Australian Government

Australian Centre for International Agricultural Research

Final report

project

Evaluating the impacts of improving postharvest processing of sea cucumbers in the western Pacific region

project number	FIS/2010/096
date published	20 / 12 / 2017
prepared by	Steven Purcell
co-authors/ contributors/ collaborators	Poasi Ngaluafe, Sione Mailau Sailasa Tagica, Watisoni Lalavanua Karibanang Tamuera Aram, Erietera Aram Simon Foale, Paul Southgate, Ravinesh Ram Brian Cullis, Nicole Cocks
approved by	NA
final report number	FR2019-49
ISBN	978-1-925747-25-6
published by	ACIAR GPO Box 1571 Canberra ACT 2601 Australia

Contents

1 Acknowledgments

We thank Chris Barlow for guidance of the research. We are grateful for constructive suggestions by scientific review panel members: Prof. Johann Bell and Kalo Pakoa.

We acknowledge and thank all of the fishery officers in Kiribati, Tonga and Fiji who contributed to data collection and support of field trips.

The Pacific Community also gave support to the project. In particular, Ian Bertram and Aymeric Desurmont offered helpful advice through the project, and we gained substantial support in the production of the training manuals by Jipe Le Bars from the Publication Section.

Support was also provided by staff of the National Marine Science Centre, Southern Cross University, Kiribati Ministry of Fisheries and Marine Resources Development, Tonga Ministry of Agriculture & Food, Forests and Fisheries, Department of Fisheries Fiji, Partners in Community Development Fiji, and Wildlife Conservation Society (Fiji). We thank the Office of Research of Southern Cross University for administering the contracts and providing support to project development, and G. Foley at the National Marine Science Centre for general administration of invoicing and accounts.

2 Executive summary

Background

Sea cucumbers are significant to coastal Pacific Island communities as a high-value export to Asian dried seafood markets. More than 20 species are harvested from Pacific Islands. The dried form, called 'beche-de-mer', is a luxury food item in Asian cultures and part of Chinese traditional medicine.

The main issues facing sea cucumber fisheries in the Indo-Pacific region are the poor quality of processing by fishers, inequitable value-chains, and the inadequate and ineffective management frameworks, enforcement and governance of the fisheries. The price of beche-de-mer paid to village fishers by exporters depends on body size, species and the quality of postharvest processing. But few fishers in the Pacific have been adequately trained in the best-practice processing methods.

Researchable issues concerned the lack of consistent skills of village fishers in postharvest processing and consequent low sale value of beche-de-mer they produce. The aim of this project was to improve the income of village fishers in Kiribati, Tonga and Fiji through support to improve the quality of post-harvest processing of sea cucumbers.

Methodology

The research approach involved an implementation phase and an impact testing phase. The strategy for community impact involved giving fishers information sources on processing (training manual and video) and showing them via hands-on village-based workshops how to use them. The test of impact relied on comparisons of socioeconomic data between baseline surveys and follow-up surveys via questionnaire-based interviews of fishers and focus-group discussions with village women.

Hundreds of sea cucumber fishers were interviewed in Fiji, Kiribati and Tonga for the baseline surveys. This was done in multiple island groups in each country, and within multiple villages within each island group — thus comprising two spatial scales of sampling within countries. Fishers were interviewed irrespective of age, gender or frequency at which they fished for sea cucumbers.

Project collaborators in each country were trained in best-practice methods for postharvest processing by a commercial processor. We developed a 44-page training manual for village fishers, translated into local languages, and distributed copies to 6000 fishers. A companion training video in each language was made available on DVDs to each village, and online via YouTube and institutional websites. Lastly, we conducted 1½-day training workshops in each of 80 villages in the three countries.

Following the workshops, the national fisheries in Kiribati and Tonga were closed by moratoria due to fears of overfishing. Therefore, impact testing was conducted only in Fiji.

One year after providing fishers with the training, Fijian villages were revisited and sea cucumber fishers were interviewed. Focus-group sessions with women in each village provided qualitative and semi-quantitative data on their views about uptake of the interventions. Interviews with commercial processors were also held. The socioeconomic impacts of the project's training were assessed through analyses of the data using modern mixed-model analyses and from appraisal of the qualitative data.

A value-chain analysis was conducted to examine the proportionate changes in value of beche-de-mer from fisher, to middlemen traders, to exporters, and finally to retail markets in China. A study trip to the main Chinese markets in 2016 revealed the current prices of Pacific Island beche-de-mer and recent changes in prices.

Results

The baseline surveys yielded five scientific publications on postharvest processing methods (prior to the project's training), trends in fishing, socioeconomic context, and perceptions of fishers. Many fishers were heavily reliant on sea cucumbers as their primary source of income and around half of sea cucumber fishers were dissatisfied with the income they were making from fishing, processing and selling the products.

We trained more than 900 fishers in the village workshops. More than 95% of workshop attendees said they workshops changed their mind about processing. The online training videos have had more than 132,000 views on YouTube, but the DVDs did not turn out to be very accessible to fishers within the villages.

Fishers reported that the workshops were more useful than the manuals or training videos. A majority of fishers regularly referred back to the manuals, so these were an enduring information source. However, more than two-third of fishers reported problems in applying the new methods. A majority of the trained fishers said they had passed on the new methods to other fishers.

The new processing methods improved efficiency for some fishers, and generally did not demand more time on the fishers. More than 90% of fishers believed they improved the quality of beche-de-mer they processed using the new methods. Many of the trained fishers were salt-curing and cooking sea cucumbers for more correct amounts of time than untrained fishers. However, some fishers were still using poor methods.

Most fishers and village women did not think the project spurred other fishers to start fishing sea cucumbers. The training did not promote fishers to go fishing more often, but some trained women started collecting more sea cucumbers on fishing trips – probably low-value species. Analyses also showed that training in postharvest processing did not cause greater dependence on sea cucumber fishing.

Fishers who processed their catch were 2.6 times more likely to be very satisfied with the income from the industry. Trained fishers were more likely than untrained fishers to believe that they were receiving higher prices after the training. But their weekly incomes were not significantly improved, probably owing to external factors such as dwindling stocks and value-chain issues. In particular, fishers and village women said that many buyers were still not giving better prices, despite improved quality of the beche-de-mer. Most fishers also did not have access to buying coarse salt, which is helpful in processing to improve product quality and sale value.

The value-chain analysis revealed that most fishers lacked information about market prices and were getting proportionately low prices for the high-value species. Most of the profits for high-value species are taken by exporters and actors further down the value-chain (e.g. importers and retailers).

A further study showed high variation in incomes of fishers among regions in Fiji. On average, Fijian sea cucumber fishers relied on the resources for 60% of their weekly income. Women fishers had considerably lower incomes than male fishers. Fishers used a large amount of boat fuel each year. Estimates suggest that the total carbon footprint of the fishery in Fiji is comparable, or higher, than many industrial fisheries globally.

We updated the data on prices, and relationships with product size, of beche-de-mer from 24 species of Indo-Pacific sea cucumbers sold in Hong Kong and Guangzhou, China. Across 20 species, average prices rose by 2.4% p.a., slightly exceeding China's average CPI increase over the same period.

The project is set to publish 16 peer-reviewed journal articles, well above the average (per funded dollar) for fisheries projects within ACIAR's Fisheries Program.

Conclusions

The most significant conclusion is that postharvest processing training and information tools can have long-lasting impacts on improved quality of beche-de-mer produced by fishers, but significant improvements in the industry are still needed in order for fishers to reap the full benefits of improved product quality. Improving the processing quality of sea cucumbers by fishers is one crucial step towards improving livelihoods. Improving value-chains so that fishers can get better income from better quality product is a second important issue, which can be the focus of future investments in the sector.

Results from the project suggest that manuals and training workshops in other countries could have positive impacts on improving the quality of beche-de-mer produced by rural fishers. Refresher training, e.g. every 3 months, will be required.

Fishery departments will need to support fishers in this industry if they are to reap the full benefits of the best-practice methods. Fishers will need help to access coarse salt, which could be sold at cost prices through regional fisheries offices.

Improvements will also be needed to value chains in sea cucumber fisheries so that fishers can get fair prices for the beche-de-mer they harvest and process. Fishery departments could develop national ‘Industry Standard Guides’ on fair prices of beche-de-mer of differing quality for each species. Systems could also be developed and trialed to give fishers better access to buyers and improve competition, such as auction systems to sell beche-de-mer to exporters. This form of upgrading of value-chain governance could improve efficiency and fisher incomes, potentially reducing the need for high fishing rates.

3 Background

Sea cucumbers are significant to coastal Pacific Island communities as a high-value export (Kinch et al. 2008a, Carleton et al. 2013). These fisheries have a high participation of both men and women. The main issues facing sea cucumber fisheries in the Indo-Pacific region are the poor quality of processing by fishers and the inadequate and ineffective management frameworks, enforcement and governance of the fisheries.

After being hand-collected, sea cucumbers are cut, gutted, salted, cooked, smoke-cured and sun-dried to a non-perishable product called beche-de-mer, which is exported predominantly to China (Purcell et al. 2012). Different processing methods are needed for different species groups to meet Chinese market specifications. The price paid to village fishers by exporters depends on body size, species and the quality of postharvest processing (Ferdouse 2004; Brown et al. 2010). Unfortunately, much potential income is lost in Pacific Island communities through poor processing methods. The nutrient composition of tropical sea cucumbers has received little attention and there is virtually no information relating to the effects of processing on this composition.

The project surmised that support to fishers in processing sea cucumbers to a high export quality using best methods could improve their incomes. Future extension programs would benefit from understanding which methods are most commercially viable and adoptable by fishers, how much economic gain can be expected, and which fisher groups are most impacted.

3.1 Partner country and Australian research and development issues and priorities

Sea cucumber stocks have been overfished in many Pacific fisheries (Purcell et al. 2013). Prior to the start of this project, overfishing prompted national fishery moratoria in Papua New Guinea, Solomon Islands and Vanuatu. In Australia, sea cucumbers are fished commercially by Torres Strait Islanders. However, those fishers have few information sources on postharvest processing and currently sell unprocessed sea cucumbers to large exporting companies.

The scale of sea cucumber fishing and processing in the Pacific is large. In Pacific Island countries (PICs) alone, there are at least 300,000 sea cucumber fishers (Purcell et al. 2013). The ACIAR–PARDI Scoping Study (PARDI/2010/004[1]) showed that a high proportion of these fishers rely on sea cucumbers as a primary source of income. Sea cucumber fishing and processing in PICs is estimated to be worth AU$20–50 million in annual export earnings[2].

The researchable issues underpinning this project concerned the lack of consistent skills of village-based fishers in postharvest processing of sea cucumbers to a high export grade and consequent poor profit margins for producers. In the ACIAR-PARDI scoping study, 47% of fishers in Tonga and 67% of fishers in Kiribati responded that they were dissatisfied with income they made from fishing and selling sea cucumbers. At the 7th Heads of Fisheries meeting, held in Noumea in 2011, fisheries agencies nominated a priority for '*training in fish-handling to meet quality standards and in post-harvest processing for value-adding in fisheries*'.

[1] PARDI/2010/004: 'Improving income of Pacific island fishers through better post-harvest processing of sea cucumber: scoping study'

[2] Average annual export from the Pacific region is about 800–1,300 t dried (see Supplementary Table in Purcell et al. 2013), at an export price of A$25–40/kg across species (ACIAR–PARDI Scoping Study)

Prior to this project, small sections on postharvest processing of sea cucumbers could be found in field identification cards (SPC 2004) and in an outdated species guidebook (SPC 1994). However, neither explains processing in great detail nor in a way that fishers could easily understand.

3.2 Research and/or development strategy and relationship to other ACIAR investments and other donor activities

This project relied upon, and built upon, a recent Scoping Study conducted through ACIAR's PARDI programme, which sought to describe the current practices in postharvest processing by sea cucumber fishers in Tonga, Kiribati and Fiji. That Scoping Study surveyed fishers in Tonga and Kiribati, provided some of the baseline ('before') data for testing impacts in this project, but did not survey fishers in Fiji. Therefore, this project conducted socioeconomic surveys of fishers in Fiji.

The ACIAR–PARDI Scoping Study found that a high proportion of fishers were using poor postharvest processing methods. Prices received by fishers from buyers varied greatly. The study concluded that support to fishers in postharvest processing would have a substantial impact.

The research approach in this study involved an implementation phase and an impact-testing phase. The strategy for community impact involved giving fishers information sources on processing and showing them via workshops how to use them. The impact testing relied on re-surveys of fishers using questionnaire-based interviews. The data collection comprised a range of variables as advocated for Social Impact Assessment (Pollnac et al. 2006).

This project included the PhD study of a John Allwright Fellow, Mr Ravinesh Ram, from Fiji to address the effects of various processing methods on product quality and nutritional value of beche-de-mer. His research helps to optimise processing methods and examined the nutrient content of beche-de-mer processed using different methods.

The project addressed ACIAR Research Priority Subprogram 2 (Integrated and sustainable agriculture, fisheries and forestry resource management and development) through value-adding processing of fisheries products. The project also addressed a second ACIAR priority of improving the resource use of vulnerable inshore fisheries. It follows from previous investments to improve the management of sea cucumber fisheries in Solomon Islands (FIS/2003/051[3]).

Through a short market study in China, the project also determined the current sale prices of Pacific Island beche-de-mer in Chinese markets and changes in pricing since a previous study 5 years earlier in 2011. This activity addressed a regional priority to monitor and give updated information on prices of beche-de-mer in the marketplace (SPC 2012, IUCN 2015).

[3] FIS/2003/051: 'Improving sustainability and profitability of village sea cucumber fisheries in Solomon Islands'

4 Objectives

The overall aim of this project was to improve the income of village fishers in Kiribati, Tonga and Fiji through support to improve the quality of post-harvest processing of sea cucumbers. One component aimed to reveal processing methods that affect product quality (Asian market preferences) and conserve nutritional benefits of beche-de-mer, leading to best-practice processing.

The researchable **questions** were:

- What methods of postharvest processing are both commercially viable and adoptable and able to produce higher grades of sea cucumber resulting in premiums to producers?
- How much improvement is gained by fishers from the training package, and are the potential impacts similar among gender, community types and countries?
- How is the potential increased income from higher selling prices distributed, and spent, within fisher families and communities?
- Does capacity building of fishers change their livelihood activities, in terms of time spent in postharvest processing and in fishing pressure?
- Have prices for beche-de-mer in China changed over the past 5 years?

The specific **objectives** were to:

1) Assess current processing, sale prices and fishing practices of sea cucumber fishers in Fiji
2) improve postharvest processing methods of fishers in Kiribati, Tonga and Fiji
3) evaluate the socio-economic consequences of the project's interventions
4) determine current prices for sea cucumbers in China.

Achieving these objectives provided immediate impact at the level of village fishers in the participating countries and furnishes proof of significant socio-economic outcomes for fishers.

5 Methodology

With few exceptions, the methodologies used to achieve each objective exactly follow those proposed in the Project Document. This is a credit to the rigorous project approval process within ACIAR and the commitment by the entire project team to conduct the activities according to the agreed methodologies.

Objective 1: Assess current processing, sale prices and fishing practices of sea cucumber fishers in Fiji

The methods used for this objective are the same as those proposed in the Project Document. Additionally, we collected much more data than proposed.

The forerunner PARDI scoping study had collected baseline socio-economic data from 218 fishers and 34 processor/exporters in Kiribati and Tonga. This project added to that data collection by interviewing another 235 fishers in Fiji using the same methods. The 30-45 min interviews used fully-structured questionnaires to acquire quantitative data on current fishing effort, catch composition, livelihood importance, processing methods, prices, supply chains, and fishing history of fishers and about processing, prices and supply chains of the processor/exporters. These questionnaires were approved for Human Ethics Research through an Australian accredited committee at SCU.

In Fiji, we collected the baseline data from the 235 fishers in 3–5 villages within a total of eight island locations: Ra province, Yasawa group, Kadavu, Bua district, Taveuni, Cakaudrove, Vanua Balavu, and southern Lau group. As proposed, we also interviewed more processor/exporters in Fiji.

Because we had collected sale price data from both fishers and buyers, we performed a value-chain analysis. That study incorporated sale price of dried sea cucumbers in Fiji and Kiribati, since processing by fishers was not practised in Tonga. The value-chain analysis comprised estimates of the proportional increase in prices along the value chain from fishers to retail stores in China. As planned, the study culminated in a peer-reviewed journal publication (Purcell et al. 2017, *Marine Policy*).

Part-way through the project, we added an additional activity to conduct a study on the economic value of the sea cucumber fishery in Fiji. Using our survey data on fuel use per fishing trip, we will also reveal the carbon footprint of artisanal vessels involved in collecting sea cucumbers in Fiji. As planned, the study was also written as a scientific article, currently in review (Purcell et al., *ICES J Mar Sci*).

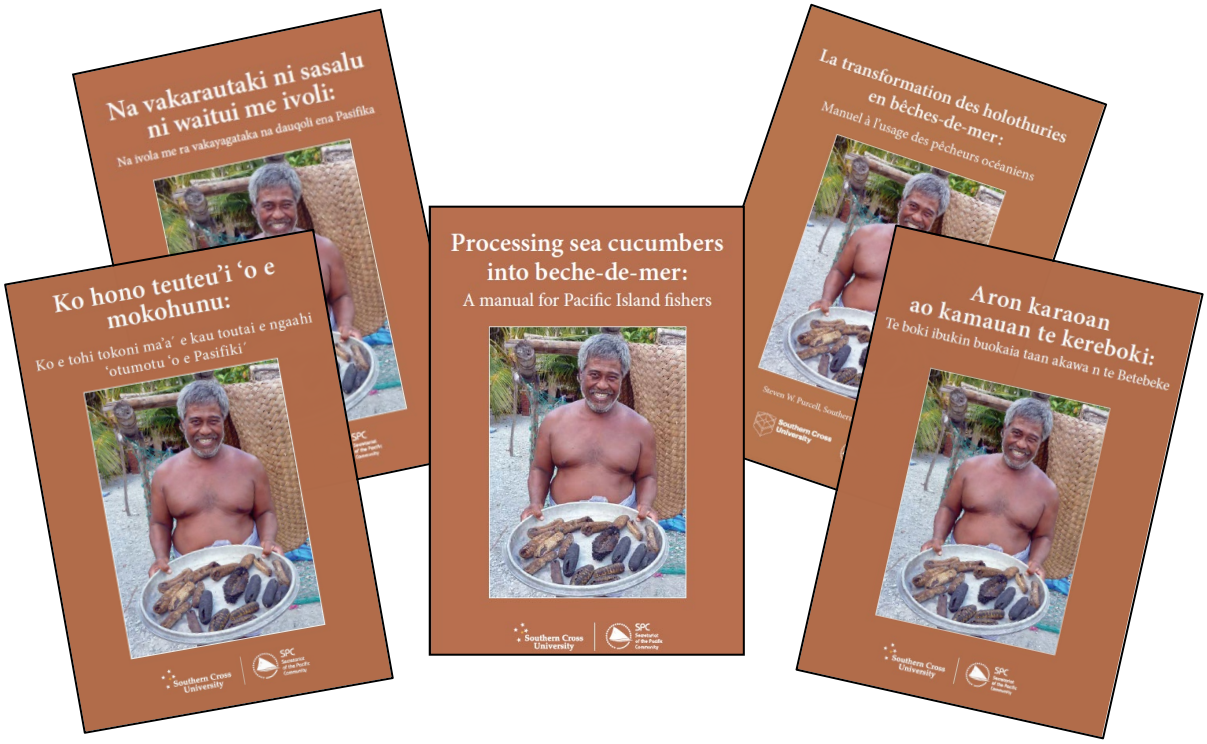
Objective 2: Improve postharvest processing methods of fishers in Kiribati, Tonga and Fiji

The methods used for this objective are the same as those proposed in the Project Document.

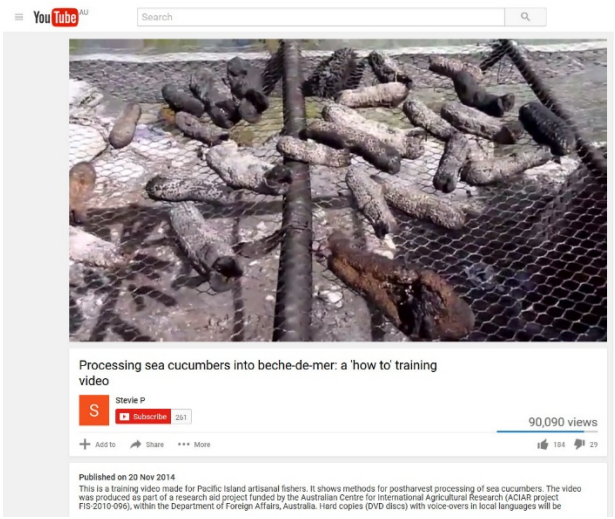
The capacity building activities were replicated in the same way in Fiji, Tonga and Kiribati.

Training trainers: Eight project team members were trained in best-practice methods for postharvest processing through a short technical workshop at the processing facility of an experienced processor/exporter in Fiji over 3 days. Essentially, we volunteered as processors at the factory and worked alongside the other workers on each step in the process from gutting to drying. Video footage taken during the workshop contributed to the preparation of the project's training video. The project officers also gained further training in work placements with reputable commercial processors in their own countries.

Processing manual: The manual is a simple (44 page, drawing-based, colour), yet comprehensive, guide in how to process sea cucumbers into beche-de-mer for export. The original English version was translated into Fijian, Tongan and Gilbertese. More recently, other institutions have funded its translation into French and Arabic. We planned to publish and distribute at least 3,000 copies to fishers, and in the end distributed about 6,000 copies to fishers in the partner countries. Initial print run was 5300 copies, second print run was 950 copies – nearly all have been distributed. Electronic copies were made available through ACIAR and SPC websites.



Training DVD: As planned, we contracted a film studio (Pasifika Communications, Fiji) to produce the training DVD in the four languages. This was based on footage that we had gained in the three partner countries and in the train-the-trainer workshop. The video was produced onto DVDs, which were given to each of the 80 villages in which we held the workshops, plus about ten additional villages in Fiji. Downloadable files in low and high resolution were made available on a dedicated SCU website. Electronic versions were also made available through YouTube, which have attracted more than 132,000 views.



Village-based training: We conducted hands-on training workshops in each of around 25–30 villages in each country. The workshops used sea cucumbers collected by village fishers, and demonstrated all processing methods from handling, gutting, cooking, salting, smoke-curing, drying and sale of the sea cucumbers. The workshops were conducted over 1½ days per village. Generally, 10–15 participants attended each workshop and we sought to include women where possible. In total, we directly trained 942 fishers in 80 villages across the three countries.

Post-workshop satisfaction forms from the participants showed that more than 96% of fishers found the manual to be “relevant and of high quality”, and more than 95% agreed or strongly agreed that the workshops “changed my mind about processing”.

Testimonials from workshop participants included the following:

- “this really improves the processing techniques I had in the past”, i-Kiribati fisher
- “now I get to know better and in detail the steps of processing sea cucumber to beche-de-mer so that I can receive higher income”, Fijian fisher
- “first time to participate on sea cucumber processing training and looking forward to carry out processing of sea cucumber in the future for better income”, Tongan fisher

Objective 3: Evaluate the socio-economic consequences of the project’s interventions

The methods used for this objective are the same as those proposed in the Project Document. As discussed in Variation 3 of the project document, the closure of the fisheries in Tonga and Kiribati half-way through the project meant that we could not conduct follow-up surveys of fishers in those countries. Therefore, the evaluation of socio-economic impacts was restricted to Fiji, where we invested more resources in collecting more data than originally planned.

The data collection for examining socio-economic impacts comprised four survey methods:

1. Socioeconomic questionnaire-based interviews of fishers
2. Focus-group sessions with women in villages
3. Demographic data on villages through an interview with village headman
4. Questionnaire interview with commercial processors.

We had proposed to interview at least 80–100 fishers in each country. Seeing as we only focussed on Fiji, we interviewed 278 fishers for these follow-up surveys. Importantly, we interviewed fishers irrespective of whether they had been exposed to any form of training from the project — hence, we interviewed both trained and untrained fishers. Owing to a traditional-management decision to cease sea cucumber fishing in Taveuni, we conducted the data collection in seven locations instead of the eight involved in baseline surveys. These questionnaire-based interviews were held approximately 1 year after having conducted the training in each of 29 villages (within the 7 locations) so that fishers had time to apply the methods. In this way, the measured impacts can be seen as long-lasting changes due to the project’s interventions, and not just short-term capacity building. The project anthropologist (JCU) helped to design the questionnaires and survey methods, and helped in training the Fijian project officers on the first data collection field trip. Fishers were selected haphazardly and by ‘snowball sampling’, and we took a gender-inclusive approach by interviewing women where possible to ensure their representation in our surveys. On average, 9.6 fishers were interviewed in each village.




Focus group sessions were held in each village with women to ask them about their involvement in processing sea cucumbers and how the manual, DVD and training have helped them. This strategy supports a constructivist inquiry (German et al. 2006).


Demographic data in villages were collected through interviews with the village administrative headman, called the *turaga-ni-koro*. These headmen had formal responsibility to keep demographic data on the villages, so this data collection was quite easy. The demographic data were used as potential explanatory variables in the modelling analyses of socioeconomic impacts (discussed later).

Interviews with processors were conducted to ask them about whether they believe the project has benefitted the industry, whether the prices have improved since the dissemination of the manual and workshops, and any problems they believe fishers had in applying the new methods.

Socio-economic data (e.g. sale prices, fishing effort, and wellbeing measures) after the interventions were be compared with the baseline ('before') data to quantitatively test impact on income and livelihoods. This was achieved using general and generalised linear mixed-model analyses, supported by the collaborating statisticians at University of Wollongong and social scientists at James Cook University. These analyse are a modern

approach for analysing continuous and binomial response data across a number of potential explanatory variables. Thanks to the standardisation of surveys across locations and villages, responses of the fishers to the projects interventions were quantitatively tested across the two spatial scales. The analyses incorporated the baseline data as the "before" condition, compared with the follow-up surveys as the "after" condition. Also, fishers trained by the project and those not trained by the project were compared in the analysis. The review panel (at the project's final review meeting) asked to also separate fishers trained by other means, but this turned out to be unworkable due to the small sample size of those fishers. The analyses also looked at whether socioeconomic responses to the training could have been attributed to gender, age and fishing experience of the fishers, and the village-scale variables such as village population, whether buyers were present, and access to coarse salt used in processing.

The modelling analyses were complemented with the qualitative data from the focus-group sessions with women and the interviews with processors. This forms the 'constructivist enquiry' approach.

Objective 4: Determine current prices for sea cucumbers in China

The methods used for this objective are the same as those proposed in the Project Document.

The previous market study giving prices of beche-de-mer in Chinese markets was made in 2011 and published several years later (Purcell 2014). In this project, we repeated the data collection 5 years after the original study through a study trip to Hong Kong and Guangzhou. The Project Leader and node coordinators from Fiji and Tonga were accompanied by a Chinese consultant (Guanglin Wang, ACIAR China Country Manager) who helped to provide access to the markets and provide interpretation. The trip provided invaluable experience on Chinese seafood markets to the Fijian and Tongan node coordinators, who are likely to have ongoing roles in advising on sea cucumber fisheries and trade in their countries.

Prices of beche-de-mer of various species were collected along with data on lengths and weights of the products from different bins in a number of stores in both Hong Kong and Guangzhou. The trip was more focussed on collection of those data than the study trip in 2011. Consequently, we collected much more data.

The range in prices of dried sea cucumbers and the relationships between prices and product size were examined using non-linear regression modelling (as was done for data from 2011). Prices in 2016 were compared to prices in 2011 to indicate recent changes in market demand over the 5-year period. Those findings have been written in three publications: one already published, on in press, and one in review (see section 10.2).

6 Achievements against activities and outputs/milestones

Objective 1: Assess current processing, sale prices and fishing practices of sea cucumber fishers in Fiji

No.	Activity	Outputs/ milestones	Completion date	Comments
1.1	Conduct baseline socio-economic surveys in Fiji	Field officers trained in Fiji (Project Leader undertook two field trips). Baseline surveys completed. 235 fishers were interviewed in 35 villages across 8 geographic locations in Fiji.	August 2014.	Strong efforts by project officers in PCDF made it possible to complete the surveys on schedule so that the Fiji node could catch up with the other nodes of the project. Five scientific articles published from the baseline data.
1.2	Conduct a value-chain analysis using the baseline data and publish the findings	Analysis of fisher-middlemen- exporter-retailer value chains from Kiribati, Tonga and Fiji. Publication of value-chain study.	Y4, m12	Article published in the journal *Marine Policy* in September 2017.
1.3	Assess the economic value and carbon footprint of the Fijian sea cucumber fishery	Analysis of the economic value of sea cucumbers to fishers. Analysis of fuel usage in the fishery by region and fishing mode.	Y5, m4	Analyses completed. Manuscript submitted to *ICES Journal of Marine Science*. Currently in review.

Objective 2: Improve postharvest processing methods of fishers in Kiribati, Tonga and Fiji

No.	Activity	Outputs/ milestones	Completion date	Comments
2.1	Prepare and publish a village-level manual and DVD on best practice for processing sea cucumbers	Manual was printed and distributed in June 2014. 6,250 copies were produced in total. The electronic version of the manual was made available for free download at SPC and ACIAR websites. Hard copies of the manual are being distributed to fishers in the village-based workshops. The training video was finalised at the end of 2014, and the DVD versions were distributed in 2015. The four language versions of the training video are available on YouTube, and at SCU and ACIAR websites. A French version was translated and published (900 copies) by SPC for Wallis and Futuna, New Caledonia and French Polynesia. An Arabic version was translated by FAO for East African fishers. FAO also plans to translate it into Swahili.	The manual was printed and dispatched in June 2014. A second print run of the manual was made in 2016. The training video was finalised in December 2014. The DVD copies of the video were made and dispatched in Feb 2015.	The English version of the training video has had more than 132,000 views on YouTube! Copies of the manual have been sent to other interested persons in more than 30 countries. Another 90 copies recently posted to Jeff Kinch in PNG for distribution to village fishers.
2.2	Train fisheries officers assigned to project in processing methods	A 3-day training workshop was held in Nadi in April 2014.	April 2014	Completed.
2.3	Conduct training courses in villages	Workshops started in June 2014 and finished in July 2015. In total, we directly trained 942 fishers in 80 villages across the three countries.	July 2015	Completed.

PC = partner country, A = Australia

Objective 3: Evaluate the socio-economic consequences of the project's interventions

No.	Activity	Outputs/ milestones	Completion date	Comments
3.1	Conduct sociological surveys of fishers and processors in PICs	All surveys of fishers completed.	Sept 2016	The fisheries in Tonga and Kiribati remained closed, so data collection was only conducted in Fiji, as planned. Other activities were added to the project in Variation 3.
3.2	From surveys, determine which of the prescribed methods and information sources were most commercially viable and adoptable	Analyses completed.	Oct 2017	Manuscript 80% completed. Due for submission in February 2018 to *Ecology and Society*.
3.3	Analyse differences in 'before' and 'after' data on incomes and livelihoods	Analyses completed.	June 2017	Manuscript will be written in 2018. Expected submission in July 2018 to *Proc Nat Acad Sci*.
3.4	Analyse differences in 'before' and 'after' data on fishing effort	Analyses completed.	June 2017	Manuscript will be written in 2018. Expected submission in July 2018 to *Proc Nat Acad Sci*.

PC = partner country, A = Australia

Objective 4: Determine current prices for sea cucumbers in China

No.	Activity	Outputs/ milestones	Completion date	Comments
4.1	Conduct a study visit to dried seafood markets in China	Data on current prices of beche-de-mer. Evaluation of price changes since 2011 and influence on fisheries.	Study trip completed Nov 2017. Analyses completed Oct 2017.	Manuscript submitted to the journal *Marine Policy* in October 2017. Currently in review.

PC = partner country, A = Australia

7 Key results and discussion

Baseline surveys

The baseline surveys yielded five scientific publications on postharvest processing methods (prior to the project's training), trends in fishing, socioeconomic context, and perceptions of fishers.

Postharvest processing

- Methods varied among countries. E.g. Tongans didn't do smoke curing.
  - Thus, we need to understand practices in each country.
- Few fishers had received training or information on processing methods.
- Poor processing methods were often used by fishers.
- In Kiribati, it seemed that few women fished for sea cucumbers but they were often involved in processing. Need to consider them as part of the fishery.
- Many fishers in Fiji experienced problems in accessing coarse salt for processing and getting fair prices by middlemen.
- Action is needed to help fishers to access coarse salt and to develop and implement industry standards on fair prices.

Fishing

- Women harvest a somewhat different suite of species than men, and these species are typical of shallow habitats.
- Fishing modes, catch rates and catch composition in small-scale fisheries can be highly context-dependent.
- Sea cucumber fishers are often fishing 3–5 days per week, and can be considered to engage in the fishery full time. Fishing effort at the fishing grounds was also quite high, showing they invest much time in harvesting sea cucumbers.
- The results imply that support to fisher livelihoods (e.g. postharvest processing training) must consider gender differences and location-specific fishing activities.
- Data on perceptions of fishers suggests that managers of Pacific Island fisheries should consider limited-entry rules, or impose short fishing seasons, as a means to reduce the overall annual catch.

Socioeconomics

- Sale prices varied significantly among fishers. This could be due, in part, to different postharvest processing methods used by fishers.
- Large disparities in gender-related price equity.
- Many fishers were upset about the income they make from the fishery. Dissatisfaction was most common in male fishers and those with difficulty selling their catch.
  - Improvement of supply chains appears as a critical need for enhancing income and wellbeing of fishers.
- 64% of fishers had just one or two livelihood activities.
- Fishing other reef resources was the most common fall-back livelihood option.
  - This infers a co-dependence among coastal fisheries through fishers.

Training tools and uptake of the project's interventions

- Of the fishers we interviewed in the follow-up surveys, 47% had been trained by one or more of our interventions. Out of all fishers, 43% had received a manual, 38% had attended a workshop, but only 9% had watched the training video.
- 79% of fishers who had attended the workshop reported that they subsequently made changes to the way they process sea cucumbers.
- A majority (58%) of fishers found the workshop most useful of the training tools.
- Of the fishers who received manuals, 82% said that they regularly referred back to the manuals.
- More than two-third of fishers reported that they had some form of problem in applying the new methods.
- Access to buying coarse salt was by far the most commonly reported problem fishers had in applying the new methods. The coarse salt is needed for salt-curing the sea cucumbers, but is an optional step.
- Few fishers had watched the training video or DVD, which was supposed to have been one of the three pillars of the training. This is attributed to two reasons:
  - In some villages, the village headmen did not pass on the DVDs to fishers.
  - In three locations, the fishery officers who were entrusted with the DVDs did not pass them on to villages.
- There was apparently good diffusion of the processing methods within communities. 82% of women and 65% of men reported that they had shared their new knowledge about processing to other [untrained] fishers.

Consequences to processing methods

- Fishers trained by the project generally did not spend more time in processing.
- Many trained fishers (31% of men and 11% of women) reported that they were now saving time because they now know they don't need to cook the sea cucumbers for so long. So the project has led to an improvement in the time efficiency with processing for many fishers. However, 60% of women and 44% of men believe the new methods took time out of other activities, namely time with family, socialising and resting.
- 93% of men and 92% of women who were trained by one of our interventions reported that their bech-de-mer was of better quality using the new methods.
- Some fishers were still using poor methods even after the workshop and manual. For example, an equivalent proportion of trained fishers were still cutting some species in the wrong location, despite showing this in the workshop and manual.
- One year after the workshops, trained fishers who used salt-curing were, on average, salting the sea cucumbers for longer periods than untrained fishers. The average salting durations of trained fishers was commensurate with our training. This was an encouraging long-term change to their postharvest processing practises.
- Similarly, trained fishers were, on average, cooking sea cucumbers for shorter periods than untrained fishers. This was also encouraging to see, and it meant the project's training had a positive impact on the efficiency of processing by fishers.

Impacts to fishing and socioeconomics

- The vast majority (89%) of fishers believed that the project's training program had not spurred other fishers to start fishing sea cucumbers. Only in 15% of villages did women think the training promoted more people to harvest sea cucumbers.

- Satisfaction with incomes from fishing sea cucumbers increased in most locations in the year after our training. Women fishers were significantly more satisfied than men and older fishers were more satisfied than younger fishers.
- Fishers who process their catch were 2.6 times more likely to be very satisfied with selling sea cucumbers relative to a fisher that does not process their catch. But the modelling found no significant change with fishers who we had trained.
- Trained fishers did not go fishing more often than untrained fishers. Between the baseline and follow-up surveys, fishers across the board decreased their fishing frequency per week, most likely because stocks were in decline. But trained women caught more sea cucumbers, on average, than untrained women fishers.
- Trained fishers were 9.8 times more likely to believe that they were receiving higher prices compared to untrained fishers. Likewise, from the focus-group sessions, in one-third of villages, women believed that they are earning more income now because of the training. Of those women who are getting higher prices for their product, all think it is significant and all agree the higher prices compensate for more work.
- From the baseline surveys, fishers in most locations believed stocks were in decline. This explains why we found that weekly reported earnings declined between the 'before' and 'after' surveys, despite rising buying prices in Fiji. The simple explanation is that they were catching less as stocks of sea cucumbers in the fishery were being depleted. Apparently, training in postharvest processing did not have a statistically significant bearing on weekly incomes, but clearly there are extenuating circumstances for why that might be the case.
- Training in postharvest processing did not cause greater dependence on sea cucumber fishing. This was shown in the modelling analysis by comparing the proportion of weekly income from sea cucumbers out of the total income of fishers (from all sources) between trained and untrained fishers. However, the analysis did indicate that: sea cucumber fishers *in general* relied upon these resources for a greater portion of their weekly income in 2015/2016 than in 2014; and women had a greater dependency on sea cucumbers for their income than men; and fishers in villages with a resident buyer were more dependent on sea cucumbers for their income than fishers in villages without a resident buyer.
- Women in villages in which sea cucumbers were the most important income source tended to believe there were no negative impacts of the training program.
- Fishers who watched the DVD were found to receive higher prices per kg than fishers who only went to the workshop or read the manual. [but see earlier comments about problems with uptake of the training videos.]
- Village women noted several constraints of getting higher income as a result of the project's training:
  - There is no constant price.
  - The scales used by buyers to weigh beche-de-mer were sometimes tapered with and inaccurate.
  - The buyer just plays around with the price and would not necessarily give a higher price even though the product was better quality. This contradicted the records from the interviews with processors, who [all but one] said that they give higher prices for beche-de-mer that was well processed.
  - The buyer is buying "first cook" sea cucumber (which have much lower weight) but offers the same prices as for fresh uncooked sea cucumbers
- Similarly, in the interviews with fishers, many reported that buyers still gave the same prices per kg of beche-de-mer, despite better quality.

Value-chain analysis

- Most fishers lacked information about market prices.
- Pacific islanders comprised almost all fishers, but represented only some middlemen and few exporters.
- Proportional increases in prices along the value chains differed greatly among sea cucumber species and between countries (see Purcell et al. 2017, *Marine Policy*).
- The relative share of the end market value that fishers received was negatively related to product end-market value; on average 50% of the end retail value for the lowest-value species but <10% for the highest-value species.
- Most fishers lacked information about market prices.
- The gross markup of exporters differed greatly between the two countries: Fijian exporters put a much higher markup on the dried products bought from fishers than i-Kiribati exporters.
- Downstream actors reaped increasingly higher proportions of the product value for higher value species.
- Improved transparency of prices to fishers could empower them to negotiate higher prices, especially for more valuable species.
- Upgrading of value-chain governance, e.g. through fisher cooperatives or auction systems, could improve efficiency and fisher incomes, potentially reducing the need for high fishing rates.

Economic value and carbon footprint in the fishery in Fiji

- Two- to three-fold variation in incomes of fishers among regions in Fiji.
- Net incomes were also highly variable among fishers within villages.
- A high average proportion of income arising from sea cucumbers (60%) points to a strong dependency on these resources for coastal village livehoods in Fiji.
- Women sea cucumber fishers in Fiji had considerably (47%) lower income. This reflects a number of factors, including their tendency to harvest shallow-water species that are less valuable and might infer some degree of gendered exploitation by traders.
- Fuel use by sea cucumber fishers varied greatly among regions.
- The average fuel use of sea cucumber fishers was 428 L fisher^{-1} y^{-1}.
- Male sea cucumber fishers had a significantly greater annual fuel use than women fishers.
- A Fijian sea cucumber fisher emitted, on average, 1.006 ±0.094 s.e. metric tonnes of CO2 per year in boat fuel to harvest the animals.
- This study estimated roughly 8,000 ±750 s.e. metric tonnes of CO_2 are emitted per year from boat fuel in Fiji's sea cucumber fishery.

Market prices

- Prices, and relationships with product size, of beche-de-mer were updated for 24 species of Indo-Pacific sea cucumbers sold in Hong Kong and Guangzhou, China.
- Prices per individual increased exponentially with increasing beche-de-mer length for three high-value species, *Holothuria fuscogilva* (white teatfish), *H. lessoni* (golden sandfish) and *H. scabra* (sandfish).

- For seven other species, price per unit weight did not relate significantly to product length.
- Across 20 species, average prices increased by an average of 16.6% from 2011 to 2016, equating to an increase of 2.4% p.a., slightly exceeding China's average CPI increase over the same period (2.1% p.a.).
- Products that were traditionally lower value appear more accepted in the marketplace.
- The analysed relationships offer a rationale for large minimum legal size limits to improve the economic performance of fisheries for the high-value species *H. fuscogilva, H. lessoni* and *H. scabra*.
- The disproportionately high prices for larger specimens of these species challenge a rethink about harvest strategies in aquaculture programs throughout the Indo-Pacific.

8 Impacts

8.1 Scientific impacts – now and in 5 years

Scientific impacts arise from the data analyses from multiple studies within the project. These are grouped under different sections below. This new information builds on paradigms about sea cucumber processing and trade and small-scale fisheries, and will be useful for fishery researchers in the Pacific and elsewhere globally for at least the next 20 years.

The project is set to publish 16 peer-reviewed journal articles. Considering the overall project budget of $1.24 million, this journal-article output per funded dollar is 60% above the average (0.8 peer-reviewed articles per $100,000 funded) for fisheries projects within ACIAR's Fisheries Program.

Small-scale fishing in Pacific Islands

The project furnishes an improved understanding of fishing effort, frequency and fisher perceptions in small-scale fisheries.

The article published in *Fisheries Research* (Purcell et al. 2016) showed gendered differences in the catch of sea cucumber fishers. This contributes to a growing body of evidence about gendered variation in small-scale fisheries. Data on perceptions of fishers suggest that Pacific Island fisheries should consider limited-entry rules, or impose short fishing seasons, as a means to reduce the overall annual catch.

The high fuel consumption by scuba-diving fishers (in addition to risks to their health) gives scientific grounds for fishery managers to ban the use of scuba in sea cucumber fisheries.

Fisheries socioeconomics

The project provides new knowledge about socioeconomics in sea cucumber fisheries. The patterns reported in the article in *PLoS One* (Purcell et al. 2016) should also be useful for underpinning our beliefs about socioeconomics in other small-scale fisheries.

Few published studies show actual income to fishers in small-scale fisheries, and fewer on the costs and consumption of boat fuel. This project provides valuable benchmarks for fisher incomes and ecological footprints in small-scale fisheries. The data, presented in a manuscript in review in *ICES Journal of Marine Science*, show that sea cucumber fishing can actually be quite lucrative for rural island fishers. However, most of them are using small boats with outboard engines and, collectively, are consuming as much fuel as some industrial-scale fisheries. This provides new evidence that fuel consumption should be an ecological consideration when resource managers decide on regulations in small-scale fisheries.

This study paints a new picture about psychological wellbeing of artisanal fishers. The study published in *PLoS One* shows that dissatisfaction with incomes is common in Pacific Island sea cucumber fisheries. The findings give important directions for future projects by showing that problems faced with selling fishery products were attributed greatly to fisher dissatisfaction.

An important finding was that fishers most commonly said they would fall back to fishing other marine resources if they could no longer harvest sea cucumbers. As it turned out, all three fisheries were closed by moratoria during the term of the project. The findings give reliable insights to fishery managers that other fishers now face heightened fishing pressure due to the closures because fishers probably did not shift to non-fishery income streams. This means that artisanal fisheries accessible to small-scale village fishers need to be managed holistically, and not as separate and exclusive systems.

Value-chain dynamics in small-scale fisheries

The project improves an understanding of value-chain dynamics in small-scale fisheries for internationally traded seafood. The study was published in *Marine Policy* (Purcell et al. 2017).

What we now know from this project is that exporters and downstream actors put increasingly higher profit margins on more expensive seafood. This appears to be because fishers need reasonable financial returns even for low-value species, so the proportionate value at first sale by fishers is not linear across a gradient of species of differing value. This finding offers a valuable paradigm for improving value-chains by targeting interventions especially for the sale of the high-value species.

Our qualitative data showed that fishers lacked information about the real value of processed sea cucumbers. This underpins a call for greater transparency in value-chains within sea cucumber fisheries, and other export fisheries, in which remote rural fishers are providing products for international markets.

Uptake of training by smallholders

The follow-up surveys in 2015/2016 provided data that offer valuable insights into how fisheries training is taken up by rural fishers.

Responses by fishers indicate that hands-on workshops are a great approach for training fishers, and that simple manuals in local languages are an enduring source of capacity-building for fishers. We found encouraging signs that fishers were using some of the new methods one year after the workshops. This gives some evidence that postharvest processing training can be a useful form of long-term capacity building in communities. On the other hand, the project also indicated that follow-up visits are needed to ensure that fishers don't slip back to using old and improper processing methods.

The study on uptake of the project's interventions, in preparation for submission to *Ecology and Society*, shows that a good proportion of fishers (especially women) were active in passing on knowledge about new processing methods.

Trade of luxury seafood

The Chinese market study, in review in *Marine Policy*, provides a globally-relevant finding that demand for luxury seafood has continued to rise, despite government-backed initiatives in China that could have been believed to reduce demand. The results affirm that the demand and prices for dried sea cucumbers has not fallen in recent years and pressure is still high on the wild fishery resources of other island nations.

Analyses of the relationship between prices and length of beche-de-mer give useful lessons for both fisheries and aquaculture policy. Exponentially higher prices for larger sea cucumbers gives an economic rationale for imposing large minimum size limits for certain high-value species in fisheries. Similarly, the relationships should underpin future cost-benefit analyses in aquaculture operations, needed in order to determine the economically optimal size at which to harvest sea cucumbers.

Nutritional value of sea cucumbers

Experiments by the JAF PhD student, Ravinesh Ram, has revealed the nutritional value of *Holothuria scabra*, known as the sandfish. This is useful, as it is the most important species for tropical aquaculture in the Indo-Pacific, and nutritional composition could be used in the marketing of aquaculture products.

The PhD student's studies also give new data on the "recovery rates" from the processing of sea cucumbers into dried beche-de-mer. These are the proportionate changes in weight from fresh animals to dried product ready for export. Results from the study, published in *Regional Studies in Marine Science*, should be of use to fishery managers

who might need to convert dried export tonnages into equivalents of fresh harvested animals.

A further study by Ram and co-workers, published in *LWT - Food Science and Technology*, showed how the quality, texture, collagen and amino acid composition of sandfish can vary depending on the methods used to processing the fresh animals into dried product. The findings provide a basis for improvements to sandfish processing that optimize textural properties of resulting beche-de-mer.

8.2 Capacity impacts – now and in 5 years

Capacity impacts were realised in two main ways: (1) impacts on the technical skills of partner-country collaborating researchers, and (2) the practical skills of fishers in processing sea cucumbers.

Capacity-building of partner-country collaborators

Through the 3-day 'train-the-trainer' workshop in Fiji, six fishery officers/researchers and the JAF PhD student gained skills in processing sea cucumbers into high-quality export-grade beche-de-mer. These skills will be potentially put to use over the next 10 years, as the officers pass on the knowledge to rural fishers when fisheries in Fiji, Kiribati and Tonga re-open.

Two fishery officers/researchers in each country (Fiji, Kiriabti, Tonga) were trained in conducting socioeconomic surveys. The training built skills in designing and asking non-leading questions, and techniques in triangulating questions to improve the reliability of responses from village fishers. The training also incorporated aspects of research ethics.

Three of the Pacific Island collaborating researchers gained 'once-in-a-lifetime' experience in the dried seafood markets in China through the study trip in November 2016. Seeing the enormity of the markets for dried shark fin, sea cucumbers, and live reef fish will undoubtedly help them to put fisheries trade into a global perspective.

Much time was taken in mentoring the partner-country collaborators in the interpretation of scientific results and scientific writing. These are skills not often well mastered by fishery officers/researchers in Pacific Islands. The collaborating researchers were each invited and encouraged to contribute to the scientific publications. The reference list of scientific papers co-authored by the officers from Kiribati, Tonga and Fiji is clear evidence of capacity impacts in scientific writing. The two Fijian project officers (Lalavanua, Tagica) both took on lead roles in writing of media articles about the project in the last year.

Capacity-building of fishers

The project trained a huge number of fishers in postharvest processing through the manuals, training videos and village workshops. In total, the workshops provided hands-on training to 942 fishers in 80 villages across the three countries. One year after the workshops, more than 90% of fishers responded that the training had improved the quality of the beche-de-mer they produce.

The project's training manuals were delivered to 6,000 fishers among the three counties. Our interview data showed that 71% of Fijian fishers who had received the project's training said that they had passed on the new knowledge to at least one other fisher. Applying this percentage to Kiribati and Tonga implies that more than 10,000 fishers across the project countries received some form of capacity building.

One also should consider the broader reach of the manuals and training videos:

> *Manuals*: In addition to the dissemination in the partner countries, around 1000 copies of the manuals were commissioned by the National Fisheries Authority (NFA) in Papua New Guinea for local fishers and disseminated by the NFA to village fishers for use upon the opening of the fishery in 2017. We sent English manuals to fishers in Torres

Strait, via the Torres Strait Regional Authority office. On request, we also sent manuals to various interested people in Australia, New Zealand, Canada, Sri Lanka, Turkey, and other countries through copies sent to the FAO Fisheries office in Rome. We had purposely developed the manuals so that they could be easily translated into other languages: the text file is a separate layer to the image file and can simply be translated into other languages and laid onto the image file in InDesign. With funding from DFAT, the manuals were translated into French and 900 copies were printed and distributed among Wallis and Futuna, New Caledonia and French Polynesia. The manual has recently been translated by FAO into Arabic for distribution to East African and Middle East countries, and they are planning to produce a Swahili version for other East African fishers.

Training videos: While the DVDs were used by a small percentage of fishers, we had phenomenal success with the online versions posted on YouTube. The videos were viewed by over 132,000 online users, many of which were probably in other countries. If we consider that even a small percentage were fishers who would use the training, this might suggest that tens of thousands of fishers were impacted, to some extent, by the project.

In summary, given the reach of the manuals in the three partner countries, manuals in other languages for other countries, and the online usage of the training videos, it would be fair to posit that, in 5 years' time, the project's training material will have benefited tens of thousands of fishers worldwide.

8.3 Community impacts – now and in 5 years

Community impacts can be understood via the data from questionnaire-based interviews with fishers and the focus-group discussions with women. The interviews indicated that fishers were happier about their sea cucumber fishing incomes in the follow-up surveys, regardless of whether they were trained or not. This might have been due, in part, to the fact that they were happier because they felt they were all getting support in the industry by our project.

8.3.1 Economic impacts

We were faced with conflicting evidence about economic impacts of the project. Many fishers believe they were earning more after the workshops, but the actual economic data on their weekly incomes from sea cucumbers indicated that, on average, they were not. Some of this is hard to unravel. For instance, the data show that prices increased in the year after the workshops but, on the other hand, stocks of sea cucumbers were in decline and male fishers were collecting fewer sea cucumbers per day than at the time of the baseline surveys.

Evidence from interviews with buyers (processor/exporters) suggests that at least some trained fishers were producing better-quality beche-de-mer after our workshops, so one would expect this to translate to higher export prices. This is because the export price depends on the grade of beche-de-mer, which is in turn strongly affected by processing quality. The signals from interviews with fishers corroborate this inference because the sale prices reported by fishers was higher for trained fishers than untrained fishers for the majority of species.

In the end, it is difficult to claim significant economic impacts of the project in the short term because the three fisheries were closed in national moratoria soon after our training. Also, we uncovered significant impediments associated with the value chains, which would need to be addressed if economic impacts are to be fully realised. This is now a development focus in some countries, including Papua New Guinea, Solomon Islands, and Vanuatu.

8.3.2 Social impacts

Generally, the data indicate that the social impacts of the project were positive, but there were possibly some minor negative impacts.

Similar to the economic impacts, we had conflicting messages from different survey questions about social impacts. Only one-quarter of fishers said the new processing methods took more time. This was probably because we encouraged them to do either salt-curing or smoke-curing and to cook the sea cucumbers at least a second time, which most fishers were not doing. So most of the fishers said that the new methods didn't take more time. But many of the women in focus-group sessions thought the new methods did take more time, and they thought this took away from some family responsibilities, socialising and rest time. Hence, we conclude that the new processing methods might require a compromise by fishers in spending a bit more time in careful processing but with the potential result of higher prices given for the products (if value-chain issues can be overcome). A further lesson is that fishers should be told that this might take more time, and they should be aware of that.

Many fishers believe the new methods had positive social impacts because they believe they improved their time efficiency in processing as a result of the workshops. In fact, 31% of male fishers believed they were saving time by applying the new methods, mostly because they now know they don't have to cook the sea cucumbers for so long.

8.3.3 Environmental impacts

The majority of evidence from interviews with fishers and focus-group sessions shows that the project had neutral environmental impacts. There was some evidence of minor positive environmental impacts and some evidence of minor negative impacts. These are discussed in response to a series of questions below.

Did the project or training encourage other fishers to enter the sea cucumber fishery?

Data from the interviews with fishers and the focus-group discussions with women show that the vast majority of respondents believe the project did not cause more people to start fishing sea cucumbers. At most, the data indicate that some new fishers might have entered the fishery in some localities because they had heard about the training and thought they could also start to harvest and process sea cucumbers. But only 11% of men and 15% of women thought this was true.

Conclusion: Postharvest processing training does not have a strong impact on encouraging other fishers to start fishing sea cucumbers.

Did the project or training encourage fishers to increase fishing effort?

One could hypothesise that trained fishers might go out and fish more often or collect more sea cucumbers per day because they feel equipped to process them better.

Data from interview questions to fishers about how often they went fishing showed that fishers, whether trained or not, decreased the frequency at which they fished each week between the baseline surveys (2014) and follow-up surveys (2015/2016). The reduction in fishing effort was likely a response to dwindling stocks. The modelling analyses confirmed that trained fishers did not go fishing more often than untrained fishers.

Data from interview questions to fishers about how many sea cucumbers they collected on average per fishing day in the past year indicated that trained fishers, on average, were collecting more sea cucumbers per fishing day than untrained fishers. The raw data showed this was the case only for women fishers. The inference is that, once empowered with knowledge on how to process low-value species, many of the trained women started collecting high numbers of them while fishing.

Conclusion: Training in postharvest processing did not encourage greater fishing *effort*. On the other hand, some trained women appeared to start collecting more sea cucumbers per fishing day, probably the low-value species that they did not previously know how to process well.

Did the project increase the use of wood as fuel for cooking sea cucumbers?

In some countries, such as Papua New Guinea, use of wood by sea cucumber fishers is a concern because this is sometimes from mangrove or forest trees that would otherwise not be felled (Kinch et al. 2008b). One could hypothesise that trained fishers might need more fuel to cook sea cucumbers, thus contributing to deforestation.

In Kiribati, fishers almost always used coconut husks as fuel, so this is a moot point for that fishery. In Fiji, fishers mostly used wood, but this was more often from trees already felled through cyclones. Only a small proportion of fishers in Fiji (30% of women and 24% of men) said that they spent more time cooking sea cucumbers. The new methods taught to them to actually cook the sea cucumbers for less time, but to also re-cook a second and even third time, which could potentially use more fuel in the end. However, given that felled wood was in abundance in Fiji already, the project was unlikely to have caused any deforestation in this case. Also, male fishers were more likely to spend less time in processing sea cucumbers using the new methods, so this could create positive environmental impacts.

Conclusion: Training in postharvest processing did not encourage deforestation in this case.

8.4 Communication and dissemination activities

Media articles

- A popular media article about the project, entitled “Making the most of sea cucumbers”, was published in *New Agriculturist* in April 2013 http://www.new-ag.info/en/developments/devItem.php?a=2964
- Eight media articles were written and published by the project team members of PCDF in Fiji about the project and recent activities:
  - Blueprint for brilliant beche-de-mer. Ra Kaka 2014/2: 4
  - Baseline survey completed. Ra Kaka 2014/2: 4
  - Villagers eager for post-harvest training. Ra Kaka 2014/3: 3
  - Department of fisheries assist in post harvesting of sea cucumber. Ra Kaka 2014/3: 4
  - Sea cucumber at the Society for Conservation Biology. Ra Kaka 2014/3: 4
  - New species of sea cucumber found in Fiji. Ra Kaka 2015/2: 4
  - DVD launched to assist fishers. Ra Kaka 2015/2: 4-5
  - Project fosters partnership with government. Ra Kaka 2015/2: 5-6
- A popular media article entitled “*Blueprint for brilliant beche-de-mer*”, written by ACIAR’s Wendy Henderson, was published on ACIAR’s website. The article presents the manual, the objectives of the project and links to other project outputs. http://aciarblog.blogspot.com.au/2014/06/blueprint-for-brilliant-beche-de-mer.html
- In 2016, the Fijian project officer wrote a media article about the project and key results from Fiji, which was published in the SPC Fisheries Newsletter #150.
- In 2016, we published a media article in the SPC Fisheries Newsletter #151 entitled “Update on beche-de-mer market prices in China”.

- In 2017, SCU put out a media release about the finalisation of the project and the key findings, which was accompanied by a 2-minute online video about the project.
- The project was mentioned in Universities Australia's 2016 book entitled "World Leading Research in Australia's Universities", and showed a photo of a training workshop in Kiribati. This was shared on the National Marine Science Centre's facebook page.
- In 2017, PCDF made a 2-page Feedback Information Sheet about the outcomes of the project, and hard copies were posted to each village involved in the project in Fiji. [Appendix 1]

Social media

- The PCDF Facebook page has photos and updates of project activities, as a means of public engagement about project activities being implemented by PCDF. The link to the PCDF Facebook page is: https://www.facebook.com/pcdfiji
- The finalisation of the training DVD was publicised on the National Marine Science Centre's Facebook page: https://www.facebook.com/nationalmarinesciencecentre/posts/867883119950563
- The article published in *Fisheries Research* has had 26 Tweets. A copy of the article was sent by email to other fisheries researchers and to fishery managers in Pacific Island countries, and the referencing information about the article was posted on ResearchGate.
- Announcements of each journal article published by the project were tweeted on Twitter.
- Several tweets were also made about recommendations from project for Fiji's sea cucumber fishery.
- The Fijian project officer, Watisoni Lalavanua, posted several blogs about our China study trip during November 2016.
- Copies of our research articles were distributed by email to fisheries researchers and fishery managers in Pacific Island countries, and the referencing information about the articles have been posted on ResearchGate.
- Folders with all articles published by the project have been prepared and will be posted to all Pacific Island fishery departments in 2018, once the articles in review and preparation have been finally published (see section 10.2).

Oral presentations

2014

- The Project Leader gave an oral presentation at USP's Institute of Marine Studies entitled: "*Global analysis of sea cucumber fisheries: overfishing, extinction risks and new management paradigms*". Later that year, he gave two further oral presentations in Fiji about the project, at the USP Marine Science Institute and at the Fiji Fisheries Department headquarters.
- The PCDF officer, Watisoni Lalavanua, gave a short presentation on the project at a Society for Conservation Biology Conference held at USP.

2015

- The PCDF officer, Watisoni Lalavanua, attended the Northern Division Fisheries Forum and gave an oral presentation about the ACIAR project. The Forum was

attended by fisheries officers and managers of the Department of Fisheries Fiji, and by NGOs and local scientists.
- The Tongan node coordinator, Poasi Ngaluafe, presented a talk at an IUCN-organised summit of Pacific Island fishery ministers, held in Tonga. The presentation summarised the project and key results on markets and surveys of fishers.
- A 30-min TV program was recorded in Vava'u, Tonga, on this ACIAR project and aired nationally.

2016

- The Project Leader gave an oral presentation about the findings from the baseline surveys at the 13th International Coral Reef Symposium in Hawai'i.
- The Project Leader gave an oral presentation about the project and its findings at University of Wollongong.
- The project team gave a 1-hour joint presentation about the project's findings at University of Hong Kong during the study trip to China.

2017

- The Fijian project officer, Sailasa Tagica, gave a presentation on the project's findings on postharvest processing methods at a national sea cucumber fishery forum in Fiji.
- The project leader gave a presentation about fisher perceptions and a second presentation on the overall project outcomes at the national sea cucumber fishery forum in Fiji.

9 Conclusions and recommendations

The most significant conclusion of the project is that postharvest processing training and information tools can have long-lasting impacts on improved quality of beche-de-mer produced by fishers, but significant improvements in the industry are still needed in order for fishers to reap the full benefits of improved product quality. The project reveals that changing the incomes of fishers is actually a complex and multi-faceted issue. Constraints to improving incomes of sea cucumber fishers can be viewed as “wicked problems”, as they are known in the development literature — they are complex, persistent or reoccurring and hard to fix because they are linked to broader social, economic and policy issues. This means that the improvement of processing quality of sea cucumbers is just one crucial step towards improving livelihoods. Improving value-chains so that fishers can get better income from better quality product is a second important issue, which can be the focus of future investments in the sector.

9.1 Conclusions

Capacity building within partner institutions

The project has, for the first time in the Pacific, built skills in fishery departments on how to train fishers in postharvest processing sea cucumbers into high-quality export-grade beche-de-mer.

Training to six fishery officers/researchers in conducting socioeconomic surveys formed valuable skills for use in other fishery studies for years to come.

The study trip to China left an indelible impression about international seafood trade on three of the Pacific Island collaborating researchers. The first-hand experience in seeing and collecting data in the Chinese markets will enrich their perspectives on the global demand for seafood that acts as a driver for exploitation of their own fisheries.

Mentoring of the partner-country collaborators built further capacity in scientific writing, which is needed in the Pacific. The skills will surely enhance their abilities to contribute to, and lead, the writing of fishery reports and scientific publications well into the future.

Outreach and capacity-building of fishers

The project had incredible outreach through its training manual, video and hands-on workshops in villages. Around 6000 manuals were delivered to fishers in the three countries, and other manuals were translated into other languages to help fishers in other Pacific Island countries and in the western Indian Ocean. Fishers continued to use the manual, so these are an enduring information source.

With over 132,000 online viewers, the project’s training video clearly had a wide outreach. Overall, this could be seen to compensate for the poor uptake of the videos through hard DVD copies.

Our direct hands-on training of more than 900 fishers in 80 villages in the three countries should have lasting impacts on their knowledge. Fishers responded that these were most useful of the three training tools. However, many fishers had forgotten about some best-practice methods and so we conclude that once-off workshops are not enough to achieve long-term change in methods used by fishers.

The project showed that the quality of beche-de-mer can be improved through training fishers. Most fishers (79%) who attended the workshops said that they subsequently changed their methods, and the vast majority of trained fishers believe that the training helped them to significantly improve the quality of their beche-de-mer that they process.

Socio-economic impacts of postharvest processing training

The postharvest processing training appears to have improved beche-de-mer quality and fishers at least believe that their incomes had been improved as a result. However, there are a number of external factors that impacted on the ability of fishers to actually earn higher weekly income as a result of the training.

Firstly, during the project, the fisheries were in decline; fishers were going out fishing less and, across the board, were earning less per week from sea cucumbers. This was despite increased prices in the final year of the fishery in Fiji. Hence, it was hard to expect that fishers could improve their income when harvests are declining and high-value species were probably in lower abundance. This is a fishery-management issue beyond the scope of the project. But we must add a caveat here that we were publishing advice on improved fishery management and gave seminars about this, even though it was not a mandate of the project.

Secondly, fishers and women in focus-group sessions said that many buyers were still not giving them better prices even though their products were better. Buyers may have had inflexible pricing to properly account for better-quality product, or were simply taking the benefits of fishers' improved processing in higher export prices of the products and not passing on those gains to fishers at the time of purchase. These are larger value-chain issues that were beyond the scope of the project (and the project team was actually instructed by ACIAR to exclude value-chain studies from the scope of the project). The very positive viewpoint is that the project gives clear recommendations for where future investments could be made to value-chains so that fishers can reap the full benefits of improved quality of their beche-de-mer.

Thirdly, fishers did not have access to all of the resources they need to apply the best-practice methods. This was chiefly due the inaccessibility of coarse salt in rural villages. The coarse salt, purchased in 20 kg bags by commercial processors, improves product quality and financial returns per sea cucumber because the product is heavier as a result of salt-curing. Despite foreseeing this constraint early in the project and encouraging the fishery departments to develop a mechanism for selling bags of coarse salt at their provincial fishery offices, like they already do for ice, this did not happen. Fishery departments will have to be more active in future about supporting these fisheries if they hope to promote optimal financial returns to fishers.

Scientific impacts

The scientific impacts of the project were diverse and substantial. The project's findings and publications offer important insights to other small-scale fisheries globally, far beyond sea cucumber fisheries. This is because sea cucumber fisheries are a suitable case study for small-scale fisheries because they are widespread, multi-species, participated by both men and women, important to coastal livelihoods, and used by domestic and international markets.

The project furnishes an improved understanding of fishing effort, gendered variation in catch composition, fishing frequency and fisher perceptions in small-scale fisheries. The findings should be valuable for underpinning our beliefs about socioeconomics in other small-scale fisheries. This was one of the few studies to report on fuel consumption of small-scale fishers, and shows that these fisheries can have significant ecological footprints comparable to, and even larger than, industrial-scale fisheries.

We now know, through the analyses of fisher satisfaction, that the psychological wellbeing of artisanal fishers can be strongly affected by value-chain issues. The project therefore gives more gravitas to improving value-chains in sea cucumber fisheries because this can be a way to also improve fisher wellbeing.

The value-chain study provides clear findings that fishers are getting a low proportion of the end-value of beche-de-mer for higher-value species. We now know that some

exporters, such as many in Fiji, were creaming the lion's-share of the profits from the industry and not passing on the value of exports to fishers. The results underpin a call for greater transparency in the value-chains and the development of initiatives that will allow fishers to get the best, fair, prices for beche-de-mer, especially if they are taking more care to process them to a higher export standard.

The publication from the previous market study conducted in 2011 during the PARDI scoping study underpinned studies by other researchers on value-chain analyses, conservation, fisheries management and aquaculture valuations (71 citations in 3 years). The market study in this project provides an invaluable update of market prices of sea cucumbers for the Indo-Pacific region, and a study of changes in prices over the past 5 years. Analyses of the relationship between prices and length of beche-de-mer give useful lessons for both fisheries and aquaculture policy.

Experiments by the JAF PhD student, Ravinesh Ram, has revealed the nutritional value of sandfish, which could be used in the marketing of aquaculture products. His study on the "recovery rates" of sea cucumbers through processing into dried beche-de-mer is useful to fishery managers for converting weights from dried to fresh sea cucumbers. The findings on the effects of processing methods on nutritional components provide a basis for fine-tuning the processing methods to optimize the quality of beche-de-mer.

9.2 Recommendations

The following recommendations are based on data and findings from the project:

1. **Provide manuals, training videos and workshops in other sea cucumber fisheries**. The workshops were especially appreciated by fishers and should be done in other countries, such as Solomon Islands, Papua New Guinea, French Polynesia, Indonesia and Philippines. The videos should be shown to fishers as part of the training, not just given to villages on DVD.
2. **Translate the manual and videos into other languages**. Both information sources had evidence of uptake.
3. **Plan and commit to providing refresher training to fishers**. Some methods trained to fishers were forgotten or misunderstood by fishers in the long term. After initial 1½-day workshops, half-day refresher training and follow-up visits to villages should be conducted probably every 3 months.
4. **Fishery departments should help fishers to access coarse salt**. In all three countries in this project, fishers had little or no support to help them process sea cucumbers. The fishery departments could buy coarse salt in bulk bags and sell them to fishers at cost price through their fishery offices. This would improve product quality and financial returns for fishers.
5. **Develop national 'Industry Standard Guides' on prices of beche-de-mer**. A booklet could be produced every year showing various grades of product for each species and the prices that fishers should get for each grade. This could involve minimum price standards, and even regulated through a Fair Trade system.
6. **Develop and test auction systems for selling beche-de-mer produced by fishers**. An auction system would see the product from fishers sold at the highest price to exporters bidding on different lots of beche-de-mer on a monthly basis. Fishers would get a partial base price for their product at the time they pass them over to the auction system, and they later get a top up of money based on whatever the product sells for above that price premium minus auction expenses. This maximises competition among buyers so that fishers get the highest price

they can for their products. And this minimises the risk that fishers get ripped off by unscrupulous buyers.

7. **Consider the opportunities for fisher cooperatives**. Fisher cooperatives apparently do not have a very successful history in the Pacific Islands, but are still used in some fisheries with success. In such a system, fishers are members of a consortium that exports the products. They get the industry standard price, depending on size and processing quality. Products then exported by the cooperative, via an Asian business manager. Such systems would need checks and balances to minimize corruption.

10 References

10.1 References cited in report

Brown, E.O., Perez, M.L., Garces, L.R., Ragaza, R.J., Bassig, R.A. and Zaragoza, E.C. (2010) Value chain analysis for sea cucumber in the Philippines. The WorldFish Center, Penang.

Ferdouse, F. (2004) World markets and trade flows of sea cucumber/beche-de-mer. In: Advances in sea cucumber aquaculture and management. FAO Fisheries Technical Paper No. 463 (eds A. Lovatelli, C. Conand , S. Purcell, S. Uthicke, J.F. Hamel and A. Mercier). FAO, Rome, pp. 101–117.

German, L., Mowo., J., Kingamkono, M. (2006) A methodology for tracking the “fate” of technological interventions in agriculture. Agriculture and Human Values 23: 353-369

IUCN (2015) “Less planning, more action”: A New Approach to Pacific Island Bêche-de-mer (BdM) Fisheries. Outcomes of a Regional Technical Bêche-de-mer (BdM) Meeting. Nuku’alofa, Tonga, 29 September – 1 October 2015. 30 p.

Kinch, J., Purcell, S., Uthicke, S. and Friedman, K. (2008a) Population status, fisheries and trade of sea cucumbers in the Western Pacific. In: Sea cucumbers: a global review on fisheries and trade. FAO Fisheries and Aquaculture Technical Paper No. 516 (eds V. Toral-Granda, A. Lovatelli and M. Vasconcellos). Rome, FAO. pp. 7–55.

Kinch, J., Purcell, S., Uthicke, S., Friedman K. (2008b) Papua New Guinea: a hot spot of sea cucumber fisheries in the Western Central Pacific. In: Toral-Granda V., Lovatelli A., Vasconcellos M. (eds.) Sea cucumbers: a global review on fisheries and trade. FAO Fisheries Technical Paper. No. 516. Rome, FAO. pp. 57-77

Pollnac, R.B., Abbott-Jamieson, S., Smith, C., Miller, M.L., Clay, P.M. Oles, B. (2006) Toward a model for fisheries social impact assessment. Marine Fisheries Review 68: 1-18

Purcell, S.W., Samyn, Y., Conand, C. (2012) Commercially important sea cucumbers of the world. FAO Species Catalogue for Fishery Purposes. No. 6. FAO, Rome, 150 pp. +30 colour plates.

Purcell, S.W., Mercier, A., Conand, C., Hamel, J.-F., Toral-Granda, V., Lovatelli, A. and Uthicke, S., (2013) Sea cucumber fisheries: global analysis of stocks, management measures and drivers of overfishing. Fish and Fisheries 14: 25-49

Purcell, S.W. (2014) Value, market preferences and trade of beche-de-mer from Pacific Island sea cucumbers. PLoS One 9: e95075

SPC (1994) Sea cucumbers and beche-de-mer of the tropical Pacific. South Pacific Commission, Noumea, 51 pp.

SPC (2004) Pacific island sea cucumber and beche-de-mer identification cards. Secretariat of the Pacific Community, Noumea.

SPC (2012) A proposed regional approach to improved management of sea cucumber fisheries. Working Paper 2. Coastal Fisheries Programme, Secretariat of the Pacific Community, Noumea. 5 p.

10.2 List of publications produced by project

Books

Purcell S.W. (2014) Processing sea cucumbers into beche-de-mer: a manual for Pacific Island fishers. Southern Cross University, Lismore, and the Secretariat of the Pacific Community, Noumea. p. 44. ISBN: 978-982-00-0711-6

Fijian version: Na vakarautaki ni sasalu ni waitui me ivoli: Na ivola dusidusi me ra vakayagataka na dauqoli ena Pasifika. ISBN: 978-982-00-0720-8

Tongan version: Ko hono teuteu'i 'o e mokohunu: Ko e tohi tokoni ma'a´ e kau toutai e ngaahi 'otumotu 'o e Pasifiki´. ISBN: 978-982-00-0719-2

Kiribati version: Aron karaoan ao kamauan te kereboki: Te boki ibukin buokaia taan akawa n te Betebeke. ISBN: 978-982-00-0717-8

French version: La transformation des holothuries en bêches-de-mer: Manuel à l'usage des pêcheurs océaniens. ISBN: 978-982-00-1074-1

Arabic version : تجهيز خياريات البحر في بيتش دي مير: دليل للصيادين جزر المحيط الهادئ. ISBN: to be announced in early 2018

http://www.spc.int/coastfish/index.php?option=com_content&Itemid=30&id=422

http://aciar.gov.au/publication/cop026

Book chapters

Purcell S.W., Lalavanua W, Tagica S (2017) Fisher perceptions about abundance and catch rates of sea cucumbers in Fiji. In: S. Mangubhai, W. Lalavanua and S.W. Purcell (Eds.). Fiji's Sea Cucumber Fishery: Advances in Science for Improved Management. Wildlife Conservation Society. Report No. 01/17. Suva, Fiji. 16–22 pp

Purcell S.W., Lalavanua, W. (2017) Postharvest processing of sea cucumbers in Fiji. In: S. Mangubhai, W. Lalavanua and S.W. Purcell (Eds.). Fiji's Sea Cucumber Fishery: Advances in Science for Improved Management. Wildlife Conservation Society. Report No. 01/17. Suva, Fiji. 30–37 pp

Refereed journal articles

Purcell, S.W., Ngaluafe, P., Tagica, S., Wang, G., Lalavanua, W., Ceccarelli, D.M. (in press) Market price trends of Latin American and Caribbean sea cucumbers inform fisheries management. *Regional Studies in Marine Science*

Purcell, S.W., Crona, B.I., Lalavanua, W., Eriksson, H. (2017) Distribution of economic returns in small-scale fisheries for international markets: a value-chain analysis. *Marine Policy* 86: 9–16

Purcell, S.W., Ngaluafe, P., Foale, S., Cocks, N., Cullis, B.R., Lalavanua, W. (2016) Multiple factors affect socioeconomics and wellbeing of artisanal sea cucumber fishers. *PLoS ONE* 11(12): e0165633

Purcell, S.W., Ngaluafe, P., Aram, K.T., Lalavanua, W. (2016) Trends in small-scale artisanal fishing of sea cucumbers in Oceania. *Fisheries Research* 183: 99–110

Ram. R., Chand. R. V., Zeng. C and Southgate. P. C. (2016). Recovery rates for eight commercial sea cucumber species from the Fiji Islands. Regional Studies in Marine Science, 8, Part 1, 59-64.

Ram. R., Chand. R.V., Forrest. A and Southgate. P.C. (2016) "An effect of processing techniques on quality, texture, collagen and amino acid composition of *Holothuria*

scabra (Sandfish) from the Fiji Islands" LWT Food Science and Technology, 86. 261-269.

Purcell, S.W., Pomeroy, R.S. (2015) Driving small-scale fisheries in developing countries. *Frontiers in Marine Science* 2:44 (1-7). doi: 10.3389/fmars.2015.00044

Purcell, S.W. (2014) Value, market preferences and trade of beche-de-mer from Pacific Island sea cucumbers. *PLoS One* 9: e95075

Non-refereed articles

Lalavanua, W., Mangughai, S., Purcell, S.W. (2017) New report urges management reforms to save Fiji's sea cucumber fishery. *SPC Fisheries Newsletter* 152: 22–26

Purcell, S.W., Ngaluafe, P., Wang, G., Lalavanua, W. (2017) Market value of flower teatfish ('Pentard'): a highly exploited Indian Ocean holothuroid. *SPC Beche-de-mer Information Bulletin* 37: 53–56

Purcell, S.W., Wu, M. (2017) Large-scale sandfish (Holothuria scabra) aquaculture in multitrophic polyculture ponds in southern China. *SPC Beche-de-mer Information Bulletin* 37: 51–52

Purcell, S.W., Ngaluafe, P., Aram, K.T., Lalavanua, W. (2016) Variation in postharvest processing of sea cucumbers by fishers and commercial processors among three Pacific Island countries. *SPC Beche-de-Mer Information Bulletin* 36: 58–66 http://www.spc.int/DigitalLibrary/Doc/FAME/InfoBull/BDM/36/BDM36.pdf

Purcell, S.W. (2016) Update on beche-de-mer market prices in China. *SPC Fisheries Newsletter* 150: 36

Tagica, S. (2016) Evaluating the impacts of efforts to improve postharvest processing of sea cucumber in Fiji. *SPC Fisheries Newsletter* 151: 25–26

Videos

Processing sea cucumbers: A training DVD for Pacific Island fishers. Hard DVD copies produced by Pasifika.
Online version: www.youtube.com/watch?v=KH6u0oZoclk
Downloadable files: http://scu.edu.au/environment-science-engineering/index.php/125

ACIAR sea cucumber post-harvest processing project
https://www.youtube.com/watch?v=S3Z5tOYVpsQ

Media articles

Blueprint for brilliant beche-de-mer. Ra Kaka 2014/2: 4

Baseline survey completed. Ra Kaka 2014/2: 4

Villagers eager for post-harvest training. Ra Kaka 2014/3: 3

Department of fisheries assist in post harvesting of sea cucumber. Ra Kaka 2014/3:4

Sea cucumber at the Society for Conservation Biology. Ra Kaka 2014/3: 4

New species of sea cucumber found in Fiji. Ra Kaka 2015/2: 4

DVD launched to assist fishers. Ra Kaka 2015/2: 4-5

Project fosters partnership with government. Ra Kaka 2015/2: 5-6

Blueprint for brilliant beche-de-mer. http://aciarblog.blogspot.com.au/2014/06/blueprint-for-brilliant-beche-de-mer.html

Refereed journal articles in review or in preparation

Hiruy, K., Murphy, R., Lewis, T., White, W., Purcell, S.W. (in review) Measuring scientific impact of fisheries and aquaculture research-for-development projects. In review in *Research Policy* [submitted Dec 2017]

MacKeracher, T. Gurney, G., Foale, S. Lalavanua, W., Purcell, S.W. (in prep) Uptake and dissemination of capacity-building interventions in an artisanal Pacific Island fishery. In prep for *Ecology and Society* [submission Feb 2018]

Purcell, S.W. Lalavanua, W., Cullis, B., Cocks, N. (in review) Small-scale fishing income and fuel consumption: Fiji's artisanal sea cucumber fishery. In review: *ICES Journal of Marine Science*

Purcell, S.W., Ngaluafe, P., Williamson, D. (in review) Chinese market value of beche-de-mer: implications for fisheries and aquaculture. In review: *Marine Policy*

Purcell, S.W., Lalavanua, W., Tagica, S., Fraser, N., Ceccarelli, D.M. (in prep) Catch composition varies among fishing modes, genders and locations in an artisanal multispecies fishery. In prep for *Frontiers in Marine Science* [submission Jan 2018]

Purcell, S.W. Lalavanua, W., Cullis, B., Cocks, N., Foale, S. (in prep) Wicked problems of improving small-scale fisher livelihoods through capacity building. In prep for *Proceedings of the National Academy of Science* [submission July 2018]

Ram. R., Forrest. A, Chand .R.V, Davis. S., Bolumargarcia. T., and Southgate. P.C. (2016) "Isolation and characterization of collagen from the body wall of sea cucumber *Holothuria scabra* (Sandfish) from the Fiji Islands" *Food Chemistry* [In review]

Ram. R., Chand. R.V., Francis. D and Southgate. P.C. (2016) "Effect of different processing techniques on the nutrient composition of Sandfish from the Fiji Islands" *Journal of Food Science and Technology* [In review]

11 Appendixes

11.1 Appendix 1:

Information sheet given to villages in Fiji at the end of the project to provide feedback about project outcomes.

Feedback Update on ACIAR Project (Evaluating the Impacts of Improving Post-Harvest Processing of Sea Cucumber in the Western Pacific Region)

Locations and Villages

Ra (Malake, Togovere, Drauniivi) Kadavu (Narikoso, Vabea, Matanuku, Muani, Galoa) Bua (Yadua, Yaqaga, Galoa) Cakaudrove (Vunisavisavi, Nakobo, Nanuca, Tacilevu) Taveuni (Drekeji, Lavena, Qeleni, Naselesele, Vuna) Lau group (south) (Tubou, Waciwaci, Waitabu, Waiqori, Dakuiloa) Yasawa (Muaira, Kese, Marou, Malevu) Vanua Balavu (Cikobia, Avea, Mavana, Narocivo, Daliconi)

Socio-economic surveys and Village-based training workshops

A fisher interview session

A training session on sea cucumber processing

A group of fishers with their training manuals after a training

The project was funded by the Australian Centre for International Agricultural Research (ACIAR) and conducted by Partners in Community Development Fiji (PCDF) and Southern Cross University, Australia. The project activities were divided into three phases: socio-economic survey, village-based training workshops, and follow-up surveys.

353 fishers were trained in the full workshops in 24 villages. In these workshops, 353-500 manuals were distributed to individuals attending the training and also to those that missed the training but were interested in processing, and a DVD was given to each village. Shorter training sessions were held in another 5 villages (Mavana, Cikobia and Daliconi, Dakuiloa and Togovere). During the shorter sessions, we provided information on processing and we distributed training manuals and training DVDs.

Satisfaction forms filled out by workshop participants showed that 95% of them believed that the workshops "provided them with new knowledge" and had "improved their perceptions of processing". Several participants also expressed their interest in participating in bi-annual refresher workshops.

Focus group session and Follow-up survey

Follow-up socio economic surveys were conducted one year after the training was done using questionnaire-based interviews with fisher. The main purpose of the survey was to collect data that will be used to test the impacts of the project's interventions. We also held focus-group sessions with women in participating villages to provide opportunities for women to

Page **1** of **2**