PROJECT: "Towards regional policies for sustainable fisheries for small pelagic in Northwest Africa"

BIOLOGICAL ASPECTS AND FISHERY OF SMALL PELAGICS OFF THE COSAT OF THE GAMBIA

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An executive summary

The present report intends to present biological information on each of the commercially important small pelagic species off the Gambia coast using available data, literature and local knowledge mainly from long term fishermen. It is expected that a collective of these information could serve as useful tool in developing a sound management plan considering the ever-increasing need to conserve the so called last 'healthy' fish stocks of our waters.
The pelagic species assessed include *Ethmalosa fimbriata, Sardinella aurita, Sardinella maderensis Trachurus trachurus,* and *Trachrus tracae*.

The study indicate July to October as period of maximum abundance of *Trachurus trachurus* & *Trachurus tracae* adult population at a depth of 15–30 m & a distance of 7 – 12 nm from the coast of Gambia.

Ethmalosa fimbriata maximum adult population are distributed at a depth of 6-20 m and a distance 4 – 8 nautical miles from the coast. This occurs between June and November. There also exist a lower estuarine population of mainly pre-adults with maximum abundance during dry season (high estuarine salinity period (March-May)

Maximum concentration of juvenile *Sardinell aurita* occur between the periods July and September & January and March) at a depth of 15 – 25 m & a distance of 7 – 10 nm from the coast

Maximum abundance of adult *S. aurita* population occur (May – Jul) at a depth of 15 – 25m and a distance of 7 – 10 nm from the coast.

Sardinalla maderensis Pre- adult are estuarine with maximum concentration between July and September. These migrate from estuary towards inshore from December
Inshore adult population maximizes during the period April – October at an approximate depth range of 6-8m and a distance of 4 – 8nm from the coast. A smooth overlap with *E.fimbriata* occur in both inshore and the estuary. But S.maderensis unlike E.fimbriata is confined in lower estuary.

Assessment of the reports of small pelagic surveys by M/V Nansen indicate a relatively a lower biomass of small pelagic off the West African coast when compared to results of earlier years surveys. This is indicative of pressurized shared resources.

1. Introduction

Small pelagic fish stocks are considered the most abundant off the Gambia coast. This is attributed to existence of and or influence of a well-defined coastal upwelling which brings to the surface nutrients. In addition the estuary of the Gambia contributes significantly to the total nutrient budget of the waters. The canary and Guinea currents (Cold and warm currents respectively) flowing north-south provides favourable hydrological conditions for growth of these stocks which form the basis for the development of other more commercially important fish stocks. Among the small pelagic fish include Bonga (*Ethmalosa fimbriata*), *Trachurus trachurus, trachurus tracae, Sardinella aurita, Sardinella maderensis and Caranx ronchus*

Ecologically these are low trophic level fish species. Their ever increasing socio-economic importance and emphasis on their study and industrial exploitation in recent years by the states that share the stocks is indicative of a down-the-web fishing scenario.

In most states within the Canary current Large Marine Eco system (CCLME) particularly The Gambia fish particularly *Ethmalosa fimbriata, Sardinella aurita and Sardinella maderensis* are the main source of protein for the population. Per capita fish consumption along the coast of Gambia is estimated at 25 kg/year as opposed to only 9kg/year in the rural area. The disparity is attributed to lack of efficient distribution mechanism of the products. However in recent years small pelagic products are distributed in refrigerated trucks to the farthest point in the country. This resulted in increased demand for the product and pressure on the stocks. The phenomenon is common in other member states in the sub region. Therefore the need to improve understanding of the status of our pelagic fish stocks became paramount.

The main small pelagic stocks in the north of FAO Statistical Area 34 are considered fully or overexploited due to recent developments (fish oil and meal factories and huge fishing vessels) in the sub-region.

Studies backed by survey results were conducted in the waters in which biological parameters such as biomass trends, length frequency distribution etc. were assessed.

The objective of the studies including the present is to improve understanding of general trends in the population dynamics of small pelagics with a view to

applying concerted effort at the sub-regional levl for effective cooperative management of the shared resources.

1.1 Justification for the study

Small pelagic fisheries of the Gambia under the management of the Department of fisheries is a purse-seine and encircling gillnet fisheries extending some 80 nautical miles north-south and about 50 nautical miles East-West. Currently there are approximately 600 artisanal fishing units targeting *Ethmalosa fimbriata, Sardinella aurita, Sardinella maderensis Trachurus trachurus, Trachrus tracae*. There are no active SPF industrial fishing units.

The stock of these species is shared within the northern CECAF sub region and managed by the individual member states.

Exploitation of these species off the coast of the Gambia is individually managed based on information on catch and effort as well as results of joint pelagic surveys with the member states in the sub region. The joint survey is annually conducted by a marine vessel Fridtjof Nansen.

The present report intends to present biological information on each of the commercially important small pelagic species off the Gambia coast using available data, literature and local knowledge mainly from long term fishermen. It is expected that a collective of these information could serve as useful tool in developing a sound management plan considering the ever-increasing need to conserve the so called last ‘healthy’ fish stocks of our waters.

1.2 Study objective

Specific objective of the study is to improve understanding of dynamics of our pelagic fish stocks using gathered information on spatio-temporal distribution of different species of the stock. The information will be further used to develop a management plan at least at country level. The plan will include guidelines for responsible exploitation of small pelagics. Issues such as impacts of climate change will also be factored in the management plan

1.3 Overview and Evolution of Fisheries targeting Small Pelagics in The Gambia

Artisanal fisheries particularly on small pelagic has shown two trends of evolution: the era of relatively primitive small planked unmotorized dugout canoes and the recent large, all-planked and motorized canoes. The former was manually paddled using small set nets. Catches were low but commensurate with the demographic level of the country. The size and number of artisanal craft increased under the influence of local demand for fish.

Canoe fishing for small pelagic entirely depend on intensity of seasonal upwelling. Bonga in their shoals are mainly caught at night when they appear on the uppermost layer and their silvery flanks visibly illuminate in the darkness. This phenomenon more elaborately occurs during period of upwelling bringing nutrient- rich water to the top. If West African upwelling is wind-driven, therefore, the future of bonga fishery will have to be systematically monitored on the background of global weather and Climate change scenarios. It goes without saying that catch volumes of more offshore small pelagic will be higher in years of weak upwelling when lesser nutrient-rich bottom water does not move sufficiently inshore. Therefore the phenomenon does not quite apply to industrial fishing for Trachurus, and *Sardinella aurita* using purse seines which are carried out all year round. Table 1 below shows evolution of artisanal and industrial fisheries in terms of catch (Source: Fisheries Department catch Assessment data for 2010)

Table 1 Evolution of artisanal fisheries in The Gambia represented by volume of catches by artisanal and industrial fishing

Production (MT)			
Year	Total Industrial	Total Artisanal	Grand Total
1981	-	14579	14579
1982	-	6209	6209
1983	-	8333	8333
1984	-	8170	8170
1985	23985	7426	31411
1986	22225	9909	32134
1987	22421	5139	27560
1988	11864	7224	19088
1989	11534	10942	22476
1990	26401	11573	37975
1991	23175	20270	43445
1992	6060	14035	20094
1993	7736	17560	25296
1994	7752	19917	27668
1995	6937	20799	27736
1996	8372	30510	38882
1997	7988	30243	38231
1998	7012	26533	33545
1999	10249	29743	39993
2000	9237	26867	36104
2001	11198	32016	43214
2002	12160	32336	44496
2003	11005	34365	45370
2004	8375	29317	37692
2005	4600	30169	36845
2006	2830	36898	39728
2007	4000	43007	47007
2008	2973	42841	45814
2009	3179	45881	49060
2010	4001	45910	49911

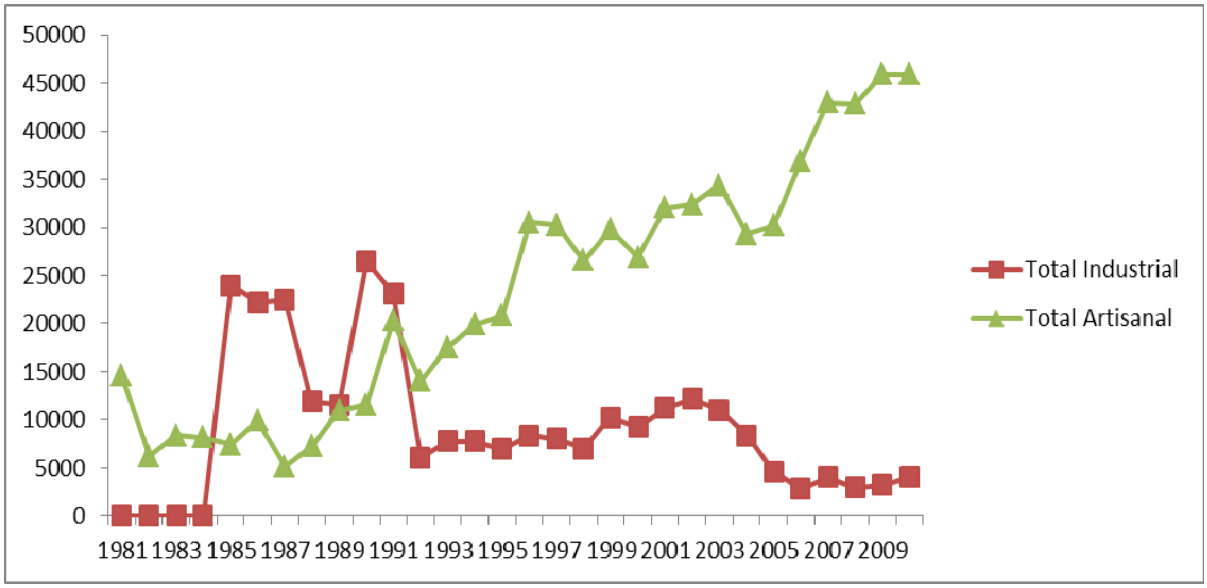


Fig. 1 Comparison of artisanal and industrial fisheries over the years (Source Fisheries Department)

1.4 Catches of Small Pelagics by Species.

Small Pelagic Species names		Catch					
English	**Scientific**	**- 2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Shad/Bonga	*Ethmalosa fimbriata*	14,977,804	13,186,990	13,876,000	117,430,000	12,577,000	12,586,000
Madeiran Sardinella	*Sardinella maderensis*	427,902	3,945,565	1,659,000	4,759,000	5,097,000	5,099,974
Round Sardinella	*Sardinella aurita*	136,157	994,665	2,781,000	23,154,000	2,480,000	2,481,246
Atlantic Horse Mackerel	*Trachurus trachurus*	762,713	317,340	407,000	212,000	205,000	207,115
Cuene Horse Mackerel		3,612	-	206,000	326,000	349,000	348,000

1.5 Small Pelagic survey by M/V Dr. Nansen fridtjof

FAO (Food and agriculture Organization, NORAD (Norwegian Agency for Development Cooperation and IMR (Institute of Marine Research (IMR) of Bergen collaborate using the vessel R/V Dr Fridtjof Nansen to undertaking national and regional acoustic fisheries research surveys on small pelagics. In collaboration with fisheries scientists from sub regional member states the surveys were conducted annually in the northern CECAF region (Morocco to Southern border of Senegal and Guinea Bissau). Emphasis was placed on data collection for analysis and development of reports by special working group (FAO Working Group on Assessment of Small Pelagics) on the state of the stock vis-a vis species distribution, abundance, species interactions, environmental conditions and ecosystem characteristics.

During th surveys in the region a common survey design has been adapted. Parallel tracks are made with 10nm apart. These are perpendicular to the coastline (fig. 2) within 15 -500 m isobaths. Biological parameters take through depth specific trawl samplings for both epi and mid pelalgic species include weight, species and Length frequency distributions, species condition factor and length-weight relationship.

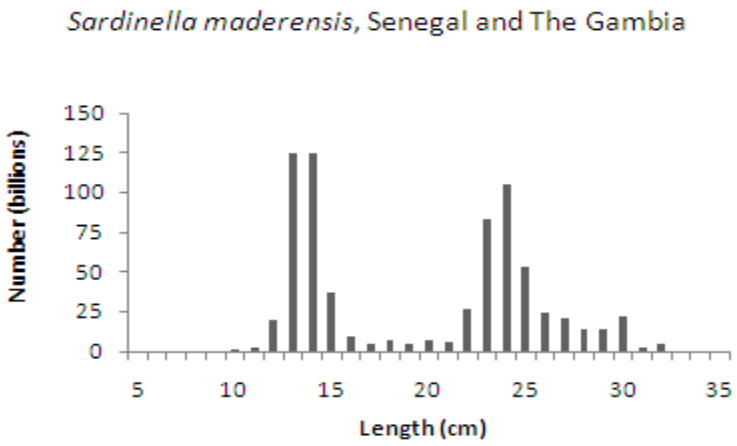
Simultaneously environmental parameters were taken using appropriate software. These were Water temperature, Salinity and Dissolved oxygen (DO). These were respectively found to be around around 28 OC, 36.2 psu and >4,5 ml O_2/l off The Gambia (Nansen cruise survey report June-July 2011)

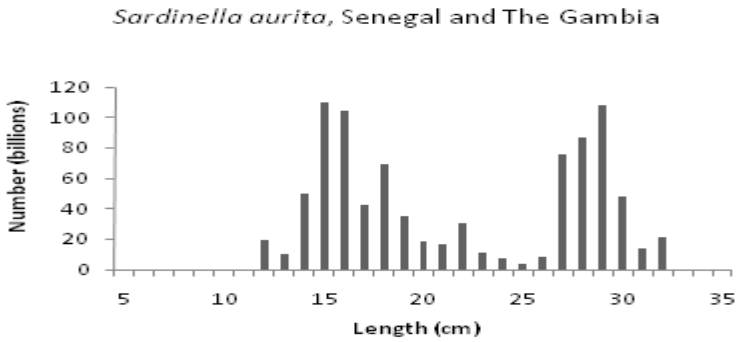
The results estimated a total biomass for the year 2011 as 101,000.0 metric tons.(table 2).

From a pooled length frequency distribution of samples taken in Gambia and Senegal waters indicate two distinct size classis of each species sampled Fig 2) The frequency distribution of *S. aurita* is bimodal (Two modes) modal length in the area were 15 and 29cm. *S. maderensis* had two modal peaks as well and these were, 13 and 14 for lower peak size class and 30 cm for the other. Few juvenile sardinella was found in the area. The biomass estimate of *S. aurita* was 30 thousand tonnes while *S. maderensis* was estimated at 8 thousand tonnes

Trachurus trecae were only found in smaller low density areas, one small area about 20 NM south of St. Louis, one larger area in the middle, and a smaller

area north of Cape Verde, Fig. 6 The biomass of *Trachurus trecae* was estimated at 12 thousand tonnes. *Trachurus trecae* in the region had one modal peak at 10 cm.





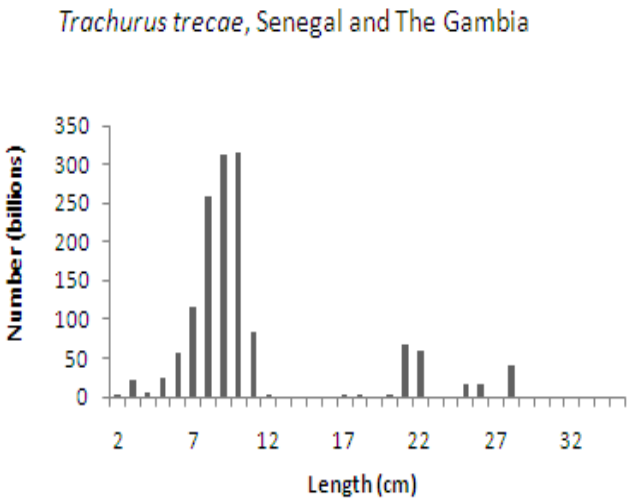


Fig. 2 Pooled length frequency distribution of small pelagic samples taken off Gambia and Senegal coast (E.M Mbye 2012: Nansen cruise survey report June-July 2011)

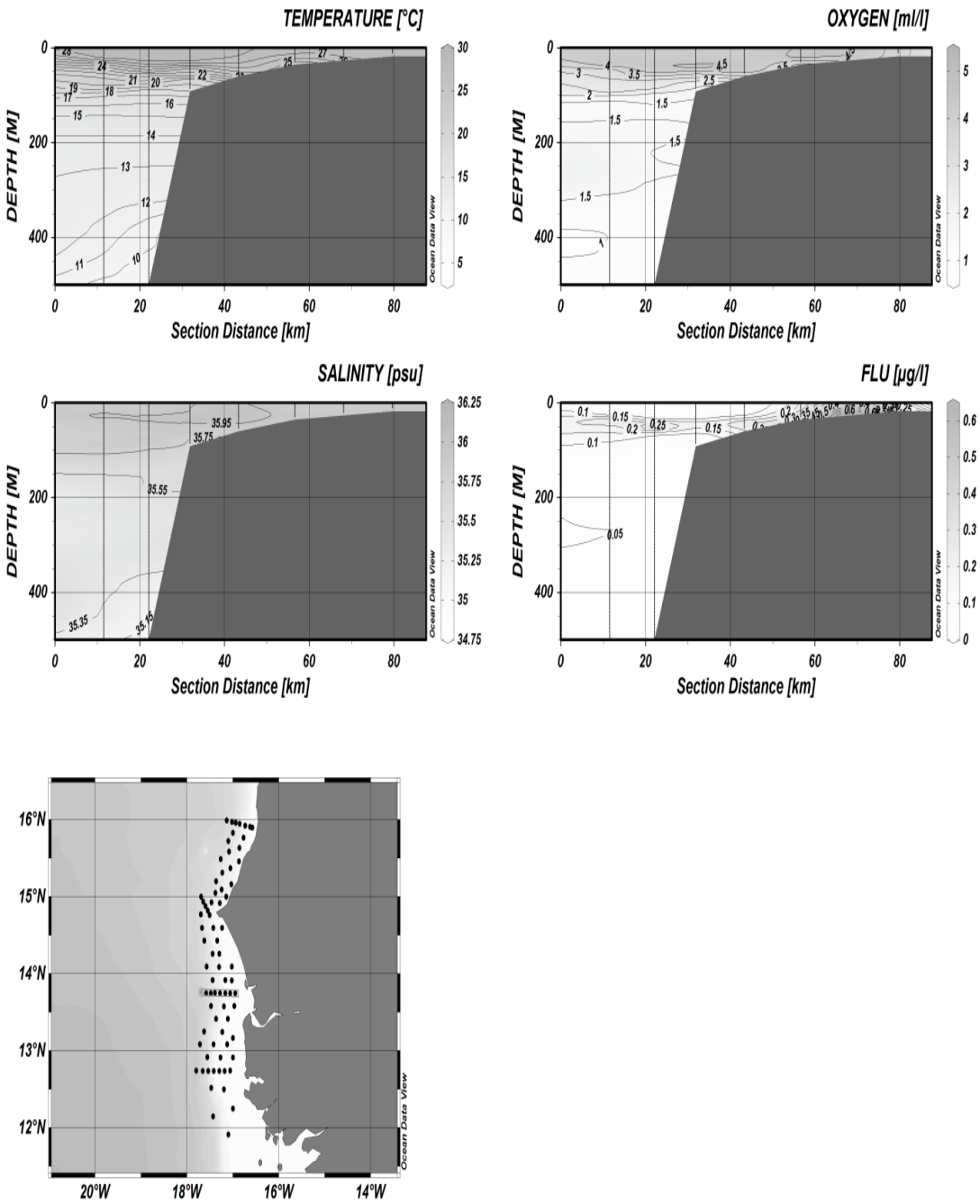


Fig 3 Hydrographical profiles with distribution of temperature, salinity and oxygen off The Gambia coast (E.M Mbye 2012: Nansen cruise survey report June-July 2011)

Table:2 Biomass estimate (Mt) in relation to total catch (Mt) of small pelagic in The Gambia (E.M Mbye 2012: Nansen cruise survey report June-July 2011)

Year	Biomass estimate (Mt	Catch landings (Mt)
1992	160,000.00	12049.8
1995	156,000.00	13962.96
1996	122,000.00	22719.5
1997	113,000.00	21622.4
1998	173,000.00	22053.3
1999	510,000.00	16286.5
2000	213,000.00	20602.9
2001	165,000.00	18847.65
2002	470,000.00	18996.3
2003	285,000.00	23745.7
2004	212,000.00	18084.3
2005	284,000.00	15545.5
2006	153,000.00	18181.7
2007 (4th – 5th Nov)	506,600.00	
2011	101,000.00	

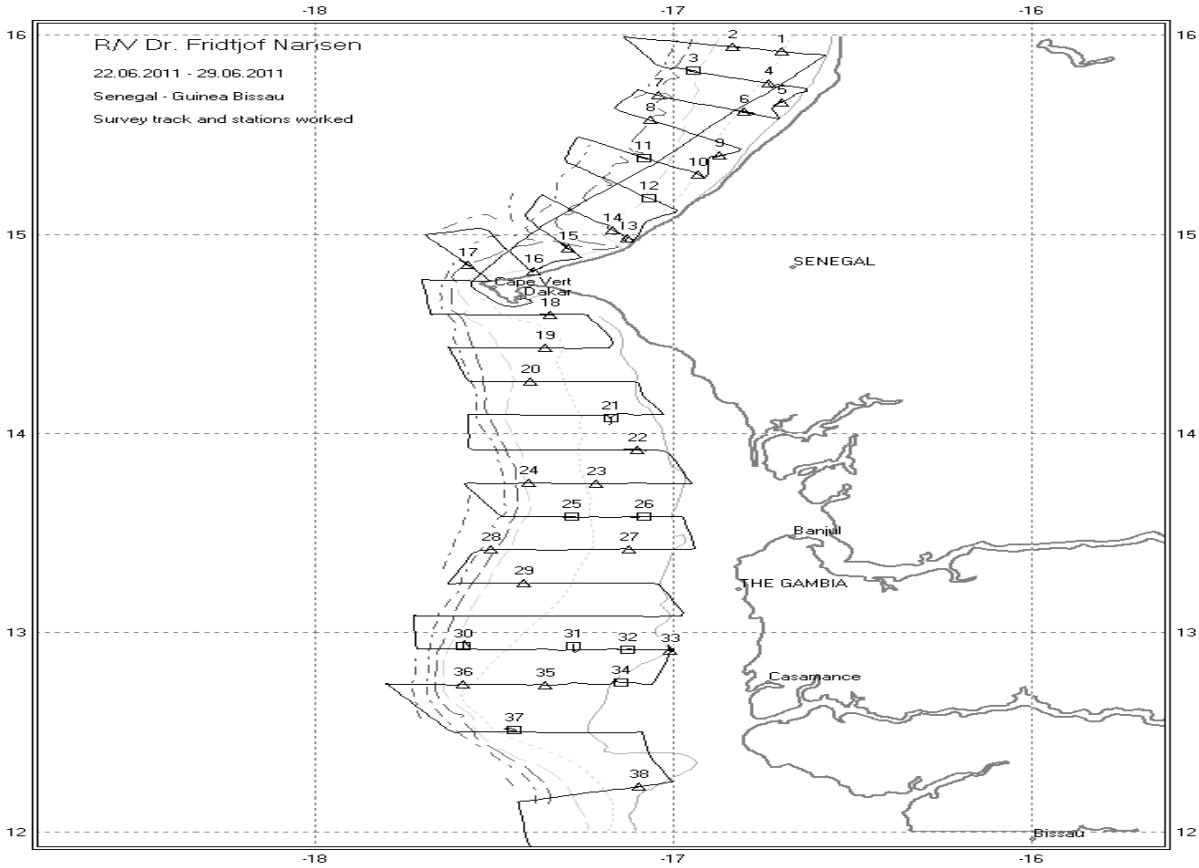


Figure 4. Survey vessel (Fridgtof Nansen) trajectory during survey of sub regional waters.

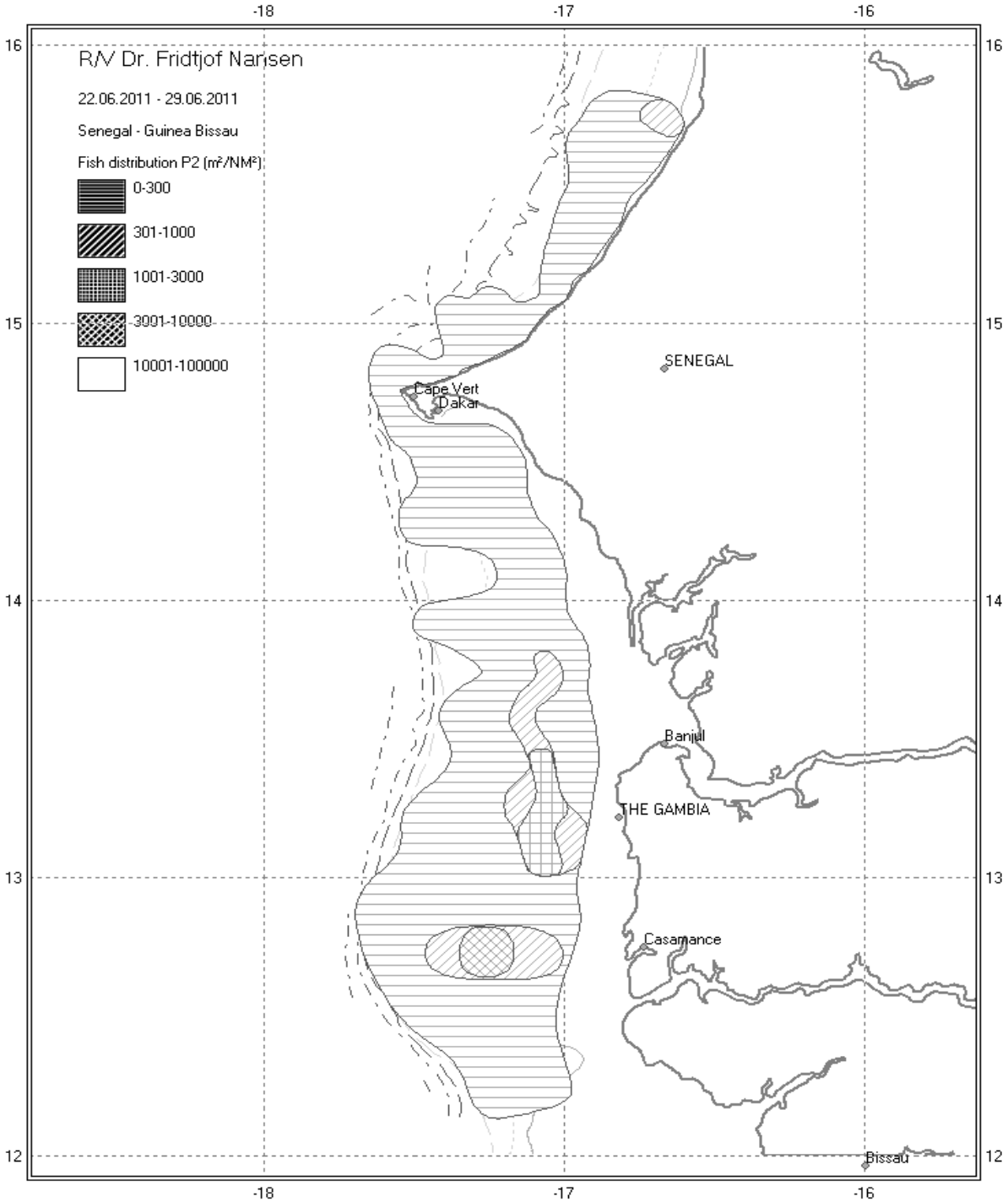


Fig. 5 Offshore distribution of carangids and associated species; Casamance to St. Louis

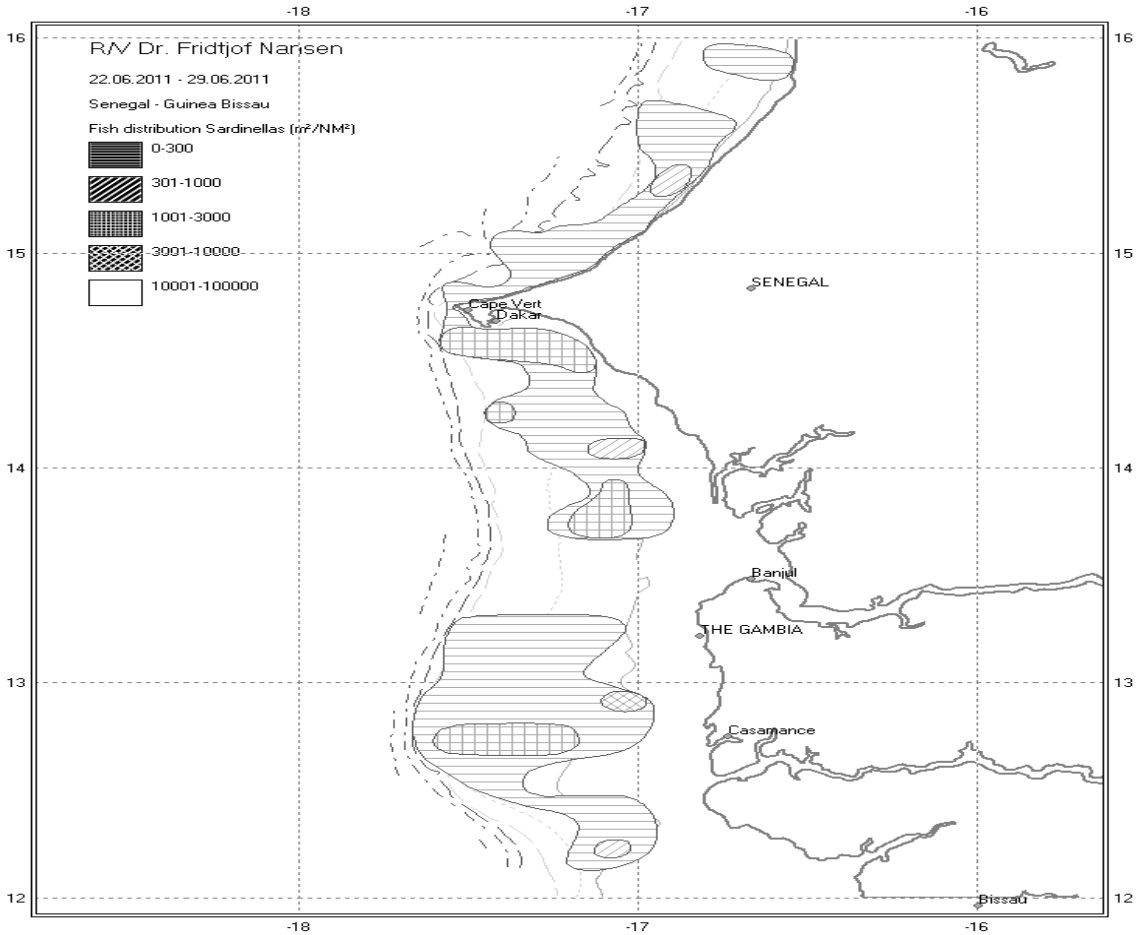


Fig. 6 Offshore distribution of sardinellas; Casamance to St. Louis.

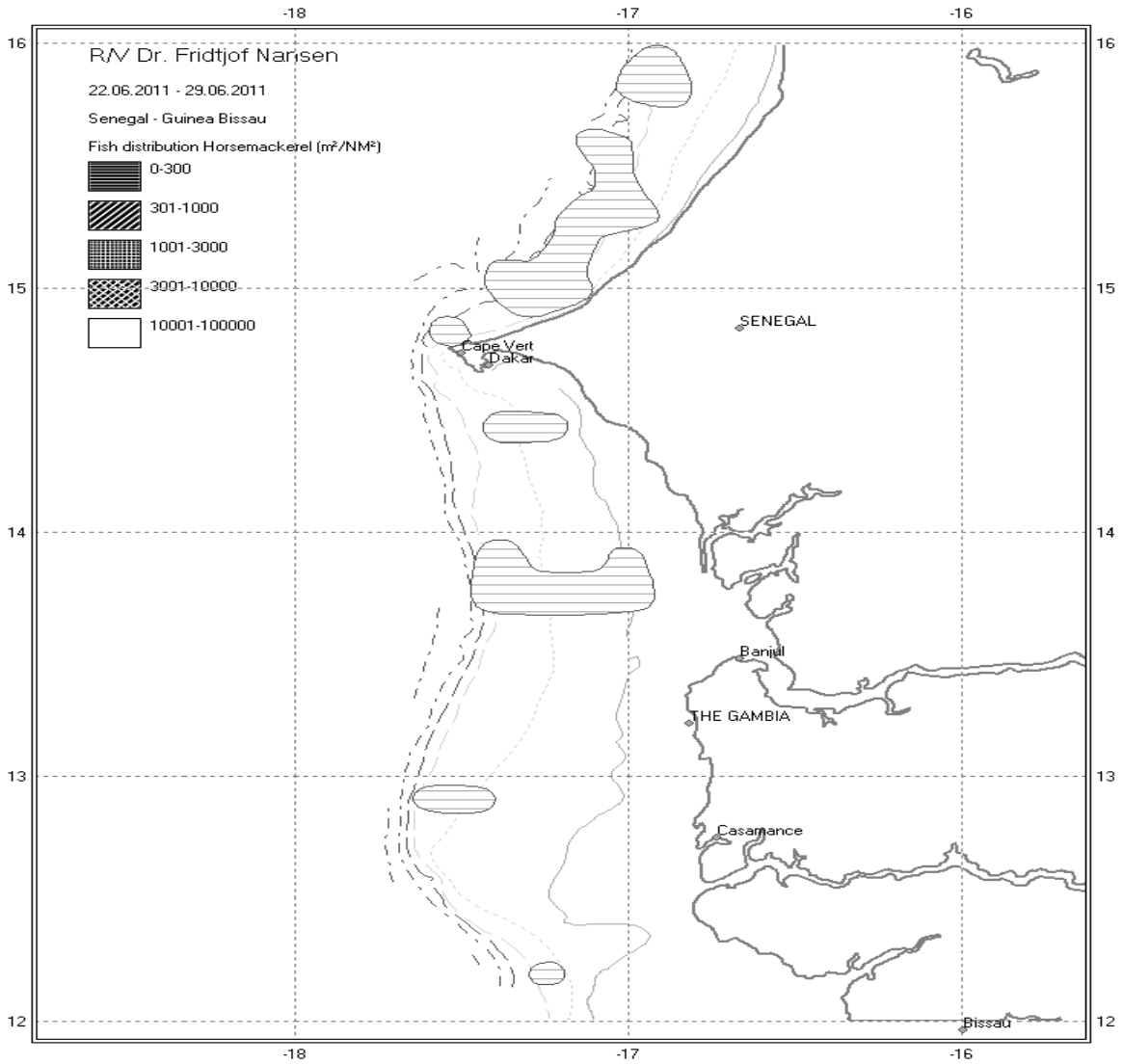


Fig. 6 Offshore distribution of *Trachurus trecae*; Casamance to St. Louis.

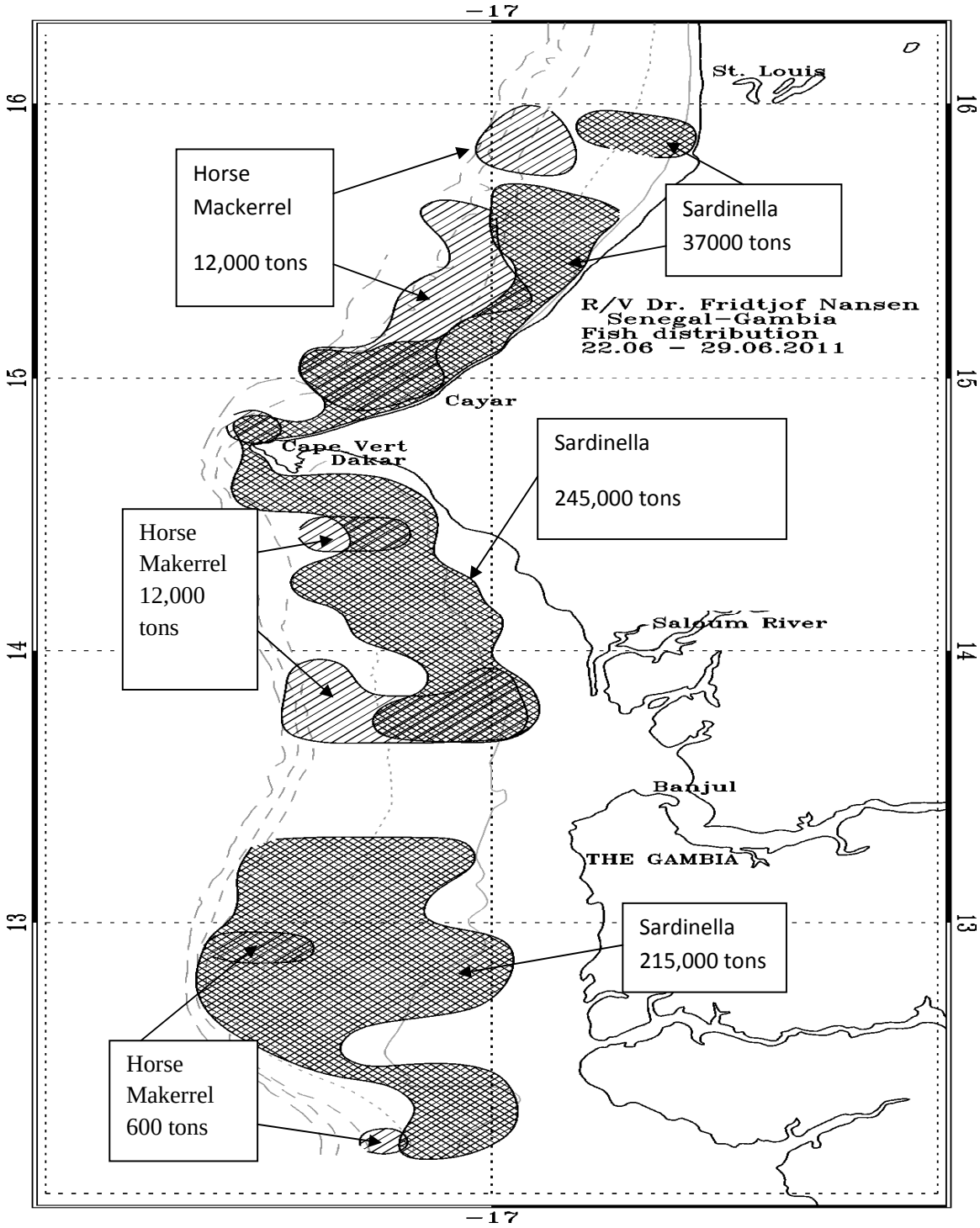


Fig. 7 Major pelagic fish concentrations offshore with estimated biomass (tonnes), Senegal and The Gambia

2. BIOLOGY OF SMALL PELAGIC (SPECIAL SECTION)

Some of the most abundant and economically important pelagic fishery resources classified as small pelagic off the Gambia coast are *Sardinella maderensis*, *Sardinella aurita*, *Trachurustrachurus*and*Ethmalosafimbriata*. These with the exception of T. trachurus and *T. tracae* (mackerels) belong the family *Clupeidae*. Majority of clupidsare characterized morphologically by flatness on both flanks (*S. maderensis*, E. fimbriataetc) although few are round in body shape with absence of lateral lines (S. aurita). These are small schooling pelagic fish very rarely up to 50cm in standard length, majority of which are marine though some eg*Ethmalosafimbriata*, *Sardinella maderensis* are catadromous entering brackish water of the Gambia estuary during early stages of lifecycle.
Significant part of feed of clupids consists of planktonic invertebrates and phytoplankton particularly diatoms.

2.1 Mackerels (jack and horse)

Mackerels belong to the family Carangidae of which there are several species found worldwide. Two species of the genera trachurus are found in the Gambia – *Trachurustrachurus* and *trachurus tracae*

2.1.1 Distribution

During summer the fish in schools carryout feeding migration towards temperate regions and in ‘winter’ return to the tropics. Off the Gambia coast they are found approximately 15 - 30m depth equivalent to about 7 – 12 nautical miles offshore on the continental shelf. No specific studies have focused on the movement of mackerels. however shuntov 1969, stevens et al.1984, Pullen 1994 found correlation between size and depth with smaller fish generally found inshore and larger fish offshore.

2.1.2 Feeding, growth and Reproduction

Majority of species in the family feed on zooplankton, juvenile fish and crustaceans.

Mackerels (particularly jack mackerel) reach a maximum of 470mm in length, 1kg in weight and 17 years of age (Last et al. 1983,Williams and Pullin, 1986, Lye et

al.2000, browne 2005. Multiple studies conducted around waters off Australia investigated the age and growth of Jack mackerel: Webb and Grant (1979), Stevens and Hausfeld (1982) and Jordan (1994) using whole otholiths. Jack mackerel grow quickly at a young age, reaching 270 mm in the first 4 yearsand 335mmby the age of 10 with no significant difference between growth rate of males and females (Lye et al.2000)

The fish attain sexual maturity in two months of its life. In The tropics of mid Eastern Central Atlantic region particularly off Gambia coast Mackerels spawns approximately 67000 pelagic eggs in portions (Jordan 1994). Intensity of spawning was observed to be highest during the first half of the rainy season between May – August (Gunjur Fishermen, pers.com).The spawning process takes place relatively inshore. Jordan (1994) found spawning to occur in semi-lunar cycle associated with full and new moons.

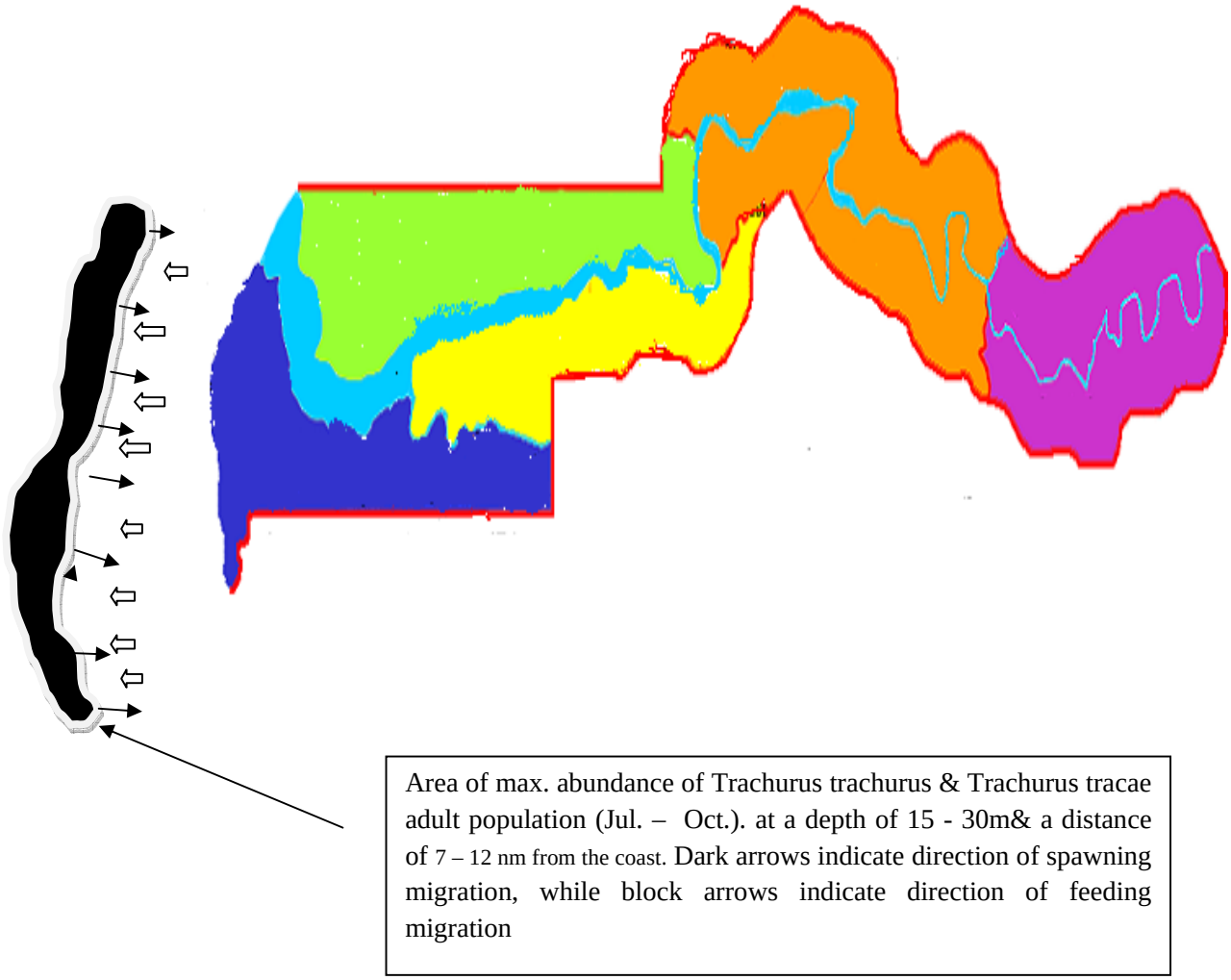


Fig.8 Map of Areal distribution of mackerels off Gambia coast

2.1.3 The fisheries

Mackerels are taken from a multi species artisanal fishery of the coast of The Gambia and sub regional member states using purse-seine fishing gear. The latest recorded catch data was (fisheries catch assessment data 2010) in the order of 348,000 kg

2.3 Bonga/Shad *Ethmalosa fimbriata* (**(Bowdich, 1825)**)

The clupeid *Ethmalosafimbriata* is abundant along the coast of western Africa. It is estuary-dependent and tropical, distributed from Mauritania to Angola (Charles-

Dominique, 1982; Lévêque*et al.*, 1990) There is high degree of unanimity among fishermen interviewed that *Ethmalosafimbriata* is the most abundant small pelagic species by both number and biomass, and it is the most heavily exploited by artisanal fisheries. It is very adaptable to environmental change and tolerates wide variation in salinity (Charles-Dominique, 1982). The author's observations on the species was made within the Ebrie Lagoon- Ivory coast that revealed that the species spawns and spends its first year of life inshore (particularly in lagoons) before migrating offshore during its second year.

Albaret and Charles-Dominique (1982) documented a study of the species which revealed its adaptability to great environmental disturbance (pollution) of both natural and anthropogenic sources. The size at first maturity was found to be inversely related to the extent of pollution of the environment. The authors found large size individuals associated with less polluted waters while smaller size individuals in heavily polluted waters. This is indicative of the species quality as a good bio-indicator of coastal water quality. Its broad distribution, relative abundance, and the fact that its early life history is spent inshore coastal areas (frequent recipient of pollutants) are advantages in the use of *E.fimbriata* as a bio-indicator in this regard.

2.3.1 Distribution

Local knowledge gathered from all sites landing E. fimbriata described its spatial distribution off Gambia coast as inshore and closely associated with the estuary. The areal of maximum adult population range between 4 – 8 nautical miles from the coast between the months of June and November at a depth of 6 – 20 metres. Pre - adult population enters the Gambia estuary (Whitehead 1985).

and distribute from the mouth to upper estuary particularly during the period of relatively low estuarine salinity (January - March) (fig.9)

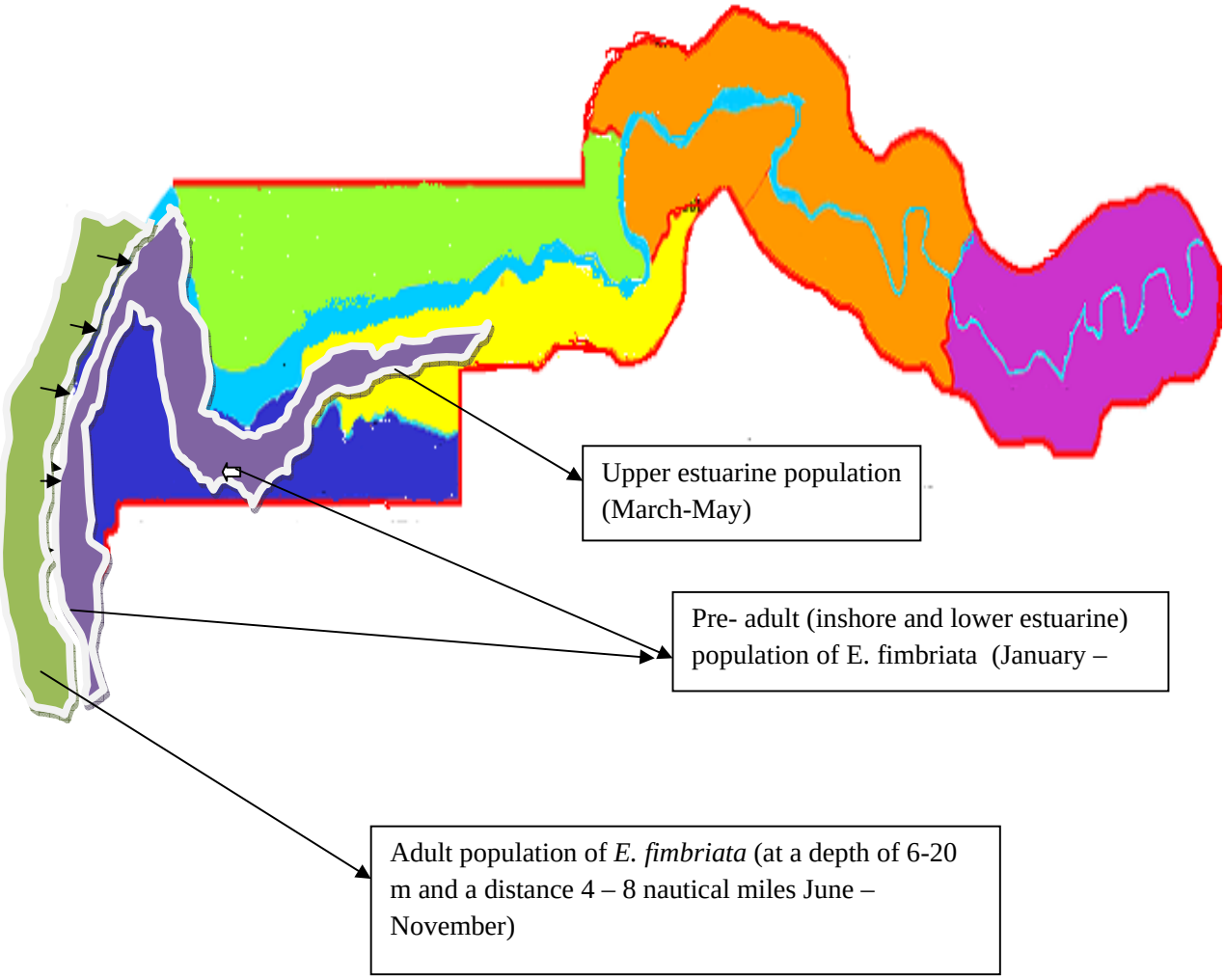


Fig. 9 Map of Areal distribution of *Ethmalosa fimbriata* off Gambia coast

During the period of extreme estuarine salinity the species progress further up the estuary where salinity is relatively lower (March-May)

Migration of *E. fimbriata* into and out of the estuaries is therefore associated with seasonal changes in salinity as well as with abundance of plankton in the estuary during the dry season. For example, is most abundant in the upper estuary during the period March to May i.e at the height of the dry season. During the wet season (May-October) the species again moves down the estuary toward the sea. It is possible that the migration is due to both spawning and feeding needs (Gunjur fishermen, Pers. Com.)

2.3.2 Feeding, Growth and Reproduction

Ethmalosa is a non-selective filter feeder subsisting mainly on large diatoms and phytoplankton (Entsua-Mensah, M., Lalèyè, P. &Moelants, T. 2010. *Ethmalosafimbriata*. In: IUCN 2011. IUCN Red List of Threatened Species.Version 2011.2.)<www.iucnredlist.org>.. This explains its naturally neritic habitat.

Two size groups can be distinguished in the Gambia waters. These are the immature pre-adult stage and of less than 21 cm long and are restricted to depths of about 2–4 m in estuary. They move further upstream than the bigger fishes during the period of high salinity. The large size individuals have lengths ranging between 22–33 cm. They are found in areas of the estuary where the water is deeper than 6 m. The population of the two sizes alternate in the areas of distribution.

Maturity is attained at sizes between 22 and 25 cm. small size individuals are caught in the estuary all through the year indicating that breeding occurs all year round (Tanji Fishermen (Pers. Com). This is confirmed by Salzen (1958) adding that spawning is highest at the beginning of the dry season and declines progressively but increases again when the wet season sets in. Salzen (1958) further suggested that the observed spawning pattern is due to the spawning area shifting further upstream as the dry season progresses while the increase during the wet season is due to the spawning area moving toward the mouth of the river as the fish return to the sea due to reduced salinity in the estuary.

2.4. Round Sardinella (SardinellaauritaValenciennes,1847)

Sardinella aurita occurs almost throughout the CECAF area. It is a cold water species extending to the shoreline. The species shoals near the surface during upwelling and retreats below the thermocline up to a depth of 300 m during the hot season (ATLANTNIRO, 1980). In the Gambia the largest aggregations of round sardine are reported at a distance of 7 – 10 nm in a depth of 15–25 m during the period March-September.

2.4.1 Distribution

Round sardinella, is a widely distributed middle-sized pelagic fish. The distribution of the species is tropical and subtropical often associated with major upwelling systems (Durand *et al.*,1998; Froese and Pauly, 2003, www.fishbase.org). Its range

extends to the western and eastern Atlantic. It Schools in coastal waters from inshore to edge of shelf preferring clear saline water with a minimum temperature below 24°C. Juveniles tend to stay in nursery areas, but on maturity rejoin adult stocks offshore. It is strongly migratory, often rising to surface at night.

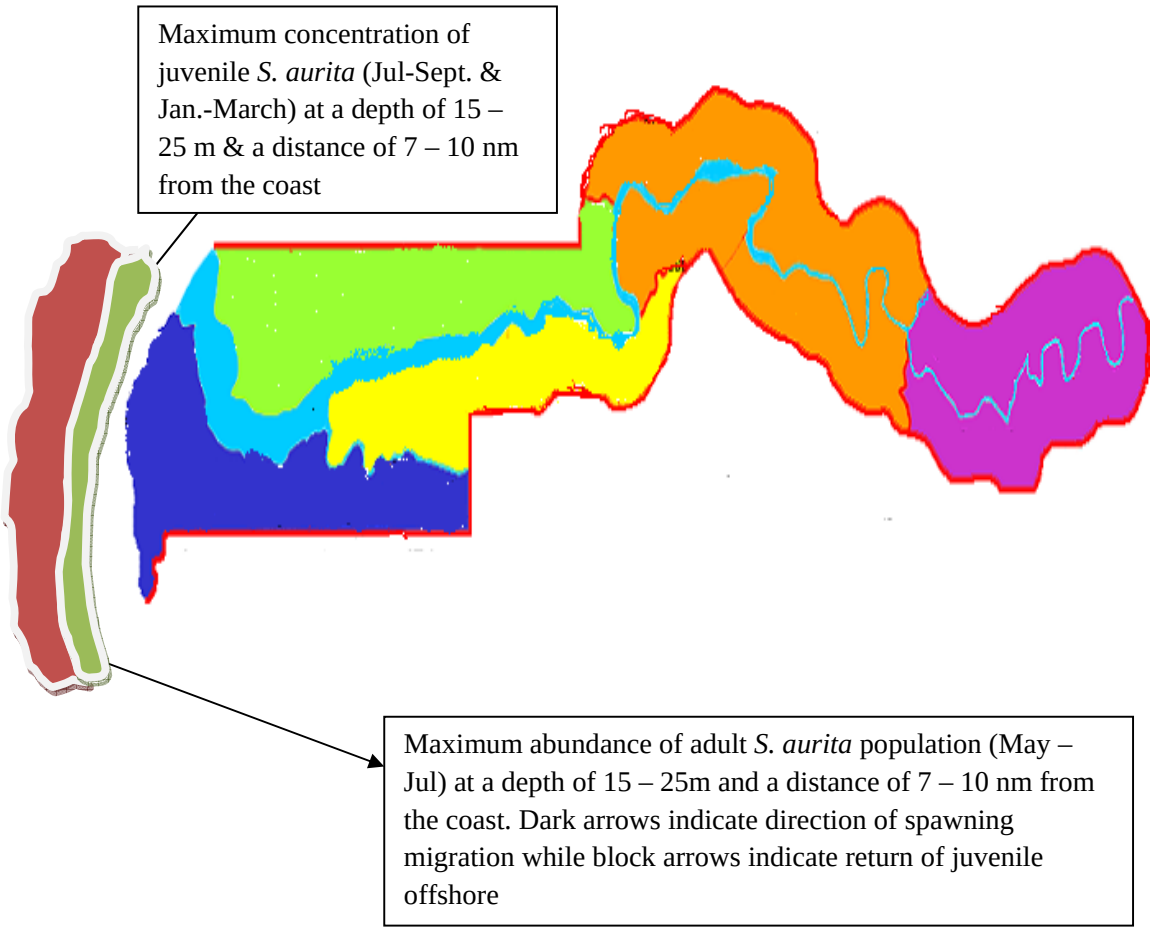


Fig. 10 Map of Areal distribution of *Sardinella aurita* off Gambia coast

2.4.2 Reproduction

Whitehead, P.J.P., 1985 reported two principal spawning periods strongly linked with upwelling regimes off West African coast. The reproductive biology of

Sardinella aurita off the Gambia coast was reported to be between May and July after attaining first sexual maturity at Lm 13cm. Spawning occurs at a depth of 10 – 15m with two spawning peaks: (a) July - September and (b) January-March.

2.4.3 Feeding

Sardinella aurita feeds on phytoplankton, copepods, etc. Concentrations of SardinellaTrematodes were also found in intestinal tract (Bigelow, H.B., M.G.Bradbury, J.R. Dymond, J.R. Greeley, S.F. Hildebrand, G.W. Mead, R.R. Miller, L.R. Rivas, W.L. Schroeder, R.D. Suttkus and V.D. Vladykov 1963 Fishes of the western North Atlantic. Part three. New Haven, Sears Found. Mar.Res., Yale Univ.)

Ocean, Round Sardinella is a stenothermic (tolerant to only narrow range of temperature changes) and stenohaline (tolerant to only narrow range of salinity changes) species (Binet, 1982; Longhurst and Pauly, 1987; Fréon and Misund, 1999).

2.4. MadeiranSadinella (*Sardinella maderensis*) (Lowe, 1839)

MadeiranSadinella - Coastal pelagic fish but tolerant of low salinities in estuaries. It is a schooling preferring waters of 24°C at surface or at bottom down to 50 m, Strongly migratory. The fish avoid very turbid waters (FAO Fish. Synop., (125)Vol.7 Pt. 1:303 p.).

Spawning is more or less continuous throughout the year but there is a period of maximum reproduction which should be during the hot season from April - October.

The young fish are concentrated in the coastal waters and the estuary from where they gradually move to open sea as they grow older; but never too far as *Sardinella aurita* (Boely, 1979), The great majority of the adults remain confined over the shallow half of the continental shelf less than 20m depth. Movement of adults are found to correlate with intensity of seasonal upwelling or other sources of plankton inducing nutrients (e.g. estuarine / river discharge). Mangroves are reputed to be an important source for seawater enrichment for the growth in the plankton (particularly diatoms) *S. maderensis* feeds on a variety of small planktonic invertebrates, also fish larvae and phytoplankton.

The fish is of considerable importance off West African coasts, but often combined with *S. aurita* in most statistics, partly because the two are often caught together. The total catch reported for this species to FAO for 1999 was 146, 097metric tons. The country with the largest catches in this sub region is Senegal with more than

105,120 metric tons in 1999. The Gambia in 2006 landed about 995 metric tons of *S. maderensis* (Fisheries Department 2006 catch assessment report)

2.5.1 Distribution

Comparison of information derived from published literature and those obtained from renowned fisherfolks in Gambia on the distribution of *S. maderensis* in time and space indicate high degree of harmony (fig.11)

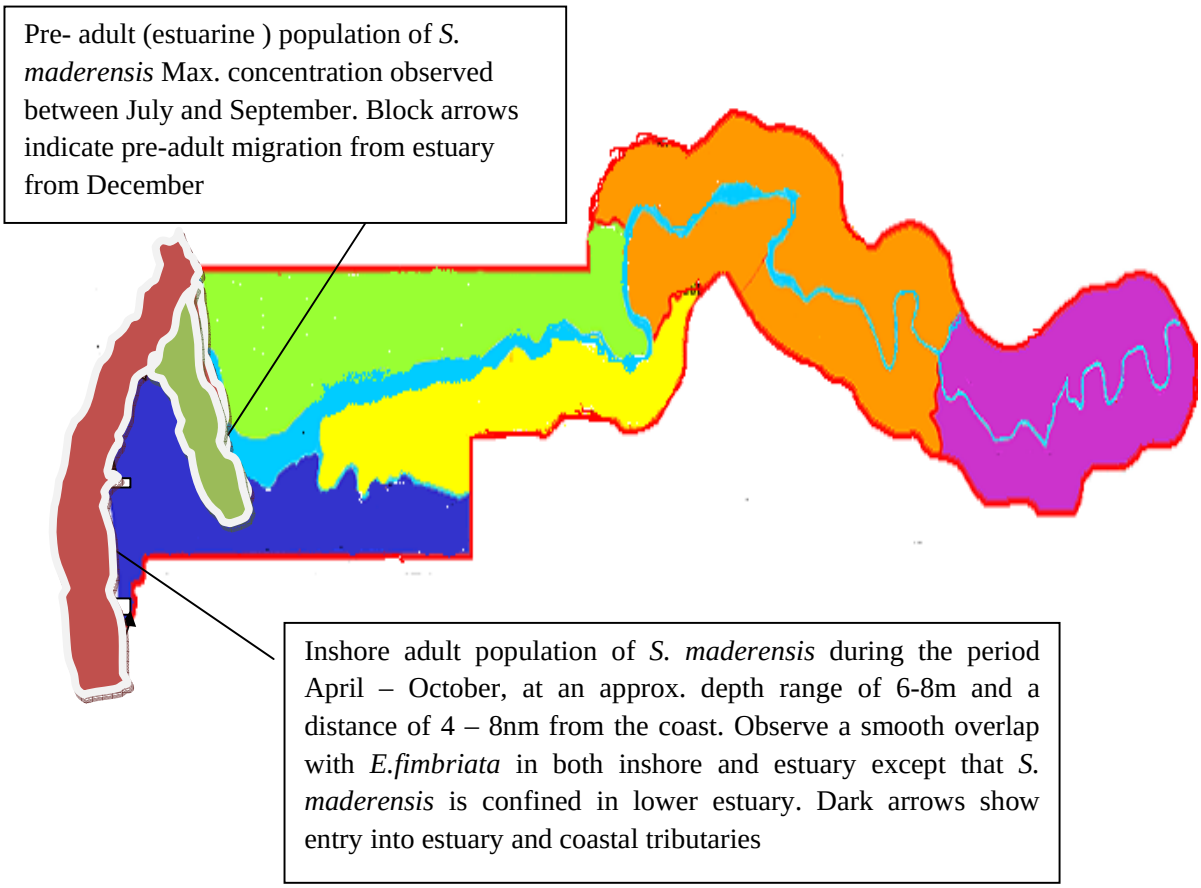


Fig. 11 Map of Areal inshore distribution of *Sardinella maderensis*

3.0 Knowledge gap in Pelagic stocks and Fisheries

There is lack of knowledge on the actual trophioc role of small pelagics our waters. Deos the apparent population explosion of pelagic stocks due to or have any

relations with over exploited demersal stocks. It is necessary to understand relationships if any between the two when planning management of pelagic stocks because the biomass estimates given may mislead policy makers into industrializing the stocks. This may have negative impact on the rate of regeneration of demersal stocks due to excessive removqal of the prey.

4.0 Discussion and Recommendations: In view of the great demand for small pelagic and the apparent abundance in the Gambia and the entire coast of the West African sub region it willsound appropriate to suggest further elaboration of the existing cooperation in the area of surveys, other research undertakings and exploitation of these shared resources. More than 80 % of Gambians derive their daily protein requirement from the small pelagic stock. This is by virtue of their affordability. This scenario may be true in other member state of the sub region therefore governments must prioritize the plight of small pelagic in their conservation plans

Impacts of Climate change threatening global ecological balance has reversed the current level of understanding of the dynamics of these stocks. Phenomena such as changes in sea surface temperature, ocean circulation, acidification, upwelling intensity, rainfall , river discharge volume etc. that are quite apparent today will justify a routine all-over-start of basic research on small pelagics. This, if routinely done will update our knowledge base of the species in tandem with climate change scenarios.

Sub regional tagging experiments should be designed to determine the fishing mortality and migration routes. Existing sub regional cooperation in the determination of age and maturity of sardines must extend to other small pelagic species. Other basic research such as standardized plankton surveys to determine periodic abundance and distribution of eggs and larvae must be routinely conducted at the level of each state. Therefore capacity at equal level must be built in each of the cooperating states.

Supportive ecosystems that help to enhance regeneration such as estuaries, mangroves and continental shelve must be conserved to continue functioning. In this regard, the role of Gambia estuary with its mangrove fringes is quite crucial as it is the only normal estuary in the sub region.

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