Received: 5 & 9 October, 2012
IOTC-2012-WPTT14-20 Rev_1

Statistics of the French purse seine fishing fleet targeting tropical tunas in the Indian Ocean (1981-2011)

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Abstract

In 2011, the French purse seine fishing fleet of the Indian Ocean was composed of 8 large size vessels that represented a total carrying capacity of about 8,000 t. Catches reached a total of 43,000 t and were composed of 50%, 42%, and 8% of yellowfin, skipjack, and bigeye, respectively. After a period of increase during 2006-2008, the fishing effort of the fleet has been decreasing to reach a minimum of 1,800 searching days in 2011. The decrease in effort was associated with a contraction of the fleet fishing grounds in the recent years and mainly characterized by a strong decrease in the number of sets made on free-swimming schools; a total of 1,800 fishing sets being made in 2011 compared to about 4,200 y^{-1} in the mid-2000s. Hence, the percentage of sets made on FAD-associated schools steadily increased since 2004 to reach more than 65% in 2010-2011, FAD-fishing resulting in 75% of the total catch of the French purse seine fishing fleet in 2011. Species-specific catch rates (in t per searching day) on FAD-associated schools reveal increasing trends over 1981-2011 with high interannual variability while no clear trend is apparent in the time series of catch rates on free-swimming schools. The year 2011 is characterized by a large proportion of yellowfin in the catch on FAD-associated schools that might indicate a good recruitment. For both fishing modes, the mean weight in the catch of the 3 tropical tunas has decreased since the mid-2000s with values in 2011 equal to 7.1 kg, 2.4 kg, and 5.4 kg for yellowfin, skipjack, and bigeye, respectively.

Keywords: fish aggregating device, free-swimming school, *Katsuwonus pelamis*, purse seine fishing, *Thunnus albacares*, *Thunnus obesus*

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Contents

1. Introduction

Statistical data for the French purse seine fishing fleet have been collected by the "Institut de Recherche pour le Développement" (IRD; ex-ORSTOM) since the arrival of the first purse seiners in the early 1980s. French purse seiners target yellowfin (*Thunnus albacares*), skipjack (*Katsuwonus pelamis*), and bigeye tuna (*Thunnus obesus*) through two major fishing modes that result in different species and size composition of the catch: log/FAD-associated (FAD) and free-swimming schools (FSC). The acronym "FAD", which stands for drifting fish aggregating device, is used here to describe any type of floating object used for increasing tuna catchability. This includes natural objects (e.g. logs, palm branches) and anthropogenic floating objects, such as man-made bamboo rafts equipped with radio-range beacons, satellite transmitters or scanning sonars. Fishing sets made on whales were classified as free-swimming school sets whereas sets made on whale sharks (*Rhincodon typus*) were classified as FAD sets (Pallarés and Hallier 1997). The fleet activities are described through a suite of fisheries indicators that provide information on fishing effort, catch, catch rates, size structure and mean weights for the 3 principal market tropical tunas, with a particular focus on the year 2011.

2. Fishing capacity and effort

2.1. Fishing fleet

The number of vessels of the French purse seine fishing fleet in the Indian Ocean rapidly increased from 2 in 1981 to a maximum of 26 during 1984-1985 with the arrival of vessels from the Atlantic Ocean. Since then, the number of vessels steadily decreased to reach a minimum of 8 in 2010-2011 (Fig. 1 and Table 1). The size of the vessels progressively increased in the French purse seine fishery over the last 30 years. The number of small-size vessels (capacity < 600 t) decreased throughout the 1980s and 1990s to become 0 in the mid-2000s while medium-size vessels (capacity between 601-800 t) disappeared from the fishery in the late 2000s (Fig. 1).

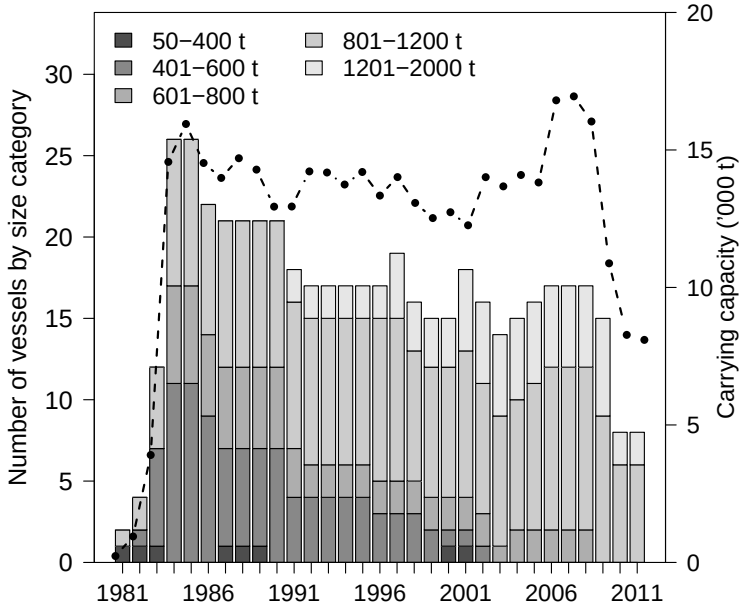

Figure 1: Fishing capacity of the French purse seine fleet in the Indian Ocean. Annual changes in the number of purse seiners by size category (barplots) and total carrying capacity (solid line with circles) during 1981-2011. Capacity was weighted by the vessel-specific proportion of the year at sea (in months). The vessel size category (t) was computed as 0.7 times the capacity expressed in m^3

2.2. Carrying capacity

The total carrying capacity expressed in tonnage strongly increased from the arrival of the first purse seiner in 1981 to about 14,000 t in the mid-1980s. Despite the steady decrease in the total number of vessels, the capacity remained stable through the 1990s and 2000s

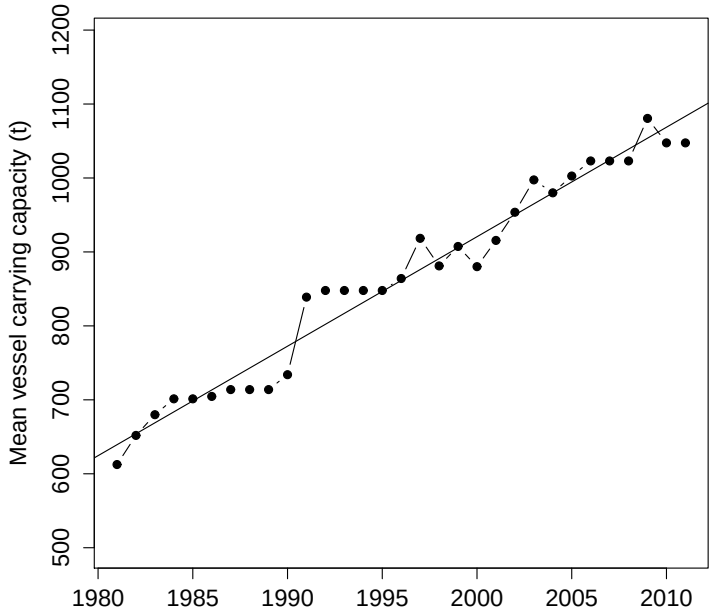

Figure 2: Changes in mean vessel carrying capacity for the French purse seine fishing fleet in the Indian Ocean, 1981-2011. The vessel-specific carrying capacity was weighted by the relative annual catch of each purse seiner. Solid line indicates mean linear regression

and increased to a maximum of 17,000 t in 2007 (Fig. 1). Indeed, the mean vessel-specific carrying capacity of the French purse seiners increased from about 600 t in the early 1980s to more than 1,000 t from the mid-2000s (Fig. 2; slope = +13 t^{-1}, p-value < 0.001). In the recent years, the capacity of the French fleet decreased to reach about 8,000 t during 2010-2011. Meanwhile, the capacity of the French overseas territories increased from less than 500 t in 2006 to more than 5,000 t in 2011 due to the construction of new purse seiners (Chassot et al. 2012).

2.3. Fishing and searching days

Fishing effort expressed in searching time (days) was computed by subtracting the time spent setting the gear from the fishing time. The time spent setting the gear was estimated by regressions linking duration and size of sets, from at-sea measurements made by scientific observers. The total number of fishing and searching days showed similar patterns over 1981-2011 with a major increase in the mid-1980s and a steady decrease until 2005 thereafter (Fig. 3). An increase in effort to a value of almost 5,000 fishing days was then observed due to the increase in the number of purse seiners from 14 in 2003 to 17 during 2006-2008. Since then, the nominal fishing effort strongly decreased and

reached in 2011 values of about 2,110 and 1,800 fishing days and searching days, respectively.

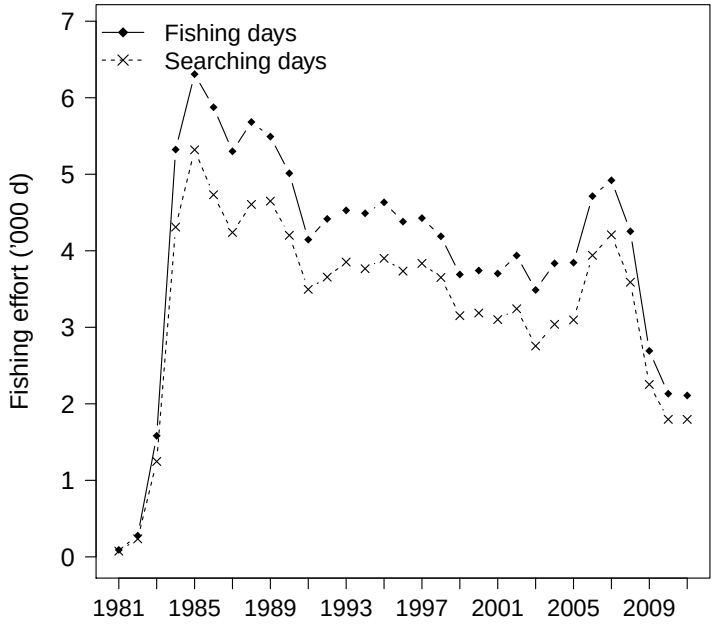

Figure 3: Changes in nominal effort over time. Annual total number of fishing and searching days for the French purse seine fishing fleet in the Indian Ocean during 1981-2011

2.4. Fishing grounds

The major fishing grounds of the French purse seine fishing fleet in 2011 were located in the north of the Mozambique Channel, west of the Seychelles, and along the Somali EEZ boundary (Fig. 4). A few fishing activities took place south of the Seychelles at longitude between 55° and 60°E and in the east of the Chagos EEZ.

After a major expansion of the fishing grounds during the early 1980s, the spatial extent of the fishery steadily increased over time from a total of about 400 squares in the mid-1980s to a mean value of 490 squares in the late 2000s (Fig. 5). The peak observed in 1998 corresponded to a particular climatic event that has been described elsewhere (Murtuggude 1999, Murtugudde et al. 2000) and led the purse seiners to explore the eastern part of the Indian ocean for fishing (Ménard et al. 2006). The different selection criteria, i.e. minimum catch, effort, or sets, did not modify the temporal patterns in the spatial extent of the fishery (Fig. 5).

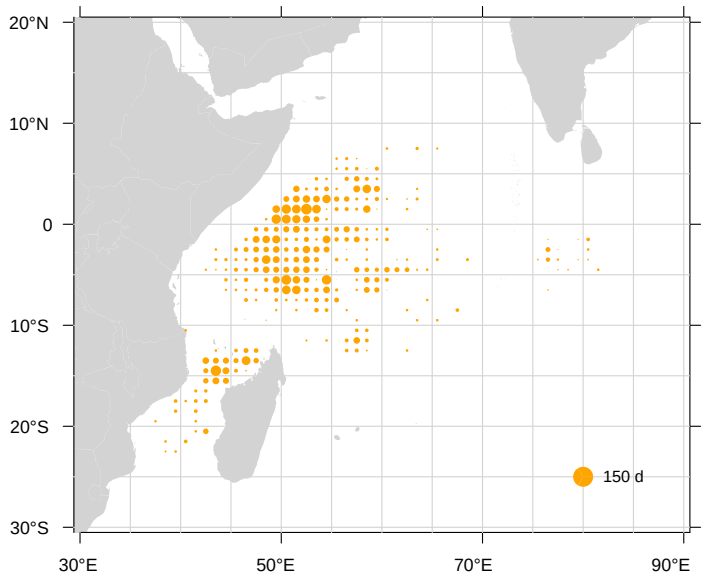

Figure 4: Fishing grounds. Spatial distribution of fishing effort (in searching days) of the French purse seine fishing fleet in 2011

2.5. Fishing activities

The total annual number of fishing sets made by the French purse seine fleet showed a general pattern consistent with the annual variations in carrying capacity and fishing effort of the fleet (Fig. 6 and Table 4). The fleet showed a strong decrease in the number of sets from more than 4,300 in the mid-2000s to less than 2,000 in 2010-2011. The total number of sets showed a pattern very similar to the annual changes in the number of sets made on free-swimming schools (Fig. 6). The annual number of sets made on FAD-associated schools was more stable over time (around 1,700 y^{-1}) and in opposite phase compared to sets made on free-swimming schools. The percentage of FAD-associated over free-swimming schools varied around a mean of 47% (SD = 10%) with FAD-associated fishing predominating from the mid-1990s to the early 2000s while sets made on free-swimming schools were more frequent during 2003-2008. The percentage of sets made on FAD-associated schools steadily increased from 37% in 2004 to reach more than 65% in 2010-2011.

The percentage of successful sets (i.e. positive tuna catch) made on FAD-associated schools has been high over the period 1981-2011, the mean annual value varying between a minimum of 85% in 1984 and a maximum of 95% in 1991. After a decrease during the development of the fishery, the percentage of successful sets on free-swimming schools steadily increased from a mean value of 37% in 1986 to an average of 54% during 2007-2011 (slope = +0.5% y^{-1}, p-value < 0.001). By contrast, the high success of sets on FAD-associated schools does

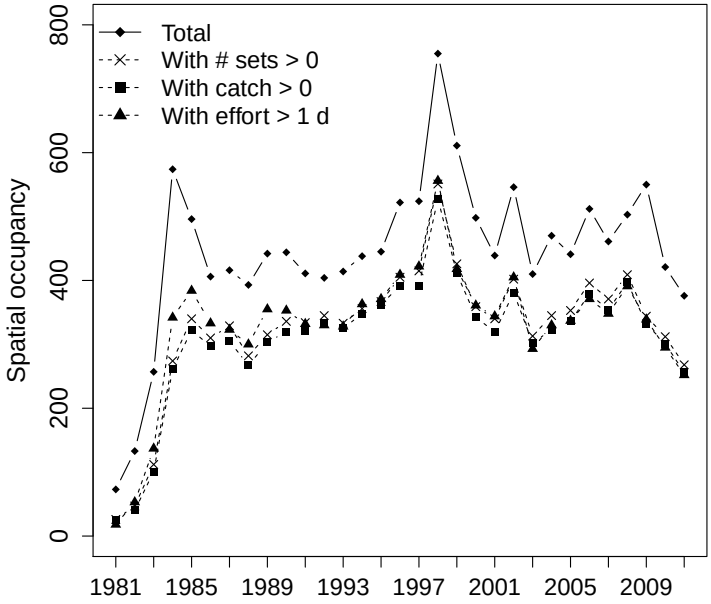

Figure 5: Changes in spatial extent of the fishery over time. Annual number of 1-degree squares explored by the French purse seine fishing fleet during 1981-2011

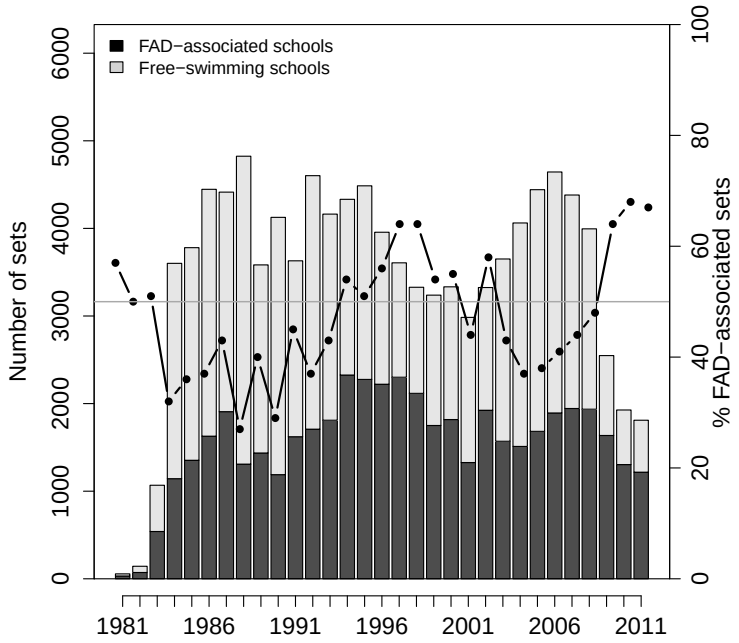

Figure 6: Fishing activities. Annual number of fishing sets in the French purse seine fishery on FAD-associated and free-swimming schools during 1981-2011. Line with solid circles indicates the percentage of sets made on FAD-associated schools over free-swimming schools. Grey solid line indicates the 50% value

not show any clear temporal pattern over the period. In the recent years, the success rate for FAD-associated schools seems to show an increasing trend that could be related to the improvement and increasing use of lateral echo sounders.

3. Fisheries production

3.1. Catch levels

The French purse seine fishery showed strong interannual variations in the catch over 1987-2008 with a minimum of 56,000 t in 1998 and a maximum of 108,000 t during 2003-2004 (Fig. 7). Since then, the total catch of the fleet strongly declined in relation with the decrease in the number of vessels and reached 43,000 t in 2011. Catches on FAD-associated schools represented on average 60% (SD = 8%) of the total fleet catch over 1981-2011. Following the large catch of tunas on free-swimming schools during 2003-2005, the percentage of FAD-associated catch steadily increased (slope = +4.3%, p-value $<$ 0.001) to reach more than 70% during 2009-2011. Catches on FAD-associated schools appeared more stable than catches on free-swimming schools during 1981-2011 (Fig. 8). They were largely dominated by skipjack that represented an annual mean of 62% (SD = 6.5%) of all species caught, varying from 53% in 1997 to more than 75% in 1991 (Fig. 8a). Catches of bigeye, re-estimated from multispecies sampling operations conducting at unloading (Pallarés and Hallier 1997), varied between 3.7% and 13% of the total of catch on FAD-associated schools during 1981-2011. Catches of yellowfin on FAD-associated schools were stable over the period representing on average 27% (SD = 5.2%) of the catch.

Catches made on free-swimming schools showed strong internannual variations in the last two decades from a maximum of 50,000 t in 2004 to a minimum of 8,000 t in 2011 (Fig. 8b). The changes over time in free-swimming schools catches drove the trends in the total catch of the fishery. The catches were largely dominated by yellowfin that represented an annual average of 74% (SD = 9%) of the FSC catch during 1981-2010, and a similar value of 74% in 2011. However, while free-swimming schools represented more than 60% of the total catch of yellowfin during 1981-2010, it only represented 38% of the total yellowfin catch in 2011. The predominance of yellowfin in the French purse seine catch from FAD-associated fishing ($>$ 50% of the catch) had only been observed during 1997-1999 during the strong El-Niño event. In the recent period, this pattern stems from the strong decrease in the number of sets made on free-swimming schools which might reveal a change in purse seine fishing strategy due to a decrease in tuna free-swimming schools in conjunction with the Somali piracy threat (Chassot et al. 2010), the implementation of the BIOT marine protected area that decreased purse seine fishing grounds as well as to the high sale price of skipjack (Table 4). In addition, the proportion of yellowfin in FAD-associated catch reached more than 40% in 2011 while it represented an average of 28% (SD = 5%) during 1982-2010 (see below).

3.2. Spatial distribution of the catch

The French purse seine fleet fishing grounds in 2011 were concentrated in the north of the Mozambique Channel and the Somali area where FAD-fishing predominated while

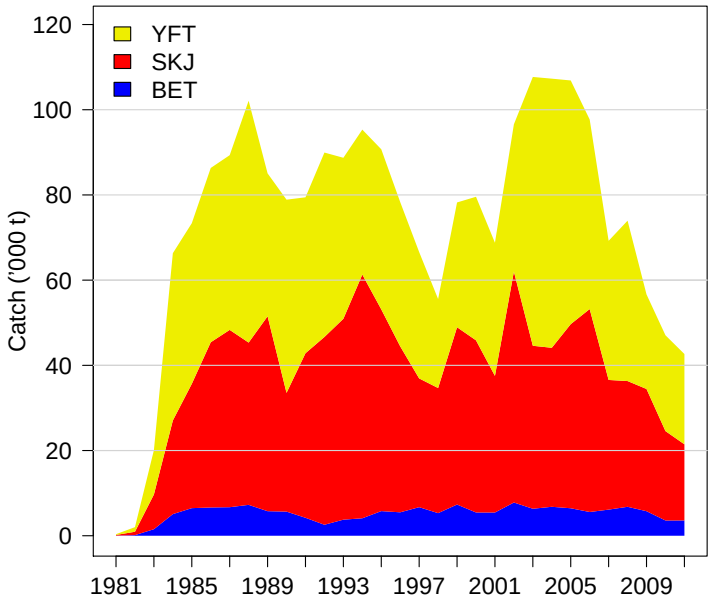

Figure 7: Total fishery production. Catch by species of the French purse seine fishing fleet during 1981-2011

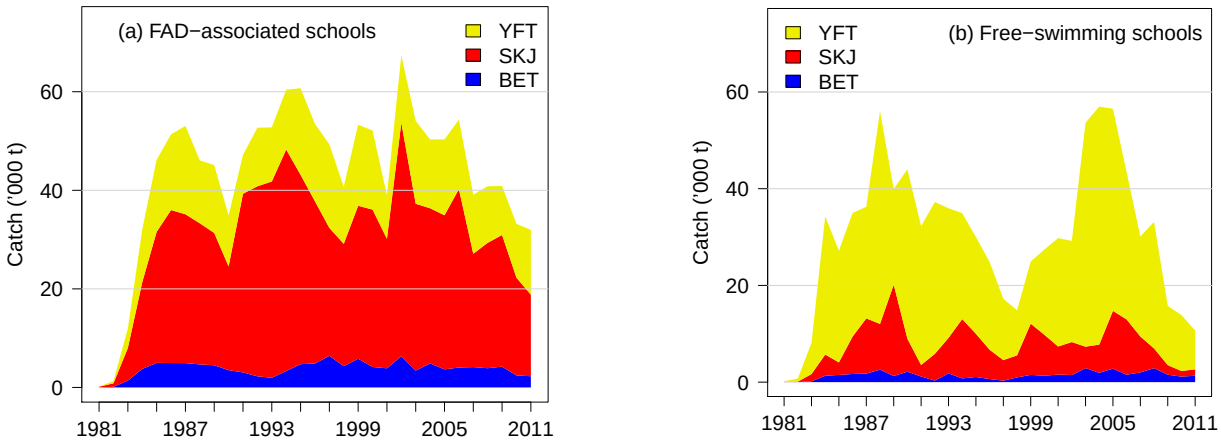

Figure 8: Fishery production by major fishing mode. Catch by species of the French purse seine fishing fleet on (a) FAD-associated and (b) free-swimming schools during 1981-2011

fishing on free-swimming schools mainly occurred around and south-east of the Seychelles islands, and in the Mozambique to a lesser extent (Fig. 9). As compared to previous years (2006-2010), the composition of the catch on FAD-associated schools in the Somali area was described by an important part of yellowfin that represented more than 50% of the catch in most of the 1x1 degree squares west of 55°E and north of 10°S (Figs. 11-12). This might result from a good recruitment of yellowfin in 2011 as suggested by the size structure of the catch (see Section 3.4).

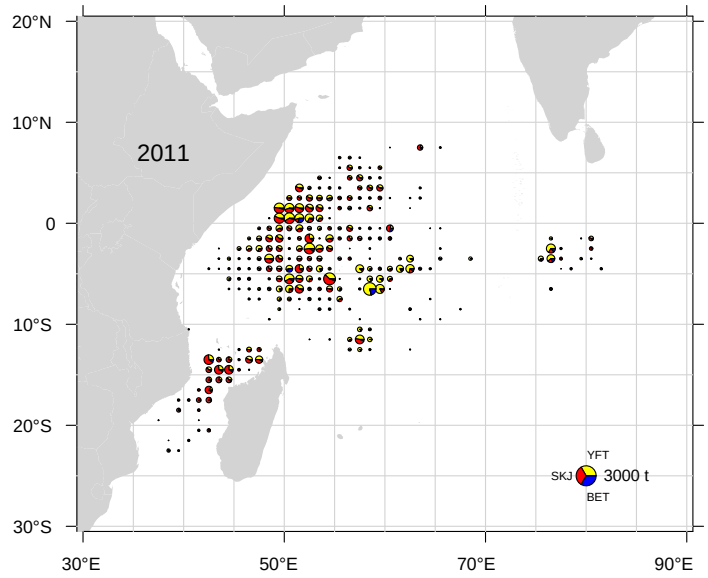

Figure 9: Spatial distribution of tuna catches of the French purse seine fishing fleet in 2011

Besides, catches on free-swimming schools in 2011 were predominated by skipjack in the Mozambique Channel (Fig. 13), as generally observed in this area, while the remaining of the catch was scattered along latitude 5°S and predominated by yellowfin, with a few squares characterized by 15-20% of bigeye (Fig. 13).

3.3. Catch rates

Raw catch rates expressed in tonnes per searching day (t d^{-1}) for the principal market tunas exhibit an increasing trend over 1981-2011, in particular from the early 1980s to the mid-1990s (Fig. 15). While skipjack and yellowfin are mainly caught in different fishing modes, their respective CPUEs were in the same order of magnitude, i.e. a mean value of 10.3 and 10 t per searching day for yellowfin and skipjack, respectively. Also, the CPUE time series showed very similar trends over time, with the notable exception of 2003-2005

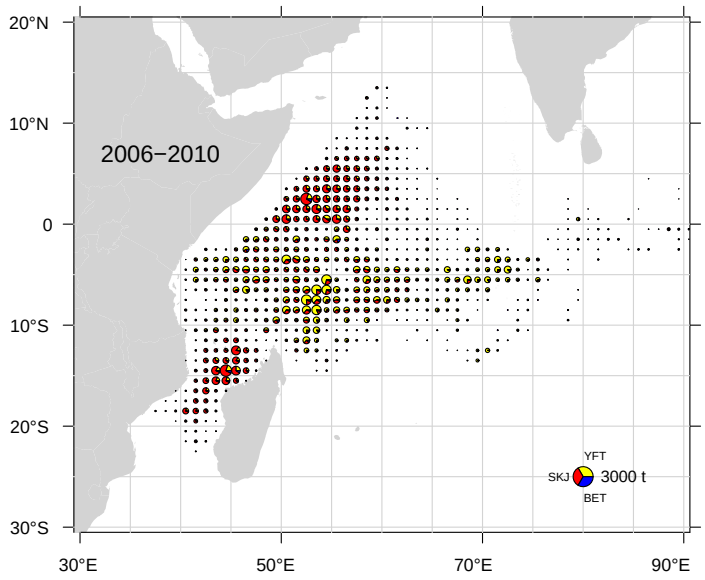

Figure 10: Spatial distribution of tuna catches of the French purse seine fishing fleet in 2006-2010

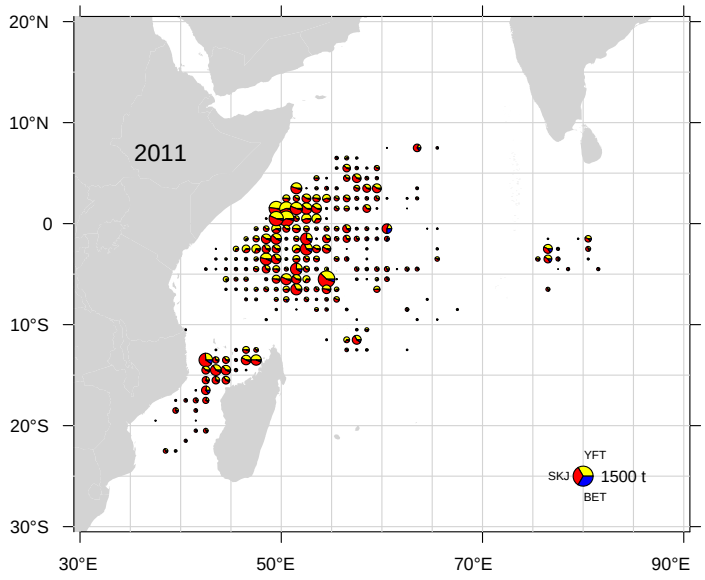

Figure 11: Spatial distribution of tuna catches of the French purse seine fishing fleet made on FAD-associated schools in 2011

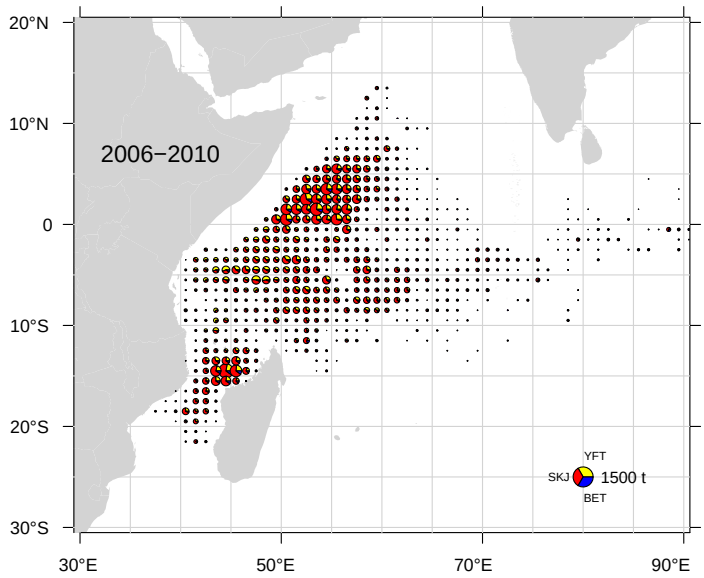

Figure 12: Spatial distribution of tuna catches of the French purse seine fishing fleet made on FAD-associated schools in 2006-2010

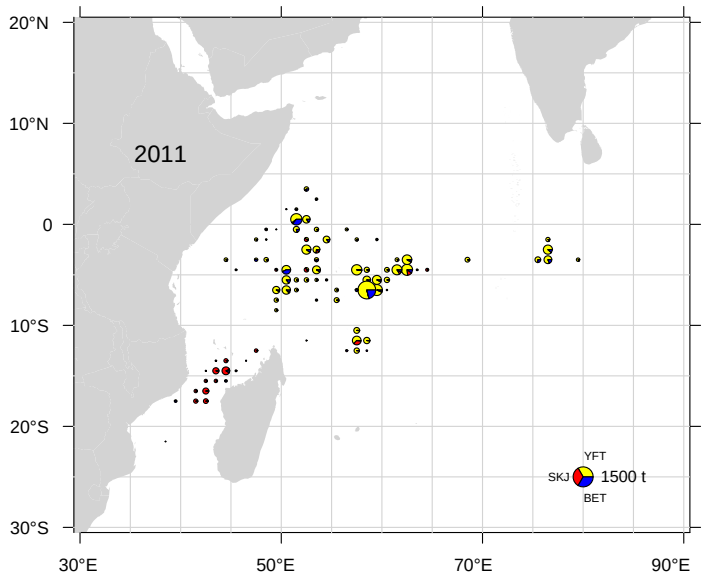

Figure 13: Spatial distribution of tuna catches of the French purse seine fishing fleet made on free-swimming schools in 2011

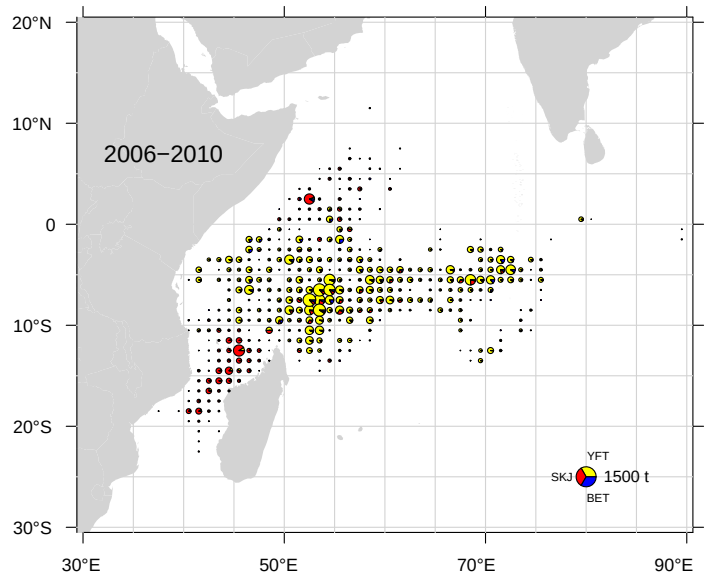

Figure 14: Spatial distribution of tuna catches of the French purse seine fishing fleet made on free-swimming schools in 2006-2010

described by abnormally high catch rates for yellowfin on free-swimming schools (Fig. 16b). Raw catch rates of bigeye also showed an increasing trend during 1981-2011 (slope = +4.4%, p-value <0.001) with an average of 1.88 t d^{-1} (SD = 0.4 t d^{-1}).

Skipjack catch rates predominated on FAD-associated schools during 1981-2011 and increased quickly through the 1980s while stabilising around 10 t searching d^{-1} (SD = 2.3 t d^{-1}) since the early 1990s (Fig. 16a). Yellowfin catch rates have shown an increasing trend since the early 1980s with some interannual variability. The maximum catch rates for yellowfin on FAD-associated schools have been observed in 2011, i.e. an annual value of 7.3 t d^{-1}. Bigeye raw catch rates on FAD-associated schools have remained stable around a mean value of 1.4 t d^{-1} since the late 1990s (Fig. 16a).

Yellowfin catch rates predominated for sets made on free-swimming schools and remained quite stable over time (mean of 7 t d^{-1} during 1984-2011), with abnormally high values during 2003-2005 > 13.5 t d^{-1} (Fig. 16b). In 2011, the catch rate of yellowfin in free-swimming schools was less than 4.5 t d^{-1}. Catch rates for skipjack have shown high interannual variability during 1986-2011 (mean = 2 t d^{-1}, SD = 1 t d^{-1}) and a decreasing trend in the recent years, with catch rates < 1 t d^{-1} during 2009-2011. Catch rates for bigeye in free-swimming schools have shown a shift from a mean value around 0.3 t d^{-1} dur-

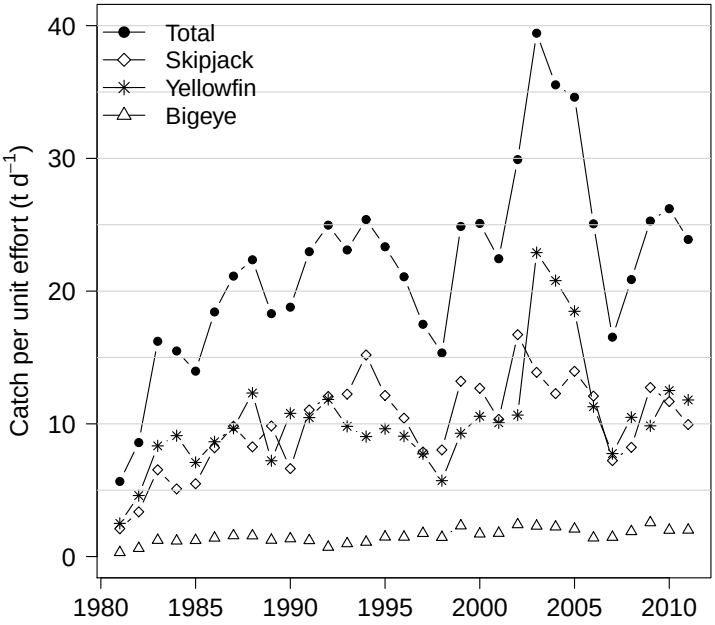

Figure 15: Annual catch rates (in t per searching day) of the French purse seine fishing fleet in the Indian Ocean during 1981-2011

ing the mid-1980s to the mid-1990s to a mean annual value of 0.6 t d^{-1} throughout the 2000s.

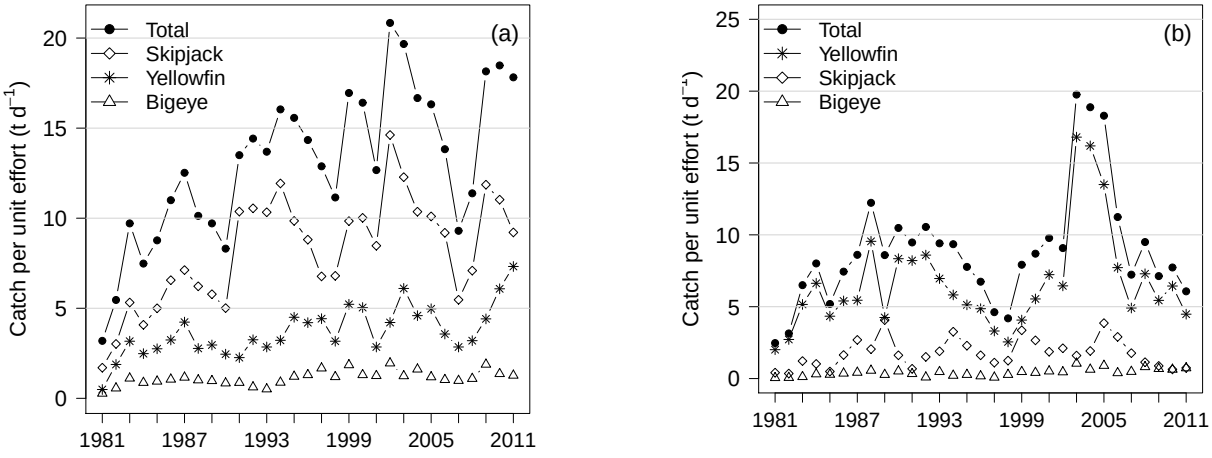

Figure 16: Annual catch rates (in t per searching day) of the French purse seine fishing fleet on (a) FAD-associated and (b) free-swimming schools in the Indian Ocean during 1981-2011

3.4. Size structure of the catch

The size structure of the catch (expressed in number) in 2011 appeared similar for the 3 tuna species to the average year representing the period 2006-2010, with the exception of skipjack caught on free-swimming schools that were smaller (Fig. 17). The sizes of yellowfin caught on FAD-associated schools were described by 2 modes for small (46 cm) and intermediate sizes (56 cm) while larger individuals (> 80 cm) were also caught but more seldomly. The year 2011 was characterized by a high peak of small yellowfin (size range of 42-48 cm fork length) which might indicate a good recruitment. Bigeye caught on FAD-associated schools in 2011 were only juvenile fishes of median size of 52 cm (sd = 9 cm). Skipjack showed a unique size mode described by a median of 46 cm (min = 31 cm and max = 69 cm) similar to 2006-2010 during which the median size of skipjack was 47 cm.

Similarly, the biomass of fish caught by size class showed overall similar patterns between 2011 and 2006-2010 except for skipjack caught smaller on free-swimming schools in 2011 (Fig. 18). For yellowfin caught on FAD-associated schools, the year 2011 was described by larger biomass of fishes comprised between 60-100 cm. In relation with the decrease in activities on free-swimming schools, the biomass of large yellowfin and bigeye (> 100 cm) caught was lower in 2011 than for the average year 2006-2010. The biomass of skipjack 44-50 cm long caught on FAD-associated schools, which represent the bulk of skipjack catch, was very similar in 2011 than during 2006-2010 while there was a strong decrease in

skipjack catch on free-swimming schools (Table 5-7).

3.5. Mean weight in the catch

Time series of the mean weight in the catch for the principal market tropical tunas were computed as the species-specific annual biomass over the total number of fishes caught. The sampling design used to collect size-frequency data aboard French purse seiners thoughout the 1980s varied over time (Pianet 1999) therefore the mean weight was computed from 1991 for data consistency. The mean weight highly differed between fishing modes and showed strong interannual variations during 1991-2011 (Fig. 19). The mean weight of yellowfin caught on free-swimming schools decreased from more than 37 kg in 1991 to a minimum of about 15 kg in 1998-1999, before progressively increasing thereafter to reach about 38 kg in 2004-2005. Since then, the mean weight decreased to about 28 kg during 2009-2011 (Fig. 19a). It is noteworthy that the yellowfin mean weight showed an increase from 25 kg in 2010 to 29 kg in 2011. After an initial decrease from about 10 kg in the early 1990s, the mean weight of yellowfin in the catch made on FAD-associated schools stabilised at around 5.7 kg (SD = $\pm$ 1.1 kg) from the mid-1990s to the late 2000s. In 2011, the mean weight of yellowfin caught on FAD-associated schools was less than 5 kg. Overall, the mean weight of yellowfin caught in the French purse seine fleet has shown a strong decrease from about 18 kg during 2003-2005 to about 7 kg in 2011 (slope = -1.4 kg $^{-1}$; p-value < 0.001) due to increasing proportion of FAD-fishing in the fishery over the last decade (Fig. 6 – dotted line).

The overall mean weight of skipjack was more stable than yellowfin during 1991-2011 and driven by the mean weight of skipjack caught on FAD-associated schools. It varied between a maximum of 3 in 1992 and a minimum of 2 kg in 2008 for fishes caught on FAD-associated schools (Fig. 19b). After a decrease during 2007-2008, the mean weight remained stable at about 2.3 kg during 2009-2011. The mean weight of skipjack caught on free-swimming schools has shown a strong and significant decrease from more than 4.2 kg in 2003-2004 to 2.4 kg in 2009-2011 (slope = -0.3 kg $^{-1}$, p-value < 0.001).

The mean weight of bigeye varied around 5.8 kg (SD $\pm$ 1 kg) during 1991-2011 for the whole fishery (Fig. 19c). It showed strong interannual variations for individuals caught on free-swimming schools with a pattern very similar to yellowfin tuna (Pearson's r = 0.77; p-value < 0.001). The mean weight of bigeye caught on FAD-associated schools showed a significant decreasing trend during 1991-2011 (slope = -0.06 kg $^{-1}$, p-value < 0.01) with high interannual variations. In 2011, the mean weight of bigeye caught on free-swimming schools and FAD-associated schools was 18.3 kg and 3.8 kg, respectively.

Acknowledgments. We thank ORTHONGEL, Pascal Cauquil, Céline Rodriguez, Julien Barde and all past and current personnel for helpful assistance in data collection and management. We are particularly grateful to Renaud Pianet, Viveca Nordstrøm and Alain Fonteneau for their dedication to the monitoring of tropical tuna fisheries and their support to the Observatoire Thonier. The collaboration with Alicia Delgado de Molina (IEO) and

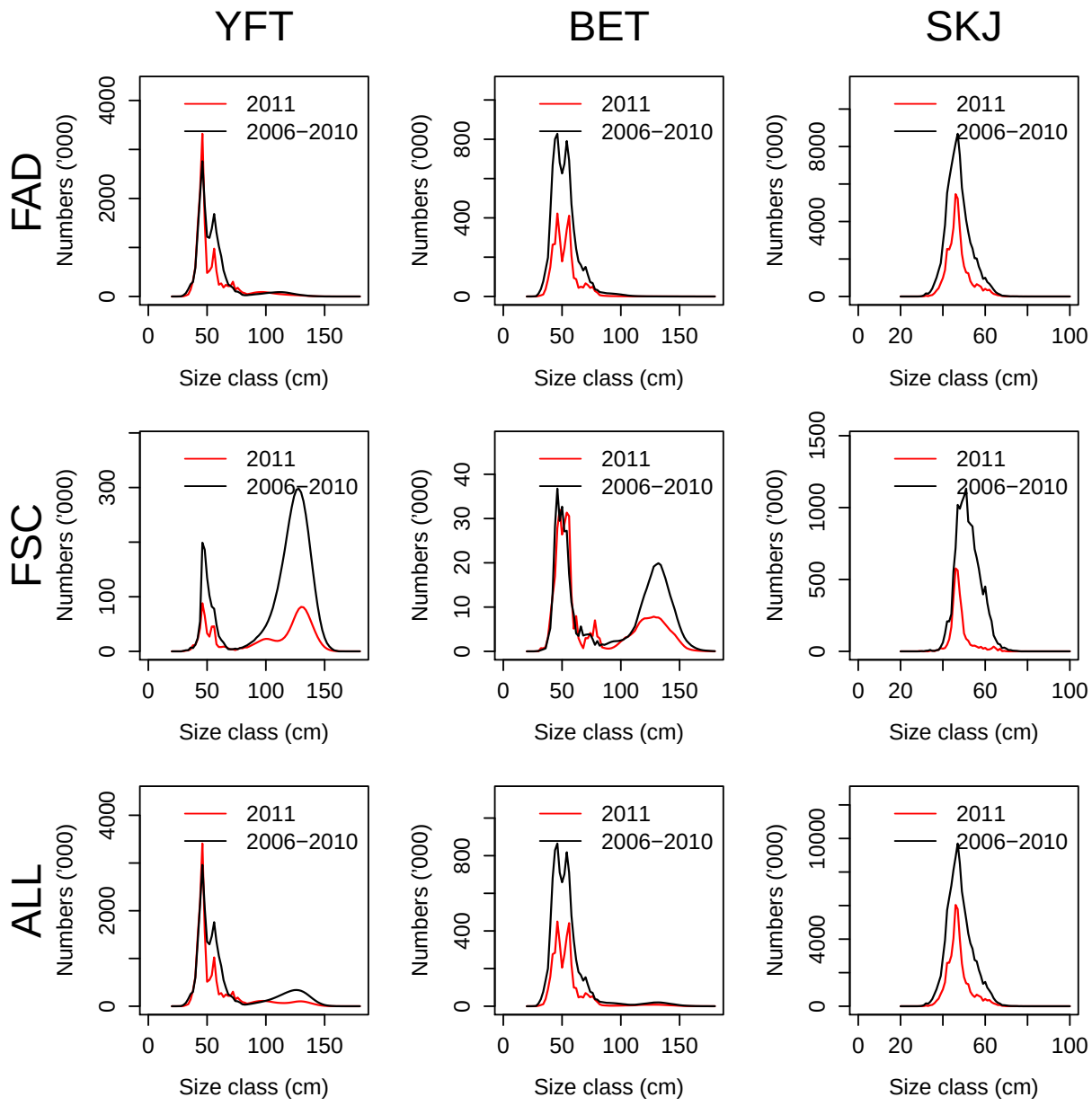

Figure 17: Size structure of the catch. Size distribution (in numbers) of the species-specific catch for the French purse seine fishing fleet in 2011 (red line) and for an average year representing the period 2006-2010 (black line)

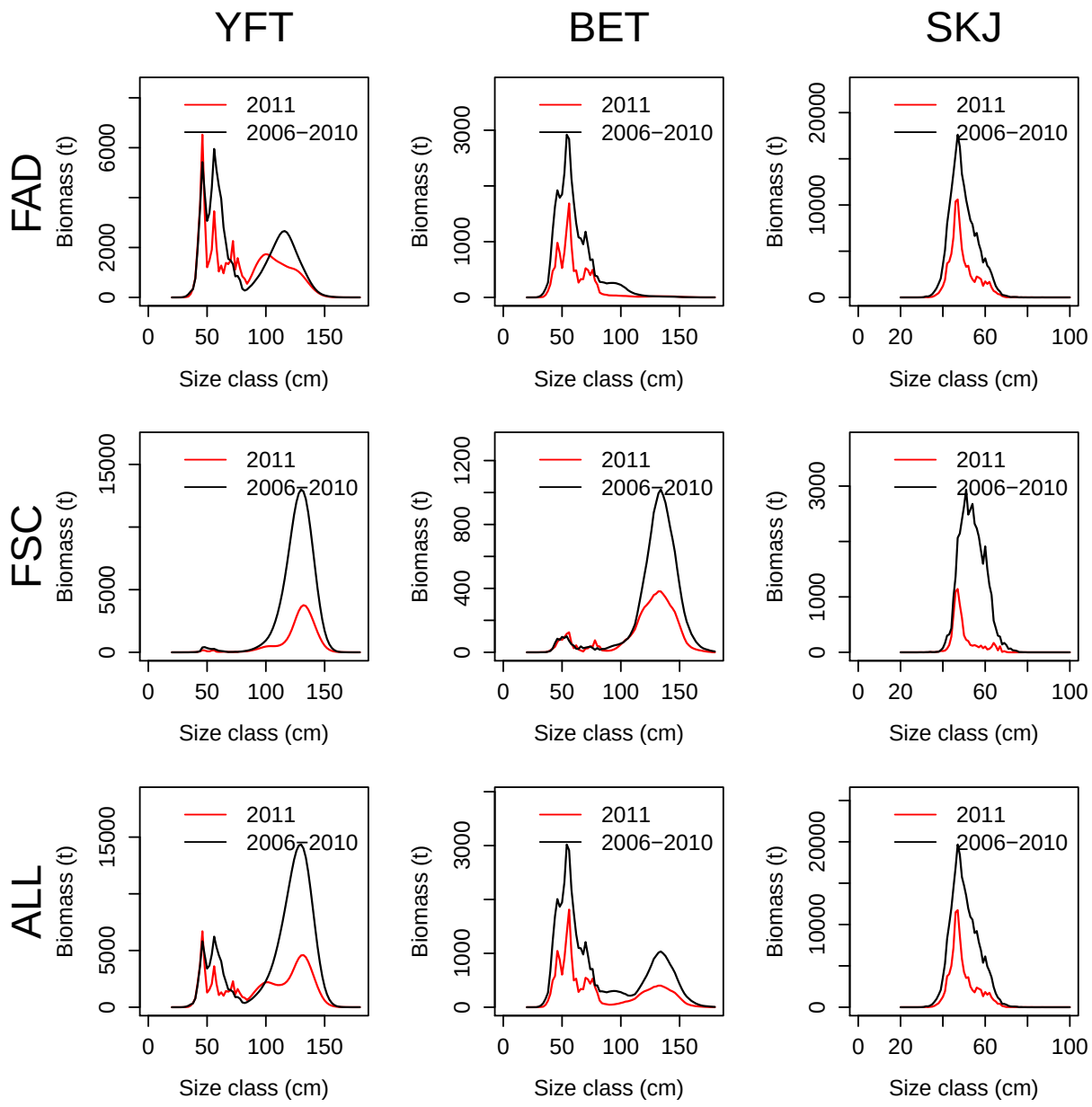

Figure 18: Size structure of the catch. Size distribution (in weight) of the French purse seine fishing fleet in 2011 (red line) and for an average year representing the period 2006-2010 (black line)

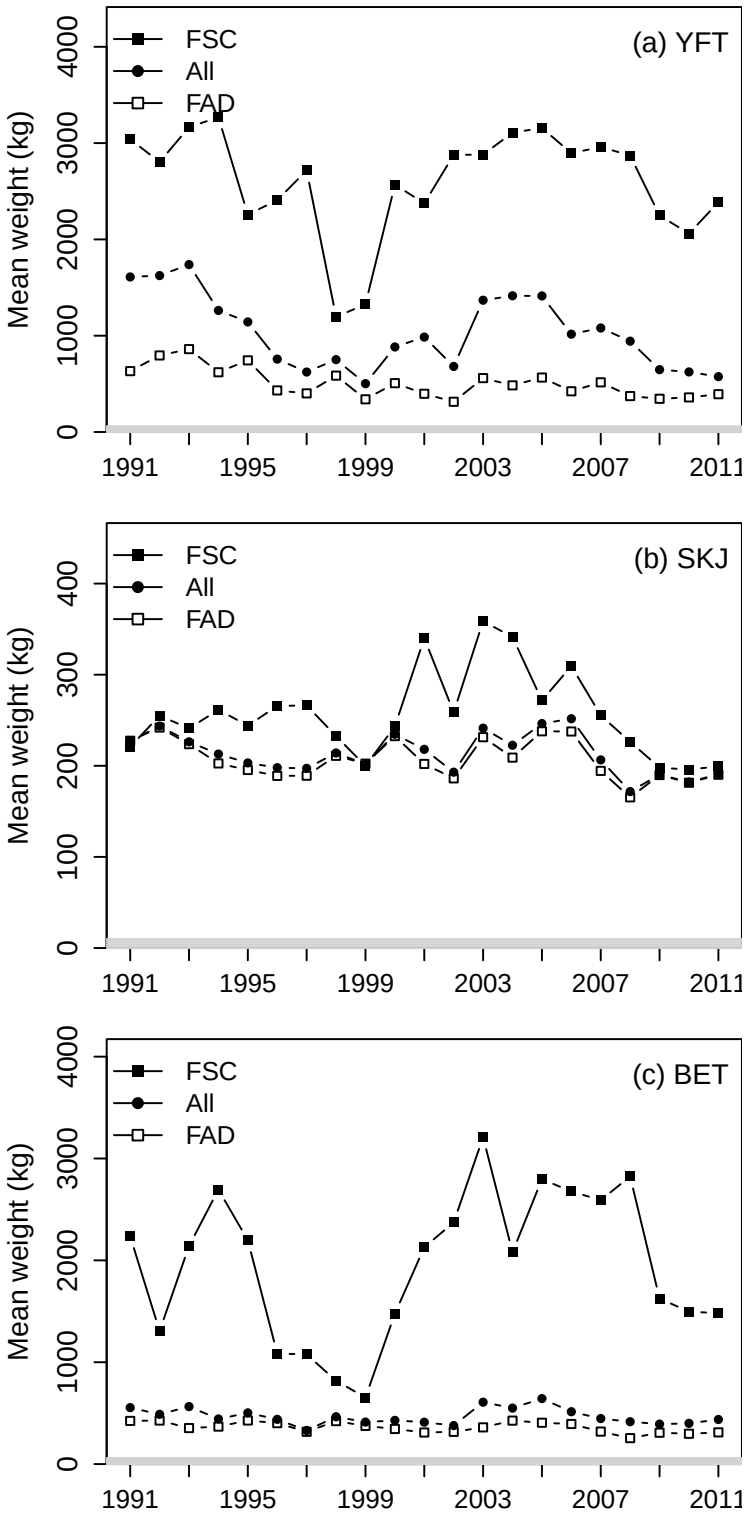

Figure 19: Annual time series of mean weight (kg) for (a) yellowfin tuna (YFT), (b) skipjack tuna (SKJ), and (c) bigeye tuna (BET) for each fishing mode during 1991-2011

Cindy Assan (SFA) was instrumental in data processing. This work was financed by the European Data Collection Framework (DCF, Reg 199/2008 and 665/2008) and supported by the Direction des Pêches Maritimes et de l'Aquaculture (DPMA).

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5. Appendix tables

Table 1: Annual number of purse seiners by size category and total carrying capacity of the French tropical tuna purse seine fishing fleet of the Indian Ocean during 1981-2011. Total carrying capacity (CC) was weighted by the proportion of the year at sea (in months)

Year	50-400	401-600	601-800	801-1200	1201-2000	>2000	Total	CC
1981	1	0	0	1	0	0	2	233
1982	1	1	0	2	0	0	4	945
1983	1	6	0	5	0	0	12	3907
1984	0	11	6	9	0	0	26	14566
1985	0	11	6	9	0	0	26	15945
1986	0	9	5	8	0	0	22	14526
1987	1	6	5	9	0	0	21	13983
1988	1	6	5	9	0	0	21	14699
1989	1	6	5	9	0	0	21	14285
1990	0	7	5	9	0	0	21	12939
1991	0	4	3	9	2	0	18	12943
1992	0	4	2	9	2	0	17	14220
1993	0	4	2	9	2	0	17	14180
1994	0	4	2	9	2	0	17	13743
1995	0	4	2	9	2	0	17	14199
1996	0	3	2	10	2	0	17	13341
1997	0	3	2	10	4	0	19	14013
1998	0	3	2	8	3	0	16	13074
1999	0	2	2	8	3	0	15	12523
2000	1	1	2	8	3	0	15	12736
2001	1	1	2	9	5	0	18	12261
2002	0	1	2	8	5	0	16	14011
2003	0	0	1	8	5	0	14	13676
2004	0	0	2	8	5	0	15	14090
2005	0	0	2	9	5	0	16	13818
2006	0	0	2	10	5	0	17	16805
2007	0	0	2	10	5	0	17	16949
2008	0	0	2	10	5	0	17	16035
2009	0	0	0	9	6	0	15	10878
2010	0	0	0	6	2	0	8	8275
2011	0	0	0	6	2	0	8	8093

Table 2: Annual nominal fishing effort of the French purse seine fleet expressed in fishing and searching days during 1981-2011. 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
1981	91	75
1982	277	235
1983	1582	1247
1984	5323	4310
1985	6308	5319
1986	5876	4732
1987	5300	4240
1988	5683	4606
1989	5492	4649
1990	5013	4202
1991	4146	3496
1992	4417	3656
1993	4528	3853
1994	4490	3766
1995	4633	3901
1996	4381	3734
1997	4427	3835
1998	4189	3651
1999	3690	3152
2000	3742	3187
2001	3703	3101
2002	3938	3242
2003	3488	2756
2004	3836	3039
2005	3845	3096
2006	4714	3940
2007	4921	4208
2008	4254	3589
2009	2692	2253
2010	2132	1797
2011	2109	1796

Table 3: Annual number of 1-degree squares explored by the French purse seine fishing fleet during 1981-2011

Year	TOTAL	#sets>0	Catch>0	Effort>1 d	Effort>5 d
1981	73	26	25	18	
1982	133	47	40	53	10
1983	257	112	101	137	60
1984	574	274	261	342	182
1985	496	340	322	384	267
1986	406	310	297	333	223
1987	416	329	305	323	206
1988	393	282	267	300	210
1989	442	315	303	355	229
1990	444	336	320	353	215
1991	411	334	321	332	200
1992	404	345	333	330	196
1993	414	333	325	328	217
1994	438	356	348	363	228
1995	445	367	362	371	229
1996	522	405	392	409	243
1997	524	415	392	422	257
1998	755	551	528	556	243
1999	611	426	411	418	195
2000	498	359	343	361	196
2001	439	340	319	344	203
2002	546	402	381	405	233
2003	410	313	302	293	186
2004	470	345	323	330	171
2005	441	353	336	337	198
2006	512	396	379	371	218
2007	461	371	354	348	222
2008	503	409	397	391	230
2009	550	344	332	339	163
2010	421	312	301	295	136
2011	376	268	256	252	123

Table 4: Number of positive and null sets by fishing mode made by the French purse seine fishing fleet of the Indian ocean during 1981-2011. FAD = Fish Aggregating Device; FSC = Free-Swimming School

	ALL			FAD			FSC		
	Total	Positive	Null	Total	Positive	Null	Total	Positive	Null
1981	56	44	12	32	29	3	24	15	9
1982	143	105	38	72	63	9	71	42	29
1983	1068	766	302	540	470	70	528	296	232
1984	3601	2211	1390	1143	971	172	2458	1240	1218
1985	3780	2274	1506	1353	1210	143	2427	1064	1363
1986	4446	2429	2017	1628	1393	235	2818	1036	1782
1987	4414	2813	1601	1908	1676	232	2506	1137	1369
1988	4824	2823	2001	1309	1177	132	3515	1646	1869
1989	3583	2243	1340	1436	1310	126	2147	933	1214
1990	4126	2527	1599	1189	1093	96	2937	1434	1503
1991	3630	2448	1182	1622	1538	84	2008	910	1098
1992	4602	2980	1622	1708	1569	139	2894	1411	1483
1993	4163	2763	1400	1810	1611	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	3238	2369	869	1750	1553	197	1488	816	672
2000	3333	2475	858	1818	1555	263	1515	920	595
2001	2984	2175	809	1327	1223	104	1657	952	705
2002	3325	2597	728	1924	1822	102	1401	775	626
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	4644	3148	1496	1893	1743	150	2751	1405	1346
2007	4381	2932	1449	1944	1747	197	2437	1185	1252
2008	3995	2874	1121	1936	1760	176	2059	1114	945
2009	2548	2060	488	1636	1502	134	912	558	354
2010	1927	1554	373	1304	1212	92	623	342	281
2011	1810	1446	364	1217	1132	85	593	314	279

Table 5: Catch by species for the French purse seine fishing fleet of the Indian ocean during 1981-2011

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
1981	188	158	23	0	56	425
1982	1081	792	145	0	0	2018
1983	10400	8153	1536	0	136	20225
1984	39268	21979	5081	224	228	66781
1985	37706	29183	6477	445	483	74293
1986	40911	38786	6636	200	693	87227
1987	41012	41620	6701	217	43	89593
1988	56766	38094	7251	177	732	103020
1989	33548	45750	5764	6	0	85068
1990	45351	27873	5663	36	31	78954
1991	36597	38630	4217	848	0	80292
1992	43287	44081	2580	1344	0	91292
1993	37792	47155	3773	292	0	89012
1994	34025	57209	4101	282	0	95617
1995	37573	47365	5781	336	0	91055
1996	33861	38958	5500	377	0	78696
1997	29661	30222	6706	514	0	67103
1998	20892	29370	5305	446	0	56013
1999	29289	41619	7326	150	0	78384
2000	33696	40407	5464	309	122	79998
2001	31253	32074	5452	645	174	69599
2002	34568	54204	7802	194	195	96963
2003	63101	38258	6334	608	368	108670
2004	63174	37323	6798	77	649	108021
2005	57198	43220	6453	86	184	107140
2006	44495	47640	5573	850	233	98791
2007	32660	30438	6132	305	3	69539
2008	37642	29520	6794	952	10	74919
2009	22195	28690	5761	295	3	56944
2010	22490	20985	3584	29	16	47103
2011	21192	17871	3593	238	0	42894

Table 6: Catch by species made on FAD-associated schools for the French purse seine fishing fleet of the Indian ocean during 1981-2011

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
1981	37	128	20	0	56	240
1982	442	709	131	0	0	1282
1983	3959	6637	1381	0	136	12114
1984	10692	17600	3762	0	191	32244
1985	14623	26582	4993	14	459	46671
1986	15353	31040	4953	0	693	52038
1987	17926	30205	4937	0	20	53089
1988	12763	28633	4675	0	602	46673
1989	13769	26850	4499	0	0	45118
1990	10312	21046	3513	0	31	34902
1991	7895	36252	3048	0	0	47195
1992	11877	38559	2261	8	0	52705
1993	10982	39820	1958	5	0	52765
1994	12122	44944	3329	22	0	60417
1995	17561	38428	4720	16	0	60725
1996	15698	32902	4863	69	0	53532
1997	16963	25966	6406	65	0	49400
1998	11568	24810	4328	12	0	40718
1999	16449	31024	5831	103	0	53407
2000	16050	31939	4150	41	122	52302
2001	8844	26273	3884	108	174	39283
2002	13654	47378	6337	0	171	67540
2003	16810	33837	3429	0	134	54209
2004	13959	31473	4882	0	339	50653
2005	15399	31270	3667	0	184	50520
2006	14074	36207	4042	0	185	54507
2007	11986	23001	4127	3	3	39119
2008	11476	25446	3901	2	10	40835
2009	9936	26710	4226	10	3	40884
2010	10925	19827	2443	4	16	33216
2011	13153	16536	2277	30	0	31997

Table 7: Catch by species made on free-swimming schools for the French purse seine fishing fleet of the Indian ocean during 1981-2011

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
1981	151	31	4	0	0	185
1982	638	83	14	0	0	736
1983	6441	1516	155	0	0	8111
1984	28576	4380	1319	224	37	34537
1985	23083	2601	1484	432	24	27623
1986	25558	7747	1683	200	0	35189
1987	23086	11415	1764	217	23	36505
1988	44003	9461	2575	177	130	56347
1989	19779	18900	1265	6	0	39951
1990	35039	6827	2150	36	0	44052
1991	28702	2378	1169	848	0	33097
1992	31410	5522	319	1336	0	38587
1993	26810	7335	1815	287	0	36247
1994	21903	12265	772	260	0	35200
1995	20012	8937	1061	320	0	30330
1996	18163	6056	637	308	0	25164
1997	12698	4256	300	449	0	17703
1998	9324	4560	977	434	0	15295
1999	12840	10595	1495	47	0	24977
2000	17646	8468	1314	268	0	27696
2001	22409	5801	1568	538	0	30316
2002	20913	6826	1465	194	24	29422
2003	46291	4422	2906	608	235	54461
2004	49215	5850	1916	77	310	57368
2005	41799	11950	2786	86	0	56620
2006	30421	11433	1531	850	48	44283
2007	20675	7438	2005	302	0	30420
2008	26166	4074	2893	950	0	34084
2009	12259	1980	1535	285	0	16059
2010	11565	1157	1140	25	0	13888
2011	8039	1335	1316	208	0	10897