

Statistics of the French purse seine fishing fleet targeting tropical tunas in the indian ocean (1981-2016)

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Résumé

KEYWORDS: Tropical tuna fisheries, French purse seining, floating objects, free swimming school, fish aggregating devices, Katsuwonus pelamis, Thunnus albacares, Thunnus obesus

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1. Introduction

French purse seiners operate in the indian ocean target yellowfin (*Thunnus albacares*), skipjack (*Katsuwonus pelamis*), and bigeye tuna (*Thunnus obesus*) through two major fishing modes : floating object-associated schools (FOB) and free-swimming schools (FSC) that result in different species and size compositions of the catches. Statistical data for the French purse seine (PS) fishing fleet have been collected by the ‘Institut de Recherche pour le Développement’ (IRD) in collaboration with the ‘Seychelles Fishing Authority’ (SFA) since the arrival of the first purse seiners in the indian ocean in the early 1980s. The French PS fleet activities are described through a suite of fishery indicators that provide information on fishing capacity, effort, catch, and catch rates for the tropical tuna species (skyjack, yellowfin and bigeye) targeted, with a particular focus on the year 2016.

2. Material and methods

2.1 Data collection

The data presented in this paper come from the collection of all logbooks and landing reports done in collaboration with the fishing companies. French purse seine logbooks are similar between companies and follow the standards defined by the Indian Ocean Tuna Commission (IOTC) following resolutions 15/01 “On the recording of catch and effort data by fishing vessels in the IOTC area of competence” and 15/02 “Mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPCs)”. They include information on the position, date, fishing activities (route, fishing set, fishing mode and operation related to FOB), and environmental conditions associated with each activity (e.g. sea surface temperature, speed and direction of the wind).

2.2 Data processing

The current sampling protocol, strata, and algorithms used for the logbook data processing were established during the European project ‘Analyse du schéma d’échantillonnage multispécifique des thonidés tropicaux’ (Pallares and Hallier 1997).

Overall, the data processing aims to adjust the tropical tuna catch to the landings and estimate the size and species composition of the catch based on large sampling areas, fishing mode, and quarter (Pallares and Petit 1998). The estimation of the size and species composition relies on the merging of all size samples collected aboard European and associated flags purse seiners. Consequently, the size structure of the catches is given for the whole European fishery in a companion paper (Chassot et al. 2014b). Fishing time is computed from logbook information and by considering that purse seiners are only fishing during daytime, i.e. 13 hours a day on average in the indian ocean. Searching time was computed by subtracting the time spent for setting the gear from the fishing time. The time spent for setting the gear was estimated by regressions linking duration and size of sets, from at sea observations made by scientific observers. The spatial distribution of the effort was estimated by evenly allocating the fishing/searching time to the position(s) of fishing sets on a daily basis.

3. Fishing capacity and effort

3.1 Fishing fleet

In 2016, the French fleet was composed of 1 supply vessel and 12 fishing vessels of capacity >800 t that corresponded to an overall carrying capacity 11,800 t (Fig. 1 and Table 1). The total number of active vessels has shown a decreasing trend over time, from a maximum of 26 in 1985 to a minimum of about 13 in the recent years, with a notable increase observed during 2006-2009 (Fig. 1). Meanwhile, the individual purse seiner carrying capacity has increased, which resulted in the overall capacity of the fleet to remain fairly constant during 1984-2016, on average of 14,000 t. The exceptional increase in the number of vessels and associated capacity during 2006-2008 was due to the arrival of several purse seiners from the atlantic ocean. This could be mainly explained by the high catch rates observed in the indian ocean during 2003-2005 that were twice those observed in the atlantic ocean. Lower catch rates which became very similar between oceans during 2006-2008, combined with piracy threat may have implied a reallocation of the purse seine effort in the atlantic ocean from 2009 (Chassot et al. 2010).

3.2 Fishing effort

The total nominal fishing effort, expressed in fishing and searching days, showed an overall decreasing trend over time during 1984-2016, similar to the number of vessels, with the notable major increase during 2006-2008 (Fig. 2 and Table 2). In recent years, the effort has shown an increase of more than 20% between 2010 and 2014. Then, the effort decreased by 9% due to the departure of 1 vessel to the Italian flag. In 2016, the total nominal effort was 3508 active days at sea, 2571 searching days and 3153 fishing days. The fishing grounds were located in the western part of the indian ocean in 2016, ranging from 15°S in the Mozambique Channel to a maximum of about 8°N, at the latitude of the horn of Africa, and from 40°E along the coasts of Mozambique and Tanzania, to 70°E (Fig. 3). While the extent of the fleet fishing grounds where some effort was exerted has decreased since 2008 from a maximum of about 400 to less than 300 squares of 1° latitude and longitude, it increased in 2016 to reach 450 squares (Fig. 4 and Table 3).

3.3 Fishing sets

The total annual number of fishing sets has remained stable during 2002-2016 at about 2,800, with 7% of the sets being successful during this period (Fig. 5 and Table 4). In 2016, two thirds of all sets made by the French purse seine fleet, i.e. 2000, were achieved on floating object (FOB) associated schools. The proportion of success increased from 85% in 2012 to 94% in 2016.

4. Fisheries production

4.1 Fishery landings

In 2016, the total landings were 68419 t with an increase of 25% compared to 2015 (Fig. 6 and Table 5). The specific composition in 2016 was 49.3%, 45.1%, 5% and 0.6% yellowfin, skipjack, bigeye and other species respectively. Catch on FOBs increased by 54% in 2016 to reach more than 49,000 t (Fig. 7a and Table 6). The proportion of catches associated with FOBs has strongly increased from about 47% in 2005 to 72% in 2016.

4.2 Catch rates

The total number of positive sets per searching day (cumulating both fishing modes) has shown an increasing trend from 0.75 in 1981 to 1.43 in 2005. Since then, it has been decreasing to reach a low value <0.8 in 2014, i.e. lower than the levels observed during the El Niño event of 1997-1998 (Table 8). In 2016, the decreasing trend stopped at a value of 1.05 instead of 0.85. This increase is mainly due to the catch rates on FOBs with a higher value of 38%. During the same period, this increase was only of 6% on FSC.

For the number of sets per searching day on FSC, the increase is only 6% between 2015 and 2016.

The total catch per positive set on FOBs decreased from high values (average of more than 36 t per set) during 1999-2006 to an average of 27 t per set during 2007-2015 (Fig. 11c and Table 10). SKJ catch per positive set strongly decreased from maximum values of more than 27 t in 2002 to less than 13 t in 2012-2015. Meanwhile, YFT catch per positive set showed strong interannual variations during 1991-2015 with an overall increasing trend.

The catch per positive set on FSC has shown an increase in recent years, from 32.3 t in 2009 to more than 43 t in 2015 (Fig. 11c and Table 9). Values of YFT catch per positive set averaged around 39.7 t during 2010-2015.

The year 2016 does not follow the trend of the previous years with a 14% increase in catch per positive set on FOBs and 15% on FSC. It will be necessary to analyze next year's values to hypothesize a trend.

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5. Figures

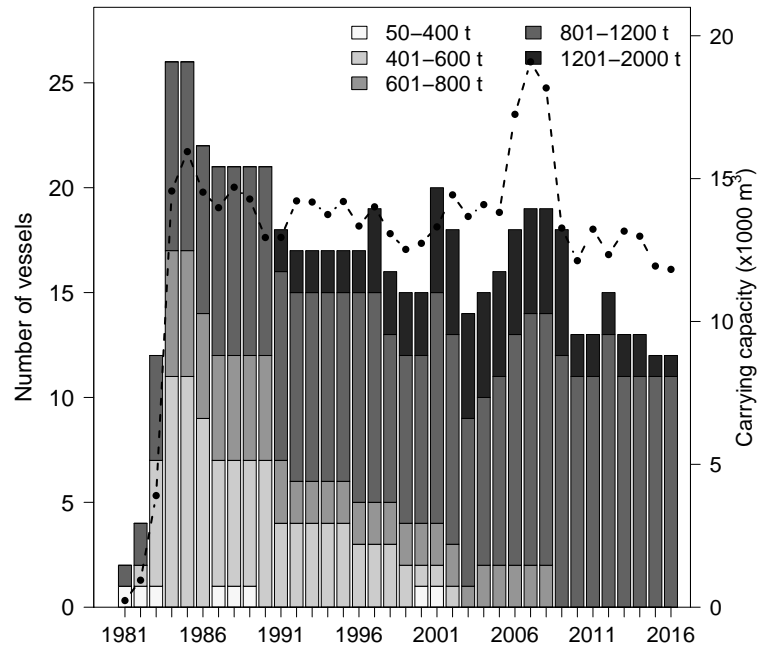


FIGURE 1 – Fishing capacity of the French purse seine fishing fleet in the indian ocean. Annual changes in the number of purse seiners by size category (barplots) and total carrying capacity (solid line with circles) during 1991-2016. Capacity was weighted by the vessel-specific proportion of the year at sea (in months). The vessel size category (t) was computed as 0.7 times the capacity expressed in m^3

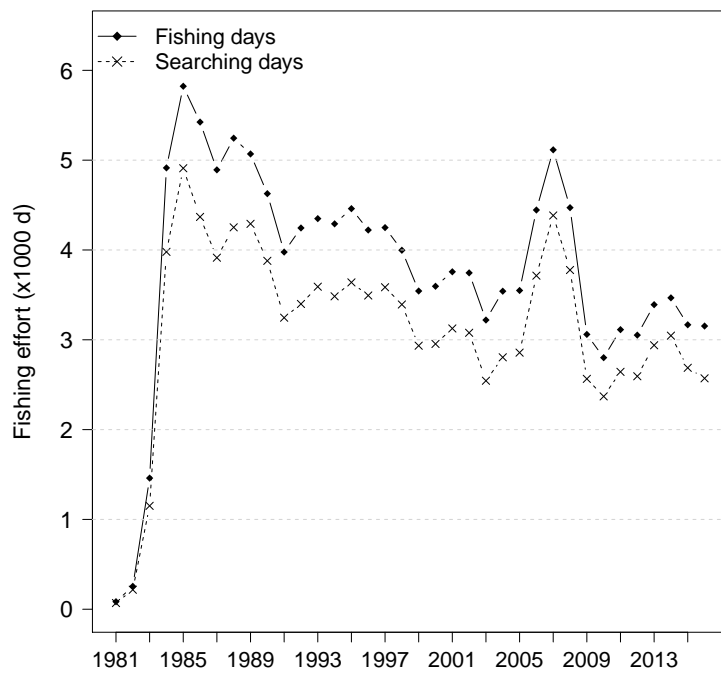


FIGURE 2 – Changes in nominal effort over time. Annual total number of fishing and searching days for the French purse seine fishing fleet in the Indian Ocean during 1991-2016

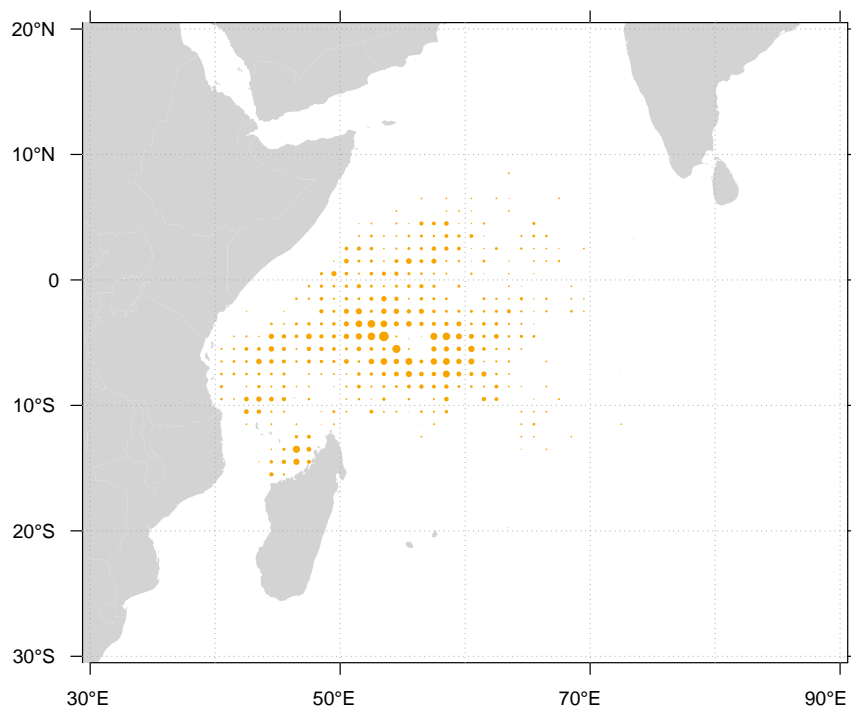


FIGURE 3 – Fishing grounds. Spatial distribution of fishing effort (in searching days) of the French purse seine fishing fleet in 2016

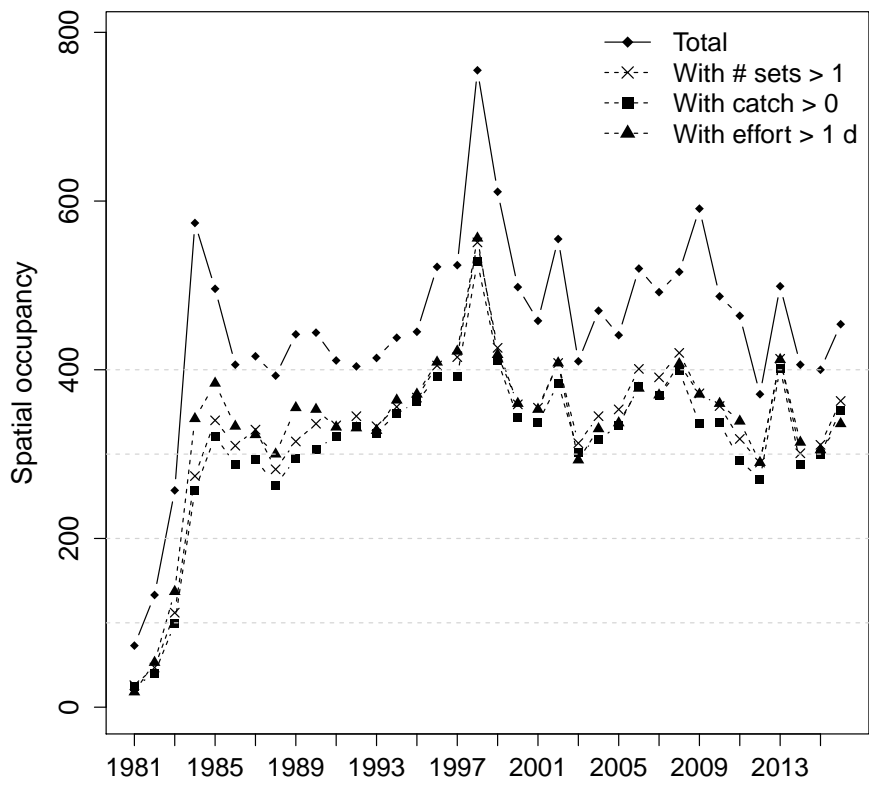


FIGURE 4 – Changes in spatial extent of the fishery over time. Mean annual number of 1-degree squares explored by each vessel of the French purse seine fishing fleet during 1991-2016. Solid line indicates standard deviation. Only vessels in activity during 12 months were selected. A loess function was fitted to the data to illustrate the trend

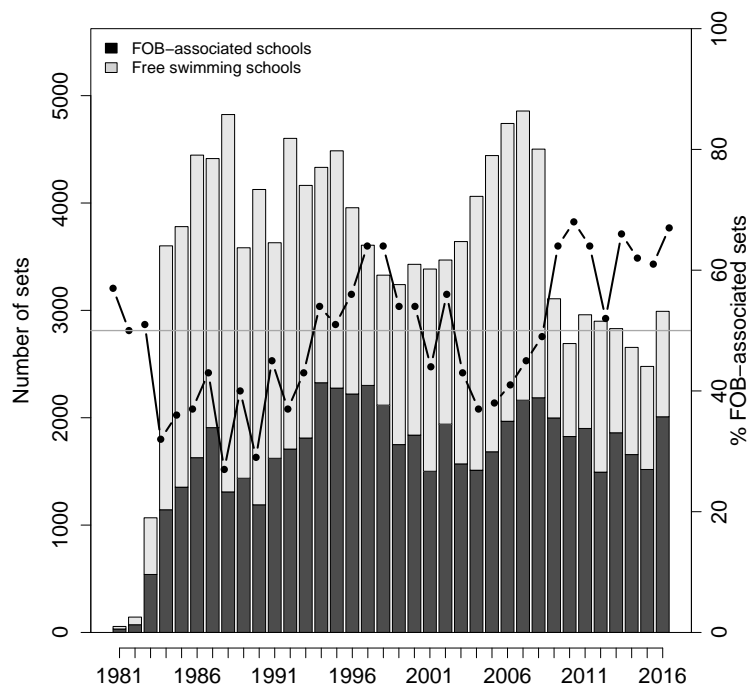


FIGURE 5 – Fishing operations. Annual number of fishing sets in the French purse seine fishery on FOB-associated and free-swimming schools during 1991-2016. Line with solid circles indicates the percentage of sets made on FOB-associated schools over free-swimming schools. Grey solid line indicates the 50% value

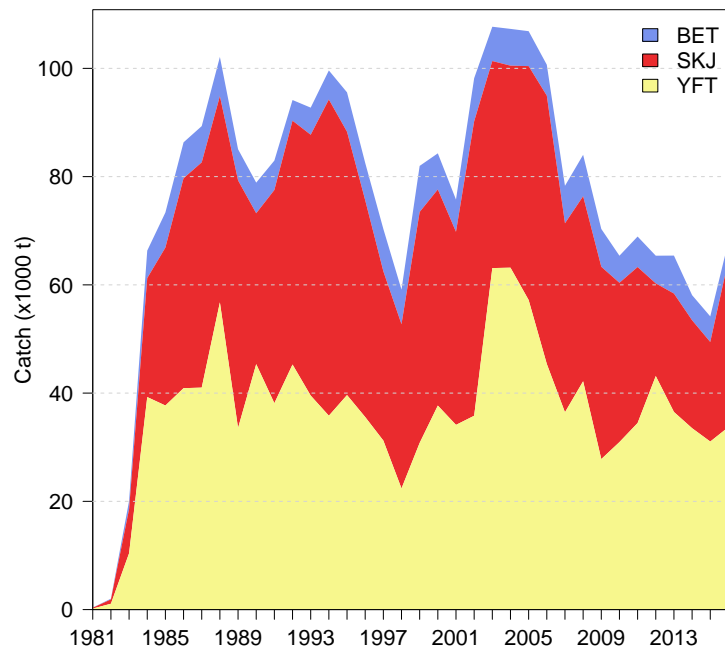


FIGURE 6 – Total fishery production. Catch by species of the French purse seine fishing fleet during 1991-2016

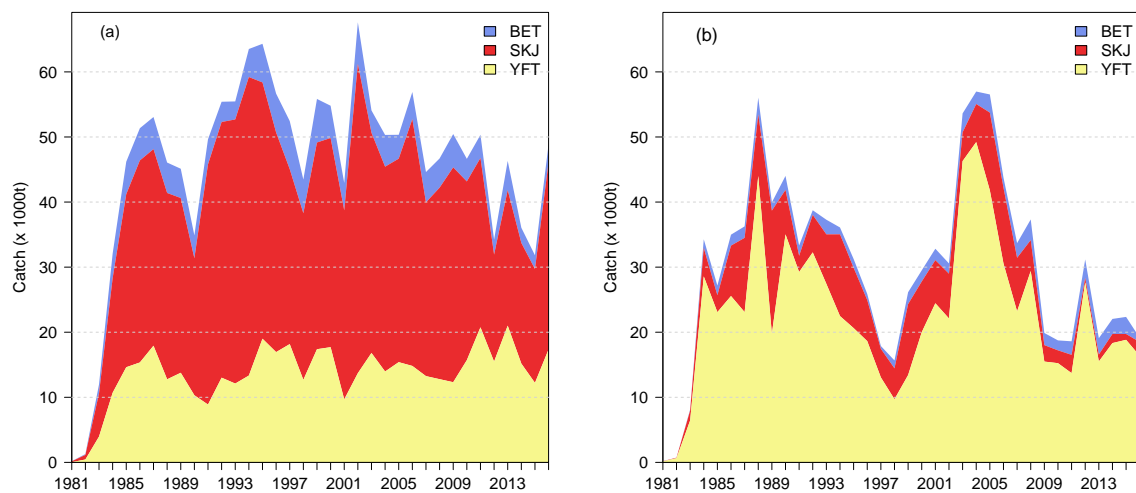


FIGURE 7 – Fishery production by major fishing mode. Catch by species of the French purse seine fishing fleet on (a) FOB-associated and (b) free-swimming schools during 1991-2016

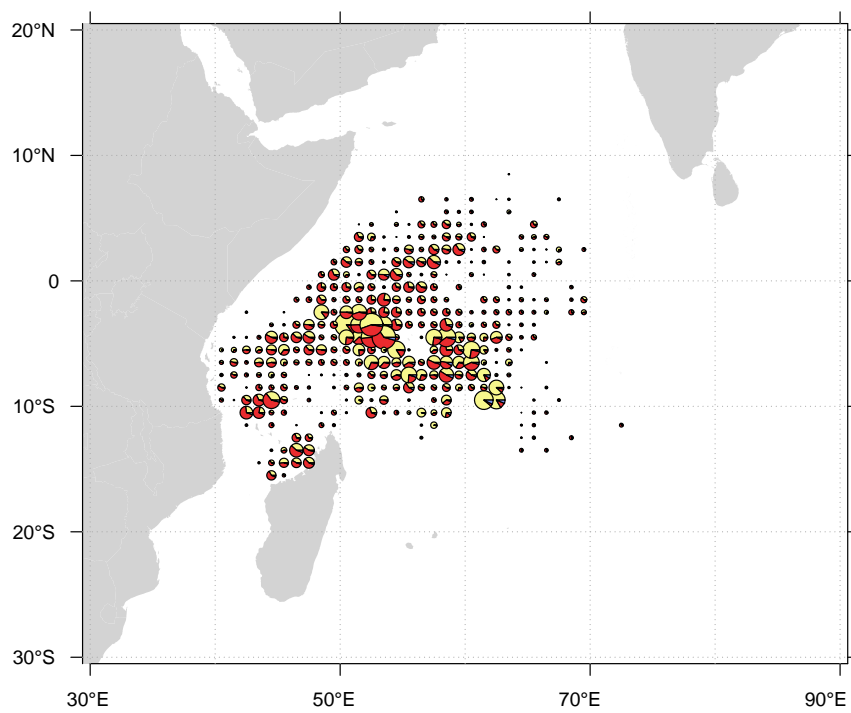


FIGURE 8 – Spatial distribution of tuna catches of the French purse seine fishing fleet in 2016

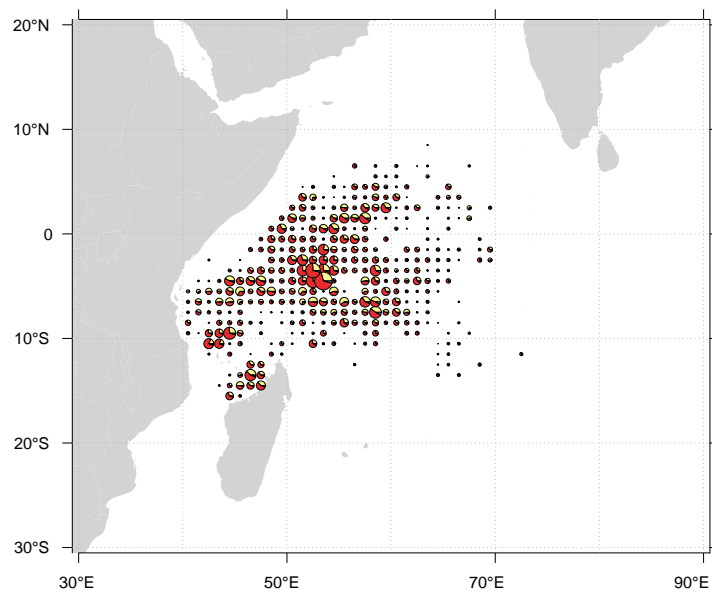


FIGURE 9 – Spatial distribution of tuna catches of the French purse seine fishing fleet made on FOB-associated schools in 2016

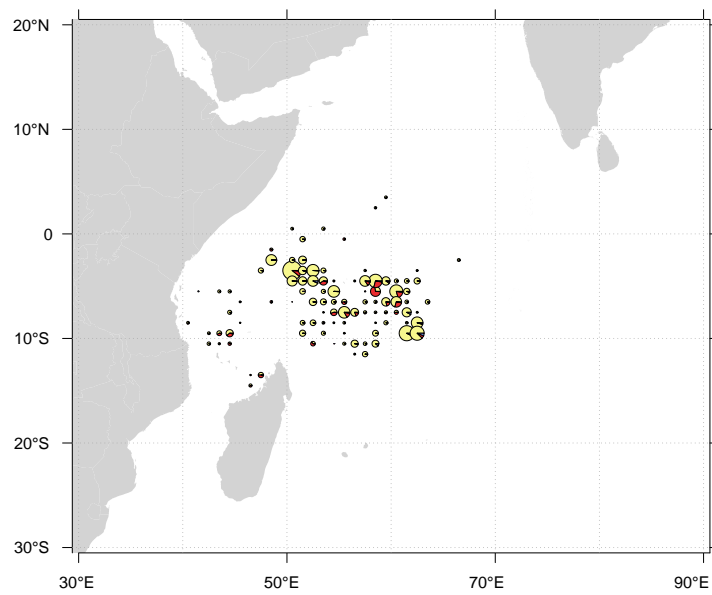


FIGURE 10 – Spatial distribution of tuna catches of the French purse seine fishing fleet made on FSC-associated schools in 2016

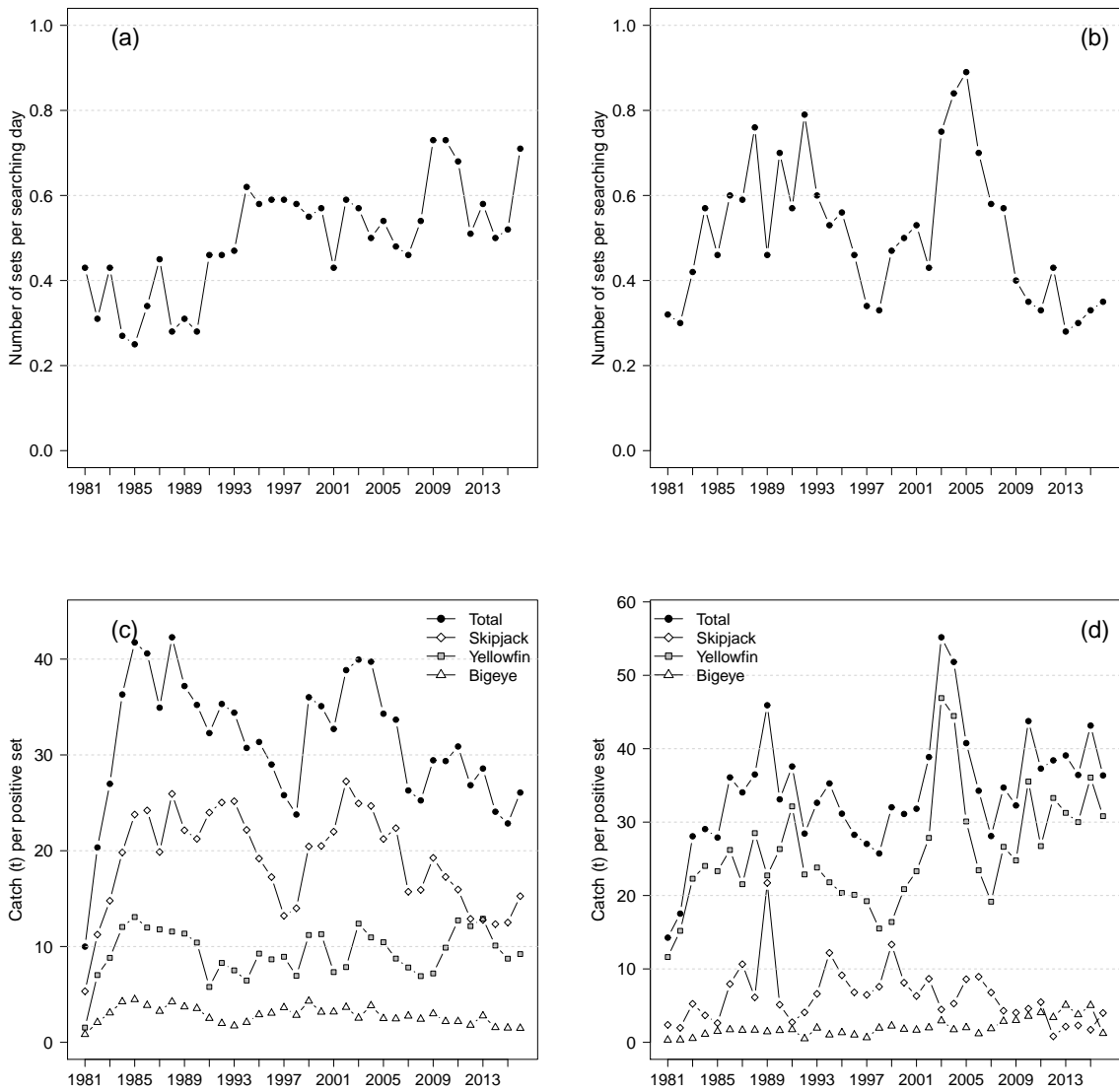


FIGURE 11 – (a-b) Annual number of sets per searching day and (c-d) catch per positive set on (left panel) FOB-associated and (right panel) free-swimming schools for the French purse seine fishing fleet in the indian ocean during 1991-2016

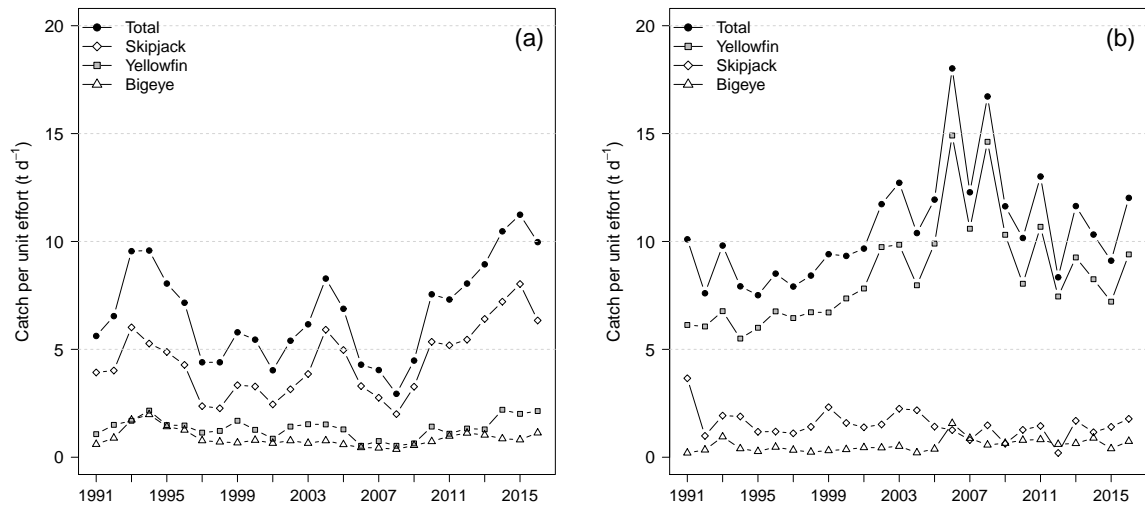


FIGURE 12 – Annual catch rates (in t per searching day) of the French purse seine fishing fleet on (a) FOB-associated and (b) free-swimming schools in the Indian Ocean during 1991-2016

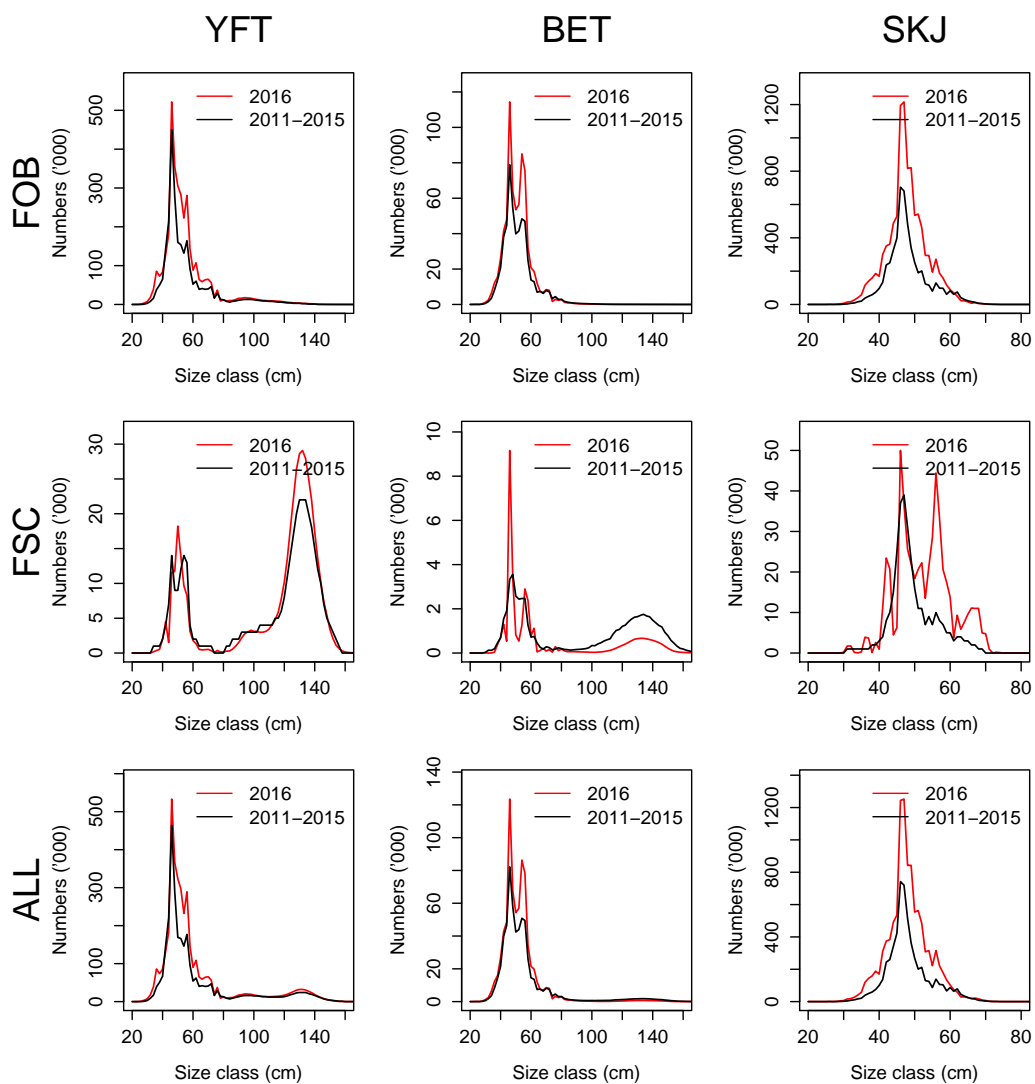


FIGURE 13 – Size distribution of the catch (in numbers) for the French purse seine fleet in 2016 (red line) and for an average year representing the period 2011-2015 (black line)

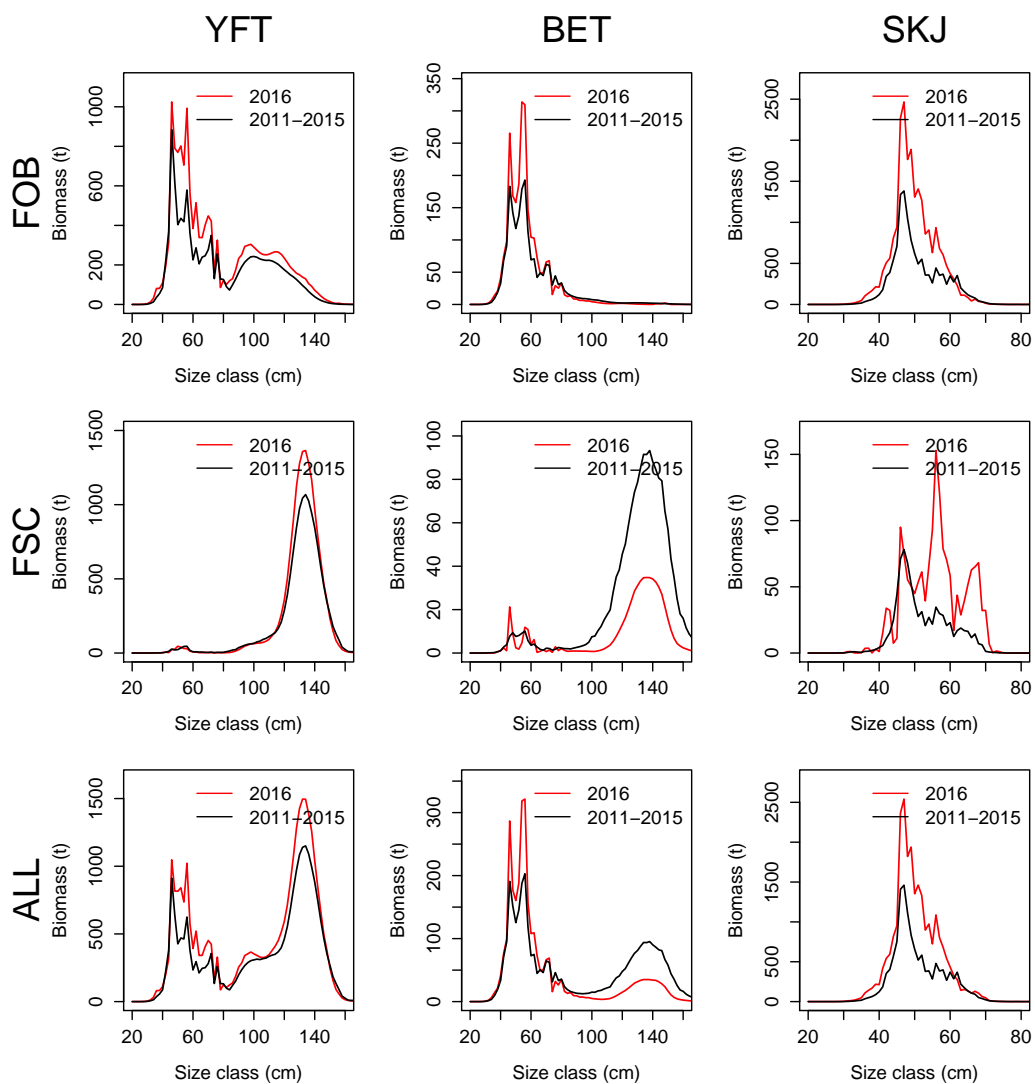


FIGURE 14 – Size distribution (in weight) of the catch for the French purse seine fleet in 2016 (red line) and for an average year representing the period 2008-2012 (black line)

6. Tables

TABLE 1 – Annual number of purse seiners by size category and total carrying capacity of the European tropical tuna purse seine fishing fleet of the indian ocean during 1991-2016. 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	Nb_vessels	nb_vessels_weighted	CC
1981	1	0	0	1	0	0	2	0	233
1982	1	1	0	2	0	0	4	1	945
1983	1	6	0	5	0	0	12	6	3907
1984	0	11	6	9	0	0	26	20	14566
1985	0	11	6	9	0	0	26	23	15945
1986	0	9	5	8	0	0	22	20	14526
1987	1	6	5	9	0	0	21	19	13983
1988	1	6	5	9	0	0	21	21	14699
1989	1	6	5	9	0	0	21	20	14285
1990	0	7	5	9	0	0	21	17	12939
1991	0	4	3	9	2	0	18	16	12943
1992	0	4	2	9	2	0	17	17	14220
1993	0	4	2	9	2	0	17	17	14180
1994	0	4	2	9	2	0	17	16	13743
1995	0	4	2	9	2	0	17	17	14199
1996	0	3	2	10	2	0	17	15	13341
1997	0	3	2	10	4	0	19	16	14013
1998	0	3	2	8	3	0	16	15	13074
1999	0	2	2	8	3	0	15	14	12523
2000	1	1	2	8	3	0	15	14	12736
2001	1	1	2	11	5	0	20	14	13311
2002	0	1	2	10	5	0	18	15	14431
2003	0	0	1	8	5	0	14	14	13676
2004	0	0	2	8	5	0	15	14	14090
2005	0	0	2	9	5	0	16	14	13818
2006	0	0	2	11	5	0	18	17	17250
2007	0	0	2	12	5	0	19	19	19087
2008	0	0	2	12	5	0	19	18	18173
2009	0	0	0	12	6	0	18	13	13270
2010	0	0	0	11	2	0	13	12	12128
2011	0	0	0	11	2	0	13	13	13229
2012	0	0	0	13	2	0	15	12	12341
2013	0	0	0	11	2	0	13	13	13162
2014	0	0	0	11	2	0	13	13	12984
2015	0	0	0	11	1	0	12	12	11940
2016	0	0	0	11	1	0	12	12	11823

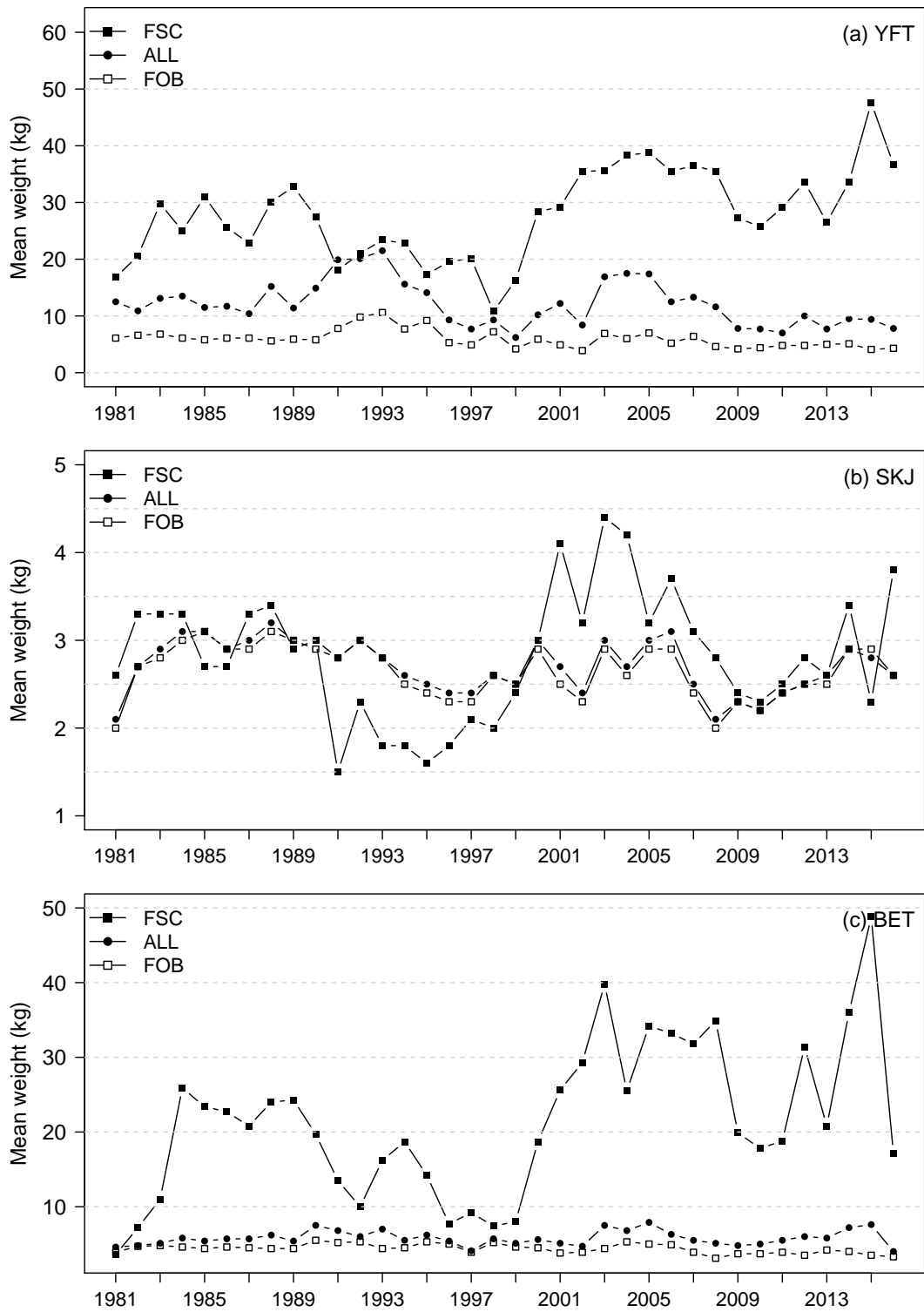


FIGURE 15 – Annual time series of mean weight (kg) for (a) yellowfin, (b) skipjack, and (c) bigeye tuna for each fishing mode during 1991-2016

TABLE 2 – Annual nominal fishing effort of the French purse seine fishing fleet expressed in fishing and searching days during 1991-2016. 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	84	69
1982	255	217
1983	1460	1151
1984	4914	3979
1985	5823	4910
1986	5424	4368
1987	4892	3914
1988	5245	4252
1989	5069	4291
1990	4627	3879
1991	3977	3246
1992	4245	3399
1993	4349	3591
1994	4291	3484
1995	4460	3639
1996	4222	3493
1997	4249	3585
1998	3997	3393
1999	3543	2934
2000	3596	2954
2001	3757	3126
2002	3745	3078
2003	3220	2544
2004	3541	2805
2005	3549	2857
2006	4445	3714
2007	5115	4384
2008	4471	3777
2009	3060	2565
2010	2801	2370
2011	3113	2643
2012	3052	2594
2013	3391	2939
2014	3467	3046
2015	3167	2688
2016	3153	2571

TABLE 3 – Annual number of 1-degree squares explored by the French purse seine fishing fleet during 1991-2016. #sets indicates squares where a least 1 fishing set was made.

Year	TOTAL	#sets	Catch >0	Effort > 1 d	Effort > 5 d
1981	73	26	24	18	
1982	133	47	40	53	10
1983	257	112	99	137	60
1984	574	274	257	342	182
1985	496	340	321	384	267
1986	406	310	288	333	223
1987	416	329	294	323	206
1988	393	282	263	300	210
1989	442	315	295	355	229
1990	444	336	306	353	215
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	337	353	219
2002	555	408	384	408	237
2003	410	313	302	293	186
2004	470	345	317	330	171
2005	441	353	334	337	198
2006	520	401	380	378	220
2007	492	391	370	370	242
2008	516	420	399	407	245
2009	591	372	336	371	189
2010	487	357	337	360	186
2011	464	318	293	339	162
2012	371	290	270	290	184
2013	499	413	402	412	221
2014	406	301	288	314	190
2015	400	311	300	305	182
2016	454	363	352	336	187

TABLE 4 – Number of positive and null sets by fishing mode made by the French purse seine fishing fleet in the indian ocean during 1991-2016. FOB = Floating Object-associated schools; FSC = Free-Swimming School

	ALL			FOB			FSC		
	Total	Positive	Null	Total	Positive	Null	Total	Positive	Null
1981	56	37	19	32	24	8	24	13	11
1982	143	105	38	72	63	9	71	42	29
1983	1068	738	330	540	449	91	528	289	239
1984	3601	2077	1524	1143	888	255	2458	1189	1269
1985	3780	2108	1672	1353	1118	235	2427	990	1437
1986	4446	2257	2189	1628	1282	346	2818	975	1843
1987	4414	2592	1822	1908	1520	388	2506	1072	1434
1988	4824	2648	2176	1309	1104	205	3515	1544	1971
1989	3583	2083	1500	1436	1213	223	2147	870	1277
1990	4126	2322	1804	1189	991	198	2937	1331	1606
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	2370	1015	1501	1321	180	1884	1049	835
2002	3469	2539	930	1940	1745	195	1529	794	735
2003	3641	2344	1297	1570	1357	213	2071	987	1084
2004	4062	2382	1680	1511	1275	236	2551	1107	1444
2005	4442	2862	1580	1683	1473	210	2759	1389	1370
2006	4741	3000	1741	1967	1696	271	2774	1304	1470
2007	4857	2909	1948	2163	1698	465	2694	1211	1483
2008	4502	2954	1548	2186	1850	336	2316	1104	1212
2009	3108	2339	769	1998	1714	284	1110	625	485
2010	2691	2019	672	1825	1590	235	866	429	437
2011	2959	2144	815	1900	1631	269	1059	513	546
2012	2899	2107	792	1493	1276	217	1406	831	575
2013	2830	2125	705	1860	1629	231	970	496	474
2014	2655	2114	541	1657	1503	154	998	611	387
2015	2478	1921	557	1518	1399	119	960	522	438
2016	2991	2415	576	2009	1884	125	982	531	451

TABLE 5 – Catch by species for the French purse seine fishing fleet of the indian ocean during 1991-2016

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
1981	188	158	23	0	0	425
1982	1081	792	145	0	0	2018
1983	10400	8153	1536	0	0	20225
1984	39268	21979	5081	224	126	66781
1985	37706	29183	6477	445	300	74293
1986	40911	38786	6636	200	516	87227
1987	41012	41620	6701	217	17	89593
1988	56766	38094	7251	177	713	103020
1989	33548	45750	5764	6	0	85068
1990	45351	27873	5663	36	0	78954
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	159	76589
2002	35815	54405	7962	264	150	98642
2003	63101	38258	6334	608	337	108670
2004	63174	37323	6798	77	610	108021
2005	57198	43220	6453	86	184	107140
2006	45383	49573	5714	850	249	101809
2007	36455	34918	6928	335	33	78669
2008	42185	34186	7652	981	0	85013
2009	27807	35532	6991	295	3	70628
2010	30946	29432	5003	63	5	65460
2011	34468	28826	5635	575	0	69504
2012	43151	17120	5115	771	14	66171
2013	36511	21882	7015	331	204	65943
2014	33513	19944	4640	242	82	58421
2015	31046	18397	4730	216	106	54495
2016	33719	30876	3425	228	171	68419

TABLE 6 – Catch by species made on FOB-associated schools for the French purse seine fishing fleet of the indian ocean during 1991-2016

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
1981	37	128	20	0	0	240
1982	442	709	131	0	0	1282
1983	3959	6637	1381	0	0	12114
1984	10692	17600	3762	0	114	32244
1985	14623	26582	4993	14	292	46671
1986	15353	31040	4953	0	516	52038
1987	17926	30205	4937	0	17	53089
1988	12763	28633	4675	0	583	46673
1989	13769	26850	4499	0	0	45118
1990	10312	21046	3513	0	0	34902
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	159	43211
2002	13704	47527	6385	0	126	67787
2003	16810	33837	3429	0	103	54209
2004	13959	31473	4882	0	300	50653
2005	15399	31270	3667	0	184	50520
2006	14818	37920	4172	0	173	57124
2007	13254	26695	4662	3	31	44645
2008	12784	29427	4486	2	0	46710
2009	12320	33004	5125	10	3	50462
2010	15704	27461	3474	32	5	46687
2011	20755	26017	3555	45	0	50372
2012	15484	16442	2287	30	10	34253
2013	21008	20814	4506	32	200	46560
2014	15180	18540	2334	36	80	36171
2015	12216	17500	2105	44	105	31969
2016	17360	28750	2775	61	164	49110

TABLE 7 – Catch by species made on free-swimming schools for the French purse seine fishing fleet of the indian ocean during 1991-2016

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	12	34537
1985	23083	2601	1484	432	8	27623
1986	25558	7747	1683	200	0	35189
1987	23086	11415	1764	217	0	36505
1988	44003	9461	2575	177	130	56347
1989	19779	18900	1265	6	0	39951
1990	35039	6827	2150	36	0	44052
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
2010	15242	1971	1529	31	0	18774
2011	13713	2809	2080	530	0	19132
2012	27668	678	2828	740	4	31917
2013	15503	1068	2509	299	4	19384
2014	18333	1404	2306	206	2	22251
2015	18830	897	2625	173	1	22526
2016	16359	2126	650	166	8	19309

TABLE 8 – Number of sets per searching on FOB-associated (FOB) and free-swimming schools (FSC) for the French purse seine fishing fleet of the indian ocean during 1991-2016

Year	ALL	FOB	FSC
1981	0.75	0.43	0.32
1982	0.61	0.31	0.30
1983	0.86	0.43	0.42
1984	0.84	0.27	0.57
1985	0.71	0.25	0.46
1986	0.94	0.34	0.60
1987	1.04	0.45	0.59
1988	1.05	0.28	0.76
1989	0.77	0.31	0.46
1990	0.98	0.28	0.70
1991	1.03	0.46	0.57
1992	1.25	0.46	0.79
1993	1.07	0.47	0.60
1994	1.15	0.62	0.53
1995	1.14	0.58	0.56
1996	1.05	0.59	0.46
1997	0.93	0.59	0.34
1998	0.91	0.58	0.33
1999	1.02	0.55	0.47
2000	1.07	0.57	0.50
2001	0.96	0.43	0.53
2002	1.03	0.59	0.43
2003	1.32	0.57	0.75
2004	1.34	0.50	0.84
2005	1.43	0.54	0.89
2006	1.18	0.48	0.70
2007	1.04	0.46	0.58
2008	1.11	0.54	0.57
2009	1.13	0.73	0.40
2010	1.07	0.73	0.35
2011	1.01	0.68	0.33
2012	0.94	0.51	0.43
2013	0.86	0.58	0.28
2014	0.80	0.50	0.30
2015	0.85	0.52	0.33
2016	1.05	0.71	0.35

TABLE 9 – Catch per unit of effort (in t per positive set) on FOB-associated schools for the French purse seine fishing fleet of the indian ocean during 1991-2016

Year	YFT	SKJ	BET	ALB	TOTAL
1981	1.54	5.33	0.83	0.00	9.99
1982	7.02	11.25	2.08	0.00	20.34
1983	8.82	14.78	3.08	0.00	26.98
1984	12.04	19.82	4.24	0.00	36.31
1985	13.08	23.78	4.47	0.01	41.74
1986	11.98	24.21	3.86	0.00	40.59
1987	11.79	19.87	3.25	0.00	34.93
1988	11.56	25.94	4.23	0.00	42.28
1989	11.35	22.14	3.71	0.00	37.19
1990	10.41	21.24	3.54	0.00	35.22
1991	5.78	23.99	2.51	0.00	32.28
1992	8.29	25.04	1.98	0.01	35.32
1993	7.51	25.17	1.72	0.00	34.41
1994	6.45	22.18	2.09	0.01	30.73
1995	9.26	19.19	2.89	0.01	31.35
1996	8.66	17.25	3.05	0.04	29.00
1997	8.93	13.21	3.63	0.03	25.80
1998	6.94	14.00	2.83	0.01	23.78
1999	11.20	20.45	4.31	0.07	36.02
2000	11.29	20.50	3.16	0.03	35.09
2001	7.33	21.99	3.18	0.08	32.71
2002	7.85	27.24	3.66	0.00	38.85
2003	12.39	24.94	2.53	0.00	39.95
2004	10.95	24.68	3.83	0.00	39.73
2005	10.45	21.23	2.49	0.00	34.30
2006	8.74	22.36	2.46	0.00	33.68
2007	7.81	15.72	2.75	0.00	26.29
2008	6.91	15.91	2.42	0.00	25.25
2009	7.19	19.26	2.99	0.01	29.44
2010	9.88	17.27	2.18	0.02	29.36
2011	12.73	15.95	2.18	0.03	30.88
2012	12.13	12.89	1.79	0.02	26.84
2013	12.90	12.78	2.77	0.02	28.58
2014	10.10	12.34	1.55	0.02	24.07
2015	8.73	12.51	1.50	0.03	22.85
2016	9.21	15.26	1.47	0.03	26.07

TABLE 10 – Catch per unit of effort (in t per positive set) on free-swimming schools for the French purse seine fishing fleet of the indian ocean during 1991-2016

Year	YFT	SKJ	BET	ALB	TOTAL
1981	11.62	2.38	0.31	0.00	14.26
1982	15.19	1.98	0.33	0.00	17.53
1983	22.29	5.25	0.54	0.00	28.07
1984	24.03	3.68	1.11	0.19	29.05
1985	23.32	2.63	1.50	0.44	27.90
1986	26.21	7.95	1.73	0.21	36.09
1987	21.54	10.65	1.65	0.20	34.05
1988	28.50	6.13	1.67	0.11	36.49
1989	22.73	21.72	1.45	0.01	45.92
1990	26.33	5.13	1.62	0.03	33.10
1991	32.14	2.74	1.74	0.96	37.58
1992	22.87	4.08	0.50	0.99	28.44
1993	23.81	6.61	1.95	0.26	32.63
1994	21.80	12.19	1.02	0.26	35.27
1995	20.35	9.14	1.33	0.33	31.15
1996	20.10	6.81	1.01	0.35	28.27
1997	19.23	6.47	0.64	0.70	27.03
1998	15.50	7.58	1.94	0.72	25.73
1999	16.39	13.33	2.23	0.06	32.02
2000	20.87	8.13	1.79	0.32	31.11
2001	23.31	6.32	1.67	0.53	31.82
2002	27.85	8.66	1.99	0.33	38.86
2003	46.90	4.48	2.94	0.62	55.18
2004	44.46	5.28	1.73	0.07	51.82
2005	30.09	8.60	2.01	0.06	40.76
2006	23.44	8.94	1.18	0.65	34.27
2007	19.16	6.79	1.87	0.27	28.10
2008	26.63	4.31	2.87	0.89	34.70
2009	24.78	4.04	2.99	0.46	32.27
2010	35.53	4.59	3.56	0.07	43.76
2011	26.73	5.48	4.05	1.03	37.29
2012	33.29	0.82	3.40	0.89	38.41
2013	31.26	2.15	5.06	0.60	39.08
2014	30.00	2.30	3.77	0.34	36.42
2015	36.07	1.72	5.03	0.33	43.15
2016	30.81	4.00	1.22	0.31	36.36

TABLE 11 – Catch per unit of effort (in t per searching day) on FOB-associated schools for the French purse seine fishery of the indian ocean during 1991-2016

Year	YFT	SKJ	BET	ALB	TOTAL
1991	1.07	3.93	0.60	0.00	5.62
1992	1.50	4.02	0.89	0.00	6.54
1993	1.69	6.02	1.73	0.00	9.55
1994	2.16	5.27	1.98	0.00	9.58
1995	1.49	4.88	1.42	0.00	8.05
1996	1.47	4.28	1.26	0.00	7.16
1997	1.14	2.37	0.77	0.00	4.40
1998	1.22	2.27	0.71	0.00	4.40
1999	1.69	3.34	0.67	0.00	5.79
2000	1.27	3.28	0.79	0.00	5.45
2001	0.86	2.45	0.65	0.00	4.03
2002	1.42	3.15	0.77	0.00	5.40
2003	1.53	3.86	0.65	0.00	6.16
2004	1.52	5.91	0.77	0.00	8.28
2005	1.29	4.97	0.59	0.00	6.88
2006	0.53	3.30	0.45	0.00	4.29
2007	0.75	2.76	0.43	0.00	4.04
2008	0.53	2.00	0.37	0.00	2.94
2009	0.64	3.27	0.55	0.00	4.48
2010	1.42	5.35	0.73	0.01	7.55
2011	1.09	5.19	0.98	0.01	7.31
2012	1.33	5.45	1.12	0.01	8.05
2013	1.29	6.41	1.03	0.01	8.94
2014	2.20	7.21	0.86	0.01	10.47
2015	2.01	8.03	0.81	0.01	11.24
2016	2.14	6.34	1.13	0.01	9.97

TABLE 12 – 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 1991-2016

Year	YFT	SKJ	BET	ALB	TOTAL
1991	6.13	3.66	0.20	0.01	10.10
1992	6.06	0.99	0.34	0.11	7.60
1993	6.77	1.93	0.95	0.14	9.81
1994	5.50	1.89	0.40	0.03	7.92
1995	6.00	1.18	0.27	0.02	7.51
1996	6.76	1.19	0.47	0.05	8.51
1997	6.45	1.11	0.33	0.01	7.91
1998	6.72	1.41	0.24	0.01	8.42
1999	6.71	2.32	0.31	0.00	9.41
2000	7.36	1.59	0.36	0.01	9.33
2001	7.82	1.39	0.45	0.00	9.67
2002	9.74	1.52	0.44	0.01	11.73
2003	9.85	2.25	0.51	0.02	12.72
2004	7.97	2.18	0.21	0.01	10.39
2005	9.90	1.42	0.38	0.24	11.94
2006	14.91	1.26	1.57	0.29	18.02
2007	10.59	0.80	0.88	0.01	12.28
2008	14.62	1.48	0.57	0.05	16.72
2009	10.31	0.63	0.65	0.04	11.63
2010	8.04	1.27	0.79	0.05	10.16
2011	10.68	1.45	0.82	0.02	13.01
2012	7.45	0.20	0.60	0.07	8.34
2013	9.26	1.69	0.64	0.03	11.64
2014	8.25	1.16	0.89	0.01	10.32
2015	7.21	1.41	0.40	0.02	9.11
2016	9.40	1.78	0.74	0.02	12.02