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 Guinea Bissau were discussed further with the participants prior to the survey.

The agreed objectives for Guinea Bissau were according to the discussions as follows:

> 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 trecae,* false scad *Decapterus rhonchus,* anchovy *Engraulis encrasicolus* and other pelagic fish.
>
> If feasible the biomass estimates shall also be presented by length groups.
>
> A swept area trawl survey is desired if possible with emphasis on shallow water shrimp.
>
> Priority should be given to the survey of pelagic resources and to the north and mid coast. Lesser importance can be given to the area south of the Bissagos Islands which can be surveyed with a more open grid.
>
> Environmental data collection should include surface temperature, some key profiles and bathymetric data.
>
> Catch sampling will comprise weight and number by species and length frequency distributions of the principal species.

1.2 Participation

Members of the scientific team from GUINEA BISSAU were:

> Amadeu Mendes de Aleida,
> Safiato Camara Lopes.

SENEGAL:

> Abibou Faye, Senegal Navy,
> Birane Samb, CRODT.

GAMBIA:

Matarr Bah,
Momodon O. Cham.

Members of the scientific staff from the Institute of Marine Research were:

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

1.3 Narrative

Figure 1 shows the course tracks and the fishing and hydrographic stations.

The work was started in the north on 5 March applying a combined acoustic- and trawl survey. The shelf from about 10 m of depth to the shelf edge at 100-200 m was covered with course tracks spaced at 10 nm and with prelocated fishing stations at the inner, mid and outer parts. Swept area hauls were mainly made during daytime. A special shrimp survey programme fishing with tickler chain in shallow inshore water mostly at night was started off Casamance and continued southwards into Guinea Bissau. Shrimp catches were, however, very low. A few incidental hauls were made in the slope beyond 200 m, but the wide extension of the shelf at depths beyond 200 m south of about 10°50'N could not be adequately covered. The southernmost part of the shelf was surveyed on March 9-10 with a wider spacing of course tracks, but with mapping of a school area of sardinella. Hydrographic profiles were worked in the north on 5 March and in the south on 10-11 March. A total of 60 stations were fished of which 52 were successful swept area hauls and the course tracks sailed amounted to about 700 nm.

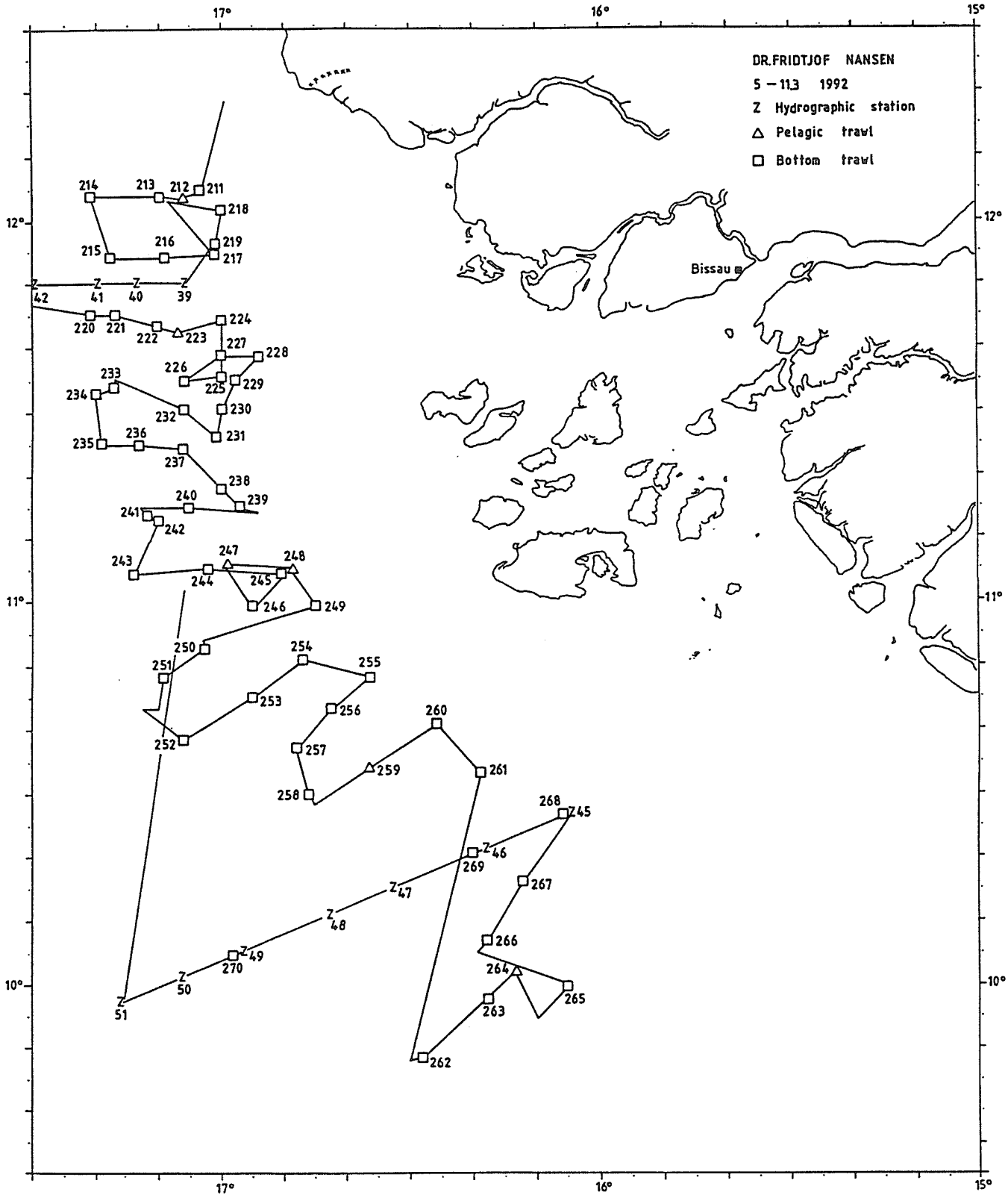

Figure 1 Course tracks with fishing and hydrographical stations.

2 THE ENVIRONMENT

2.1 The shelf and the slope

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. The shelf from about 10 to about 200 m of depth is 25-30 nm broad in the north, but widens to more than 60 nm in the south. The slope further out is very steep in the north, but from about 10°50'N southwards it becomes gentler and the 500 m depth line is found 20-25 nm outside the 200 m line. The slope as observed in the south is here even and smooth.

Table 1 shows approximate estimates of shelf areas by depth ranges and regions.

Table 1 Estimated shelf areas by depth ranges and regions, nm^2.

	10-20m	20-100m	100-150m	150-200m	200-500m
North Bissagos (to 11°20')	(200)	660	70	20	(20)
	20-50m	50-100m	100-150m	150-200m	200-500m
South Bissagos (11°20'-10°00')	1620	870	370	470	1400

2.2 Hydrography

The surface temperature was 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.

Figure 3 shows the sea surface temperature at 4 m of depth and Figure 4 shows the distribution of temperature and salinity in the two profiles. The temperature front area was found outside the north part of the Bissagos Islands. The northern profile shows isolines ascending shorewards in the upper 100 m indicating upwelling. This situation is typical of winter conditions. The southern profile shows a stabilized thermocline and with lower salinity inshore.

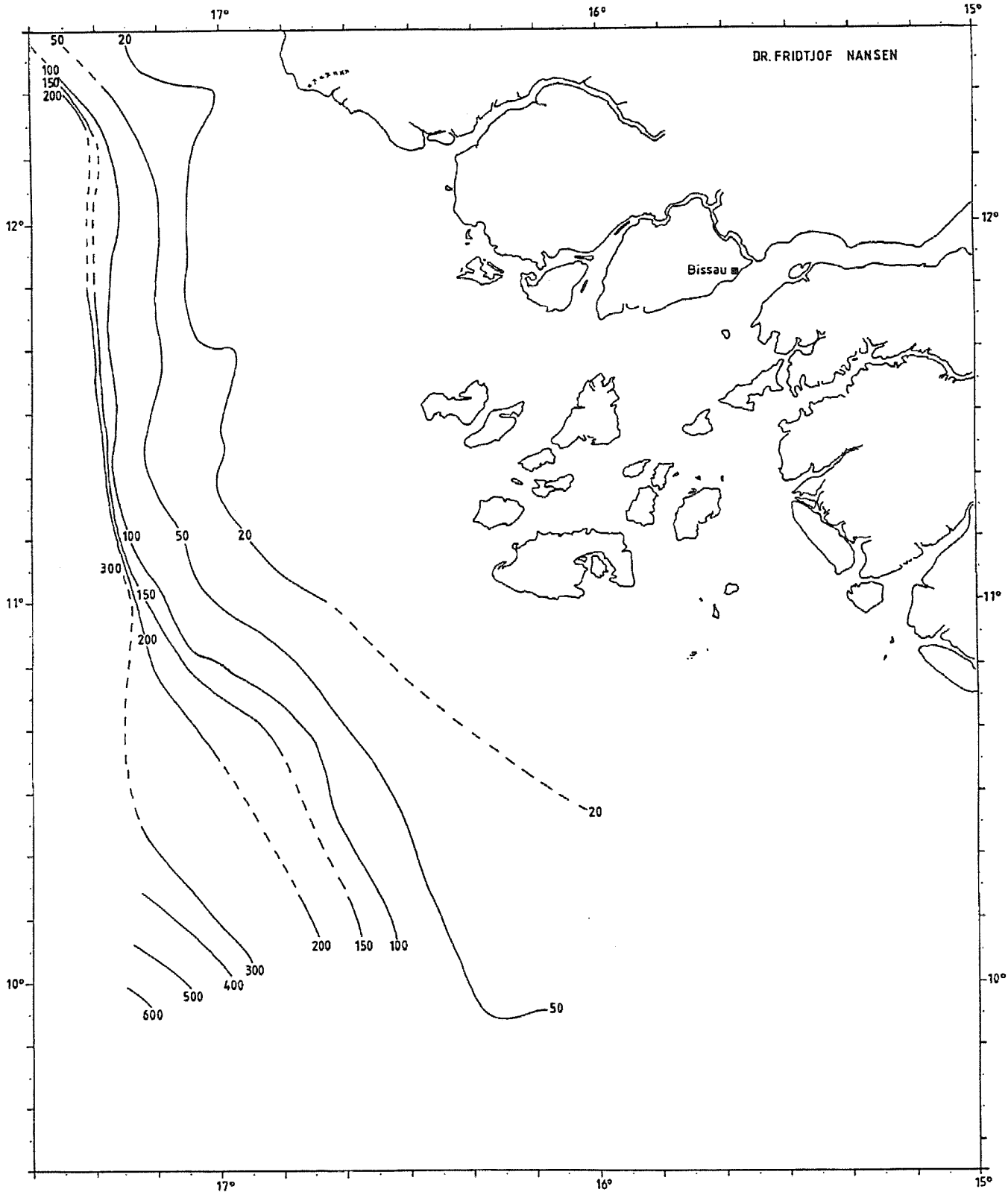

Figure 2 Bathymetric chart.

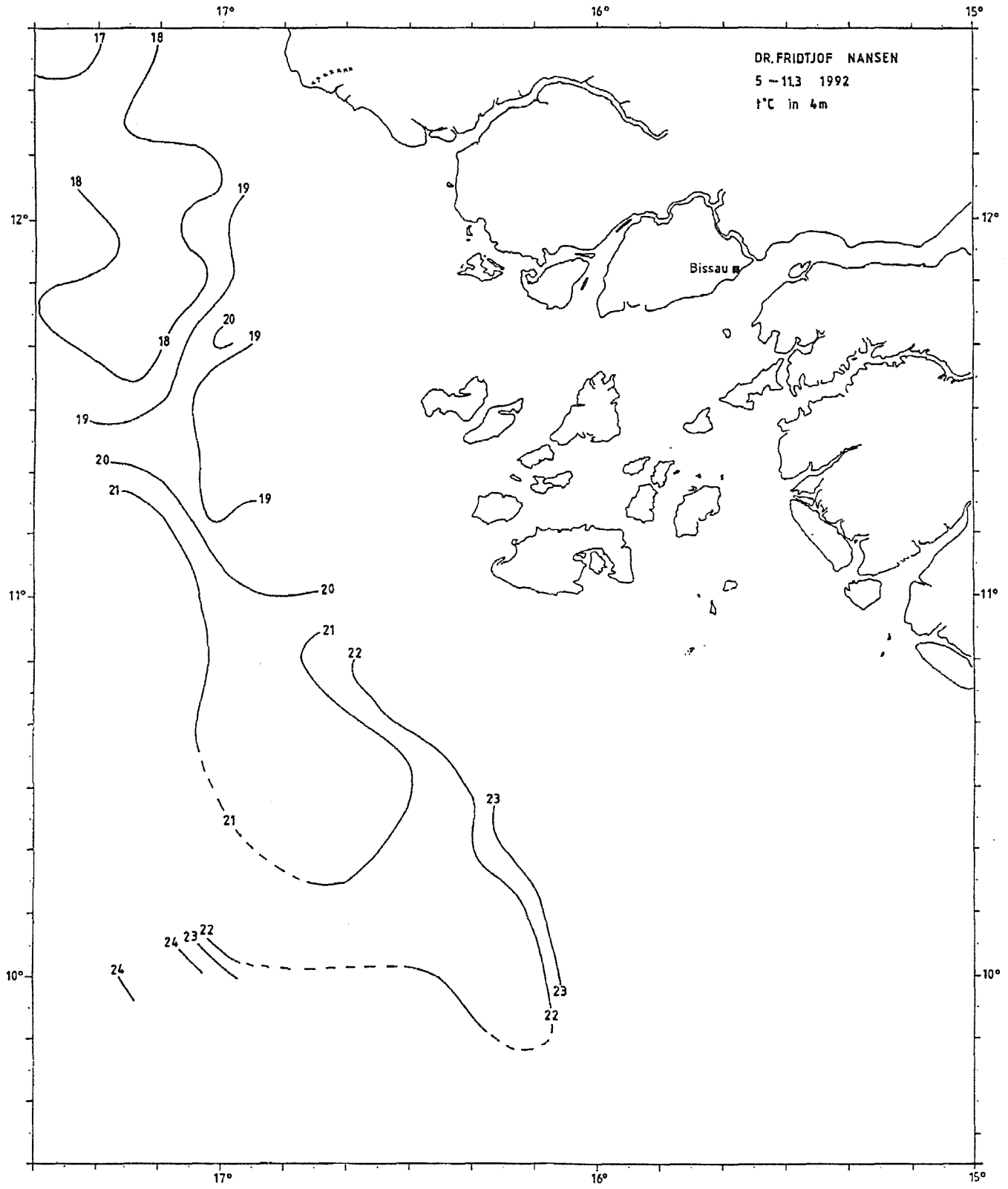

Figure 3 Sea surface tenperature recorded at 4 m of depth.

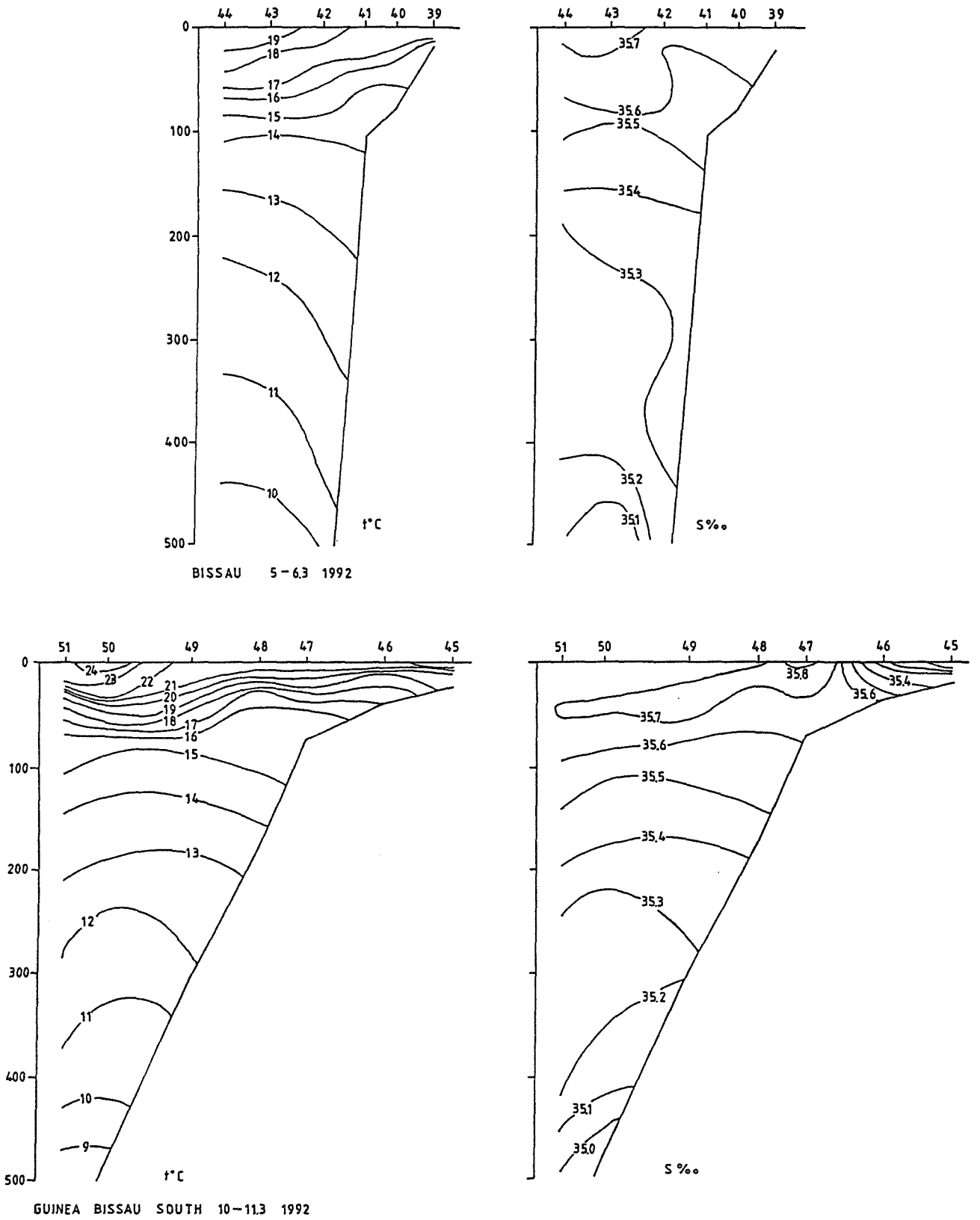

Figure 4 Hydrographic profiles with distribution of temperature and salinity.

3 RESULTS OF THE ACOUSTIC AND TRAWL SURVEY

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 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 for the main pelagic species are shown in Annex II. The complete records of fishing stations are shown in Annex IV.

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 observed mean acoustic densities for post stratified areas are converted to numbers and biomass of fish using the above length related target strength, observed condition factors for the various species, sampled length compositions and measurements of the area extensions of the various levels of fish density.

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 Guinea Bissau: sardinellas, Cunene horse mackerel and false scad. Catch compositions form the basis for a further separation of the sardinellas.

In the swept area trawl survey 30 min. hauls were made at predetermined positions along the cruise tracks covering the various depths between about 10-20 m and the shelf edge at 100-200 m. A few hauls were made at greater depths in the slope.

According to observations on the geometry of the type of trawl used, the distance between the wings during towing is approximately 18 m. 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 hour towing.

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

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

3.2 Pelagic fish

Figure 5a shows the distribution of the sardinellas. An almost continuous band of denser and more dispersed school areas was found mostly over the mid shelf at 40-50 m of depth. In the north there was a continuous distribution into Senegal. In some areas the schools were partly close to the surface and could be seen during the day and through bioluminescence at night. Sampling for identification and size measurements with pelagic trawl was successful in most parts.

Round sardinella dominated and the fish was large sized over most parts, but the dense patch at about 11°N gave medium sized samples. The flat sardinella was mostly medium sized. The size compositions are shown in Annex II and the stock compositions by numbers and weight are given in Annex III. Both the bimodal composition for the round sardinella and the wide medium sized composition with a mode around 19 cm for the flat sardinella are similar to the size compositions found for these two species in the Casamance region. This similarity and the continuity of the main distribution in the whole area suggest that the sardinellas off Guinea Bissau form part of joint Senegal-Gambia-Guinea Bissau stocks.

The Cunene horse mackerel was found over the outer shelf in the north, see Figure 5b. The fish was large sized see Annex II. Only a small patch of medium sized scad was found.

The biomass estimates based on the acoustic observations are shown in Table 2. The biomass of the sardinellas, more than 500 000 tonnes is unexpectedly high, but it is in conformity with the high levels of these stocks found from Mauritania southwards. The biomass of the carangids is on the other hand very low.

Table 2 Biomass estimates of pelagic fish Guinea Bissau shelf. 1 000 tonnes.

Flat sardinella	Round Sardinella	Horse mackerel	False scad
65	470	26	4

The results of previous DR. FRIDTJOF NANSEN surveys of the pelagic resources of Guinea Bissau can be summarized as follows: (1 000 tonnes)

	Mainly sardinellas	Carangids	Trigger fish
1981-82	20-90	20-400	350-590
1986 (approximate)	< 30	100	200

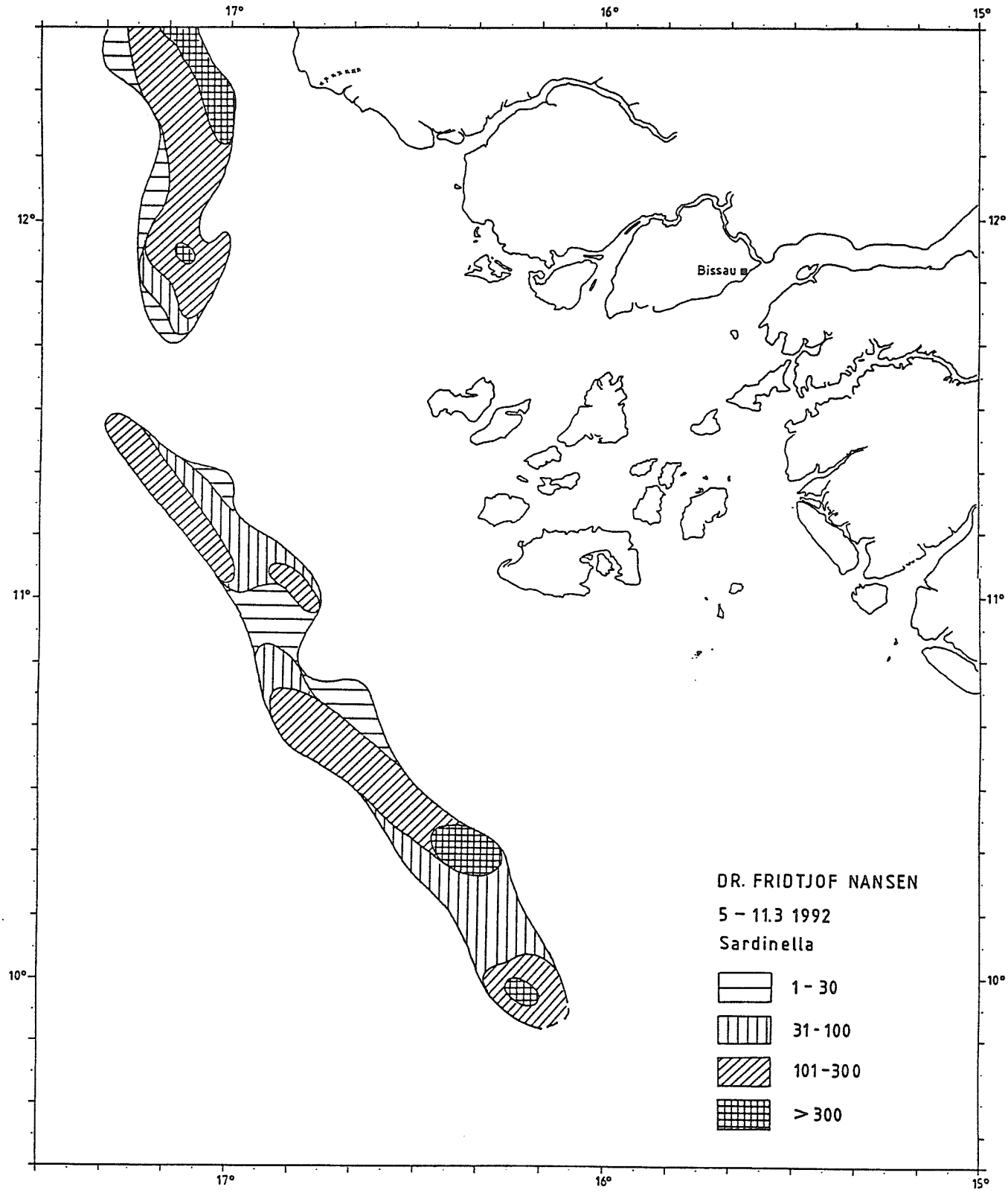

Figure 5a Distribution of sardinellas.

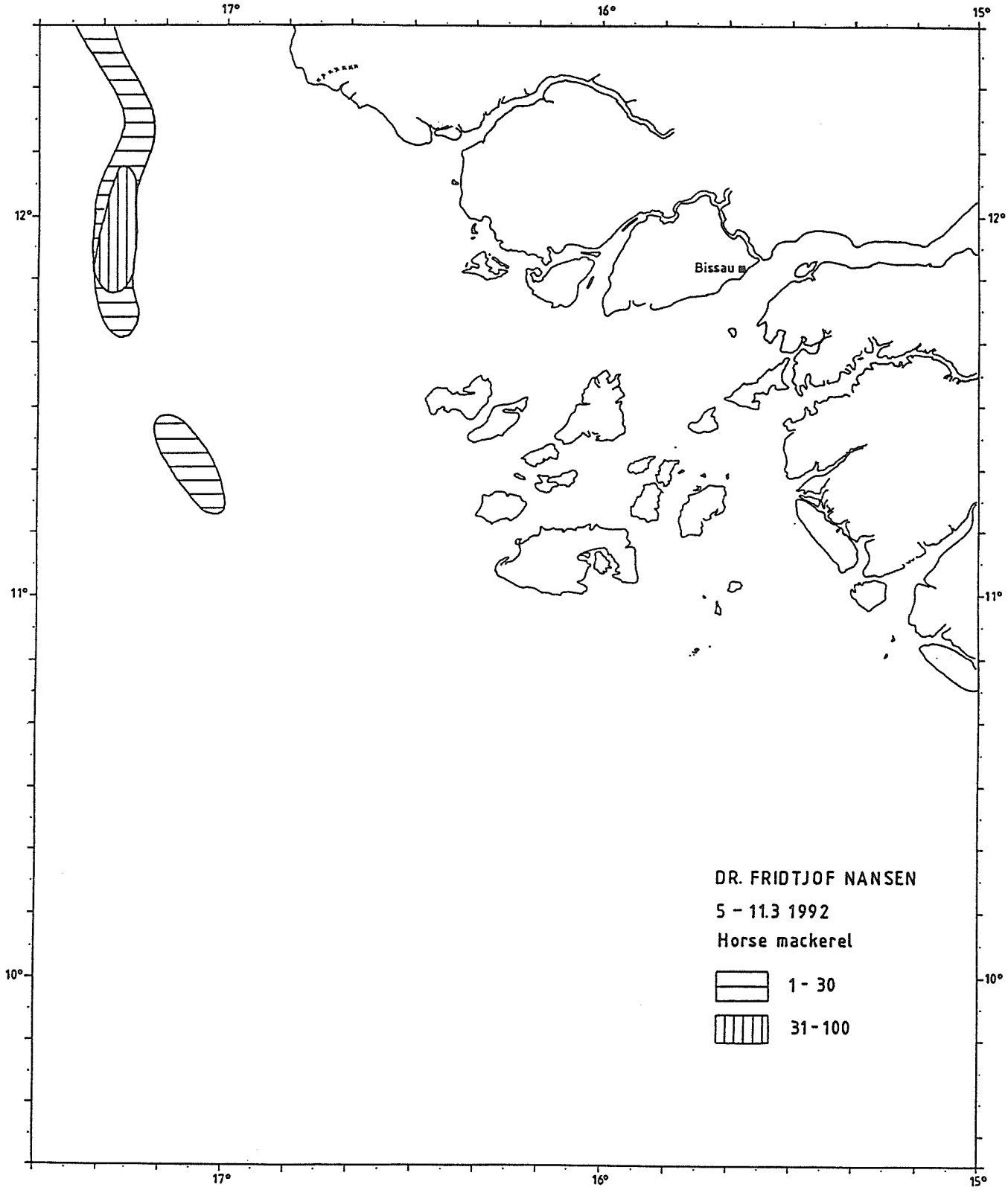

Figure 5b Distribution of Cunene horse mackerel.

The present level of sardinellas is thus high compared to these previous findings, but with the low level of carangids and the absence of the trigger fish the total pelagic biomass is well within the range of previous levels and would thus not seem to be unreasonably related to the carrying capacity of the eco system.

It is also appropriate to recall that pelagic system in this region is likely to be highly dynamic with movements into and out of the area of investigation. The findings are thus first of all only representative of the time and season covered, but they have also a wider significance for instance in terms of joint stocks.

3.3 Demersal resources

The composition of the trawl catches indicated differences in the demersal fauna between the northern and southern parts of the Guinea Bissau shelf. This is perhaps related to the difference in hydrographical regimes, at least in winter in the two areas. The analysis of the demersal survey data has therefore been done separately for the two areas: North Bissagos, the shelf from the border with Senegal to 11°20'N, and South Bissagos, the shelf from 11°20'N southwards.

North Bissagos

Annex I shows the fish densities by species and main groups estimated from the swept area hauls for various depth ranges. Big eye grunt *Brachydeuterus auritus* and hairtail *Trichiurus lepturus* are the most abundant species in the shallow waters with some red pandora *Pagellus bellotti* and longneck croaker *Pseudotolithus typus*. In the deeper shelf various sparids are the most important species together with sharks and silvery John dory *Zenopsis conchifer*. The shrimps in shallow water are pink shrimp *Penaeus notialis*, Caramote prawn *Penaeus kerathurus* and the small sized Guinea shrimp *Parapenaeopsis atlantica* and in deep water the rose shrimp *Parapenaeus longirostris*, striped soldier shrimp *Plesionika edwardsii* and the smaller Narwal shrimp *Parapandalus brevipes*.

Table 3 shows catches by main groups. The highest catches of seabreams were big eye dentex *Dentex macrophthalmus*, Angola dentex *D. angolensis* and Morocco dentex *D. maroccanus*; the grunts were exclusively big eye grunt; long neck croaker dominated this group; smooth hound was the most common shark and squids, octopus and cuttlefish all contributed small catches.

From Table 1 it appears that the 20-100 m depth range represents the main part of the shelf area outside the 10 fathom line. The only species found in high density in this depth range is the big eye grunt. An estimate of its biomass based on density and extension of the area is 8 000 tonnes. The community of seabreams is found in relatively high densities, but mainly on the narrow shelf outside the 100 m depth line and their estimated biomass is accordingly very low. It is considered pointless to try to estimate the biomass of the shallow water croakers whose distribution must extend into the vast shallow areas around the Bissagos archipelago.

Table 3 Catches by main groups, North Bissagos. Kg/hour.

ST.NO.	DEP.	Seabreams	Grunts	Croakers	Sharks	Squid	Other
211	12		84.0	13.8			80.4
213	45	26.0	1281.8			1.4	76.4
214	109	170.8		7.6	12.8	7.8	232.3
215	100	73.8				29.4	192.3
217	11		2.0				126.6
218	11		62.6	6.7			60.0
219	12		31.8	12.6			46.0
220	268	284.4		1.3	23.5	26.1	382.2
221	97			1.2	13.3	0.8	640.8
222	50		1485.0				144.8
224	12		42.0	74.6			84.3
225	28		737.8	3.0			81.7
226	42		1024.0				44.8
227	20		25.2	13.0	29.2		86.6
228	16		30.0	9.1	29.4		61.8
229	22		101.3	2.8		0.8	139.5
230	20	0.4	0.4			0.8	24.0
231	21	68.4	0.4			4.0	33.4
232	38	15.6	0.2			5.2	25.5
233	102	28.3		0.4	40.3	18.2	41.6
234	212					8.3	167.4
235	102	125.0		1.9	43.4	8.5	18.3
236	48	2.2				11.2	43.8
237	35	8.4		2.0		18.4	75.9
MEAN		33.5	204.5	6.3	8.0	5.9	121.3

South Bissagos

Annex I shows the fish densities by species and depth ranges. The greeneye *Chlorophthalmus atlanticus* and the silver rag driftfish *Ariomma bondi* occurred in high densities in some hauls at about 200m. Of the seabreams the red pandora was common inside 100 m, the other sparids belong to the community at greater depths. The African cuttlefish *Sepia bertheloti* is mainly found inside 100 m of depth.

Table 4 shows the catches of the main groups. Grunts and croakers were almost absent in the hauls. The larger catches of seabreams were Morocco and Angola dentex and red pandora in more shallow water. The size of the seabreams were, however, generally small, see Annex VI. Cuttlefish seems to show increasing catch rates towards the south.

The seabreams on the deeper shelf has an estimated biomass of about 7 000 tonnes.

Table 4 Catches of main groups, South Bissagos. Kg/hour.

ST.NO.	DEP.	Groupers	Seabreams	Sharks	Squid/Oct.	Cuttlefish	Other
238	18		44.0				299.8
239	14	5.6	17.6			0.8	174.4
240	39		15.0			9.0	257.3
242	68	40.6	72.2	1.8	3.6	10.4	46.0
243	181		387.2				60.8
244	39	5.6	0.2		2.0	4.0	45.0
245	18		4.2		0.6	1.8	153.0
246	44		14.0			15.4	305.9
249	30		1.2			11.6	92.6
250	105	5.6	366.8	60.2			435.4
251	205			8.0	16.0		2407.0
252	214				2.0		3341.6
253	110		148.5		4.5		2691.0
254	46		1.2		8.0	7.4	21.0
255	34				1.1	7.0	56.5
256	53		47.0	42.0	5.2	31.0	50.5
257	130		49.2	22.7	7.1	1.3	125.1
258	102		109.2	60.8	0.6	1.2	217.0
260	28					13.2	39.4
261	28	0.9				4.3	73.7
262	59				0.3	15.0	146.2
263	44		34.8	1.5	0.4	6.6	71.2
265	38		0.4			6.8	95.5
266	43		109.2		1.2	1.8	59.7
267	34		2.2	24.0	0.8	9.4	41.0
268	24					23.2	15.0
269	39					14.5	137.2
MEAN		2.2	52.7	8.2	2.0	7.3	428.4

Shrimps

In an effort to sample the shallow water shrimp stocks a number of fishing stations were distributed inshore, see Figure 1 and a good part of these were fished during nighttime. Table 5 shows the catches of pink shrimp *Penaeus notialis*, Caramote prawn *Penaeus kerathurus* and the small sized Guinea shrimp *Parapenaeopsis atlantica* in all bottom trawl hauls inside about 50 m of depth. A few pink shrimp and Caramote prawn were occasionally caught in mid water trawling in surface layers. The catch rates were very low as was the case also in the similar effort off the Gambia and off Casamance.

The gear used by the DR. FRIDTJOF NANSEN is relatively heavy, but has been used with reasonable success in other shrimp survey programmes although catch rates are expected to be lower than those of commercial shrimpers. The low rates obtained in these waters may perhaps be related to seasonal variations of stock densities.

Table 5 Catches of shallow water shrimp in hauls inside about 50m of depth.

ST.NO.	DEP.	Pink	Caramote	Guinea	Other
211	12	0.9		0.3	177.0
213	45				1385.6
216	36				
217	11	0.2		1.0	127.4
218	11	0.2			129.1
219	12	0.1		2.7	87.6
222	50	0.4			1629.4
224	12				200.9
225	28	2.0			820.5
226	42	1.0			1067.8
227	20	0.3		76.0	77.7
228	16		0.1		130.3
229	22	5.1	0.2		239.2
230	20	0.7	1.8		23.1
231	21		0.2		106.0
232	38	1.3			45.2
236	48				57.2
237	35				104.7
238	18				343.8
239	14				198.4
240	39	0.3			281.0
244	39				56.8
245	18				159.6
246	44				335.3
249	30	0.2			105.2
254	46				37.6
255	34				64.6
256	53				175.7
260	28				52.6
261	28				78.9
263	44				114.4
265	38				102.7
266	43				171.9
267	34				77.4
268	24				38.2
269	39				151.8
MEAN		0.4	0.1	2.2	248.7

A few hauls were made at the shelf edge and in the slope to test for deep water shrimps. Table 6 shows the catch rates for rose shrimp *Parapenaeus longirostris*, golden shrimp *Plesionika martia*, striped soldier shrimp *Plesionika edwardsii* and narwal shrimp *Parapandalus narwal*. The three first species are commercial, the last of uncertain interest. These few incidental hauls give positive indications of fishable stocks. In the present survey there was unfortunately not time for a coverage of the slope, but if the slope area has not been fully surveyed previously it is recommended as a priority task for any forthcoming trawl survey. Special attention should be given to the gently descending slope area of some 1300 nm² extension from 200 m to beyond 500-600 m south of 10°50'N.

Table 6 Catches of deep water shrimp in a few shelf edge and slope hauls.

ST.NO.	DEP.	Rose	Golden	Soldier	Narwal	Other
220	268					717.4
234	212	2.8		31.6	43.4	97.9
243	181					448.0
251	205	0.2				2430.8
252	214					3343.6
270	294	6.2	3.2			98.8
MEAN		1.5	0.5	5.3	7.2	1189.4