Seychelles Sea Cucumber Fishery Report: 2023-2024

Fisheries Research Department

Seychelles Fisheries Authority

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Compiled by: Clara Belmont

Assited and reviewed by:

Stephanie Hollanda and Dainise Quatre

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1.Background

The sea cucumber fishery in the Seychelles has a long history, with harvesting activities dating back to the 1800s. However, it was not until the late 1990s that exploitation significantly increased, driven by rising global demand and the corresponding spike in prices (Aumeeruddy and Payet, 2002). This surge in interest led to a shift in fishing practices, transitioning from shallow-water collection by foot to deeper-water harvesting using scuba gear. This change resulted in a notable rise in both catch volumes and prices (Aumeeruddy and Payet, 2002). Despite the rapid expansion of the fishery, it initially operated as an open-access system with minimal baseline data on sea cucumber stocks and fishing activities, particularly before 1999 (Aumeeruddy & Conand, 2008).

By 1999, the decline in economically targeted species led the Seychelles Fisheries Authority (SFA) to implement precautionary management measures, such as issuing fishing and processing licenses and limiting the number of divers to four per license. Ultimately, the fishery was temporarily closed in 2001 due to insufficient measures and a lack of data.

1.1. Management

Prior to 1999, the sea cucumber fishery was unregulated, with no formal measures in place. However, when the need for regulation became clear, control measures were introduced through the Fisheries (Amendment) Regulations of 1999. These included the requirement for fishing and processing licenses, with an annual fee of SCR 300, a cap of 25 licenses, and a maximum of four divers allowed per license, (Aumeeruddy, 2007). In 2005, Total Allowable Catch (TAC) quotas were established for each commercial species, based on the Maximum Sustainable Yield (MSY) as part of a broader management plan. While these regulations have largely remained in place, the cost of the fishing license has since increased to 7,000 SCR amongst others listed below (Aumeeruddy, 2007).

In 2013, a Management Advisory Committee (MAC) was established, comprising representatives from the SFA and industry stakeholders, and it serves as a platform for discussing issues related to fishery and proposing potential solutions.

The management regulations for the fishery over the past three seasons (2020/21, 2021/22, and 2022/23) were as follows below, except for a change in species in the 2022/23 season, where White Teatfish was replaced by Sandfish:

- A limit of 25 non-transferable fishing licenses and 4 processing licenses
- An 8-month open fishing season
- A maximum of 4 divers per license
- Mandatory logbook reporting of catch and effort data
- Only three species are permitted for exploitation on the Mahe plateau: Flower Teatfish (Pentard, *Holothuria spp.)*, Prickly Redfish (Sanpye, *Thelenota ananas*), and Golden Sandfish (Kokonm, *Holothuria lessoni*)
- The Total Allowable Catch (TAC) per species

All license holders are required to adhere to these regulations as part of their fishing license conditions. These management measures are reviewed seasonally and adjusted as needed. Adjustments may involve changes to TAC quotas and the species allowed for harvest, based on fishery performance analysis, trends in catch and quota usage, and the findings and recommendations from stock assessment surveys.

This summary report presents an overview of the methods used and data processing steps, and a detailed analysis of the catch and effort data for the Sea cucumber fishery during the **2023-2024 fishing season**. It outlines the fluctuations in total catch, fishing effort, variations in Catch Per Unit Effort (CPUE), and percentage quota utilization, providing insights into the fishery's performance and trends over these periods.

2. Materials and Methods

2.1. Sampling methodology

To determine the status of the fishery, data on the fishery is collected through the following sources:

i) Paper logbooks (Appendix I) are provided to skippers during departure inspections. Skippers fill these logbooks at sea, recording catch and effort data after each dive. Catch is recorded as the number of sea cucumber pieces.

ii) Port Control Officers collect landings data during inspections when the catch is being unloaded. Landings are documented as the total number of sea cucumber pieces and the total weight by species.

Annual logbook training is undertaken before each fishing season and whenever there is a change in skippers, to ensure that they understand the importance of reliable and accurate data collection. Currently, the only fishing method for sea cucumbers is scuba diving. The following details must be entered into the logbook after every dive:

- Diving date
- Fishing site (GPS position or fishing grid provided by SFA (Appendix II)).
- Start and end diving time.
- Number of divers
- Depths
- Dive time for each diver.
- Catch in numbers of individual species; only three species are allowed to be caught.

After each trip, the logbooks are collected and sent to the Research Department for data entry and verification using the SIH-OBSDEB landing fishery data collection tool. Once all the data for the fishing season has been entered and verified, it is downloaded, cleaned, and analysed using Microsoft Excel and R programming software.

2.2. Fishing Area

The fisheries operate within the Seychelles EEZ however, it is divided into management zone. The Authorised Zones which are divided into Zone 1, Zone 2, Zone 3 and Zone 4 (Figure 1) are the areas where the aforementioned quota and species allowances (3 species) are applicable. The 'Other Zones' are zones within the Seychelles EEZ other than the Authorised Zones where a licensee can conduct fishing activities subject to written permission from SFA.

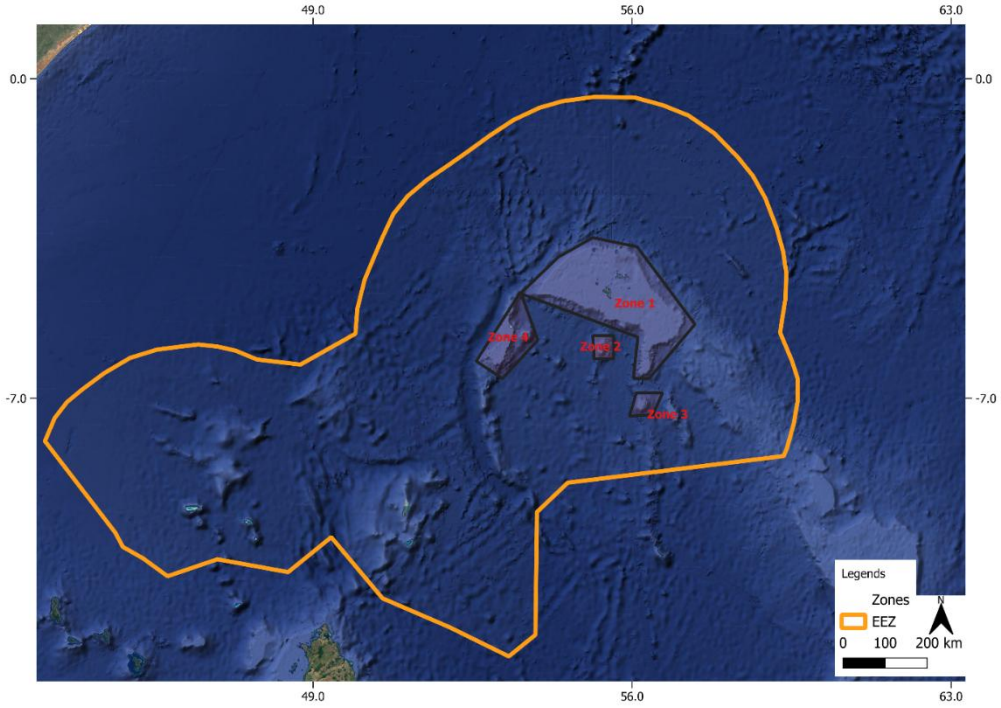

Figure 1: Map indicating all fishing zones that is classified as the Authorised zones

2.3. Data analysis

2.3.1. Catch, effort and catch per unit effort.

For each species caught, the total catch in pieces was calculated seasonally using data collected from logbooks. The effort was measured in terms of the total number of trips, diver days, and dive minutes. Diver day and dive minutes were calculated using the same method used in the 2012 and 2017 fisheries dependent stock assessments (MRAG, 2012, 2017).

Dive time was calculated by multiplying the recorded dive time by the number of divers. If divers in a pair had differing dive times, only the longest recorded time was considered. In cases where recorded dives included two divers and the total dive time exceeded 70 minutes, the dive time was used as is, without doubling it. However, the recorded dive times varied significantly, ranging from just a few minutes to several hours.

To try to address the problem, the following rules were applied:

- **Dive time > 70 min** was treated as **total dive time** regardless of the number of divers

- **Dive time > 0** but number of divers was 0, dive time was treated as **total dive time.**
- **Total dive time = recorded dive time × number of divers.**
- Dive time less than 10 minutes were not included in the analysis.

Diver days was also calculated as per the equation (MRAG,2012):

$$E_i = d_i \frac{1}{n}$$

Where ***E*** is effort, ***d*** is the recorded number of divers and $\mathbf{n}$ is the total number of records on the same day for the same vessel. For example, if the dataset contains three records, each with four divers for a specific vessel and day, the effort for each record was estimated to be $\frac{4}{3}$ diver days. This method assumes equal effort for all records for a specific vessel on any given day.

From the two calculated efforts, CPUE was then determined for each diving operation as per the equation below.

Dive time:

$$CPUE = \frac{Catch\ (pieces)}{Effort\ (dive\ time\ in\ \min)}$$

Diver day:

$$CPUE = \frac{Catch\ (pieces)}{Effort\ (Diver\ day)}$$

The average CPUE was calculated by summing the CPUEs from all diving operations and then dividing by the total number of diving operations.

Maps were also generated (section 3.3.1) to show fishing effort (dive time per minutes) across the Mahé plateau and the Amirantes bank.

2.3.2. Quota utilization

Quota utilization for the sea cucumber fishery was calculated for each vessel using the landings data, by comparing the recorded landings per species against the vessel's allocated quota for that species. The utilization rate for each vessel and species was determined using the formula:

$$Quota\ utilisation\ (\%) = \frac{Vessel\ landings\ per\ species}{Vessel\ quota\ per\ species}\ \text{x}\ 100$$

Additionally, an overall utilization rate was calculated for each vessel by summing the landings across all species and comparing this total to the combined species quotas allocated to the vessel. This process was repeated for each fishing season, resulting in species-specific and overall quota utilization rates per vessel.

To summarise the data by fishing season, the minimum, maximum, and average quota utilisation rates were calculated across all vessels.

3.Results

3.1. Fishing seasons

The **2023/2024** season lasted eight months, from October 1st, 2023, to June 30th, 2024. The authorized species were Flower Teatfish (Pentard, *Holothuria spp*.), Prickly Redfish (Sanpye, *Thelenota ananas*) and Golden Sandfish (Kokonm, *Holothuria lessoni*). Under current licensing conditions, additional species such as White Teatfish, may be harvested from the Other Zones, but only upon formal request and with official permission granted.

3.2. Catch

A total of 233,285 sea cucumbers were harvested during the 2023/2024 fishing season, marking a slight increase of 1.3% compared to the 230,248 caught in the previous season (2022/2023). The dominant species remained Flower Teatfish, which accounted for 199,611 individuals in 2023/2024, a 2.7% increase from the 194,390 recorded in the

previous year. Prickly Redfish catch declined by 9.4%, from 26,925 to 24,401, while Sandfish (3,620) showed a sharp decrease compared to the 8,933 Golden Sandfish recorded in 2022/2023. Additionally, 5,038 White Teatfish and 615 Black Teatfish were harvested under special permissions in the Other Zones. Excluding these two species, the total catch from the Authorised Zones stands at 227,623, showing only a marginal decrease (1.1%) compared to the previous season (Figure 2).

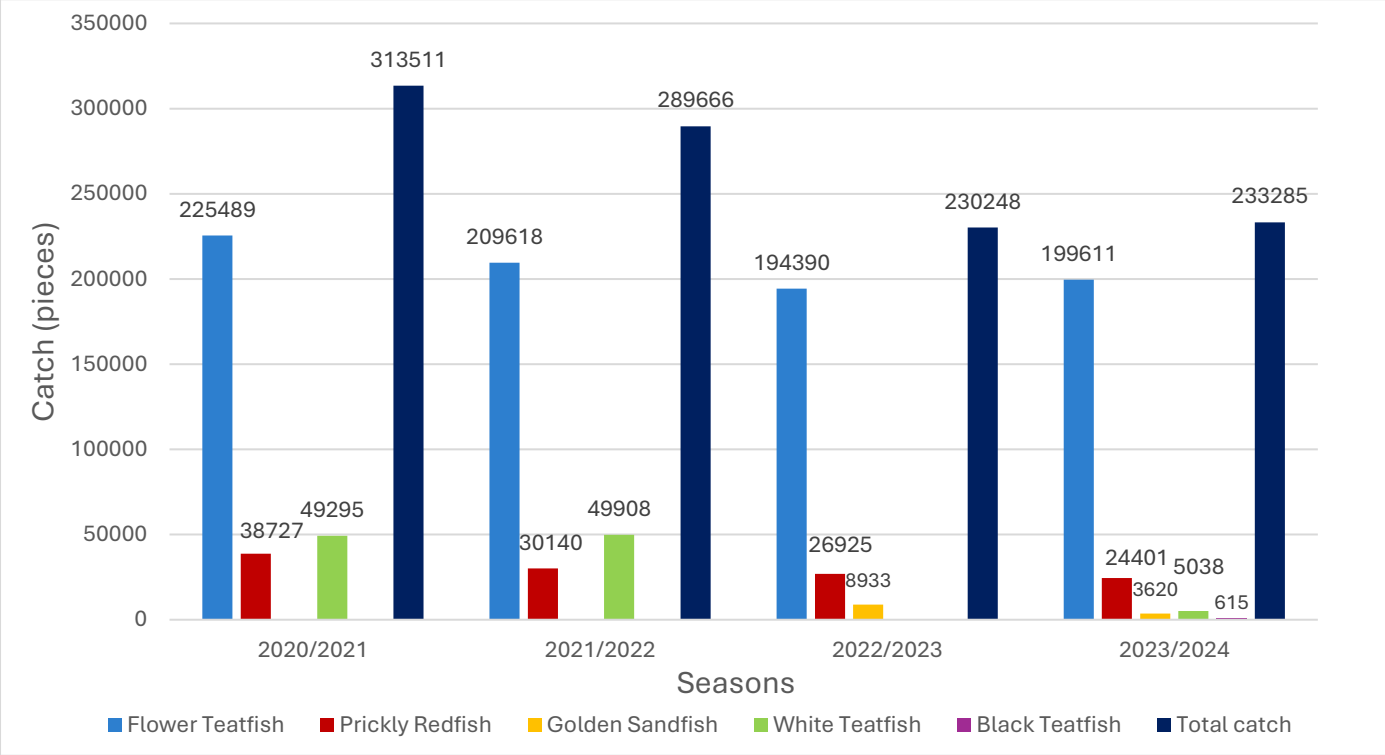

Figure 2: Catches of sea cucumber by species for the past four fishing season.

3.2.1. Catch by months

During the 2023/2024 fishing season, the highest catch was recorded in December, with a total of 33,690 individuals across all species. In contrast, the lowest catch occurred in June, with only 6,935 individuals landed. Catch levels declined in January (24,500 individuals) and this downward trend became more evident in March (21,500 individuals). An increase was recorded in April (29,700 individuals), before catches

dropped again toward the end of the season, falling to 18,800 individuals in May.(Figure 3).

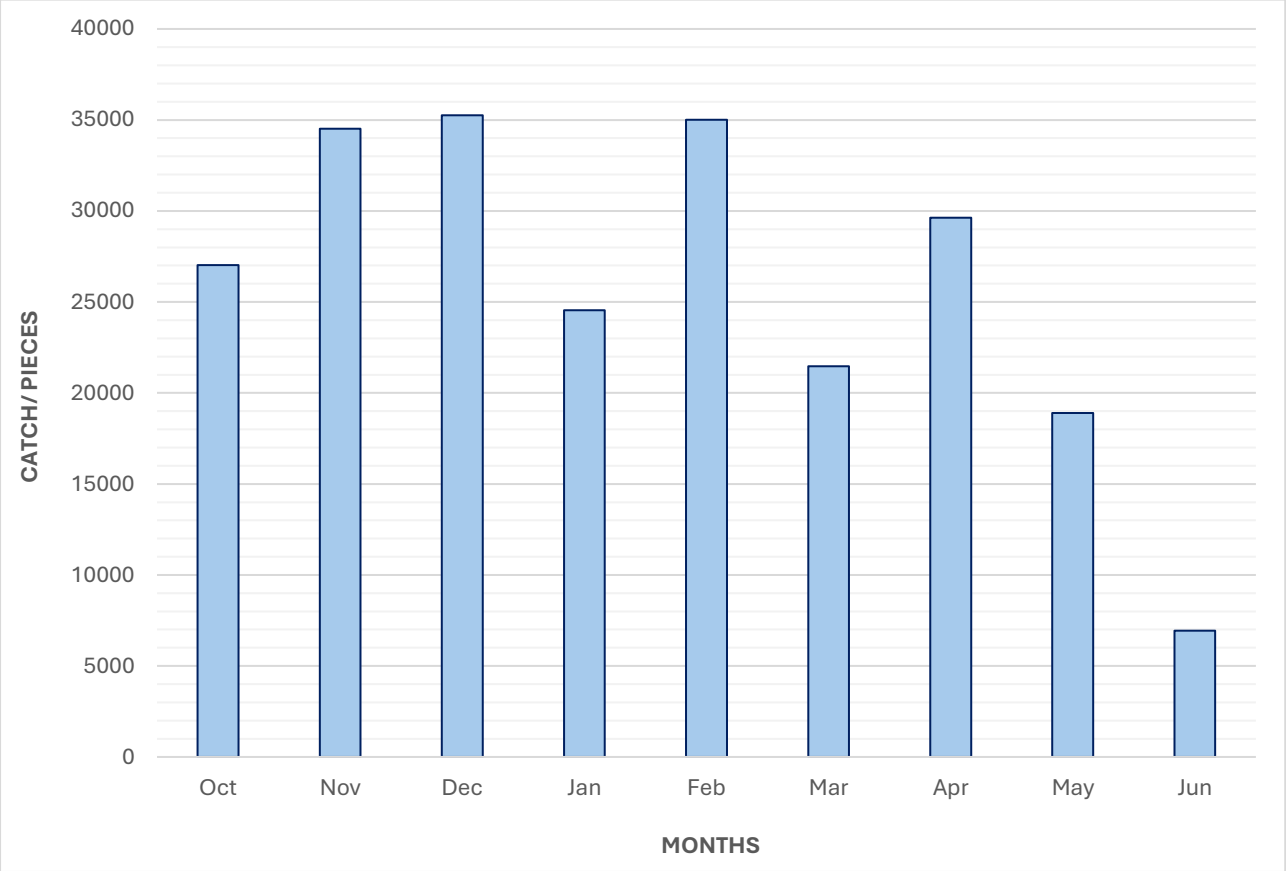

Figure 3:Monthly Sea cucumber catch data for 2023/2024 fishing season.

3.3. Effort

In the 2023/2024 season, 133 trips were made, totaling around 1,193,553 dive minutes, at an average of 99.58 minutes per dive. This season also recorded 6,718 total diver days, with an average of 0.56 diver days per trip (table 1).

Between the 2022/2023 and 2023/2024 seasons, there was a general increase in diving activity with the number of trips rising from 127 to 133, and the total dive minutes increasing by 8.5%. Total diver days also saw a rise of 15.6%, going from 5,813 to 6,718, while the average diver days per trip also increased from 0.53 to 0.56.

Table 1: Fishing effort for the 2020/2021, 2021/2022, 2022/2023 and 2023/2024 fishing seasons.

Season	No. of trips	Total dive mins	Avg. dive mins	Total diver days	Avg. diver days
2020/2021	153	1404692	96.15	7695	0.52
2021/2022	141	1509084	96.84	6939	0.44
2022/2023	127	1100343	101.15	5813	0.53
2023/2024	**133**	**1193553**	**99.58**	**6718**	**0.56**

3.3.1. Spatial Distribution of fishing effort

Figure 4 provides a visual representation of the analysis for the **2023/2024** dive effort on the Mahé Plateau distributed across all regions, with the central and western areas remaining the most dominant. Significant activity was recorded throughout the plateau, indicating that divers spent considerable time underwater. On the Amirantes Plateau, diving took place across the entire area, though the longest dive durations were concentrated in the southern part of the plateau.

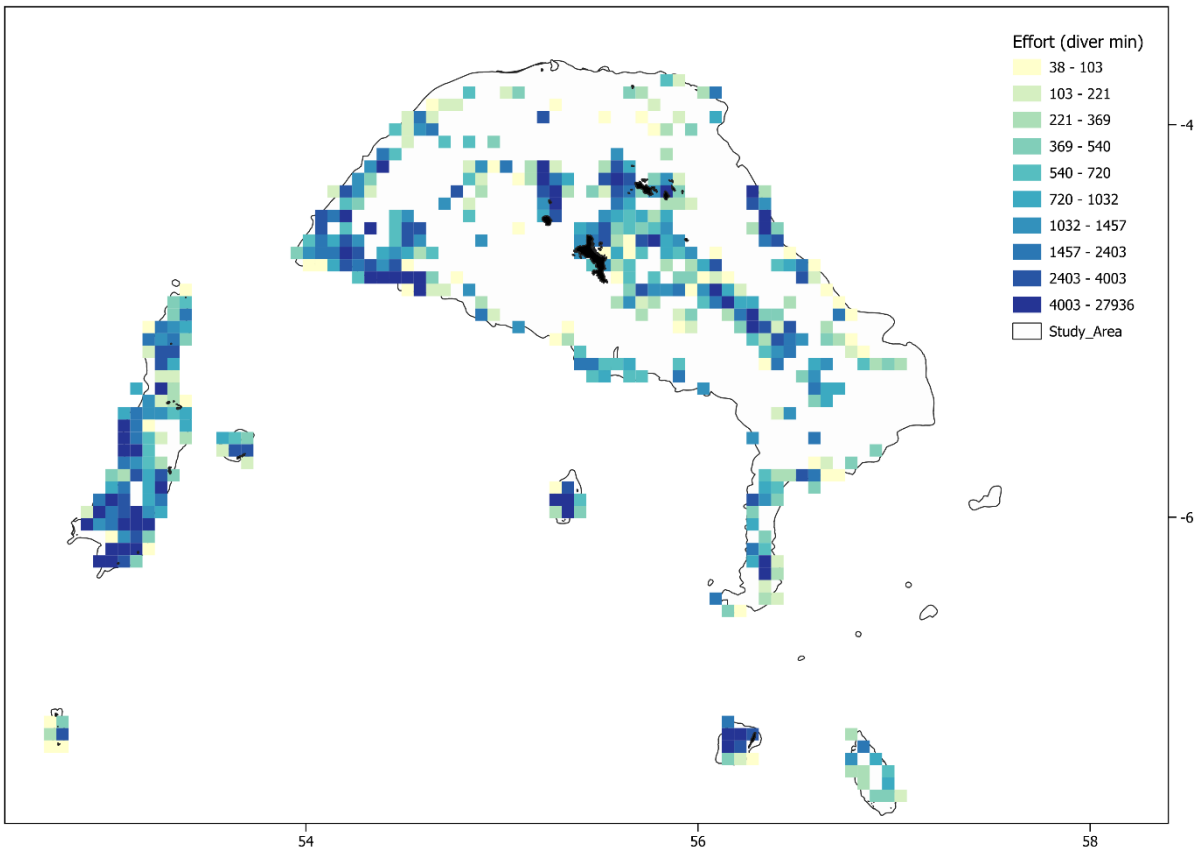

Figure 4:Map illustrating dive effort during the 2023/2024 fishing season across the Mahé Plateau and Amirantes.

Figure 5 shows dive effort in the outer islands, including the Farquhar Group. Some notably high dive times were recorded around Coetivy island. While dive times in these areas were lower compared to the Mahé and Amirantes plateaus, the data indicates that they were not left unexploited.

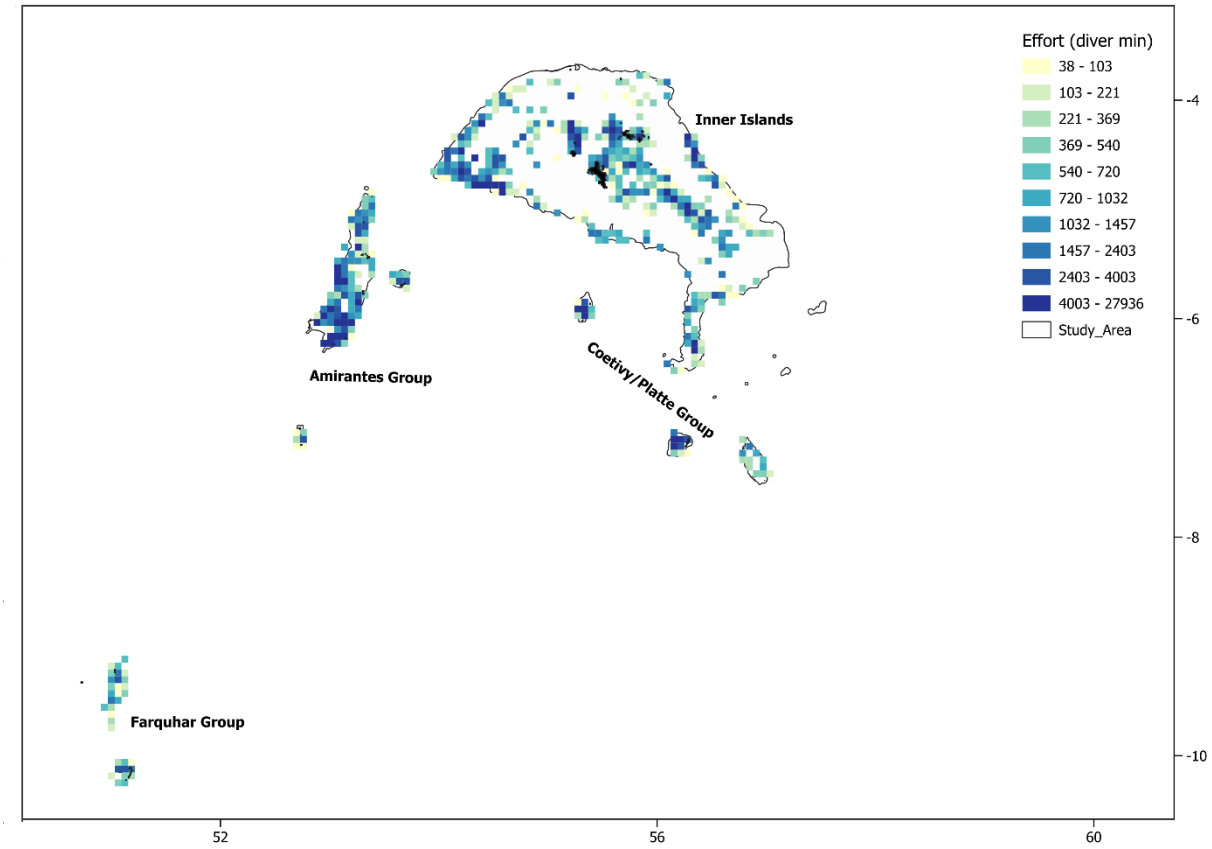

Figure 5:Map illustrating dive effort during the 2023/2024 fishing season around the outer islands.

3.4. Catch Per Unit Effort (CPUE)

During the **2023/2024 fishing** season, the overall CPUE was 44 pieces per diver day, with Flower Teatfish contributing the highest at 37 pieces, followed by Prickly Redfish (5 pieces), White Teatfish 0.87, Sandfish 0.70 pieces, and Black Teatfish 0.090. CPUE has been declining over the last couple of seasons for all species (Figure 6).

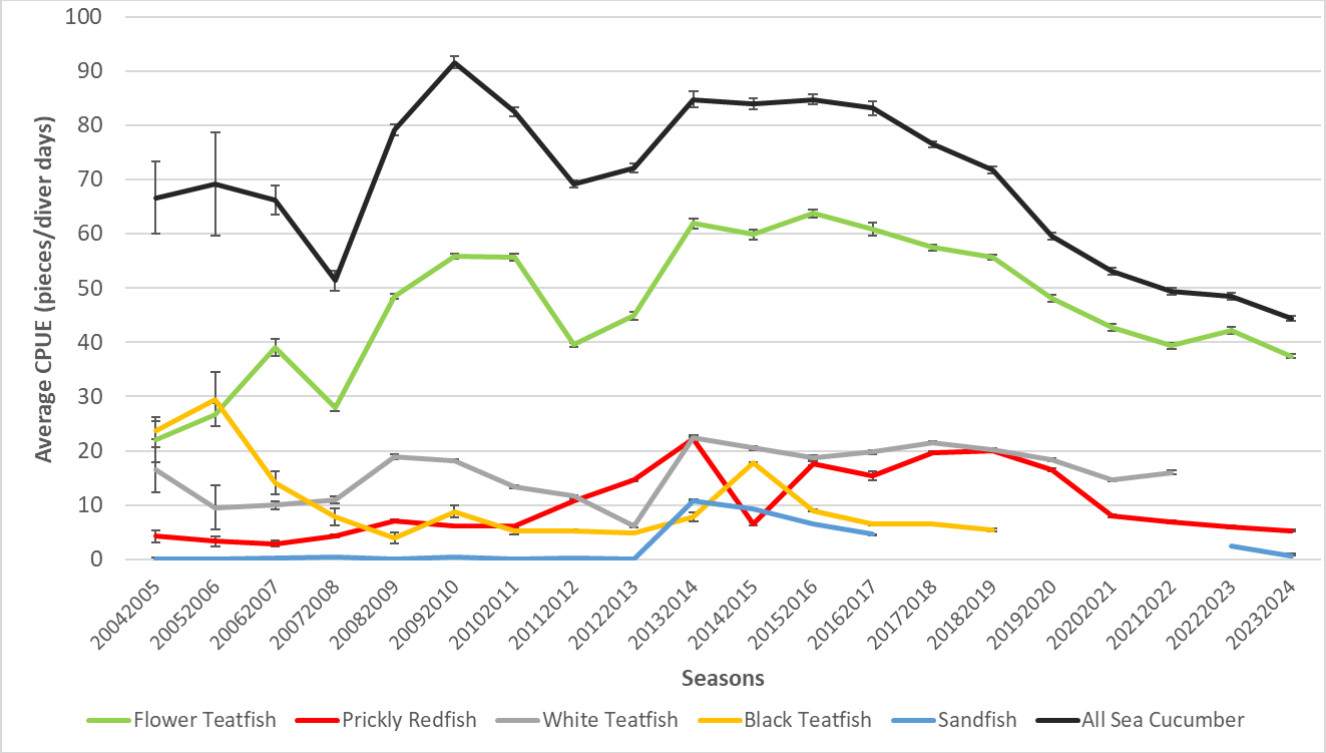

Figure 6: Mean CPUE per diver days by species, and for all species combined for the 2004/2005 to 2023/2024 fishing season.

The overall CPUE, expressed as the average number of pieces per dive minute for the 2023/2024 season was 0.22 pieces per dive minute. Flower Teatfish had a CPUE of 0.19, followed by Prickly Redfish (0.021), White teatfish (0.0038), Sandfish 0.0035, and Black teatfish (0.0004). Similarly, CPUE by diver days has also been declining (Figure 7).

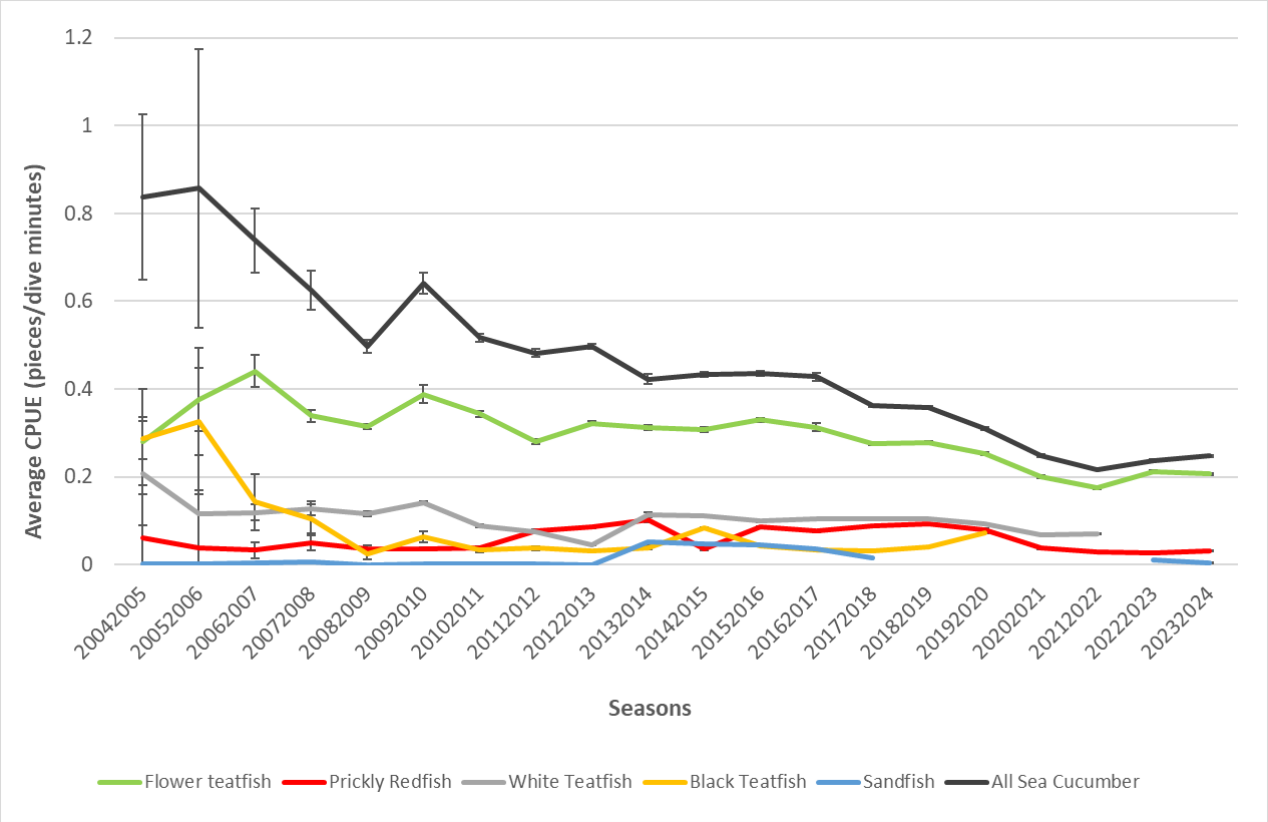

Figure 7: Mean CPUE in pieces per dive minutes by species and for all species combined for the 2004/2005 to 2023/2024 fishing season.

3.5. Quota Utilisation

The box plot illustrates the percentage difference in quota utilisation by fishing vessels since the introduction of quota. Over the years the mean utilisation for all species has declined, with quotas in the recent years remaining consistently underutilised by most vessels. For the 2023/2024 season 83% of the Flower Teatfish quota was utilised, 55% for Prickly Redfish and only 5% for Golden Sandfish (Table 2).

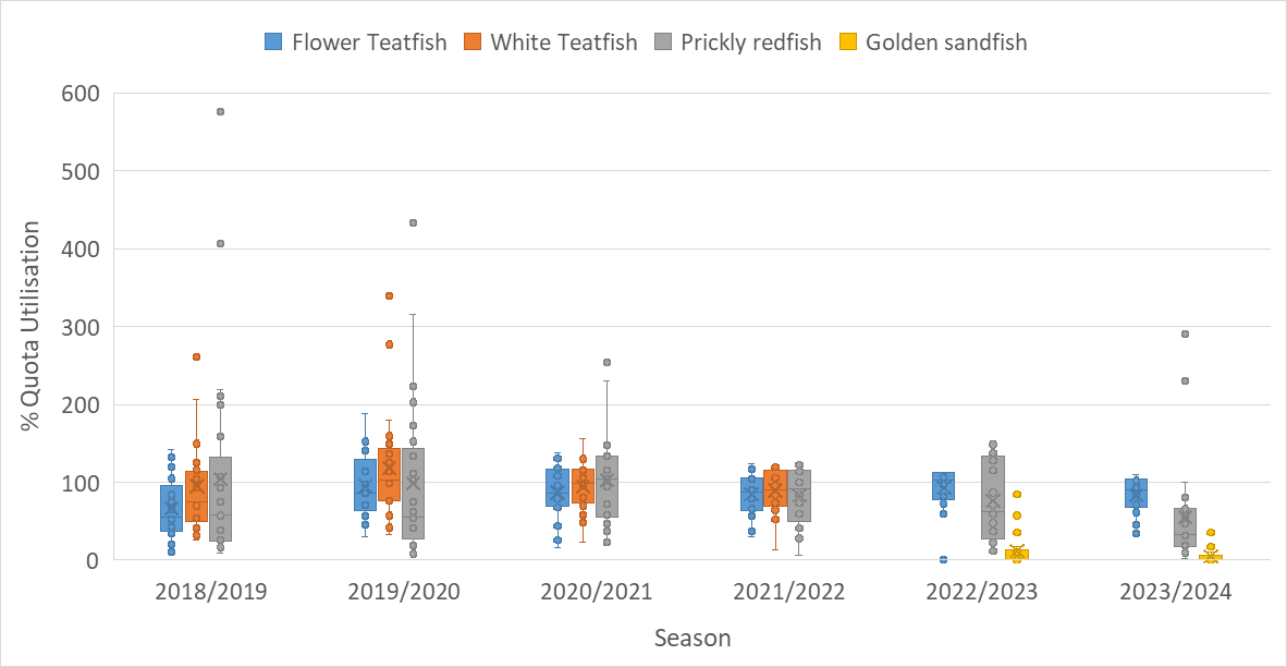

Figure 8: Percentage quota utilisation by species and by fishing seasons

Table 2: Summary statistics for the percentage quota utilisation amongst fishing vessels by species for 2023/2024 fishing season.

	Flower Teatfish			Prickly Redfish			Golden Sandfish			All species		
Season	**Min**	**Avg.**	**Max**	**Min**	**Avg.**	**Max**	**Min**	**Avg.**	**Max**	**Min**	**Avg.**	**Max**
2023/2024	32	83	110	2	55	290	0	5	35	24	60	102

4.Conclusion

Overall, the 2023/2024 season recorded a slight increase in fishing effort compared to the previous year, reflected with more trips, higher total dive minutes, and greater diver days recorded. Despite this increased effort, total catch volumes remained relatively stable, with only minor changes in species composition across the main commercial species.

CPUE results continue to show that Flower Teatfish remains the dominant contributor to the fishery, while catches of other species remain comparatively low. However, the long-term decline in CPUE across multiple seasons indicates a continued reduction in catch rates, which may be symptomatic of reduced stock abundance, increasing fishing pressure, or changing environmental conditions.

Quota utilisation also declined further during the 2023/2024 season, dropping to 60% the lowest level in the past four seasons. This persistent under-utilisation suggests that although fishing effort has been maintained, the fishery is not achieving its full yield potential, likely due to operational constraints, reduced stock availability, or broader socio-economic challenges faced by fishers.

In summary, the declining CPUE trends, stable but lower-than-expected catch volumes, and decreasing quota utilisation point to potential stock stress or changes in fishery productivity. Furthermore, external factors such as socio-economic conditions and environmental changes, must be incorporated into monitoring and management strategies, as they can also impact long-term catch efficiency and quota utilization.

5.References

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6. Appendices

6.1. Appendix I: Paper Logbook

Sea Cucumber Catch and Effort Logbook

Licence No:									Species									
No	Date	Fishing Site	Fishing Time		No. Divers	Depth (m)		Dive Time per Diver (minutes)	Flower Teat Fish Pentard	White Teat Fish kokosye Blan	Black Teat Fish Kokosye Nwar	Prickly Red Fish Sanpye	Black Fish Spork	Red Surf Fish Vent Blan	Yellow Surf Brizan	Sand Fish Kokom	Total
			Start	End													
1							1 2 3 4 5										
2							1 2 3 4 5										
3							1 2 3 4 5										
4							1 2 3 4 5										
Remark:																	
Sz No:			Master Name:									Master Signature					

6.2. Appendix II: SFA Grid Map