

Economic Impact of the Seychelles Sea Cucumber Fishery and Industry



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Executive summary

1. The Seychelles sea cucumber industry has a non-transferable licensing framework granting access to only 25 fishing and 4 processing licenses. A Total Allowable Catch (TAC) was introduced in 2018 with only three species allowable for fishing: flower teatfish, prickly redfish and white teatfish. The fishing fleet is comprised of 25 vessels embarking on average 6 trips per season and with a mean fishing trip duration of 17 days. Some form of pre-processing is conducted onboard involving eviscerating and salting the sea cucumber. At the processing-level, the 4 licensed processors utilize the entire supply of landings and processes the sea cucumbers to a dried state. Based on the processors' estimates, the industry's processing capacity can increase twofold.
2. On a seasonal basis for the 2019/2020 season [October to May], the sea cucumber fishing fleet landed 371,599 pieces of sea cucumbers representing a 34% increase from the 2017/2018 season and a 40% increase from the 2018/2019 season. Flower teatfish had the highest landings (72%) followed by white teatfish (18%) and prickly red (10%). The fleet utilised 99% of the TAC which is an improvement of 28 percentage points compared to the previous season.
3. On an annual basis in 2020, a total of 376,181 sea cucumbers were landed with an estimated landings revenue of SCR 51.9 million. This represents a 78% increase from 2018 and a 22% increase from 2019. Fishers tend to be paid a standard unit price for each specimen, with a SCR 10 commission earned only on the sale of flower teatfish and white teatfish to processors. Increases in ex-vessel prices were observed in 2019, with flower teatfish and white teatfish growing by 25% and 35% respectively. White teatfish garnered the highest ex-vessel price per piece with prices typically SCR 15-20 higher than flower teatfish and SCR 80-110 higher than prickly redfish.
4. Export consignments of dried sea cucumbers are mainly transported via air with Hong Kong as its only destination. Export trends indicate that export is on the rise despite a marginal fall in both the number of pieces and weight by 1% and 4% respectively during 2018-2019. In 2020, data is from January-July and shows that export value has attained an increase of 32% from 2018 and 3% from 2019. Similar to ex-vessel prices, white teatfish is the most valuable specimen exported and in 2020, all 3 species recorded individual highs with white teatfish at SCR 2,295 per kg, flower teatfish at SCR 2,040 per kg and prickly red at SCR 1,020 per kg. Average export prices for white teatfish, flower teatfish and prickly red stands at SCR 1,539, 1,401, 720 per kg respectively.
5. The sea cucumber industry directly supports about 185 jobs generating an income impact of approximately SCR 29.6 million. The fishing component generated the most jobs (150) and income earnings (SCR 23.9 million).

There are 118 locals employed in the fishery, resulting to about 143 households directly dependent on the industry, ultimately leading to an estimated 486 individuals impacted to some degree by the industry.

6. The Government through the SFA charges various fees to operators including licensing fees, management fees, and an inspection fee. In 2020, SFA collected SCR 1.8 million in such fees translating to a 18% increase in 2018 and a 15% increase in 2019.
7. In 2019, it is estimated that the mean operational cost for a sea cucumber fishing vessel amounts to SCR 1.2 million, with the main operational cost items being labour remuneration (79%), food (9%), fuel (6%), and accommodation (5%). Vessel owners benefit from a fuel excise tax exemption equivalent to SCR 8.50 per litre. This subsidy reduced fleet-level costs by SCR 1.5 million and lowered the annual operational cost of a vessel by 4%.
8. The industry generated a value-added impact of SCR 43.5 million, with the fishing component and processing/exporting components contributing SCR 31.3 million and SCR 12.3 million respectively.

1. Overview of the sea cucumber industry

1.1 History of sea cucumbers

Sea cucumber is a globally traded commodity, that brings lucrative returns due to its high demand from Asian markets. It is eaten raw, boiled, or pickled. The most important sea cucumber product however is the dried body wall which is marketed as *bêche-de-mer*, also called *trepang* (Conand and Byrne, 1993). Globally, there are at least 58 different species of sea cucumber commercially exploited for human consumption, and many other species that are exploited either in a small number of localities or in relatively small quantities. They are harvested and traded in more than 70 countries worldwide and exploited in industrialized, semi-industrialized, and artisanal (small-scale) fisheries in polar regions, temperate zones and throughout the tropics. In some fisheries, more than 20 species can be exploited (Purcell et al., 2012). However, studies have shown that sea cucumber fisheries are prone to boom-and-bust cycles and effective management, usually in the forms of license restrictions, quotas, closed seasons and Marine Protected Areas (MPA), can be implemented to ensure the sustainability of the fishery (Anderson et al., 2010).

1.2 In the context of Seychelles

In Seychelles, sea cucumbers have been fished for more than a hundred years, with reports of *bêche-de-mer* exports dating back to the late 1800s. However, quantities harvested were fairly low and it is only in the late nineties that the fishery has seen a rapid development. This makes the fishery one of the recent fisheries in the state and by 1999 there were already signs of population depletion, including lower volumes of high value species and fishers having to travel further and dive deeper to maintain catch rates, and concerns were raised regarding the sustainability of the fishery (Aumeeruddy, 2007). These noteworthy concerns led to a change in the status of the fishery in which some management measures were introduced in 1999 to regulate access to the fishery as proposed by Mees et al. (1998) (Aumeeruddy, 2007). Interestingly, based on responses from the main actors of the industry it was indicated that relative to other fisheries in Seychelles and in the SWIO¹ region, the sea cucumber fishery is considered to be one of the best regulated, monitored, and managed fisheries.

1.3 Socio-economic relevance

Albeit the echinoderm² does not play a key nor subsidiary part in the daily dietary consumption of the local population, the commercialization of sea cucumber plays an impactful role in the socio-economic development of Seychelles. Its socio-economic importance to the local fishing community appears from the three operations of fishing, i.e., the

¹ The Southwest Indian Ocean (SWIO) region is comprised of Madagascar, Kenya, Tanzania, Mozambique, Comoros, South Africa, Mauritius, Seychelles, Reunion, and Somalia.

² Echinoderm refers to a variety of invertebrate marine animals belonging to the phylum Echinodermata, characterised by a hard, spiny covering or skin in which sea cucumbers fall under.

collection of the sea cucumbers, processing which involves cleaning and drying of the product, and trading which involves sales to different markets. Despite being considered small, the industry creates numerous employment opportunities across various occupations with jobs such as divers, skippers, cooks, processing plant workers, administrative & managerial personnel, and so on. Furthermore, due to its high valued nature, exportation of sea cucumbers to Asian markets brings in a significant amount of export revenue with an annual mean value of SCR 43 million from 2015-2017, which is equivalent to less than 1% of total export of fish and fishery products. Although this represents a small percentage, excluding export of canned tuna which constitutes the bulk of fish and fishery products, export of sea cucumber makes up around 16% during this period³. Its importance towards injecting revenue and foreign currency into the economy has been more evident with the economic impact caused by the global epidemic [COVID-19] as the economy is now more reliant on revenue from exports following financial disruptions from other key productive sectors, particularly the tourism sector.

1.4 Purpose of the report

The overarching objectives of this study are to provide a better insight into the dynamics of the sea cucumber industry and to assess its economic impact to the Seychelles economy. The report provides descriptive statistics of the most pertinent areas of interest and uses different measures such as sales (commercial landings & export), employment, income, expenditures (e.g., operational cost, licenses, export levies, taxes), value added, and subsidies to determine how the industry affects the economy. Additionally, the report is designed to provide a historical look of the industry with a special focus on recent years. Information in this report is based on a semi-structured survey administered to the boat owners and processors as well as data collected by the Seychelles Fishing Authority and other partner entities⁴. Responses from the survey provided a better contextual interpretation of the sector and a rapid data collection exercise. Readers should note that this report may exclude some features required to determine the full performance of the sea cucumber industry. Follow-up studies and analyses will be conducted to strengthen the results found in this report and provide a better understanding of the industry's overall socio-economic importance.

Readers should also note that some figures presented in this report may be different to previously published figures and this may be due to revisions following thorough verifications carried out on the data resulting from data reviews, database upgrading, and new data received that were previously missing.

³ Merchandise Trade. National Bureau of Statistics (NBS), Victoria, Seychelles.

⁴ Tax data was retrieved from the Seychelles Revenue Commission (SRC).

2. Management measures

2.1 Main management measures

The Seychelles Fishing Authority (SFA) as the executive arm of Government for the fisheries sector implemented some management measures in 1999 in response to local depletion of some species. This was evident with fishers finding it necessary to dive deeper to find sea cucumbers in viable numbers, with some resorting to the use of SCUBA equipment (Aumeeruddy and Payet, 2004). A license for fishing and processing sea cucumbers was introduced, but the licensees failed to provide adequate and timely catch data. This led to more stringent regulations whereby catch and effort reporting became mandatory, and a more conservative limit was imposed on the number of fishing licenses (Aumeeruddy and Payet, 2004). Presently the key management measures include (SFA, 2020):

Management regime

- Licensing system of limited entry of 25 non-transferable licenses for fishing and 4 licenses to process sea cucumbers.
- Open fishing season of 8-9 months.
- Introduction of a Total Allowable Catch (TAC) in 2018 (an individually non-transferable quota).
- Restriction on species which can be fished with only three species; flower teatfish (*Holothuria* ‘pentard’), prickly redfish (*Thelenota ananas* ‘Sanpye’) and white teatfish (*H. fuscogilva* ‘Kokosye Blan’) (**Fig. 1**), allowed to be collected as per the allocated quota for each licensee (**Table 1**).

Table 1: Breakdown of quota distribution per specimen and per vessel⁵.

	Flower teatfish	Prickly redfish	White teatfish	Total
Quantity per species	281,250	37,500	56,250	375,000
Quantity per vessel	11,250	1,500	2,250	15,000

License conditions

- Applicants shall be a citizen of Seychelles.
- The boat shall have a valid 'Local fishing vessel' license and a valid 'Sea cucumber fishing' license.
- Maximum of 4 divers and 1 apprentice diver per fishing license.
- Fishing trip shall be limited to a maximum of 30 fishing days.
- Commercial targeting of other species (fish) during the closed season can only be undertaken following written request made by the licensee to the SFA and the subsequent issue of a written approval by the SFA.

⁵ Table derived from the Fisheries Comprehensive Plan 2019, pg. 18, produced by the Ministry of Fisheries and Agriculture.

- Traditionally license to fish sea cucumbers was valid during the open season from 1st October to 31st May (8 Months) but for the 2020/2021 season the open is from 15th September 2020 to 15th June 2021 (9 months).



Figure 1: Visual illustration of the three sea cucumber species allowable to be collected. From left to right; flower teatfish, white teatfish, and prickly redfish.

2.2 New eLogbook system

In addition to the management measures stated, as from September 2020, SFA has introduced a new electronic logbook system for the purpose of recording sea cucumber catch and effort data. The system allows on-site data, such as, catch, dive times, fishing locations and water visibility to be collected quicker and more accurately. Once back into port, the data is easily offloaded onto a server where it can be processed to produce estimates of sea cucumber density by zones. This data will be used to assess changes in the abundance of harvested species over time, which will be useful information for the sustainable management of the fishery.

2.3 MAC

Finally, SFA in collaboration with key partners in the industry have created a Management Advisory Committee (MAC) to support the creation and revision of management measures. This encourages collaborative management and trust between the Authority and the industry through greater stakeholder engagement in the decision-making process and other aspects related to the management of sea cucumber resources.

3. Fleet composition

3.1 Features of the fleet

As stated, the licensing framework grants only 25 sea cucumber fishing licenses per year. The fleet is composed of several vessel types predominated by Schooners and with some medium-sized longliners of which fall under Class 3, 4 and 5⁶ of the vessel length classification. They exclusively target sea cucumbers during the open season whereas

⁶ Vessel length classification based on the Fisheries Comprehensive Plan 2019, pg. number 10.

during the closed season, upon approval from the regulatory Authority [SFA], they are given permission to target demersal/semi-pelagic/pelagic species in the dropline fishery. Only a few vessels follow this route while the remainder of the fleet prefers to anchor and undertake any maintenance and repair works until the next season. The main reason for ceasing their operations completely is due to the interval of the closed season which coincides with the Southeast monsoon ('Vann Swet'). During this period [end of May to the beginning of October] the weather is characterized by strong winds from the southeast which means that the large expanse of sea becomes very rough. As a consequence of the rough seas, bottom sediments are stirred up which in turn affects the clarity of the water and divers' visibility is greatly affected. All this creates unfavourable conditions to embark on fishing trips. **Table 2** provides an overview of the main characteristics of the fishery component in recent years.

Table 2: Main features of the commercial sea cucumber fishing fleet in recent years. Annual mean values (\pm standard deviation) are provided for the period 2019-2020.

Number of vessels	Vessel type	Length overall	Number of trips per season	Trip duration in days	Main storage process
25	Schooners Medium-sized semi-industrial longliners	10 – 24 meters	5.72 (0.76)	16.54 (8.36)	Salt preservation

4. Processing of sea cucumbers

4.1 Processing method

Before the introduction of processing plants in Seychelles, sea cucumbers were exported by sea straight after fishing with only a form of pre-processing done onboard the vessel. This process involves eviscerating the sea cucumber by creating an incision, removing the internal organs, rinsing, and preserving in salt. The introduction of processors has allowed the product to undergo further value addition on land which typically involves cleaning, boiling, drying, and packaging. Prior to the cooking phase small wooden sticks/bamboo sections are placed in the incision to keep it wide open. In the following step [cooking] the sea cucumbers are boiled under optimal temperature of around 90 °C for species such as *H. nobilis* [black teatfish] and *B. marmorata* [brown sandfish] for around 10-30 minutes. During this phase they become stiff and lose 50-70% of their body fluids, assuming a yellowish colouration in species like *T. ananas* [pineapple sea cucumber] and *S. hermanni* [curryfish], and blackish colouration in most other species. The sea cucumbers are then rinsed again once they are removed from the hot water and the cooked product is then sun dried or placed in in drying furnace while ensuring that each sea cucumber is regularly turned over every few hours. Up to 3-5 days may be required to dry the products completely. Proper cooking and drying of sea cucumbers is essential. If not cooked completely, the sea cucumber will soon start to rot and acquire an undesirable smell. Additionally, overcooking may also damage the product as a very soft bodied sea cucumber may not be processed

into a high-quality product. The ratio of dry weight to wet weight of the processed sea cucumber is 27:1 in *H. nobilis* [black teatfish], 17:1 in *A. lecanora* [white-bottomed sea cucumber] and *A. mauritiana* [surf redfish] (FAO. Li X., 2004).

4.2 Features of the processors

Presently there are only 4 licensed processors, namely James Lesperance, Morin Group Pty Ltd, Oceanic Harvest Pty Ltd, and Providence Sea-Cucumber. They operate small- to medium- sized plants with boiling and drying rooms. All four are locally owned and situated mostly at the Providence Industrial Estate (Mahé) within the vicinity of the main landing port. Production capacity differs across processors with the variability dependent on factors such as processing area, manpower, supply of raw material and others. From the previous season [2019/2020] roughly all of the sea cucumbers landed were utilised by the processors with the exception of a few being discarded due to their smaller size. Responses from the interviews conducted with the processors indicate that they are able to increase their processing capacity twofold with the exception of one claiming that the factory is currently encountering mechanical issues thus can only maintain current levels.

4.3 Relationship between fishers and processors

Based on the interviews it has been observed that compared to other fisheries in Seychelles, most of the main actors in the sea cucumber fishery have adopted a distinct relationship with each other. The two entities [fishers and processors] have established a mutual agreement in which the processors provide numerous capital equipment and supplies with the vessels they are affiliated with (i.e., working with). These include compressors, diving equipment (i.e., diving cylinders, oxygen regulators, et cetera...), salt, and spare parts. Such equipment and supplies come at a significant cost to the processors with compressors being the costliest at around SCR 120,000 for a single unit of which each vessel requires two. With all these costs (explicit and implicit) borne by the processors, the fishers in return compensate them by selling their catch at a lower value compared to the resource's real market value.

5. Methodology

5.1 Socio-economic survey

Conducting socio-economic surveys play an impactful role in gauging the social and economic development within a specific population. The target population for this study were the two main actors of the industry, i.e., sea cucumber fishers and processors. A purposive sampling method was considered, and two separate semi-structured questionnaires tailored based on the characteristics of each target group were used as the survey instrument (see Appendix I of this report). The team consisting of two economists from SFA conducted in-person interviews with each participant and administered the questionnaires accordingly.

Due to multiple constraints including time, man resources and non-availability of a sampling frame for such a study, the choice of the sample size was not based on any statistical measure. Given the lower number of processors compared to vessels, focus was placed on processors and a lower coverage rate was envisaged for the fishing fleet. All 4 processors and 4 out of the 25 boat owners were interviewed, thus giving us a coverage of 100% and 16% respectively. The vessels targeted provided an adequate representation of the fleet as in terms of landings rank 2nd, 5th, 7th, and 16th in the 2019/2020 season. Data collected from the survey allowed us to estimate multiple indicators such as ex-vessel value, employment, income, expenditures, and value added. In addition to the survey, data from numerous sources were retrieved to complement the findings of the study.

5.2 Capture statistics

Since reporting of catch and effort data for the fishery is mandatory, upon arrival to port following a fishing trip, all vessels must land their catch under supervision by SFA. By doing this the Authority accurately collects landing data and ensures that the required compliance measures are met.

5.3 Trade statistics

For each consignment exported the processor must acquire an export permit from the Customs Division (Seychelles Revenue Commission). The document provides details on the contents being exported and its intended destination. Information from the permits is imported into SFA's database management systems and was used as the only export figures for the study.

5.4 Payments, and fees

Fees paid by the industry is collected by SFA and receipts received in foreign currencies were converted into Seychelles rupees based on the annual exchange rate.

5.5 Subsidies and Taxes

Subsidies reviewed in this study relates to the Fuel Incentive Scheme which SFA facilitates its implementation. As such data on the amount bunkered and subsidies received is recorded by SFA. Given the complexity of disaggregating other subsidies based solely on activities related to sea cucumbers other subsidies were not considered. Information on taxes were extracted from SRC.

6. Landings revenue

6.1 Historical look at the production of sea cucumbers

Since the formal collection of catch and effort data began in 2000 (Aumeeruddy and Conand, 2008), the main species exploited on a commercial basis are black teatfish, chalky cucumber, elephant trunkfish, flower teatfish, hairy

blackfish, lollyfish, prickly redfish, sand fish, surf redfish, white teatfish and white belly/spork. The fishery has evolved from a collector-type, whereby fishers collect sea cucumbers on foot, to a more sophisticated one where most of the fishing is done by divers using SCUBA gear (FAO, 2008). From the most recent stock assessment of the fishery, it was recorded that during 2012-2017 diving depth ranges between 10-40 metres with a mean dive depth of approximately 30 metres. Furthermore, the Mahé Plateau was found to be the most productive region followed by Amirantes, Coetivy, Platte and Alphonse (SFA, 2017). The fishery is relatively new with around 30 years of recorded existence. Previous exploitation of the resource was reported but to some extent values were negligible. Over the past two decades with the expansion of the industry, production of sea cucumbers has seen rapid developments (**Fig. 2**).

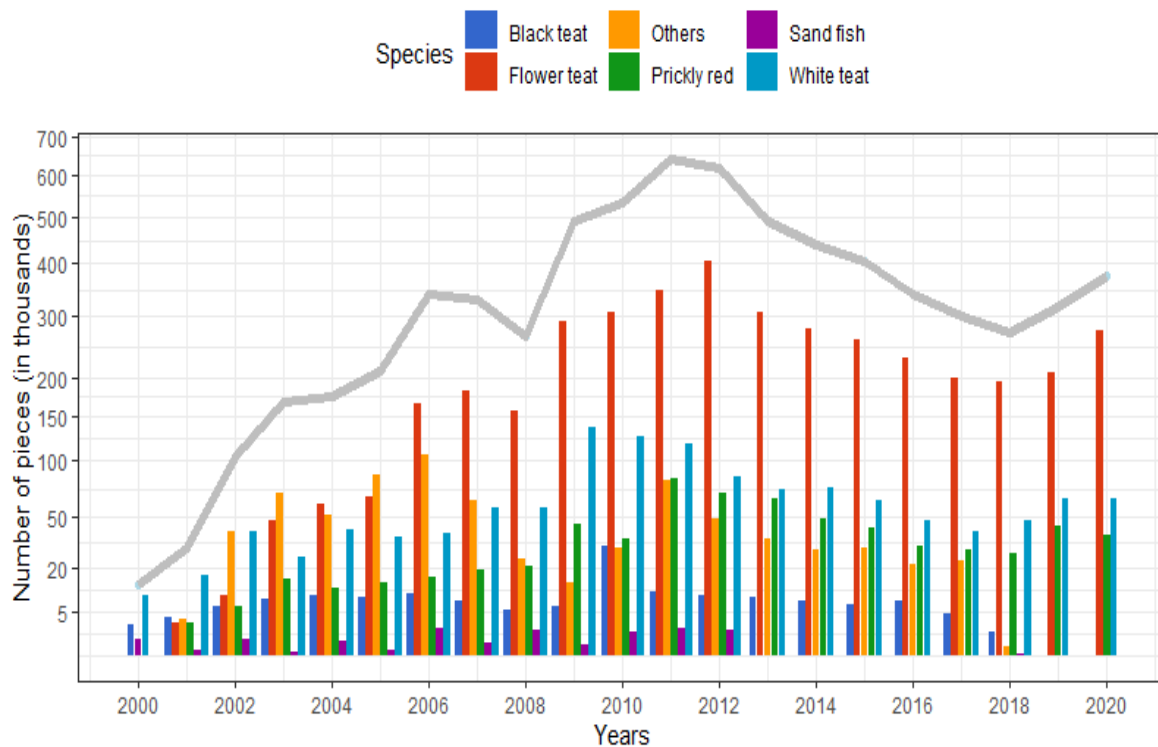


Figure 2: Historical landings of sea cucumbers in Seychelles from 2000-2020. Production is measured in number of pieces and the ‘Others’ category is an aggregation of all other sea cucumbers not identified in the legend.

As from the early 2000s production of sea cucumbers, measured in terms of number of pieces collected, surged (25 times) to a high of 338,792 in 2006. For the following year production fell marginally and once again in 2008 by 19%. This studder in growth was mainly due to the financial crisis in 2007/2008 whereby global demand for all products fell. After the 2-year fall the fishery regained its initial momentum and managed to return to its initial trajectory reaching a new all-time high of 642,404 in 2011. Over this 11-year stint [2000 to 2011] production of sea cucumbers grew by an astonishing 4,767%. This boom in production can be explained by the introduction of SCUBA gears which given its ability to improve diving range made previously inaccessible unharvested grounds accessible. This

coupled with the influx of substantial start-up investment led to a rise in both the number of vessels and processors in the industry thus inducing an increased level of demand for the resource. Following the high of 2011 the fishery began to experience a downturn in production across all species with flower teatfish being the most affected with a fall of more than 100,000 pieces in just 5 years. Two contributing factors led to this drop with the first being that divers had to go further out into deeper waters as population in shallow areas were depleted. The other was due to a lack of supply of labour specifically amongst divers whereby the labour participation rate of locals for the position was persistently falling for years due to documented substance abuse. For the following years production continued to fall, dipping below 300,000 pieces, and reaching a new low of the decade in 2018 which is comparable to the level in 2008. For the subsequent years [2019 onwards] production managed to recover and is steadily growing towards the 400,000 mark.

6.2 Current seasonal production

In this section we aim to solely provide an overview of the seasonal production of the fishery but note that for statistical purposes, data in the remaining sections are aggregated on an annual basis. The fishery operates on a seasonal basis and for the 2019/2020 season the 25 licensed vessels landed a total of 371,599 pieces of sea cucumbers (Table 3). Compared to the previous season [2018/2019] this translates to a considerable increase of 40% in number of pieces landed with flower teatfish contributing about 85% of the rise. Breaking down the increase by specimen relative to the previous season, flower teatfish and white teatfish grew by 51% and 32% respectively whilst prickly redfish fell by 1%. Furthermore, the upsurge in landings led to an improvement in the mean catch per vessel by 34%, going from 11,072 to 14,864 pieces for the 2018/2019 and 2019/2020 seasons respectively. The seasonal minimum and maximum recorded catch per vessel of the fleet also improved from 2,429-22,941 to 5,271-27,783 pieces in the same period. Given the amount landed, the total quota of 375,000 pieces of sea cucumbers which was introduced in 2018 was respected over the past two seasons [2018/2019 & 2019/2020] with a utilization rate of 71% and 99% respectively. However, by species-specific allocation, for the 2018/2019 season, prickly redfish went above by a mere 54 pieces and for the following season white teatfish went beyond by 10,241 pieces.

Table 3: Landings comparison for the three most recent sea cucumber seasons [2017/2018, 2018/2019, 2019/2020]. Percentage change is calculated using values from the previous season.

Species	Pieces	% Change
2017/2018	277,390	-15.36
Black teatfish	1,029	-79.78
Flower teatfish	193,103	-9.42
Prickly redfish	32,130	+46.21
Sandfish	12	-91.18

Species	Pieces	% Change
Spork	3,254	-87.03
White teatfish	47,862	-0.26
2018/2019	265,732	-4.20
Flower teatfish	177,929	-7.86
Prickly redfish	37,554	+16.88
White teatfish	50,249	+4.99
2019/2020	371,599	+39.84
Flower teatfish	268,047	+50.65
Prickly redfish	37,061	-1.31
White teatfish	66,491	+32.32

6.3 Species proportion

During 2007-2017, out of the total amount landed flower teatfish made up about 61% followed by white teatfish (18%), prickly redfish (10%), and Others (11%). With the introduction of the limit to only three species in 2018, proportions have changed slightly with more effort being placed on flower teatfish. In 2020, flower teatfish accounts to about 73% of production followed by white teatfish (17%) and prickly redfish (10%) (Fig. 3).

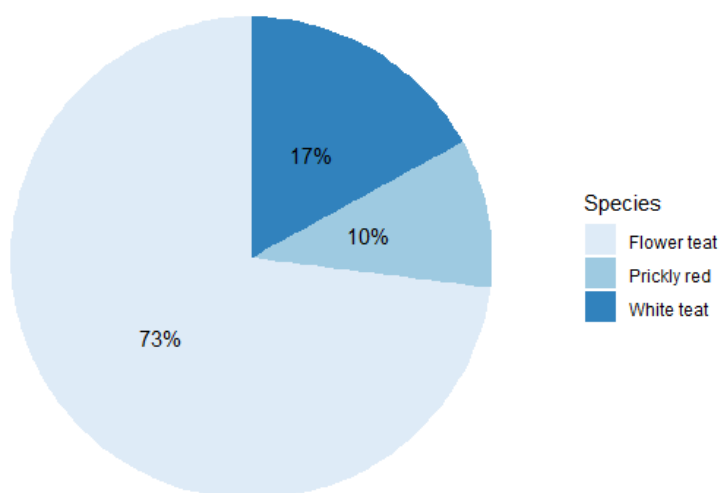


Figure 3: Composition by species of sea cucumbers landed in 2020.

6.4 Ex-vessel price & Commission

Fishers usually sell their catch to processors on a unit price basis. The price is dependent on the species, size, and quality of the product. Following the data collection exercise, we managed to establish the annual mean ex-vessel price for each of the commercially exploited species for the period 2018-2020 (**Table 4**). During this period, it can be observed that the most highly valued species are white teatfish and flower teatfish, with white teatfish fetching the highest price typically SCR 15-20 more than flower teatfish. Prickly redfish is of lower value and over the past three years its price has remained constant at SCR 50 per piece. Following extensive discussions and negotiations between the fishers and processors which was facilitated by the Government, it was concluded that purchase prices will be revised. The adjustment led to the ensuing rise in prices for flower teatfish and white teatfish by 25% and 35% respectively in 2019. In addition to the flat price for each specimen, a SCR 10 per piece commission is given only on flower teatfish and white teatfish. It must be noted that the commission is dependent on the size of the cucumber with smaller sizes not qualifying.

6.5 Ex-vessel value

Given the complexity in identifying which sea cucumber receives the commission, for the sake of this study it is assumed that the commission is applicable to all eligible. Using annual mean unit prices including commissions for each specimen we estimated the ex-vessel value [landings revenues] of the fleet during 2018-2020 (**Table 4**). In 2020, landings revenue for the fleet amounted to SCR 51.85 million with flower teatfish contributing a majority of SCR 39.65 million. Compared to the previous year this is a considerable increase of SCR 9.18 million (22%) mainly due to a 59,450-piece rise in landings. It can also be observed that during 2018-2019, ex-vessel value improved by SCR 13.53 million (46%) while landings improved by 44,418 pieces (16%). This almost half increase in value was largely due to a rise of SCR 8.6 million by flower teatfish.

Table 4: Landings revenue for sea cucumbers during 2018-2020. Prices and commissions are based on annual mean prices offered by the processors, measured in Seychelles rupees. The term ex-vessel value is interchangeable with production value/landings revenue and is also in Seychelles rupees.

Species	Landings	Unit Price	Commission	Ex-vessel value
2018	272,313			29,148,320
Black teatfish	1,466	50	0	73,300
Flower teatfish	195,296	100	10	21,482,560
Others	240	10	0	2,400
Prickly redfish	27,495	50	0	1,374,750
Sand fish	7	20	0	140
White teatfish	47,809	120	10	6,215,170
2019	316,731			42,673,440

Species	Landings	Unit Price	Commission	Ex-vessel value
Flower teatfish	207,506	135	10	30,088,370
Prickly redfish	44,463	50	0	2,223,150
White teatfish	64,762	150	10	10,361,920
2020	376,181			51,851,885
Flower teatfish	273,457	135	10	39,651,265
Prickly redfish	38,502	50	0	1,925,100
White teatfish	64,222	150	10	10,275,520

7. Export revenue

7.1 Global export

Based on available statistics, the trade of sea cucumber is a lucrative business and in 2019, it attained a global market value of around US\$ 510 million (SCR 7.3 billion⁷). Trade of live, fresh, or chilled sea cucumbers made up a mere US\$ 10 million of this value from main consumer markets in USA (19.2%), Saudi Arabia (22%), Bulgaria (12.5%), Spain (14%) and China, including Hong Kong, (8.7%). The remaining US\$ 500 million (SCR 7.1 billion) was from trade of smoked, frozen, dried, salted or in brine sea cucumbers, with trade from Hong Kong by far the most important market accounting for 51.3%, and together with China accounts for 73.2% of the global market⁸. Prices vary considerably depending on species, size, and quality, but in 2016 prices of *bêche-de-mer* species in Chinese stores (Hong Kong & Guangzhou) showed that it can fetch up to US\$ 31-389 (SCR 417-5,236⁹) kg⁻¹ on average (Purcell et al., 2018). A more specific study on the market value of the highly exploited Indian Ocean flower teatfish showed that its value ranged from US\$ 44-273 (SCR 611-3,792¹⁰) kg⁻¹ dried. In addition, bigger sized dried products yield a higher market value due to the multiplicative effect of product weight (Purcell et al., 2017). These statistics provide a glimpse into the profitability of exploiting sea cucumbers and the potential premium price it can attain.

7.2 Perspective of Seychelles

In the context of Seychelles, most of the sea cucumbers fished are processed to a dried state and exported to main Asian markets. There is a very small market for local consumption of sea cucumbers, due mostly to the small Chinese community present in the country. However, local sale figures are trivial compared to export. Presently the product [dried sea cucumber] is exported mainly by air as it takes relatively less time to reach its destination compared to

⁷ Conversion based on 2019 US\$ to SCR annual mean exchange rate 14.28.

⁸ International Trade Centre (ITC) database, <https://www.intracen.org>.

⁹ Conversion based on 2016 US\$ to SCR annual mean exchange rate 13.46.

¹⁰ Conversion based on 2017 US\$ to SCR annual mean exchange rate 13.89.

exporting via sea. Although this is costly for the exporter and even with its extended shelf life from the drying process, maintaining the products' quality is paramount as this guarantees the successful sale at the pre-specified price. The complete switch to mainly exporting via air cargo began in 2015 and from then on, the use of this mode of transportation has remained predominant. In 2018 and 2019, 47 and 51 consignments were exported by air respectively with none by sea. Interestingly, one of survey respondents from the processing-level commented that in 2020, with the shutdown of the airline industry caused by the current pandemic [COVID-19] the company attempted to export by sea, but this is time consuming as it may take up to 45 days to reach its destination. Moreover, the product is affected by moisture and dampness due to the long duration at sea leading to its deterioration and fall in quality.

7.3 Export markets

Over the past decade [2010-2019], Seychelles has been exporting sea cucumbers to two main markets namely Singapore and Hong Kong as the principal market constituting 99% of the market share. As from 2017, Hong Kong is the standalone market utilizing the entire supply of sea cucumbers from Seychelles. A slight anomaly was observed in 2019 with a single consignment of 22 kgs of dried flower teatfish and white teatfish valued at SCR 23,710 was exported to Sri Lanka.

7.4 Historical export prices

Historically export prices have varied considerably, with the most lucrative species making upward movements. From **Fig. 4**, increases in export prices have been observed across the four main species [black teatfish, flower teatfish, prickly redfish and white teatfish]. White teatfish and flower teatfish attained the highest rise, with prices almost doubling during this period. Between 2010-2018, prices and changes in prices for prickly redfish and black teatfish have been similar, with an annual mean price differential of SCR 10 per kg over that period (SCR 464 and SCR 474 per kg respectively). In 2015, lollyfish attained a high of SCR 304, shortening the gap between the next specimen [prickly redfish] to a differential of only SCR 326 compared to SCR 638 in 2012. Unfortunately, for the following years, the value of lollyfish fell back below the 250 mark and stagnated. The lumped group 'Other' is composed of the least valued sea cucumbers and has merely hovered around the same price level [SCR 250], thus demonstrating its constant low valuation. It can also be seen from the figure the cut-off points of all the prohibited sea cucumbers except for the three allowable species. Note that whilst the limit to only three species began in 2018, small amounts of other pieces were exported possibly due to processed species landed in 2017.

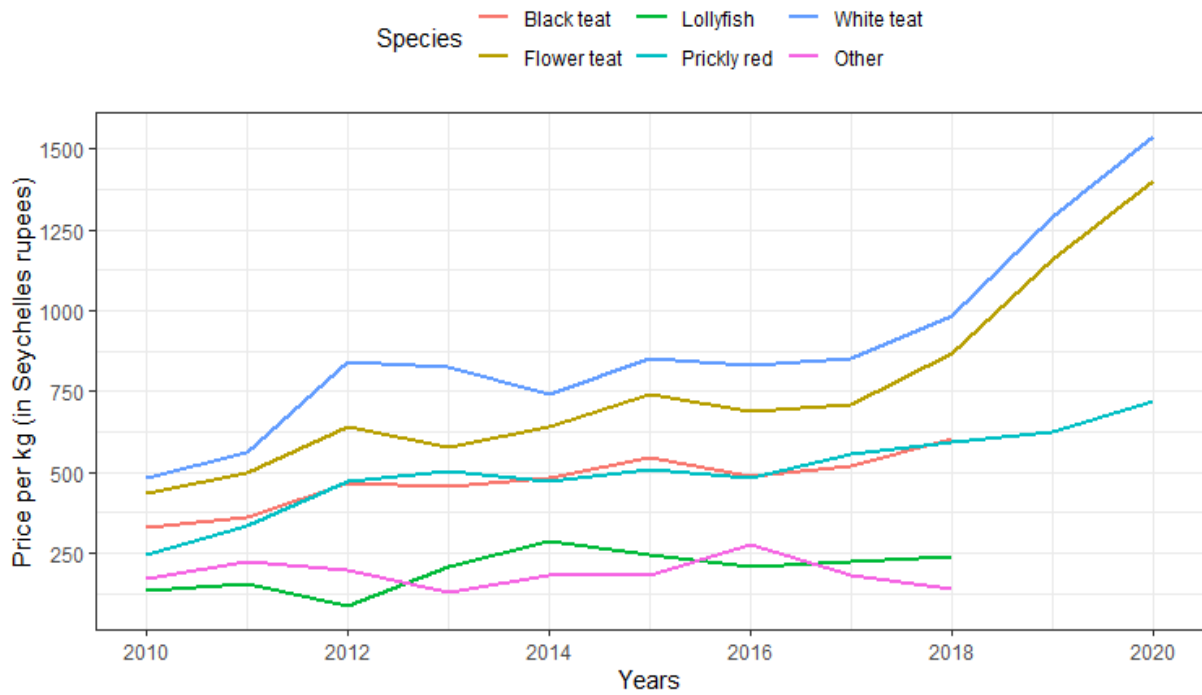


Figure 4: Historical trends in mean export prices of sea cucumbers between 2010-2020. ‘Other’ is a lumped group of the 5 least valued sea cucumbers [chalky sea cucumber, elephant trunkfish, sand fish, surf redfish, white belly/spork].

7.5 Current export prices

With a focus on the past 3 years, white teatfish has consistently been the highest priced specimen followed by flower teatfish and prickly redfish (**Fig. 5**). From 2018-2020 mean export prices of white teatfish, flower teatfish and prickly redfish achieved increases of 56%, 62% and 21% respectively. In 2020, all 3 species recorded individual highs with white teatfish at SCR 2,295 per kg, flower teatfish at SCR 2,040 per kg and prickly redfish at SCR 1,020 per kg. The average prices on the other hand for white teatfish, flower teatfish and prickly redfish stands at SCR 1,539, SCR 1,401, and SCR 720 per kg respectively. As stated in **Fig. 5**, export prices for 2020 are from January-July. Given the constant depreciation of the Seychelles rupee against the US dollar, there is a possibility that higher prices will be observed across all species for 2020.

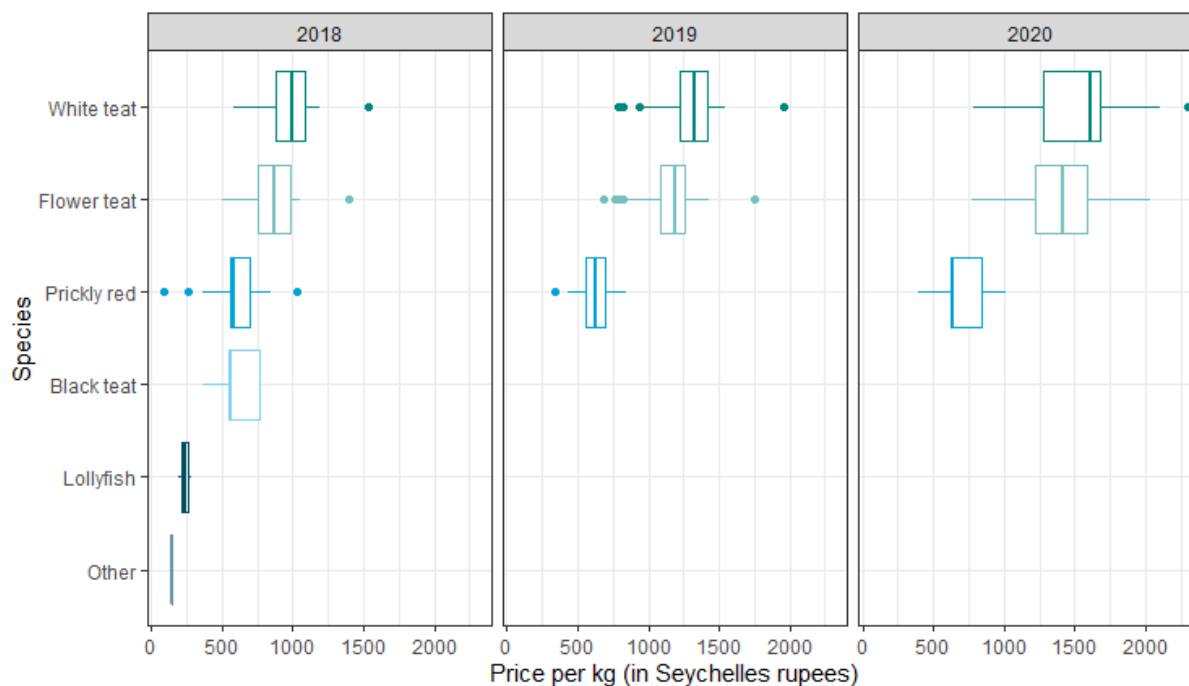


Figure 5: Export price variation of sea cucumbers for the three most recent years [2018-2020]. ‘Other’ is a lumped group of the 5 least valued sea cucumbers [chalky sea cucumber, elephant trunkfish, sand fish, surf redfish, white belly/spork]. For 2020*, export is from January-July.

7.6 Export trends

During 2018-2020, exportation of sea cucumbers has followed the same trend as production hence demonstrating the resource’s high export-orientation and limited consumption by the local market (**Table 5**). This is confirmed by the variation between landings and export during the open season of 2017/2018 and 2018/2019, of which export accounts up to 97% of total production. The remaining portion is either sold to the domestic market or is lost during processing. Additionally, it could be due to the margin of error associated in data collection.

Table 5: Export of dried sea cucumbers for the period 2018-2020. Weight and value are measured in metric tons and Seychelles rupees respectively. For 2020*, export is from January-July.

Species	Pieces	Weight	Value
2018	282,337	54.11	44,029,100
Black teatfish	803	0.12	64,329
Flower teatfish	193,846	36.64	30,759,588
Lollyfish	1,966	0.09	19,650
Prickly redfish	33,294	6.76	3,211,261

Species	Pieces	Weight	Value
White Belly/Spork	220	0.01	1,576
White teatfish	52,208	10.50	9,972,696
2019	278,686	51.94	56,707,056
Flower teatfish	181,308	33.69	38,048,736
Prickly redfish	40,918	6.37	3,934,872
White teatfish	56,460	11.88	14,723,448
2020*	241,612	42.09	58,336,921
Flower teatfish	175,418	30.99	43,852,764
Prickly redfish	21,704	3.30	2,424,723
White teatfish	44,490	7.80	12,059,434

During 2018-2019, the amount of sea cucumbers exported measured by number of pieces and weight declined marginally by 1% and 4% respectively. On the other hand, a 29% upward variation in value was observed resulting from increases in flower teatfish (SCR 7.29 million) and white teatfish (SCR 4.75 million). This change is rather significant given that in 2019 only three species were exported compared to 6 in 2018. The rationale behind the increase is attributed to three main factors:

- depreciation of the Seychelles rupees against the US\$,
- higher amounts of the most highly valued specimen were exported (i.e., white teatfish = +1.38 mt),
- export prices for the 3 species in 2019 increased considerably, especially for flower teatfish and white teatfish.

Preliminary figures for 2020 indicate that on a month-on-month basis whilst number of pieces and weight in July have not reached the level of the previous, value has surpassed, demonstrating a rise in export value for year 2020. This growth in value is partly explained by the substantial depreciation of the Seychelles rupees against the US\$ and increases in export prices. Moreover, it is projected that the number of pieces and weight will also exceed the prior year with total value potentially reaching the SCR 60 million mark, which would be a new 5-year high.

7.7 Exporters

Export of sea cucumbers from Seychelles is conducted by the 4 licensed processors, under strict supervision by SFA and the Customs Division of the Seychelles Revenue Commission (SRC). For confidentiality purposes the exporter's name in this section will be removed and replaced with generic names. Over the past few years, Exporter 2 and Exporter 4 have competed to be the leading exporter (**Table 6**). In 2018, Exporter 2 was the frontrunner in both weight and value. For the subsequent year, Exporter 4 managed to surpass Exporter 2 in the weight category only. Exporter

2 was able to maintain its lead in value by a mere 1%. This was because their export prices were relatively higher than Exporter 4. In 2020, based on the data available Exporter 4 currently leads considerably in all categories. Lastly, it appears that over this period the export operations of Exporter 3 have been steadily declining.

Table 6: Export of dried sea cucumbers decomposed by exporter during 2018-2020. Weight and value are measured in metric tons and Seychelles rupees respectively. For 2020*, export is from Jan-Jul.

	Weight	% Share	Value	% Share
2018	54.11		44,029,100	
Exporter 1	10.35	19%	6,947,044	16%
Exporter 2	19.59	36%	17,746,974	40%
Exporter 3	9.39	17%	8,048,334	18%
Exporter 4	14.78	27%	11,286,748	26%
2019	51.94		56,707,056	
Exporter 1	14.25	27%	15,659,314	28%
Exporter 2	14.03	27%	17,984,859	32%
Exporter 3	4.73	9%	5,407,388	10%
Exporter 4	18.93	36%	17,655,495	31%
2020*	42.09		58,336,921	
Exporter 1	9.50	23%	10,628,413	18%
Exporter 2	11.37	27%	18,115,640	31%
Exporter 3	3.77	9%	5,126,970	9%
Exporter 4	17.46	41%	24,465,898	42%

8. Employment

8.1 Highlights of the industry's labour market

Fishing of sea cucumber is considered a dangerous and difficult profession as divers face both physical and health hazards (e.g., drowning, decompression sickness, et cetera...) during diving operations. Over the years the fishery has encountered multiple labour issues caused by the activity's intrinsic risks coupled with other systemic labour issues in Seychelles, such as substance abuse amongst the crew. To address this concern SFA implemented certain measures whereby divers must undergo a medical exam indicating a negative drug test prior to a fishing trip (Seychelles News Agency, 2017). In 2016, these multifaceted labour issues subsequently led to a change in the recruitment policy of the fishery whereby boat owners were now able recruit foreign workers (Ministry of Labour and Human Resource Development, 2015).

8.2 Crew on board

A typical vessel in the fishery is composed of 6 crew members with 4 divers, 1 cook, 1 skipper and with the possibility of 1 apprentice diver, preferably from the Seychelles Maritime Academy¹¹. The apprenticeship program was created with the intention to engage youths to develop their diving skills and to encourage them to take a job in the sector and mitigate the influx of foreign labour within the fishery. Based on the fleet of vessels, the fishery directly supports around 150 jobs, with about two thirds being divers. Foreigners, mostly of Malagasy origin, constitute 36% (54) whereas locals make up the remaining 64% (96). Based on the guideline for recruiting of non-Seychellois workers (Ministry of Labour and Human Resource Development, 2015), the fishery can have up to 50% of the crew as non-Seychellois. In absolute terms, the 54 foreign crew members signals a strong reliance on foreigners and a low workforce participation rate by locals. When the season is closed, many of the foreigners are sent back to their home state while the remaining local crew continue to participate in other fisheries or seek for employment elsewhere.

Crew payment arrangements differ across boat owners, but most respondents paid their crew according to a boat share system. This typically involves the distribution of net revenues after specified costs are subtracted. For example, (1) some operators subtract trip costs, keep one third (33.33%) of what is left over and then divide the remaining two thirds (66.67%) among crew members. (2) Some operators may change the sharing proportion by keeping 25% and the rest for the crew. (3) Other boat owners may remove the owner's share first and then what is left over is deducted of trip costs and shared across the crew. Due to the diverse range of share systems, the most predominant system which involves the 1:2 share ratio between boat owner and crew (1), was used to estimate labour expenses of the fleet. Together with vessel-level expenses derived from the survey, we estimated the labour cost of the fleet for 2019, ergo the income impact on the fishing side. This amounted to SCR 23.87 million and with respect to the estimated number of crew members, the annual mean income per crew amounted to SCR 159,116.

8.3 Processing workers

At the processing-level, in 2019, it was recorded that the industry supported around 35 jobs contributing to an estimated income impact of SCR 5.72 million (**Table 7**). About two thirds of the workforce are locals, with 8 in managerial positions (75% male), 6 in administrative positions (83% female) and 8 in manual positions (100% male). Foreigners account for a smaller portion with only 13 in manual positions (100% male). It is important to also note that whilst these are the number of employees on record, the processing plants on occasions, when workload is high, recruit casual workers on a daily basis.

¹¹ The Seychelles Maritime Academy (SMA) is a tertiary-level vocational school that provides quality maritime training and professional qualifications in accordance with international standards.

Table 7: Average monthly salary by structure, gender, and nationality in 2019. Average monthly salary (Avg. monthly salary) is measured in Seychelles rupees.

Structure	Nationality	Gender	Number	Avg. monthly salary
Management			8	*29,167
Management	Local	Male	6	**30,000
Management	Local	Female	2	***25,000
Administration			6	9,500
Administration	Local	Male	1	10,000
Administration	Local	Female	5	9,400
Manual			21	11,667
Manual	Local	Male	8	9,125
Manual	Foreigner	Male	13	13,231

*Average salary based on 6 individuals as 2 do not receive a salary.

**Average salary based on 5 individuals as 1 does not receive a salary.

***Average salary based on 1 individual as 1 does not receive a salary.

As expected, individuals in management positions are the highest earners with an average monthly income of SCR 29,167 followed by manual posts at SCR 11,667 and administration posts at SCR 9,500. Foreign manual workers earn a higher income compared to their local counterparts as additional explicit costs such as accommodation and food are incorporated in their salary. Furthermore, manual workers tend to earn a higher income compared to administrative personnel due to the higher skilled nature of their occupations (i.e., mechanics, electrician). From a gender point of view, there appears to be a slight downwards wage gap with female management and administrative workers earning less than their male counterparts. However, this gap is considerably small, with the differential being attributed to the position in which the individual occupies, i.e., upper management who receives a salary is made up of only males. Please note that one male and one female in Management posts do not receive a salary as per their preference.

8.4 Households/Individuals impacted

The sea cucumber industry directly generates 185 jobs with 118 being locals (64%). Together with the number of boat owners results in about 143 households directly dependent on the industry. With an average household size in Seychelles of 3.4 (National Bureau of Standards, 2013), an estimated 486 individuals are impacted to some degree by the industry. A more detailed employment study implemented by SFA is expected to be completed by March 2021 and will provide a better assessment on the number of jobs and wages in the sector.

9. Payments and fees revenue

9.1 Fishing license fees

Whilst the open season for the fishery lasts for about 8 months and overlaps in years, fishing licenses are granted on an annual basis with an associated fee equal to SCR 7,000. Presently each licensee is allocated an individual non-transferable quota of 15,000 pieces per season (flower teatfish = 11,250 | prickly redfish = 1,500 | white teatfish = 2,250) in which vessels are not permitted to transfer their excess allocation and failure to stay within the quota would lead to a fine of up to SCR 300,000. This quota also referred to as the Total Allowable Catch (TAC) was calculated based on the maximum sustainable yield (MSY) for each specimen. In addition to the sea cucumber fishing license, vessels must have a valid local vessel fishing license which stands at SCR 500. By aggregating both licenses we attain the actual access fees. Based on the number of vessels with fishing licenses granted per year (**Table 8**), license fee receipts over the past 3 years are presented in **Table 9**. For 2020, the sea cucumber fishery accounts to about 40% in fishing licensing revenue relative to other local fisheries (excluding industrial fisheries).

9.2 Processing license fees

The number of processors is capped at 4 and is non-transferable. The associated fee for a sea cucumber processing license is SCR 20,000. No production limit is placed on the processors but given the quota at the fishing-end, processors are limited by the amount landed. Over the past 3 years, all 4 processors have been operating year-round (**Table 8**) and the license fee receipts are given in **Table 9**. In 2020, the amount received was SCR 15,000 lower than the previous years and this is because one of the processors was given a 3-month license instead of a full year one as they were experiencing machinery related issues.

Table 8: Number of sea cucumber fishing and processing license holders for the period 2018-2020.

Year	No. of licensed vessels	No. of licensed processors
2018	24	4
2019	25	4
2020	25	4

9.3 Registration fee

Based on the conditions for acquiring a sea cucumber fishing license, all crew members must be registered with SFA. The assigned registration fee is SCR 250 per crew member for both fishermen and divers. With the estimated number of crew members, the amount collected from registration fees is given in **Table 9**.

9.4 Inspection fee

Under circumstances where port entry and inspection are undertaken outside the specified hours (between 0600-1800 hrs. during working days), weekends and public holidays the vessel is charged SCR 1,000. This inspection fee is paid to SFA, and receipts are given in **Table 9**.

9.5 Management fee

As part of the management of the industry, an export levy of US\$ 2 kg⁻¹ is charged for exporting sea cucumbers. The export levy, also referred to as the ‘Management fee’ is charged by SFA and given in **Table 9**.

Table 9: Payments and fees received from the sea cucumber industry for the period 2018-2020. Local vessel fishing license = SCR 500, sea cucumber fishing license = SCR 7,000 (total given in parentheses), processing license = SCR 20,000, registration fee = SCR 250, inspection fee = SCR 1,000, management fee = US\$ 2 kg⁻¹.
Values are measured in Seychelles rupees.

Year	Fishing	Processing	Registration	Inspection	Management	Total
2018	180,000 (168,000)	80,000	36,000*	15,000	1,179,989	1,490,989
2019	187,500 (175,000)	80,000	37,500*	35,000	1,195,200	1,535,200
2020	187,500 (175,000)	65,000	37,500*	Not available	1,469,589	1,759,589

*Values are based on the estimated number of crew members.

10. Value added & subsidies

10.1 Overview of expenditures

In this section we aim to provide an overview of the expenditures incurred by sea cucumber fishing vessels and processors. Expenditures also known as costs can be broken down into two main components; fixed costs (direct): costs independent from the level of fishing/processing activity, and variable costs (indirect): costs dependent on the level of fishing/processing activity (FAO, 2017). Note that some of these costs, such as license renewals, registration fees, management fees, remuneration of employees (wages) have been covered in the previous sections. **Table 10** provides a list of the overall cost items incurred by each operator. As it can be seen processors bear most of the expenses including the capital costs of compressors used to collect sea cucumbers. Fishers on the other hand mainly cover the vessel’s operational costs.

Table 10: Overview of expenses incurred by operators in the sea cucumber industry.

Fishers	Processors
Accommodation Bookkeeping Food & Ice Fuel Gainful Occupation Permit Inspection fee Insurance Labour (remuneration) Local vessel & sea cucumber fishing licenses Maintenance & repairs Taxes Telecommunication Registration fee Utilities	Accommodation Air freight charges Bookkeeping Clearing agent fees Compressors and diving equipment Export levy Fuel & Transport Gainful Occupation Permit Gas bottles Insurance Labour (remuneration) Maintenance & repairs Processing license fee Wooden sticks /Bamboo Salt Sea cucumber purchases Taxes Telecommunication Utilities

10.2 Fleet-level expenses

At the fishing-level, fuel is one of the main cost components and under the Fuel Incentive Scheme the fleet benefits from a reduced rate of SCR 8.50 from the pump selling price. The scheme allows for bunkering to be conducted at the two designated fuel depots at the main fishing ports of Victoria and Providence following a formal fuel claim request by the boat owners. In 2019, a total of 136 bunkering operations was recorded with volume ranging between 150-2,800 litres. During this time, a total of 179,975 litres was bunkered at a value of SCR 3,292,538 (value with respect to pump price, i.e., inclusive of concession). With the recruitment of foreigners, GOP payments in 2019 amounted to SCR 259,200. Based on the survey administered to the boat owners we established the operational cost of the fishing fleet for 2019. **Table 11** provides a representation of the operational costs associated with a sea cucumber vessel.

Table 11: Average operational cost for a single sea cucumber fishing vessel during 2019. Value of fuel represents the subsidised rate and in parentheses the monetary value of the concession.

Operational cost item	Value
Accommodation	61,920
Fuel	70,510 (61,192)
Food	106,000
Ice	5,400
Labour remuneration	954,695
Telecommunication	9,000
Utilities	7,600
Total	1,215,125

10.3 Processor-level expenses

Similar to the fishing component, in 2019, processors incurred payments towards GOP amounting to SCR 93,600. Additionally, for each consignment exported, the exporter pays a number of charges consisting of the airlines' freight charges, a Corporate Social Responsibility tax (CSR), and an export levy of US\$ 2 kg⁻¹. Freight charges are typically calculated based on the content of the cargo and weight and prior to COVID-19 exporters were paying US\$2 kg⁻¹, equivalent to SCR 28 kg⁻¹.

10.4 Value added

The importance of establishing and capturing the costs incurred by the industry allows us to incorporate an additional measure of economic impact known as value added. Gross Value Added (GVA) at market prices is an economic productivity metric that measures the contribution of a given component, in this case the sea cucumber industry to the economy. The indicator provides a value of the output by the industry, minus the cost of all inputs and raw materials that are directly attributable to its production plus taxes and minus subsidies. Using estimation techniques and recorded expenses made by the operators in the industry, we estimated the valued added by the industry (**Table 12**). It must be emphasized that some of the intermediate costs needed to provide a more accurate estimate is currently not available and requires further investigation. Furthermore, figures to determine the sum of subsidies provided to the processing/exporting component is currently unavailable.

Table 12: Value added by the sea cucumber industry by component for 2019. Note that the intermediate consumption by each component is not comprehensive and is based on available statistics.

Sea cucumber industry	Value
Fishing component	
Output	42,673,440
Inputs = intermediate consumption	9,851,723
Taxes	-
Subsidies	1,529,788
Gross value added	31,291,927
Processing/exporting component	
Output	56,707,167
Input = intermediate consumption	45,256,629
Taxes	804,052
Subsidies	-
Gross value added	12,254,590
Industry Total	43,546,516

As it can be observed in 2019, the industry generated SCR 43.55 million in value added impact. Fishing component contributed the most with SCR 31.29 million and the processing/exporting component contributed SCR 12.25 million.

10.5 Subsidies

In terms of subsidies, vessels, and processors within the industry benefit from multiple schemes provided by the Government. These include tax reductions and/or exemptions (Value Added tax (VAT) and Excise tax), part payments on their vessel's insurance premium, et cetera... Under the vessel insurance scheme, no sea cucumber vessel applied for the scheme. On the other hand, vessels were exempted from paying the excise tax on each litre of fuel bunkered. Based on the recorded level of fuel bunkered, a total of SCR 1,529,788 from 179,975 litres was subsidised in 2019.

10.6 Man hours

Beneficial subsidies in the form of fisheries management, enforcement, and research are also provided to the industry. These are considered more of an indirect subsidy and based on the services provided by SFA we managed to quantify the cost of each service based on the number of man hours and average salaries. The results are shown in **Table 11**.

Table 13: Estimated number of man hours and cost allocated for overseeing the industry for 2020. Cost measured in Seychelles rupees.

	Man hours	Cost
Monitoring, Control & Surveillance	200	16,389
Management	240	72,000
Research	2,560	408,827
Total	3,000	497,216

A total of 3,000-man hours was allocated to the industry at an associated cost of SCR 497,216. This costs accounts to about 28% of the amount received from fee receipts during 2020.

11. Challenges and opportunities

Following interviews with the target population, feedbacks were positive, with a consensus that the industry is well managed. Nonetheless, some challenges have been identified:

1. While dried and processed sea cucumbers (commonly known as beche-de-mer) have been traded on international markets for a millennium (Conand and Byrne 1993), over the last 40 years trade has increased

exponentially due to buoyant prices driven by the growing demand from Asia (Anderson et al. 2011). Recent documented declines in populations have led to increasing concerns of the potential flow-on effects on ecosystem health (Purcell et al. 2013, 2016). If overexploitation continues, there is the possibility of densities decreasing to a level at which successful reproduction and replenishment of the population cannot be sustained; this is known as the ‘Allee’ effect (Allee 1938; Friedman et al. 2011; Kinch et al. 2008a; Purcell et al. 2013). Such an outcome benefits neither fishers nor sea cucumbers and recognizing the role of international trade as a threat to the conservation of sea cucumber species, consideration has been given to the possible role of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) as a complementary measure for regulating the sustainable use of sea cucumber fisheries. The country-multilateral treaty was created to protect threatened and endangered plants and animals (*Isostichopus fuscus* [brown sea cucumber] is currently listed by Ecuador in Appendix III). Parties of the convention have proposed the listing of *Holothuria (Microthele) fuscogilva* [white teatfish] and, the two black teatfishes *Holothuria (Microthele) nobilis*, *Holothuria (Microthele) whitmaei* under CITES Appendix II. As of August 28, 2020, the three species were successfully included and entered into force under CITES Appendix II. CITES Appendix II is the list of plants and animals who are not under extinction but whose trade must be controlled to prevent practices unsustainable to their survival. Sea cucumber exporters must now comply to the requirements under CITES by applying for a CITES certificate prior to shipping the goods. Additionally, stakeholders in the industry are also pushing for the inclusion of the flower teatfish but encountering issues due its taxonomy being under investigation. This investigation will determine if the species is a separate species or simply a variant of another teatfish species (Muthiga and Conand, 2014). Its taxonomic investigation is required prior to applying for its listing.

2. Based on the Fisheries Comprehensive Plan 2019, one of the main policies mentioned with regards to the sea cucumber fishery is to conduct a fisheries-independent stock assessment to determine the level of abundance. Given the nature of the survey this will subsequently lead to the closure of the sea cucumber fishing season. Such a closure is detrimental to the operators in the industry as it will cause a complete shutdown of their operations. From the interviews, the operators concur that the assessment is a necessity, but the commissioning of the study should be postponed for a few years (approx. 2 to 3 years) to allow them to establish alternative means of continuing their business. A clear deadline and participatory planning of the closure would allow them to organize their investments accordingly. It must be noted that the implementation of the policy is yet to be confirmed as concerns are still being considered.
3. Sea cucumbers play a key role in maintaining ecosystem services through bioturbation (refers to a reworking, stirring, or mixing of sediments layers by organisms), nutrient cycling, improving local water chemistry and providing symbiotic relationships (Purcell et al., 2016). A sacrificial role played by sea cucumbers is to act

as prey to predator species, thereby transferring energy from microalgae and organic detritus to consumers at higher trophic levels (Purcell et al., 2016). It has been researched that the depletion of sea cucumbers have a cascading impact on biodiversity and abundance as its depletion will also deplete symbiont populations (Purcell et al., 2016). Cutting off the food sources of higher trophic level species ultimately leads to an adverse cascading effect along marine food webs which negatively affects the biomass of even higher trophic level species such as finfish species.

4. Substance abuse in the industry, especially within the fishing fleet has been ongoing for years. This is evident with the crackdown by SFA to address this concern by making it mandatory for divers to submit medical certification with a negative drug test prior to embarking on a fishing trip. Respondents of the survey indicated that during fishing trips the substance abuser may go into withdrawal consequently causing the vessel to return to port or in circumstances where the skipper refuses to return, the abuser will sabotage the equipment onboard to force the vessel to terminate the trip. This adversely affects the vessel's operations, and the ensuing costs are borne by the vessel owner and processor. Furthermore, as operations shift to deeper waters, more health-related accidents have been recorded, consequently causing a burden on health care services and on the operators.

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APPENDIX I – Survey questionnaires



ECONOMIC IMPACT OF THE SEYCHELLES SEA CUCUMBER FISHERY AND INDUSTRY QUESTIONNAIRE – HARVESTERS

Ref No.

Date of interview

Name of Vessel:

Fishery Type:

Location of Business:

Completed by: _____

Capacity: Owner Manager Skipper

Employment

The table below refers to the crew onboard the vessel for 2019

Position	Full-time or Part-time	Gender	Nationality	Wage

Vessel expenses

The table below refers to the direct and indirect costs incurred by the fishing vessel. Please fill the table with the required information for the year **2019**.

Cost item	Value (SCR)	Comments
Insurance		

Loan Payments		
Maintenance and Repairs		
Compressor		
Diving equipment		
License fees		
Registration fees		
Gainful Occupation Permit		
Bookkeeping		
Boat fuel		
Food		
Accommodation		
Labour (remuneration)		
Utilities		
Telecommunication		
Selling and distribution		
Transport		
Salt		
Ice		
Other intermediate inputs		
Depreciation		
Business tax		
Corporate Social Responsibility		
Progressive Income Tax		
Other taxes (e.g., VAT)		



ECONOMIC IMPACT OF THE SEYCHELLES SEA CUCUMBER FISHERY AND INDUSTRY QUESTIONNAIRE – PROCESSORS

Ref No. _____ Date of interview _____
 Name of Processor: _____ Processing Type: _____
 Location of Business: _____

Completed by: _____

Capacity: Owner Manager Plant worker

Employment

The table below refers to the number of workers employed by the processing business for 2019.

Position	Full-time or Part-time	Gender	Nationality	Wage

Production capacity

The table below refers to the production capacity of your processing plant. Please provide the exact number or range for the number of pieces and tonnage processed in the 2019/2020 season and state the maximum production capacity you can achieve. **Note that if the information given is for the year 2020 instead of the 2019/2020 season, please indicate in the comments section.

	No. of pieces	Weight (kg)	Comments
Actual production			
Maximum production			

Sea cucumber purchases

The table below refers to sea cucumbers purchases during 2018-2020. Please fill the table with the required information for each sea cucumber specimen. *Note that the prohibition of harvesting the other species excluding the 3 current allowable species commenced in the 2018/2019 season.

Year	Species	No. of pieces	Weight (kg)	Unit Price	Commission	Comments
2018	Black teat					
	Flower teat					
	Lollyfish					
	Prickly red					
	Sand fish					
	Spork					
	White teat					
2019	Flower teat					
	Prickly red					
	White teat					
2020	Flower teat					
	Prickly red					
	White teat					

Processor expenses

The table below refers to the direct and indirect costs incurred by the processing plant. Please fill the table with the requires information for the year 2019.

Cost item	Value (SCR)	Comments
Sea cucumber purchases		
Salary (Remuneration)		
Accommodation		
Food		

Utilities		
Telecommunication		
Selling and distribution		
Gainful Occupation Permit (GOP)		
Fuel & Transport		
Wood		
Cooking gas bottles		
Other intermediate inputs		
Compressors		
Diving equipment		
Bookkeeping		
Clearing agent fees		
Air freight charges		
Export levy		
License fees		
Insurance		
Loan payments		
Depreciation		
Business tax		
Corporate Social Responsibility		
Progressive Income Tax		
Other taxes (e.g., VAT)		

