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Oceanographic Research Center of Dakar - Thiaroye

SCIENTIFIC REPORT

Profile of *Sardinella* and *Ethmalosa* fisheries in Senegal

COMFISH PLUS PROJECT



Sardinelle Ronde *Sardinella aurita* (Valenciennes, 1847)



Sardinelle Plate, *Sardinella maderensis* (Lowe, 1838)



Ethmalose, *Ethmalosa fimbriata* (S. Bowdich, 1825)

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July 2018

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Acronym

CPUE: Catch Per Unit Effort

CRODT: Oceanographic Research Center of Dakar - Thiaroye

DPM: Directorate for Marine Fisheries

CFA Francs: Franc African Financial Community

EGN: Encircling gill net

PS: Purse Seine

USAID/COMFISH: American development cooperation project with the maritime sector

EEZ: Exclusive Economic Zone

I. INTRODUCTION

The project “Collaborative Management for a Sustainable Fisheries Future in Senegal” (PENCOO GEJ) (USAID/ COMFISH) is funded by the United States Agency for International Development (USAID). The aim of the USAID/COMFISH Project is to support the Senegalese government in its efforts to reform the fisheries sector as contained in the Sectoral Policy Letter on Fisheries and Aquaculture Development by enhancing the conditions needed to improve governance, and by promoting the use of effective management tools and approaches.

The various activities conducted during the early years of the project led to the participatory selection of priority species on which the project has been working to support the development of co-management plans for these priority stocks. CRODT was commissioned to conduct “studies on *Sardinella* and *Ethmalosa* stocks to support the development of participatory management plans”. This report presents a profile of small pelagic fisheries in Senegal for the COMFISH PLUS (2017/2018) project.

The overall objective of this work is to draw up the profile of small pelagic fisheries from 1990 to 2016 by studying the dynamics of the fisheries of the two *Sardinella* species and *Ethmalosa*. More specifically, it aims to document the number of canoes per maritime region, fishing effort per region, catches per zone, per fishing gear, per month, and prevailing landed prices of these three species and to analyze actors’ profile.

II. MATERIALS AND METHODOLOGY

The fisheries data used are drawn from the database of the Oceanographic Research Center of Dakar - Thiaroye of the Senegalese Institute for Agricultural Research (CRODT/ISRA). These are a series of catch data for the three (3) small pelagic species, namely *Sardinella aurita*, *Sardinella maderensis* and *Ethmalosa fimbriata* landed at the eight main artisanal fishing sites of Senegal, and finally fishing efforts data estimated in the number of trips by canoes, number of canoes per region and landed prices.

2.1 Protocol on the monitoring of fish exploitation systems

2.1.1. Inventory of fishing units

In the absence of any specific constraints, especially financial constraints, CRODT conducts an inventory twice a year (cold and dry seasons). The area covered mostly stretches from Saint-Louis to Djifère. Exceptionally, it covers the entire coastline of Senegal when the Ministry for Fisheries expresses the need for it and provides the needed financial resources. That was the case in 1997, 2005 and recently in 2015, when the inventory was combined with a major survey

on the socio-economic parameters of fishermen and canoe owners. The information gathered related to home ports and origins of canoes, crews, engine capacity, fishing gears used, among others.

2.1.2. Surveys of fisheries activities

Fishing activities surveys focused on fishing efforts, catches, sizes of the main species landed and landed prices. The surveys are regularly conducted at the eight main landing sites of Saint-Louis, Kayar, Yoff, Ouakam, Soumbédioune, Hann, Mbour and Joal. Other one-off surveys are also conducted at some sites of Saloum and Casamance under the project. Fishing effort is recorded by beach enumerators who gather information daily on the number of trips per fishing gear. For catches, the methodology is based on a three-level of multistage strata (site – time (every 15 days), fishing gear) aimed at better taking into account spatio-temporal fluctuations and the peculiarities of each type of fishery. For each fishing unit sampled, a wide variety of information was collected, such as the fishing zone, the fishing gear, fishing duration, fishing depth, species caught, quantities landed, size of individuals caught and landed prices.

2.2 Data processing

Survey data processing mainly forms part of a computation procedure leading to the estimation of efforts and catches at each site surveyed and in each maritime region. First, for each site and each fishing gear, fishing efforts are cumulated, then aggregated per fortnight, taking into account the number of days without collection of efforts during the fortnight. For catches, the data from the survey are, first, used to estimate catches per unit effort (CPUE in kg per trip) per fortnight and per fishing gear. Then, the combination of CPUEs with the aggregated effort leads to the determination of catches extrapolated per fishing site. Finally, regional extrapolation coefficients are used according to seasons and groups of fishing gears to estimate fishing statistics (effort and catches) at regional and national levels. All these raw and processed data are stored in the servers of CRODT's database using specialized applications (Thiao, 2009).

III. DYNAMICS OF SARDINELLA AND ETHMALOSA FISHERIES PROFILE IN SENEGAL

3.1 Fishing effort dynamics

In Senegal, *Sardinella* is mainly exploited by two artisanal fishing gears and, to a lesser extent, by industrial fishing. For artisanal fishing, the gears used are purse seine and encircling gill net. Purse seine is the most developed artisanal fishing gear and the closest to industrial fishing gears. The main fishing gear used for the exploitation of *Ethmalosa* is encircling gill net.

3.1.1. Number of canoes inventoried in 2015

With reference to the last inventory conducted in 2015, which covered the entire Senegalese coastal zone, including estuaries in Sine-Saloum and Casamance, one can note that the number of canoes recorded in the Cap Vert region was the highest (21%), followed by Sine Saloum and Thiès Nord (Kayar), Thiès Sud (Mbour and Joal), Fleuve (Saint Louis), Casamance and finally Louga (Lompoul, Mboro, Fasse Boye) which accounts for 1% of the total number (Table 1).

Table 1. Number of canoes per region in 2015

Region	Number of canoes
Cap Vert	3,772
Sine Saloum	3,372
Thiès Nord	3,203
Thiès Sud	3,125
Fleuve	2,591
Casamance	2,057
Louga	164
Total	18,284

3.1.2. Fishing efforts for fishing fleets targeting *Sardinella* and *Ethmalosa*

The breakdown of fishing efforts per fishing gear during the 1990 to 2016 period is presented in table 2. However, it should be noted that this effort concerns units operating in the area covered by CRODT survey system. Purse seine fishing effort during the period under review fluctuated between 50,000 and 80,000 trips per year with some pronounced fluctuations. Besides, it should be noted that from 2009 onward, purse seine fishing efforts have been on the increase. On the other hand, encircling gill net fishing efforts have remained relatively stable over the 1990 - 2016 period, ranging from 9,000 to 35,000 trips (Figure 1). These are encircling gill nets based in the Petite Côte area, especially between Mbour and Joal. If Sine Saloum had been covered, it would have certainly brought out more significant and dynamic efforts.

Efforts by other fishing gears do not specifically target *Sardinella* and *Ethmalosa*; they are caught only incidentally.

According to a study by CRODT for the COMFISH project (Thiao, et al., 2014), part of the fishing effort by fishing gears targeting *Ethmalosa* occurs outside the Senegalese EEZ. Hence, for purse seine, the proportion of effort outside the national EEZ was estimated at 19%. It was at 18% for encircling gill nets.

Table 2. Fishing effort expressed in number of trips disaggregated by fishing gear from 1990 to 2016

Year	PS	EGN	Others
1990	55,533	22,283	589,051
1991	54,779	18,547	575,472
1992	60,553	22,671	596,284
1993	62,470	18,197	596,157
1994	56,955	13,645	661,687
1995	53,495	15,698	772,392
1996	51,136	27,435	827,357
1997	51,197	35,955	898,899
1998	55,436	22,400	937,878
1999	54,641	22,039	957,035
2000	61,568	20,619	1,036,753
2001	64,784	24,420	841,893
2002	65,224	19,544	960,396
2003	72,596	22,091	982,063
2004	61,546	19,427	990,304
2005	60,219	23,317	942,105
2006	53,315	22,988	841,702
2007	60,528	9,053	772,220
2008	62,718	23,709	888,668
2009	57,854	19,547	863,358
2010	54,255	21,660	828,219
2011	66,346	16,835	826,723
2012	79,093	17,861	813,954
2013	71,370	22,554	703,641
2014	77,293	30,513	765,216
2015	97,847	26,697	694,248
2016	81,401	24,406	744,265

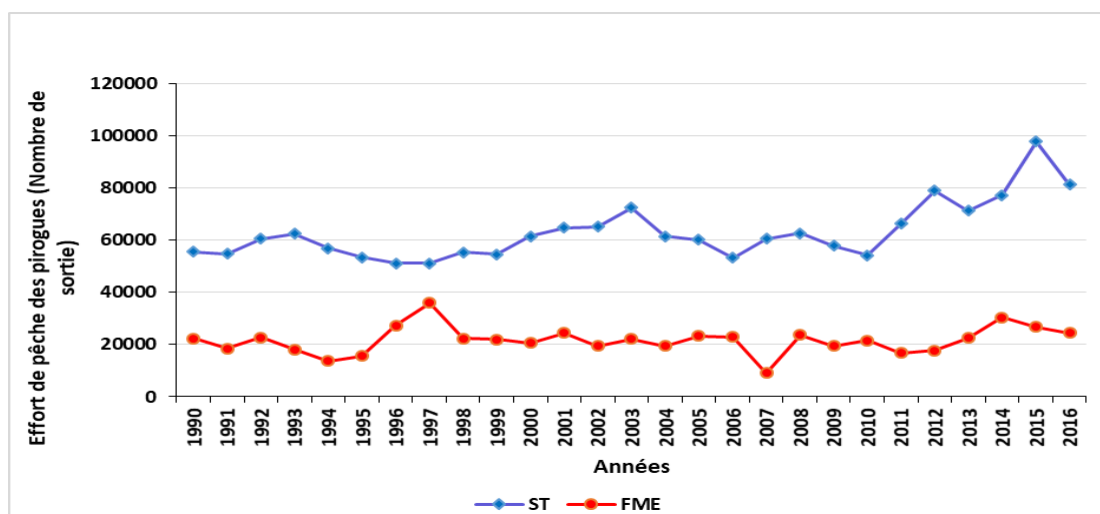


Figure 1. Trends in fishing effort (number of trips) for purse seine and encircling gill nets between 1990 and 2016.

3.1.3. Fishing effort per maritime region

Table 3 shows overall fishing efforts per maritime region from 1990 to 2016. The maritime regions are Cap-Vert, Fleuve (Saint Louis), Thiès nord (Kayar) and Thiès Sud (Mbour and Joal). Annual purse seine fishing effort fluctuated from 10,000 to 50,000 trips in the Cap Vert region, 4,000 to 12,000 trips in Saint Louis, 5,000 to 14,500 trips in Kayar and 17,000 to 30,000 trips in Thiès Sud (Mbour and Joal) (Table 4 and figures 3 and 4).

It should be noted that fluctuations in PS fishing effort in the Fleuve region (Saint Louis) has a correlation with access to Mauritanian waters or lack thereof. The highest purse seine fishing effort was recorded in Thiès Sud (Mbour and Joal), followed by the Cap Vert region (Figure 3). In the Cap Vert region, fishing effort increased from 2011, and peaked in 2015.

On the other hand, efforts for encircling gill nets varied from 250 to 4,500 trips in Cap Vert, 0 to 300 trips in Fleuve and 7,500 to 35,000 trips in Thiès Sud. The decrease in EGN fishing effort noted for some years in Thiès Sud were due to the sedentarization of small-scale fishermen in their communities coupled with the arrival of Guinean processors. Traditionally, small-scale fishermen of Sine Saloum migrated to Petite Côte during the dry season.

In Thiès Nord, effort for encircling gill nets fishing is almost non-existent. Gill nets are mostly concentrated in Thiès Sud (Mbour and Joal) and, to a lesser extent, in the Cap Vert region.

Table 3. Overall fishing effort (number of trips) per maritime region from 1990 to 2016.

Region	Cap Vert	Fleuve	Thiès Nord	Thiès Sud	Total
1990	208,528	36,931	119,122	302,286	666,867
1991	262,311	35,167	102,073	249,247	648,798
1992	264,684	40,780	128,291	245,753	679,508
1993	208,701	49,512	187,257	231,354	676,824
1994	244,919	55,578	165,317	266,473	732,287
1995	364,102	53,507	162,581	261,399	841,589
1996	399,085	56,260	135,140	315,443	905,928
1997	474,804	48,090	135,519	327,638	986,051
1998	472,664	39,316	172,070	331,664	1,015,714
1999	484,358	46,444	193,827	309,086	1,033,715
2000	595,737	43,985	161,493	317,725	1,118,940
2001	426,982	42,933	98,043	363,139	931,097
2002	421,090	35,611	104,576	483,887	1,045,164
2003	428,348	31,312	115,639	501,451	1,076,750
2004	436,628	32,497	107,006	515,681	1,091,812
2005	415,243	32,756	109,954	490,200	1,048,153
2006	402,163	34,938	101,046	403,572	941,719
2007	326,618	36,493	118,159	387,093	868,363
2008	427,969	43,539	133,922	400,291	1,005,721
2009	432,512	41,748	140,379	356,569	971,208
2010	390,776	37,348	130,641	375,787	934,552

2011	349,730	36,290	142,616	408,363	936,999
2012	359,778	49,411	144,389	395,347	948,925
2013	325,489	36,694	133,787	329,713	825,683
2014	349,271	35,571	173,577	341,072	899,491
2015	408,808	40,298	54,795	344,356	848,257
2016	360,837	40,494	126,637	352,622	880,589

Table 4. Effort for purse seine (PS) and encircling gill net (EGN) fishing per maritime region from 1990 to 2016

Maritime region	Cap Vert		Fleuve		Thiès Nord		Thiès Sud	
Fishing gear	EGN	PS	EGN	PS	EGN	PS	EGN	PS
1990	2,112	11,329		4,109		14,635	20,171	25,460
1991	562	11,262		5,641		11,291	17,985	26,585
1992	3,006	13,038		7,087		12,745	19,665	27,683
1993	572	10,598		8,955		14,339	17,625	28,578
1994	382	13,571		8,152		12,432	13,263	22,800
1995	262	15,959		7,340		10,291	15,436	19,905
1996	377	16,550	107	7,656	4	5,415	26,947	21,515
1997	680	13,652	307	6,768		8,605	34,968	22,172
1998	584	13,395	7	8,870		11,859	21,809	21,312
1999	1,295	12,796	1	10,539		13,724	20,743	17,582
2000	850	15,380		9,964		15,258	19,769	20,966
2001	845	16,760	1	10,490		11,498	23,574	26,036
2002	1,324	16,465	1	10,138		14,047	18,219	24,574
2003	927	18,163	32	11,525		13,909	21,132	28,999
2004	2,423	16,809	10	11,952	0	10,014	16,994	22,771
2005	4,557	16,814	3	10,241	0	9,893	18,757	23,271
2006	2,379	14,257	3	11,221	0	9,162	20,606	18,675
2007	1,422	16,576	1	9,930		10,415	7,630	23,607
2008	5,065	17,354	0	12,913	9	8,867	18,635	23,584
2009	2,975	18,274	137	11,162		8,313	16,435	20,105
2010	2,642	16,281		6,930	2	6,734	19,016	24,310
2011	2,262	18,003	3	9,192		11,997	14,570	27,154
2012	2,302	29,669		11,394	8	8,663	15,551	29,367
2013	2,869	28,061	2	8,574		7,775	19,683	26,960
2014	2,023	27,811		9,102		12,293	28,490	28,087
2015	4,758	51,313		10,833		4,284	21,939	31,417
2016	2,842.8	30,971.4	2.5	9,819	8	9,002.4	20,046.6	28,597

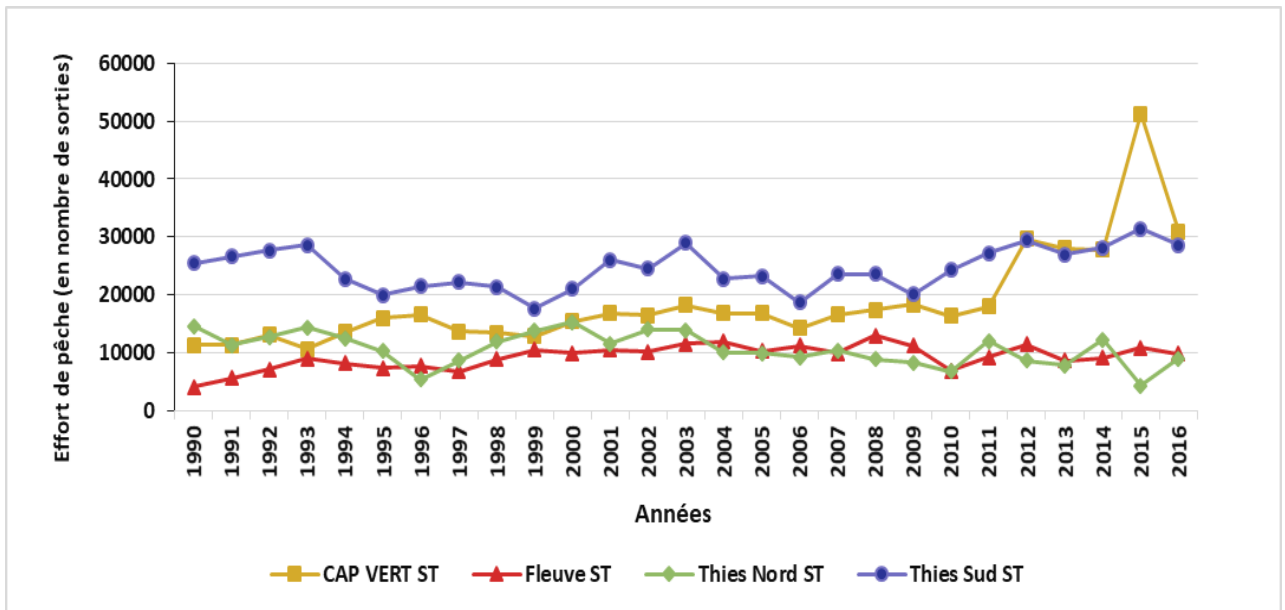


Figure 2. Trends in purse seine fishing effort per maritime region between 1990 and 2016

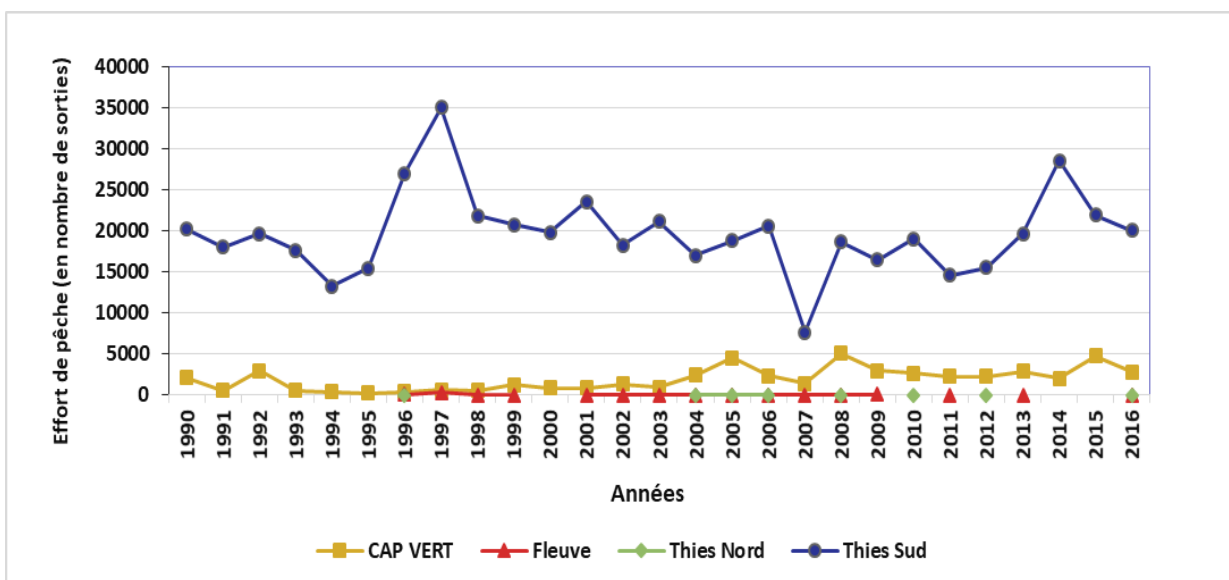


Figure 3. Trends in gill net fishing effort per region between 1990 and 2016

3.2 Annual catches of the two *Sardinella* species and *Ethmalosa*

From 1990 to 2016, the overall landings of the two species of *Sardinella* and *Ethmalosa* fluctuated on average around 280,000 tons. Round *Sardinella* forms the greater proportion of landings (58%), followed by flat *Sardinella* (37%). *Ethmalosa* landings accounted for 5% of this volume (Figure 4). Overall, the quantities of both *Sardinella* species surged tremendously over the 2001-2015 period.

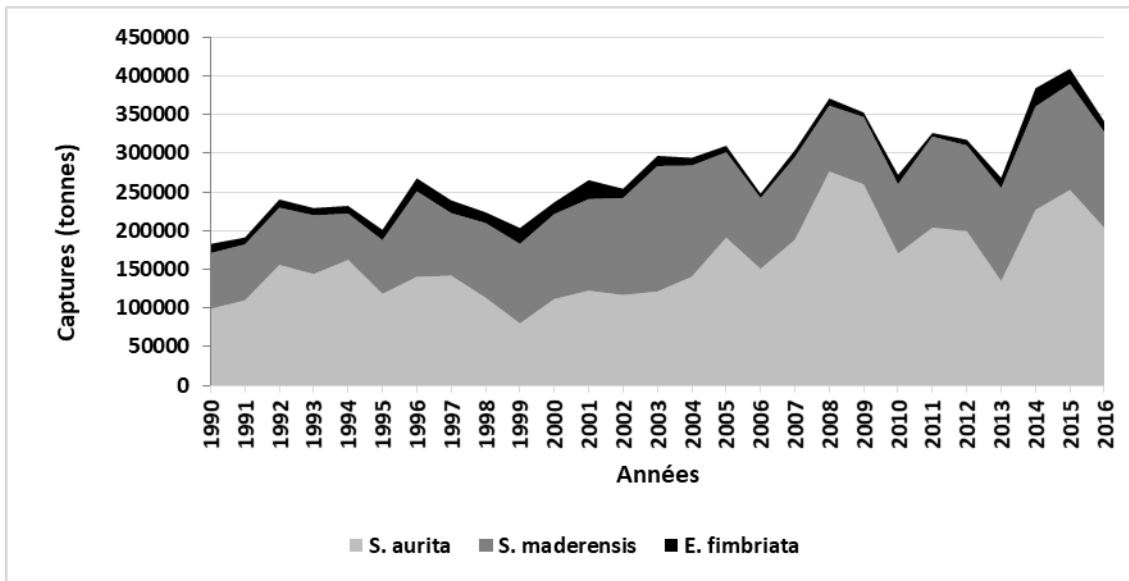


Figure 4. Trends in total annual catches of the two *Sardinella* species and *Ethmalosa*

An upward trend was recorded in round *Sardinella* catches between 1990 and 2016 (Figure 5) with a peak of more than 250,000 tons in 2008. This increase recorded over the past 15 years is attributable to the issuing of permits by the Mauritanian government. Indeed, since 2001, Mauritania has been issuing each year 300 permits to Senegalese small-scale fishermen. However, from 2015 to 2016, there has not been any fisheries agreements between Mauritania and Senegal.

The trends in catches per fishing gear demonstrates that purse seine is the main fishing gear used to fish round *Sardinella* (Figure 6). Catches with other fishing gears are very low as compared to those with purse seine.

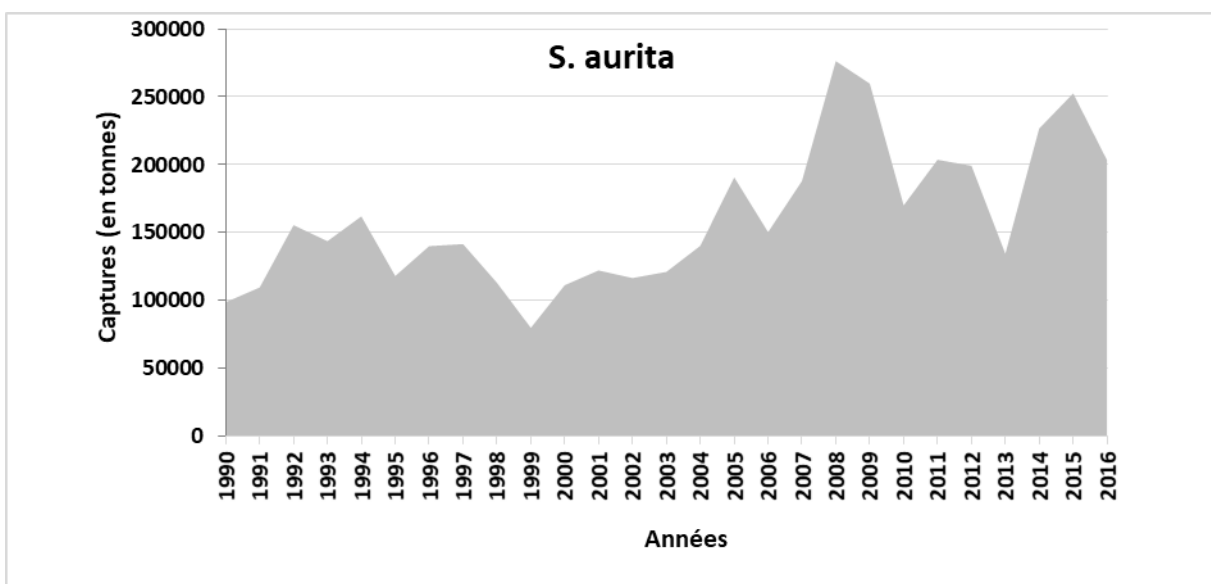


Figure 5. Trends in annual catches of *Sardinella aurita*

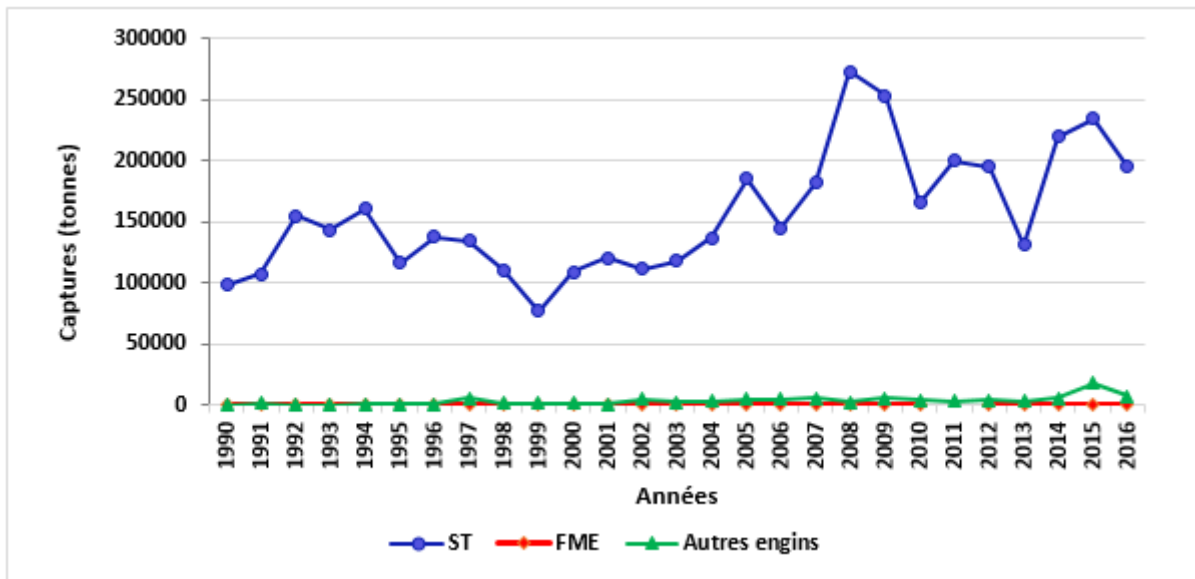


Figure 6. Annual catches of round *Sardinella* per fishing gear

As regards flat sardinella, annual catches grew considerably between 1990 and 2004, reaching a peak of 160,000 tons in 2004. From 2005, the quantities started declining, reaching 80,000 tons in 2010. However, from 2011, there has been an upward trend with 133,600 tons recorded in 2015 (Figure 7).

Contrary to round *Sardinella*, flat sardinella is exploited both with encircling gill nets and purse seines (Figure 8). overall, purse seine catches recorded a growing trend, except in 2006 and 2009.

For encircling gill nets, catches fluctuated between 22,000 and 70,000 tons from 1990 to 2016.

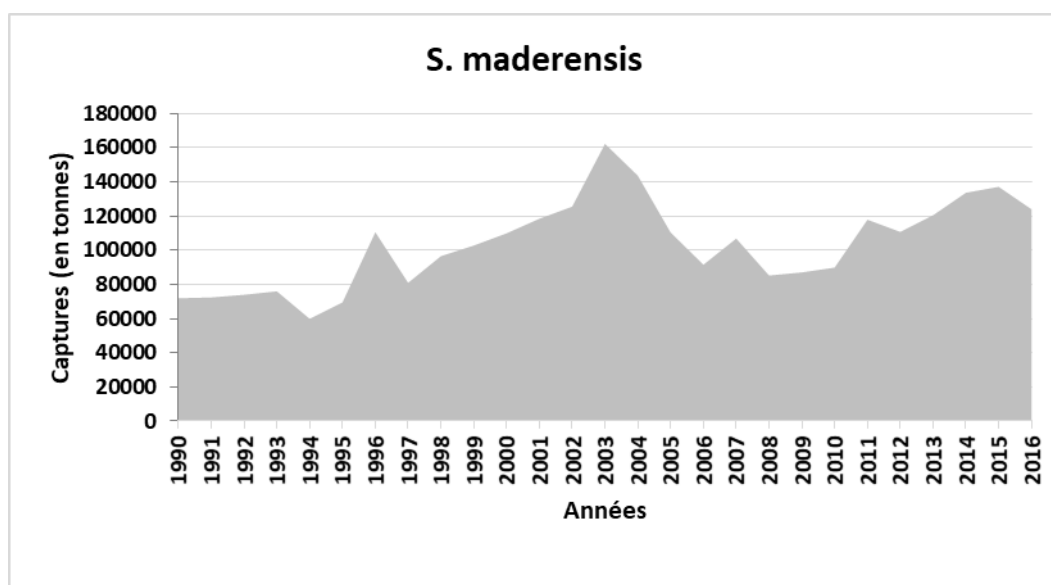


Figure 7. Trends in annual catches of *Sardinella maderensis*

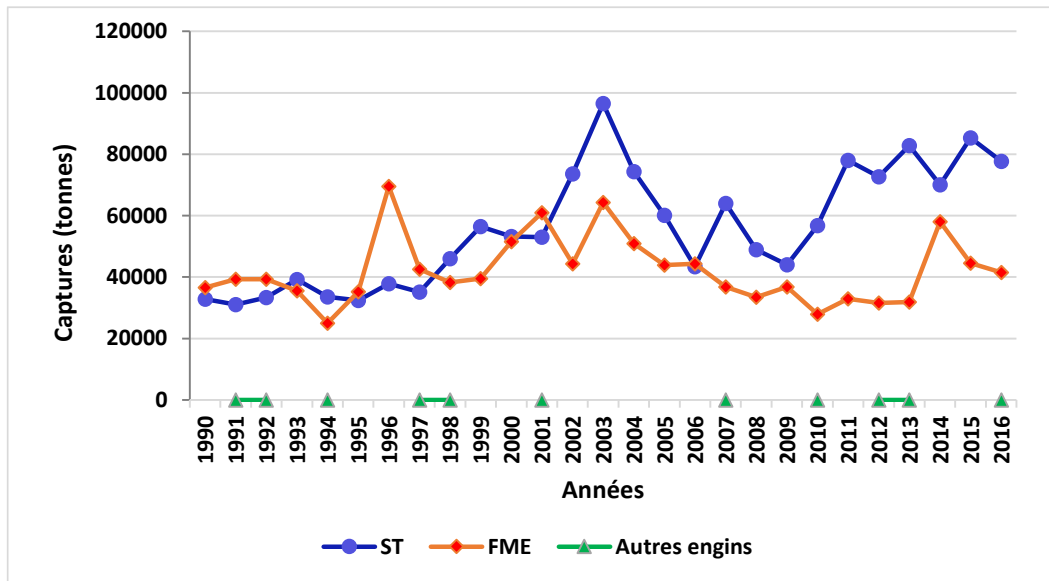


Figure 8. Annual catches of flat *Sardinella* per fishing gear

Ethmalosa catches in Senegal grew exponentially between 1990 and 2001, reaching a peak of 24,000 tons. However, from 2002, catches started declining, reaching about 4,700 tons in 2011. From 2012, catches picked up with 23,000 tons recorded in 2014 before falling anew in 2015 and 2016 (Figure 9).

Ethmalosa production is mainly dominated by encircling gill net fishing units and, to a lesser extent, by purse seine units (Figure 10). With an annual average production of 12,560 tons, gill net catches accounted for 60% of the total production of *Ethmalosa* as compared to 37% for purse seine. Other fishing gears account for only 3% of the total production. It should be emphasized that 5% of *Ethmalosa* quantities landed are from the EEZ of countries in the sub-region, especially the Gambia (Thiao *et al.* (2013)

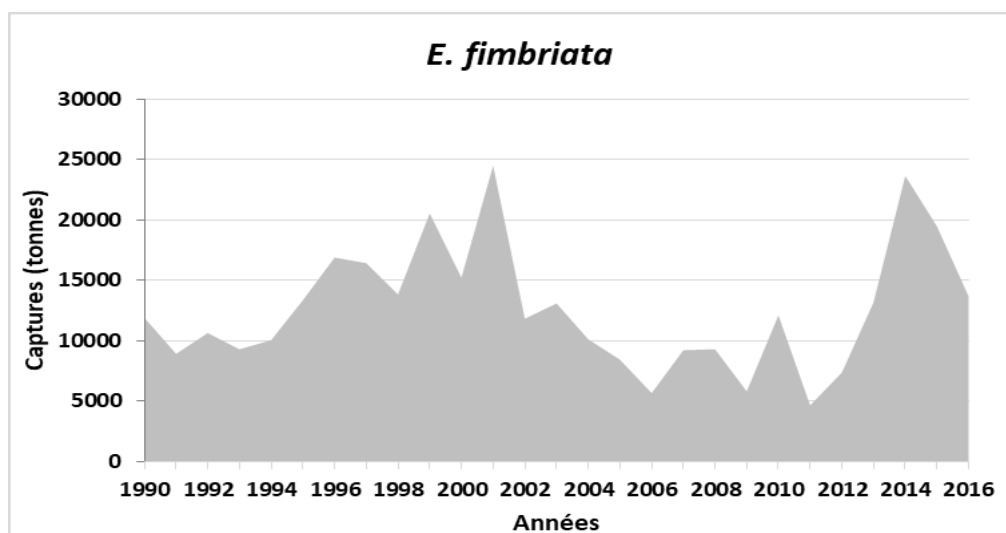


Figure 9. Trends in annual catches of *Ethmalosa fimbriata*

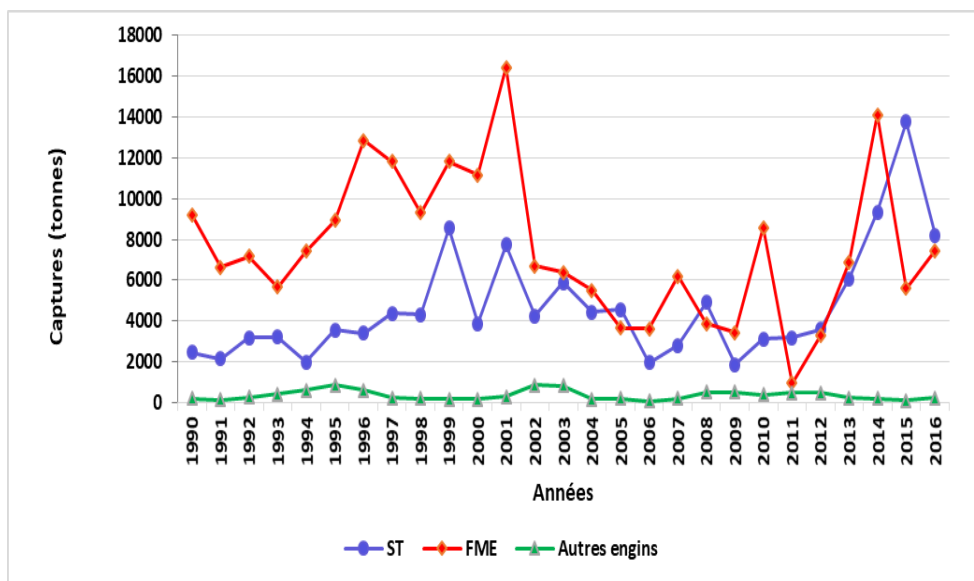


Figure 10. Annual catches of *Ethmalosa* per fishing gear

3.3 Spatio-temporal dynamics of *Sardinella* and *Ethmalosa* catches per maritime zone

Figures 11, 12 and 13 provide trends in the catches of round *Sardinella*, flat *Sardinella* and *Ethmalosa* per region from 1990 to 2016. Table 5 shows the breakdown of annual catches per species and per region between 1990 and 2016.

3.3.1. Spatio-temporal trends in round *Sardinella* catches

Trends in round *Sardinella* catches from 1990 to 2016 show exponential quantities of catches in Thiès Sud (Mbour and Joal) over the entire period. But between 2006 and 2009, the Fleuve region (Saint Louis) recorded a sharp increase, reaching a peak of more than 110,000 tons in 2008 (Figure 11). This tremendous increase was attributable to fishing permits issued by the Mauritanian government which enabled fishermen to have access to fishing zones where round *Sardinella* stock was more abundant than along the Senegalese coast. On the other hand, catches recorded in Thiés Nord (Kayar) and in Cap-Vert remained relatively less significant. It should be noted that the Cap Vert region is mostly characterized by demersal fishing with quite negligible landings of round *Sardinella*. However, during the past two years, 2015 and 2016, round *Sardinella* catches declined anew in almost all fishing zones.

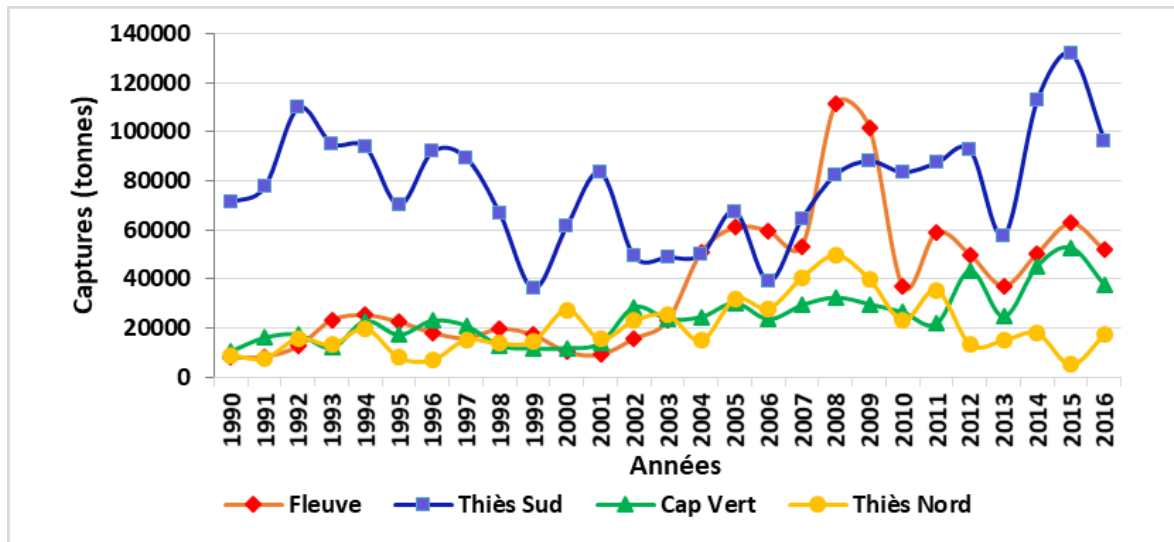


Figure 11. Annual trends in round *Sardinella* catches per region

3.3.2. Spatio-temporal trends in flat *Sardinella* catches

The spatio-temporal distribution of flat *Sardinella* landings shows a predominance of Thiès Sud region (Joal and Mbour) (Figure 12). Over the greater part of the 1990-2005 period, catches in Thiès Sud increased sharply, with a record high of 140,000 tons in 2003. However, from 2004, flat *Sardinella* catches entered a period of sharp decline, reaching 60,000 tons in 2010. From 2010 onward, catch volumes increased anew, with 100,000 tons recorded in 2015. On the other hand, catches in other regions were very low and stable over the entire period of 1990 to 2016. However, a slight increase was noted in the Fleuve region (Saint Louis) over recent years.

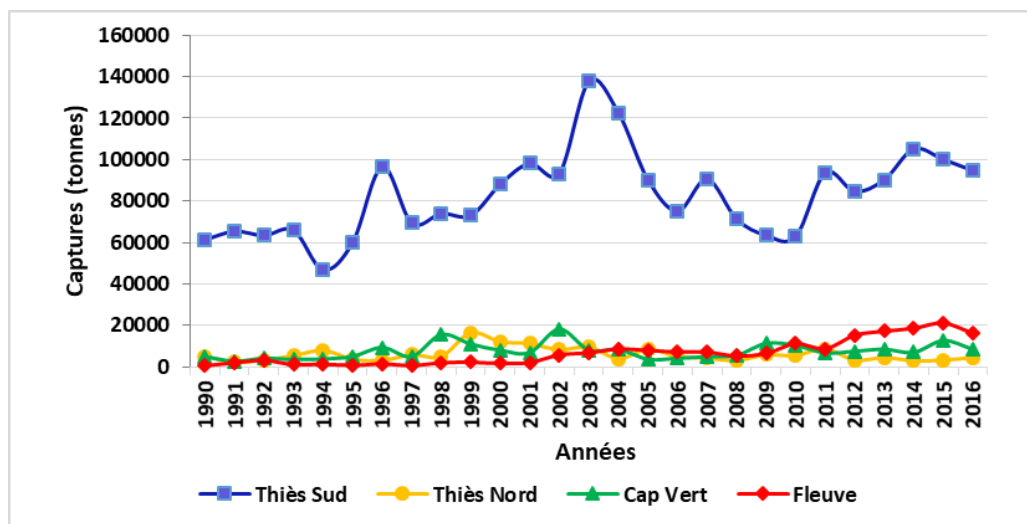


Figure 12. Annual trends in flat *Sardinella* catches per region

3.3.3. Spatio-temporal trends in Ethmalosa catches

An analysis of the spatial distribution of Ethmalosa catches shows that among the four artisanal fishing regions covered by CRODT's survey, Thiès Sud accounts for the greatest proportion of this fishery (Figure 13). In other regions, the volume of catches landed are very low, or even negligible. During the 1990-2001 period, trends in Ethmalosa catches in Thiès Sud were generally high with a maximum production of 25,000 tons in 2001. By contrast, catches saw an overall downward trend, reaching close to 5,000 tons in 2011. From 2012 onward, they increased anew, reaching a peak of 25,000 tons in 2014. This growth was driven by the presence of sub-regional markets, processing plants, fish meal factories and smoking facilities set up at Petite Côte by foreign communities. However, since then, catches have been on the decrease. It should be underscored that the greater proportion of catches landed in Thiès Sud were recorded in fishing zones located in the Sine Saloum estuary.

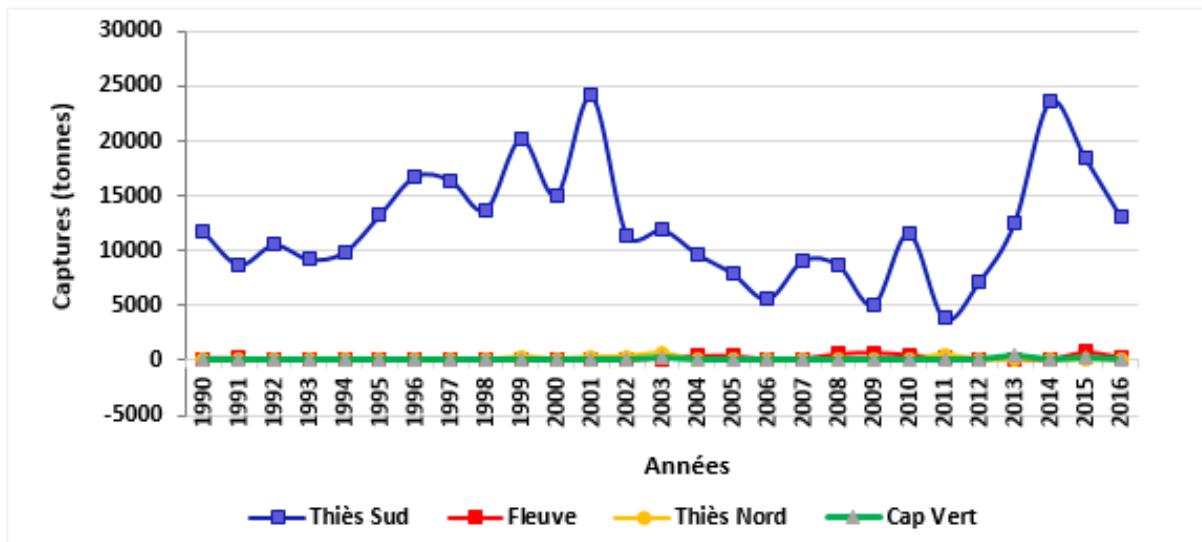


Figure 13. Annual trends in Ethmalosa catches per maritime region

Table 5. Overall catches of the two *Sardinella* species and *Ethmalosa* per region from 1990 to 2016

Year	<i>Sardinella aurita</i>				<i>Sardinella maderensis</i>				<i>Ethmalosa Fimbriata</i>			
	Cap Vert	Fleuve	Thiès Nord	Thiès Sud	Cap Vert	Fleuve	Thiès Nord	Thiès Sud	Cap Vert	Fleuve	Thiès Nord	Thiès Sud
1990	10,612	8,000	9,073	71,253	4,994	582	5,021	61,353	1	179	4	11,714
1991	16,150	8,475	7,692	77,454	2,727	1,986	2,288	65,404		180	0	8,744
1992	17,436	12,620	15,888	109,681	4,159	3,144	3,254	63,399	1	95	0	10,547
1993	12,021	23,351	13,251	95,200	3,544	1,105	5,425	65,921	16	52		9,228
1994	22,951	25,339	19,953	93,813	3,835	1,285	7,964	46,793	66	91		9,897
1995	17,337	22,612	8,025	70,225	5,041	737	3,688	60,019	7	71	0	13,276
1996	23,066	18,138	7,077	91,888	9,364	1,434	3,106	96,684	5	60	43	16,782
1997	21,024	15,999	15,289	89,369	4,987	661	5,847	69,439	1	4	0	16,419
1998	12,917	19,718	13,756	66,847	15,587	1,950	5,094	73,948	5	95	0	13,732
1999	11,747	17,323	14,726	36,233	11,051	2,233	16,445	73,073	10	24	298	20,208
2000	11,854	10,369	27,554	61,684	8,016	1,637	12,142	88,138	0	53	105	15,069
2001	14,015	9,310	15,575	83,384	6,987	2,108	11,193	98,175	16	31	284	24,141
2002	28,594	15,728	23,101	49,264	18,247	5,755	8,287	93,234	8	39	349	11,432
2003	23,853	23,164	25,344	48,846	8,070	6,815	9,618	137,780	361	151	631	11,952
2004	24,575	50,981	14,933	49,908	8,445	8,598	3,989	122,632	29	372	0	9,719
2005	30,241	60,994	31,982	67,595	3,690	7,983	8,537	90,228	1	396	91	7,953
2006	23,688	59,609	28,114	39,112	4,144	7,174	5,087	75,152	0	56	24	5,595
2007	29,416	53,393	40,646	64,650	4,877	7,145	4,194	90,656	3	116	6	9,101
2008	32,529	111,524	49,689	82,525	5,594	5,195	3,113	71,319	13	601	0	8,693
2009	29,814	101,836	40,004	88,065	11,348	6,425	5,828	63,465	4	719	2	5,090
2010	26,495	36,993	23,111	83,522	10,331	11,197	5,474	62,881	2	508	0	11,597
2011	21,835	58,981	35,627	87,262	6,732	8,720	8,764	93,668	128	204	492	3,836
2012	43,466	49,917	13,352	92,557	7,552	15,243	3,280	84,663	15	171	0	7,185
2013	24,727	37,235	15,051	57,528	8,512	17,196	4,508	90,285	500	77	23	12,580
2014	45,421	50,562	17,877	112,845	6,997	18,613	2,912	105,158	1	44	0	23,597
2015	52,823	62,723	5,106	131,855	12,698	21,136	3,235	100,080	198	754	0	18,510
2016	37,654	51,883	17,402	96,409	8,498	16,182	4,540	94,771	168	250	103	13,141

3.3.4. Specific monthly average catches per fishing gear and per region (1990 - 2016).

The highest monthly average purse seine catches of round *Sardinella* were recorded in Thiès Sud, Thiès Nord and Cap-Vert during cold seasons, notably from December to April (Figure 14).

For flat *Sardinella*, the highest average monthly catches were recorded in December and July in Thiès Sud, Thiès Nord and Cap-Vert (Figure 15).

For *Ethmalosa*, average monthly catches were recorded during the cold season, reaching a peak of 1,740 tons in December in Thiès sud (Mbour and Joal) (Figure 16).

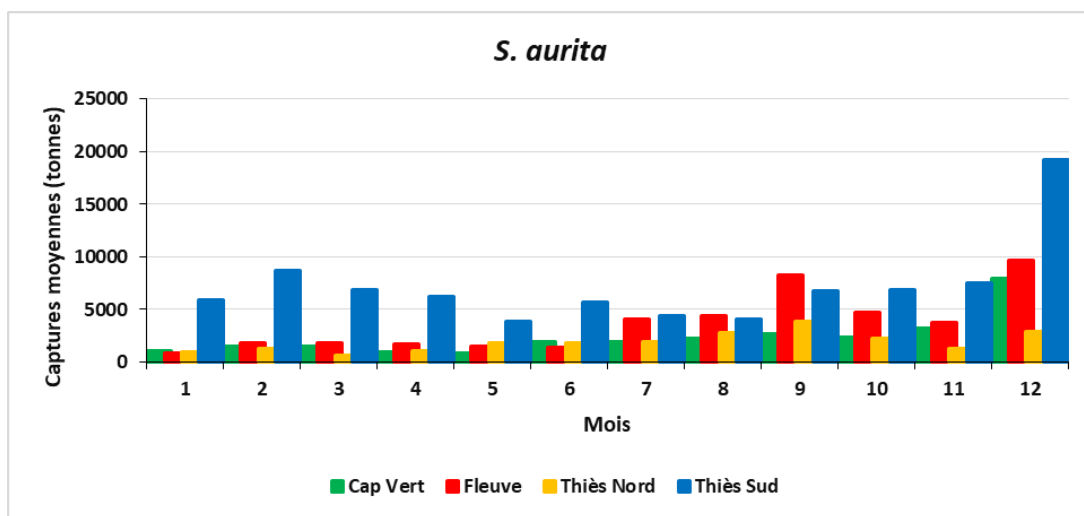


Figure 14. Spatio-temporal distribution of average catches of round *Sardinella*

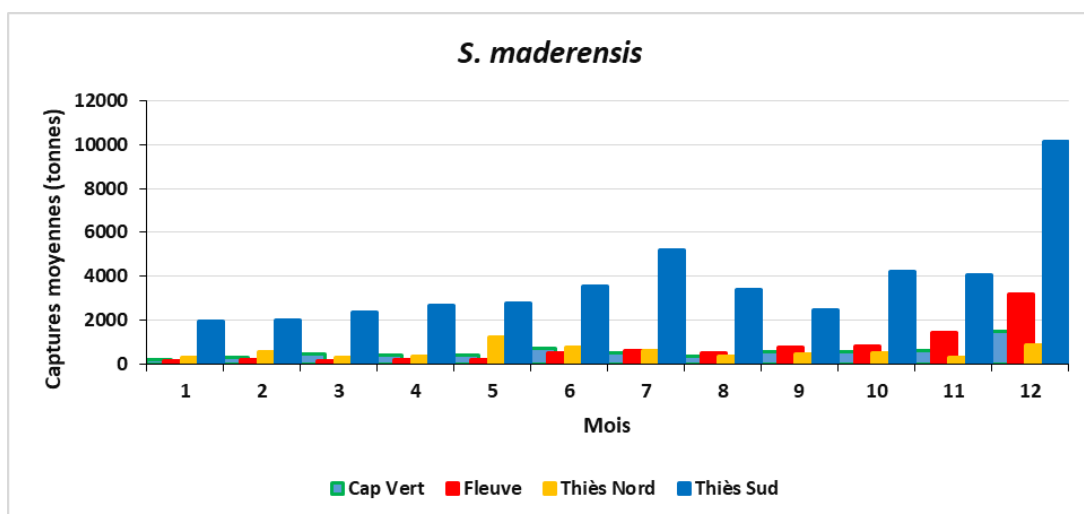


Figure 15. Spatio-temporal distribution of average catches of flat *Sardinella*

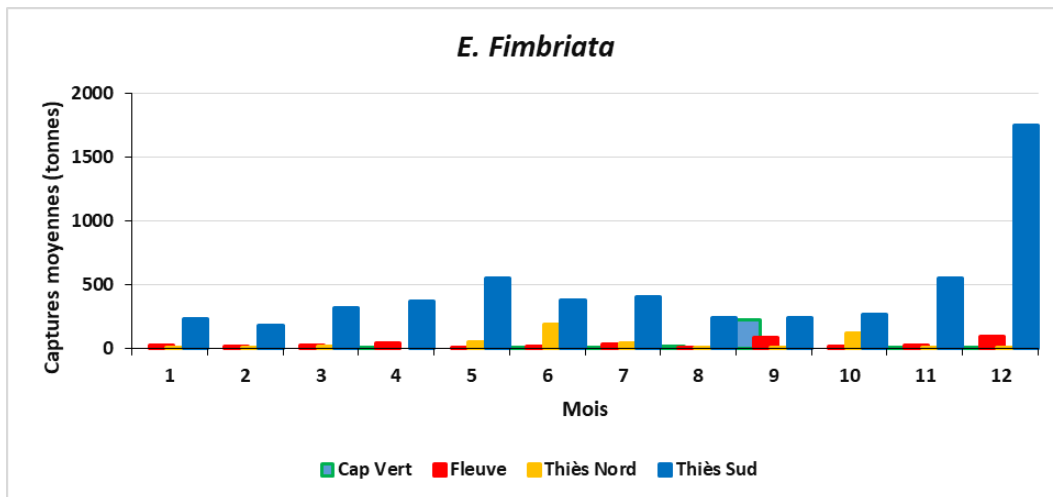


Figure 16. Spatio-temporal distribution of average catches of *Ethmalosa*

As regards encircling gill nets, they operate mainly in Thiès Sud, notably in Joal and Mbour and, to a lesser extent, in Cap Vert. They are almost non-existent in Fleuve and Thiès Nord. Figures 17, 18 and 19 show the monthly distribution of average gill net catches of round *Sardinella*, flat *Sardinella* and *Ethmalosa*. For round *Sardinella*, the highest average catches were recorded in March in Thiès Sud. Average catches with encircling gill nets in Cap Vert are relatively low. As for flat *Sardinella*, the highest catches were recorded between January and May, with a peak in March. On the other, *Ethmalosa* catches peaked in June with average monthly catches of 1,848 tons.

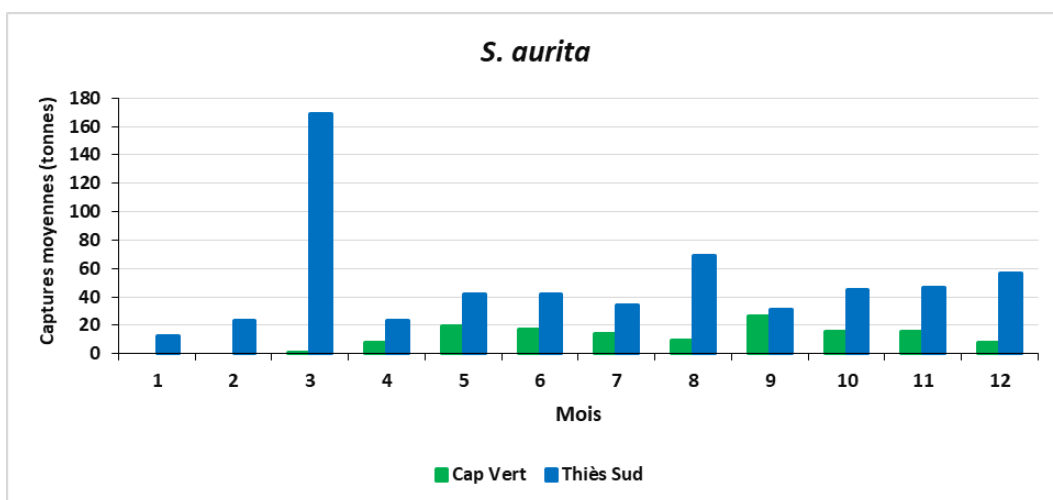


Figure 17. Spatio-temporal distribution of average catches of round *Sardinella*

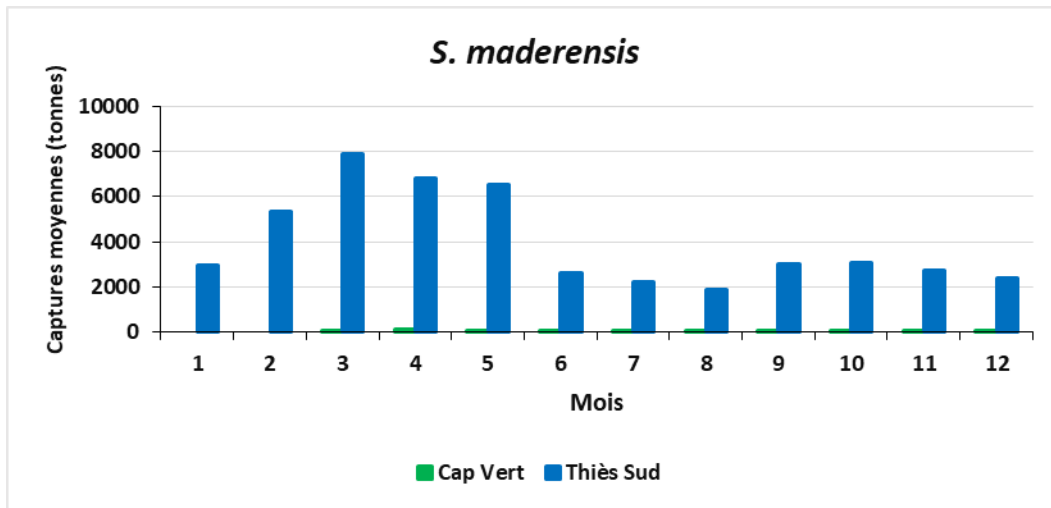


Figure 18. Spatio-temporal distribution of average catches of flat Sardinella.

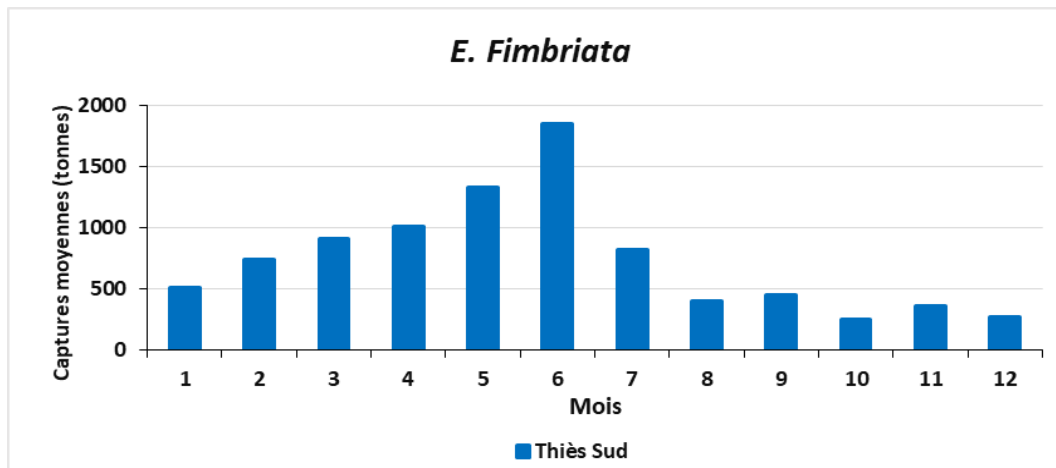


Figure 19. Spatio-temporal distribution of average catches of Ethmalosa

Fishing gears other than purse seine and encircling gill net catch Sardinella and Ethmalosa incidentally. Figures 20, 21 and 22 show the distribution of catches per region for the two Sardinella species and Ethmalosa.

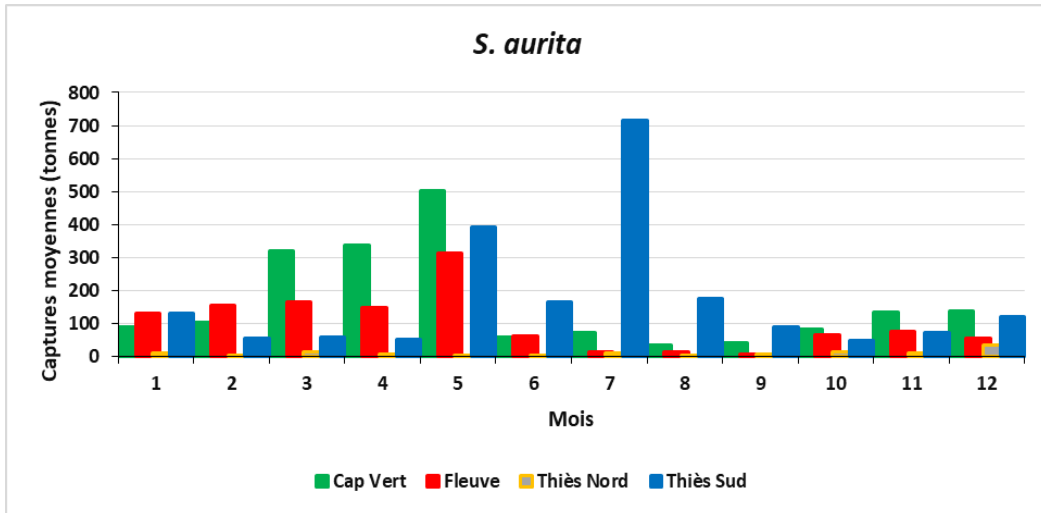


Figure 20. Spatio-temporal distribution of average catches of round Sardinella

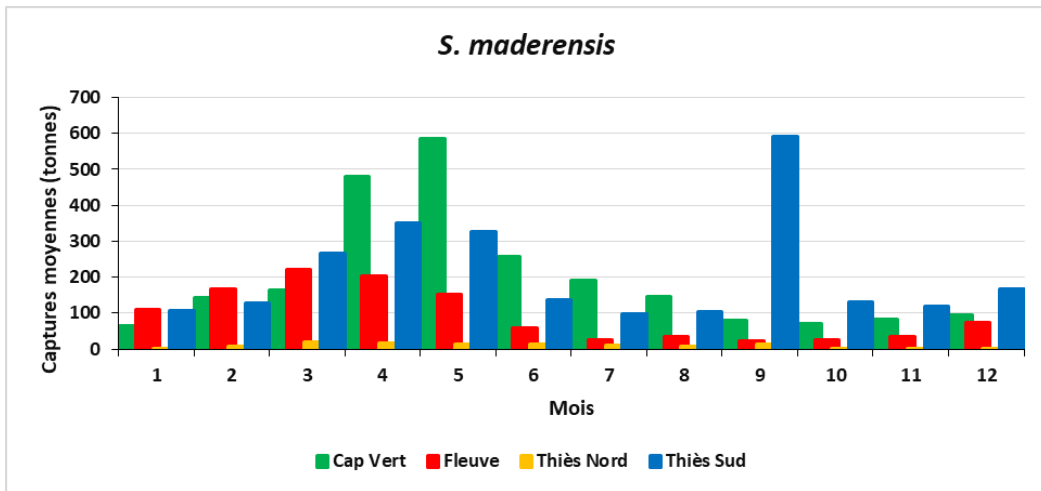


Figure 21. Spatio-temporal distribution of average catches of flat Sardinella

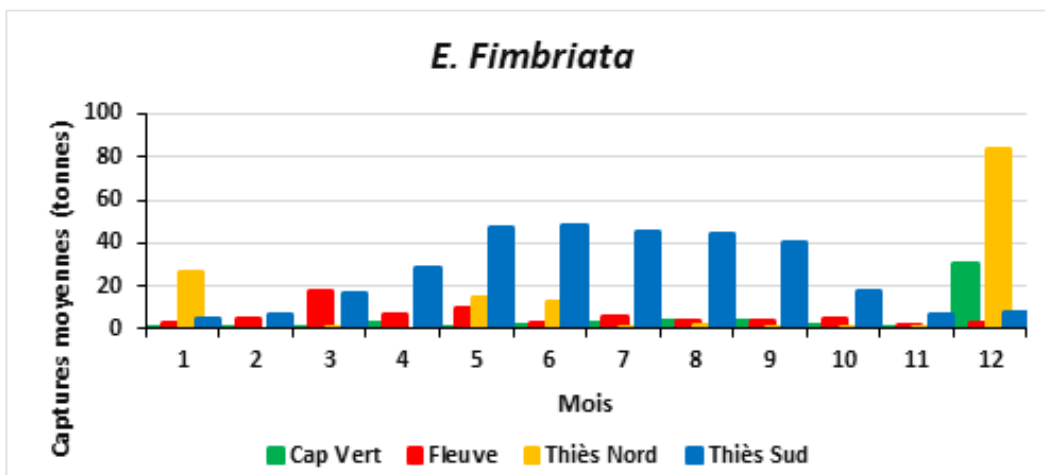


Figure 22. Spatio-temporal distribution of average catches of Ethmalosa

IV. EX-VESSEL PRICES PER FISHING SITE

The ex-vessel price for coastal small pelagic species (round Sardinella, flat Sardinella, Ethmalosa) varies considerably. Such fluctuations are mainly driven by supply (landed quantities) and demand (absorption capacity of the market). Other important factors also influence the price level of these species. These are landing locations, fishing seasons and substitution species, among others.

The remoteness of landing sites from major urban markets adversely affect fish price, while proximity can boost it. Hence, the landed price of the three species falls as the distance increases between the landing sites and the central fish market of Dakar, where the greater proportion of the production is sent on daily basis. Prices at Hann, located closely to the central market, are also higher. Since fish dealers of other regions have to bear additional costs for ice and transportation while selling on the same market as their counterparts from Hann and Kayar for example as they take into account those additional costs when setting their prices. Landed prices of Sardinella at Saint Louis can be very high in the absence of access to permits to fish in the in the EEZ of Mauritania.

The seasonal factor can also adversely affect the landed price of fish, owing in most cases to limited processing facilities in the winter in some landing sites.

The flat sardinella is less fatty than round Sardinella which largely destined for smoking is generally sold at lower prices. This situation is typical in Joal.

Tables 6 to 9 present the trends in landed prices of target species in Hann, Joal, Saint-Louis and Kayar landing sites.

Table 5. Trends in landed prices of target species at Hann

Year/species	Ethmalosa	Round Sardinella	Flat Sardinella
1990		50	64
1991		59	50
1992	55	51	52
1993	36	45	46
1994	134	54	44
2001		82	82
2002	133	75	142
2003		108	198
2010		142	88
2011	90	143	134
2012	140	175	130
2013	60	174	164
2014		155	140
2015	150	186	161
2016		184	153

Table 6. Trends in landed prices of target species at Joal

Year/species	Ethmalosa	Round Sardinella	Flat Sardinella
1990	13	23	18
1991	14	21	19
1992	9	16	12
1993	10	17	15
1994	14	20	20
2000	30	25	73
2001	34	37	34
2002	69	46	52
2003	68	53	39
2004	25	56	33
2005	33	44	48
2006	45	53	55
2007	35	55	37
2008	39	43	43
2009	55	35	52
2010	38	76	69
2011	66	77	71
2012	83	108	108
2013	77	138	146
2014	61	104	104
2015	82	81	110
2016	73	130	108

Table 7. Trends in landed prices of target species at Saint Louis

Year/species	Ethmalosa	Round Sardinella	Flat Sardinella
1991	95	71	53
1992	159	56	51
1993	78	52	25
1994	173	66	37
2001	713	202	132
2002	160	122	72
2003	73	115	80
2004	157	54	71
2007	138	89	87
2009	250	89	100
2010	92	102	109
2011	119	183	93
2012	167	169	122
2013	150	205	176
2014	76	163	134
2015	200	235	167
2016	195	207	159

Table 8. Trends in landed prices of target species at Kayar

Year/species	Ethmalosa	Round Sardinella	Flat Sardinella
1990		67	46
1991		62	55
1992		46	41
1993		41	29
1994		60	37
2001		86	73
2002		122	94
2003		123	67
2004		56	57
2005		71	102
2006		107	86
2007		126	66
2008		59	86
2009		91	58
2010		160	95
2011		160	159
2012		147	154
2013		352	186
2014		235	188
2015		238	161
2016		213	278

V. FISHERIES STAKEHOLDERS' PROFILE

Round Sardinella, flat Sardinella and Ethmalosa are mainly exploited by two artisanal fishing gears: purse seine and encircling gill net.

With reference to the last national survey conducted by CRODT in 2015, which covered the entire Senegalese coastal zone, including Sine-Saloum and Casamance estuaries, 1,126 purse seine fishing units were counted, as compared to 725 units of encircling gill nets out of a total of 18,284 fishing units (Table 1). Fishing units using purse seine are more present in maritime regions of Fleuve (especially Saint-Louis), Cap-Vert (Hann) and Thiès Sud (Mbour and Joal). Encircling gill nets are mostly used in the maritime regions of Thiès sud (Joal) and Saloum (Foundiougne).

The average size of the crew varies according to the type of fishery practiced. It stands at 22.1 fishermen for purse seine, 7.8 for encircling gill net and 3.8 for other types of fishing gears.

In all, 94,942 small-scale fishermen were counted along the Senegalese coast in 2015, out of which 27,204 operate on board of purse seine fishing units and 5,341 on board of encircling gill net units (Table 10). This represents 28.6 % and 5.7 % respectively of the number of small-scale fishermen. Overall, 34.3% of small-scale fishermen counted (32,345) are involved only in the fishery of coastal small pelagics.

Table 9. Number of fishing units, average crew on board per fishery type.

Maritime region	Fishing fleet				Average crew			Number of fishermen			
	Purse Seine	Encircling gill net	Other	Total	Purse Seine	Encircling gill net	Other	Purse Seine	Encircling gill net	Other	Total
Fleuve/Louga	312	0	2,443	2,755	18.6	-	3.9	5,803	0	9,573	15,376
Thiès Nord	99	0	3,104	3,203	12.6	-	3.4	1,247	0	10,491	11,738
Cap Vert	404	40	3,328	3,772	25.6	6.9	3.7	10,342	276	12,305	22,923
Thiès Sud	253	223	2,649	3,125	32.7	7.1	4.5	8,273	1,583	11,839	21,695
Saloum	3	420	2,949	3,372	16.0	7.3	4.0	48	3,066	11,904	15,018
Casamance	55	42	1,960	2,057	27.1	9.9	3.2	1,491	416	6,285	8,192
Total	1,126	725	16,433	18,284	22.1	7.8	3.8	27,204	5,341	62,397	94,942
%	6.1	4.0	89.9	100	-	-	-	28.6	5.7	65.7	100

Source: CRODT, 2015

Many artisanal fishing-related activities, such as artisanal fish processing and wholesale trade, largely depend on landings of small coastal pelagic species. According to a study conducted by COMFISH/CRODT in 2012, 40,000 women are involved in artisanal fish processing activities, out of which 75% are involved in the braising and smoking of small coastal pelagics, the greater proportion of which are Sardinella and Ethmalosa (Dème *et al.*, 2012).

The vast majority of the 9,500 individuals in the wholesale industry distribute almost exclusively Sardinella and, to a lesser extent, Ethmalosa.

There are also indirect jobs associated with artisanal fisheries. Given the high mechanization rate of close to 90% or even 100% for purse seine and encircling gill net fishing units, the artisanal fisheries sector has witnessed significant growth in the engine repair industry (photo 1). The tremendous role played by canoes in the artisanal fisheries system in Senegal has also enhanced the significance of carpenters (figure 23, 24).



Figure 23. Carpentry shop
Dème, 2017



Figure 24. Outboard engine repair shop
Dème, 2017

VI. CONCLUSION

Fisheries statistics provided and analyzed in this report are from CRODT's survey system put in place since the 70s. However, this data system does not always cover Sine Saloum and Casamance zones, where considerable *Sardinella* and *Ethmalosa* fisheries take place. That has been the case especially for flat *Sardinella* and *Ethmalosa* which are highly exploited in those areas. This situation may result in the underestimation of the fishing pressure and the overexploitation of *Sardinella* species and *Ethmalosa*. In the same perspective, it should be noted that some *Sardinella* catches are carried out outside the EEZ of Senegal (especially in Mauritania except from 2015 to 2016) and landed in Senegal. It should be recalled that there is no monitoring of quantities used by fish meal factories set up along Senegalese coast.

VII. BIBLIOGRAPHY

Deme (M.), Thiao, (D.), Ngom (F.S.), Sarre, (A.), Diadhiou (H.D.), 2012, Dynamique des Populations de Sardinelles en Afrique du Nord-Ouest: Contraintes Environnementales, Biologiques et Socioéconomiques. USAID/COMFISH project, Senegal, University of Rhode Island, Narragansett, RI 125 pp.

Thiao D., Diadhiou H. D., Dème M., 2013. Evaluation de l'effort et des captures réalisés hors de la ZEE sénégalaise par la pêche artisanale. Rapport technique final de recherches, Projet Usaid/Comfish, 51p.

Thiao D., Barry M.D. et Thiam M., 2009. Présentation du système d'information national sur la pêche et statistiques de la pêche maritime sénégalaise de 1997 à 2008. *Document scientifique N° 148, ISRA/CRODT*, 63 pages.