

HISTORICAL REVIEW: 50 YEARS OF TROPICAL TUNA FISHING BY SENEGALESE FISHERIES

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SUMMARY

This document is making an overview of the history of the various Senegalese industrial tuna fisheries, baitboats and purse seiners, which have been actively targeting tropical tunas in the Eastern Atlantic during the 1965-2014 period. Fishing identify of Senegalese vessels are interesting to identify, as that have been mixed during many years with French and Ivorian in the ICCAT statistics. This paper is based on the landing data of the fleet (available since 1965 on 100% of the catches) and on log book data (available since 1969 on covering 83 % of the Senegalese total catches) and on the commonly managed size sampling of the Senegalese and of various associated fleets. Yearly number of vessels active each year, their characteristics and the yearly catches and nominal CPUE by species and by type of vessel. Changes of fishing zones and sizes of tunas caught by periods are also examined and discussed. The paper made also a short focus on artisanal small tuna and sailfish fisheries.

RÉSUMÉ

Ce document présente un aperçu général de l'histoire des différentes pêcheries thonières sénégalaises industrielles, des canneurs et des senneurs, qui ont ciblé activement les thonidés tropicaux dans l'Atlantique Est au cours de la période 1965-2014. La pêche des navires sénégalais est intéressante à identifier, car les prises de ceux-ci ont été mélangées pendant de nombreuses années avec celles des navires sous pavillon français et ivoirien dans les statistiques de l'ICCAT. Le présent document est fondé sur les données de débarquement de la flottille (disponibles depuis 1965 pour 100 % des captures), sur les données des carnets de pêche (disponibles depuis 1969 couvrant 83% des captures totales sénégalaises) et sur l'échantillonnage de tailles généralement réalisé par la flottille du Sénégal et différentes flottilles associées. Le nombre annuel de navires actifs chaque année, leurs caractéristiques et les prises annuelles ainsi que la CPUE nominale par espèce et par type de navire sont abordés. Les changements de zones de pêche et des tailles des thonidés capturés par période sont également examinés et discutés. Le document fait également une brève mise au point sur les pêcheries artisanales ciblant les thonidés mineurs et le voilier.

RESUMEN

Este documento realiza un resumen de la historia varias pesquerías industriales de túnidos de Senegal, flotas de cebo vivo y cerco, que se han dirigido de forma activa a los túnidos tropicales en el Atlántico oriental durante el período de 1965-2014. Resulta interesante identificar la pesca de los buques senegaleses, ya que durante muchos años sus capturas aparecían fusionadas con las de Francia y Côte d'Ivoire en las estadísticas de ICCAT. Este documento se basa en los datos de desembarque de la flota (disponibles desde 1965 para 100% de las capturas) y en los datos de los cuadernos de pesca (disponibles desde 1969 y que cubren el 83% de las capturas totales senegalesas) y en el muestreo de tallas realizado habitualmente en la flota senegalesa y en varias flotas asociadas. Se presenta información sobre el número anual de buques activos cada año, sus características y las capturas anuales y CPUE nominal por especie y por tipo de buque. También se examinan y discuten los cambios de las zonas de pesca y tallas de los túnidos por periodos. El documento también se centra brevemente en las pesquerías artesanales de pez vela y pequeños túnidos.

KEYWORDS

Tropical tuna, Senegalese fishery statistics

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1. Introduction

Good statistical data are permanently available on the activities, catches and fishing efforts of the Senegalese fleet since their 1st year of activity in 1965 and these catches being permanently declared to ICCAT. However, the activities of Senegalese flag vessels have been often combined in the ICCAT statistics of a so-called “FIS fleet” combining in a single category the activities of the French, Senegalese and Ivorian fleets. This category of fishing vessels was created in the early seventies in order to avoid potential bias in the landing statistics, because of frequent confusion between catch by flag and landing by fishing port. This FIS entity had positive results, there was no double counting in the tuna statistics and it has allowed a consistent statistical follow up of the fleet, but as a result, the activities and catches and effort of the Senegalese, Ivorian and French flag vessels remain somehow difficult to identify during historical times. This paper will make a review of the available basic data that have been collected by scientists on this Senegalese fleet during its 50 years of activity, targeting a full and permanent identification of the Senegalese flag vessels activities since 1965. This work will also be useful to clarify, based on real data, the real catches and catch per vessel of the Senegalese fleet that have been wrongly & widely overestimated in a recent work by Belhabib et al. 2014.

2. Material and method

All the basic data on the catches and effort and sizes landed by Senegalese tuna vessels have been collected mainly in Senegal by the ISRA/CRODT team of scientists, but also in historical times (1967-1997) by ORSTOM³ scientists based in the landing ports of Pointe Noire and Abidjan (CRO). These data are the base of this work, but this data base remains somehow heterogeneous over time, as it will be explained thereafter.

- ❧ **Landing data of the Senegalese fleet** have been collected since 1965, the first year of activity of the Senegalese fleet, for 100% of the catches and for all the individual landings, independently of the landing ports (Dakar, Abidjan and Pointe Noire). The name and detailed characteristics of all the vessels involved in these landings are also well known. This landing file also provides for most of the trip a knowledge of the duration of each trip, allowing to estimate a nominal CPUE in terms of catch per day at sea. This file also allows to estimate the catch by large fishing zone, for instance in the 3 areas off Senegal, Cote d'Ivoire and Congo, at least for the landing of the early period when all the vessels were doing short trips at sea (method used by Champagnat 1973). All landings of the artisanal fishery active in Senegal have been collected primarily by CRODT scientists and these data have been routinely submitted to the ICCAT since 1975. This data set available in the ICCAT data base will simply be reviewed and discussed in the context of the peculiar and very active artisanal fisheries that are active in Senegal.
- ❧ **Log book** have been collected on the fleet since 1969 on a large proportion of the landings: an average 78% of the Senegalese trips had a log book recovered by scientists during the 1969-2014 period, this log book system, similar to the French and Ivorian system, covered an average 83% of the landings during the period. These log books have been computerized since 1969 and all the TASK2 catch and effort data estimated based on them have been permanently submitted to the ICCAT, keeping in mind that this Senegalese TASK2 has been declared mixed with French and Ivorian catches, catch and effort, and size statistics until 1989. Unfortunately, it should be noted that because of a change of computer in the early eighties, the computerized original log book data of the 1969-1979 period have been lost, and these historical data have not been computerized again. As a consequence, the only basic TASK2 information available during the 1969-1979 period are the 1^o squares and month catch and effort data combining France, CI and Senegal, this data set being stratified in 4 categories: ice baitboats, freezer baitboats, small and large purse seiners. Our work will use this data set to estimate catches, and fishing zones of the various fishing gear during the 1965-2014 period.
- ❧ **Size data** have been permanently collected on Senegal landings since 1966 and in all the landing ports, obtained by a port sampling scheme targeting various fleets. This size sampling moved to a multispecies sampling scheme in 1980. These sizes have been submitted to ICCAT. Statistical analysis of these samples have been consistently showing that sizes caught are independent of the flag but dependent of time and area strata, allowing to use multiple flags in the estimation of sizes caught.

³ ORSTOM, Office de la Recherche Scientifique et Technique Outre Mer, now IRD (Institut de recherches pour le Développement).

3. Results

3.1 Senegalese industrial vessels active yearly

The studied period 1965 to 2014 can easily be stratified in 2 distinct periods of widely different fishing fleets:

(1) **1965-1976**: an early historical period, when a large fleet of brand new tuna vessels, baitboats and small purse seiners, owned by a Senegalese state company created in 1962 with various international partners. The SOSAP (Société Sénégalaise d'Armement de Pêche) fleet has been very active in the entire Guinea Gulf, fishing in a wide area between Pointe Noire and Dakar between 1965 & 1975. The rise and fall of this historical fleet has been analyzed by various authors (Jamet 1975, Charneau 1986).

(2) **1977-2014**: during this period smaller scale activities have been conducted by a smaller and heterogeneous fleet of baitboats and of small and large purse seiners, always managed by private companies, and mainly active in the Senegal area.

The Senegalese fleet has been stratified in our report in 4 categories of vessels: ice and freezer baitboats, small purse seiner and large purse seiner (under and over 400 tons of carrying capacity).

The yearly numbers of active Senegalese vessels in each of these 4 categories are shown by **figure 1** (these numbers are not weighted by the duration of the yearly fishing activities).

It can be noticed that these numbers of vessels are much lower than the numbers estimated by Belhabib et al 2014. The average sizes of the Senegalese vessels active yearly can be summarized by the average carrying capacity (in tons) of the baitboats and purse seiners. This basic information is shown by **figure 2**.

The total yearly carrying capacity of the Senegalese fleet is shown by **figure 3** (these values are not weighted by the duration of the yearly fishing activities)

3.2 Yearly catches by the industrial fisheries

The yearly catches of the Senegalese vessels have been well followed during the entire period and for nearly 100% of the Senegal landings, and they have been declared to ICCAT, either included in the FIS category or as Senegalese catches. These total yearly Senegalese catches are given in **table 1** and summarized by gear in **figure 4a** (baitboat) and **4b** (purse seiner).

It can be noticed that these yearly catches by Senegal flag vessels during the 1965-2014 period are at a average level of only 3800 tons (then much lower than the catches estimated by Belhabib et al 2014). It can also be noticed that the species composition of these catches has been widely variable over the years. This variability is due to a combination of various reasons such as:

- Changes in the market and in the value of each species: in the sixties and early seventies, the main species targeted was yellowfin, and the other tuna species had very low landing value, while the today differences in landing price of the 3 species are reduced today.
- Changes in fishing area: historical coastal fishing areas are showing a higher proportion of yellowfin and lower percentage of bigeye.
- Changes in the fishing method: the associated schools that are fished today (and since 1985) by the new fishing method developed by the Dakar baitboats (Fonteneau and Diouf 1994) are showing a peculiar species composition.
- Major changes of species composition of tuna catches in the Senegalese fishing area that are probably due to unknown environmental causes.
- Statistical bias underestimating Bigeye catches during the period 1965-1979 before the implementation of the multispecies sampling programme of the Senegalese catches implemented since 1980.

It is also important to compare these estimated Senegalese total catches with the catches kept in the ICCAT data base as they have been submitted by Senegal, These various statistical series are given by **table 3**. These various data sets are quite inconsistent and the following comments can be done on these series:

- ⚡ In the ICCAT data base, there are no Senegalese catches visible before 1990, but these catches have been declared to ICCAT and they have been classified in the statistical category of FIS catches. Most of the year during the 1990 and today are showing similar levels of yearly catches in the ICCAT and in our data base, but yearly catches in the ICCAT statistics would appear to be too low (2007 and 2011).
- ⚡ The FAO catch statistics (FISHSTAT) are covering a wider period, starting in 1974, but its level of yearly catches are too low and by far during the 1974-1980 period, and all the catches during the 1965-1973 period are absent from this FAO data set.
- ⚡ Another series of yearly Senegalese catches was provided by Chassot et al 2008 for the period 1969-1989, this data set was very similar to our series, being based on the same sources, but missing the previous period 1965-1979 and being limited to an overview of Senegalese yearly catches.

These basic serious differences in the levels of the Senegalese fisheries are due to various historical causes, but they are quite artificial because this fishery has been well followed by scientists since its first year of activity. Its real catches by species and gear are probably very close to the levels shown by the **figure 2 and table 1**, when the errors in the various official FAO & ICCAT statistics are easy to understand, being due to a combination of administrative reasons.

3.3 Fishing zones of the industrial fisheries

The areas fished by Senegalese baitboats and purse seiners have been quite variable during the periods. Changes in fishing zones can be classified in 4 distinct periods shown by **figure 5a** (1969-1979), **5b** (1980-1990), **5c** (1991-2002) and **5d** (2003-2014), taking note that senegalese baitboat have been active during each of these 4 periods, while purse seiners have been active only during the 2 first periods.

Yearly catches of purse seiners are shown by **figure 6a and 6b** (before and after 1980).

These fishing maps are well showing that the fishing zones of the Senegalese fleet have been quite distinct between the various periods and between baitboats and purse seiners, but a large proportion of these catches being caught outside Senegal EEZ.

3.4 Yearly nominal fishing efforts and nominal CPUEs by gear types

Fishing efforts have been analyzed in term of nominal days at sea exerted by Senegalese vessels, stratified by fishing mode (baitboat & purse seine) and by categories of the vessels. The information on catches was available on 100% of the 1965-2014 landings and the information on the number of days at sea on a great majority of the trips, the fishing efforts has been obtained for most of the vessels during the entire period. Only 10% of the total catches landed by Senegal vessel do not have a corresponding fishing effort, but these missing efforts can be estimated based on the CPUE of the well followed vessels belonging to the same group of vessels. The yearly nominal total fishing efforts exerted by the Senegalese tuna fleet are shown by **figure 7** and given in **table 2**.

The yearly average numbers of days at sea by the average Senegalese BB and are also interesting; the steady increase in the yearly numbers of fishing days exerted by Senegalese BB during the last 20 years is clearly visible on this figure. This increase is in direct relation with the new fishing mode of the Dakar BB developed since the early eighties (Fonteneau & Diouf 1994): when the historical traditional BB fishery was seasonal in the Senegalese area, the today fishery and its tuna school permanently associated to a couple of associated BB is now allowing successful fishing operation all year round (see **figure 8**)

It can be noticed that the nominal CPUE of Senegalese baitboats have been fluctuating but not showing a declining trend during recent years, as many other fisheries (**figure 9**). On the opposite, recent CPUEs of baitboats tend to be sustained at quite higher levels than in historical times, the activity of the fleet being concentrated now in a smaller area. This high level of recent CPUEs is also due to the larger size of the fishing vessels (**figure 2**) and also to the very efficient fishing method developed by Dakar baitboats since the late eighties (Fonteneau and Diouf 1994). There is no doubt that these nominal CPUEs are not representative of the trend in stock sizes, as each of the 3 exploited stocks was close to a virgin status in the sixties, when they are heavily exploited today and at a much lower of stock biomass. **Figure 10** is showing the nominal CPUEs of Senegalese small and large purse seiners during their entire period of activity 1969-1989.

It can be noted that the nominal CPUEs of small purse seiners were at similar level for Senegalese and for French vessels (**figure 11**).

3.5 Seasonality of the baitboat fishery off Senegal

It is interesting to examine the major changes in the seasonality of the baitboat fishery active off Senegal and also the changes in its target species between the historical and the today fisheries. These changes are well shown by the pie diagram **figure 12**. This figure has been stratified in 2 major periods of activity in the Senegal area (north of 5°N, including Cape Verde Islands):

- (1) the historical period 1969-1979 when the BB fishery was targeting a mixture of YFT and SKJ (an average of 47 and 50 %) caught in free schools searched by each individual BB, this fishery being seasonal and mainly active between May and November and catching a small amount of BET (only 2.3%).
- (2) the today fishery: active all year round, where all the fishing activity are conducted by pairs of associated BB that are now permanently using the MAC fishing mode (Hallier et al., 1998, Fonteneau and Diouf 1994, Ngom et al., 2011). The species composition of the catches obtained under this new fishing mode are quite distinct: most often showing a much higher percentage of BET, an average of 10 % (BET being a species most often associated to floating objects), higher amount of SKJ (71%), but much less YFT (19%).

3.6 Sizes caught by the industrial fisheries

Statistical analysis conducted on the sizes of tuna caught by purse seiners and baitboat have been showing that these sizes are independent of the flag of the fishing vessels, being solely conditioned by the gear and by the time and area strata. Consequently, it can be assumed without risk of bias that the sizes of yellowfin, skipjack and bigeye caught by the Senegalese vessels were identical to the sizes landed caught by the same gear fishing in the same strata. All these information on the tuna size caught are already fully available in the ICCAT data base. However it could be kept in mind that the early purse seine coastal fisheries, dominated by small vessels, was catching during the late sixties and early seventies sizes of yellowfin that were widely distinct from today catch at size. **Figure 13** is for instance showing an average yellowfin catch at size figure of purse seiners during 2 periods: the historical period 1969-1974, when there was an active purse seine fishery, and the today purse seine fisheries (2000-2013).

It should be considered that this distinct size pattern is mainly/only due to changes in fishing patterns (FADs, area, gear, etc), and probably not to changes in size structure of the fished yellowfin population. The quite large number of yellowfin caught in historical times could for instance be due to the small size of the schools most often caught by purse seiners: these small and highly mobile medium size yellowfin are seldom caught today by large purse seiners, while they were more efficiently caught by small purse seiners: because they were using live bait in order to stabilize the schools and because they were ready to set their net on a small 5 tons schools (when today these small tuna schools are never targeted by large purse seiners).

3.7 Observer data obtained in April 1971 on a small Senegalese purse seiner

The 1st scientific observer on a purse seiner active in the Atlantic has been a French scientist, Patrick Soisson, on board a Senegalese small purse seiner in April- May 1971. When this type of small purse seiner was very active until the late seventies but is now vanished, his report remains interesting today. It shows well the various peculiarities of the Senegalese small purse seiner and of an historical fishing method. The importance of this historical fishing method should also be kept in mind: small purse seiners were dominant in the sixties and in the early seventies, **figure 14**, and for instance producing 68% of the total catches by the FIS fleet in 1971.

The same type of fishing vessels and fishing mode was also used during this period by Spanish purse seiners. This peculiar fishing mode of the historical Senegalese purse seiner fisheries is interesting to keep in mind, for instance to better understand the major changes in the purse seiner fishery and to fully understand the multiple additive causes explaining the spectacular increases observed today in the fishing efficiency of purse seiners and the observed changes in species composition and in catch at size of the purse seiner fishery. The annex 1 makes a summary of various observations selected from the Patrick Soisson 1971 observer report.

3.8 Artisanal Senegalese tuna fisheries

Artisanal fisheries have been active for centuries in Senegal, but they have been showing major development during the last 50 years following major changes in this fishery, among them the motorization of all the canoes in the sixties and the development of an important purse seiner canoe fishery targeting primarily small pelagic fishes, and secondarily tunas. This artisanal fishery is highly multispecific in its nature: targeting a wide range of species, at variable degrees, depending of the resources available, the time and area strata, the changes in the market, the weather, etc... An important point to note is that major tunas such as YFT, SKJ and BET are very seldom caught by artisanal gears, most of the tuna catches belonging to only two species (*Euthynnus* and *Sarda*) and to one billfish species, the sailfish *Istiophorus* (**figure 15 and table 4**).

These small tuna and sailfish catches constitute a minor part of the very large catches by Senegal artisanal fisheries: between 1 and 2 % of their total catches during the 1980-2013 period). A majority of these tunas are caught as by catches by the PS canoe fishery operating between Saint Louis and MBour in various landing places, most often landing their catches on the beaches (see **figure 16**). Large PS Canoes are showing a length of about 18 meters, a carrying capacity of about 2 tons; they are powered by an outboard engine of 40 HP and they are handled by a crew of about 15 fishermen. Small canoes are handled by 2 or 3 fishermen, using troll lines or hand line, have been also permanently active in this fishery, catching minor quantities of small tunas, but also all the sailfish caught by artisanal fisheries. It should be noted that some fishermen fishing with hand line in small canoes are sometimes targeting small tunas as a primary target species. It should also be kept in mind that significant quantities of sailfish were also caught each year by the Senegalese sport fishery active in the Dakar area each year since 1967 between June and September (Limouzy and Cayré 1981).

It is interesting to note that the catches of small tunas by the Senegalese artisanal fisheries have been showing a quite stable trend, while the fishing effort exerted by the fishery and also its total catches of the small pelagic target species was showing increasing trends. This flat curve of the yearly tuna catches may be due to a full exploitation of local resources, but the relationship between tuna catches and fishing efforts exerted by the artisanal fisheries should be further studied by scientists. However, this relationship is very complex, because of the highly multigear & multispecific nature of these fisheries, and because of the very minor relative weight and relative economical value of tunas in this fishery.

4. Conclusion

The industrial tuna fisheries developed by Senegal vessel during the last 50 years have been more or less permanently active during the period, but permanently showing a great diversity of its fishing pattern, gear, fishing zones and efficiency that are quite difficult to follow in the ICCAT data base or in the scientific literature. It shows that Senegalese fleets have been permanently targeting tunas, and catching an average catch of 3800 tons of tunas during the 1965-2014, but also showing a permanent variability of its fishing activities. Because of their variability and because of the quite low level of the fishery, these data are of minor interest to the stock assessment analysis done by scientists. This paper should help all interested persons to better follow the important changes of this interesting fleet. This work should also be the first step allowing to identify soon and well in the ICCAT TASK1 and TASK2 statistics, all the activities of the various flags that are still mixed today in an the FIS group.

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Table 1. Total yearly catches by species and by gear.

Year	BB				PS				Total Senegal			
	YFT	SKJ	BET	Total	YFT	SKJ	BET	Total	YFT	SKJ	BET	Total
1965	241	76	0	317	0	0	0	0	241	76	0	317
1966	1272	352	0	1624	0	0	0	0	1272	352	0	1624
1967	3083	684	0	3767	0	0	0	0	3083	684	0	3767
1968	3227	487	0	3714	0	0	0	0	3227	487	0	3714
1969	1536	380	141	2058	984	268	4	1256	2521	648	145	3314
1970	1217	474	160	1851	2865	1421	81	4366	4082	1894	241	6217
1971	1110	812	95	2017	4225	2662	82	6969	5335	3473	177	8985
1972	1152	298	2	1452	6126	3679	13	9818	7278	3977	15	11271
1973	8	31	0	39	6299	2449	550	9298	6306	2480	550	9337
1974	37	58	0	95	4261	3509	83	7853	4298	3567	83	7948
1975	0	0	0	0	2813	2415	148	5376	2813	2415	148	5376
1976	125	67	24	216	1866	1106	0	2972	1991	1173	24	3188
1977	70	64	28	162	855	1306	81	2242	925	1370	109	2404
1978	84	101	76	260	919	2397	111	3427	1002	2498	187	3688
1979	51	42	33	126	245	494	60	799	296	535	94	925
1980	57	67	0	124	0	0	0	0	57	67	0	124
1981	38	72	0	110	483	1780	9	2271	521	1852	9	2381
1982	0	0	0	0	1509	2033	40	3582	1509	2033	40	3582
1983	0	0	0	0	971	2019	9	2998	971	2019	9	2998
1984	140	211	0	350	1396	2756	2	4154	1536	2967	2	4505
1985	204	129	55	388	1987	3793	6	5786	2191	3923	61	6174
1986	256	309	129	694	1166	1875	3	3043	1422	2184	132	3737
1987	216	207	130	552	1006	1640	247	2893	1222	1847	376	3445
1988	118	306	41	465	814	881	61	1756	931	1187	103	2221
1989	191	402	1	595	69	309	1	378	260	711	2	973
1990	89	123	0	212	3	8	0	11	92	131	0	223
1991	52	343	5	400	0	0	0	0	52	343	5	400
1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	9	55	4	67	0	0	0	0	9	55	4	67
1994	1	64	8	72	0	0	0	0	1	64	8	72
1995	94	282	180	557	0	0	0	0	94	282	180	557
1996	77	238	136	451	0	0	0	0	77	238	136	451
1997	152	429	218	799	0	0	0	0	152	429	218	799
1998	248	1699	735	2682	0	0	0	0	248	1699	735	2682
1999	663	1632	1372	3668	0	0	0	0	663	1632	1372	3668
2000	194	1357	915	2466	0	0	0	0	194	1357	915	2466
2001	279	1284	1159	2723	0	0	0	0	279	1284	1159	2723
2002	558	1178	497	2232	0	0	0	0	558	1178	497	2232
2003	253	639	322	1214	0	0	0	0	253	639	322	1214
2004	576	1446	490	2511	0	0	0	0	576	1446	490	2511
2005	1106	5033	770	6909	0	0	0	0	1106	5033	770	6909
2006	1347	3858	1318	6523	0	0	0	0	1347	3858	1318	6523
2007	1068	4552	1292	6911	0	0	0	0	1068	4552	1292	6911
2008	682	3045	734	4462	0	0	0	0	682	3045	734	4462
2009	1024	4506	1143	6673	0	0	0	0	1024	4506	1143	6673
2010	895	2707	954	4555	0	0	0	0	895	2707	954	4555
2011	1199	5383	455	7036	0	0	0	0	1199	5383	455	7036
2012	1839	4414	432	6685	0	0	0	0	1839	4414	432	6685
2013	1052	4490	599	6141	0	0	0	0	1052	4490	599	6141
2014	491	3092	359	3942	0	0	0	0	491	3092	359	3942

Table 2. Yearly nominal fishing effort (days at sea) exerted by Senegalese baitboats and purse seiners during the 1965-2014 period.

Year	BB	PS	Year	BB	PS
1965	107	0	1990	79	11
1966	953	0	1991	85	0
1967	1262	0	1992	0	0
1968	1178	0	1993	0	0
1969	1202	376	1994	43	0
1970	1135	1026	1995	45	0
1971	1547	1333	1996	305	0
1972	944	1993	1997	117	0
1973	0	2589	1998	634	0
1974	22	2324	1999	144	0
1975	0	1716	2000	1344	0
1976	208	1039	2001	549	0
1977	126	430	2002	714	0
1978	130	654	2003	950	0
1979	90	295	2004	458	0
1980	82	0	2005	501	0
1981	86	355	2006	1919	0
1982	0	777	2007	2736	0
1983	0	858	2008	1976	0
1984	157	741	2009	1167	0
1985	136	751	2010	2679	0
1986	275	482	2011	991	0
1987	187	563	2012	1404	0
1988	167	383	2013	2099	0
1989	316	187	2014	3214	0

Table 3. Yearly tuna catches by Senegal vessels available from various sources.

Year	Our data	ICCAT	FAO	Chassot et al
1965	317	0	0	-
1966	1624	0	0	-
1967	3767	0	0	-
1968	3714	0	0	-
1969	3314	0	0	3281
1970	6217	0	0	6274
1971	8985	0	0	9201
1972	11271	0	0	10791
1973	9337	0	0	9013
1974	7948	0	211	8102
1975	5436	0	146	6110
1976	3252	0	222	3699
1977	2404	0	162	2655
1978	3688	0	250	3786
1979	907	0	144	965
1980	124	0	136	0
1981	2381	0	2323	1554
1982	3582	0	2373	3415
1983	3058	0	2446	2418
1984	4505	0	3946	4055
1985	6176	0	5409	5313
1986	3731	0	3691	2372
1987	3445	0	2004	2688
1988	2189	0	2004	2585
1989	1055	0	900	315
1990	212	0	224	0
1991	400	396	799	-
1992	0	0	305	-
1993	67	59	123	-
1994	72	75	191	-
1995	588	96	275	-
1996	286	286	342	-
1997	867	867	921	-
1998	2605	2889	2944	-
1999	3786	3938	3938	-
2000	2888	2888	2889	-
2001	2874	2874	2874	-
2002	2063	2063	2065	-
2003	1486	1486	1487	-
2004	2552	2552	2577	-
2005	6896	6896	6897	-
2006	6063	6063	6111	-
2007	3896	3896	3902	-
2008	5137	5137	5175	-
2009	6711	6711	6894	-
2010	4422	4422	4517	-
2011	5994	5994	6112	-
2012	6149	6149	6253	-
2013	5871	5871	-	-

Table 4. Yearly catches of tunas and billfish caught by the Senegalese artisanal and sport fisheries.

	Euthynnus	Sarda	Sailfish	Total
1974	416	4	107	527
1975	1092	40	122	1254
1976	705	164	189	1058
1977	1540	614	160	2314
1978	1446	523	143	2112
1979	1697	159	107	1963
1980	2444	140	325	2909
1981	2997	1446	498	4941
1982	5009	1489	572	7070
1983	5460	655	510	6625
1984	7723	269	163	8155
1985	4257	698	241	5195
1986	6823	781	572	8176
1987	2720	438	596	3753
1988	6174	439	587	7200
1989	5767	774	552	7093
1990	4363	525	1040	5928
1991	3484	597	466	4547
1992	4011	345	860	5216
1993	4724	171	462	5356
1994	4536	814	162	5512
1995	3613	732	167	4512
1996	1972	1012	240	3223
1997	4174	1390	560	6124
1998	4715	2213	260	7188
1999	1607	2558	238	4403
2000	3546	286	786	4618
2001	5176	545	953	6674
2002	2866	621	240	3727
2003	4394	195	673	5263
2004	3508	183	567	4258
2005	2699	484	463	3646
2006	3826	2304	256	6386
2007	3885	1020	737	5643
2008	5108	1380	446	6934
2009	5683	4029	630	10343
2010	6371	1677	484	8533
2011	4910	2876	174	7960
2012	2769	1453	247	4469
2013	5912	514	165	6590

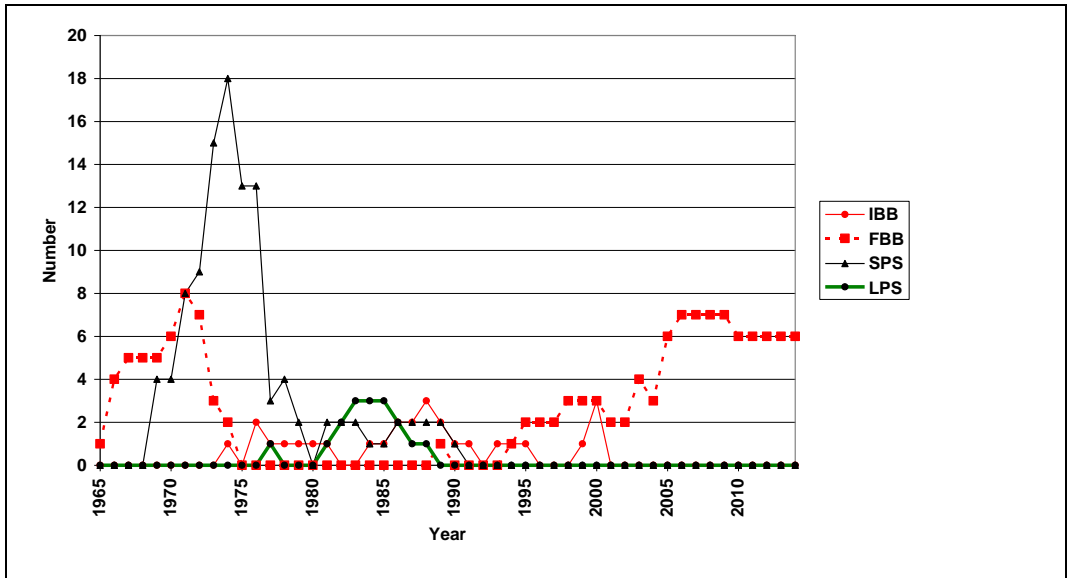


Figure 1. Numbers of fishing vessels: ice baitboat (IBB), freezer baitboat (FBB), small (SPS) and large purse seiner (LPS) active yearly in the Senegalese fleet during the 1965-2014 period.

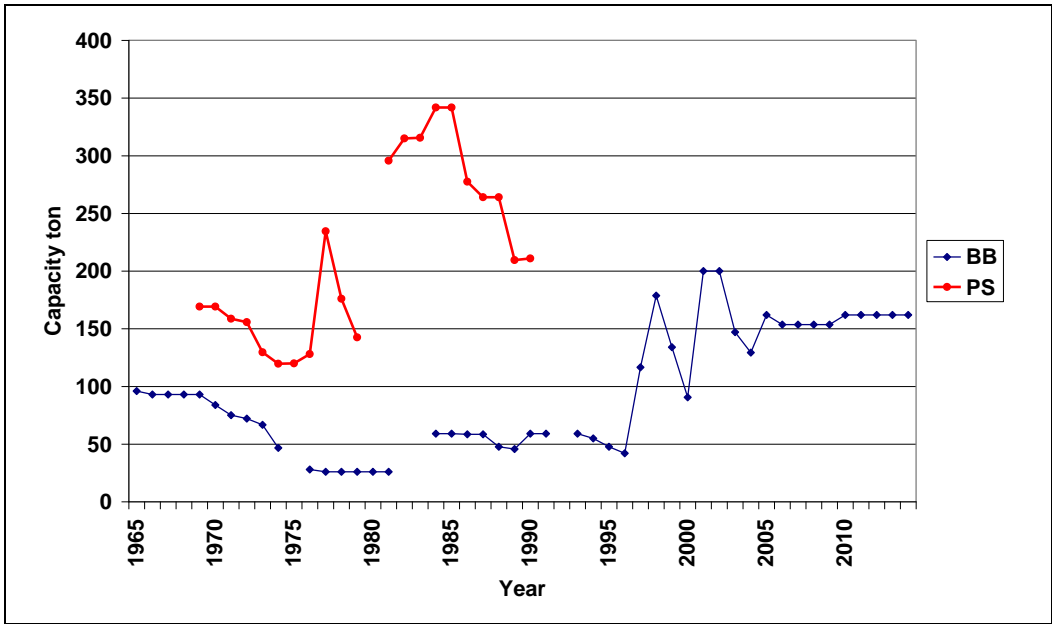


Figure 2. Yearly carrying capacity (in tons) of the average Senegalese baitboat and purse seine vessels.

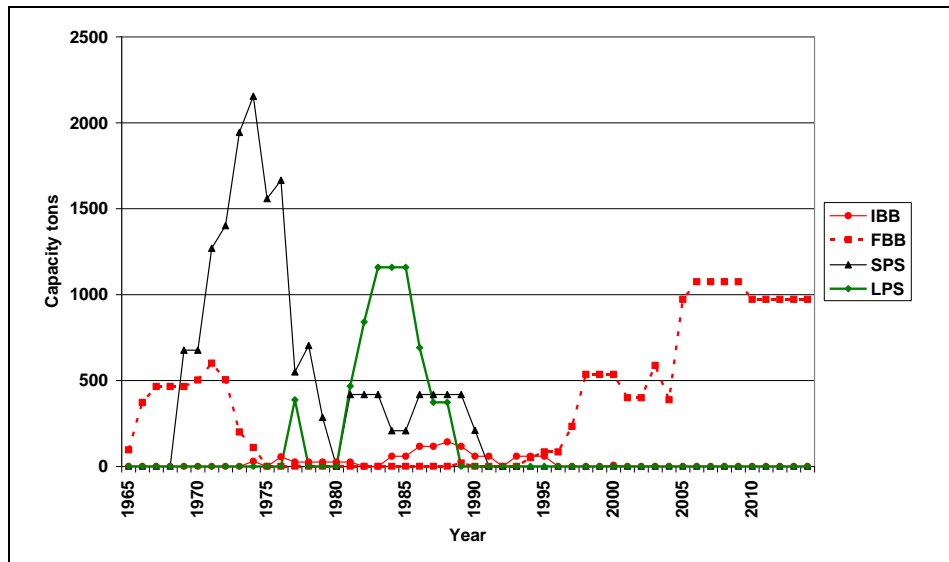


Figure 3. Yearly carrying capacity, by gear and category, of the Senegalese tuna fleet.

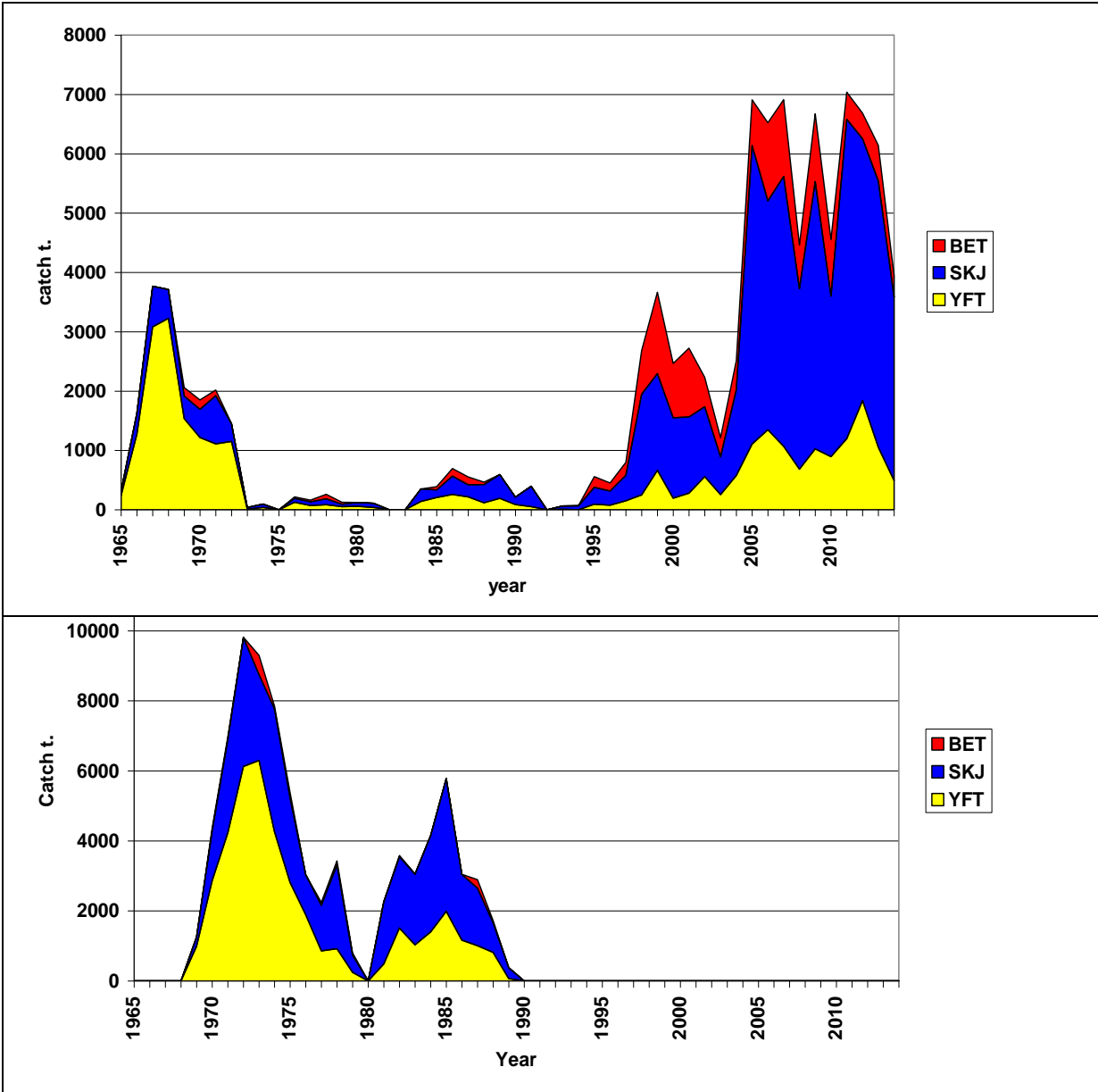


Figure 4. Yearly total catch by species by Senegalese baitboat (upper fig 4a) and purse seiner (lower figure 4b) (2014 data still provisional).

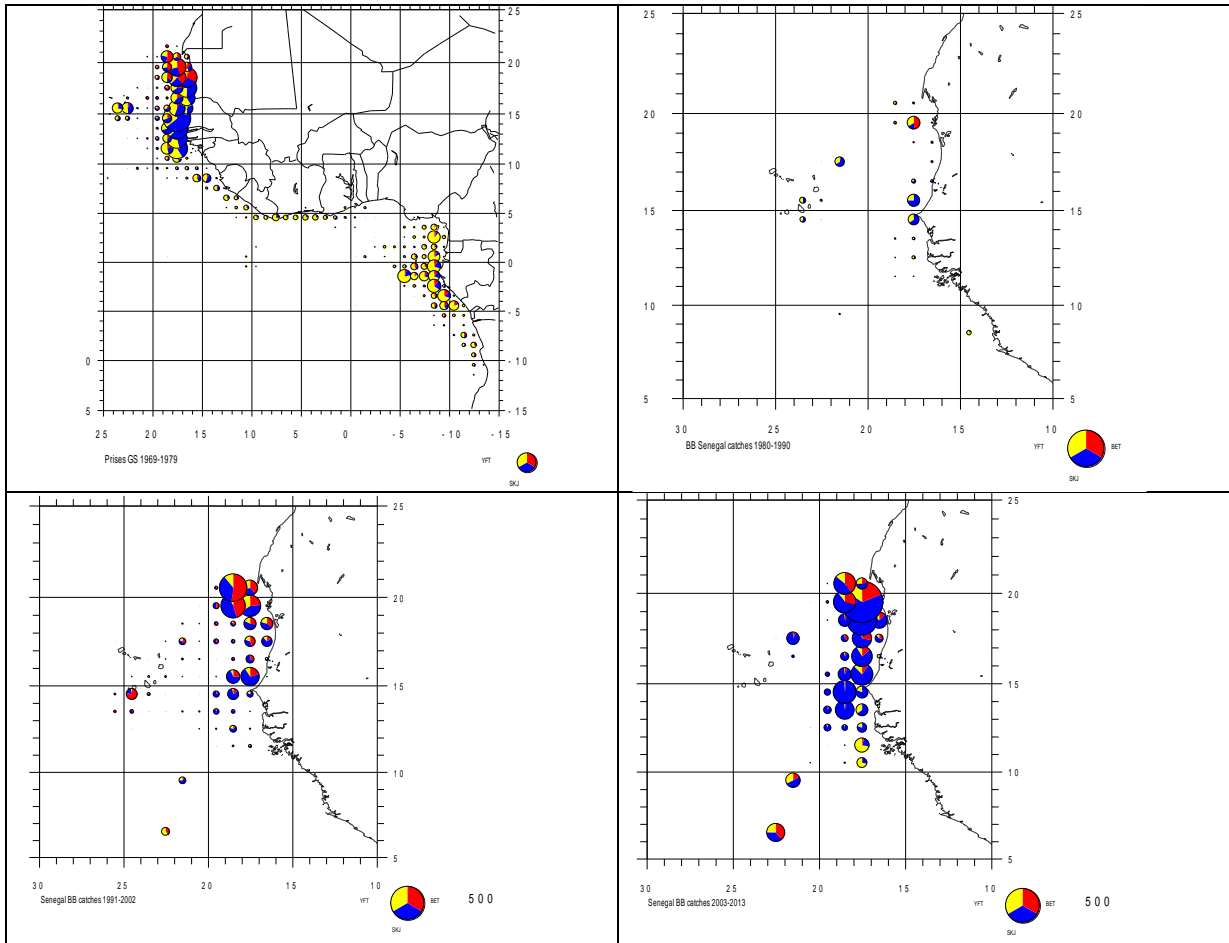


Figure 5. Average catch by 1° square, by species of the Senegalese baitboat fleet during 4 periods: 5a upper left 1969-1979, 5b upper right 1980-1990, lower left 5c 1991-2002 and lower right 5d 2003-2013.

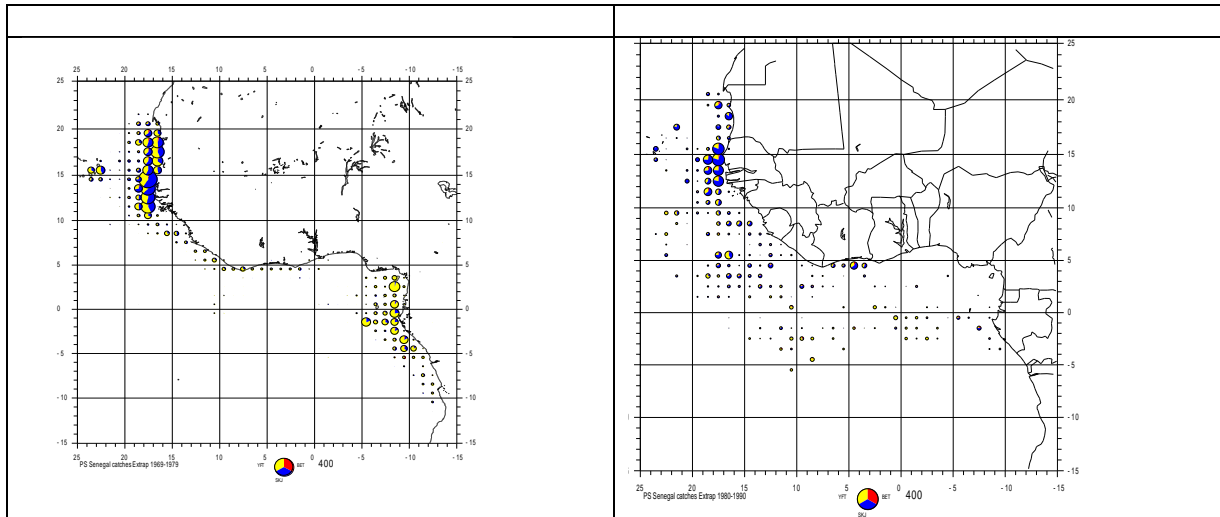


Figure 6. Average catch by 1° square, by species of the Senegalese purse seine fleet during 2 periods: left 1969-1979, right 1980-1990.

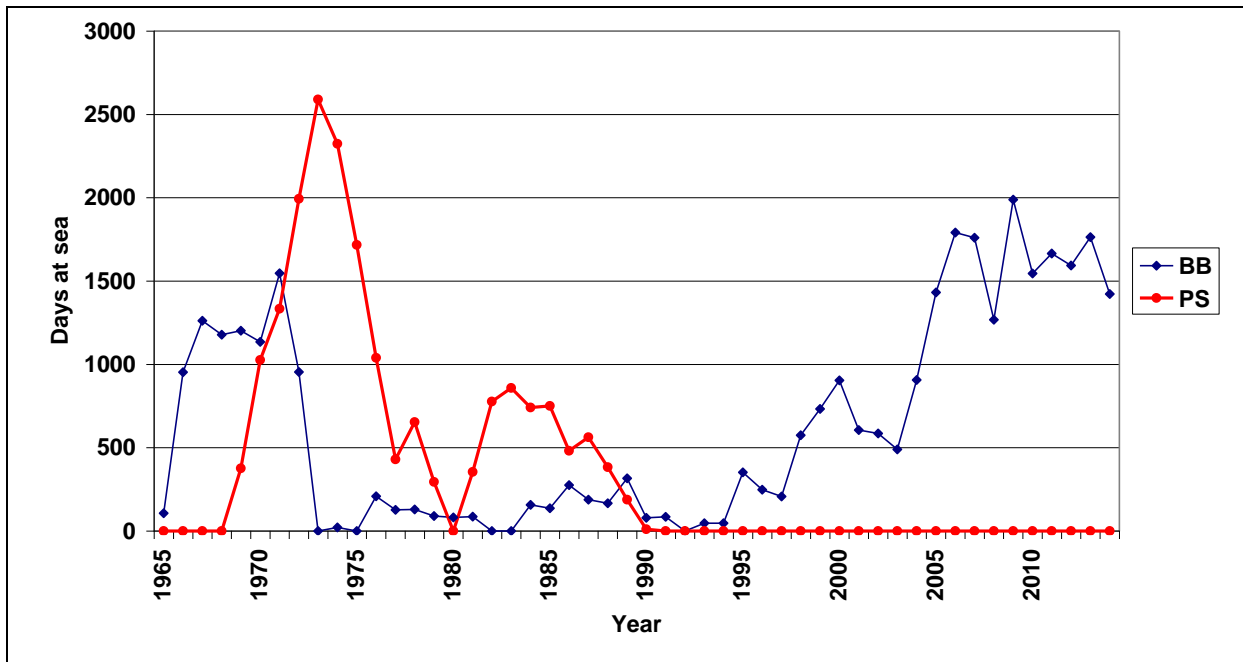


Figure 7. Nominal fishing efforts (days at sea) estimated for the Senegalese fleet during the 1965-2014 period.

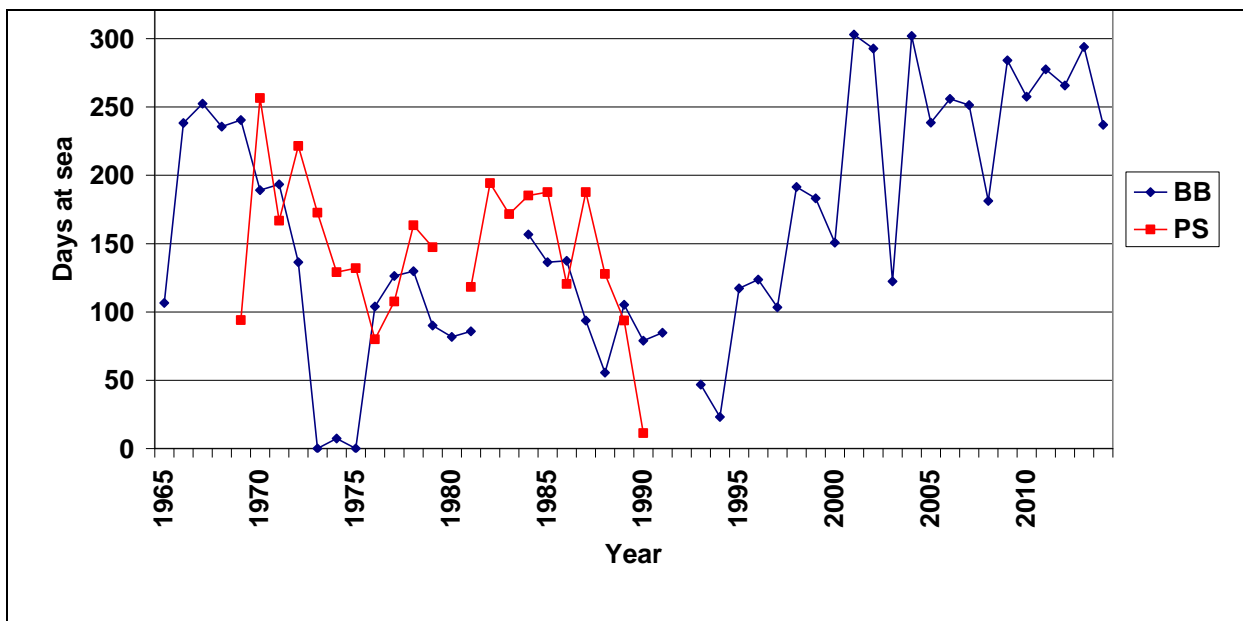


Figure 8. Average number of days at sea deployed yearly by the average Senegalese baitboats and purse seiners during the 1965-2014.

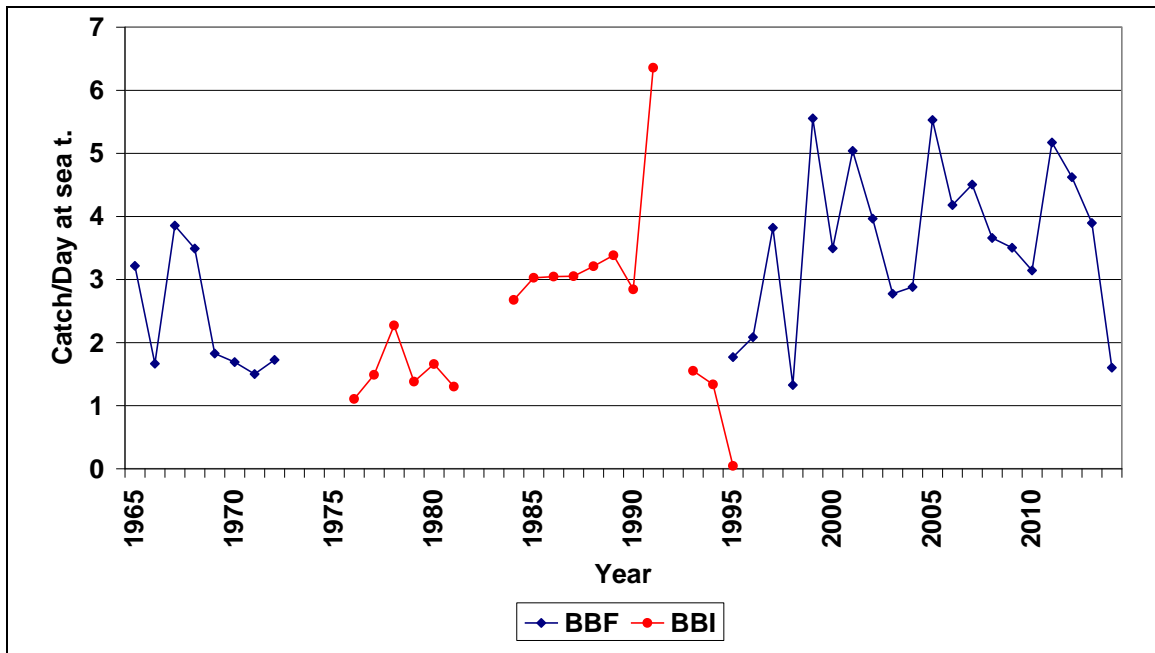


Figure 9. Yearly nominal total CPUEs of Senegalese ice (BBI) & freezer baitboat (BBF) (in tons per days at sea).

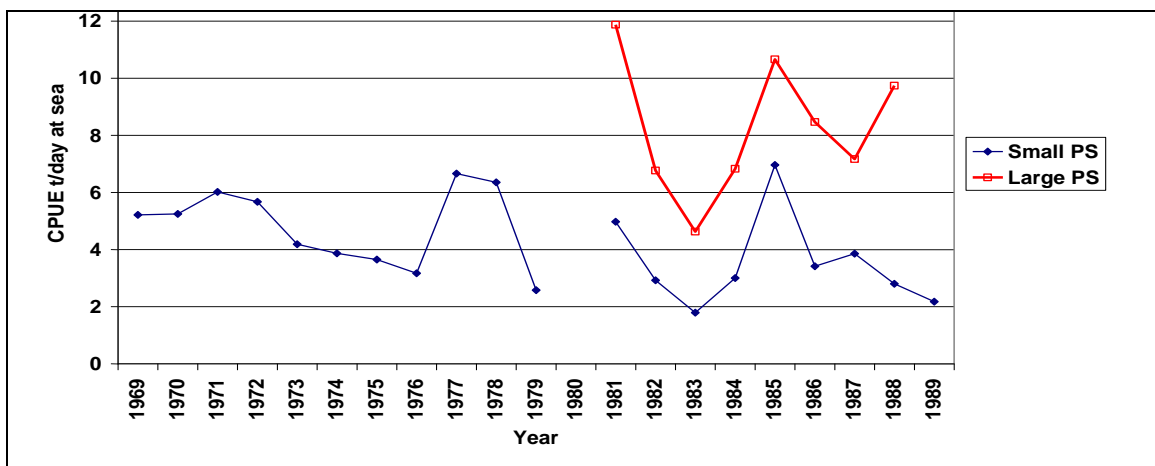


Figure 10. Yearly nominal CPUEs (in tons per day at sea) of small and of large Senegalese purse seiner.

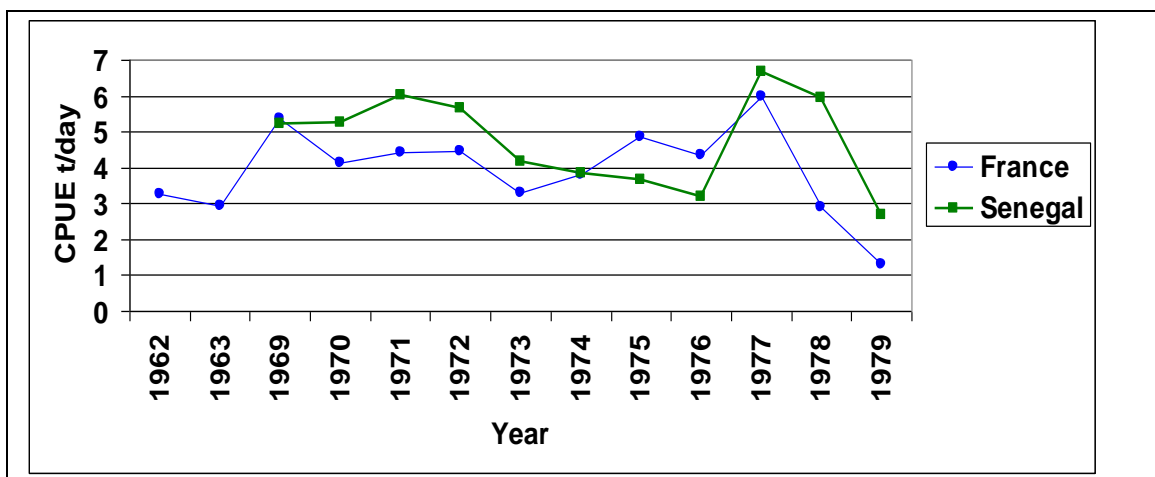


Figure 11. Average yearly CPUEs of historical small purse seiners : French and Senegalese

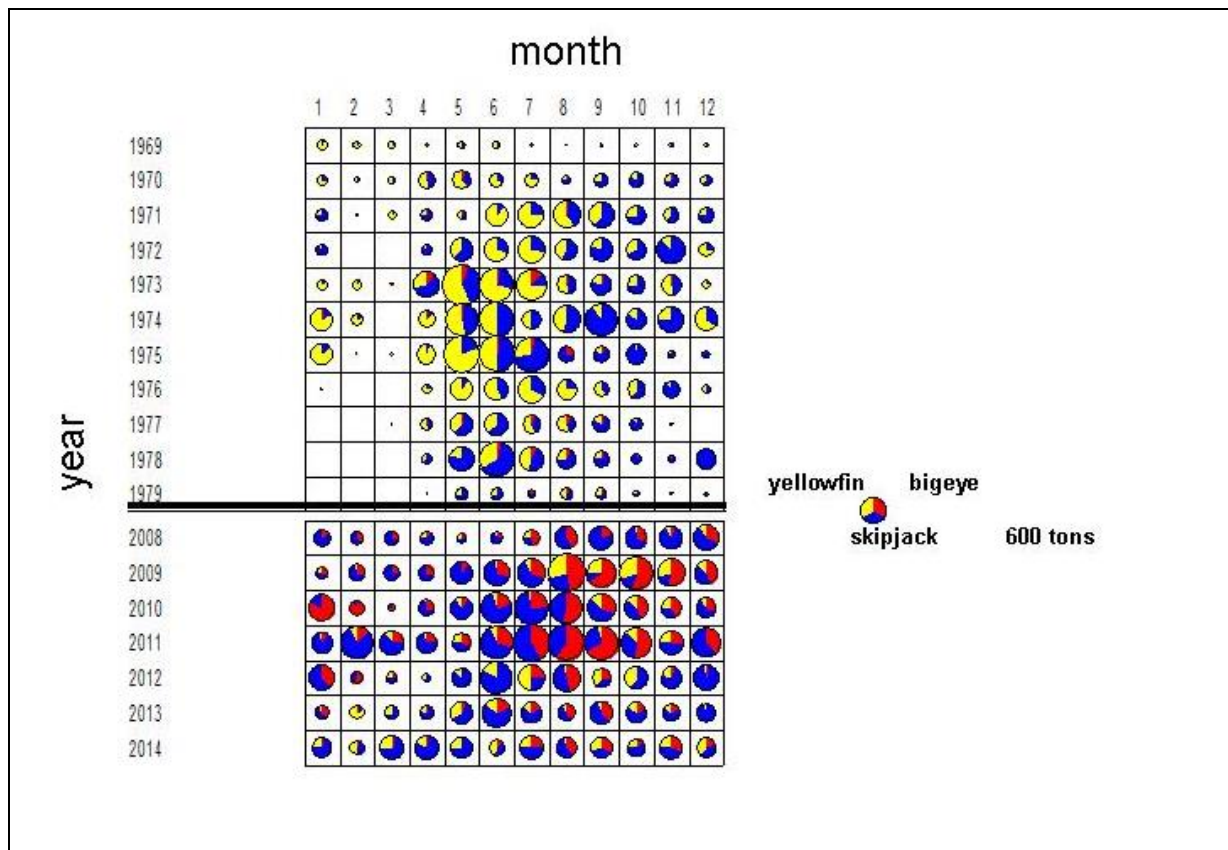


Figure 12. Monthly catches by species caught by Senegalese baitboat in the Senegal area (North of 10°N) during an historical period, 1969-1979, and during recent years (2000-2014).

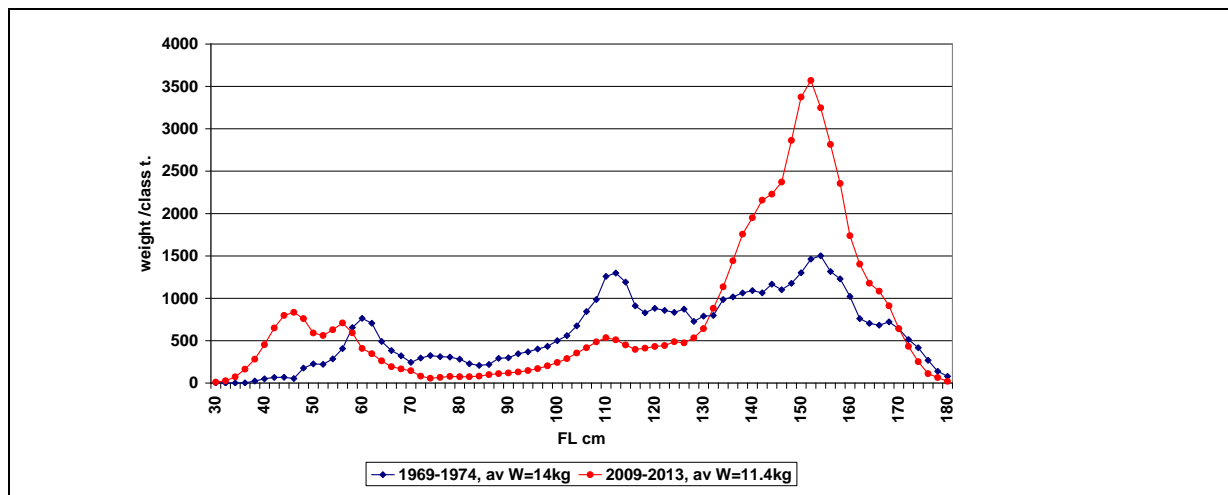


Figure 13. Average catch at size of yellowfin caught by purse seiners in the early fishery during which Senegalese purse seiners was very active (1969-1974) and in the today purse seine fishery (2009-2013).

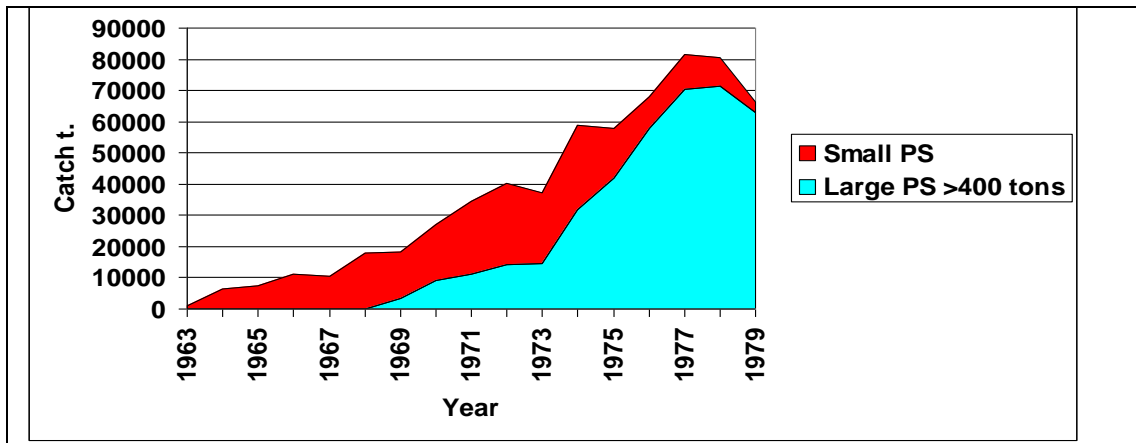


Figure 14. Total yearly catches by small and by large French, Senegal and d'Ivory Coast purse seiners during the 1969-1979 period.

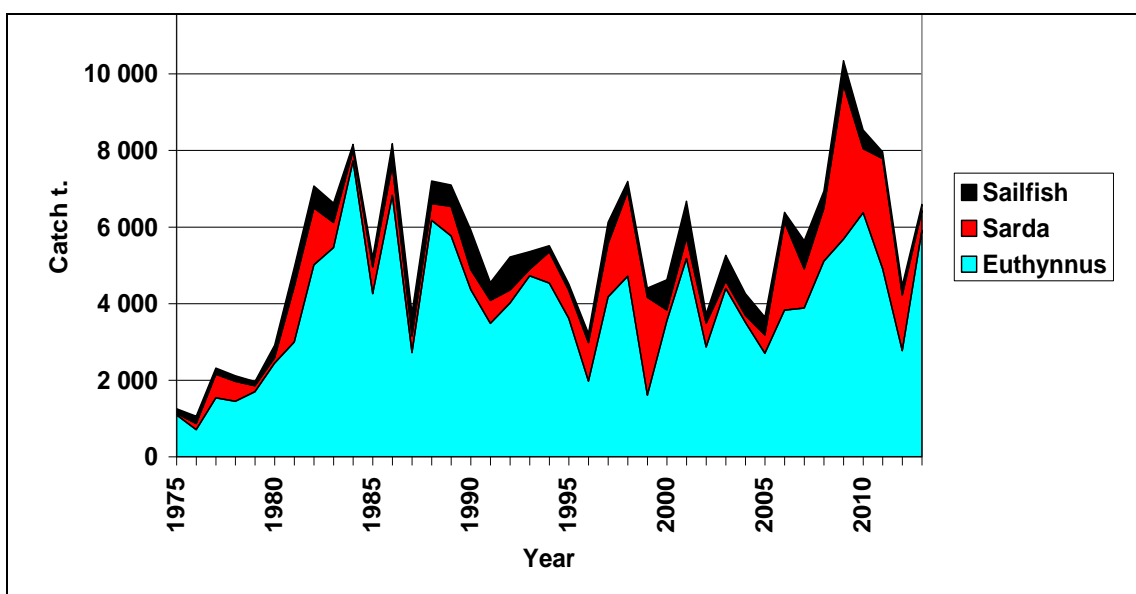


Figure 15. Yearly catches of tunas and sailfish by species landed by the artisanal and sport Senegalese fisheries.

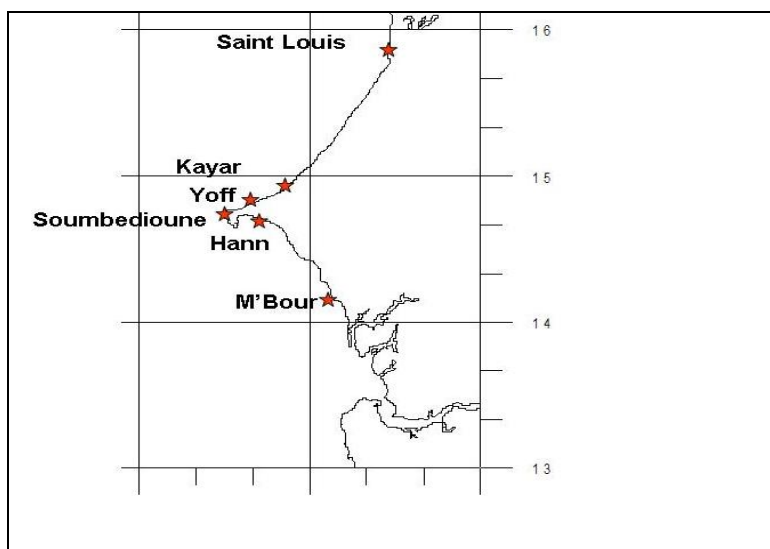
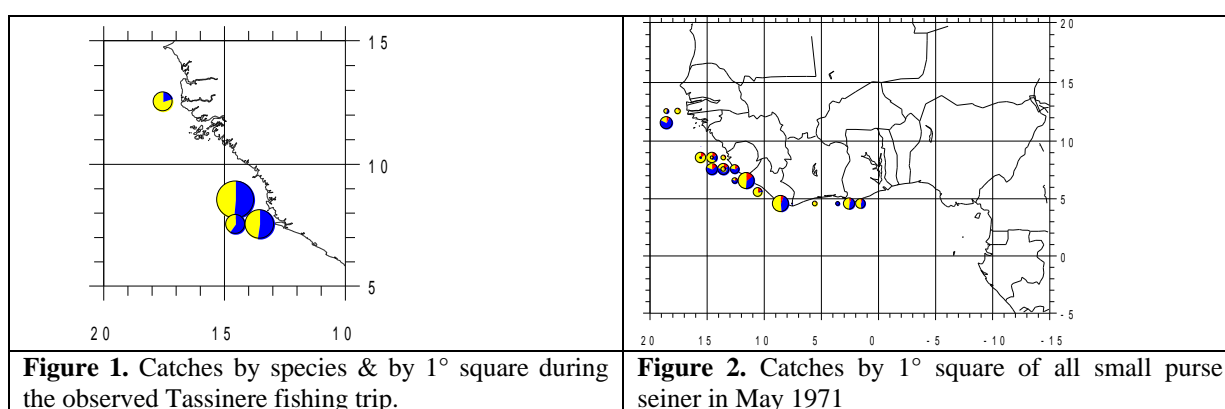


Figure 16. Main landing points of the artisanal Senegalese fisheries.

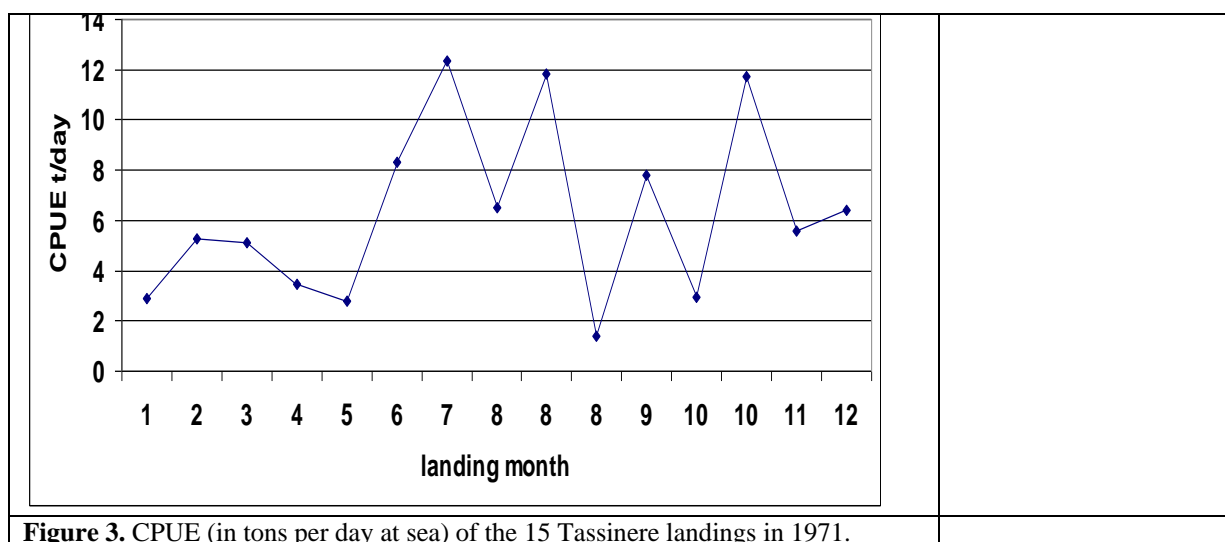
Annex 1: summary of the Patrick Soisson observer cruise on the Tassinere in April May 1971

1) The fishing vessel and its basic equipment: This Senegalese purse seiner, the Tassinère, built in 1969 had an overall length of 35 m and a carrying capacity of 120 tons. It was handled by a crew of 20 fishermen: 6 french and 14 senegalese (when today 8 European and 15 African are embarked on each French large purse seiner). Its speed was reaching 11 knots, and it was equipped with a small purse seine 850 meter long and 100 m height, that was closing at an approximated depth estimated between 50 and 60 meters. The surface of this purse seiner was of only 85 Km², vs a much larger surface between 400 and 500 Km² of the today purse seiner. This purse seiner was equipped with an echo sounder and also with a sonar, but it was noted by the observer that this sonar was seldom used by the skipper. Various points observed during this trip are interesting to show and to compare with the today observed activities of modern large purse seiners.

2) Coastal fishing zones: The observed fishing trip was solely positioned in the coastal traditional fishing zone along the continental shelf, between Senegal and Sierra Leone (figure 1). This fishing area was typical of this period (see figure 2), as in 1971 tuna fisheries were active before the implementation of EEZ and in the coastal areas of several African countries (then without fishing agreement).



3) A total catch of 75 tons (41 t. of yellowfin & 34 t. of skipjack) was observed during a **28 days** trip, then a CPUE of **2.8 tons/day** at sea (while the average 1971 CPUE of this vessel was at 6.4 t./day, then this observed trip ran during an intermediate fishing season was quite an unsuccessful one, see figure 3).



There was no bigeye observed in the tuna caught; possibly because of a confusion between small bigeye and yellowfin⁴, but also because of the bigeye rarity in the coastal area fished: the 2000-2012 multispecies sampling of free school sets has been showing a low percentage of bigeye (and only 1,2 % of bigeye in the 106 free

⁴ In 1971 the catches of small bigeye were poorly identified by fishermen, scientists and canneries, and often classified as small yellowfin.

schools samples, 66% of these samples without any bigeye). This typical species composition sampled today in the 1971 Tassinere fishing zone is shown by figure 4 by a Definetti ternary plot showing the species composition observed on recent samples from this coastal area.

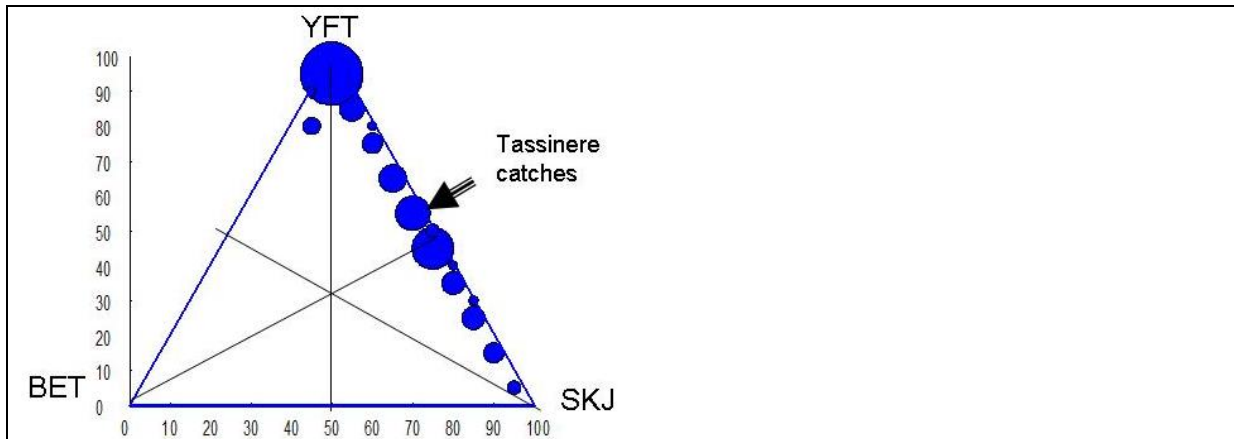


Figure 4. Species composition of free schools sets sampled in the coastal 1° squares fished by the Tassinere in April 1971 (106 schools).

4) This purse seiner was **always using live bait** caught in the Dakar bay: a peculiar fishing operation allows to catch in coastal peculiar areas the live bait. It was done at the beginning of the trip during 3 days (17% of the time at sea spent in bait searching and bait fishing). An approximate amount of 2 tons of live bait was stored in 6 wells (used later to store the frozen tunas). This need of bait is clearly introducing serious constraints in the fished areas (as for baitboats).

5) And correspondingly, a **peculiar configuration and use of the annex**, a small but heavy and slow boat (a weigh of 7 tons, a speed of 5 knots) equipped to carry some quantity of live bait and used to stabilize the tuna school before setting the net: this period was observed with quite short average durations of 9 minutes spent for an average set (26 observed sets, minimal duration of this baiting period of 3 mn, & maximum duration of 26 mn). It was noticed by the observer that this baiting annex was too slow, as tuna schools were often swimming too fast to be reach by the annex.

6) **Very small catch per set**: an average catch of 2.9 tons per set, the larger set with only 12 tons, i.e. a much smaller level than the average 30 tons per positive set observed today for large purse seiners. It was noted by the observer that these small catches were often due to the fact that a large proportion of the schools escaped from the net before the closure of the purse seine.

7) Short **duration** of sets: an average set duration of 1.7 hour (a minimum of 1.2 h for a null set and a maximum of 2.7 h. for a 12 tons set) (figure 5), then much shorter durations than the observed set durations of large purse seiners for small sets: 2.75 hours in 1980 and 2 hours today (figure 6).

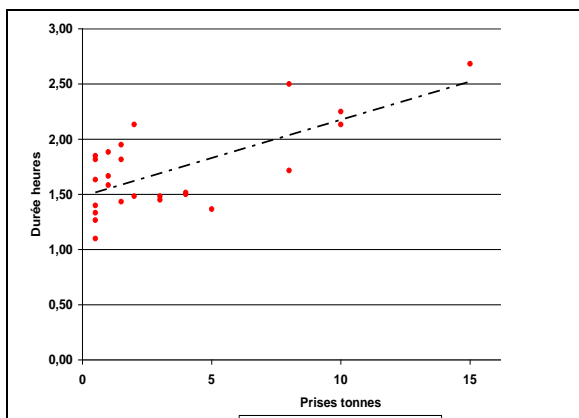


Figure 5. Observed duration of sets as a function of catch per set for the Tassinère, small Senegalese purse seiner in 1971.

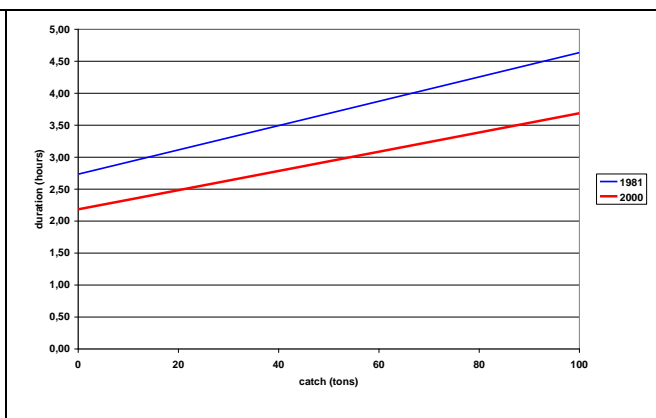


Figure 6. Average duration of sets as a function of catch per set estimated for French large purse seiners during 2 periods.

9) Natural logs: there was no record in the observer report of sets identified in association to natural logs/FAD, but it was noted by the observer that floating objects (and also dolphins) were often searched by the crew as they allow interesting tuna catches. It was also noted but not observed, based on information given by the skipper, that natural logs may sometimes offer opportunities of positive sets done on successive days on the same logs.

10) Large discards of *Euthynnus*: an estimated discard of 74 tons of *Euthynnus alleteratus*, caught in 4 sets was observed during this trip; then this amount of discards was nearly equivalent to the landed catches. Such very high rate of discard has been very seldom (or never?) noticed by observers in recent years, and it was probably in relation with the coastal fishing location of this trip and with the peculiar fishing mode used by this type of purse seiner.

11) Slow landing process: 2 days were needed to land the 74 tons of tunas caught by the Tassinere, because all the tunas are frozen and landed one by one (then a very slow landing process compared to today landing: more than 100 tons of tunas landed daily).