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 Institute of Marine Research, Bergen. During this meeting the schedule and the objectives of the various parts of the survey was established.

Objectives for the survey in Mauritania as agreed on this meeting were:

> By hydroacoustic methods to map the distribution and produce a biomass estimate for the main small pelagic fish species; sardine *Sardina pilchardus*, anchovy *Engraulis encrasicolus*, sardinella *Sardinella aurita, S. maderensis*, horse mackerel *Trachurus trachurus, T. trecae* and false scad *Decapterus rhonchus*.
>
> If feasible the biomass estimates shall also be presented by length groups.
>
> Survey area will be from Cap Blanc to the border with Senegal.
>
> For the target species trawl sampling will be carried out. The biological parameters will be: catch in weight and number by species and length frequency distributions from the principal pelagic species.
>
> The hydrographic work will comprise logging of surface temperature and bathymetric data. Three hydrographical sections will be carried out with a CTD sonde.
>
> Where conditions permit special studies on target strength measurements and fish behaviour will be performed in order to improve the accuracy of the acoustic estimates.

1.2 Participation

Members of the scientific team from CNROP Nouadhibou, Mauritania were:

> Mohammed Mahfoudh Taleb and Djigo Yahya.

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

> Tore Strømme, Ingvald Svellingen, Kjell Strømsnes, Erling Molvær and Endre Aas.

1.3 Narrative

Due to technical difficulties during the previous cruise the "DR FRIDTJOF NANSEN" was 2 days behind schedule at the start of the survey. The vessel left Nouadhibou on afternoon 11 February, starting with a hydrographical section off Cape Blanc. The shelf was covered southwards with acoustic transects 10 nm apart, see Figure 1. At Cape Timiris and at latitude N 17°15' data for hydrographical sections were collected.

As the vessel could not obtain clearance from immigration in Dakar to repatriate the mauritanian scientist through Dakar, a call was made off Nouachott on 17 February to disembark the two scientists there. The vessel then steamed to Dakar with arrival afternoon 18 February.

The weather was favourable for an acoustic survey throughout the cruise.

1.4 Effort

Distance sailed:	1 500 nautical miles
Days at sea:	7 days
Sampling:	20 trawl stations
	15 hydrographic stations, 3 sections
	60 length frequency samples

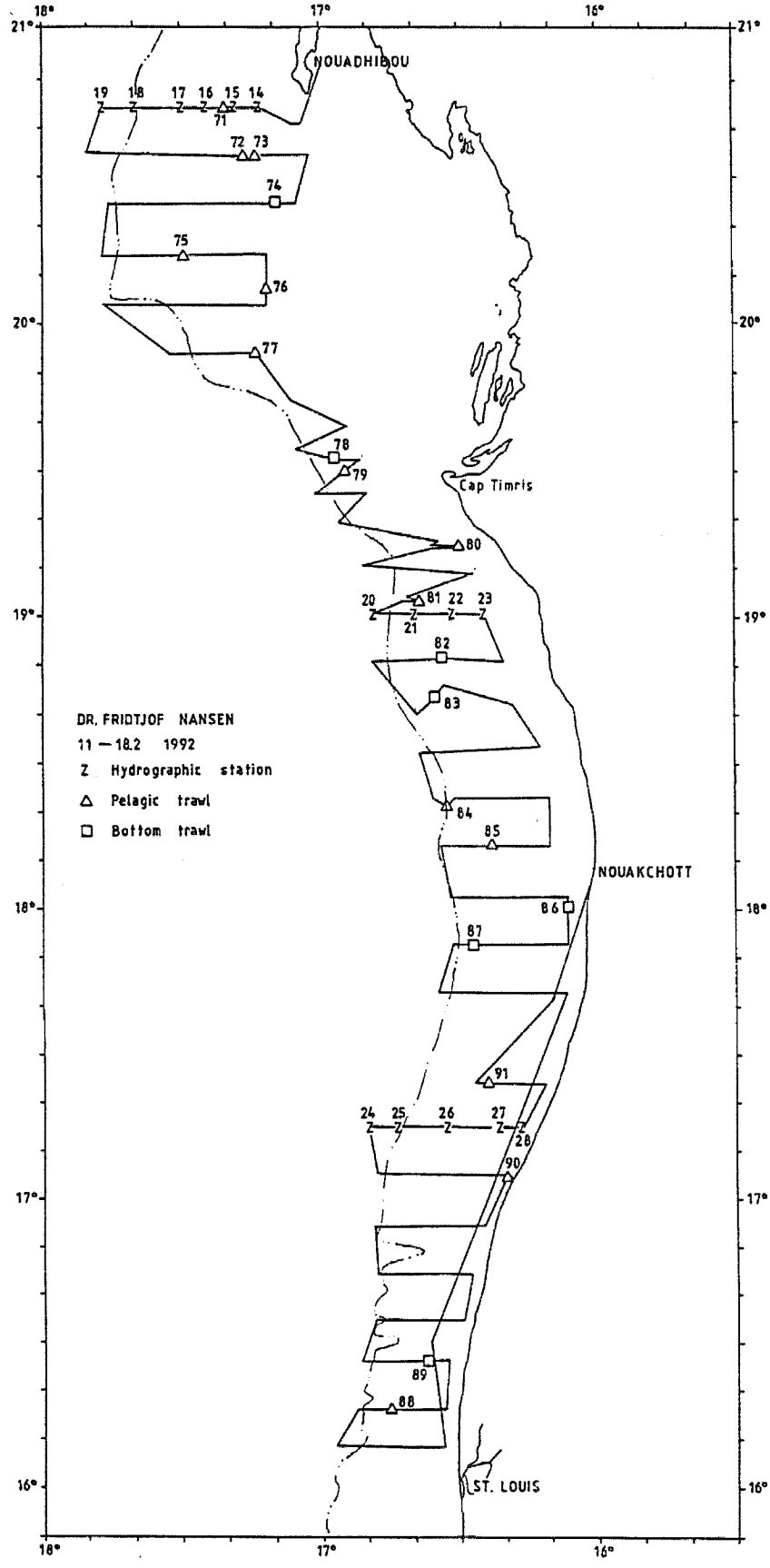

Figure 1. Course track and fishing and hydrographic stations.

2 THE ENVIRONMENT, HYDROGRAPHY

The distribution of sea surface temperature recorded at 4 m depth is shown in Figure 2 and the three hydrographical profiles recorded are presented in Figure 3. Both figures demonstrate a declining temperature gradient towards the shore, indicating coastal upwelling. The rising sub-surface isolines in the profiles confirm the same picture.

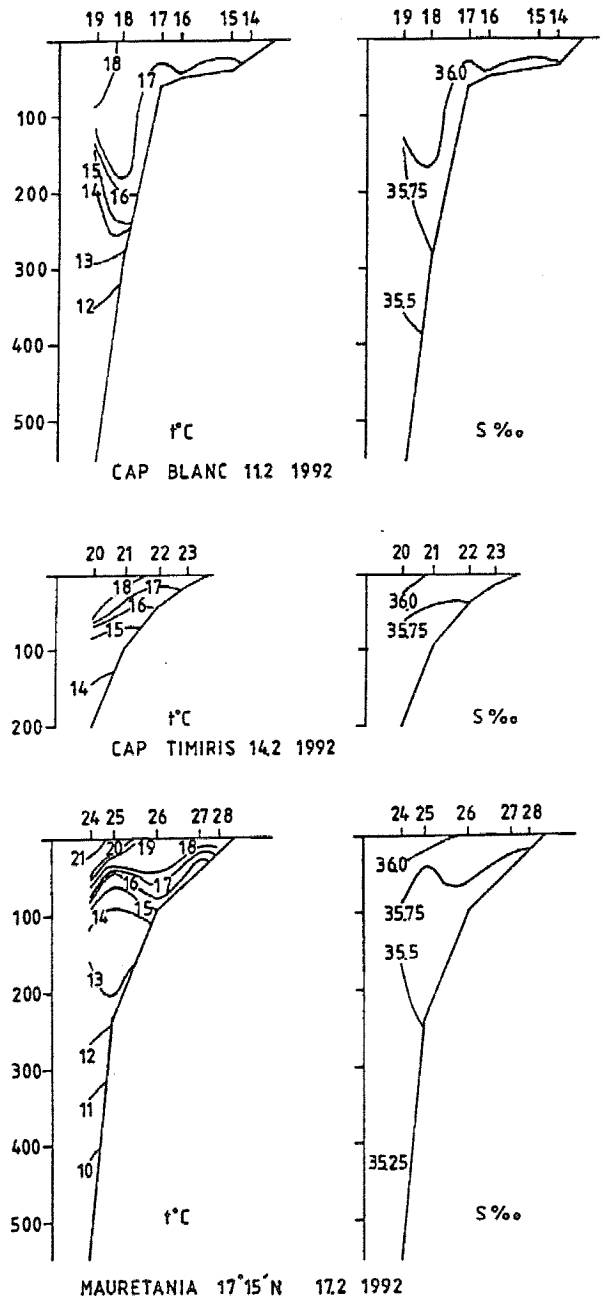

Figure 3. Hydrographic profiles.

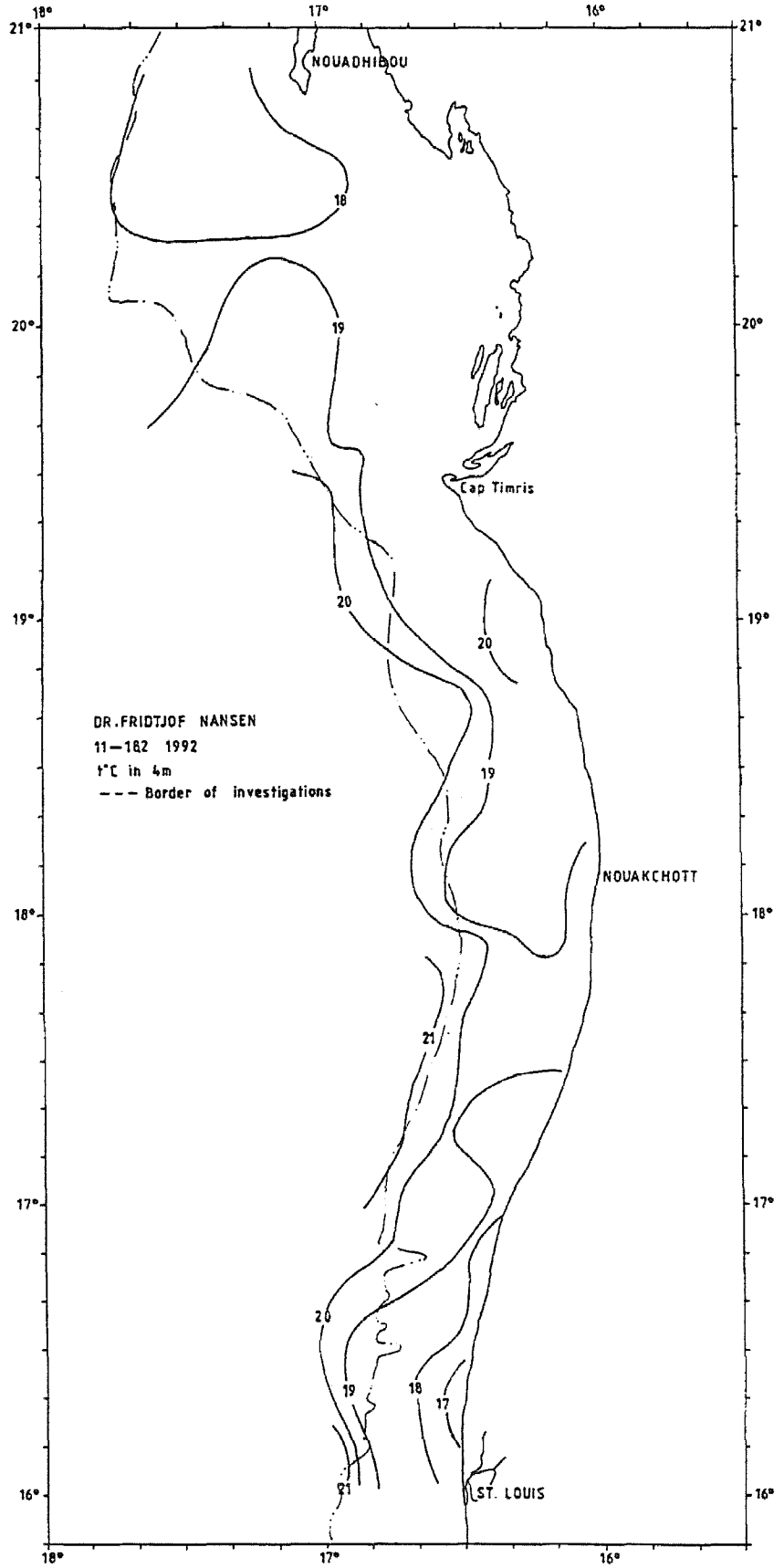

Figure 2. Sea surface temperatures.

3 METHODS

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

All catches were sampled for composition by weight and number 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 and sardinella were measured by fork lengths. The collected length frequencies are given in ANNEX I, and pooled frequency distributions by target species and regions are shown in ANNEX II. The complete records of fishing stations are shown in ANNEX III.

Surface temperature was logged automaticly and recorded with position and bottom depth every nautical mile sailed. Figure 2 shows the surface temperature recorded.

Hydrographical profiles were collected with a portable mini CTD sonde with internal logging of records of temperature, salinity, and depth 30 times per minute. From these data series records were selected from standard depths and presented in Figure 3.

The biomass estimates are based on the acoustic 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:

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

For the sardinellas measured by fork length the relation is:

$$TS = 20 \log L - 70.4$$

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

$$\rho_i = \frac{1}{4\pi} * s_a \frac{n_i}{\sum_{i=1}^{max} n_i k_i} \qquad k_i = 10^{2 \log l_i - 7.2}$$

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 (measured as total 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 (nm^2)
I = Average integrator value from distribution area in m^2/nm^2
L = Total mean length of fish
C = Condition factor (based on total length)

The two sardinella species and the two horse mackerel species have a high degree of co-occurrence, the latter also with false scad. It is impossible to separate the species by the echotraces, and the catch distribution forms the basis for separating them. Distribution charts are made for the sardinella group and the horse mackerel group (including false scad), while the abundance estimates on these groups are split by species on basis of the catches and the length compositions.

ANNEX IV gives a description of the instruments and the fishing gear used.

4 DISTRIBUTION AND ABUNDANCE OF PELAGIC FISH

The acoustic integration system provided observations of fish densities averaged over 5 nm distances. The unit of acoustic reflection used was m^2/nm^2 reflecting surface. The integrator values from fish targets were allocated to the following groups on the basis of trawl sampling and characteristic behaviour recognised from the echo recordings:

Sardine (*Sardina pilchardus*)
Round sardinella (*Sardinella aurita*)
Flat sardinella (*Sardinella maderensis*)
Anchovy (*Engraulis encrasicolus*)
Atlantic horse mackerel (*Trachurus trachurus*)
Cunene horse mackerel (*Trachurus trecae*)
False scad (*Decapterus rhonchus*)
Other fish, mainly demersal
Plankton, including 0-group fish and myctophides.

4.1 Distribution

In summary, pelagic fish were found at most part of the shelf. In the north, between Cape Blanc and Cape Timiris the fish fauna was a continuation from the distributions further north as found during the preceeding survey in Morocco. The species were mainly sardine, Atlantic horse mackerel and sardinella (a mixture of juveniles and adult) and anchovies. South of Cape Timiris the Cunene horse mackerel became predominant, and the sardinella distributions were composed of adult fish. Sardine was not found south of Cape Timiris, and anchovies were few compared to in the north.

The distributions of sardine, sardinella, anchovies and horse mackerel are shown in Figures 4, 5, 6 and 7 respectively. An arbitrary semi-log scale was used in the distribution charts to illustrate different levels of density. The units on the maps are the integrator units (m^2/nm^2) divided by 10 to make them comparable with the maps from the previous surveys.

Pooled length frequency distributions by main species and regions are given in ANNEX II.

4.2 Abundance of pelagic fish

The following condition factors were applied: sardine 0.75, anchovy 0.62, young sardinella 1.2 (f.l.), adult round sardinella 1.6 (f.l.) adult flat sardinella 1.7 (f.l.), horse mackerel 0.9 and false scad 1.0. These conditions factors were derived from the length frequency samples collected and reflect the best fit for these samples assuming an isometric growth.

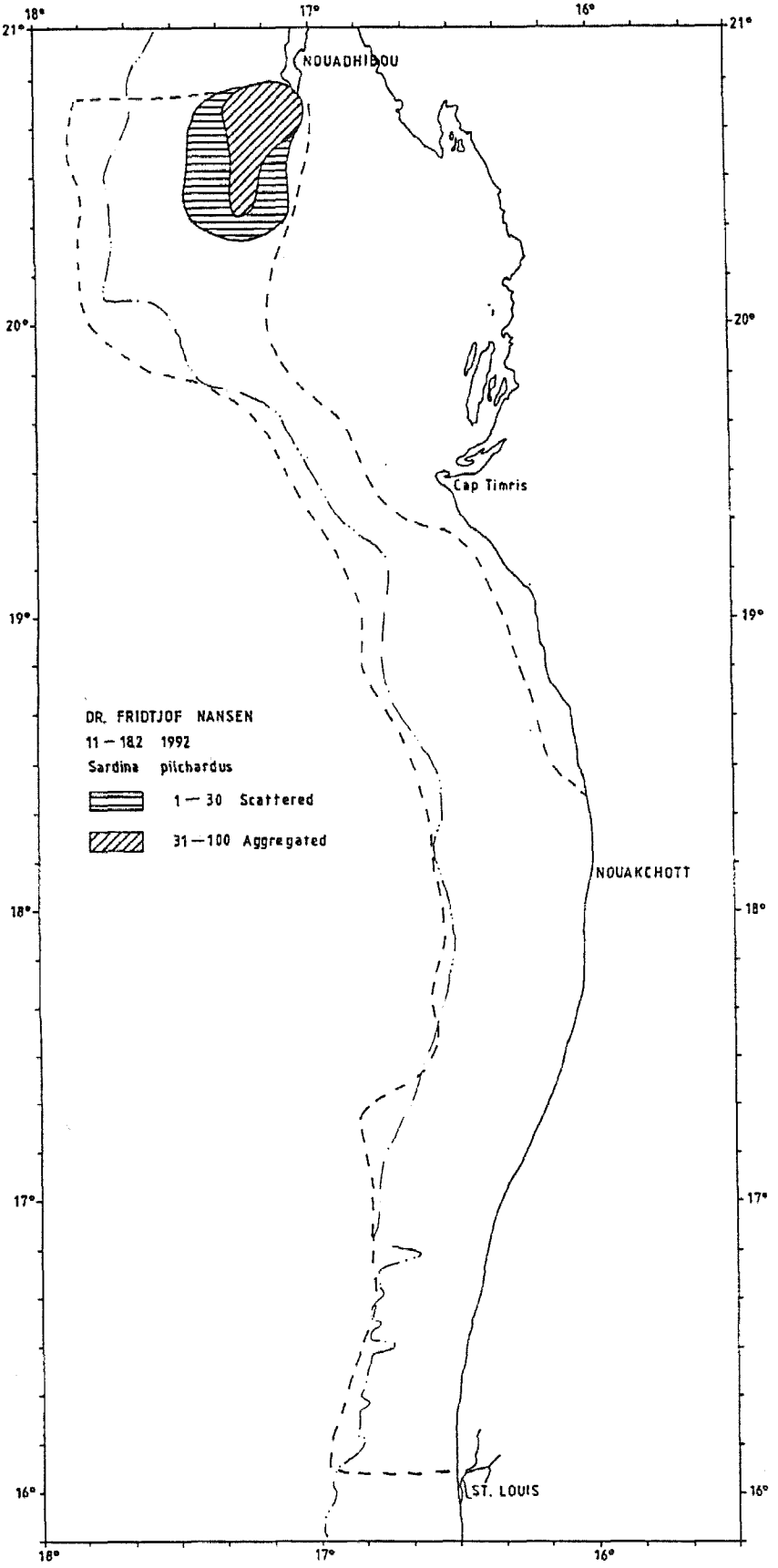

Figure 4. Distribution of sardine.

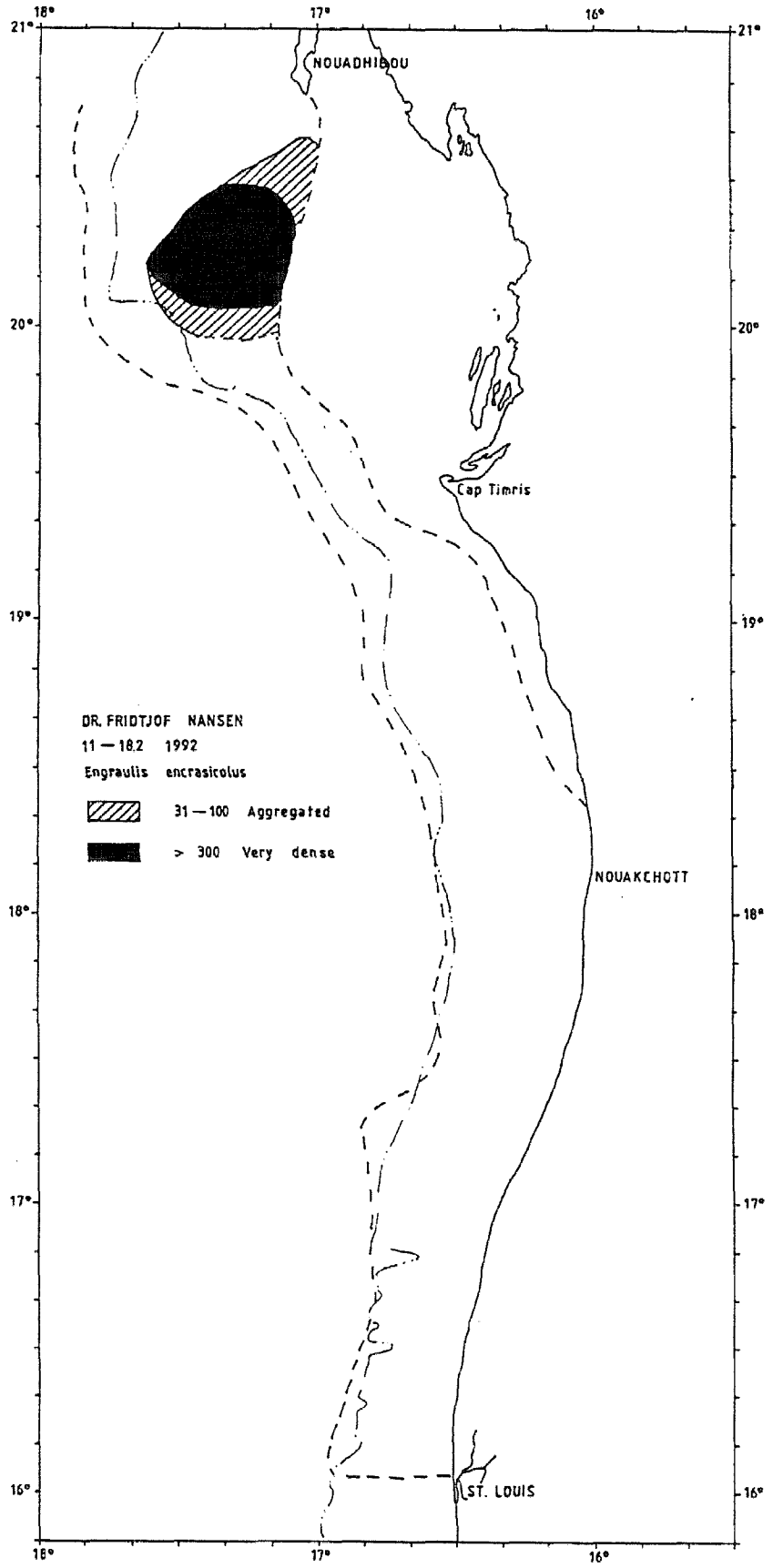

Figure 5. Distribution of anchovy.

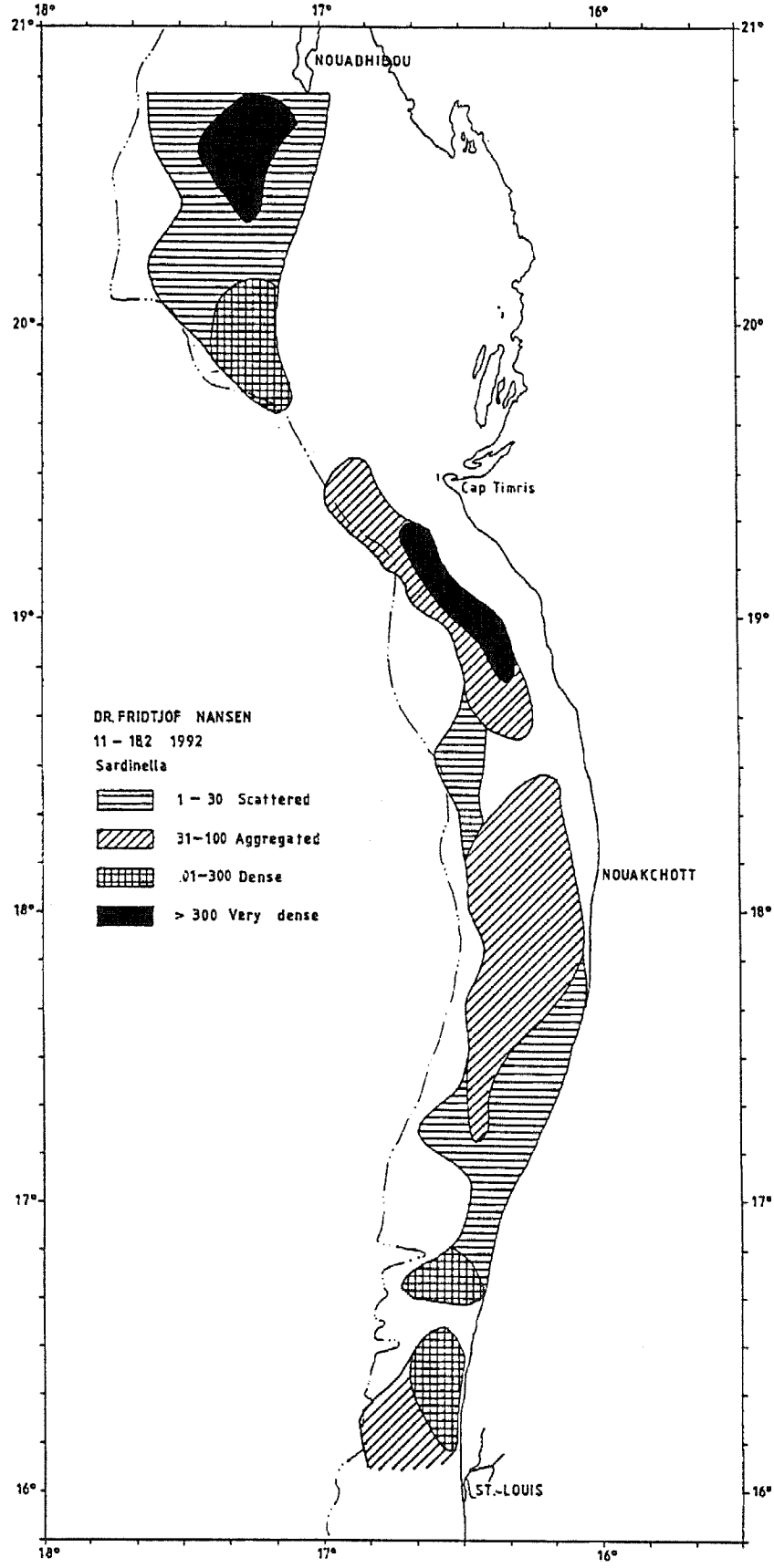

Figure 6. Distribution of sardinellas.

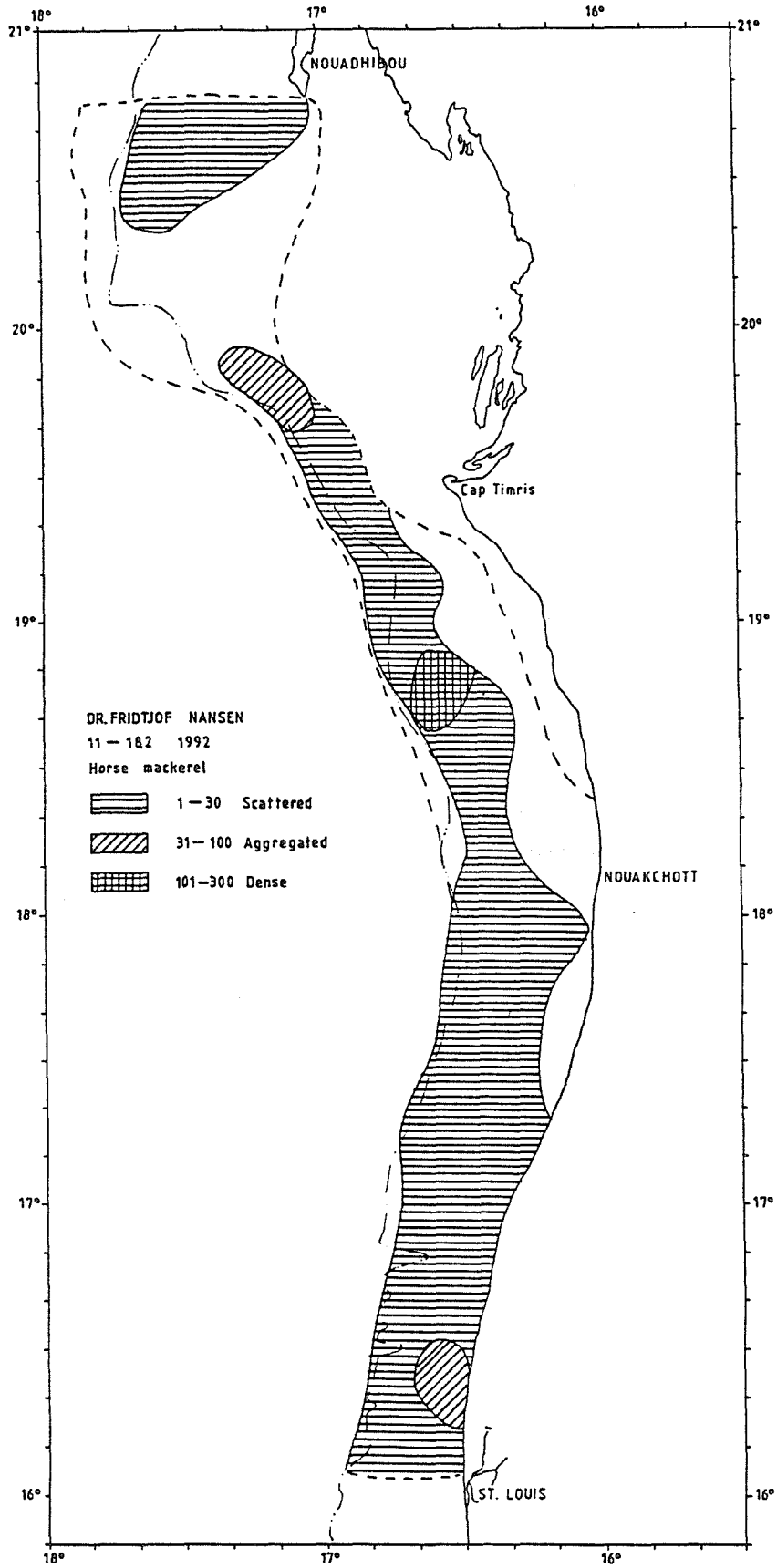

Figure 7. Distribution of horse mackerel.

The total biomass estimates for the sardine, sardinella and anchovy are shown in Table 1, and the horse mackerels in Table 2.

Biomass estimates are also presented (ANNEX V) by one cm length groups with number and tonnes in each length class. The basis for distributing the total biomass by length classes are the pooled regional length frequency distributions in ANNEX II.

4.2.1 Pelagic fish type 1 (Clupeids and anchovies)

The sardine, which was restricted to the area between Cape Blanc and Cape Timiris was estimated to 21 000 tonnes, forming only a portion of the stock distributed north of Cape Blanc.

Anchovy is estimated to 240 000 tonnes and was only found north of Cape Timiris.

Round and flat sardinella were found mixed along the entire coast. In the north, between Cape Blanc and Cape Timiris the two species were estimated to 350 000 and 220 000 respectively. There was an important element of juveniles of both species in the catches in this area, estimated to 60% of the numbers and 6% of the weight of round sardinella and 60% in number with 5% in weight of the flat variety. As the estimated proportions of young fish is strongly influenced by the different catchability of young and adult sardinella these percentages should only be treated as indicative. The young sardinella was especially abundant in the more shallow areas and the distribution of the juveniles most likely extends into the more shallow waters of the Arguin Bank unsurveyed by the vessel. There has not been made compensation for this in the estimates and the juveniles are therefore probably considerably underestimated. South of Cape Timiris the round sardinella is estimated to 1 060 000 tonnes and the flat sardinella to 340 000 tonnes, composed exclusively of adult fish.

The total estimate of round sardinella in Mauritania is thus 1 410 000 tonnes and the flat sardinella 560 000 tonnes. These estimates are the highest ever recorded by acoustic methods in the country and indicates a stock with a recent strong growth and in a healthy state. The distribution of both species extended further southwards into Senegal.

Table 1 Species composition and biomass estimates (in 1 000 tonnes) of pelagic type-1 fish by regions.

Area	Sardine	Anchovy	Round Sardinella	Flat Sardinella	Total
Cape Blanc-Cape Timiris	20	240	350	220	830
South of Cape Timiris	0	0	1 060	340	1 400
Total	20	240	1 410	560	2 230

4.2.2 Pelagic fish type 2 (mackerel and horse mackerel)

The two species of horse-mackerel, the Atlantic type and the Cunene species are estimated to 70 000 and 90 000 tonnes respectively. The false scad was estimated to 30 000 tonnes. The total estimate on pelagic carangids in Mauritania is thus 190 000 tonnes.

In the period 1981 to 1982 four surveys were carried out by Dr. Fridtjof Nansen. The estimates from these surveys were 370 000, 190 000, 470 000 and 350 000 tonnes respectively. In November 1986 a single survey was carried out. The carangids were then estimated to 540 000 tonnes. The recent estmate thus falls in the lower range of previous "Dr. Fridtjof Nansen" estimates.

Table 6 Species composition and biomass estimates (in 1 000 tonnes) of pelagic type-2 fish.

Atlantic horse mackerel	Cunene horse mackerel	False scad	Total
70	90	30	190