

## Statistics of The Seychelles Purse Seine Fleet Targeting Tropical Tunas In The Indian Ocean (2000-2018)

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### SUMMARY

*In 2018, the Seychelles purse seine fishing fleet was composed of 13 purse seiners and 7 support vessels.*

*The total annual number of fishing sets reported to be 2,956 which consists of 2,739 positive sets and 217 null sets. The large majority of fishing sets (2,784 sets, i.e. 94%) were made on schools associated with drifting floating objects (FOBs), which are predominated by man-made artificial Fish Aggregating Devices (FADs), and 172 sets were made on free swimming schools (FSC). The total nominal effort in 2018 in terms of fishing and searching was about 2,786 and 2,230 days, respectively, which represents a respective decrease of 15% and 12% in fishing and searching days compared to 2017.*

*The total catch recorded by Seychelles purse seine fleet operating in the Indian Ocean reached a total of about 123,000 Mt, very similar to that of 2017. After processing the data with a large number of size samples collected in Port Victoria from the whole purse seine fleet, skipjack tuna was found to dominate the Seychelles purse seine catches, accounting for 66% of the total catch followed by yellowfin tuna representing 28%, whilst bigeye tuna made up only 5% of the total catch. Catches on FSC was predominated by yellowfin tuna representing 60% of the total catch whilst skipjack and bigeye tuna accounted for 27% and 12% of the rest of the FSC catch, respectively.*

*About 120,000 Mt of tuna were caught on FAD representing 97% of the total catch and about 3,500 Mt or 3% of the total catch was caught on FSC. This reflects a 15% increase in catches on FADs' associated schools and an 80% decrease on free swimming school relative to 2017, respectively.*

## 1. Introduction

Seychelles registered purse seiners started fishing operations in the Indian Ocean in 1991 and are currently of French and Spanish origin. Two main fishing modes, defined by the type of tuna school association, are used to catch tuna in purse seine fishery; the free-swimming schools (FSC) and the tunas associated with drifting floating objects (FOBs), predominated by man-made artificial Fish Aggregating Devices (FADs).

Traditionally, purse seiners mainly fished on free swimming schools and natural floating objects until the mid-1990s when major changes were introduced to the fishing strategy with the extensive use of FADs (Hallier et al. 1991, Fonteneau et al. 2000). The composition of species and size resulting from FOB-fishing varies considerably in comparison to fishing on free schools whereby skipjack (*Katsuwonus pelamis*) is the main species caught and there is a higher rate of juveniles (<10 kg) of yellowfin (*Thunnus albacares*) and bigeye (*Thunnus obesus*). The fishing activities of the Seychelles registered vessels are monitored by the Seychelles Fishing Authority (SFA) through collection of logbook and transshipment declaration, well plans and length frequency sampling conducted in ports during unloading of catches.

## 2. Materials & Methods

### 2.1. Fisheries data

Information on the characteristics and main attributes of the Seychelles fishing vessels (e.g. length overall, carrying capacity) is available from licensing documents, the IOTC vessel registry and data collected by onboard observers. The annual carrying capacity (CC) in tonnage for the Seychelles fleet was computed from the sum of individual vessel capacity in cubic meters ( $\times 0.7$ ) that was weighted by the vessel-specific proportion of the year at sea (in months).

Fisheries data for the Seychelles purse seine fleet are collected from logbooks, landing and transshipments forms and well plans. Logbooks follow the standards defined by the IOTC (Res. 15/01) completed by the skippers and/or captains contain records of the vessel's daily activities. They are submitted to SFA on a weekly basis. The logbook must be completed for each trip undertaken during the period the vessel is registered as a Seychelles flagged vessel. Information recorded in the logbook for each sets and FAD's activity includes but is not limited to:

- Date of the activity
- Geographical location of the activity
- Species composition by weight category
- For FAD's Activities; the type of visit, FAD type, BUOY Type and ID
- Environmental information (e.g. SST, wind and current direction and speed).

When the vessels are not fishing, a blank logbook must be submitted to SFA for the non-fishing period stating reason for non-fishing. It must be noted that the support vessels, vessels assisting the purse seiners during their fishing trip, must also complete a similar logbook to be submitted to SFA at the end of each trip. The well plans contain information on where the catches are stored on the vessel. This is important for the port sampling program in Port to link the samples to the spatio-temporal strata of origin of the fish.

In addition, landing and transshipment information are obtained from either the local representative (agent) of the vessel or the vessel owner. They provide details of unloaded catch by species and commercial weight category for each vessel and each operation.

## 2.2. Sampling

The multi-species nature of tropical tuna surface fisheries gives rise to a series of difficulties at the time of estimating basic catch by species and catch by size statistics. Complications are mainly due on one hand to the unreliability of the weight and species composition declared in the logbooks (visual estimates) and to the tendency of classifying landings into commercial categories, solely according to the sizes of individual rather than according to both size and species. In order to improve the accuracy of statistics for sound stock assessment, a tuna-sampling programme has been implemented in Port Victoria for all Seychelles flagged purse seiners since the start of the fishery (Pallarés and Hallier 1997).

The statistical sampling unit is the brine-freezing well that may contain multiple fishing sets. The sampling is made in two rounds separated from a few hours and supposed to be a simple random sampling within each selected well. Samples combined with species-specific length-length ( $L_D$ - $L_F$ ) and length-weight relationships are then used to estimate the size and species composition of the catch sampled. The number of fishes counted and measured depends both on the fish size category within the well and on the fish species:

- The well only contains large fish (>70 cm). 100 tunas are randomly sampled for each of the 2 rounds, identified and measured with a calliper in predorsal length, i.e. the projected straight distance from the tip of the snout to the anterior base of the first dorsal fin ( $L_D$ ) - to the nearest 0.5 cm.
- The well only contains small fish (<70 cm). 300 and 200 tunas are randomly sampled, identified and measured with a calliper in fork length, i.e. the projected straight distance from the tip of the snout to the shortest caudal ray ( $L_F$ ), to the nearest 1 cm in the first and second rounds, respectively. Within each round, all yellowfin, bigeye, and albacore are measured while only the first 25 skipjack are measured, the rest being counted.
- The well contains a mix of small and large fish. 300 and 200 tunas are randomly sampled, identified and measured with a calliper in the first and second rounds, respectively. The large individuals are measured in  $L_D$  to the nearest 1/2 cm and the small individuals are measured in  $L_F$  to the nearest 1 cm. Within each round, all yellowfin, bigeye, and albacore are measured while only the first 50 skipjack are measured, the rest being counted.

In 2018, a total of 354 samples were collected at the unloading of Seychelles purse seiners in Port Victoria by the SFA sampling team. This represents a total of more than 180,000 fish sampled, of which about 90,000 were measured in either  $L_D$  (8,040) or  $L_F$  (81,210) (Table I). Among these samples, 311 were assessed to be of good quality (i.e. from homogeneous strata; Pallarés and Hallier 1997) and used for the processing of the fisheries data in conjunction with 325, 316, 54 and 4 samples collected from Spanish, French, Italian, and Mauritian purse seiners, respectively.

Table I. Number ( $N$ ) of fish by species collected at unloading from Seychelles purse seiners and measured in predorsal length ( $L_D$ ) and fork length ( $L_F$ ) in 2018 in Port Victoria. ALB = albacore tuna; BET = bigeye tuna; FRI = frigate tuna; KAW = kawakawa; SKJ = skipjack tuna; YFT = yellowfin tuna.

Species	Measurement type	N
ALB	LD	1
BET	LD	308
BET	LF	8166
FRI	LF	4173
KAW	LF	696
SKJ	LF	34200
YFT	LD	7731
YFT	LF	33975
TOTAL		89250

### 2.3. Data Processing

Following data capture of logbooks, landings, transshipments, well plans and samples, a series of verification is undertaken to check and correct possible data entry errors. VMS data are used to validate the activity geographic position declared in the logbook. Data capture, verification and validation are carried out using a dedicated software developed for the purse seine fishery by the French Institut de Recherche pour le Développement.

The data are then processed to obtain the total catch for the fishery by geographical location. The sampling data are used to correct the species composition declared in the logbooks and the total amount of catch declared in the logbook is adjusted to the total landings and transshipments for each trip. The current sampling protocol, strata, and algorithms used for the data processing were established during the European project "Analyse du schéma d'échantillonnage multispécifique des thonidés tropicaux" (Pallarés and Hallier 1997).

## 3. Results and Interpretation

### 3.1. Fleet Capacity

The number of Seychelles purse seiners operating in the Indian Ocean increased from 6 vessels in 2000 to reach 13 vessels in 2004. Following a decrease in the number of vessels active to 7 in 2012, the number of vessels increased to reach a total of 13 vessels in 2015 and for the subsequent 3 years (Figure 1).

In 2018, the fleet was composed of 1 vessel of carrying capacity (CC) 601-800 Mt, 2 vessels of CC 800-1200 Mt, 7 vessels of CC 1201-2000 Mt and 3 vessels of CC >2000 Mt. Historical trend of total carrying capacity, weighted by the months of activity for each vessel, shows an increasing trend from 2000 to 2008, followed by a decreasing trend during the period 2009-2013 which is attributed to the threat of piracy era (Chassot et al. 2010). The carrying capacity of the Seychelles purse seine fleet has since then been on the increase to reach the highest record of ~20,000 Mt in 2016 (Figure 2). In 2018 the carrying capacity decreased to 16,173 Mt compared to 18,730 Mt for the previous year in relation with the stop of some purse seiners that reached their quota prior to the end of the year.

During 2018, 7 Seychelles registered support vessels were in operation in the Indian Ocean compared to 8 in 2017. The supply vessel roles consist of assisting in the search for tuna schools and in deploying and managing the stock of FADs and associated buoys through deployment of FADs, visits and retrieval of some buoys or FADs that drift outside the purse seine fishing grounds (Assan et al. 2015). The Seychelles support vessels spent a total of 1,416 days at sea in 2018.

### *3.2. Fishing Effort*

Historical trend of fishing effort shows the total fishing days increasing from 1,065 days in 2000 to 3,149 days in 2007 followed by a decreasing trend to reach 1,809 days in 2013. Since then the total fishing days has been on the increase reaching a peak of more than 4,000 days in 2016. A similar trend was observed for searching days with an increasing trend from 916 days in 2000 to 2,724 days in 2007 followed by a decreasing trend to reach 1,428 days in 2013. The total searching days has since then increased to reach a peak of 3,229 days in 2016. The total nominal effort in 2018 in term of fishing and searching was about 2,786 and 2,230 days (Figure. 3) which represent a decrease by 15% and 12% in fishing and searching days compared to the year 2017, respectively.

### *3.3. Fishing Sets*

The total number of fishing sets increased from about 900 in the year 2000 to almost 2,700 recorded in the year 2005. The fishing sets then remained stable, fluctuating between 1,825 and 2,259 during the period 2006 to 2014. The number of fishing set recorded increased sharply from 2,942 sets in 2015 to reach 4,179 fishing set in 2016. The total annual number of fishing sets in 2018 was reported to be 2,956 (2,739 positive sets and 217 null sets). A total of 2,784 sets were associated to FOBs (including sets on FADs) and 172 sets made on free swimming schools (FSC).

### *3.4. Fisheries Production and Species Composition*

Analysis of historical data shows that the total catch increased from about 27,000 Mt recorded in 2000 to reach a total of more than 87,000 Mt in 2005, followed by a decreasing trend to reach about 50,000 Mt in 2012. A steady increasing trend was then observed in the total catch to reach a record high of 123,000 Mt in 2018, similarly to that observed in 2017 (Figure 8).

Skipjack tuna dominated the Seychelles purse seine catches, accounting for 66% of the total catch followed by yellowfin tuna representing 28% of the total catch, whilst bigeye tuna made up only 5% of the total catch. Skipjack tuna also dominated the purse seine catches during the period 2000 to 2011 and was then replaced by yellowfin tuna for the period 2012 to 2014. Since then, skipjack has remained the dominant species caught by the Seychelles purse seine fleet.

In 2018, a total of about 120,000 Mt of tuna were caught on FADs, representing 97% of the total catch while a bit more than 3,500 Mt was caught on FSC, i.e. or 3% of the total catch. During the previous year, 85% or about 104,000 Mt of catches were made on FADs' associated schools whilst 15% or about 19,000 Mt of the catches were reported to have been caught on FSC. This reflects a 15% increase in catches on FADs' associated schools and an 80% decrease in catch on FSC, respectively.

Catches on FADs were predominated by skipjack tuna representing 67% of the catch in 2018, while yellowfin and bigeye tunas represented 27% and 5% of catches, respectively compared to 64 %, 29% and 7% for skipjack, yellowfin and bigeye in 2017, respectively.

Catch on FSC was dominated by yellowfin tuna representing 60% of the total catch whilst skipjack and bigeye tuna accounted for 27% and 12% of the FSC catch respectively. In 2017, yellowfin, skipjack and bigeye accounted for 64%, 19% and 16% respectively (Figure 9).

### 3.5. Spatial Distribution

Spatial distribution of fishing activities off the Seychelles purse seine fleet in 2018 (Figure 4) is similar to the previous five years (Figure 5) although a slight decrease was observed in the overall spatial extent of the fishery (Figure 6).

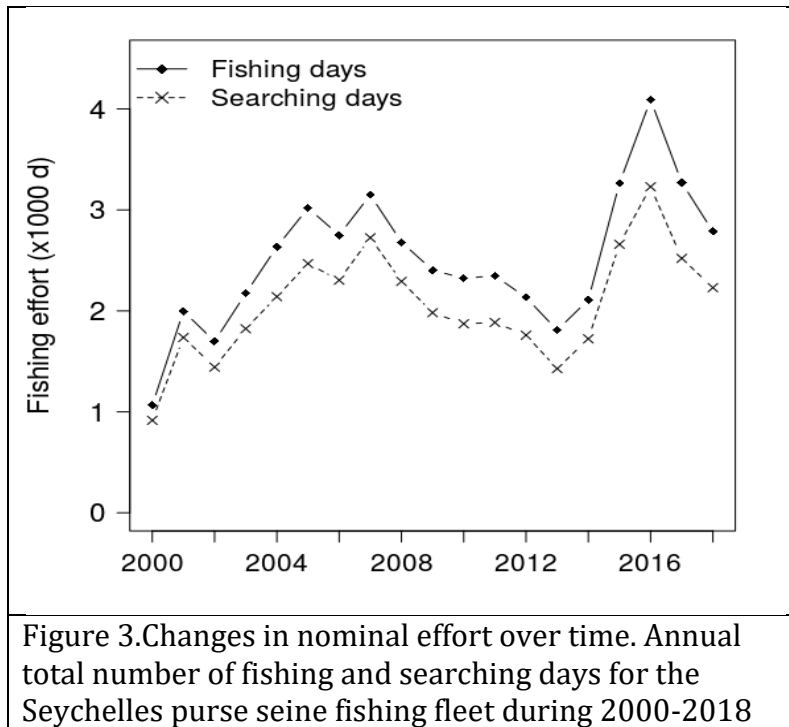
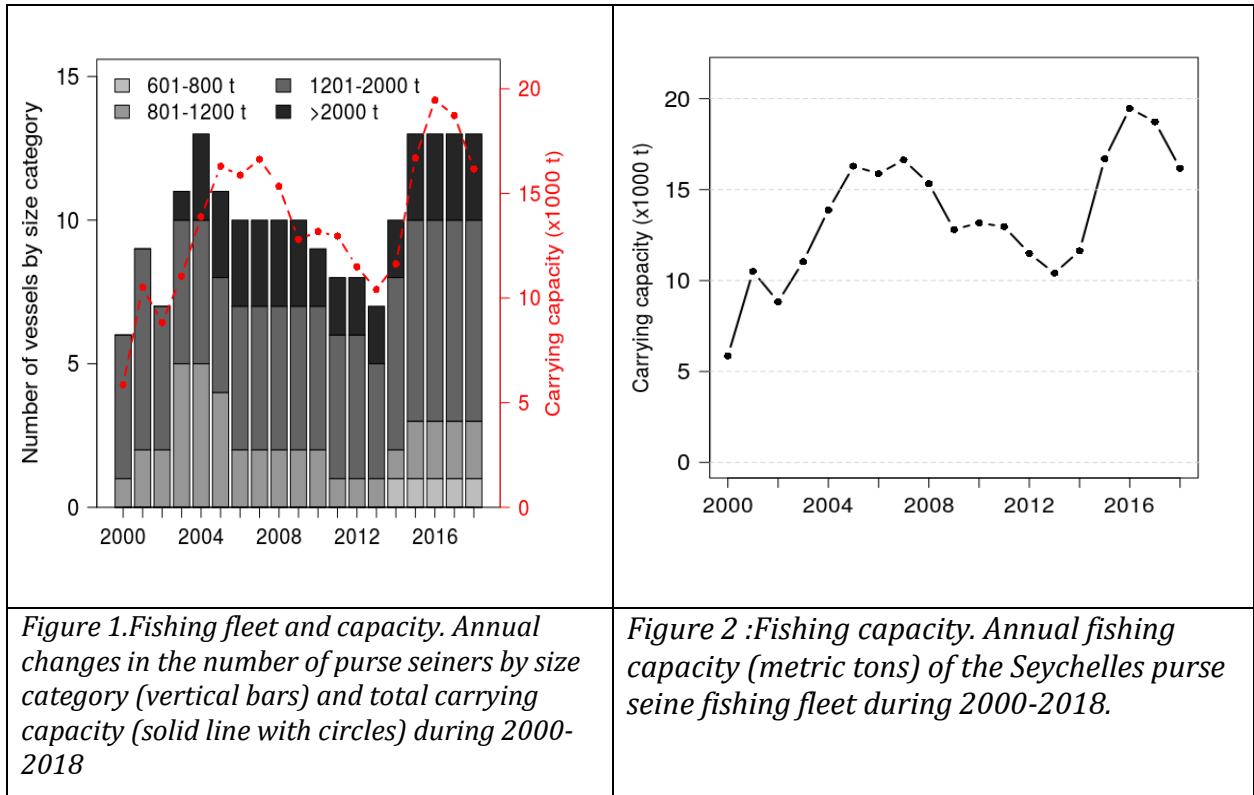
## 4. Conclusions

In conclusion although the total catch of the Seychelles purse seine fleet in the Indian ocean in 2018 remained like the previous year whilst the fleet capacity, fishing effort and spatial extent decreased slightly.

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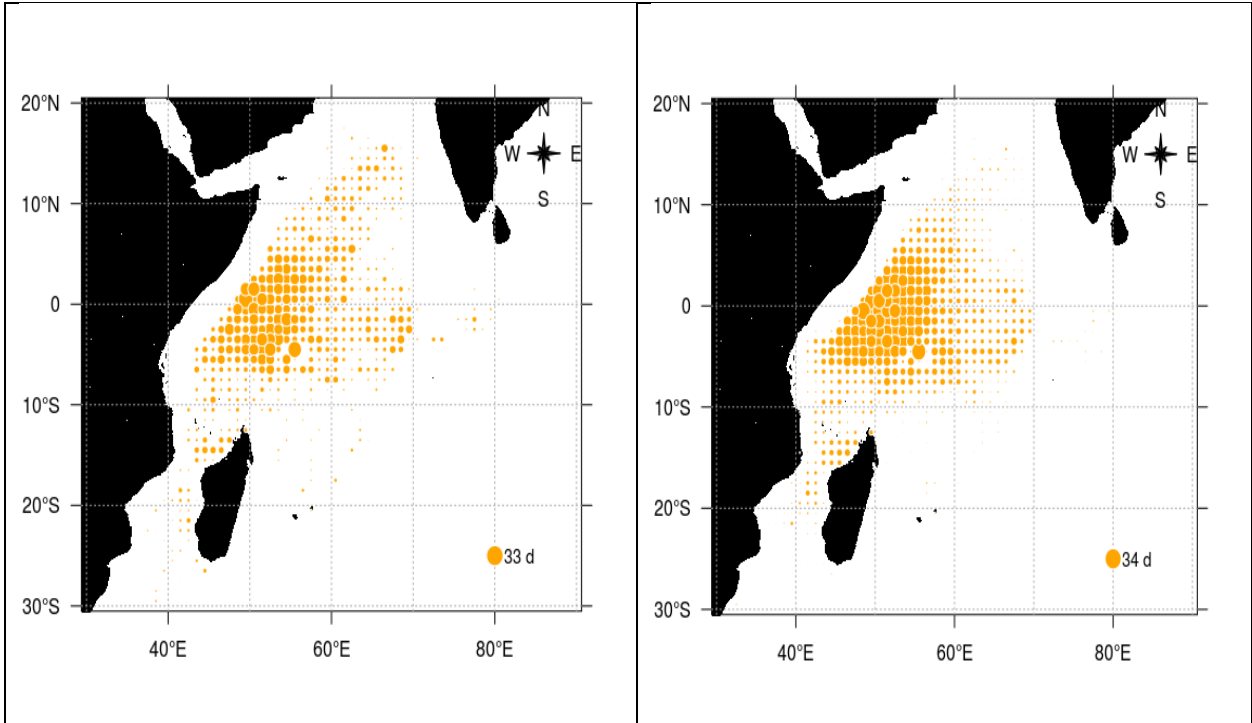


Figure 4. Fishing grounds. Spatial distribution of fishing effort (in searching days) of the Seychelles purse seine fishing fleet in 2018

Figure 5. Fishing grounds. Spatial distribution of fishing effort (in searching days) of the Seychelles purse seine fishing fleet during 2013-2017

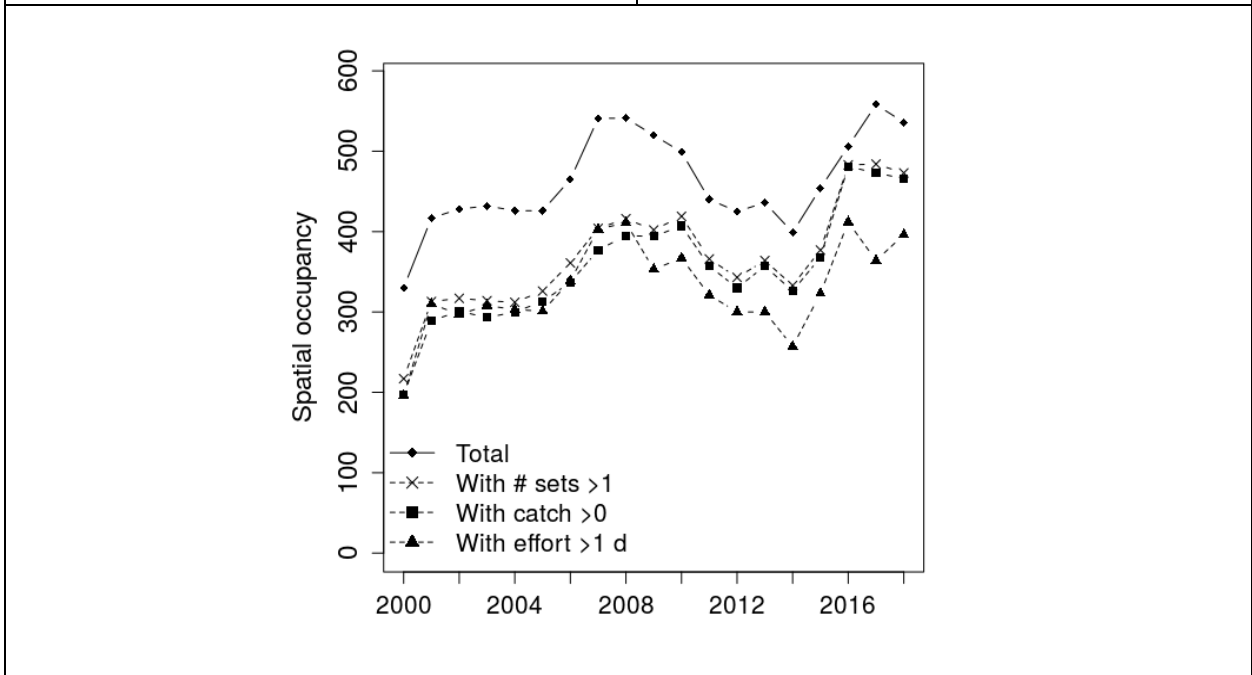


Figure 6: Changes in spatial extent of the fishery. Annual number of 1-degree squares explored by the Seychelles purse seine fishing fleet during 2000-2018



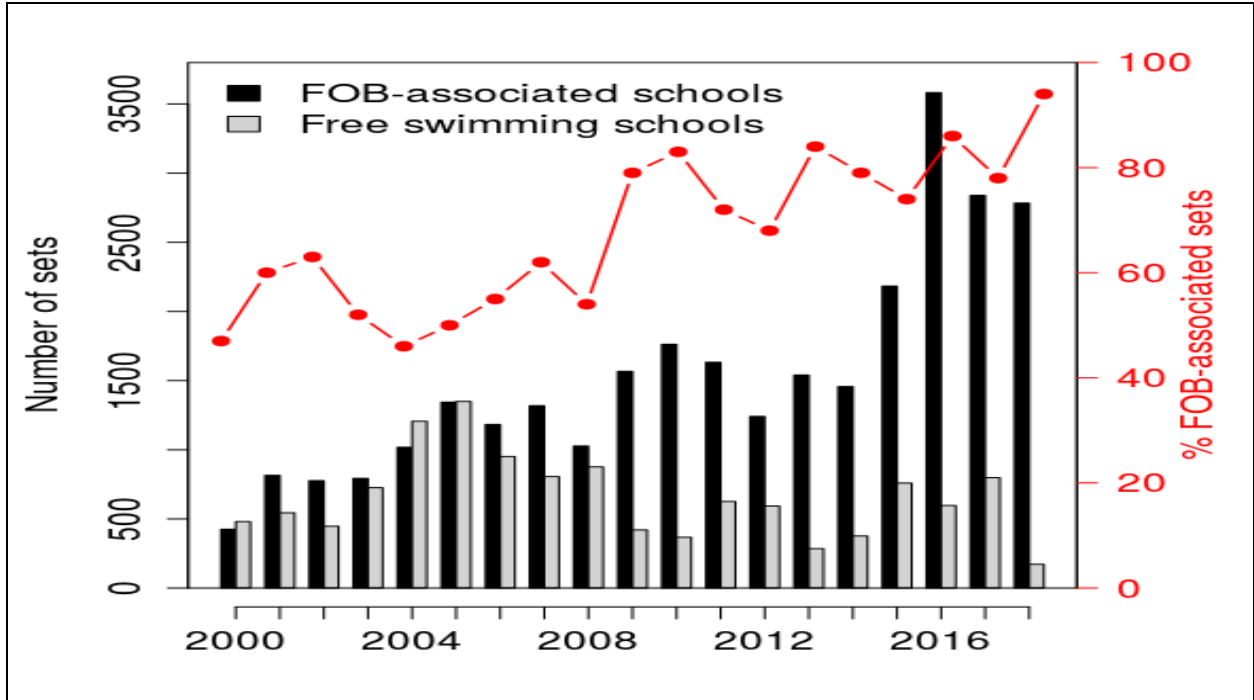
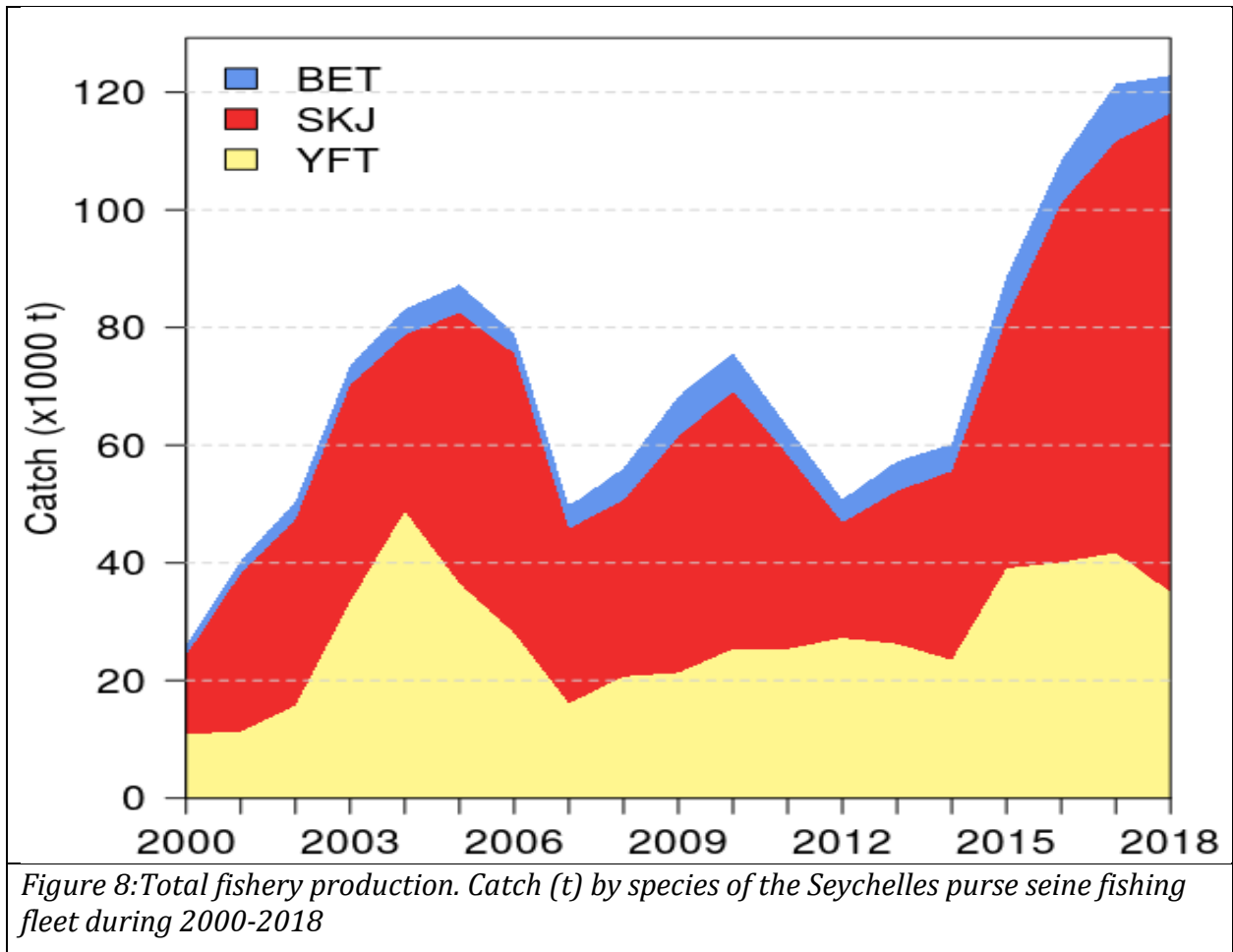
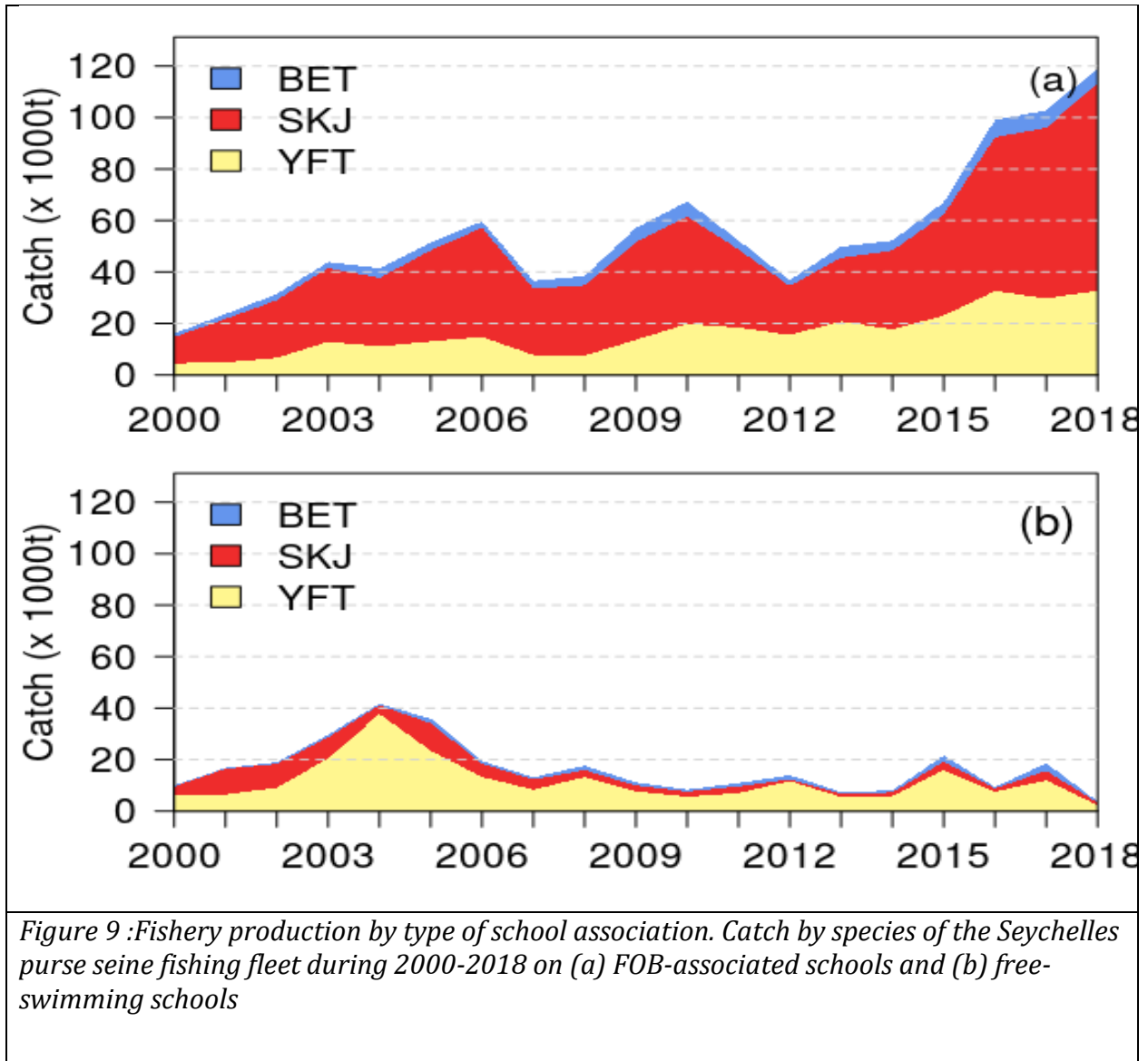
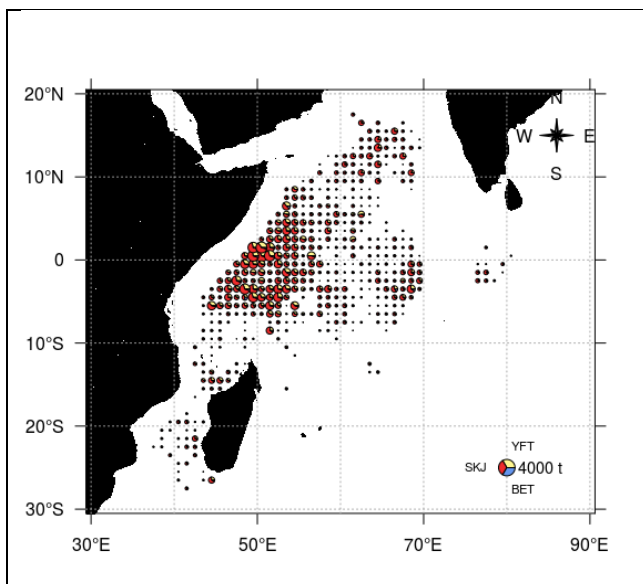


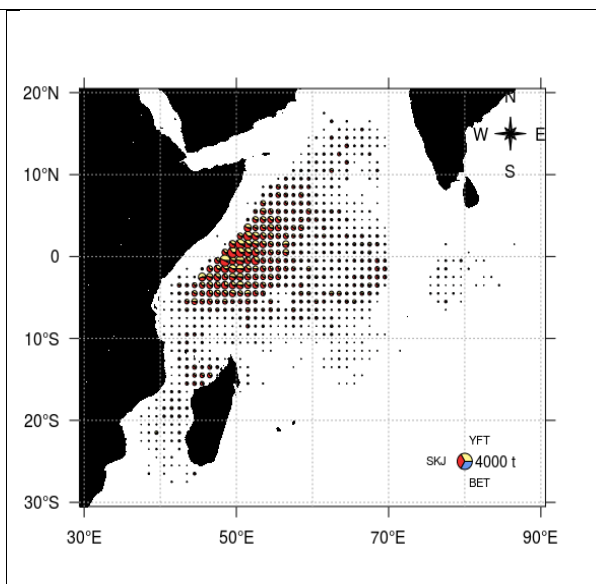
Figure 7: Fishing operations. Annual number of fishing sets made by the Seychelles purse seine fishing fleet on FOB-associated and free-swimming schools during 2000-2018. Line with solid circles indicates the percentage of sets made on FOBs. Grey solid line indicates the 50% value



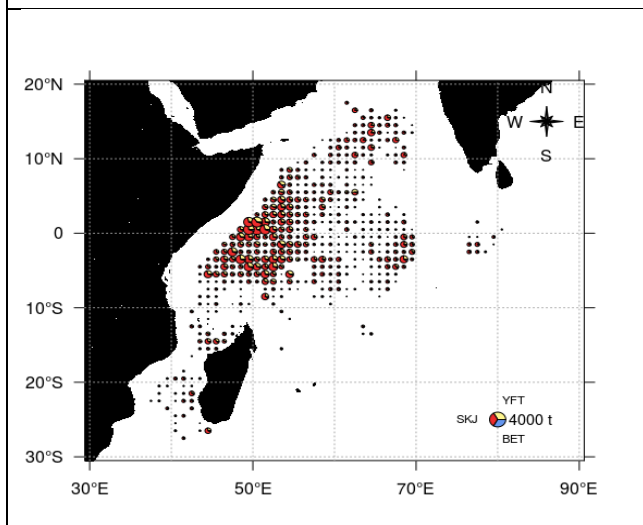




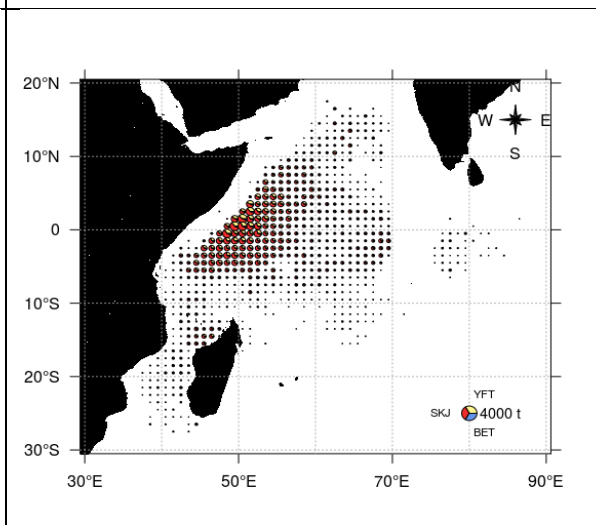
*Figure 10: Spatial distribution of tuna catches of the Seychelles purse seine fishing fleet in 2018*



*Figure 11: Spatial distribution of tuna catches of the Seychelles purse seine fishing fleet during 2013-2017*



*Figure 12: Spatial distribution of tuna catches of the Seychelles purse seine fishing fleet made on FOB-associated schools in 2018*



*Figure 13: Spatial distribution of tuna catches of the Seychelles purse seine fishing fleet made on FOB-associated schools during 2013-2017*

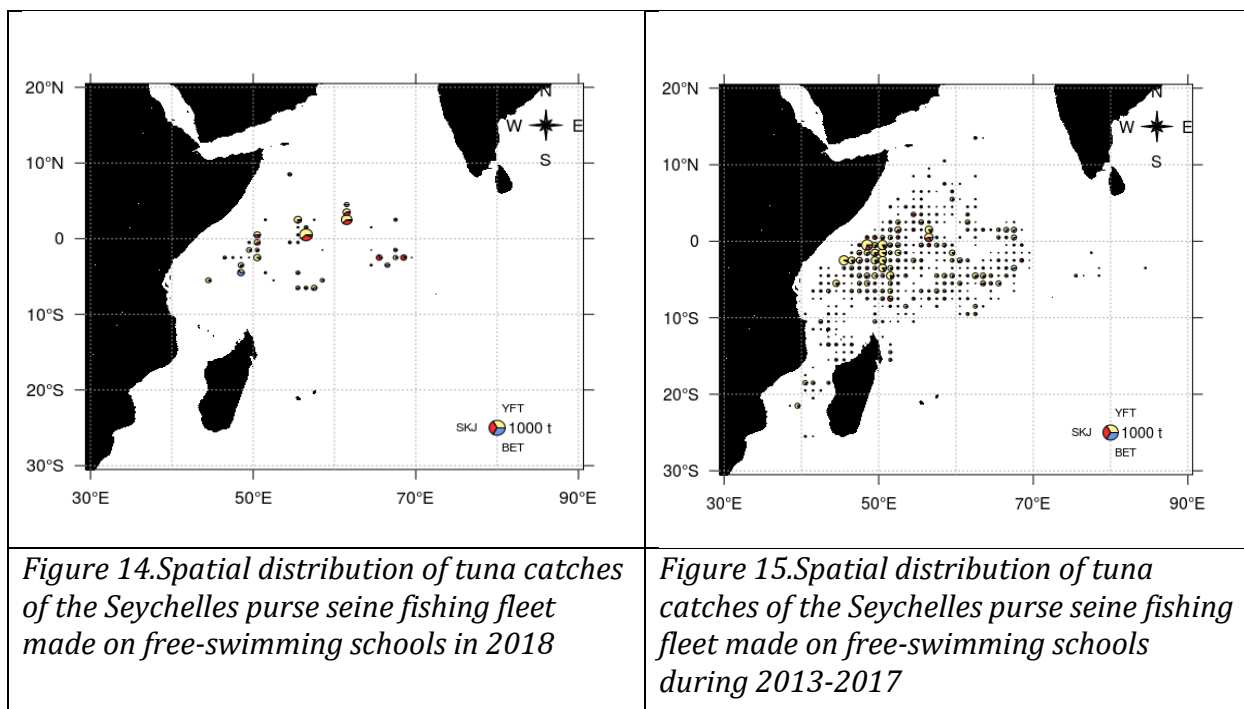


Figure 14. Spatial distribution of tuna catches of the Seychelles purse seine fishing fleet made on free-swimming schools in 2018

Figure 15. Spatial distribution of tuna catches of the Seychelles purse seine fishing fleet made on free-swimming schools during 2013-2017

Table 1. Annual number of purse seiners by size category and total carrying capacity of the Seychelles purse seine fishing fleet during 2000-2018. N = total number of purse seiners; Nw = Number of purse seiners weighted by the monthly activity. Total carrying capacity (CC) was weighted by the proportion of the year at sea (in months)

Year	601-800	801-1200	1201-2000	>2000	N	Nw	CC
2000	0	1	5	0	6	4	5855
2001	0	2	7	0	9	8	10506
2002	0	2	5	0	7	6	8837
2003	0	5	5	1	11	8	11048
2004	0	5	5	3	13	10	13880
2005	0	4	4	3	11	10	16291
2006	0	2	5	3	10	9	15877
2007	0	2	5	3	10	10	16629
2008	0	2	5	3	10	9	15337
2009	0	2	5	3	10	8	12806
2010	0	2	5	2	9	8	13170
2011	0	1	5	2	8	8	12961
2012	0	1	5	2	8	7	11494
2013	0	1	4	2	7	6	10405

2014	1	1	6	2	10	7	11630
2015	1	2	7	3	13	11	16694
2016	1	2	7	3	13	13	19466
2017	1	2	7	3	13	12	18730
2018	1	2	7	3	13	11	16173

*Table 2. Annual nominal fishing effort of the Seychelles purse seine fleet expressed in fishing and searching days during 2000-2018. Searching days was derived from the total time spent at sea corrected for periods of damage, route towards port, and purse seine operation*

Year	Fishing days	Searching days
2000	1065	916
2001	1997	1736
2002	1698	1443
2003	2172	1823
2004	2634	2141
2005	3019	2468
2006	2750	2304
2007	3149	2724
2008	2681	2292
2009	2403	1982
2010	2323	1872
2011	2347	1885
2012	2133	1759
2013	1809	1428
2014	2109	1723
2015	3264	2659
2016	4092	3229
2017	3271	2520
2018	2786	2230

*Table 3. Number of successful (Positive) and unsuccessful (Null) sets by fishing mode made by the Seychelles purse seine fishing fleet during 2000-2018. A = All schools; F = School associated with floating object; L = Free-Swimming School*

Year	A- Total	A- Positive	A- Null	L- Total	L- Positive	L- Null	F- Total	F- Positive	F- Null
2000	905	693	212	425	374	51	480	319	161
2001	1359	1073	286	815	778	37	544	295	249
2002	1223	1016	207	776	731	45	447	285	162
2003	1519	1228	291	793	760	33	726	468	258
2004	2224	1702	522	1018	972	46	1206	730	476
2005	2693	2074	619	1344	1286	58	1349	788	561
2006	2134	1673	461	1183	1110	73	951	563	388
2007	2124	1633	491	1318	1176	142	806	457	349
2008	1903	1514	389	1027	979	48	876	535	341
2009	1987	1796	191	1567	1504	63	420	292	128
2010	2129	1900	229	1762	1698	64	367	202	165
2011	2259	1894	365	1633	1559	74	626	335	291
2012	1834	1524	310	1241	1163	78	593	361	232
2013	1825	1605	220	1540	1446	94	285	159	126
2014	1833	1611	222	1457	1393	64	376	218	158
2015	2942	2557	385	2183	2071	112	759	486	273
2016	4179	3679	500	3582	3384	198	597	295	302
2017	3637	3198	439	2839	2749	90	798	449	349
2018	2956	2739	217	2784	2663	121	172	76	96

*Table 4. Catch by species for the Seychelles purse seine fishing fleet during 2000-2018*

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
2000	10,917	13,311	1,847	57	745	26,877
2001	11,286	26,921	2,209	829	87	41,332
2002	15,746	31,583	3,075	102	16	50,522
2003	33,360	36,822	3,364	174	60	73,780
2004	48,797	29,960	4,395	59	94	83,305

2005	36,479	46,038	4,794	18	208	87,537
2006	28,054	47,515	3,496	46	231	79,342
2007	16,085	29,727	3,857	136	131	49,936
2008	20,681	30,036	5,369	128	168	56,382
2009	21,330	40,156	6,821	10	22	68,339
2010	25,330	43,828	6,602	14	12	75,787
2011	25,371	32,962	4,837	29	13	63,212
2012	27,220	19,641	3,928	148	1	50,938
2013	26,231	25,997	5,045	49	2	57,324
2014	23,463	32,104	4,636	45	7	60,255
2015	39,072	42,426	7,168	60	13	88,740
2016	40,121	60,991	7,325	110	65	108,613
2017	41,711	69,994	9,761	56	681	122,202
2018	35,023	81,451	6,450	13	373	123,310

*Table 5. Catch by species made on schools associated with floating objects for the Seychelles purse seine fishing fleet during 2000-2018*

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
2000	4,526	10,167	1,389	37	92	16,210
2001	4,889	16,901	1,860	229	84	23,963
2002	6,648	22,352	2,456	1	16	31,474
2003	12,909	28,628	2,335	-	17	43,889
2004	11,104	26,605	3,741	2	92	41,543
2005	13,008	35,350	3,061	-	187	51,605
2006	14,808	42,372	2,424	-	228	59,831
2007	7,771	25,783	3,003	16	126	36,699
2008	7,460	27,364	3,612	-	167	38,603
2009	13,701	37,883	5,527	2	22	57,134
2010	19,795	41,806	5,814	-	12	67,427
2011	18,390	30,374	3,514	-	13	52,291



2012	15,566	18,989	2,273	-	1	36,829
2013	20,755	24,749	4,376	1	2	49,883
2014	17,671	30,659	3,870	12	7	52,220
2015	23,105	39,207	4,783	4	9	67,108
2016	32,609	59,674	6,807	13	65	99,169
2017	29,757	66,346	6,777	5	681	103,566
2018	32,748	80,410	6,000	13	373	119,544

*Table 6. Catch by species made on free-swimming schools for the Seychelles purse seine fishing fleet during 2000-2018*

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
2000	4,760	2,305	370	5	652	8,093
2001	5,577	4,058	310	596	-	10,540
2002	8,194	2,865	447	101	-	11,607
2003	20,216	7,806	1,015	174	43	29,255
2004	37,693	3,355	654	57	2	41,762
2005	23,469	10,668	1,733	18	21	35,910
2006	13,246	5,143	1,072	46	3	19,511
2007	8,314	3,944	855	119	5	13,237
2008	13,222	2,673	1,757	128	1	17,780
2009	7,629	2,274	1,295	8	0	11,206
2010	5,531	2,018	787	14	- 0	8,349
2011	6,975	2,460	1,322	29	-	10,786
2012	11,654	652	1,655	148	0	14,109
2013	5,409	1,052	662	48	-	7,171

2014	5,792	1,445	766	33	-	8,035
2015	15,959	3,218	2,385	56	5	21,622
2016	7,416	1,160	511	97	-	9,185
2017	11,928	3,600	2,979	50	1	18,557
2018	2,212	1,006	447	-	0	3,665