

1 INTRODUCTION

1.1 Objectives of the Cruise

A planning meeting was held in Rabat 13-14 January with participants from Morocco, Mauritania, Senegal, Gambia, Guinea Bissau, FAO and the Institute of Marine Research, Bergen. During this meeting the schedule and the objectives of the various parts of the survey was established. The objectives of the work in Senegal and the Gambia were discussed further with representatives from these countries in Dakar on 19 and 28 February.

Objectives for these parts of the surveys as agreed at the various meetings were:

By hydroacoustic methods to map the distribution and produce a biomass estimate for the main small pelagic fish species; sardinella *Sardinella aurita*, *S. maderensis*, horse mackerel *Trachurus trachurus*, *T. trecae*, false scad *Decapterus rhonchus*, anchovy *Engraulis encrasicolus* and other pelagic fish.

If feasible the biomass estimates shall also be presented by length groups.

For the Gambia and for the Senegal Casamance area the priority objective of the trawl survey is shallow water shrimp *Penaeus notialis*. This requires trawling in shallow waters preferably during the night. A trawl programme for the Casamance area was submitted by Senegal.

A general swept area trawl coverage of the shelf survey should be conducted on the Gambian shelf. This is an objective also for Senegal, but the pelagic survey should be accorded priority.

A further objective for Senegal is an intercalibration exercise with the R/V LOUIS SAUGER taking the form of a comparative mini survey of an area with suitable fish aggregations.

Environmental data collection should include surface temperature, some key profiles and bathymetric data.

The survey area will be from the border at St. Louis to the border with Guinea Bissau.

Catch sampling will comprise weight and number by species and length frequency distributions of the principal species.

1.2 Participation

Members of the scientific teams from participating countries were:

SENEGAL

Abibou Faye, Senegal Navy, 19/2 - 12/3

Birane Samb, CRODT, 19/2 - 12/3

Moustapha Seck, CRODT, 19/2 - 27/2

GAMBIA

Matarr Bah, 28/2 - 12/3

Momodou O. Cham, 28/2 - 12/3

GUINEA BISSAU

Amadeu Mendes de Aleida, 28/2 - 12/3

Safiato Camara Lopes, 28/2 - 12/3

Members of the scientific staff from IMR, Bergen were:

Gunnar Saetersdal, Oddgeir Alvheim, Kjell Strømsnes, Martin Dahl, Erling Molvær and Endre Aas.

1.3 Narrative

The course tracks with the fishing and hydrographical stations are shown in Figure 1.

After departure from Dakar on 19 February work started off St. Louis on 20 February with course tracks spaced 10 nm apart. A swept area trawl program was included with predetermined positions of fishing covering roughly the inner, middle and the outer shelf. Sampling of observed aggregations of pelagic fish was mostly done by fishing with mid water trawl at night. The coverage extended to the shelf edge, only a few incidental fishing stations were made in the slope. Bottom conditions on the shelf were generally good for trawling except close to the Cayar Canyon. In this area high numbers of artisanal fishing boats prevented coverage of the inner shelf at night. A hydrographic profile was worked north of Cape Vert on 23 February. The survey to Cape Vert was completed on 23 February with 25 swept area stations and about 400 nm steaming.

In the period 23 to 27 February the survey programme was continued with coverage of the region Cap Vert to the Gambia. On 25 February a mini survey of a school area of sardinella was made jointly with the R/V LOUIS SAUGER for the purpose of comparison of estimates. The results from DR. FRIDTJOF NANSEN have been submitted for analysis, but the experiment is not expected to have been successful because of a paucity of schools at the time of the survey. The work in this region included 20 swept area trawl stations and 560 nm of survey tracks.

After a call on Dakar 27-28 February to embark participants from the Gambia and Guinea Bissau, the survey programme was resumed with some work for identification of echo recordings along the shelf edge southwards from Dakar. The work in the Gambia was started on 28 February evening with a hydrographical profile from deep waters in along the border.

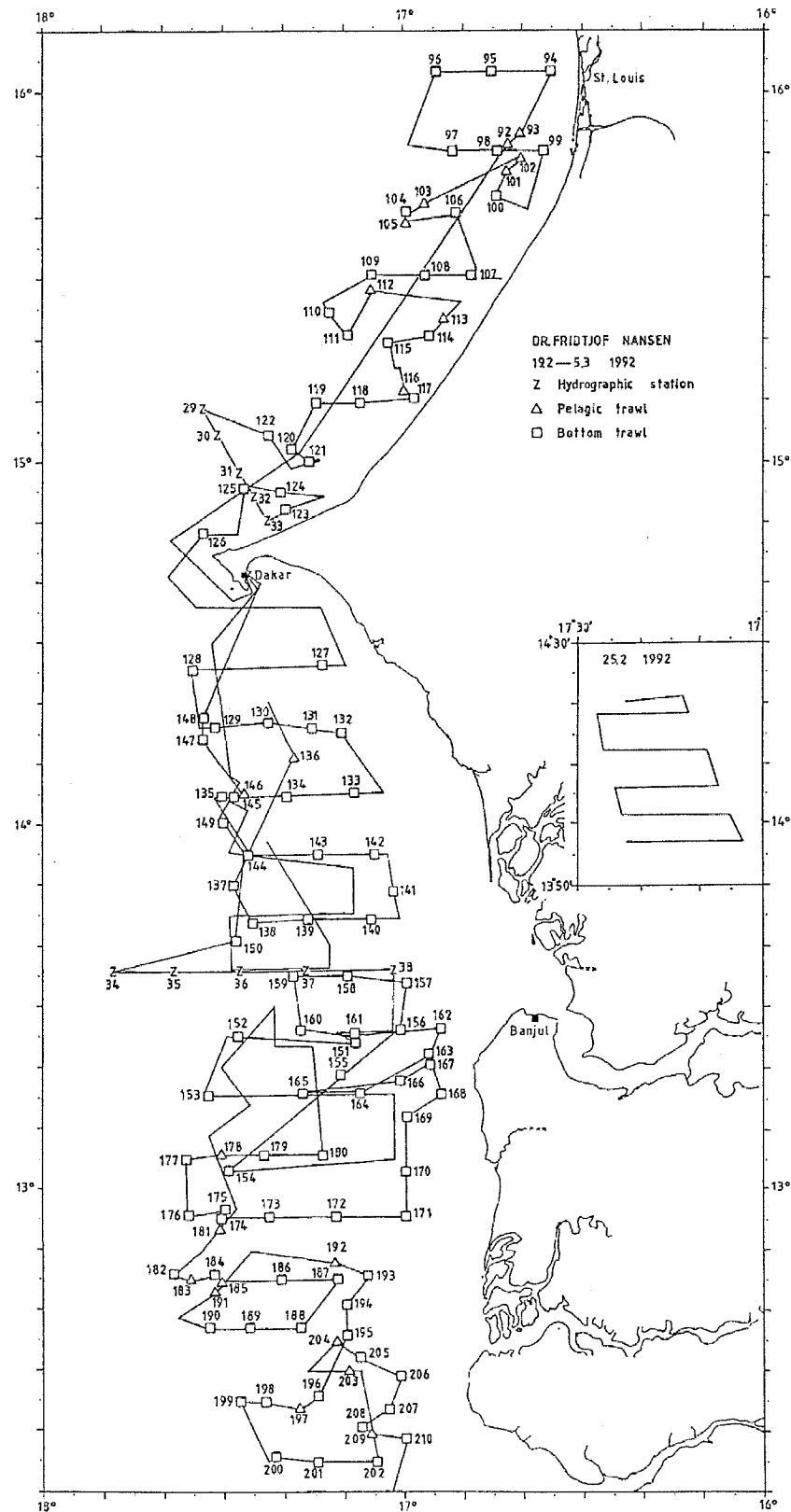


Figure 1 Course tracks with fishing and hydrographical stations.

In order to have a synoptic acoustic coverage, the work continued with a coverage of the shelf applying a set of course tracks 10 nm apart with swept area stations provisionally only near the edge, with the trawl programme to follow. Unfavourable weather delayed the work in the outer parts of the shelf. An attempt was made to map the shrimp distribution in shallow waters at about 7-20 m of depth with swept area trawl hauls mostly taken during nighttime. The work off Gambia was completed on 2 March with an effort to sample pelagic fish on the offshore shelf and included 21 swept area hauls and about 400 nm of survey track.

The Casamance shelf was surveyed 2-4 March with acoustic and swept area coverage of the shelf and a night fishing programme inshore for shrimp. 29 swept area stations were fished and 450 nm of survey tracks worked.

2 THE ENVIRONMENT

2.1 The shelf

Figure 2 shows a bathymetric chart based on automated depth recordings and GPS observations from all survey tracks. These data are made available on diskettes and include the sea temperature observed at 4 m of depth. Table 1 shows estimated shelf areas by depth ranges and regions.

Table 1 Estimated shelf areas by depth ranges and regions nm ² .					
	0-20m	20-50m	50-100m	100-150m	150-200m
StLouis-C.Vert	230	420	610	390	130
C.Vert-Gambia	960	770	590	80	60
Gambia	570	460	350	50	30
Casamance	1110	920	300		

2.2 Hydrography

The distribution of sea surface temperature recorded at 4 m of depth is shown in Figure 3, and the hydrographical profiles worked are presented in Figure 4. These data demonstrate a situation with the characteristics of northern winter with cold inshore surface water revealing upwelling north of about 12°N. The Cap Vert profile shows isolines rising towards the surface over the inner shelf while that off the Gambia demonstrates lifting of intermediate water onto the shelf. A profile off northern Guinea Bissau shows lifting isolines in the upper 100 m.

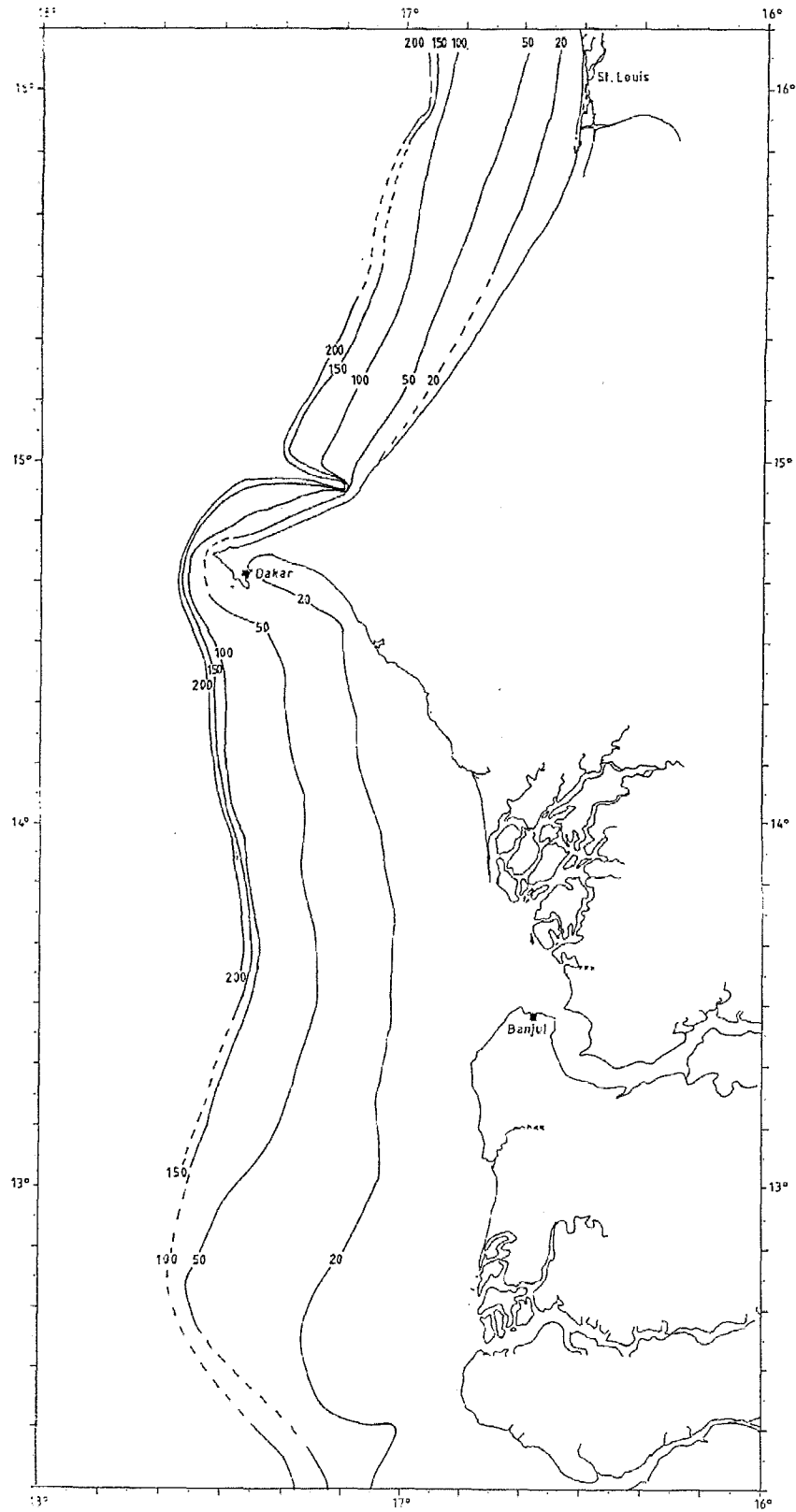


Figure 2 Bathymetric chart.

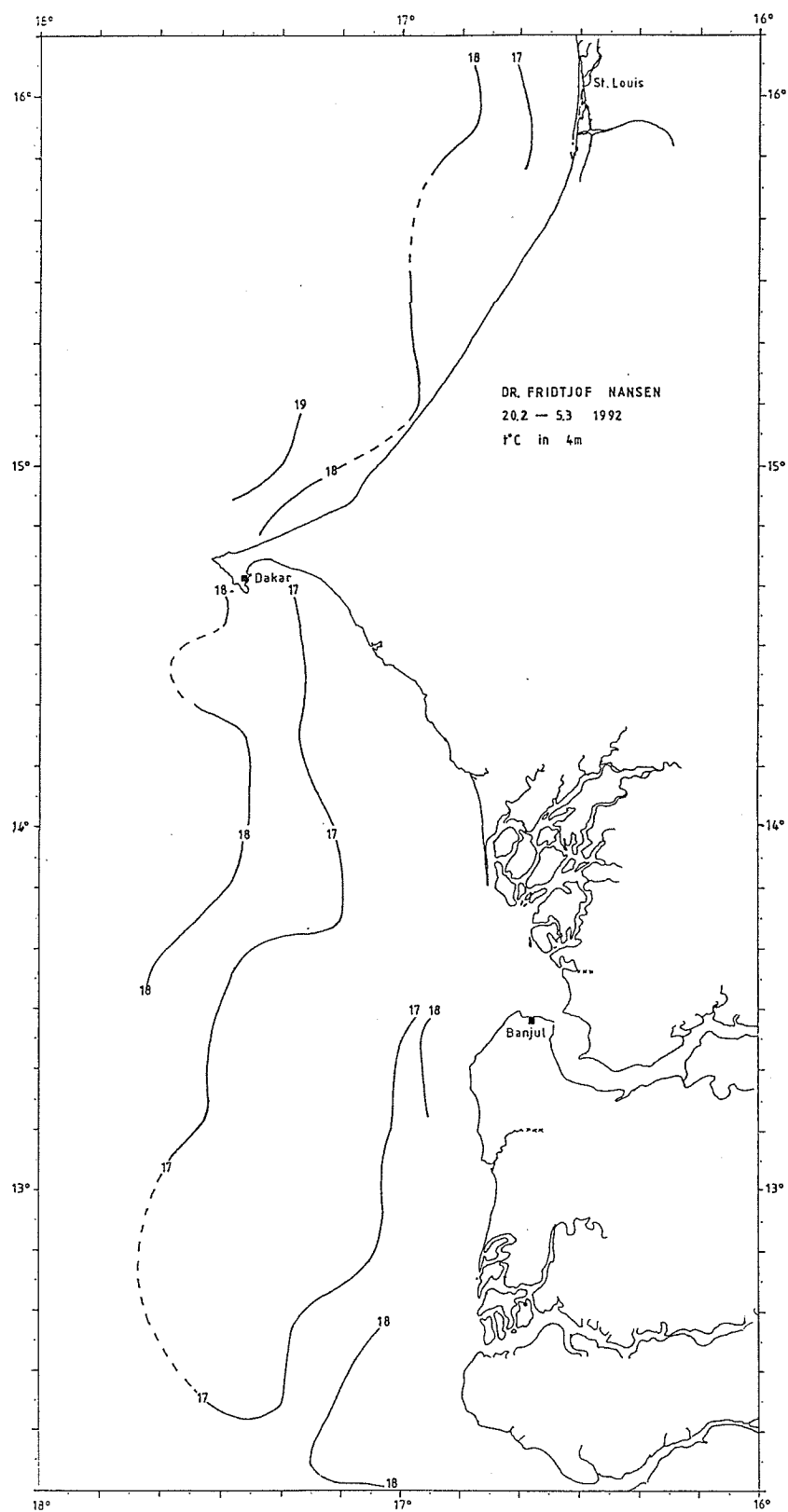


Figure 3 Sea surface temperature recorded at 4 m of depth.

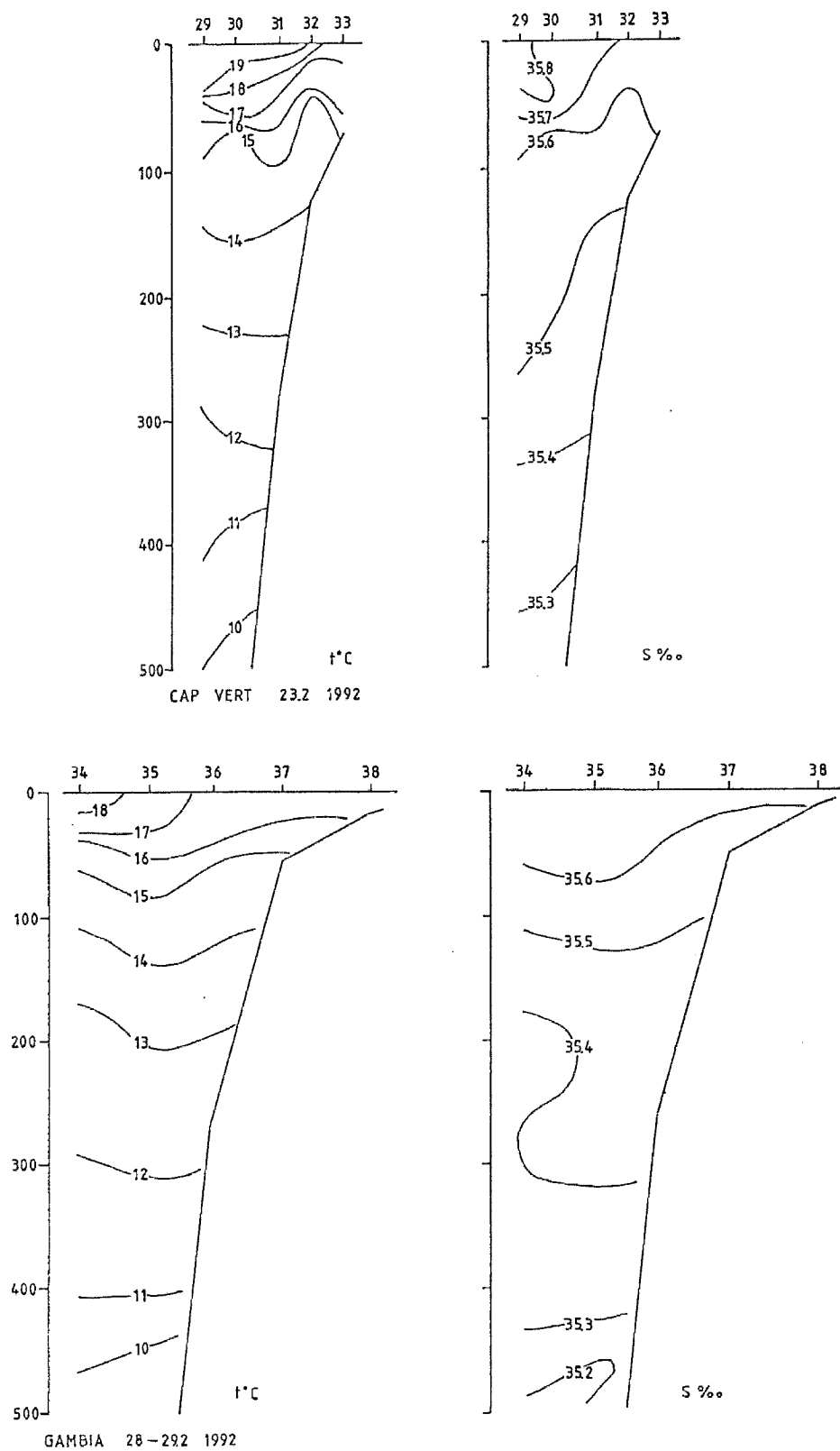


Figure 4 Hydrographic profiles with distribution of temperature and salinity.

3 RESULTS OF THE ACOUSTIC AND TRAWL SURVEYS

3.1 Methods

All catches were sampled for composition by weight and numbers of each species. The length frequency distributions of the target species was almost always taken. Following the CECAF recommendations the sardine and anchovy was measured by total length while horse mackerel, false scad, sardinellas and demersal fish were measured by fork lengths. A record of the length sampling by species is given in Annex VI, and pooled frequency distributions by target species and regions are shown in Annex II. The complete records of fishing stations are shown in Annex IV.

Surface temperature were logged automatically and recorded with position and bottom depth every nautical mile sailed.

Hydrographical profiles were collected with a portable mini CTD sonde with internal logging of records of temperature, salinity, and depth 12 times per minute. From these data series records were selected from standard depths and presented in figures.

The acoustic biomass estimates are based on the integration technique, similar to that used in previous assessments of the same stocks. The North Sea herring target strength was used for all pelagic fish:

$$TS = 20 \log L - 72$$

The biomass density in numbers/nm² of a length group i is calculated from the formula:

$$\rho_i = \frac{1}{4\pi} * s_a \frac{n_i}{\sum_{i=1}^{\max} n_i k_i} \quad k_i = 10^{21 \log l_i - 7.2}$$

where s_a = Mean total integrator value from a species distribution area in m²/nm²
 n_i = frequency count of length group i in pooled representative sample from distribution area.
 l_i = total length of fish in length group i .

These densities are then converted from numbers to weight applying the condition factor for the species. Absolute biomasses are obtained by multiplying the densities with the size of the distribution area, usually obtained with a digital planimeter.

A more direct and simpler method for biomass estimation, not giving biomass per length classes are:

Using a fish constant for 17 cm fish and normalizing the fish length to 17 cm the biomass (in tonnes) is calculated by the formula:

$$\text{Biomass} = A * I * 2.14 * C * L/17$$

where

- A = Size of distribution area (nm²)
- I = Average integrator value from distribution area in m²/nm²
- L = Total mean length of fish
- C = Condition factor

The integrator outputs were split on fish groups using a combination of behaviour pattern as deduced from echo diagrams and catch composition. The following groups were used for Senegal: sardinellas, horse mackerels (*Trachurus* spp.), false scad and other pelagic fish. The last group comprises chub mackerel, hairtails, lookdowns, jacks etc. Catch compositions form the basis for a further separation of biomass by species.

In the swept area trawl survey 30 min hauls were made at predetermined positions along the cruise tracks covering the various depths between about 10-20m and the shelf edge at 100-200m. A few hauls were made at greater depths in the slope where bottom conditions were favourable. According to observations on the geometry of the type of trawl used, the distance between the wings during towing is approximately 18m. For conversion of catch rates to fish densities this distance is assumed to be the width of the effective fishing area i.e. q is equal to 1. For the records catch rates are converted to kg per hours towing.

Annex V gives a description of the instruments and the fishing gear used.

All data of fishing stations, length sampling and bathymetry are made available to the participants on diskettes and may be analyzed by use of the NANSIS programme.

3.2 St. Louis - Cap Vert

Pelagic fish

Figure 5 shows the distribution of the main groups of pelagic fish.

Sardinellas were found in well defined school areas mostly over the inner parts of the shelf, but off St. Louis also over the outer shelf. This more offshore location was the only in which the round sardinella made a significant contribution to the catch with approximately 50%. The average proportion of the two species were 20% round and 80% flat sardinella. The density of fish in the school areas was high especially in the north. The sardinellas in this area represent an extension of an almost continuous distribution of these species in Mauritania from Cap Timeris southward. The size compositions of the two species in this Mauritanian area is very similar to pooled samples from St. Louis to Cap Vert, see Annex II.

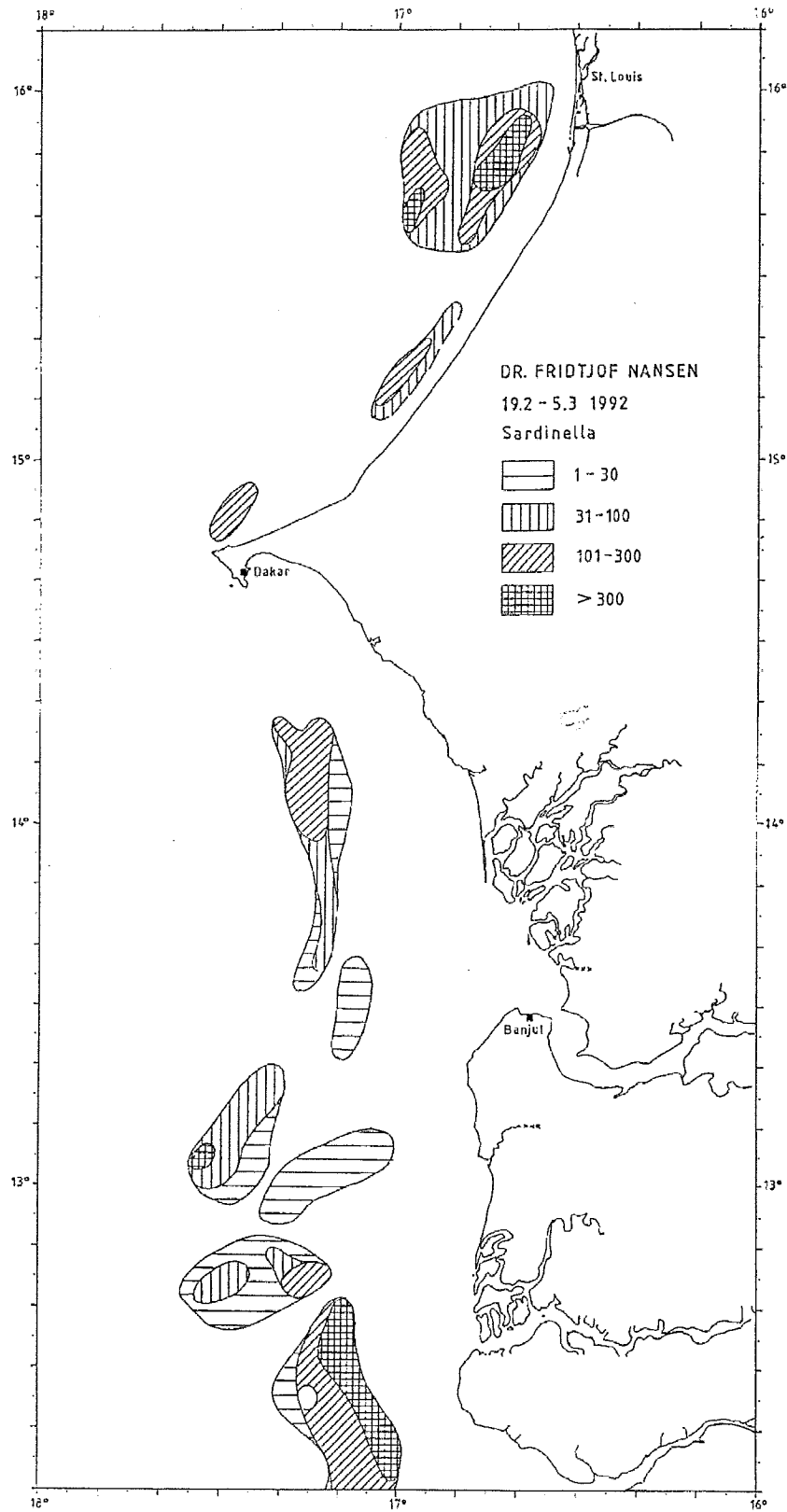


Figure 5a Distribution of sardinellas.

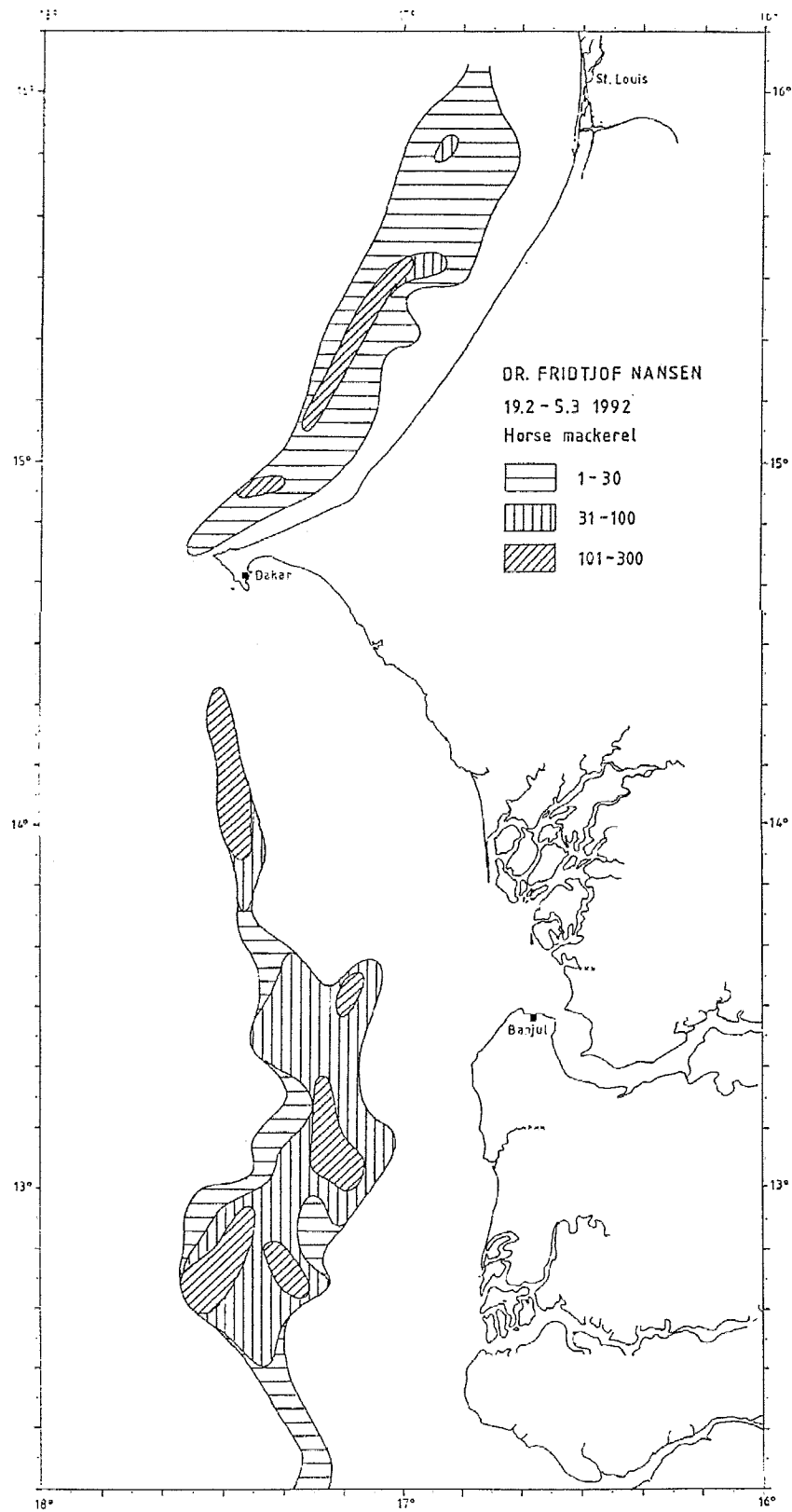


Figure 5b Distribution of horse mackerel.

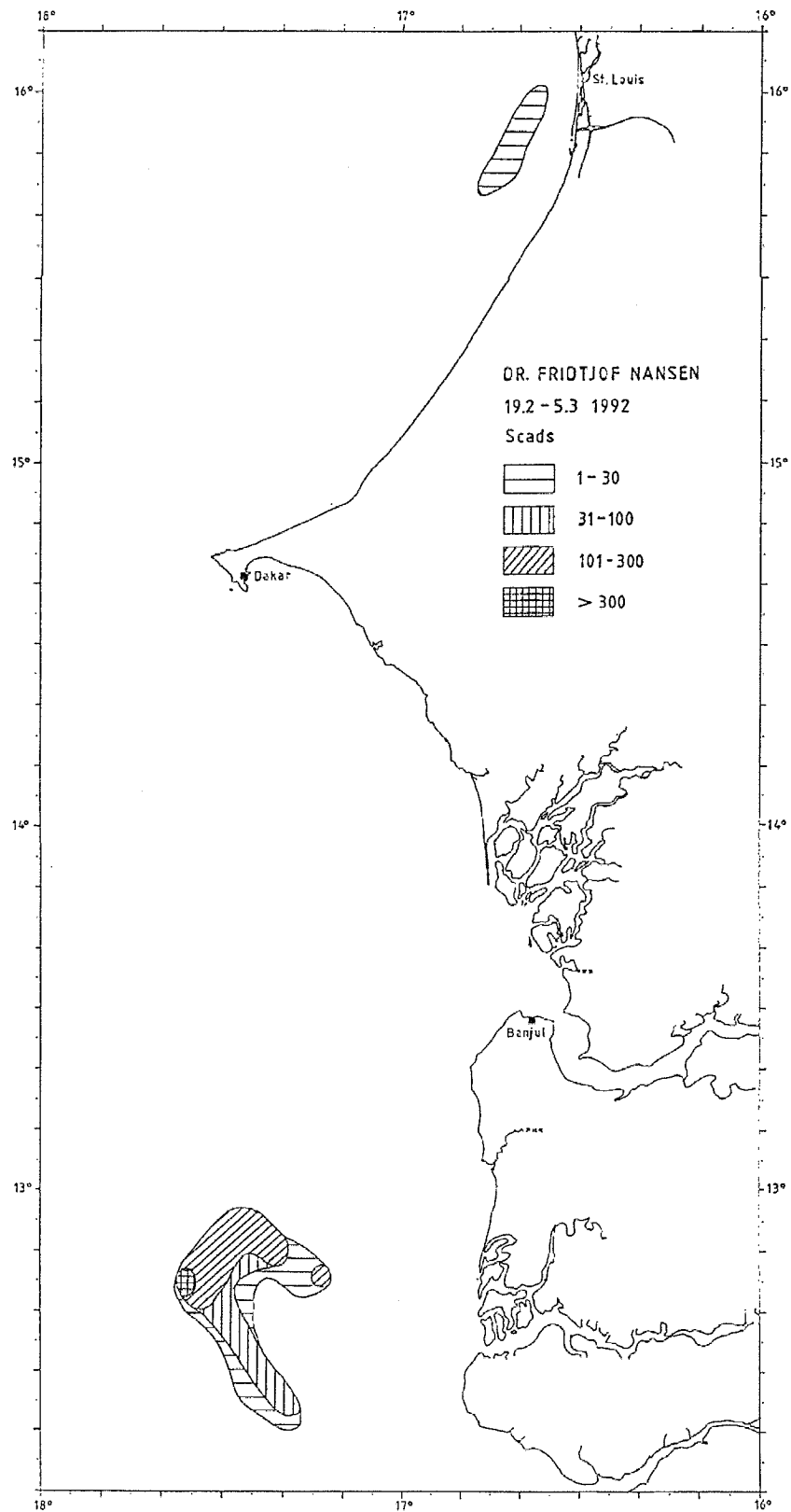


Figure 5c Distribution of scad.

The horse mackerel had as usual the highest abundance on the outer parts of the shelf. The Atlantic species *Trachurus trachurus* appeared in 7 of 30 catches, but its proportion in the total catch was only 1:9 of that of *Trachurus trecae*.

Scad *Decapterus rhonchus* was only located in low abundance in the north. Hairtail *Trichiurus lepturus* was the most abundant species of the group "Other pelagics", but lookdown *Selene dorsalis* was also common in shallow water.

Pooled size compositions of the main species are shown in Annex II.

The biomass of the pelagic fish was estimated using the following condition factors (relating to total fish length): sardinellas 0.95, horse mackerel 0.85, scad 0.9 and other pelagics 1.0. The estimates are shown in Table 2. Well over half of the 70 000 tonnes of other pelagics were hairtails, the major part of the rest being carangids, predominantly lookdown. The total pelagic biomass in the region was thus estimated to be in excess of 800 000 tonnes, a high level.

Table 2 Biomass estimates of pelagic fish, St.Louis to Cap Vert. 1 000 tonnes				
Flat sardinella	Round Sardinella	Horse mackerel	False scad	Other pelagics
530	160	120	2	70

The estimated total stock size compositions by numbers and weight are shown in Annex III for the two sardinella species.

Demersal fish

The location of the fishing stations are shown in Figure 1 and their complete records are given in Annex IV. Annex 1 shows the estimated densities by main species for the different depth ranges, the incidence and the catch distributions. From this table one can for instance see that the Cunene horse mackerel had the highest mean density in the trawl survey and was particularly abundant on the middle and outer parts of the shelf. The big eye grunt *Brachydeuterus auritus* had high abundance in the shallow range as had the lookdown. The hairtail was common down to 100 m of depth and the Morocco dentex *Dentex maroccanus* within the 50-200 m range. Darwins slimehead (orange roughy) *Gephyroberyx darwini* appeared with large specimens in one slope haul.

Table 3 shows the distribution of catches for main groups of shelf fish. The carangids are dominated by Cunene horse mackerel with some lookdown, and the sparids by Morocco dentex with some large eye dentex *Dentex macrophthalmus* and red pandora *Pagellus bellottii*. The two high catch rates of seabreams were from the shelf south of Cayar dominated by Morocco dentex. The most common sciaenid was Boe drum *Pteroscion peli* which presumably is too small to be of commercial interest. Some Cassava croakers and Canary drum *Umbrina canariensis* were caught.

ST.NO.	DEP.	Carangids	Sparids	Trichiur.	Brachyd.	Sciaenids	Other
94	24	5.8	3.0	68.6	145.0	3.4	40.6
95	71	10.0		22.6			3.7
96	124	11.0	3.4	36.4			31.0
97	80	295.3	60.0	50.2			52.6
98	44	11.0	15.4	122.2	111.6	29.6	12.8
99	17	62.6		15.6	100.0		59.4
100	29			0.9	9.5	9.5	14.9
104	130	16.0	23.2	14.4		2.0	127.9
106	56	109.5	9.2	73.7	9.2	0.9	12.6
107	34	108.6	2.0	54.4	93.4		5.2
108	86	402.9	2.7	133.2			26.6
109	166	862.0	73.3				494.1
110	335			15.4			331.8
111	155	65.8	62.4				633.6
114	44	5.8	42.8	77.0	279.4	4.8	26.0
115	93	44.0	5.0	187.0			26.5
117	30	825.4	56.8	142.8	783.4	25.2	488.6
118	94	51.0	29.0	37.0			18.1
119	133	142.4	27.5	20.4			125.3
120	130	47.6	10.6	16.0			18.5
121	104	197.1	44.3	10.0			119.0
122	318						449.6
123	88	29.0	505.0	7.0		4.0	49.3
124	117	15.0	456.0	2.0		12.0	41.6
125	140	81.6	51.6	49.2		1.8	276.0
126	111	382.2	65.8	58.0		14.6	125.0
MEAN		145.5	59.6	46.7	58.9	4.2	138.9

Table 4 shows the catch rates for the main species near the edge and in two slope hauls. Of the hakes *Merluccius polli* dominated the deeper hauls with *M. senegalensis* more shallow. The relatively high shrimp catch in this haul were *Nematocarcinus* sp., a small sized shrimp. The Jon dory *Zeus faber* is most common in the south.

The estimates of fish density from the swept area hauls can be used to obtain a rough estimate of the standing biomass of the demersal fish making use of the calculated areas of the shelf shown in Table 1. The resulting data are as follows for the shelf from 10-200 m:

Total fish biomass	25 000 t
Of which:	
Grunts	3 900 t
Croakers	1 400 t
Seabreams	3 300 t
Carangids	8 700 t

There are various sources of bias which in general will tend to give underestimates of the true biomass of the groups. The main grunt species is the big eye grunt, perhaps of doubtful commercial interest although a high quality fish. Cunene horse mackerel is the main carangid. This group is of course grossly underestimated because it is mainly found above the bottom.

Table 4 Catches for main species near the edge and in slope hauls. St. Louis to Cap Vert. Kg/hour.							
ST.NO.	DEP.	Hakes	Cusk eel	Dories	Greeneyes	Shrimp	Other
94	24						266.4
95	71						36.3
96	124	19.4		3.0	1.4		58.0
97	80	1.6		16.6			440.0
98	44			6.2		1.1	295.4
99	17						237.6
100	29					0.1	34.6
101	5						3323.9
102	15						2002.8
103	13						719.7
104	130	63.8	22.0	0.7	3.4	0.1	93.5
105							40.0
106	56	0.6		9.0			205.5
107	34						263.6
108	86			8.7			556.8
109	166	89.4		0.7	359.2		980.0
110	335	211.4			62.3		73.5
111	155	46.0		7.0	247.0		461.8
112	135	1.0					81.2
113	10						360.0
114	44			9.6		2.0	424.2
115	93	5.0	1.0			2.5	254.0
116	30						173.8
117	30					6.4	2315.8
118	94	11.4		0.2			123.5
119	133	57.2		1.4	2.8		254.2
120	130	10.0		6.6			76.1
121	104	7.1	27.1	21.4			314.7
122	318	263.2			33.6	49.0	103.8
123	88			32.5			561.8
124	117		4.6	14.0			508.0
125	140	46.2		85.5			328.5
126	111	32.2		30.8			582.6
MEAN		26.2	1.7	7.7	21.5	1.9	501.6

3.3 Cape Vert - Gambia

Pelagic fish

Sardinella schools were found rather dispersed over the mid shelf in this region as shown in Figure 5a. One sample gave a majority of flat sardinella of a size similar to that found north of Cape Vert. Cunene horse mackerel and "other pelagics" appeared in some low densities near the edge of the shelf. Schools of tunas were observed in the surface waters on various occasions when fishing on the outer shelf. The size compositions of the flat sardinella are shown in Annex II. Due to the paucity of samples in this region use was made of the size compositions and the ratio between flat and round sardinella from the northern area for the purpose of biomass estimates.

The estimates of biomass are shown in Table 5.

Table 5 Biomass estimates of pelagic fish, Cap Vert to Gambia. 1 000 tonnes

Flat sardinella	Round sardinella	Horse mackerel
100	30	80

Demersal fish

The distribution of the swept area trawl stations were in some parts of this region limited by rough bottom. Annex 1 shows the densities by species and for various depth ranges. The overall mean density was slightly lower than that of the northern region. The Cunene horse mackerel was also here the most common species in the catches, but now caught mainly in shallow waters and consisting mainly of small sized fish. But otherwise there were some clear differences in the fauna. The big eye grunt and the hairtail were no longer dominant species, the seabreams as a group were more abundant, but dominated by the small sized bogue *Boops boops*. The groupers were represented with the white grouper *Epinephelus aenus* and the comb grouper *Mycteroperca rubra*. The rose shrimp *Parapenaeus longirostris* was more abundant in the deep hauls.

Table 6 shows the catches by main groups of commercial interest. The seabream grouping excludes the bogue. Morocco dentex is the most common species. Both seabreams and groupers show highest catches from the mid and outer shelf, the dories are most common on the deeper shelf.

Table 6 Catches by main groups, Cap Vert - Gambia. Kg/hour.

ST.NO.	DEP.	Carangids	Seabreams	Groupers	Dories	Rose shrimp	Other
127	30		37.7				21.7
128	235				19.0	46.0	232.5
129	119	11.4	52.5		28.3		11.9
130	59	12.6	26.6	40.6	17.0		241.9
131	35	258.6	55.2				18.0
132	23	2.2	7.3				4.9
133	26	97.0	6.6	0.2			181.8
134	63	1.8	18.0	9.0	4.0		73.9
135	163				40.4		4.2
136	20	12.7					35.0
137	329					10.6	29.8
138	88		352.0	30.4	2.0		158.6
139	46	0.8	9.1	18.8	3.1		79.3
140	25	612.3	50.7				128.2
141	17	0.2	4.2	4.6			55.8
142	27	2333.3					356.7
143	43	713.3			10.0		646.4
144	87	0.7	36.4		5.6		8.7
145	94	41.3					36.0
146		7.2					101.1
147	276				69.7	4.1	124.4
MEAN		195.5	31.3	4.9	9.5	2.9	121.5

Biomass estimates of demersal fish from fish densities and shelf areas gave the following estimates:

Total fish biomass	32 000 t
Of which:	
Groupers	500 t
Grunts	800 t
Croakers	100 t
Seabreams	9 900 t
Carangids	19 000 t
Dories	600 t

The carangids consist mostly of small sized horse mackerel which has a more demersal behaviour.

3.4 The Gambia shelf

Pelagic fish

A smaller school area of large sized sardinella was located on the offshore shelf and some patches of small sized sardinella was found inshore, see Figure 5a. These were mixed with small sized horse mackerel which appeared in quite high densities in shallow waters. A sample of the offshore sardinella showed predominance of *S. aurita* and the size composition was similar to that found further north.

Table 7 shows the biomass estimates of the pelagics.

Table 7 Biomass estimates of pelagic fish, Gambia. 1 000 tonnes.		
Flat sardinella	Round sardinella	Horse mackerel
10	70	80

Demersal fish

Annex 1 shows the densities by species and depth ranges. A line of stations worked immediately south of the border with Casamance are included in order to improve the basis for the description of the fish fauna. The overall mean density is higher than in the two northern regions. Large eye grunt shows high abundance in shallow water, highest shallower than 20 m. The seabreams cover all depth ranges and are represented with a number of species. Also the squids are found over the whole shelf, while the croakers are mostly limited to shallow water.

Table 8 shows the catches by main groups of commercial interest. The bogue *Boops boops* are excluded from the seabreams and the big eye grunt from the grunts. The red pandora and the Morocco and Angola dentexes were the most common seabreams while the sompat grunt *Pomadasy jubelini* and the bastard grunt *Pomadasy incisus* were most abundant in this group. The cephalopods included common octopus *Octopus vulgaris*, the common cuttlefish *Sepia officinalis* and the african cuttlefish *Sepia bertheloti*. The shrimp catches most of which were from night hauls were as can be seen only very small and consisted of pink shrimp *Penaeus notialis* and caramote prawn *Penaeus kerathurus*.

Table 8 Catches of main groups, Gambia. Kg/hour.							
ST.NO.	DEP.	Seabreams	Grunts	Croakers	Cephalopod	Shrimp	Other
150	130	62.0		0.1	11.4		42.2
151	32	3.9					421.0
152	89	129.4		11.8	7.0		38.3
153	101	712.2			18.6		44.8
154	58	25.8	2.0	0.8			47.2
155	34	111.3	16.8				3319.2
156	15	360.4			57.8	0.5	564.4
157	14	108.0			10.4	0.8	125.2
158	34	152.5	23.0		3.0		371.6
159	62	44.4			44.2		62.6
160	52	14.6	3.4		36.0		92.4
161	33	60.0			5.4		652.4
162	7		2.8	13.2	3.4	0.3	134.5
163	9	1.0	179.2	43.8		0.5	202.6
164	27	133.2	1.8		0.6		52.2
165	46	40.4	7.8		1.0		61.6
166	14	150.0	16.0		37.6	1.3	913.0
167	10	7.3	38.7	40.7	14.7	1.5	322.7
168	8	198.0	30.8	8.8	66.0	0.1	448.8
169	12	59.4	72.6		8.8	0.8	476.3
170	14	1.6			4.0	0.8	188.8
171	14	21.6	104.4		24.6	1.7	92.7
172	25	268.8	56.0		33.6		1206.0
173	40	97.7					1308.1
174	46	29.1			36.0		174.0
175	47	25.9			6.5		118.1
176	68	26.0	4.6		46.8		86.2
177	99	1253.8					91.8
179	48	35.8	3.6		5.6		78.4
180	31	463.6	22.8		11.4		1592.2
MEAN		153.3	19.5	4.0	16.5	0.3	444.3

Estimates of the standing biomass of the fish caught in the swept area hauls are as follows:

Total fish biomass	30 000 t
Of which:	
Groupers	130 t
Grunts	9 600 t
Croakers	400 t
Seabreams	9 200 t
Carangids	5 400 t
Dories	250 t
Cephalop.	940 t

The grunts are nearly exclusively the big eye grunt and the carangids mainly *Cunene* horse mackerel.

3.5 The Casamance shelf

Pelagic fish

Various pelagic fish were found in high density in this region. For the sardinellas, see Figure 5a, the high density patch in the inshore southern shelf is especially notable. This was mainly flat sardinella occurring in very heavy schools in shallow water, mostly inside the 20 m depth line. The low density offshore patch was round sardinella mixed with large sized scad and horse mackerel, see Figure 5b and 5c, which occurred in dense schools in this area. The size composition of the flat sardinella, see Annex II shows a mode at about 20 cm, considerable smaller than further north.

The biomass estimates of the main pelagic groups are shown in Table 9.

The aggregations of pelagic fish in this region is probably a seasonal phenomenon resulting from a southward winter migration adjusted to the displacement of the upwelling regime.

Table 9 Biomass estimates of pelagic fish, Casamance. 1 000 tonnes			
Flat sardinella	Round Sardinella	Horse mackerel	False scad
410	220	160	180

Demersal fish

Annex 1 shows the estimated densities from the swept area hauls by species and depth ranges. A few stations north and south of the border to this region are included in the analysis to improve the data base. The overall density is higher than further north, but this is due to the very high densities of big eye grunt in shallow water. Various carangids also also high density.

Table 10 shows catch rates for the main groups. The higher catches of seabreams consist mainly of red pandora, Morocco and Angola dentex and bogue *Boops boops*. Big sized shrimp, pink shrimp and Caramote prawn were only caught in small numbers, but some amounts of small sized Guinea shrimp *Parapenaeopsis atlantica* were taken in inshore hauls.

Estimates of the standing biomass of the fish caught in the swept area hauls in the Casamance region are as follows:

Total fish biomass	77 000 t
Of which:	
Groupers	130 t
Grunts	34 000 t
Croakers	800 t
Seabreams	10 300 t
Carangids	26 000 t
Cephalop.	600 t

Table 10 Catches of main groups, Casamance. Kg/hour.							
ST.NO.	DEP.	Seabreams	Grunts	Croakers	Cephalopod	Shrimp	Other
170	14	1.6	148.0		4.0	0.8	40.8
171	14	21.6	160.2		24.6	1.7	36.9
172	25	268.8	1052.8		33.6		209.2
173	40	496.3	177.4				732.1
174	46	29.1	1.3		36.0		172.7
175	47	25.9			6.5		118.1
176	68	60.0	4.6		46.8		52.2
177	99	1253.8					91.8
179	48	35.8	3.6		5.6		78.4
180	31	737.2	197.6		11.4		1143.8
182	73	9.0			2.4		171.2
184	44	31.0					511.0
186	27	55.8	414.0				43.2
187	18	40.2	2191.2	12.8		0.4	231.8
188	22	40.0	1124.0				2692.0
189	34	297.0	931.5				605.3
190	44	22.3	2.7	0.4	3.8		42.5
193	14	38.4	200.4		8.4	2.2	76.8
194	14	35.0	170.0		6.0	2.5	82.0
195	13	22.5	151.5		12.0	1.5	195.6
196	19	108.4	3511.7				2482.1
198	53	158.2			2.4		46.4
199	72	410.0		30.4			53.6
200	100	136.9		2.1	24.0		34.6
201	44	14.0	5.6	53.2			807.2
202	23						
205	12	1.6	151.2	2.4		2.1	72.4
206	11		281.6	108.8			84.0
207	13		99.0	5.4		20.6	44.4
208	20		44.0	0.4		28.7	18.0
210	18		48.8	33.8		21.8	85.1
MEAN		140.3	357.2	8.1	7.3	2.7	356.6

4 OVERVIEW AND SUMMARY OF RESULTS

The survey was conducted successfully in the period 19 February to 4 March with a total of 119 fishing stations of which 92 for the swept area programme and with a survey track of approximately 2 000 nm.

The hydrographical data revealed a typical winter situation with upwelling north of about 12°N and the front located at about 11°30'N off the Bissagos islands.

Pelagic fish

Sardinellas were found in school areas all along the shelf, but in highest densities with flat sardinella dominating in the extreme north and south. The school area in the south extended in a more dispersed distribution into Guinea Bissau waters.

Cunene horse mackerel also occurred over the whole region with highest densities in the offshore parts where the fish was large sized. Small sized horse mackerel was found inshore, especially on the Gambia shelf.

A significant school area of scad *Decapterus rhonchus* was found on the offshore shelf in the Casamance region.

An overview of the estimates of biomass of the main groups of pelagic fish based on the acoustic integration data is shown in Table 11. The allocation on species must be regarded as approximate especially between the two sardinellas.

Table 11 Biomass estimates of pelagic fish, Senegal and Gambia. 1 000 tonnes.				
	Flat sardinella	Round sardinella	Horse mackerel	False scad
St Louis-Cap Vert	530	160	120	2
Cap Vert-Gambia	100	30	80	
Gambia	10	70	80	
Casamance	410	220	160	180
Total	1 050	480	440	182

The aggregations of sardinellas and horse mackerels in the northern and southern extremes of the Senegal-Gambia shelf may indicate the existence of sub stocks of these species. At this season the fish is likely to be at the southern part of their range and the distributional area of the sub stocks would then be West Sahara, Mauritania, Northern Senegal and Senegal south of Cap Vert with Gambia respectively.

For comparison with previous findings the total stocks between Cape Blanc and Cape Roxo should be considered. Mauritania was surveyed with the DR. FRIDTJOF NANSEN immediately prior to the Senegambia coverage. The total biomass estimates of the pelagics for the two areas are (1 000 tonnes):

	Round sardinella	Flat sardinella	Horse mackerels and scad
Mauritania 11-18 Febr.	1 410	560	200
Senegambia 19 Feb-4 Mar.	480	1 050	620
Total	1 890	1 610	820

The estimated standing biomass for the two sardinellas is thus 3.5 mill. tonnes with a close to 50/50 proportion. The proportion is in reasonable agreement with previous observations, but the stock biomass is very much higher than previously published findings.

A brief review of some previous survey results show the following (1 000 tonnes):

Project	Mainly sardinellas	Horse macks.& scads	Other
CAP7408, 1974*	680	1 010	680
ECHOSAR3, 1981*	620	660	1030
DR. F.NANSEN, 1981-82*	90-480	280-940	90-690
DR. F.NANSEN, 1986	680	710	230

* Quoted from CECAF Series 84/29

Our present estimate for the horse mackerels and scads thus fall well within the range of previous results, but that of sardinellas is about 4 times higher than the highest previous level. A part of the difference may be an effect of improved methodology. The school density of sardinellas is very high, much higher than for carangids, and instrument saturation was previously a problem causing underestimation. This was demonstrated by the experience that night surveying would give higher mean densities than found during the day. In the new generation of scientific acoustic instruments now in use (EK 500 system) the dynamic range has been greatly increased and this has solved the problem of saturation. It is thought, however, that this instrument improvement can only explain a smaller part of the great difference in the stock estimates.

Another possible cause for the difference may be that the previous surveys did not cover the complete area of distribution of the northern stock which ranges into the West Saharan region. In this survey nearly the whole northern stock was found in Mauritania-North Senegal.

There also appears to be a difference in the survey results relating to the group "Other fish" which in the previous surveys ranged up to 1 mill. tonnes while in the present survey it is of the order of 100 000 tonnes. This could indicate faunistic changes or problems with identification.

The large areas of extension of the aggregations of sardinella schools found in this survey is a further demonstration of unusual high levels of stock abundance. One can conclude that the sardinella stocks are in a healthy condition and with a biomass which considerably exceed that of the previous years of surveys.

Demersal fish

The swept area programme cover the shelf from about 10 m of depth to the shelf edge at 100-200 m. A few incidental test hauls were made for hake and deep water shrimp in the slope where bottom conditions were favourable. The efforts to cover the shrimp grounds off the Gambia and Casamance rivers with hauls with tickler chain in very shallow water at night did not give significant shrimp catches. Although the shrimp/cum fish trawl used by the DR. FRIDTJOF NANSEN is heavier than normal shrimp gear, it has given reasonable

catches both of shallow water and deep water shrimp in other programmes. The low catches can perhaps be explained by seasonal fluctuations.

The biomass estimates resulting from the swept area trawl programme are summarized in Table 12. These are in general underestimates of the true standing stocks, grossly so for the carangids which are predominantly pelagic. The grunts are dominated by the small sized big eye grunt. The sea breams represent the most abundant commercial group.

Table 12 Biomass estimates of demersal fish, Senegal and Gambia. Tonnes.						
	Groupers	Grunts	Croakers	Seabreams	Carangids	Totals fish
St Louis- Cap Vert		3 900	1 400	3 300	8 700	25 000
Cap Vert- Gambia	500	800	100	9 900	19 000	32 000
Gambia	130	9 600	400	9 200	5 400	30 000
Casamance	130	34 000	800	10 300	26 000	77 000
Total	760	48 300	2 700	32 700	42 000	164 000

