Statistics of the purse seine fleet of France's overseas territories targeting tropical tunas in the Indian Ocean (2001-2011)

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Abstract

In 2011, the purse seine fleet of France's Overseas Territories operating in the Indian Ocean was composed of 5 large size purse seiners that represented a total carrying capacity of more than 5,000 t. Catches reached a total of 26,000 t and were composed of 50%, 42%, and 8% of yellowfin, skipjack, and bigeye, respectively. With the progressive arrival of new purse seiners, the fishing effort of the fleet has steadily increased since 2006 to reach more than 1,000 searching days in 2011. The increase in effort was associated with an expansion of the fleet fishing grounds in the recent years. Fishing sets increased from about 100 in 2006 to more than 1,100 in 2011, with 60% of the sets made on FAD-associated schools and 40% on free-swimming schools. In relation with the high success of sets on FAD-associated schools, the proportion of catch from FAD-fishing increased from 60% in 2007 to more than 70% in 2010-2011. Species-specific catch rates (in t per searching day) do not reveal any clear trend over the short period 2007-2011 but suggest an increase in catch rates of small yellowfin on FAD-associated schools.

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

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1. Introduction

Statistical data for the purse seine fleet of the France's Overseas Territories (FRAT) have been collected by the "Institut de Recherche pour le Développement" (IRD) since 2001. Purse seiners registered in the harbour of Dzaoudzi, Mayotte, belong to the EU purse seine fleet of the Indian Ocean and data collection and processing are similar to the ones used for the French component of the fleet. These 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, and catch rates 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 purse seine fishing fleet of France's overseas territories increased from 2 in 2001 to 5 in 2010-2011 (Fig. 1 and Table 1). No vessel was active during 2003-2005.

All purse seiners were described by a carrying capacity >1200 t. The total carrying capacity expressed in tonnage increased from 1,000 t in 2001 to more than 5,000 t in 2011 (Fig. 1).

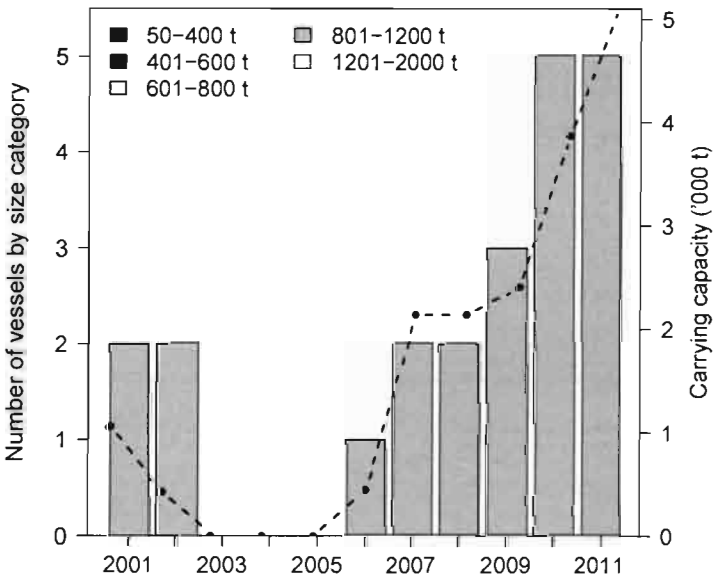

Figure 1: Fishing capacity of the purse seine fleet of France's overseas territories in the Indian Ocean. Annual changes in the number of purse seiners by size category (barplots) and total carrying capacity (solid line with circles) during 2001-2011. Carrying capacity was weighted by the vessel-specific 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. 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 2001-2011 and closely matched the increase in fleet capacity (Fig. 2). In 2011, the nominal fishing effort of the FRAT purse seine fleet reached maxima of more than 1,250 and 1,000 fishing and searching days, respectively.

2.3. Fishing grounds

The major fishing grounds of the FRAT purse seine fishing fleet in 2011 were very similar to the fishing grounds of the French purse seine fleet (Chassot et al. 2012). They were located

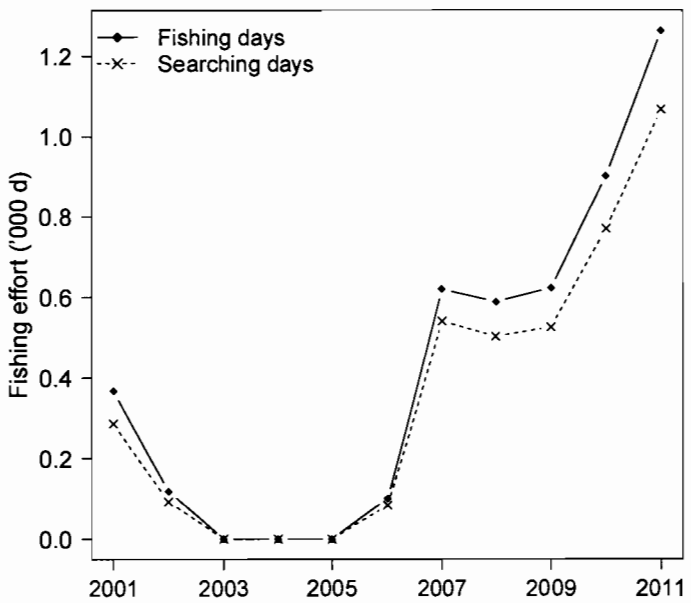

Figure 2: Changes in nominal effort over time. Annual total number of fishing and searching days for the purse seine fleet of France's overseas territories in the Indian Ocean during 2001-2011

in the north of the Mozambique Channel, west of the Seychelles, and along the Somali EEZ boundary (Fig. 3). 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.

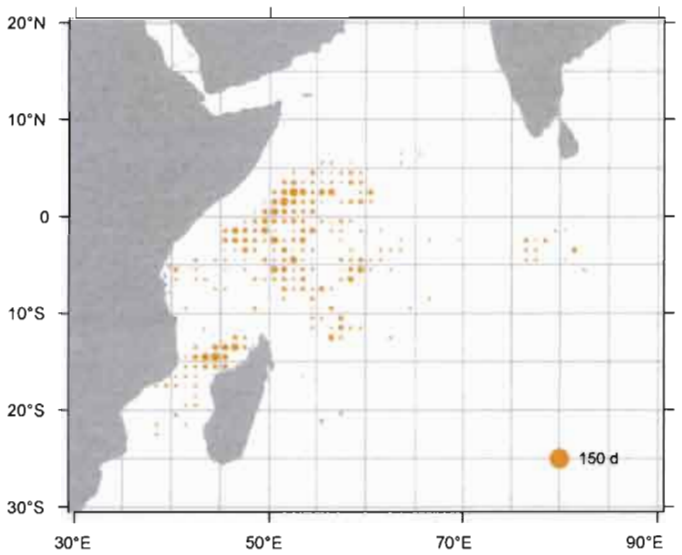

Figure 3: Fishing grounds. Spatial distribution of fishing effort (in searching days) of the purse seine fleet of France's overseas territories in 2011

The arrival of new vessels in 2007 and 2010 resulted in increases of the spatial extent of the fleet from less than 100 squares in 2006 to more than 350 squares in 2010-2011 (Fig. 4), a spatial extent very similar to the one of the French fishing fleet (Chassot et al. 2012). 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. 4).

2.4. Fishing activities

The total annual number of fishing sets made by the purse seine fleet of France's overseas territories showed a pattern consistent with the annual variations in carrying capacity and fishing effort of the fleet (Fig. 5 and Table 4). The total number of sets increased from about 100 in 2006 to more than 1,100 in 2011. The percentage of FAD-associated over free-swimming schools increased from 46% in 2007 to a maximum of 68% in 2010 and 59% in 2011, a trend similar to the one observed for the French component of the EU purse seine fleet (Chassot et al. 2012).

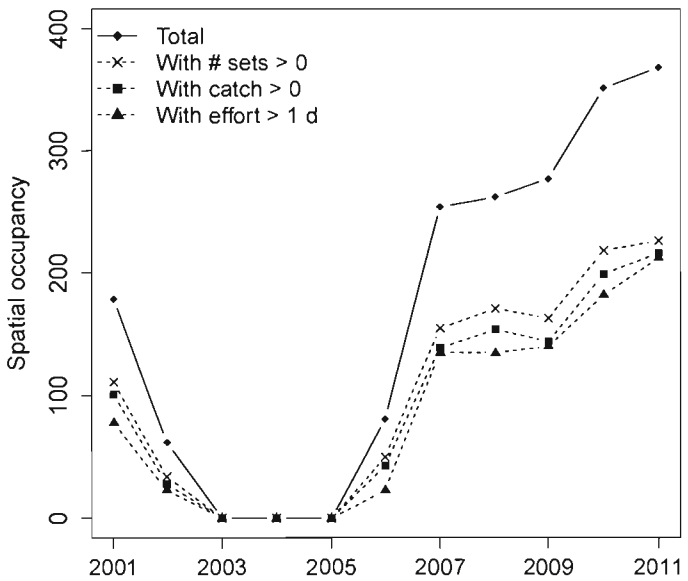

Figure 4: Changes in spatial extent of the fishery over time. Annual number of 1-degree squares explored by the purse seine fleet of France's overseas territories during 2001-2011

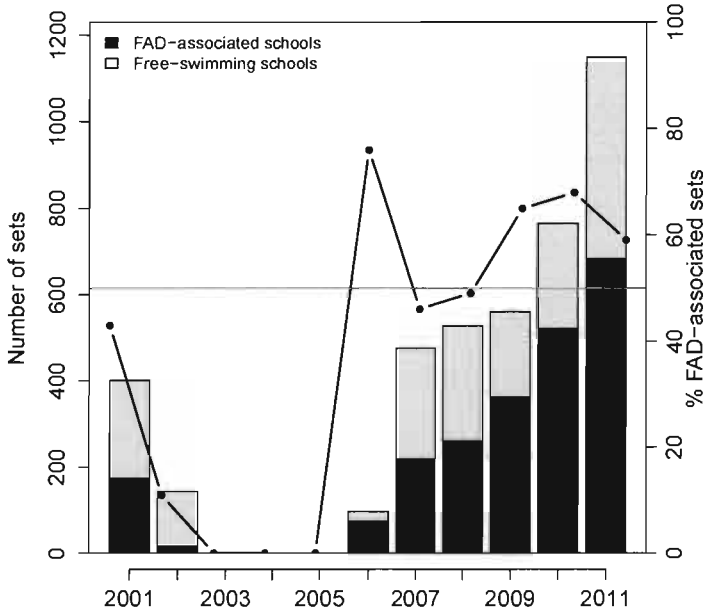

Figure 5: Fishing activities. Annual number of fishing sets in the purse seine fishing fleet of France's overseas territories on FAD-associated and free-swimming schools during 2001-2011. Line with solid circles indicates the percentage of sets made on FAD-associated schools over free-swimming schools. Grey solid line indicates the 50% value

The percentage of successful sets (i.e. positive tuna catch) made on FAD-associated schools has been high over the period 2001-2011, the mean annual value varying between a minimum of 81% in 2002 and a maximum of 96% in 2006. It remained stable at an average value of 88% (SD = 2%) during 2007-2011 (Table 4). The percentage of successful sets on free-swimming schools varied between 50% and 66% during 2001-2011 withouth exhibiting any particular trend over time.

3. Fisheries production

3.1. Catch levels

The total catch of the purse seine fleet of France's overseas territories increased from 3,000 t in 2006 to exceed 25,000 t in 2011 (Fig. 6). Catches on FAD-associated schools represented on average 70% (SD = 2.3%) of the total catch of the FRAT fleet during 2009-2011. They were dominated by skipjack during 2006-2009 that represented an annual mean of 66% (SD = 1%) of all species caught (Fig. 7a). The percentage of skipjack in the catch on FAD-associated schools decreased to 57% in 2010 and 52% in 2011. Consequently, yellowfin caught on FAD-associated schools increased from about 23% during 2007-2009 to 35% and 41% in 2010 and 2011, respectively. Catches of bigeye, estimated from multispecies sampling operations conducting at unloading (Pallarés and Hallier 1997), varied between 5% and 19% of the total of catch on FAD-associated schools during 2001-2011.

Catches made on free-swimming schools increased from 3,600 t in 2007 to more than 8,200 t in 2011 (Fig. 7b). Yellowfin represented an average of 73% (sd = 4.2%) of the catch on free-swimming schools during 2007-2011 while bigeye remained stable at about 8% (sd = 1.1%).

3.2. Spatial distribution of the catch

The FRAT 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 fishing on free-swimming schools mainly occurred around and south-east of the Seychelles islands, and in the Mozambique to a lesser extent (Fig. 8). 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. 10-11).

Besides, catches on free-swimming schools in 2011 were mainly composed of skipjack in the Mozambique Channel (Fig. 12) 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. 12).

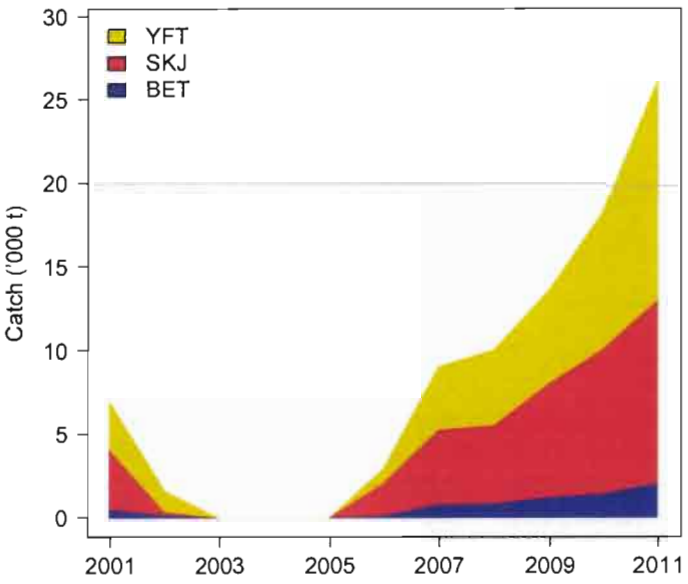

Figure 6: Total fishery production. Catch by species of the purse seine fishing fleet of France's overseas territories during 2001-2011

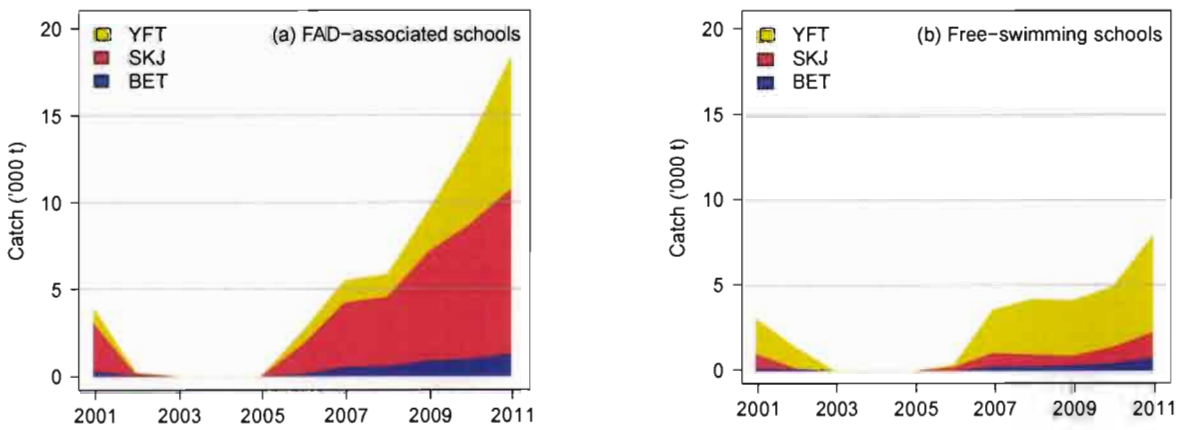

Figure 7: Fishery production by major fishing mode. Catch by species of the purse seine fishing fleet of France's overseas territories on (a) FAD-associated and (b) free-swimming schools during 2001-2011

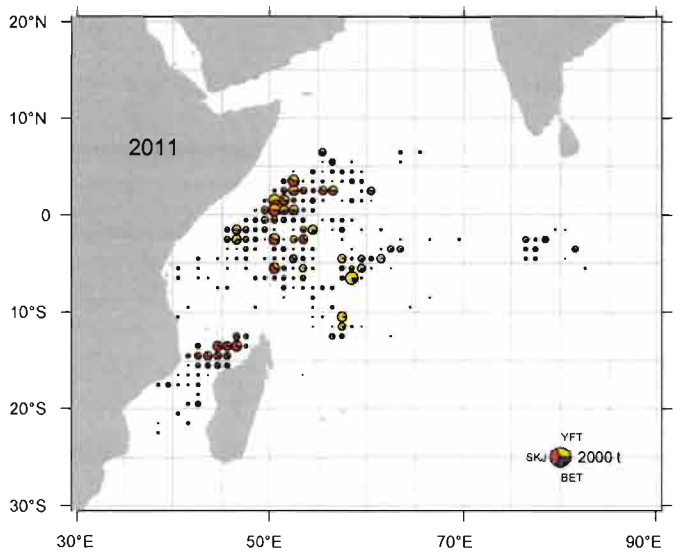

Figure 8: Spatial distribution of tuna catches of the purse seine fishing fleet of France's overseas territories in 2011

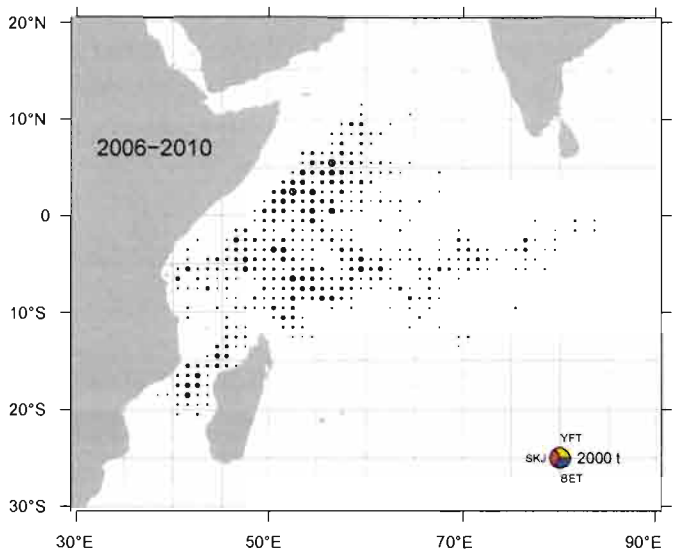

Figure 9: Spatial distribution of tuna catches of the purse seine fishing fleet of France's overseas territories in 2006-2010

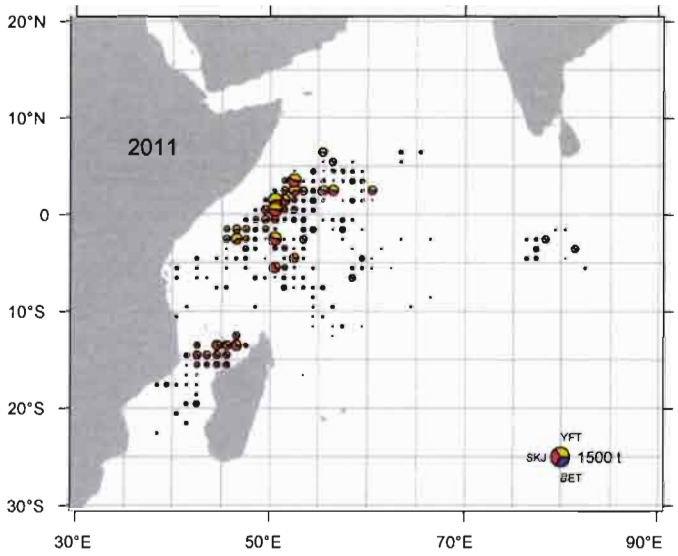

Figure 10: Spatial distribution of tuna catches of the purse seine fishing fleet of France's overseas territories made on FAD-associated schools in 2011

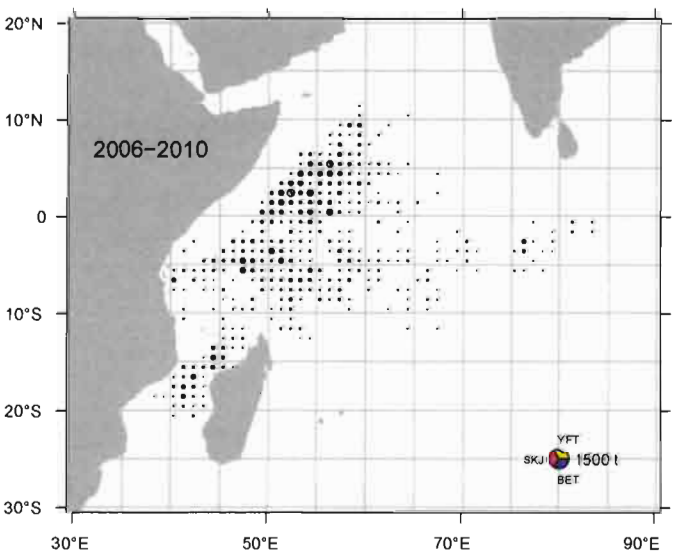

Figure 11: Spatial distribution of tuna catches of the purse seine fishing fleet of France's overseas territories made on FAD-associated schools in 2006-2010

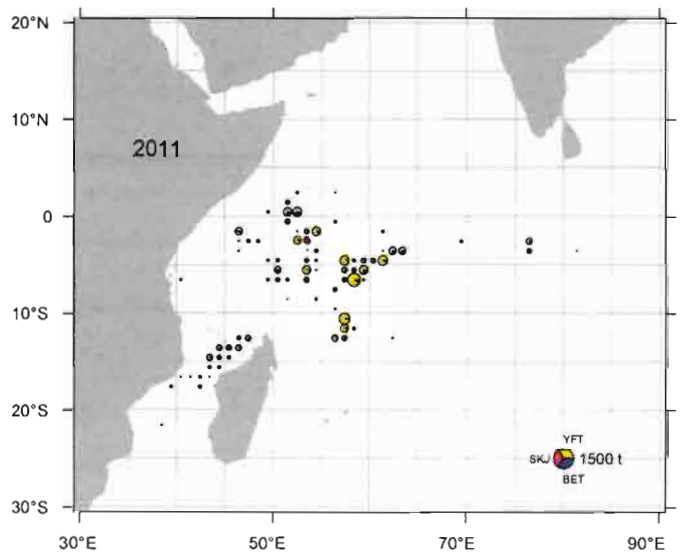

Figure 12: Spatial distribution of tuna catches of the purse seine fishing fleet of France's overseas territories made on free-swimming schools in 2011

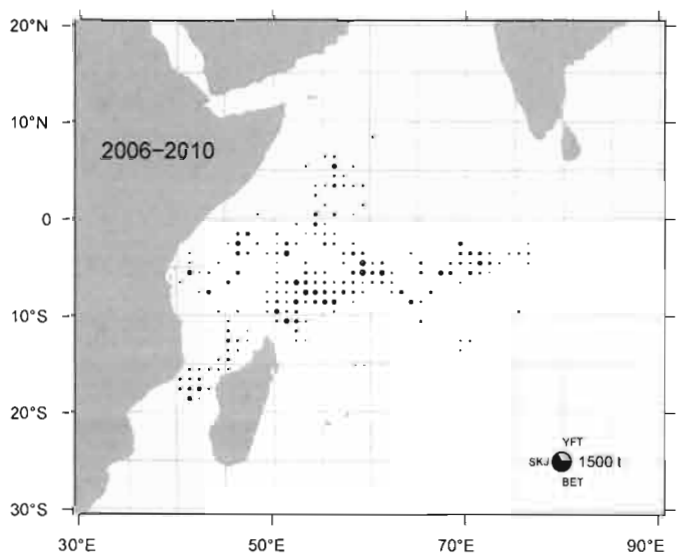

Figure 13: Spatial distribution of tuna catches of the purse seine fishing fleet of France's overseas territories made on free-swimming schools in 2006-2010

3.3. Catch rates

Raw catch rates expressed in tonnes per searching day (t d^{-1}) for the principal market tunas did not exhibit any clear trend over 2001-2011 (Fig. 14). Due to the presence of only 1 vessel in activity in 2006, the catch rates observed for this year should be interpreted with caution. As observed for the French component of the European purse seine fleet (Chassot et al. 2012), the catch rates of skipjack and yellowfin show similar orders of magnitude during 2007-2011.

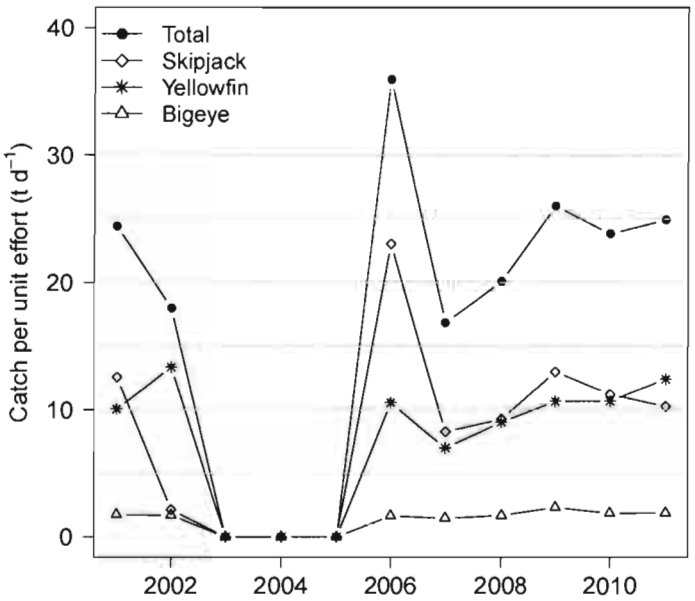

Figure 14: Annual catch rates (in t per searching day) of the purse seine fishing fleet of France's overseas territories in the Indian Ocean during 2001-2011

Skipjack catch rates predominated on FAD-associated schools during 2007-2011 with an average of 9 t d^{-1} (sd = 2 t d^{-1}) (Fig. 15a). Although smaller, yellowfin catch rates on FAD-associated schools have shown a steady increase from 2.3 t d^{-1} in 2007 to more than 7 t d^{-1} in 2011. Bigeye raw catch rates on FAD-associated schools have remained stable around a mean value of 1.3 t d^{-1} (Fig. 15a). Meanwhile, yellowfin catch rates have predominated for sets made on free-swimming schools around an average of 5.4 t d^{-1} (sd = 0.8 t d^{-1}) (Fig. 15b). During 2007-2011, catch rates for skipjack and bigeye appeared small with average values of 0.6 and 1.3 t d^{-1}, respectively.

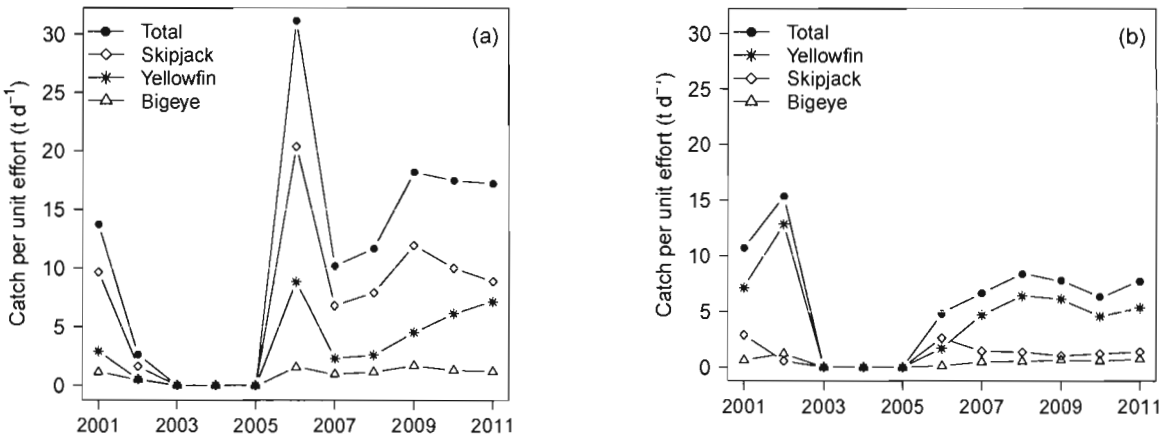

Figure 15: Annual catch rates (in t per searching day) of the purse seine fleet of France's overseas territories on (a) FAD-associated and (b) free-swimming schools in the Indian Ocean during 2001-2011

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5. Appendix tables

Table 1: Annual number of purse seiners by size category and total carrying capacity of the purse seine fishing fleet of France's overseas territories in the Indian Ocean during 2001-2011. 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	>1200	Total	CC
2001	0	0	0	2	0	2	1050
2002	0	0	0	2	0	2	420
2003	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0
2006	0	0	0	1	0	1	445
2007	0	0	0	2	0	2	2138
2008	0	0	0	2	0	2	2138
2009	0	0	0	3	0	3	2392
2010	0	0	0	5	0	5	3853
2011	0	0	0	5	0	5	5136

Table 2: Annual nominal fishing effort of the purse seine fleet of France's overseas territories expressed in fishing and searching days during 2001-2011. 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
2001	367	286
2002	119	93
2003	0	0
2004	0	0
2005	0	0
2006	101	84
2007	620	541
2008	589	503
2009	623	526
2010	902	770
2011	1264	1067

Table 3: Annual number of 1-degree squares explored by the purse seine fleet of France's overseas territories during 2001-2011

Year	TOTAL	#sets	Catch >0	Effort > 1 d	Effort > 5 d
2001	179	111	101	78	10
2002	62	34	28	23	3
2003	0	0	0	0	0
2004	0	0	0	0	0
2005	0	0	0	0	0
2006	81	50	43	23	1
2007	254	155	139	135	19
2008	262	171	154	135	20
2009	277	163	144	140	24
2010	351	218	199	182	36
2011	368	226	216	212	80

Table 4: Number of positive and null sets by fishing mode made by the purse seine fleet of France's overseas territories in the Indian ocean during 2001-2011

	ALL			FAD			FSC		
	Total	Positive	Null	Total	Positive	Null	Total	Positive	Null
2001	401	306	95	174	155	19	227	151	76
2002	144	76	68	16	13	3	128	63	65
2003	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0
2006	97	85	12	74	71	3	23	14	9
2007	476	322	154	219	186	33	257	136	121
2008	527	390	137	260	234	26	267	156	111
2009	560	428	132	362	318	44	198	110	88
2010	764	583	181	521	461	60	243	122	121
2011	1149	888	261	683	613	70	466	275	191

Table 5: Catch by species for the purse seine fishing fleet of France's overseas territories of the Indian ocean during 2001-2011

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
2001	2875	3598	504	13	0	6990
2002	1248	202	161	69	0	1679
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	887	1933	141	0	57	3018
2007	3795	4480	796	30	30	9130
2008	4543	4666	858	28	0	10094
2009	5612	6842	1230	0	1	13685
2010	8233	8654	1437	34	0	18358
2011	13276	10955	2042	338	0	26610

Table 6: Catch by species made on FAD-associated schools for the purse seine fishing fleet of France's overseas territories of the Indian ocean during 2001-2011

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
2001	834	2772	322	0	0	3928
2002	50	150	48	0	0	247
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	744	1713	131	0	29	2617
2007	1268	3694	536	0	28	5526
2008	1308	3981	585	0	0	5875
2009	2384	6295	899	0	1	9578
2010	4727	7721	995	28	0	13472
2011	7602	9481	1278	15	0	18376

Table 7: Catch by species made on free-swimming schools for the purse seine fishing fleet of France's overseas territories of the Indian ocean during 2001-2011

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
2001	2041	826	182	13	0	3062
2002	1198	52	113	69	0	1432
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	143	220	11	0	27	401
2007	2527	786	260	30	2	3605
2008	3234	685	273	28	0	4219
2009	3229	547	331	0	0	4107
2010	3505	933	442	5	0	4886
2011	5674	1474	764	322	0	8235

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