SENEGALESE CANOE FISHERY FOR SARDINELLA

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Abstract :

This document provides a synthesis of the main features of small scale fisheries from Sénégal which target on two Sardinella species, using different gears. The life cycle of the two species in sénégalo-mauretanian coastal waters is summed up. The strong relationship between the state of the resources and environmental conditions is emphasized.

Résumé :

Ce document synthétise les principales caractéristiques des pêcheries artisanales du Sénégal qui visent les deux espèces de Sardinelles, selon les engins. Les éléments du cycle vital des deux espèces dans les eaux sénagalo-maurétaniennes sont résumés. La forte dépendance des resources vis à vis des conditions de l'environnement est soulignée.

1. Introduction

Senegalese marine artisanal fishery is one of the most important in the west african subregion. It involves at least 5.000 motorized canoes spread over one hundred landing points. These last years, the estimated total catches are around 300.000 metric tons with an important percentage of pelagic fish. Two great events are mainly responsible of the catch increase during these last twenty years : the successful introduction of outboard motors and the development of the purse seine activity.

Pelagic fish are caught either by an industrial fleet than by a dynamic canoe fishery. The subject of the present paper is dealing with the sardinella canoe fishery, in relation with environment conditions. Several authors have already worked on the subject and we will try to summarize some of the publications available in the «Centre de Recherches Océanographiques de Dakar Thiaroye» (C.R.O.D.T.).

2. Fishing Patterns

Sardinella exploitation is a very old one in Sénégal : it concerns huge fish landing sites in connection with great fish consumer centers (figure 1). The most important landing sites are Joal, Mbour, Hann and Rufisque on the south coast, Kayar and Saint Louis on the north coast. The main gears used are passive (fixed gillnets) or active nets (beach seines, surrounding gillnets and purse seines). Pelagic fish exploitation is growing up since the beginning of the seventies in relation with canoe motorization expansion and appearance of purse seine.

2. 1 The surface gillnet fishery

Fixed gillnets are operated with small canoes (6 to 8 m), motorized or using paddles and sail, with 1 to 4 fishermen on board. This is an old fishing type, actually located in some fishing sites of the Cap Vert and the south coast regions where they are in competition with collective nets : they are mainly used by «lébou» fishermen and their main target is flat sardinella.(S. maderensis). During 1990, 2.500 metric tons were landed with 92 % of flat sardinella (Anonyme 1992).

2. 2 The beach seine fishery

It is another old one fishing type : the gear has already been described by Seck (1980). The net, 800 to 1.500 meters long is set fishing from a canoe of 8 to 15 m long. On each side of the net is attached a rope used by two teams of 20 or 30 fishermen each, hauling out the fishing gear and its catch. The beach seines, targetting juveniles and young spawners (18 to 25 cm long) and also anchovies, were very numerous in Gorée Bay up to the beginning of the eighties. They were working all the year round with a peak of activity on the beginning and the end of the warm season, i.e. July and October : after that they were in great competition with purse seines. The most important sardinella landings take place in the Cap Vert region and are not well sampled : 570 tons in 1984 by 74 seines and 300 tons in 1990 by 73 seines (Anonyme 1985, 1992).

2. 3 The surrounding gillnet fishery

This fishing type is operated with motorized canoes (14 to 16 m long) by 6 or 8 fishermen «niominka» mainly on the south coast. The daily outings last no longer than 12 hours. Two kinds of nets are used in Sénégal : the sardinella net (with small mesh size of 30 mm) and the bonga net (with larger mesh size of

40 mm). The first one catches mainly sardinellas with 90 % of S. maderensis ; for the second one, E. fimbriata represent at least 80 % of the catch. This last gear is particularly used between June and October, this period corresponding to maximum abundance of bonga on the fishing grounds. The other type of net which appear more important, is working all the year long in the south coast. Its catch and species size composition are relatively constant. For the sardinellas, the fork length are between 17 and 25 cm but the 19-23 cm length classes are very well represented. Smaller individuals are specially caught during April and May.

The maximum development period of this fishery on the south coast was during the years 1972-1973 : the total catch of the two types of surrounding gillnets was about 35.000 tons per year with 65 % of flat sardinella, 20 % of bonga, 10 % of round sardinella (S.aurita). After 1977, the total catches fell down to 10.000 tons per year, due to the expansion of the purse seines. However, with the degradation of the economical conditions within the fishing sector, there is a come back to the activity of this fishing type : from 75 units in 1982, the number of nets is up to 137 in 1990, with amounts of catch respectively equal to 10.000 and 46.000 tons.

2. 4 The purse seine fishery :

Trials for adapting that fishing gear to the canoe fishery were done in 1960 (Grasset 1972), but it appears really in the fishing areas in 1973. The net is 200 to 300 meters long, with 40 m large and 20 to 40 mm of stretched mesh. It is operated by twenty or so fishermen from a 14 m long canoe, sometimes two ; the second one, much bigger is used for carrying fish: the opening of new sales facilities has carried out the carving of large canoes, up to 20 tons capacity. The outings are daily and can be done either during the day or at night according to the lunar cycle.

Catch composition is very different from those of the previous gears. Purse seine is very efficient for catching round sardinella which particularly escape to gillnets by diving when encircled by the fishing gear. The fishing effort of purse seine is very high between March and September, period during which round sardinella is abundant in the fishing zones (Freon 1988).

The use of purse seine is specially developped on the south coast of Sénégal where are located the two most important landing sites in the country : 87.000 tons of pelagic fish have been landed by the purse seines in Mbour and Joal during 1990. By the beginning of the 80"s, purse seine fishing expanded to the Cap Vert region (Hann, Rufisque) and the north coast area (Kayar, Saint Louis) : these two geographical regions give respectively an amount of 18.000 and 31.000 tons caught by purse seines during the active cold season, mainly from December to May.

It is noticed, since a lot of years, some changes in the activity pattern of the purse seines : with the decrease of fishing yields and the increase of operating costs for fishing units (fishing grounds are now very far), fishermen use only one canoe to carry out at once the net and the catch.

3. Importance of Pelagic Resources

Pelagic resources assessments are conducted on the west african continental shelf since the seventies through acoustic surveys. Since 1982, CRODT is owning his appropriate equipment and is executing acoustic surveys with the vessel «Louis Sauger». Some surveys carried out since march 1983, during the cold season, give an idea of the distribution of the pelagic fish total biomass by geographical area, as well as changes between years (by 1.000 tons).

3. 1 Sardinella resource assessment

The sardinellas represent the most important part of the pelagic biomass, but no specific assessment has been done except during «Fridtjof Nansen» surveys. The breakdown of total biomass by species is not very easy : the several acoustic campaign were not conducted covering the same area and the sampling designs were very variable. Apart of that, fishing gears used were not always appropriate for sampling small pelagic fish aggregations.

Within regional survey programs, the oceanographic vessel «Fridtjof Nansen» worked out in the subregion in 1981, 1986 and 1992. The following table presents the specific biomass values estimated for the sardinellas (by metric tons).

The predominance of flat sardinella is real : this species represent up to 69 % of the total biomass. This one seems to be relatively stable between 1981 and 1986 : on the other hand, the last survey gives a biomass much more important than the previous ones. This high level of biomass has been analyzed by norvegian scientists. In comparison with former surveys, they notice a decrease in the biomasses of mackerels and horse mackerels, and a four times increase in those of sardinellas. They also observed that the new equipment used during the 1992 campaign had not the saturation problems identified with the old equipment. Besides, they extended their prospecting zone to the coastal area where flat sardinella concentrations are much more important. The last survey has also been done in march, season during which adults of round sardinella are present on the senegalese continental shelf (figure 2).

3. 2 Geographical distribution and migration of sardinella

They have been studied through the analysis of fishery statistics, or the data collected by exploratory surveys in the senegalo-mauritanean area : no tagging experiment has been successfully conducted on these species.

According to Fréon (1988), we can summary the migratory cycle of Sardinella aurita as follows (figure 2) : from October to December, scattering step between Mauritania to Sahara ; during January and February, quick southward movement step ; eggs maturation concentration step in the southern living area (Senegal south and Guinea Bissau) in March-April ; from May to September, northward movement step up to 24°N and 25 °N with spawning processes. Two important nurseries have been identified : one in Mauritania in the south of Cap Blanc, and the other in the south coast of Sénégal.

Flat sardinella is present between Mauritania and Angola, within sligthly the same area than the round one. Sardinella maderensis is often abundant near the estuaries, living in no turbid but warm waters, not very far from upwelling zones (figure 3). There is not enough knowledge on the biology and distribution of this species. Two nurseries exist, one in the south coast of Sénégal and the other by the south of Cap Timiris. Juveniles and young spawners do some seasonal movements within these nurseries. The adult part of the stock is fished north of the Cap Vert peninsula.

3. 3 Artisanal fishery landings

In Sénégal, sardinella landed by artisanal fishermen have always represented an important part of the total catches. Detailed data are available only since 1977 (Table 1) and are dealing particularly with purse seines and surrounding gillnets.

3. 3. 1 Trends in catch statistics

Fish landings have quickly increased between 1977 and 1990, due to the increasing number of purse seines and the extension of fishing areas to the Cap Vert region and the north coast of Sénégal. From 1978 to 1990, the north coast shared 2 to 15 % of the total sardinella landings.

Catch specific composition varied during these years with an increase in round sardinella landings because of its position as a target for purse seines, small mesh sized surrounding gillnets dealing mainly with flat sardinellas. According to Fréon (1988), over 35.000 tons landed by the artisanal fishery on the south coast during the years 1972-1973, 65 % were Sardinella maderensis and 10 % S. aurita. In 1983, these proportions became respectively 30 % and 50 % from 90.000 tons; they seem to be about 50 % each in 1989 and 1990. the catches of flat sardinella and bonga by purse seines and surrounding gillnets are done on the same year classes. Young spawners of round sardinella are well represented in the annual landings.

The adult individuals appear in the catch only during the cold season. They are by now much more fished, as artisanal fishermen are targetting them by going farther since the time their yields are decreasing.

3. 3. 2 Trends in fishing effort

Within the last ten years, the purse seine outings have regularly increased on the north and the south coast (Table 2). For surround gillnets, there is an increase in the number of outings up to 1985 : the 1984-1985 peak of activity corresponds to the bad fishing season for the purse seines.

During the year, purse seine activities are seasonal in the north coast, with high levels of outings between December and June (the cold season). On the south coast, the activity seems to be intensive all the year round. We notice also a decrease in the surrounding gillnet activity during the warm season, due to the agricultural works of «niominka» fishermen during this period (Table 3).

3. 3. 3 Trends in catch per effort (yields) :

In the same way, purse seine catch per outing on an annual basis have also increased within the two regions (Table 4). The levels of catch are much higher on the south coast as this area is a nursery for the two species of sardinella. The same observation can be done for surrounding gillnet yields.

Within the year, the yields obtained by purse seines in the north and surrounding gillnets in the south coast are very low during the warm season (Table 5). On the other hand, during that period, the purse seine yields are the highest. The fishermen are active on the fishing grounds where they can find juveniles and young sardinella spawners.

4. Environmental Charges and Sardinella Exploitation

The senegalese coast is under the influence of the trade winds from November to December : they create local upwelling phenomenon (Rebert 1982). In that case, a contrasted hydroclimate is occuring on the continental shelf, with two large marine seasons separated by two small ones :

- a cold season from December to May, the duration of which decreases gradually from the north to the south : sea surface temperatures are about 16 to 18° C and the water salinity is about 35,5 to 36 ‰
- a warm season from July to October with sea surface temperatures between 25 and 27° C and water salinity ranging from 36 to 35 ‰;
- a short transition cold-hot season in May-June ;
- a short transition hot-cold season in October-November.

The upwelling period begins on the senegalese continental shelf with the setting up of the trade winds: from November to January, it is due to the north-east winds and is slightly more intense on the north coast (10^4 versus 10^3 m^3/sec/ 10m of coastline). During February, north-west wind components are dominant and the upwelling is more intensive on the south coast (figure 4). The upwelling season last up to June on the north coast and July on the south coast : its intensity is maximum in the south in March-April. On the north coast, the upwelling appear first in Saint Louis area in November and begins to desappear by the south in Kayar area in May. The continental shelf is very narrow on the north coast : the upwelling which developpes there is really in the coastal zone, with its focus point at 16°N. On the other hand, the south coast has a larger shelf : the maximum upwelling is located on the middle of that area (Laloe et Samba 1990).

On an interannual basis, the trends in upwelling intensity show a succession of high intensive upwelling periods (1971 to 1978 and after 1985) and low intensive ones (1963 to 1970 and 1978 to 1984) (figure 5) (Roy 1988).

As shown earlier in table 5, sardinellas exploitation scheme is seasonal in the north coast, related to the upwelling intensity indices : high c.p.u.e. are observed during the December-May period.

It is now recognized that environmental changes and upwelling extension is important for life cycle and dynamics of sardinellas ; the detected biomasses by acoustics during the cold season is much more important on the upwelling boundary area ; during the warm season, river discharges have a huge inmpact on pelagic fish abundance (Demarcq et Samb 1991). These observations have also been done earlier by some other scientists who proposed to introduce environmental variables within classical production models (Freon 1988). An important working group held in 1989 in Dakar analyses the relationships between pelagic stocks and environmental variability : it emphasized strongly on sardinellas behaviour in upwelling zones (Cury et Roy 1991). The results of this working group, and the main conclusions are very useful for the understanding of sardinellas exploitation and the stock assessment purposes. Nevertheless, it is not obvious to consider as a study case the year 1984. The 1984 CRODT acoustic survey announced a decrease in the cold season pelagic biomass, specially for round sardinella stock. In the same period, artisanal fishermen registered very low catch yields for this species with a big amount of small individuals. Bad recruitment processes due to low upwelling intensities the previous years ? Low catchability of round sardinella to purse seining ? Local or global environment events ?

Fonteneau (1989) observed for the same year a low catchability of adult yellowfin tuna to large tuna purse seiners, maybe linked to an increase of the thermocline depth.

5. Conclusion

Sardinellas catches are the most important part of the artisanal fishery landings (up to 150.000 tons in 1991). These species are also widely used for food consumption, fresh or smoked : small quantities are also exported to neighbouring countries. Since 1985, sardinellas landings are increasing regularly. To preserve that resource, it is useful to try to draw up some guidelines for future research programs on sardinella stocks :

- best catch statistics recovery for long range fleet fishing migratory part of the stock ;
- study of large scale environment variability, as well as short term levels (weekly may be) of the upwelling dynamics by using satellites accomodation ;
- ecology study of fish and behaviour of fishermen (fleet dynamics) ;
- try to quantify river discharges, related to fish food supply ;
- in another level, regarding sardinella species identification during acoustic surveys, improve fishing sampling technics while detecting fish biomasses.

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CAPTIONS OF TABLES AND FIGURES

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Table 2 : Number of trips by year 1981-1991 for different gears and areas.

Table 3 : Monthly averages number of trips for different gears and areas.

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Figure 1 : Senegalo-mauretanian coastline : main landing sites.

Figure 2 : Migratory cycle, nurseries and adult concentrations of Sardinella aurita in Senegalo-mauretanian area.

Figure 3 : Migration pattern, main nursery zones for Sardinella maderensis.

Figure 4 : Mean annual cycle of the coastal upwelling index (wind data from Yoff airport 1963-1986) Source Roy (1988).

Figure 5 : Interannual variability of the coastal upwelling index during the cold season, north and south of the Cap Vert peninsula. Source Roy (1988).

Years	Sard. Aurita.	Sard. Mader.	Aur.+Mader.	Other pelag.	Total
1977	17293	4520	21813	11006	32819
1978	12779	11117	23896	12939	36835
1979	12801	13009	25810	15171	40981
1980	17250	9529	26779	19779	46558
1981	24274	20571	44845	29309	74154
1982	19113	32302	51415	44583	95998
1983	22544	48370	70914	44323	115237
1984	18745	51926	70671	49694	120365
1985	32904	53903	86807	35259	122066
1986	53526	48428	101954	49031	150985
1987	70731	67793	138524	47522	186046
1988	76945	63117	140062	54368	194430
1989	81554	64784	146338	54603	200941
1990	82981	67202	150183	51477	201660

Table 1 : Annual trends in sardinella catch

Years	North coast	South coast	
	Purse seine	Purse seine	Surr. gillnet
1981	654	1633	633
1982	894	1902	837
1983	976	2374	1230
1984	1665	2366	1677
1985	1156	2236	2083
1986	1145	2968	1693
1987	1375	2748	1989
1988	1316	3012	1861
1989	1415	2645	1874
1990	1822	2400	1844
1991	1655	2526	1584

Table 2 : Monthly average number of trips by year.

Month	North coast	South coast	
	Purse seine	Purse seine	Surr. gillnet
January	1468	2292	1597
February	1621	2071	2331
March	1994	2440	2609
April	1861	2380	2548
May	2308	2415	2217
June	1383	2487	1419
July	561	2744	731
August	586	2568	950
September	480	2252	1191
October	527	2468	1277
November	991	2688	995
December	1573	2441	1012

Table 3 : Average number of trips by month

	North coast	South coast	
Years			
	Purse seine	Purse seine	Surr. gillnet
1981	662	2147	373
1982	417	1467	654
1983	486	1763	665
1984	494	1332	859
1985	480	1852	834
1986	691	1904	926
1987	799	2438	1237
1988	756	2427	1359
1989	1045	2797	1480
1990	959	2994	1600
1991	1077	3138	1816

Table 4 : Annual mean catch per trip

Month	North coast	South coast	
	Purse seine	Purse seine	Surr. gillnet
January	714	2016	1347
February	979	1524	1477
March	1054	1554	1538
April	850	1614	1193
May	677	1886	1024
June	560	2351	788
July	318	2715	682
August	254	2204	868
September	258	2243	895
October	604	2661	1051
November	1277	2956	853
December	1037	2742	1157

Table 5 : Monthly average catch per trip

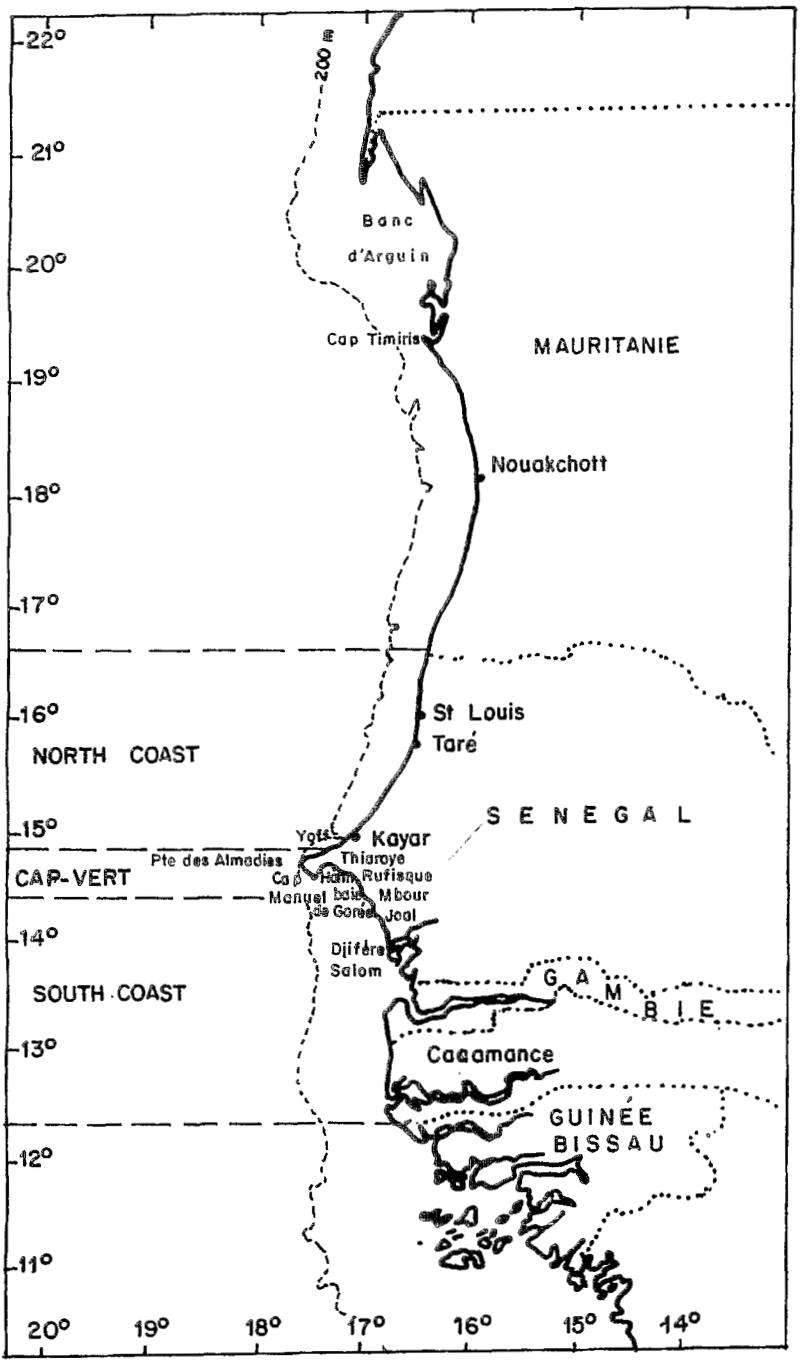


Figure 1 : Senegalo-mauretanian coastline : main landing sites.

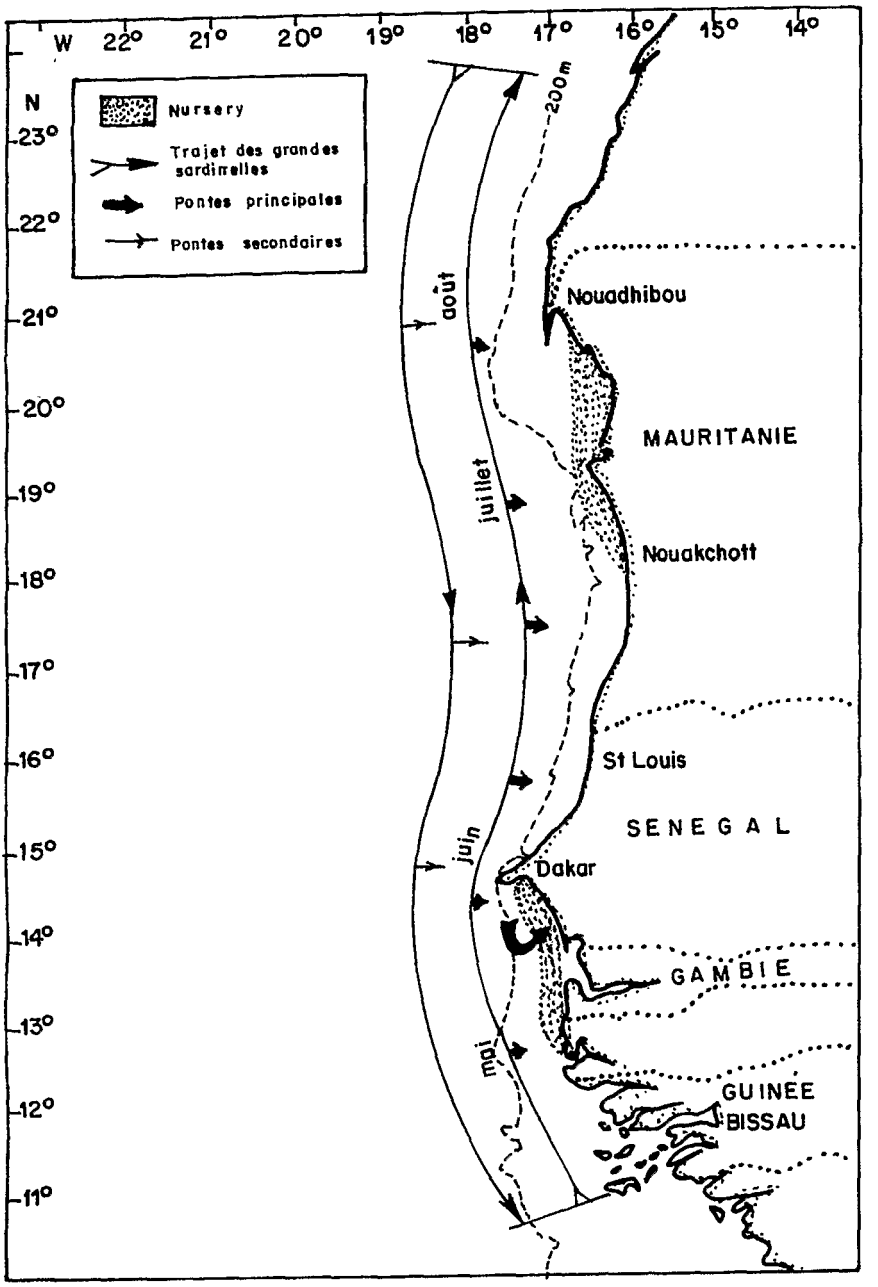
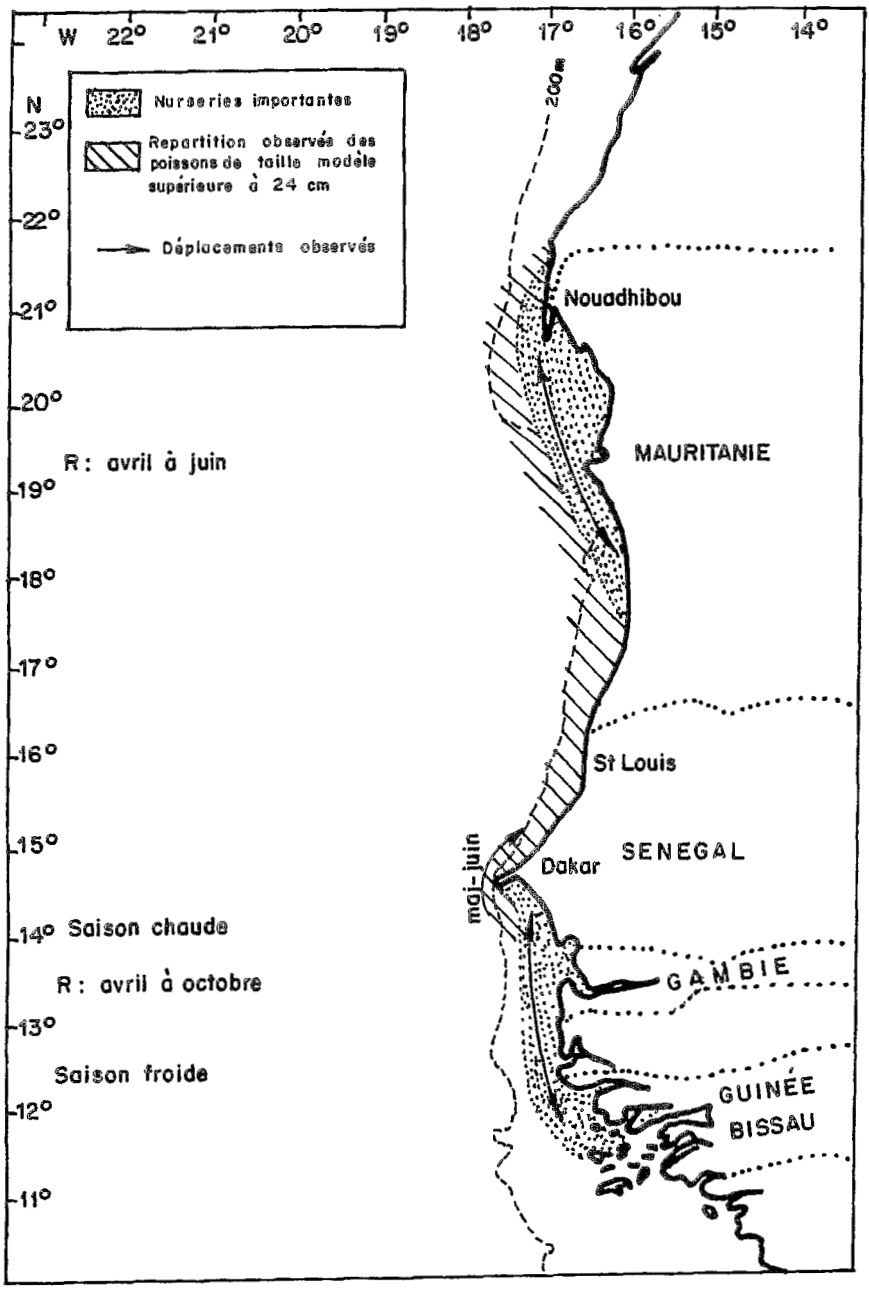


Figure 2 : Migratory cycle, nurseries and adult concentrations of Sardinella aurita in Senegalo-mauretanian area.



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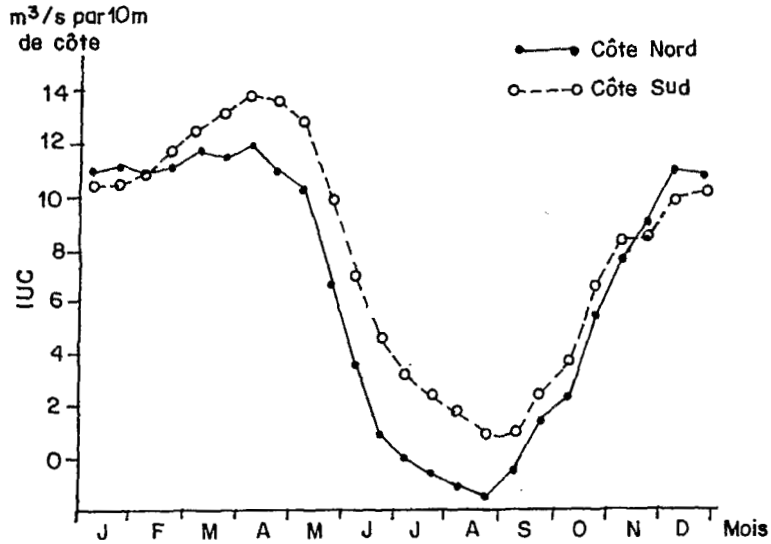

Figure 4: Mean annual cycle of the coastal upwelling index (wind data from Yoff airport 1963-1986) Source Roy (1988).

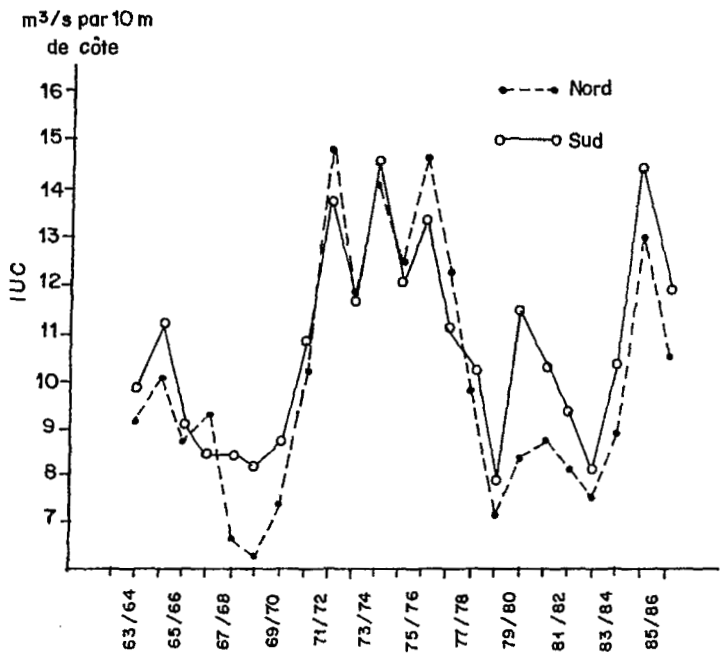

Figure 5: Interannual variability of the coastal upwelling index during the cold season, north and south of the Cap Vert peninsula. Source Roy (1988).