Octopus Project Report

Determining baseline information for the effective management of the Seychelles' small-scale octopus' fishery

Fisheries Research Department
Seychelles Fisheries Authority
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1. Introduction

Octopus fisheries in the Western Indian Ocean (WIO) present significant cultural and socio-economic value, supporting the livelihoods of men, women, and children in the region (Rocliffe & Harris, 2016). Globally, octopus fisheries have expanded rapidly in response to a growing market, shifting many operations from small-scale subsistence to large-scale commercial fishery (McCabe et al., 2024). This transition has been driven partly by declines in finfish catches, leading to the overexploitation of invertebrates (Anderson, 2011), as well as habitat degradation and emerging climate change impacts, such as rising sea temperatures, which affect octopus growth and maturation (Chande et al., 2021). Consequently, fishery practices have shifted from traditionally gleaning for octopuses in intertidal zones to diving in deeper waters, posing threats to octopus populations, ecosystems, and the livelihoods that depend on them.

In Seychelles, the octopus fishery has been traditionally practiced for many years, evolving from a subsistence activity into a commercial operation (McCafferty et al., 2025; Mees et al., 1998). The ease of exploitation, increasing market demands, and the absence of effective management measures have placed considerable fishing pressure on octopus resource. In recent decades, there have been growing concerns about the long-term sustainability of this resource. Various reviews assessed the state of the fishery and proposed potential management recommendations (Mees et al., 1998; Payet, 1996).

Compared to octopus fisheries in Madagascar, Comoros, Rodrigues, and Tanzania (Aina, 2010; Benbow et al., 2014; Guard, 2009; Guard & Mgaya, 2002; Harris, 2007; Jhangeer-Khan et al., 2015; McCabe et al., 2024; Raberinary & Benbow, 2012; Rocliffe & Harris, 2015, 2016; Westerman & Benbow, 2013), there is a notable lack of governance, scientific information and monitoring effort for the fishery. This highlights the need for the Seychelles Fisheries Authority (SFA) to reconsider its management approach.

Despite ongoing reporting efforts, there is limited information on the socioeconomic and biology of the fishery. Data limitation is a common challenge in the region, where inadequate collection hinders a comprehensive understanding of the fishery's status (UNEP & WIOMSA, 2015).

To improve monitoring efforts and understanding of the Seychelles octopus fishery, baseline study is essential to address critical knowledge gaps. With support from the Seychelles Climate Change Adaptation Trust (SeyCCAT) Blue Grants Fund 5, the SFA launched an Octopus Project titled “Determining Baseline Information for the Effective Management of the Seychelles’ Small-Scale Octopus Fishery”. This initiative aimed to generate insights into the fishery and provide recommendations for effective management strategies. It also promoted collaborative research approach with the local fishing community, fostering co-management and identifying viable long-term solutions for the octopus fishery.

1.1. Objectives

This project aimed to conduct comprehensive baseline study of octopus fisheries on Mahé, Praslin and La Digue islands to establish information on the socioeconomic, biological, and ecological aspects of the fishery. The results aimed at informing the review of potential management strategies to ensure the long-term viability of the resource.

Main objectives:

1. Gather robust data on the socioeconomic and biological aspect of the octopus fishery.
2. Identify the main species of octopus found around the inner Seychelles islands.
3. Produce recommendations for management measures to promote sustainable management of the fishery.
4. Raise awareness of octopus fisheries monitoring efforts.

The overall outcome of the project is to support the development of effective management strategy for the small-scale artisanal octopus fishery in Seychelles.

Specific outcomes:

1. Improved understanding of the socioeconomic and biological aspects of the octopus fishery.
2. Recommendations for the establishment of management measures.
3. Increased awareness of octopus fisheries monitoring efforts.

The objectives and outcomes were achieved through the successful completion of several surveys, including socioeconomic, catch-and-effort, and habitat composition surveys conducted around the inner islands of Mahé.

2. Socioeconomic Survey

The survey was designed to gather information on the socioeconomic dimensions of the octopus' fishery, with the goal of informing potential management measures to ensure the long-term sustainability of the fishery.

Main objectives:

- Assess the socioeconomic aspect of the octopus fishery.
- Identify the constraints and challenges faced within the fishery.
- Outline the characteristics of fishery operation.
- Document fishers' perception on the fishery trend and governance.

2.1. Methodology

The survey was conducted from December 2023 to March 2024 on Mahé, Praslin, and La Digue islands. It specifically targeted commercial octopus fishers. To initiate the survey, communication with stakeholders was established through official media announcements, followed by visits to landing sites. One-on-one questionnaire interviews were then conducted based on fishers' consent and availability. Participation in the survey was voluntary, and responses were kept confidential throughout.

The interview questionnaires were structured into two main sections: one focusing on socioeconomic status and the other on the fishery status. These sections aimed to determine the demographic characteristics, economic conditions, fishery operators' perceptions and fishery governance. The survey data included both quantitative and qualitative information. Following the data collection, numeric responses were summarized using descriptive statistics (percentages) and visualized using graphs.

2.2. Results and Discussion

2.2.1. Demographic Characteristics

A total of 35 individuals were interviewed, with participants from Mahé (21), Praslin (9) and La Digue (5) islands. All participants were octopus fishers, with 97% identified as male and 3% as female. The survey highlighted the very low representation of females in active fishing roles within the fishery. Instead, many women contribute to the sector as boat owners, in administrative roles, or in post-harvest activities, while men predominantly engage in fishing operations. This gender distribution contrasts with regional trends observed in other countries. In Madagascar, for example, women traditionally dominate octopus harvesting, accounting for 86% of fishers compared to men (Westerman & Benbow, 2013). Similarly, in Mozambique and Rodrigues, both men and women harvest octopus using gender-specific fishing techniques (Rocliffe & Harris, 2026; Jhangeer-Khan et al., 2015). In Tanzania, octopus fishing has traditionally been practiced by women and children (Guard & Mgaya, 2002).

The age distribution of fishers ranged from 19 to 65 years old. The average age of fishers was 43 years old, with a great proportion (25 individuals) above 40 years of age, while a smaller group (10 individuals) were below 40 years (Figure 1). Notably, only three fishers were aged between 19 and 30 years old, indicating low recruitment of younger, full-time fishers in the fishery. Fishers reported an average of 21 years of fishing experience, suggesting that the fishery has been traditionally practiced and passed down across generations. On average, fishers reported a household size of 3 dependents. While a small proportion (1 individual) reported having no dependents, the majority (17 individuals) reported having of 2 to 3 individuals. This distribution highlights the importance of fishers' livelihood, given that many have family responsibilities.

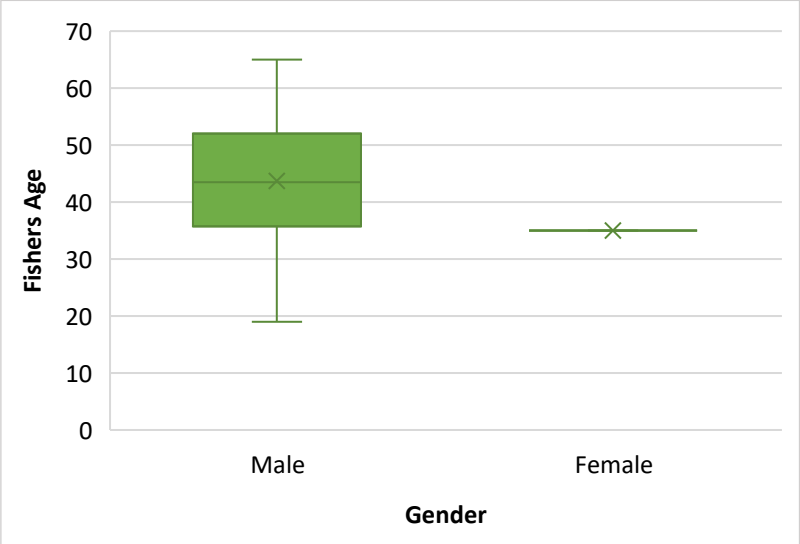


Figure 1: Age distribution of fishers in the fishery.

In terms of education, the majority of fishers held a professional certificate (20 individuals), followed by secondary (13 individuals) and primary (2 individual) education levels. The number of fishers involved only in octopus fishing and other professions alongside fishing were slightly equal, with 18 fishers exclusively engaged in octopus fishing and 17 fishers involved in other professions. This dual engagement reflects the seasonal variability of fishing activities due to changing weather and sea conditions, which necessitates alternative income sources.

The monthly income generated from the fishery varied among fishers; 31% of fishers reported that more than 80% of their monthly income is generated from the octopus fishery (Figure 2). Overall, a great proportion of fishers (66%) reported earning an average monthly income ranging between SCR 7,500 to SCR 25,000, depending on the fishing operation (Figure 3). In contrast, only 24% of fishers reported earning more than SCR 25,000.

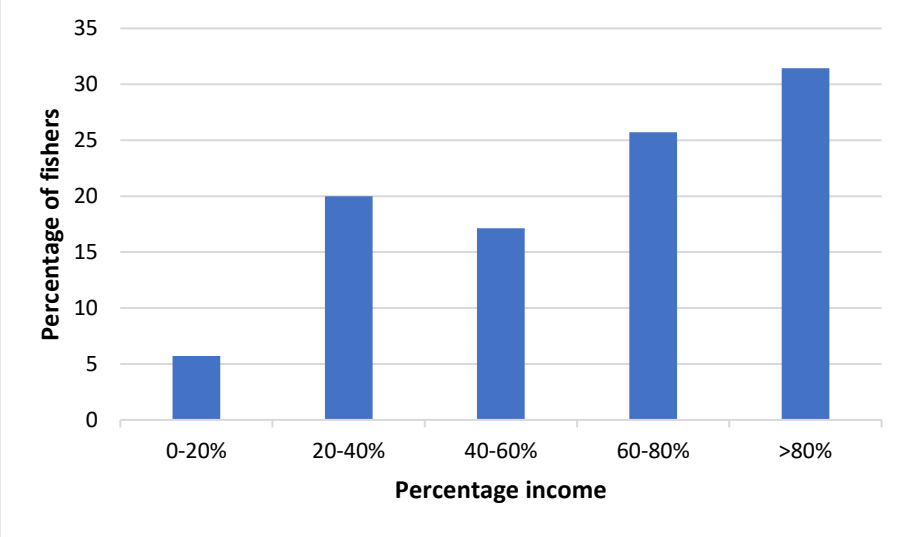


Figure 2: Reported percentage income from the octopus fishery among fishers.

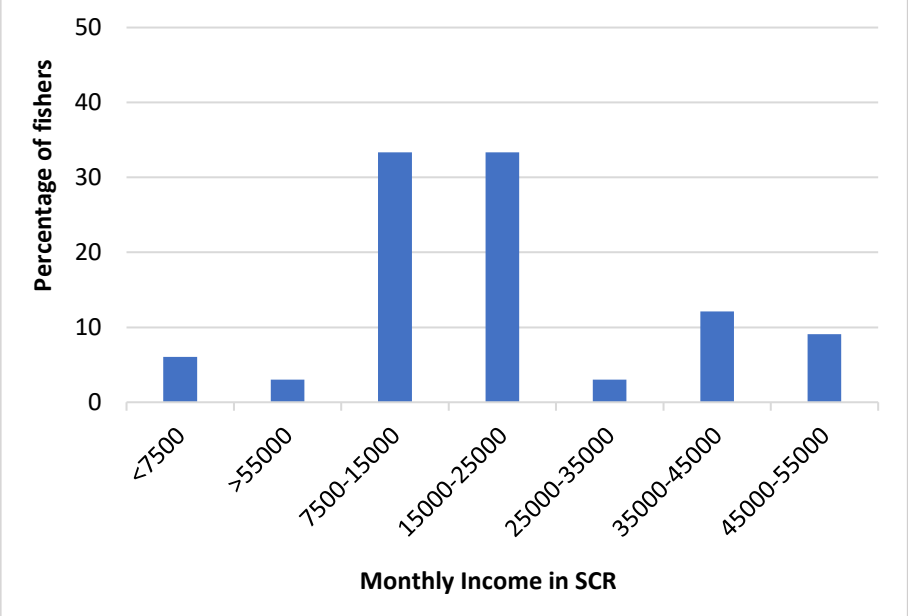


Figure 3: Average reported monthly income of fishers from the octopus fishery.

2.2.2. Fishery Operation

The majority of fishers (91%) primarily use motorized boats, while a smaller proportion (9%) rely on a combination of boats and gleaning on foot to access off-reef and inter-tidal fishing grounds around Mahé and the inner islands. Fishers who access fishing grounds on foot are limited to fishing from the shore, which explains why most fishers either exclusively use boats or combine methods to access more distant areas.

Fishing activities are predominantly conducted by snorkeling (57%), with fewer fishers (3%) using only self-contained underwater breathing apparatus (SCUBA) or a combination of both methods (40%), with steel harpoons at average depths ranging from 5 to 18 meters (minimum: 1m; maximum: 30m). Historically, gleaning, snorkeling, traps and fishing lines were the main

methods used for octopus fishing (Payet, 1996). While gleaning was not reported among surveyed fishers, it is believed to occur as a subsistence activity on a recreational basis.

Globally, octopus fishing methods vary depending on traditions, target species, and the scale of the fishery (Emery et al., 2016). In the Western Indian Ocean (WIO), fishing practices are often gender-specific, with women primarily harvesting octopus on reef flats through gleaning, while men dive at deeper depths using harpoons (Guard & Mgaya, 2002; Jhangeer-Khan et al., 2015; Westerman & Benbow, 2013). In other regions, octopus is commonly fished using fishing lines, trawl nets, or modified baited traps or pots of various sizes. However, these methods can be highly destructive to the surrounding environment (Sauer et al., 2019).

Although fishing activities occur year-round, fishers reported peak periods from October to April (Figure 4). While the species catch composition is not known, *Octopus vulgaris* (Cuvier, 1797) and *Octopus cyanea* (Gray, 1849) are the primary species in the region (Rocliffe et al., 2014). 71% of fishers identified weather conditions as the primary factor influencing how often they fish, followed by lunar phase (46%) and the tidal conditions 46%. Demand for octopus and financial need were each selected by 17% and 14% of fishers, respectively. These findings highlight that environmental factors play a dominant role in determining fishing frequency, while economic considerations are less commonly cited but remain relevant for some fishers.

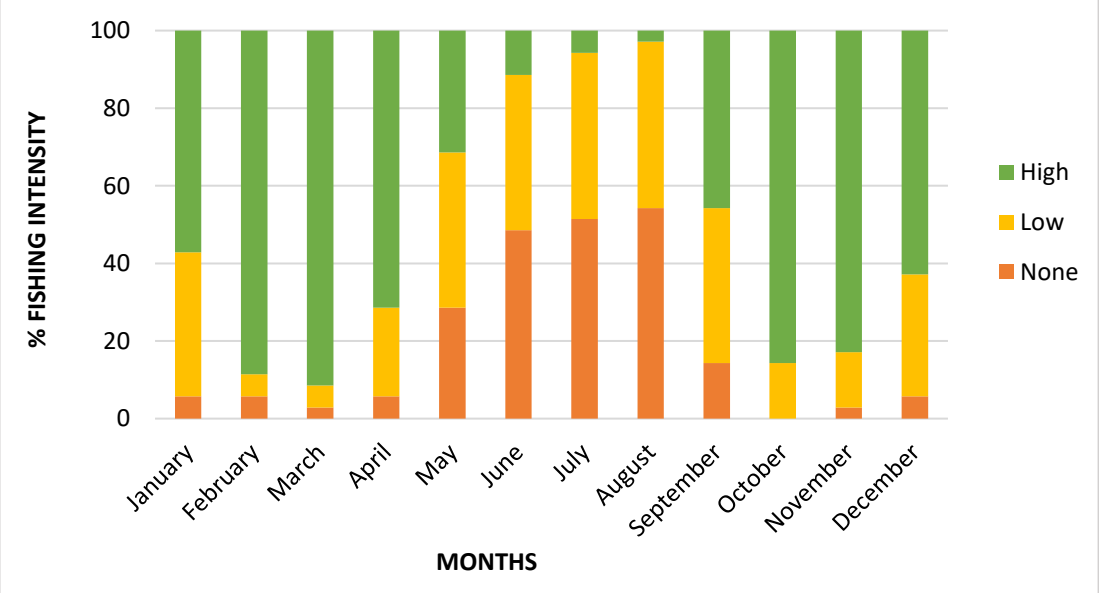


Figure 4: Fishers' perceptions of the monthly octopus fishing effort.

Among the fishers surveyed, 89% reported engaging in other fishing activities besides octopus harvesting. Handlines were used by 69% of fishers and traps by 54%, to target a variety of species, while 37% utilized SCUBA or snorkel to target octopus. In addition, 31% of fishers engaged in gillnet fishing to target mackerel. Despite the variety of activities, 89% of fishers reported that they exclusively target octopus species when fishing for octopus, while 11% target other species as well.

Depending on market demand, most fishers (60%) sell their catch at various landing sites immediately upon landing, while a small proportion (23%) prefer to store their catch or do both (17%). Octopus catches are primarily sold fresh or frozen, with prices varying based on size and season. 30 out of the 35 fishers provided information with regards to the sale of octopus (Figure 5). 37% of fishers reported that they sell 50% or more of their catch directly to hotels or restaurants. In contrast, 30% of fishers sell 50% or more of their catch directly to individual buyers. Similarly, 30% of fishers sell 50% or more of their catch directly to fishmongers or retailers. The price of octopus (per kg) varied across the different buyer categories. For individual buyers, prices ranged from SCR 75 to SCR 250 (average: SCR 153). In contrast the price ranged from SCR 100 to SCR 300 for fishmongers/retailers (average: SCR 174), hotels/restaurants (average: SCR 175) and processors (average: SCR 163). Unlike other octopus' fisheries in the WIO region, Seychelles is one of the countries that does not export octopus (Rocliffe & Harris, 2016).

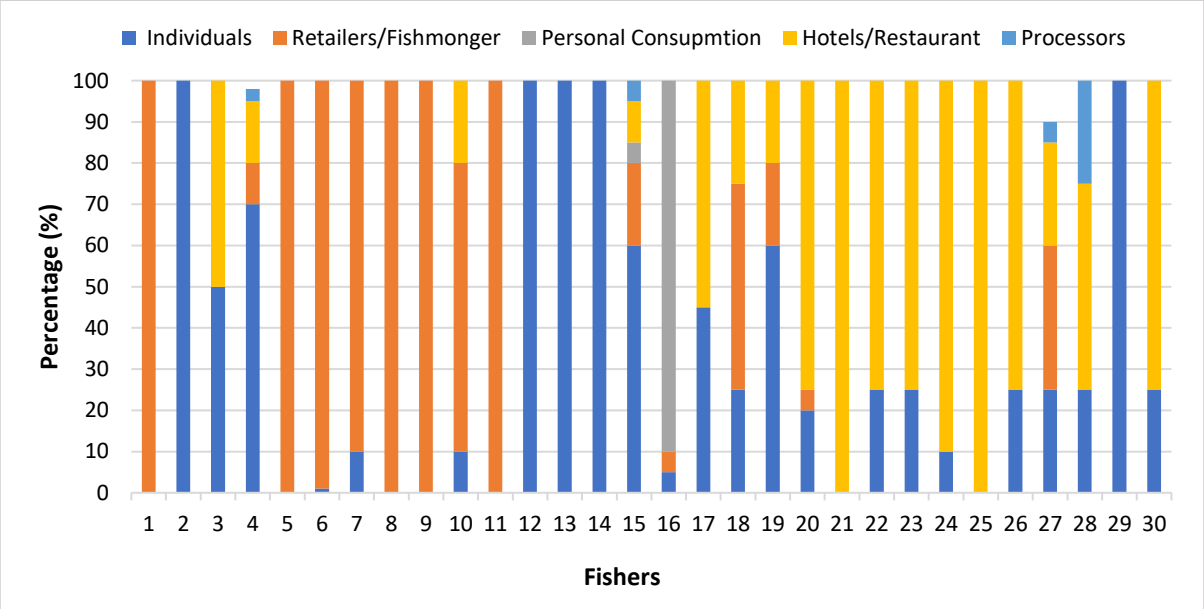


Figure 5: Percentage distribution of octopus sales by buyer categories.

2.2.3. Fishery Perceptions

Overall, 43% of fishers perceived a decline in the octopus population, while 51% believed it had remained stable (Figure 6). This result aligns with findings from a value chain study conducted in 2023, in which 49% of stakeholders reported a decrease in octopus supply (McCafferty et al., 2025). Moreover, these responses mirror findings from previous studies, including Payet (1996), which also indicated a decline in octopus stocks.

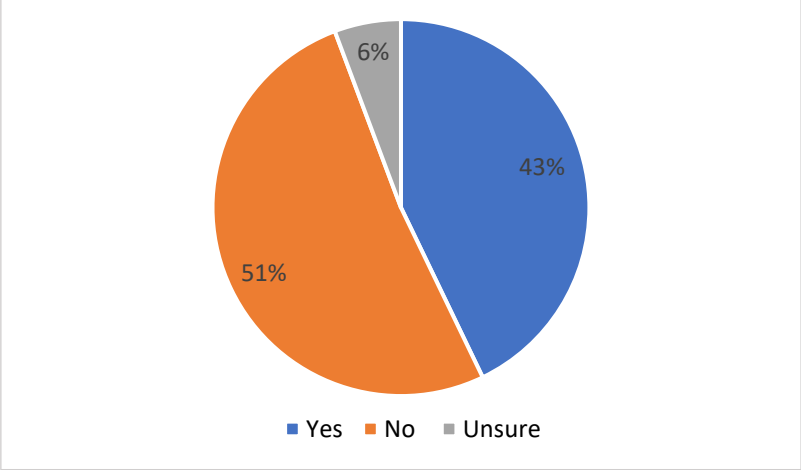


Figure 6: Fishers' perceptions of the octopus population in the Seychelles.

2.2.4. Fishery Governance

Despite past efforts to develop a draft octopus fishery management plan, including proposed measures such as a licensing framework, minimum size limit, annual catch quota, and seasonal closures, the fishery remains open access (SFA, 2024). Although no formal management strategy has been implemented, the SFA has been monitoring and reporting octopus' landings across Mahé, Praslin, and La Digue islands since 1985 through its Catch Assessment Survey (CAS).

The survey revealed that 94% of the participants are registered as full-time artisanal fishers with the authority. Among them, the majority (60%) are affiliated with fisher associations on Mahé, Praslin and La Digue, some of which play an active role within the association while others are not active. A small proportion (40%) are not affiliated with any association, citing various reasons. Participation in associations is voluntary, and some fishers view it as non-essential. However, this lack of participation poses challenges for promoting co-management of artisanal fisheries, particularly since bottom-up approaches are mainly employed in the region. Fisher associations serve as a platform for members to engage in fisheries governance and contribute to sustainable fisheries initiatives and decision-making, fostering inclusion, compliance, transparency, and accountability in fisheries management (Rangel et al., 2019).

The fishers proposed several ways to enhance participation. 27.5% of fishers believed that being part of an association is a personal choice, while 17% suggested that incentives for artisanal fishers should be restricted to association members only to encourage greater participation. Additionally, some fishers emphasized the need for stronger unity among fishers, improved organization and proactivity within associations. They also emphasized the importance of raising awareness, enhancing fishers' role in decision-making, securing stronger support from authorities, and ensuring good governance as key factors for increasing participation (Figure 7).

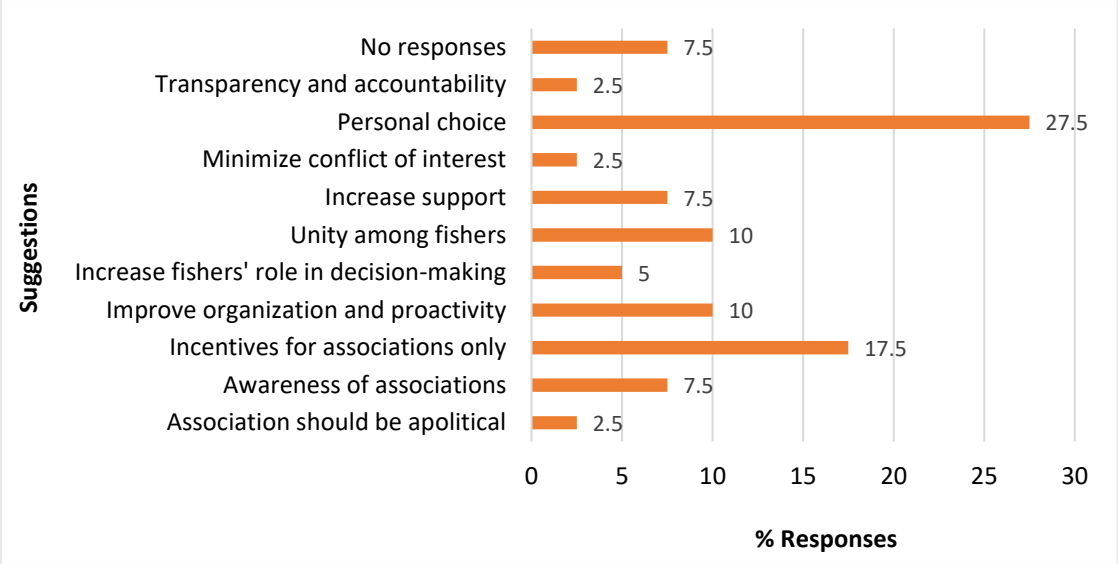


Figure 7: Fishers' recommendations for enhancing participation in associations.

Overall, only a small proportion of fishers (14%) were very satisfied with the current open-access fishery. In contrast, a larger proportion reported being just satisfied (29%), unsatisfied (26%), or very unsatisfied (11%), while 17% remained neutral (Figure 8). Regarding engagement between the SFA and octopus fishers, 54% of fishers stated that they have never been consulted before decisions were made, and 57% reported never being informed about decisions after they were made concerning the fishery. However, 20% of fishers indicated that they are occasionally consulted prior to decision-making, while 14% are occasionally informed after decisions are made. This is understandable, as specific octopus management initiatives have not yet been implemented in Seychelles. Additionally, 46% of fishers indicated that they had never interacted with the SFA for catch reporting, as many fishers either store their catch or sell it directly upon landing. Only 20% of fishers indicated that they interacted with SFA for catch reporting (Figure 9).

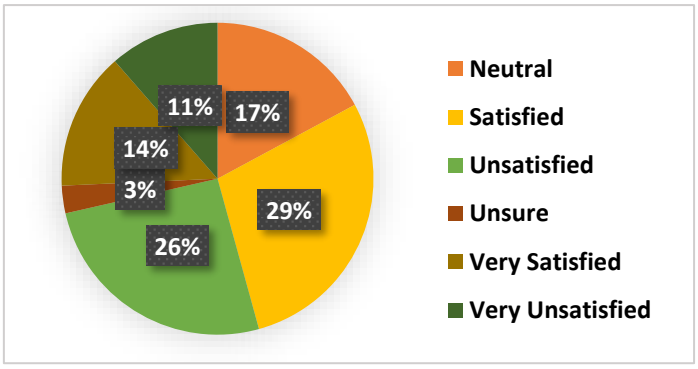


Figure 8: Fishers' level of satisfaction with the current octopus fishery management.

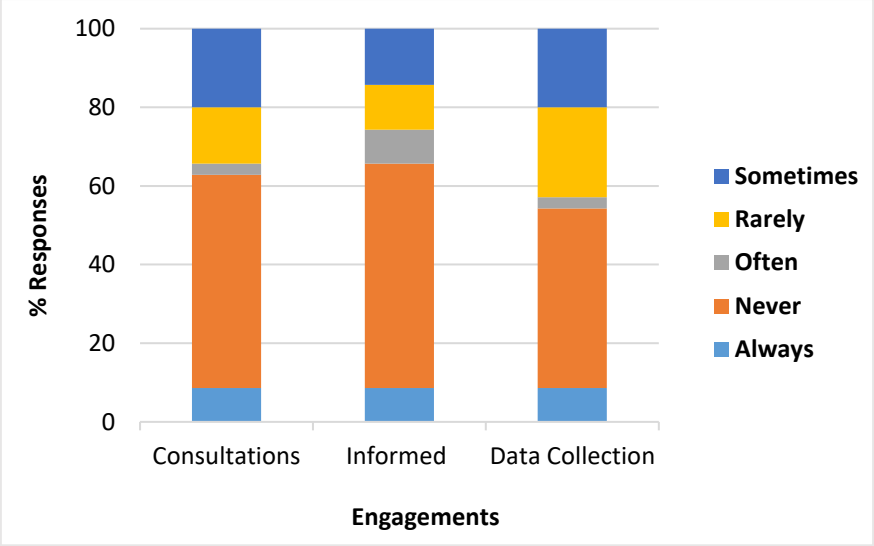


Figure 9: Percentage of fishers' responses to SFA engagement.

2.2.5. Fishery Constraints

The shift from a subsistence to a commercial fishery, driven by increasing development and demand, has introduced several constraints that threaten the long-term viability of the fishery. Key issues identified by fishers (Figure 10) include the excessive number of fishers in the fishery, as the open-access nature of the fishery allows any individuals to operate at subsistence, recreational or commercial levels. This, coupled with increasing social ills, has led to considerable fishing pressure. Additionally, fishers also cited the lack of support from authorities, especially as seafood companies continue to increase octopus imports. As a result, fishers argue that these factors limit market demand and contribute to price instability.

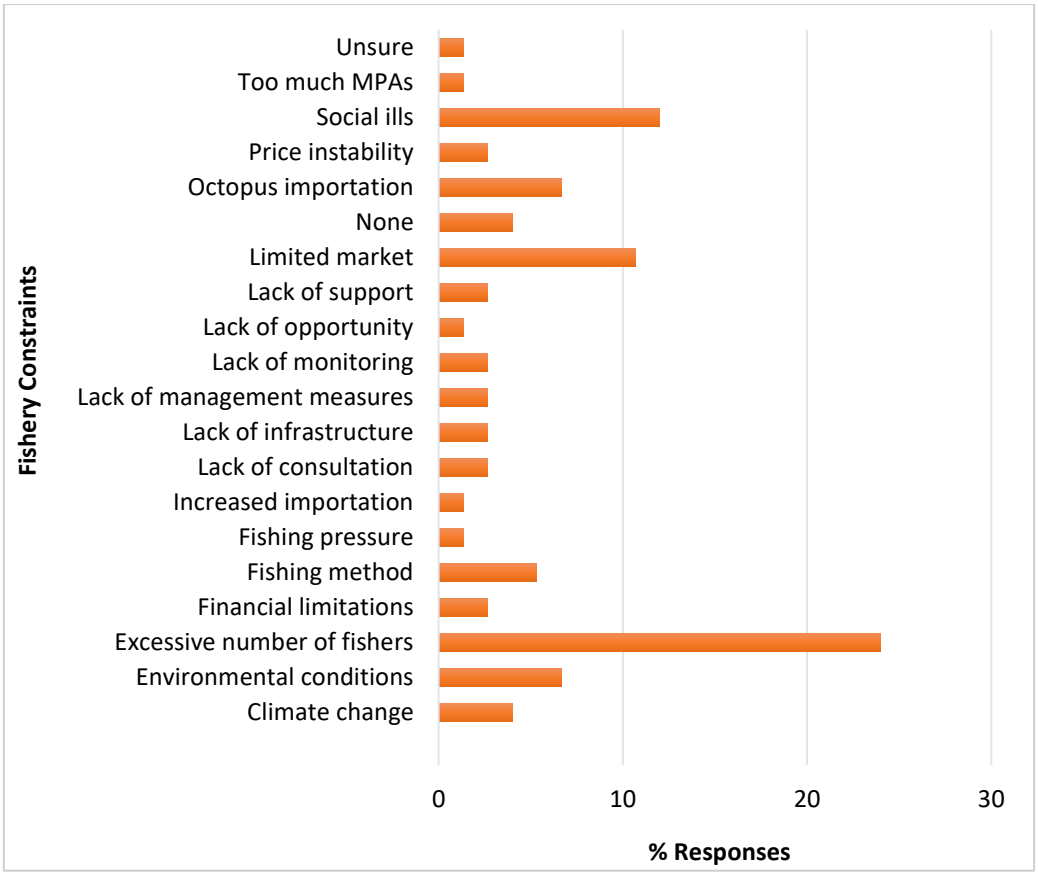


Figure 10: Constraints identified by fishers.

Overall, fishers view the current governance of the fishery as a major constraint, citing inadequate consultation, lack of management measures, insufficient monitoring, and limited infrastructure to sustain their livelihoods. Additional issues highlighted include fluctuating environmental conditions and climate change, which affect octopus recruitments and fishery outcomes, as well as detrimental fishing practices targeting undersize octopus. Financial limitations, the excessive number of Marine Protected Areas (MPAs), and limited opportunities for expanding fishery operations were also noted. However, some fishers expressed satisfaction with the current state of the fishery and did not perceive any constraints.

2.2.6. Fishery Management

The majority (97%) of fishers recommended introducing management measures for the octopus fishery to safeguard both their livelihood and the resource. Several management approaches were identified, with 89% supporting the introduction of fishing licenses, 86% advocating size limits, and 69% favoring restrictions on recreational fishing. In contrast, a significant number of fishers opposed spatial closures (91%), daily catch limit (80%), exclusive access rights (71%), and limited access licenses (69%) (Figure 11). Some fishers also expressed reluctance to disclose their views on management measures, citing the need to establish further biological research and discussion between authorities and fishers.

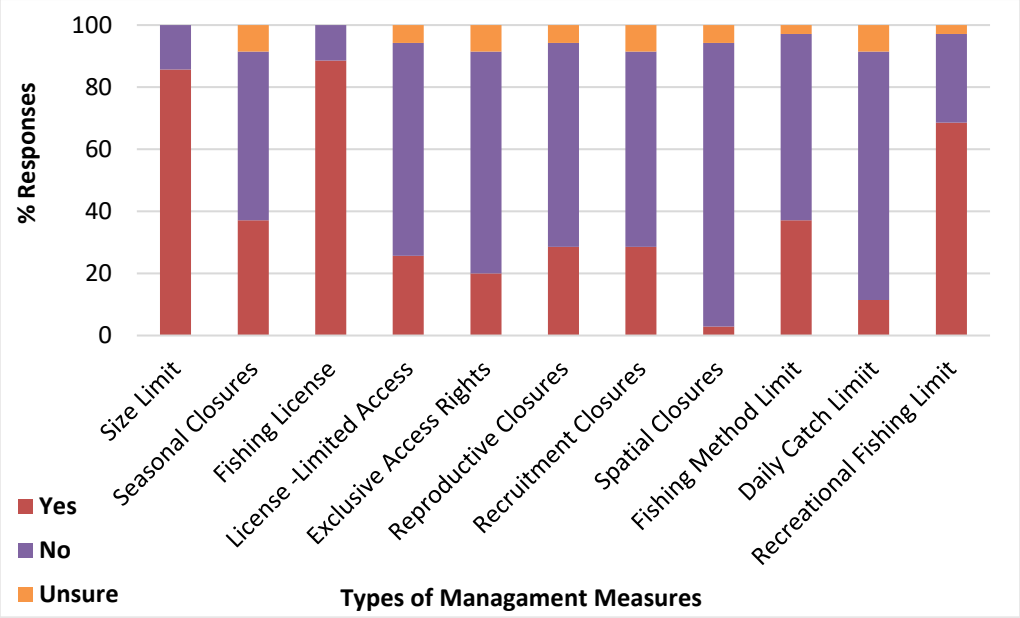


Figure 11: Percentage of fishers' responses to various fishery management approaches.

Managing octopus fisheries presents challenges due to the species' complex biological traits, which includes short lifespan, rapid growth, semelparous reproduction, and natural mortality driven by environmental variability (Guard, 2009). These factors contribute to annual fluctuations in abundance, which influence spawning and recruitment rates. Nevertheless, with the right management approach, octopuses are well suited for interventions since they can recover rapidly (Harris, 2007).

Regionally, various input controls have been introduced as precautionary measures, including licensing systems, seasonal closures, and minimum size limits. Minimum size limits are informed by studies on sexual maturity. This management approach allows the species time to mature and spawn, thereby reducing the capture of juveniles, as observed in Tanzania (Guard, 2009). Minimum size limits adopted in the region varies, for example, Madagascar has set a minimum weight of 350g, Tanzania at 500g, Kenya has set a mantle length of 10.5cm, and Rodrigue at 7cm (Rocliffe & Harris, 2016). However, enforcing minimum size limits remains challenging due to the non-selective nature of the fishery (Benbow et al., 2014).

Fishery closures provide octopus populations with an opportunity to grow and reproduce without fishing pressure. This strategy often implemented in areas with high juvenile abundance or during peak brooding periods, has been shown to increase landings, as observed in Madagascar (Benbow et al., 2014). Annual two-month closures are common in the region, including in Rodrigue and Madagascar (Jhangeer-Khan et al., 2015).Additionally, some fisheries regulate gear types and fishing methods to control fishers' efficiency and harvest rates (Emery et al., 2016).

The successful implementation of these management strategies depends on stakeholder buy-in, which has been shown to improve compliance, increase landings and enhance profits in the region (Rocliffe & Harris, 2015).

2.2.7. Conclusion

The survey results provided valuable insights into the fishery, including its socio-economic aspects, fishers' perceptions, and the challenges they face; an area that had not been previously explored. The current state of the fishery raises significant concerns regarding both the stock health and fishers livelihoods. The open-access nature of the fishery, coupled with the lack of comprehensive monitoring, underscores the need for a structured management approach. To address these challenges, the following recommendations are proposed:

1. Stakeholder consultations
   Extensive consultations with stakeholders are essential to ensure inclusive decision-making. It is crucial to raise awareness and promote inclusion to strengthen collaborative octopus fishery management efforts. This could be achieved through the creation and formalization of an Octopus Fishery Committee, consisting of representatives from SFA and fisher associations, as well as meaningful exchange programs between regional countries and public outreach.

2. Introduction of Management Measures
   The open-access nature of the fishery has led to increased fishing pressure and unsustainable practices. To mitigate these issues, the fishers have recommended the introduction of precautionary measures, such as licensing framework to facilitate monitoring and a minimum size limit to prohibit the capture of undersized octopus. Although, seasonal closures were unfavored, it is recommended to allow the stock to recover during peak reproductive periods, specifically in October and January (Jhangeer-Khan et al., 2015).

3. Improve Monitoring
   The limited available data on the octopus fishery highlights the need for further biological studies to better inform the development of effective management strategies. This includes biological studies to determine size, sex ratios, age at maturity, brooding, and recruitment peaks. Although octopus' landings are reported, there is a need to improve the quality and accuracy of catch and effort data reported for future assessment purposes.

A notable outcome of this survey was the willingness of fishers to participate in a 12-month collaborative catch monitoring initiative and a habitat survey, which represented the next step of the study.

3. Catch Survey

The primary objective of this survey was to establish baseline biological data on the artisanal octopus fishery, in collaboration with commercial octopus fishers on the main islands of Mahé, Praslin, and La Digue.

The specific aims were to:

- Facilitate co-management of the octopus fishery through collaborative data collection.
- Evaluate octopus catch and fishing effort.
- Determine size variation of octopus.
- Analyse sex ratios.
- Identify species composition.

3.1. Methodology

A voluntary logbook system was implemented to collect biological data over a 12-month period, from February 2024 to February 2025. Logbooks were provided by the SFA to nine fishers operating on the islands of Mahé, Praslin, and La Digue. All participants were trained in data collection procedures. Data were collected monthly, with fishers recording their daily catch on a flexible schedule, depending on their fishing activity and availability.

Biological information was obtained following fishing operations, with the location and duration of each fishing operation recorded, along with the total landed weight, number of fishers involved, fishing depth, and the gear and method used. Based on the total catch size, either the entire catch or a portion was sampled. Each octopus was weighed to the nearest 0.1g using a digital handheld scale. Weights were recorded as either gutted or ungutted. Due to the nature of the fishery, gutted weights were commonly recorded. Sex was determined through external morphological examination by identifying the presence of a hectocotylized third arm on either the right or left side, a feature characteristic of males (FAO, 2016).

Morphological identification of octopus species was not feasible due to the challenges of visually distinguishing between species. Therefore, tissue samples of approximately 2 cm in length were collected from the mantle or arm of the octopus and immediately preserved in 96% ethanol for DNA barcoding analysis.

3.2. Data Analysis

Data collected from fishers were verified and stored in an excel database. Descriptive statistics were performed using R software (version 4.4.2) to summarize the data. Results were visualized using pie charts, histograms, boxplots, scatter plots and line graphs to illustrate the distributions and trends.

3.2.1. Sex Ratio

Only octopuses for which sex was successfully determined were included in the sex ratio analysis. The sex ratio was calculated as the number of males per female, using the following equation:

$$\text{Sex Ratio} = \frac{Number\ of\ Males}{Number\ of\ Females}$$

To assess whether the observed sex ratio significantly deviate from the expected 1:1 (male: female) ratio, a Chi-square test (χ^2) was applied. Analysis was conducted across the entire survey period, rather than on a monthly basis. A significant (χ^2) result ($p < 0.05$) indicates a deviation from the expected equal distribution of sexes.

3.2.2. Catch Per Unit Effort (CPUE)

The fishing effort was estimated based on the number of fishers, the number of fishing trips and hours spent fishing. The Catch Per Unit Effort (CPUE) was calculated by dividing the total landed catch (kg) by the corresponding effort measure and the values were then averaged across months to obtain the mean monthly CPUE for each category. The following CPUE indicators were derived:

- Mean CPUE (kg/fisher)
- Mean CPUE (kg/fishing-hour)
- Mean CPUE (kg/trip)
- Mean CPUE (kg/trip/fishing site)

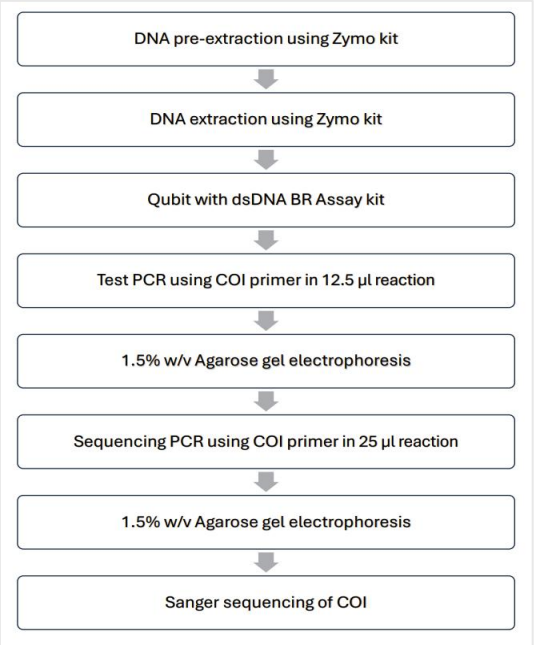
3.2.3. Statistical Analysis

All statistical analyses were computed using R software (version 4.4.2). The non-parametric Kruskal-Wallis's test was used to assess significant differences in monthly size distribution, total landings, and CPUE, as the data did not meet the required assumptions for parametric tests. Consequently, the Mann-Whitney U test was used to evaluate significant differences between fishing methods. In addition, the relationship between depth and individual size of the catch was examined using Spearman's rank correlation. Significant thresholds were set at $p < 0.05$ for all tests.

3.2.4. DNA Barcoding

DNA barcoding was used for species identification. DNA was extracted from individual octopus samples using the Zymo kit, followed by Polymerase Chain Reaction (PCR) amplification of the mitochondrial cytochrome c oxidase subunit I (COI) gene and Sanger sequencing to generate the DNA barcodes (Table 1). The resulting barcodes were validated using analytical tools available through the Barcode of Life Data Systems (BOLD) platform to confirm species identity.

Table 1. Workflow from DNA extraction to sequencing (Govender, 2025).



3.3. Results

3.3.1. Data Collection Effort

A total of eight fishers participated in the study, with variation in both the frequency and timing of their contributions. Figure 12 illustrates each fisher's monthly data collection effort, highlighting individual participation patterns and the temporal distribution of effort. Reported fishing trips were primarily concentrated around Mahé and Silhouette islands (Figure 13), with most trips conducted using snorkeling as the fishing method (Figure 14).

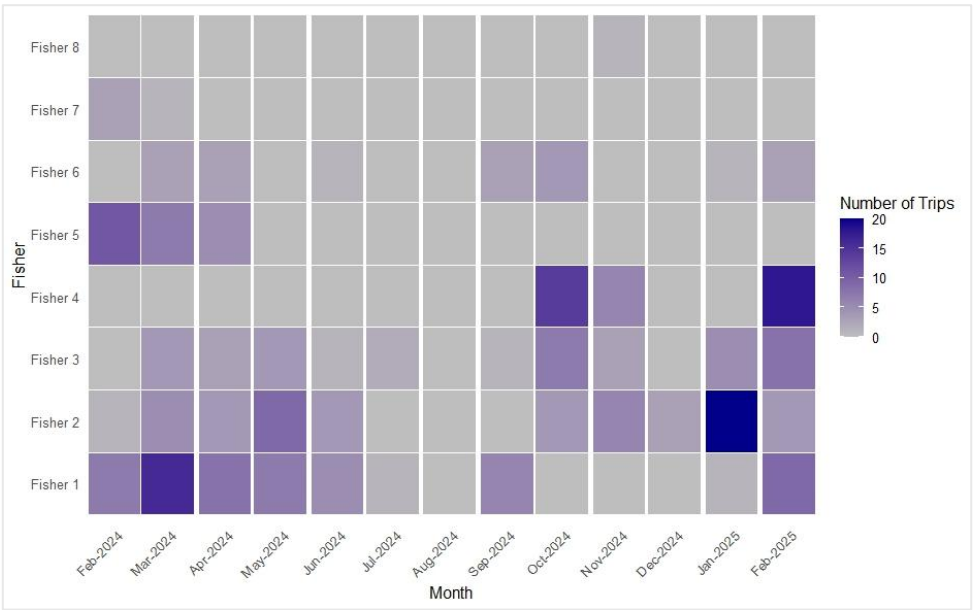


Figure 12: Monthly data collection effort from February 2024 to February 2025. Each row represents a fisher, and the colour intensity indicates the number of trips recorded per month, with darker cells showing higher trip counts.

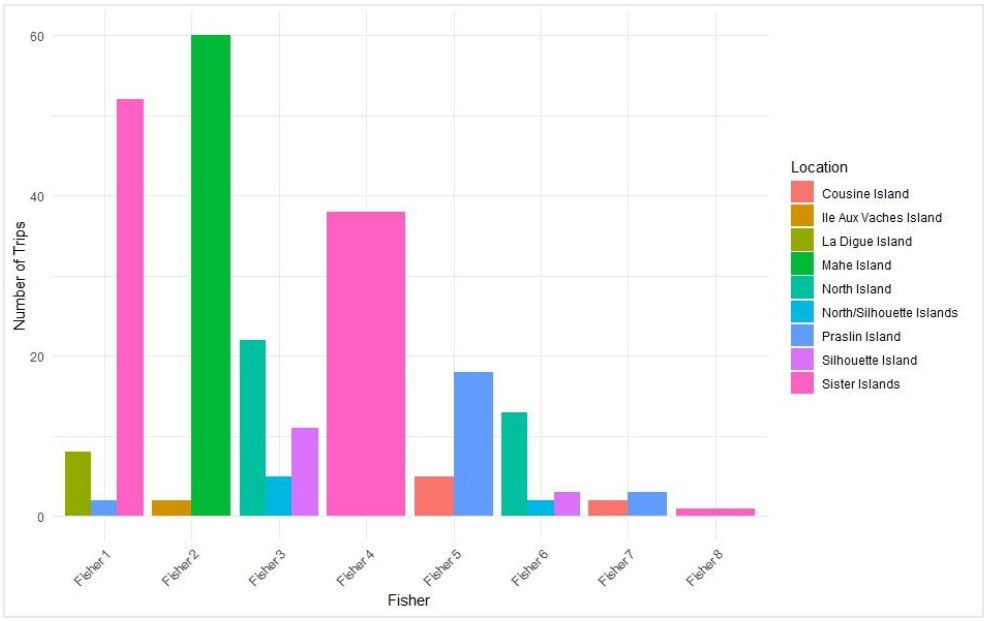


Figure 13: Number of trips per fisher by fishing location.

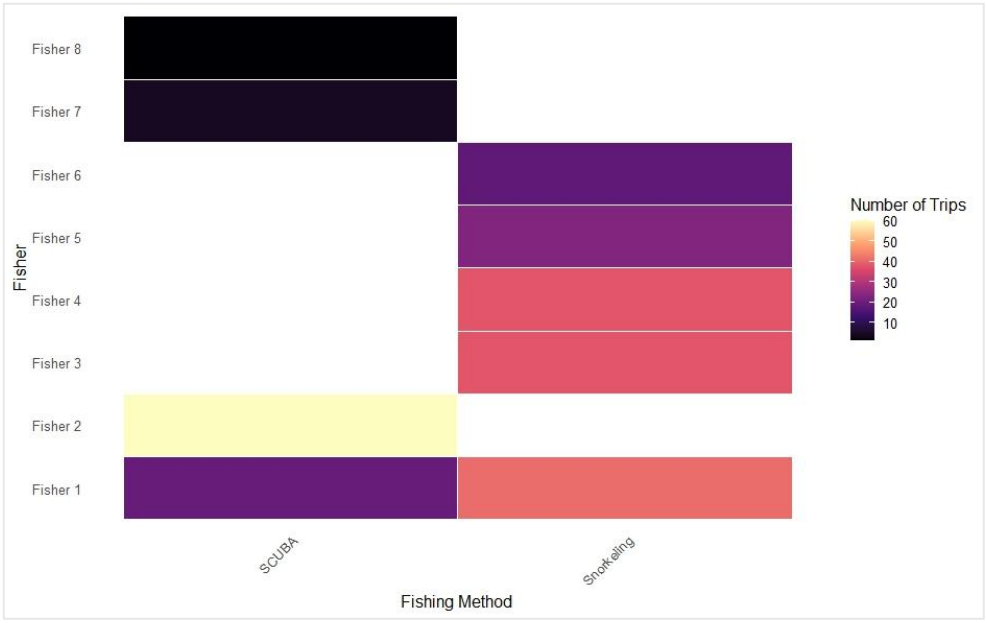


Figure 14: Fishing trips by method per fisher. Each row represents a fisher, and the colour intensity represents the number of trips, and blank spaces indicate no trips were recorded for that method.

3.3.2. Landings

A total of 4,096 kg (4.1 tons) of octopuses were recorded from 267 fishing trips, with an average daily catch of 15 kg. Daily landings ranged from 0 to 60 kg. Landings differed significantly across months (Kruskal-Wallis $\chi^2 = 91.985$, df = 11, p-value = 6.8e-15). Recorded landings peaked in February 2025 (1,144 kg), followed by March 2025 (441 kg) and October 2024 (750 kg) (Figure 15). No landings were recorded in August due to a lack of fishing activity.

Octopuses were predominantly harvested around Sister Islands, which include Félicité, Marianne, Grande Soeur, and Petite Soeur Islands, with a total catch of 1,810 kg, representing 44% of the overall catch. North Island followed with 853 kg (21%), while Silhouette recorded

416 kg (10%) of the total catch (Figure 16). Sites with comparatively low landed catch included Praslin Island (337 kg, 8%), Mahe island (314 kg, 8%), and La Digue (155kg, 4%). The lowest catches were observed at Cousine Island (98 kg, 2%) and Ile Aux Vaches (3 kg, 0%) (Figure 17).

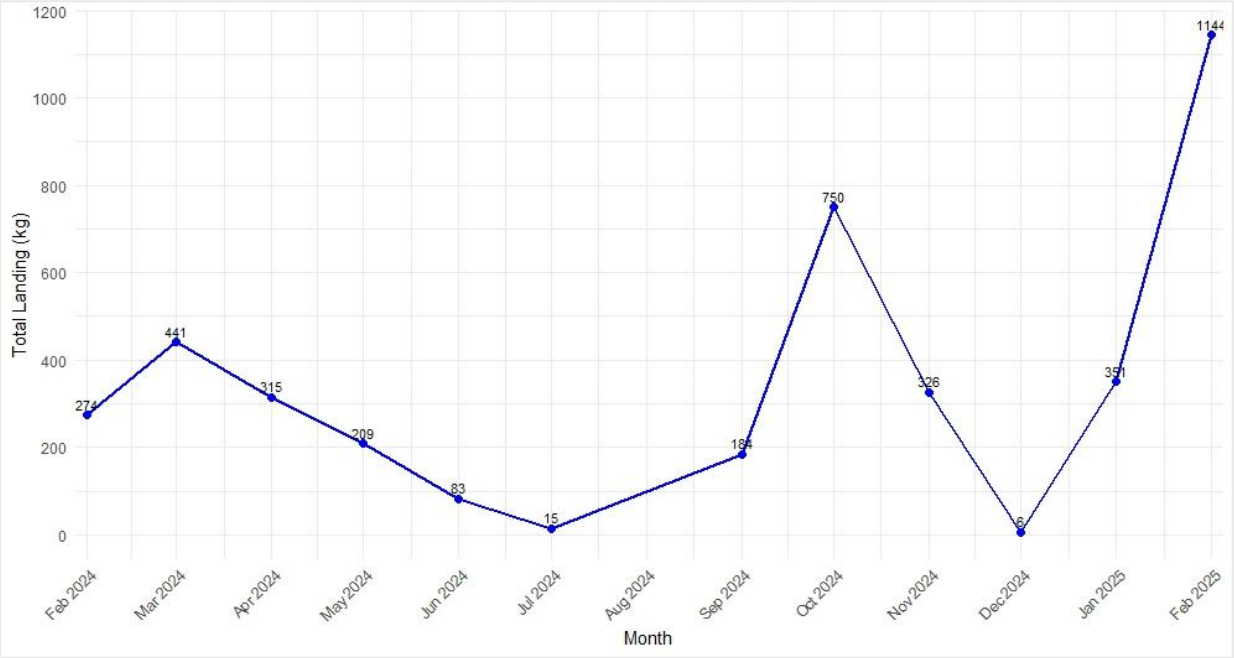


Figure 15: Total octopus landing (kg) by month.

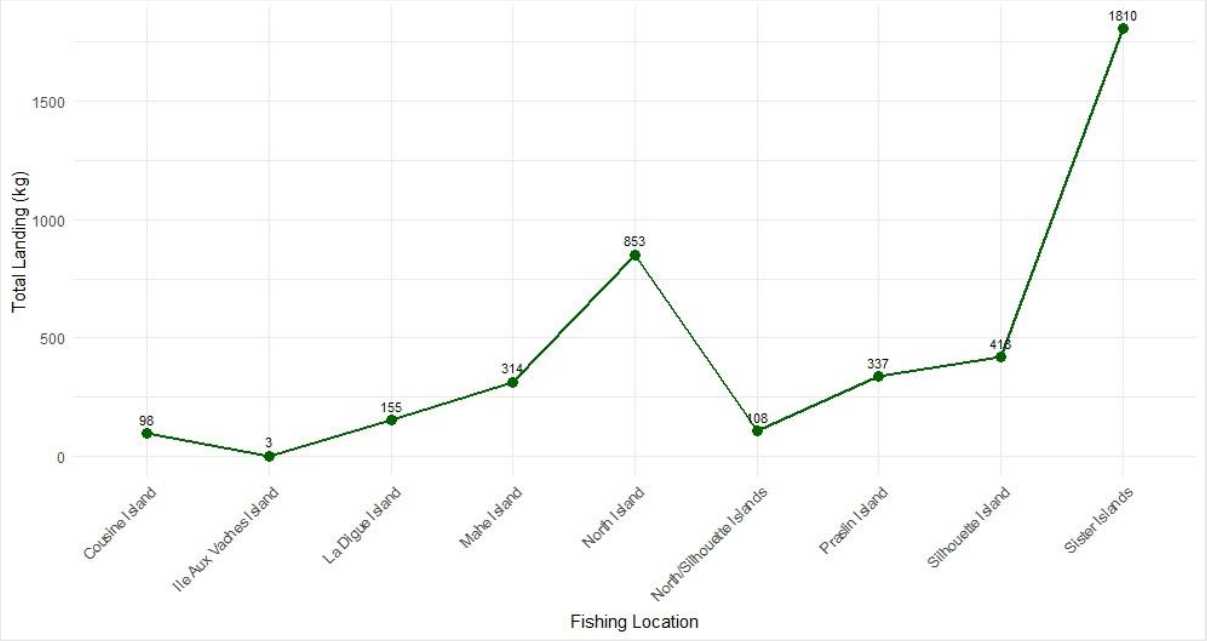


Figure 16: Total octopus landed (kg) by fishing sites.

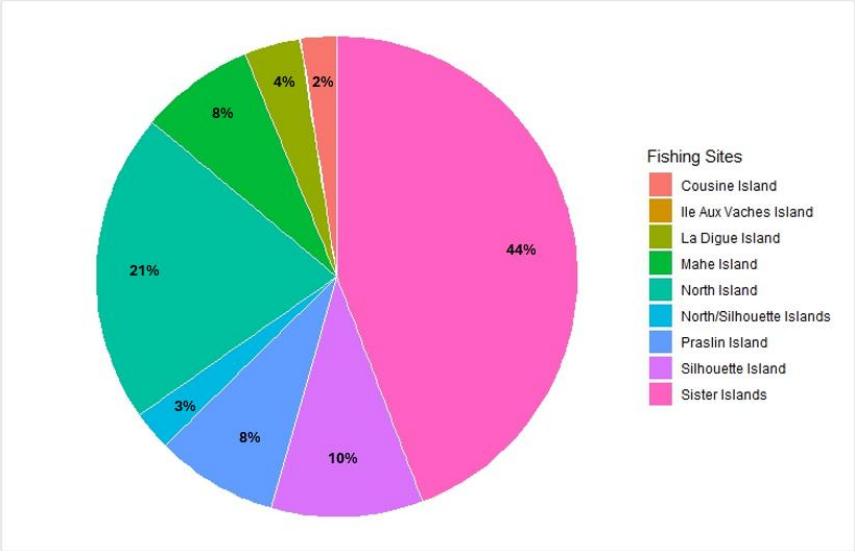


Figure 17: Percentage of total octopus landed by fishing sites.

3.3.3. Fishing Method

Snorkeling was the primary method used, accounting for 60% of the effort, while SCUBA at 40% (Figure 18). Octopuses were harvested at an average depth of 9 meters, with depths ranging from 0 to 26 meters. Individuals caught using SCUBA ranged in weight from 500 g to 3,740 g, while snorkeling showed a greater size variation, with weights ranging from 305 g to 6,100 g (Figure 19). Despite this, there was no statistically significant difference in the size distribution of octopuses between the two fishing methods (Wilcoxon rank sum test, W = 175449, p-value = 0.6912).

However, octopus harvested at depths between 6 to 13 meters showed the greatest variation in size. Spearman's correlation indicated a statistically significant relationship between depth and octopus weight (S = 446,320,781, p-value < 2.2e-16, ρ = 0.216). This suggests that octopus size tends to increase with depth, however, there is substantial variability in the data, and this should be interpreted with caution (Figure 20).

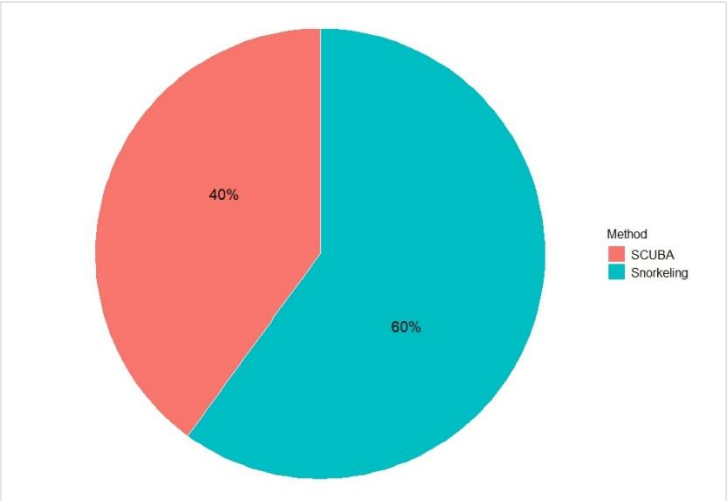


Figure 18: Percentage fishing methods employed.

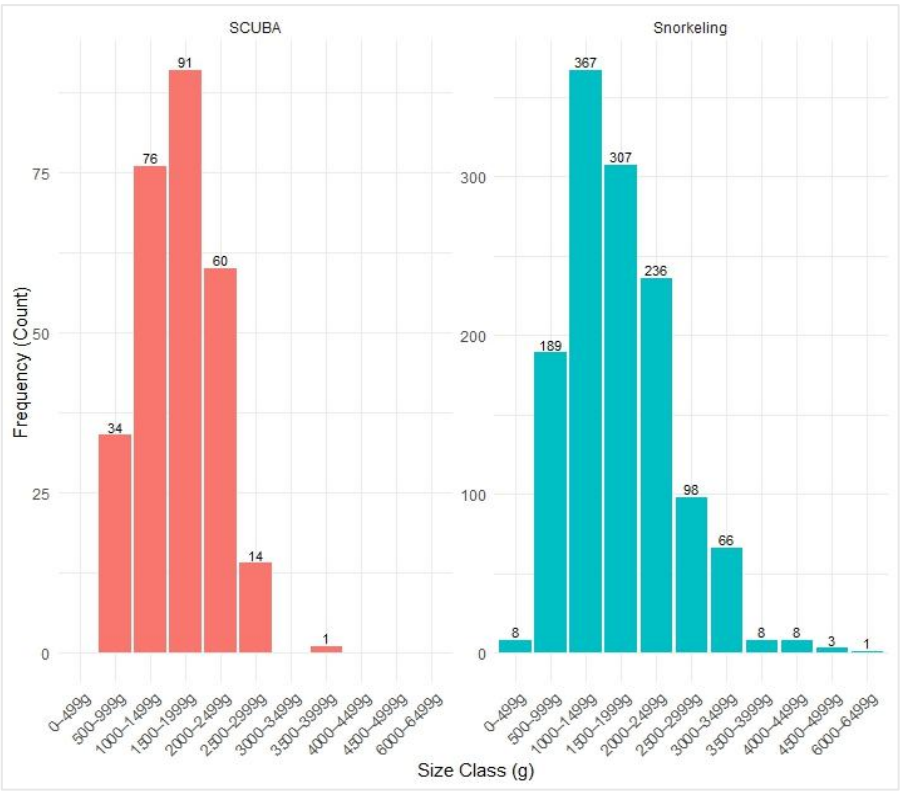


Figure 19: Frequency distribution of octopus weights (g) by fishing method.

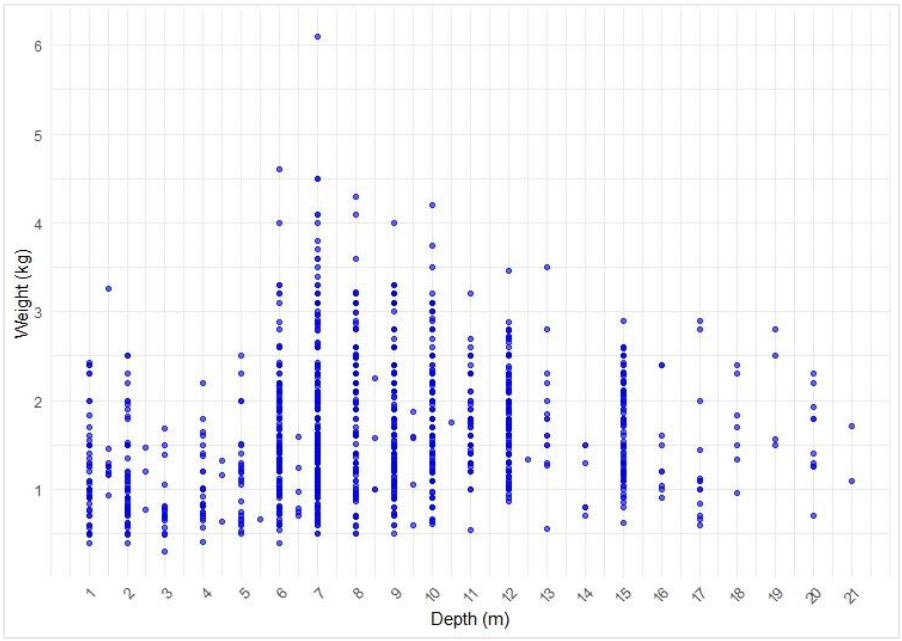


Figure 20: Distribution of octopus weight (kg) by fishing depth.

3.3.4. Catch Per Unit Effort (CPUE) Trends

The CPUE by weight per fisher (kg/fisher) varied significantly among months (Kruskal-Wallis χ^2 = 79.599, df = 11, p-value = 1.764e-12). The highest mean CPUE was recorded in February 2025 at 13 kg per fisher, followed by September, October, and November. The lowest mean CPUE occurred in December at 1 kg per fisher, followed by 4 kg in July, 5 kg in both June and January, and 6 kg in May (Figure 21).

Monthly CPUE by weight per fishing hour (kg/hour) also exhibited significant variation (Kruskal-Wallis χ^2 = 35.143, df = 11, p-value = 0.0002347). The highest mean value was observed in November at 4 kg/hour, followed by 3 kg/hour in October, September, May, and June. The lowest values were recorded in July and December, at 1 kg/hour (Figure 22).

Similarly, CPUE by weight per fishing trip (kg/trip) showed significant differences among months (Kruskal-Wallis χ^2 = 91.775, df = 11, p-value = 7.479e-15). February 2025 had the highest mean CPUE per trip at 27 kg, followed by October (25 kg), November (24 kg), and September (18 kg). December recorded the lowest mean CPUE per trip at 2 kg (Figure 23).

Significant variation in CPUE by weight per fishing trip (kg/trip) was also observed across fishing sites (Kruskal-Wallis χ^2 = 111.18, df = 8, p-value < 2.2e-16). The highest mean CPUE per trip was recorded at Silhouette Island (30 kg), followed by North Island (24 kg) and the Sister Islands (20kg). In contrast, the lowest mean values were recorded at Ile aux Vaches (3 kg) and Mahé Island (5kg) (Figure 24).

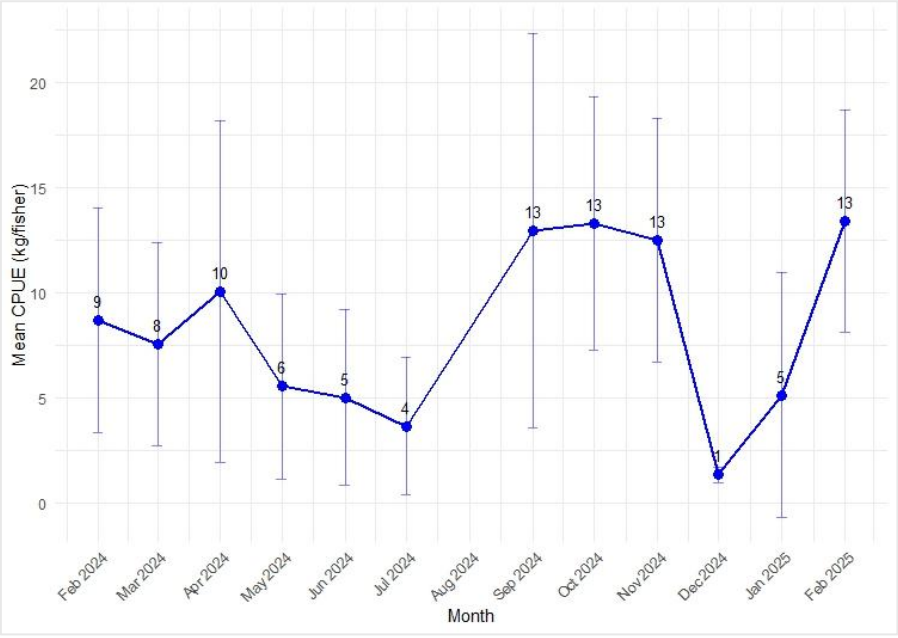


Figure 21: Monthly mean CPUE weight per fisher (kg/fisher).

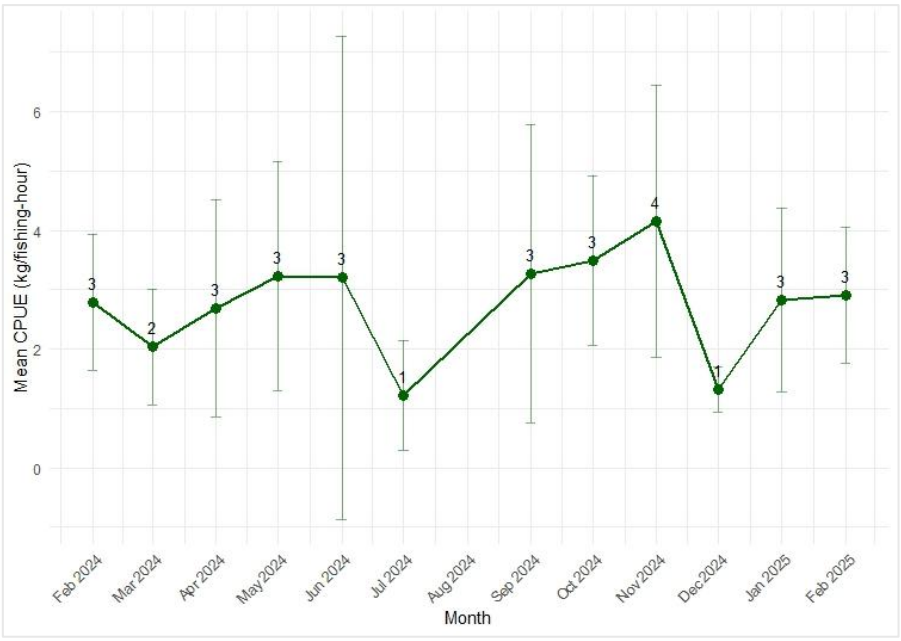


Figure 22: Monthly mean CPUE weight per fishing hour (kg/hour).

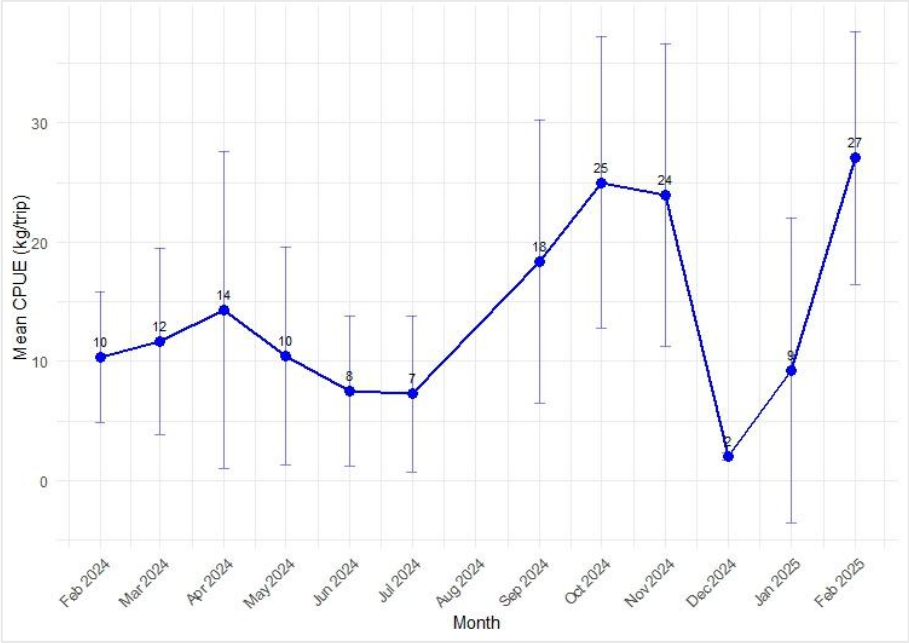


Figure 23: Monthly mean CPUE weight per trip (kg/trip).

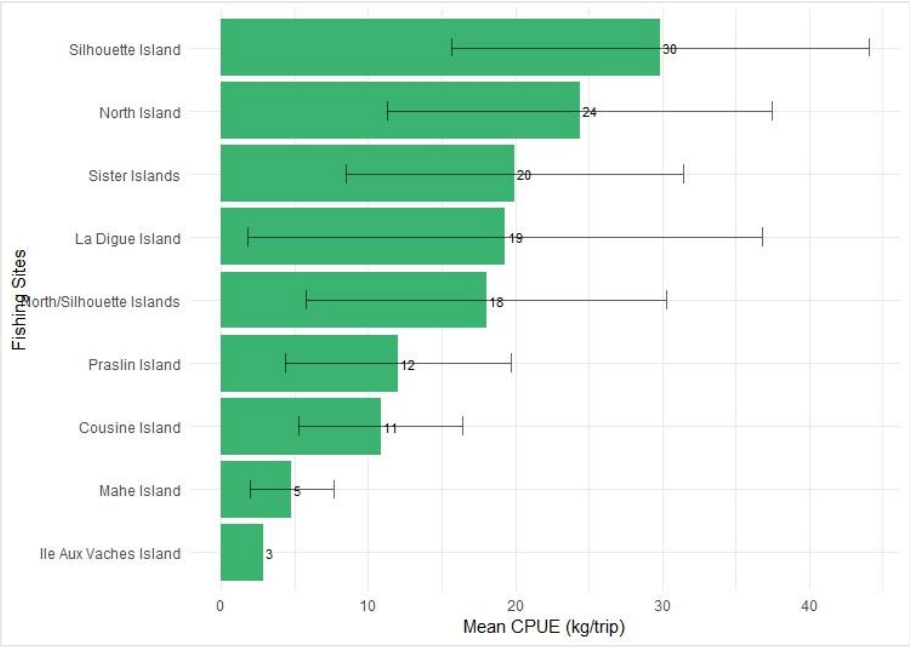


Figure 24: Mean Catch Per Unit Effort (kg/trip) by Fishing Site.

3.3.5. Sample Size and Sex Ratio

A total of 1,630 octopuses (2,714 kg) were sampled. These included 618 females (38%), 513 males (31%), and 499 individuals of undetermined sex (31%) (Figure 25). “Undetermined sex” refers to individuals whose sex could not be visually determined.

Size distributions were broadly similar across identified sexes, with female weights ranging from 370 g to 4,500 g, males from 400 g to 4,200 g, and individuals of undetermined sex from 305 g to 6,100 g (Figure 26). Average weights were also comparable, with females averaging 1,662 g and males 1,741 g.

The observed male-to-female sex ratio differs significantly from the expected 1:1 ratio with a female skewed ratio of 1:1.2 (χ^2 = 9.748, df = 1, p-value = 0.001795). Due to substantial variation in monthly data collection, it was not possible to compute sex ratio by month to identify potential monthly trends in sex distribution.

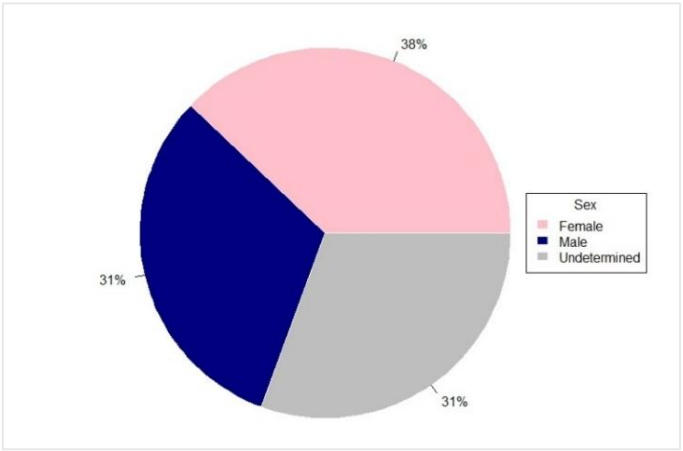


Figure 25: Pie chart illustrating the proportions of male, female, and undetermined sexes.

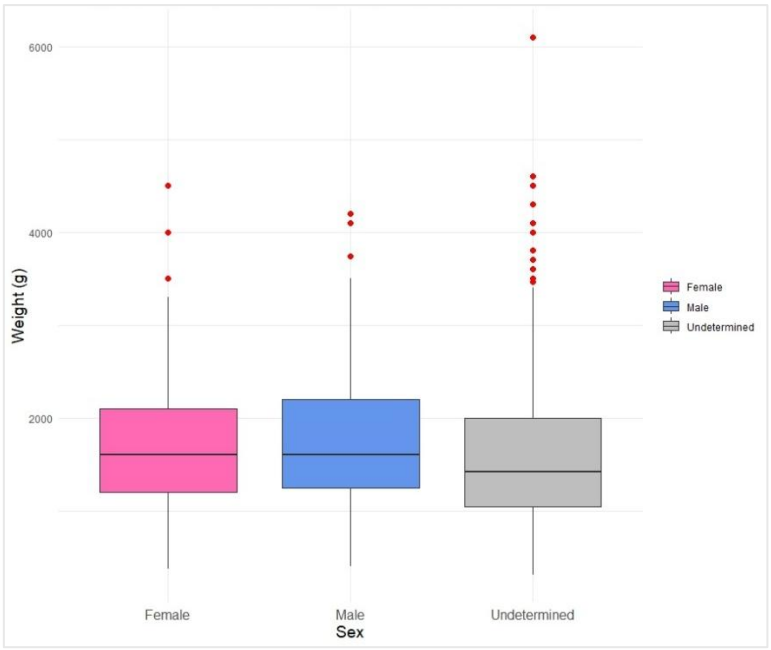


Figure 26: Boxplot illustrating the weight distribution (g) across female, male, and undetermined sex categories.

3.3.6. Size Distribution

The weight of individual octopuses ranged from 305 g to 6,100 g, with an average size of 1,665 g. A significant difference in weight distribution across months was observed (Kruskal-Wallis $\chi^2 = 73.567$, df = 10, p-value = 9.035e-12). Most individuals (85%) weighed more than 1,000 g, while 15% weighed less than 1,000 g (Figure 27).

Octopus size varied throughout the study period, with the highest median weight (1,800 g) recorded in January and February 2025, with individual weights ranging from 500 g to 4100 g. The lowest median weights were recorded in June (1,275 g) and July (1,200 g) (Figure 28). The smallest individuals were recorded in March (480g), April (305g), September (400g) and October (400g). The greatest size variation with the presence of the largest individuals was observed in April, with weights (305 g to 6,100 g), followed by March (480 g to 4,300 g) and May (540 g to 4,500 g). In contrast, December exhibited the least variation in sizes (1,100 g to 2,080 g). No data were available for August due to no fishing activity.

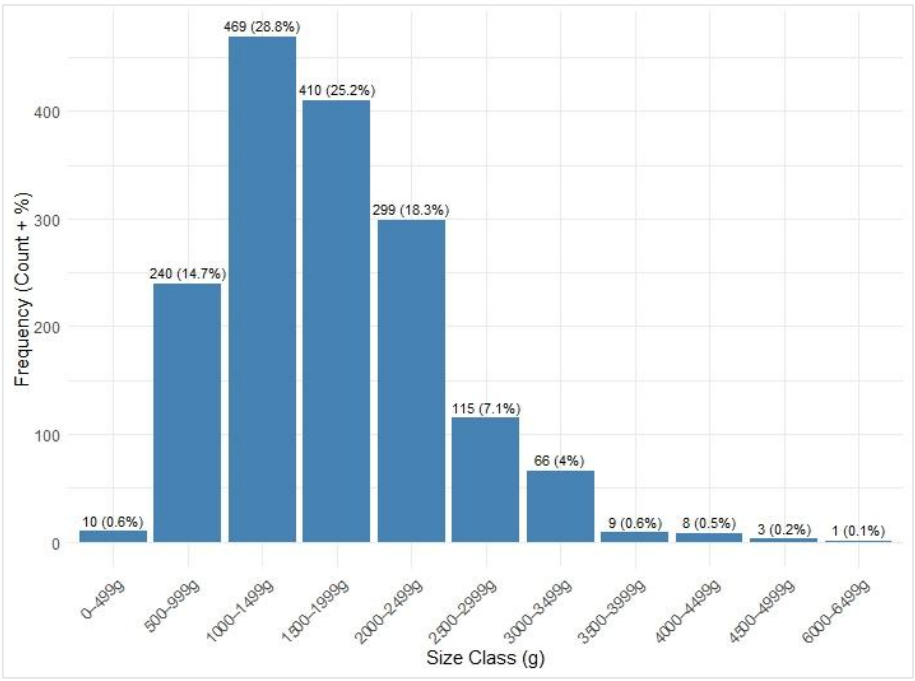


Figure 27: Frequency distribution of octopus weight (g).

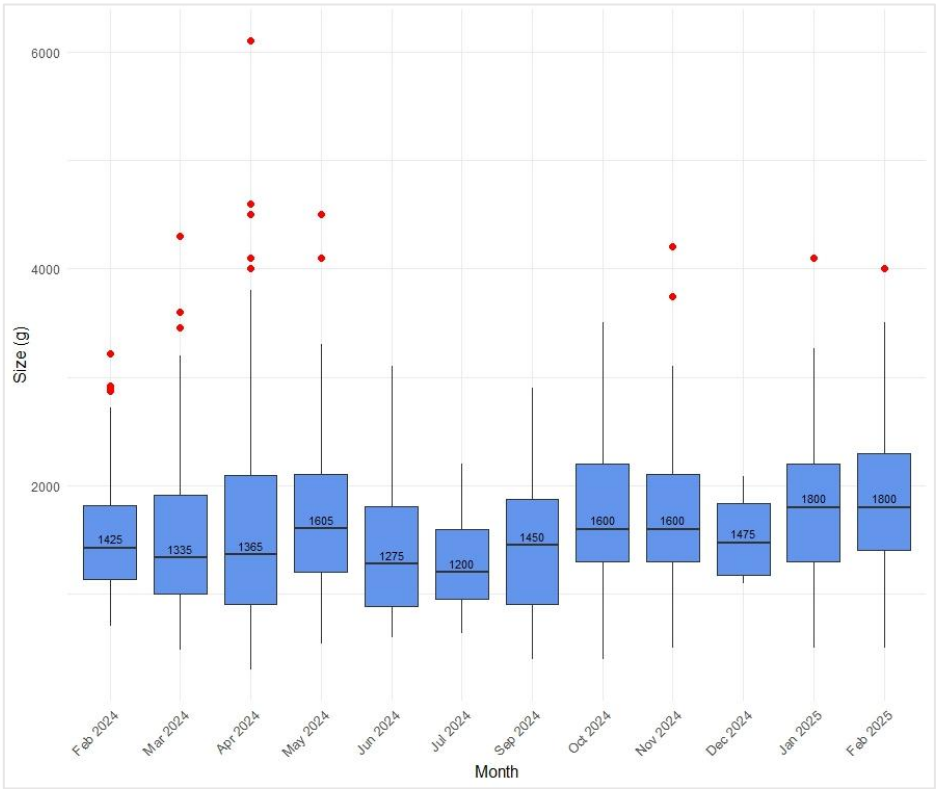


Figure 28: Octopus monthly median size (g) distribution.

3.3.7. Species catch composition

Specimen representing 6% of the total sampled catch (100 individuals), collected from 12 locations, were subjected to DNA barcoding for species identification (Figure 29). COI sequencing with HCO and LCO primers was successfully completed for all specimens, and the resulting sequences were compared against the BOLD database. All specimens were identified as *O. cyanea,* with species identity values ranging from 99% to 100%.

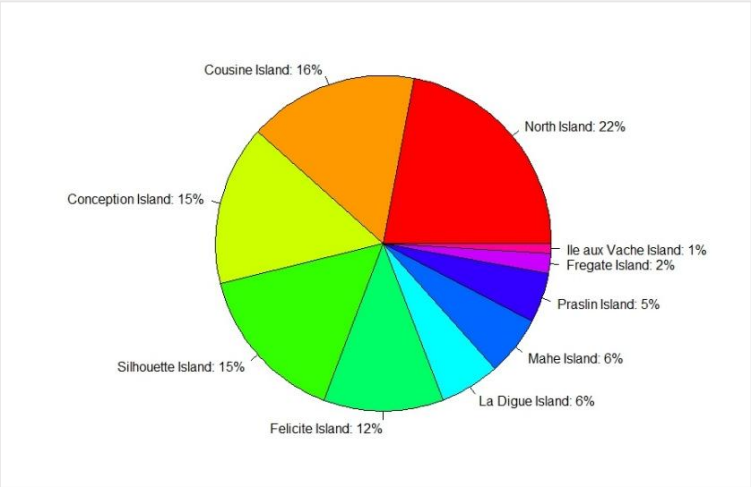


Figure 29: Percentage distribution of samples collected from different locations.

3.4. Discussion

The octopus fishery holds considerable importance for local communities in the Seychelles. However, comprehensive knowledge of the fishery, including temporal trends in exploitation, remains limited. This study contributes valuable baseline information on octopus landing within the inner islands, offering insights that can support future monitoring and management efforts.

The results indicate that all octopus sampled from the catch consisted of *Octopus cyanea* (Gray, 1849), aligning with observations reported by Treleven et al., (2024). This challenges the assumption that the fishery is dominated by *Octopus vulgaris* (Payet, 1996). Uncertainty around species composition in the landing statistics remains a significant challenge, primarily due to limited expertise in species identification and the lack of biological research on octopus in the Seychelles.

The landed catch was dominated by female octopuses, a pattern also observed in other parts of the region, though contrasting trends have been reported elsewhere (Hamad et al., 2025). The dominance of females has been linked with peak brooding periods, during which mature individuals tend to occupy subtidal areas, making them more susceptible to capture (Guard & Mgaya, 2002). This may explain the high number of females caught, particularly since brooding peaks are not well documented in Seychelles. However, due to limitations in maturity assessments and sample size, variations in sex ratio and sexual maturity could not be thoroughly assessed.

The majority of octopuses sampled were relatively small to medium-sized, weighing less than 3 kg, with only a few larger individuals observed. Interestingly, while the average size of males in this study was greater than females, previous studies have shown that males are generally smaller in size compared to females (Hamad et al., 2025; Kivengea et al., 2014). Total weight is considered an effective proxy for assessing sexual maturity, although the size at maturity varies geographically (Raberinary & Benbow, 2012). Based on the observed size distribution, it is suggested that over 80% of the sampled individuals had likely reached sexual maturity. This assumption is supported by findings from Madagascar, where *O. cyanea* reached maturity at a minimum weight of 2,246 g for females and 643 g for males (Raberinary & Benbow, 2012), and Tanzania, where lower maturity weight of 600 g for females and 320 g for males has been reported (Guard & Mgaya, 2002). In contrast, *O. vulgaris* matures at larger sizes, with minimum weights of 1,788 g for females and 903 g for males (Otero et al., 2007).These maturity sizes correspond with those observed in this study.

However, female size at maturity appears to be more variable, and unlike males, the total weight may not be a reliable indicator of maturity for females (Raberinary & Benbow, 2012). Some female octopuses have been reported to reproduce at significantly larger sizes, while others at smaller sizes, reportedly induced by fishing pressure (Guard & Mgaya, 2002). In contrast, males tend to mature at smaller sizes and younger age (Herwig et al., 2012). This variability suggests that caution is needed when using weight as a proxy for sexual maturity.

Over the study period, the presence of small-sized individuals in March, April, September and October may indicate a potential recruitment period. This observation concurs with previous studies that reported an increase in immature and juvenile individuals from September and December through March (Hamad et al., 2025). Although octopuses spawn throughout the year with peak brooding periods, the presence of larger individuals between January and February could indicate potential brooding peak, as peaks in average size associated with brooding have been reported in Tanzania (Guard & Mgaya, 2002), and in Rodrigues (Jhangeer-Khan et al., 2015). However, further microscopic maturity assessments are required to confirm this trend and to better understand the year-round size distributions between sexes.

Additionally, the low number of larger individuals observed suggests a degree of fishing pressure on the smaller size classes, potentially limiting their survival and growth to larger sizes. This aligns with previous findings, where high fishing pressure has led to a catch composition dominated by smaller individuals (Guard and Mgaya, 2002; Jhangeer-Khan et al., 2015). In some areas, such as Madagascar, fishing pressure has been found to be depth limited due to the nature of gleaning practices (Raberinary & Benbow, 2012). This was not the case in this study, as octopuses were harvested at depths of up to 26 meters using both snorkeling and SCUBA techniques, with no significant differences observed in catch composition between the two methods. However, we observed a positive correlation between octopus size and depth, suggesting that larger individuals may be more accessible in deeper areas. This aligns with previous studies indicating the influence of depth gradient on octopus size distribution, with smaller individuals inhabiting shallow areas, compared to

larger individuals (Leite et al., 2009). Octopus migration has also been found to influence fishery dynamics, particularly for o. vulgaris where differences in size was observed between female and male octopus in intertidal and subtidal areas, indicating migration of larger individuals to mate, spawn and brood (Oosthuizen & Smale, 2003).

The CPUE analysis revealed temporal variations in catch rates and fishing activity over the course of the study period, largely reflecting variations in fisher participation. A notable decline in both fishing trips and catch was observed from May to July. This trend may be attributed to the southeast monsoon season, during which unfavorable weather conditions restrict fishing operations. No data was recorded in August, as fishing activity ceased entirely, with fishers reportedly engaged in alternative livelihoods. This seasonal shift is evident in the increased effort and catch observed from September to November, which coincides with improved conditions. However, CPUE in December dropped, likely because of a shift in weather conditions.

Spatial variation in CPUE was also evident. Higher values were recorded at Silhouette, North Island and the Sister Islands, which are areas with relatively low inhabitants and only accessible by boat, which may contribute to low fishing pressure. In contrast, the more accessible and densely populated main islands of Mahé and Praslin exhibited lower CPUE values. Interestingly, La Digue demonstrated a higher CPUE compared to Mahé and Praslin, suggesting differences in fishing intensity. Mahé, in particular, exhibited the lowest CPUE, likely due to a higher intensity of subsistence and commercial fishing activities which exert greater pressure on octopus resource.

3.5. Conclusion

This study provides crucial baseline information on the octopus fishery in the Seychelles, offering preliminary insights into species composition, size distribution, sex ratio, and seasonal trends in fishing effort and catch. Despite limitations in species identification and sample coverage, the study represents an important first step towards understanding species composition and sex differentiation within the fishery.

The findings underscore the need for further progress in morphological identification, assessment of sex ratio variations, sexual maturity, and implementation of long-term monitoring to accurately define reproductive peaks and seasonal variations. Variability in fisher participation and consistency throughout the study may have influenced temporal patterns in catch and CPUE. Consequently, the findings should be interpreted as indicative rather than definitive trends.

Overall, this study serves as a foundation for future research and the development of science-based management strategies. Enhancing monitoring efforts through broader fisher participation and more comprehensive data collection is recommended. Additionally, a reproductive study is essential to better understand reproductive patterns, sexual maturity, and size distribution within the fishery.

4. Habitat Survey

The primary objective of this survey was to characterise the composition and complexity of benthic habitats occupied by octopus around the inner islands of Mahé. The main aims were to:

- Collect baseline data on habitat composition.
- Assess the structural complexity of the habitat.

4.1. Methodology

A total of nine sites were identified through the socioeconomic survey and stratified according to depth range predominantly targeted by the fishery, which is 5 to 15 meters, as well as benthic cover types, specifically granitic and coral reefs (Figure 30). In-situ transects using Underwater Visual Census (UVC) and Rugosity Transect methods were used to obtain data on habitat composition and complexity. The surveys were conducted in April and November 2024.

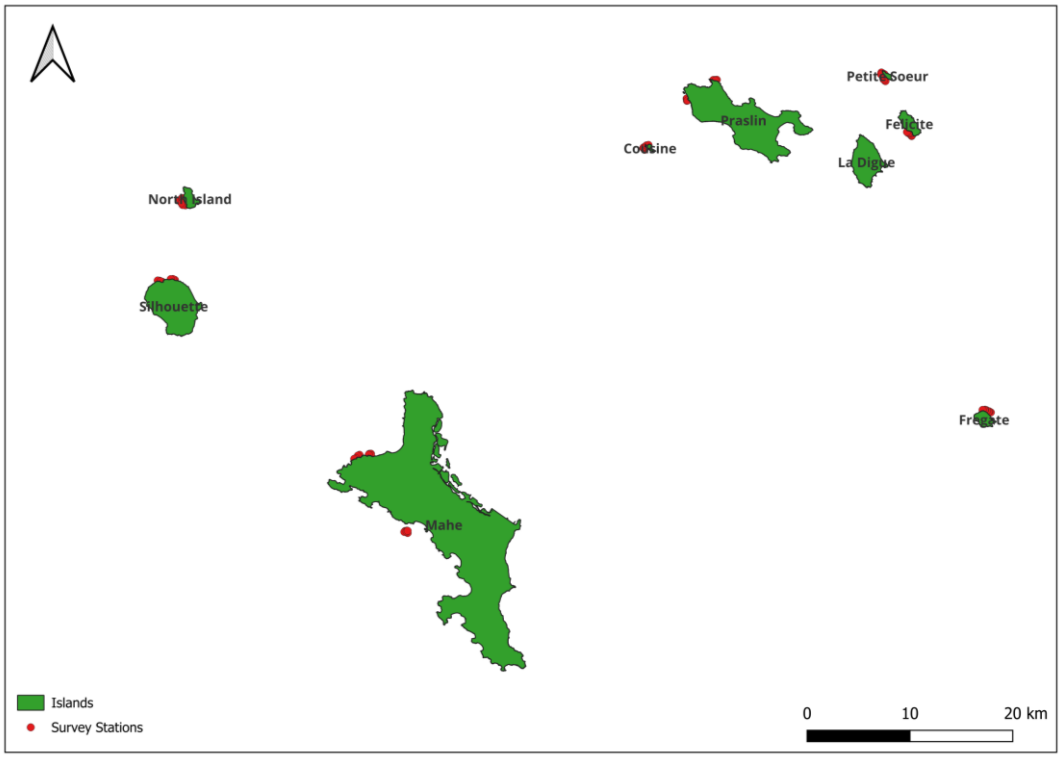


Figure 30: Surveyed sites within the inner islands of Mahé.

4.1.1. Underwater Visual Census (UVC)

UVC surveys were conducted along a transect of 200 meters in length and 2.5 meters in width, parallel to the coast. A total of four replicates were performed at each site, with two replicates at each depth interval of 5 to 10 meters and 10 to 15 meters (Figure 31). Benthic compositions were quantified by estimating the percentage cover of the substrate types and counting the number of octopus and dens observed. Other benthic species present were also recorded (See Annex 1).

Figure 31: Schematic layout of the UVC on the transect of the survey station.

4.1.2. Rugosity Transect

Rugosity transects were conducted within the 200-meter line at 50 m, 100 m and 150 m intervals. The structural complexity of the terrain was measured by carefully laying a 10-meter steel chain on the surface of the substrate over a straight line of 5 meters (Figure 32). The length of the steel chain was recorded using a measuring tape. A total of six replicates were performed on each transect, with three replicates on each side of the transect.

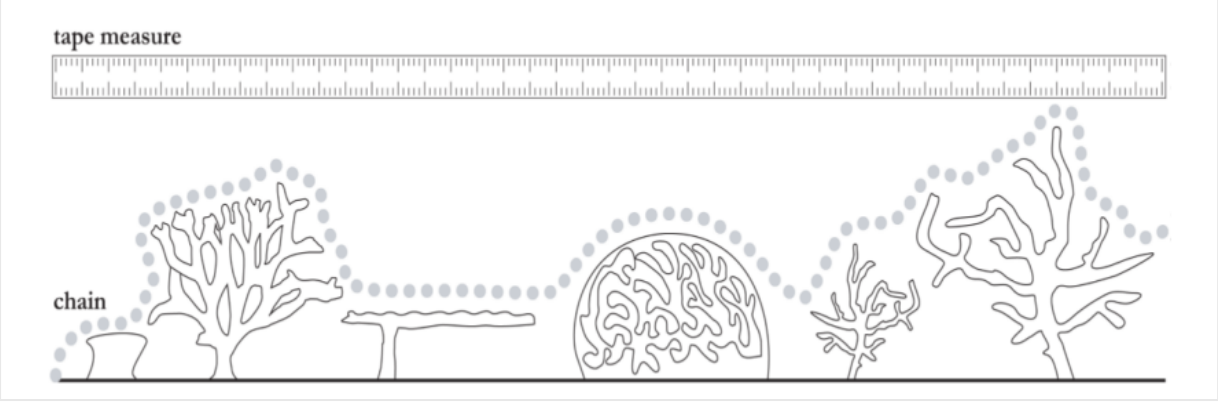


Figure 32: Schematic layout of the rugosity method employed. Retrieved from Friedman et al., (2012).

4.2. Data Analysis

Data collected were verified and stored in an excel database. Descriptive statistics were performed using R software (version 4.4.2) to summarise the physical variables and the distribution of octopus and empty den densities. Results were visualised using attribute table, bar graphs, and boxplots to illustrate values, distributions, and trends.

- Total: The sum of all values.
- Mean: The average of the values.
- Median: Middle value of the values or average of the two middle values.
- Range: The minimum and maximum values observed.

4.2.1. Density Assessment

Density for each transect was estimated by first calculating the survey area, using the formula:

$$\text{Transect Area (m2)} = \text{Length (m)} \times \text{Width (m)} = 200 \text{ m x } 5 \text{ m} = 1{,}000\ m^2$$

To obtain the total surveyed area per site, the transect area was multiplied by the number of transects conducted at that site, using the formula:

$$\text{Total Area Per site } (m^2) = 1{,}000\ m^2 \text{ x number of transects}$$

The density of octopuses and dens per site was then calculated by dividing the total count observed by the total surveyed area and standardizing the result to $1{,}000\ m^2$, using the formula:

$$\text{Density Per Site} = \frac{\text{Total Count}}{\text{Transect Area Surveyed}} x\ 1{,}000\ m^2$$

To determine density per depth interval, the start and end depths of each transect were averaged. These mean depth values were then grouped into depth intervals, and the average densities of octopus and empty dens within each interval were calculated. The overall trend was assessed using a linear regression scatter plot.

4.2.2. Rugosity Assessment

Rugosity was estimated by comparing the linear distance of the benthic area to the chain measurement taken along the surface terrain of the area. Benthic complexity was calculated by dividing linear distance by the chain measurement, using the formula:

$$r = \frac{Linear\ Distance\ (cm)}{Chain\ Measurement\ (cm)}$$

Where:

- Linear Distance refers to the length of the surveyed terrain.
- Chain Measurement is the surface distance measured along the terrain between the start and end points of the chain.

High complexity is indicated when the chain measurement is less than the linear distance (<1), suggesting a more complex terrain. Low complexity occurs when the linear distance equals to the chain measurement (r = 1), indicating a relatively flat surface area.

4.2.3. Habitat Characterisation

To characterise the overall habitat types of the surveyed area, compositional habitat data (substrate and benthic cover percentages) were analysed using the Principal Component Analysis (PCA). This allowed the identification of dominant substrate and cover types among sites, highlighting how sites differ and relate in terms of overall composition. Additionally, boxplots were used to visualise correlations between dominant substrate and benthic cover types with densities of octopus and empty dens per 1,000 m^2.

4.2.4. Statistical Analysis

Statistical analyses were performed using R software (version 4.4.2). The non-parametric Kruskal-Wallis's test was used to assess significant differences (p-value < 0.05) in octopus and empty den density distributions across sites, depth intervals, and benthic substrate and cover types, as the data did not meet the required assumptions for parametric test. In addition, Pearson's Correlation test was used to evaluate the linear relationship between mean rugosity and the distribution of octopus and empty dens densities across sites.

4.3. Results

4.3.1. Physical Variables

Environmental conditions varied across survey sites , with depths ranging from 4 to 17 meters, sea temperatures between 25°C and 31°C, and visibility, rated on a scale from 1 to 10, ranging from 2 to 10 (Table 2).

Table 2. Summary of physical characteristics at the survey sites.

Attribute	Depth (m)	Temperature (℃)	Visibility (1-10 scale)
Mean	9	29	7
Min	4	25	2
Max	17	31	10

4.3.2. Octopus and Den Distribution

A total of 58 octopuses and 140 empty dens were recorded during the survey. The number of octopus observed per site ranged from 0 to 18, while dens count ranged from 8 to 25. Densities per 1,000 m² ranged between 0 to 6 for both octopuses and dens.

Both octopus and empty den counts varied across site, with mean densities of 2.5 dens and 1.05 octopuses per site. Octopus densities were consistently higher than den densities, indicating that while dens were available, occupancy was generally higher at the time of the survey. The highest mean densities of octopus were observed at Félicité (3.2) and Silhouette (3.1) The highest empty dens densities were found at Cousine (2.2), followed by Fregate and Silhouette (1.8) , whereas no dens were recorded at Belombre (Figure 33). A significant difference in octopus' densities was observed among sites (χ^2 = 21.958, df = 8, p-value = 0.004995), while den density did not vary significantly across sites (χ^2 = 4.9308, df = 8, p-value = 0.7649).

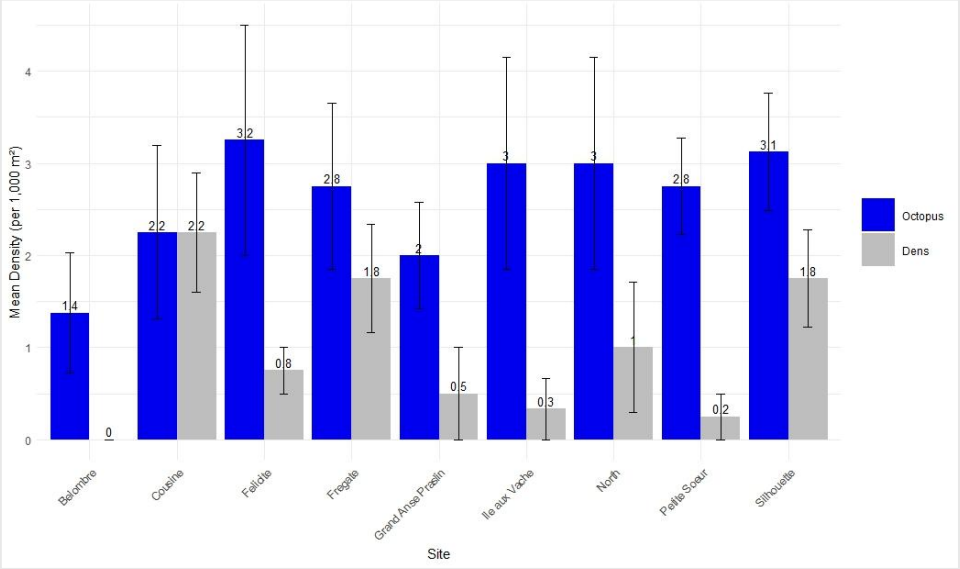


Figure 33: Mean density (± standard error) of octopuses and dens per 1,000 m² across sites.

Depths across the surveyed sites ranged from 4 to 17 m, and the distribution of octopus and den densities varied across depth intervals. From 0 to 15 m, mean den densities were consistently higher than octopus densities, suggesting low occupancy. Beyond 15 m, the mean octopus density was higher and lower for den (Figure 34). However, a Kruskal-Wallis test indicated no significant difference in octopus density across depth intervals (χ^2 = 6.9292, df = 3, p-value = 0.07419). Similarly, no significant difference was found in den density (χ^2 = 4.0172, df = 3, p-value = 0.2596), suggesting no strong variation in observation.

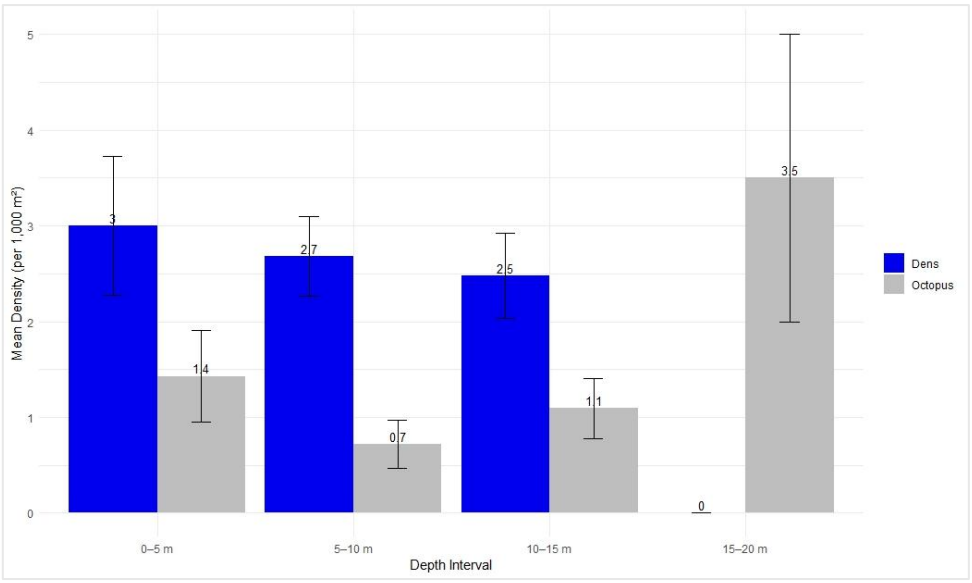


Figure 34: Mean density (± standard error) of octopuses and dens per 1,000 m² across depth intervals.

4.3.3. Habitat Characteristics

Benthic habitat composition varied significantly across surveyed stations. Principal Component Analysis (PCA) plots highlighted distinct patterns in both dominant substrate and benthic cover types across sites.

PCA of dominant substrate composition (Figure 35) revealed distinct variation among stations, with the first two principal components (Dim1 44.2% and Dim2 42.2%) explaining 86.4% of the total variance. PC1 (Dim1) was positively driven by coral and pavement dominated stations and negatively associated with rock-dominated stations. In contrast, PC2 was positively influenced by sand and negatively by pavement (Appendix 2: Loadings for PCA of substrate type).

The patterns observed indicate that stations dominated by rock and pavement formed distinct clusters, suggesting relatively homogeneous substrate characteristics. In contrast, sand-dominated stations were more widely dispersed, reflecting greater habitat heterogeneity. Coral-dominated stations showed moderate spread and some overlap with sand-dominated stations, suggesting they may represent transitional compositions.

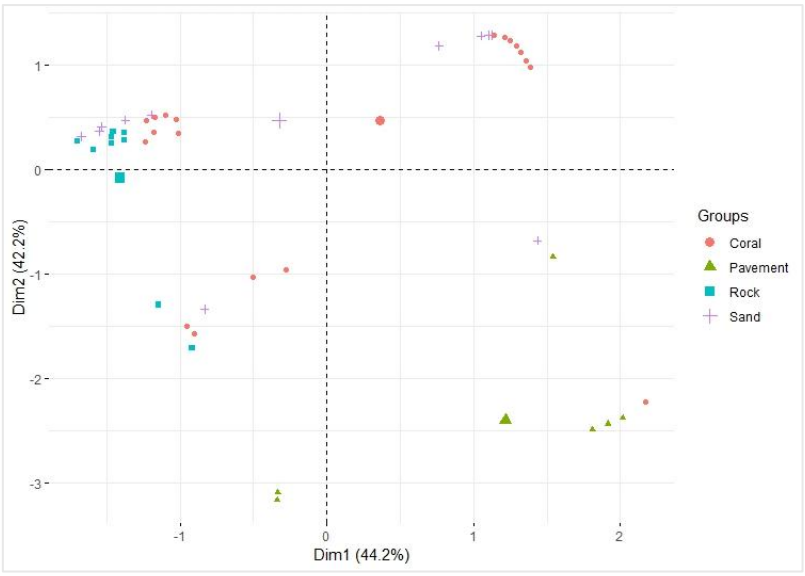


Figure 35: PCA plot of surveyed stations coloured by dominant substrate type.

Benthic cover composition varied, with the first two principal components (Dim1 28.5% and Dim2 24.1%) explaining 52.6% of the total variance (Figure 36). PC1 are driven by consolidated and unconsolidated rubble and negatively driven by hard coral. In contrast, PC2 were positively driven by soft coral and consolidated rubble and negatively by fungids and sponge (Appendix 3: Loadings for PCA of benthic cover).

The patterns observed indicate that stations dominated by hard coral and consolidated rubble exhibit moderate overlap, indicating similarity in overall benthic structure. In contrast, stations dominated by unconsolidated rubble exhibit broad variability, suggesting a more heterogeneous structure. Soft coral dominated stations are few and positioned separately, indicating distinct characteristics.

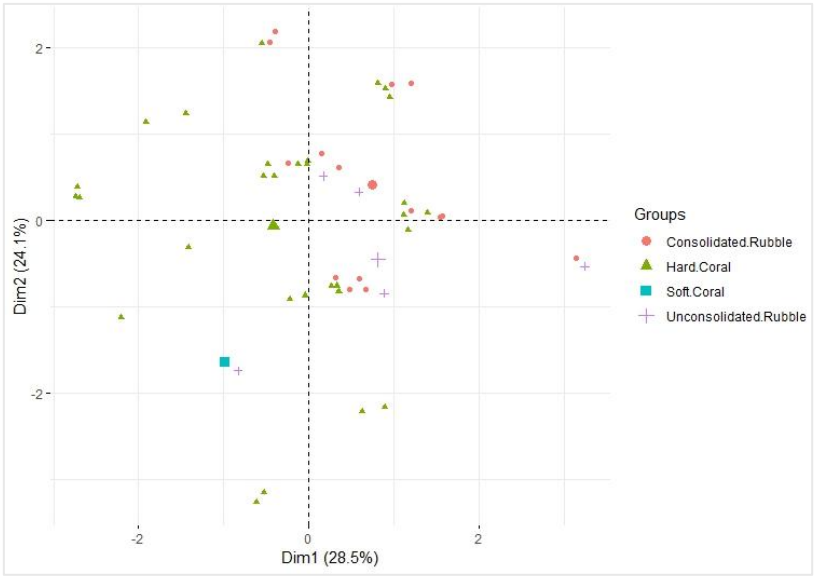


Figure 36: PCA plot of surveyed stations coloured by dominant benthic cover type.

4.3.4. Density Variation

The distribution of octopus and den densities varied across dominant benthic cover and substrate categories. Coral dominated habitats exhibited the highest den density (median: 2.5 per 1,000 m²), while octopus density remained low (median: 1). Pavement dominated habitats recorded the second-highest den density (median: 3), followed by rock and sand substrates, both with lower densities of dens (median: 2) and octopuses (Figure 37).

Among the dominant cover types, consolidated rubble showed the highest den density (median: 5), followed by hard coral (median: 3.5). However, octopus' densities in these habitats were relatively lower (median: 2) or absent (median: 0), suggesting high shelter availability. Soft coral dominated habitats supported very few dens (median: 2) and no observed octopuses (median: 0), while unconsolidated rubble also exhibited low densities for both (Figure 38).

Overall, habitats dominated by coral and pavement appeared to provide more den structures, but octopus occurrence remained consistently low or absent. However, the Kruskal-Wallis test revealed no significant differences in octopus and den densities across substrate types (octopus: $\chi^2 = 4.0789$, df = 3, p-value = 0.2531; dens: $\chi^2 = 3.2155$, df = 3, p-value = 0.3596). In contrast, octopus density differed significantly across cover types ($\chi^2 = 17.484$, df = 3, p-value = 0.0005619), however, den density did not differ significantly across cover types ($\chi^2 = 5.8237$, df = 3, p-value = 0.1205) suggesting that shelter availability did not vary significantly with changes in benthic cover.

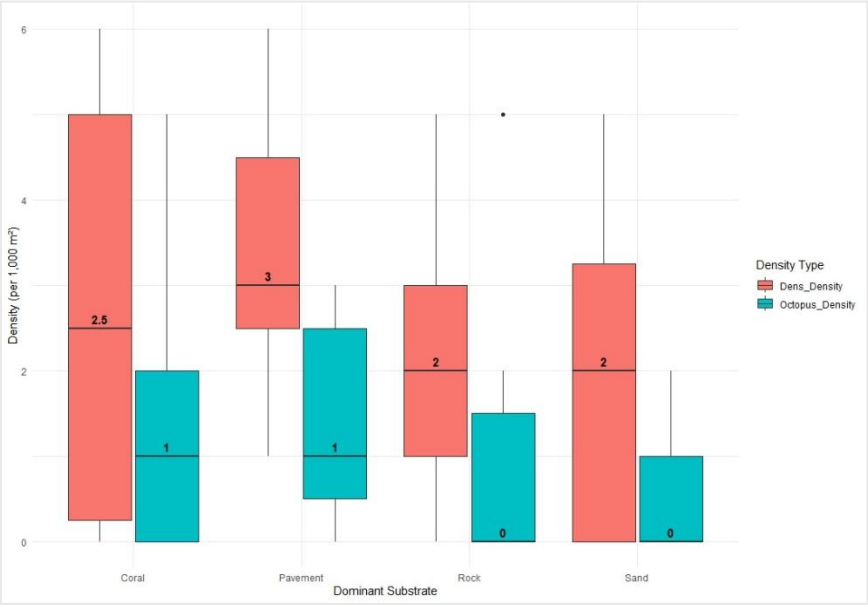


Figure 37: Boxplot illustrates the distribution of octopus and dens densities (per 1,000 m²) across dominant substrate types.

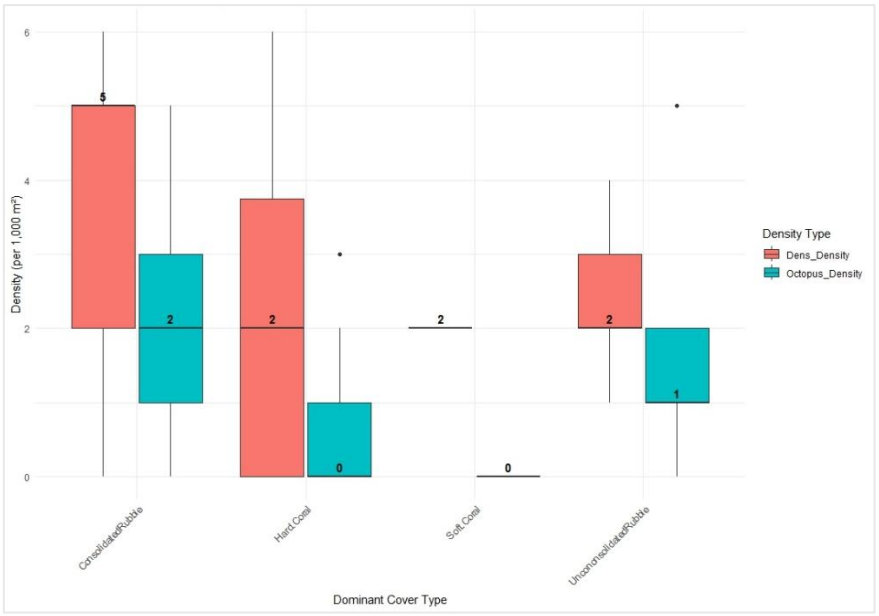


Figure 38: Boxplot illustrates the distribution of octopus and dens densities (per 1,000 m²) across dominant cover types.

4.3.5. Structural Complexity

Overall, high complexity was observed across sites, with median values ranging from 0.80 at Silhouette to 0.98 at North. The highest rugosity was observed at 0.80 at Silhouette and Félicité (0.81), suggesting a more complex habitat. A Kruskal-Wallis test further confirmed that rugosity differed significantly among sites ($\chi^2 = 47.774$, df = 8, $p < 0.001$) (Figure 39).

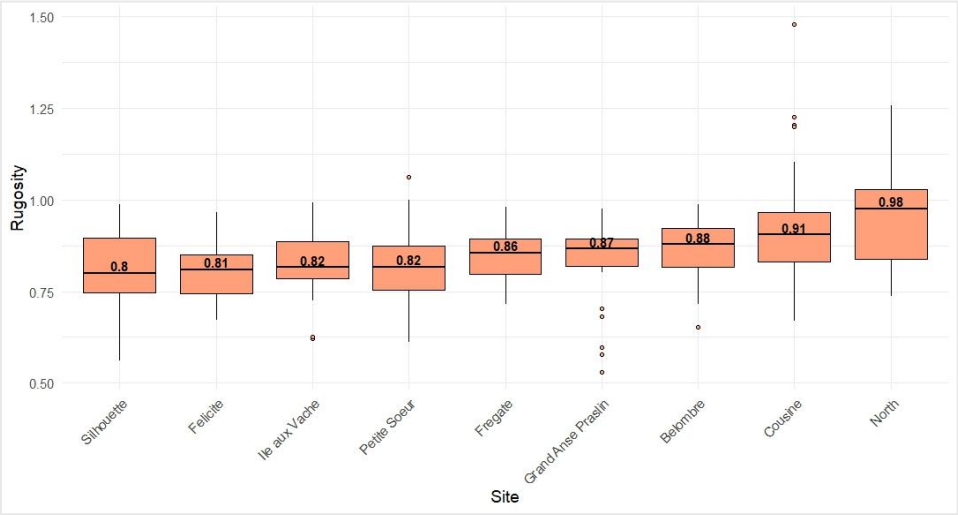


Figure 39: Boxplot showing the distribution of rugosity across survey sites.

The relationship between octopus density and rugosity across sites was examined. The regression line showed a positive trend, suggesting that octopus density may increase with lower habitat complexity. Notably, North and Cousine islands which had lower complexity showed higher octopus occurrence (Figure 40). However, Pearson's correlation test revealed a positive but non-significant correlation ($r = 0.33$, $t(7) = 0.92$, $p = 0.388$), indicating no strong linear association between rugosity and octopus density across sites.

In contrast, sites with higher complexity showed higher den densities, while sites with lower rugosity showed moderate densities (Figure 41). The relationship between mean rugosity and empty den density showed a weak negative trend. Pearson's correlation test indicated a weak negative and non-significant correlation ($r = –0.20$, $t(7) = –0.53$, $p = 0.611$). Overall, both relationships were weak and statistically non-significant, likely due to substantial variation among sites.

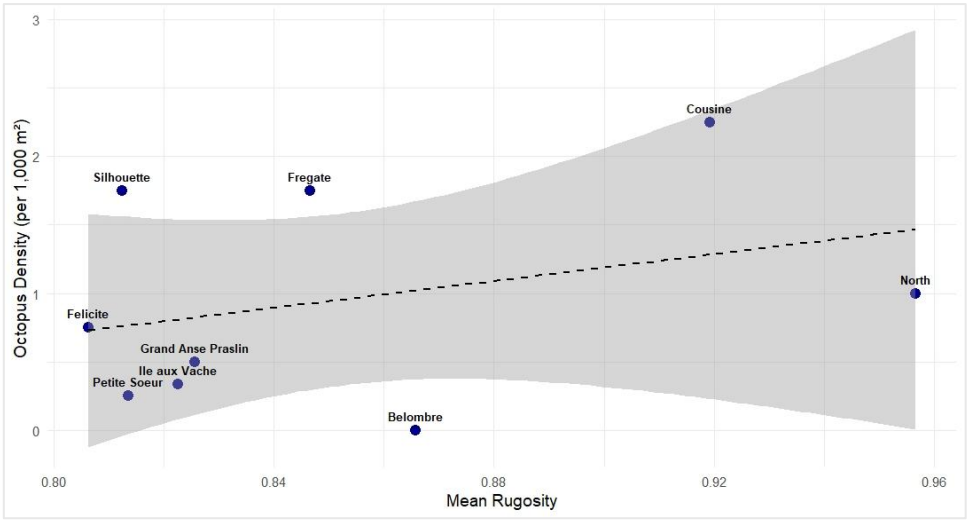


Figure 40: Relationship between mean rugosity and octopus density per site (per 1,000 m²). Each point represents a survey site, and the dashed line indicates the linear regression trend, illustrating the overall relationship between rugosity and octopus density.

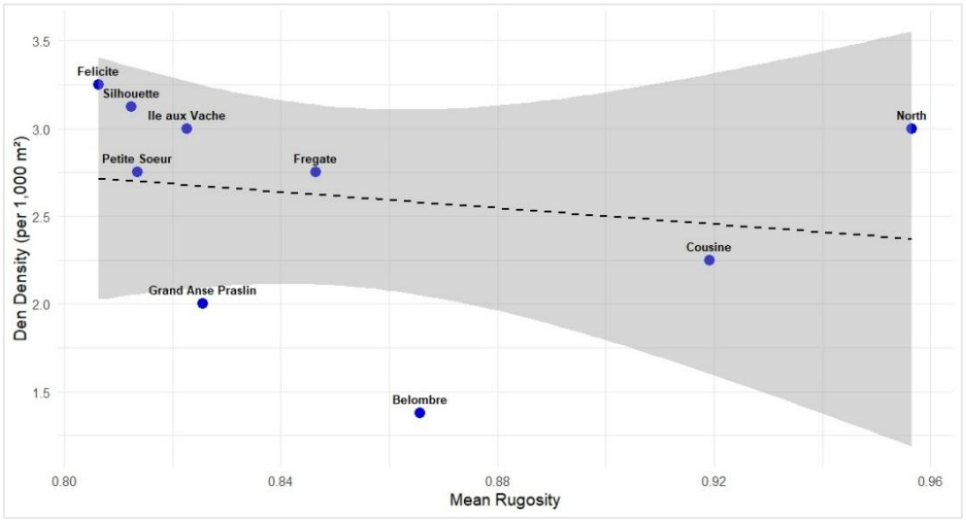


Figure 41: Relationship between mean rugosity and empty den density per site (per 1,000 m²). Each point represents a survey site, and the dashed line indicates the linear regression trend, illustrating the overall relationship between rugosity and empty den density.

4.4. Discussion

The study provides valuable insights into the habitat composition of octopuses and examines correlations between octopus densities and habitat types around the inner islands of Mahé. The habitats occupied were primarily composed of coral, pavement, rock, or sand, ranging from the intertidal zone to deeper reef areas. Understanding theses habitat characteristics are essential for assessing the ecological status of the fishery.

Overall, habitat composition was relatively consistent across sites, however, variations in dominant substrate and cover types resulted in either more homogeneous or heterogeneous benthic characteristics. These differences suggest that while some areas share similar structures, others exhibit distinct benthic variability. Although statistical analyses did not reveal significant differences in density distribution across substrate types, patterns in the data indicate that habitats dominated by coral and pavement tended to offer more potential den structures. Moreover, octopus' densities were notably higher in areas dominated by consolidated rubble, suggesting that both octopus and den densities are typically greater in structurally complex habitats.

These findings are supported by previous studies. For instance, Genave (2000) identified pavement as a preferred habitat for octopuses in Rodrigues, while Wicks (2005) reported that consolidated limestone rubble and pavement supported the highest octopus and den abundances. Access to suitable dens is crucial for octopuses as they provide shelter from predators. Benthic habitat characteristics are considered one of the main factors influencing octopus' distribution and density (Leite et al., 2009). Interestingly, Genave (2000) also recorded low octopus' occurrence in areas with abundant dens, suggesting that competition for shelter may limit occupancy. Other factors such as seasonality, reproduction, depth, and sea temperature also play significant roles in octopus distribution patterns (Katsanevakis & Verriopoulos, 2004).

This study highlights the spatial variation in both octopus and empty den densities across sites. The highest octopus' densities were recorded at Cousine, whereas Félicité and Silhouette exhibited the greatest densities of empty dens. These islands are relatively uninhabited, located farther from the more densely populated main islands, and are accessible only by boat. This relative isolation may contribute to reduced fishing pressure, potentially supporting higher octopus and den abundances.

Although no statistically significant differences in octopus or den densities were found across depth intervals, previous research has shown that depth can influence octopus size distribution (Leite et al., 2009) and migration patterns. Mature individuals are known to migrate to deeper waters for mating, spawning, and brooding (Oosthuizen & Smale, 2003). Nonetheless, these findings should be interpreted with caution due to the limited sample size and the influence of multiple interacting factors that may affect octopus' density and distribution.

4.4.1. Study Limitations

This study was limited to a maximum survey depth of 15 meters. As a result, the observed numbers of octopuses and empty dens may not accurately represent their true abundance, particularly in deeper habitats. Additionally, some survey sites may have been subject to varying levels of fishing pressure at the time of data collection, potentially influencing octopus' occurrence.

Interpretation of the results should be approached with caution due to the limited sample size and short survey duration. The timing and depth range of the surveys may have constrained the ability to capture the full distribution of octopuses, especially mature individuals known to migrate to deeper subtidal zones for spawning (Guard, 2009). This biological behaviour was not accounted for and may have affected the observed densities.

Moreover, data collection occurred exclusively during daylight hours (7 a.m. to 4 p.m.), which may have influenced detection rates, as cephalopods typically forage during early morning and dusk periods (Guard, 2009). Another methodological consideration is the potential for observer bias during underwater visual censuses. Although the surveys were conducted by experienced fishers, octopus counts may have been underestimated due to their camouflage abilities or occupancy of dens by other marine organisms.

The methods used to assess structural complexity and habitat characteristics also warrant improvement. Incorporating more advanced techniques, such as reef photogrammetry or 3D habitat mapping, could allow for more accurate and quantitative assessments of habitat complexity and benthic community structure. Such approaches would provide deeper insights into the environmental factors influencing octopus distribution.

Despite these limitations, the study offers valuable baseline information on octopus habitat characteristics and their potential relationship with octopus' distribution around Mahé.

4.5. Conclusion

This study represents the first assessment of octopus habitat characteristics around Mahé, emphasizing the need for further research to build upon these preliminary findings. Future investigations should aim to incorporate more robust methodologies for evaluating habitat complexity and structure.

In particular, further research is recommended to explore the relationship between benthic habitat types and octopus' distribution more comprehensively. This includes examining temporal changes in habitat structure, assessing their potential impacts on octopus' densities, and conducting comparative studies in areas experiencing varying levels of fishing pressure. Such efforts would enhance our understanding of the ecological requirements of octopuses and support the development of effective fishery strategies.

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6. Appendix A: Press Release on the Fishery Socioeconomic Survey

Socioeconomic Survey of the Octopus Fishery

The Seychelles Fishing Authority (SFA) is in the process of conducting a Socio-economic Survey with fishers involved in the Octopus fishery. The aim is to collect information about the social and economic impact of the Seychelles Octopus fishery.

The SFA is therefore seeking the support and cooperation of fishers to provide information related to the fishing operations, social and economic factors.

This exercise will be conducted by SFA employees carrying SFA Identification Cards. The survey will be implemented on Mahe, Praslin and La Digue during October – December 2023, during week days and outside working hours from 9:00am to 5:00pm from Mondays to Saturdays.

For further information, members of the public may contact the authority on following number: 4670300

XXXXXXX

Lotorite lapes Sesel (SFA) pe antreprann en Socio-economic Survey avek bann dimoun ki angaze dan lapes zourit. Bi sa Survey i pou SFA kolekte lenformasyon lo laspe sosyal, ekonomik e loperasyon aktivite lapes dan sa sekter.

SFA i alors pe demann sipor e korperasyon bann peser e endividi pou donn bann detay ki konkret an relasyon laspe sosyal, ekonomik e loperasyon aktivite lapes ki zot antreprann.

Sa legzersis pe ganny fer par bann zofisye SFA ki pou annan kart idantifikasyon SFA avek zot. Bann zofisye pe pas dan bann diferan distrik lo Mae, Praslin e Ladig, depi Lendi a Sanmdi pandan lasemenn, ant 8er bomaten a 5er apremidi, pandan mwan Oktob a Desanm 2023.

Pour plis lenformasyon, manm piblik I kapab kontakte SFA lo nimero: 4670300 or 2811280

7. Appendix B: Socioeconomic Survey Questionnaire

Project Title: *Determining baseline information for the effective management of the Seychelles' small-scale octopus' fishery.*

Consent form

We invite you to participate as a key informant of this research on the octopus' fishery in Seychelles carried out by the SFA. This research aims to determine baseline information for the effective management of the fishery. Your knowledge is very important and valuable for helping us to better understand the biological, ecological, social and economic particularities of this fishery. This interview last 45-60 min.
All the data collected during this survey will remain confidential and only be used for the purposes of this survey. The survey output will be anonymous. We truly appreciate your time and collaboration!

I agree* to take part in this survey and hereby declare that:
• I have received adequate and sufficient information by the researcher, about:
  o The objectives of the study, its scope and type of work to be carried out (survey).
  o That my participation is voluntary and altruistic.
• I have been able to ask the questions I have considered necessary about the study.
• I have received information about the procedure and the purpose for which my data will be used and the guarantees of confidentiality.
• That at any time I can revoke my consent (without having to explain the reason) and request the deletion of my personal data.
• I am 18 years or older and I am competent to provide consent.

I CONSENT TO PARTICIPATE IN THIS STUDY ( ) YES ( ) NO

I CONSENT TO THE USE OF PHOTOGRAPHIC MATERIAL USED TO PUBLISH AND SUPPORT THIS RESEARCH ( ) YES ( ) NO

For the record, I sign below:

Name_____Date_____Signature_____

Name and signature of interviewer: _____

*Participation in this survey is voluntary. Respondents are entitled at any moment to access and/or rectify their personal data, as well as to delete their data . The data will be stored for one year after the end of the project (September 2024). If you have questions or comments, please contact Rodney Govinden at SFA (rgovinden@sfa.sc).

Project Title: *Determining baseline information for the effective management of the Seychelles' small-scale octopus' fishery.*

Interviewer: _____ **# Interview:** _____
Date: _____ **Island/district:** _____
Start time: _____ **End time:** _____

Section 1: Socio-economic profile

Name: _____

1. Gender: ( ) Male ( ) Female ( ) Non binary ( ) DK/DA
2. Age: _____
3. Civil status: ( ) Single ( ) Married ( ) Divorced ( ) Widowed ( ) DK/DA
4. Where do you live? Island: _____ District: _____ Location: _____
5. Where were you born? Island: _____ District: _____ Location: _____
6. Did you move here for fishing related reasons? ( ) No ( ) Yes. Explain_____
7. Household: number of people dependants of your incomes (specify by gender, age group, and if any of them need special care (e.g., elderly care, physical/developmental/emotional care, etc.):

Age group	Man	Woman	Special care
Adult > 65 y/o			
Adult 18-65 y/o			
Adolescent 13-17 y/o			
Children 0-12 y/o			

8. Highest level of education attained:

( ) None ( ) Primary school ( ) Secondary School ( ) Professional Certificate
( ) BSc ( ) MSc ( ) PhD ( ) DK/DA

9. Do you have any other paid job? ( ) No ( ) Yes.

If yes, ( ) Self Employed ( ) Tourism ( ) Education ( ) Fisheries ( ) Governmental
Others _____

10. Relative incomes from this other job?
( ) <20% ( ) 20-40% ( ) 40-60% ( ) 60-80% ( ) >80%

11. Activities developed by the other household members

	Man	Woman	Octopus fisher	Artisanal fisher	Other occupation
Adult 1					
Adult 2					
Adult 3					
Adult 4					
Adult 5					

Section 3: Octopus Fishery Operation

12. What is your role in the octopus fishery?
( ) Fisher ( ) Recreational Fisher ( ) Trader ( ) Other:_____

13. How long have you been working in the commercial octopus fishery? _____

14. How long have you been working as a commercial fisher? _____
Notes:

15. Why did you become an octopus fisher?
( ) Family tradition ( ) Good job opportunity ( ) Passion ( ) No other job opportunities
( ) DK/DA Other:_____

16. Besides harpoon for octopus, do you fish with other fishing gears?
( ) Handline Species?_____Season?_____
( ) Traps Species?_____Season?_____
( ) Gillnets Species?_____Season?_____
( ) _____ Species?_____Season?_____
( ) _____ Species?_____Season?_____
Notes (how regular you use other fishing gears compare to harpoon/octopus, season, # days,…):

17. When going fishing for octopus, do you just catch octopus, or do you also fish other resources?
( ) Only octopus ( ) Other resources, which ones? _____

18. How do you access the octopus fishing grounds?
( ) On foot ( ) Motorised boat ( ) Surfboards/paddleboard ( ) Kayak
( ) Other method_____
Does the way of access change depending on the season? ( ) Yes ( ) No
Notes:

19. If by boat, who is the owner? ( ) myself ( ) other person:_____

20. How do fish for octopus?
( ) Free diving ( ) SCUBA diving ( ) Gleaning on foot ( ) Other method: _____

21. What diving equipment do you use?
( ) goggles ( ) fins ( ) wet suit ( ) tanks ( ) regulator ( ) jacket ( ) other_____

22. How deep do you regularly fish for octopus?
( ) <1 m ( ) 1-5 m ( ) 5-10 m ( ) 10-15 m
( ) 15-20 m ( ) 20-25 m ( ) >25 m ( ) Max depth: _____

23. Which fishing gears do you use for catching octopus?
( ) By hand (no fishing gear) ( ) Wooden stick ( ) Wooden stick with metal tip
( ) Metal rod + pointy head ( ) Metal rod + hook ( ) Spearguns
( ) Other: _____

24. On average, how many days do you fish octopus per week?
( ) 1-2 days ( ) 3-4 days ( ) 5-6 days

25. On average, how many hours do you spend per day to reach fishing grounds?
( ) <1hour ( ) 1-2 hours ( ) 3 - 4 hours ( ) >4 hours

26. What is your daily average fishing hours?
( ) <1hour ( ) 1-2 hours ( ) 3 – 4 hours ( ) >4 hours

27. What determines how often you go out fishing?
( ) Weather conditions ( ) Lunar phase ( ) Tidal conditions
Notes:

28. How often do you undertake octopus fishing? ( ) Weekly ( ) Seasonally ( ) Occasionally

29. When do you usually go fishing octopus? Intensity level: 1, ½ , 0

Jan	Feb	Mar	Apr	May	Jun	Jul	Agt	Sep	Oct	Nov	Dec

30. What are the reasons determining the good (1) and bad (0) seasons?
( ) Weather/Sea conditions ( ) Octopus migration ( ) Demand ( ) Others: _____
Notes:

31. What is your average catch per day during ….. good season (1) ?_____kg/day

bad season (0) ?_____kg/day

32. What is the average volume (Kg) of octopus captured by you per year?

Section 4: Economics: income and marketing

33. At which scale do you operate?
( ) Community level/Local scale ( ) National level ( ) International scale (export)

34. How much of your income is generated by the octopus' fishery?
( ) 0-20% ( ) 20-40% ( ) 40-60% ( ) 60-80% ( ) >80%( ) DK/DA

35. On average, what's your current monthly income as a fisher?
( ) <7,500 scr ( ) 7,500-15,000 scr ( ) 15,000-25,000 scr ( ) 25,000-35,000 scr
( ) 35,000-45,000 scr ( ) 45,000-55,000 ( ) >55,000 scr ( ) DK/DA

36. How has your income changed from the last 5 years (excluding covid)?
( ) Increased ( ) Stable ( ) Decreased ( ) DK/DA

37. Are you satisfied with the income you get from octopus' fishery?
( ) Very satisfied ( ) Satisfied ( ) Neutral ( ) Unsatisfied ( ) Very unsatisfied ( ) DK/DA

38. Do you land your catch on landing sites? ( ) Yes ( ) No
If no, then where?

39. Do you sell your catch directly after landing? ( ) Yes ( ) No
If no, then why?

40. How is the octopus sold?
( ) Fresh ( ) Chilled ( ) Frozen ( ) Dried ( ) Salted ( ) Brine

41. What percentage of your catch are dedicated/sold to.
( ) Individual people_____ ( ) Hotels/Restaurants_____
( ) fishmongers/retailers_____ ( ) Processors_____
( ) Own consumption ( ) Others_____

42. What price are you selling octopus? _____scr/kg to buyer/s_____

_____scr/kg to buyer/s_____

43. In the last 5 years, how has the price of octopus changed?
a) Increased ( ) Decreased ( ) DK/DA

44. Does the price vary with the size of the octopus? ( ) No ( ) Yes
How? _____

45. What is the average volume (Kg) of octopus commercialized by you per year? _____

Section 5: Governance and management

46. Are you a registered fisher with a fishing licence? ( ) No ( ) Yes

47. Are you a vessel owner? ( ) No ( ) Yes

48. Are you part of any fishers association? ( ) No ( ) Yes
If no, then why?

If yes, what's your role in the association? _____

49. What do you think should be done to increase fishers' participation in the associations?

50. What do you think the fishers' associations need to be stronger/empowered? (material capacity, staff capacity, premises, landing sites, ice plants, fees for services, …)

51. Does the government consult you during decision making for managing the artisanal fisheries?
( ) Never ( ) Rarely ( ) Sometimes ( ) Often ( ) Always

52. After decisions making, are you directly informed by the government?
( ) Never ( ) Rarely ( ) Sometimes ( ) Often ( ) Always

53. What is your level of satisfaction with the management of the octopus fishery?
( ) Very satisfied ( ) Satisfied ( ) Neutral ( ) Unsatisfied ( ) Very unsatisfied ( ) DK/DA

54. Have you ever participated in any attempt to manage the octopus fishery? ( ) Yes ( ) No
If yes, was there any measure implemented? If no measure implemented, why?

55. How often does the SFA fisheries enumerator record your octopus catch?
( ) Never ( ) Rarely ( ) Sometimes ( ) Often ( ) Always

56. How often do you think recreational fishers sell the octopus catch?
( ) Never ( ) Rarely ( ) Sometimes ( ) Often ( ) Always

57. To whom do you think recreational fishers sell their octopus catch?
( ) Individual people ( ) Hotels ( ) Restaurants
( ) Fishmongers/retailers ( ) Processing companies ( ) Others

58. Why this happens? (no surveillance & control to fishers, buyers, social issue/drugs, …)

59. Do you think the octopus's population may be declining? ( ) Yes ( ) No

60. Are management measures needed for the octopus fishery sustainability? ( ) Yes ( ) No
If yes, what measures would you be more supportive of?

Measures	Agree	Disagree	Comments
Size/Weight limit			Weight?
Seasonal closures			When? How long?
Fishing license			
Limited access (similar to lobster/sea cucumber)			
Exclusive access rights			
Fishers have surveillance/enforcement power in their areas in collaboration with SFA			
Reproductive closures			When?
Recruitment closures			When?
Spatial closures (No take zones)			Where?
Fishing gears limitations			Should any be banned? (e.g. scuba, pots,…)
Daily catch limits			How much?
Recreational fishery limitations			Which ones?

61. What are the 3 main problems/barriers faced within the octopus fishery? (limited to social, economic, marketing, or management. Biological/ecological/environmental issues will be asked in another survey)

62. What would be your proposed solutions to those main problems?

63. Any other comment you would like to make?

8. Appendix C: Catch Survey Data Sheet

Octopus Project: Catch Log

Date:..... **Fisher Name:**..... **Fishing site:** .....

Method: a) Free Dive b) SCUBA Dive c) On foot **Time in:**..... **out:**..... **Number of fishers:** .....

Fishing gear:..... **Total octopus caught (N) :**..... **Total weight (kg):**.....

N	Weight (Kg)	Depth (m)	Bottom Type	N	Weight (Kg)	Depth (m)	Bottom Type
1				11			
2				12			
3				13			
4				14			
5				15			
6				16			
7				17			
8				18			
9				19			
10				20			

*** Note: if <20 octopuses are captured, weight them all, if >20 octopuses are captured, just weight 20.**

9. Appendix D: Octopus Tissue Sample Data Sheet

Octopus Tissue Collection

Date	Sample Location	Fishing location	TW	ML	TL	H. Arm	Sample ID	Sampler	Recorder

10. Appendix E: Underwater Visual Census (UVC) Data Sheet

Survey Site				
Date				
Start Depth				
End Depth				
GPS Start Point				
GPS End Point				
Bottom Temperature				
Visibility				
Divers				
Transect side	**R**	**L**	**R**	**L**
Coral %				
Sand %				
Rock %				
Pavement %				
Live Corals %				
Dead Corals %				
Hard Corals %				
Soft Corals %				
Fungids %				
Sponge %				
Rubble unconsolidated %				
Consolidated rubble %				
Algae %				
Seagrass %				
N° Fauna				
Octopus				
Empty Dens				
Sea cucumbers				
Urchins				
Starfish				
Lobsters				
Eel				
Notes				

11. Appendix F: Rugosity Data Sheet

Rugosity Datasheet

Measurer: **Recorder:**

Date	Survey Site	Depth		GPS		Rugosity Chain Measurement					
		Start	End	Start Point	End Point	C1	C2	C3	C4	C5	C6

Comments: