

STATISTICS OF THE FRENCH PURSE SEINE FISHING FLEET TARGETING TROPICAL TUNAS IN THE ATLANTIC OCEAN (1991-2020)

L. Floch¹, P. Cauquil², M. Depetris¹, A. Duparc¹, D. Kaplan¹, J. Lebranchu¹, D. Yala²

SUMMARY

This document presents an up-to-date summary of the French purse seine fleet targeting tropical tunas in the Atlantic Ocean. The statistics cover the period 1991-2020 and specifically focus on the activity of the last year of the fishery. In 2020, 9 French purse seiners operated in the eastern Atlantic Ocean. The total capacity weighted by the months of activity for each vessel is 9 401 t. The total nominal effort was of 2052 fishing days and 1547 sets. The total catch of the French component of the EU purse seine fleet was 30 261 t, being composed of 51.8%, 40.2%, 6.5% of yellowfin, skipjack, and bigeye respectively and 1.5% of other species. The year 2020 was characterized by a general decrease for catches of 29%, carrying capacity of 5%, effort in fishing days of 29% and number of sets of 32%.

RÉSUMÉ

Ce document présente un résumé actualisé de la flottille de senneurs français ciblant les thons tropicaux dans l'océan Atlantique. Les statistiques couvrent la période 1991-2020 et portent particulièrement sur les activités réalisées par la pêcherie au cours de la dernière année. En 2020, 9 senneurs français ont opéré dans l'océan Atlantique Est. La capacité totale pondérée par mois d'activité de chaque navire est de 9 401 t. L'effort nominal total était de 2.052 jours de pêche et 1.547 calées. La capture totale de la composante française de la flottille de senneurs de l'UE totalisait 30.261 t, composée de 51,8%, 40,2%, et 6,5% d'albacore, de listao, de thon obèse respectivement et 1,5% d'autres espèces. L'année 2020 s'est caractérisée par une réduction générale des captures (29%), de la capacité de transport (5%), de l'effort en jours de pêche (29%) et du nombre de calées (32%).

RESUMEN

Este documento presenta un resumen actualizado de la flota de cerco francesa que se dirige a los túnidos tropicales en el Atlántico. Las estadísticas cubren el periodo 1991-2020 y se centran específicamente en las actividades del último año de la pesquería. En 2020, 9 cerqueros franceses operaron en el Atlántico oriental. La capacidad total ponderada por los meses de actividad para cada buque es de 9.401 t. El esfuerzo nominal total fue de 2052 días de pesca y 1547 lances. La captura total del componente francés de la flota de cerco de la UE en el Atlántico fue de 30.261 t, compuesta por 51,8 % de rabil, 40,2 % de listado, 6,5 % de patudo y 1,5 % de otras especies. El año 2020 se caracterizó por un descenso general en las capturas del 29 % de la capacidad de transporte, el 5 % de esfuerzo en días de pesca y del 32 % de número de lances.

KEYWORDS

Tuna fisheries, purse seining, fish catch statistics, fishing effort, logbooks, size distribution, Katsuwonus pelamis, Thunnus albacares, Thunnus obesus

¹ MARBEC, Univ Montpellier, CNRS, IFREMER, IRD, Sète, France

² IRD, Abidjan, Côte d'Ivoire

1 Introduction

French tuna purse seiners have been fishing yellowfin tuna (*Thunnus albacares*, YFT), skipjack tuna (*Katsuwonus pelamis*, SKJ), and bigeye tuna (*Thunnus obesus*, BET) in the eastern atlantic ocean since the early 1960s. 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 (FOB) now predominated by artificial Fish Aggregating Devices (FAD) deployed by the fishing vessel. The French purse seine fishery has been monitored by the French National Research Institute for Sustainable Development (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). In this document, we report a synthesis of the fishing activities of the French purse seiners during 1991-2020 based on the collection of logbooks, landing reports and sampling operations conducted at ports during unloading for target species (i.e. BET, SKJ, YFT).

2 Material and methods

2.1 Fishing data from professional activities

Logbooks and landing reports were collected in collaboration with fishing companies and covered 100% of the fishing trips that occurred during 1991-2020. For each trip, at unloading, shipment was sorted by species (and by commercial categories) and weight at the cannery. For each set, vessels crew reported in the logbook all information on their activities including:

- Catch weight visually assessed
- Raw species composition of the sets visually assessed
- Date of the sets;
- Geographic location of the sets.
- Activity and details on floating objects (mainly FAD), since 2014.

2.2 Sampling

In 2020, 313 well samples were collected at unloading of French vessels in the ports of Abidjan and Dakar. These 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 flag of Spain and other flags associated with the French purse seine fleet (Pallarès and Petit, 1998). A total of about 129 000 tunas counted and measured were used in the T3 (Traitement des Thons Tropicaux) processing of the French purse seine fishery data for 2020.

2.3 Fishing effort

Nominal fishing effort was derived from logbooks and expressed in days-at-sea and fishing days considering that fishing operations purse seiners occur only 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. In the atlantic ocean, the maximum duration of a day for the purse seine fishing fleet targeting tropical tunas is 12 hours.

2.3 dFAD density map estimation

In brief, the methodology used for calculating French dFAD tracking buoy density maps involves the following steps:

- 1) Basic filtering of the data to remove aberrant information
- 2) Classification of positions into onboard and at sea classes using a random forest algorithm
- 3) Interpolation of buoy trajectories at midnight each day
- 4) Elimination of beached positions and positions classified as onboard a vessel
- 5) Aggregation of remaining positions into daily, instantaneous $1^\circ \times 1^\circ$ density raster maps
- 6) Averaging of daily maps over annual time periods
- 7) Correction of nominal densities using annual raising factors based on the inverse of the fraction of known buoy identifiers in observer data per ocean and year

³ Pallarès, P., and Ch. Petit. 1998. Tropical tunas: new sampling and data processing strategy for estimating the composition of catches by species and sizes. Collect. Vol. Sci. Pap. ICCAT 48:230–246.

Basic filtering of data followed previously published literature (e.g., Maufroy *et al.* 2015⁴). Aberrant positions at the poles or international date line were removed, multiple positions for a single timestamp were averaged into a single position, and pairs of subsequent identical positions for the same buoy were consolidated into a single position. Note that this filtering did not remove any class of positions that could be considered true positions (e.g., it did not remove beached positions or positions on land).

The classification algorithm used to separate onboard FAD positions from in water positions is an improvement on that presented in Maufroy *et al.* (2015⁵) that has been previously described in Imzilen *et al.* (2021). In brief, improvements include an extended and more recent training dataset and the use of better predictive variables related to the variance in speed and temperature in the immediate vicinity of a position to be classified. The algorithm is highly accurate, with an overall estimated error rate of ~2.3% that reduces to ~0.2% when considering just at sea positions (Imzilen *et al.* 2021).

Individual, classified buoy trajectories were then interpolated at midnight GMT every day. For a given buoy, a trajectory was taken to be any contiguous set of positions without any gap superior to 5 days (i.e., individual buoys could have multiple such trajectories, each divided by a gap >5 days). Boat and water classifications were not directly taken into account for dividing up buoy trajectories, but instead the classification state was also linearly interpolated between data points with 0 associated with positions classified as onboard and 1 for positions classified in the water. This interpolation of class was only non-trivial for interpolations at dates falling between pairs of subsequent positions, one of which was classified as onboard and the other of which was classified as at sea. Only 1.1% of all interpolated positions had interpolated classifications states different from 0 and 1.

This interpolated data was then filtered to remove boat positions and beaching events. A minimum cutoff of 0.75 on the interpolated class of the position was used for selecting in water positions. The choice of 0.75 is largely arbitrary, but only affected a very small fraction of all positions (data with interpolated class between 0.75 and <1 represented only 0.36% of all interpolated in water positions).

Identification of beaching events is described in detail elsewhere (e.g., Imzilen *et al.* 2021). In brief, beachings were identified as any set of 3 positions from the raw position data of a single buoy that are within 200m of the first position and separated in time by at least 1 day. These potential beachings were further filtered to remove any beaching events for which <90% of the positions between the beginning and the end of the beaching event were included in the beaching event based on the distance test. Conditions on proximity to land, depth or classification of preceding positions as at sea were not pertinent for density calculations as the objective was to remove all positions that were abnormally stationary. Any interpolated buoy positions between the beginning and end of the resulting beaching events were removed from the dataset before estimating densities.

For each day, the at sea, non-beached interpolated positions were aggregated on a 1° × 1° lon-lat grid. These daily raster maps were average over annual time periods to produce annual average nominal density maps. These nominal density maps were corrected for partial coverage by our dFAD tracking buoy database. The inverse of the annual, by-ocean observer-FADs identifier agreement rate was used as a raising factor to correct average density maps for missing data. Among the “agreeing identifiers,” we included both observer buoy-deployment identifiers that match an identifier in the dFAD tracking buoy trajectory database and observer identifiers that do not match, but for which there is a buoy position in the tracking buoy database that is within 2.5 km and ±12 hours of the observer data and for which the Levenshtein distance between the observer buoy identified and corresponding buoy identifier in the trajectory database is inferior or equal to 3.

As observer data before ~2010 are quite limited and dFAD tracking buoy data is known to be incomplete before this time period (Maufroy *et al.* 2015), dFAD tracking buoy densities are only estimated for the period 2010-2020. For the year 2010 in the Indian Ocean, the amount of observer data is very limited (9 buoy identifiers). As such and given that the results for the two oceans for this year were not statistically different, I have merged the observer data for the two oceans when calculating the raising factor for 2010 for the Indian Ocean.

⁴ Maufroy A, Chassot E, Joo R, Kaplan DM (2015) Large-Scale Examination of Spatio-Temporal Patterns of Drifting Fish Aggregating Devices (dFADs) from Tropical Tuna Fisheries of the Indian and Atlantic Oceans. *PLoS ONE* 10:e0128023. doi:10.1371/journal.pone.0128023

⁵ Imzilen T, Lett C, Chassot E, Kaplan DM (2021) Spatial management can significantly reduce dFAD beachings in Indian and Atlantic Ocean tropical tuna purse seine fisheries. *Biological Conservation* 254:108939. doi:10.1016/j.biocon.2020.108939

3 Results and interpretations

3.1 Fleet capacity

In 2020, 9 French purse seiners (**Figure 1**) operated in the eastern Atlantic Ocean and conducted a total of 81 fishing trips lasting on average 30 days (**Table 2**). The fleet was composed of 1 vessel of carrying capacity (CC) of 600-800 t, 6 vessels of CC 800-1200 t, and 2 vessels of CC >1,200 t (**Table 1**). Total carrying capacity in 2020 decreased of 5% in comparison with the last year and the total capacity weighted by the months of activity for each vessel is 9 401 t.

3.2 Activity effort

The total nominal effort in 2020 for fishing⁶ and searching⁷ was respectively 2052 and 1726 days (**Figure 2** and **Table 2**) which is similar to the trend of the last years. Indeed, after the drop from 1991 to 2008, activities duration slightly increased. Duration for both activities actually represent the half of the 1991's level.

3.3 Fishing sets

The total annual number of fishing sets in 2020 reached 1547 (1312 positive sets and 235 null sets). A total of 697 sets were associated with FOBs (mainly FADs) and 850 sets associated to free swimming schools (FSC) (**Table 3**). The proportion of positive sets is 98% of FOBs and 74% of FSC. In 2020, the percentage of FOB sets is 45% in the range of value since 2012 confirming a consistency in fishing activity type (**Figure 3**).

3.4 Deployment of Fishing Aggregating Devices (FADs)

The deployment of Fishing Aggregating Devices (FADs) has been declared in logbooks of the purse seiners and supply vessel since 2014. In 2017, the French supply vessel left the Atlantic to the Indian Ocean.

The number of deployments increased toward a maximum of 2486 in 2018, 249 per vessel. In 2020, the total number of deployments decreased to 1789 FADs, 199 per vessel. (**Table 4**).

3.5 Spatial distribution of fishing

Spatial extent used by vessels decreased in 2020 compared to 2019 but in the continuity of the trend of decreasing since 2018 (**Figure 4** and **Table 5**). **Figure 5** and **6** respectively represent maps of the catches on FOB and FSC. The fishing effort shifted to the west and south part of the fishing ground resulting of the absence of an EU fishing agreement with the Gabon since 2017 (**Figure 7**). It was necessary to resize the maps to show catches close to coast of Angola and to 30° W of longitude.

3.6 Fisheries production, specific composition and size distribution

Total catch of tropical tuna in eastern Atlantic Ocean was marked since 1991 by a huge drop between 2003 and 2008 mainly due to the departure of vessels for Indian Ocean (**Figure 8**). For instance, the French fleet was composed of 14 vessels in 2003 and only 6 in 2007 (**Table 1**). In 2020, landings of the principal market tunas by the French purse seine fleet operating in the eastern Atlantic Ocean reached a total of 30261t corresponding to a decrease of 29% compared to 2019 (**Table 6a**). Those landings are composed of 51.8%, 40.2%, 6.5% and 1.5% of YFT, SKJ, BET and other species (**Table 6b**), respectively.

Catch composition on FSC was usually dominated by YFT whereas it was dominated by SKJ on FOB. In 2020, catches on FSC, YFT represented 89.3% of the total while SKJ and BET represented 4.5% and 6.1% of catches, respectively. In comparison with 2019, the percentage of BET with 6.1 decreased but came back in the range of values of the time series. 2019 with 15% was a particular year (**Figure 9, Table 6d**).

Catches on FOB were predominated by SKJ tuna representing 75.3% of the catch while YFT and BET tunas represented 14.9% and 6.9% of catches, respectively. Finally, species composition values were quite similar to last year's species composition whatever the school type (**Figure 9, Table 6e**).

⁶ Fishing time: Number of hours that a vessel is at sea for fishing activities

⁷ Searching time: Duration in hour for which vessel is considered searching for new schools (fishing time – sets' duration)

The size frequency distributions for the three species collected in 2020 for both FOB-associated and all fishing mode combined sets are quite similar with the average frequency distributions observed for the period 2014-2019 (**Figure 10**), FSC except for which large YFT and BET were more abundant.

3.6 Yield and Nominal catch per unit effort (CPUE)

Historically, the number of sets for FOB by searching day was between 0.2 and 0.3 until 2009, except around 1995 for which the rate peaked to 0.38 (**Figure 12**). Since 2009, the number of sets for FOB by searching day leapt above 0.4 and continued to slightly increase. Regarding the FSC, this rate describes a bell-shaped curve starting around 0.5 in the 90s, peaking at 0.79 in 2008 before decreasing to 0.56 in 2018. The number of sets per searching day decreased for 2 years for FOB but increased (0.49) for FSC compared with 2019 (**Figure 12**, and **Table 7**).

At the same time, mean all species catches per set decreased on FOB but increased for Yellowfin Tuna (**Figure 12**, **Table 8**). On FSC, mean all species catches per set increased but only for Yellowfin Tuna (**Figure 12**, **Table 9**).

Nominal CPUE regarding the fishing time are similar to catch per set patterns, i.e., consistent to 2019 for FOB and decreasing for FOB (**Figure 13**, **Tables 10** and **11**).

3.7 dFAD indicators

Time series of active buoys

Though the number of in water French buoys found in dFAD trajectory data was relatively stable over 2017, large increases were observed in the second halves of 2016 and 2018. Overall, there has been a sustained increase in the number of active dFADs (i.e., transmitting position information), over the last half decade, increasing from <500 in water buoys per day in 2011 to over 1500 in water buoys at the end of 2020. The decline in the number of active buoys in 2020 does not have an immediate explanation, but this is potentially linked to the impacts of COVID-19 on the fishery (**Figure 14**).

Maps of dFAD densities

The FAD density maps for the Atlantic Ocean roughly follow the distribution of fishing activity, with areas of high density found in the Gulf of Guinea, the southern part of West Africa and the coast of Angola (**Figure 15**). Maximum annual average density values for the Atlantic Ocean were of order 6 dFADs per $1^\circ \times 1^\circ$ grid cell, but daily density values (not shown) can be an order of magnitude larger than this in extreme cases. After accounting for the increasing overall number of FADs, the relative spatial distribution of FADs is for the most part stable across years, though high densities in some areas with more variable fishing activity (due to environmental variability or lack of fishing agreements permitting the French fleet to access some EEZs), such as off Western Africa, Angola or the EEZ of Gabon, are not consistently observed in all years (**Figure 15**).

3 Conclusion

The year 2020 is characterized by a general decreasing for catches 29%, carrying capacity 5%, effort in fishing days 29% and number of sets 32%.

Catch composition on FSC was dominated by YFT with 89.3 %. The percentage of BET with 6.1 decreased but came back in the range of values of the time series. So 2019 with 15% was a particular year (**Figure 9**, **Table 6d**). Catch composition on FOB was similar to previous year.

The CPUE (in t per positive set) decreased on FOB-associated schools and increased on free-swimming schools. The spatial area is larger than in the previous years with more catches in the south close to Angola (20°S) and in the west of Atlantic Ocean (30°W).

Acknowledgments

We thank ORTHONGEL and all past and current personnel for helpful assistance in data collection and management.

Sampling operations were conducted by the Observatory of exploited pelagic tropical ecosystem, Ob7 of the IRD and technicians of the Centre de Recherches Océanologiques, CRO d'Abidjan and the Centre de Recherches Océanographiques de Dakar-Thiaroye, CRODT de Dakar. (CRODT Sénégal).

The data used were collected through the Data Collection Framework (Reg 2017/1004 and 2016/1251) funded by both IRD and the European Union, and supported by the French Direction des Pêches Maritimes et de l'Aquaculture (DPMA). The Ob7 of the IRD is certified ISO 9001:2015 since February 2019.

Table 1. Annual number of purse seiners by size categories and total carrying capacity of the European tropical tuna purse seine fishing fleet of the Atlantic Ocean during 1991-2020. 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
1991	2	9	6	6	0	0	23	17.42	11910
1992	1	8	2	6	0	0	17	16.08	11510
1993	1	8	3	6	0	0	18	16.33	11923
1994	1	8	3	6	0	0	18	16.83	12151
1995	0	10	2	5	0	0	17	14.92	10850
1996	0	9	2	5	0	0	16	15.75	11231
1997	0	10	2	5	2	0	19	14.67	11306
1998	0	7	2	6	0	0	15	14.58	10910
1999	0	8	2	5	0	0	15	14	10376
2000	0	7	2	5	0	0	14	13.5	10086
2001	0	7	2	7	1	0	17	14	11153
2002	0	8	3	5	1	0	17	12.25	9441
2003	0	8	1	5	0	0	14	12.42	9464
2004	0	6	1	5	0	0	12	10.08	8188
2005	0	4	0	5	0	0	9	8.25	6833
2006	0	4	0	3	0	0	7	5.42	3890
2007	1	3	0	2	0	0	6	4.92	3460
2008	0	3	2	2	0	0	7	4.67	3600
2009	0	1	2	4	3	0	10	7.33	6905
2010	0	1	2	4	3	0	10	9.08	8871
2011	0	1	2	4	2	0	9	8.17	7972
2012	0	0	2	5	2	0	9	8.67	9004
2013	0	0	2	5	2	0	9	8.42	8733
2014	0	0	2	5	2	0	9	8.92	9258
2015	0	0	2	5	2	0	9	8.75	9133
2016	0	0	2	7	2	0	11	9.5	9831
2017	0	0	2	6	2	0	10	9.58	9812
2018	0	0	2	6	2	0	10	9.58	9888
2019	0	0	2	6	2	0	10	9.58	9902
2020	0	0	1	6	2	0	9	8.83	9401

Table 2. Annual nominal fishing effort of the French purse seine fishing fleet expressed in fishing and searching days during 1991-2020. Searching days was derived from the total time spent at sea corrected for periods of damage, route towards the port, and purse seine operation. The duration per day for fishing activities is 12 hours.

Year	Number of trips	Duration in days	Days at sea	Fishing days	Set duration in days	Searching days
1991	167	28	5088	4843	650	4193
1992	151	29	4627	4568	499	4069
1993	180	24	4621	4576	608	3969
1994	188	24	4847	4815	590	4225
1995	156	26	4335	4293	576	3717
1996	158	28	4618	4550	640	3910
1997	135	29	4327	4300	471	3829
1998	132	32	4396	4361	524	3837
1999	134	28	4049	3933	499	3434
2000	126	30	3968	3898	478	3419
2001	122	30	4086	4049	458	3590
2002	125	26	3468	3364	409	2955
2003	134	24	3463	3360	523	2837
2004	97	28	2942	2855	387	2469
2005	86	26	2309	2274	302	1973
2006	62	22	1453	1388	198	1189
2007	47	29	1396	1322	174	1148
2008	45	26	1303	1263	211	1052
2009	64	29	2075	2019	326	1693
2010	76	31	2625	2549	439	2110
2011	78	27	2290	2214	393	1821
2012	72	32	2530	2474	395	2079
2013	82	27	2402	2341	420	1921
2014	76	32	2597	2545	449	2096
2015	84	27	2453	2406	431	1975
2016	86	29	2801	2706	500	2207
2017	84	31	2853	2794	492	2302
2018	88	30	2850	2798	527	2271
2019	93	28	2829	2899	478	2421
2020	81	30	2212	2052	326	1726

Table 3. Number of positive and null sets by fishing mode made by the French purse seine fishing fleet in the Atlantic Ocean during 1991-2020. FOB = Floating Object; FSC = Free-Swimming School.

Year	ALL			FOB			FSC			%fob
	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	820	636	184	171	156	15	649	480	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	2122	1810	312	932	884	48	1190	926	264	44
2015	2023	1736	287	960	907	53	1063	829	234	47
2016	2359	2008	351	949	905	44	1410	1103	307	40
2017	2335	1996	339	1044	1002	42	1291	994	297	45
2018	2480	2141	339	1204	1170	34	1276	971	305	49
2019	2278	1977	301	1148	1125	23	1130	852	278	50
2020	1547	1312	235	697	682	15	850	630	220	45

Table 4. Number of Fishing Aggregating Devices (FADs) deployed by the French fleet from 2014 to 2020.

FlagVesCod	Year	No Purse seiners	NoFADsDep Purse Seiner	No Supply	NoFADsDep_ Supply	NoFADsDep by vessel	NoFADsDep Total
FRA	2014	9	595	0	239	93	834
FRA	2014	9	1009	1	340	135	1349
FRA	2015	9	1082	1	317	140	1399
FRA	2016	11	1434	1	357	149	1791
FRA	2017	10	1784	1	730	229	2514
FRA	2018	10	2486	0	0	249	2486
FRA	2019	10	2125	0	0	212	2125
FRA	2020	9	1789	0	0	199	1789

NoFADsDep : Number of FADs deployed

Table 5. Annual number of 1-degree squares explored by the French purse seine fishing fleet during 1991-2020. #sets indicate 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	296	167	154	207	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	344	238	229	244	134
2015	274	219	212	207	122
2016	388	243	238	254	140
2017	363	250	246	251	137
2018	417	287	278	267	132
2019	396	275	270	266	143
2020	388	225	218	220	113

Table 6a. Catch by species made on FOB-associated (FOB) and free-swimming schools (FSC) for the French purse seine fishing fleet in the Atlantic Ocean during 1991-2020.

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	13245	4427	781	12	248	18713
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	22192	16903	3763	49	151	43057
2015	20055	19893	2752	60	267	43027
2016	25684	18064	4387	65	481	48682
2017	25626	15295	3582	99	1128	45730
2018	24441	21926	3843	27	976	51214
2019	17554	19146	4859	18	899	42477
2020	15681	12161	1957	11	452	30261

Table 6b. Percentage of catches by species made on FOB-associated (FOB) and free-swimming schools (FSC) for the French purse seine fishing fleet in the Atlantic Ocean during 1991-2020.

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
1991	45.8	48.3	5	0.1	0.8	65893
1992	54.2	35.9	8.8	0.8	0.4	56833
1993	44	41.3	13.9	0.7	0.1	76404
1994	44.4	41.5	13.8	0.2	0.2	72977
1995	48.9	39.6	11	0.1	0.3	56919
1996	53	35.2	11.2	0.3	0.3	60702
1997	62.1	28.5	9	0.1	0.3	46805
1998	62.9	29.2	7.5	0.1	0.3	48440
1999	55.7	37.6	6.5	0	0.2	51791
2000	58.8	33.2	7.8	0	0.2	50200
2001	63.6	28.1	8	0	0.2	49020
2002	65.3	27.3	7.1	0	0.2	50517
2003	60.8	32.6	6.2	0.1	0.3	53096
2004	50.9	43.4	5.3	0	0.4	45998
2005	59.5	34	5.2	1.3	0.1	37117
2006	69.2	20.4	9.1	1.3	0	26534
2007	70.8	23.7	4.2	0.1	1.3	18713
2008	77.2	17.7	4.8	0.2	0	20629
2009	68	24.2	7.5	0.2	0.1	27274
2010	53.5	37.4	8.6	0.3	0.3	37365
2011	57.9	32.7	8.8	0.1	0.4	36990
2012	53.7	34.6	10.5	0.5	0.8	33999
2013	51.5	39.5	8.1	0.2	0.6	39345
2014	51.5	39.3	8.7	0.1	0.3	43057
2015	46.6	46.2	6.4	0.1	0.6	43027
2016	52.8	37.1	9	0.1	1	48682
2017	56	33.4	7.8	0.2	2.5	45730
2018	47.7	42.8	7.5	0.1	1.9	51214
2019	41.3	45.1	11.4	0	2.1	42477
2020	51.8	40.2	6.5	0	1.5	30261

Table 6c. Catch by species made on free-swimming schools for the French purse seine fishing fleet in the Atlantic Ocean during 1991-2020.

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	12733	970	455	12	0	14170
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	17801	2303	1911	29	10	22055
2015	15849	2974	908	39	35	19805
2016	20942	3976	1748	42	68	26777
2017	21591	1226	1088	90	32	24028
2018	21729	3681	1453	26	19	26908
2019	15089	1109	2860	16	13	19086
2020	13404	670	909	7	19	15010

Table 6d. Percentage of catch by species made on free-swimming schools for the French purse seine fishing fleet in the Atlantic Ocean during 1991-2020.

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
1991	60.7	36.3	2	0.1	1	42339
1992	80.3	13.1	4.4	1.5	0.7	30700
1993	69.1	19.7	9.7	1.5	0	38872
1994	70.2	24.1	5.1	0.4	0.2	33150
1995	80.1	15.8	3.5	0.3	0.3	27834
1996	79.8	14	5.6	0.6	0	33102
1997	81.5	14.1	4.2	0.1	0.1	30290
1998	80.1	16.8	2.9	0.1	0.1	32221
1999	71.7	24.8	3.3	0	0.1	32128
2000	79	17	3.9	0.1	0	31878
2001	80.9	14.3	4.6	0	0.1	34727
2002	83.2	13	3.8	0.1	0	34614
2003	77.9	17.8	4.1	0.2	0	35840
2004	76.7	21	2	0.1	0.3	25660
2005	82.9	11.9	3.2	2	0	23548
2006	82.7	7	8.7	1.6	0	21433
2007	89.9	6.8	3.2	0.1	0	14170
2008	87.4	8.9	3.4	0.3	0	17578
2009	88.6	5.4	5.6	0.3	0	19691
2010	79.2	12.5	7.8	0.5	0	21433
2011	82.1	11.2	6.3	0.2	0.2	23685
2012	89.4	2.4	7.2	0.8	0.1	17323
2013	79.6	14.5	5.5	0.3	0.2	22356
2014	80.7	10.4	8.7	0.1	0	22055
2015	80	15	4.6	0.2	0.2	19805
2016	78.2	14.9	6.5	0.2	0.3	26777
2017	89.9	5.1	4.5	0.4	0.1	24028
2018	80.8	13.7	5.4	0.1	0.1	26908
2019	79.1	5.8	15	0.1	0.1	19086
2020	89.3	4.5	6.1	0	0.1	15010

Table 6e. Catch by species made on FOB-associated schools for the French purse seine fishing fleet in the Atlantic Ocean during 1991-2020.

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
1991	4476	16465	2501	0	112	23554
1992	6116	16370	3619	0	28	26133
1993	6723	23884	6853	0	72	37532
1994	9124	22273	8372	0	59	39827
1995	5549	18155	5274	4	103	29084
1996	5750	16736	4941	0	173	27599
1997	4371	9076	2945	0	122	16515
1998	4669	8725	2712	0	113	16219
1999	5795	11478	2316	0	74	19663
2000	4335	11207	2696	0	84	18322
2001	3090	8792	2335	0	76	14292
2002	4198	9308	2287	0	110	15903
2003	4332	10937	1833	0	155	17256
2004	3742	14602	1901	0	94	20338
2005	2547	9805	1165	5	47	13569
2006	626	3925	541	0	10	5102
2007	512	3457	326	0	248	4543
2008	557	2103	391	0	0	3051
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	250	16677
2013	2476	12317	1972	15	208	16989
2014	4391	14599	1852	19	140	21002
2015	4206	16919	1844	22	232	23222
2016	4742	14088	2639	23	414	21905
2017	4035	14069	2494	9	1096	21702
2018	2712	18245	2390	1	957	24307
2019	2466	18037	1999	2	887	23391
2020	2277	11490	1048	4	433	15251

Table 6f. Percentage of catch by species made on FOB-associated schools for the French purse seine fishing fleet in the Atlantic Ocean during 1991-2020.

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
1991	19	69.9	10.6	0	0.5	23554
1992	23.4	62.6	13.8	0	0.1	26133
1993	17.9	63.6	18.3	0	0.2	37532
1994	22.9	55.9	21	0	0.1	39827
1995	19.1	62.4	18.1	0	0.4	29084
1996	20.8	60.6	17.9	0	0.6	27599
1997	26.5	55	17.8	0	0.7	16515
1998	28.8	53.8	16.7	0	0.7	16219
1999	29.5	58.4	11.8	0	0.4	19663
2000	23.7	61.2	14.7	0	0.5	18322
2001	21.6	61.5	16.3	0	0.5	14292
2002	26.4	58.5	14.4	0	0.7	15903
2003	25.1	63.4	10.6	0	0.9	17256
2004	18.4	71.8	9.3	0	0.5	20338
2005	18.8	72.3	8.6	0	0.3	13569
2006	12.3	76.9	10.6	0	0.2	5102
2007	11.3	76.1	7.2	0	5.5	4543
2008	18.3	68.9	12.8	0	0	3051
2009	14.4	72.9	12.4	0	0.3	7583
2010	18.8	70.9	9.6	0.1	0.6	15932
2011	14.9	71	13.3	0.1	0.7	13305
2012	16.5	68	13.9	0.1	1.5	16677
2013	14.6	72.5	11.6	0.1	1.2	16989
2014	20.9	69.5	8.8	0.1	0.7	21002
2015	18.1	72.9	7.9	0.1	1	23222
2016	21.6	64.3	12	0.1	1.9	21905
2017	18.6	64.8	11.5	0	5	21702
2018	11.2	75.1	9.8	0	3.9	24307
2019	10.5	77.1	8.5	0	3.8	23391
2020	14.9	75.3	6.9	0	2.8	15251

Table 7. Number of sets per searching on FOB-associated (FOB) and free-swimming schools (FSC) for the French purse seine fishing fleet in the Atlantic Ocean during 1991-2020.

Year	ALL	FOB	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	0.71	0.15	0.57
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
2014	1.05	0.43	0.62
2014	1.01	0.44	0.57
2015	0.99	0.47	0.52
2016	1.06	0.43	0.63
2017	1.01	0.45	0.56
2018	1.09	0.53	0.56
2019	0.94	0.47	0.47
2020	0.9	0.4	0.49

Table 8. Catch per unit of effort (in t per positive set) on FOB-associated schools for the French purse seine fishing fleet in the Atlantic Ocean during 1991-2020.

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	0.45	3.01	0.28	0	0.24	3.98
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	2.09	6.95	0.88	0.01	0.19	10.13
2015	2.05	8.24	0.9	0.01	0.38	11.57
2016	2.13	6.33	1.19	0.01	0.36	10.01
2017	1.75	6.11	1.08	0	0.58	9.53
2018	1.19	8.03	1.05	0	0.54	10.82
2019	1.02	7.45	0.83	0	0.41	9.7
2020	1.32	6.66	0.61	0	0.27	8.85

Table 9. Catch per unit of effort (in t per positive set) on free-swimming schools (FSC) for the French purse seine fishing fleet in the Atlantic Ocean during 1991-2019.

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	11.09	0.84	0.4	0.01	0	12.34
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	8.48	1.1	0.91	0.01	0.01	10.51
2015	7.72	1.45	0.44	0.02	0.07	9.69
2016	9.41	1.79	0.79	0.02	0.07	12.07
2017	9.38	0.53	0.47	0.04	0.04	10.47
2018	9.57	1.62	0.64	0.01	0.02	11.86
2019	6.23	0.46	1.18	0.01	0.01	7.88
2020	7.76	0.39	0.53	0	0.02	8.7

Table 10. Catch per unit of effort (in t per searching day) on FOB-associated schools for the French purse seine fishery in the Atlantic Ocean during 1991-2020.

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	0.45	3.01	0.28	0	0.24	3.98
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	2.09	6.95	0.88	0.01	0.19	10.13
2015	2.05	8.24	0.9	0.01	0.38	11.57
2016	2.13	6.33	1.19	0.01	0.36	10.01
2017	1.75	6.11	1.08	0	0.58	9.53
2018	1.19	8.03	1.05	0	0.54	10.82
2019	1.02	7.45	0.83	0	0.41	9.7
2020	1.32	6.66	0.61	0	0.27	8.85

Table 11. Catch per unit of effort (in t per searching day) on free-swimming schools (FSC) for the French purse seine fishery in the Atlantic Ocean during 1991-2020.

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	11.09	0.84	0.4	0.01	0	12.34
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	8.48	1.1	0.91	0.01	0.01	10.51
2015	7.72	1.45	0.44	0.02	0.07	9.69
2016	9.41	1.79	0.79	0.02	0.07	12.07
2017	9.38	0.53	0.47	0.04	0.04	10.47
2018	9.57	1.62	0.64	0.01	0.02	11.86
2019	6.23	0.46	1.18	0.01	0.01	7.88
2020	7.76	0.39	0.53	0	0.02	8.7

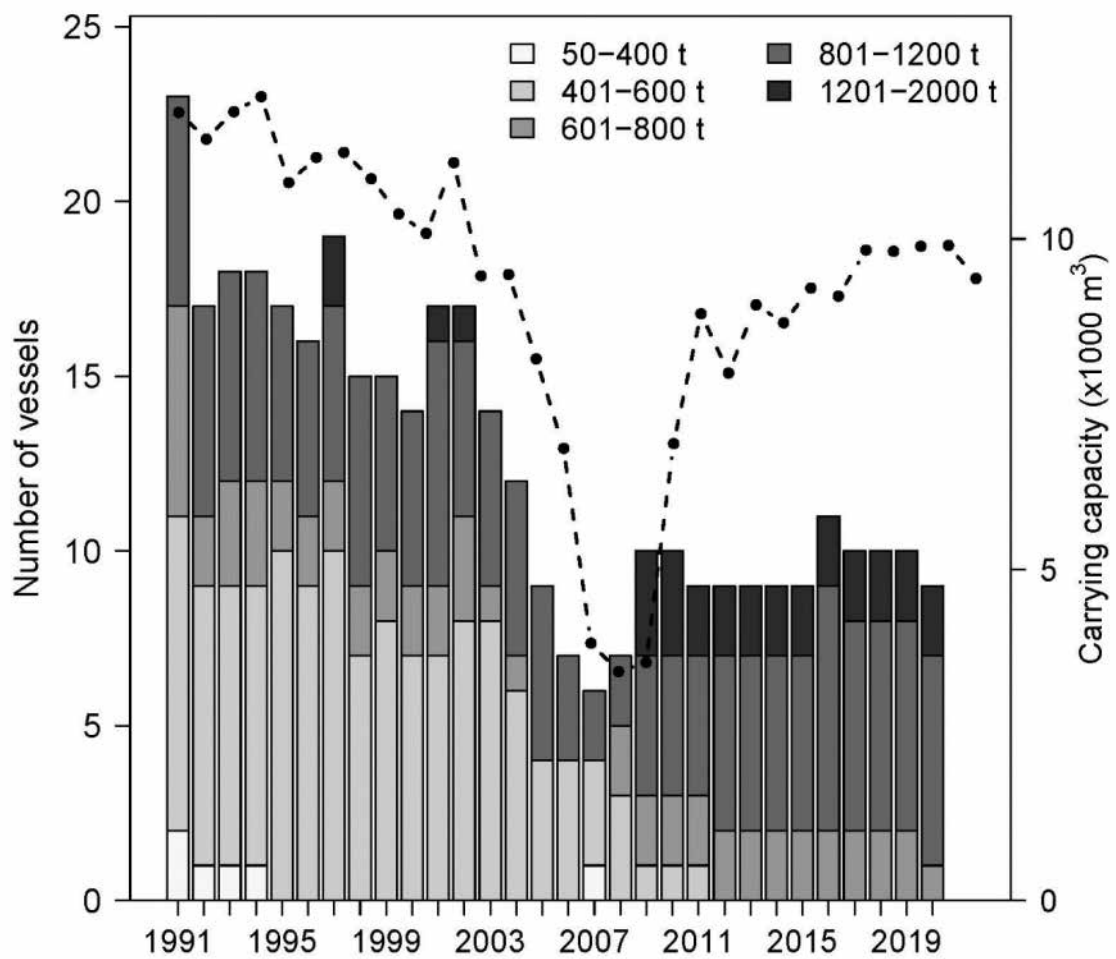


Figure 1. Fishing capacity of the French purse seine fishing fleet in the Atlantic Ocean. Annual changes in the number of purse seiners by tonnage categories (barplots) and total carrying capacity (dashed line with circles) during 1991-2020.

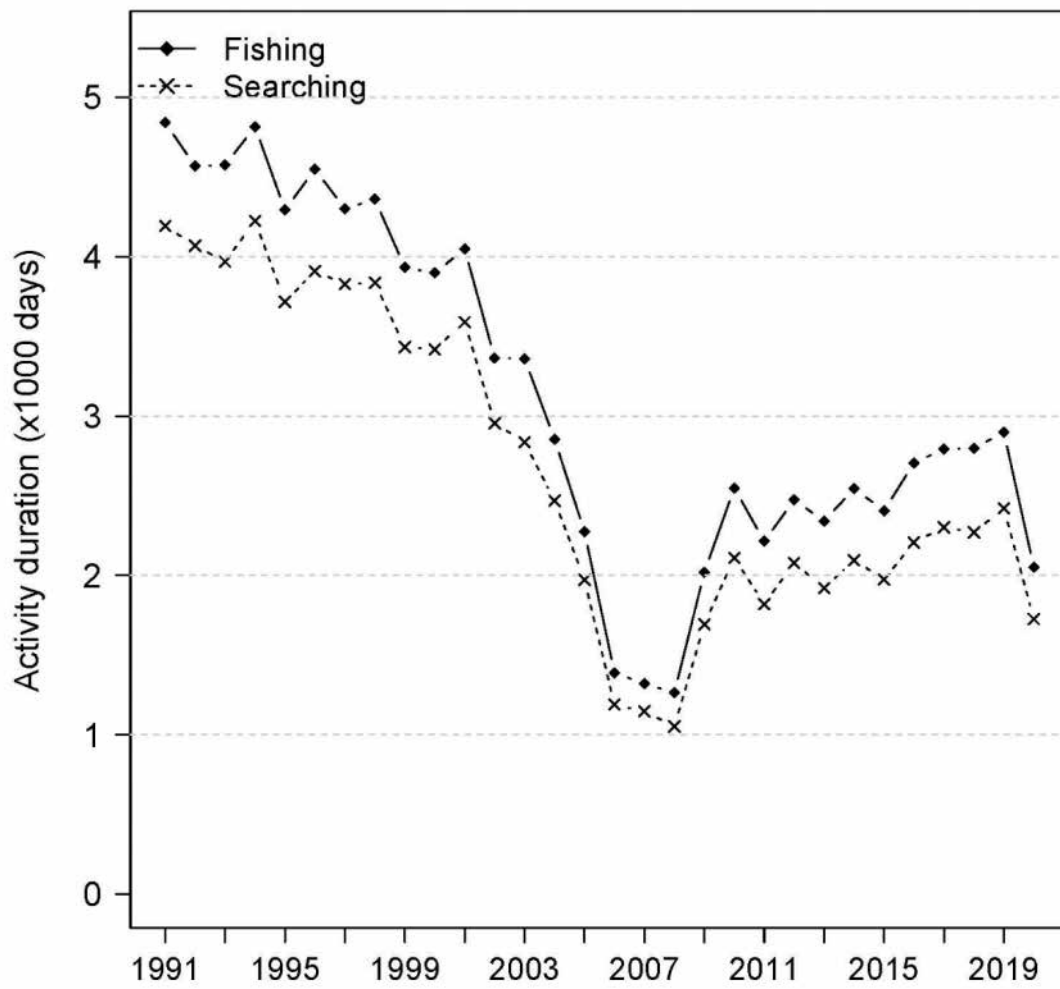


Figure 2. Changes in nominal effort over time. Annual total number of fishing and searching days for the French purse seine fishing fleet in the Atlantic Ocean during 1991-2020.

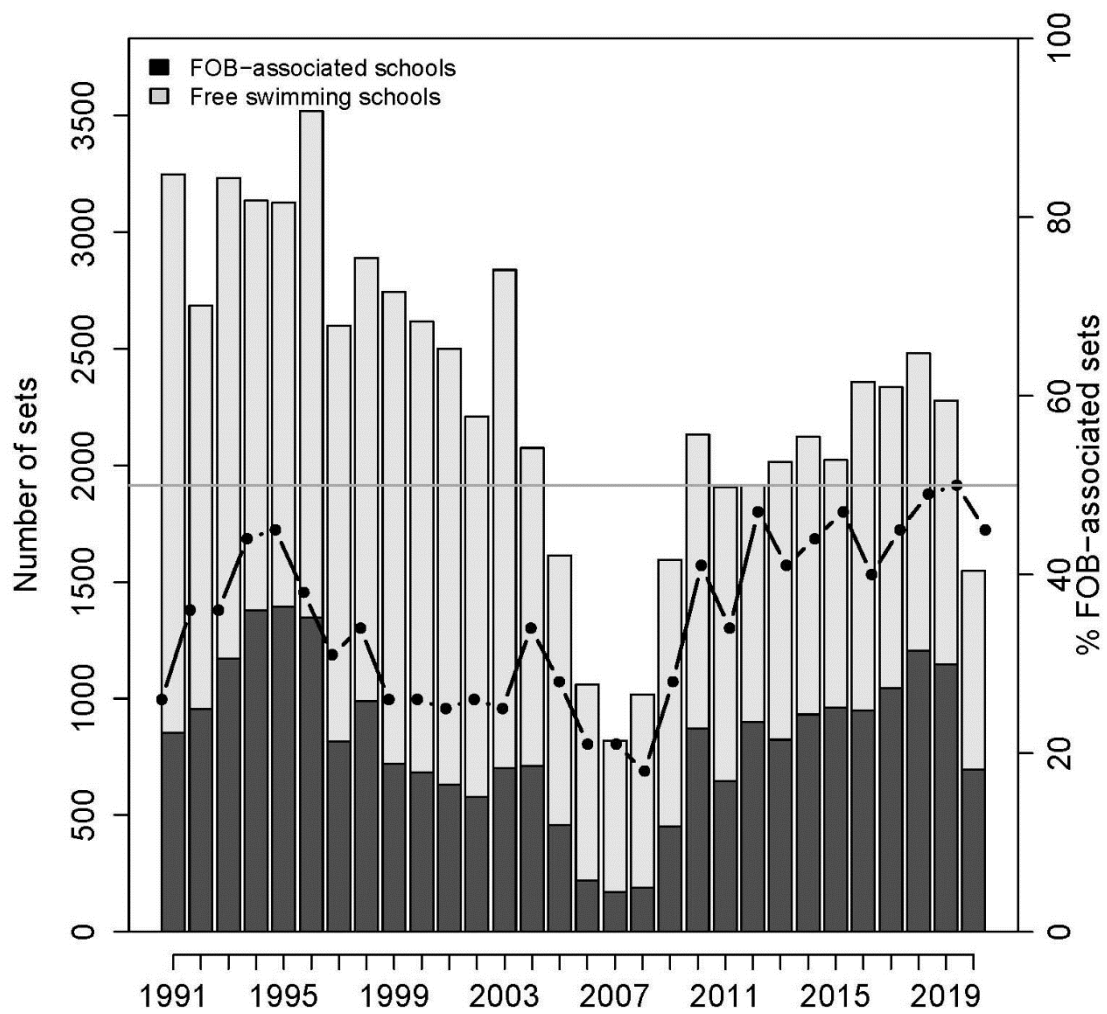


Figure 3. Fishing operations. Annual number of fishing sets in the French purse seine fishery on FOB- associated and free-swimming schools during 1991-2020. Line with solid circles indicates the percentage of sets on FOB-associated schools. Grey solid line indicates the 50% value.

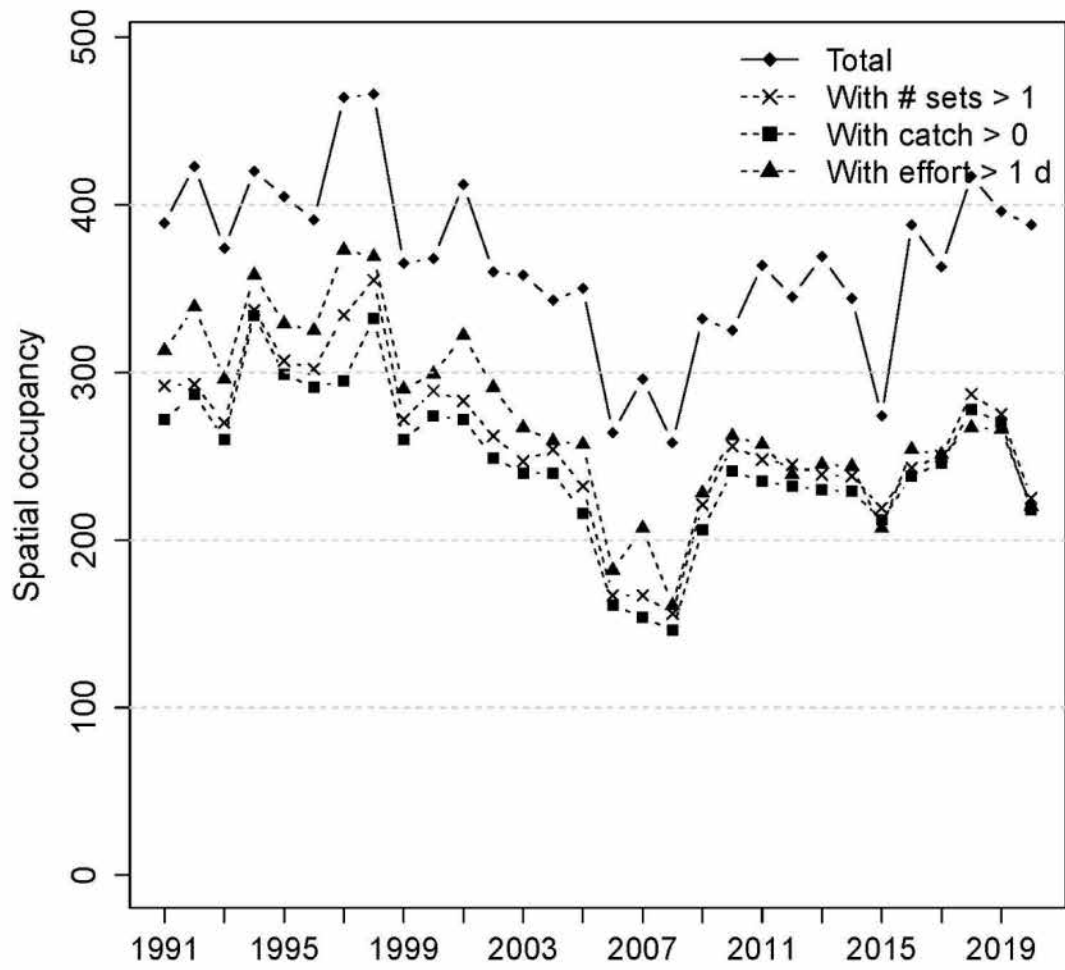


Figure 4. Changes in spatial extent of the fishery over time. Annual number of 1-degree squares explored by each vessel of the French purse seine fishing fleet during 1991-2020.

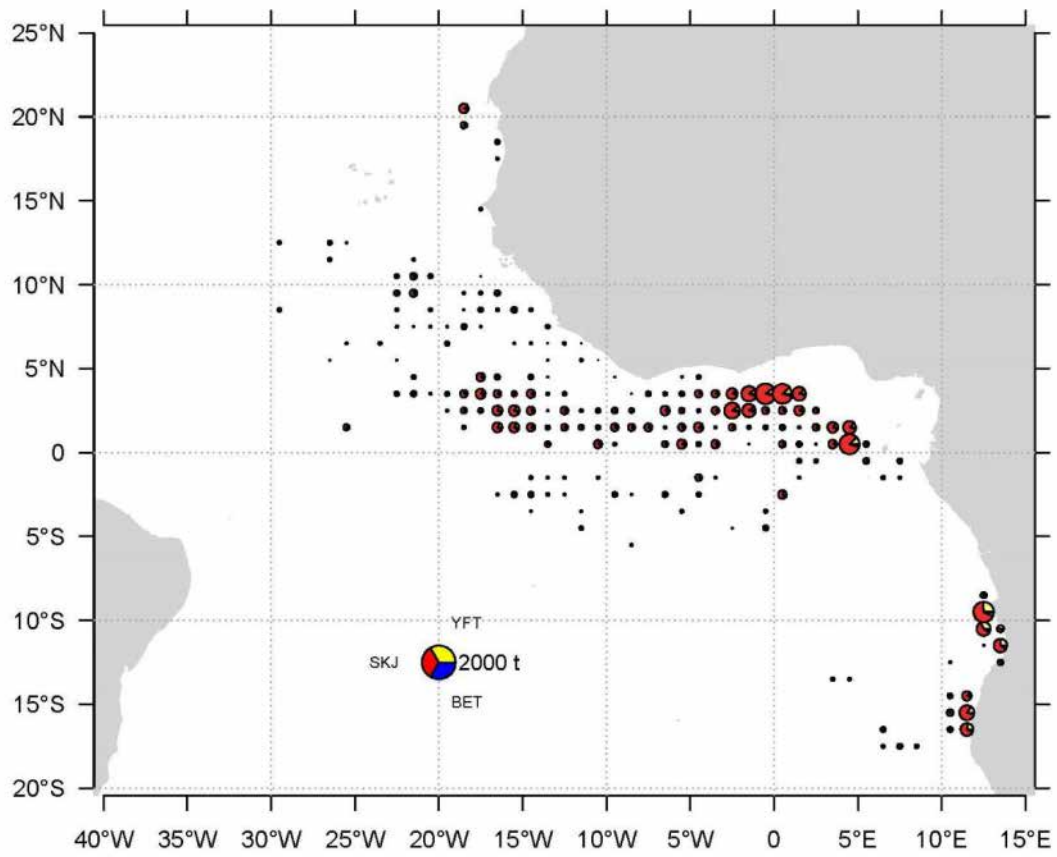


Figure 5. Spatial distribution of tuna catches of the French purse seine fishing fleet made on FOB- associated schools in 2020.

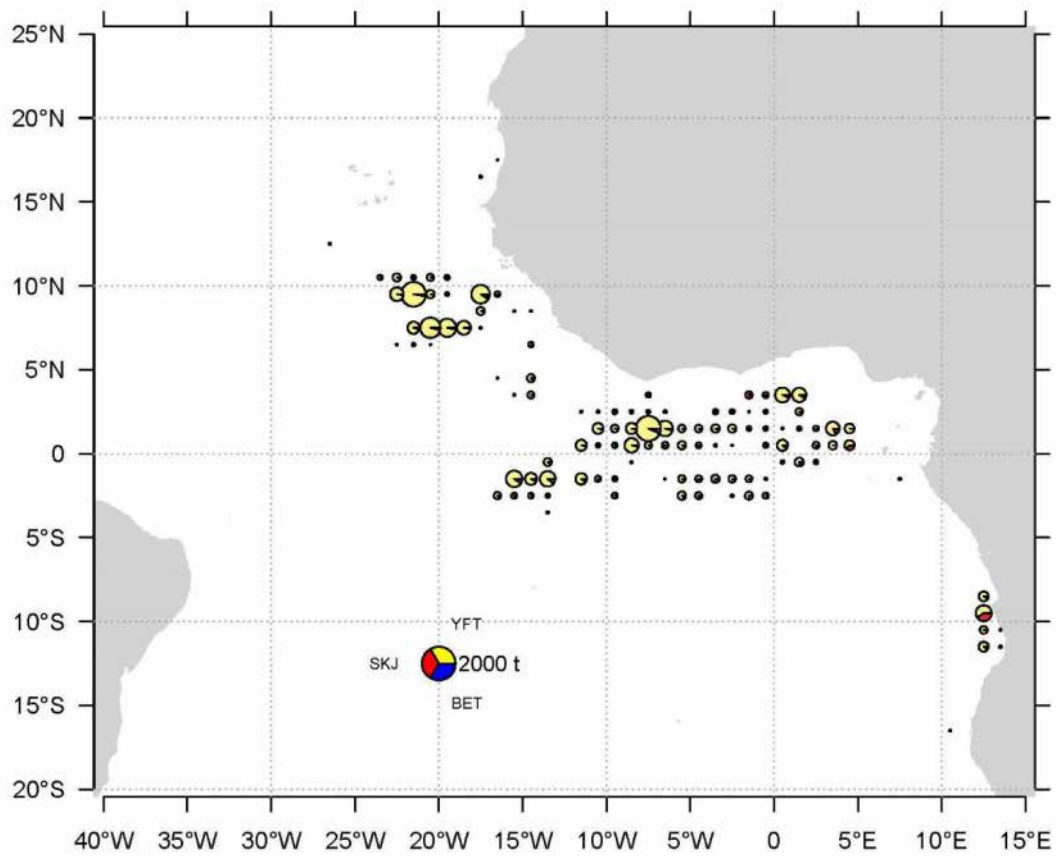


Figure 6. Spatial distribution of tuna catches of the French purse seine fishing fleet made on FSC- associated schools in 2020.

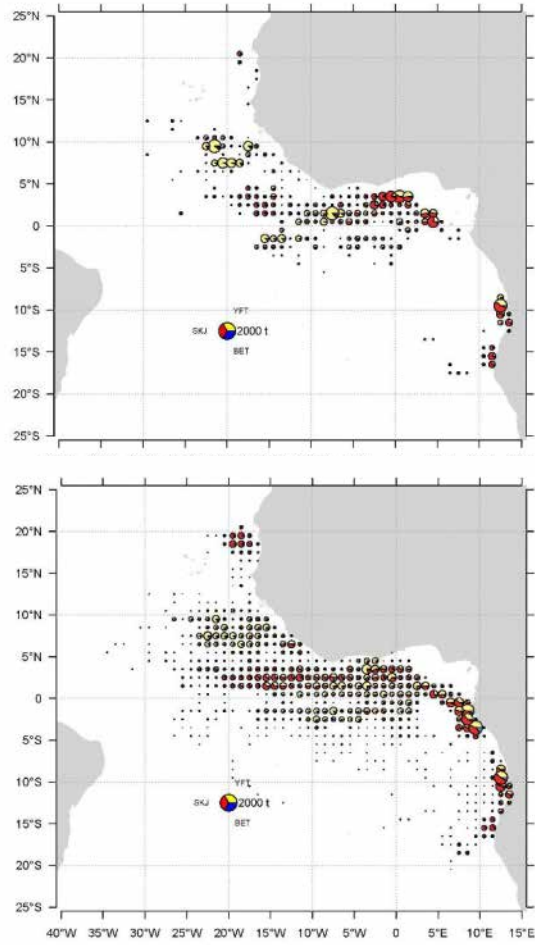


Figure 7. Maps of catches by species accounting all fishing mode in 2020 (left panel) and mean of the 2015-2019 period (right panel).

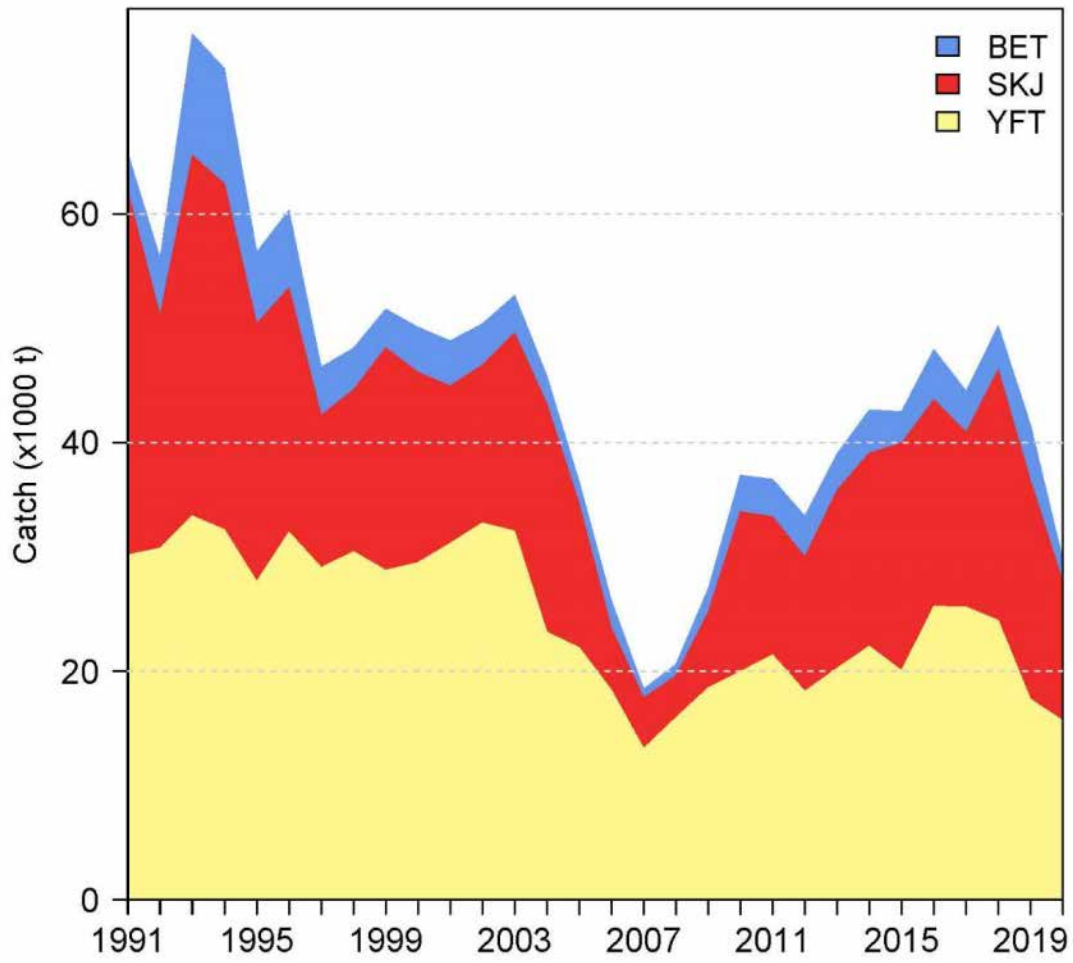


Figure 8. Total fishery production. Catch by species of the French purse seine fishing fleet during 1991-2020.

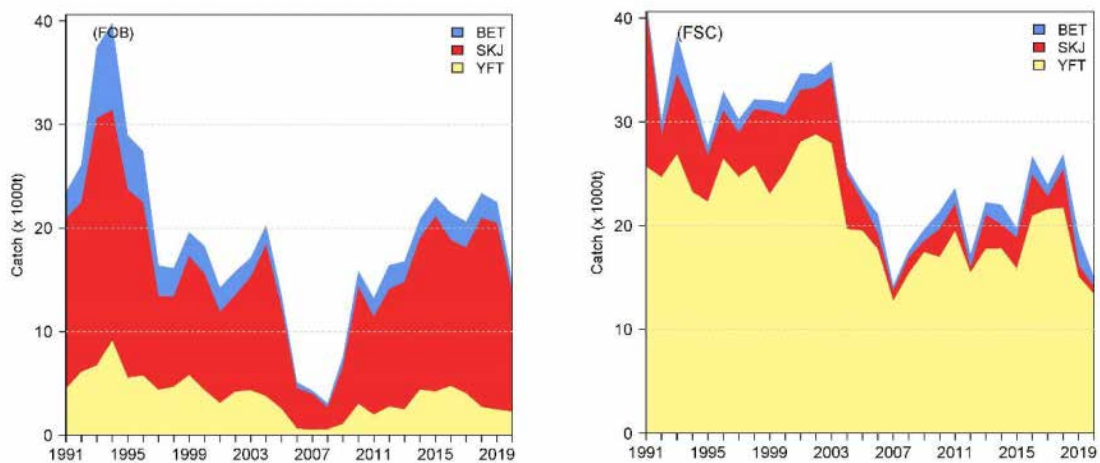


Figure 9. Fishery production by major fishing mode. Catch by species of the French purse seine fishing fleet on FOB-associated and free-swimming schools during 1991-2020

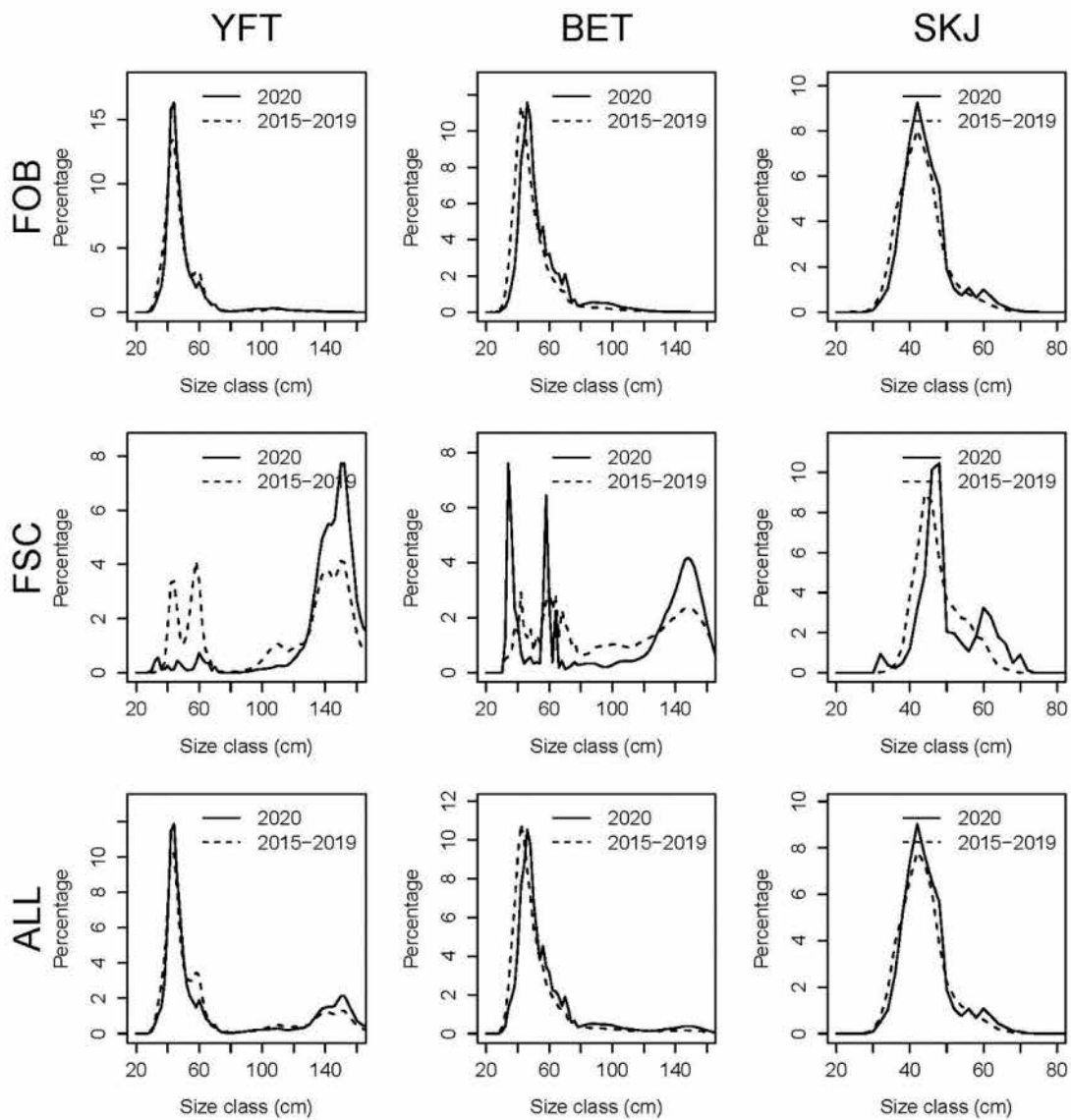


Figure 10. Distribution by size class of the catch (in percentage of the total number of fishes) for the French purse seine fleet in 2020 (solid line) and for an average year representing the period 2015-2019 (dotted line).

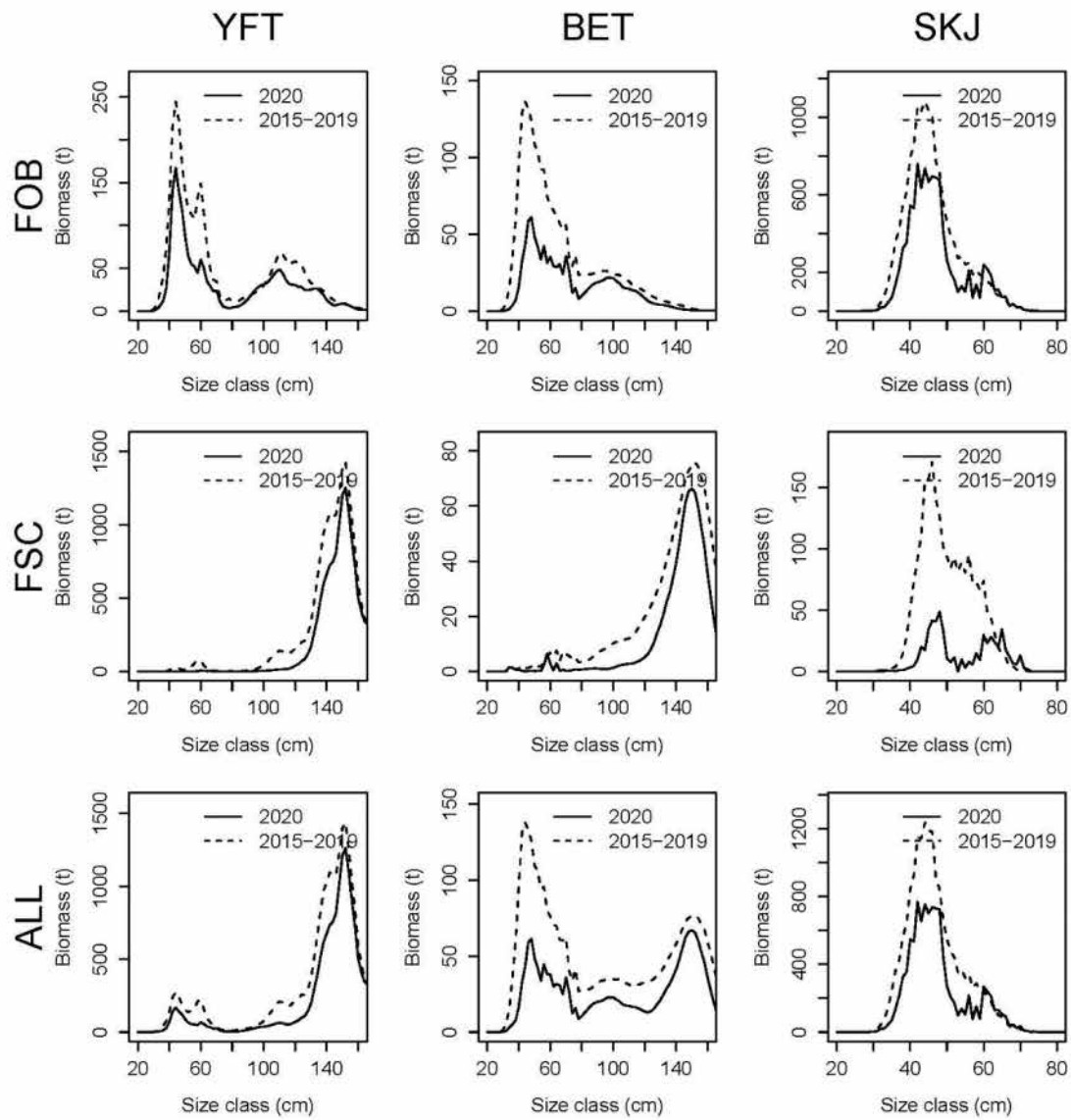


Figure 11. Weight distribution of the catch for the French purse seine fleet in 2020 (red line) and for an average year representing the period 2015-2019 (dotted line).

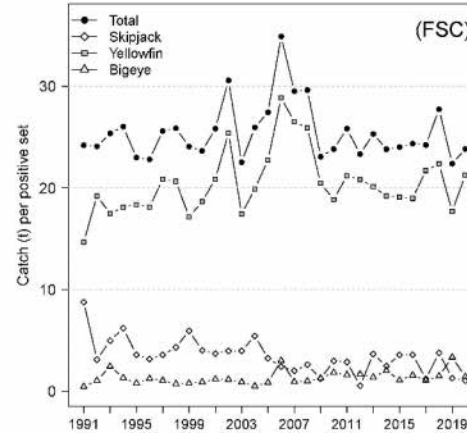
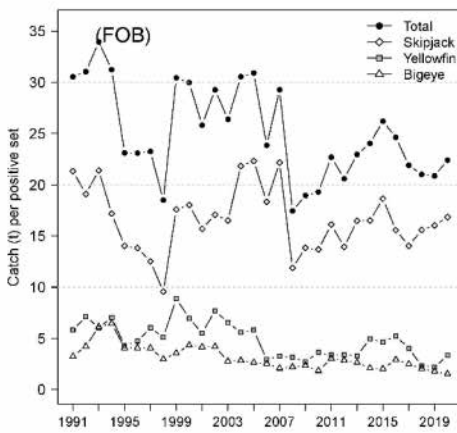
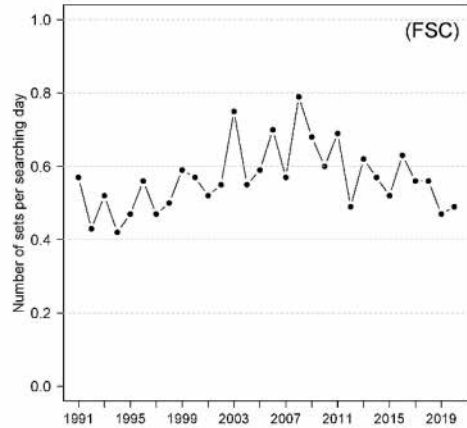
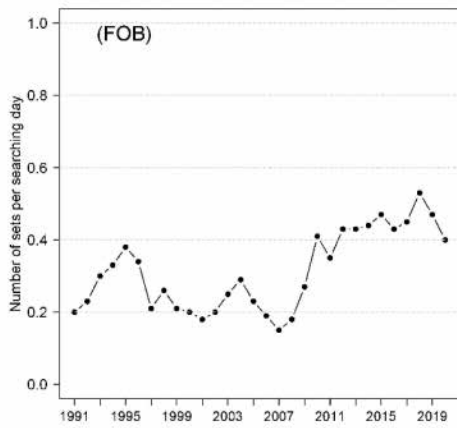


Figure 12. Annual number of sets per searching day and catch per positive set on FOB-associated (left panel) and free-swimming schools (right panel) for the French purse seine fishing fleet in the Atlantic Ocean during 1991-2020.

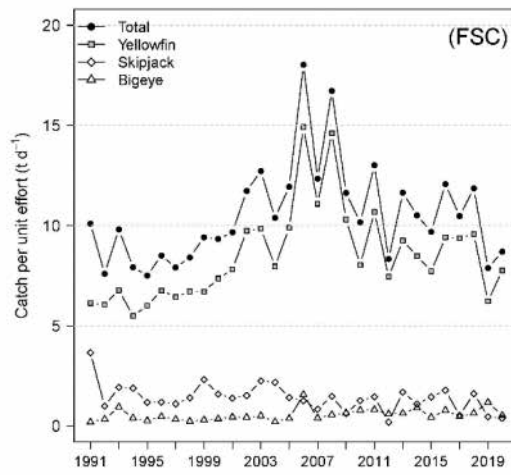
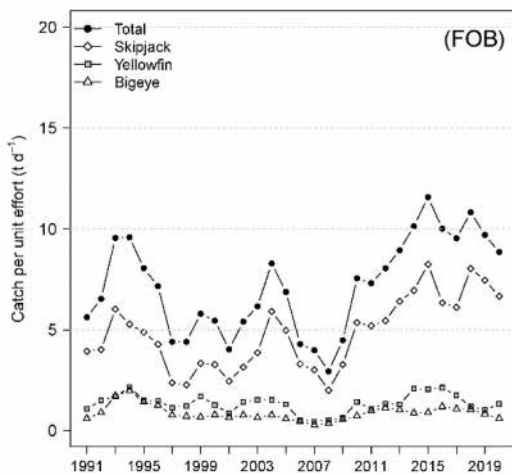


Figure 13. Annual catch rates (in t per searching day) of the French purse seine fishing fleet on FOB- associated and free-swimming schools in the Atlantic Ocean during 1991-2020.



Figure 14. Number of buoys in DB per day, Atlantic. Time series of the number of active (i.e., transmitting position information) buoys per day in the French dFAD tracking buoy database for the Atlantic Ocean. Raw indicates the number found in the raw data including all positions, even those classified as on board a vessel. Water indicates the number of active buoys after filtering out positions that are considered to be on board or beached and after having interpolated over small gaps of at most 4 days (so this amount can occasionally be greater than Raw if missing days are filled in). Echo indicates the subset of Water buoys possessing an echosounder. Note that these estimates do not account for missing data. In particular, the decline in the number of active buoys since 2019 is partially or entirely compensated by missing Satlink trajectory data not found in our database.

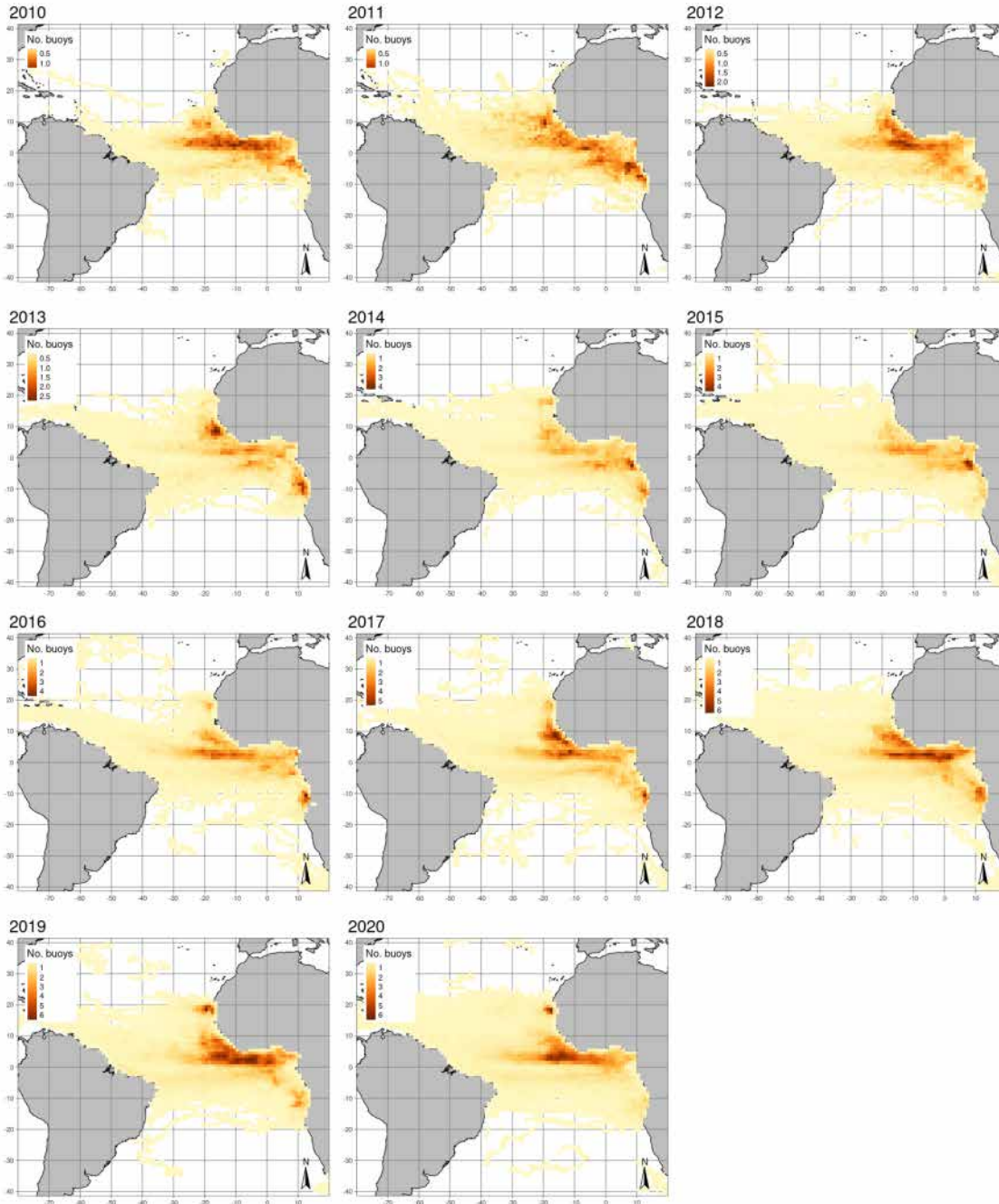


Figure 15. Estimated dFAD tracking buoy densities as a function of year for the Atlantic Ocean. Numbers indicate the average number of active (i.e., transmitting position information), in-water dFAD tracking buoys per $1^\circ \times 1^\circ$ cell per day. Numbers have been adjusted using the raising factors to account for trajectory data missing from our database (assuming this data has the same spatial distribution to that of available data).