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Statistics of the French purse seine fishing fleet targeting tropical tunas in the Indian Ocean (1981-2012)

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SUMMARY

France

KEYWORDS: fish aggregating device, *Katsuwonus pelamis*, *Thunnus albacares*, *Thunnus obesus*

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1. Introduction

French purse seiners operating in the Indian Ocean 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: fish aggregating device-associated (FAD) and free-swimming schools (FSC). Statistical data for the French purse seine 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 fleet activities are described through a suite of fisheries indicators that provide information on fishing capacity, effort, catch, and catch rates for the principal market tropical tunas, with a particular focus on the year 2012.

2. Fishing capacity and effort

3. Fisheries production

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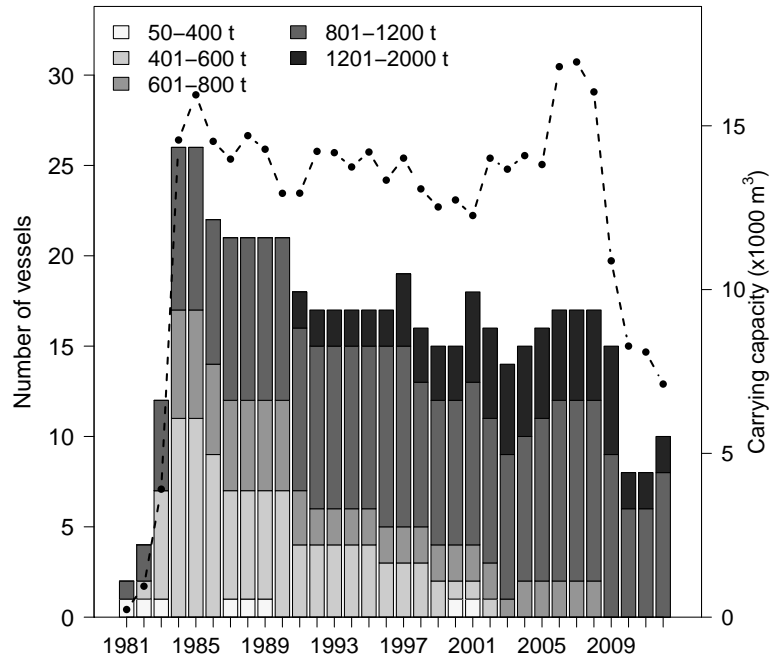


Figure 1: Fishing capacity of the French purse seine fishing fleet in the Indian Ocean. Annual changes in the number of purse seiners by size category (barplots) and total carrying capacity (solid line with circles) during 1981-2012. Capacity was weighted by the vessel-specific proportion of the year at sea (in months). The vessel size category (t) was computed as 0.7 times the capacity expressed in m^3

4. Figures

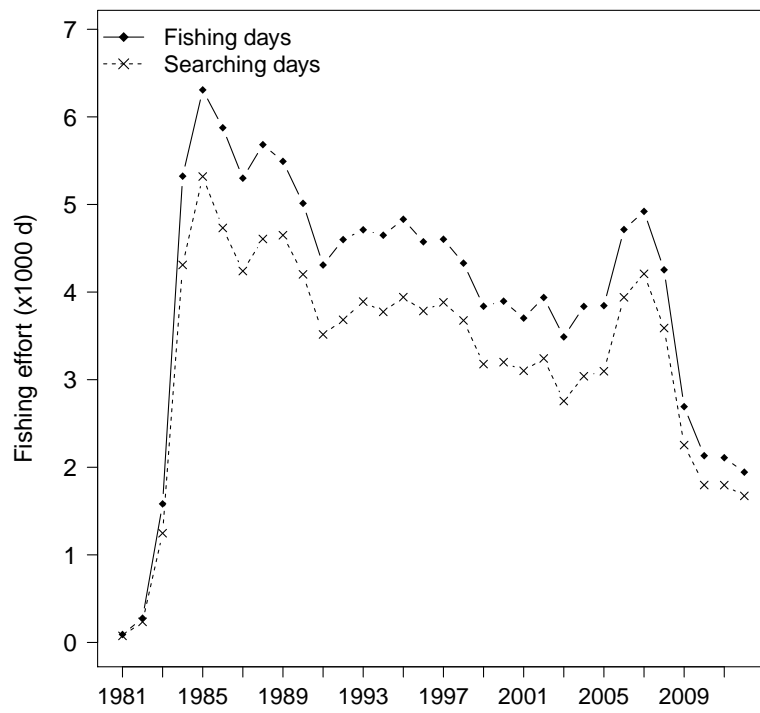


Figure 2: Changes in nominal effort over time. Annual total number of fishing and searching days for the French purse seine fishing fleet in the Indian Ocean during 1981-2012

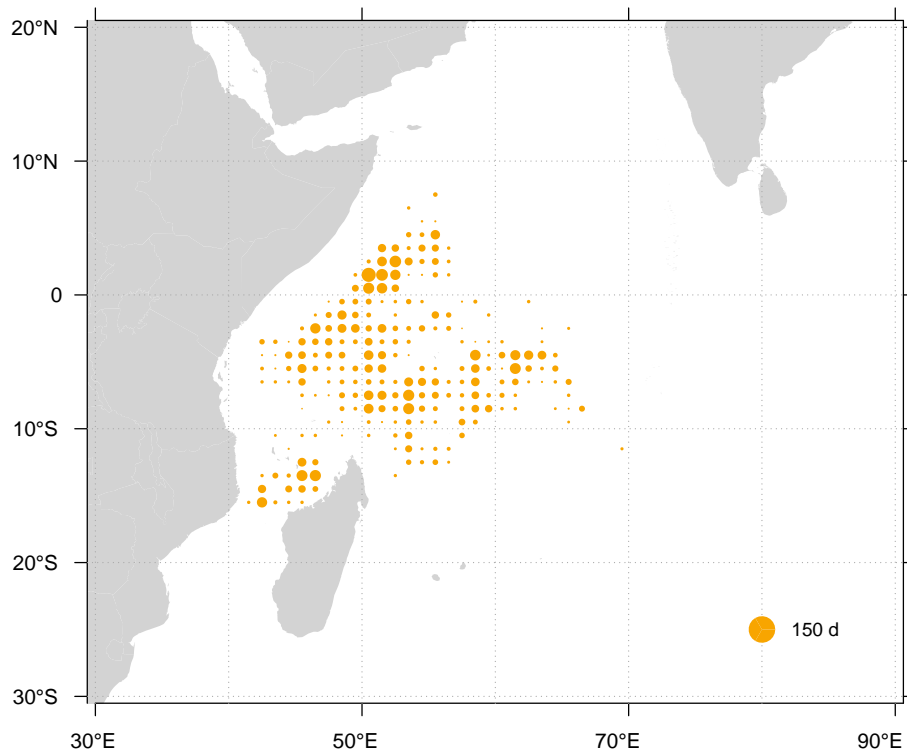


Figure 3: Fishing grounds. Spatial distribution of fishing effort (in searching days) of the French purse seine fishing fleet in 2012

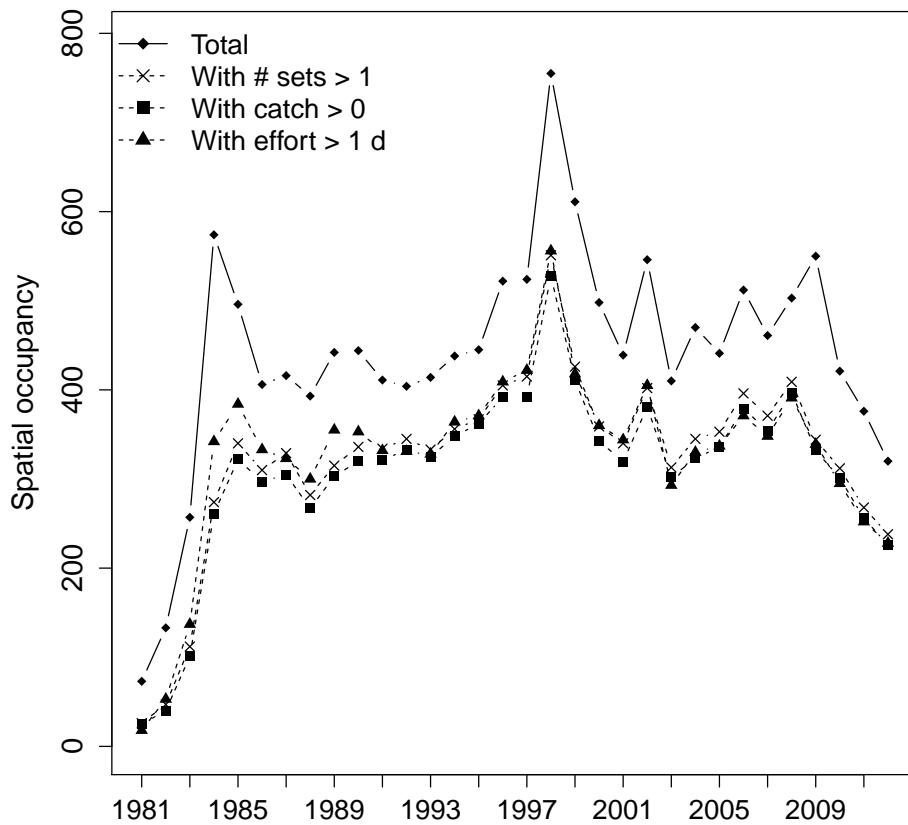


Figure 4: Changes in spatial extent of the fishery over time. Mean annual number of 1-degree squares explored by each vessel of the French purse seine fishing fleet during 1981-2012. Solid line indicates standard deviation. Only vessels in activity during 12 months were selected. A loess function was fitted to the data to illustrate the trend

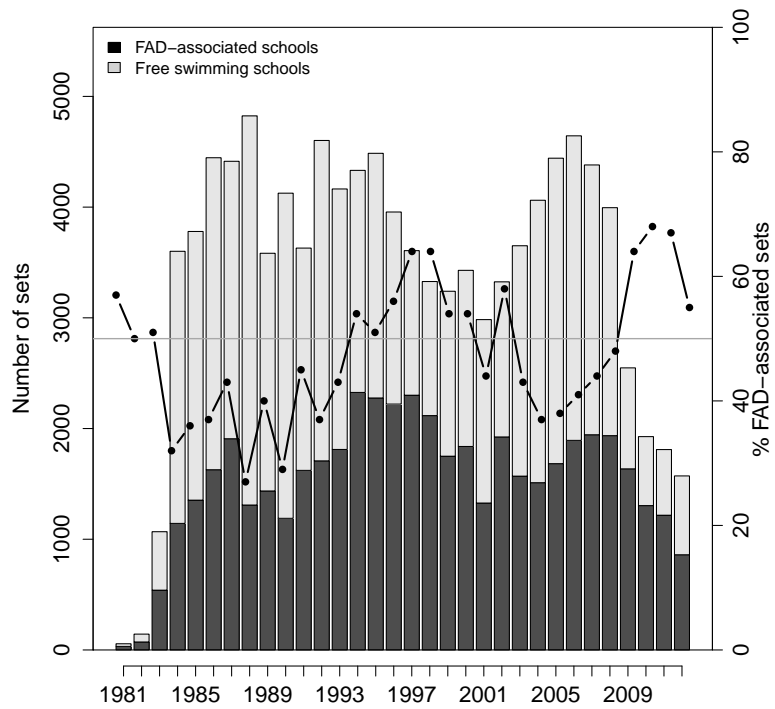


Figure 5: Fishing operations. Annual number of fishing sets in the French purse seine fishery on FAD-associated and free-swimming schools during 1981-2012. Line with solid circles indicates the percentage of sets made on FAD-associated schools over free-swimming schools. Grey solid line indicates the 50% value

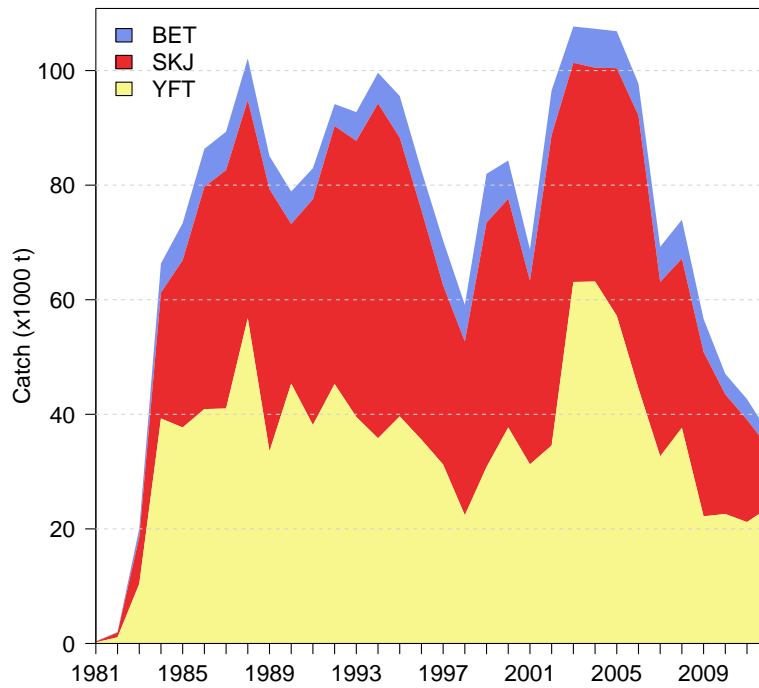


Figure 6: Total fishery production. Catch by species of the French purse seine fishing fleet during 1981-2012

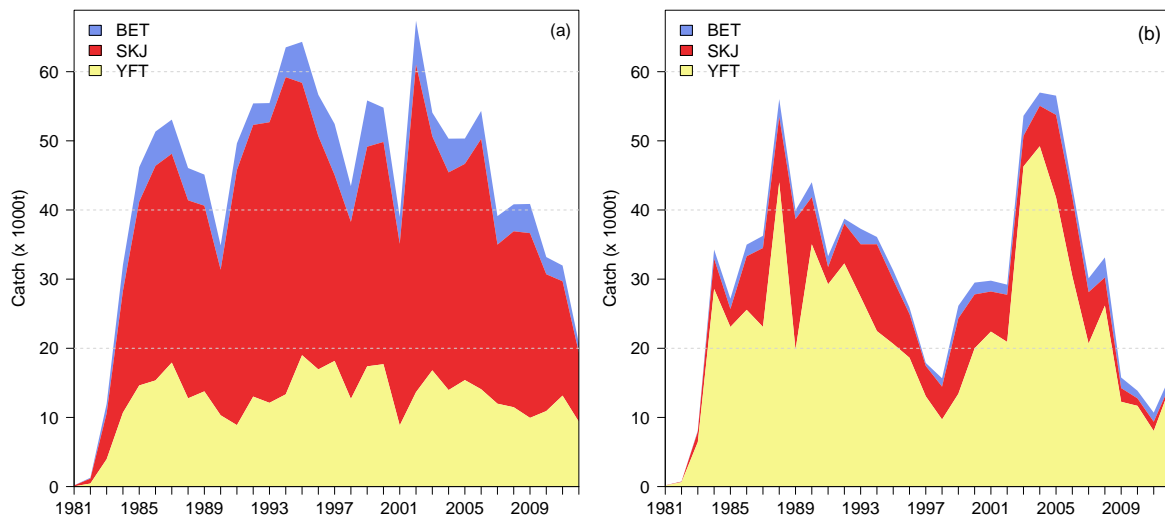


Figure 7: Fishery production by major fishing mode. Catch by species of the French purse seine fishing fleet on (a) FAD-associated and (b) free-swimming schools during 1981-2012

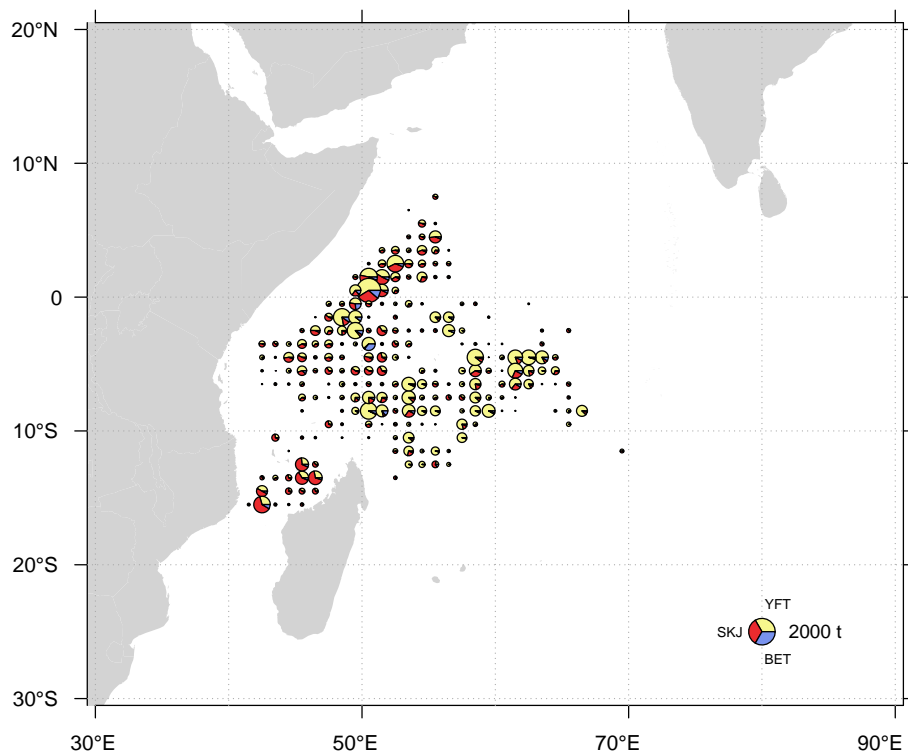


Figure 8: Spatial distribution of tuna catches of the French purse seine fishing fleet in 2012

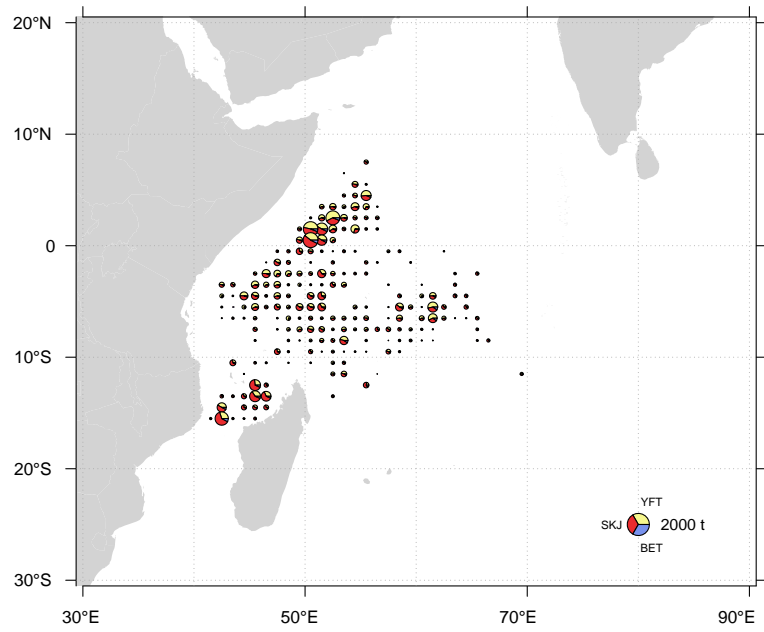


Figure 9: Spatial distribution of tuna catches of the French purse seine fishing fleet made on FAD-associated schools in 2012

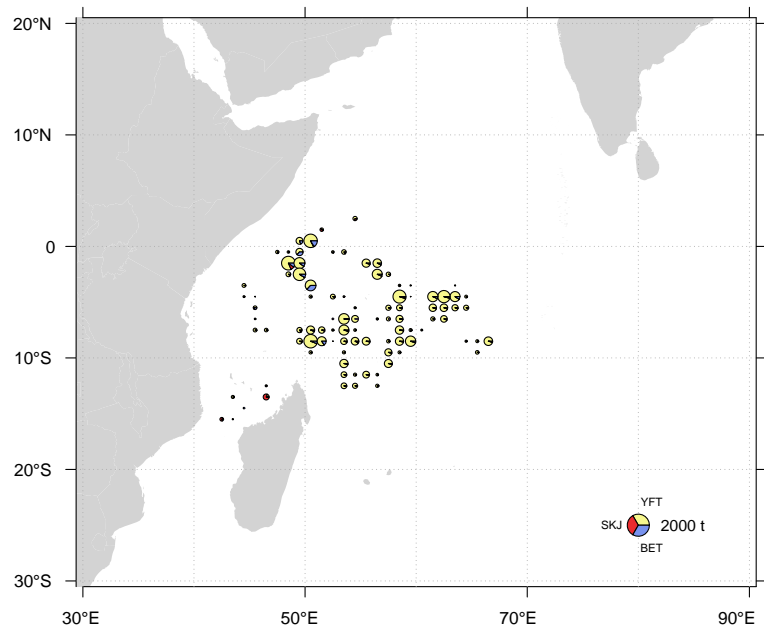


Figure 10: Spatial distribution of tuna catches of the French purse seine fishing fleet made on FSC-associated schools in 2012

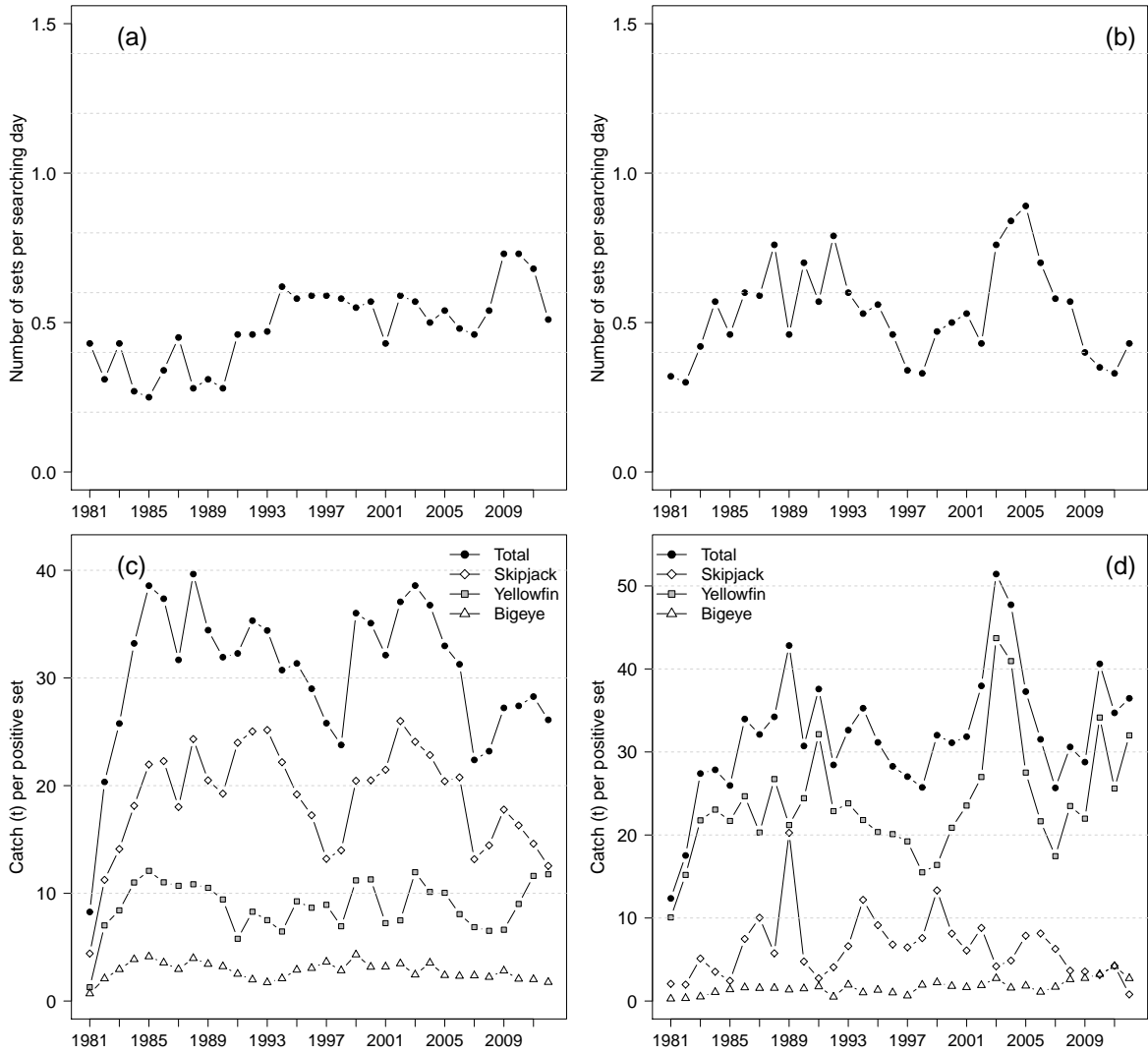


Figure 11: (a-b) Annual number of sets per searching day and (c-d) catch per positive set on (left panel) FAD-associated and (right panel) free-swimming schools for the French purse seine fishing fleet in the Indian Ocean during 1981-2012

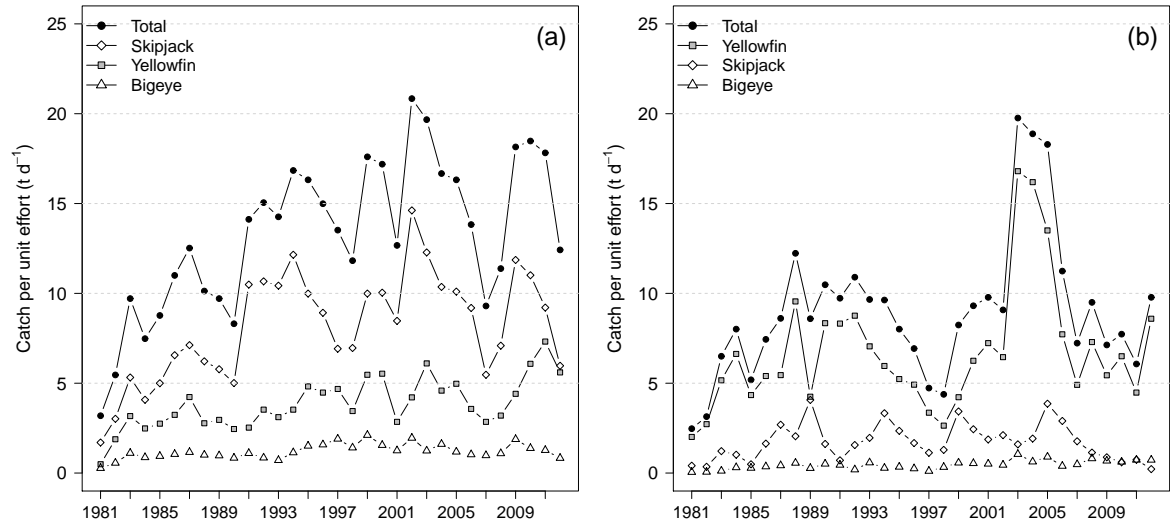


Figure 12: Annual catch rates (in t per searching day) of the French purse seine fishing fleet on (a) FAD-associated and (b) free-swimming schools in the Indian Ocean during 1981-2012

5. 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 1981-2012. 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
2012	0	0	0	8	2	0	10	7116

Table 2: Annual nominal fishing effort of the French purse seine fishing fleet expressed in fishing and searching days during 1981-2012. 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	4309	3516
1992	4599	3683
1993	4711	3891
1994	4649	3774
1995	4831	3942
1996	4574	3784
1997	4603	3883
1998	4330	3676
1999	3838	3178
2000	3896	3200
2001	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
2012	1944	1673

Table 3: Annual number of 1-degree squares explored by the French purse seine fishing fleet during 1981-2012. #sets indicates squares where a least 1 fishing set was made.

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	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	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
2012	320	238	226	228	125

Table 4: Number of positive and null sets by fishing mode made by the French purse seine fishing fleet in the Indian ocean during 1981-2012. 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	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	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
2012	1572	1245	327	860	796	64	712	449	263

Table 5: Catch by species for the French purse seine fishing fleet of the Indian ocean during 1981-2012

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	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	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	22599	20863	3595	29	16	47103
2011	21192	17871	3593	238	0	42894
2012	23732	10352	2616	441	14	37155

Table 6: Catch by species made on FAD-associated schools for the French purse seine fishing fleet of the Indian ocean during 1981-2012

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	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	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	10921	19784	2489	4	16	33215
2011	13153	16536	2277	30	0	31997
2012	9366	9991	1391	23	10	20783

Table 7: Catch by species made on free-swimming schools for the French purse seine fishing fleet of the Indian ocean during 1981-2012

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	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	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	11678	1079	1106	25	0	13888
2011	8039	1335	1316	208	0	10897
2012	14366	361	1224	417	4	16372

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 Indian ocean during 1981-2012

ALL	FAD	FSC	NA
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	0.76
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

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 Indian ocean during 1981-2012

Year	YFT	SKJ	BET	ALB	TOTAL
1981	1.28	4.41	0.69	0.00	8.27
1982	7.02	11.25	2.08	0.00	20.34
1983	8.42	14.12	2.94	0.00	25.77
1984	11.01	18.13	3.87	0.00	33.21
1985	12.09	21.97	4.13	0.01	38.57
1986	11.02	22.28	3.56	0.00	37.36
1987	10.70	18.02	2.95	0.00	31.68
1988	10.84	24.33	3.97	0.00	39.65
1989	10.51	20.50	3.43	0.00	34.44
1990	9.43	19.26	3.21	0.00	31.93
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	7.23	21.48	3.18	0.09	32.12
2002	7.49	26.00	3.48	0.00	37.07
2003	11.96	24.08	2.44	0.00	38.58
2004	10.13	22.84	3.54	0.00	36.76
2005	10.05	20.41	2.39	0.00	32.98
2006	8.07	20.77	2.32	0.00	31.27
2007	6.86	13.17	2.36	0.00	22.39
2008	6.52	14.46	2.22	0.00	23.20
2009	6.62	17.78	2.81	0.01	27.22
2010	9.01	16.32	2.05	0.00	27.41
2011	11.62	14.61	2.01	0.03	28.27
2012	11.77	12.55	1.75	0.03	26.11

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 1981-2012

Year	YFT	SKJ	BET	ALB	TOTAL
1981	10.07	2.07	0.27	0.00	12.36
1982	15.19	1.98	0.33	0.00	17.53
1983	21.76	5.12	0.52	0.00	27.40
1984	23.05	3.53	1.06	0.18	27.85
1985	21.69	2.44	1.39	0.41	25.96
1986	24.67	7.48	1.62	0.19	33.97
1987	20.30	10.04	1.55	0.19	32.11
1988	26.73	5.75	1.56	0.11	34.23
1989	21.20	20.26	1.36	0.01	42.82
1990	24.43	4.76	1.50	0.03	30.72
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	23.54	6.09	1.65	0.57	31.84
2002	26.98	8.81	1.89	0.25	37.96
2003	43.71	4.18	2.74	0.57	51.43
2004	40.94	4.87	1.59	0.06	47.73
2005	27.52	7.87	1.83	0.06	37.27
2006	21.65	8.14	1.09	0.60	31.52
2007	17.45	6.28	1.69	0.25	25.67
2008	23.49	3.66	2.60	0.85	30.60
2009	21.97	3.55	2.75	0.51	28.78
2010	34.15	3.15	3.23	0.07	40.61
2011	25.60	4.25	4.19	0.66	34.71
2012	32.00	0.80	2.73	0.93	36.46

Table 11: Catch per unit of effort (in t per searching day) on FAD-associated schools for the French purse seine fishery of the Indian ocean during 1981-2012

Year	YFT	SKJ	BET	ALB	TOTAL
1981	0.49	1.70	0.27	0.00	3.19
1982	1.88	3.02	0.56	0.00	5.46
1983	3.17	5.32	1.11	0.00	9.71
1984	2.48	4.08	0.87	0.00	7.48
1985	2.75	5.00	0.94	0.00	8.77
1986	3.24	6.56	1.05	0.00	11.00
1987	4.23	7.12	1.16	0.00	12.52
1988	2.77	6.22	1.01	0.00	10.13
1989	2.96	5.78	0.97	0.00	9.71
1990	2.45	5.01	0.84	0.00	8.31
1991	2.53	10.49	1.10	0.00	14.12
1992	3.53	10.67	0.85	0.00	15.05
1993	3.11	10.43	0.71	0.00	14.26
1994	3.53	12.15	1.14	0.01	16.84
1995	4.82	9.99	1.51	0.00	16.32
1996	4.48	8.92	1.58	0.02	14.99
1997	4.68	6.92	1.90	0.02	13.52
1998	3.45	6.96	1.41	0.00	11.82
1999	5.47	9.99	2.11	0.03	17.60
2000	5.53	10.04	1.55	0.01	17.19
2001	2.85	8.47	1.25	0.03	12.67
2002	4.21	14.62	1.95	0.00	20.84
2003	6.10	12.28	1.24	0.00	19.67
2004	4.59	10.36	1.61	0.00	16.67
2005	4.97	10.10	1.18	0.00	16.32
2006	3.57	9.19	1.03	0.00	13.83
2007	2.85	5.47	0.98	0.00	9.30
2008	3.20	7.09	1.09	0.00	11.38
2009	4.41	11.86	1.88	0.00	18.15
2010	6.08	11.01	1.38	0.00	18.48
2011	7.32	9.21	1.27	0.02	17.82
2012	5.60	5.97	0.83	0.01	12.42

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 1981-2012

Year	YFT	SKJ	BET	ALB	TOTAL
1981	2.01	0.41	0.05	0.00	2.47
1982	2.72	0.35	0.06	0.00	3.14
1983	5.16	1.22	0.12	0.00	6.50
1984	6.63	1.02	0.31	0.05	8.01
1985	4.34	0.49	0.28	0.08	5.19
1986	5.40	1.64	0.36	0.04	7.44
1987	5.45	2.69	0.42	0.05	8.61
1988	9.55	2.05	0.56	0.04	12.23
1989	4.25	4.07	0.27	0.00	8.59
1990	8.34	1.62	0.51	0.01	10.48
1991	8.32	0.71	0.45	0.25	9.73
1992	8.76	1.56	0.19	0.38	10.90
1993	7.05	1.96	0.58	0.08	9.66
1994	5.96	3.33	0.28	0.07	9.63
1995	5.23	2.35	0.34	0.08	8.01
1996	4.92	1.67	0.25	0.08	6.93
1997	3.36	1.13	0.11	0.12	4.73
1998	2.64	1.29	0.33	0.12	4.38
1999	4.22	3.43	0.57	0.02	8.24
2000	6.25	2.44	0.54	0.10	9.31
2001	7.23	1.87	0.51	0.17	9.78
2002	6.45	2.11	0.45	0.06	9.08
2003	16.80	1.60	1.05	0.22	19.76
2004	16.19	1.92	0.63	0.03	18.88
2005	13.50	3.86	0.90	0.03	18.29
2006	7.72	2.90	0.39	0.22	11.24
2007	4.91	1.77	0.48	0.07	7.23
2008	7.29	1.14	0.81	0.26	9.50
2009	5.44	0.88	0.68	0.13	7.13
2010	6.50	0.60	0.62	0.01	7.73
2011	4.48	0.74	0.73	0.12	6.07
2012	8.59	0.22	0.73	0.25	9.78