Exploitation Status	Unknown	
Spanner Crab Sampling Programme Report 2023-2024		
Scientific Name	**Common Name**	**Local Name**
Ranina ranina	Spanner crab	Krab ziraf

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Abstract

The spanner crab fishery in Seychelles dates to the late 1980s and is primarily centred around the Mahé Plateau. However, despite its longevity, the lack of consistent monitoring over the past three decades has left the spanner crab stock status largely unknown. This report concludes the third year of the monitoring programme and presents the results of the fisheries-dependent data collected during the 2023/2024 sampling period. Statistical analysis was conducted to compare the CPUE, size and weight distribution of spanner crabs between 2022/2023 and 2023/2024 sampling periods. Results indicated that CPUE and catch were highest in November and lowest in February, suggesting potential seasonal variations in crab abundance or coinciding with periods of increased fishing activity. Individuals caught during the fishing season 2022/2023 were significantly larger and heavier compared to 2022/2023 (9.8 cm and 0.343 kg). In 2023/2024, undersized spanner crabs represented a small portion of the catch, with 30 individuals (24 females and 6 males) measuring below the 8 cm legal minimum. Males sampled in 2023/2024 were statistically larger and heavier in April and November. The observed sex ratio was 2.9:1, with males three times as abundant than females. Since December 2023, the fishery officially launched a licensing framework; however, enforcement of the licensing conditions remains weak, limiting compliance and the effective management and monitoring of the fishery. This report emphasises the importance of ongoing monitoring efforts, including the continued collection of biological data, to establish a comprehensive understanding of the spanner crab fishery dynamics in Seychelles. However, caution should be taken when interpreting the CPUE and catch data.

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1. Introduction

Ranina ranina (Linnaeus, 1758), commonly known as, 'spanner crab' (Australia), 'krab ziraf' (Seychelles), 'curacha' (Philippines) or 'kona crab' (Hawaii), is a species of large marine crustacean characterised by its frog-like appearance, reddish-orange colour, and elongated carapace. This brachyuran crab can be found widely distributed throughout the tropical and subtropical Indo-Pacific regions in depths of 10 meters (m) to over 100 m (Matondo & Demayo, 2015). Within the Raninidae family, the spanner crab is the only species with great commercial value and is actively exploited in Thailand, Japan, Hawaii and Australia (Brown et al., 2001; Matondo & Demayo, 2015).

In Seychelles, the spanner crab fishery dates back to the late 1980's and is restricted to the Mahé Plateau (Boullé, 1995). Generally, fishers use schooner fishing vessels to exploit known offshore regions where spanner crabs congregate. On average, a fishing trip lasts about 10 days, and multiple fishing sites may be visited depending on catch rates. The main fishing gear used is the baited circular tangle net known as 'kale'. The tangle nets are secured individually to a mainline along with a surface buoy and held on the seafloor by an anchor system (Boullé, 1995). The fishing gear is usually deployed in 1 to 3 sets, with each mainline consisting of 90 to 100 traps. Each set can soak for 20 minutes to 1 hour. Fishing activities take place during the day (Boullé, 1995). Harvesting of spanner crab is open year-round; however, fishing activities mostly occurs from October to April during the northwest monsoon, when fishing conditions are proven to be more favourable (Boullé, 1995).

The fishery has operated for more than three decades without systematic monitoring, resulting in limited information on fishing effort, catch size structure, and leaving the stock status largely unknown. Until recently, total catch estimates relied solely on data collected through the Catch Assessment Survey (CAS); however, concerns regarding

the reliability of these records suggest that reported catches may not fully reflect actual removals.

Historically, regulatory oversight of the spanner crab fishery was limited to provisions under the Fisheries Act of 1986, later amended by the Fisheries Act of 2014, which prohibited the harvesting of berried crustaceans. Aside from this provision, no additional regulations or formal management framework were in place until the introduction of a licensing system in December 2023.

Current management of the spanner crab fishery is led by the Seychelles Fisheries Authority (SFA) and was initiated in response to increasing interest in the fishery. Rising catch and effort levels observed between 2018 and 2021 prompted the adoption of a precautionary approach to improve monitoring and ensure sustainable exploitation. The newly introduced licensing framework incorporates both input and output controls. Input controls include a limit of 10 fishing licences per year and restrictions on the number of traps permitted (up to 350), while output controls include the establishment of a minimum legal size and the continued prohibition on harvesting berried females.

In addition, the Fisheries Research Department introduced a fishery-dependent sampling programme in 2021 to address longstanding data gaps. This programme aims to collect essential biological and fisheries information to improve understanding of the stock and to support the long-term sustainable management of this valuable resource.

The main purpose of this report is to summarise the catch history and present the findings of the fishery-dependent sampling conducted from November 2023 to October 2024. It compares key stock indicators, specifically the size and weight structure of spanner crabs and the harvest rate across all previous fishing periods (2023/2024, 2022/2023, and 2021/2022).

2. Methodology

2.1. Data Collection

2.1.1. Catch Data

The total catch data presented here was obtained from the Catch Assessment Survey (CAS) undertaken by the SFA Fisheries Statistics Department. The primary objective of the CAS is to collect catch, effort, and species composition data to enable timely monitoring and assessment of status and trends in the major artisanal fisheries including the spanner crab fishery. As the catch and effort logbook was still under development and not yet fully operational, information recorded in the logbooks was not considered reflective of actual landings. Instead, total spanner crab landings were recorded by fisheries statistical technicians and subsequently compiled and reported in the official statistical reports. Due to recent system updates and the subsequent re-analysis of historical data by the Statistical Department, revisions have been made to the recorded figures. As a result, the historical landings of spanner crab from 2018 to 2024 may differ from those reported previously.

2.1.2 Biological Sampling

Sampling was carried out between **November 2023 and October 2024** by the Fisheries Research team. Previous reports covered sampling activities from November to April; however, the current report includes data from November through October of the following year. This adjustment reflects the implementation of the spanner crab fishing license, which is now valid for a full year (November to October). In contrast, to the previous report spanner crab sampling period was shaped by fishing activity, typically spanning seven months, from October to April.

Regular inspections were conducted at the Victoria and Providence artisanal fishing ports to monitor spanner crab landings. A total of four vessels and ten fishing trips

were sampled during this period. The sampling strategy aimed to randomly capture around 5% of the total landed ensuring a representative dataset for the spanner crab fishery ensuring a representative dataset for the spanner crab fishery.

Depending on the tonnage landed, spanner crabs were randomly taken from the vessel's hold and placed into containers for sampling (Gabriel & Ebrahim, 2021). Morphological characteristics such as body weight (grams (g)), sex, carapace length (millimetre (mm)), and reproductive markers (berried state, sperm plaque, setae hair etc..) were measured and recorded. Sexes were identified by abdomen shape, whereas male spanner crab have a narrow-shaped abdomen (**Figure 1** A-B), female crab's abdomen is broader and rounded (**Figure 1** C-D). The carapace length (cm) was measured to the nearest 0.05 cm from the tip of the rostrum to the posterior carapace margin using a vernier calliper. The body weight (g) was weighted on a top-loading digital balance to the nearest 0.01 g. A detailed description of the method can be obtained in the Fishery and Biological Data Collection: Standard Operating Procedures and Guidelines (Gabriel & Ebrahim, 2021).

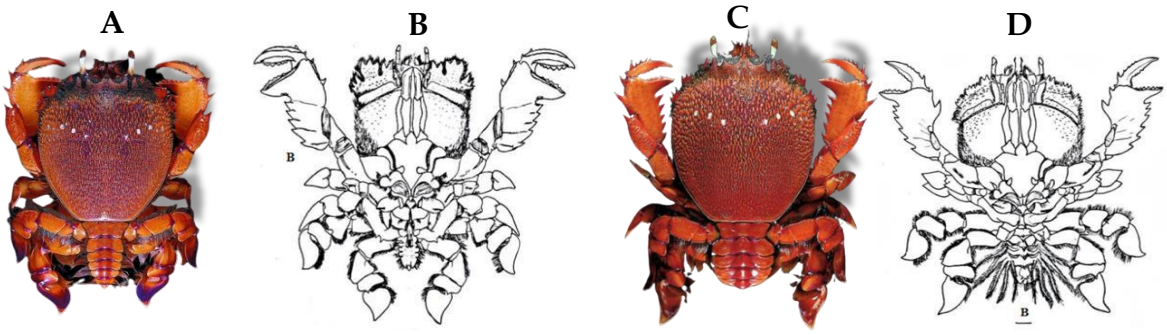

Figure 1: Spanner crab (R. ranina) male and female. A-B) The dorsal and ventral view of a male spanner crab. C-D) The dorsal and ventral view of a female spanner crab.

2.1.3. Fishery Information

During biological sampling, additional information concerning fishing activity was recorded to understand the catch and effort dynamics. This included vessel name, trip duration, number of nets, number of net lifts, total catch, and fishing location. The

vessel name allowed for the identification of a specific vessel involved in the fishing activity, while the trip duration, along with the number of nets used and number of net lifts, provided insights into the intensity and effort of the fishing activity. The total catch helped to estimate the amount of spanner crab harvested into the fishery and the fishing location offered important information on the spatial distribution of fishing activities and distribution of spanner crab on the Mahé Plateau.

2.2. Data Analysis

The R software (version 4.2.2) and Microsoft Office Excel software (Window 10) were used for statistical analysis and production of graphs. A significance level of α=0.05 was used throughout the analysis.

2.2.1. Catch And Catch Per Unit Effort (CPUE)

CPUE was calculated using data collected directly from fishermen. Although a logbook system exists, persistent challenges such as delayed or missing submissions, repeated errors, and incomplete entries have limited its reliability. As a result, logbook data are currently excluded from the annual spanner crab reports. To estimate total monthly catch and fishing effort, the catch (total catch per trip) and fishing effort (trip duration) for each vessel were summed for each month. Monthly CPUE was then calculated by dividing the total catch by the total fishing effort [(1)]. Additionally, the sampling period for 2022/2023 was adjusted to reflect changes arising from the implementation of the licensing framework. While the previous spanner crab report (SFA,2024) covered sampling activities from October to April, the current report extends the 2022/2023 sampling period to span November 2022 to October 2023 to ensure comparability across fishing seasons.

$$1)\ CPUE_{month} = \frac{\sum Catch\ (kg)_{month}}{\sum Fishing\ Effort\ (trip\ durationin\ days)_{month}}$$

Similarly, the catch and effort for each season were summed to determine the total catch and fishing effort (trip duration in days) for each sampling season. The CPUE was then calculated by dividing the total catch by the total fishing effort [(2)].

$$2)\ CPUE_{season} = \frac{\sum Catch\ (kg)_{season}}{\sum Fishing\ Effort\ (trip\ durationin\ days)_{season}}$$

2.2.2. *Size Frequency Distribution*

The spanner crab length frequency distribution was constructed using carapace length measurements. Separated histograms were plotted for both females and males sampled. The class groups were classified based on the carapace length, which ranged from 6 to 14 cm (bin size by 1 cm), including the frequency per each size range. A box plot was also plotted to visually compare sexes by species across different months and sampling seasons. The proportion of crabs in relation to the minimum size limit of 8 cm CL was also examined.

The carapace length data was transformed using the natural logarithm (ln) to meet the assumptions for a normal distribution. Size differences between males and females sampled during each month were investigated using the Wilcoxon test (Mann-Whitney U test). Sex-specific size differences across months were compared for each sex using the Kruskal Wallis or ANOVA statistical test. Following a statistically significant difference, a Dunn Test or a Tukey HSD post hoc was performed for multi-comparison. While sex-specific size was used across months per season, Welch's t-test, T-test, or Wilcoxon test was used based on the data distribution and variance homogeneity.

2.2.3. *Weight Distribution*

The weight distribution of spanner crab was determined from the individual's body weight after measurements. Individual body weights between females and males were compared. A box plot was also plotted to visually compare sexes by species

across different months and sampling seasons. Sex-specific weight differences across seasons were compared for each sex using the Wilcoxon test, while across months Wilcoxon test or Kruskal Wallis was used.

2.2.4. Sex-Ratio

The sex ratio provides fundamental information on population dynamics, specifically the reproductive potential of a given species. Data collected from both sexes were used to determine the trend in the sex ratio, which is given as (M: F) [(2)].

$$2)\ \text{Sex Ratio} = Count\frac{Male}{Female}$$

3. Results

3.1. Fishery Landing Overview

The spanner crab landings from 2000 to 2023 fluctuate over the years (**Figure 2)**. There was a significant reduction in landings, decreasing from 71.2 metric tons (MT) in 2021 to 17.4 MT in 2022, reflecting 89% decrease. The 2024 catch data logged 46.5 MT, 64. 9% lower than the overall average of 28.2 MT.

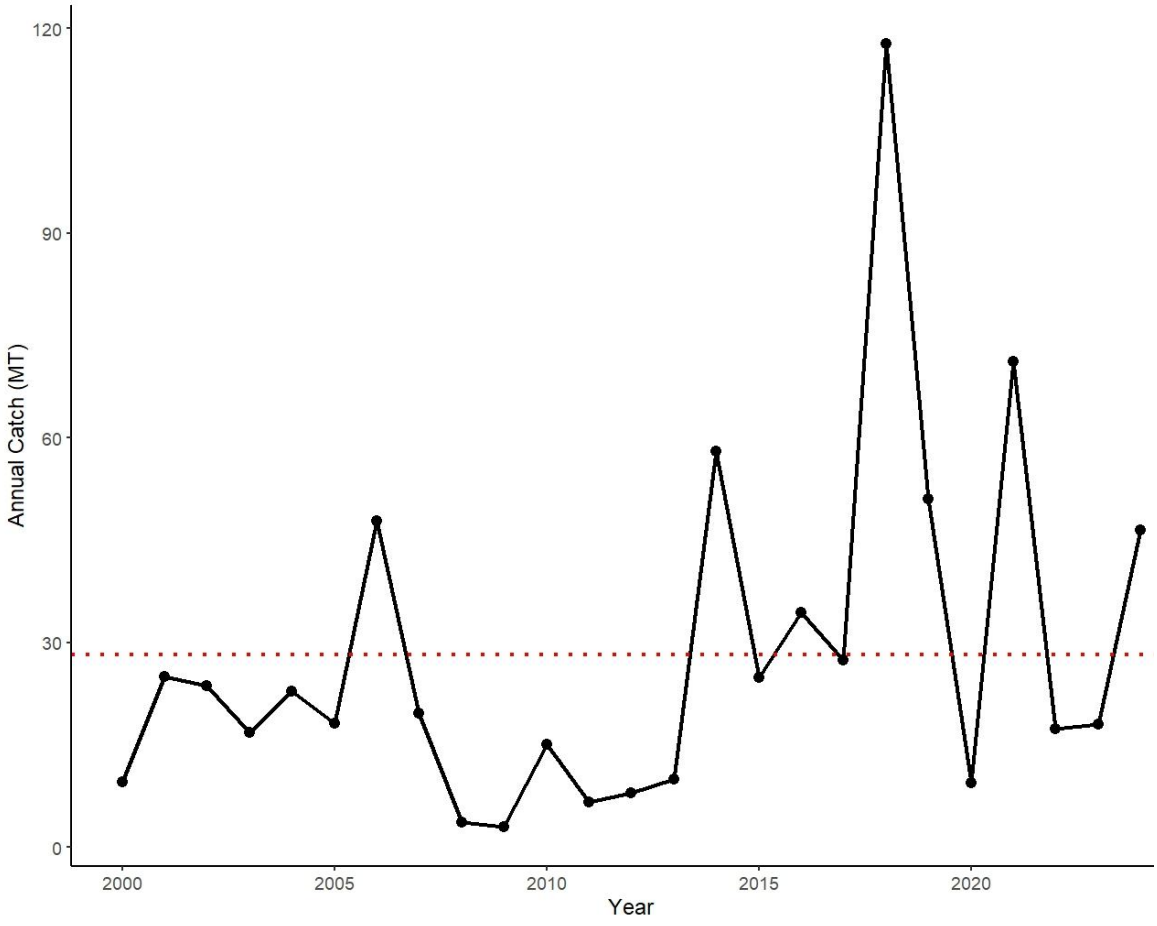

Figure 2: Spanner crab annual reported landing catch in Metric Tonnes (MT) from 2000 to 2023. The dashed red line indicates the average seasonal catch of 28.2 MT. **Note:** data from 1988 to 1998 were excluded from the graph.

3.2. Fishing locations: 2021/2022 vs 2022/2023 vs 2023/2024

The spatial distribution of fishing effort between the 3 consecutive fishing seasons was analysed (**Figure 3**). The grey grids indicate areas fished in the 2021/2022 season, orange grids represent areas fished in the 2022/2023 season, and green grids represent areas fished in the 2023/2024 season. During the 2023/2024 season grid I6, J4, J5, J6, K4 and K5 were newly targeted. This spatial shift might be attributed to the search for new spanner crab stocks. The fishing grids Q7, R7, Q8, R8 and Southeast Mahé (reported without grid number) were visited in all three seasons. These zones likely represent high-yield areas where spanner crabs remain viable, and catch is stable, maintaining their importance for the fishery across all three seasons.

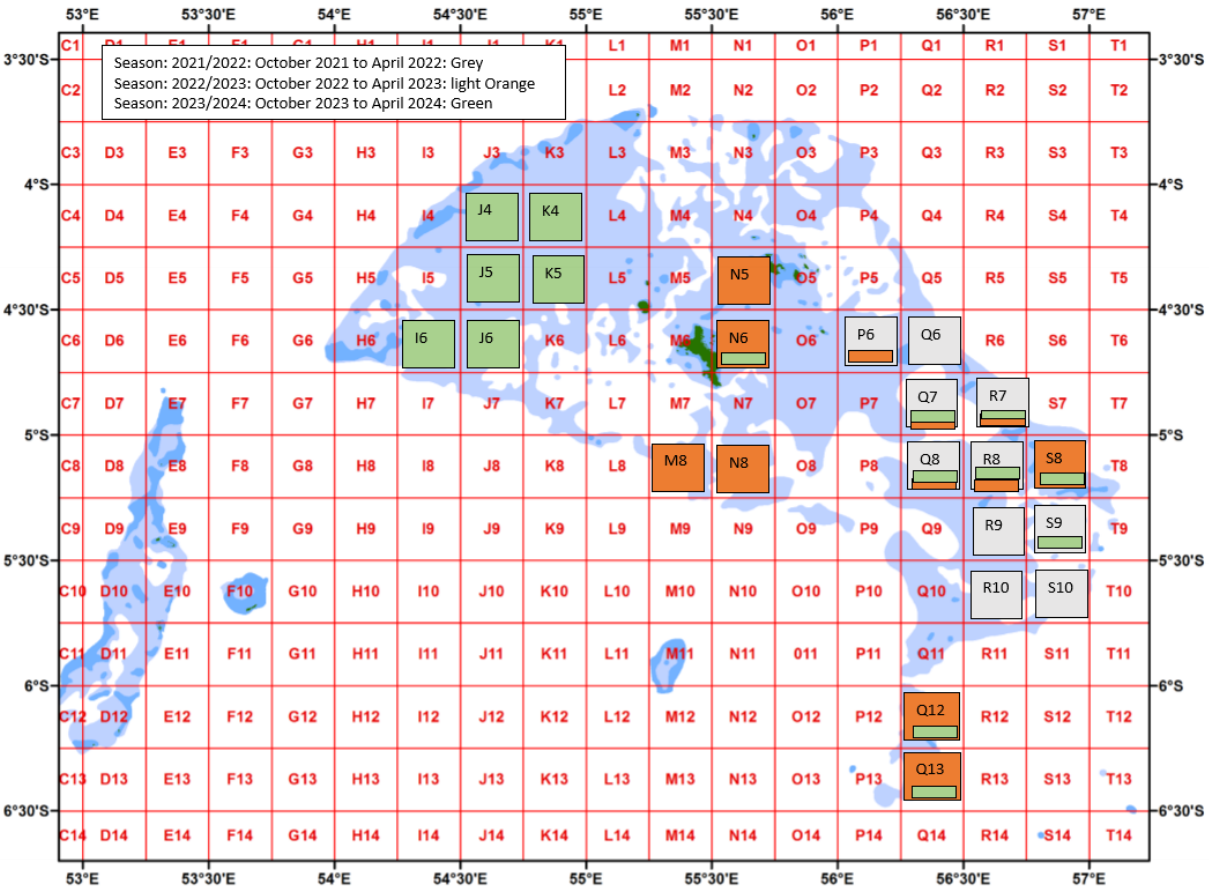

Figure 3: Fishing location recorded during the spanner crab sampling from 2021/2022, 2022/2023 and 2023/2024. The fishing seasons were color-coded as follows: grey for 2021/2022, orange for 2022/2023, and green for 2023/2024. **N.B:** A few fishing locations were not included, as the location name was provided instead of the fishing grid.

3.3. Landing and CPUE Trend

The total landed catch per year is shown in **Figure 4**. In the 2023/2024 fishing season, the estimated total catch reported was 19,200 kg (missing 2024), compared to 36,600 kg in 2022/2023, representing an increase of 48%. From the 19,200 kg, 10,253 kg of spanner crab was sampled. The highest catch of 4,000 kg was recorded in November 2022, while the lowest catch of 300 kg was observed in November 2021.

3.4. CPUE by sampling seasons

The CPUE (kg/trip duration) estimates per sampling season are shown in **Figure 5**. The CPUE represents data collected from the vessels or trips captured under the sampling programme. CPUE in 2021/2022 was a value of 153 kg per duration and CPUE in 2022/2023 was a value of 266 kg per duration representing an increase of 74%. Whereas, in 2023/2024, a CPUE of 147 kg per duration was recorded, representing a decrease of 45 % from 2022/2023.

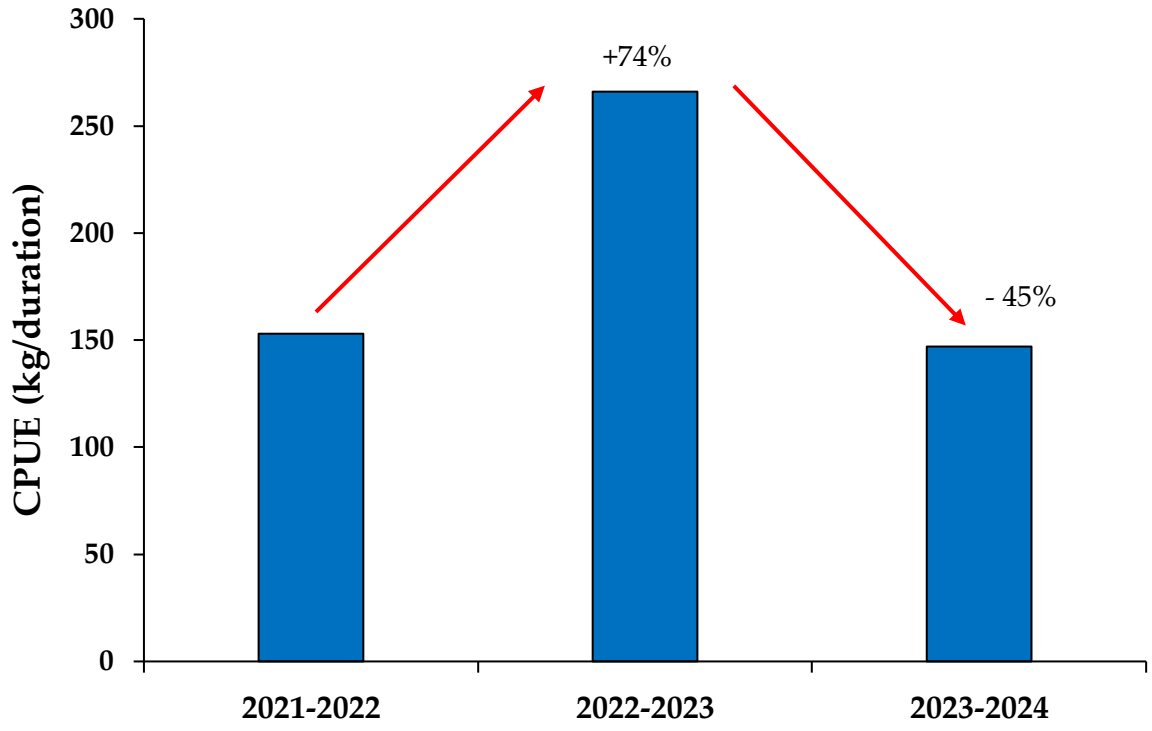

Figure 4*:* CPUE comparison between seasons 2021/2022, 2022/2023 and 2023/2024. The red arrow shows CPUE change between fishing seasons.

3.5. Sampling Effort

Fourteen (14) fishing trips were sampled from October 2021 to April 2022 during 2021/2022 season (**Table 1**), and eleven (11) fishing trips were sampled from November 2022 to October 2023 during 2022/2023 season (**Table 2**), in contrast to eight (10) fishing trips sampled from November 2023 to October 2024 during the 2023/2024 season (**Table 3**). All sampling activities were concentrated at the artisanal fishing port in Victoria, and therefore, the sampling efforts were concentrated on Mahé Island only. A total of 1193 individuals were sampled during 2023/2024 season, comprising of 439 females and 754 males, with a combined weight of 355 kg. In contrast, in 2022/2023 a total of 1314 individuals were sampled, indicating a decrease of 10% (121 individuals). As compared to 2021/ 2022, 1692 individuals were sampled, indicating a decrease of 30% of individuals sampled in 2023/2024 (499 individuals). Males were almost twice more abundant in the samples than females, with a ratio of 1.72:1. In 2023/2024 season, one sampling session in Nov 23 encountered difficulty with weighing scale, therefore weight was extrapolated from length-weight relationship coefficient from K. Gabriel et al., (2024).

Table 1: Number of trips and individuals sampled by sexes from October 2021 to April 2022.

Month	Trip sampled	Female	Male	Total sampled
October_2021	2	61	189	250
November_2021	4	77	341	418
December_2021	4	148	350	498
March_2022	3	107	319	426
April_2022	1	61	39	99
Total	**14**	**454**	**1238**	**1692**

Table 2: Number of trips and individuals sampled by sexes from November 2022 to October 2023.

Month	Trip sampled	Female	Male	Total sampled
November_2022	5	170	429	599
December_2022	3	108	292	400
February_2023	1	25	75	100
April_2023	1	6	109	117
October_2023	1	76	24	100
Total	**11**	**385**	**929**	**1314**

Table 2: Number of trips and individuals sampled by sexes from November 2023 to October 2024.

Month	Trip sampled	Female	Male	Total sampled
November_2023	3	77	253	330
December_2023	2	87	189	276
January_2024	2	172	128	300
March_2024	1	1	99	100
October_2024	2	102	85	187
Total	**10**	**439**	**754**	**1193**

3.6. Size Frequency Distribution

In 2021/2022, female carapace length (CL) ranged from 6 to 11.5 cm, with a mode of 8.7 cm and a median of 8.4 cm (**Figure 5**). In the 2022/2023 sampling period, female CL ranged from 7.1 cm to 10.9 cm, a mode of 9.1 cm and a median of 8.8 cm (**Figure 6**). In the 2023/2024 sampling period, female CL ranged from 7.0 cm to 11.6 cm, a mode of 8.8 cm and a median of 9.0 cm (**Figure 5**). The female CL average size was 8.5 cm in 2021/2022, 8.9 cm in 2022/2023 and 9.0 cm in 2023/2024. Female CL was statistically significantly larger ($p < .05$) in 2023/2024 than in 2022/2023 [(1)], with the most significant difference in size being between 2023/2024 and 20212022[1] (**Figure 5**). The proportion of females below the minimum size limit of 8 cm was 8.6% (145 individuals) in 2021/2022, 1.2% (16 individuals) in 2022/2023, and 2.0% (24 individuals) in 2023/2024.

In contrast, males in 2021/2022 carapace length ranged from 6.9 to 13.3 cm, a mode of 9.7 cm and a median of 9.5 cm (**Figure 5**). In 2022/2023 males' CL ranged from 7.5 to 13.9 cm, with a mode of 11 cm, median of 10.2 cm. In 2023/2024, males' CL ranged from 7.7 to 14.3 cm, with a mode of 10.4 cm, median of 10.2 cm (**Figure 6**). The male CL average size was 10.2 cm in 2023/2024, 10.1 cm in 2022/2023 and 9.5 cm 2021/2022. Male CL was statistically significantly larger ($p < .05$) 2023/2024 than in 2022/2023, with

[1] Kruskal-Wallis: $\chi 2\ (2) = 77.532$, $p < 2.2e\text{-}16$

the most significant difference being between 2023/2024 and 20212022[2] (**Figure 6**). The proportion of males below the minimum size limit of 8 cm was 0.5% (6 individuals) in 2023/2024 and 0.8% (10 individuals) in 2022/2023, compared to 5.2% (88 individuals) in 2021/2022.

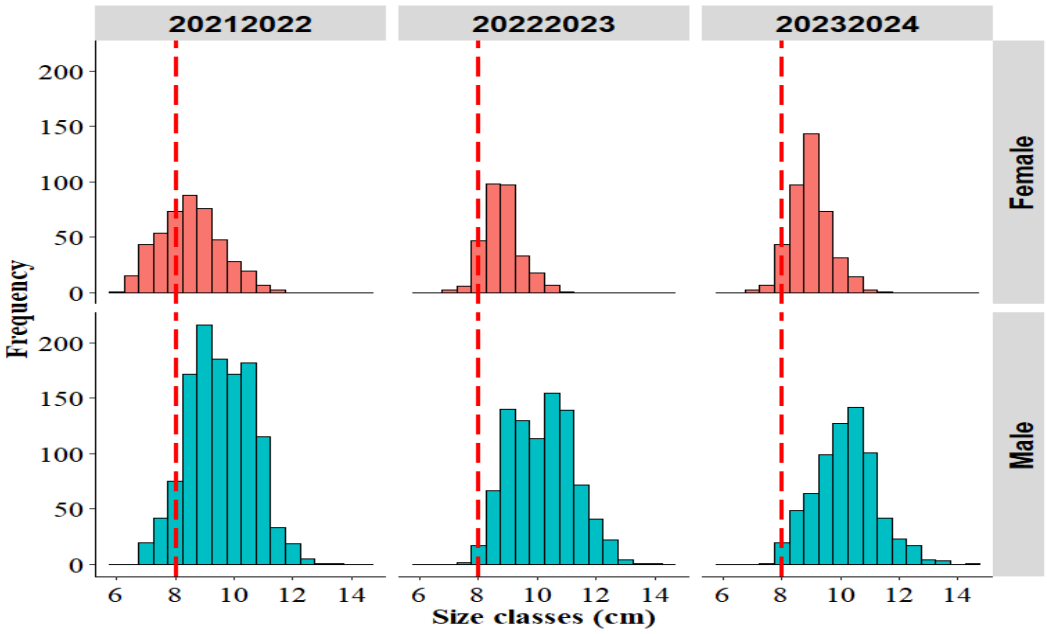

Figure 5: Carapace length size frequency distribution of all crabs sampled in 2021/20222, 2022/2023 and 2023/2024. The Red dashed line represents the minimum size limit of 8 cm.

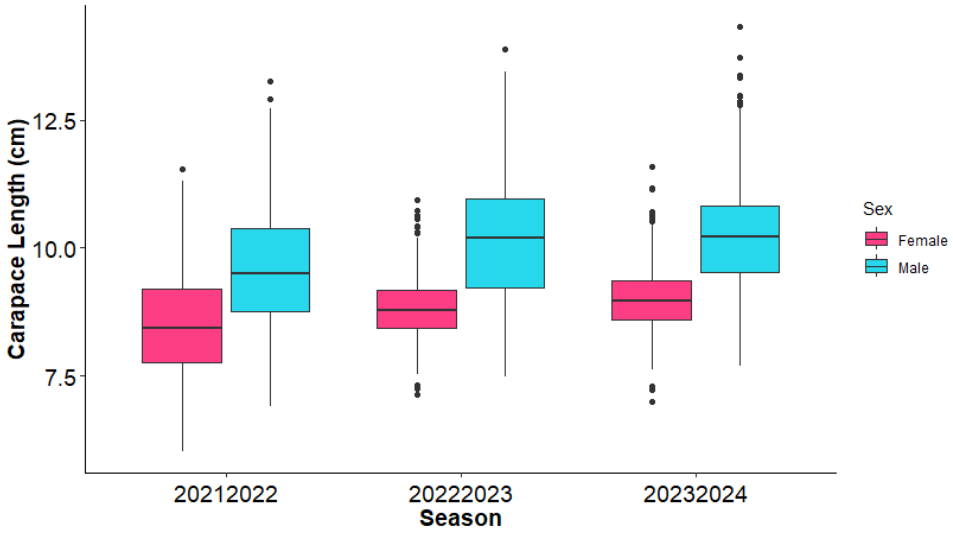

Figure 6: Boxplot of the size distribution of females and males for all sampling periods

[2] Kruskal-Wallis: $\chi 2$ (2) = 207.71, $p < 2.2e\text{-}16$

3.7. Monthly Size Distribution

3.7.1. Monthly Carapace Length Comparison: 2023/2024

Male carapace length (cm) was statistically significantly ($p < .05$) different across the months [3] (**Figure 7**). On average, the carapace length of males sampled in March 2024 was larger (10.4 ± 0.47) compared to other months (**Table 2, Appendix 2**). In comparison, female carapace length (cm) was statistically significant ($p < .05$) different across the months[4]. On average, the carapace length of females sampled in November 2023 (10.2 ± 1.28) was larger compared to other months (**Figure 7**).

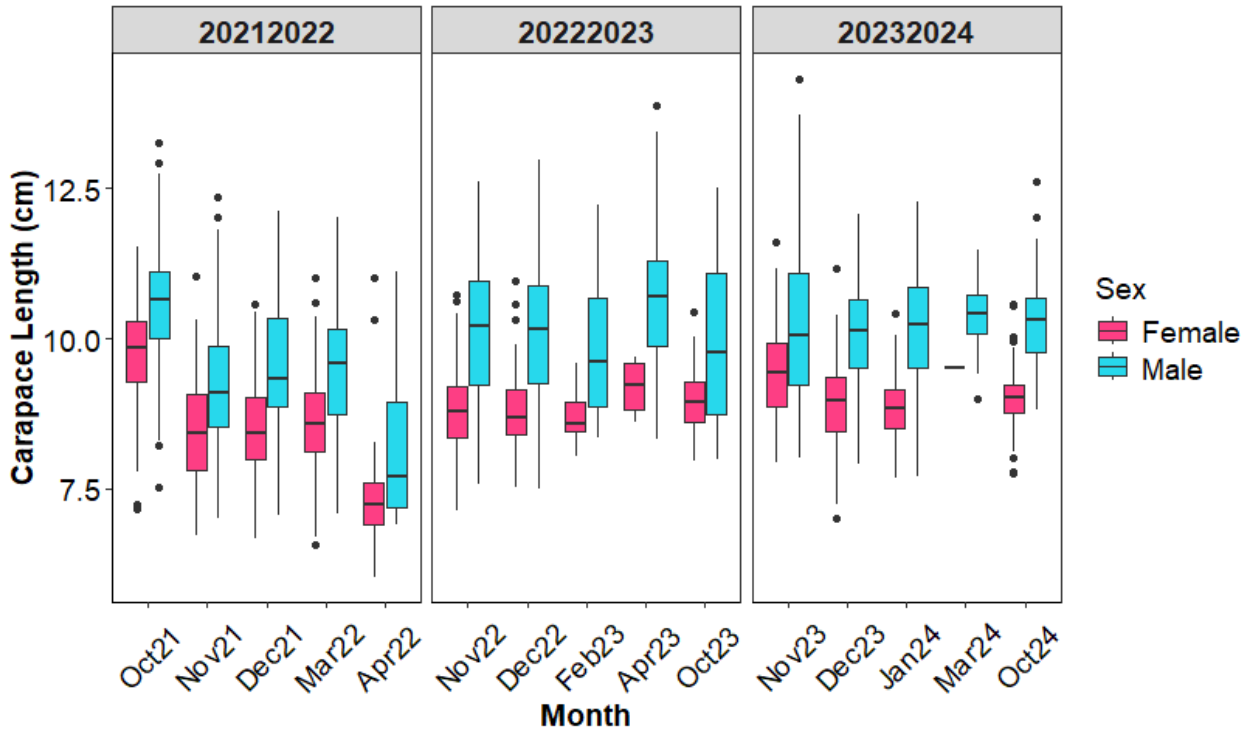

Figure 7: Carapace length distribution by month and sex, showing the variability and median values across different months for both male and female spanner crabs between the all-sampling seasons.

[3] Kruskal-Wallis: $\chi2_{(4)} = 10.139$, $p = 0.03815$
[4] ANOVA: $F_{(3,434)} = 16.21$, $p < 5.29e\text{-}10$

3.7.2. Monthly Carapace Length Comparison: 2021/2022 vs 2022/2023 vs 2023/2024

Spanner crab sizes between the 2021/2022, 2022/2023 and 2023/2024 sampling period showed statistically significant differences for both females and males. On average, female and male carapace lengths were larger in October[5&6] 2021/2022, November[7&8] 2023/2024, and December[9&10] 2023/2024 and 2021/2022 compared to the same months in 2022/2023 and 2023/2024 (**Figure 7**, **Table 4).**

Table 3. Monthly Carapace Length Comparison: 2021/2022 vs 2022/2023 vs 2023/2024

Month	Female Mean (cm) ± SD			Male Mean (cm) ± SD		
	2021/2022	**2022/2023**	**2023/2024**	**2021/2022**	**2022/2023**	**2023/2024**
October	9.69 ± 0.92	8.97 ± 0.49	9.04 ± 0.53	10.3 ± 0.91	9.90 ± 1.37	10.3 ± 0.75
November	8.45 ± 0.89	8.85 ± 0.66	9.43 ± 0.81	9.19 ± 1.01	10.14 ± 1.05	10.2 ± 1.28
December	8.47 ± 0.80	8.77 ± 0.61	8.91 ± 0.74	9.20 ± 0.94	10.07 ± 1.08	10.0 ± 0.92

Note: The months January (2023/2024), February (2022/2023), and March–April for the relevant seasons (2021/2022 and 2023/2024) were excluded from the analysis due to missing sampling data, which prevented meaningful comparisons.

3.8. Weight Frequency Distribution

The body weight for all spanner crab sampled during the 2023/2024 period ranged from 0.120 to 0.928 kg, with a mean of 0.298 kg. When analysed by sex, in 2023/2024, female body weight ranged from 0.120 kg to 0.520 kg, mode of 0.240 kg and a mean of 0.241 kg (**Figure 8**). For 2022/2023, female body weight ranged from 0.120 to 0.570 kg, mode of 0.210 kg and a mean of 0.240 kg (**Figure 8**). For 2021/2022, female body weight ranged from 0.100 to 0.590 kg, mode of 0.170 kg and a mean of 0.236 kg (**Figure 8)** Female body weight was statistically significantly larger ($p < .05$) in 2023/2024 than in 2021/2022[11], with a positive trend throughout all three seasons (**Figure 8**).

In contrast, for 2021/2022, male body weight ranged from 0.110 to 0.915 kg, mode of 0.220, and a median of 0.325 kg. In 2022/2023, male weight ranged from 0.145 to 0.975 kg, mode of 0.260 kg, and a median of 0.375 kg (**Figure 8**). In 2023/2024, male weight

[5] Kruskal-Wallis: $\chi2_{(47.417)} = 2$, p-value = 5.053e-11 (Female)
[6] Kruskal-Wallis: $\chi2_{(13.535)} = 2$, p-value = 0.00115 (Male)
[7] Welch's Anova: $F_{(27.156)} = 143.26$, p < 1.001e-10 (Female)
[8] Kruskal-Wallis: $\chi2_{(151.83)} = 2$, p-value < 2.2e-16 (Male)
[9] Welch's Anova: $F_{(10.518)} = 208.47$, p < 4.449e-05 (Female)
[10] Kruskal-Wallis: $\chi2_{(54.176)}$ 2, p-value = 1.721e-12 (Male)
[11] Kruskal-Wallis: $\chi2$ (24.487) = 2, p-value = 4.816e-06 (Female)

ranged from 0.140 to 0.928 kg, mode of 0.380 kg, and a median of 0.360 kg (**Figure 7**). The average male body weight was 0.325 kg ± 0.119 in 2021/2022 and 0.387 kg ± 0.136 in 2022/2023 and 0.375 ± 0.123 in 2023/2024. Male body weight was statistically significantly larger ($p < .05$) in 2022/2023 followed by 2023/2024 than in 2021/2022[12] (**Figure 8**).

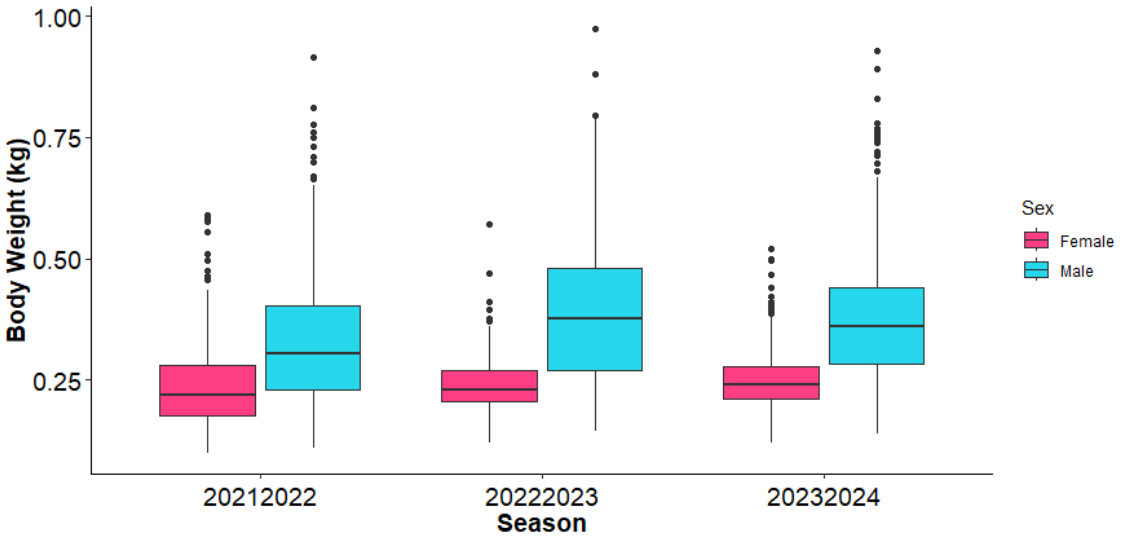

Figure 8: Size frequency distribution (body weight) of Females and Males for 2021/2022, 2022/2023, 2023/2024 sampling period. Showing the variability and median values across the season for both male and female spanner crabs.

3.9. Monthly Weight Frequency Distribution

3.9.1. Monthly Body Weight Comparison: 2023/2024

On average, the body weight of males sampled in March 2024 (mean ± SD = 0.398 ± 0.06) and October 2024 (0.391 ± 0.10) were heavier compared to other months[13] (**Table 5, Appendix 1**). In contrast, the average female body weight (kg) was significantly heavier in November 2023 (0.291 ± 0.08) and October 2024 (0.252 ± 0.053) (compared

[12] Kruskal-Wallis: $\chi 2$ (140.64) = 2, p-value < 2.2e-16 (Male)
[13] Kruskal-Wallis: $\chi 2_{(4)} = 19.697$, $p = 0.0005731$

to other months[14], following a negative trend, with January 2024 (0.233 ± 0.04) having the lowest average. March 2024 was omitted from the analysis due to having only one female recorded (**Figure 9, Table 4**).

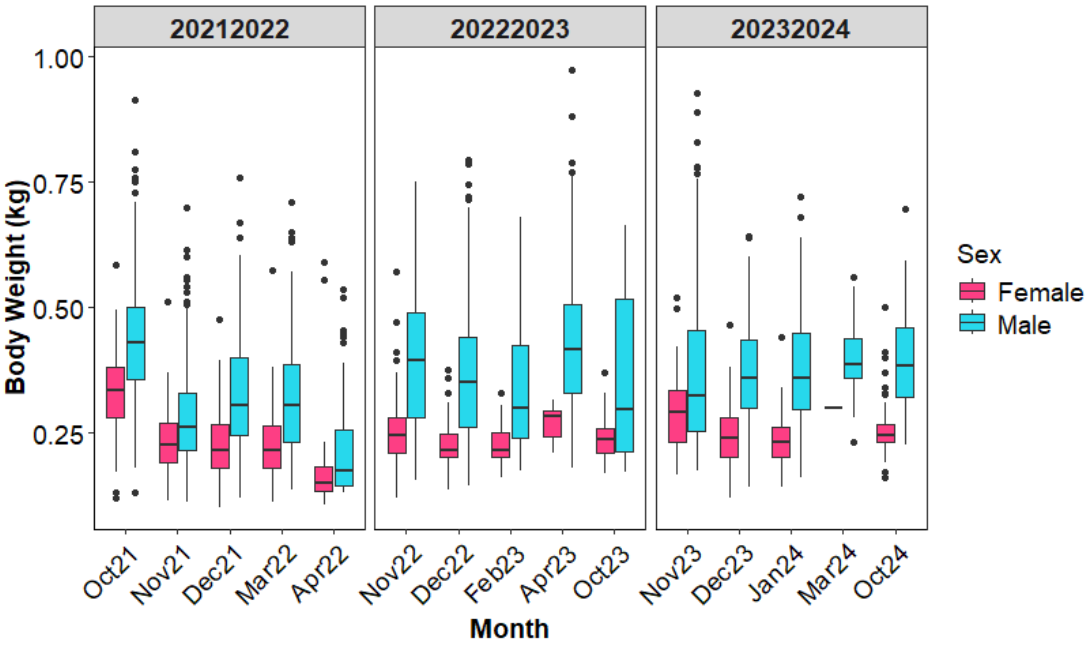

Figure 9: Body weight distribution by month and sex, showing the variability and median values across different months for both male and female spanner crabs.

3.9.2. Monthly Body Weight Comparison: 2021/2022 vs 2022/2023 vs 2023/2024

Spanner crab body weight between the 2021/2022, 2022/2023 and 2023/2024 sampling period showed statistically significant differences between females and males. On average, female and male body weight were heavier in October[15&16] 2021/2022. Female and male body weight were also heaviest in November[17&18], December[19&20] of 2023/2024 and 2022/2023 respectively (**Figure 9**, **Table 5**).

[14] Kruskal-Wallis: $\chi 2_{(3)} = 40.199$, = 9.667e-09
[15] Kruskal-Wallis: $\chi 2\ (5) = 21.187$, p = 2.84e-14 (Female)
[16] Kruskal-Wallis: $\chi 2\ (2) = 14.742$, p = 0.0006292 (male)
[17] Welch's Anova: F (14.048) = 148.53, p = 2.584e-06 (Female)
[18] Kruskal-Wallis: $\chi 2\ (2) = 151.38$, p < 2.2e-16 (male)
[19] Welch's Anova: F (1.9885) = 206.99, p = 0.1395 (Female)
[20] Kruskal-Wallis: $\chi 2\ (2) = 21.18$, p = 2.517e-05 (male)

Table 4: Monthly mean body weight and standard deviation.

Month	Female Mean (cm) ± SD			Male Mean (cm) ± SD		
	2021/2022	2022/2023	2023/2024	2021/2022	2022/2023	2023/2024
October	0.330 ± 0.08	0.240 ± 0.04	0.252 ± 0.05	0.436 ± 0.13	0.352 ± 0.16	0.391 ± 0.10
November	0.233 ± 0.07	0.251 ± 0.06	0.249 ± 0.08	0.284 ± 0.10	0.398 ± 0.13	0.242 ± 0.16
December	0.228 ± 0.06	0.225 ± 0.04	0.241 ± 0.06	0.327 ± 0.12	0.368 ± 0.13	0.362 ± 0.11

Note: Months January (2023/2024), February (2022/2023), March, and April (2021/2022), (2023/2024) were removed from the analysis due to the absence of corresponding sampling periods, preventing a valid comparison.

4. Discussion

The spanner crab fishery, while established in Seychelles since the late 1980s, remains under-studied, with its stock status largely unknown due to inconsistent monitoring efforts. The 2023/2024 sampling program provides valuable insights into the current state of the fishery, highlighting several trends that may have significant implications for future management and sustainability. The trends in the estimated total catch vary from fishing year to fishing year. However, in 2021 there has been a noticeable increase in the amount of catch landed by commercial fishers. This increase could be influenced by several factors such as fishing intensity, active fishing vessels, market demands, search methods, seasonal variation in environmental factors, or recruitment (Laevastu and Marasco 1982).

4.1. Landing and CPUE Trends

The total landing catch (kg) and catch per unit effort (CPUE; kg/duration) trends show an increase of 11% and 74%, respectively, between the 2022/2023 and 2023/2024 seasons, which might indicate more crab availability and improved fishing efficiency or effort in 2023/2024. Moreover, variation in CPUE per month for 2023/2024 was highest in November, while February had the lowest CPUE value. Such variations in

CPUE can be influenced by multiple factors, from crab availability and fishing efficiency and market demand to the number of vessels sampled. The fluctuations in catch rates across months underscore the influence of market demand, with festive seasons possibly being a key driver for fishing activity and catch variability throughout the sampling season. However, caution is necessary when interpreting the catch and CPUE data presented here, as these values are collected exclusively from the vessels captured under the sampling program. Since some fishers may over- or underestimate their effort, intentionally or unintentionally, this could distort the relationship between catch and effort. As a result, the data from the sampling program may not fully reflect overall fishing activity or accurately capture CPUE across the fishery. Without precise data on the fishing catch and effort (total catch, trip numbers, soaking time etc.), it is challenging to interpret these CPUE values accurately. Since CPUE is commonly used as a proxy for stock abundance and if effort data is missing, inconsistent or unreliable, it could lead to incorrect assumptions about stock health. Effective enforcement of the logbook system would help reduce uncertainty and ensure the availability of reliable, accurate data on fishing activities.

4.2. Size and Weight Distribution

The comparison of size and weight showed significant differences, with males consistently larger and heavier than their counterparts. This observation was made for all sampling periods. This trend could be related to differences in the mechanical and physical physiology of both sexes, with males attaining a higher growth potential while females invest in reproductive effort (Kennelly, 1992; Chen & Kennelly, 1999; Hartnoll, 2006).

Environmental conditions, fishing pressure, and behaviour, among other things, may drive the sampling period and monthly variation in size and weight between both sexes. Crustaceans typically flourish in environments with abundant food resources,

underlining the importance of dietary factors in their development (Maszczyk & Brzeziński, 2018). Interestingly, during 2023/2024, males' mean size and weight were significantly larger overall and per month than in the previous season. This could be attributed to fishers targeting areas on the Mahé Plateau that have larger spanner crab compared to the original fishing area, suggesting that the fishing area may influence the size and weight of the catch if the area has not been frequently targeted for more than 30 years. Additionally, this trend might indicate that fishing efforts have not adversely impacted the male population in some areas to a significant extent, as larger males continue to be caught.

Although females were larger in the 2023/2024 sampling period, the average size and weight across months remained consistent, indicating less variability than males. Furthermore, could be females are less targeted by the fishery, particularly if it is in a berried state (egg carrying). As such, this may allow the female to have a stable rate without the same level of fishing-induced pressure that could cause significant changes in their growth patterns. Furthermore, although the proportion of spanner crab below the fishery minimum size limit of 8 cm is relatively low, it raises concerns for the sustainability of the fishery.

4.3. Sex Ratio and Implications for Reproductive Capacity

Males were almost twice as abundant in the 2023/2024 samples compared to females (1.72:1), as compared to observed in the 2022/2023 season (2.91:1) (Gabriel et al., 2023). This raises concerns for the fishery, as selectively fishing one sex over the other can have significant implications for population dynamics. Although research on spanner crab species in Seychelles is limited, the literature suggests that a skewed sex ratio can increase a population's vulnerability to overfishing and reduce its reproductive capacity (Sato, 2012). With fewer males available for reproduction, there is a risk of reducing the population's ability to replenish itself, leading to an overall decline (Sato

& Yoseda, 2010). From a fisheries management perspective, a higher male-to-female ratio in the short term can appear beneficial to leaving more females in the population, mainly because of the requirement for releasing berried females. However, this strategy could pose long-term sustainability risks if it impacts the reproductive dynamics. Monitoring the sex ratios for any persisting sign of stress and using adaptive management measures, such as seasonal or spatial closure, amongst other management measures, can also be considered. However, implementing management measures is challenging without properly studying reproductive biology and other life history parameters. Understanding the reproductive dynamics, such as fecundity level, spawning period, and reproductive success, including other reproductive parameters, can shape management measures for this specific fishery. Hence, more research is required.

4.5. Sampling limitation

Several limitations were encountered during spanner crab sampling programme, which may have impacted the comprehensiveness of the data collection process. One notable limitation was the constraint imposed by limited staffing and resources for the sampling activities. With restricted manpower and equipment, there were challenges in covering all landing sites and conducting sampling across all fishing operations. Additionally, the absence of a predetermined landing plan further increased the sampling limitations, as there was no clear indication or coordination regarding the timing and location of crab landings. These limitations underscore the importance of adequate staffing, resources, and logistical planning in ensuring the success of the sampling program. Furthermore, since the logbook system is still under trial and not fully operational, the fishing effort data collected are
estimates and may not be entirely accurate. Additionally, total landings per vessel are not fully recorded, preventing proper standardization. Addressing these limitations is essential to improve the reliability and accuracy of data, thereby enhancing the effectiveness of monitoring and management of the spanner crab fishery.

5. Conclusion

In conclusion, the spanner crabs sampling programme has yielded valuable insights into the population dynamics, notably highlighting an encouraging increase in size, indicative of a potential shift in the demographic structure. There are still some uncertainties regarding this fishery, but the results indicate encouraging trends within the spanner crab population. Fluctuations in catch rates highlight the dynamic nature of spanner crab fisheries and underscore the influence of market demand as a key driver of fishing activity and catch variability throughout the fishing season. Moreover, the skewed sex ratio towards males raises concerns regarding the potential implications for reproduction and overall population health. Furthermore, the lack of a regulatory framework (aside from restrictions on catching berried females) or harvest strategy underscores the need for a more robust management plan. It is imperative to delve deeper into understanding the underlying factors driving these changes and to develop proactive management strategies by conducting scientific research. By embracing a holistic approach that integrates scientific knowledge, stakeholder collaboration, and adaptive management, we can strive towards securing a prosperous future for spanner crabs and their associated marine environment.

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Appendix 1

Table 5: Post hoc pairwise comparisons of male log carapace length (cm) by month for 2023/2024 sampling period **using Dunn Test**. P values were adjusted using the Bonferroni method.

№	Comparison Groups	Carapace Length (cm)	
		Adjusted P value	**Significance level**
1	Dec23 - Jan24	1.00000000	ns
2	Dec23 - Mar24	0.01063617	P <.05
3	Jan24 - Mar24	0.21488603	ns
4	Dec23 - Nov23	1.00000000	ns
5	Jan24 - Nov23	1.00000000	ns
6	Mar24 - Nov23	0.05834100	ns
7	Dec23 - Oct24	0.84543022	ns
8	Jan24 - Oct24	1.00000000	ns
9	Mar24 - Oct24	0.86471450	ns
10	Nov23 - Oct24	1.00000000	ns

Significance level at 0.05. ns; nonsignificant difference.

Table 5: Post hoc pairwise comparisons of male log body weight (kg) by month for 2023/2024 sampling period using **Dunn Test.** P values were adjusted using the Bonferroni method.

№	Comparison Groups	Body Weight (kg)	
		Adjusted P value	**Significance level**
1	Dec23 - Jan24	1.0000000000	ns
2	Dec23 - Mar24	0.0118219049	P <.05
3	Jan24 - Mar24	0.0482412716	P <.05
4	Dec23 - Nov23	1.0000000000	ns
5	Jan24 - Nov23	1.0000000000	ns
6	Mar24 - Nov23	0.0003162128	P <.05
7	Dec23 - Oct24	0.3236378851	ns
8	Jan24 - Oct24	0.6627061222	ns
9	Mar24 - Oct24	1.0000000000	ns
10	Nov23 - Oct24	0.0348420094	P <.05

Significance level at 0.05. ns; nonsignificant difference.