EVOLUTION OF SWORDFISH LONGLINE FISHERY (*Xiphias gladius*) OPERATING IN THE WEST INDIAN OCEAN FROM SEYCHELLES

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Abstract

The local pelagic long line fishery targeting swordfish started in the Seychelles in 1995. Actually 10 vessels are active. This document describes the evolution of catch in number and nominal weight from 1995 to 2002. Fishing effort increased from 31,480 hooks in 1995 to 235,057 in 2002. Fishing effort is concentrated on the northern part of the EEZ, in an area of approximately 240,000 km². Swordfish's catches in number represents 57.1% of total annual catches, followed by yellowfin (16.2%) and bigeye (10.2%). The by-catches constituted of sharks (7.8%), sailfish (3.8%), marlin (1.6%) and other species (3.0%). Since 2000, some local longliners change fishing strategies to target sharks. Annual swordfish CPUE show a significant decreasing trend with a maximum in 1998 (22 fish.1000 hooks^{-1}) and a minimum in 2002 (10 fish.1000 hook^{-1}). No significant trend is observed for tunas. On a monthly basis, high CPUE's on swordfish are obtained from April to June (17 to 22 fish.1000 hook^{-1}) and between December and May for tunas (CPUE $^{Dec.\ to\ May}$: 5.4 for yellowfin and 3.1 for bigeye). Predation data were also analysed since 1995. Swordfish is the species with most attacks, 55.8% of total predation, followed by yellowfin (12.8%) and bigeye (10.4%). Mean predation rate for these 3 species is 1.5 fish.1000 hooks^{-1} (3.0 for swordfish). During the period 1995-2002, the predation rate was maximum in 1998. No monthly trend is observed. Monitoring of size frequency, carried out since 1995 do not show important variation of mean length since 1997, with MFL ranging between 136 and 139 cm. Significant trend is observed in monthly analyses with increase in swordfish size from March to June. A comparison was made with Taiwanese longliners activities in the Seychelles EEZ from 2002 to 2003. Tunas are the main species caught in number with 61% of total commercial species. Swordfish represents only 25% of the total catches. The maximum CPUE were obtained for yellowfin with a mean of 4.8 fish.1000 hooks^{-1}. No significant monthly trend is observed. Swordfish CPUE are significantly higher on the north west and centre west of the Seychelles' EEZ. The opposite is observed for yellowfin and bigeye.

Résumé

La pêcherie palangrière seychelloise ciblant l'espadon a démarré aux Seychelles en 1995. Actuellement, 10 navires sont en activité. Ce document décrit l'évolution des captures en nombre et en poids de 1995 à 2002. L'effort de pêche a augmenté de 31 480 à 235 057 hameçons sur la période considérée. L'effort de pêche est concentré dans la partie Nord de la ZEE sur une surface d'environ 240 000 km². Les captures d'espadon représentent en nombre 57,1% des captures totales, suivies par l'albacore (16,2%) et le thon obèse (10,2%). Les prises accessoires sont constituées de requins (7,8%), de voilier (3,8%), de marlins (1,6%) et d'autres espèces (3,0%). Depuis 2000, quelques palangriers ont modifié leur stratégie de pêche pour cibler les requins. Les CPUE annuelles diminuent de façon significative depuis 1998 (22 poissons.1000 hameçons^{-1}) pour atteindre un minimum en 2002 (10 poissons.1000 hameçons^{-1}). Aucune tendance n'est observée pour les thons. Au niveau mensuel, les CPUE maximales d'espadon sont obtenues d'avril à juin (17 à 22 poissons.1000 hameçons^{-1}) et de décembre à mai pour les thons (CPUE $^{Dec.\ to\ May}$: 5,4 pour albacore et 3,1 pour thon obèse). Le phénomène de prédation est analysé depuis 1995. L'espadon est l'espèce la plus attaquée avec 55,8% des attaques totales, suivi par l'albacore (12,8%) et le thon obèse (10,4%). Le taux moyen de prédation pour ces 3 espèces est de 1,5 poissons.1000 hameçons^{-1} (3,0 pour espadon). Sur la période 1995 à 2002, le taux de prédation fut maximal en 1998, aucune tendance mensuelle n'est observée. Le suivi des fréquences de taille conduit depuis 1995 ne montre pas de variation importante des tailles moyennes avec des tailles (LMF) comprises entre 136 et 139 cm, mais des variations mensuelles significatives sont observées avec un accroissement des tailles moyennes des espadons capturés entre mars et juin. Une comparaison est réalisée avec des palangriers taiwanais en activité dans la ZEE des Seychelles entre 2002 et 2003. Les thons sont les principales espèces capturées avec 61% des prises commerciales. L'espadon ne représente que 25% des captures. Les CPUE maximales sont obtenues pour l'albacore avec une moyenne de 4,8 poissons.1000 hameçons^{-1}. Aucune tendance n'est observée au niveau de l'évolution mensuelle des rendements. Les CPUE sont significativement supérieures au Nord et Nord Ouest de la ZEE, l'inverse est observé pour l'albacore et le thon obèse.

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Introduction

The monofilament longline fishery targeting swordfish (*Xiphias gladius*) and tuna started in 1994 with experimental trips by Seychelles Fishing Authority's (SFA) research vessel. Interesting results were obtained with catch rate averaging 0.9 kg/hook (Bargain *et al*., 2000; Bargain, 2001). Following these promising results, commercial trips were considered by Seychellois operators and professional campaigns started in 1995. Between 1995 and 2001, the fleet increased gradually to reach a maximum of 11 vessels in 2001.

Seychellois and foreign longliners (French and Indonesian) licensed to fish in the Seychelles' water were involved in this development. The French boats (averaging 2 vessels per year, 34 meters) have fished in the Seychelles' EEZ until 2000. The Indonesian (25 metres vessels) were fishing through a joint venture with a Seychellois operator. They started their activities in 1998, with 4 vessels, and by 2000, 8 vessels were operating. They stopped operating in the middle of 2000. In 2001, a new joint venture was created between a Seychellois operator and 14 Taiwanese boats (24 metres). These boats were in operation until the middle of 2003.

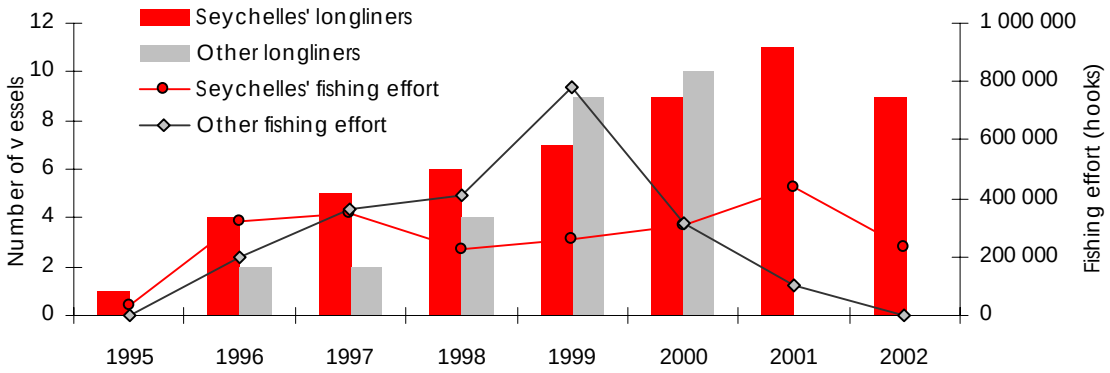

Figure 1. *Evolution of number of vessels and total fishing effort (number of hooks) between 1995 and 2002 by longliners authorised to fish in the Seychelles' EEZ. Taiwanese boats (2001-2003) are not represented on this figure.*

The fishing gear use by the local longline fishery (Berkeley et al., 1983) is made of a 20 to 40 km long polyamide monofilament (2 to 4 mm diameter) main line. Longline are equipped with 400 to 900 hooks (8/0, Tuna hook or "J" hook) snapped on the main line (branch line was in polyamide monofilament 0.18 – 0.20 mm diameter). Each segment (or basket) contained from 5 to 10 hooks. To target Swordfish the line was generally set after the sunset (Boggs, 1992; Carey, 1990; Carey *et al*., 1981), and hooks were generally baited with defrosted squid (200 – 300 g) . Fluorescent green light sticks were generally used above the hooks to increase the attraction to the bait.

A monitoring program was set up by SFA in 1995 to closely monitor the fishery. Several data were collected from; logbooks filled by fishermen, fish landed in Victoria harbour and weighted by fishing operators. Fish were also sampled to collect biometric data.

1. Local Fishery

1. 1. Fishing effort

The data analysed in this chapter related to the Seychellois longliners are only from 1995 to 2002. Since 1995, the fishing effort (in hooks) deployed by set (figures 2) show a decreasing trend from 850 hooks in 1996 to reach less than 560 hooks in the period 1998 – 2002. The monthly fishing effort doesn't show any significant trends except for a light increase for March and April. Evolution of mean fishing trip duration (figures 3) shows different trends with a gradual increase from 4 to 5.4 days between 1995 and 1998. In 1999, 2000 and 2001 the duration stayed constant (around 6.5 days) but increased in 2002 to reach 8.1 days. Evolution of average fishing trip duration by month shows no significant trend. Duration range between 5.7 and 7.6 days, though a light decrease in the first quarter of the year followed by an increase from May to August (probably linked to evolution of swordfish's CPUE) was observed. Fishing effort increased from 31,480 hooks in 1995 to 235,057 in 2002, with a maximum of 441,435 hooks in 2001. During the period 1996 – 2002, the mean fishing effort was 306,344 hooks (1995 could be considered as a started year).

The geographical distribution (by ½ a degree) of the fishing effort show that effort is centred around the Mahe continental shelf with, a maximum on the North-East of the plateau (figure 4).

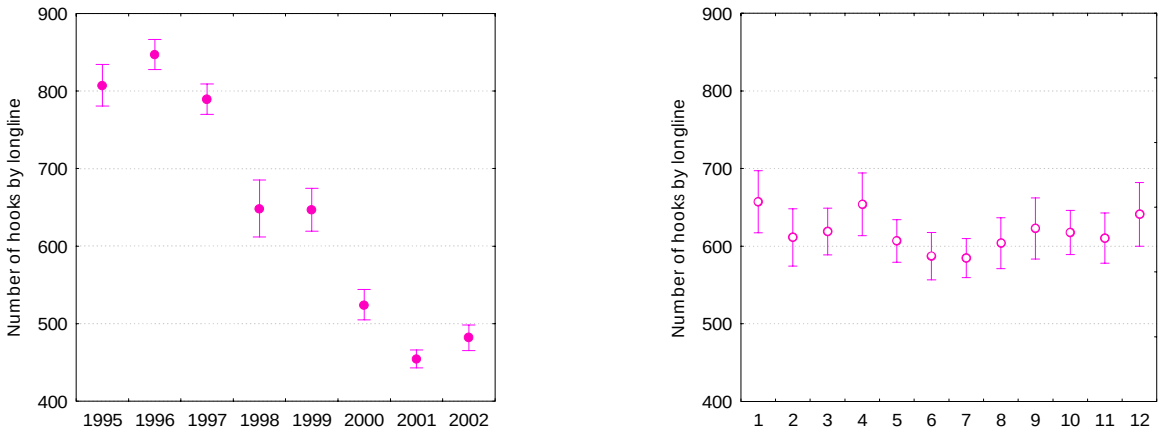

Figure 2. *Fishing effort (in hooks) evolution by long line (+1ES) by year (left) and by month (right).*

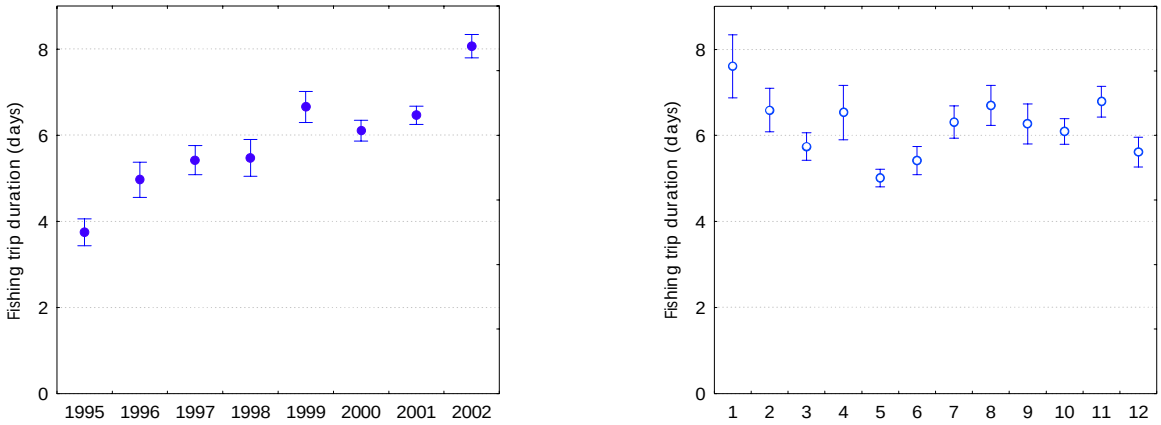

Figure 3. *Duration of fishing trips (in days) evolution by long line (+1ES) by year (left) and by month (right).*

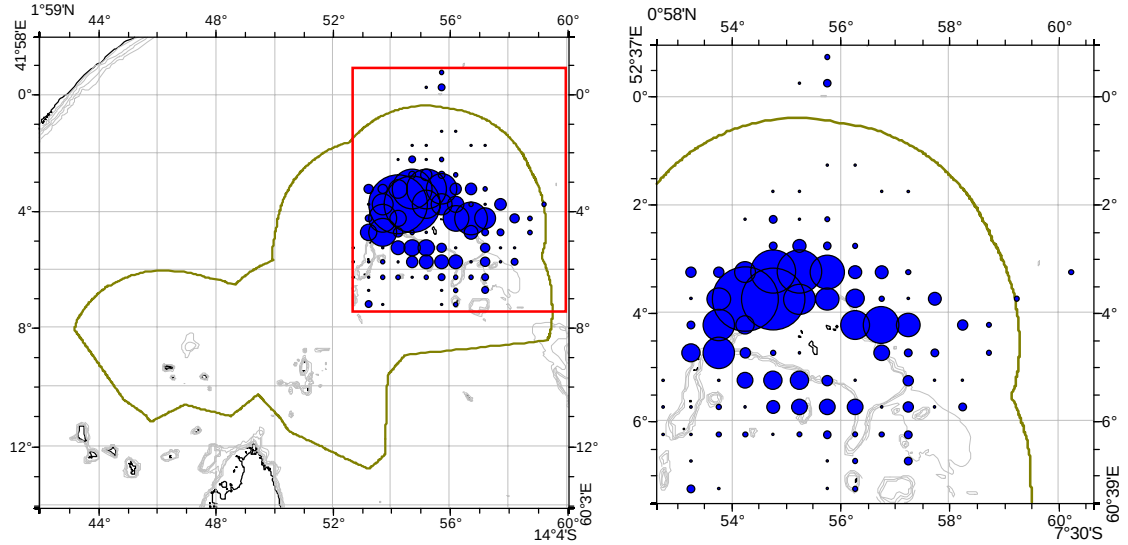

Figure 4. *Total fishing effort (in hooks) on the period 1995 - 2002 realised by local longliners in the Seychelles' EEZ.*

Distribution of annual fishing effort from 1995 to 2002 is presented in figure 5. From 1996 to 1999 fishing effort is located in the North and North East of the plateau. After 1999, a modification of the strategy is observed with an effort more spread but always located around the shelf. The same trend was observed in 2001. The year 2002 is characterised by a decrease in the fishing effort probably caused by a modification of target species (sharks vs. swordfish) linked to exportation constraints. These representations show that over the 8 years period the range covered by the fleet is very low. Fishing effort is located on a sector of 4° of latitude and 6° of longitude (2° - 6° south and 52° - 58° East) on which we should subtract continental shelfs (45,000 km² for Mahe, 6,200 km² for North Amirantes and 340 km² for Plate island), that means around 240,000 km².

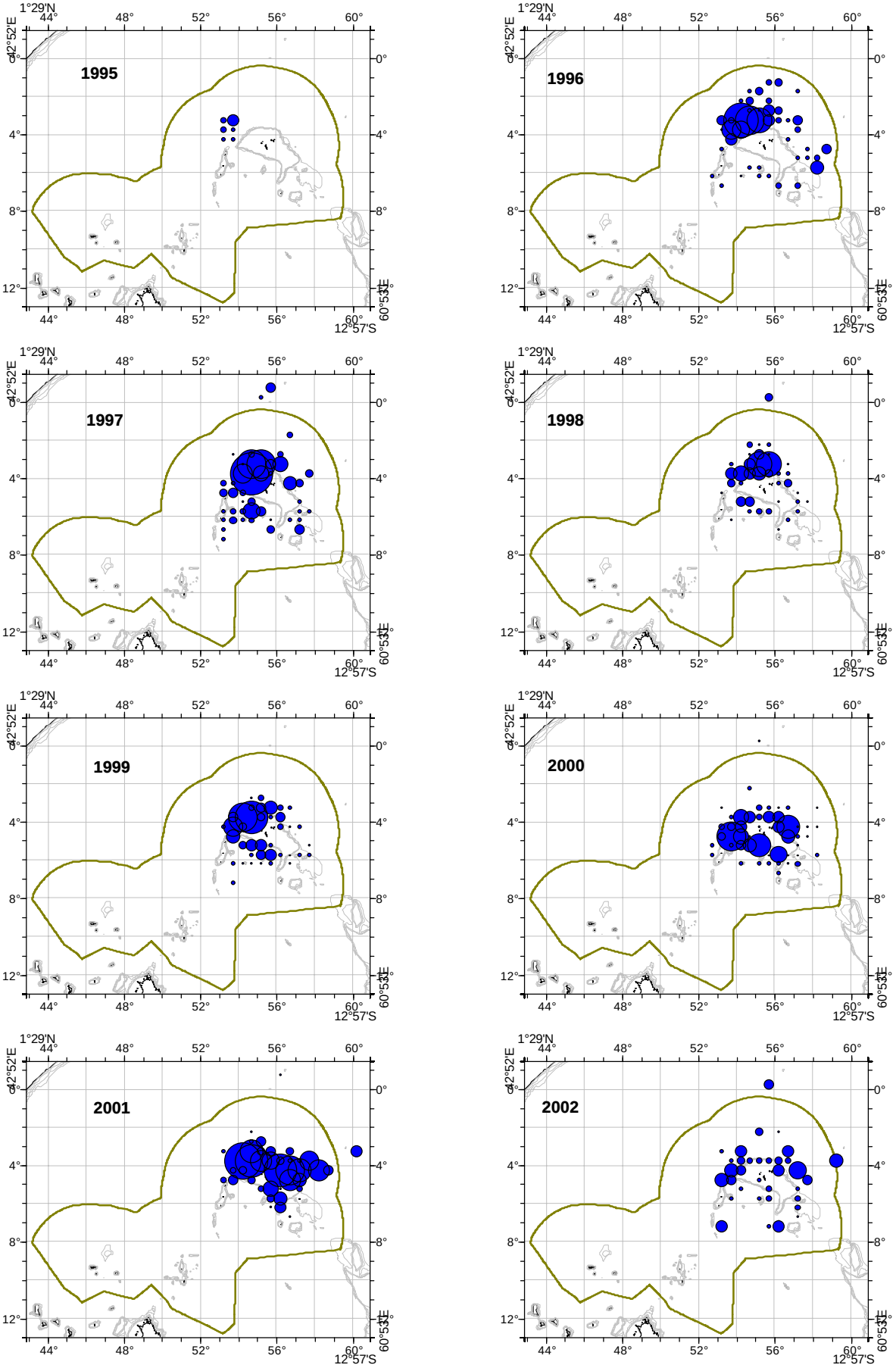

Figure 5. *Total fishing effort (in hooks) from Seychelles' longliners, 1995 to 2002.*

1.2. Catches

During the last 7 years (1995 excluded, considered as a started year), the number of swordfish caught (around 30,000 fish) represents 57.1% of total annual catches, followed by yellowfin tuna (*Thunnus albacares*) with 16.2% and bigeye tuna (*Thunnus obesus)* with 10.2%. The by-catches constituted of sharks (7.8%), sailfish (3.8%), marlin (1.6%) and other species (3.0%). The annual evolution of catches (in number of fish) do not show any significant trend (figure 6). Swordfish catches varies between 47 to 68%, 11 to 20% for yellowfin and 7 to 12% for bigeye. The only trend observed is in shark catches, increasing from 1 to15 % between 1995 and 2001. Landed weight for main commercial species since 1995 are shown in table 1.

Sharks' catches consist of *Prionace glauca, Carcharinus longimanus, Carcharinus falciformis, Sphyrna spp., Isurus oxyrinchus, Alopia sp.* and *Galeocerdo cuvieri*. The sharks landed are estimated around 8%, however, a non negligible percentage of catches are finned and discarded at sea taking into account the low commercial value of the meat. Since 1999, linked with decreasing swordfish CPUE and exportation constraints several longliners have modified their fishing strategy to increase sharks' catches by fishing in specific areas and using specific gear (metal ganglion). These activities increased rapidly after 2000, and in 2002 SFA estimated that 28% (and around 50% for the first semester 2003) of fishing effort was dedicated to target sharks.

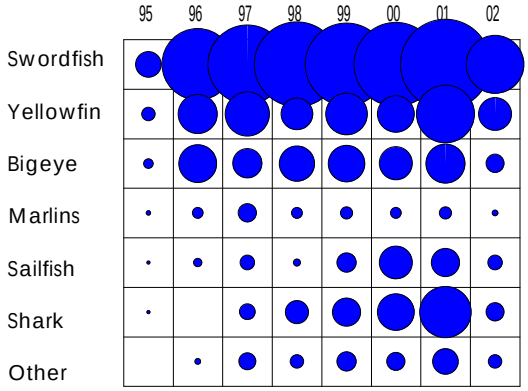

Figure 6. *Catches from 1995 to 2002 realised by the Seychelles' longliners.*

Table 1. *Nominal catches of main commercial species (tonnes) landed by the Seychelles's longliners from 1995 to 2002 (tunas: yellowfin tuna + bigeye tuna).*

Année	Swordfish	Tunas	Sail fish and Marlin	Other	TOTAL
1995	21	11	0	2	35
1996	150	108	5	4	267
1997	221	132	123	45	520
1998	214	88	0	30	333
1999	232	125	6	66	430
2000	227	86	37	15	365
2001	247	146	35	19	447
2002	142	58	17	7	224
Total *(%)*	**1 455** *(55%)*	**754** *(29%)*	**224** *(9%)*	**189** *(7%)*	**2 622**

1.3. CPUE

From data recorded on logbooks, operator's declarations and sampling program, the CPUE (in number of fish.1000 hook^{-1}) have been calculated for the 1995 – 2002 period. Annual swordfish CPUE (figure 7 - left) show significant variations with a maximum of 22 fish.1000 hooks^{-1} in 1998 and a permanent decrease from then on to reach 10 fish.1000 hook^{-1} in 2002 (mean CPUE $^{1995 - 2002}$: 14.6). On a monthly basis (figure 7 - right), 2 periods are observed; one with high CPUE between 17 to 22 fish.1000 hook^{-1} from April to June and the other from July to February with low rate of 9 to 14 fish.1000 hook^{-1}.

For yellowfin and bigeye tuna no significant trend is observed, except a low CPUE for 2002 (figure 8 – left). During the last 8 years, Yellowfin CPUE (CPUE $^{1995 \text{ to } 2002}$: 4.1) are 1.5 times higher than bigeye CPUE. (CPUE $^{1995 \text{ to } 2002}$: 2.7). Similarly, monthly variation of CPUE show 2 periods. For yellowfin, between December to May, average CPUE (CPUE $^{\text{Dec. to May}}$: 5.4) are higher than annual mean. Between June to November, CPUE are minimum with 2.7 fish.1000 hook^{-1}. The same trend is observed for bigeye tuna but it is less marked (CPUE $^{\text{Dec. to May}}$: 3.1 and CPUE $^{\text{Jun. to Nov.}}$: 2.2).

CPUE on by-catches (figure 9) is inferior to 1 from 1995 to 1997. In 1998, shark CPUE increased significantly to reach a maximum in 2001. A similar trend is observed for sailfish in 1999 and 2000. Marlin catches are constant with mean around 0.5 fish.1000 hook^{-1}. Unlike swordfish and tuna CPUE, no monthly trend is observed.

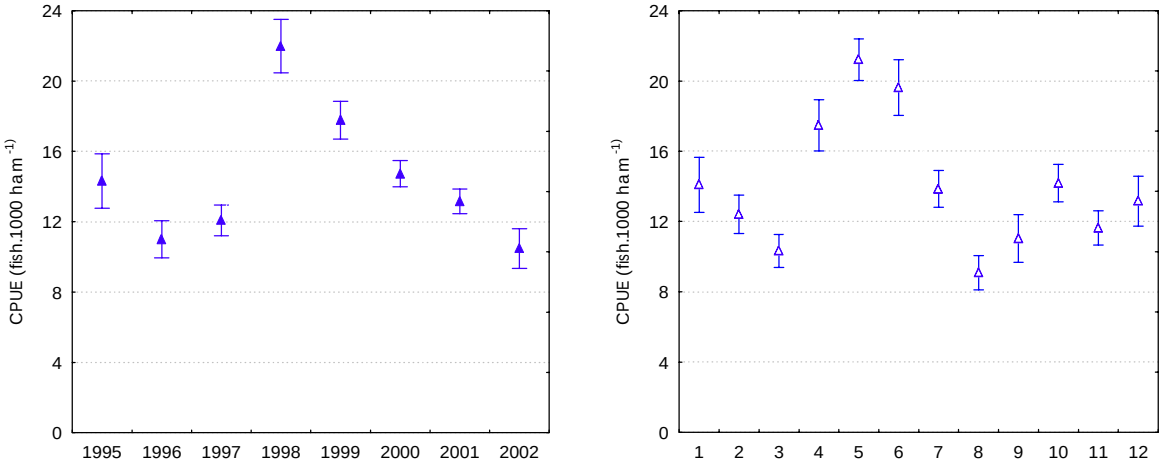

Figure 7. *Swordfish CPUE evolution (+1SE) by year (left) and by month (right) for the Seychelles' longline fishery.*

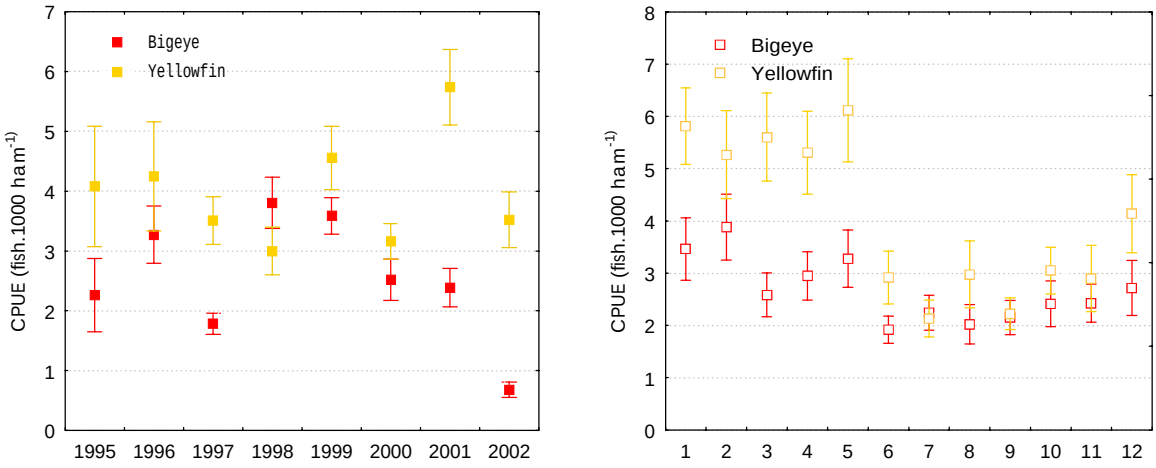

Figure 8. *Yellowfin and bigeye tuna CPUE evolution (+1SE) by year (left) and by month (right) for the Seychelles' longline fishery.*

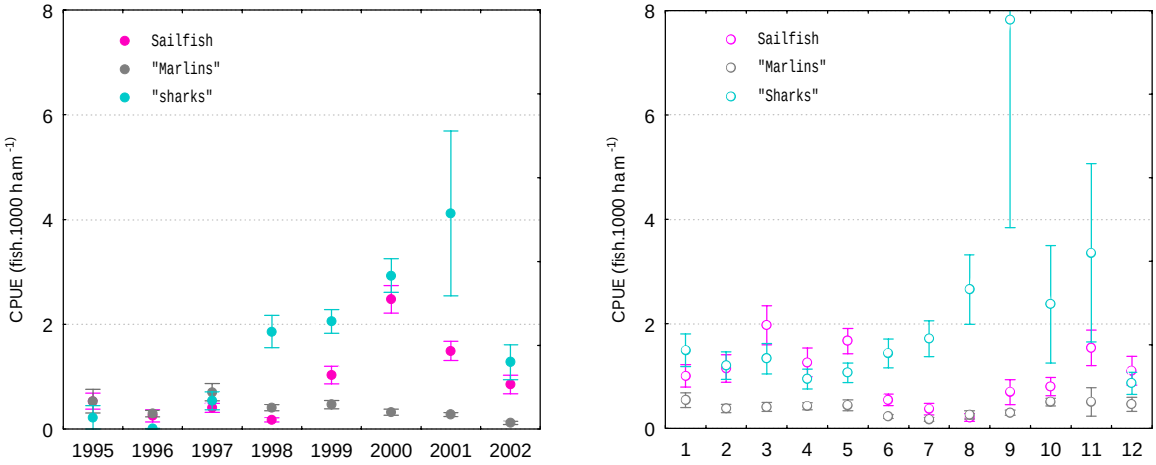

Figure 9. *By-catch CPUE evolution (+1SE) by year (left) and by month (right) for the Seychelles' longline fishery.*

The geographical distribution of swordfish's CPUE (figure 10), show homogenous repartition on the entire fishing area. Nevertheless, 2 sectors are distinguished by high CPUE; on the North of the EEZ around the Coco de mer Sea Mounts and on the north east of the continental shelf.

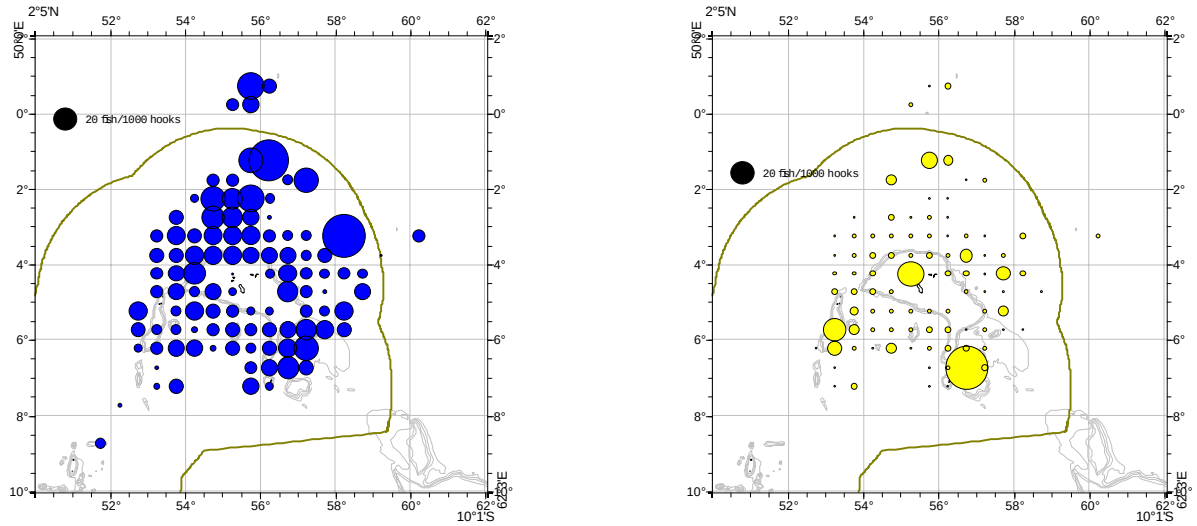

Figure 10. *Spatial distribution of CPUE (number fish.1000 hooks^{-1}) for swordfish (blue at left) and yellowfin tuna (yellow at right) by 0.5 square mille (n = 25,226 swordfish; n = 6,810 yellowfin).*

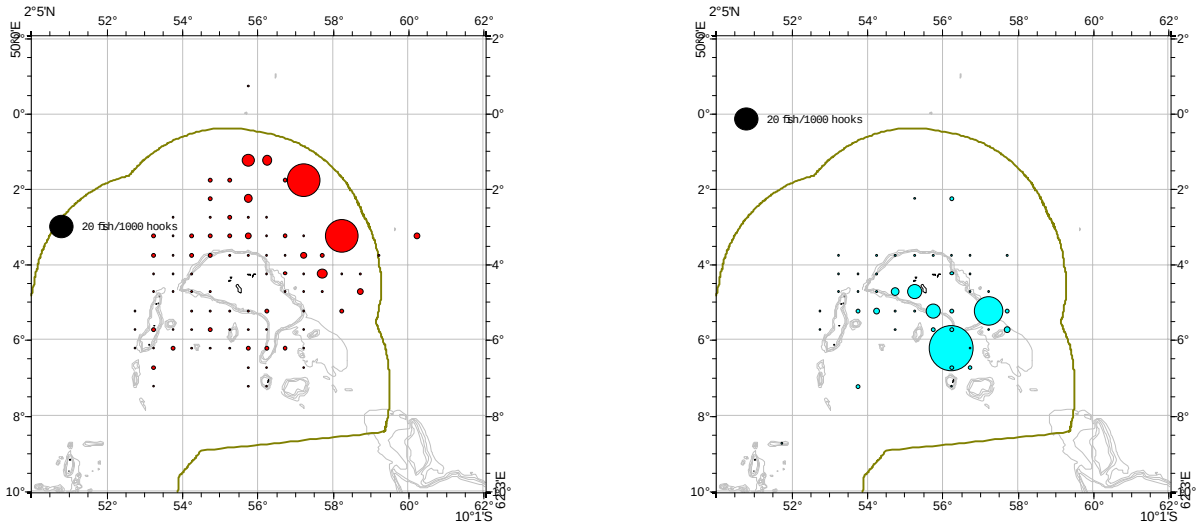

Figure 11. *Spatial distribution of CPUE (number fish.1000 hooks^{-1}) for bigeye tuna (red at left) and sharks (light blue at right) by 0.5 square mille (n = 5,505 bigeye and n = 1,127 sharks).*

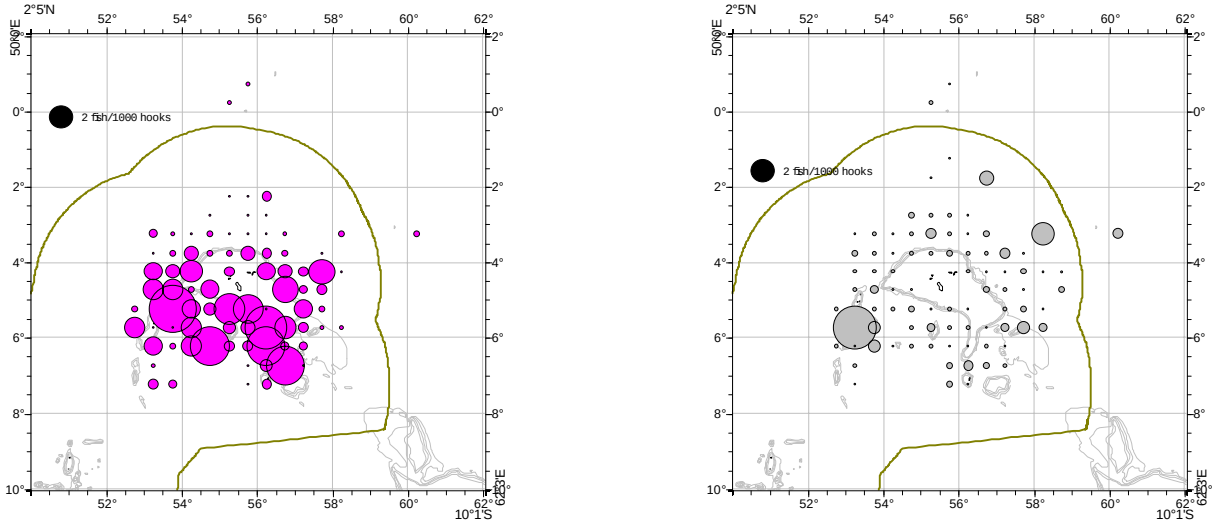

Figure 12. *Spatial distribution of CPUE (number fish.1000 hooks^{-1}) for sailfish (pink at left) and marlins tuna (grey at right) by 0.5 square mille (n = 569 marlins; n = 538 sailfish).*

1.4. Predation

Predation by marine mammals and sharks have been commonly described on longline fishery since the beginning of the century (Klinowska, 1991; Nishida, 2001; Nishida *et al.*, 2001[a] et [b]). For the Seychelles' longline fishery, predation is a major problem taking into account the economic loss it generates. Moreover, predation have not been fully incorporated in regional statistics, hence what represents additional uncertainties for stock assessment. The main species concerned in predation belong to 2 groups, sharks and marine mammals (ondotocetes). For the South West Indian Ocean, 4 species have been identified (Poisson et al., 2001), *Pseudorca crassidens*, *Globicephala macrorhynchus*, *Orcinus Orca* and *Grampus griseus*. In the Seychelles, systematic collection of data on predation have been realised since 1995 (Bargain, com. Pers.).

To evaluate, predation two indices have been calculated; the predation rate (PR) corresponding to a negative CPUE (number of fish lost.1000 hooks^{-1}), and specific percentage of predation (SP) corresponding to the number of one species fished and attacks reported on the total number of this species fished. On the period 1995 to 2002, swordfish is the species with most attacks, 55.8% of total predation. For yellowfin and bigeye tuna predation are 12.8% and 10.4% respectively. For by-catches predation are equal to 0.7% for sharks, 0.4% for marlins, and 0,3% for sailfish. Predation rate (PR) and specific predation (SP) have been calculated for swordfish, yellowfin, bigeye tuna (table 2). For these 3 species average PR is equal to 1.5 fish.1000 hooks^{-1}, however this value should be considered as underestimated because it excludes the fish hooked and totally eaten by predators or became unhooked. If we compare this predation rate to other longline fishery activities in the Indian Ocean, like the Japanese fishery (Nishida T. *et al.*, 2003), we observed similar predation rate for yellowfin and bigeye, 11% and 14% respectively. However, predation on swordfish is about 2 times lower (7% compare to 17.5% for Seychelles).

Table 2. *Predation rate (PR) mean (number of fish attacked.1000 hooks^{-1}) and specific predation (SP) for the 3 main species of the Seychelles longline fishery on the period 1995-2002.*

Species		Predation rate	Specific predation
Xiphias gladius	(1)	3.02 *(+/- 0.21)*	17.5 %
Thunnus albacares	(2)	0.71 *(+/- 0.47)*	12.8 %
Thunnus obesus	(3)	0.58 *(+/- 0.49)*	14.9 %
Total	*(1+2+3)*	**1.50** *(+/- 0,09)*	**16.2 %**

Monthly evolution of predation rate for swordfish and tunas are presented on figure 13. For the 3 species we observed that predation rates are stable for 1996 and 1997 and between 1999 and 2002. 1998 is characterised by a high predation on swordfish and tunas with values 3 times more important. On a monthly basis (figure 14), no significant trend is observed for PR. Nevertheless, SP (figure 15) shows a maximum percentage of predation for all the species around August.

On the basis of annual average fishing effort deployed by the Seychelles's longline fleet on the period 1996-2002 (271,986 hooks), the total predation by shark and marine mammals represent an annual economic loss estimated at around 820 swordfish and 350 tunas.

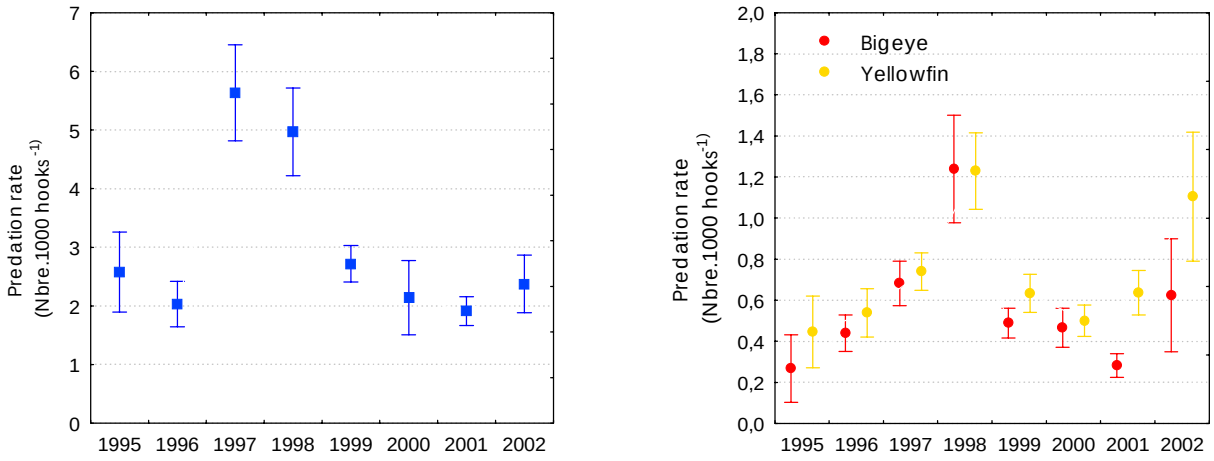

Figure 13. *Annual evolution of predation rate (number of fish attacked.1000 hooks^{-1}) for swordfish (left), yellowfin and bigeye tuna (right) (n = 8,069 swordfish, n = 1,984 yellowfin and 1,611 bigeye).*

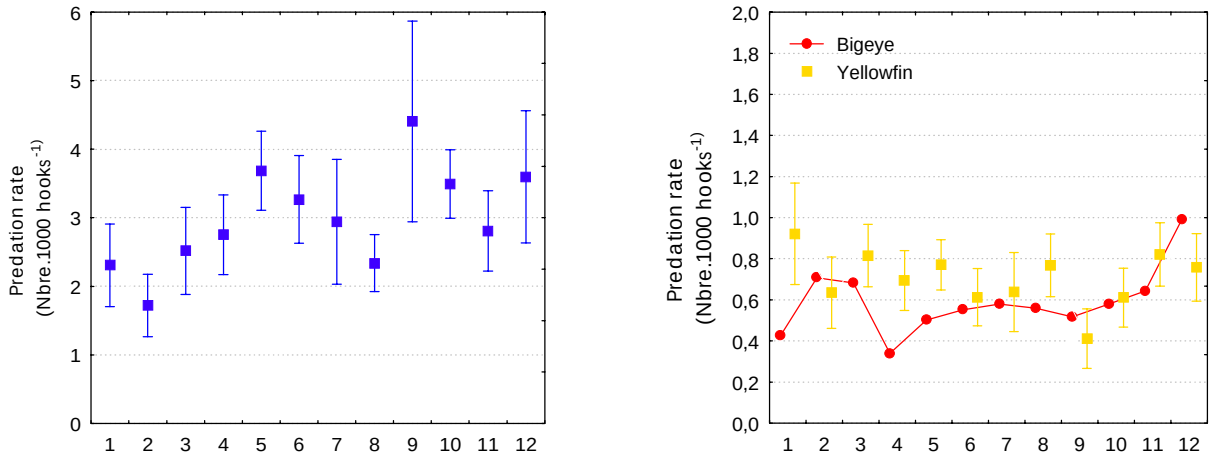

Figure 14. *Monthly evolution of predation rate (number of fish attacked.1000 hooks^{-1}) for swordfish (left), yellowfin and bigeye tuna (right) for the period 1995 – 2002 (n = 8,069 swordfish, n = 1,984 yellowfin et 1,611 bigeye).*

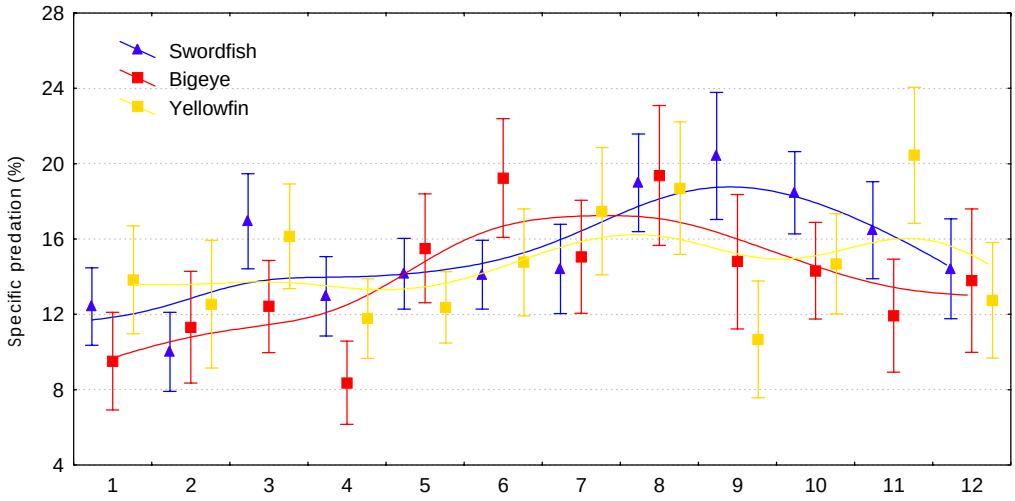

Figure 15. *Monthly evolution of specific predation (number of fish attacked, reported on the total number of the same species fished) obtained for swordfish, yellowfin and bigeye tuna during the period 1995 – 2002.*

1.5. Monitoring of size frequency

The monitoring of size frequencies have been carried out by SFA staff since 1995 during the landing of fish since 1995. Analysis of size frequency were realised from Maxillary Fork Length (MFL) and Pectoral Anal Length (PAL). The annual swordfish size frequency distributions are presented in figure 16[1]. The size class are in centimetres. Sample effective is low (less than 20% of total catch) for the period 1997 to 2002. Annual evolution of the mean length is presented in figure 16[2]. Between 1998 and 2001, the mean PAL do not show any significant trend, with range between 47 and 48 cm (equivalent to MFL: 136 to 139 cm).

Monthly evolution of the mean PAL aggregated by month show significant trends (figure 16[3]) with increase in swordfish size from March (PAL: 45.1 cm) to June (PAL: 50.5 cm). From June to September PAL decrease to reach a minimum of 44.1 cm. This period is also the time of the year where maximum CPUE are observed (figure 7).

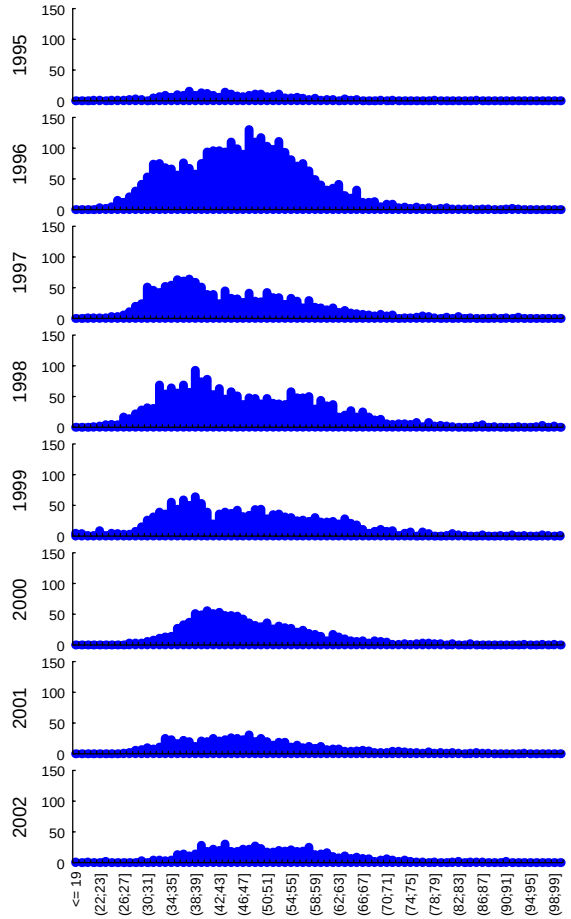

Figure 16.(1) *Swordfish size frequency distributions (PAL in cm) from fish landed by Seychelles' longliners in Victoria for the period 1995 - 2002 (n 1995 = 261, n 1996 = 2897, n 1997 = 1350, n 1998 = 1942, n 1999 = 1402, n 2000 = 1056, n 2001 = 649, n 2002 = 616).*

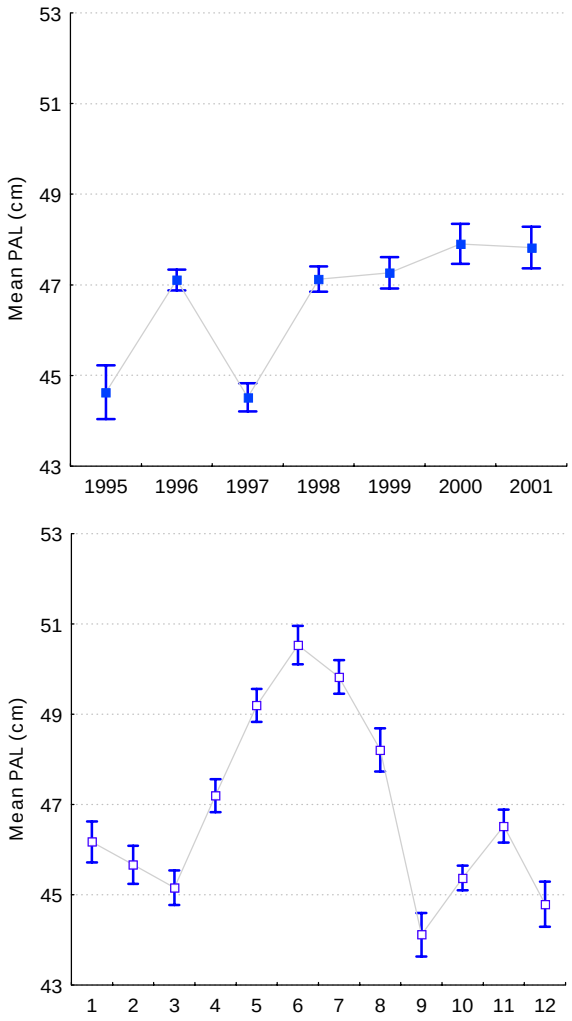

Figure 16.(2 & 3) *Mean size (PAL in cm) evolution by year (up) and month (down) on the period 1996 - 2001 for Seychelles' longliners (n 1995 = 261, n 1996 = 2897, n 1997 = 1350, n 1998 = 1942, n 1999 = 1402, n 2000 = 1056, n 2001 = 649) – not enough monthly data for 2002.*

2. Comparison with other longline fishing activities in the Seychelles's EEZ

2. 1. Fishing effort

In 2001, a joint venture between a Seychellois operator and 14 Taiwanese vessels was set up, which allowed the longliners (23 meters) to fish in the Seychelles' EEZ. The current analysis covers activities for the year 2002 plus the beginning of 2003 based solely on logbooks. These data concern a 12 months period from the 28th January 2002 to the 13th February 2003.

Total fishing effort recorded for this period was 27,922,262 hooks for 31,789 longline sets and 136 fishing trips. For comparison, fishing effort for Seychellois longliners represent only 1% of that deployed by these boats. Number of hooks by set varied from 800 to 1350 hooks (mean 1035; +/- 0,8), that is to say about 2 times more than Seychelles's longliners (mean 1995 - 2002: 550 hooks/set). Mean duration of fishing trip is 20 days, but trips could vary from 14 to 36 days. Between 2 and 14 vessels were active per month (mean: 8.14 vessels/month). Geographic localisation of fishing effort is presented by 1 square degree in figure 17. The effort is centred on the North of the EEZ from 2° N – 6° S and 50° E – 63° E on which we should subtract continental shelf, that means around 1 230,000 km², 5 times more than area covered by Seychelles' fleet.

Spatial-temporal analysis of fishing effort is presented in figure 18, taking into account 6 areas where fishing activities were concentrated: North West, North East, Centre West, Centre East, South West and South East areas (describe on figure 17). This analysis shows that areas 3 and 4 are the 2 main fishing areas. On a period base, the effort is maximum from March to May.

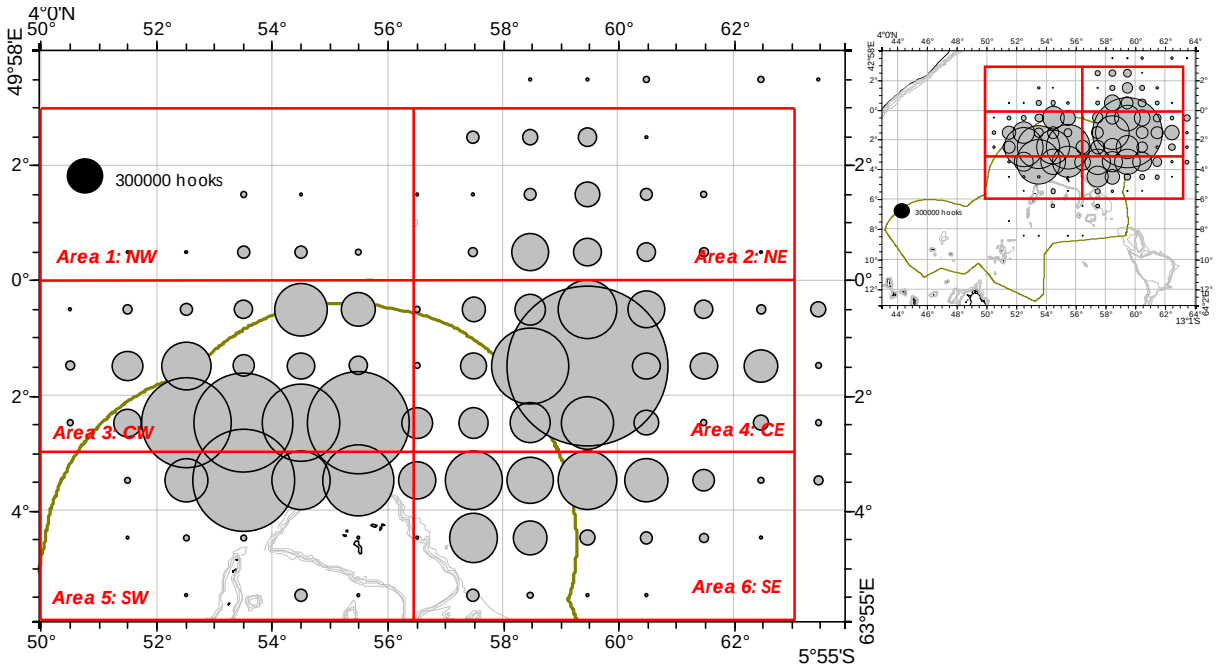

Figure 17. *Total fishing effort of the Taiwanese longliners (number of hooks) deployed from January 2001 to December 2002.*

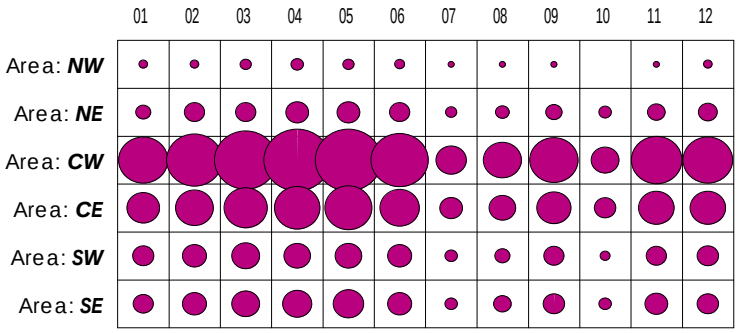

Figure 18. *Monthly fishing effort of the Taiwanese longliners (number of hooks) deployed from January 2001 to December 2002 by area (North West – North East – Centre West – Centre East – South West – South East).*

2.1. Catches

Contrary to the Seychelles' longline catches, tunas are the main species caught in number with 61% of total commercial species, 35% for yellowfin tuna and 26% for bigeye tuna. Swordfish represents only 25% (min: 23%; max: 27%) of the total catches (compared to 57% for Seychelles' fleet). These results are due to fishing strategies, particularly to the time period of set made during the day. By-catches consist of marlins for 7%, sailfish 3% and 4% for "other". Sharks catches are not declared.

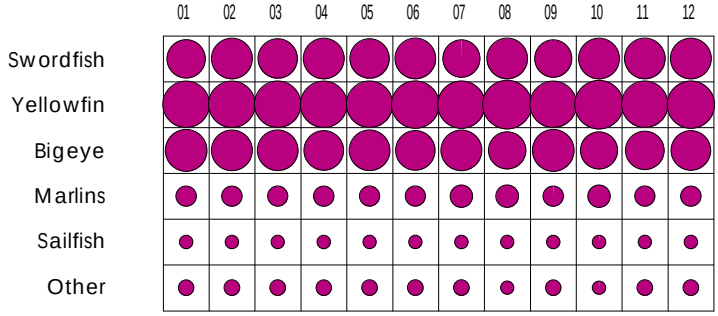

Figure 19. *Monthly evolution of catches by species (in %) from Taiwanese's longliners (from January 2001 to December 2002) authorised to fish in the Seychelles's EEZ.*

2.2. CPUE

From data collected on logbooks, CPUE have been calculated (fish.1000 hooks^{-1}) for the 3 main species and non-target species (figure 20). The maximum CPUE were obtained for yellowfin with a mean of 4.8 (4.4 – 5 fish.1000 hooks^{-1}), no significant trend is observed by month. For swordfish CPUE are spread between 2.9 and 3.9 and for bigeye between 2.6 and 3.9. No significant trend is observed by month. For non-targeted species declared, the number of fish caught by month per 1000 hooks is constant for marlins (mean: 1.0) and slight variation for sailfish (mean: 0.4). The group "other" represent 0.4 fish.1000 hooks^{-1}.

Spatial-temporal analysis of CPUE are presented in figure 21 for swordfish, yellowfin and bigeye tuna, taking into account the 6 areas of main fishing location (North West, North East, Centre West, Centre East, South West and South East areas (describe in figure 17). For all the species no significant trend is observed. However, swordfish CPUE are significantly higher on the north and north west of the Seychelles' EEZ. The opposite is observed for yellowfin (lowest CPUE in the North West and North East area) and bigeye (lowest CPUE in the North West area). Billfish CPUE has show similar characteristics to tuna CPUE, with lowest rate recorded in areas located on the North West. Geographical distribution of annual mean CPUE are presented in figures 22, 23 and 24.

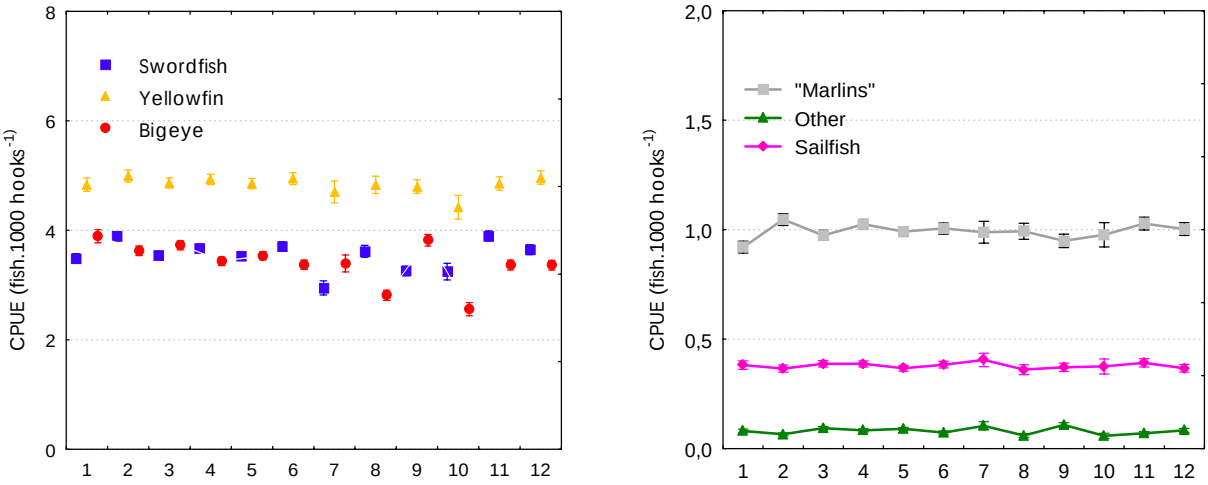

Figure 20. *(left) Monthly evolution of CPUE (+1SE) for target species (swordfish, yellowfin, bigeye) and (right) non target species (Marlins, Sailfish and other) from Taiwanese's longliners (from January 2001 to December 2002) authorised to fish in the Seychelles's EEZ.*

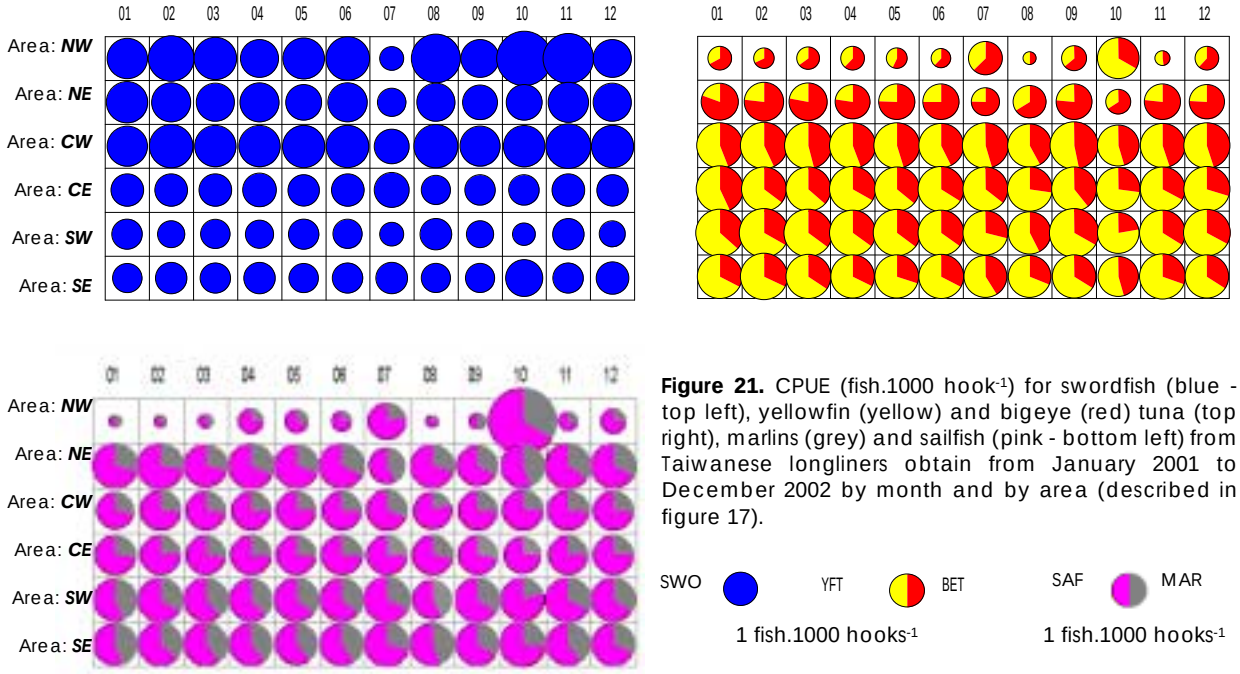

Figure 21. CPUE (fish.1000 hook^{-1}) for swordfish (blue - top left), yellowfin (yellow) and bigeye (red) tuna (top right), marlins (grey) and sailfish (pink - bottom left) from Taiwanese longliners obtain from January 2001 to December 2002 by month and by area (described in figure 17).

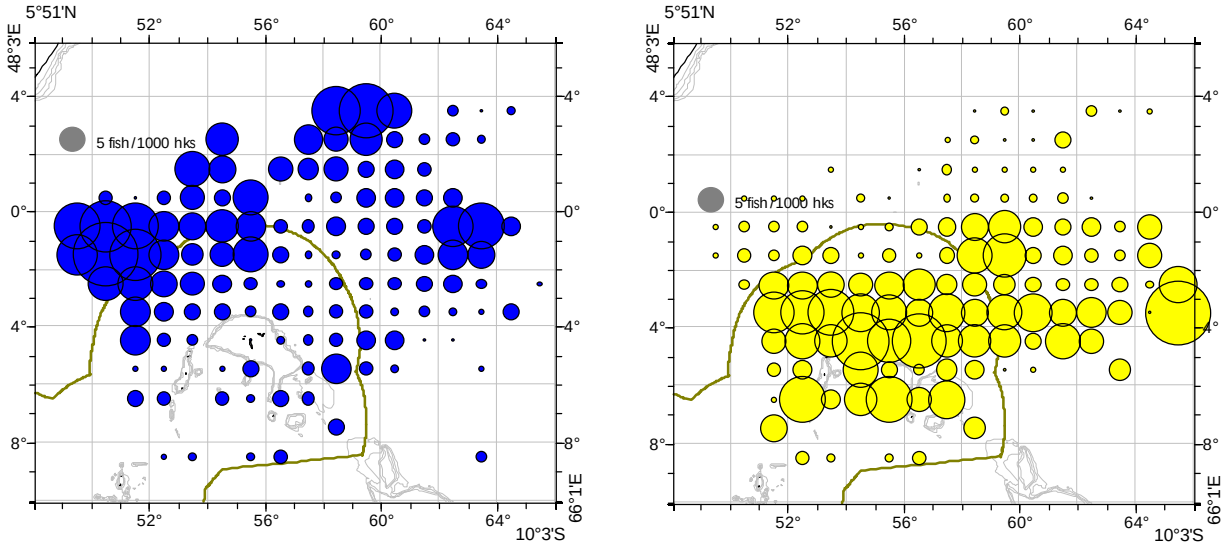

Figure 22. *Spatial distribution of CPUE (number fish.1000 hooks^{-1}) for swordfish (blue at left) and yellowfin tuna (yellow at right) by 1 square mille (n = 78,292 swordfish; n = 108,189 yellowfin).*

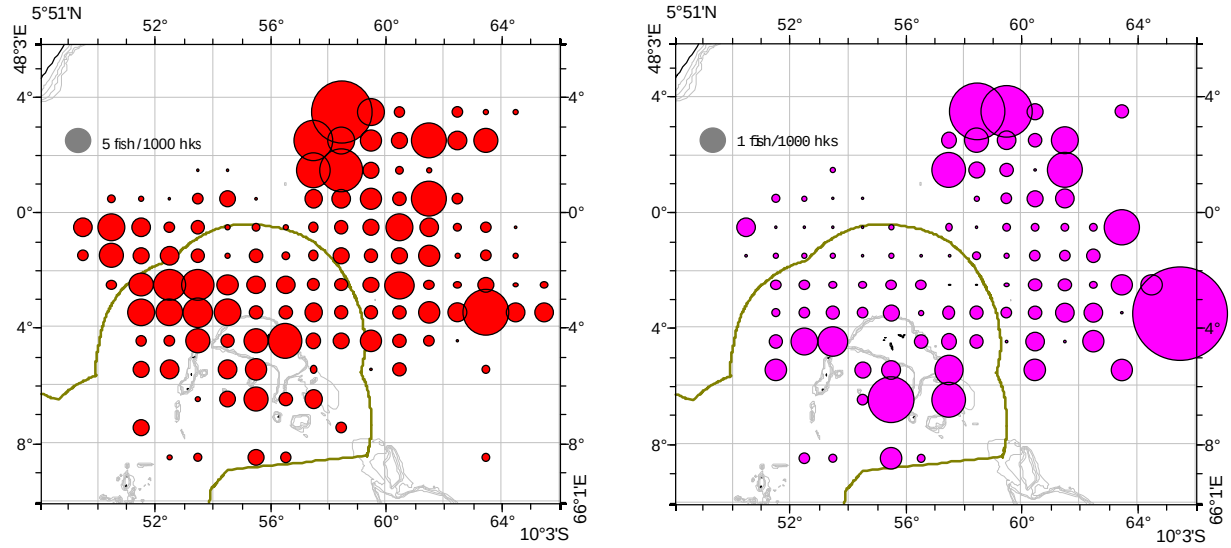

Figure 23. *Spatial distribution of CPUE (number fish.1000 hooks^{-1}) for bigeye tuna (red at left) and sailfish (pink at right) by 1 square mille (n = 78,795 bigeye and n = 8,592 sailfish).*

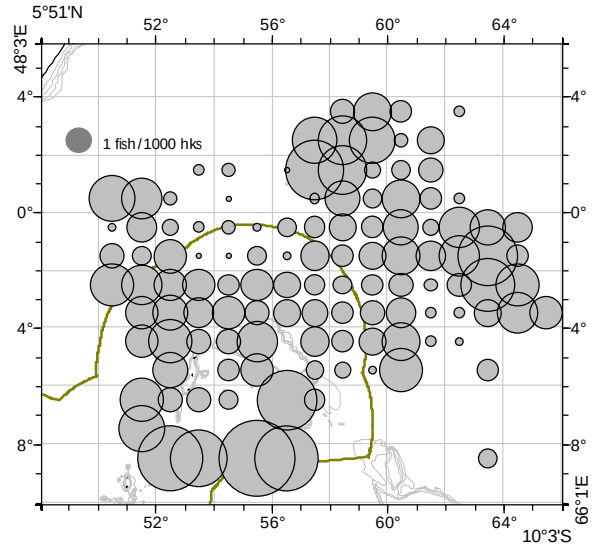

Figure 24. *Spatial distribution of CPUE (number fish.1000 hooks^{-1}) for marlins (grey) by 1 square mille (n = 22,336 marlins).*

This comparative summary of the Seychellois and Taiwanese CPUE (table 3) is interesting for local fishery subjected with several constraints.

Table 3. *CPUE (fish.1000 hooks^{-1}) comparison between Seychelles' and Taiwanese's longliners fishing in the Seychelles' EEZ during the same period, from January 2001 to December 2002.*

Fishery	Swordfish	Yellowfin	Bigeye	Marlin	Sailfish
Seychelles	**11.8** *(± 1.34)*	4.6 *(± 1.11)*	1.5 *(± 0.85)*	0.2 *(± 0.08)*	1.2 *(± 0.32)*
Seychelles (Research program[2])	**12.2** *(± 1.34)*	3.5 *(± 0.5)*	2.5 *(± 0.6)*	-	-
Taiwan	3.5 *(± 0.08)*	**4.8** *(± 0.04)*	3.4 *(± 0.11)*	1.0 *(± 0.01)*	0.4 *(± 0.01)*

Taking into account the decreasing trends in swordfish CPUE and the switch in target species (sharks vs. swordfish), new fishing technique will be required to target tuna species in the Seychelles' EEZ.

* * *

[2] *: From Wendling B., Lucas V., 2003. Evolution of swordfish longline fishery (Xiphias gladius) operating in the West Indian Ocean from Seychelles. Indian Tuna Commission, 3 rd Meeting of the Working Party on Billfish, November 10-14th, Perth, Australia, WPB-03-05.*

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