A rapid assessment of the Seychelles octopus fishery value chain

Food and Agriculture Organization of the United Nations

December 2023

James McCafferty, Dr Ameer Ebrahim, Prof Warwick Sauer, Annie Vidot

Executive Summary

Octopus fisheries are important contributors to the food and nutrition security, livelihoods, identities, income, and wellbeing of many coastal communities in the Western Indian Ocean (WIO) region. In the Republic of Seychelles, octopus fishing has been traditionally practised for decades, and octopus is deeply rooted in traditional creole cuisine and culture. It is also a popular delicacy for tourists, fetching high prices in restaurants and hotels. However, in comparison to octopus fisheries in other WIO countries, there is a general lack of ecological, social and economic information on the status and characteristics of the Seychelles octopus fishery. The minimal data that exist indicate overfishing may be taking place, yet past efforts to implement a management plan drafted in 1998 stalled, contrasting with more progressive octopus fisheries management in neighbouring WIO countries.

To address concerns related to the sustainability of octopus fishing in Seychelles, the Seychelles Fishing Authority (SFA) (the competent authority for fisheries management in Seychelles) embarked on a socioeconomic and biological study in 2022 under the SeyCCAT Blue Grants Fund 5 with the overall aim of developing an octopus fishery management plan. To complement this study, a rapid assessment of the octopus fishery value chain was conducted by the Food and Agriculture Organization of the United Nations (FAO) under a Technical Cooperation Programme entitled 'Support for business development and investment opportunities in fisheries' (TCP/SEY/3805) to provide additional information that could contribute towards developing a holistic picture of the octopus fishery in Seychelles. The objectives of the value chain study were to (1) describe the value chain in terms of fishing activities, processing, distribution, and retail, (2) develop a high-level map of the octopus fishery value chain showing production, processing, distribution, markets, and sales, (3) outline constraints and opportunities for the octopus fishery value chain, and (4) provide recommendations to inform future studies.

Field surveys were conducted from November to December 2023 across Mahé, Praslin and La Digue islands. A total of 75 questionnaires were administered to fishers, processors, traders, retailers and hospitality stakeholders to capture data on volumes, products, processing methods, pricing, trading relationships, risks and challenges. Concurrent literature reviews and data mining of peer-reviewed and grey literature, and SFA biological surveys supplemented the primary dataset. Information was collated into a database for value chain mapping and initial catch estimates.

The findings showed that the octopus value chain comprises multiple actors including fishers, middlemen, seafood companies, hotels, restaurants, and tourist- and resident consumers. Total catch was estimated at around 190 tonnes annually, over 5 times the number in official landings data, with a landed value of around SCR 31 million. Almost half of the stakeholders interviewed (49%) expressed the opinion that the supply of local octopus had decreased over the last 5 – 10 years which was largely attributed to overfishing and the harvesting of juvenile octopus. Frozen octopus is also imported from India, Vietnam, the United Arab Emirates, Morocco, and Spain by seafood companies and large supermarkets. Around 10 tonnes was imported in 2021.

Shore-based fishers are typically mobile vendors who sell fresh octopus directly to restaurant owners/managers at their premises. Boat-based fishers sell fresh octopus directly to restaurants, hotels, middlemen, seafood companies, and individuals. Some also act as middlemen and have their own processing, storage, and distribution facilities. Middlemen are individuals who act as processors and wholesalers and carry out their own distribution. There are at least three major

middlemen in operation on Mahé and one on Praslin who collect bulk volumes (up to 20 tonnes/annum) of fresh octopus from multiple shore-based and boat-based fishers and sell to hotels, restaurants, and seafood companies. There are at least three major seafood companies, all based on Mahé, that collect octopus from multiple sources including fishers and middlemen before washing, packing, and blast freezing.

Consumers of octopus in Seychelles included both tourists and local residents. Hotels largely sold octopus dishes to tourists whereas restaurants sold octopus to tourists as well as local residents. Margins obtained by middlemen and seafood companies were similar whereas hotels and restaurants obtained larger margins due to using small quantities of octopus in their dishes which were sold at high prices.

Key constraints facing Seychelles' octopus fishery value chain include inadequate governance and awareness of the status of octopus stocks, along with substance abuse amongst irregular, informal fishers spurring overfishing concerns. Stakeholders advocated for licensing the fishery, introducing a minimum size limits and temporal closures during reproductive periods to ensure sustainability. Targeted education programs and public-private coordination mechanisms are also advised to support emerging management measures.

Acknowledgements

We would like to thank the following people for their contribution to this study:

Honourable Jean-Francois Ferrari - Minister responsible for Fisheries and the Blue Economy
Roy Clarisse - Principal Secretary for Fisheries
Keven Nancy - Principal Secretary for Agriculture & FAO National Correspondent
Aubrey Harris - Executive Board Member of the Seychelles Fishing Authority
Audrey Zelia - FAO Programme Coordinator, Seychelles
Jan Robinson - CEO, SFA
Dainise Quatre – SFA, Research
Andrew Souffre – SFA, Research
Clara Belmont – SFA, Research
Maya Marday – SFA, Research
Vasco Schmidt - FAO, Subregional Office for Southern Africa (SFS)
Hasina Razafimbahiny – FAO, Madagascar
Darney Barbe – Glacis Fishermen Association
Rodney Nichole – Belombre Fishermen Association

We would also like to acknowledge the many stakeholders who participated in the study and contributed to this report, including fishers Angelin Bouchereau, Richie Payet, Trevor Payet; purchasing and operations managers Jacintaia Athanase, Glen Kinder, Ahbina Issa, Floyd, Stella Pedrazzini, Travis, Reg Moses, Lindy Sainbina, Didier, Magdalene, Pramodh Govinden, Cedrick Kidd, , Davy Dugasse, Mervin Gean, Berty Joubert, Stuart Hull; factory and processor managers Guillian, Neven Cinoti; hotel managers Fumudh Hewage, Daya; restaurant owners and managers Richard , Sajan Dhurma, Lydia, Suren Venkaya, Joel Vivien, Hansel Labonte, Juan-Lul Savy, Marlene Young, Maevel, Graham Green, Vito Vargiolu, Elvis Malbrook; and procurement managers Jose and Vanessa, Murphey Hoareau, Shabutin, Mike and Nella, and Pascal Lesperance.

Contents

List of Figures

List of Tables

Acronyms and Abbreviations

EAF	Ecosystem Approach to Fisheries (FAO)
FAO	Food and Agriculture Organization of the United Nations
SCR	Seychelles Rupee
SDG	Sustainable Development Goal (UN)
SFA	Seychelles Fishing Authority
UN	United Nations
WIO	Western Indian Ocean

1. Introduction

Octopus fisheries are important contributors to the food and nutrition security, livelihoods, identities, income, and wellbeing of many coastal communities in the Western Indian Ocean (WIO) region (Rocliffe and Harris, 2016; Willer et al., 2023). They also provide a range of essential ecosystem services (Ainsworth et al., 2023) and may be an important source of livelihoods for women (Willer et al., 2023). As such, they play an integral role in contributing towards the United Nations Sustainable Development Goals (UN SDGs), particularly No Poverty (SDG 1), Zero Hunger (SDG 2), Gender Equality (SDG 5), Responsible Consumption and Production (SDG 12), and Life Below Water (SDG 14) (UN General Assembly, 2015).

Octopus fishing is an important socio-economic activity in many WIO countries (Rocliffe and Harris, 2016). In the Republic of Seychelles (hereafter Seychelles), octopus fishing has been traditionally practised for decades, and octopus is deeply rooted in traditional creole cuisine and culture (SFA, 2014). It is also a popular delicacy for tourists, fetching high prices in restaurants and hotels (Advance Africa Management Services, 2018). However, in comparison to octopus fisheries in other WIO countries such as Madagascar (e.g. see Aina, 2010; Benbow and Harris, 2011; Belazis, 2011; Raberinary and Benbow, 2011; Westerman and Benbow, 2013; Benbow et al., 2014; Blue Ventures Conservation, 2014; Oliver et al., 2015; Ratsimbazafy et al., 2016), United Republic of Tanzania (Guard and Mgaya, 2002; Robertson et al., 2018; Chande et al., 2021; Silas et al., 2021; Mtonga et al., 2022; Silas et al., 2023), and Mauritius (including Rodrigues) (Sauer et al., 2011; Sweenarain, 2012; SmartFish, 2014; Bhandari, 2020), there is a general lack of ecological, social and economic information on the status and characteristics of the Seychelles octopus fishery. Indeed, questions remain as to the genetic identity of the principal target species; it is mostly cited as *Octopus vulgaris* (Payet, 1996; Mees et al., 1998; Seychelles Fishing Authority, 2014; Rocliffe and Harris, 2015) although evidence suggests that it may actually be *O. cyanea* (Taylor, 2014; Trevelen et al., in prep).

The limited information on the octopus fishery that is available, which is entirely contained in technical reports within the grey literature, highlights how overfishing may be occurring, and stresses the need for better management (Payet, 1996; Mees et al., 1998; SFA, 2014; Rocliffe and Harris, 2015). However, despite previous attempts to regulate the fishery, including the development of a Draft Management Plan in 1998 (Mees et al., 1998), there are currently no

active management measures in place to ensure the sustainable utilisation of the octopus resource. This stands in contrast to other WIO countries such as Madagascar and Mauritius (Rodrigues) that have developed and implemented effective octopus fisheries management plans.

To address concerns related to the sustainability of octopus fishing in Seychelles, the Seychelles Fishing Authority (SFA) (the competent authority for fisheries management in Seychelles) embarked on a study in 2022 with the overall aim to inform and review potential management measures. The objectives of the SFA study are to obtain data on the socioeconomic and biological characteristics of the octopus fishery, identify the main octopus species in the Inner Seychelles islands, formulate recommendations for sustainable fishery management measures, and promote public awareness regarding the ongoing monitoring efforts in octopus fisheries (Vidot and Ebrahim, 2022). The SFA study is an important step towards developing and implementing a management plan for Seychelles; however, the scope of the study does not cover the entire octopus fishery value chain. It is increasingly acknowledged that adopting a value chain approach towards fisheries research and management, which looks at, among other things, the characteristics, behaviours and interactions between different user groups, supply and demand dynamics, and the power of the market, is critical for identifying the necessary steps required to ensure that the resource is utilised in an ecologically, socially, and economically responsible manner (Coronado et al., 2020). To this end, this rapid study of the octopus fishery value chain was conducted by the Food and Agriculture Organization of the United Nations (FAO) to provide additional information that will contribute towards developing a holistic picture of the octopus fishery in Seychelles. The work will complement the SFA study with the end goal to support the development of an octopus management plan aligned with the FAO Ecosystem Approach to Fisheries (EAF).

2. Aim and Objectives

The aim of the study was to provide a high-level overview of the Seychelles octopus fishery value chain with a view towards identifying opportunities and constraints and providing recommendations to enhance its sustainability.

More specifically, the objectives were to:

1. Describe the value chain in terms of fishing activities, processing, distribution, and retail;
2. Develop a high-level map of the octopus fishery value chain showing production, processing, distribution, markets, and sales;
3. Outline constraints and opportunities for the octopus fishery value chain; and
4. Provide recommendations to inform future studies.

3. Materials and Methods

3.1. Data Collection and Analysis

Field surveys were carried out from 5 November to 5 December, 2023. Surveys were conducted on the islands of Mahé, Praslin, and La Digue. Questionnaires (see Annexure 1) were administered to processors, traders, retailers, restaurant and hotel owners, and purchasing managers. The questionnaires were structured to obtain primary data on sources, volumes, products and product forms, processing methods, prices, trading, relationships between value chain actors, risks and challenges along the value chain, and areas in which there may be opportunities for improvement or growth.

A comprehensive data mining exercise and literature review was conducted to collect secondary data to supplement the primary data collected during the fieldwork. This included a review of all available peer-reviewed, scientific and grey literature on the subject that could be found and accessed through various databases and specialist search engines. Amongst others, these included JSTOR; Scopus; Science Direct; WorldCat Dissertations and Theses; African Journals Online; BioMed Central; Fish, Fisheries and Aquatic Biodiversity Worldwide; Waters and Oceans Worldwide, FAO online catalogue; FishBase; Google Scholar; blog articles and opinion pieces in the printed media; as well as reports and information from webpages that refer to the Seychelles octopus fishery. Secondary data collected during the SFA study were also used, where relevant, to supplement the primary data from our fieldwork.

The primary and secondary data were collated in a database. The Seychelles octopus fishery value chain was then mapped to visually represent the relationships between value chain actors, and the movement of octopus within the value chain. A high-level summary of the costs, prices and margins obtained by different value chain actors was also developed.

A preliminary approximation of the total yearly octopus catch was obtained by first determining the mean tonnage purchased annually by hotels and restaurants of varying sizes,

and subsequently extrapolating this figure across the total quantity of small, medium and large hotels and restaurants operating nationwide in Seychelles.

3.2. Stakeholder Workshop

The preliminary results of the study were presented at a Seychelles National Octopus Workshop in Victoria, Mahé in December 2023. Participants at the workshop included a diverse range of stakeholders from fishers to processors to government officials. A full list of the participants is provided in Appendix C. The workshop session was used to validate the findings of the study as well as to gain additional insights and input, particularly on management options, that were subsequently incorporated into this report.

3.3. Limitations

The rapid nature of this study meant that the timeframe available for conducting comprehensive surveys and data analysis was highly constrained. The short survey duration of only one month limited the extent of sampling that could be achieved. More exhaustive sampling and engagement with stakeholders may have yielded additional insights and quantitative evidence regarding catch volumes, product flows, costs and earnings.

Additionally, there was hesitancy among certain actors operating along the octopus value chain to divulge commercially sensitive information on transactions, margins and relationships. Such confidentiality concerns unfortunately placed practical boundaries on the depth of quantitative data that could be elicited. In cases where respondents were uncomfortable providing details, we obtained the maximum information possible within their acceptable limits of disclosure.

4. Results

A total of 75 questionnaires were administered over the course of the study. The respondents included fishers, middlemen, seafood companies, and purchasing managers/managers/owners of hotels and restaurants (Table 1). The list of stakeholders that were interviewed is provided in Appendix B.

Table 1: List of key actors interviewed during the field surveys of Mahé, Praslin, and La Digue.

Key Actors	Interviews (n)
Fishers	31
Middlemen	4
Seafood Companies	3
Hotels	23

A map of the octopus value chain in Seychelles is shown in Figure 1. Each stage of the value chain is described in further detail below.

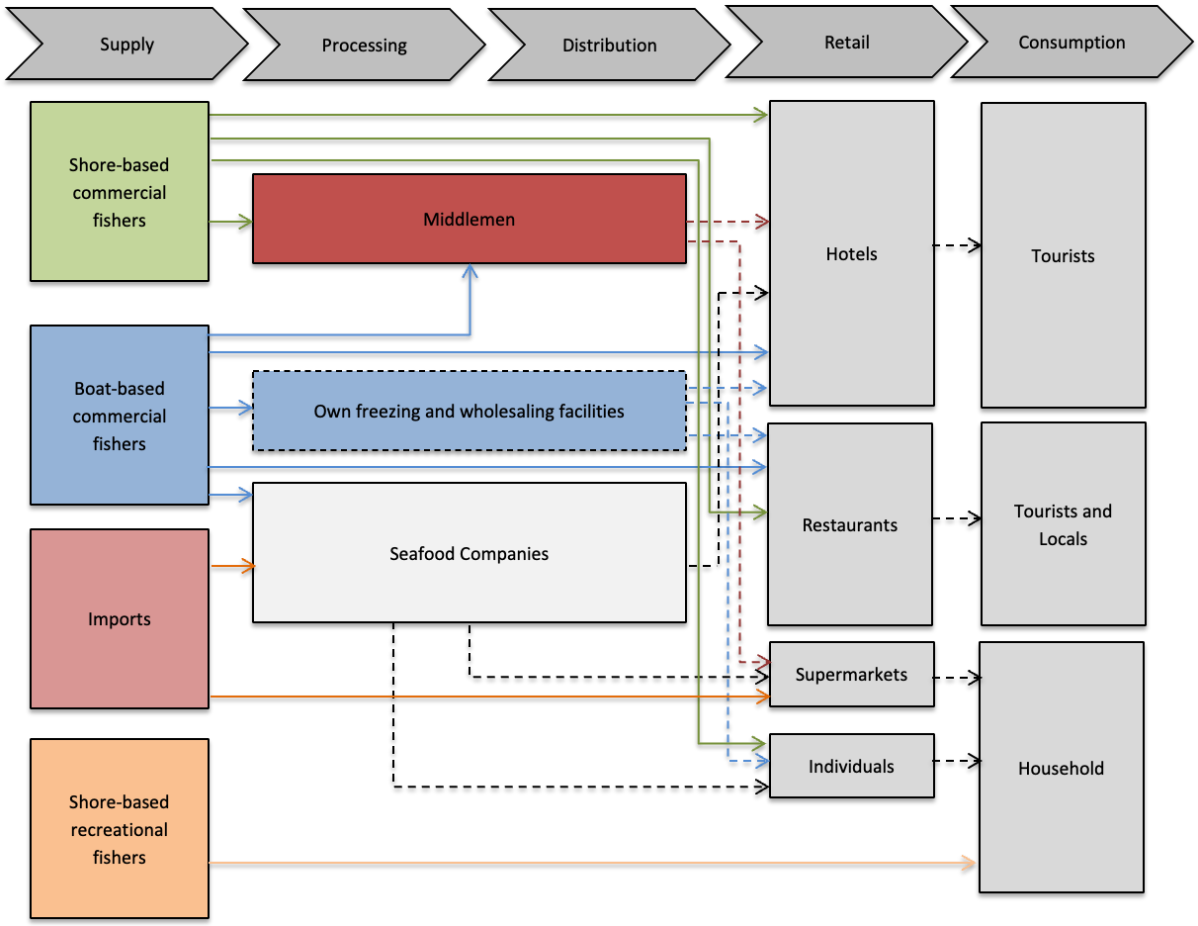

Figure 1. The Seychelles octopus fishery value chain.

4.1. Supply

4.1.1. Fishing Activities

The octopus fishery can be split into two distinct components: (1) a shore-based component where fishers access intertidal areas from shore and harvest octopus with steel harpoons on foot and/or by skindiving, and (2) a boat-based component where fishers access intertidal and off-reef areas with motorised vessels and harvest octopus with steel harpoons by skindiving and/or using self-contained underwater breathing apparatus (SCUBA) (Figure 2). Shore-based fishers can be split further into recreational fishers who harvest octopus for home consumption and commercial fishers who harvest octopus for onward sale.

Figure 2: Octopus fishing in Seychelles includes a shore-based component (left; Source: flickr.com) and a boat-based component (right; Source: FAO).

Shore-based fishing effort is largely concentrated around the islands of Mahé, Praslin, and La Digue whereas boat-based fishers are more mobile and, in addition to these islands, may fish around other neighbouring islands including Silhouette, North Island, Fregate, Felicite, and Curieuse. Fishing is conducted year-round although effort declines during the south-east monsoon due to rough seas and turbid water which reduces visibility. Peak catches are made during the months of November and December.

Questionnaire results showed that fishing was conducted entirely by men. Extrapolating from the average annual volumes purchased by hotels and restaurants, we estimated total octopus catch to be around 193 tonnes per annum (Table 2). Based on these data, total octopus catch is almost five times greater than both the 39 tonnes reported in 2021, and the average annual catch estimate of 35 tonnes over the period 1980 to 2021 (FAO, 2023a). It is important to note that this estimate does not include household consumption by recreational fishers, and assumes that all hotels and restaurants in Seychelles serve local octopus. Given the current average landed price of octopus of SCR 160/kg, the total landed value of octopus in Seychelles was estimated at SCR 30.88 million, at the lowest end of the value chain.

The average harvest size reported was between 1 and 3 kg; however, some buyers reported being offered “small octopus” including individuals of less than 10 cm in length. Of the value chain actors interviewed, almost half (49%) expressed the opinion that the supply of octopus had decreased over the last 5 – 10 years while 38% were of the view that there had been no

change (Figure 3). Decline in supply was largely attributed to overfishing and the harvesting of juvenile octopus. Around 44% were also of the view that the supply of octopus from the fishery was inconsistent (Figure 3). Inconsistency in supply was largely attributed to reduced fishing effort during the south-east monsoon and, to a lesser extent, overfishing.

Table 2: Average and estimated total annual volumes of octopus purchased by hotels and restaurants in Seychelles.

Purchaser	Average volume (tonnes) purchased per annum	n	Estimated total volume (tonnes) purchased per annum
Small hotels	0.39	30	11.70
Medium hotels	1.71	15	25.65
Large hotels	2.47	19	46.93
Restaurants	1.73	63	108.99
Total			**193.27**

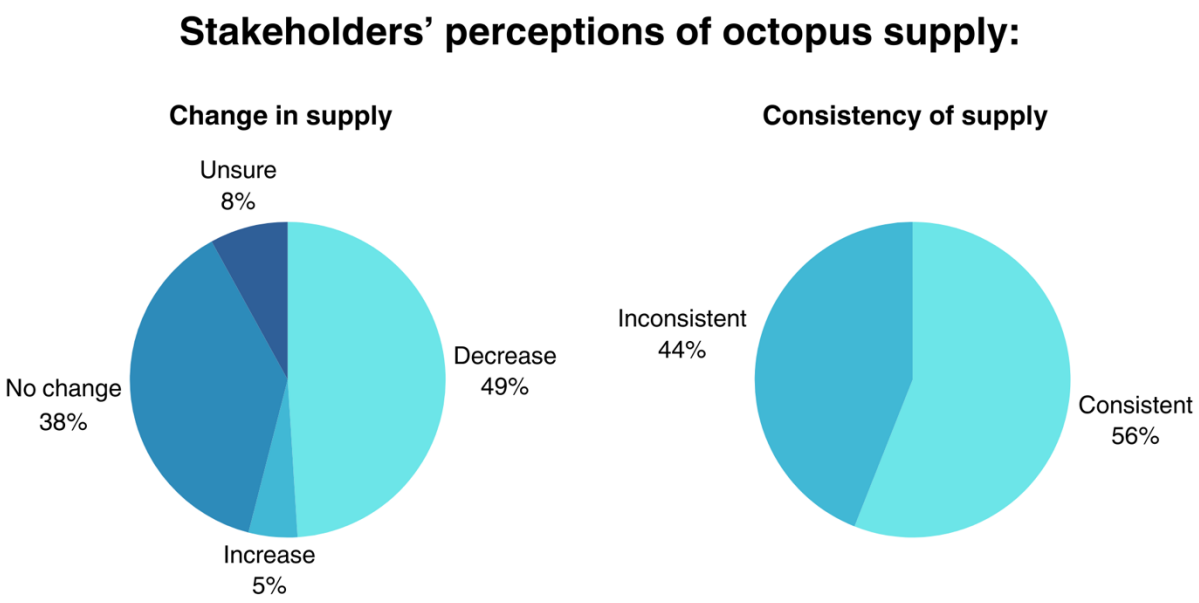

Figure 3: Stakeholders perception of the change in supply (left), and the consistency of supply (right) of octopus in Seychelles over the last 5 - 10 years.

4.1.2. Imports

Frozen octopus is imported from India, Vietnam, the United Arab Emirates, Morocco, and Spain by seafood companies and large supermarkets. The first recorded imports were in 2006; from 2010 to 2013, imports spiked, reaching close to 100 tonnes in 2010, although these subsequently declined and only 10 tonnes was imported in 2021 (Figure 4) (FAO, 2023b). All imported octopus is frozen; products include whole adult and baby octopus (Figure 5). Several fishers and middlemen were of the view that the importation of octopus posed a threat to their

operations (see Section 4.5). On the other hand, some large supermarkets and high-end hotels relied heavily on imports due to the reliability of the product and significantly lower prices.

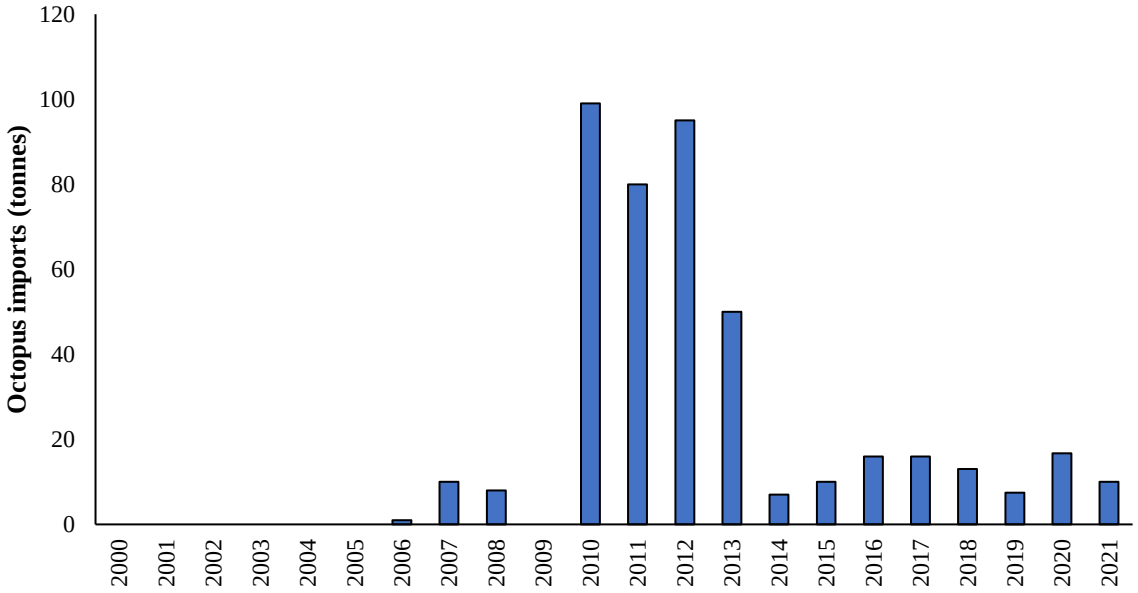

Figure 4: Total octopus imports into Seychelles over the period 2000-2021 (Source: FAO, 2023b).

Figure 5: Imported octopus products from India (left) and Vietnam (right) (Source: FAO).

4.2. Distribution, Processing, and Trade

Shore-based fishers are typically mobile vendors who sell fresh octopus directly to restaurant owners/managers at their premises. They also sell to middlemen who collect octopus from them as they come to shore. On Mahé (e.g. Anse aux Pins, Glacis), there are also certain sites where shore-based fishers sell fresh octopus on the roadside to individual consumers (mostly residents). In general, there was a reluctance on the part of hotel owners to purchase octopus from shore-based fishers, particularly on Mahé. This seemed to be because (1) they did not

want informal, shore-based fishers, commonly considered to be under the influence of narcotics, interacting with their guests, and/or (2) they were bound by international food safety standards and, as such, only purchased imported octopus and/or local octopus from suppliers with well-established cold chain facilities aligned with international standards.

Boat-based fishers sell fresh octopus directly to restaurants, hotels, middlemen, seafood companies, and individuals. Some also act as middlemen and have their own processing, storage, and distribution facilities.

The questionnaire results indicated that fishers typically obtained a price of around SCR 160/kg although this ranged from as low as SCR 125/kg during periods of high supply (November/December) to as high as SCR 220/kg during the south-east monsoon (May-August).

4.2.1. Middlemen

There are two distinct types of intermediaries in the octopus value chain: (1) middlemen and (2) seafood companies. Middlemen are individuals who act as processors and wholesalers and carry out their own distribution. There are at least three major middlemen in operation on Mahé and one on Praslin who collect bulk volumes (up to 20 tonnes/annum) of fresh octopus from multiple shore-based and boat-based fishers and sell to hotels, restaurants, and seafood companies. After collection, octopus may be transported fresh in large plastic containers on the back of pick-ups and sold directly to restaurants or hotels, or cleaned, packaged (in plastic bags, vacuum packed, and occasionally polystyrene trays), blast frozen and stored (Figure 6). During periods of high supply from the fishery, middlemen store surplus octopus which enables them to provide consistent volumes to their customers during periods of low supply. This allows them to enter into offtake agreements with customers, typically hotels, as they can guarantee consistent volumes year-round. On average, the questionnaire results showed that middlemen obtained a price of around SCR 235/kg.

Figure 6: Middlemen freeze and package their octopus for onward sale (Source: Nella Coco)

4.2.2. Seafood companies

The other intermediaries are the seafood companies. There are at least three major seafood companies, all based on Mahé, that collect octopus from multiple sources including fishers and middlemen before washing, packing, and blast freezing. One seafood company that was interviewed also stated that they augmented their octopus supply with imports because of a lack of consistent local supply. Another major company has stopped dealing with octopus altogether due to a lack of consistent local supply.

Seafood companies commonly sell octopus to restaurants and hotels; in addition, they have their own retail outlets for sales directly to local consumers (Figure 7). The questionnaire results showed that seafood companies typically sold frozen octopus for around SCR 300/kg.

Figure 7: Frozen local octopus on sale at a seafood company on Mahé (Source: FAO)

4.3. Retail and Consumption

Consumers of octopus in Seychelles include both tourists and residents. Hotels largely sell octopus dishes to tourists whereas restaurants sell octopus to tourists and residents. The most common dishes identified through the questionnaire included octopus curry (which was either sold a la carte for around SCR 350 – 550 or on seafood buffets) and octopus salad (SCR 400 - 500). Other dishes included whole grilled octopus (SCR 400), octopus carpaccio (SCR 190 – 200), octopus gratin (SCR 300-400), octopus pasta (SCR 345) and, in one instance, octopus burgers (SCR 300). The majority of hotels and all of the restaurants interviewed used only locally caught octopus in their dishes. Some hotels used imports to ensure consistent supply and/or due to food safety standards. Large supermarkets sold both local and imported frozen octopus while small supermarkets only sold imported frozen octopus. Octopus in smaller supermarkets were largely sold to local residents for home consumption, while larger supermarkets e.g. STC sold predominantly to hotels.

4.4. High-level overview of costs and margins

An overview of the costs and margins obtained by different value chain actors is shown in Table 3. Margins obtained by middlemen and seafood companies were similar whereas hotels and restaurants obtained very large margins due to using small quantities of octopus in their dishes and high retail prices.

Table 3: Costs and margins obtained by different octopus value chain actors

Value chain actor	Purchase price (SCR/kg)	Sale price (SCR/kg)	Gross margin (SCR/kg)	Gross margin (%)
Shore-based fishers		160		
Boat-based fishers		160		
Middlemen	160	235	75	32
Seafood companies	160-235	235-300	65-75	20-30
Hotels and restaurants	250	600-1 000	350-750	140-300

4.5. Constraints

The most commonly cited constraint to the octopus industry in Seychelles was widespread drug abuse among informal, shore-based fishers. Drug abuse has created an 'informal fishery' whereby addicts target octopus, regardless of size, to gain some quick cash. These activities may be contributing to overfishing and the harvesting of undersized juvenile octopus. Overall, governance and management of the sector was inadequate according to the stakeholders. Issues here included a lack of trust, consultation, regulation and enforcement around size limits, licensing, and seasonal closures. It was also noted that there was a general lack of awareness, particularly among shore-based fishers, of the status of the resource and the need for management and regulations. Other constraints that were highlighted included competition with cheaper imports, price instability and concerns around issues like fixing prices or introducing VAT, financial and operational issues for processors like electricity costs and accessing loans, and occasional food quality/hygiene concerns. Finally, several large players want to promote 100% local product but there is no price floor which makes imports an attractive option.

4.6. Opportunities

Stakeholders were of the view that developing or improving post-harvest infrastructure for mass storage and retail could alleviate inconsistency in supply and product availability. Currently, there is little to no infrastructure on Praslin and La Digue Islands that could support a reliable octopus supply for both islands.

Several stakeholders were also of the view that there was an opportunity for developing export channels for octopus, in a similar manner to that which has been established in Rodrigues. However, it must be noted that in the absence of data on stock status and effort, the bio-economic feasibility of this opportunity is unclear and should be treated with caution.

4.7. Stakeholder recommendations

Stakeholders were largely supportive of introducing a licensing framework and trialling well-designed seasonal closures during key reproductive periods, and highlighted the need for a comprehensive management plan. Stakeholders also stressed the need for targeted educational and awareness-raising initiatives focused on promoting responsible and ethical fishing practices. Structuring more formalised associations and a public-private sector working group was also recommended for promoting participatory decision-making regarding emerging management measures.

On the market development side, stakeholders advocated for various interventions to stabilise and add value across the value chain. This included centralising trade channels through a dedicated octopus marketing and auction facility which would allow for improved dialogue between buyers and sellers. The site could also enable the implementation of minimum price floors during periods of particularly high landings when leverage shifts to processors and traders. Several participants insisted investment in specialised landing sites, processing infrastructure and cold storage capacity, especially in secondary hubs like Praslin, was important to reduce product losses while embedding value-added activities like cleaning, freezing, and packaging locally.

5. Discussion

The current study provides a useful "snapshot" of Seychelles' octopus value chain and possible barriers and challenges currently faced by the various players in the octopus fishery sector. Survey findings revealed that the major constraints were a lack of governance, inadequate awareness of the status of the resource and, most significantly, widespread substance abuse. What is clear is that the scale of the octopus fishery is far greater than previously thought and, while limited, the data also point to possible overexploitation pressures on octopus stocks that could undermine the fishery's long-term viability if it is not effectively managed. As such, a key outcome of the study is the urgent need for a comprehensive Octopus Fisheries Management Plan. The current study highlighted several key areas for consideration in the compilation of such a plan, and these are set out below:

Stakeholder consultation

Comprehensive stakeholder consultation is a must and this will require input across the value chain, taking into consideration the distinct challenges faced by different value chain actors on the different islands, and the current socio-economic status of many of the fishers, including widespread substance abuse and associated challenges.

Understanding the value chain

The current study, while useful, has limitations in terms of the sample size and geographic coverage. Expanding surveys will provide critical missing quantitative data on volumes, values, and product flows. Detailed market and consumer research can also clarify leverage points for upgrading. A possible social leverage point may include building upon stakeholder enthusiasm for management. Lastly incorporating value chain development as a key facet in management strategies could prove advantageous. By actively promoting and supporting value chain initiatives within management frameworks and integrating them into planning tools, value chain actors could maximise their potential benefits while ensuring sustainability.
Broadening of the current market

At present there is no export of octopus from Seychelles, and any interventions to promote export must be carefully considered. Apart from the economic viability, the impact on the local markets and the effect of increasing the current pressure on the stock requires a precautionary approach. A ban on any potential exports might be considered until such information is available and an informed decision is possible. Economic analyses weighing trade-offs would help guide policy here.

Introduction of progressive management measures

Given the nature of the industry at present and the challenges faced in terms of monitoring and compliance, it is suggested that consideration is given in the short term to introducing measures that prohibit the purchasing of undersized octopus by individuals, hotels and restaurants. Restricting the market size in this way is a short-term measure that could have a meaningful impact; moreover, compliance is easier to monitor at this level.

Considerations for management measures that may be introduced in the longer term are outlined below.

1. *Size restrictions:*

The results of the survey indicate that stakeholders largely agree that the number and size of octopus is declining, posing concerns for future recruitment. Stakeholders across the value chain were overwhelmingly in favour of a size limit and such an introduction would be useful as a management measure. To be effective, the minimum size should be debated with all stakeholders whilst also following scientific best practice.

2. *Closed seasons:*

The introduction of closed seasons has been particularly effective in other countries within the south WIO region, but requires careful consideration and debate with all stakeholders. Interviews indicated possible spawning in October and April with juvenile octopus on the reef areas by December/January and June/July. The south-east monsoon period in May through to August restricts effort at a time when many juvenile octopus would be found on the inshore reefs which is a useful self-regulatory mechanism.

3. *Fishing methods:*

The current fishing methods used, notably fishing the reefs on foot during low tides as well as free diving and SCUBA diving, do raise concern. Free diving takes place at depths of up to 15 m while SCUBA diving takes place as deep as 25 m. Interviewees confirmed that brooding female octopus are removed, which has the potential to influence recruitment. There is a need to consider the different fishing methods employed at present and possible restrictions.

4. *Closed areas:*

In areas of high abundance, it may be possible to introduce closed areas to aid recruitment but ensuring compliance has proved to be challenging in many countries and this management measure requires careful consideration before being proposed.

5. *Stock assessment:*

The collection of catch and effort data and basic biological information is useful to look at indicators of the current stock status as well as allowing possible stock assessment methods to be utilised. However, given the dispersed nature of the fishery, limited numbers of octopus taken to landing sites, and possible market restrictions on catch at some periods in the year unrelated to stock size, the nature of the data collection scheme requires careful consideration.

6. Recommended next steps

1. Continue with the value chain study to provide a higher-resolution picture of the current status, constraints, and opportunities.
2. Given the requirement for a diverse set of management measures, develop a proposal for an octopus fishery management plan with clear objectives, actions, timelines, and costing.
3. Set up an octopus fishery management committee in a similar fashion to that which has been done for the sea cucumber fishery. Representatives should include stakeholders at all levels from fishers to government officials.

References

Advance Africa Management Services. 2018. *Development of Seychelles' Seafood Sector Value Chains*. Ministry of Finance, Trade and Economic Planning, Seychelles. 194p.

Aina, T.A.N. 2010. Management of octopus fishery off south west Madagascar. United Nations University Fisheries Training Programme, Iceland [final project]. http://www.unuftp.is/static/fellows/document/tantely09prf.pdf

Ainsworth, Gillian B., Pablo Pita, Cristina Pita, Katina Roumbedakis, Graham J. Pierce, Catherine Longo, Gregory Verutes, Tereza Fonseca, Daniela Castelo, Carlos Montero-Castaño, Julio Valeiras, Francisco Rocha, Laura García-de-la-Fuente, Jose Luis Acuña, M. del Pino Fernández Rueda, Alberto Garazo Fabregat, Alberto Martín-Aristín & Sebastián Villasante. 2023. Identifying sustainability priorities among value chain actors in artisanal common octopus fisheries. *Reviews in Fish Biology and Fisheries* 33: 669–698.

Belazis, M. 2011. *A Habitat and Abundance Study of Octopus cyanea in Southwest Madagascar*. Independent Study Project (ISP) Collection. 998. https://digitalcollections.sit.edu/isp_collection/998

Benbow, S. & Harris, A. 2011. Managing Madagascar's octopus fisheries. Conference presentation at the Workshop on *Octopus cyanea* fisheries, 5-6 April 2011, Toliara. Blue Ventures Conservation, London.

Benbow, S., Humber, F., Oliver, T.A., Oleson, K.L.L., Raberinary, D., Nadon, M., Ratsimbazafy, H. & Harris, A. 2014. Lessons learnt from experimental temporary octopus fishing closures in south-west Madagascar: benefits of concurrent closures. *African Journal of Marine Science* 36(1): 31–37.

Bhandari, K. 2020. The den ecology and the effects of fishing pressure on the distribution of *Octopus cyanea* (Octopodidae: Mollusca) in Rodrigues lagoon, Rodrigues, Mauritius. *Journal of Natural History* 54: 2961-2977.

Blue Ventures Conservation. 2014. Octopus fisheries management in Madagascar. Presented at the Regional Symposium on Octopus Fisheries Management in the South West Indian Ocean, Flic en Flac, Mauritius.

Chande, M. A., Mgaya, Y. D., Benno, L. B. & Limbu, S. M. 2021. The influence of environmental variables on the abundance and temporal distribution of *Octopus cyanea* around Mafia Island, Tanzania. *Fisheries Research* 241: 105991.

Coronado, E., Salas, S., Cepeda-Gonzalez, M. F. & Chuenpagdee, R. 2020. Who's who in the value chain for the Mexican octopus fishery: Mapping the production chain. *Marine Policy* 118: 104013.

FAO. 2023a. Fishery and Aquaculture Statistics. Global capture production 1950-2021 (FishStatJ). In: FAO Fisheries and Aquaculture Division [online]. Rome. Updated 2023. www.fao.org/fishery/statistics/software/fishstatj/en.

FAO. 2023b. Fishery and Aquaculture Statistics. Global Aquatic Trade - All partners aggregated 1976-2021 (FishStatJ). In: FAO Fisheries and Aquaculture Division [online]. Rome. Updated 2023. www.fao.org/fishery/en/statistics/software/fishstatj.

Guard, M. & Mgaya, Y. D. 2002. The Artisanal Fishery for *Octopus cyanea* in Tanzania. *AMBIO: A Journal of the Human Environment* 31(7): 528-536.

Mees, C. C., Shotton, R. & Marguerite, M. 1998. *An inshore fisheries management strategy for Seychelles.* Final Report of Project No. FAO/TCP/SEY/6713(A), May 1998, Seychelles Fishing Authority, Victoria, and Food and Agriculture Organisation, Rome.

Mtonga, C., Jiddawi, N. & Benjamen, D. 2022. Recent rise in exploitation of Tanzanian octopuses: a policy and management challenge. *Western Indian Ocean Journal of Marine Science Special Issue* 1: 107-118.

Oliver, T.A., Oleson, K.L.L., Ratsimbazafy, H., Raberinary, D., Benbow, S. & Harris, A. 2015. Positive Catch & Economic Benefits of Periodic Octopus Fishery Closures: Do Effective, Narrowly Targeted Actions 'Catalyze' Broader Management? *PLoS ONE* 10(6): e0129075. doi:10.1371/journal.pone.0129075

Payet, R. 1996. *Review of the octopus (Octopus vulgaris) resource in Seychelles*. Seychelles Fishing Authority, August 1996.

Raberinary, D & Benbow, S. 2011. The reproductive cycle of *Octopus cyanea* in southwest Madagascar and implications for fisheries management. *Fisheries Research* 125-126: 190–197.

Ratzimbazafy, H. A., Oleson, K. L., Roy, R., Raberinary, D. & Harris, A. 2016. Fishing site mapping using local knowledge provides accurate and satisfactory results: Case study of Octopus fisheries in Madagascar. *Western Indian Ocean Journal of Marine Science* 15 (2): 1-7.

Robertson, M. D., Midwaya, S. R., West, L., Tillya, H. & Rivera-Monroy, V. H. 2018. Fishery characteristics in two districts of coastal Tanzania. *Ocean and Coastal Management* 163: 254-268.

Rocliffe, S., and Harris, A. 2016. *The status of octopus fisheries in the Western Indian Ocean***.** Blue Ventures. London.

Sauer, W. H. H., Potts, W., Raberinary, D., Anderson, J. & Perrine, M. J. S. 2011. Assessment of current data for the octopus resource in Rodrigues, western Indian Ocean. *African Journal of Marine Science* **33**: 181-187.

Seychelles Fishing Authority (SFA). 2014. Octopus Fishery in the Seychelles. Conference presentation at the Regional Symposium on Octopus Fisheries Management in the South West Indian Ocean, Flic en Flac, Mauritius.

Silas, M. O., Kishe, M. A.l, Mshana, J. G., Semba, M. L., Mgeleka, S. S., Kuboja, B. N., Ngatunga, B. P., Chande, M. A. & Matiku, P. 2021. Growth, mortality, exploitation rate and recruitment pattern of *Octopus cyanea* (Mollusca: Cephalopoda) in the WIO region: A case study from the Mafia Archipelago, Tanzania. *Western Indian Ocean Journal of Marine Science* 20(1): 71-79.

Silas, O., Kishe, M. A., Semba, M. R., Kuboja, B. N., Ngatunga, B., Mgeleka, S. S., Linderholm, H. W., Dahl, M. & Gullström, M. 2023. Seascape configuration influences big blue octopus (*Octopus cyanea*) catches: Implications for a sustainable fishery. *Fisheries Research* 264: 106716.

Smartfish. 2014. *Management of the octopus fishery in Rodrigues*. Smart Fiche 12.

Sweenarain, S. 2012. *Value Chain Analysis of Fisheries Sector for Rodrigues*. SmartFish Programme, Indian Ocean Commission, Port Louis, Mauritius.

Taylor, A. L. 2014. Population structure and phylogeography of *Octopus cyanea* and *Lethrinus* species in the southwestern Indian Ocean. School of Biological Sciences, Royal Holloway University of London. PhD Dissertation.

Trevelen, C. R., Elsmore, M. A. M., Healey, A. J. E., Kishe, M. A., Sauer, W. H. H., Shaw, P. W. & McKeown, N. J. 2023. Genetic analysis of *Octopus cyanea* reveals high gene flow in the South-West Indian Ocean. Unpublished manuscript.

UN General Assembly. 2015. *Transforming our world: the 2030 Agenda for Sustainable Development*. A/RES/70/1. 21 October 2015. Available at: https://www.refworld.org/docid/57b6e3e44.html.

Vidot, A. and Ebrahim, A. 2021. *Determining baseline information for the effective management of the Seychelles' small-scale octopus' fishery*. Project Proposal submitted to Seychelles Conservation and Climate Adaptation Trust (SeyCCAT). Seychelles Fishing Authority.

Westerman, K & Benbow, S. 2013. The Role of Women in Community-based Small-Scale Fisheries Management: The Case of the South West Madagascar Octopus Fishery. *Western Indian Ocean Journal of Marine Science* 12: 119-132.

Willer, D.F., Aldridge, D.C., Gough, C. & Kincaid, K. 2023. Small-scale octopus fishery operations enable environmentally and socioeconomically sustainable sourcing of nutrients under climate change. *Nature Food* 4: 179–189.

Appendix A

Questionnaire

Interviewer:

Date:

Start time:

End time:

Respondent Information

Name (optional):

Gender:

Highest level of education:

Stakeholder Category (Small-scale trader, Large-scale trader, Retailer, Wholesaler, Processing company, Exporter, HoReCa establishment):

Business Name (if applicable):

Location (island):

Years working in octopus industry:

1. Where do you purchase your octopus?

2. From whom do you purchase your octopus?

3. Do you purchase octopus per kilo or per piece?

4. What is the largest/smallest/average size of octopus that you purchase?

5. What size of octopus do you prefer to purchase?

6. What is the typical volume (kilos/pieces) of octopus you purchase weekly/monthly/annually?

7. What is the highest/lowest/average price you pay per kilo/piece?

8. Does purchase price vary seasonally? If so, how?

9. How consistent is the supply of octopus?

10. Is there competition among octopus traders/buyers?

11. Has the supply of octopus changed over the last 5/10 years?

12. Has the size of octopus changed over the last 5/10 years?

13. What is the best and worst time of the year in your opinion to harvest/purchase octopus?

14. Do you engage in any processing/value addition activities? If yes, please describe.

15. What octopus products do you sell?

16. Who do you sell your octopus products to?

17. What is the highest/lowest/average sales price per kilo/piece/product?

18. What is the typical volume (kilos/pieces) of octopus you sell weekly/monthly/annually?

19. How do market prices for octopus fluctuate over the year, and what factors influence these fluctuations?

20. Was the octopus industry impacted by COVID-19? If so, has it recovered? If no, why do you think this is the case?

21. What are the barriers/challenges faced in the octopus industry?

22. How would you suggest overcoming these barriers?

23. Are there areas in which you see opportunities for improvement or growth? If so, please describe.

Appendix B

List of questionnaire respondents and their role in the value chain

Respondent	Role	Business Name
Angelin Bouchereau	Fisher	
Richie Payet	Fisher/Middleman	
Trevor Payet	Fisher/Middleman	
Jacintaia Athanase	Purchasing Manager	Chez Marston Guesthouse and Restaurant
Glen Kinder	Hotel Purchasing Manager	Carana Beach Hotel; Denis Island Hotel
Ahbina Issa	Purchasing Manager	La Digue Island Lodge
Floyd	Purchasing Manager	Hilton Hotel
Stella Pedrazzini	Purchasing Manager	Le Repaire Hotel and Restaurant
Travis	Manager	Castello Beach Hotel
Reg Moses	Purchasing Manager	Story Hotel
Lindy Sainbina	Manager	Patatran Village Hotel
Didier	Purchasing Manager	Lemuria Hotel
Magdalene	Purchasing Manager	Laila Resort
Pramodh Govinden	Operations Manager	Oasis Hotel
Cedrick Kidd	Purchasing Manager	Ephelia Hotel
Madhura	Cost Controller	Raffles Hotel
Davy Dugasse	Purchasing Manager	Paradise Sun Hotel
Mervin Gean	Purchasing Manager	L'Archipel Hotel
Berty Joubert	Store Keeper	Le Duc Hotel
Stuart Hull	Manager	Le Nautique Hotel
Guillian	Office Manager	Rass Fish Processor/Retailer
	Purchasing Manager	FishTec
Neven Cinoti	Factory Manager	Oceana Seafood Company
Fumudh Hewage	Purchasing Manager	DoMaine Hotel
Daya	Purchasing Manager	Kempinski Hotel
Richard Mancienne	Restaurant Owner	Boathouse Restaurant
Sajan Dhurma	Purchasing Manager	Greenhouse Restaurant
Gavin Batt	Manager	Bravo Restaurant
Lydia Lablache	Hotel and Restaurant Owner	Villa de Mer
Suren Venkaya	Manager	Mabuya Restaurant
Joel Vivien	Owner	Paradise Restaurant
Hansel Labonte	Manager	Del Place
Juan-Lul Savy	Head Chef	Maison Marengo
Marlene Young	Manager	Surfers Restaurant
Marvel Godley	Restaurant Manager	Capricorn Restaurant
Graham Green	Fisher/Manager	Coolicks Restaurant
Vito Vargiolu	Manager	Chevalier Bay Restaurant
Elvis Malbrook	Operations Manager	Fishtrap Restaurant
Jose and Vanessa	Procurement and Purchasing Managers	STC
Murphey Hoareau	Shop Manager	99 Ship Chandler
Shabutin	Manager	MAS Supermarket
Mike	Fisher/middleman	Aquamen Suppliers
Pascal Lesperance	Middleman	Pascalo

Appendix C

List of participants at the Seychelles National Octopus Workshop held on 20 December in Mahé, Seychelles.

Name	Institution
Honourable Jean-Francois Ferrari	Minister of Fisheries and The Blue Economy
Roy Clarisse	Principal Secretary for Fisheries
Keven Nancy	Principal Secretary for Agriculture & FAO National Correspondent
Radley Weber	Chairman, SFA Board
Aubrey Harris	Executive Board Member of the SFA
Audrey Zelia	FAO Programme Coordinator, Seychelles
Jan Robinson	CEO, Seychelles Fishing Authority
Vincent Lucas	HOD Fisheries Management, SFA
Betty Victor	Senior Technical Coordinator, SFA
Antoine Almaze	Fisher, Mahe
Guy Estrale	Fisher, Mahe
Fabian Antat	Fisher, Mahe
Gonzalo Macho	Fisheries Consultant
Liam Weber	Grants Manager, SeyCCAT
Annike Faure	Manager, SeyCCAT
Maggie Moustache	Senior Economist, Ministry of Fisheries and the Blue Economy
Yannick Rouccou	Legal Advisor, SFA
Chloe Morel	Ministry of Employment
Julia Malbrook	Fisheries Research, SFA
Karyss Auguste	Licensing, SFA
Jadon Philoe	Fisheries Research, SFA
Dainise Quatre	Fisheries Research, SFA
Clara Belmont	Fisheries Research, SFA
Rodney Nicole	Fisher, Mahe
Richard Bossy	Fisher, Praslin
Elvis Dingwall	Fisher, Praslin
Marcel Adrienne	Fisher, La Digue
Jody Ladouceur	Fisher, La Digue
Angelin Bouchereau	Fisher, La Digue
Joanne Lucas	Fisheries Management, SFA
Rodney Govinden	HOD Fisheries Research, SFA
Annie Vidot	Fisheries Research, SFA
Andrew Souffre	Fisheries Research, SFA
Kettyna Gabriel	Fisheries Research, SFA
Richie Payet	Middleman, Praslin
Trevor Payet	Middleman, Praslin
Faizal Suleman	Fisher, Mahe
Julie Barra	Ministry of Fisheries and the Blue Economy
Warwick Sauer	Project Team Member
James McCafferty	Project Team Member
Ameer Ebrahim	Project Team Member