. All fishing gear is designed to make it easier for humans to catch fish. But if there are too many people catching, or if the gear is too large-scale compared with the size of the fish stock, or if the size of the fish stock is reduced because of non-fishing impacts, then *any* fishing gear can become “damaging”.

Even fishing with bare hands — for example collecting intertidal shellfish — can become a problem if over done, and if the resources being collected are not “resilient”. Consider: it is easy to pick up every last giant clam on the reef top — giant clams need to expose themselves to sunlight to survive — and giant clams are

slow-growing, erratically recruiting animals. Giant clam populations are not resilient. But some organisms are more resilient. But would you be able to catch every last trochus, with the juveniles hidden in crevices and under rocks? For the ultimate in resilience, how about trying to catch every crown of thorns starfish? Many attempts have been made to eradicate those.

FADs have real advantages under certain circumstances:

- They can minimise searching time by boat users. And if that boat is a powered boat then less fuel may be used. FADs may even make it possible to use unpowered boats — paddle or sail-powered, where an engine would otherwise be necessary to search for fish. Thus FADs can be considered “carbon-friendly”;
- Reduced searching time also means more time is available in subsistence communities — of which there are many in the Pacific Islands — for other activities, once the basic protein needs of the family have been met. Under the right circumstances, inshore FADs can be considered “development-friendly”;
- Nearshore pelagic FAD-fishing can provide alternative livelihoods and food sources for people who are trying to rehabilitate or reduce fishing effort on reef or lagoon fisheries. Under the right circumstances FADs can be considered “MPA-friendly”;
- FADs can increase the catch per unit effort for certain types of fish. Sometimes dramatically. For example a purse-seine set on a FAD or other floating object in PNA waters can yield an average of 50% more skipjack by weight, than a similar set on a free school. (This is not a hard rule: Setting purse-seine nets around FADs produces less yellowfin tuna than free school sets, and in the far western Pacific, FADs actually produce a lower tonnage of fish per set than free schools, perhaps because the fish caught around

<sup>1</sup> <http://ip-208-109-238-104.ip.secureserver.net/viewstory.php?storyid=28873>

FADs are smaller, or the purse-seine gear used around FADs in the waters of the Philippines and Indonesia is perhaps smaller-scale than the gear used to catch free schools.)

And of course FADs have disadvantages under other circumstances:

- The very increase in catch per unit of effort that improves the efficiency of fishing can more quickly contribute to overfishing if market incentives, regulatory deficiencies, and poor stock status conspire to put a fish stock in a vulnerable state. For example, purse-seine sets around FADs can catch over six times as much bigeye tuna as free-school sets;
- Purse-seine catches around FADs contain a greater number of species than sets made around free swimming schools of tuna. And since purse seiners retain only tuna, those other species become bycatch — usually discarded;
- Purse-seine FAD sets produce smaller tuna, on average, than free schools. As well as increasing the risk of recruitment overfishing (through lower spawning potential), smaller fish have a lower value per unit of weight and are sometimes unsaleable. You may catch more fish but they may not be worth as much;
- Purse-seine fishing is a surface fishing method and the community of marine creatures around FADs is much more diverse than in free schools; thus, purse-seine fishing around FADs is likely to catch more surface-swimming, non-tuna species than other fishing methods around FADs, or than purse-seine fishing on free schools of tuna. Simply put: the surface biota contains a relatively high number of vulnerable species — think air-breathing species such as turtles and marine mammals, or species feeding on sunlight-dependent organisms.

So how do we weigh the relative values and horrors of FADs in terms of these pros and cons?

The simplest way is to bear in mind that there are essentially two types of FAD, depending on who is using them, and how.

1. “Oceanic” FADs — usually freely-drifting “d-FADs”, set far from shore, and used by large-scale (in the Pacific Islands region, usually foreign) vessels fishing for tuna, usually with purse-seine nets (although pole-and-line and troll vessels can also benefit from oceanic FADs);
2. “Coastal” FADs — usually anchored or tethered “t-FADs”, set relatively close outside the reef (within outboard or canoe range), and used by artisanal, local boats fishing with hook and line, and fully using the whole range of species caught. This kind of t-FAD may also benefit tag-and-release game fishing tourism.

I will leave it up to you to decide which kind of FAD is most “sustainable”, and under what circumstances.

The important thing to remember is that FADs are used in different situations, and while FADs may have unacceptable consequences in certain fisheries, in other circumstances they may be beneficial, particularly in developing country artisanal fisheries.

## Pacific Islands action on oceanic FADs

This is probably the time to point out that the countries that are Party to the Nauru Agreement (PNA) have decided that cutting down on the use of d-FADs by industrial tuna purse seiners in the western tropical Pacific will be part of their strategy for reducing fishing mortality on bigeye tuna to the levels advised by SPC’s fishery scientists to be sustainable.

The logic is simple. A purse-seine net set on a d-FAD in PNA waters will catch on average 600% more bigeye tuna than a free-school set. Reducing d-FAD use is one of the more effective ways of reducing fishing mortality on bigeye tuna — a species that is experiencing overfishing in the western tropical Pacific — without unduly impacting catches of skipjack (the main target species). The idea is to reduce the use of FADs by purse seiners and get them fishing on free schools of skipjack — and if everybody has to follow the same rules there should be no unfairness.

This logic was also picked up by the entire membership of the Western and Central Pacific Fisheries Commission in 2008 when the Commission agreed not only to a three-month annual closed season for FADs, but to actually start the Pacific-wide ban a year ahead of PNA’s ban.

The first year with a FAD closed season — two months in 2009 — did not appear to have a huge impact. But the PNA ruling that all purse seiners in PNA waters should have an observer aboard was not yet in effect and, judging by the number of pre-dawn sets made (it is normally only useful to set a purse-seine net in the dark if it is around a d-FAD — free schools have to be spotted by eye), and the average species composition of the catch, many vessels were apparently still using FADs in defiance of the closed season agreed to by their flag states.

However, the results are now in for the second western and central Pacific purse-seine FAD closed season (July–September 2010), and this one appears to have had a significant effect. The average catch composition changed, and in addition, many vessels seem to have also reduced their FAD use before and after the closed season. The results have been considered by PNA countries that have jointly decided to increase the length of the purse-seine FAD closed season to four months in 2012, with an option to extend this up to six months in the future.

The third purse-seine FAD closed season was in effect from 1 July to 30 September 2011 and the results are being analysed with close interest.

## The future of drifting FADs

Some governments are considering a complete ban on d-FADs as one of the potential future options, if the other existing strands in the regional bigeye tuna fishing mortality reduction strategy do not produce the desired results.

These other strands include preventing purse seiners (that they licence) from fishing in the high seas to the east of the region (where bigeye tuna turn up in purse-seine nets in larger proportions than in the west), requiring full retention aboard of all small tuna caught (small bigeye were often discarded, and retention introduces an economic incentive for trying to avoid catching too many of them), as well as increasing port sampling and observer coverage (small bigeye and small yellowfin are sometimes confused in vessel reports).

However, the jury is still out. A complete purse-seine FAD ban might well be a step too far, causing disproportionate hardship to skipjack fisheries for possibly little extra gain in terms of bigeye conservation. Purse seiners are not the only vessels catching bigeye tuna. In fact, longliners catch much more. Over the past 60 years, longliners have taken around 77% of the bigeye tuna caught in the western and central Pacific, and purse seiners around 15% (with the rest being

taken by other methods such as pole-and-line fishing and trolling) (Fig. 1).

However, the purse-seine impact on bigeye has been increasing, simply because purse-seining is a relatively new fishing method in this region and has grown rapidly. Summed over the last 15 years rather than the last 60 years, the purse-seine share of the bigeye catch has jumped to 27% of the total regional bigeye catch, and longlining has dropped to 64%.

A bigeye tuna caught by a longliner is far more valuable than a bigeye tuna caught by a purse seiner. For companies or countries that run both purse seiners and longliners, it makes a lot of economic sense to require their purse seiners to avoid bigeye so they can be caught by their longliners. In addition, longlining is a smaller-scale fishing method and may be seen as a more feasible development path for the Pacific Islands private fisheries sector than purse-seining.

However, purse-seine fleets, and the PNA small island countries that are highly dependent on the rentals they obtain from access by purse seiners to their waters, might justifiably ask why they should be required to bear most of the burden of bigeye conservation when the far more numerous longline boats face much lighter restrictions. Longliners are not required to have an observer aboard every vessel during every trip, their bycatch to target species ratio is much higher than for purse seiners, their reporting compliance is much lower, and their effort levels are not limited (at least not yet).

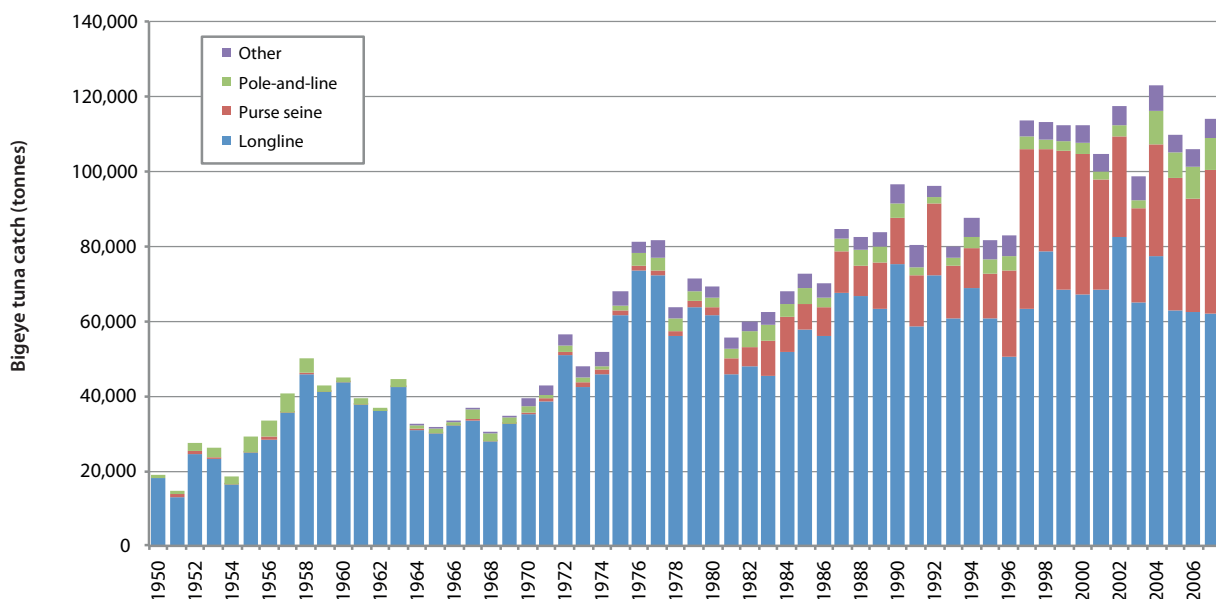


Figure 1. Annual catch (tonnes) of bigeye tuna in the western and central Pacific categorised by fishing method (Source of data: SPC Tuna Fishery Year Books).

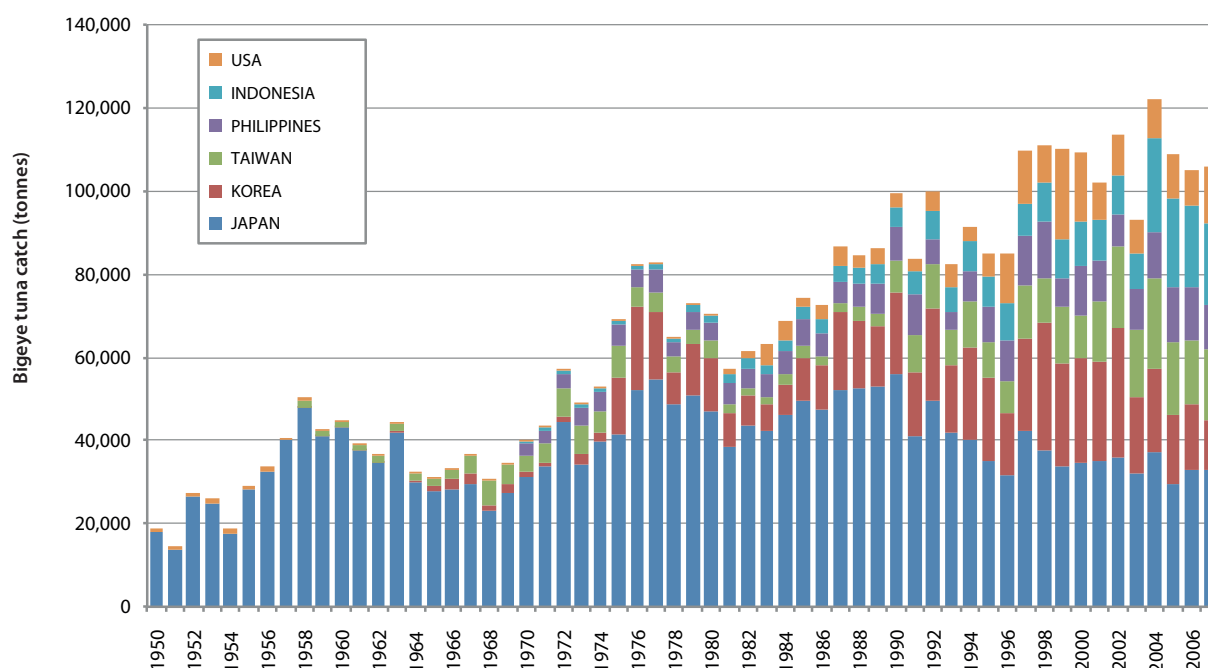


Figure 2. Annual catch of bigeye in the western and central Pacific categorised by catching vessel nationality (flag states with the top six largest catches only) (Source of data: SPC Tuna Fishery Year Books).

Whether or not further d-FAD limitations are imposed by PNA governments in PNA waters in the future, it is clear that purse-seine d-FADs need to be brought under the fisheries management umbrella alongside purse-seine vessels themselves. And this is something that is best done by agreement at the regional or subregional level. Like purse seiners, and the tuna stocks that they harvest, d-FADs are “highly migratory”. During the course of its short lifetime, a d-FAD is likely to drift through several national exclusive economic zones.

This year’s annual Meeting of the Parties to the Nauru Agreement discussed potential d-FAD management possibilities in some detail, and learned that it would be technically relatively simple to implement d-FAD tracking and reporting requirements through the existing electronic vessel monitoring system. As well as helping to better monitor and regulate d-FAD use this would also provide a quantum leap in the information available to oceanic fisheries and other scientists because many of these d-FADs not only have satellite location communicators, but also fish-finding equipment attached.

## Market forces

Another part of the PNA strategy to reduce reliance on d-FADs, and hence bigeye bycatch, by purse seiners is ecolabelling — using the carrot of the market rather than the stick of regulation. FAD-caught skipjack tuna has been excluded from the Marine Stewardship Council sustainability certification that has been granted to the PNA for skipjack caught on free schools in their waters.

With the MSC label attached, free school-caught skipjack will have a market advantage over FAD-caught skipjack from PNA waters. Purse-seine vessels that wish to obtain the price premiums and access the markets that the MSC approval unlocks will be able to apply for registration under the PNA programme, provided they are willing and able to follow PNA rules in order to qualify for the label. Strict net-to-cannery documentation and chain of custody controls are being implemented, using observers and inspectors to verify vessel, transport and cannery records, to ensure that FAD or floating object-caught fish are never mixed with free school-caught fish at any point in the supply chain.

Some worry that banning FADs will drive the price of tuna off the charts. Although it is unlikely that canned skipjack will ever command the same prices as, say, smoked wild salmon or caviar, anyone who has noticed the gourmet cachet that is attached to certain brands of fully traceable sardines, and who is aware of the increasing price trend for fisheries across the globe, knows that the day may well come when some brands of canned skipjack tuna are considered luxury items.

Is it a bad thing for Pacific Islanders if the price of cannery skipjack increases? It’s not as if Pacific Island nutrition will be affected — after all, Pacific Islanders are not dependent on locally canned tuna. They either catch their own fresh, or eat cheaper imported canned fish from the large continental-shelf fisheries at higher latitudes. And with discards now banned, a lot of very cheap tuna will increasingly be landed at Pacific Island ports. And tuna purse-seine owners are not without a

cent or two — witness the number of vessels that are currently under construction in Asia, intending to enter a Pacific Islands regional fishery that is currently very lucrative for Pacific rim businesses.

As far as I can see, an increase in the cannery buying price for skipjack has hugely more benefit for the Pacific than disadvantage. For those countries that cannot support the infrastructure necessary to run their own purse-seine vessels, a higher skipjack tuna price is going to lead to higher resource rentals per unit of catch, and at least three PNA economies are critically dependent on this source of income. For those Pacific Island countries that have their own fishing vessels, the benefits of higher catch values are obvious. And for the resource itself, a tight, well-controlled fishery, producing a highly traceable, high-quality product using reduced-bycatch fishing methods, has got to be beneficial.

Even the foreign purse-seine companies will benefit, at least those that work within regional standards and thereby on the one hand gain access to premium markets, and on the other hand avoid running foul of ever-more-efficient PNA fishery monitoring, control and surveillance measures.

Pacific Island countries with skipjack canneries, however, may worry that an increasing world price of raw material (landed skipjack tuna) will affect their economic feasibility. But if consumers are prepared to pay more for non-FAD caught skipjack, the increased cost of supply should be offset by increased retail prices. In any case, should we really be aiming for an increasingly high-volume, low-value form of production — a mechanism that is really only feasible in low-wage-rate economies or those with preferential access to large markets — or should we be trying to maximise the value of the finite natural resources available to us?

As the fisheries sector analysis for the Pacific Plan urged in 2004,<sup>2</sup> “most Pacific Island fish stocks, whether

offshore or inshore, are felt to be at their maximum safe level of production, and extra economic benefit is likely to be derived not from increasing overall fishing effort in the region but from (a) developing higher-price markets and higher-value or higher-quality products; (b) Pacific Island vessels substituting for distant water fishing vessels, or encouraging foreign vessels to land fish in Pacific Island countries for value-adding; ... Before trying to increase the economic value of fisheries and aquaculture however, it will be essential for PICTs to consolidate and sustain the value of what they currently have.”

And as the 2010 regional “Future of Pacific Islands Fisheries Study”<sup>3</sup> suggested:

“Offshore fisheries could support stable high catch rates with healthy tuna resources at levels that maximize benefits for PICTs. Effective use of sovereignty over these resources could leverage much greater economic benefits than at present. An orderly reduction of foreign access and its replacement by genuine locally based investments would see the development of competitive domestic industries. The growing Asian markets and the trend for eco-certification could create opportunities for innovative and alternative tuna products. The effective management of bycatch and the banning of discards could help supply the domestic market with fish at an affordable price.”

Restricting the use of d-FADs may have far-reaching effects.

*Source: Adapted from an article on the weblog “Gonedau – fishy musings from the Pacific Islands: A semi-personal take on fish and fisheries”, maintained by Tim Adams at <http://www.gonedau.blogspot.com>*

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<sup>2</sup> <http://www.spc.int/DigitalLibrary/Doc/FAME/Meetings/HOF/4/BP6.pdf>

<sup>3</sup> [http://www.spc.int/DigitalLibrary/Doc/FAME/Reports/Gillett\\_10\\_FutureFisheries\\_Report\\_and\\_appendices.pdf](http://www.spc.int/DigitalLibrary/Doc/FAME/Reports/Gillett_10_FutureFisheries_Report_and_appendices.pdf)