<table>
<tr><td>Exploitation Status</td><td colspan="2">Unknown</td></tr>
<tr><td colspan="3">Spanner Crab Sampling Programme
Report 2022-2023</td></tr>
<tr><td>Scientific Name</td><td>Common Name</td><td>Local Name</td></tr>
<tr><td>Ranina ranina</td><td>Spanner crab</td><td>Krab ziraf</td></tr>
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Acknowledgements

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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 second year of the monitoring programme, presenting results of the fisheries-dependent data collected during the 2022/2023 sampling period. Statistical analysis was conducted to compare the CPUE, size and weight distribution of spanner crab between 2021/2022 and 2022/2023 sampling period. Results indicated that the CPUE and catch were the highest in November and the lowest in February, showing potential seasonal variations in crab abundance or fishing activity. However, caution should be taken when interpreting the CPUE and catch data. Males sampled in 2022/2023 were statistically significantly larger and heavier in April and November. While no significant differences in size were observed, females in November were statistically significantly heavier. Males and females were statistically significantly larger and heavier in 2022/2023 compared to 2021/2022. A significant proportion of spanner crabs were below the proposed fishery minimum size of 8 cm, which poses concerns for the fishery's sustainability. The observed sex ratio was 2.9:1, with males being three times more abundant than females. A skewed sex ratio raises concerns regarding the potential implications for reproduction and overall population health. The fishery lacks a regulatory framework harvest strategy, underscoring the need for a more robust management plan. Such a plan could include monitoring, logbook systems, licensing framework and enforcement mechanisms to ensure compliance and effective management 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.

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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 can last for 10 days, and multiple fishing sites can be visited depending on the catch rate. 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 into 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). The fishery has no specific season set; however, fishing activities mostly occurs from October to April during the northwest monsoon, when fishing conditions are proven to be more favourable (Boullé, 1995). Apart from the Fisheries Act (2014), which restricts the catch of berried crustaceans, this fishery has no other regulations or a management plan in place.

The fishery relies solely on the Catch Assessment Survey (CAS) to record total catch data. However, there are questions about the accuracy and completeness of the current catch record, which may not fully represent the actual catch. With no monitoring for over 30 years, there is a lack of information on the levels of fishing effort and size structure of the catch, leaving the stock status unknown. To address this issue, the Fisheries Research Department has implemented a fishery-dependent sampling programme to gather biological and basic fisheries information from the fishery. This programme aims to improve our understanding of the fishery and ensure the long-term sustainability of this valuable resource.

This report's main objective is to present the results of the sampling programme from November 2022 to April 2023. It compares the stock indicators, namely, size and weight structure of spanner crabs and the harvest rate between the 2022/2023 and 2021/2022 fishing period. Additionally, a brief overview of the catch history is also presented.

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 a catch and effort logbook is still in development phase, the total landed catch, and the species for the spanner crab are collected by statistical technicians. These are then reported in the fisheries statistical report.

2.1.2 Biological Sampling

Sampling was conducted between November 2022 and April 2023 by the Fisheries Research team. Regular inspections were carried out at the Victoria and Providence artisanal fishing ports to monitor the landings of spanner crabs. A total of 4 vessels and approximately 10 fishing trips were randomly sampled during this period. The sampling size was determined to capture 5% of the total catch landed, ensuring sufficient data to obtain a representative sample of the Spanner crab catch.

Depending on the tonnage, spanner crabs were randomly taken from the vessel fish hold and placed into a container 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 crabs have a narrow-shaped abdomen (**Figure 1** A-B), female crab's abdomen is broader and rounded (**Figure 1** C-D). The carapace length (mm) was measured to the nearest 0.05 mm 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).

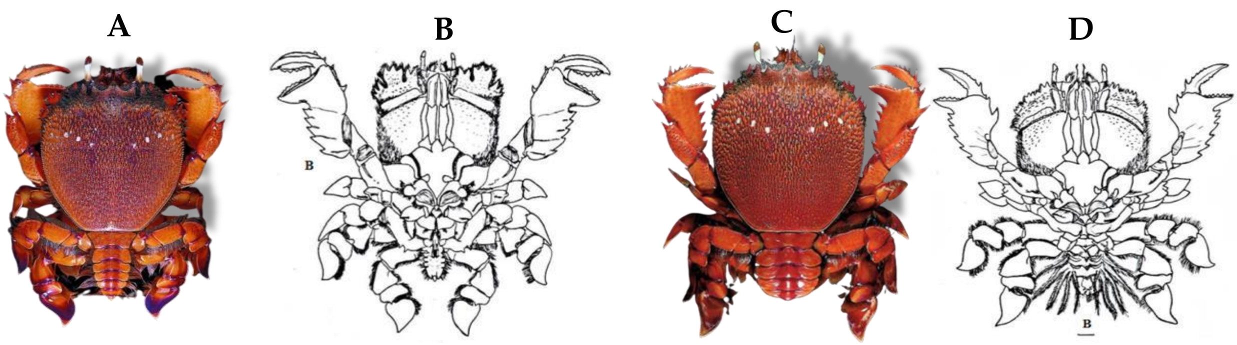

Figure 1: Spanner crab (R. ranina) male and female. A-B) The dorsal and ventral view of a male Spanner crab. C-D) The dorsal and ventral view of a female Spanner crab.

2.1.3. Fishery Information

During the biological sampling, additional information related to the fishing activity was recorded on the sampling form 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 Cab harvested into the fishery and the fishing location offered important information on the spatial distribution of fishing activities and spanner crab distribution 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)

The CPUE was calculated based on the data collected from fishermen. Unfortunately, there are no logbooks available to verify the accuracy of the information provided by the fishermen. To calculate the total catch and fishing effort per month, the sum of catch (total catch) and fishing effort (trip duration) for each vessel was determined. The CPUE for each month was then determined by dividing the total catch by the total fishing effort [(1)].

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

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 proposed 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)].

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

3. Results

3.1. Fishery Landing Overview

The spanner crab landings from 1988 to 2021 fluctuate over the years (**Figure 2)**. There was a significant rise in landings, increasing from 9.39 metric tons (MT) in 2020 to 155.6 MT in 2021, reflecting a dramatic 1557% increase. The 2021 catch was also 419% higher than the long-term average of 30 MT. Data for the 2022/2023 season is still being processed by the CAS and was unavailable at the time of this report's completion (SFA, 2023).

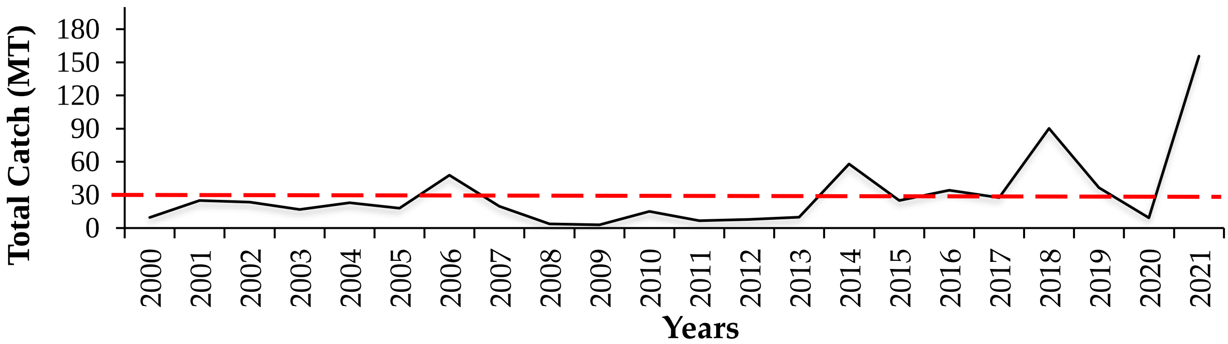

Figure 2: Spanner crab annual reported landing catch in Metric Tonnes (MT) from 2000 to 2021. The dashed red line indicated the average seasonal catch of 30 MT. **Note:** data from 1988 to 1998 were excluded from the graph. Data for 2022/2023 are still being processed and not shown.

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

The spatial distribution of fishing effort between the 2 consecutive fishing seasons was analysed (**Figure 3**). The grey grids indicate areas fished in the 2021/2022 season, and orange grids represent areas fished in the 2022/2023 season. During the 2022/2023 season grid M8, N8, Q12, and Q13 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 both seasons. These zones likely represent high-yield areas where spanner crabs remain viable, and catch is stable, maintaining their importance for the fishery across both seasons.

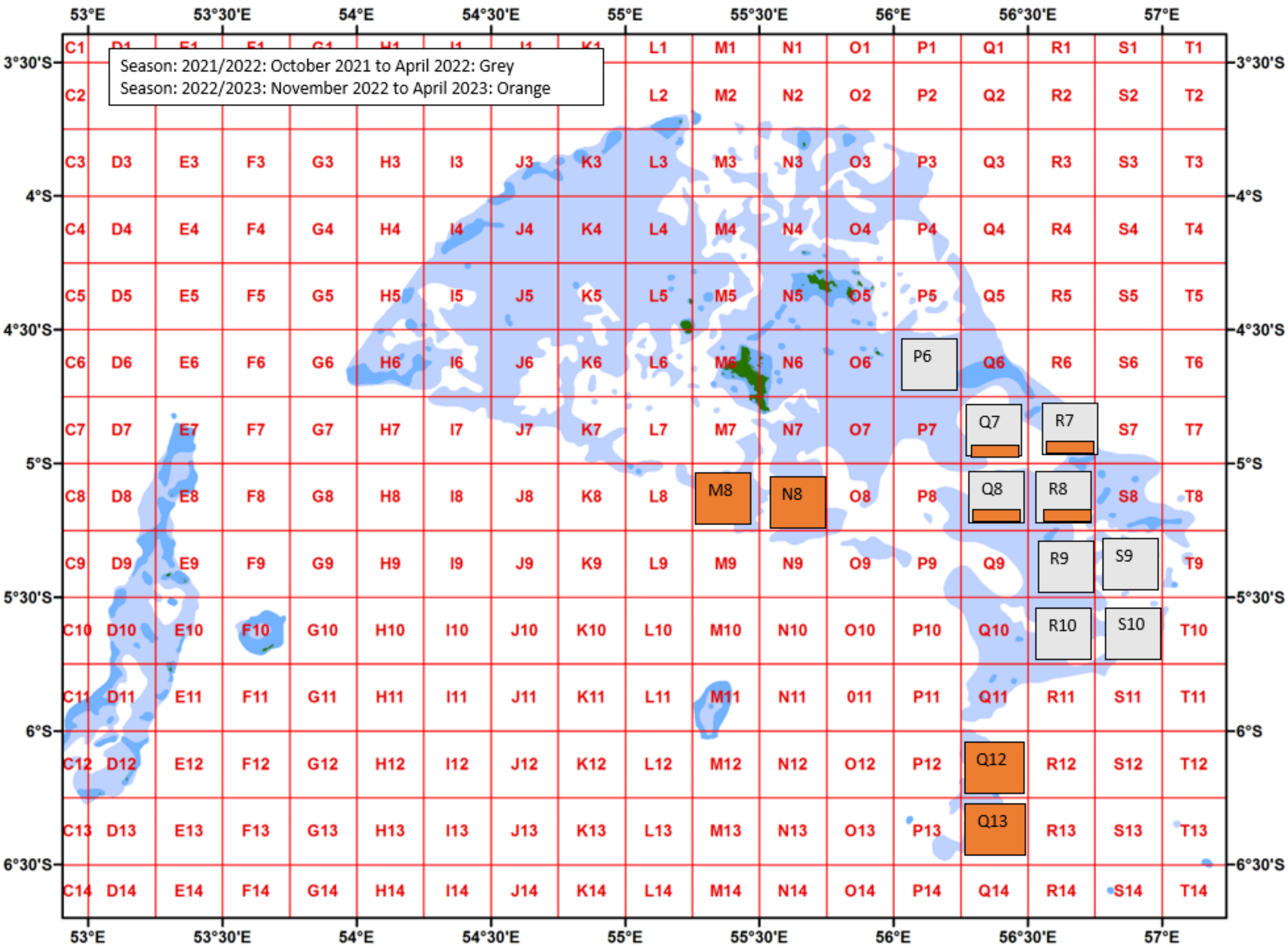

Figure 3: Fishing location recorded during the spanner crab sampling from 2021/2022 and 2022/2023. **N.B:** A few fishing locations were not included, as the location name was provided instead of the fishing grid.

3.3. Landing and CPUE Trend

The total landed catch per month is shown in **Figure 4**. In the 2022/2023 fishing season, the estimated total catch reported was 16,750 kg, compared to 15,150 kg in 2021/2022, representing an increase of 11%. From the 16,750 kg, 429.4 kg of spanner crab was sampled. The highest catch of 8,350 kg was recorded in November 2022, while the lowest catch of 1,000 kg was observed in February 2023.

The Catch Per Unit Effort, (CPUE) trends indicate fluctuations over the observed period (**Figure 4**). The highest recorded CPUE was November 2022 with a value of 1507 kg per trip duration, reflecting a period of optimal fishing efficiency. Conversely, February 2023 reported, the lowest CPUE, with a value of 111 kg per trip duration.

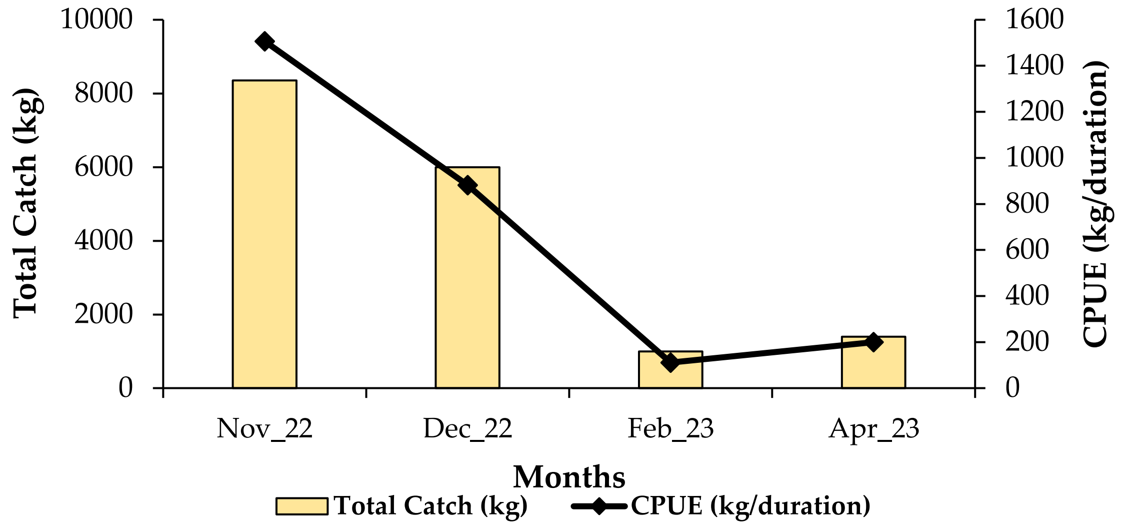

Figure 4: Total catch (kg) and CPUE (kg/duration) from the 2022/2023 sampling period. Note: catch and trip duration (days) is an estimation of what fishers provided. No sampling was conducted in January and March of 2023. Number of trips sampled per month; November 2022: 5, December 2022; 3 and February and April 2023; 1 each.

3.4. CPUE by sampling seasons

The CPUE 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 153kg per duration, while in 2022/2023, a CPUE of 266 kg per duration was recorded, representing an increase of 74%.

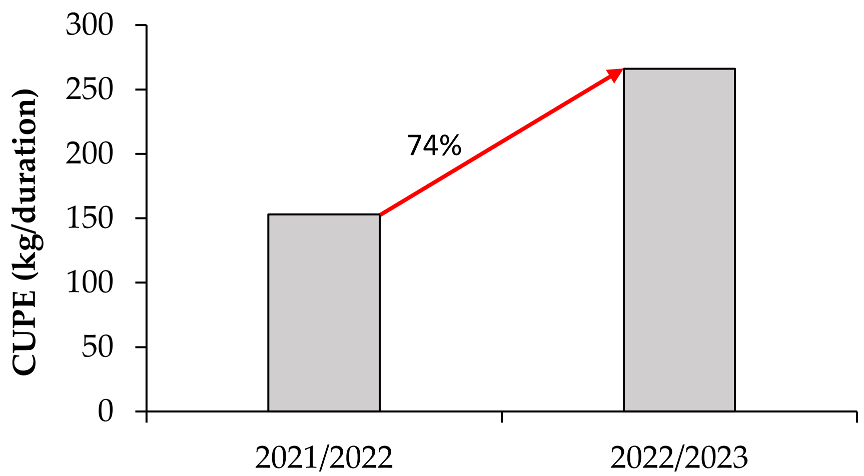

Figure 5: CPUE comparison between seasons 2021/2022 and 2022/2023. The red arrow demonstrates the increase of CPUE between seasons.

3.5. Sampling Effort

Ten (10) fishing trips were sampled between November 2022 and April 2023 (**Table 1**). 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 1214 individuals were sampled, comprising 309 females and 905 males, with a combined weight of 425 kg. In contrast, in 2021/ 2022, 1692 individuals were sampled, indicating a decrease of 28% (478 individuals). Males were almost 3 times more abundant in the samples than females, with a ratio of 2.9:1.

Table 1: Number of trips and individuals sampled by sexes from November 2022 to April 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	115
Total	**10**	**309**	**905**	**1214**

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 and a median of 8.4 cm (**Figure 6**). In the 2022/2023 sampling period, female CL ranged from 7.1 cm to 11 cm, a mode of 9.1 cm and a median of 8.8 cm (**Figure 6**). The CL average size was 8.5 cm in 2021/2022 and 8.8 cm in 2022/2023. Female CL was statistically significantly larger ($p < .05$) in 2022/2023 than in 20212022[1](**Figure 7**). The proportion of females below the proposed minimum size limit of 8 cm was 4.5% in 2022/2023, compared to 32% in 2021/2022.

In contrast, males in 2021/2022 carapace length ranged from 7 to 13.3 cm, with a mean of 9.5 cm, a mode of 9 cm and a median of 9.5 cm (**Figure 6**). In 2022/2023, males' CL ranged from 7.5 to 13.9 cm, with a mode of 10.2 cm and a median of 10.2 cm (**Figure

[1] Mann Whitney: $U = 55343$, $p < 7.343e\text{-}07$

6). The CL average size was 10.2 cm in 2022/2023 and 9.5 cm in 2021/2022. Male CL was statistically significantly larger ($p < .05$) in 2022/2023 than in 2021/2022[2] (**Figure 7**). The proportion of males below the proposed minimum size limit of 8 cm was 0.99% in 2022/2023, compared to 7% in 2021/2022.

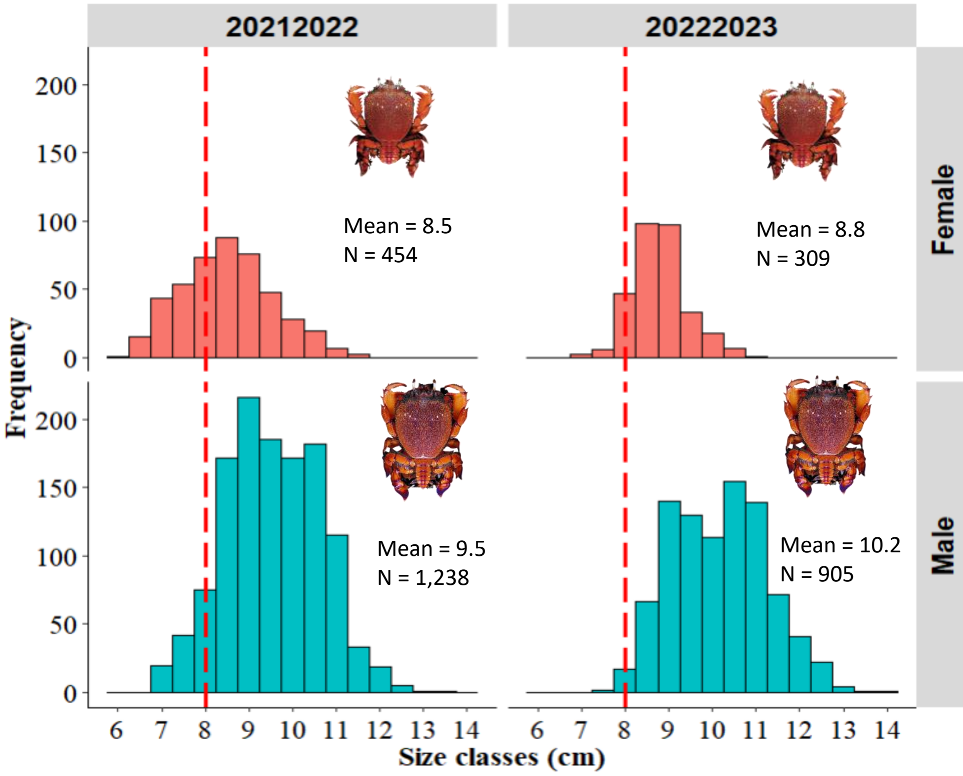

Figure 6: Carapace length size frequency distribution of females and males sampled in 2021/2022 and 2022/2023. Frequency representing crab counts in each size class. The Red dashed line represents the proposed minimum size limit of 8 cm.

[2] Mann Whitney: U = 393607, p < 2.2e-16

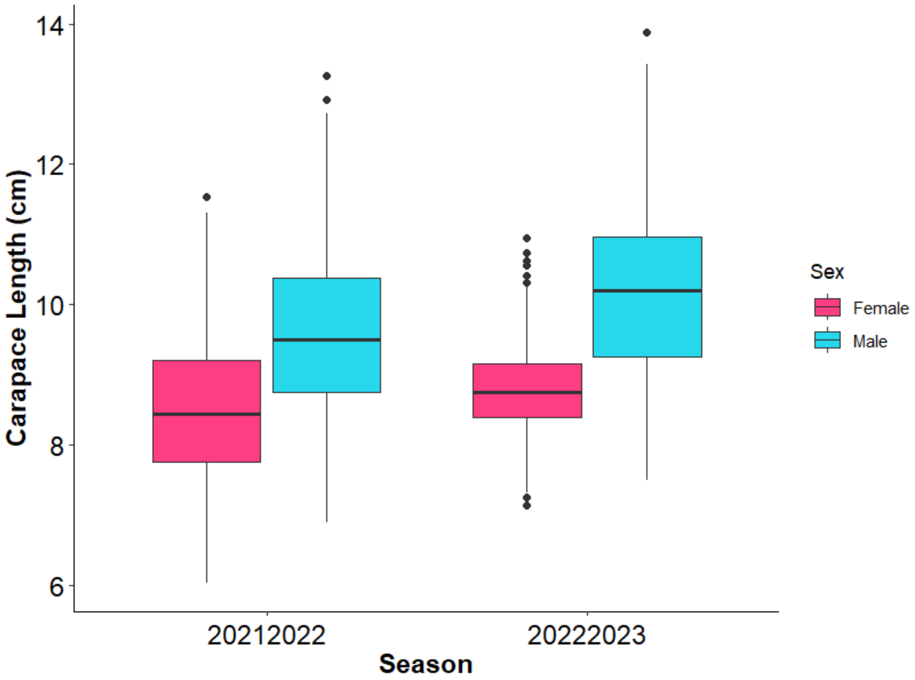

Figure 7: Boxplot of the size distribution of females and males for the 2 sampling periods.

3.7. Monthly Size Distribution

3.7.1. Monthly Carapace Length Comparison: 2022/2023

Male carapace length (cm) was statistically significantly ($p < .05$) different across the months [3] (**Figure 8**). On average, the carapace length of males sampled in April 2023 was larger (mean= 10.6 cm ± SD = 1.16) compared to other months (**Table 2, Appendix 2**). Similarly, males sampled in November were larger on average (10.1 cm ± 1.05) compared to February (9.8 cm ±1.05). In contrast, female carapace length (cm) was not statistically significant ($p > .05$) different across the months[4] (**Figure 8**).

[3] Kruskal-Wallis: $\chi 2_{(3)} = 23.371$, $p = < 3.38e-05$

[4] ANOVA: $F_{(3,305)} = 1.389$, $p > 0.246$

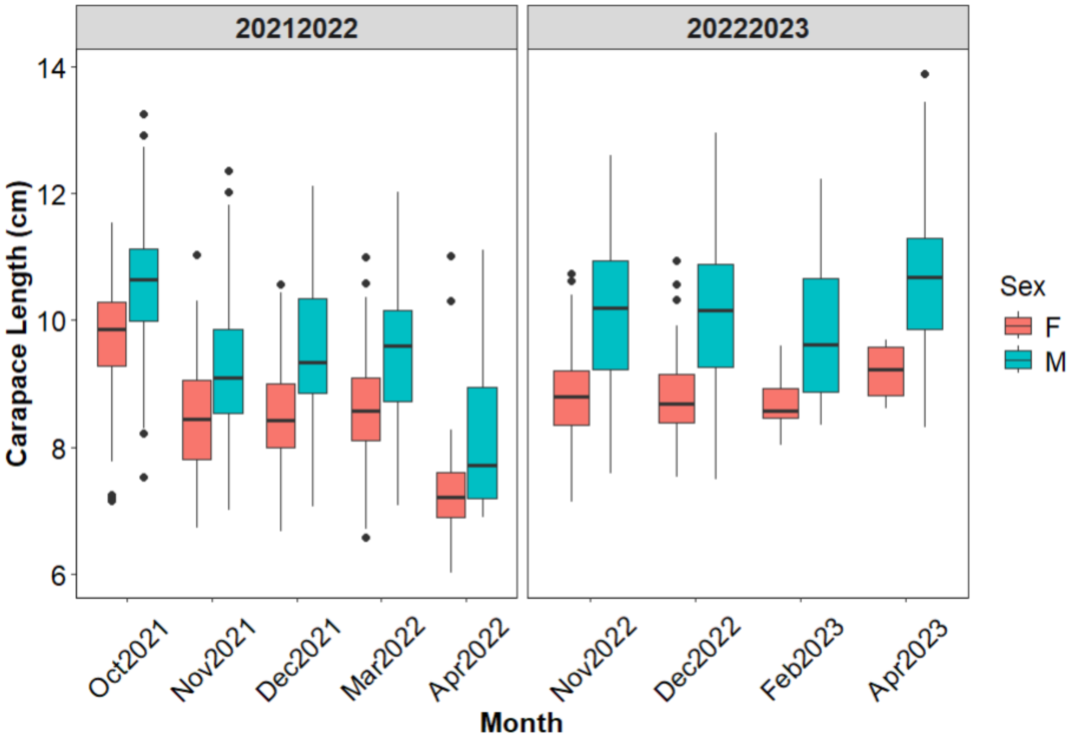

Figure 8: Carapace length distribution by month and sex, showing the variability and median values across different months for both male and female spanner crabs between the 2 sampling seasons.

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

Spanner crab sizes between the 2021/2022 and 2022/2023 sampling period showed statistically significant differences for both females and males. On average, female and male carapace lengths were larger in November[5&6], December[7&8] and April[9&10] of 2022/2023 compared to the same months in 2021/2022 (**Figure 8**, **Table 2**).

Table 2: Monthly mean carapace length and standard deviation.

Month	Female Mean (cm) ± SD		Male Mean (cm) ± SD	
	2021/2022	2022/2023	2021/2022	2022/2023
November	8.45 ± 0.89	8.85 ± 0.66	9.19 ± 1.01	10.14 ± 1.05
December	8.47 ± 0.80	8.77 ± 0.61	9.53 ± 0.94	10.07 ± 1.08
April	7.32 ± 0.76	9.19 ± 0.46	8.23 ± 1.32	10.61 ± 1.16

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

5 Welch's t-test: $t_{(110.66)} = -3.6738$, $p < 3.700e-04$ (Female)
6 T-test: $t_{(768)} = -12.775$, $p < 2.2e-16$ (Male)
7 Welch's t-test: $t_{(253.98)} = -3.5698$, $p < 4.272e-04$ (Female)
8 T-test: $t_{(640)} = -6.6468$, $p < 6.42e-11$ (Male)
9 T-test: $t_{(65)} = -5.9752$, $p < 1.068e-07$ (Female)
10 Mann Whitney: $U = 438$, $p < 2.088e-13$ (Male)

3.8. Weight Frequency Distribution

The body weight for all spanner crab sampled during this period ranged from 0.120 to 0.980 kg, with a mean of 0.35 kg. In 2021/2022, female body weight ranged from 0.100 kg to 0.590 kg, mode of 0.170 kg and a median of 0.220 kg (**Figure 9**). For 2022/2023, female body weight ranged from 0.120 kg to 0.570, mode of 0.21 kg and a median of 0.23 (**Figure 9**). The average body weight was 0.234 kg ± 0.08 in 2021/2022 and 0.240 kg ± 0.06 in 2022/2023. Female body weight was statistically significantly larger ($p < .05$) in 2022/2023 than in 2021/2022 [11](**Figure 10**).

In contrast, in 2021/2022, male weight ranged from 0.110 to 0.915 kg, with a mode of 0.220 kg, and a median of 0.119 kg (**Figure 9**). In 2022/2023, male weight ranged from 0.15 to 0.98 kg, mode of 0.260 kg, and a median of 0.380 kg (**Figure 9**). The average body weight was 0.325 kg ± 0.12 in 2021/2022 and 0.388 kg ± 0.14 in 2022/2023. Male body weight was statistically significantly larger ($p <.05$) in 2022/2023 than in 2021/2022 [12] (**Figure 10**).

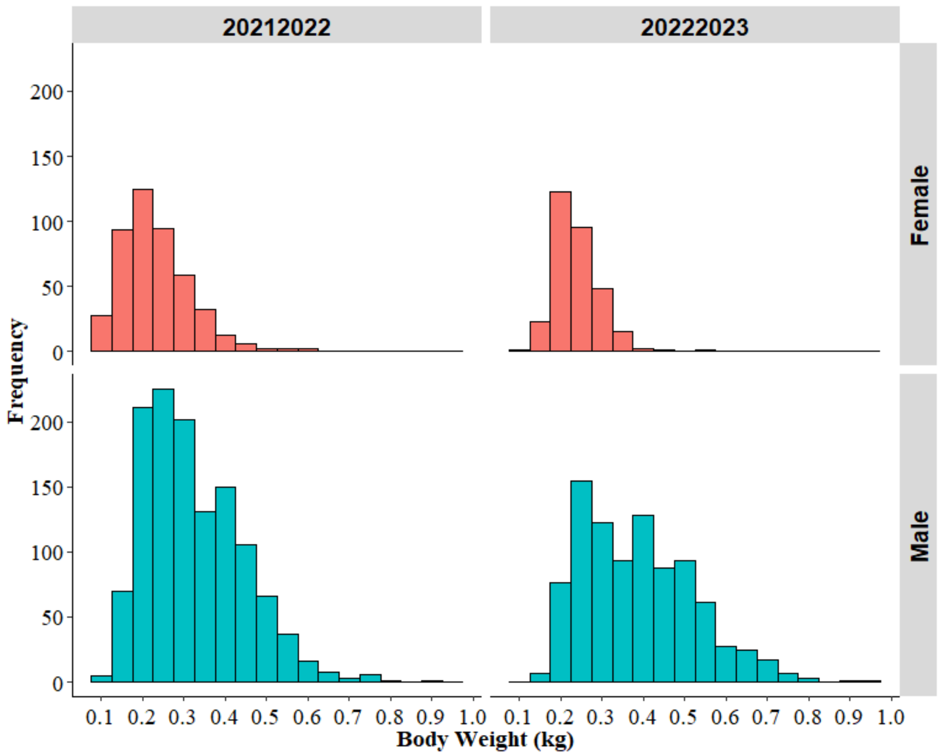

Figure 9: Size frequency distribution (body weight) of Females and Males for the 2022/2023 sampling period. Frequency represents the proportion of counts of each size class.

[11] Mann Whitney: U =140286, p < 2.2e-16 (Female)
[12] Mann Whitney: U =410870, p < 2.2e-16 (Male)

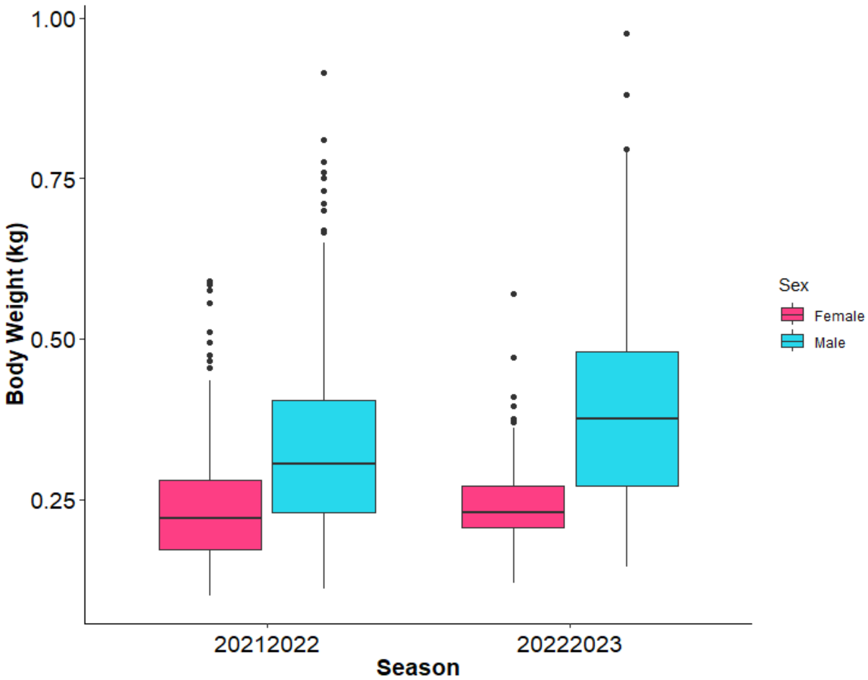

Figure 10: Body weight distribution by season and sex, showing the variability and median values across the season for both male and female spanner crabs.

3.9. Monthly Weight Frequency Distribution

3.9.1. Monthly Body Weight Comparison: 2022/2023

On average, the body weight of males sampled in April 2023 (mean = 0.433 kg ± standard deviation = 0.16) and November (0.398 ± 13) were heavier compared to other months [13] (**Table 6, Appendix 2**). In contrast, female body weight (kg) was statistically significant heavier in November (0.251 ± 0.06) compared to December (0.225 ± 0.04; (**Figure 11, Table 3**).

[13] Kruskal-Wallis: $\chi2_{(3)}$ =27.06, p = < 5.72e-06

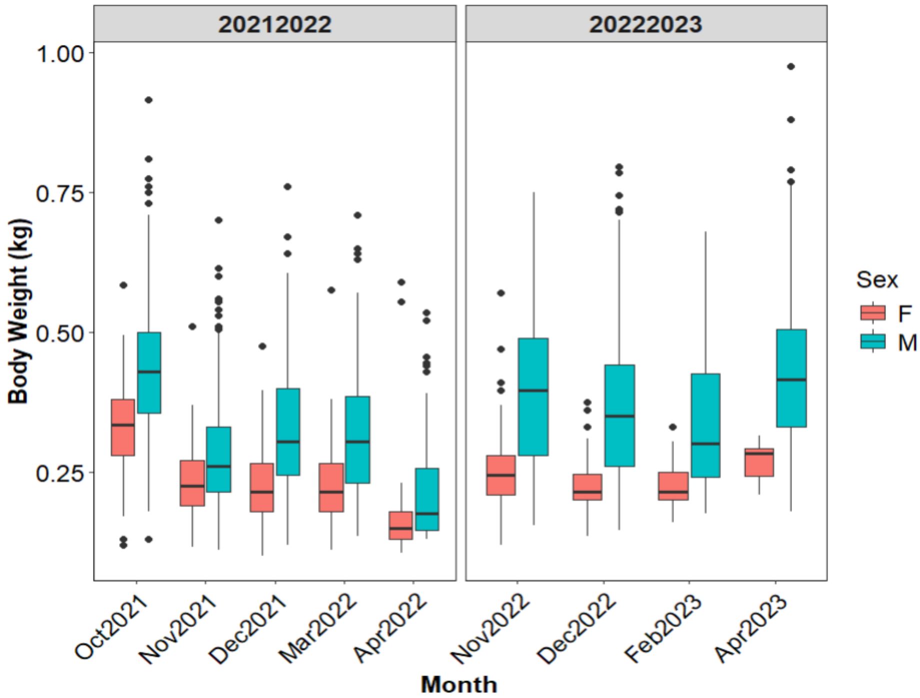

Figure 11: Body weight distribution by month and sex, showing the variability and median values across different months for both male and female spanner crabs.

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

Spanner crab body weight between the 2021/2022 and 2022/2023 sampling period showed statistically significant differences between females and males. On average, female and male body weight were heavier in November[14&15], December[16&17] and April[18&19] of 2022/2023 compared to the same months in 2021/2022 (**Figure 11**, **Table 3**).

Table 3: Monthly mean body weight and standard deviation.

Month	Female Mean (cm) ± SD		Male Mean (cm) ± SD	
	2021/2022	2022/2023	2021/2022	2022/2023
November	0.233 ± 0.07	0.251 ± 0.06	0.284 ± 0.10	0.398 ± 0.13
December	0.228 ± 0.06	0.225 ± 0.04	0.327 ± 0.12	0.368 ± 0.13
April	0.167 ± 0.08	0.269 ± 0.04	0.232 ± 0.12	0.433 ± 0.16

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

[14] Mann Whitney: U =13090, p < 2.2e-16 (Female)
[15] Mann Whitney: U =35560, p < 2.2e-16 (Male)
[16] Mann Whitney: U =15984, p < 2.2e-16 (Female)
[17] Mann Whitney: U =42402, p < 2.013-04 (Male)
[18] Mann Whitney: U =366, p < 6.114e-05 (Female)
[19] Mann Whitney: U =589, p < 2.284e-11 (Male)

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 2022/2023 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 season to season. 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 2021/2022 and 2022/2023 seasons, which might indicate more crab availability and improved fishing efficiency or effort in 2022/2023. Moreover, variation in CPUE per month for 2022/2023 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 overestimate or underestimate their effort, either unintentionally or deliberately, this could distort the relationship between catch and effort. As a result, the data from the sampling program may not fully reflect the overall fishing activity or accurate 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. Implementing a logbook system will help reduce uncertainty and provide reliable and accurate data on fishing activity.

4.2. Size and Weight Distribution

The comparison between size and weight showed significant changes, with males constantly larger and heavier than their counterparts. This observation was made for both 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 2022/2023, males' mean size and weight were significantly larger overall and per month than the previous season. This could be attributed to fishers targeting areas on the Mahé Plateau that have larger spanner crabs 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 2022/2023 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 crabs below the proposed 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 approximately three times more abundant in the samples compared to females, with a ratio of 2.9:1. A similar trend was observed in the previous season (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. To address these, management measures such as size limits or gear modification could allow the smaller males to remain in the population, to mature, and contribute to the population. Subsequently, 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 the spanner crab sampling program, 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, the lack of a logbook system only means the effort data collected is not accurate, and the total landing per vessel is not known to do the necessary raising. Addressing these constraints is essential for improving the reliability and accuracy of data collected, thereby enhancing the effectiveness of monitoring and management efforts for spanner crab fisheries.

5. Conclusion

In conclusion, the spanner crab sampling program 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. Such a plan could include monitoring, logbook systems, licensing framework and enforcement mechanisms to ensure compliance and effective management of the fishery. 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.

6. Reference

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Appendix 1

Table 4: Post hoc pairwise comparisons of male log carapace length (cm) by month for 2022/2023 sampling period **using Dunn Test**. P values were adjusted using the Bonferroni method.

№	Comparison Groups	Carapace Length (cm)	
		Adjusted P value	**Significance level**
1	Apr2023-Dec2022	3.745229e-04	P <.05
2	Apr2023-Feb2023	1.558468e-05	P <.05
3	Dec2022 - Feb2023	1.519391e-01	ns
4	Apr2023 - Nov2022	1.525210e-03	P <.05
5	Dec2022 - Nov2022	1.000000e+00	ns
6	Feb2023 - Nov2022	3.909492e-02	P <.05

Significance level at 0.05. ns; nonsignificant difference.

Table 5: Post hoc pairwise comparisons of male log body weight (kg) by month for 2022/2023 sampling period **using Dunn Test**. P values were adjusted using the Bonferroni method.

№	Comparison Groups	Carapace Length (cm)	
		Adjusted P value	**Significance level**
1	Apr2023-Dec2022	3.086373e-04	P <.05
2	Apr2023-Feb2023	1.851795e-04	P <.05
3	Dec2022 - Feb2023	6.065969043e-01	ns
4	Apr2023 - Nov2022	2.423250010e-01	ns
5	Dec2022 - Nov2022	3.1459987e-03	P <.05
6	Feb2023 - Nov2022	2.8435268e-03	P <.05

Significance level at 0.05. ns; nonsignificant difference.