

STATISTICS OF THE FRENCH PURSE SEINE FISHING FLEET TARGETING TROPICAL TUNAS IN THE ATLANTIC OCEAN (1991-2014)

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SUMMARY

The French purse seine fleet was composed in 2014 of 9 purse seiners of storage capacity >700 t and >60 m length overall, and 1 support vessel of 40 m length overall. The fleet capacity and overall nominal effort have remained stable in the recent years with a total annual number of about 2,000 fishing sets made in 2014, among which 55% on free-swimming schools and 45% on schools associated with fish aggregating devices (FADs). The total number of buoys used for tracking FADs has remained stable during 2010-2014 at around 660 (SD = 100), despite some important variations between vessels and seasons. In 2014, the total landings of the French fleet reached more than 40,000 t and were composed of about 50% yellowfin, 40% skipjack, and less than 10% bigeye. Skipjack predominated in the catch on FAD-associated schools (i.e. 70% in 2014) while large yellowfin predominated in the free-swimming schools catch (i.e. 80% in 2014). Catch rates on FADs have steadily increased to exceed 10 t per searching day in 2014. This increase results from the combination of an increased number of sets on FADs and an increased expected catch per successful set related to increased mean weights of skipjack and yellowfin in the catch.

RÉSUMÉ

En 2014, la flottille de senneurs français était composée de neuf senneurs d'une capacité de stockage > 700 t et d'une longueur hors tout > 60 m et d'un navire de support de 40 m de longueur hors tout. La capacité de la flottille et l'effort nominal global sont restés stables ces dernières années, avec un nombre total annuel d'environ 2.000 opérations de pêche réalisées en 2014, dont 55 % sur bancs libres et 45 % sur des bancs associés à des dispositifs de concentration de poissons (DCP). Le nombre total des bouées utilisées pour le suivi des DCP est demeuré stable entre 2010 et 2014 à environ 660 (SD = 100), malgré quelques variations importantes entre les navires et les saisons. En 2014, les total des débarquements de la flottille française a atteint plus de 40.000 t et était composé d'environ 50 % d'albacore, 40 % de listao et moins de 10 % de thon obèse. Le listao prédominait dans les captures réalisées sur des bancs associés aux DCP (70 % en 2014), tandis que l'albacore prédominait dans les prises effectuées en bancs libres (80 % en 2014). Les taux de capture sous DCP n'ont cessé d'augmenter pour dépasser 10 t par jour de recherche en 2014. Cette augmentation résulte de la combinaison d'un nombre accru d'opérations sous DCP et d'une augmentation escomptée de la capture par opération réussie.

RESUMEN

La flota francesa de cerco se componía en 2014 de nueve cerqueros con una capacidad de almacenamiento de >700 t y >60 m de eslora total, y de un buque de apoyo de 40 m de eslora total. La capacidad de la flota y el esfuerzo nominal total han permanecido estables en años recientes, con un número total anual de aproximadamente 2000 lances pesqueros realizados en 2014, entre los cuales el 55% fue sobre bancos libres y el 45% sobre bancos asociados con dispositivos de concentración de peces (DCP). El número total de boyas usadas para hacer un seguimiento de los DCP ha permanecido estable durante 2010-2014 en aproximadamente 660 (SD = 100), a pesar de algunas variaciones importantes entre buques y temporadas. En 2014, los desembarques totales de la flota francesa alcanzaron más de 40.000 t y aproximadamente el

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50% correspondía a rabil, el 40% a listado y menos del 10% a patudo. El listado predominaba en la captura sobre bancos asociados a DCP (es decir, el 70% en 2014) mientras que el rabil grande predominaba en la captura sobre bancos libres (es decir el 80% en 2014). Las tasas de captura sobre DCP han aumentado de forma constante hasta superar las 10 t por día de búsqueda en 2014. Este aumento es consecuencia de la combinación de un mayor número de lances sobre DCP y de una mayor captura por lance con éxito prevista.

KEYWORDS

Catch statistics, FAD, Free-swimming school, High seas fisheries, Purse seining

1. Introduction

French tuna purse seiners have been fishing yellowfin (*Thunnus albacares*), skipjack (*Katsuwonus pelamis*), and bigeye tuna (*Thunnus obesus*) in the eastern Atlantic Ocean since the early 1960s (Postel 1965). Tuna schools are harvested through two major fishing modes that result in different species and size composition of the catch, i.e. tunas in free-swimming schools (FSC) and tunas associated with drifting floating objects now predominated by artificial fish aggregating devices (FAD). The French purse seine fishery has been monitored by the “Institut de Recherche pour le Développement” (IRD) since the late 1960s in collaboration with the 'Centre de Recherches Océanologiques' (CRO; Ivory Coast) and the 'Centre de Recherches Océanographiques de Dakar-Thiaroye' (CRODT; Sénégal). Here, we report a synthesis of the fishing activities of the French purse seiners during 1991-2014 based on the collection of logbooks and landing reports and sampling operations conducted at ports during unloading. No information on bycatch species and discards at-sea collected from observations at-sea is presented in the report.

2. Materials and Methods

Logbooks and sale reports were collected in collaboration with fishing companies and covered 100% of the fishing trips that occurred during 1991-2014.

2.1. Fishing effort

Nominal fishing effort was derived from logbooks and expressed in days-at-sea and fishing days considering that purse seiners operate during daylight. Searching time (days), which accounts for the expected time required for setting the purse seine, was also used to describe the nominal purse seine effort. Information on the number of FADs in use by the French fleet was derived from (i) the quarterly reports of buoy transmission activity available from satellite communication providers for each individual vessel, (ii) purse seine logbooks that include activities related to FADs and buoys since January 2013 and (iii) GPS location of French buoys that provide information on FAD deployment areas and drifting trajectories (Maufroy et al. 2015).

2.2. Catch

In 2014, a total of 256 samples were collected at unloading of French purse seiners in the ports of Abidjan and Dakar. Samples were used to estimate the size and species composition of the catch following a sampling and processing protocol common with purse seiners flying the flags of Spain, Guinea Conakry, Ivory Coast and other flags associated with the European purse seine fleet (Pallarés & Petit 1998). Hence, a total of 1,056 samples corresponding to more than 550,000 tunas measured were used in the processing of the French purse seine fishery data for 2014.

3. Fishing capacity and effort

3.1. Fleet capacity

In 2014, a total of 9 French purse seiners operated in the eastern Atlantic Ocean and conducted a total of 90 fishing trips lasting on average 32 days (**Figure 1**). The fleet was composed of 2 vessels of carrying capacity (CC) of 600-800 t, 5 vessels of CC 800-1200 t, and 2 vessels of CC >1,200 t (**Table 1**). In addition, a vessel of 40 m length overall has been operating in the eastern Atlantic Ocean since the second quarter of 2010 in support of

French purse seiners. Support vessel's activities mainly consist in searching for tuna schools and managing the stock of FADs and associated buoys through deployment of FADs, visits and retrieval of some buoys or FADs that drift outside the purse seine fishing grounds. The French support vessel spent a total of 225 days at sea in 2014, contributing to 7.5% of the cumulated time-at-sea of the French fishing fleet. The total storage fish capacity of the fleet was similar to that of 2012-13 and equal to about 12,700 m³, corresponding to 8,900 t of fish hold volume.

3.2. Nominal effort

Excluding the support vessel, the total nominal effort in 2014 was about 2,400 and 2,000 fishing and searching days, respectively (**Figure 2** and **Table 2**). The overall spatial extent of the fishery was similar to that observed on average during 2009-2013, corresponding to a total of 234 squares of 1° longitude and latitude where some effort was exerted in 2014 (**Figure 3** and **Table 3**). In 2014, the effort however extended further north, i.e. from the coasts of Mauritania up to 18°N, and down to 12°S along the coasts of Angola (**Figure 4**). It was the first time since 2001-2002 that the French purse seine fleet operated in the fishing grounds of Mauritania while the Spanish fleet has been fishing in the area since 2012 (Delgado de Molina *et al.* 2015).

The total number of emitting buoys for the French purse seine fleet has remained stable at around 660 (SD = 100) during 2010-2014. Automatic reports provided by satellite data transmitters indicated that the total number of buoys having emitted in 2014 varied between a minimum of 610 during July-September to a maximum of 974 during January-March (**Figure 5**). This corresponded to a median number of buoys by French purse seiner varying between 50 and 80 on a quarterly basis (**Figure 6**). These figures are conservative (i.e. high estimates) as buoys can be shared between vessels and are then repeated in quarterly reports. Information on FAD activities reported in the logbooks provided complementary information to the buoy activation reports and showed that the area of FAD deployments and buoys transfers overlaid with the whole fishing grounds of the fleet (**Figure 7**). The Cape Lopez appeared as the most active area of buoy transfers and FAD visits during August-October in relation with the enrichment of the area through the Ogooué river in Gabon and Congo river in the Democratic Republic of the Congo. Data on FAD trajectories estimated from GPS location of buoys showed that French FADs occurred all over the Gulf of Guinea, with some concentration off the coasts of Gabon, Angola and Guinea to a lesser extent (**Figure 8**).

The total annual number of fishing sets was rather stable during 2010-2014 at about 2,000 sets y⁻¹, among which about 45% were made on FAD-associated schools and 55% on FSCs in 2014 (**Figure 9**). Proportions of successful sets were high in 2014, i.e. 95% on FAD-associated schools and 78% of free-swimming schools (**Table 4**).

4. Fishery production

Landings of the principal market tunas by the French purse seine fleet operating in the eastern Atlantic Ocean reached a total of 40,000 t in 2014 (**Figure 10**). The magnitude and composition of landings were very similar as that observed for 2013, with about 51%, 41%, and 8% of yellowfin, skipjack, and bigeye, respectively (**Table 5**). Catches on FAD-associated schools represented 50% of the catch in 2014 and were predominated by SKJ (70%), while YFT and BET accounted for 21% and 8% of the FAD catch, respectively (**Figure 11-a** and **Table 6**). Catches on free-swimming schools were predominated by large YFT which represented 80% of the catch (**Figure 11-b** and **Table 7**). The French purse seine catch was distributed from 15°N-20°N off the coasts of Mauritania down to 12°S off the coast of Angola (**Figure 12**). FAD catch was concentrated off Mauritania and off Gabon in the Cape Lopez area (**Figure 13**) while FSC catch was more spread across the Gulf of Guinea (**Figure 14**).

The total number of sets per searching day was about 1 in 2014, close to that observed during 2008-2013 (**Figure 15a** and **Table 8**). Between 2013 and 2014, the average catch of YFT per positive set increased by 50% on FAD-associated schools (i.e. from 3.3 t to 5.1 t; **Table 9**) while it decreased by 8% on free-swimming schools (i.e. from 20.1 t to 18.7 t) (**Figure 15b** and **Table 10**). The average catch of SKJ per set on FADs remained at around 16.5 t in 2014. Overall, the increasing trend in the number of sets per searching day combined with the increased catch rates of YFT and SKJ since 2008 has resulted in a progressive increasing catch on FADs that reached in 2014 a maximum value of 10.5 t per searching day (**Figure 16a** and **Table 11**). The total catch on FSC per searching day, predominated by YFT, was at a low value of 10.3 t in 2014 (**Figure 16b** and **Table 12**).

5. Conclusions

Since the return of several purse seiners from the Indian to the Atlantic Ocean in 2009-2010, the nominal effort of the French purse seine fishing fleet operating in the eastern Atlantic Ocean and associated catches have remained rather stable in the last 4 years, despite the decrease in catch in 2012 that has been mainly explained by the non access to the fishing grounds of Gabon. In the case of the French purse seine fleet, a support vessel has been shared within the fleet since 2010 to manage a stock of drifting FADs as well as to search for free-swimming schools. The effort of such support vessel should be accounted for in the overall effort of the fishery as it directly contributes to the efficiency of the purse seiners. Nevertheless, such information is currently lacking in the statistics available at ICCAT. Similarly and although informative on the relative density of satellite-tracked floating objects in the Atlantic, information on drifting FADs from other fleets and fisheries is essential to assess the potential effects of FADs on the biology and distribution of tunas (Hallier & Gaertner 2008, Sempo *et al.* 2013).

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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 Atlantic Ocean during 1991-2014. *N* = Total number of purse seiners having operated at least 1 day. *Nw* = Total number of purse seiners weighed by the proportion of months of activity. *CC* = Total carrying capacity (t) weighted by the proportion of months at sea.

Year	50-400	401-600	601-800	801-1200	1201-2000	>2000	N	Nw	CC
1991	2	9	6	6	0	0	23	17.42	11850
1992	1	8	2	6	0	0	17	16.08	11457
1993	1	8	3	6	0	0	18	16.33	11870
1994	1	8	3	6	0	0	18	16.83	12121
1995	0	10	2	5	0	0	17	14.92	10863
1996	0	9	2	5	0	0	16	15.75	11243
1997	0	10	2	5	2	0	19	14.67	11331
1998	0	7	2	6	0	0	15	14.58	11071
1999	0	8	2	5	0	0	15	14	10538
2000	0	7	2	5	0	0	14	13.5	10248
2001	0	7	2	7	1	0	17	14	11314
2002	0	8	3	5	1	0	17	12.25	9601
2003	0	8	1	5	0	0	14	12.42	9610
2004	0	6	1	5	0	0	12	10.08	8345
2005	0	4	0	5	0	0	9	8.25	6980
2006	0	4	0	3	0	0	7	5.42	4040
2007	0	3	0	2	0	0	5	4.67	3581
2008	0	3	2	2	0	0	7	4.67	3678
2009	0	1	2	4	3	0	10	7.33	6876
2010	0	1	2	4	3	0	10	9.08	8846
2011	0	1	2	4	2	0	9	8.17	7945
2012	0	0	2	5	2	0	9	8.67	8986
2013	0	0	2	5	2	0	9	8.42	8715
2014	0	0	2	5	2	0	9	8.58	8908

Table 2. Annual nominal fishing effort of the French purse seine fishing fleet expressed in fishing and searching days during 1991-2014. 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	4843	4193
1992	4568	4069
1993	4576	3969
1994	4815	4225
1995	4293	3717
1996	4550	3910
1997	4300	3829
1998	4361	3837
1999	3933	3434
2000	3898	3419
2001	4049	3590
2002	3364	2955
2003	3360	2837
2004	2855	2469
2005	2274	1973
2006	1388	1189
2007	1278	1126
2008	1263	1052
2009	2019	1693
2010	2549	2110
2011	2214	1821
2012	2474	2079
2013	2341	1921
2014	2418	1988

Table 3. Annual number of 1-degree squares explored by the French purse seine fishing fleet in the Atlantic Ocean during 1991-2014. #sets indicates squares where a least 1 fishing set was made.

Year	TOTAL	#sets	Catch >0	Effort > 1 d	Effort > 5 d
1991	389	292	272	313	213
1992	423	293	287	339	215
1993	374	270	260	296	192
1994	420	337	334	358	256
1995	405	307	299	329	200
1996	391	302	291	325	209
1997	464	334	295	373	220
1998	466	355	332	369	214
1999	365	272	260	290	184
2000	368	289	274	299	184
2001	412	283	272	322	195
2002	360	262	249	291	185
2003	358	247	240	267	163
2004	343	254	240	259	149
2005	350	232	216	257	137
2006	264	167	161	182	85
2007	272	166	153	194	84
2008	258	156	146	161	80
2009	332	221	206	228	121
2010	325	256	241	262	142
2011	364	248	235	257	128
2012	345	245	232	239	126
2013	369	239	230	245	122
2014	337	230	222	234	126

Table 4. Number of positive and null sets by fishing mode made by the French purse seine fishing fleet in the Atlantic Ocean during 1991-2014. FAD = Fish Aggregating Device ; FSC = Free-Swimming School.

Year	ALL			FAD			FSC			% Log
	Total	Positive	Null	Total	Positive	Null	Total	Positive	Null	
1991	3247	2521	726	853	772	81	2394	1749	645	26
1992	2685	2140	545	955	857	98	1730	1283	447	36
1993	3232	2650	582	1172	1116	56	2060	1534	526	36
1994	3135	2581	554	1377	1296	81	1758	1285	473	44
1995	3126	2508	618	1394	1294	100	1732	1214	518	45
1996	3519	2670	849	1347	1212	135	2172	1458	714	38
1997	2598	1908	690	816	725	91	1782	1183	599	31
1998	2889	2162	727	988	913	75	1901	1249	652	34
1999	2745	1995	750	720	653	67	2025	1342	683	26
2000	2616	1971	645	683	622	61	1933	1349	584	26
2001	2500	1904	596	630	560	70	1870	1344	526	25
2002	2209	1678	531	577	545	32	1632	1133	499	26
2003	2838	2263	575	701	662	39	2137	1601	536	25
2004	2075	1657	418	712	669	43	1363	988	375	34
2005	1613	1297	316	459	439	20	1154	858	296	28
2006	1059	828	231	221	214	7	838	614	224	21
2007	819	635	184	171	156	15	648	479	169	21
2008	1018	770	248	188	177	11	830	593	237	18
2009	1595	1253	342	451	400	51	1144	853	291	28
2010	2133	1725	408	872	826	46	1261	899	362	41
2011	1908	1503	405	645	586	59	1263	917	346	34
2012	1913	1556	357	900	813	87	1013	743	270	47
2013	2016	1631	385	824	748	76	1192	883	309	41
2014	2033	1734	299	903	857	46	1130	877	253	44

Table 5. Catch by species for the French purse seine fishing fleet of the Atlantic Ocean during 1991-2014.

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
1991	30172	31814	3327	50	529	65893
1992	30778	20383	4985	451	236	56833
1993	33590	31537	10629	565	83	76404
1994	32381	30251	10075	130	140	72977
1995	27850	22542	6262	83	182	56919
1996	32179	21370	6778	191	184	60702
1997	29065	13335	4209	39	157	46805
1998	30468	14144	3641	40	146	48440
1999	28833	19457	3383	13	104	51791
2000	29506	16642	3936	23	94	50200
2001	31183	13774	3943	11	109	49020
2002	32982	13806	3597	18	113	50517
2003	32268	17318	3289	63	159	53096
2004	23413	19982	2417	19	168	45998
2005	22073	12606	1913	478	47	37117
2006	18353	5423	2402	347	10	26534
2007	12775	4012	1485	12	72	18356
2008	15929	3661	989	50	0	20629
2009	18545	6602	2043	60	24	27274
2010	19974	13983	3199	109	99	37365
2011	21427	12088	3268	53	152	36990
2012	18243	11749	3574	161	273	33999
2013	20260	15559	3197	73	256	39345
2014	20763	16637	3475	47	147	41069

Table 6. Catch by species made on FAD-associated schools for the French purse seine fishing fleet of the Atlantic Ocean during 1991-2014.

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
1991	4476	16465	2501	0	136	23578
1992	6116	16370	3619	0	509	26614
1993	6723	23884	6853	0	432	37892
1994	9124	22273	8372	0	721	40489
1995	5549	18155	5274	4	933	29915
1996	5750	16736	4941	0	559	27985
1997	4371	9076	2945	0	457	16850
1998	4669	8725	2712	0	787	16893
1999	5795	11478	2316	0	289	19877
2000	4335	11207	2696	0	405	18643
2001	3090	8792	2335	0	243	14459
2002	4198	9308	2287	0	164	15957
2003	4332	10937	1833	0	372	17473
2004	3742	14602	1901	0	191	20435
2005	2547	9805	1165	5	47	13569
2006	626	3925	541	0	12	5104
2007	850	3112	489	0	98	4549
2008	557	2103	391	0	37	3088
2009	1089	5531	939	0	24	7583
2010	3001	11297	1530	13	92	15932
2011	1978	9443	1776	12	96	13305
2012	2756	11335	2321	15	312	16739
2013	2476	12317	1972	15	391	17173
2014	4365	14327	1711	19	395	20817

Table 7. Catch by species made on free-swimming schools for the French purse seine fishing fleet of the Atlantic Ocean during 1991-2014.

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
1991	25696	15349	826	50	417	42339
1992	24662	4013	1366	451	208	30700
1993	26867	7653	3776	565	11	38872
1994	23257	7979	1703	130	81	33150
1995	22301	4387	988	79	78	27834
1996	26430	4634	1837	191	11	33102
1997	24694	4259	1264	39	35	30290
1998	25799	5419	930	40	33	32221
1999	23038	7980	1067	13	30	32128
2000	25170	5435	1240	23	10	31878
2001	28094	4982	1608	11	33	34727
2002	28784	4498	1310	18	3	34614
2003	27936	6382	1456	63	4	35840
2004	19671	5380	516	19	73	25660
2005	19527	2801	749	472	0	23548
2006	17727	1498	1861	347	0	21433
2007	11925	900	996	12	0	13834
2008	15372	1558	598	50	0	17578
2009	17456	1071	1104	60	0	19691
2010	16973	2687	1668	97	8	21433
2011	19449	2646	1493	41	56	23685
2012	15486	414	1253	146	23	17323
2013	17784	3242	1224	58	47	22356
2014	16399	2310	1764	27	10	20510

Table 8. Number of sets per searching on FAD-associated (FAD) and free-swimming schools (FSC) for the French purse seine fishing fleet of the Atlantic Ocean during 1991-2014.

Year	ALL	FAD	FSC
1991	0.77	0.2	0.57
1992	0.66	0.23	0.43
1993	0.81	0.3	0.52
1994	0.74	0.33	0.42
1995	0.84	0.38	0.47
1996	0.9	0.34	0.56
1997	0.68	0.21	0.47
1998	0.75	0.26	0.5
1999	0.8	0.21	0.59
2000	0.77	0.2	0.57
2001	0.7	0.18	0.52
2002	0.75	0.2	0.55
2003	1	0.25	0.75
2004	0.84	0.29	0.55
2005	0.82	0.23	0.59
2006	0.89	0.19	0.7
2007	0.73	0.15	0.58
2008	0.97	0.18	0.79
2009	0.94	0.27	0.68
2010	1.01	0.41	0.6
2011	1.05	0.35	0.69
2012	0.92	0.43	0.49
2013	1.05	0.43	0.62
2014	1.02	0.45	0.57

Table 9. Catch per unit of effort (in t per positive set) on FAD-associated schools for the French purse seine fishing fleet of the Atlantic Ocean during 1991-2014.

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
1991	5.8	21.33	3.24	0	0.18	30.54
1992	7.14	19.1	4.22	0	0.59	31.05
1993	6.02	21.4	6.14	0	0.39	33.95
1994	7.04	17.19	6.46	0	0.56	31.24
1995	4.29	14.03	4.08	0	0.72	23.12
1996	4.74	13.81	4.08	0	0.46	23.09
1997	6.03	12.52	4.06	0	0.63	23.24
1998	5.11	9.56	2.97	0	0.86	18.5
1999	8.87	17.58	3.55	0	0.44	30.44
2000	6.97	18.02	4.33	0	0.65	29.97
2001	5.52	15.7	4.17	0	0.43	25.82
2002	7.7	17.08	4.2	0	0.3	29.28
2003	6.54	16.52	2.77	0	0.56	26.39
2004	5.59	21.83	2.84	0	0.29	30.55
2005	5.8	22.33	2.65	0.01	0.11	30.91
2006	2.93	18.34	2.53	0	0.06	23.85
2007	5.45	19.95	3.13	0	0.63	29.16
2008	3.15	11.88	2.21	0	0.21	17.45
2009	2.72	13.83	2.35	0	0.06	18.96
2010	3.63	13.68	1.85	0.02	0.11	19.29
2011	3.38	16.11	3.03	0.02	0.16	22.7
2012	3.39	13.94	2.85	0.02	0.38	20.59
2013	3.31	16.47	2.64	0.02	0.52	22.96
2014	5.09	16.72	2	0.02	0.46	24.29

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 Atlantic Ocean during 1991-2014.

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
1991	14.69	8.78	0.47	0.03	0.24	24.21
1992	19.22	3.13	1.06	0.35	0.33	24.09
1993	17.51	4.99	2.46	0.37	0.04	25.38
1994	18.1	6.21	1.33	0.1	0.31	26.04
1995	18.37	3.61	0.81	0.07	0.14	23
1996	18.13	3.18	1.26	0.13	0.11	22.81
1997	20.87	3.6	1.07	0.03	0.04	25.61
1998	20.66	4.34	0.74	0.03	0.11	25.88
1999	17.17	5.95	0.8	0.01	0.16	24.08
2000	18.66	4.03	0.92	0.02	0.02	23.65
2001	20.9	3.71	1.2	0.01	0.02	25.84
2002	25.41	3.97	1.16	0.02	0.04	30.59
2003	17.45	3.99	0.91	0.04	0.15	22.54
2004	19.91	5.45	0.52	0.02	0.07	25.97
2005	22.76	3.26	0.87	0.55	0	27.45
2006	28.87	2.44	3.03	0.57	0	34.91
2007	24.9	1.88	2.08	0.03	0	28.88
2008	25.92	2.63	1.01	0.08	0	29.64
2009	20.46	1.26	1.29	0.07	0	23.08
2010	18.88	2.99	1.86	0.11	0.01	23.84
2011	21.21	2.89	1.63	0.04	0.06	25.83
2012	20.84	0.56	1.69	0.2	0.05	23.34
2013	20.14	3.67	1.39	0.07	0.06	25.32
2014	18.7	2.63	2.01	0.03	0.03	23.4

Table 11. Catch per unit of effort (in t per searching day) on FAD-associated schools for the French purse seine fishing fleet of the Atlantic Ocean during 1991-2014.

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
1991	1.07	3.93	0.6	0	0.03	5.62
1992	1.5	4.02	0.89	0	0.13	6.54
1993	1.69	6.02	1.73	0	0.11	9.55
1994	2.16	5.27	1.98	0	0.17	9.58
1995	1.49	4.88	1.42	0	0.25	8.05
1996	1.47	4.28	1.26	0	0.14	7.16
1997	1.14	2.37	0.77	0	0.12	4.4
1998	1.22	2.27	0.71	0	0.21	4.4
1999	1.69	3.34	0.67	0	0.08	5.79
2000	1.27	3.28	0.79	0	0.12	5.45
2001	0.86	2.45	0.65	0	0.07	4.03
2002	1.42	3.15	0.77	0	0.06	5.4
2003	1.53	3.86	0.65	0	0.13	6.16
2004	1.52	5.91	0.77	0	0.08	8.28
2005	1.29	4.97	0.59	0	0.02	6.88
2006	0.53	3.3	0.45	0	0.01	4.29
2007	0.75	2.76	0.43	0	0.09	4.04
2008	0.53	2	0.37	0	0.04	2.94
2009	0.64	3.27	0.55	0	0.01	4.48
2010	1.42	5.35	0.73	0.01	0.04	7.55
2011	1.09	5.19	0.98	0.01	0.05	7.31
2012	1.33	5.45	1.12	0.01	0.15	8.05
2013	1.29	6.41	1.03	0.01	0.2	8.94
2014	2.2	7.21	0.86	0.01	0.2	10.47

Table 12. Catch per unit of effort (in t per searching day) on free swimming schools for the French purse seine fishing fleet of the Atlantic Ocean during 1991-2014.

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
1991	6.13	3.66	0.2	0.01	0.1	10.1
1992	6.06	0.99	0.34	0.11	0.1	7.6
1993	6.77	1.93	0.95	0.14	0.02	9.81
1994	5.5	1.89	0.4	0.03	0.09	7.92
1995	6	1.18	0.27	0.02	0.04	7.51
1996	6.76	1.19	0.47	0.05	0.04	8.51
1997	6.45	1.11	0.33	0.01	0.01	7.91
1998	6.72	1.41	0.24	0.01	0.04	8.42
1999	6.71	2.32	0.31	0	0.06	9.41
2000	7.36	1.59	0.36	0.01	0.01	9.33
2001	7.82	1.39	0.45	0	0.01	9.67
2002	9.74	1.52	0.44	0.01	0.02	11.73
2003	9.85	2.25	0.51	0.02	0.09	12.72
2004	7.97	2.18	0.21	0.01	0.03	10.39
2005	9.9	1.42	0.38	0.24	0	11.94
2006	14.91	1.26	1.57	0.29	0	18.02
2007	10.59	0.8	0.88	0.01	0	12.28
2008	14.62	1.48	0.57	0.05	0	16.72
2009	10.31	0.63	0.65	0.04	0	11.63
2010	8.04	1.27	0.79	0.05	0	10.16
2011	10.68	1.45	0.82	0.02	0.03	13.01
2012	7.45	0.2	0.6	0.07	0.02	8.34
2013	9.26	1.69	0.64	0.03	0.03	11.64
2014	8.25	1.16	0.89	0.01	0.01	10.32

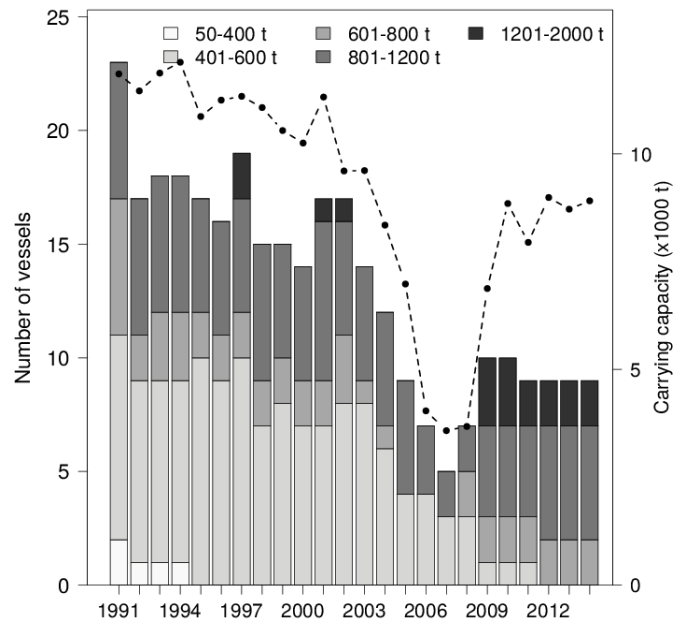


Figure 1. Fishing capacity of the French purse seine fishing fleet in the Atlantic Ocean. Annual changes in the number of purse seiners by size category (barplots) and total carrying capacity (dashed line with circles) during 1991-2014.

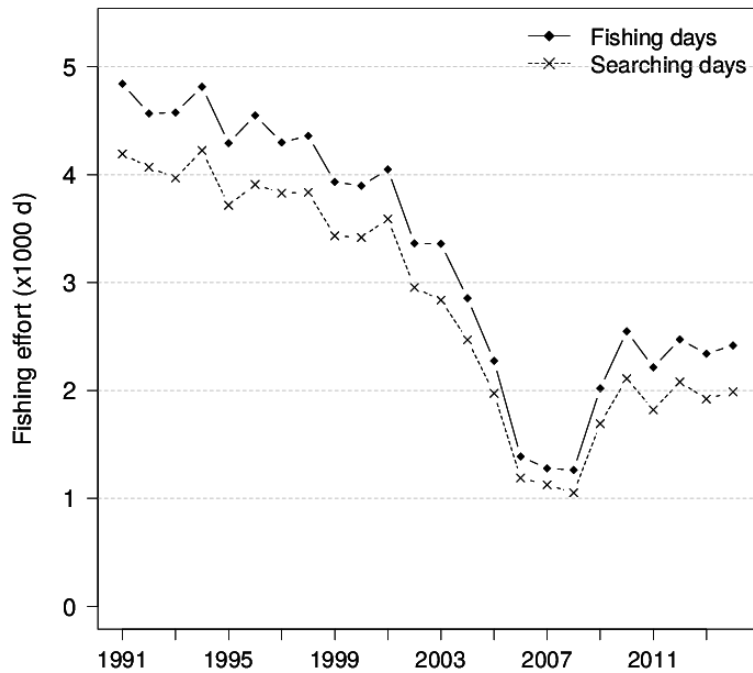


Figure 2. Changes in nominal effort over time. Annual total number of fishing and searching days for the French purse seine fishing fleet in the Atlantic Ocean during 1991-2014.

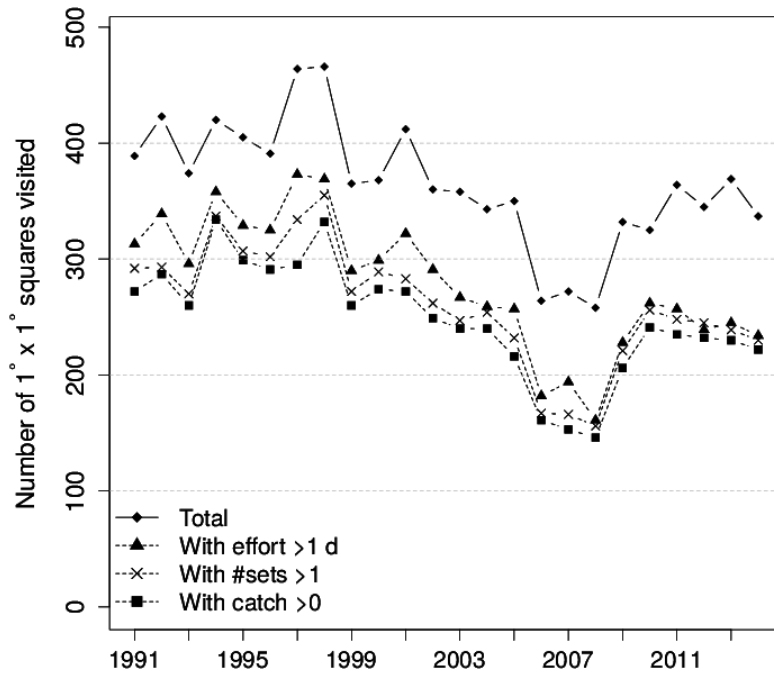


Figure 3. Annual number of 1-degree squares explored by the French purse seine fleet during 1991-2014.

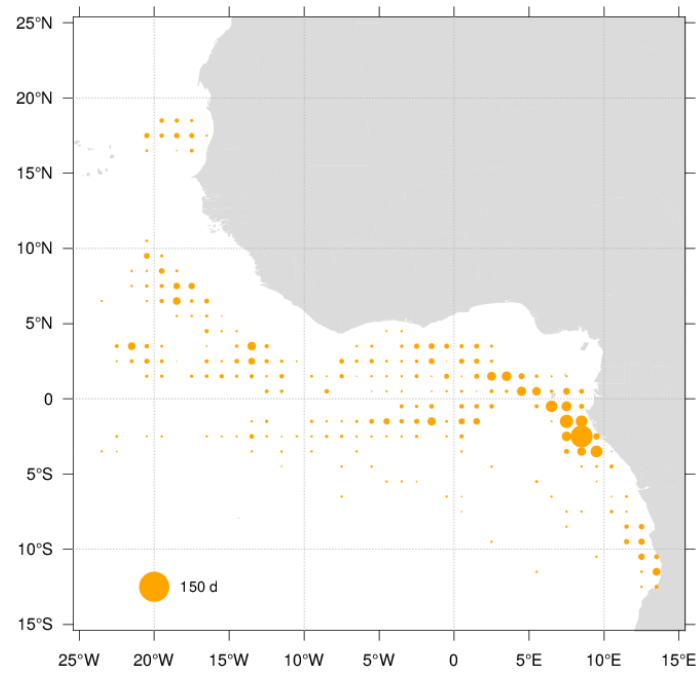


Figure 4. Fishing grounds. Spatial distribution of fishing effort (in searching days) of the French purse seine fishing fleet in 2014.

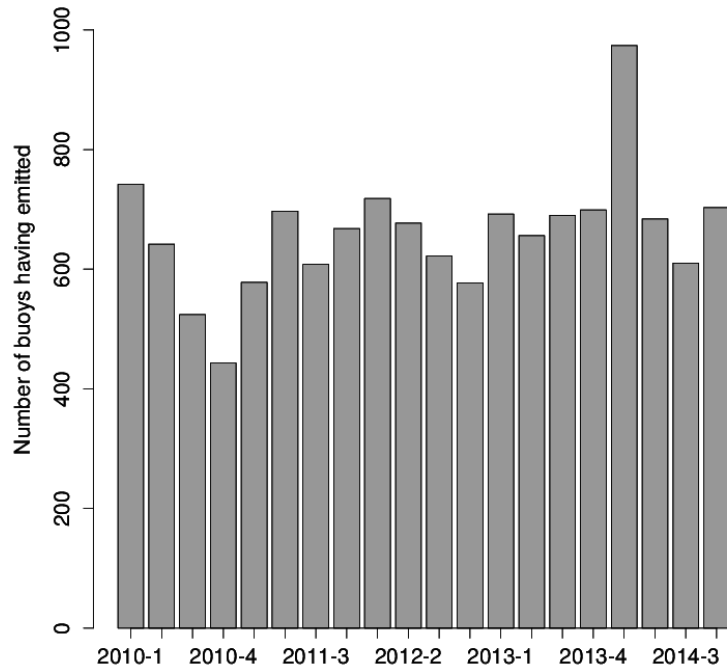


Figure 5. Total quarterly number of buoys of the French purse seine fleet having emitted in the eastern Atlantic Ocean during 2010-2014.

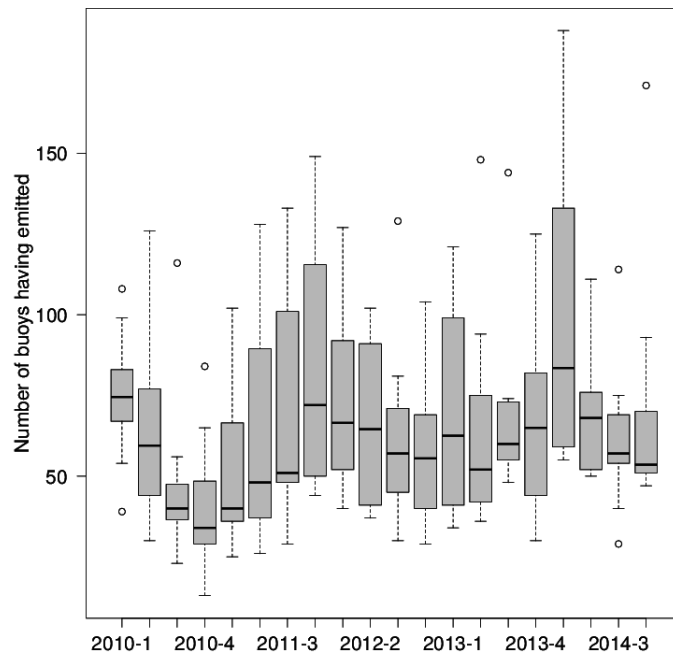


Figure 6. Quarterly number of buoys by French purse seiner and their support vessel having emitted during 2010-2014.

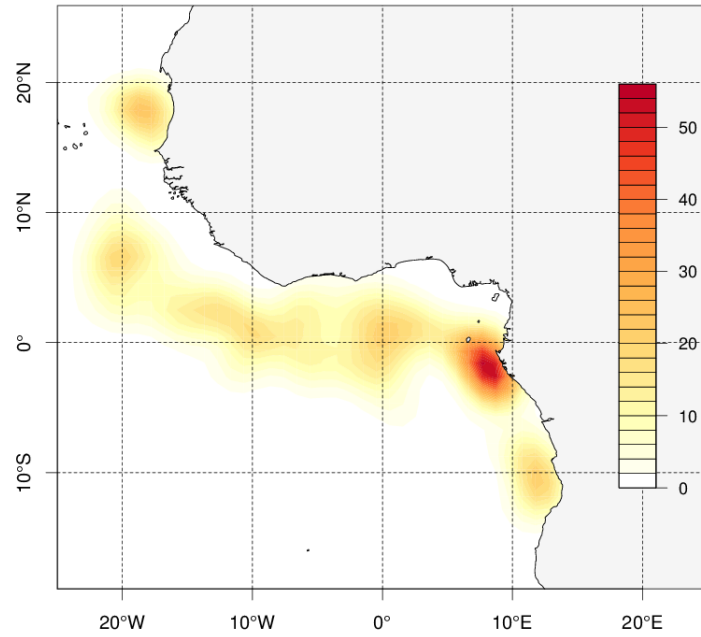


Figure 7. Location of deployments of fish aggregating devices and buoy transfers on existing FADs in the Atlantic Ocean in 2014 as reported in the logbooks.

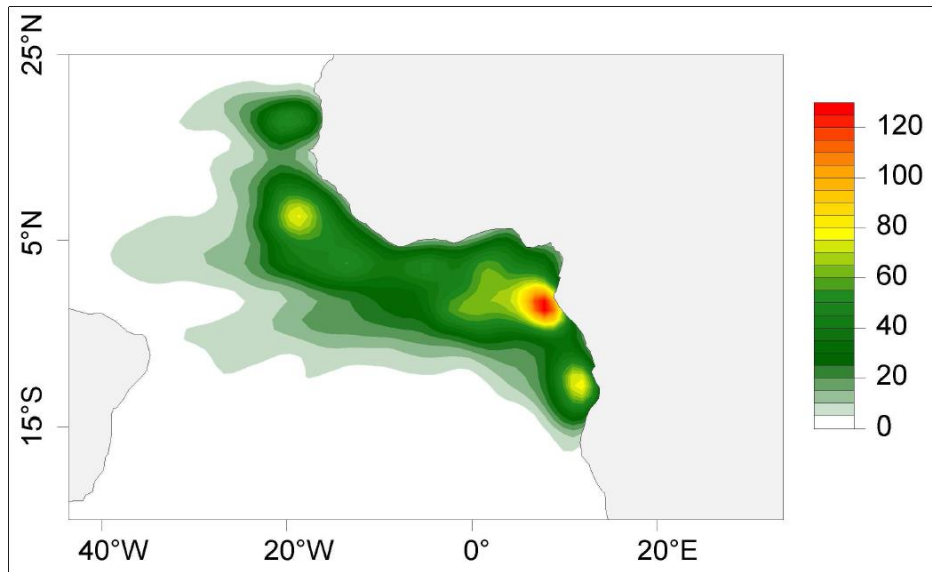


Figure 8. Density map of occurrence of fish aggregating devices (including natural floating objects and artificial rafts) equipped with French GPS tracking buoys in the Atlantic Ocean in 2014.

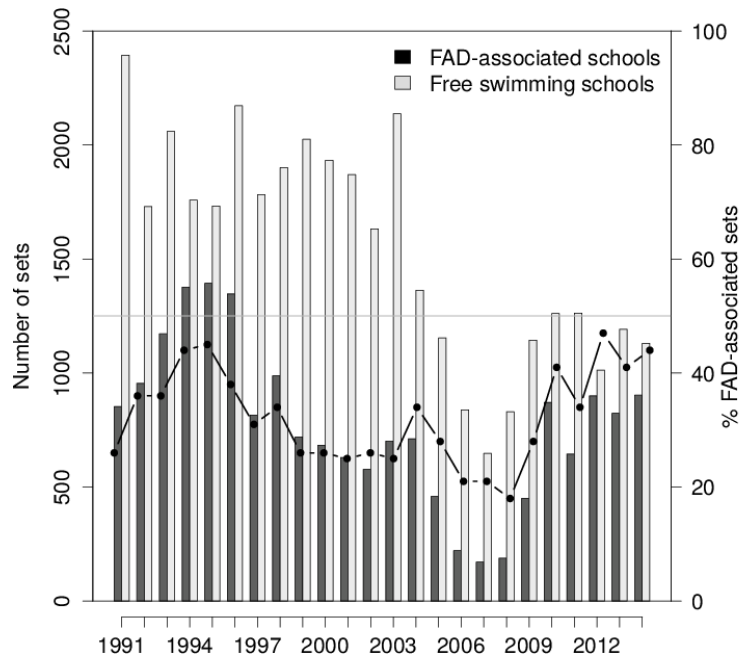


Figure 9. Fishing operations. Annual number of fishing sets in the French purse seine fishery on FAD-associated and free-swimming schools during 1991-2014. Line with solid circles indicates the percentage of sets made on FAD-associated schools over free-swimming schools. Grey solid line indicates the 50% value.

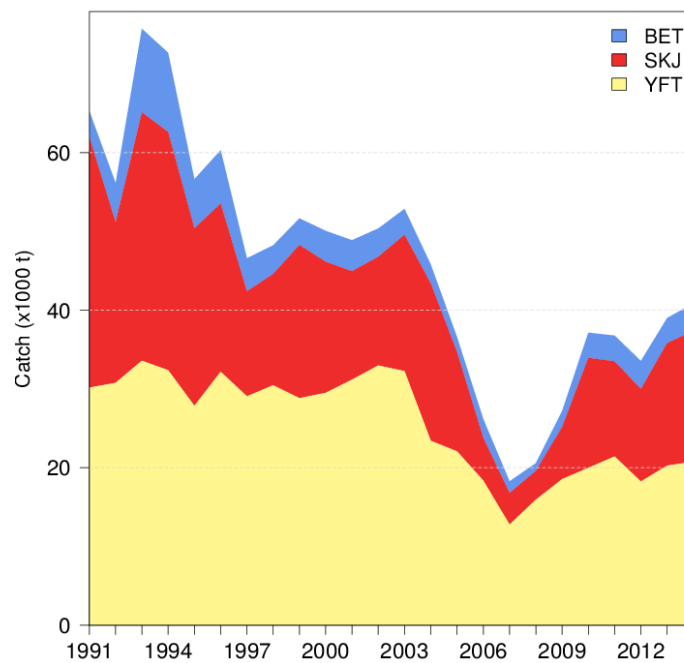


Figure 10. Total fishery production. Catch by species of the French purse seine fishing fleet during 1991-2014.

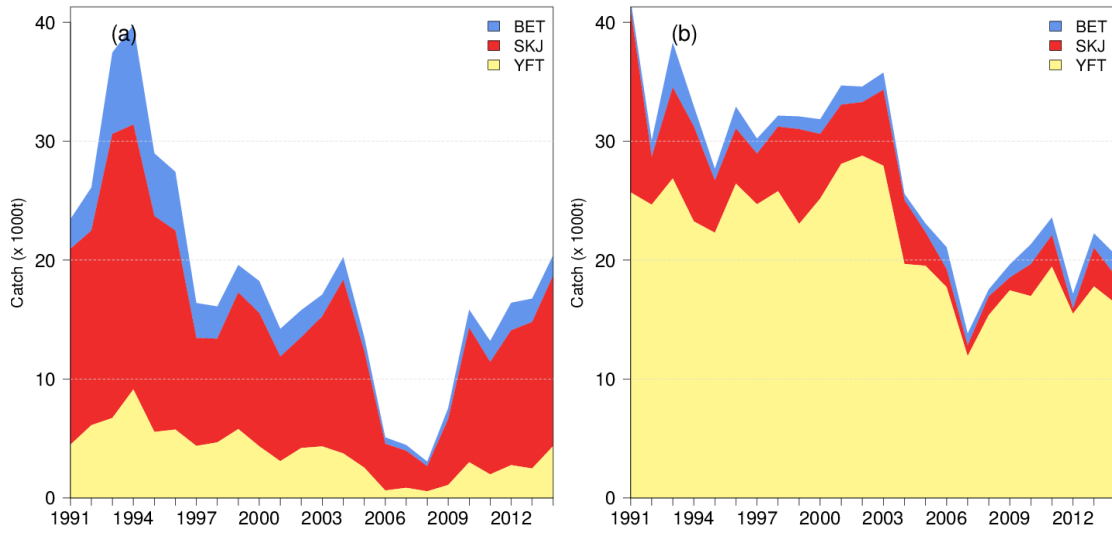


Figure 11. Fishery production by major fishing mode. Catch by species of the French purse seine fishing fleet on (a) FAD-associated and (b) free-swimming schools during 1991-2014.

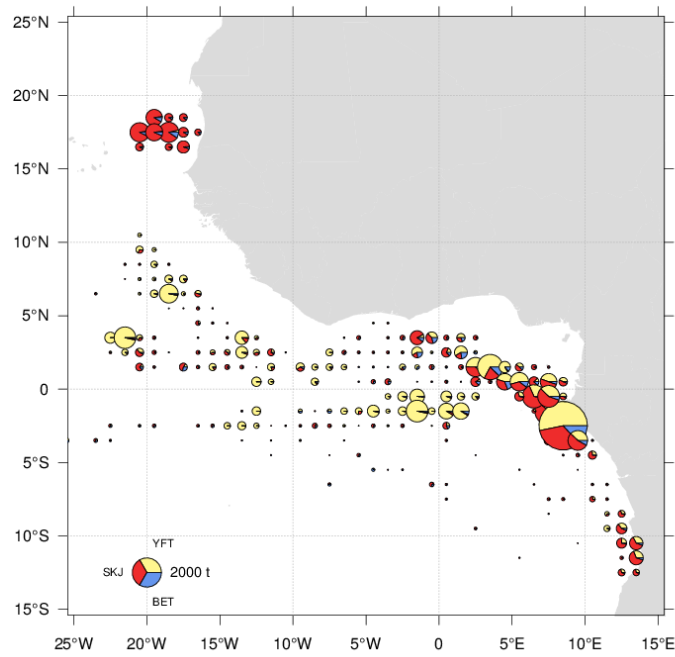


Figure 12. Spatial distribution of tuna catches of the French purse seine fishing fleet in 2014.

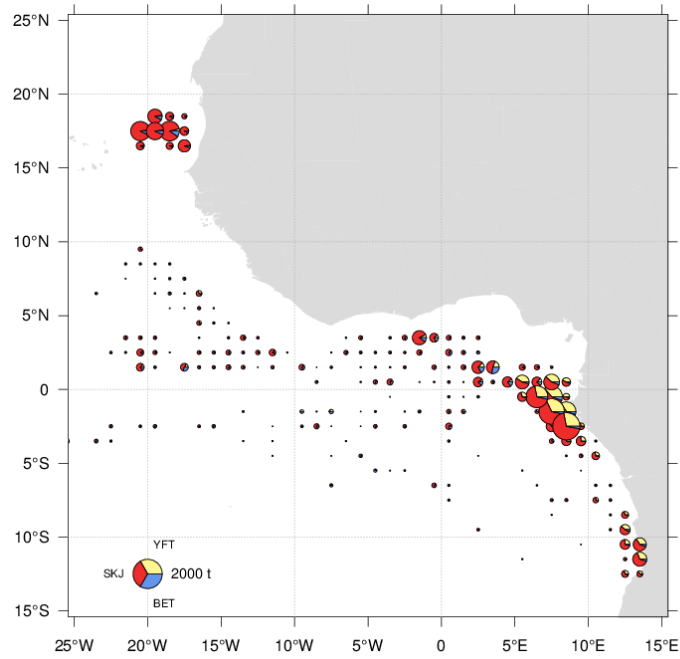


Figure 13. Spatial distribution of tuna catches of the French purse seine fishing fleet made on FAD-associated schools in 2014.

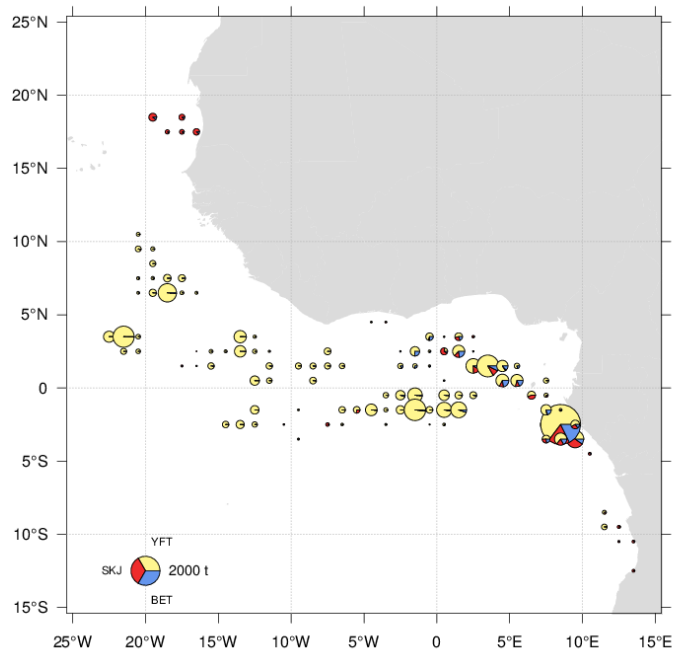


Figure 14. Spatial distribution of tuna catches of the French purse seine fishing fleet made on FSC-associated schools in 2014.

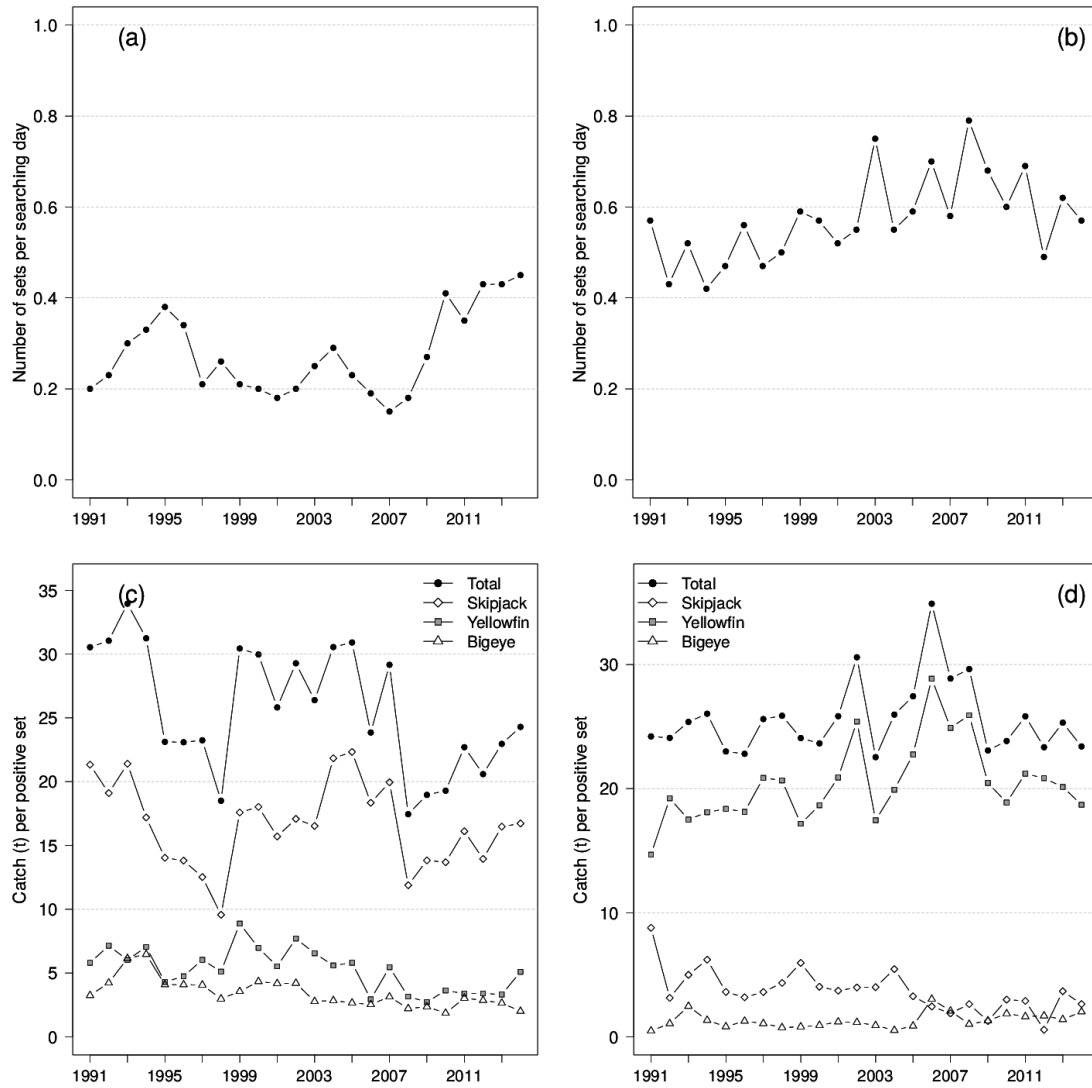


Figure 15. (a-b) Annual number of sets per searching day and (c-d) catch per positive set on (left panel) FAD-associated and (right panel) free-swimming schools for the French purse seine fishing fleet in the Atlantic Ocean during 1991-2014.

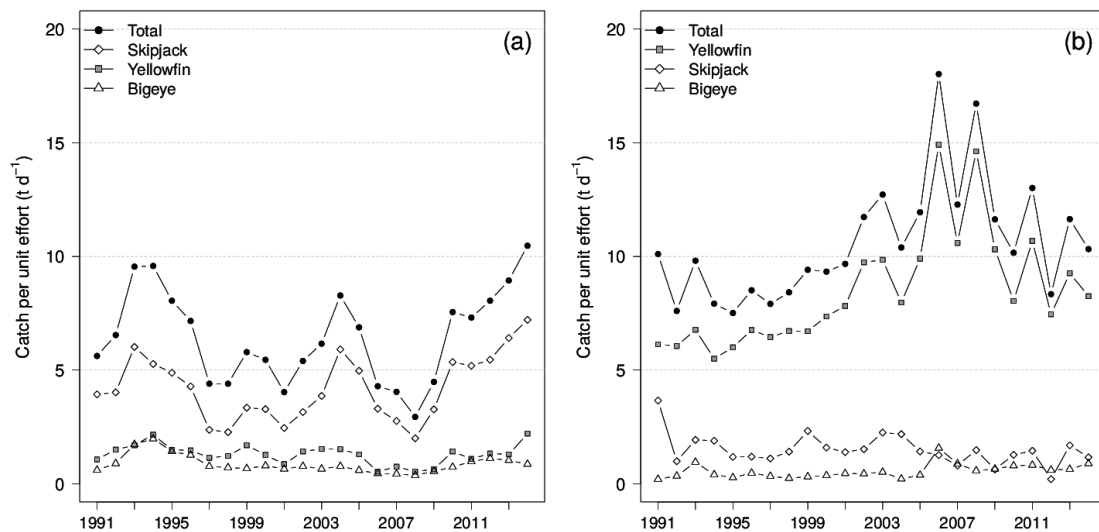


Figure 16. Annual catch rates (in t per searching day) of the French purse seine fishing fleet on (a) FAD-associated and (b) free-swimming schools in the Atlantic Ocean during 1991-2014.