



# SEYCHELLES FISHING AUTHORITY TECHNICAL REPORT

## REPORT ON THE SPINY LOBSTER FISHERY Summary of Fishing Activity for the 2023 season



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**Summary of Fishing activity for the 2023 season**



**SFA Fisheries Research Section**

**June 2023**



## **Acknowledgements**

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## Abstract

In Seychelles, the spiny lobster fishery has traditionally been managed as a seasonal closure and limited access (license-limited) fishery. The lobster fishing season usually opens for 3 months; however, the 2023 season was open for 2 months only. The season was extended for a further 2 weeks following low catch and effort because of unfavourable weather conditions. As a precautionary measure, the extension was limited to only 2 weeks due to a noticeable decrease in CPUE compared to previous seasons. This decision was based on a pre-analysis of the catch for January and February. This report presents analyses of the fishery-dependent data collected from the spiny lobster fishery during the 2023 fishing season and compares previous fishing seasons. To achieve this, data collected from fishers and sampled Catch and Effort logbooks were used. Statistical analyses were performed to compare sizes between the previous seasons for *Panulirus longipes* (Long-legged spiny lobster) and *Panulirus penicillatus* (Pronghorn spiny lobster). Results for the 2023 season showed that snorkeling was the dominant fishing method. An increase in both the total catch (3.33 Metric Tonnes) and the number of fishing trips (135 trips) was observed compared to the 2 previous seasons. In regard to fishing location, Mahé remains the most dominant area for both total catch and the number of trips amongst the major fishing sites. The CPUE has increased compared to 2021/2022. Therefore, there are positive indications of an increase in lobster abundance. For the 2023 season, mean carapace length (CL) sizes for male *P. penicillatus* were larger than in 2021/2022. In contrast, the mean CL in female *P. penicillatus* was larger, while *P. longipes* were smaller compared to 2020/2021. Male *P. longipes* mean carapace length remained the same over the past 3 years. Overall, data collected during the 2023 season indicates an increase in lobster's relative abundance. The annual Participatory Lobster Monitoring Programme (PLMP) will not be undertaken in 2023 due to the extensive fishery-independent assessment. It is recommended that the next fishing season remains closed due to the apparent decreasing trend in catch after remaining open for 4 consecutive seasons. As a precautionary approach, the fishery closure will be beneficial to allow the stock to replenish, improving the fisher's future financial gain. Furthermore, closing the fishery while conducting an extensive fishery-independent assessment is the right approach to prevent the results from being influenced by ongoing extraction by fishers.



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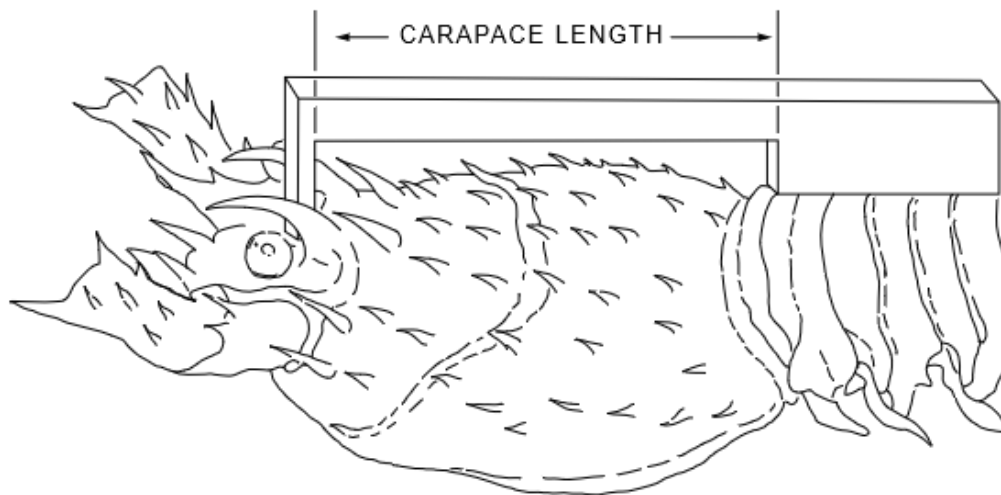
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## 1. Introduction.

The Seychelles artisanal spiny lobster fishery targets shallow water lobster stocks around the main granitic islands (Seychelles Fishing Authority [SFA], 2019). Locally, there are four species harvested, notably, *Panulirus penicillatus*, the Pronghorn spiny lobster (Oliver, 1791); *Panulirus longipes*, the Long-legged spiny lobster (A. Milne Edwards, 1868); *Panulirus versicolor*, the Painted spiny lobster (Latreille, 1804); and *Panulirus ornatus*, the Ornate spiny lobster (Fabricius, 1798) (SFA, 2017). These reef-dwelling species prefer fringing carbonate reefs and granitic reef habitats, constituting of crevices, burrows, and coral overhangs (Withy-Allen and Hovel, 2013; Hovel and Lowe, 2007; Holthuis, 1991). Such protective structures provide shelter against multiple ecological factors such as predation, thus maximising survival probabilities (Behringer and Butler, 2010). Since spiny lobsters are mainly nocturnal scavengers, fishing operations are conducted from dusk to dawn (Radhakrishnan et al., 2019; SFA, 2017). Fishers generally utilise small outboard vessels to access various coastal fishing grounds and on average, a fishing trip consists of two to three men fishing for approximately five hours (SFA, 2017). Scuba diving, snorkeling and bamboo traps are the different fishing techniques practiced locally (SFA, 2017). Amongst these, snorkeling or skin diving is the most popular fishing method, whereby fishers use snorkeling gears and underwater flashlight to extract lobsters from the crevices. Scuba diving and bamboo traps fishing methods are used on a lesser extent and account for a small percentage of the catch.

In Seychelles, the spiny lobster fishery is licenced and seasonally managed, whereby fishers are required to apply for licences prior to the opening of the fishing season. Currently, the management regulations implemented for the spiny lobster fishery are as follows:

- I. Restrictions on the number of licences**
- II. Seasonal restrictions (the fishery is typically opened for a 3-month period)**
- III. Minimum size (75 mm carapace length for all species)**
- IV. Prohibition to retain berried females**

Additionally, the licence conditions also specify that logbooks and sale receipts be maintained and submitted. A copy of the new amended licence conditions is listed in **Appendix 1**. The management





measures provide a degree of input control. However, there are no output controls (such as Total Allowable Catches (TACs)) in place to limit the total catches.

Since 1992, a monitoring programme for the spiny lobster fishery was established by the SFA (Mees, 1992). From there onwards, reports have been produced at the end of each season outlining several aspects of the fishery including research and management.

The most recent lobster fishing season was opened on the 15<sup>th</sup> of January 2023 and was scheduled to close on the 15<sup>th</sup> of March 2023. However, following a preliminary analysis on the performance of the fishery, the fishing season was extended for 2 more weeks, closing on the 28<sup>th</sup> of March 2023. A compliance bond of SCR5000 was maintained to ensure that licence holders submit their logbooks and sale records at the end of the fishing season. A total of sixteen fishing licences were taken of which 11 were from Mahé, 4 from Praslin and 1 from La digue. This report presents an analysis of fisheries-dependent data collected for the spiny lobster fishery during the 2023 fishing season. It also compares the stock indicators, namely, the size structure of lobsters, and the harvest rate between the 2020/2021, 2021/2022 and 2023 fishing seasons.

## **2. Methodology.**

### **2.1. Sampling procedures.**

During the 2023 season data was collected from fishermen operating on Mahé, Praslin and La Digue through three different sources:

- a) **Fisher Catch and Effort log (FCEL):** Each licenced fisherman was given a logbook to record information on their fishing activities (**Appendix 2**). Information collected included information on catch, effort and fishing location.
- b) **Sampled Catch and Effort log (SCEL):** SFA technicians sampled the landed catch directly whenever possible. Information on the species caught, weight and length measures were collected (**Appendix 3**). Interviews were also conducted to determine total effort and fishing location.
- c) **Receipt Book:** At the end of the fishing season, receipt books completed by licensed fishermen with sales of lobsters were collected to derive total sales. The fishermen recorded the number and weight of lobsters sold.



## 2.2. Data analysis.

Information collected from the FCEL and the SCEL were crosschecked to determine the number of lobsters not sampled for each fishing trip. The average weight for each species was derived from the total weight and total number of lobsters (per species) recorded from the SCEL <sup>(a)</sup>. The weight of lobsters not sampled for each fishing trip was estimated by raising the average weight of each species to the total number of that species caught <sup>(b)</sup>. During the 2023 fishing season, there was no data collected on the biological parameters of *Panulirus ornatus*. Alternatively, the raised average weight was taken from the 2020/2021 fishing season. The total catch of lobsters <sup>(c)</sup> for the 2023 season was derived from the sum of weights of lobsters from the SCEL and the total sum of the raised weight of lobsters not sampled (SFA, 2017).

$$a) \text{ Average weight} = \frac{\sum \text{Weight (kg)}}{\mathcal{N}^0 \text{ of Lobster (per species)}}$$

$$b) \text{ Raised Weight} = \text{average weight} * \mathcal{N}^0 \text{ of lobsters not sampled (per species)}$$

$$c) \text{ Catch (kg)} = \sum \text{of weight sampled catch effort log} + \text{raised weight of lobsters not sampled}$$

The total effort was based on the total number of fishing trips undertaken derived from FCEL. The catch per unit effort (CPUE) was calculated from the total catch in kg and the total effort<sup>(e)</sup>. The catch, effort, CPUE and species composition was calculated for the main fishing location groupings.

$$e) \text{ CPUE} = \sum \text{total} \frac{\text{Catch (kg)}}{\text{Fishing Effort } (\mathcal{N}^0 \text{ of trips})}$$

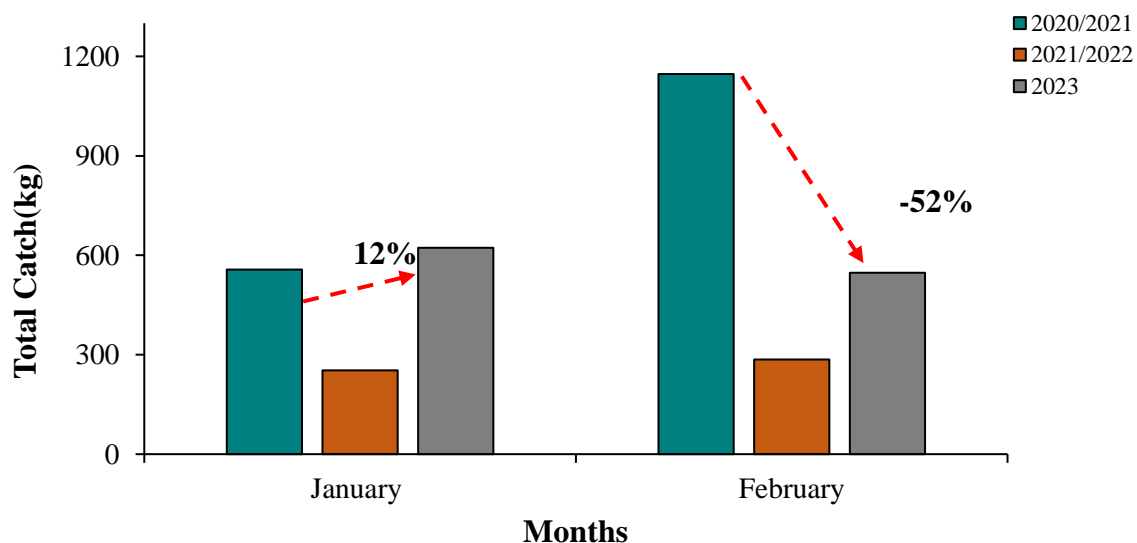
The length frequency (carapace length (CL)) distributions of males and females for the different lobster species sampled in 2023 was compared with distributions of lobsters sampled in the previous seasons (2021/2022 and 2020/2021), using univariate analysis of variance (ANOVA) or Kruskal-Wallis non-parametric tests. Assumptions of the ANOVA model were checked by examining the residual plots for normality of error terms and homogeneity of variances. In addition, homogeneity of variances was verified by running the Fligner-Killeen test. A significance level of  $\alpha=0.05$  was used throughout the analysis.



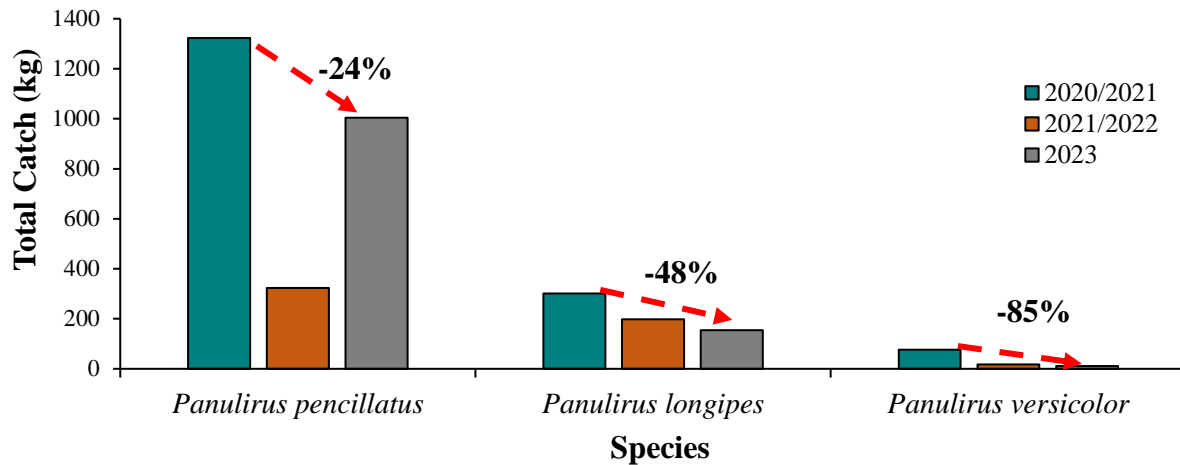
### 3. Fishery extension.

#### 3.1. Comparison of the months January and February over three seasons.

At the end of February this year, a comparative analysis was conducted to assess fishery information collected for the months of January and February in 2021, 2022 and 2023. This analysis aimed to provide insights for the determination of whether the 2023 season should be extended into March. The assessment involved a comparison of catch, effort and CPUE data across these three years. The 2021 fishing season was used as the benchmark for this analysis. To note, the 2020/2021 fishing season spanned over 3 months, while the 2021/2022 fishing season was limited to only 2 months. The cut-off date for comparison was 15/01/2023 to 26/02/2023 however, the 2021/2022 fishing season closed on the 15<sup>th</sup> of February; thus, comparison was only possible with 2020/2021. A total catch of 1169 kg (1.16 Metric Tonnes (MT)) of lobsters were caught as opposed to 1704 kg (1.70 MT) in 2020/2021, represented a total decrease of 31%. The data shows that there was a 12% increase in catch during the fishing season of January 2023, in comparison to the catch during the 2020/2021 fishing season. However, there was a decrease in catch by 52% during the fishing season of February 2023 (**Figure 1**). Moreover, the species composition analysis indicates that *Panulirus penicillatus* experienced a decline of 24%, *Panulirus longipes* faced a decline of 48%, and *Panulirus versicolor* had a decline of 85%, compared to the catch in the 2020/2021 fishing season (**Figure 2**).

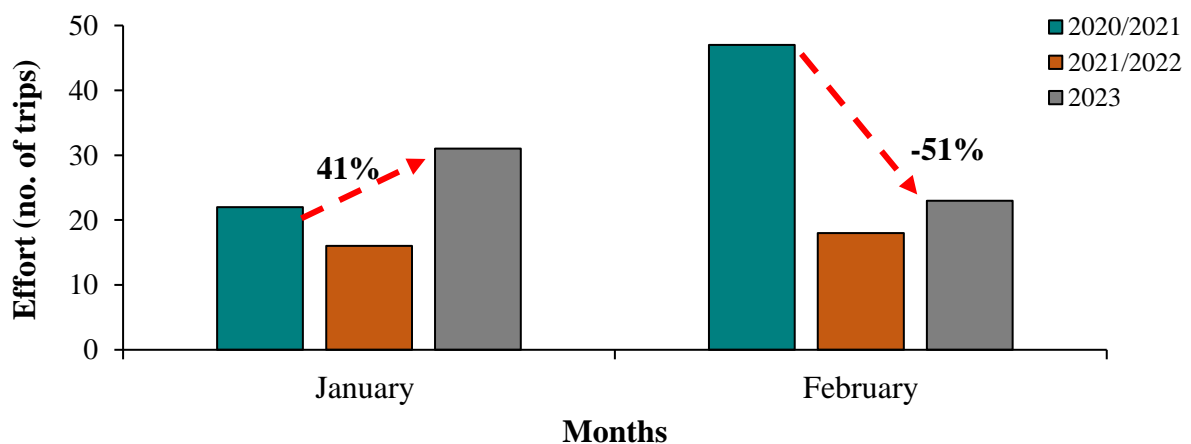


**Figure 1:** Monthly total catch (kg) compared to the 2020/2021 season. Red dashed arrow highlights changes observed. **NB:** The 2020/2021 fishing season was used as the benchmark.



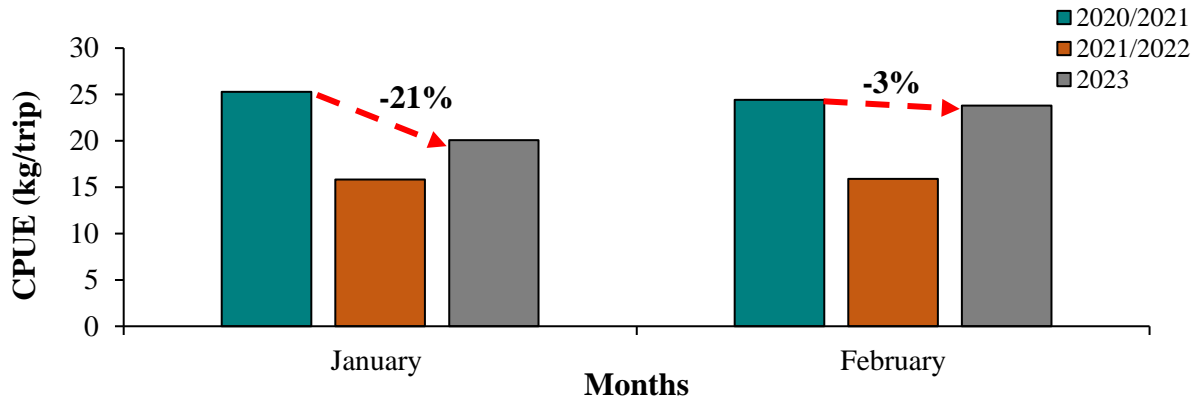
**Figure 2:** January and February (2021,2022 and 2023) catches (kg) over 3 fishing season. Red dashed arrow highlights changes observed. **NB:** The 2020/2021 fishing season was used as the benchmark.

In relation to effort by number of trips, in January, an increase of 41% was observed in the fishing effort compared to the 2020/2021 fishing season. An increase in fishing effort during January was expected as it was the start of the fishing season. A 51% decrease in fishing efforts was observed in February (**Figure 3**). Furthermore, when comparing the catch per unit effort data (CPUE) without the fishery extension, 2023 reported a 21% and 3 % decrease compared to the 2020/2021 season (**Figure 4**). The analysis provided valuable insights into the performance of the fishing season which led to the decision to extend the fishing season. However, due to the observed decrease in the CPUE (an index of relative abundance), as a precautionary measure, the extension was limited to just an additional two weeks..



**Figure 3:** Monthly fishing effort (no. of trips) over the last 3 fishing season. Red dashed arrow highlights changes observed. **NB:** Comparison made between 2023 and 2020/2021 fishing season.



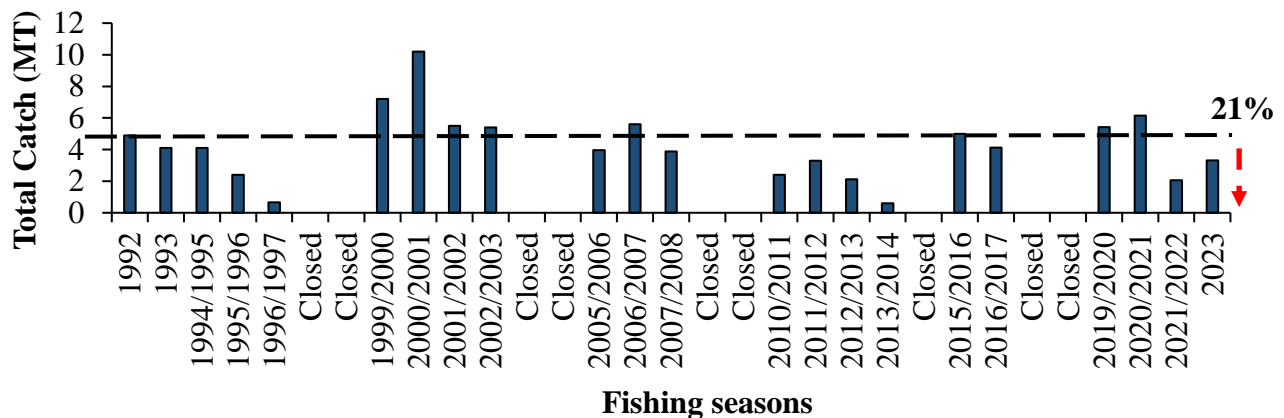


**Figure 4:** Catch per unit effort (CPUE) (kg/trips) over the last 3 fishing season. Red dashed arrow highlights changes observed in the CPUE. **N.B:** fishery extension was excluded in the analysis.

## 4. Results.

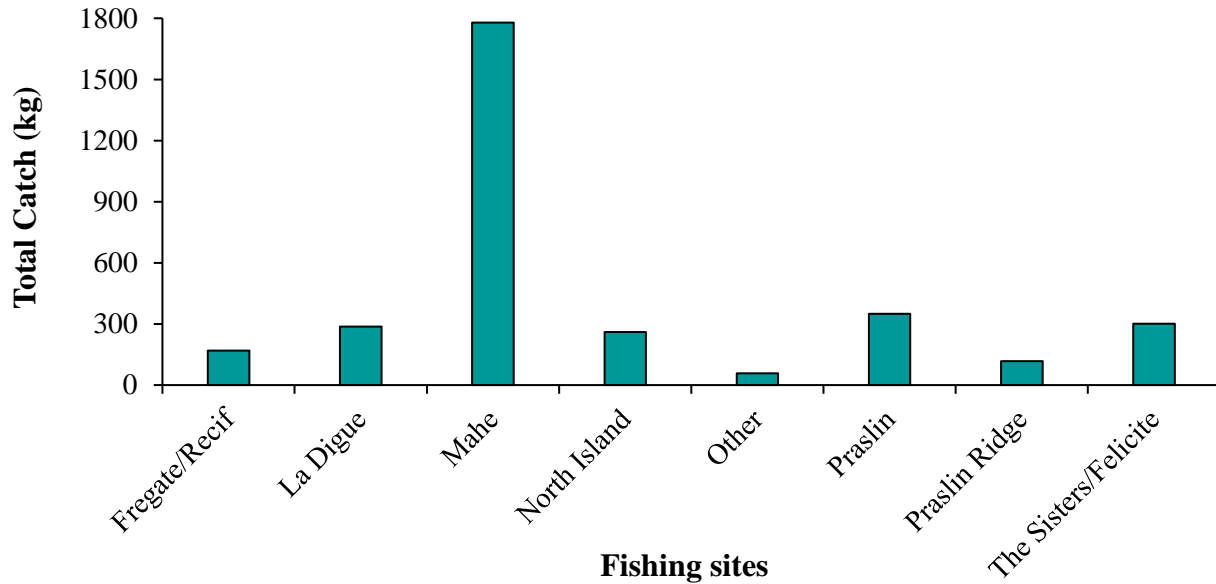
### 4.1. Catch, effort and catch per unit effort.

For the 2023 lobster fishing season, a total catch of 3.32 MT was recorded, compared to 2.05 MT in 2021/2022 and 6.14 MT in the 2020/2021 season, representing a 62% increase and 46% decrease, respectively. The 2023 catch was 21% lower than the historical mean of 4.20 MT (**Figure 5**). The predominant method used to catch lobster was snorkeling, accounting for 95% of the total catch. The only other fishing method used was scuba diving. The fishing technique used remained consistent with the previous fishing season, where mostly snorkeling fishing techniques were used.

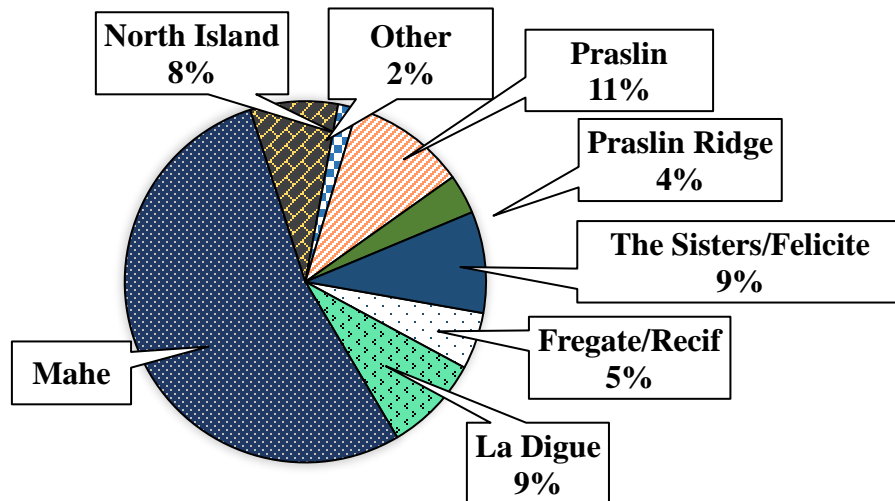


**Figure 5:** Spiny lobster historical seasonal catch (metric tonnes) from 1992 to 2023. The dashed black line of 4.20 MT indicates mean seasonal catch since the monitoring began in 1992. **N.B.** 2019/2020 season spanned a complete three-month period, while the 2020/2021 season was extended to accommodate a one-month extension, resulting in a duration of over four months. In contrast, both the 2020/2021 and 2023 seasons were two months in duration.

Fishing activities were predominantly around the region of Mahé. The landed catch for 2023 was 1779 kg (1.7 MT; **Figure 6**), representing 54% of the total catch compared to 63% in 2021/2022 and 48% in 2020/2021 seasons. The second most dominant fishing site was Praslin with a total catch of 350 kg, followed by 301 kg from The Sisters/Felicite, accounting for 11% and 9% of the total catch respectively. Minor fishing sites comprised of La Digue (289 kg), North Island (261 kg), and Praslin Ridge (118 kg), representing 9%, 8% and 4% of the total catch (**Figure 7**).



**Figure 6:** Total Catch (kg) by major fishing locations for the 2023 fishing season.

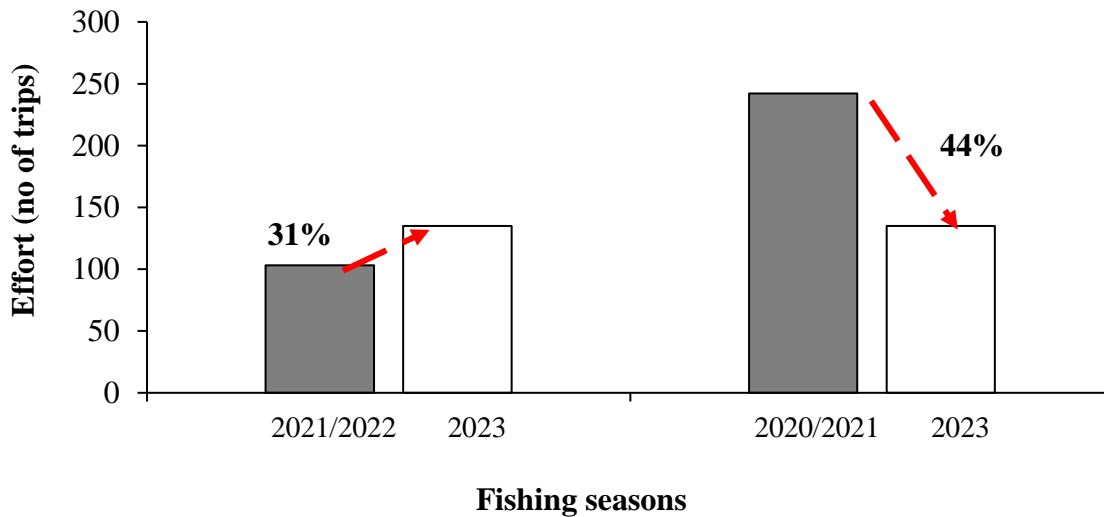


**Figure 7:** Total catch in percentage by major fishing location for the 2023 fishing season.

A total of 135 (mostly dominated on Mahé (75 trips)) fishing trips were recorded during the 2023 season (**Figure 8**), compared to 103 trips in 2021/2022 and 242 trips in 2020/2021, representing an increase of 31% and a decrease of 44% respectively (**Figure 9**).

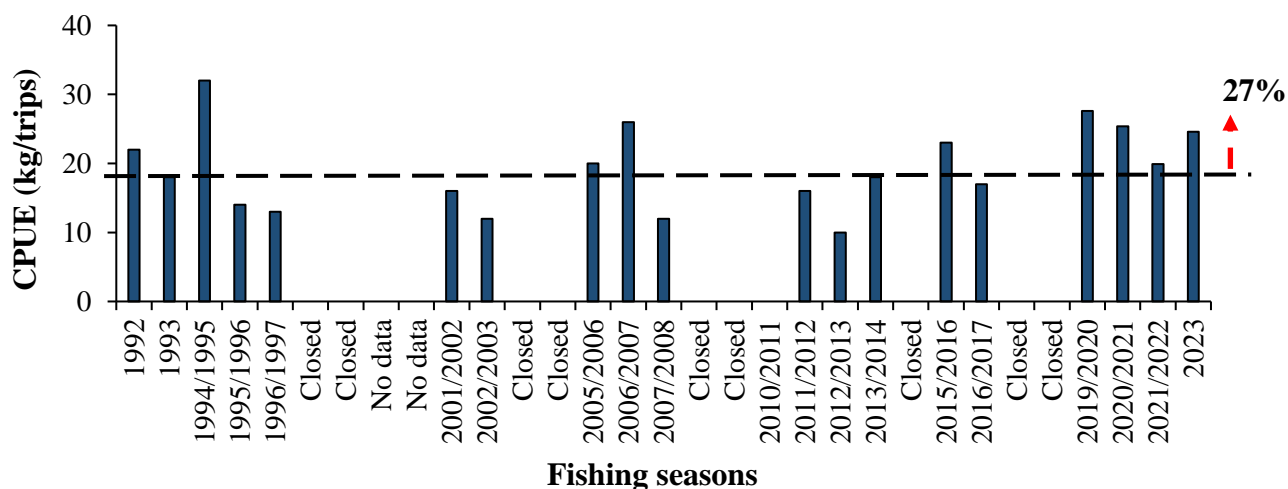


**Figure 8:** Fishing effort (no. of trips) by major fishing location for the 2023 fishing season.

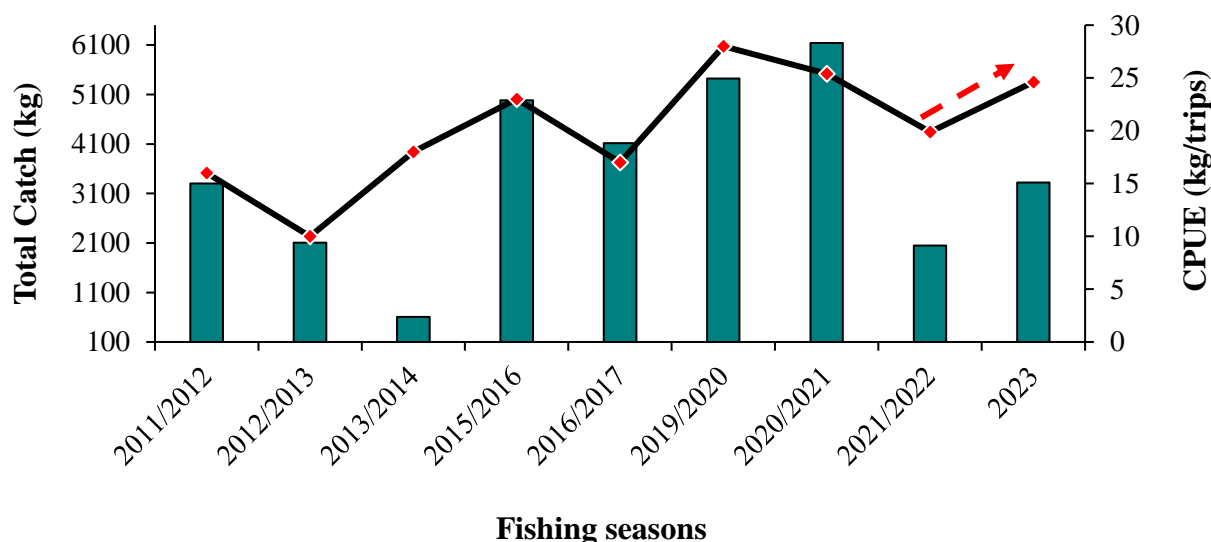


**Figure 9:** Comparisons of fishing efforts (no. of trips) between the recent fishing season to the 2 previous fishing seasons. The Red dashed arrow highlights the increase in the number of efforts.

The overall CPUE for the 2023 season was 24.6 kg/trip compared to 19.9 kg/trip in the 2021/2022 and 25 kg/trip in 2020/2021 seasons, respectively (**Figure 10**). The CPUE was 27% higher than the historical mean of 19.3 MT. An increase of 24% compared to the 2021/2022 season and a decrease of 3% compared to the 2020/2021 season was observed (**Figure 11**).



**Figure 10:** Seasonal CPUE (kg/trip) for open seasons of the lobster fishery between 1992 and 2023. The red dashed line highlights the CPUE increase from the historical mean of 19.3 kg/trips represented by the dashed black line. **N.B.** Due to unavailable data for 2 open seasons and underreporting for the 2010/2011 season, the CPUE was not calculated.

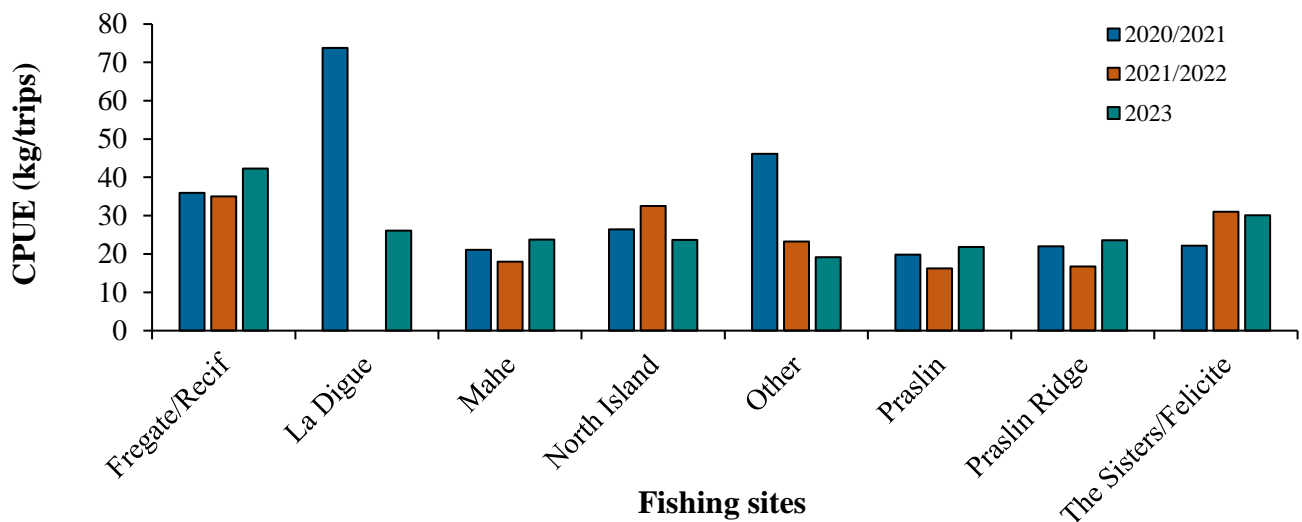


**Figure 11:** Total catch (kg; bars) and CPUE (kg/trips; black line) for the past open fishing seasons. Red dash line indicates changes observed.





The catch per unit effort (CPUE) was compared by fishing locations (**Figure 12**). The trends in CPUE have fluctuated throughout the last 3 fishing seasons. The highest catch rate in 2023 was recorded at Fregate/Recif, The Sisters/Felicite, and La Digue, with 42, 30, and 26 kg/trip, respectively. In contrast, 2021/2022, Fregate/Recif, North Island and The Sisters/Felicite reported a higher catch rate of 35, 33 and 31 kg/trip, respectively. La Digue, ‘Other’ and Fregate/Recif recorded a higher catch rate of 60, 51 and 36 kg/trip respectively in 2020/2021. Whereas the lowest catch rate in 2023 fishing season was recorded around ‘Other’ and Praslin, with 19 and 22 kg/trip, respectively. In 2021/2022 catch rate around Mahé, Praslin and Ridge Praslin were 18, 17 and 16 kg/trip, respectively. The lowest catch rate around The Sisters/Felicite and Praslin Ridge recorded 22 kg/trip each and Mahé with 21 kg/trip.

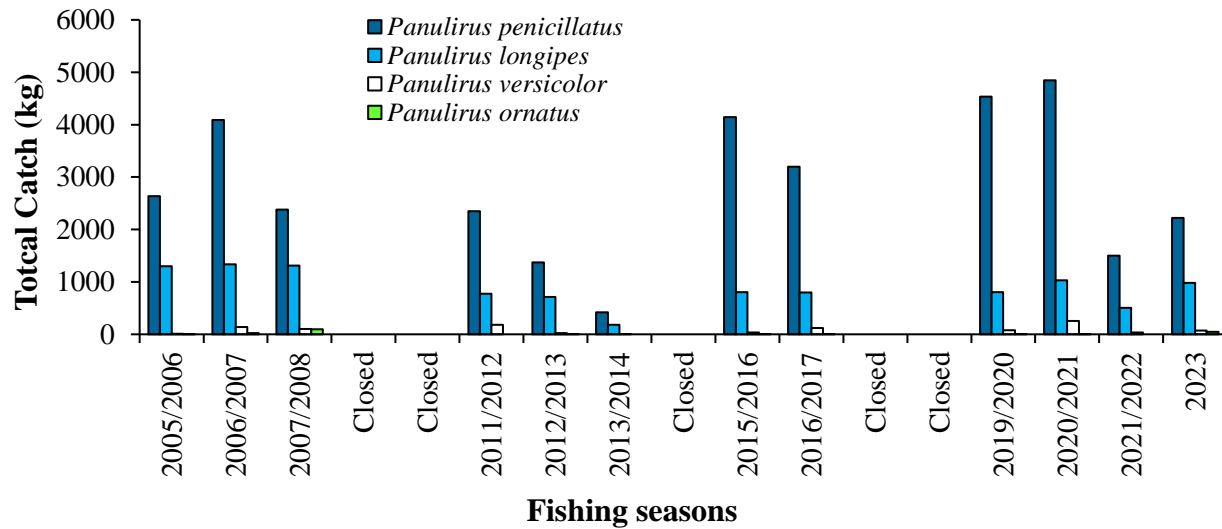


**Figure 12:** Catch per unit effort (CPUE) (kg/trip) for the last 3 fishing seasons per major fishing location.

#### 4.2. Species catch composition.

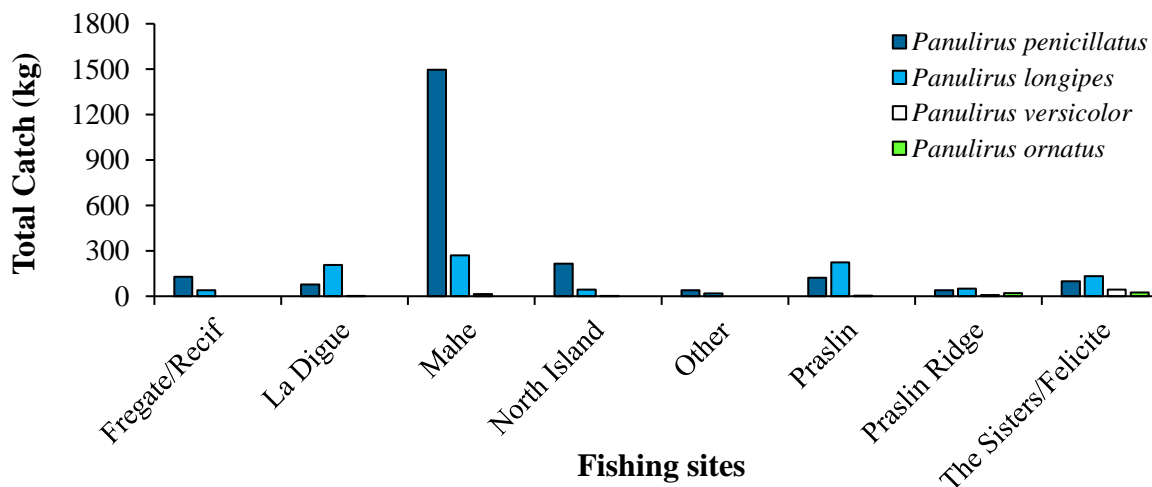
The catch composition for the main targeted species was dominated by *P. penicillatus*. A total of 2219 kg (2.21 MT) of *P. penicillatus* was caught compared to 1502 (1.50 MT) in 2021/2022 and 4849 kg (4.84 MT) in 2020/2021. *P. longipes* remained the second most dominant species, accounting for 984 kg of the catch compared to 506 kg and 1031 kg caught in 2021/2022 and 2020/2021, respectively. *P. versicolor* remained the third dominant species, comprising of 73 kg compared to 37 kg and 253 kg caught in 2021/2022 and 2020/2021. As for the rarest species, *P. ornatus* comprised of 46 kg in 2023 compared to 8 kg caught in 2020/2021 (**Figure 13**). **NB:** No *P. ornatus* were caught during the 2021/2022 fishing season.





**Figure 13:** Species catch (kg) composition over the 15-year period from 2005/2006 to 2023.

Three lobster species constituted the catch landed from Mahé, with *P. penicillatus* being the most dominant species with 67 % (1497 kg), followed by *P. longipes* with 27% (269 kg). Whilst *P. versicolor* was more dominant in catches reported on fishing sites around The Sisters/Felicite, consisting of 61% (45 kg) of the catch in that area (**Figure 14**).



**Figure 14:** Species compositions of spiny lobster caught from the main fishing locations during the 2023 fishing season.



### 4.3. Size frequency distribution.

A total of 2296 spiny lobsters were sampled for carapace length (CL) and sexed during the 2023 season compared to 2300 in 2021/2022 and 6298 in 2020/2021. This represents a sampling coverage of about 60% (81 trips sampled) of fishing activities for the 2023 season. In contrast, in 2021/2022 and 2020/2021 the sampling coverage was 89% and 87%, respectively. Unfortunately, contrary to previous seasons, sampling on Praslin and La Digue could not be undertaken due to unforeseen circumstances. On average, males dominated females in the samples with a ratio of 2.2:1 (**Table 1**).

**Table 1:**Quantity sampled per species for the last 3 open seasons.

Season	Species	F	M	Total
2020/2021	<i>P. penicillatus</i>	2346	2401	4747
	<i>P. longipes</i>	574	774	1348
	<i>P. versicolor</i>	128	73	201
	<i>P. ornatus</i>		2	2
2021/2022	<i>P. penicillatus</i>	509	1168	1677
	<i>P. longipes</i>	178	409	587
	<i>P. versicolor</i>	21	15	36
	<i>P. ornatus</i>			
2023	<i>P. penicillatus</i>	597	1246	1843
	<i>P. longipes</i>	113	319	432
	<i>P. versicolor</i>	12	9	21
	<i>P. ornatus</i>			

**Note:** M=males, F=females

#### 4.3.1. *Panulirus penicillatus*.

The relative size frequency distributions of males and females *P. penicillatus* sampled over the last 3 fishing seasons are shown in **Figure 15**. The relative strength of size classes (7.5-9.5 and 13 -16 cm CL) for males decreased, and for females (8.5-9.5 cm CL) increased in 2023 compared to the previous 2 seasons.

##### 4.3.1.1. Females.

Female *P. penicillatus* sampled during the 2023 season had carapace length (CL) ranging from 7 to 12.9 cm, with a mode of 8.9 cm, and a median of 8.1 cm. For the 2021/2022 season, females CL ranged from



7.4 to 15.3 cm, with a mode of 11 cm, and a median of 9.3 cm. Whilst in the 2020/2021 season, females CL ranged from 6.8 to 13.8 cm, with a mode at 10.2 cm, and a median of 8.9 cm (**Figure 16**). The CL average size was 9.1 cm in 2023, 9.2 cm in 2021/2022 and 9.4 cm in the 2020/2021 fishing seasons (**Figure 17**). There was a significant difference ( $p < 0.05$ ) amongst the female's CL average size between the 3 fishing seasons<sup>1</sup>. Females sampled in 2023 were smaller compared to 2020/2021 (**Figure 17** and **Table: 2 Appendix 4**). During the 2023 season, 0.1% of females were undersized ( $< 7.5$  cm), whilst in 2021/2022 and 2020/2021, the proportion was 2.6% and 1.2%, respectively.

#### 4.3.1.2. Males.

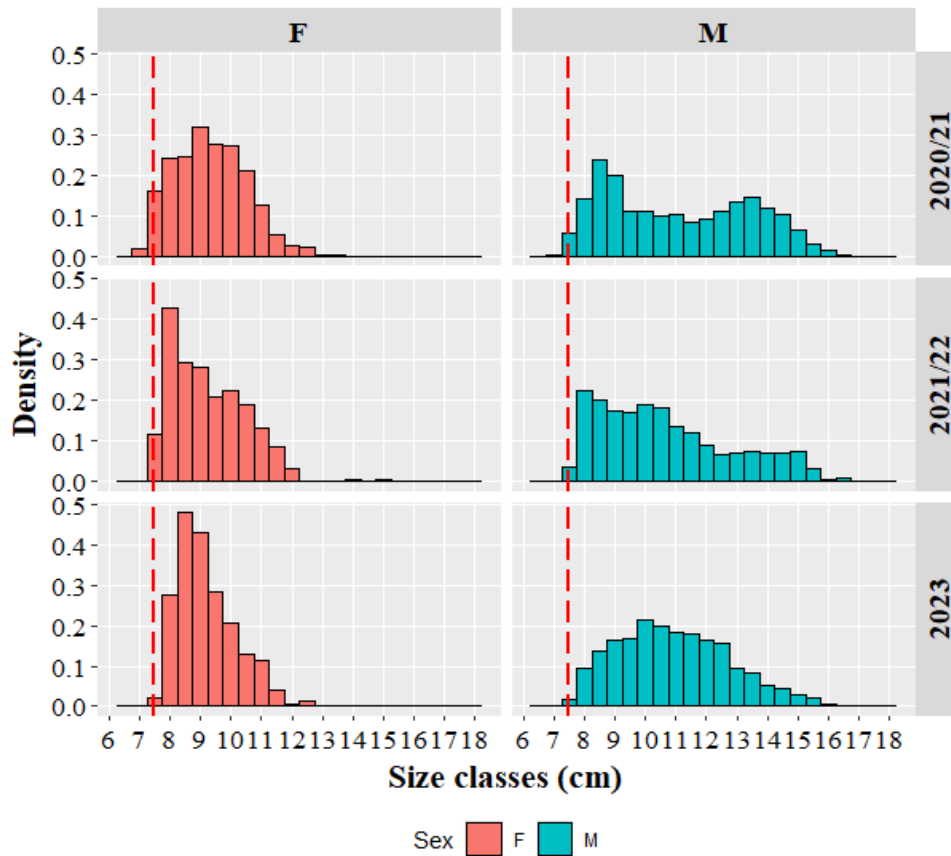
Males *P. penicillatus* sampled during the 2023 season had CL ranging from 7.3 to 18 cm, with a mode of 10.1 cm, and a median of 10.7 cm. For the 2021/2022 season, males CL sampled ranged from 7.12 to 19.35 cm, with a mode of 11.9 cm, and a median of 10.4 cm. Whilst in the 2020/2021 season, males CL sampled ranged from 6.5 to 17 cm, with a mode of 8.4 cm, and a median of 10.9 cm. (**Figure 16**). The CL average size was 10.9 cm in 2023, 10.7 cm in 2021/2022 and 11.1 cm in 2020/2021 (**Figure 17**). A significant difference ( $p < 0.05$ ) amongst the male's CL average size between the 3 fishing seasons<sup>2</sup>. Males CL sampled in 2023 was larger compared to the 2021/2022 season (**Figure 17** and **Table: 3 Appendix 4**). During the 2023 season, 0.1% of males were undersized ( $< 7.5$  cm), whilst in 2021/2022 and 2020/2021, the proportion was 0.2% and 2.3%, respectively.

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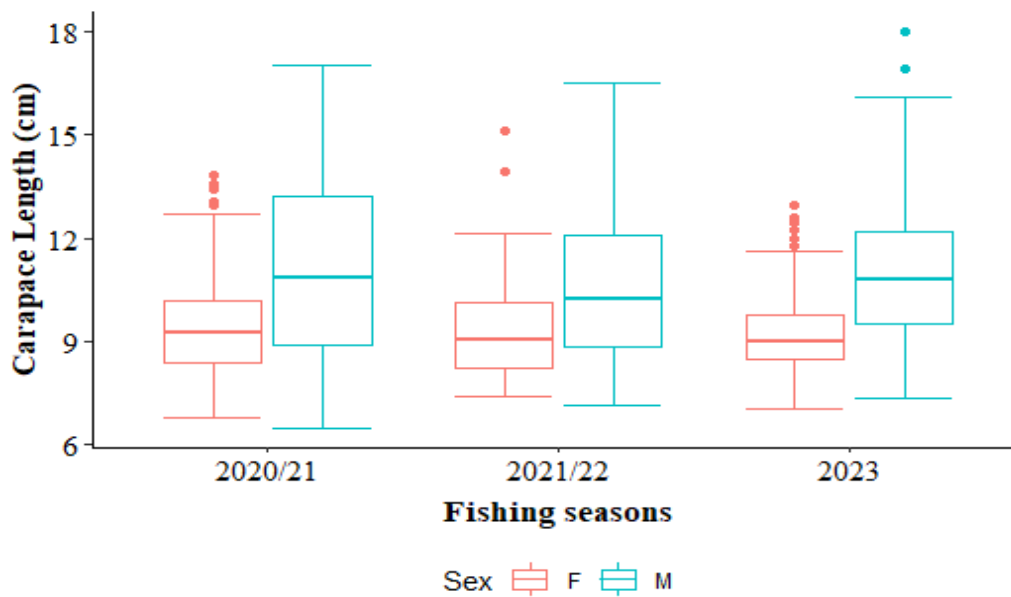
<sup>1</sup> Kruskal-Wallis test: ( $\chi^2_{(2)} = 8.2071, p < 0.05$ )

<sup>2</sup> Kruskal-Wallis test: ( $\chi^2_{(2)} = 28.463, p < 0.05$ )

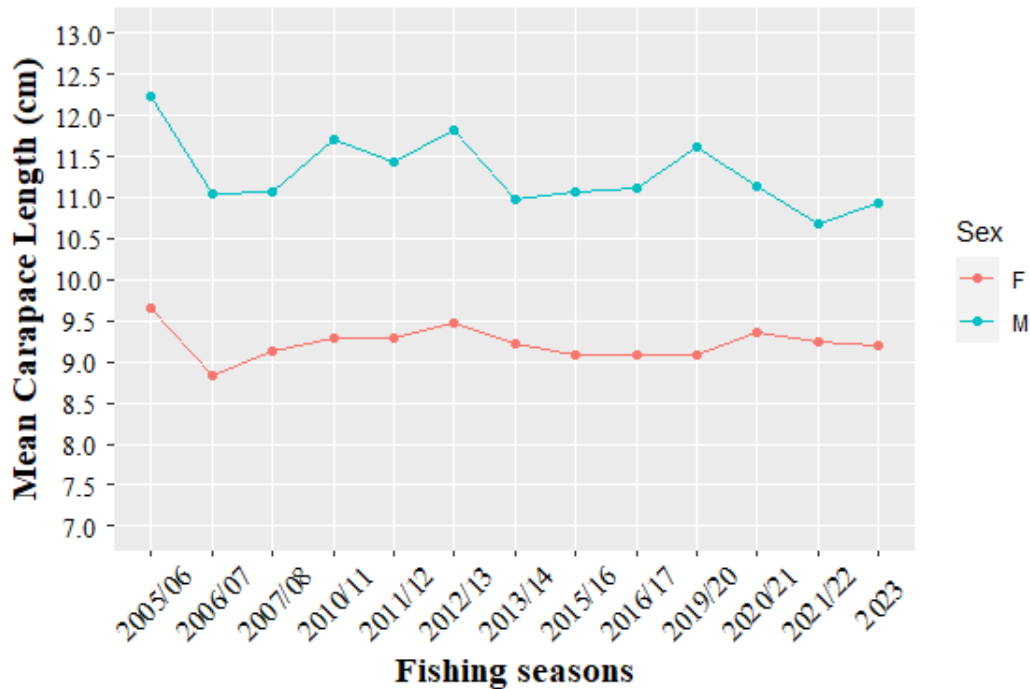




**Figure 15:** Size frequency distribution of female and male *P. penicillatus* over the last 3 open seasons. Density represents the proportion of counts of each size class. The minimum size limit of 7.5 cm (CL) is highlighted by the dashed redline.



**Figure 16:** Box plot of the size distribution of female and male *P. penicillatus* for the 3 fishing seasons.



**Figure 17:** Average sizes of *P. penicillatus* caught during the fishing season between sexes (M = males and F= females) from 2005 to 2023

#### 4.3.2. *Panulirus longipes*.

The relative size frequency distributions of males and females *P. longipes* sampled over the last 3 fishing seasons are shown in **Figure 18**. The relative strength of size classes (8-8.5 cm CL) for males and females increased in 2023 compared to previous 2 seasons.

##### 4.3.2.1. Females.

Female *P. longipes* sampled during the 2023 season had CL ranging from 6.5 to 9.1 cm, with a mode of 8.1 cm, and a median of 8.1 cm. For the 2021/2022 season, female CL ranged from 7.1 to 9.3 cm, with a mode of 7.8, and a median of 7.9 cm. Whilst in the 2020/2021 season, female CL ranged from 6.2 to 9.4 cm, with a mode of 7.8 cm, and a median of 7.9 cm (**Figure 19**). The CL average size was relatively similar over the last 3 seasons at 8.1 cm in 2023 and 2021/2022 and 7.9 cm in 2020/2021 (**Figure 20**). There was a significant difference ( $p < 0.05$ ) amongst the female CL average size between the 3 fishing seasons<sup>3</sup>. Female CL sampled in 2023 was larger compared to 2020/2021 (**Figure 20** and **Table: 4**

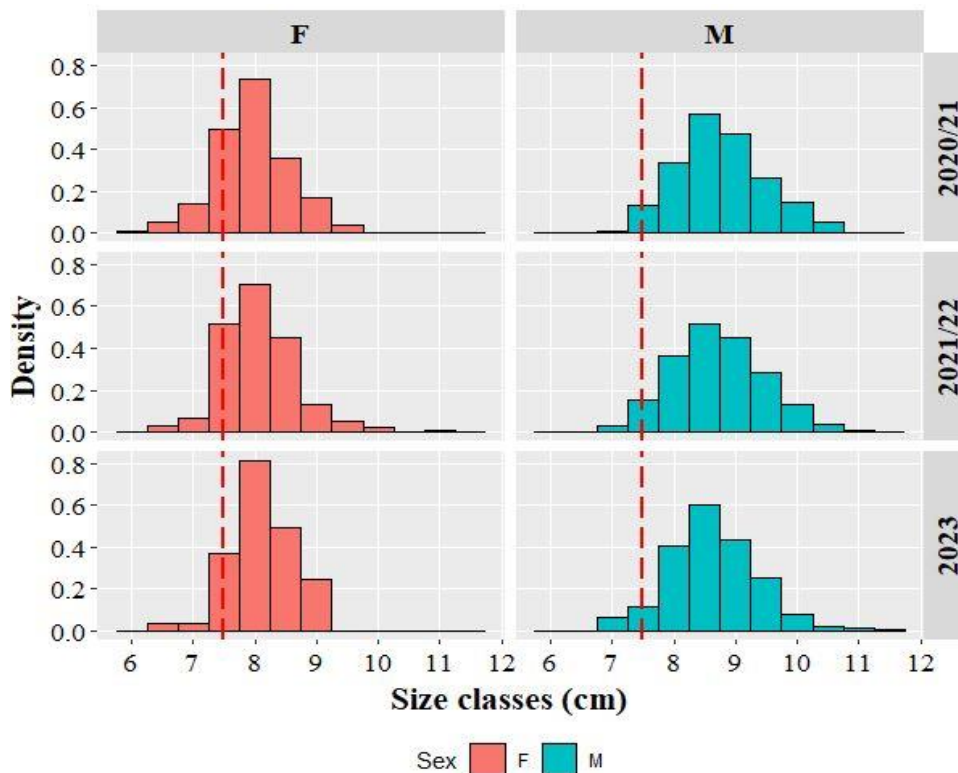
<sup>3</sup> Kruskal-Wallis test: ( $\chi^2_{(2)} = 7.241, p < 0.05$ )



**Appendix 4).** During the 2023 season, 0.4% of females were undersized (below 7.5 cm); in 2021/2022 and 2020/2021, the proportion was 3% and 8%, respectively.

#### 4.3.2.2. Males.

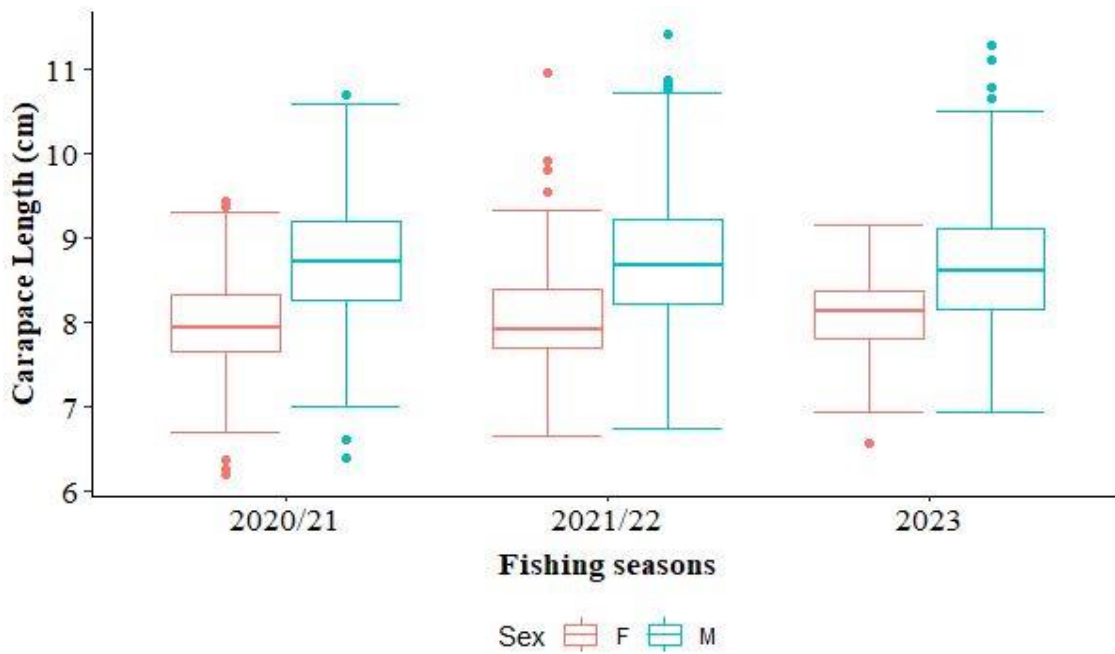
Male *P. longipes* sampled during the 2023 season had CL ranging from 6.9 to 11.2 cm, with a mode at 8.3 cm and a median of 8.6 cm. For the 2021/2022 season, the male’s CL sampled ranged from 6.7 to 11.4 cm, with a mode at 8.8 cm and a median of 8.7 cm. Whilst in the 2020/2021 season, males CL sampled ranged from 6.4 to 10.7 cm CL, with a mode of 8.8 cm CL and a median of 8.7 cm CL (**Figure 19**). The CL average size was 8.6 cm in 2023, 8.7 cm in both 2021/2022 and 2020/2021 (**Figure 20**). Males CL sampled in 2023 were not statistically significantly different ( $p > 0.05$ ) from males CL in 2020/2021 and 2021/2022 <sup>4</sup> (**Figure 20** and **Table: 5 Appendix 4**). During the 2023 season, 0.8% of males were undersized (below 7.5 cm), whilst, in 2021/2022 and 2020/2021, the proportion was 1% and 2.3%, respectively.



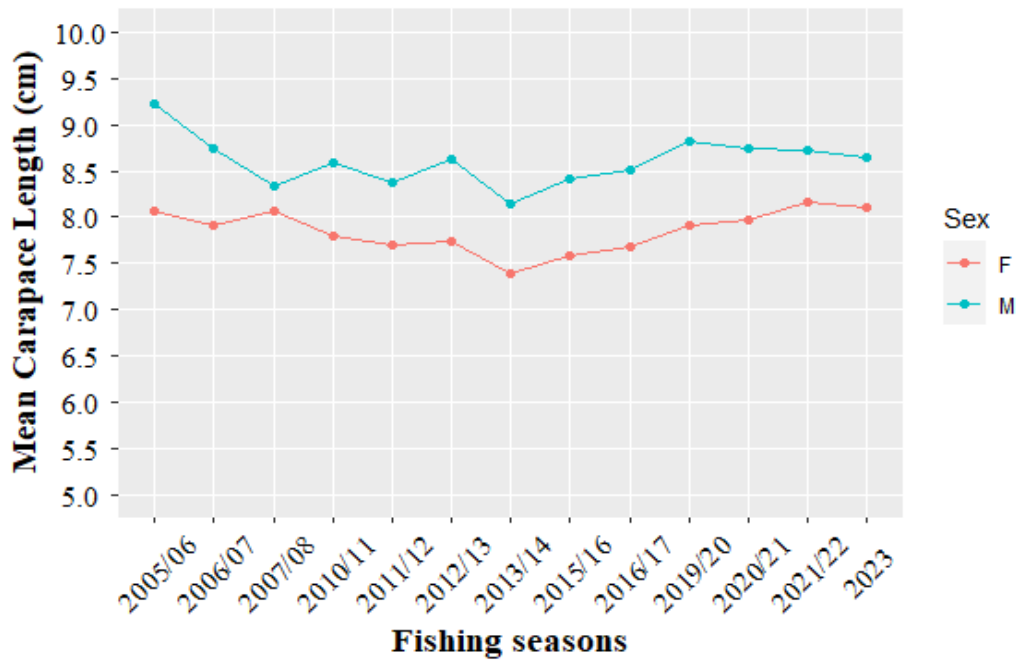
**Figure 18:** Size frequency distribution of female and male *P. longipes* over the last 3 open seasons. Density represents the proportion of counts in each size class whilst the minimum size limit of 7.5 cm is illustrated by the dashed redline.

<sup>4</sup> ANOVA test:  $F_{(2,1496)} = 2.22, p > 0.05$





**Figure 19:** Box plot of the size distribution of female and male *P. longipes* for the 3 fishing seasons.



**Figure 20:** Average sizes of *P. longipes* caught during the fishing season between sexes (M = males and F = females) from 2005 to 2023.



## 5. Discussion.

The lobster fishery has been opened over the last four consecutive fishing seasons. Due to declines in CPUE observed during the 2021/2022 fishing season, the 2023 lobster fishing season was opened for only 2 months compared to the typical 3-month duration. A total of 16 licenses were issued, however, only one fisher failed to utilise their license.

As with previous fishing seasons, the lobster fishers have expressed their concerns in relation to unfavourable weather conditions. This has affected the fisher's ability to engage in usual fishing activities, although some have still managed to brave the unfavourable conditions. Nonetheless, following concerns raised by the fishers and the results from the preliminary analysis of fisheries data a noticeable decrease in total catches, fishing effort, and a decline in the CPUE was observed. After careful consideration, the lobster fishery was extended for a further of 2 weeks.

For the 2023 fishing season, an increase in the total catch and fishing effort can be observed compared to the 2021/2022 seasons. In contrast, the catch and fishing effort declined compared to the 2020/2021 fishing season. The increase relative to the 2021/2022 season may be attributed to the extension of the fishing season in 2023. The length of the 2020/2021 fishing season was two months compared to 2.5 months for the 2023 season. In contrast, the 2020/2021 season was opened for four months (3 months plus 1 month extension).

Lobster fishing was prevalent in the Mahé area similar to the previous fishing season. This could be related to a higher number of fishermen being issued with a lobster licence compared to the other islands. It is more practical for fishers to target closer fishing sites, however, this may highly depend on multiple factors such as operation expenses to travel to distant fishing sites and lobster abundance in those areas.

The CPUE for the 2023 fishing season was 24% higher than the 2021/2022 fishing season and was 27% above the historical mean. Assuming that the nominal CPUE is a good indicator of the relative abundance of lobsters, this indicates an increase in the relative abundance of lobsters. However, this increase should be interpreted cautiously as multiple factors can contribute to this increase. Factors such as weather conditions, changes in fishing grounds, lunar phases and water turbidity can influence the catchability of lobsters. Moreover, the reduced length of the 2020/2021 season may have allowed more time for the lobster stock to recover for the 2023 season. As for CPUE per fishing location, Fregate/Recif recorded



the highest value, indicating higher biomass in that area. However, it is difficult to say with certainty that this is the case, given the low fishing effort (4 trips) around this location. It is worth noting that in this year's fishing season, all 4 licences allocated to Praslin Island were taken compared to the previous seasons. All 4 fishers have undertaken fishing activities regularly, which may have influenced the CPUE. However, another important observation of the CPUE was that Mahé had one of the lowest CPUE despite having the highest catch of all the fishing locations. This may indicate that the lobster populations around Mahé is under stress and experiencing localized depletion in population.

Over the last 3 fishing seasons, a noticeable change in the sizes of lobsters caught has been observed. The size distribution patterns for *P. penicillatus* and *P. longipes* shows few larger lobsters are being caught with skewness toward medium sized lobster when compared to the previous two fishing seasons. This information holds tremendous implications for the future fishable population, which deserves close attention. As larger lobsters have greater spawning potential, it is important to maintain these individuals within the population and allow smaller individuals to spawn at least once (Bertelsen and Matthews 2001, Fanning et al., 2011). It is apparent that opening the fishing season for 4 consecutive seasons has likely exerted significant fishing pressure on the lobster population. As such, it is critical to maintain consistent monitoring and to allow the stock to replenish in turn, this will guarantee the long-term sustainability of this highly valued seafood commodity.

Changes in the average size for both *P. penicillatus* and *P. longipes* were observed over the last 3 fishing seasons. Male *P. penicillatus* were significantly larger than lobsters caught in the 2021/2022 season, whilst females were smaller compared to 2020/2021. On the other hand, male *P. longipes* mean size remained constant as opposed to larger females in comparison to 2020/2021. The mean size of *P. penicillatus* for females and males and females for *P. longipes* remains fairly stable throughout, with slight fluctuation over the years. It is important to highlight that there has been a considerable decline in the number of undersized lobsters caught. Specifically, in 2023, the undersized catch accounted for only 1.4% compared to previous fishing seasons in 2021/2022 and 2020/2021. *P. longipes* accounted for 1.2% of the undersized catch. This positive trend could be due to improved monitoring efforts and increased awareness of fishers on fishery regulations.



As to previous seasons, the proportion of male lobsters was higher than female lobsters caught. This is assumed to be driven by the existence of licence regulation (i.e., the release of berried females) whereby fishers may be targeting more males than females, thus influencing the disproportion between the sexes.

Although efforts were made to improve Monitoring, Control, and Surveillance (MCS), reports of illegal fishing have been brought forth on multiple occasions by licensed fishers. Unregulated fishing poses a significant threat to the lobster stock. It is imperative that an extensive and effective monitoring plan is developed and enforced with the inclusion of frequent and regular monitoring patrols. This will not only ensure continuous compliance to license conditions by license holders but will also deter illegal activities which can reduce stress on the stock.

Similar to previous seasons, the Fisheries Research Department has successfully collected biological information this season despite facing various challenges. The sampling coverage was extensive.

The accuracy of the data presented in this report is highly dependent on the reliability and cooperation received from the licensed fishers. Generally, despite logbooks being submitted, several issues regarding data reporting were identified. These included inconsistency in recording (1) fishing date, (2) effort number and (3) under-reporting of total catch per trip.

Overall, data collected during the 2023 season indicates an increase in lobster's relative abundance (CPUE) compared to the previous season. An extensive fisheries independent assessment will be conducted during the fourth quarter of 2023 to evaluate the spiny lobster population and overall health. The assessment will generate data on the abundance and distribution of spiny lobster throughout the granitic and coralline islands within the Mahé plateau, including the fishery's impact on the localized populations. By conducting this research, we will gain greater insights into the spiny lobster fishery in Seychelles and further aid with future fisheries management of this resource. The intent is to ensure sustainable exploitation is adopted to derive the utmost long-term, socio-economic benefit for the fishery. As a result, the annual PLMP survey will not be undertaken in 2023. It is recommended to postpone the reopening of the next fishery season until the resources assessment is completed. Consequently, it is highly recommended that the next fishing season remain closed. This is because a noticeable decrease in the catch of lobsters can be observed when the fishery is kept open for 3 to 4 consecutive periods, as opposed to when it is closed for 1 or 2 years as depicted in Figure 5. This declining trend would have

been more apparent if the fishery extension in 2021/2022 and 2023 had not occurred. Additionally, the trend in CPUE (Catch Per Unit Effort) for the last two fishing seasons also indicates that more effort is being expended, while fewer lobsters are being caught.

As a precautionary approach, the fishery closure will be beneficial to allow the stock to replenish, improving fisher's future financial gain. Furthermore, closing the fishery while conducting an extensive fishery-independent assessment is the right approach to prevent the results being influence `by ongoing extraction fishers.



## 6. References.

- Behringer, D.C. and Butler, M.J., 2010. Disease avoidance influences shelter use and predation in Caribbean spiny lobster. *Behavioural ecology and sociobiology*, 64(5), pp. 747-755.
- Bertelsen, R.D. and Matthews, T.R., 2001. Fecundity dynamics of female spiny lobster (*Panulirus argus*) in a south Florida fishery and Dry Tortugas National Park lobster sanctuary. *Marine and Freshwater Research*, 52(8), pp.1559-1565.
- Chauvet, C. and Coutures, E., 2001. Growth and minimum suitable catch size of spiny lobsters, *Panulirus penicillatus* (Olivier, 1791) and *Panulirus longipes* (Bispinosus borradaile, 1899) (Decapoda, Palinuridae) in the southern lagoon of New Caledonia. *Crustaceana*, 74(11), pp.1189-1199.
- Chauvet, C. and Farman, R., 1994. Spiny lobsters *Panulirus penicillatus* and *Panulirus longipes* on the Isle of Pines growth, mortality and yield per recruit. In: *Twenty-Fifth Regional Technical Meeting on Fisheries*. New Caledonia: South Pacific Commission, pp. 1-6.
- Emmerson, W., 2017. *A Guide To, And Checklist For, The Decapoda Of Namibia, South Africa And Mozambique*. United Kingdom: Cambridge Scholars Publishing, 3, pp.1-720.
- Fanning, L., Mahon, R. and McConney, P., 2011. Towards marine ecosystem-based management in the wider Caribbean (p. 428). Amsterdam University Press.
- Holthuis, L., 1991. Marine Lobsters of the World: An Annotated and Illustrated Catalogue of Species of Interest to Fisheries Known to Date. In: *FAO Fisheries Synopsis*. Italy: Food and Agriculture Organization of the United Nations, 125(13), pp. 8-292.
- Hovel, K. and Lowe, C., 2007. *Shelter Use, Movement, And Home Range of Spiny Lobsters in San Diego County*. Research Final Reports. San Diego: University of California, pp. 1-4.
- Mees, C., 1992. *Procedures for monitoring catch, effort and biological parameters from Seychelles Lobster Fishery*. Seychelles: Seychelles Fishing Authority, pp.1-5.
- Morgan, A.C. and Burgess, G.H., 2005. 11. Fishery-dependent sampling: total catch, effort and catch. *Management techniques for elasmobranch fisheries*, (474), p.182.
- Pitcher, C., 1993. Spiny Lobster. In: A. Wright and L. Hill, (eds). *Nearshore Marine Resources of the South Pacific*. Honiara: Forum Fisheries Agency, pp. 539-607.
- Porobic, J., Fulton, E.A., Parada, C., Frusher, S., Ernst, B. and Manríquez, P., 2019. The impact of fishing on a highly vulnerable ecosystem, the case of Juan Fernández Ridge ecosystem. *PloS One*, 14(2), pp. 1- 32.
- SFA., 2017. Report on the spiny lobster fishery: Summary of Fishing activity for the 2016-2017 season. Seychelles: Seychelles Fishing Authority, pp. 1-10. SFA/R&D/080.
- SFA., 2019. Report on the spiny lobster fishery: Summary of Fishing activity for the 2019-2020 season. Seychelles: Seychelles Fishing Authority, pp. 1-10. SFA/R&D/083.
- Radhakrishnan, E., Phillips, B. and Achamveetil, G., 2019. *Lobsters: Biology, Fisheries and Aquaculture*. 1st ed. Singapore: Springer Nature, pp. 14-677.
- Withy-Allen, K.R. and Hovel, K.A., 2013. California spiny lobster (*Panulirus interruptus*) movement behaviour and habitat use: implications for the effectiveness of marine protected areas. *Marine and Freshwater Research*, 64(4), pp. 359-371.

## Appendix 1

Lobster fishery licence terms and conditions during open season.

### Conditions of this license

1. A COMPLIANCE BOND OF SR5000 WILL BE PAID TO SFA AS A DEPOSIT PRIOR TO ISSUANCE OF THE LICENCE. THE SFA SHALL WITHHOLD THE COMPLIANCE BOND IN THE EVENT OF SUSPECTED NON-COMPLIANCE TO THESE CONDITIONS, THE FISHERIES REGULATIONS AND THE FISHERIES ACT.
2. THE LICENSEE SHOULD FILL IN THE LOGBOOK CORRECTLY, WITH A MARGIN OF ERROR OF +/-10 UNITS AND SHALL SUBMIT TO THE SFA FORTNIGHTLY, FOR THE LENGTH OF THE FISHING SEASON. ALL COMPLETED LOGBOOKS SHALL BE SUBMITTED TO THE SFA WITHIN ONE WEEK AFTER CLOSURE OF THE LOBSTER FISHING SEASON.
3. THE HOLDER OF THE LICENCE SHALL NOT AT ANY TIME FISH FOR, CATCH, OR KILL HOMARD IN A PROTECTED AREA.
4. THE HOLDER OF THE LICENCE SHALL NOT FISH FOR, CATCH OR KILL HOMARD WHICH IS LESS THAN 7.5 CM IN LENGTH MEASURED FROM THE EYE SOCKET ALONG A LINE PARALEL TO THE CENTRE LINE OF THE BODY SHELL (CARAPACE) OF THE HOMARD.
5. THE HOLDER OF THE LICENCE SHALL NOT FISH, CATCH, KILL, SELL OR BE IN POSSESSION OF A HOMARD IN THE BERRIED STATE.
6. THE HOLDER OF THE LICENCE SHALL PROVIDE ACCESS TO THE SFA FISHERIES RESEARCH TECHNICIANS TO ALL CATCHES, AND PROVIDE ALL REASONABLE ASSISTANCE IN THE COLLECTION OF ALL FISHERIES RELATED DATA (i.e. INFORMATION RELATING TO FISHING LOCATION etc..)
7. THE HOLDER OF THE LICENSE SHALL COMPLETE AND PROVIDE A SALES RECEIPT FOR ALL SALE OF LOBSTERS. THE HOLDER OF THE LICENSE SHALL PROVIDE THE SFA WITH A COPY OF THE RECEIPT BOOK AT THE CLOSURE OF THE LOBSTER SEASON.
8. THE HOLDER OF THE LICENSE SHALL NOTIFY THE SFA OF THE NAME OF THE VESSEL(IF APPLICABLE) THAT IS BEING USED FOR THE PURPOSES OF LOBSTER FISHING, AS WELL AS THE FOLLOWING DETAILS OF THE CREW ONBOARD
  - a. NAME AND SURNAME
  - b. NATIONAL IDENTIFICATION NUMBER
9. IT SHALL BE THE RESPONSIBILITY OF THE LICENSE HOLDER TO INFORM THE SFA ON ANY CHANGES THEREOF.
10. THE LICENSE HOLDER SHALL SUBMIT A COLOR PICTURE OF FISHING VESSEL BEING NOTIFIED FOR THIS PURPOSE.
11. THE HOLDER OF THE LICENSE SHALL NOTIFY THE SFA PRIOR TO THE COMENCEMENT OF ANY FISHING TRIP, ON 2811280.
12. ALL CREW MEMBERS SHALL CARRY THEIR NATIONAL IDENTIFICATION CARD DURING FISHING TRIPS. THE NATIONAL IDENTIFICATION CARD MUST BE PRODUCED AT THE REQUEST OF AN AUTHORIZED FISHERY OFFICER, OR ANY MEMBER OF A LAW ENFORCEMENT AGENCY.



## Appendix 2

Fishers Catch and Effort Logbook (FCEL).

<b>Lobster Catch and Effort Logbook</b>											
SFA No. :											
Date:			Name:			Landing Sites:					
<b>Scuba &amp; Snorkeling</b>											
Fishing Site				Fishing Site				Fishing Site			
Scuba	<input type="checkbox"/>	Snorkeling	<input type="checkbox"/>	Scuba	<input type="checkbox"/>	Snorkeling	<input type="checkbox"/>	Scuba	<input type="checkbox"/>	Snorkeling	<input type="checkbox"/>
Time in				Time in				Time in			
Time out				Time out				Time out			
No. fishers				No. fishers				No. fishers			
Bottom Type				Bottom Type				Bottom Type			
Oumar Rouz	No:	Kg:		Oumar Rouz	No:	Kg:		Oumar Rouz	No:	Kg:	
Oumar Ver	No:	Kg:		Oumar Ver	No:	Kg:		Oumar Ver	No:	Kg:	
Grosse Tete	No:	Kg:		Grosse Tete	No:	Kg:		Grosse Tete	No:	Kg:	
Porcelaine	No:	Kg:		Porcelaine	No:	Kg:		Porcelaine	No:	Kg:	
<b>Trap</b>											
Fishing Site				Fishing Site				Fishing Site			
Time set				Time set				Time set			
Time Haul				Time Haul				Time Haul			
No. Traps				No. Traps				No. Traps			
Bottom Type				Bottom Type				Bottom Type			
Oumar Rouz	No:	Kg:		Oumar Rouz	No:	Kg:		Oumar Rouz	No:	Kg:	
Oumar Ver	No:	Kg:		Oumar Ver	No:	Kg:		Oumar Ver	No:	Kg:	
Grosse Tete	No:	Kg:		Grosse Tete	No:	Kg:		Grosse Tete	No:	Kg:	
Porcelaine	No:	Kg:		Porcelaine	No:	Kg:		Porcelaine	No:	Kg:	
Remark:											



### Appendix 3

#### Sampling Catch and Effort Logbook (SCEL).

**Lobster data collection form**

Date..... Licensee Name ..... License No.....

Landing site..... Fishing Location .....

Fishing Method ..... No. Men/Trap .....

Time in..... Time out..... Substrate type .....

	Species	Sex	CL (mm)	Weight (g)	Eggs	Tar spot	Setae hair	Tag no.
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								

Comments .....

Measurer..... Recorder.....



## Appendix 4

Pairwise comparison between fishing seasons.

**Table 2:** Pairwise comparisons between average carapace length of *Panulirus penicillatus* females caught in 2023, 2021/2022, and 2020/2021 fishing seasons. P values adjusted with the Bonferroni method.

Comparison Groups	P value	Significance level
2020/2021 - 2021/2022	0.08964660	ns
2020/2021 - 2023	0.04129902	$p < 0.05$
2021/2022 - 2023	1.00000000	ns

Significance level at 0.05. ns; nonsignificant difference.

**Table 3:** Pairwise comparisons between average carapace length of *Panulirus penicillatus* males caught in 2023, 2021/2022, and 2020/2021 fishing seasons. P values adjusted with the Bonferroni method.

Comparison Groups	P value	Significance level
2020/2021 - 2021/2022	5.654659e-07	$p < 0.05$
2020/2021 - 2023	1.000000e+00	ns
2021/2022 - 2023	1.900146e-04	$p < 0.05$

Significance level at 0.05. ns; nonsignificant difference.

**Table 4:** Pairwise comparisons between average carapace length of *Panulirus longipes* females caught in 2023, 2021/2022, and 2020/2021 fishing seasons. P values adjusted with the Bonferroni method.

Comparison Groups	P value	Significance level
2020/2021 - 2021/2022	0.65990617	ns
2020/2021 - 2023	0.02289518	$p < 0.05$
2021/2022 - 2023	0.40422884	ns

Significance level at 0.05. ns; nonsignificant difference.

**Table 5:** Pairwise comparisons between average carapace length of *Panulirus longipes* males caught in 2023, 2021/2022, and 2020/2021 fishing seasons. P values adjusted with the Bonferroni method.

Comparison Groups	P value	Significance level
2021/2022 - 2020/2021	0.9245181	ns
2020/2021 - 2023	0.0930890	ns
2021/2022 - 2023	0.2698559	ns

Significance level at 0.05. ns; nonsignificant different.

