Project BGF5: "Determining baseline information for the effective management of the Seychelles' small-scale octopus' fishery"

Seychelles' small-scale Octopus Fishery: Baseline report

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Table of contents

1. Glossary

Below are presented the abbreviations and acronyms used in the report.

CPUE	Catch per unit effort
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization
FBOA	Seychelles Fishing Boat Owners Association
GEF	Global Environment Facility
HoReCa	Hotels, Restaurantes & Catering
IUU	Illegal, unreported and unregulated fishing
MCS	Monitoring, Control and Surveillance
MSY	Maximum Sustainable Yield
SFA	Seychelles Fishing Authority
SWIO	Southwest Indian Ocean
ToR	Terms of Reference
UNDP	United Nations Development Programme

2. Executive summary

The information regarding octopus and the octopus fishery in Seychelles is scarce and scattered between several reports, documents and statistical bulletins and there is not any recent compilation. The intention of this *Baseline report* is to compile all the initiatives and studies ever done on octopus in Seychelles and put together all the information available from different sources. This *Baseline report* was not initially considered in the ToR and the consultant's contract, but it has been considered fundamental in order to build from what it is already known and set the baseline of the fishery, and to identify the key gaps of information that are worth focusing along the project. Compiling the historical landings and effort since the beginning of the fishery, or at least since the firsts data were collected, is particularly important not to fall in the 'shifting baseline syndrome' as defined by Pauly (1995); '*this symptom has arisen because each generation of fisheries scientists accepts as a baseline the stock size and species composition that occurred at the beginning of their careers, and uses this to evaluate changes'*. Nevertheless, it is not the intention of this report to make a formal reconstruction and estimate of octopus catches to be compared with the official landings reported. Although this task would significantly allow a better understanding of the productivity of the octopus stocks in Seychelles, it would be time consuming, and it is out of the scope of this project. Besides published information, we have also used in this report our own knowledge of the fishery and Traditional knowledge (TK) from preliminary engagements with octopus fishers held in Mahé, Praslin and La Digue from April to June 2023.

In this report we have compiled:

1- Historical evolution of the octopus fishery in Seychelles from a subsistence and recreational activity to a commercial fishery.

2- Number octopus species present in Seychelles and genetic studies.

3- Studies on the biology and ecology of the main octopus species done in Seychelles or in the SWIO region.

4- Fishing techniques and gears used for catching octopus.

5- Management and regulations of the fishery.

6- Historic fishery statistics based on SFA data.

7- Historic trading (imports and exports) of octopus in Seychelles from FAO FishStatJ database.

8- All reports and information published so far on octopus in Seychelles. A list of references is given at the end.

3. History of the octopus fishery in Seychelles

It is unclear when and how the octopus fishery started in Seychelles since there is no information on the fishery before the 1980s. The first reported octopus' landings are from 1985 and during those years it was broadly classified as a subsistence fishery, although some fishers were already working on a commercial basis, mainly in Praslin and La Digue (Payet 1996).

The evolution from subsistence/recreational to a commercial fishery is associated with the tourism development in Seychelles; 40 years ago octopus was not harvested commercially, but the effort and landings intensified 15 years ago as fishing activities expanded from shallow reefs (<6 m) into deeper benthic habitats to supply the tourism market (Darell Green, personal communication). Not much details are known, but it is considered that the fishery expanded first from on foot to freediving (between 4-9 m) and then to SCUBA diving (usually between 10-18 m but up to 25 m deep) (Seychelloise fishers, personal communication). SCUBA diving for octopus is mainly common on La Digue and Mahe but it also takes place in Praslin and it could be risky as most fishers are not trained to SCUBA dive and they are conducting multiple deep dives in a day (Seychelloise fishers, personal communication).

All fishers use a harpoon (usually in the form of a metal rod with a pointy head and/or another one with a hook). Besides the directed fishery with harpoons, octopus may occasionally be captured as bycatch with other fishing gears like handline or fish traps (SFA 2016).

Based on the licencing scheme and fishers' interviews currently there are:

- Licensed artisanal commercial fishers with harpoons:
    - On foot harvesting
    - Free divers on foot (also using surf/paddle boards or similar)
    - Free divers on motorised boat
    - Scuba divers on motorised boat

- Unlicensed subsistence/recreational fishers (no commercial activity is allowed by law):
    - On foot harvesting
    - Free divers on motorised boat
    - Scuba divers on motorised boat

There are several conflicts between these groups of fishers, mainly because commercial fishers claim that many recreational fishers sell the octopus catches (not allowed under the Fisheries Act 2014, section 3 - Interpretation; Recreational fishing) reducing their market demand and price. Free divers also claim that scuba divers catch octopus before they can migrate to shallower waters, making them dive deeper and further.

4. Octopus species present in Seychelles

Following Taylor (2014) four octopus species have been determined in the SWIO from samples from subsistence and commercial octopus fisheries: the common octopus, *Octopus vulgaris*

Cuvier, 1797, the big blue octopus or day octopus, '*Octopus*' *cyanea* Gray, 1849, the white-striped octopus, *Callistoctopus ornatus* (Gould, 1852), a night active species, and the marbled octopus, *Amphioctopus aegina* (Gray, 1849), a small octopus of just 30 cm total length.

Until at least 2014, it was believed that the main exploited octopus species in Seychelles was *O. vulgaris*, contrary to the rest of the countries of the SWIO region, where the main commercial species is *O. cyanea* (IOC-SmartFish, 2014). And therefore, the SFA has always used the name *O. vulgaris* on its official reports, and it is still the name currently used in the official statistics.

But in 2014, Taylor (2014) found that from 114 octopus individuals collected in Seychelles (North Island and Praslin Island) at fishing markets and directly from fishers, the great majority (111 individuals, 97.4%) were genetically identified as *O. cyanea*, being only 3 individuals (2.6%) identified as *O. vulgaris*, and none as *C. ornatus* or *A. aegina*. This is so far the only genetic study on octopus made in Seychelles. The SFA is still using the name *O. vulgaris* on its official reports.

Octopus vulgaris is a species complex; *Octopus vulgaris sensu stricto* is only distributed in the Mediterranean Sea, central and north-east Atlantic Ocean, but one of the types of the complex, *Octopus "vulgaris"* type III, is distributed in temperate South Africa and southern Indian Ocean (Norman et al. 2016) (Fig. 1). Guerra et al. (2010) found *O. vulgaris* in the SWIO in Amsterdam and St Paul Islands, which based on Norman et al. (2016) may be type III or an additional member of this complex. The work of Taylor (2014), published as a PhD, was not considered in the review done by Norman et al. (2016), so, it is unclear where those individuals would fit in this species complex.

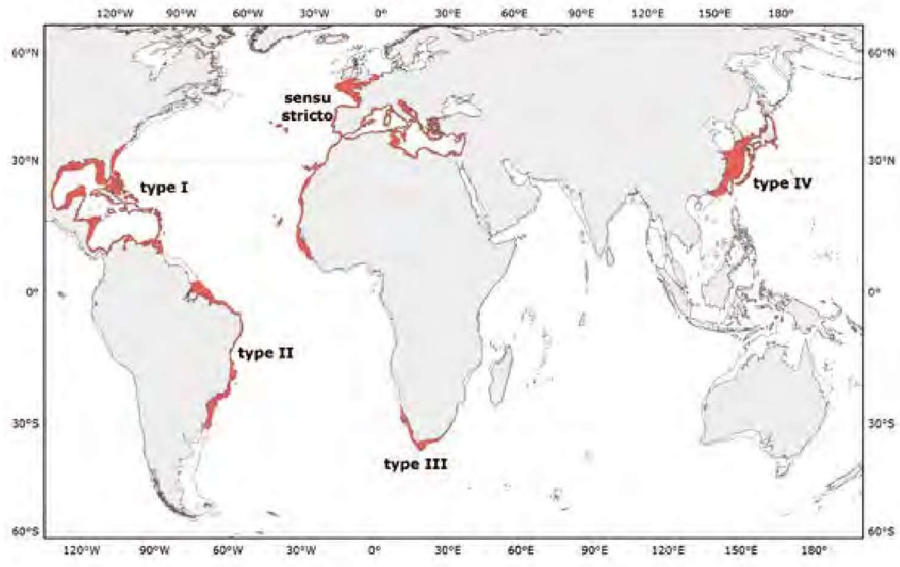

Figure 1. Geographical distribution range of *Octopus vulgaris* complex (red areas mean known distribution). Source: Norman et al. 2016.

Octopus cyanea is a species provisionally placed in the genus *Octopus*. It has been demonstrated that this species is not a member of the genus *Octopus* sensu stricto (i.e. *O. vulgaris* group),

showing stronger affinities with the genus *Abdopus*, and therefore, currently its generic placement remains unresolved (Norman et al. 2016). *O. cyanea* is widely distributed in the tropical Indian and Pacific oceans, from the east coast of Africa to Hawaii, and from southern Japan to northern Australia (Norman et al. 2016) (Fig. 3). *O. cyanea* is as well the main octopus species in the artisanal coastal fisheries in SWIO countries like Comoros, Kenya, Madagascar, Mozambique, Rodrigues, Tanzania and Zanzibar (Rocliffe and Harris 2016) and as well in Seychelles according to Taylor (2014).

The studies above suggest that *O. vulgaris* and *O. cyanea* have slightly overlapping distribution ranges. Moreover, the similarity of appearance, habits and general behaviour of both species make it difficult to differentiate when mixed in fisheries landings (Taylor 2014).

Callistoctopus ornatus is widely distributed in tropical waters of the Indian and western and central Pacific Oceans, from the Hawaiian Islands Archipelago and Easter Island in the east, through the Pacific Islands to Asia and Australia, and into the Indian Ocean to east Africa (Norman et al. 2016) (Fig. 2). The genetic study done by Taylor (2014) did not find *C. ornatus* in Seychelles, and only found two individuals in Madagascar and Mauritius, representing <0.4% of the octopus samples analysed. Fishers and local researchers in Seychelles have reported anecdotic catches of this species in the country during the preliminary engagements (Darell Green, personal communication) and in the social media respectively (www.facebook.com/ SeychelleSeatizens).

It is very probable that *O. cyanea* is the dominant octopus species in Seychelles, with very low population numbers of *O. vulgaris* and *C. ornatus*, resulting in *O. cyanea* dominating the catches in the fishery and very low levels of the other two species.

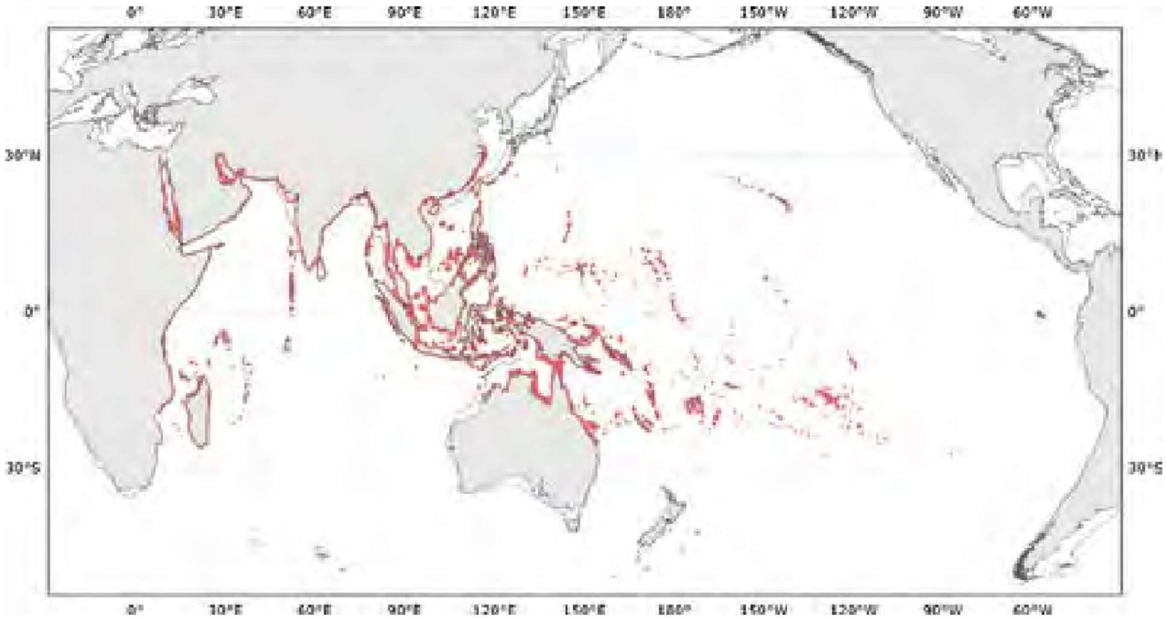

Figure 2. Geographical distribution range of *Callistoctopus ornatus* (red areas mean known distribution). Source: Norman et al. 2016.

5. Distribution and habitat of *Octopus cyanea* in Seychelles

Since *O. cyanea* is most likely the main species in the octopus fishery in Seychelles, we have focused the section on this species.

Octopus cyanea is widely distributed in tropical waters of Indian and Pacific oceans (Fig. 3), from the east coast of Africa to Hawaii, and from southern Japan to northern Australia, including the Red Sea, Arabian Sea, Bay of Bengal, Andaman Sea, South and East China Sea, Philippine Sea, Coral Sea and the Polynesia (Norman et al. 2016) from 33°N to 36°S and from 30°E to 134°W (Roper et al. 1984). In Africa, *O. cyanea* is a native species of Comoros, Djibouti, Egypt, Eritrea, Kenya, Madagascar, Mauritius, Mayotte, Mozambique, Réunion, Seychelles, Somalia, South Africa, Sudan and Tanzania (Norman et al. 2016).

Octopus cyanea is a shallow-water benthic species inhabiting coral reefs and found in a variety of substrata from lairs in coral bedrock, live and dead coral heads and excavations in sand and rubble (Norman et al. 2016), and naturally-occurring holes on rocks or dens (Forsythe & Hanlon 1997). It is usually found from intertidal flats to at least 22 m deep (Norman et al. 2016), although some studies mention it can live down to a depth of 45 m (Norman 1991) and even 150 m (Humber et al. 2006).

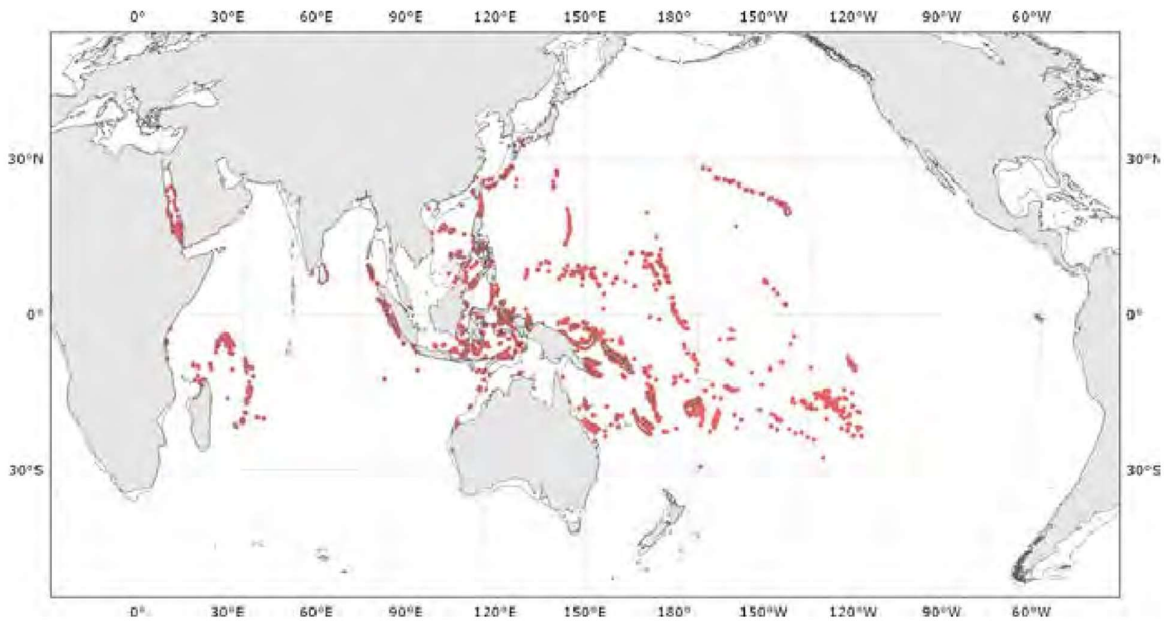

Figure 3. Geographical distribution range of *Octopus cyanea* (red areas mean known distribution). Source: Norman et al. 2016.

In Seychelles no studies have been carried out on the distribution and habitat of *O. cyanea*, although it is considered that it is mainly distributed in the granite islands of the Mahé Plateau, but not in the outer coralline islands. In the outer islands fishers have only found a small nocturnal octopus species, probably *C. ornatus* (Marc Grandcourt and Richard Bossy, personal communication).

Regarding the habitat, Seychelloise fishers reported that there are no octopus on the branched coral reef because they can be easily predated by nurse sharks by breaking the caves, instead,

octopus like floors with coral rubble or a mix of limestone slabs and sand where they can use caves or dig a hole to hide (Darell Green, personal communication). Fishers also mentioned the presence of octopus in Seychelles up to at least 18-25 m deep (Darell Green and Jordy Ladouceur, personal communication).

6. *Octopus cyanea* biology and ecology

Since *O. cyanea* is most likely the main species in the octopus fishery in Seychelles, we have focused the section on this species.

Octopuses are gonochoric (separation of the sexes in different individuals) and semelparous (producing offspring only once during its lifetime) and male and female adults usually die shortly after spawning and brooding, respectively (Rupper et al. 2004).

O. cyanea, as all octopuses, is a short lived species, and usually both growth and mortality rates are extremely high, with an estimated lifespan of between 9-18 months, reaching a maximum weight of 12kg (Guard, 2009). *O. cyanea* females tend to mature at a larger size than males, although big differences have been found between studies: in Madagascar 50% maturity of female and male occurred at 2,246g and 643 g respectively, while in Tanzania it appears to mature at an overall way smaller size (600 g for females and 320 g for males) (Sauer et al. 2019).

Studies in the SWIO have shown that although *O. cyanea* is likely to spawn all year round, different peak spawning and brooding periods have been found , for example, from November to December in Rodrigues, in June with a smaller peak in December in Tanzania (Sauer et al. 2019) and in January and from October to November as well in Tanzania (Guard 2003). Mature *O. cyanea* female individuals often migrate from shallow reef flats into deeper subtidal areas for spawning (Raberinary & Bembow 2012), laying clusters of 150,000–700,000 eggs to the roof of the den and brooding them until they hatch (Sauer et al. 2019), usually after 30 days during which the female ceases to feed (Guard 2009).

The larvae are planktonic, remaining in the water column for 1 to 2 months before settlement experiencing a wide ranging dispersal, with larvae travelling up to several hundred kilometres (Sauer et al. 2019). Settlement occurs at a size of approximately ½ cm (de San 2013), and after 2 months post-settlers have grown to recruits to the fished population reaching 50-105g (Guard & Mgaya 2002). Recruitment peaks a few months after brooding periods, in Tanzania a large pulse was found in September (from the brooding peak of June) and a second smaller pulse in February (Guard & Mgaya 2002).

In Seychelles no studies have been carried out on the biology and ecology of *O. cyanea*. Nevertheless, it is thought that the spawning period in Seychelles goes from May to September (IOC-SmartFish 2014). A limited octopus seasonal migration has been proposed in Seychelles, usually overwintering in deeper waters during the SE monsoon, from May to September, and inhabiting shallower waters the rest of the year (Payet 1998, de San 2013). The information on octopus' life cycle collected during the preliminary engagements with Seychelloise fishers was very limited and sometimes inconsistent, but some relevant information on octopus' reproduction was found: 1) fishers don't usually see females incubating eggs, maybe because this

happens at deeper waters, 2) mating occurs during a few days around new and full moon, and 3) reproduction takes place all year round.

7. Implications of the octopus life cycle in the fisheries management

The life cycle of octopus has several characteristics with strong implications in fisheries management: short lifespan (9-18 months), semelparity (dying after reproduction), strong annual recruitment fluctuations, extremely rapid growth (up to 200g in 15 days), ontogenetic migration patterns from deeper to shallower waters, high natural variability in the abundance due to environmental factors and its strong spatial structure as metapopulations.

The shorter life span combined with its rapid growth imply that the time to adjust the fishing strategy to the changes detected in the population biology is markedly reduced. This implies that routine monitoring of commercial fishery catches, including sampling of biological data, on a (preferably) weekly or (at least) monthly basis during the period leading up to and including the main fishing season, would permit in-season real-time assessment of stock status (Pierce et al. 2021). This routine monitoring would detect changes in the population and take quick and informed management decisions (e.g. when and where to set temporal and spatial closures for protecting reproduction and recruitment events).

The trait of a single breeding event after which the female dies, would seem to indicate octopus to be susceptible to recruitment overfishing, especially if brooding occurs over a defined period through which fishing continues (Boyle & Rodhouse 2005, Guard 2009). Nevertheless, in the case of tropical species like *O. cyanea*, this can be counterbalanced with year round brooding with several brooding peaks. This should result in a more variable pulsed recruitment into the population and on this basis may buffer the recovery potential for this species (Guard 2009). However, this would depend on leaving enough females reaching brooding size so as to contribute to the reproductive stock and in heavily fished areas this might not be the case (Guard 2003). Actually, given cephalopods' rapid life history and terminal spawning, it would be desirable to use biological reference points connected to escapement biomass levels that would secure sufficient spawning (Arkhipkin et al. 2021) ensuring enough recruitment to the next generation that can sustain next year's population and fishing season.

Octopus cyanea has extremely high growth rates (as much as 200g in only 15 days) which implies that if not recruitment limited, it would be capable of rapid recovery from fishing mortality and may therefore be more resilient to intensive fishing pressure (Guard 2009). Actually, there is potential for large numbers of new recruits to enter the fishery even between fished spring tide periods. This rapid increase in weight has been extensively used in the SWIO to support short-term closures as a successful management measure engaging as well the communities in the decision-making (Olivier et al. 2015, Rocliffe & Harris 2016). The timings of these closures, aiming to coincide with recruitment and spawning peaks, have largely been based on limited information (Raberinary & Bembow 2012), although more and more science and communities are working together to understand the optimal timing of the closures (Rocliffe & Harris 2016). More quantitative data on the life cycle of octopus (mainly reproductive and recruitment peaks, growth rates and migrations) would support this optimal timing, which should also be aligned with the

local context (e.g. regarding tides, weather conditions and market limitations) to achieve the highest economic revenues for the communities.

Another relevant factor is that mature *O. cyanea* female individuals often migrate from shallow reef flats into deeper subtidal areas for spawning (Raberinary & Bembow 2012), usually out of the fishing grounds generally harvested in the SWIO diving fisheries. Migrations to and from the fishing grounds pose restrictions on the use of assessment models because it may not be clear whether a sudden decrease in catch per unit effort (CPUE) is owing to fishery exploitation (fisheries depletion) or emigration of the target species from the fishing area (Arkhipkin et al. 2021), resulting in doubts in the management measures to adopt.

The wide annual fluctuations of octopus recruitment, often influenced by environmental variability (e.g. by winds and rainfall, see Otero et al. 2008 and Sobrino et al. 2020), leads to large year-to-year natural differences in abundance and catches. This might obscure the effectiveness of the fisheries management measures implemented hindering and even frustrating the learning process at the local level. Although forecasting models may reduce unpredictability (Otero et al. 2008 and Sobrino et al. 2020), it will not reduce the nature variability, which may only be reduced by avoiding overfishing and improving fisheries management (Pierce et al. 2021).

Octopuses are benthic species living for protracted periods in specific or structurally complex habitats (e.g., rocky or coral reefs), often displaying social behaviour (e.g. territoriality) and most probably structured as metapopulations (Orensanz & Jamieson 1998, Caddy & Defeo 2003). This strong spatial link with an area, mainly after recruitment took place, opens the opportunity for the local management measures (e.g. size limit, short-term closures or rotational fishing) to have a significant impact at the local population level and as well for the local fishing community if any type of restrictive access right have been granted (e.g. Territorial Users Rights for Fishing or a system of Customary Marine Tenure).

8. Fishing operation and gears

The octopus fishery in Seychelles operates in the granitic islands of the Mahé Plateau, mainly in the larger islands of Mahé, Silhouette, Praslin and La Digue, but as well around other smaller islands like North Island, Fregate Island, Île aux Récifs, Ile Therese and Conception Island (Seychelloise fishers, personal communication) (Fig. 4). The exact location of the fishing grounds is unknown. Based on the fishers' knowledge there is no octopus fishing in the outer coraline islands.

Octopus fishers access the fishing grounds, between 0 and 25 m deep, on foot, by motorised boats or other alternative ways like surfing/paddle boards. At the shallowest fishing grounds octopus is harvested directly by reef gleaning on foot. On deeper grounds free diving or scuba diving is used. The specific fishing gear for capturing octopus is the harpoon (usually in the form of a metal rod with a pointy head and/or another one with a hook) (Fig. 5) used by fishers on foot and divers. Divers also use goggles and fins and some of them the scuba gear as well.

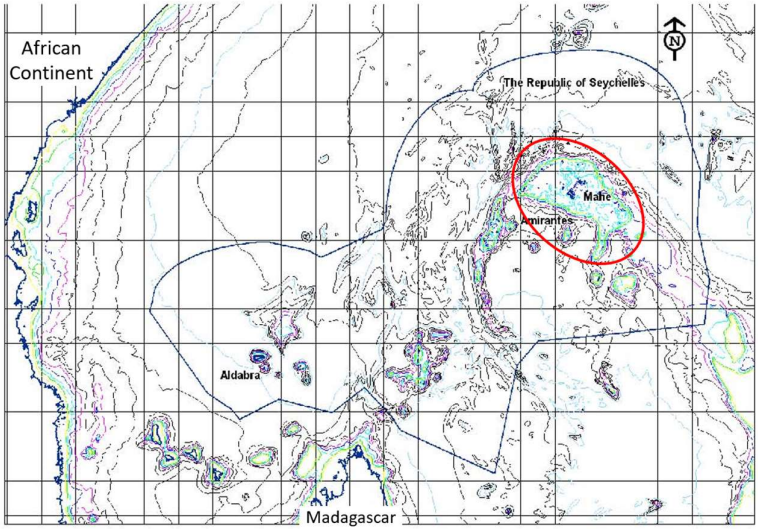

Figure 4. Location of the Mahé Plateau (shallower area encircled in red), where the octopus fishery operates, within the Seychelles EEZ delimited by a dark blue line.

Figure 5. Octopus fishing gears (harpoons: metal rods with a pointy head and hook) in Seychelles. Photo taken in Bel Ombre, Mahé. (Photo credit: Gonzalo Macho).

Based on the SFA Artisanal Statistical reports from 1991 to 2016 besides the directed fishery with harpoons, octopus may also be captured as bycatch with other fishing gears like handline or fish traps (SFA 2016) with variable level of landings (Fig. 6). The main historic fishing gear capturing octopus is harpoon on foot (FOOTHAR), with the exception of 1995 when the main gear was encircling gillnets (OBGNC), 1996 (traps on foot - FOOTFIXS) and 2013-16 (handlines by boat - OBLHP) (Fig. 6). It seems that those 'weird years' are more due to data inaccuracies than to real changes in the fishery. The information on landings by fishing gear presented has to be taken with caution since it still needs to be carefully reviewed.

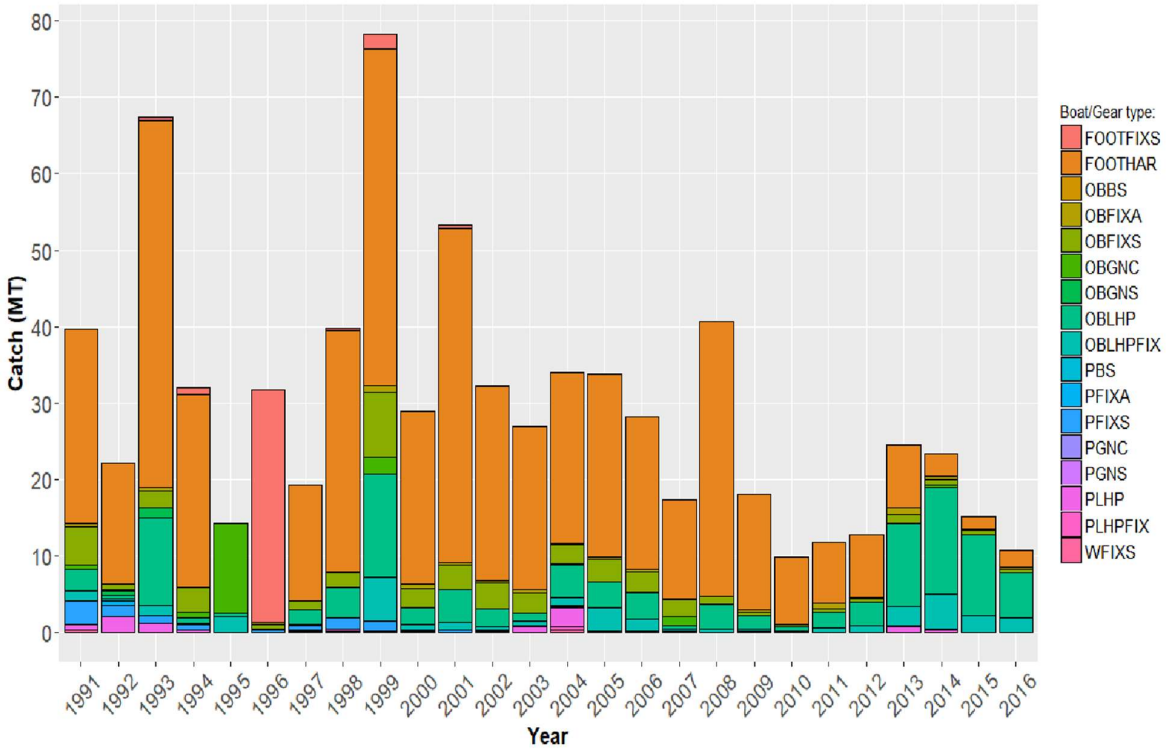

Figure 6. Historical octopus landings in Seychelles by fishing gears (see text for gears' legends). Source: SFA (from the Artisanal Statistical reports 1991-2016)

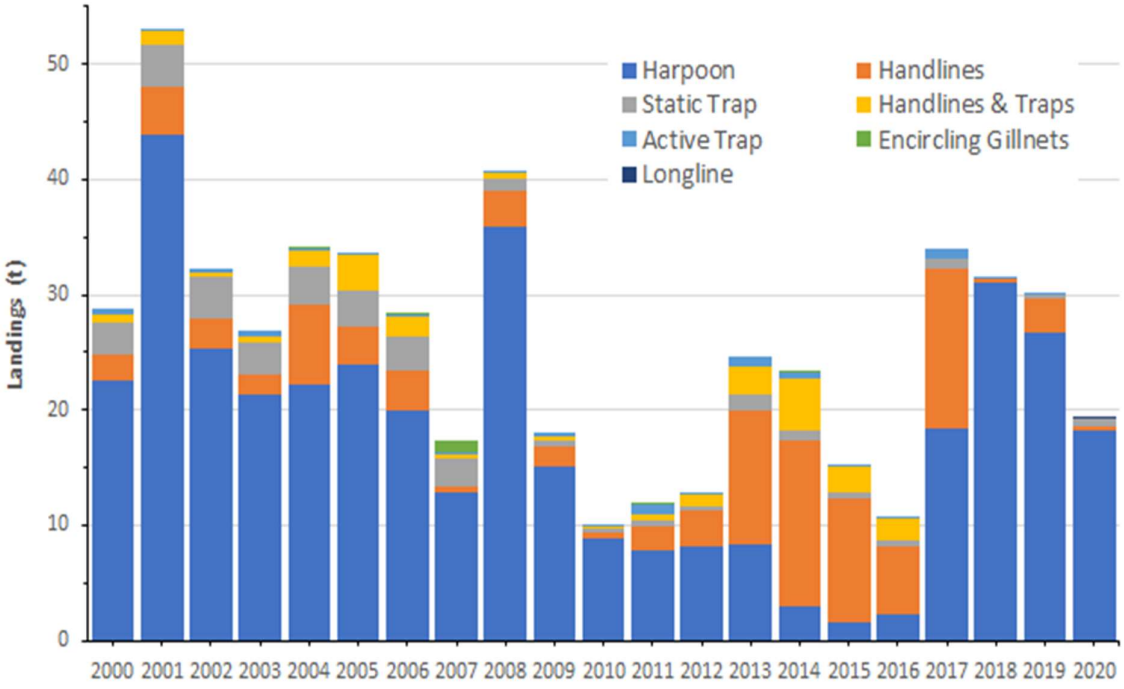

Figure 7. Historical octopus landings (2000-20) in Seychelles by fishing gear. Source: own elaboration based on SFA data.

In Figure 7 a more updated dataset from 2000 to 2020 of octopus landings in Seychelles by fishing gear is shown. On average, during the last 20 years, harpoons represented 70.3% of the landings, handlines 17.9%, Static Traps 6.0% and handlines & traps 4.3%. Other residual landings have been registered with active traps (1.2%), encircling gillnets (0.3%) and longlines (0.002%). It is clear that historically and in the most recent years the great majority of octopus' catches are done using harpoons. Nevertheless, octopus landings with handlines are also important, being during some years (2013-17) of a big magnitude (6-14 t) and higher than harpoon catches.

So far, there is no information on what proportion the harpoon octopus catches have been done on foot, free diving or scuba diving.

9. Octopus fisheries management

Commercial octopus fishery

The commercial octopus fishery in Seychelles is open-access and unregulated, although fishing boats need to be registered. A commercial fishing licence for artisanal fishery, which allows the use of multiple artisanal gears for capturing multiple species, is required for the boat, but on foot fishers do not require any licence, just to be registered.

There is a recognition of the need to implement management measures for octopus since the first reports on the fishery (Payet 1996, SFA 1998). Payet (1996) considered that a management plan for the octopus fishery should be considered as a priority, and proposed two management measures, closed areas and size limits. In 1998 a draft management plan was presented focused on the harpoon octopus fishery which at that time represented more than 75% of the total landings (SFA 1998). The management plan was considered to be urgently needed since octopus was under heavy fishing pressure (SFA 1998). The plan determined fishery specific objectives (1-examine the demand of octopus, 2-use of MSY or ⅔ MSY as the limit reference point, 3-maximise the fishers' economic return and 4-develop a sustainable licencing system) and management instruments (1-all vessels registered at SFA and licensed to limit the fishing effort, 2-an annual TAC of ⅔ MSY after which the fishery would be closed, 3-a 2 months closed season in September-October corresponding to the major spawning period, 4-closed areas, 5-an immediate 1-year closure of the fishery to allow stock recovery). The plan considered biological and socioeconomic aspects and briefly included as well a communication plan, enforcement system, monitoring and evaluation, research priorities and a economic cost/benefit analysis of managing the fishery.

A FAO consultancy done in 1998 noted big catches of small octopus (200g) and proposed a minimum size to be urgently implemented and a yield-per-recruit analysis as a research priority for the octopus fishery (Mees et al. 1998). In this work exclusive access rights in pilot areas were proposed for the first time in the fishery based on the low enforcement capacity and the fishers likely low compliance to imposed measures. The report recommended that by doing so fishers would have an incentive to assume enforcement responsibilities in their areas and that any benefit from the conservation of the resource should accrue to those fishers.

Per Erik (2012) in a general study in Seychelles pointed out that most artisanal fisheries remain open access and excess fishing effort, especially in inshore areas, has led to localised overexploitation, highlighting the need to reassess the management regimes for most artisanal fisheries. In 2013 another consultancy (de San 2013) reinforced the measures and approach of the previous studies on the octopus fishery of Payet (1996), SFA (1998) and Mess et al. (1998). The following management measures were proposed: 1) a minimum size of 0.5-1 kg, 2) enforcement of the MPAs to create octopus spawning reserves around Mahé, La Digue and Praslin, 3) a 2 months octopus fishing closure during the spawning peak, probably in September-October. The study also highlighted the need to transfer the responsibilities for the enforcement and the conservation benefits to the harvest right holders, based on the sedentary nature of octopuses.

During those years, a pilot initiative was taking place under a UNDP-GEF project in collaboration with SFA, which proposed a comanagement area around Praslin and La Digue for the inshore fisheries. A management plan was developed and the following measures were proposed for octopus: 1) a minimum size of 1 kg and, 2) a daily bag limit of two octopuses per person to unlicensed or recreational fishers (IOC-SmartFish 2014).

Sadly none of the above proposed management measures and research priorities has ever been implemented and the octopus fishery in Seychelles remains nowadays unregulated and with the same research gaps on the biology of the species.

Subsistence and Recreational octopus fishery

Subsistence and recreational octopus fishing has a strong tradition in the Seychelloise culture. The activity is not regulated, although there is a great number of recreational fishers (on foot and by boat) all year round, especially from September to May when waters are calmer and clearer (Seychelloise fishers, personal communication). The Fisheries Act 2014 does not allow to commercialise catches from recreational fishing, although based on fishers' comments this happens quite frequently. The level of subsistence and recreational octopus catches is expected to be quite relevant.

Illegal, unreported and unregulated (IUU) fishing

There is no specific information on the MCS for the octopus fishery, but in general, in the semi-industrial and artisanal fishery, notably the inshore fishery, compliance and enforcement are very weak (Breuil & Grima 2014). It is suspected that considerable IUU fishing activities are taking place in Seychelles waters; the main IUU activities in the artisanal fishery are fishing during closed season (for lobster and sea cucumber, the only two fisheries regulated) and the use of unlicensed fishing gear (Per Erik 2012). In the preliminary engagements with the octopus fishers in April-June 2023 they all highlighted that there is a complete lack of MCS in the fishery and that octopus catches are not being registered by SFA since they very rarely land on the designated landing sites. Instead, octopus is generally sold directly to individual buyers, HoReCa establishments, processors and retailers without passing by the designated landing sites (Seychelloise fishers, personal communication). Artisanal fishers also claim that many recreational fishers sell their

catches to locals, hotels and restaurants, although this is not permitted by law. Many of the recreational catches are apparently done by individuals with drug addictions, attracted by high prices of octopus in the market and an easy fishing operation (closeby fishing grounds and low tech fishing gears). There is no information regarding the potential IUU catches on MPAs where fishing is banned.

Based on the above a considerable level of IUU catches is expected in the octopus fishery in Seychelles. Actually, de San (2013) highlighted that octopus statistics are recognised as inaccurate because of the difficulty to collect data from subsistence/recreational fishers and after discussion with stakeholders assumed that around 50% of the catch is sold unrecorded directly to the consumers (private, restaurants and hotels).

10. Octopus fishery statistics: Historical compilation

A compilation of annual landings for octopus has been done using official data from SFA reports (1998, 2022) and different databases from the SFA Statistics Department. Figure 8 shows official landings after data get processed. If we assume that 50% of the catch is sold unrecorded, following de San (2013) estimation, real octopus catches would be 2 times the official reported landings.

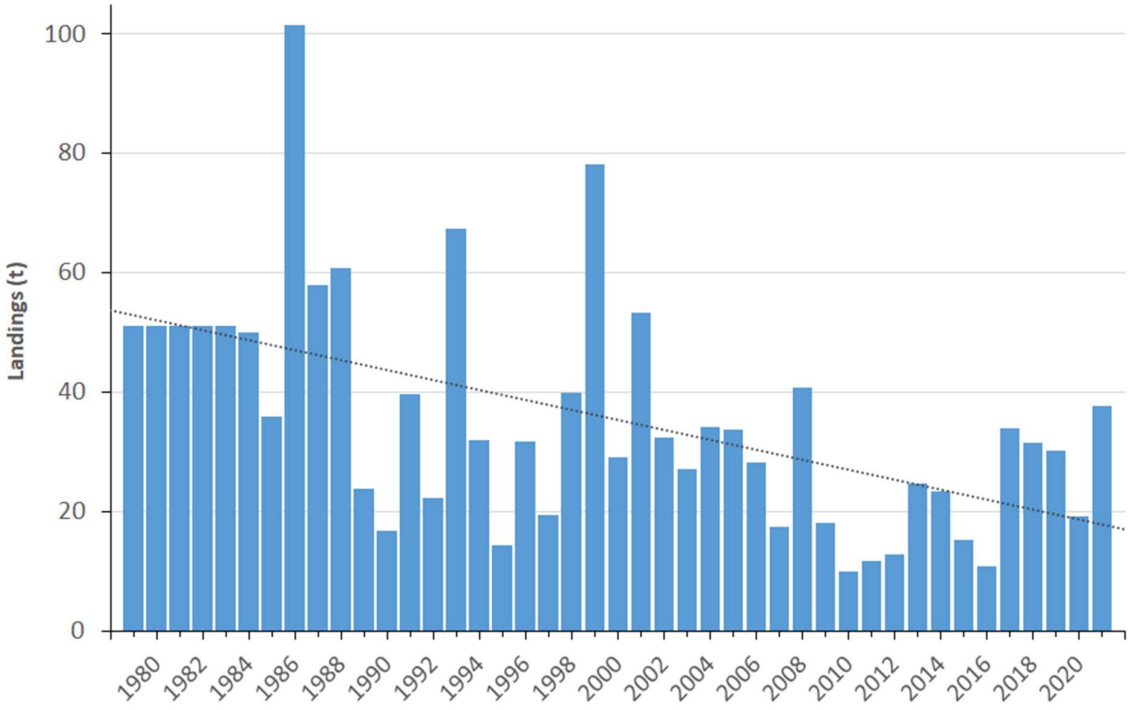

Figure 8. Historical octopus landings in Seychelles for the period 1979-2021. (Note that landings in 2021 correspond only to semester 1). Source: own elaboration based on data from FAO Fisheries Division, Statistics and Information Branch. FishStatJ (FAO 2023), SFA reports (1998, 2022) and SFA Statistics Department.

Historic octopus official landings (FAO & SFA) for the period 1979-2021 (Fig. 8) are extreamly fluctuating with maximums between 60-100 t, found in the first decades, and minimuns around 10 t, mainly observed in the last decade, showing a downward trend. In the last decade landings have fluctuated between 10-38 t.

Data from the first decade of the octopus fishery (1985-1995) shows great annual variability of landings by islands between Mahé and La Digue/Praslin (Fig. 9). The island with the main landings varies from year to year, following sometimes even opposite directions. For the octopus catches with harpoon there is data available by landing site for the period 2017-21. The main landing site is Glacis (N Mahé) with 56% of the accumulated octopus landings in those five years, followed by La Digue (31%). The relevance of the rest of the landings sites is minimal: Anse Etoile (6%), Belombre (3%), Cascade (2%), Anse Aux Pins (1%), Anse Boileau (0.3%), in Mahé, Baie Ste Anne (0.2%) in Praslin, Anse Royale (0.1%), Roche Caiman (0.1%) & English River (0.1%) in Mahé, and Grand Anse (0.1%) in Praslin.

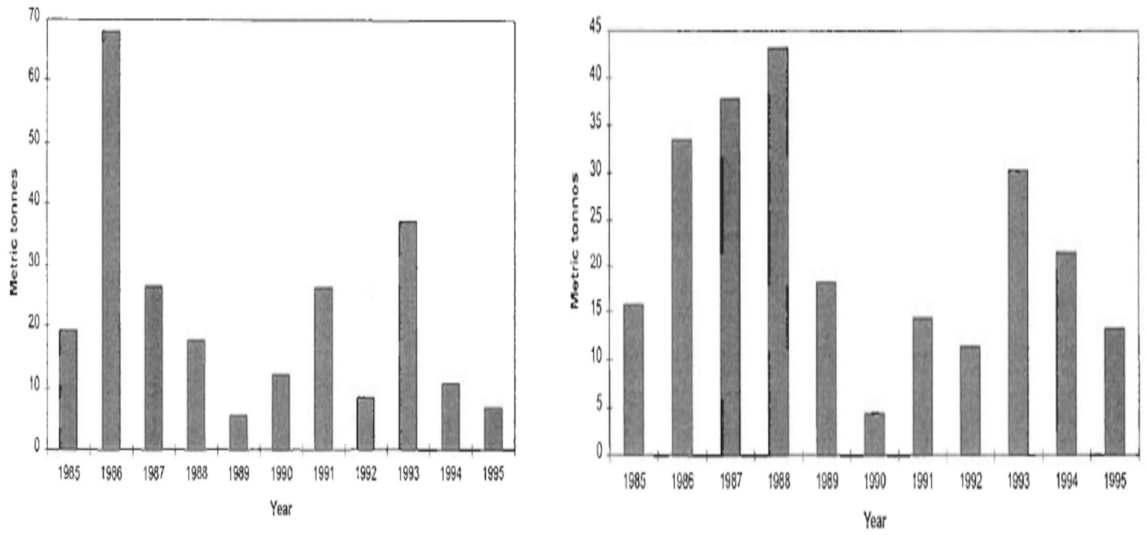

Figure 9. Historical octopus landings in Seychelles by islands (left panel Mahé, right panel La Digue and Praslin together). Source: Payet (1996). (Note: data analysis needs to be updated).

Globally, during the period 2000-20, Mahé accounted for 70% of the octopus landings, (fluctuating annually between 50-88%), while La Digue and Praslin together represented the other 30% (Fig. 10). Following the variability observed in figure 9 for the period 1985-1995, octopus' landings by island also varied enormously in the period 2000-20. Mahé landed between 6-37 t, with an average of 18 t. La Digue and Praslin landed between 3-17 t, with an average of 8 t.

The only information on octopus landings disaggregated by the 3 main islands (Mahé, La Digue and Praslin) corresponds to the recent 2017-20 period. During these years, Mahé landed between 14.1 and 26.3 tonnes of octopus, La Digue fluctuated between 4.2 and 10.9 tonnes and Praslin between 0.1 and 3.6 tonnes (Table 1).

The relative importance of Mahé in terms of octopus landings varied annually between 62-83%, La Digue fluctuated between 12-36% and Praslin between 0-11%.

	Mahé		Praslin		La Digue		total (t)
	tonnes	%	tonnes	%	tonnes	%	
2017	26.3	77%	3.6	11%	4.2	12%	**34.0**
2018	26.3	83%	0.7	2%	4.5	14%	**31.6**
2019	18.5	62%	0.7	2%	10.9	36%	**30.1**
2020	14.1	74%	0.1	0%	5.0	26%	**19.2**

Table 1. Annual octopus landings in Seychelles by island for the period 2017-20. Source: own elaboration based on SFA data.

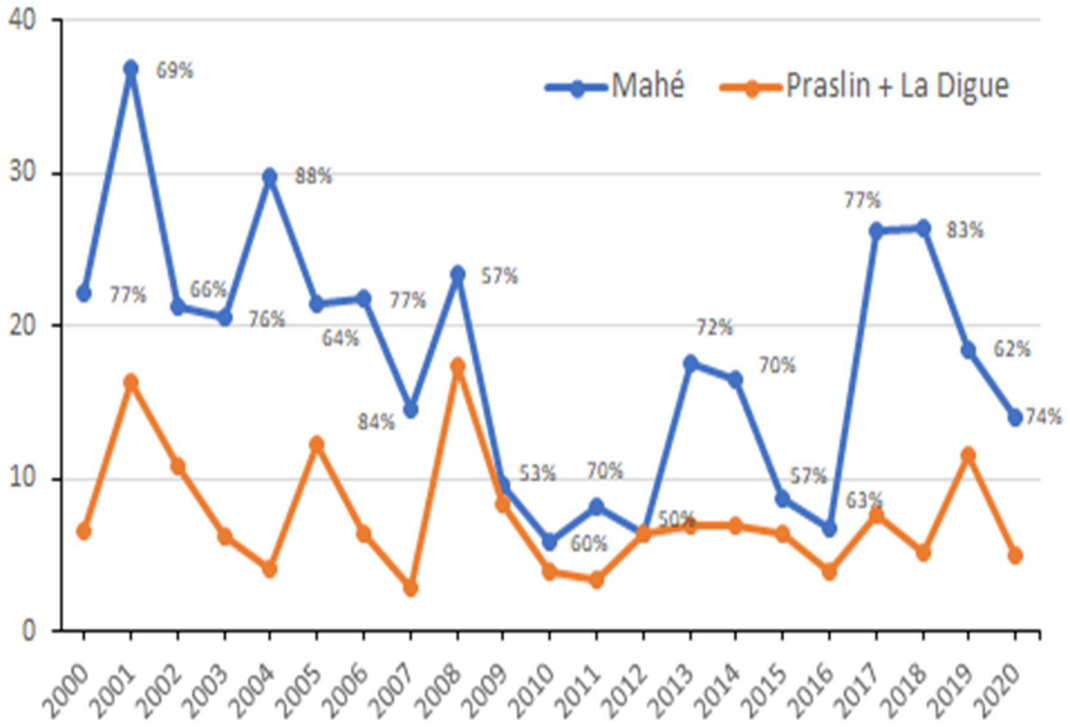

Figure 10. Annual octopus landings in Seychelles by island for the period 2000-20. Labels show the percentage that Mahé landings represent each year. Source: own elaboration based on SFA data. Note that there is no disaggregated data for Praslin and La Digue.

Regarding the intraannual variation, a strong seasonal variation of octopus landings is observed along the year, with peaks during the two inter-monsoon periods, in March-April and in October, and very low landings during the SE monsoon winds from June to August (Fig. 11).

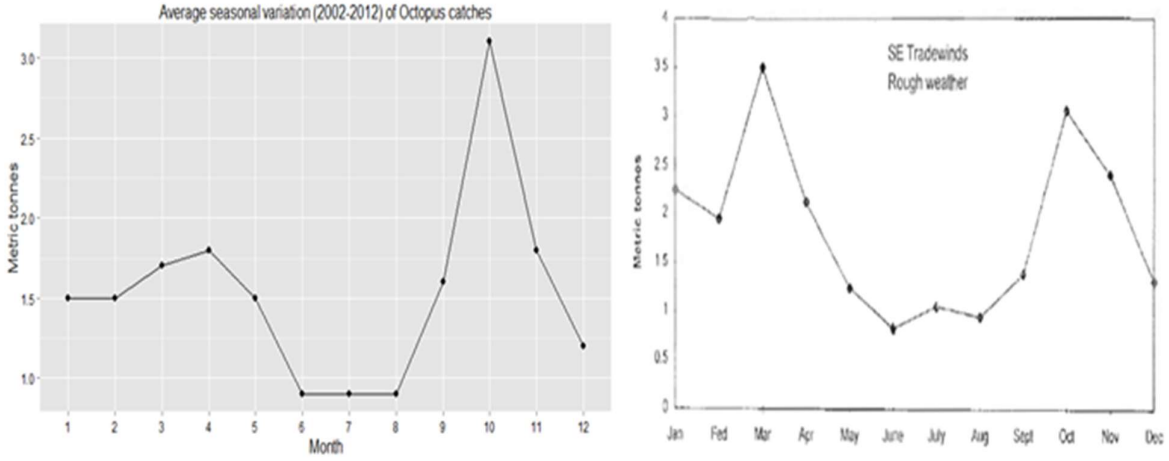

Figure 11. Monthly average octopus landings in Seychelles. Left panel period 2002-2012 (Source: IOC-SmartFish 2014) and right panel period 1985-1995 (Source: Payet 1996). (Note: data analysis needs to be updated).

When comparing octopus landings and fishing effort (1986-2012) together for the octopus directed fishery using harpoons a similar trend is observed, with an overall decline from 2001 to 2012 (Fig. 12). It is unclear whether this reduction of the fishing effort is real or whether it is due to inaccuracies in its estimation.

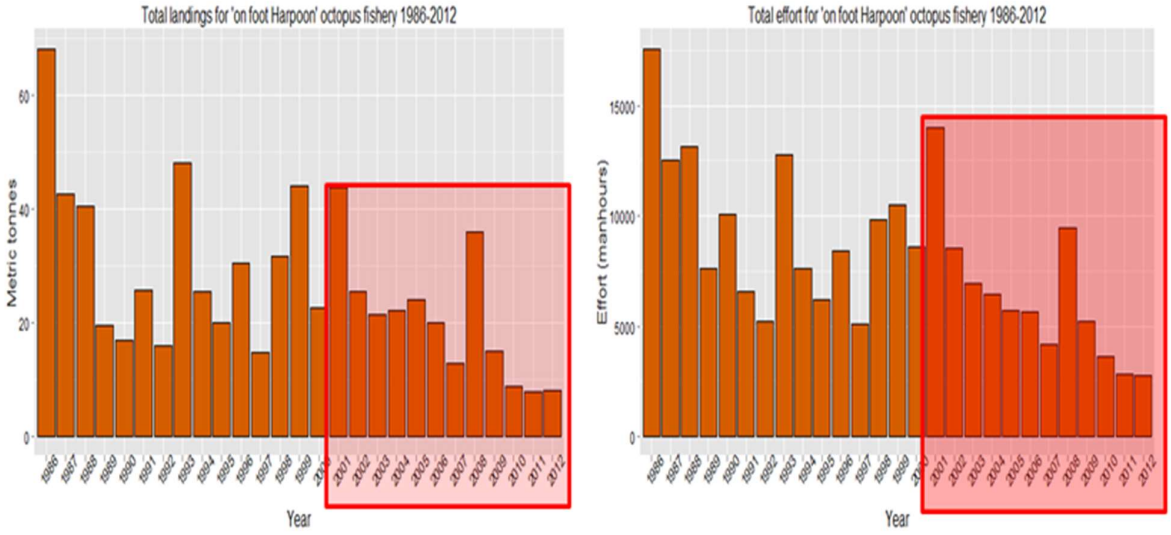

Figure 12. Octopus landings (left) and fishing effort (right) using harpoons for the period 1986-2012. Source: IOC-SmartFish 2014. (Note: data analysis needs to be updated).

11. Octopus stock status

The first report on the fishery (Payet 1996) already raised concerns in the 1990s of decreasing octopus stocks in Seychelles due to considerable fishing pressure. An assessment of the octopus stock was done applying a Schaffer Production Model to catch and effort data, and a MSY of 33.7 t was estimated for the Mahé Plateau (SFA 1998). This threshold was surpassed many years in the history of the fishery (Fig. 8).

The octopus stock has not been studied in the last two stock assessments of the artisanal fisheries resources (Gutiérrez 2011, Robinson 2021), and it has never been part of any other assessment in the last decades. The current status of octopus in the Seychelles is therefore unknown, although total annual landings show a downwards trend (Fig. 8).

Doubts regarding the octopus status have been always present. de San (2013) considered that it was not clear if the fishery has a problem of recruitment or if it has a problem of overfishing a sedentary population close by the granitic islands.

No reference points and no reliable indices are available. The CPUE time series has remained relatively stable fluctuating between 2.5 and 4 kg/manhour (Fig. 13), although the estimation of effort is inaccurate (IOC-SmartFish 2014). The SFA considered in 2014 that it was difficult to assess the status of the resource due to inaccuracies in the catch and effort data and poor knowledge on the biology of the species (spawning period and zones and size of maturity is unknown), nevertheless, it is likely that localised overfishing particularly in coastal zones is taking place (IOC-SmartFish 2014).

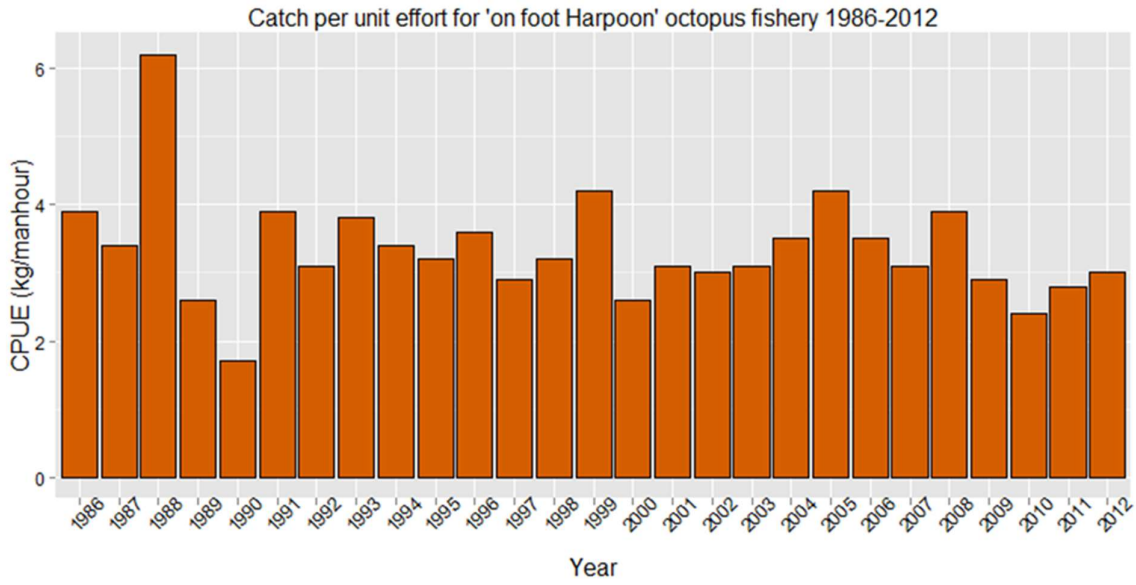

Figure 13. Octopus CPUE for the period 1986-2012. Source: IOC-SmartFish 2014. (Note: data analysis needs to be updated).

12. Octopus trading (imports/exports), markets and economics

The principal markets for octopus are hotels, restaurants and take-away outlets catering for tourist and domestic purchasers, and directly to local buyers (de San 2013, IOC-SmartFish 2014). In 2015, it was estimated that 52% of the reported catch was sold to processors, and the rest was sold directly to consumers at fish markets, to retailers or fishmongers (Advance Africa 2018). Processors sell most of the octopus to local hotels and restaurants, which are also supplied directly by fishers and fishmongers (Advance Africa 2018). The SFA (1998) estimated the consumption of octopus in hotels in Seychelles to around 15.6 t in the late 1990s. Average official octopus landings in 1996-98 were 30.9 t, representing roughly 50% of the catches destined to hotels, assuming that all catches were reported.

In Seychelles, octopus is served as a delicacy, fetching high prices in the tourist markets (Advance Africa 2018). Ex-vessel price in 1997 was already 32-40 scr/kg (SFA 1998). In 2013 the price for octopus sold directly to consumers was around 110 scr/kg and the price paid by the middle men was around 75 scr/kg (de San 2013). In 2023 ex-vessel octopus price was between 100-150 scr/kg although it could reach 250-300 scr/kg when sold directly to hotels (Seychelloise fishers, personal communication).

The great majority of the octopus catches are consumed fresh or frozen by the internal market in Seychelles, although there are small exports of frozen octopus to Mauritius, Russia and the EU (Advance Africa 2018), although precise data is not available. Payet (1996) found small imports of octopus of 0.5-4 t/year in 1990-92, but ceased afterwards. After meeting with processing and exporting companies, de San (2013) estimated between 20 to 30 t of octopus imported every year to Seychelles. A total consumption of octopus in Seychelles was estimated around 40-60 t/year based on 50% coming from local production and 50% from importation (de San 2013).

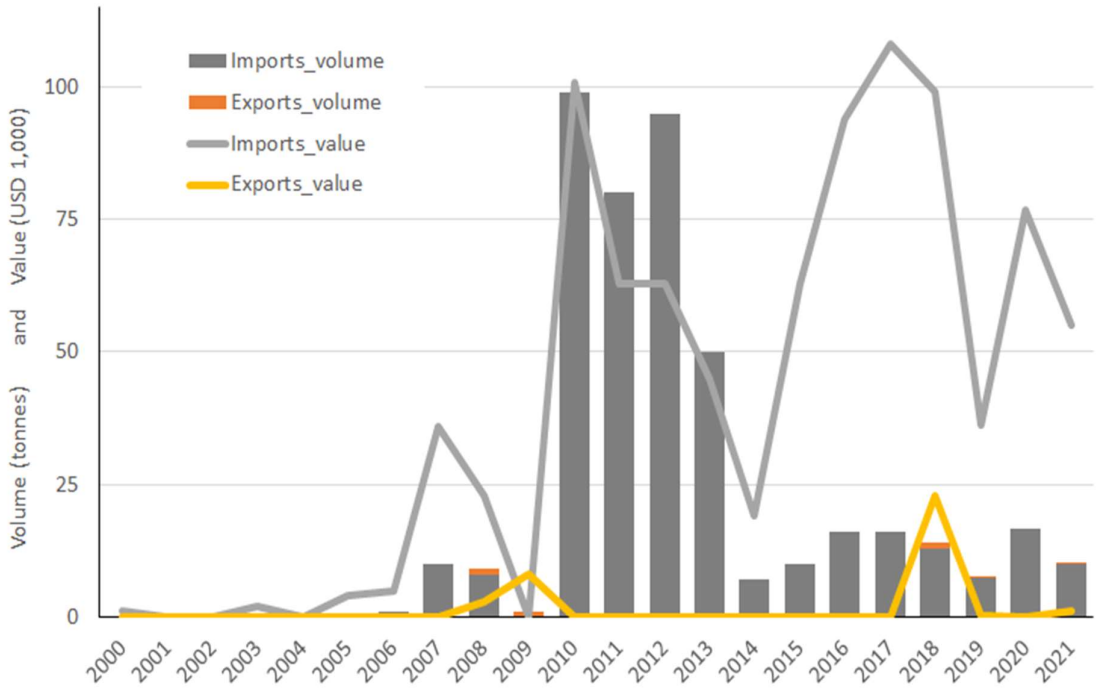

Figure 14. Seychelles annual octopus exports and imports (in volume and value) for the period 2000-21. Source: own elaboration based on data from FAO Fisheries Division, Statistics and Information Branch. FishStatJ (FAO 2023).

Based on FAO data from FishStatJ (FAO 2023), octopus (all species considered) exports from Seychelles are negligible, always below 1 tonne per year. On the other hand, octopus imports, considering all products (frozen, dried, salted or in brine, smoked, prepared or preserved, live, fresh or chilled), are relevant, especially during early 2010s with 50-100 t per year (Fig. 14). Since 2014, octopus imports have been always below 17 t per year.

There are two main countries where octopus is imported in Seychelles; United Arab Emirates and India, with almost 4 t per year on average from each country during the period 2019-21, representing 34 and 33% respectively (Fig. 15). Belgium (1.6 t, 14%) and Germany are also relevant (1 t, 9%). Other countries where octopus is imported are Netherlands, France and Vietnam.

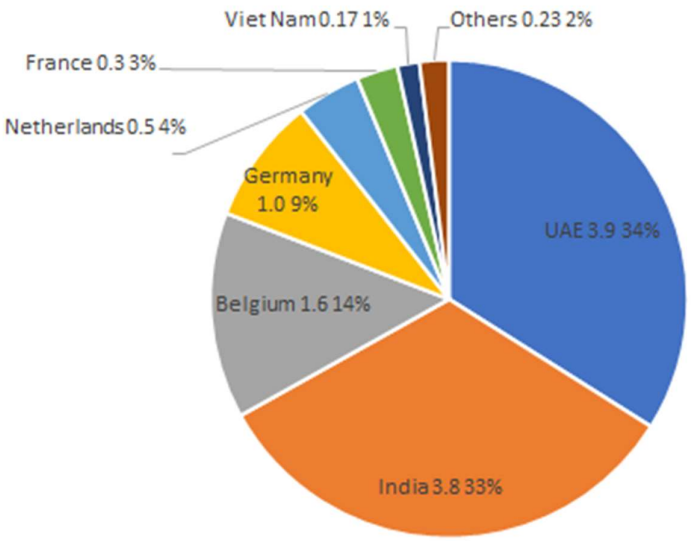

Figure 15. Seychelles octopus imports (in tonnes and % that each country represents); annual average by country for the period 2019-21. Others include China, Japan, Spain, USA, Italy, Mauritius, Sri Lanka and South Korea. Source: own elaboration with data from FAO Fisheries Division, Statistics and Information Branch. FishStatJ (FAO 2023).

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