

Statistics of the French purse seine fleet targeting tropical tunas in the Indian Ocean (1991-2009)

Emmanuel Chassot, Laurent Floch, Patrice Dewals, Viveca Fonteneau, Renaud Pianet

▶ **To cite this version:**

Emmanuel Chassot, Laurent Floch, Patrice Dewals, Viveca Fonteneau, Renaud Pianet. Statistics of the French purse seine fleet targeting tropical tunas in the Indian Ocean (1991-2009). IOTC Proceedings, 2010, IOTC-2010-WPTT-12, 31 p. ird-00579088

HAL Id: ird-00579088
https://ird.hal.science/ird-00579088

Submitted on 23 Mar 2011

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Statistics of the French purse seine fleet targeting tropical tunas in the Indian Ocean (1991-2009)

Chassot E.[a], L. Floch[a,1], P. Dewals[b], V. Fonteneau[c], R. Pianet[a]

[a] *Institut de Recherche pour le Développement, CRH, Avenue Jean Monnet, BP 171, 34 203 Sète Cedex, FRANCE*

[b] *Institut de Recherche pour le Développement, Seychelles Fishing Authority, BP 570, Victoria, SEYCHELLES*

[c] *FIESTA, 9 Boulevard Porée, 35 400 Saint Malo, FRANCE*

Abstract

The document describes the fishing activities of the French purse seiners targeting tropical tunas, i.e. *Thunnus albacares*, *Katsuwonus pelamis*, and *Thunnus obesus* in the Indian Ocean during 1991-2009. The catch time series of the fleet over the period 2001-2009 has been updated following a change in the spatial stratification used in the multispecies sampling and a few modifications in data processing. Information is provided on fishing effort (fishing days, searching days, and fishing sets), catch, catch rates, and mean weights for the major tropical tuna species. Two major fishing modes are considered for the fishery: log-associated and free swimming schools,

Keywords: purse seine fishing, *Thunnus albacares*, *Katsuwonus pelamis*, *Thunnus obesus*, fishing aggregating device

1. Introduction

The French purse seine fishing fleet has been monitored by the Institut de Recherche pour le Développement (IRD) in collaboration with the Seychelles Fishing Authority (SFA) since the beginning of the fishery in the early 1980s (Pianet 1999). Since 2002, statistical data from the European fleet (i.e., France and Spain) have been collected within the framework of the EU "Data Collection Regulation" (DCR, Reg. 1543/2000 and 1639/2001), followed in 2008 by the "Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy" (DCF, Reg 199/2008 and 665/2008). The document describes the activities of the French purse seine fleet during 1991-2009 that is a time period fully consistent in terms of multispecies sampling scheme and data processing used to correct for the species composition of the catch. Statistical data over the period 1981-1990 can be found in Pianet

*Corresponding author

Email address: Laurent.Floch@ird.fr (L. Floch)

et al. (2006). The French fleet includes the vessels flying French flags as well as the vessels from the French overseas collectivity of Mayotte. The document provides a new time series of catch data by species since some changes have recently been made in the data processing, particularly through the addition of a spatial stratum so as to take into account the spatial gradients in tuna species composition observed in the Somali area in the 2000s.

2. Changes in data processing

The catch time series of the French purse seine fishing fleet in the Indian Ocean during 2001-2008 has been modified compared to the data available in Pianet et al. (2009). In particular, the progressive expansion of the purse seiners north of the Somali area in the 2000s has revealed significant differences in the species composition of tunas caught in the ET area 'East Somali' (2201) (Pallarés and Hallier 1997), i.e. a strong decrease in bigeye tuna proportion north of 8°N. Accordingly, a change in the spatial strata used to estimate the species composition of tunas based on multispecies sampling has been done through the splitting of the North Somali area stratum into two areas, a 'South Somali' (2201) area comprised between 0 and 8°N and a 'North Somali' area (2211) between 8° and 15°N. The 'Arabian Sea' area (2207) has then been reduced by moving up its southern limit to 15°N. This change did not affect the total catch declarations but only slightly modified the species composition of the catch in the somali area during 2001-2009.

In addition, a few changes have been made over time in the data processing used to correct the species composition of the catch through port sampling (Pallarés and Hallier 1997, Pianet et al. 2000). In particular, a change has been done in March 2002 in the key used to convert dorsal length into fork length data for yellowfin tuna. In November 2003, the substitution scheme of the data processing has been modified. From this period, multi-species port samples from the first 3 substitution levels have been subsequently cumulated to increase sample size, i.e. if the addition of the samples from the first substitution level to the samples from the stratum of interest was not sufficient to reach a target number (e.g. 25 samples), samples from the second substitution level would then be added up to the samples from the first substitution level. Samples from the third substitution level would then be used if necessary. Such modifications have been included to account for progressive improvements in ancillary information provided to the data processing (e.g. morphometric relationships) or in situations of very poor sampling and had only little impact on the time series of catch and effort annually provided to the IOTC.

3. Fishing capacity

The number of fishing vessels of the French purse seine fishing fleet has varied around 16.6 (SD $\pm$ 1.3) over the period 1991-2009, with a minimum of 14 and a maximum of 19 in 2003 and 1997, respectively (Fig. 1 and Table 1). The total carrying capacity expressed in

gross tonnage (GRT) has increased through time from about 14,000 t in the early 1980s to more than 16,000 t in the late 2000s (Fig. 1). In summer 2009, 5 vessels left the Indian Ocean toward the Atlantic Ocean, decreasing the total carrying capacity to about 11,000 t. This departure was mainly related to low catch rates compared to the Atlantic ocean and the increasing expansion of Somali piracy attacks that induced a strong reduction of the fishing grounds, particularly in the vicinity of the somali area during the FAD-fishing season (June-October). In September 2009, a new purse seiner, the Franche Terre, entered the fishery. In November 2009, the Torre Giulia which was formerly flying the Italian flag joined the French purse seine fleet.

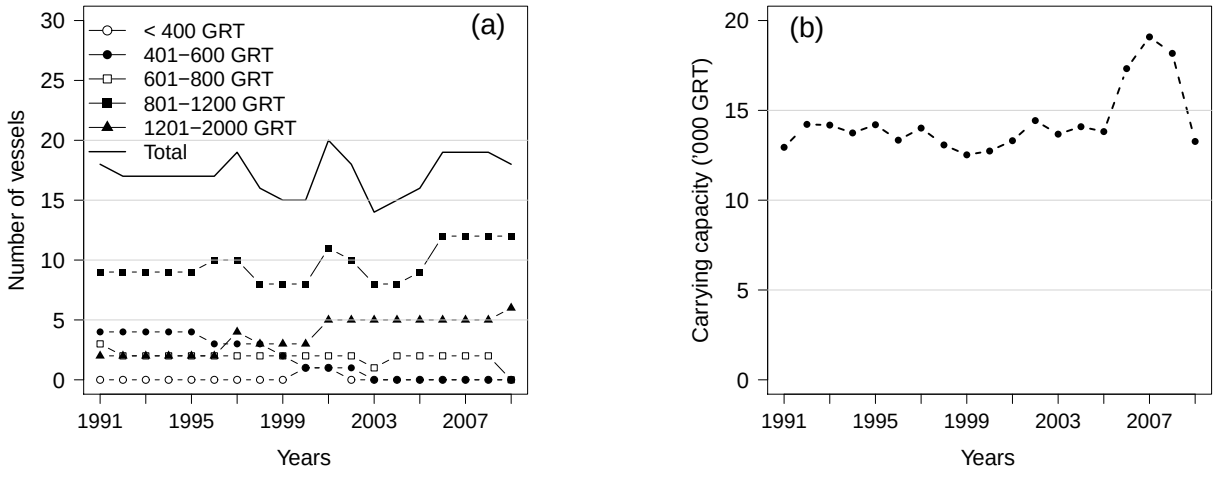


Figure 1: (a) Number of fishing vessels by GRT category operating in the Indian Ocean (b) Changes in total carrying capacity (CC) of the French fishing fleet during 1991-2009. Annual values of CC were weighted by the relative proportion of year (in months) spent in the Indian Ocean. The vessel GRT category was computed as 0.7 times the capacity expressed in m^3

4. Fishing effort

4.1. Fishing and searching days

The fishing effort expressed in fishing and searching days showed similar patterns over 1991-2009 with a decrease from 1993 to 2003 followed by a large increase during 2006-2008 (Fig. 2). Fishing effort strongly decreased in 2009 and reached the lowest values of the time period with 3,315 and 2,779 fishing and searching days, respectively. This pattern was consistent with the changes of the carrying capacity observed over the time period (Fig. 1b) due to the departure of some vessels to the Atlantic ocean (see above).

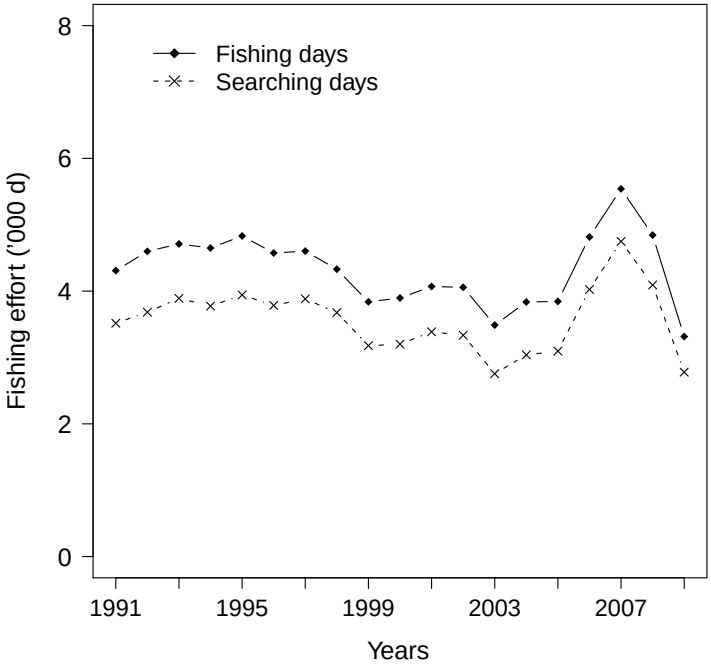


Figure 2: Annual total number of fishing and searching days for the French purse seine fleet in the Indian Ocean during 1991-2009

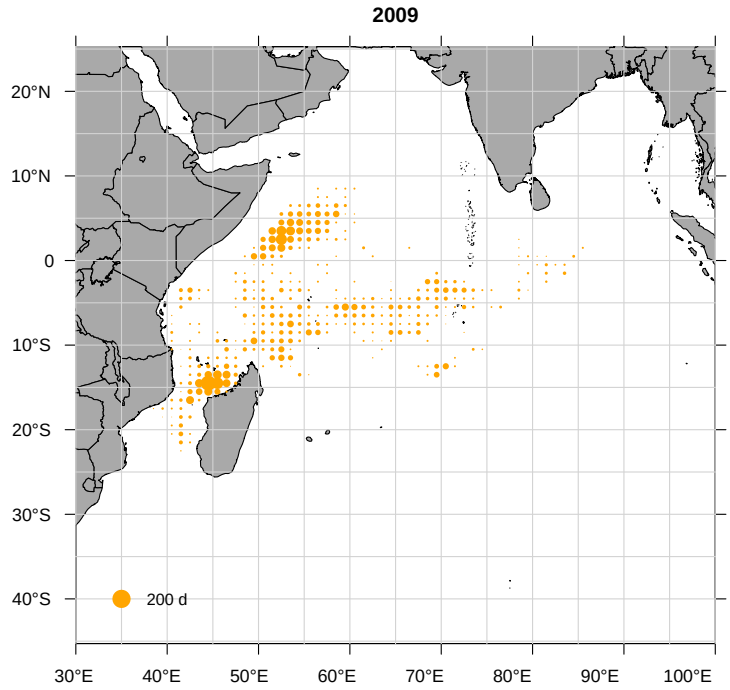


Figure 3: Spatial distribution of fishing effort (in searching days) of the French purse seine fishing fleet in 2009

The fishing effort of the French purse seine fishing fleet is mainly distributed in the western Indian Ocean, south of 10°N and north of 20°S (Fig. 3).

4.2. Fishing activities

Whatever the selection criterium applied, the number of 1-degree squares by latitude and longitude where the French purse seiners occurred showed similar patterns over the period 1991-2009, except for the final year (Fig. 4 and Table 3). The purse seine fishing grounds increased from 1991 to 1998 and then decreased to reach in the early 2000s similar levels as observed in the early 1990s. The high values of spatial occupancy in 1998 corresponded to one of the strongest warm events observed in the Indian Ocean (Murtuggude et al. 1999, Murtugudde et al. 2000) that led purse seiners fishing in the eastern zone (Ménard et al. 2007). The fishing grounds area has steadily increased since 2003 but showed a decrease in 2009 probably in relation with the influence of Somali piracy and the decrease in the number of vessels occurring in the Indian Ocean.

The total annual number of fishing sets made by the French purse seine fleet has varied around 4,000 during 1991-2009, showing a general pattern consistent with the annual variations in carrying capacity and in fishing effort (expressed in fishing or searching days) of the fleet (Table 4). The fleet showed a strong decrease in the number of sets from more than 4,500 in the late 2000s to about 3,100 in 2009. The total number of sets showed a

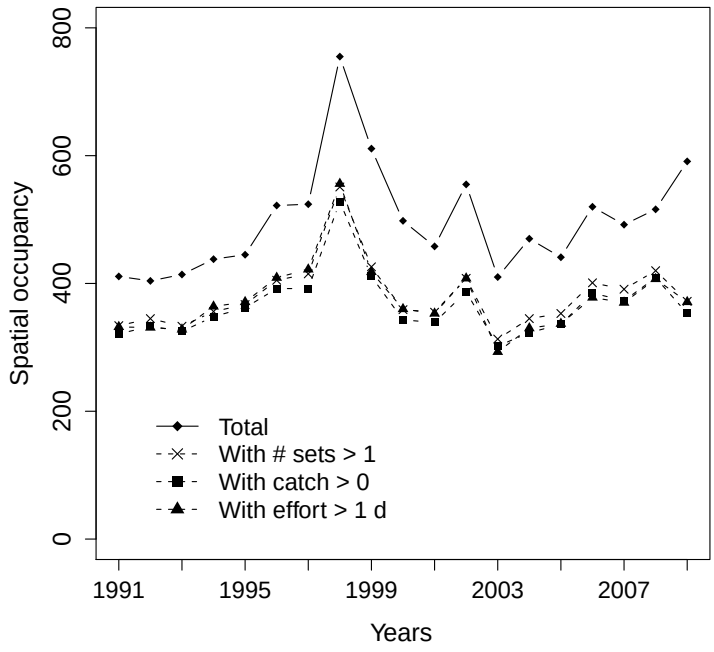


Figure 4: Annual number of 1-degree squares explored by the French purse seine fleet during 1991-2009

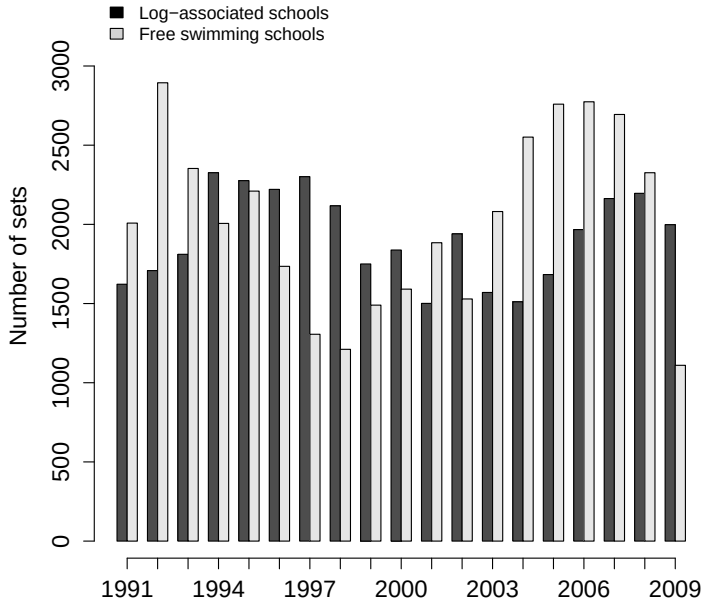


Figure 5: Annual number of fishing sets in the French purse seine fishery on log-associated and free swimming schools during 1991-2009

pattern very similar to the annual changes in the number of sets made on free swimming schools (Fig. 5). The number of sets made on log associated schools was more stable through time and in an opposite phase than sets made on free swimming schools. The percentage of log-associated over free swimming schools varied around a mean of 50% ($\pm$ SD = 10%) with log-associated fishing predominating from the mid-1990s to the early 2000s while sets made on free swimming schools were more frequent during 2003-2008. In 2009, the number of sets on free swimming schools substantially decreased from more than 2,300 to 1,110 while sets made on log-associated schools remained close to 2,000. This major decrease is related to the necessity of French purse seiners to operate in pairs for security reasons, favouring fishing on log-associated over free swimming schools. Tables 5-7 give the detail of the total number of fishing sets by set size and fishing mode.

5. Fisheries production

5.1. Catch levels

The French purse seine fishery showed strong interannual variations in the catch over 1991-2009 with a minimum of 60,000 t in 1998 and a maximum of 108,000 t during 2003-2004 (Fig. 6). Catches on log-associated schools represented about 60% of the total catch, increasing from 60% in the early 1990s to about 70% in the late 1990s, and then

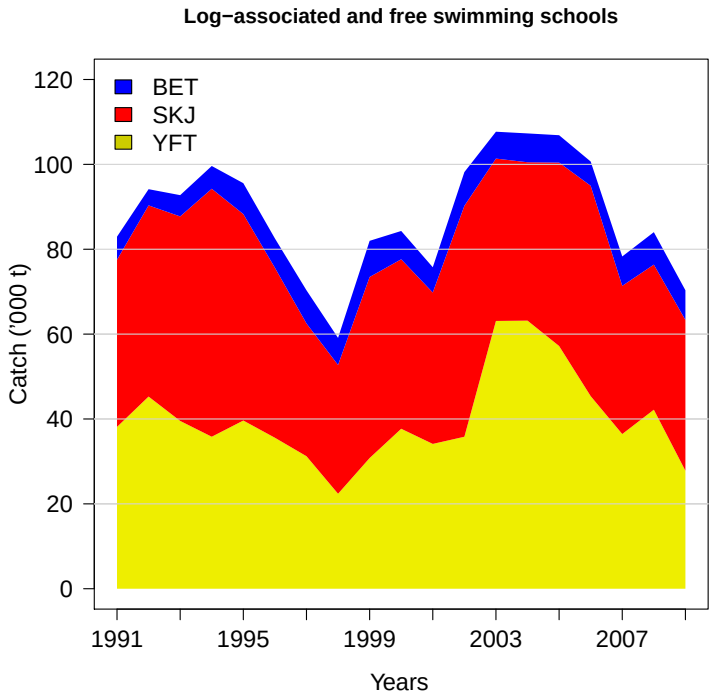


Figure 6: Catch by species of the French purse seine fishing fleet during 1991-2009

decreasing to less than 50% during 2003-2005. The percentage has increased since then to reach about 70% in 2009. Catches on log-associated schools appeared more stable than catches on free swimming schools during 1991-2009 (Fig. 7). They were largely dominated by skipjack that represented about 64% (SD ± 6.2%) of all species caught, varying from 50% to about 75% over the period (Fig. 7a). Catches of bigeye estimated through multispecies sampling varied between 5% and 14% of the total of catch on log-associated schools during 1991-2009. Catches of yellowfin on log-associated schools were stable over the period representing 27% of the catch and an annual average of about 14,000 t (SD ± 2,800 t).

Catches made on free swimming schools showed strong internannual variations in the last two decades from less than 20,000 t in the late 1990s to more than 50,000 t during 2003-2005 (Fig. 7b). The changes over time in free swimming schools catches drove the trends in the total catches of the fishery. The catches were largely dominated by yellowfin that represented more than 70% (SD ± 9%) of the catch during 1991-2009. Catches of yellowfin strongly decreased from 42,000 t in 2008 to less than 30,000 t in 2009, mainly due to the departure of 5 vessels to the Atlantic Ocean and the associated decrease in fishing sets on free swimming schools, i.e. from more than 2,300 in 2008 to about 1,100 in 2009 (Table 4).

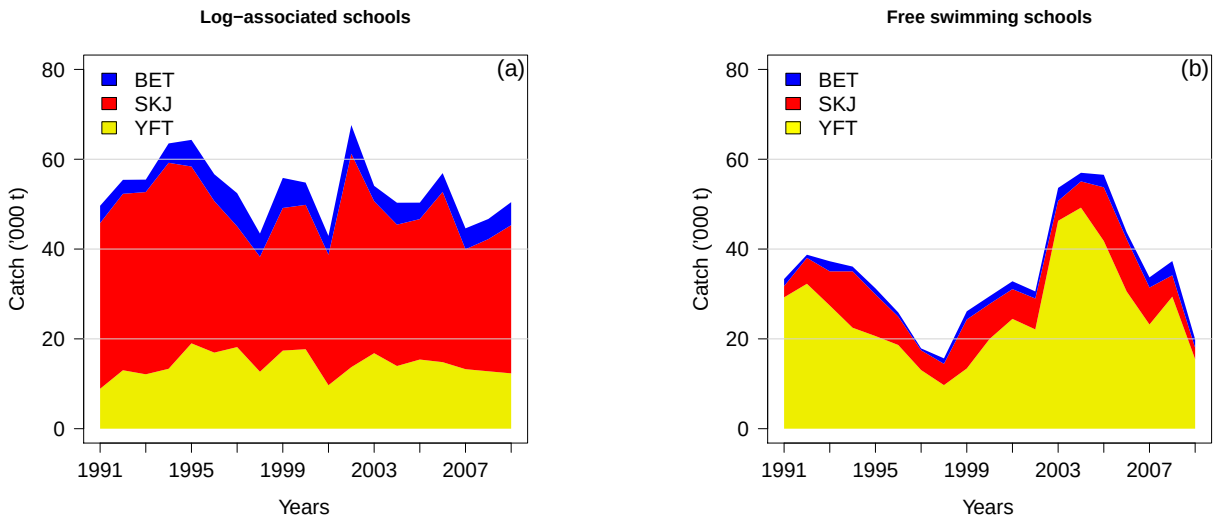


Figure 7: Catch by species of the French purse seine fishing fleet on (a) log-associated and (b) free swimming schools during 1991-2009

5.2. Spatial distribution of the catch

The spatial distribution of the catch in 2009 is highly patchy with two major fishing grounds dominated by skipjack located along the Somali coast and in the north of the Mozambique Channel; the catches dominated by yellowfin tuna being more spread along the 5°S latitude around and east of the Seychelles (Fig. 8). In 2009, few catches have been made in the areas off the coasts of Tanzania, Kenya, and the south of Somali compared to the precedent years (Fig. 9). Thanks to the boarding of military personnel aboard purse seiners to ensure their security, the fishing activities in the Somali area were made in 2009 closer to the coast than in 2008. Some catches were made in 2009 east of Maldives, south of Sri Lanka which could be linked to some environmental effects.

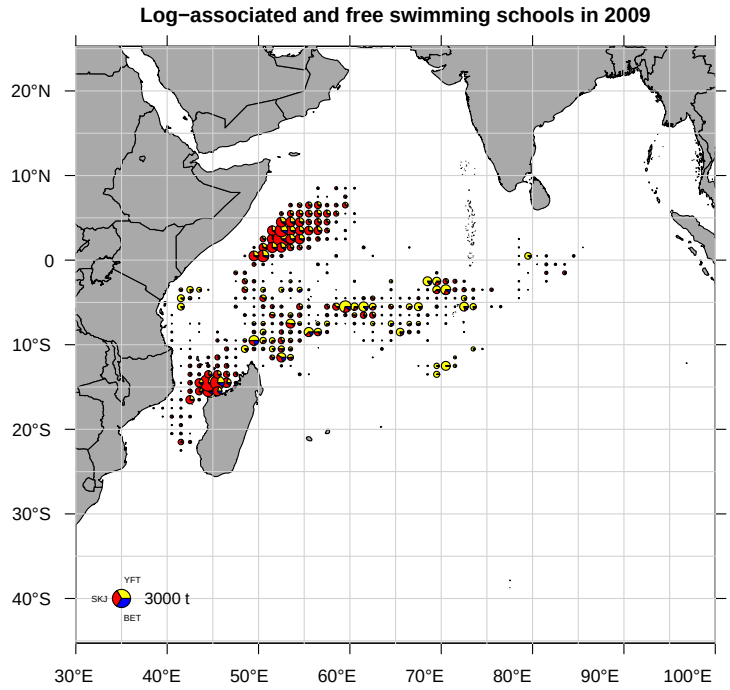


Figure 8: Spatial distribution of tuna catches of the French purse seine fishing fleet in 2009

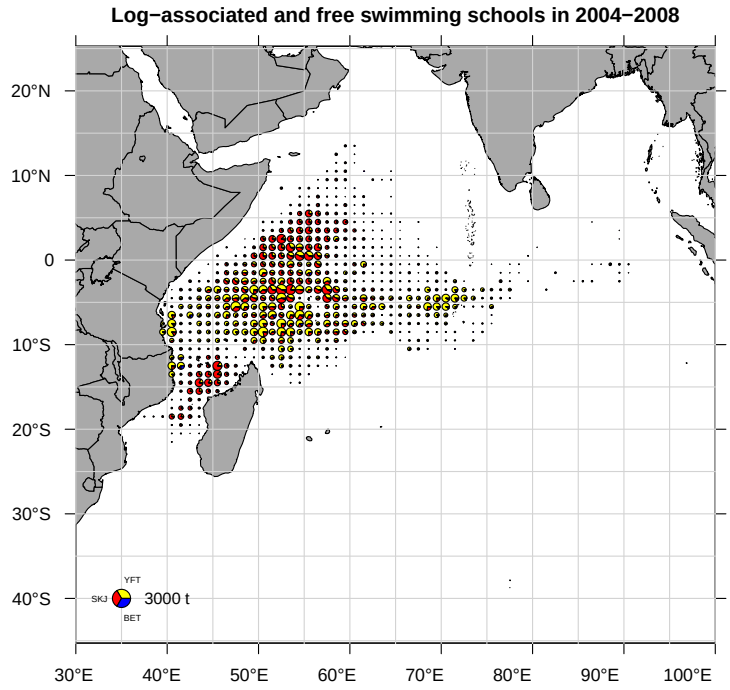


Figure 9: Spatial distribution of tuna catches of the French purse seine fishing fleet in 2004-2008

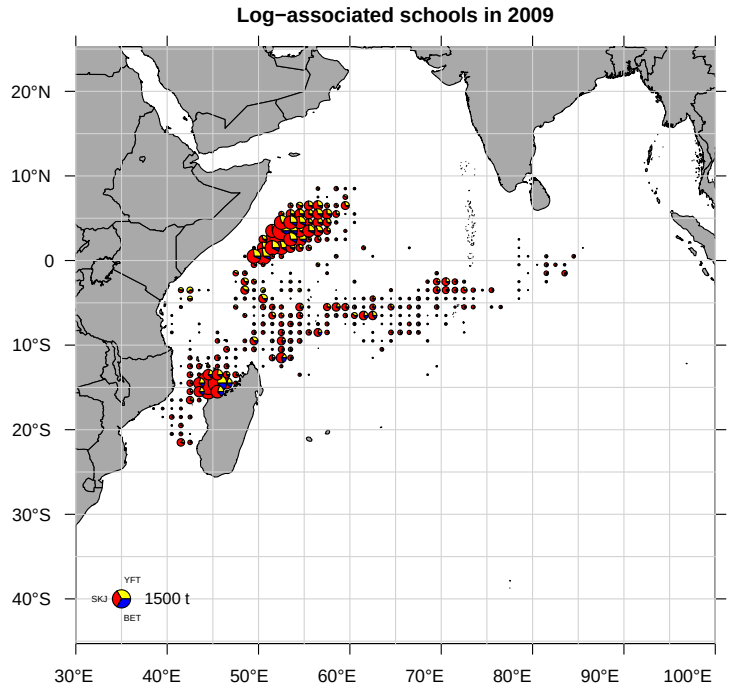


Figure 10: Spatial distribution of tuna catches of the French purse seine fishing fleet made on log-associated schools in 2009

5.3. Catch rates

The catch rates (expressed in t per fishing day) for the 3 species during 1991-2009 did not exhibit clear patterns but showed a strong interannual variability very similar to the time series of catch (Figs. 6-14). The time series of catch rates computed from data collected on log-associated school fishing for the 3 species did no show any trend over time and were characterized by high interannual variability (Fig. 15a). Catch rates were around 9.8 (CV $>$ 20%), 4.1 (CV = 25%), and 1.4 (CV $>$ 25%) t d^{-1} for skipjack, yellowfin, and bigeye, respectively. Catch rates of yellowfin caught on free swimming schools showed a decrease from more than 8 t d^{-1} in 1991 to less than 3 t d^{-1} in 1998. Catch rates then increased to reach levels higher than 15 t d^{-1} during 2003-2004 (Fig. 15b). Since then, catch rates have decreased to lower than average levels around 5.9 t d^{-1} in the recent years. Catch rates of skipjack on free swimming schools showed strong interannual variability around a mean value of 2 t d^{-1} and without any trend. Similarly, catch rates of bigeye did not show any clear trend over 1991-2009 and were characterized by a small mean value of 0.5 t d^{-1} (SD $\pm$ 0.24).

5.4. Size structure of the catch

The total number of fishes caught in 2009 ($\sim$ 550,000) was lower than during the period 2004-2008 ($\sim$ 740,000) while the size structure of the catch was similar for the 3 tuna species (Fig. 16). The sizes of yellowfin caught on log-associated schools showed a major

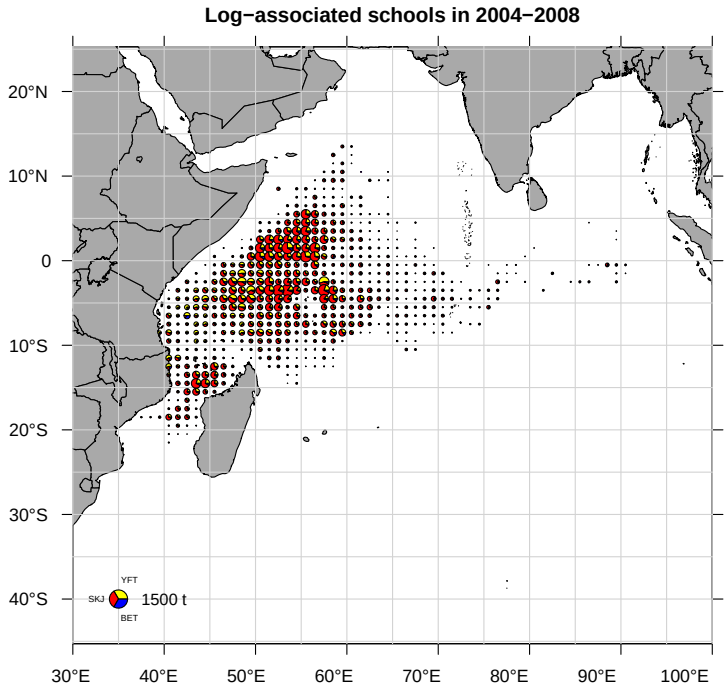


Figure 11: Spatial distribution of tuna catches of the French purse seine fishing fleet made on log-associated schools in 2004-2008

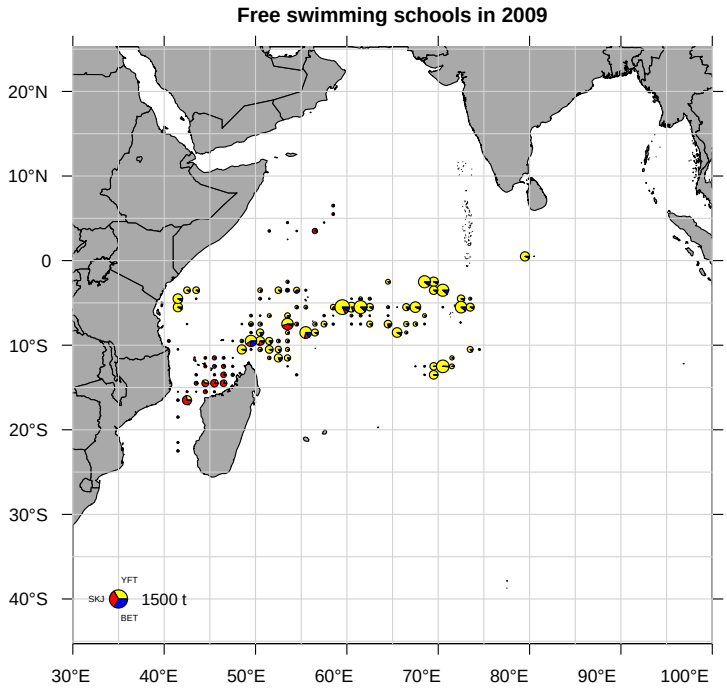


Figure 12: Spatial distribution of tuna catches of the French purse seine fishing fleet made on free swimming schools in 2009

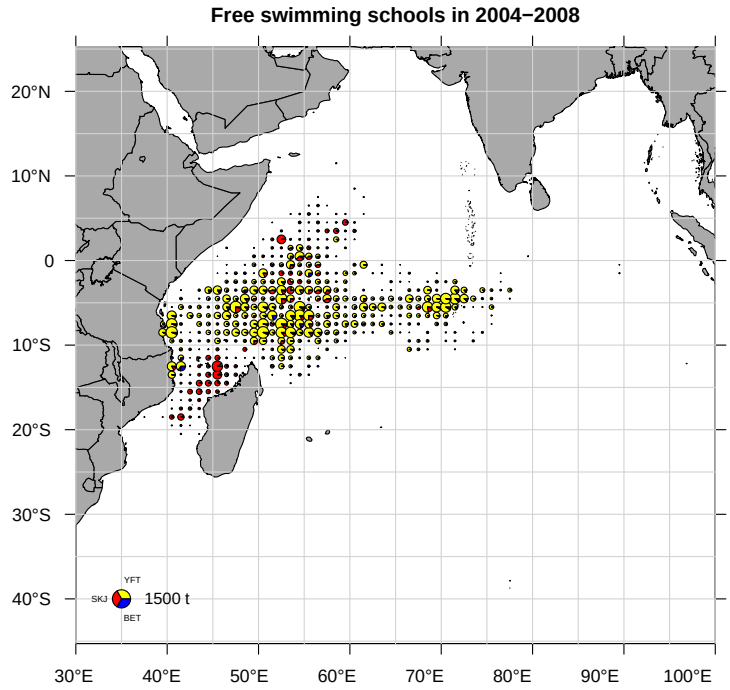


Figure 13: Spatial distribution of tuna catches of the French purse seine fishing fleet made on free swimming schools in 2004-2008

mode between 40 and 70 cm and a smaller mode around 110-120 cm. Bigeye caught on log associated schools were only juveniles fishes of median size 52 cm and the distribution was skewed to the right with a few individuals ($< 4\%$) larger than 80 cm. Skipjack showed one unique mode with sizes described by a median of 47 cm (min = 30 cm and max = 70 cm). Skipjack caught on log-associated and free swimming schools in 2009 were smaller (median sizes of 47 and 48 cm, respectively) than during the 2004-2008 period (median sizes of 48 and 52 cm, respectively).

The biomass of fish caught by size class showed very similar patterns in 2009 as observed during 2004-2008 (Fig. 17). The biomass of large yellowfin (> 100 cm) caught on log-associated and free swimming schools was lower in 2009 than for the average year 2004-2008 while it was rather similar for bigeye. The biomass of skipjack 44-50 cm long caught on log-associated schools, which represent the bulk of skipjack catch, was higher in 2009 than during 2004-2008 while there was a strong decrease in skipjack catch on free swimming schools (Table 8-10). Overall, the total catch of skipjack in 2009 was very close to the catch during 2004-2008 ($\sim$ 35,000 t) despite the strong decrease in fishing effort and was characterized by smaller individuals.

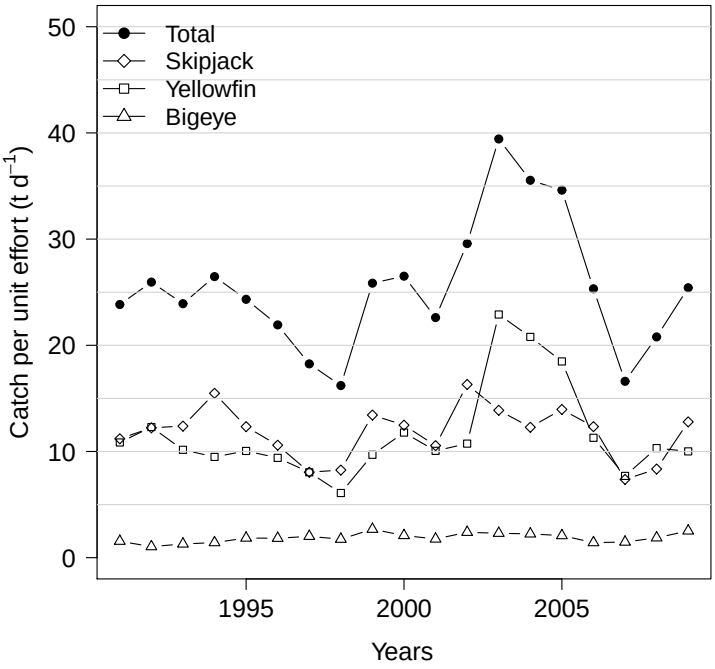


Figure 14: Annual catch rates (in t per searching day) of the French purse seine fleet in the Indian Ocean during 1991-2009

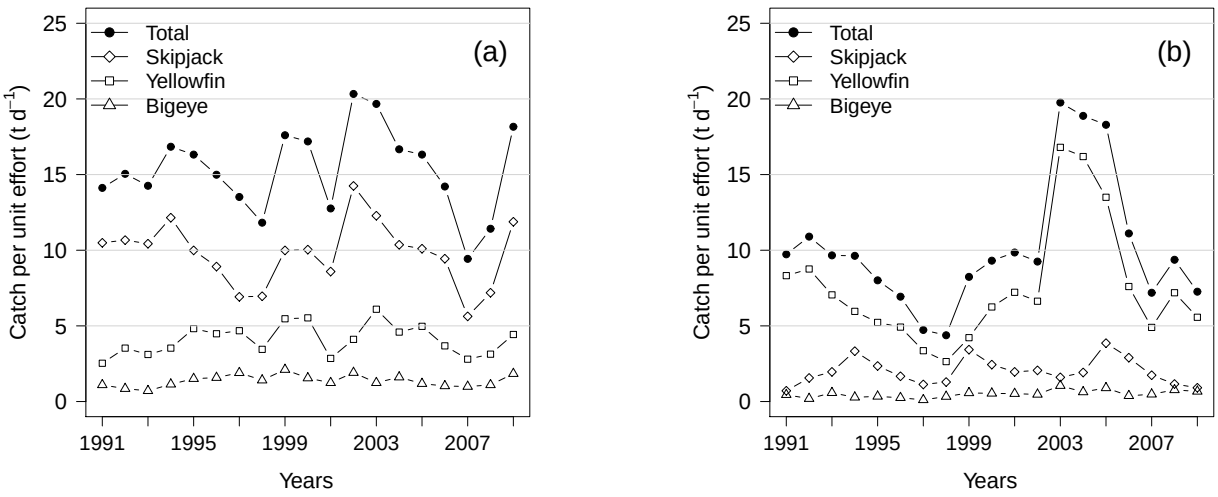


Figure 15: Annual catch rates (in t per searching day) of the French purse seine fleet on (a) log-associated and (b) free swimming schools in the Indian Ocean during 1991-2009

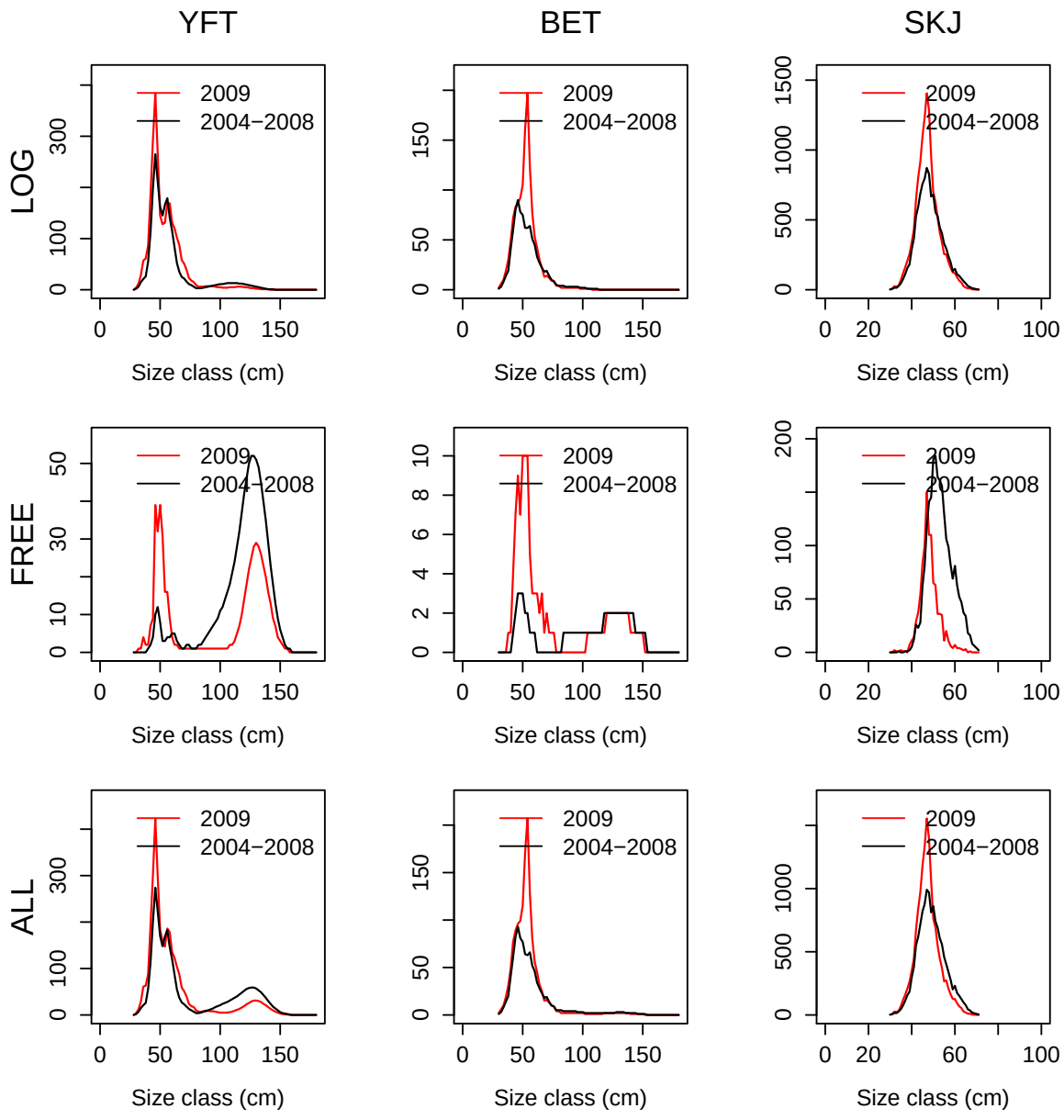


Figure 16: Total numbers of fish (in thousands of individuals) caught by size class after extrapolation of the French purse seine fleet in 2009 and for an average year representing the period 2004-2008

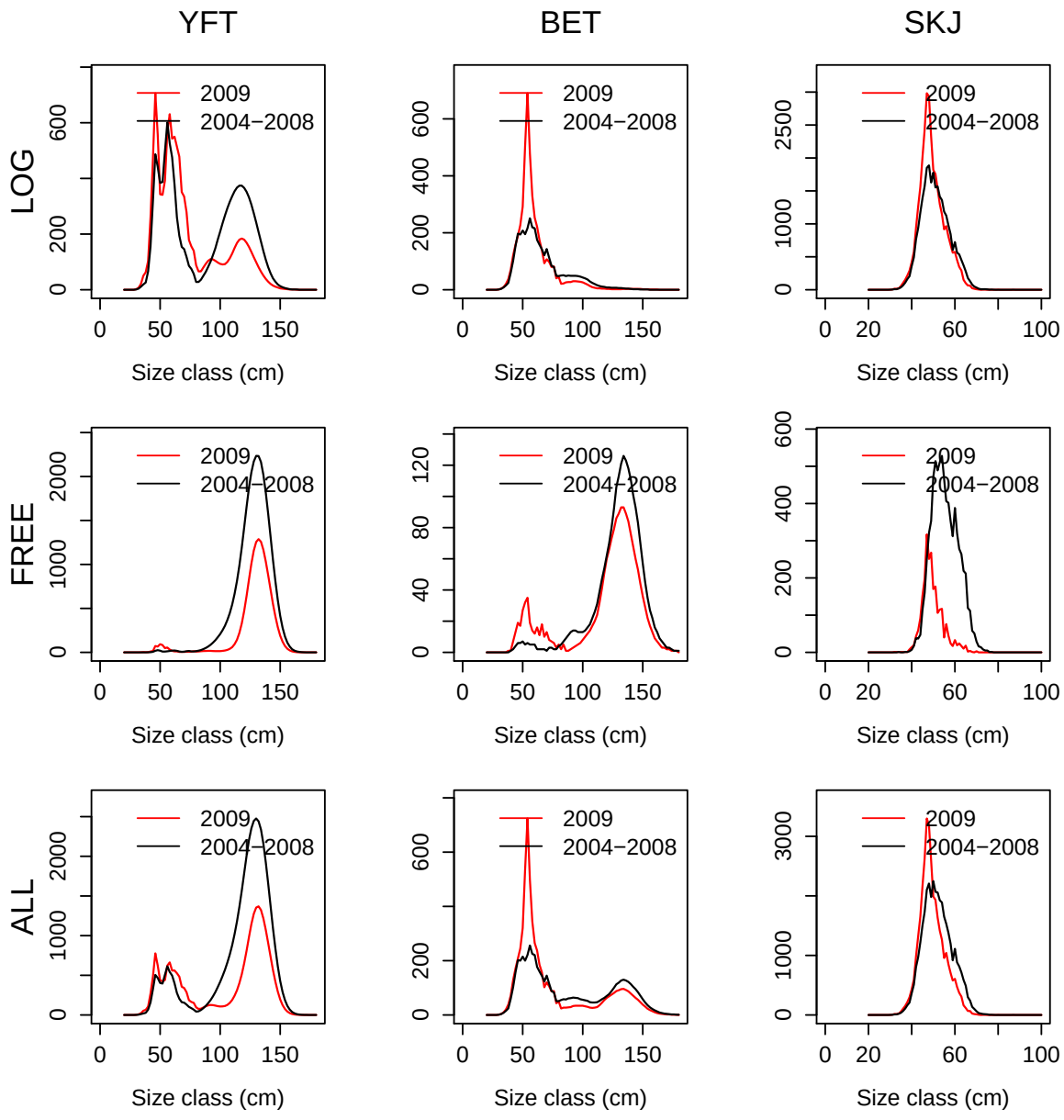


Figure 17: Total biomass (t) of fish caught by size class after extrapolation of the French purse seine fleet in 2009 and for an average year representing the period 2004-2008

5.5. Mean weight in the catch

The mean weight of the major tropical tunas in the catch highly differed between fishing modes and showed strong interannual variations during 1991-2009 (Fig. 18). The mean weight of yellowfin caught decreased from more than 37 kg in 1991 to about 15 kg in 1998-1999, before progressively increasing thereafter to reach about 40 kg in 2007-2008. The mean weight of yellowfin strongly decreased in 2009 to about 28 kg (Fig. 18a). After an initial decrease from about 10 kg in the early 1990s, the mean weight of yellowfin in the catch made on log-associated schools was stabilised from the mid-1990s to the late 2000s at around 5.8 kg (SD = $\pm$ 1.2 kg). Similarly to free swimming schools, the mean weight decreased in 2009 to reach a small value of 4.2 kg per individual caught. The time series pattern of the mean weight of yellowin for the whole fishery was mainly driven by the interannual changes in mean weight for individuals caught in free swimming schools.

The mean weight of skipjack was more stable than yellowfin during 1991-2009 and varied between a minimum of 2.3 kg in 2002 and a maximum of 3.1 in 2006 for fishes caught on log-associated schools Fig. 18b). In the recent years, the mean weight of skipjack strongly decreased from more than 3 kg in 2005-2006 to less than 2.4 kg in 2009. The mean weight of bigeye has remained stable during 1991-2009 at about 6 kg (SD $\pm$ 1 kg) for the whole fishery. It has shown strong interannual variations for individuals caught on free swimming schools with a pattern ver similar to yellowfin tuna.

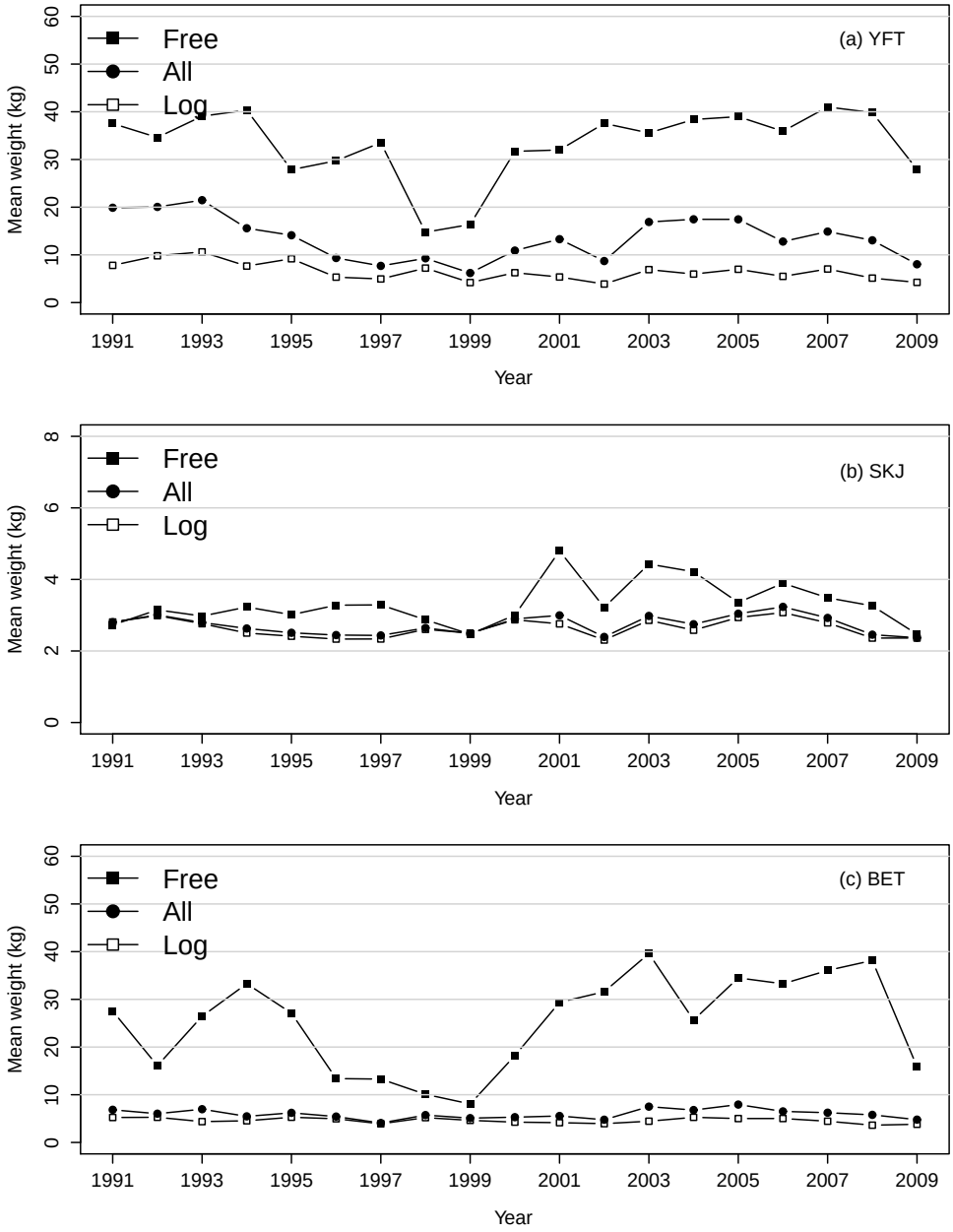


Figure 18: Annual time series of mean weight (kg) for (a) yellowfin, (b) skipjack, and (c) bigeye tuna for each fishing mode during 1991-2009

Acknowledgments. We are grateful to ORTHONGEL and all people involved in data collection and processing since the beginning of the monitoring of tuna purse seine fisheries in the Indian and Atlantic Oceans. We are indebted to Alain Fonteneau for his major contribution to the "Observatoire Thonier" of IRD and Jean-Jacques Lechauve and Pascal Cauquil for development and management of databases. The collaboration with the Instituto Español de Oceanografia (IEO) was instrumental in data processing and benefited from help by Alicia Delgado de Molina and Javier Ariz. This work was financed by the European Data Collection Framework and supported by the Direction des Pêches Maritimes et de l'Aquaculture (DPMA).

6. References

Ménard, F., F. Marsac, E. Bellier, and B. Cazelles. 2007. Climatic oscillations and tuna catch rates in the Indian Ocean: a wavelet approach to time series analysis. Fisheries Oceanography 16: 95–104.

Murtuggude, R. G., S. R. Signorini, J. R. Christian, A. J. Busalacchi, C. R. McClain, and J. Picaut. 1999. Ocean color variability of the tropical Indo-Pacific basin observed by SeaWiFS during 1997–1998. Journal of Geophysical Research 104: 18351–18351.

Murtuggude, R. G., J. P. McCreary, and A. J. Busalacchi. 2000. Oceanic processes associated with anomalous events in the Indian Ocean with relevance to 1997-1998. Journal of Geophysical Research 105: 3295–3306.

Pallarés, P., and J. -P. Hallier. 1997. Analyse du schéma d'échantillonnage multispécifique des thonidés tropicaux (Programme n° 95/37). IEO/ORSTOM. Pianet, R. 1999. Evolution du système de collecte et de traitement des données de la pêche thonière des senneurs européens et assimilés de 1981 à 1998. IOTC Proceedings 2: 74–96.

Pianet, R., P. Pallarés, and C. Petit. 2000. New sampling and data processing strategy for estimating the composition of catches by species and sizes in the European purse seine tropical tuna fisheries. IOTC Proceedings 3: 104–139.

Pianet, R., V. Nordstrøm, and A. Hervé. 2006. French purse-seine tuna fisheries statistics in the Indian Ocean, 1981-2005. IOTC Proceedings IOTC-2006-WPTT-27.

Pianet, R., V. Nordstrøm, and P. Dewals. 2009. French purse seine tuna fisheries statistics in the Indian Ocean, 1981-2008. IOTC Proceedings IOTC-2009-WPTT-23.

7. Appendix tables

Table 1: Annual number of purse seiners by GRT category and total carrying capacity (GRT) of the French tropical tuna purse seine fishing fleet of the Indian Ocean during 1991-2009. Total carrying capacity (CC) was weighted by the proportion of time spent (in months) in the ocean

Year	200-400	401-600	601-800	801-1200	> 1200	Total	CC
1991	0	4	3	9	2	18	12943
1992	0	4	2	9	2	17	14220
1993	0	4	2	9	2	17	14180
1994	0	4	2	9	2	17	13743
1995	0	4	2	9	2	17	14199
1996	0	3	2	10	2	17	13341
1997	0	3	2	10	4	19	14013
1998	0	3	2	8	3	16	13074
1999	0	2	2	8	3	15	12523
2000	1	1	2	8	3	15	12736
2001	1	1	2	11	5	20	13311
2002	0	1	2	10	5	18	14431
2003	0	0	1	8	5	14	13676
2004	0	0	2	8	5	15	14090
2005	0	0	2	9	5	16	13818
2006	0	0	2	12	5	19	17323
2007	0	0	2	12	5	19	19087
2008	0	0	2	12	5	19	18173
2009	0	0	0	12	6	18	13269

Table 2: Annual fishing effort of the French purse seine fishery expressed in fishing and searching days during 1991-2009. 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
1991	4309	3516
1992	4599	3683
1993	4711	3891
1994	4649	3774
1995	4831	3942
1996	4574	3784
1997	4603	3883
1998	4330	3676
1999	3838	3178
2000	3896	3200
2001	4070	3387
2002	4057	3335
2003	3488	2756
2004	3836	3039
2005	3845	3096
2006	4815	4024
2007	5541	4749
2008	4844	4092
2009	3315	2779

Table 3: Annual number of 1-degree squares explored by the French purse seine fleet during 1991-2009

Year	Total	#sets > 1	Catch > 0	Effort > 1 d	Effort > 5 d
1991	411	334	321	332	203
1992	404	345	333	331	198
1993	414	333	325	328	218
1994	438	356	348	364	231
1995	445	367	362	371	232
1996	522	405	392	409	245
1997	524	415	392	422	258
1998	755	551	528	556	245
1999	611	426	411	418	196
2000	498	359	343	360	201
2001	458	355	339	353	219
2002	555	408	387	408	237
2003	410	313	302	293	186
2004	470	345	323	330	171
2005	441	353	336	337	198
2006	520	401	385	378	220
2007	492	391	373	370	242
2008	516	420	409	407	245
2009	591	372	353	371	189

Table 4: Number of positive and null sets by fishing mode made by the French purse seine fleet of the Indian ocean during 1991-2009. A = all; L = log-associated schools; F = free swimming schools

Year	A-Total	A-Positive	A-Null	L-Total	L-Positive	L-Null	F-Total	F-Positive	F-Null
1991	3630	2448	1182	1622	1538	84	2008	910	1098
1992	4602	2980	1622	1708	1569	139	2894	1411	1483
1993	4164	2764	1400	1811	1612	199	2353	1152	1201
1994	4332	3099	1233	2326	2068	258	2006	1031	975
1995	4486	3066	1420	2276	2052	224	2210	1014	1196
1996	3956	2883	1073	2221	1956	265	1735	927	808
1997	3607	2714	893	2301	2035	266	1306	679	627
1998	3328	2454	874	2117	1828	289	1211	626	585
1999	3240	2371	869	1750	1553	197	1490	818	672
2000	3429	2526	903	1838	1568	270	1591	958	633
2001	3385	2481	904	1501	1378	123	1884	1103	781
2002	3469	2673	796	1940	1835	105	1529	838	691
2003	3651	2464	1187	1570	1405	165	2081	1059	1022
2004	4062	2580	1482	1511	1378	133	2551	1202	1349
2005	4442	3051	1391	1683	1532	151	2759	1519	1240
2006	4741	3233	1508	1967	1814	153	2774	1419	1355
2007	4857	3254	1603	2163	1933	230	2694	1321	1373
2008	4522	3264	1258	2196	1994	202	2326	1270	1056
2009	3108	2488	620	1998	1820	178	1110	668	442

Table 5: Distribution of the number of sets made on log-associated schools by set size (t) for the French purse seine fishery during 1991-2009

Year	0.1-10	10.1-20	20.1-30	30.1-40	40.1-50	50.1-60	60.1-70	70.1-80	80.1-90	90.1-100	>100
1991	211	428	306	211	125	68	48	26	26	26	63
1992	263	386	293	170	129	82	48	46	28	23	100
1993	264	413	294	167	118	87	60	55	44	27	83
1994	308	595	419	257	168	77	68	47	27	23	78
1995	389	511	369	239	160	104	79	57	45	37	61
1996	407	550	361	229	117	82	49	47	39	18	57
1997	530	570	334	235	121	66	47	42	29	19	42
1998	482	604	309	174	72	49	33	38	18	7	40
1999	312	360	256	165	107	74	60	48	32	26	113
2000	311	381	261	172	110	78	52	46	37	25	95
2001	274	404	233	155	81	47	42	33	24	18	67
2002	309	503	296	179	113	106	70	58	37	30	134
2003	269	344	220	137	99	76	43	49	37	15	116
2004	268	329	226	168	95	67	44	28	25	22	106
2005	315	407	238	152	110	75	71	34	28	16	86
2006	452	468	298	165	108	79	50	41	27	32	94
2007	578	553	314	185	104	74	26	30	17	10	42
2008	547	580	353	208	110	67	44	30	13	11	30
2009	424	503	287	214	120	87	48	40	24	11	61

Table 6: Distribution of the number of sets made on free swimming schools by set size (t) for the French purse seine fishery during 1991-2009

Year	0.1-10	10.1-20	20.1-30	30.1-40	40.1-50	50.1-60	60.1-70	70.1-80	80.1-90	90.1-100	>100
1991	148	200	156	103	86	47	46	24	24	17	59
1992	283	413	248	159	99	68	47	25	16	14	39
1993	242	286	191	111	95	55	52	21	22	22	54
1994	160	256	180	101	94	64	41	42	17	27	47
1995	175	265	197	115	90	47	35	27	15	17	31
1996	199	256	185	89	58	52	22	19	12	10	25
1997	163	176	128	80	47	29	18	16	4	2	16
1998	162	193	104	47	45	20	21	5	6	7	15
1999	199	196	137	73	66	30	25	18	22	13	39
2000	205	252	170	105	57	50	28	22	16	6	47
2001	282	268	181	99	73	57	43	30	18	7	45
2002	170	190	147	73	67	47	31	20	16	12	65
2003	146	195	150	108	97	78	48	35	33	34	135
2004	161	217	179	146	89	84	54	62	38	36	136
2005	224	363	275	193	120	80	58	61	25	25	95
2006	277	382	242	157	112	76	50	27	24	20	52
2007	325	387	230	126	99	41	37	24	11	9	32
2008	325	317	200	121	89	50	45	30	21	20	52
2009	147	169	111	61	64	35	24	10	11	5	31

Table 7: Distribution of the total number of sets by set size (t) for the French purse seine fishery during 1991-2009

Year	0.1-10	10.1-20	20.1-30	30.1-40	40.1-50	50.1-60	60.1-70	70.1-80	80.1-90	90.1-100	>100
1991	359	628	462	314	211	115	94	50	50	43	122
1992	546	799	541	329	228	150	95	71	44	37	139
1993	506	699	485	278	213	142	112	76	66	49	137
1994	468	851	599	358	262	141	109	89	44	50	125
1995	564	776	566	354	250	151	114	84	60	54	92
1996	606	806	546	318	175	134	71	66	51	28	82
1997	693	746	462	315	168	95	65	58	33	21	58
1998	644	797	413	221	117	69	54	43	24	14	55
1999	511	556	393	238	173	104	85	66	54	39	152
2000	516	633	431	277	167	128	80	68	53	31	142
2001	556	672	414	254	154	104	85	63	42	25	112
2002	479	693	443	252	180	153	101	78	53	42	199
2003	415	539	370	245	196	154	91	84	70	49	251
2004	429	546	405	314	184	151	98	90	63	58	242
2005	539	770	513	345	230	155	129	95	53	41	181
2006	729	850	540	322	220	155	100	68	51	52	146
2007	903	940	544	311	203	115	63	54	28	19	74
2008	872	897	553	329	199	117	89	60	34	31	82
2009	571	672	398	275	184	122	72	50	35	16	92

Table 8: Catch by species for the French purse seine fishery of the Indian ocean during 1991-2009

Year	YFT	SKJ	BET	ALB	Others	Total
1991	38134	39388	5441	875	0	83837
1992	45282	45048	3822	1403	0	95555
1993	39539	48192	5015	310	0	93057
1994	35819	58430	5367	292	0	99908
1995	39636	48652	7280	350	0	95918
1996	35578	40056	6908	391	0	82933
1997	31227	31276	7824	539	0	70866
1998	22382	30340	6389	460	0	59571
1999	30799	42665	8518	154	0	82136
2000	37694	39935	6673	350	172	84825
2001	34127	35673	5956	659	174	76589
2002	35815	54405	7962	264	195	98642
2003	63101	38258	6334	608	368	108670
2004	63174	37323	6798	77	649	108021
2005	57198	43220	6453	86	184	107140
2006	45383	49573	5714	850	290	101809
2007	36455	34918	6928	335	33	78669
2008	42185	34186	7652	981	10	85013
2009	27807	35532	6991	295	3	70628

Table 9: Catch by species made on log-associated schools for the French purse seine fishery of the Indian ocean during 1991-2009

Year	YFT	SKJ	BET	ALB	Others	Total
1991	8886	36896	3858	0	0	49639
1992	13014	39286	3112	9	0	55421
1993	12111	40582	2769	5	0	55467
1994	13340	45866	4313	23	0	63543
1995	19002	39380	5933	17	0	64332
1996	16944	33741	5975	70	0	56730
1997	18173	26882	7389	67	0	52511
1998	12680	25599	5173	13	0	43464
1999	17389	31759	6692	103	0	55943
2000	17699	32142	4960	43	172	55017
2001	9678	29045	4206	108	174	43211
2002	13704	47527	6385	0	171	67787
2003	16810	33837	3429	0	134	54209
2004	13959	31473	4882	0	339	50653
2005	15399	31270	3667	0	184	50520
2006	14818	37920	4172	0	214	57124
2007	13254	26695	4662	3	31	44645
2008	12784	29427	4486	2	10	46710
2009	12320	33004	5125	10	3	50462

Table 10: Catch by species made on free swimming schools for the French purse seine fishery of the Indian ocean during 1991-2009

Year	YFT	SKJ	BET	ALB	Others	Total
1991	29248	2492	1583	875	0	34198
1992	32268	5762	710	1394	0	40134
1993	27428	7611	2246	305	0	37590
1994	22479	12564	1054	269	0	36365
1995	20634	9272	1348	333	0	31587
1996	18633	6315	933	321	0	26203
1997	13054	4394	434	472	0	18355
1998	9702	4742	1215	448	0	16107
1999	13410	10907	1826	51	0	26193
2000	19995	7793	1713	307	0	29808
2001	24450	6627	1750	551	0	33377
2002	22111	6878	1578	264	24	30855
2003	46291	4422	2906	608	235	54461
2004	49215	5850	1916	77	310	57368
2005	41799	11950	2786	86	0	56620
2006	30564	11653	1542	850	76	44684
2007	23201	8224	2265	332	2	34024
2008	29401	4758	3166	979	0	38303
2009	15487	2527	1866	285	0	20166

Table 11: Catch per unit of effort (in t per searching day) for the French purse seine fishery of the Indian ocean during 1991-2009

Year	YFT	SKJ	BET	ALB	Total
1991	10.85	11.20	1.55	0.25	23.84
1992	12.30	12.23	1.04	0.38	25.95
1993	10.16	12.39	1.29	0.08	23.92
1994	9.49	15.48	1.42	0.08	26.47
1995	10.05	12.34	1.85	0.09	24.33
1996	9.40	10.59	1.83	0.10	21.92
1997	8.04	8.05	2.01	0.14	18.25
1998	6.09	8.25	1.74	0.13	16.21
1999	9.69	13.43	2.68	0.05	25.85
2000	11.78	12.48	2.09	0.11	26.51
2001	10.06	10.55	1.76	0.19	22.61
2002	10.74	16.31	2.39	0.08	29.58
2003	22.90	13.88	2.30	0.22	39.43
2004	20.79	12.28	2.24	0.03	35.54
2005	18.48	13.96	2.08	0.03	34.61
2006	11.29	12.34	1.42	0.21	25.32
2007	7.70	7.37	1.47	0.07	16.61
2008	10.32	8.35	1.87	0.24	20.79
2009	10.01	12.79	2.52	0.11	25.42

Table 12: Catch per unit of effort (in t per searching day) on log-associated schools for the French purse seine fishery of the Indian ocean during 1991-2009

Year	YFT	SKJ	BET	ALB	Total
1991	2.53	10.49	1.10	0.00	14.12
1992	3.53	10.67	0.85	0.00	15.05
1993	3.11	10.43	0.71	0.00	14.26
1994	3.53	12.15	1.14	0.01	16.84
1995	4.82	9.99	1.51	0.00	16.32
1996	4.48	8.92	1.58	0.02	14.99
1997	4.68	6.92	1.90	0.02	13.52
1998	3.45	6.96	1.41	0.00	11.82
1999	5.47	9.99	2.11	0.03	17.60
2000	5.53	10.04	1.55	0.01	17.19
2001	2.85	8.59	1.24	0.03	12.76
2002	4.11	14.25	1.91	0.00	20.33
2003	6.10	12.28	1.24	0.00	19.67
2004	4.59	10.36	1.61	0.00	16.67
2005	4.97	10.10	1.18	0.00	16.32
2006	3.68	9.44	1.03	0.00	14.21
2007	2.80	5.63	0.99	0.00	9.43
2008	3.13	7.19	1.10	0.00	11.42
2009	4.43	11.88	1.84	0.00	18.16

Table 13: Catch per unit of effort (in t per searching day) on free swimming schools for the French purse seine fishery of the Indian ocean during 1991-2009

Year	YFT	SKJ	BET	ALB	Total
1991	8.32	0.71	0.45	0.25	9.73
1992	8.76	1.56	0.19	0.38	10.90
1993	7.05	1.96	0.58	0.08	9.66
1994	5.96	3.33	0.28	0.07	9.63
1995	5.23	2.35	0.34	0.08	8.01
1996	4.92	1.67	0.25	0.08	6.93
1997	3.36	1.13	0.11	0.12	4.73
1998	2.64	1.29	0.33	0.12	4.38
1999	4.22	3.43	0.57	0.02	8.24
2000	6.25	2.44	0.54	0.10	9.31
2001	7.22	1.96	0.52	0.16	9.85
2002	6.63	2.06	0.47	0.08	9.25
2003	16.80	1.60	1.05	0.22	19.76
2004	16.19	1.92	0.63	0.03	18.88
2005	13.50	3.86	0.90	0.03	18.29
2006	7.60	2.90	0.38	0.21	11.11
2007	4.90	1.74	0.48	0.07	7.19
2008	7.19	1.16	0.77	0.24	9.37
2009	5.57	0.91	0.67	0.10	7.26