

## **SURVEYS OF THE FISH RESOURCES OF ANGOLA**

**Cruise Report No 2/2006**

**Survey of the pelagic resources  
21 July – 21 August 2006**

**Institute of Marine Research  
IMR  
Bergen**

**Instituto Nacional de Investigação Pesqueira  
INIP  
Luanda**

**Ministère de la Agriculture  
Elevage et Pêche  
R.D.Congo**

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The Programme has previously conducted the following demersal surveys in the area:

<b>Area</b>		<b>Period</b>
January 1985	-	June 1986 (6 surveys)
January 1989	-	December 1989 (3 surveys)
May 1991	-	September 1992 (3 surveys)
January 1994	-	August 2006 (16 surveys)

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21 July – 21 August 2006**

**by**

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## CHAPTER 1 INTRODUCTION

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### 1.1 Objectives

This survey is one of a series aimed at monitoring the pelagic fish resources of Angola, as agreed with the Instituto Nacional de Investigação Pesqueira (INIP), Luanda.

The main objectives of the survey were the following:

- To estimate the abundance and to map the distribution of the main commercially important pelagic and semi-pelagic fish species in Angolan waters, including the two sardinella species *Sardinella aurita* and *S. maderensis*, the Cunene horse mackerel *Trachurus trecae*, the Cape horse mackerel *Trachurus trachurus capensis* and other pelagic species.
- To study the biological condition of the main species, including length weight-relationships, reproductive stages and stomach fullness.
- To collect gonads, stomachs and otoliths from both horse mackerel and sardinella species, and to collect depth stratified samples of zoo and phytoplankton in order to continue the studies on feeding biology, relating stomach contents to estimated zooplankton compositions and densities.
- To map the general meteorological, hydrographical and biological conditions in the survey area by means of continuous recordings of weather data, CTD-casts (Temperature, Salinity and Oxygen), ADCP measurements (Acoustic Doppler Current Profiler) and plankton sampling along acoustical and hydrographical transect lines.
- On-the-job training for the Angolan participants on the main survey routines, including using the NAN-SIS and Hydrobase software, scrutinizing acoustical data (BEI) and producing acoustical biomass estimates.

The aim of the time series that this survey is part of is to map fluctuations in stock levels in the main pelagic species and to improve the understanding of these fluctuations in terms of the biology of the main species in relation to the environment. Pelagic management decisions for 2006 will be based on the results obtained from this survey.

## 1.2 Participation

The scientific staff consisted of:

From INIP, Luanda:

Filomena VAZ-VELHO (Team leader, 21/7 – 30/7), Bomba BAZIKA (21/7 – 30/7), António BARRADAS (21/7 – 21/8), Paulo COELHO (21/7 – 30/7), João Gouveia EUSÉBIO DÍAS DOS SANTOS (21/7 – 30/7), N'kosi LUYEYE (Team leader 30/7 – 21/8), Henriette LUTUBA NSILULU (30/7 – 21/8), Andom António LUSSEVAKUENO (30/7 – 21/8) and Geraldina SALVADOR (30/7 – 21/8).

From CIP, Benguela:

David QUISSUNGO (21/7 – 30/7) and Tito MILAGRE (21/7 – 21/8).

From CIP, Namibe:

Fernando João GOMBO (30/7 – 21/8) and Erdison DOS ANTOS SAQUENHA (30/7 – 21/8).

From , R.D. Congo:

François BELANGANAYI (21/7 – 30/7).

From IMR, Bergen:

Oddgeir ALVHEIM (Cruise leader, 21/7 - 30/7), Diana ZAERA (Cruise leader, 30/7 – 21/8), Tore MØRK (21/7 - 21/8) and Jan Frode WILHELMSSEN (21/7 - 21/8).

## 1.3 Narrative

The vessel departed Pointe Noire 21 July at 08:00 UTC and steamed to the Angolan border where the survey started at 13:45 UTC the same day. A systematic survey track with equally spaced transect lines (7 nautical miles apart) perpendicular to the coast was followed for the duration of the survey. The surveyed area was divided into four regions:

(a) Congo-CABINDA (4°–5°S); (b) Congo River - north of Pta. das Palmerinhas (6°–9°S): ANGOLA NORTH; (c) The region between 9°S and 13°S: ANGOLA CENTRAL; (d) the region limited by the parallel of 13°S and Cunene River (17°15'S): ANGOLA SOUTH. The survey was completed at Cunene River on the 17<sup>th</sup> August at 01:00 UTC. The vessel called on Luanda July 30<sup>th</sup> at 08:00 UTC and departed next day (July 31<sup>st</sup>) at 20:30 UTC. The survey was resumed the same day at 22:30 UTC. The coverage of the Central region was completed on the 8<sup>th</sup> of August at 17:00 UTC. The survey of the Southern region began the 10<sup>th</sup> of August at 09:00 UTC, after the calibration of the equipment in Baía dos Elefantes (see below) and the vessel reached the end of the southern region and the survey grid at the Cunene River outlet on 17<sup>th</sup> August at 01:00 UTC. The transducer keel was lowered on the 14<sup>th</sup> of August 03:00 UTC. Due to unusual bad weather conditions all work had to be suspended between August the 14<sup>th</sup> 21:30 UTC and the 15<sup>th</sup> 23:30 UTC. During this period the boat just drifted waiting for better conditions to re-start the survey.

The acoustic transducers (18, 38 and 120 kHz (split beam, EK500 1) and 200 kHz (single beam, EK500 2)) were calibrated on the 9<sup>th</sup> of August in Baía dos Elefantes. In addition, as a request from Mrs. J. Coetzee (MCM, South Africa), a full beam plot at 38 kHz was made while all four frequencies were running at 12.8 and 23 m. The sampling trawls, including the small and the mid-sized (15 m vertical opening) pelagic trawls and the demersal trawl (5 m), were used during the survey.

The standardized survey strategy applied in 2002 is now implemented and a systematic survey track with equally spaced transect lines perpendicular to the coast was followed.

The acoustic transects generally cover a depth range of 20 - 500 m. In certain areas in the central region surveying is stopped at about 50 m depth due to extreme steepness of the shelf. The shallowest part of the shelf between N'zeto and the Congo River is partly inaccessible for trawling due to oil platforms and wells. This year this region was only partly covered.

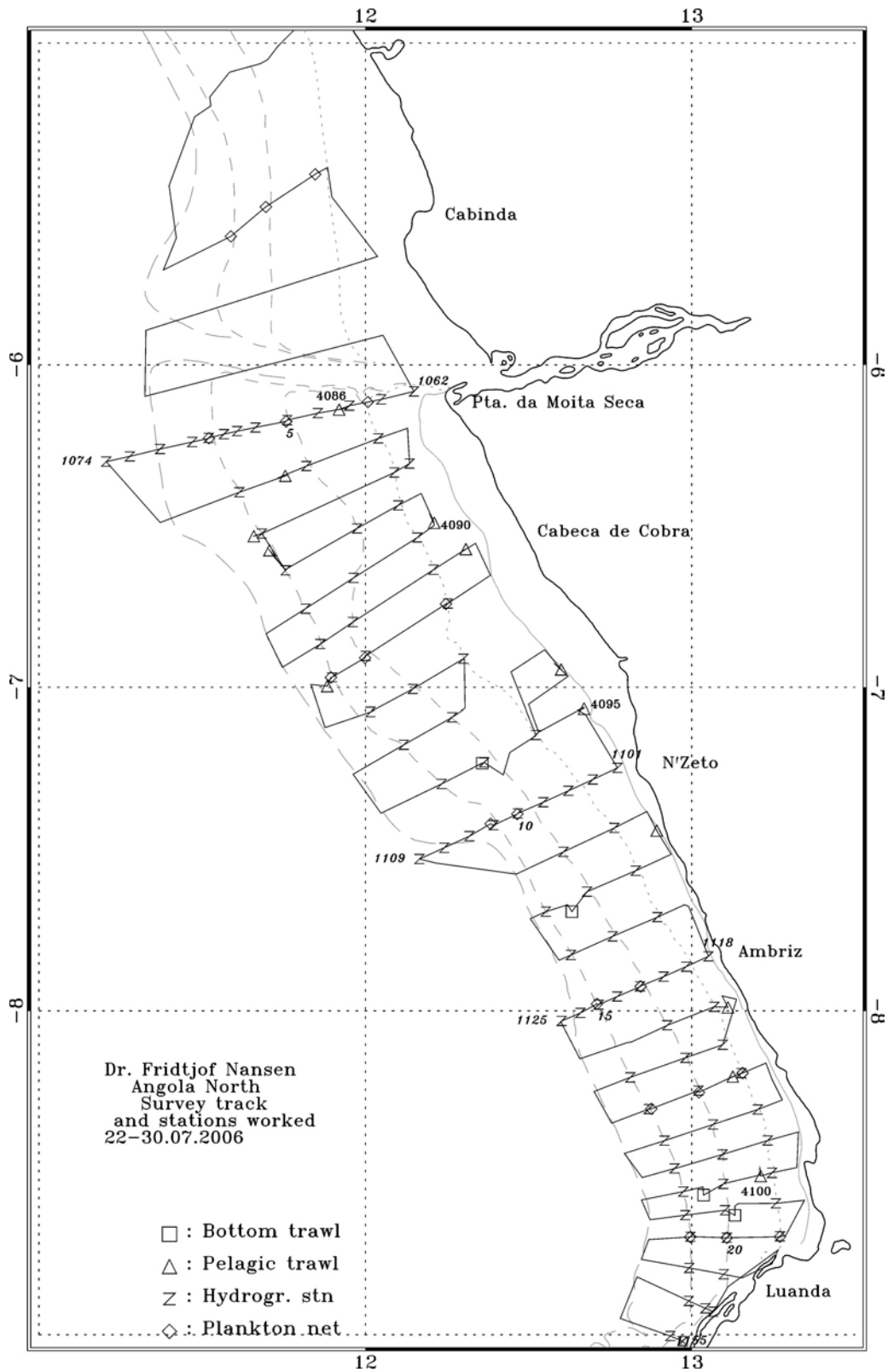
CTD sections that have been covered routinely over the past few years are included in the new, standardized survey grid. ADCP (Acoustic Doppler Current Profiler) recordings were logged continuously along the survey track. Additional CTD stations were added on most transects at bottom depths 50, 100 and 200 m. Samples of phytoplankton were collected on selected CTD stations during daytime. Zooplankton samples were obtained using *Hydrobios Multinet* plankton sampler near selected CTD locations.

#### 1.4 Survey effort

Figure 1(a-c) shows the cruise tracks with fishing, plankton and hydrographic stations for the Cabinda and northern region, central and southern regions of Angola. Table 1 summarizes the survey effort by regions.

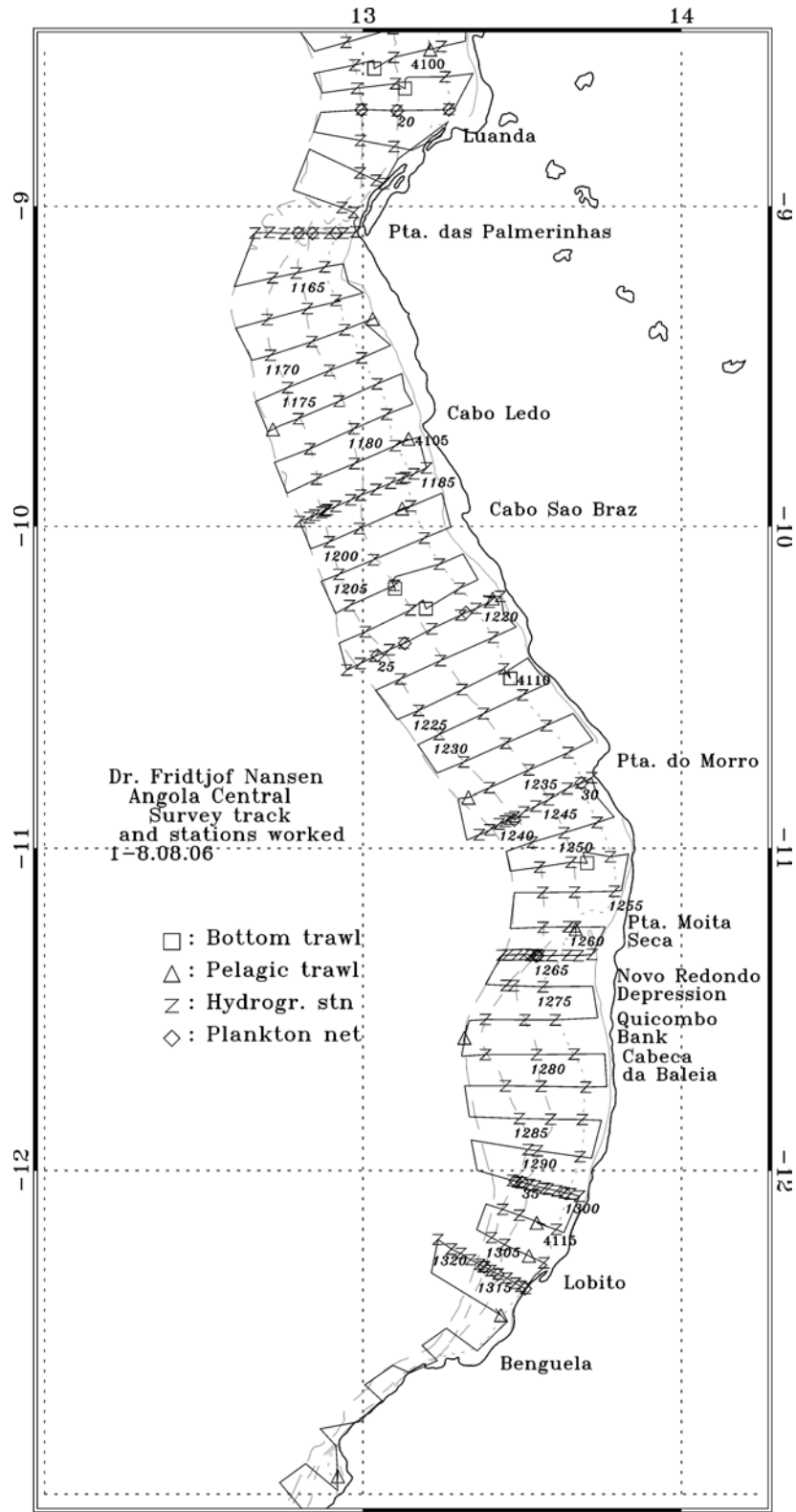
**Table 1.** Summary of survey effort by regions, including number of demersal (BT) and pelagic (PT) trawl hauls, CTD casts, Multinet stations (2-5 zooplankton samples per station) and distance surveyed (log).

Area	BT	PT	Total Trawls	CTD casts	Multinet stations	Log (NM)
Cabinda - Congo	0	0	0	0	3	177.0
Pta. Palmerinhas - Congo River	4	13	17	61	18	1264.6
Benguela - Pta. Palmerinhas	4	12	16	170	18	1369,1
Cunene River - Benguela	9	10	19	90	21	1052.3
Total	17	35	52	321	60	3862.7

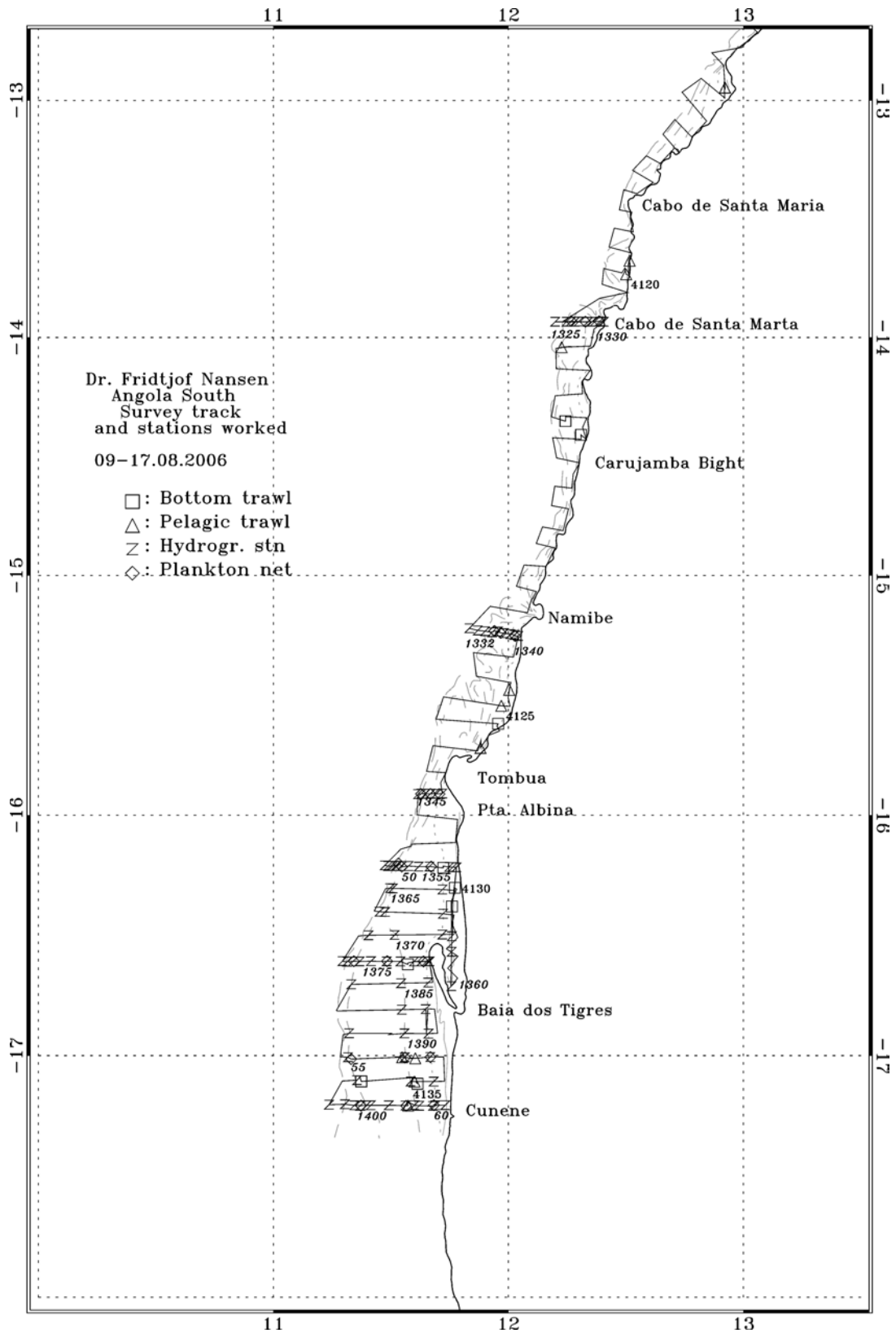


**Figure 1a.** Course track with fishing, plankton and hydrographic stations, Pta. das Palmerinhas- Congo River, including Cabinda. Depth contours at 20, 50, 100, 200, and 500m.





**Figure 1b.** Course track with fishing, plankton and hydrographic stations, Benguela -Pta. das Palmerinhas. Depth contours at 20, 50, 100, 200, and 500m.



**Figure 1c.** Course track with fishing, plankton and hydrographic stations, Cunene-Benguela. Depth contours at 10, 20, 50, 100, 200 and 500 m.

## CHAPTER 2      METHODS

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### 2.1      Hydrographic sampling

A Seabird 911+ CTD probe was used to obtain vertical profiles of the temperature, salinity and oxygen. Real time logging was carried out using the PC based Seabird Seasave software. CTD casts were conducted along the cruise track in transects at about 20 NM distance, and *ad hoc* as deemed necessary. The casts were stopped a few meters above the bottom, and at a maximum of 500 m depth.

Measurements were carried out on CTD stations and selected transects only, using the hull-borne Acoustic Doppler Profiler (ADCP). The ADCP was set to ping every 8 seconds, the depth bins were set to 8 m and the number of bins was 40. Data were averaged at 300 seconds intervals and stored on an IBM compatible PC using Transect v. 2.70 software.

Meteorological data logged from the Aanderaa meteorological station included wind direction and speed, air temperature, incident solar intensity and sea surface temperature (SST). All data were averaged by unit distance sailed (1 NM).

Continuous data on sea surface salinity (SSS) were recorded using a thermosalinigraph SBE 21 Seacat.

### 2.2      Fish sampling

A brief description of the sampling trawls are provided in Annex I. All trawl catches were sampled for species composition by weights and numbers. Records of catch rates are given in Annex II. Length frequencies were taken for the two species of sardinella, two species of horse mackerel, round herring and some species of the Carangidae family, such as the false scad.

Biological samples were obtained for the two species of sardinella and the two species of horse mackerel. Total length and body weight were determined to the nearest 1 cm and 1 g below, respectively. Sex and reproductive stages were determined by means of macroscopic examination, scoring each fish according to the five-point classification scale first proposed by Holden and Raitt (1974) (Table 2).

**Table 2.** The five-point gonad maturity scale proposed for partial spawners by Holden and Raitt (1974). Additional information specific for Cunene horse mackerel (*Trachurus trecae*) as described by Dr. Isabel Afonso Dias during the 2001 survey are included (***bold italic***)

Stage	Maturity status	Description
I	Immature	Ovary and testis lengths about 1/rd of body cavity length. Ovaries pinkish, translucent; testis whitish. Ova not visible to the naked eye.  <b><i>Ovary and testis quite narrow and have a tubular shape.</i></b>
II	Maturing virgin and recovering spent	Ovary and testis about ½ length of body cavity length. Ovary pinkish, translucent; testis whitish, more or less symmetrical. Ova not visible to the naked eye.  <b><i>Ovary more opaque; small specks make gonad appear more granular. Testes develop lobules, hence loosing the tubular shape. Some recovering spent ovaries have conspicuous blood vessels.</i></b>
III	Ripening	Ovary and testis about 2/3rds length of body cavity length. Ovary pinkish-yellow colour with granular appearance, testis whitish to creamy. No transparent ova visible.  <b><i>Milt can be seen inside testes when cut. Ovaries granular due to the presence of opaque oocytes. First time spawners have very swollen gonads. Ovaries that have spawned once lose consistency, but maintain the external appearance typical for this stage.</i></b>
IV	Ripe	Ovary and testis from 2/3rds to full length of body cavity. Ovary orange-pink in colour with conspicuous superficial blood vessels. Large transparent, ripe ova visible. Testis whitish to creamy, soft.  <b><i>Ovaries jelly-like due to the presence of translucent oocytes. Gonads extrude oocytes or milt when gently pressed.</i></b>
V	Spent	Ovary and testis shrunken to about ½ length of body cavity. Walls loose. Ovary may contain remnants of disintegrating opaque and ripe ova, darkened or translucent. Testis bloodshot and slack.  <b><i>Testes may have sperm remaining in the seminal duct. Pinkish areas appear in the periphery of the testes. Ovaries bloodshot and slack.</i></b>

Stomach samples of horse mackerel and sardinella were collected for further analysis at INIP, Luanda. Feeding biology will be investigated in more detail at a later stage by relating the stomach contents to recorded availability of zooplankton. Gonads and otoliths were collected for *ad-hoc* examination.

### 2.3 Plankton sampling

#### *Zooplankton*

The zooplankton sampling was conducted by means of HYDROBIOS Multinet, at three depths, 50, 100 and 200 m, at predetermined positions along the survey track. The nets (405 µm) were fitted with a flowmeter to estimate sample volume. A SCANMAR depth sensor gave real-time information of the depth. The nets were opened and closed remotely from the bridge of the vessel. The samples were preserved in formalin 4%.

## 2.4 Acoustic sampling

### *Acoustic equipment*

The acoustic recordings were conducted using two Simrad EK 500 echosounders (Bodholt *et al.* 1989) running keel mounted transducers at nominal operating frequencies of 18, 38, 120 (EK500 1) and 200 kHz (EK500 2). Few locations along the Angolan coast are favourable for transceiver calibration (essentially Baía dos Tigres and Baía dos Elephantes), and the survey was therefore started without *a priori* calibration. All transceivers were calibrated in Baía dos Elephantes the 9<sup>th</sup> of August.

Acoustic raw-data were logged with the help of the Sun-Unix based Bergen Echo Integrator (BEI) (Knudsen 1996) version 2000. The technical specifications and operational settings of the echosounders used during the survey are given in Annex IV.

### *Allocation of acoustic energy to target taxii*

The acoustic data were scrutinized using the post-processing module of the BEI software. Scatterers were displayed at 38 kHz, standardized to 5 NM echograms with 1 000 pings (horizontal) by 500 bins (vertical). The mean 5 NM area backscattering coefficient  $s_A$  ( $m^2/NM^2$ ) was allocated to a predefined set of taxii on the basis established echogram features. Acoustic groups and respective taxii are listed in Table 3. Ground truthing and estimation of mean length and weight were accomplished by means of targeted pelagic and demersal trawling.

**Table 3.** Allocation of acoustic densities to taxa. Note that for the groups sardinella, horse mackerel, big-eye grunt and pilchard all encountered species are listed, while only examples are listed for the remaining groups.

<b>Group</b>	<b>Taxon</b>	<b>Species</b>
Sardinella	<i>Sardinella</i> sp.	<i>S. aurita</i> <i>S. maderensis</i>
Horse mackerel	<i>Trachurus</i> sp.	<i>T. trecae</i> <i>T. trachurus capensis</i>
Pilchard	Sardinops	<i>S. ocellatus</i>
Big-eye grunt		<i>Brachydeuterus auritus</i>
Pelagic species 1	Clupeiformes <sub>1</sub>	<i>Ilisha Africana</i> <i>Etrumeus whiteheadi</i> <i>Engraulis encrasicolus</i>
Pelagic species 2	Carangidae <sub>2</sub>	<i>Selene dorsalis</i> <i>Chloroscombrus chrysurus</i> <i>Decapterus rhonchus</i> <i>Seriola carpenteri</i>
	Scombridae	<i>Auxis thazard</i> <i>Sarda sarda</i> <i>Scomber japonicus</i>
	Sphyraenidae	<i>Sphyraena guachancho</i>
	Others	<i>Trichiurus lepturus</i> <i>Lepidopus caudatus</i>
Other demersal species	Sparidae <sub>3</sub>	<i>Dentex angolensis</i> <i>D. macrophthalmus</i> <i>D. congoensis</i> <i>D. canariensis</i> <i>D. barnardi</i> <i>Pagellus bellottii</i> <i>Sparus caeruleostictus</i> <i>S. pagrus africanus</i>
	Other taxii	<i>Saurida brasiliensis</i> <i>Arioma bondi</i> <i>Pomadasys incisus</i> <i>Galeoides decadactylus</i>
Mesopelagic species	Myctophidae <sub>3</sub>	<i>Diaphus dumerili</i>
	Other mesopelagic fish	<i>Trachinocephalus myops</i>
Plankton	Calanoidae	<i>Calanus</i> sp.
	Euphausiidae	<i>Meganyctiphanes</i> sp.
	Other plankton	

<sub>1</sub>: other than *Sardinops* sp.; <sub>2</sub>: other than *Trachurus* sp.; <sub>3</sub>: main taxon in group.

*Estimation of biomass*

The target strength (TS) function used to convert mean area backscattering coefficient  $s_A$  ( $m^2/NM^2$ ) at 38 kHz to number of fish corresponds to:

$$TS = 20 \log L - 72 \text{ (dB)} \quad (1)$$

or

$$C_F = \frac{10^{7.2}}{4\pi} \cdot L^{-2} \quad (2)$$

where  $C_F$  is the conversion factor from acoustic density to fish biomass and  $L$  is the mean total fish length. This target strength function was originally established for North Sea herring, but has later been attributed to clupeids in general (Foote *et al.*, 1986; Foote, 1987). No specific target strength relations presently are available for the species at hand, and equation (2) has therefore been applied consequently for all targeted species in this time series. The biomass was calculated by multiplying the number of fish by the expected length at weight, estimated by regressing the log-length (total) against total weight. Separate length-weight relationships were worked for each region (north, central, south), pooling all data within each region.

The boundaries of encountered fish aggregations (post strata) were determined by means of contouring within the inner and outer zero-value limits of the transect lines. The strata contours were digitised using a CalBoard III digitising board / Atlas Draw v. 2.1 PC based software. Distribution plots and area calculations on the strata were carried out using IDL 6.1 for MS Windows. Sub-stratification was used to isolate areas of similar densities, using the following pre-defined, standard categories: 1:  $s_A = 0-300$ ; 2:  $s_A = 301-1\ 000$ ; 3:  $s_A = 1\ 001-3\ 000$ ; 4:  $s_A > 3\ 001$ .

Mean 5-NM integrator values ( $s_A$ ) computed along the transect lines were re-averaged for each stratum. The short spacing between the lines (7 NM) makes it impossible to exclude all between-transect values without removing some on-line contributions, particularly for sardinella on the inner shelf. The potential positive bias of including between-line values is likely smaller than the negative bias that would have been introduced by excluding high on-line contributions. This bias is also counteracted by the shallow distribution pattern (partly above the integration limit) and vessel avoidance behaviour of sardinella (Misund and Aglen, 1992). All estimates should consequently be considered as relative indices of abundance.

The overall length frequency distributions within strata were estimated by weighting the sample-distributions with the nearest valid 5 NM integrator value, or the average of two adjacent values. Target species of the same genus, i.e. *S. aurita* / *S. maderensis* and *T. trecae* / *T. trachurus capensis*, are not acoustically distinguishable, and the  $s_A$  values were therefore split according to the relative distributions of the two species in each length group. The total number of fish in each length group was estimated as:

$$\rho_i = \frac{\langle s_A \rangle t_{i,j} \cdot u_i \cdot A_s}{\sum_i \frac{u_i}{C_{Fi}}} = \frac{10^{7.2} \cdot t_{i,j} \cdot u_i \cdot \langle s_A \rangle \cdot A_s}{4\pi \sum_i u_i \cdot (L_i + 0.5)^2} \quad (3)$$

where:

$\rho_i$	=	estimated number of fish in length group i
$\langle s_A \rangle$	=	mean recorded area backscattering coefficient ( $m^2/NM^2$ )
$t_{i,j}$	=	proportion of species j in length group i
$u_i$	=	proportion of sampled fish in length group i
$A_s$	=	horizontal area of stratum s
$C_{Fi}$	=	conversion factor for length group i
$L_i$	=	length group i (nearest full cm below total length)
$L_i+0.5$	=	mean length in $L_i$ .



## CHAPTER 3 OCEANOGRAPHIC CONDITIONS

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### 3.1 Surface distribution

#### *Cabinda and the northern region*

The wind observed in this region during this survey was moderate, with an average velocity of around 10 knots (5m/s) (Figure 2a), though it was stronger than that of last year. The dominant direction was from the south and southwest. Around Ambriz the wind speed increased at about 20 knots (10m/s). Between Ambriz and Luanda the average wind direction became predominantly southeast with an area of wind relaxation blowing from the east.

The sea surface temperature (taken at 5m depth) is shown in Figure 3a. The isotherms are mainly oriented alongshore with colder waters located inshore. Between Ambriz and Luanda we can observe a deflection of the isotherms offshore at the place where the wind blows from the east. It is important to mention that the surface temperature is higher than previous year in one or two degrees, ranging from 20 to 22°C, except south of Luanda where we found inshore temperatures of 19°C.

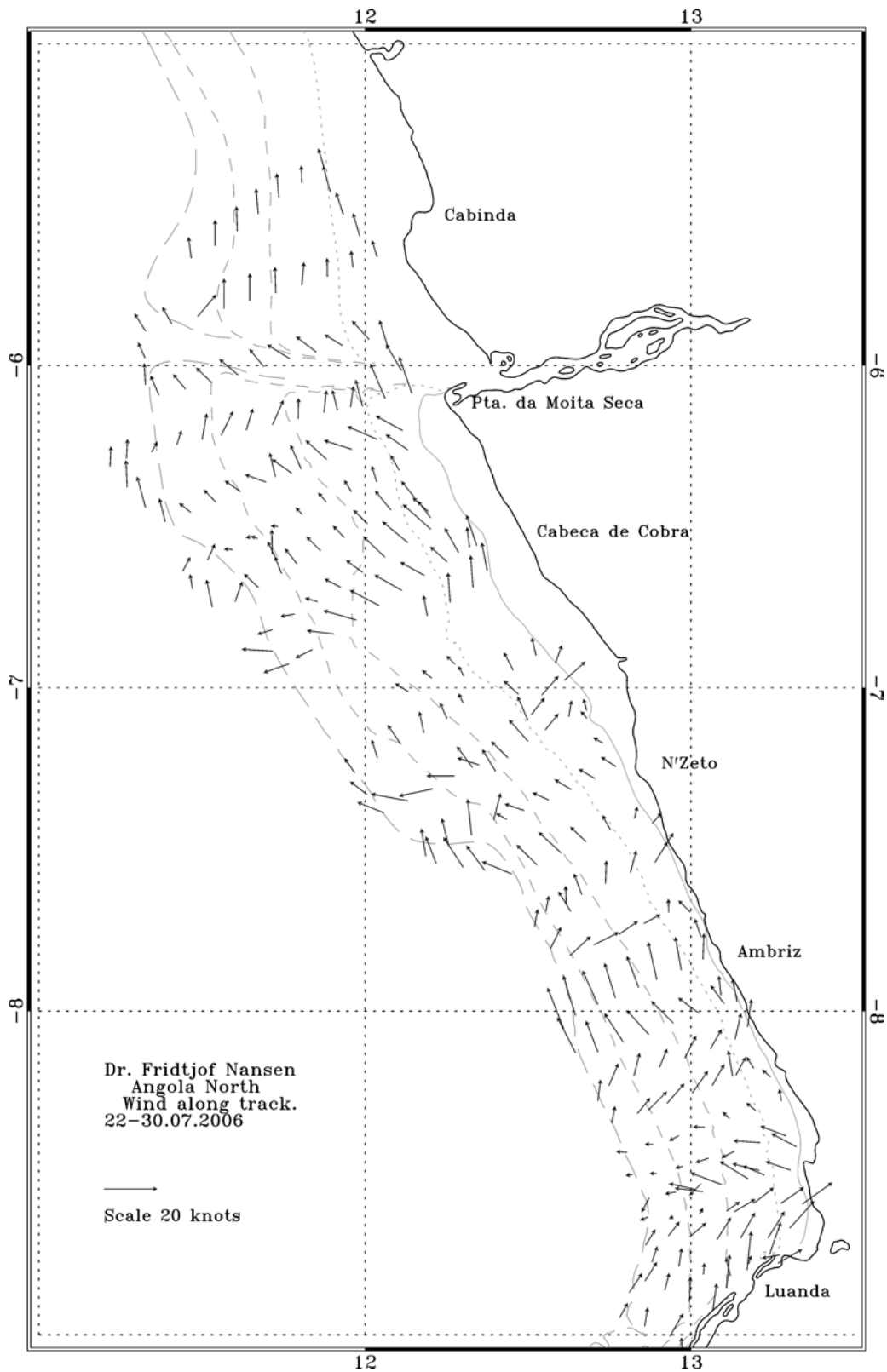
#### *Central Region*

In this region the wind was very variable both in strength and direction (Figure 2b). The strongest winds (around 20 knots) were registered between south of Pta. das Palmerinhas and south of Cabo São Braz. The main wind direction oscillated between southeast and southwest. The surface water temperature registered lower values than in the northern region, varying between 19 and 21°C (with a pocket of warmer water offshore south of Cabo São Braz) (Figure 3b). Here as well, the isotherms were oriented alongshore.

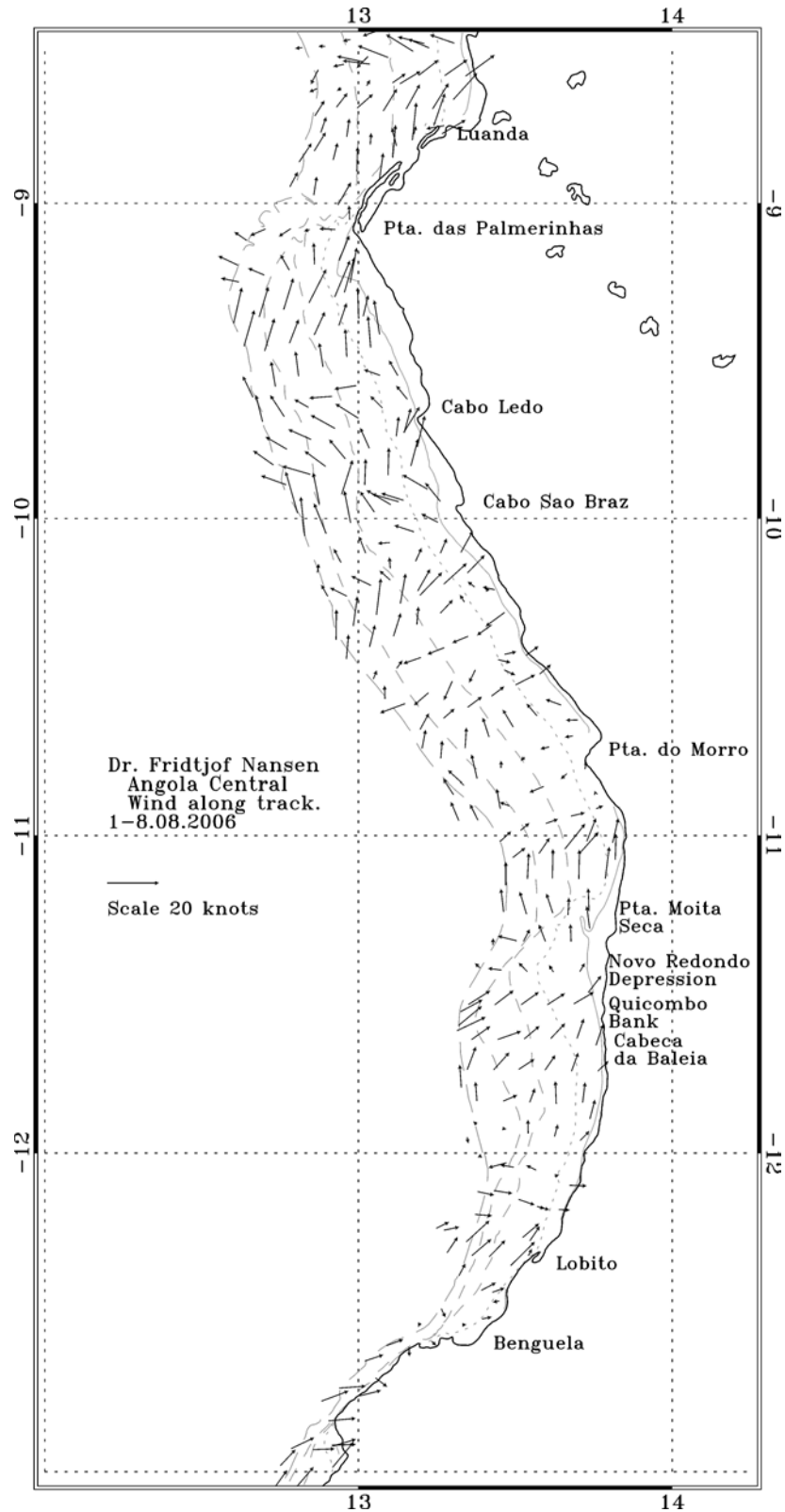
#### *Southern Region*

The wind in this region was stronger and with less variance regarding its direction (Figure 2c), and the dominant direction was from the south. Around Carujamba, Namibe and at Congo River's mouth the wind came from the east or from the north and speeds were at minimum. Two focus of strong wind were encountered: around Cabo de Sta. Marta with winds blowing SW and around Baía dos Tigres where the wind had a more SE direction. In this later location the winds were unusually strong, forcing the ship to suspend all kind of work. The speeds registered in this area reached the 47 knots.

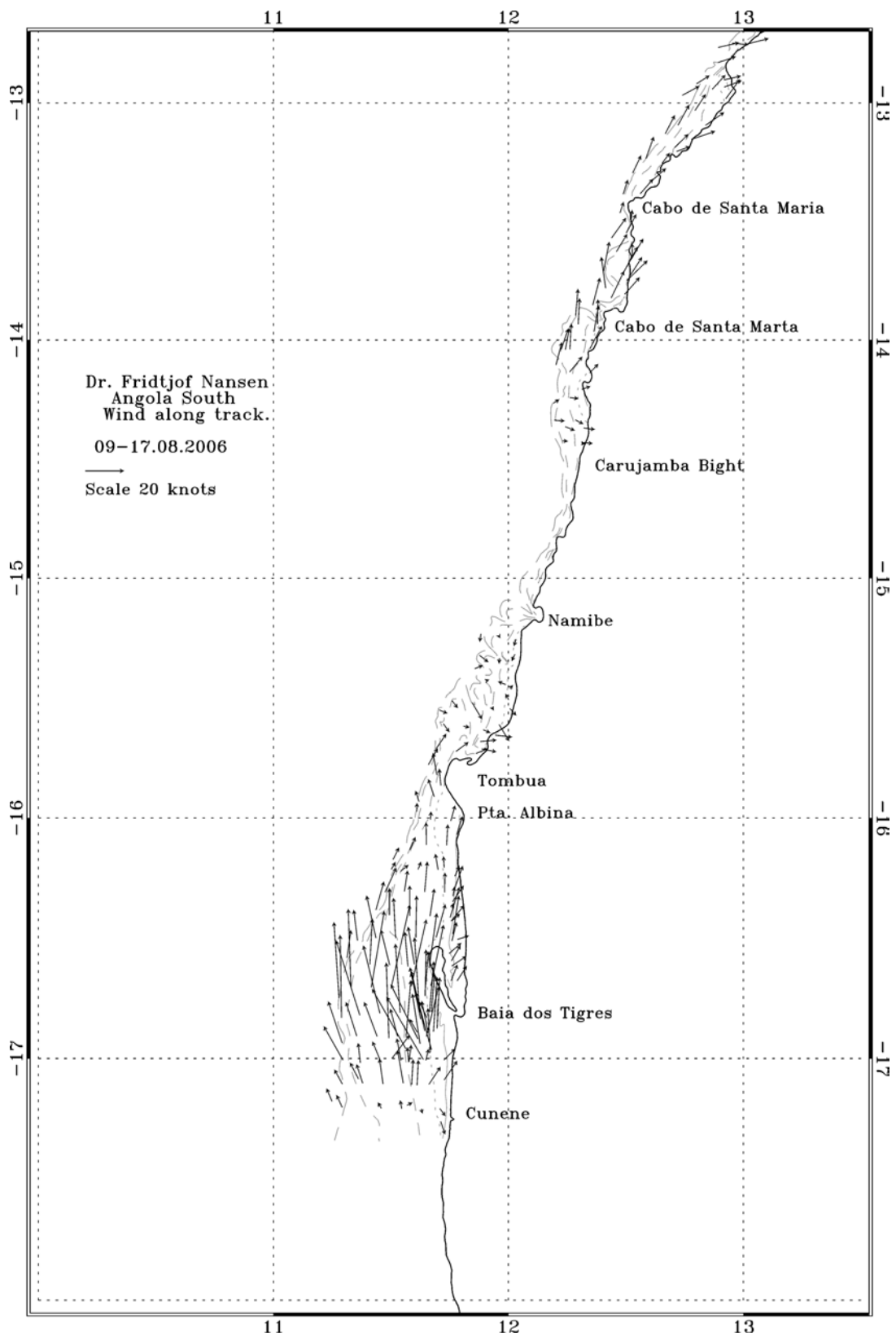
The horizontal temperature distribution (Figure 3c) shows a relatively flat structure. The isotherms were oriented along shore for most of the southern region, it was only between Tombua and Baía dos Tigres when they are deflected and tend to run oblique to the coast. It is also in this region where the water temperature was the lowest (16 to 18°C).



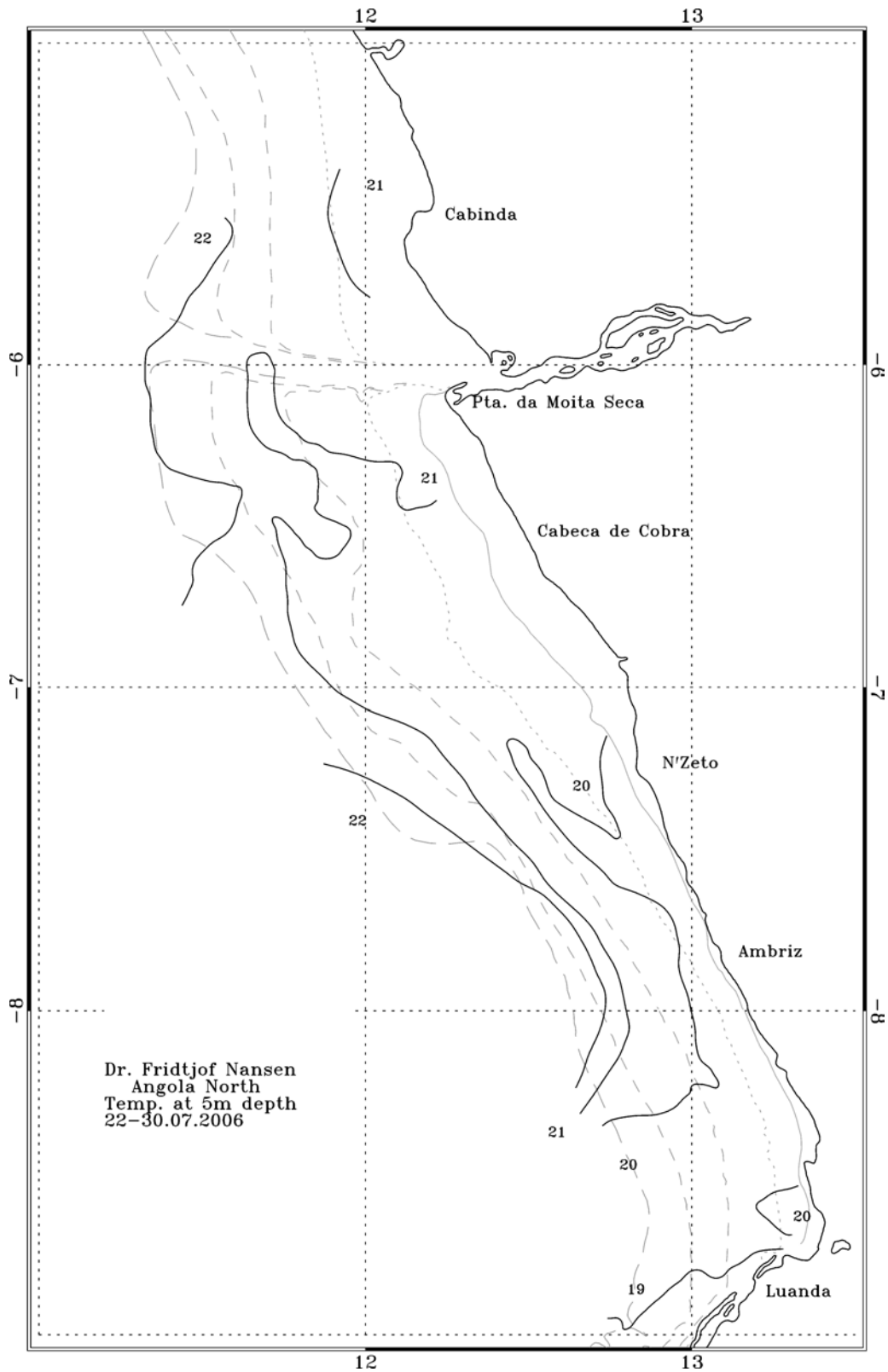
**Figure 2a.** Distribution of wind velocities along the survey track for the northern region, including Cabinda. Depth contours at 20, 50, 100, 200, and 500m.



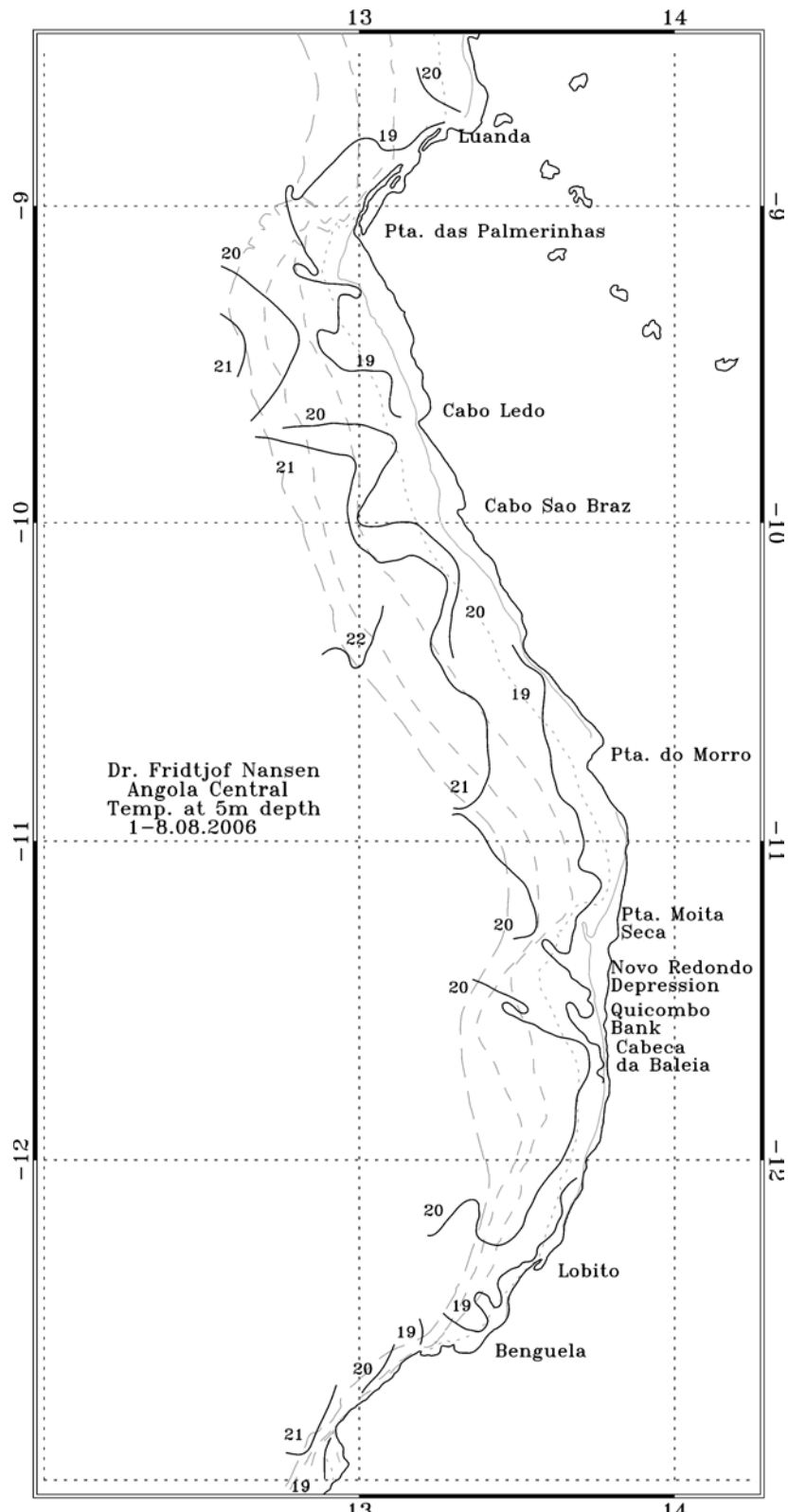
**Figure 2b.** Distribution of wind velocities along the survey track for the central region. Depth contours at 20, 50, 100, 200, and 500m.



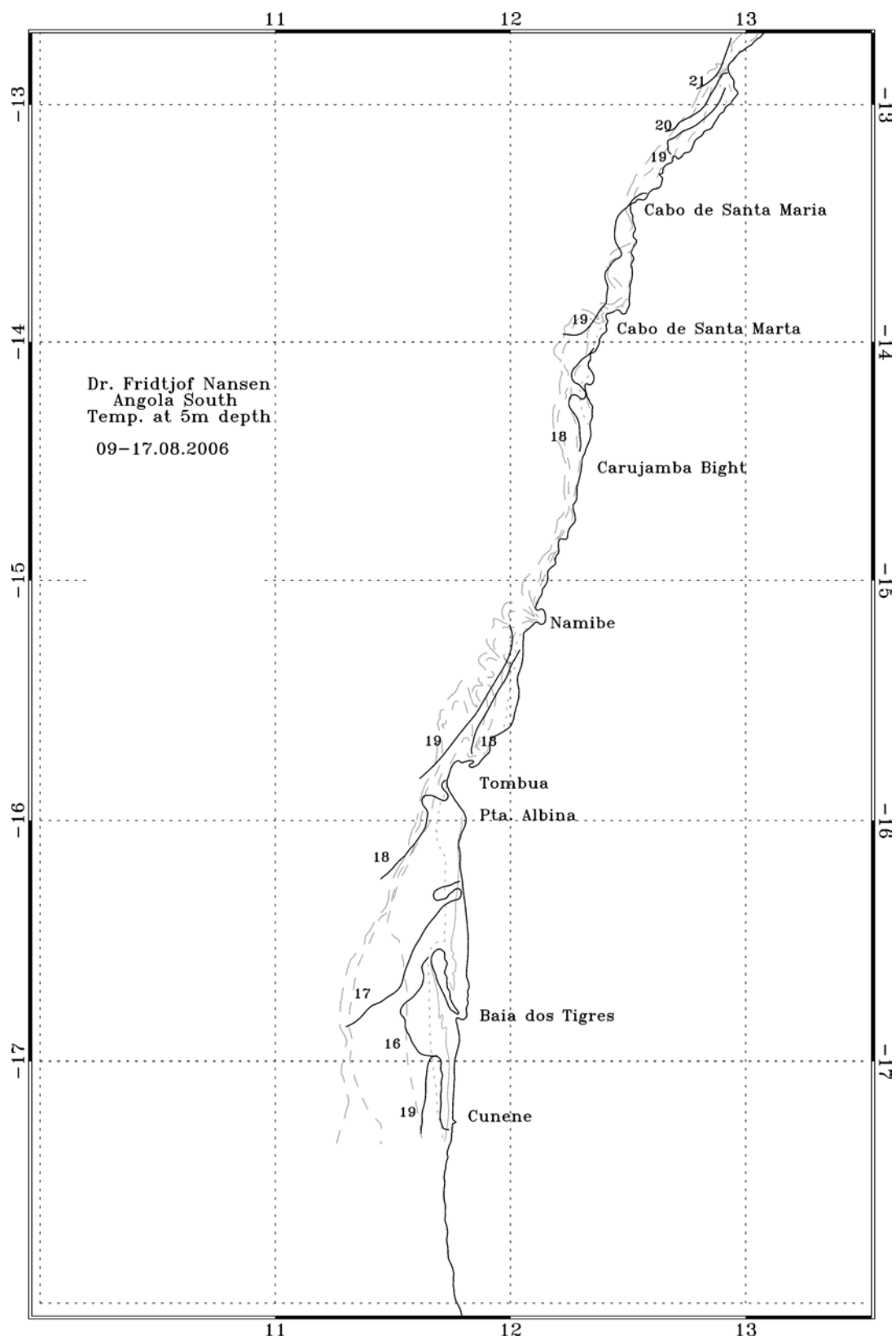
**Figure 2c.** Distribution of wind velocities along the survey track for the southern region. Depth contours at 10, 20, 50, 100, 200 and 500 m.



**Figure 3a.** Distribution of water temperatures at 5m depth in the northern region, including Cabinda. Depth contours at 20, 50, 100, 200, and 500m.



**Figure 3b.** Distribution of water temperatures at 5m depth in the central region. Depth contours at 20, 50, 100, 200, and 500m.



**Figure 3c.** Distribution of water temperatures at 5m depth in the southern region. Depth contours at 20, 50, 100, 200, and 500m.

### 3.2 Standard sections

Section off **Moita Seca** (Figure 4a). This section is located off the Congo River's mouth. Although the river discharge is reduced during this months (winter season), the plume of fresh water can be observed in the stations close to the coast. At station 1067 we can observe subsurface water welled up to the surface. Oxygen content is high at the surface (5ml/l), while low oxygen waters (1ml/l) appear below 250m depth. In this section, as in all the others, the maximum temperature is found near the surface and decreases with depth.

In the sections of **N'zeto** (Figure 4b) and **Ambriz**, (Figure 4c) the distribution of oceanographic parameters is very similar in both sections, and indicates a weak upwelling. Oxygen content onshore at the surface is as high as 7 ml/l.

Section off **Pta. of Palmerinhas** (Figure 4d). The salinity distribution shows lower values (35.3-35.6 psu) at the surface than the previous sections. This may be due to the outflow of the Kwanza River. Surface temperatures (18-19°C) and oxygen content (4ml/l) also show lower values than previous sections. From this section southward the oxygen distribution reveals an offshore minimum at about 200-400 m.

Section off **Cabo Ledo** (Figure 4e). The salinity distribution reveals the presence of brackish water probably as a result of the influence of local rivers. The elevation of the isolines indicates an ongoing upwelling process.

Sections off south **Cabo São Braz** and **Pta. do Morro** (Figure 4f and 4g). Temperatures near the coast are lower than in previous section. The thermo and haloclines appear below 20-30 m. We did not observe the upwelling registered in the previous section.

Section off **Novo Redondo** (Figure 4h). Lower levels of oxygen (1ml/l) at the bottom appear in shallower waters compared with the previous sections (around 50m). The offshore elevation of the isolines indicates a weak open sea upwelling process.

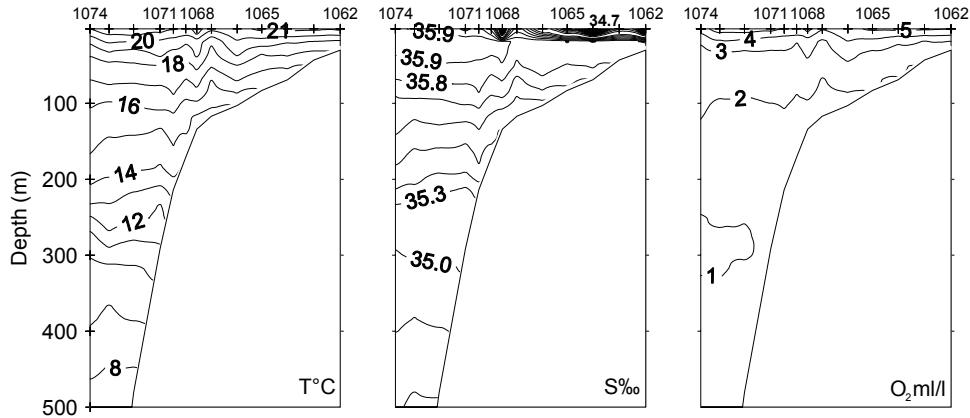
The Figures 4i and 4j show the vertical distributions of temperature, salinity and oxygen worked out off **Ponta do Egito** and **Lobito**. Oceanographic conditions in these two sections are very similar with surface temperatures of 18-19°C, salinities of about 35.7-35.8 psu and levels of oxygen of 3-4 ml/l, at the surface. There were no signs of upwelling.

Section off **Cabo de Sta. Marta** (Figure 4k). This vertical section shows the presence of colder waters inshore (18°C), and the presence of waters poor in oxygen located around 250-300m depth.

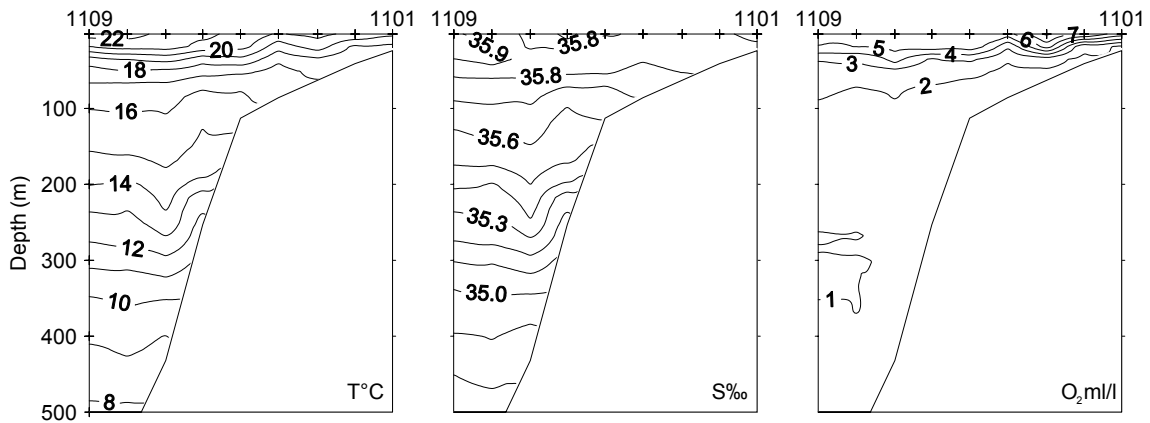
Section off **Namibe** (Figure 4l). Temperature gets cooler towards the coast and the layer of low oxygen (1ml/l) was found offshore around 100 m. The maximum surface salinity (36.0 psu) was found in this section.



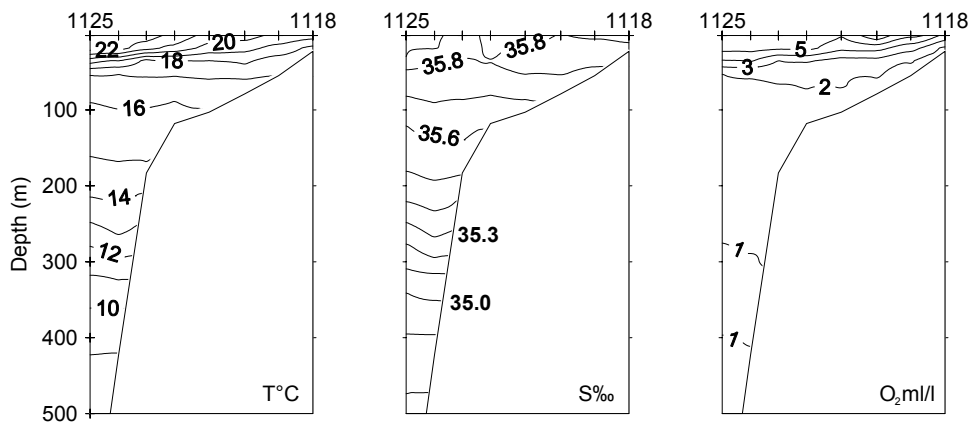
Sections off **Pta. Albina** (Figure 4m), **Baía dos Tigres** (Figure 4n) and off **Cunene River** (Figure 4o). In this region we have observed lower surface temperatures than elsewhere, with values down to 14°C in the Cunene section. The influence of Cunene River is shown in the surface salinity values (35.4 psu). Low oxygen values appeared already below the 100m off Baía dos Tigres.



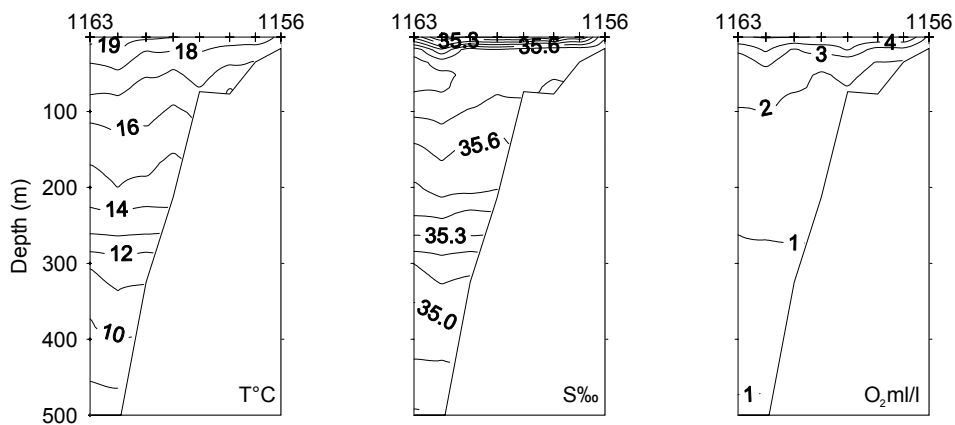
**Figure 4a.** Vertical sections of temperature, salinity and oxygen off Pta. Moita Seca.



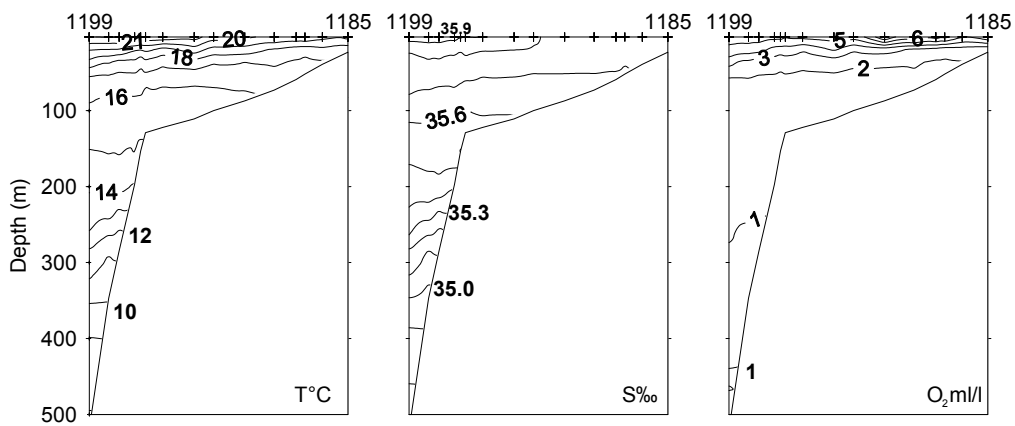
**Figure 4b.** Vertical sections of temperature, salinity and oxygen off N'zeto.



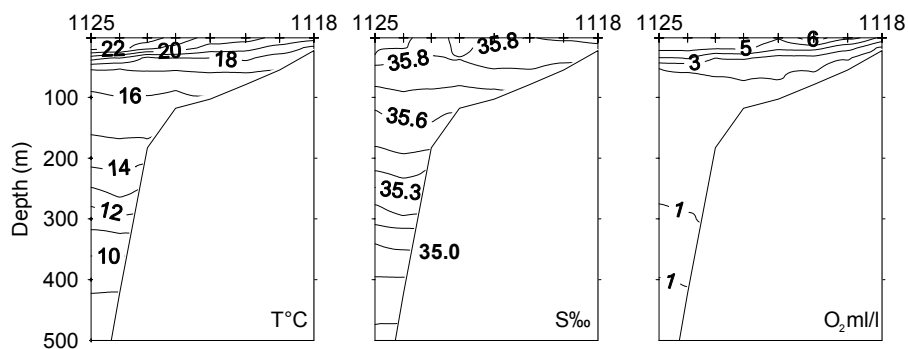
**Figure 4c.** Vertical sections of temperature, salinity and oxygen off Ambriz.



**Figure 4d.** Vertical sections of temperature, salinity and oxygen off Pta. Palmerinhas.



**Figure 4e.** Vertical sections of temperature, salinity and oxygen off Cabo Ledo.



**Figure 4f.** Vertical sections of temperature, salinity and oxygen off south Cabo São Braz.

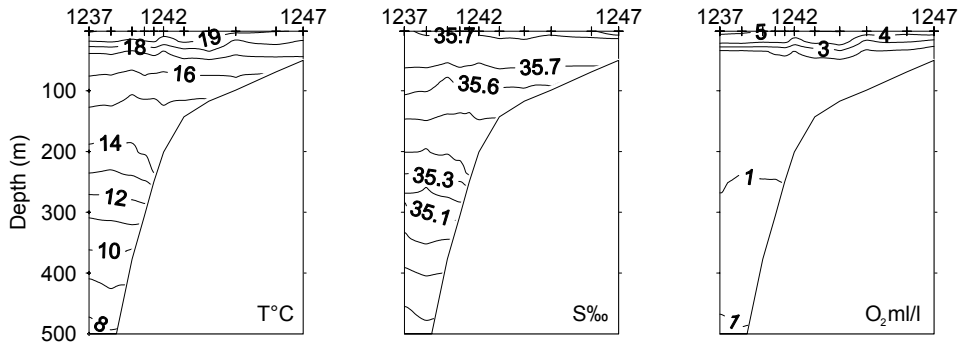


Figure 4g. Vertical sections of temperature salinity and oxygen off Pta. do Morro.

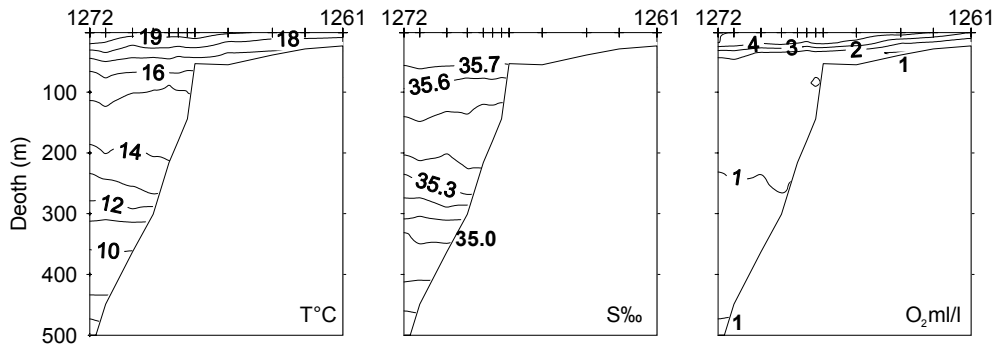


Figure 4h. Vertical sections of temperature salinity and oxygen off Novo Redondo.

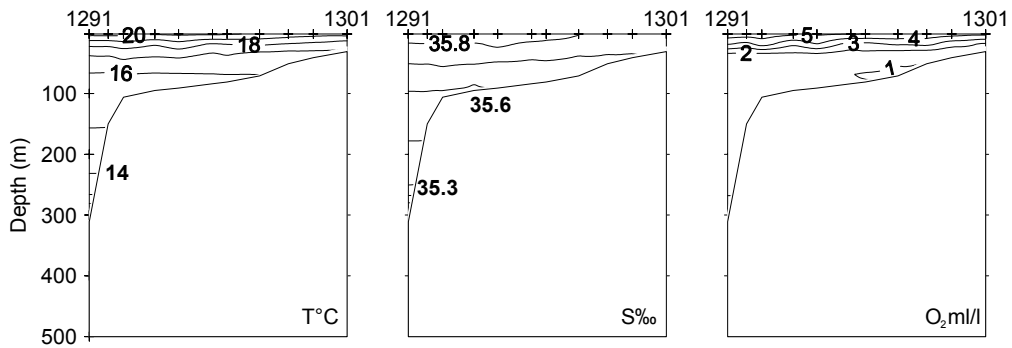


Figure 4i. Vertical sections of temperature salinity and oxygen off Egito.

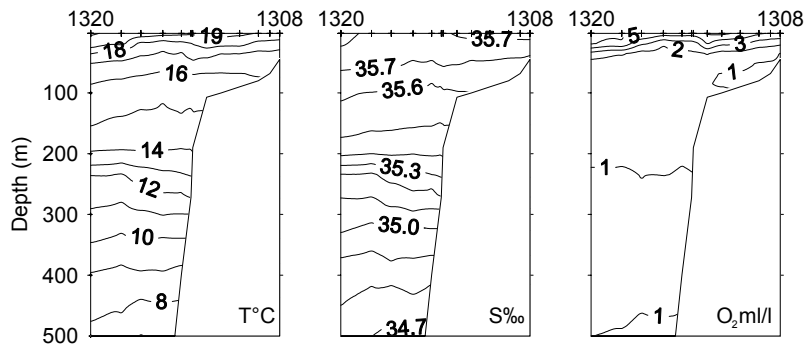
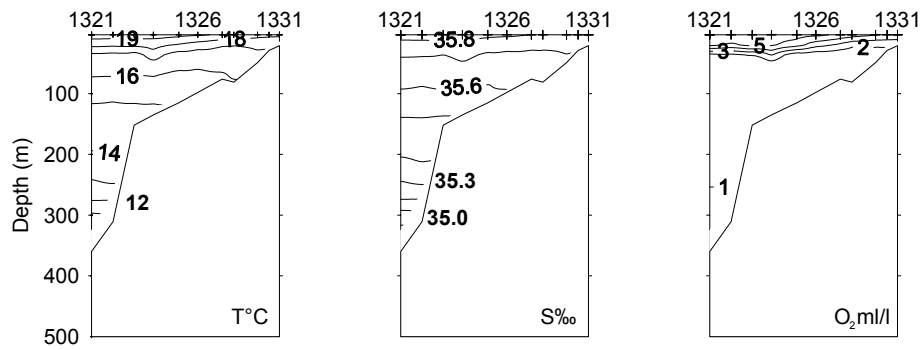
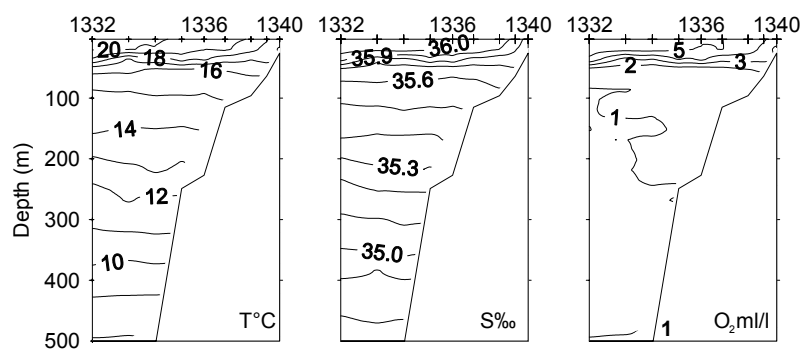


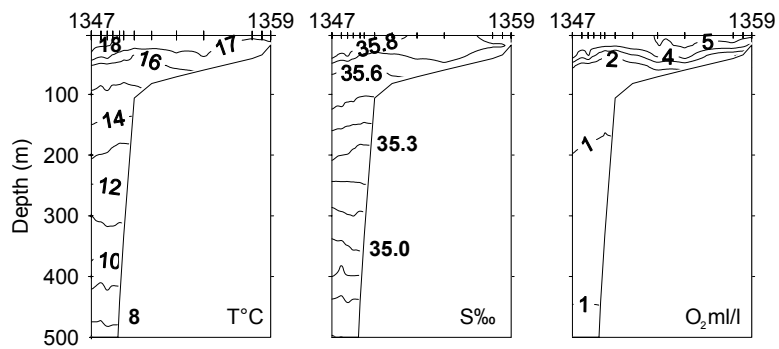
Figure 4j. Vertical sections of temperature salinity and oxygen off Lobito.



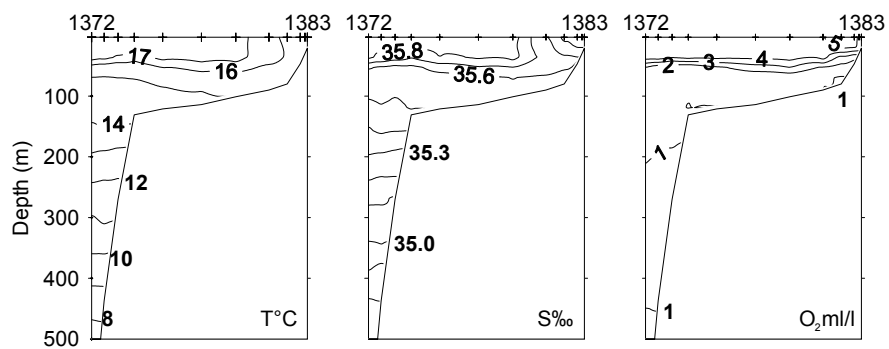
**Figure 4k.** Vertical sections of temperature salinity and oxygen off Cabo de Sta. Marta.



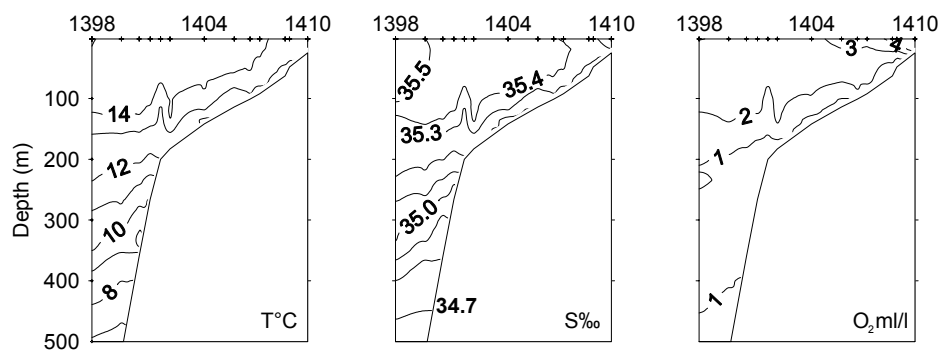
**Figure 4l.** Vertical sections of temperature salinity and oxygen off Namibe.



**Figure 4m.** Vertical sections of temperature salinity and oxygen off Pta. Albina.



**Figure 4n.** Vertical sections of temperature salinity and oxygen off Baía dos Tigres.



**Figure 4o.** Vertical sections of temperature salinity and oxygen off Cunene River.

## CHAPTER 4      DISTRIBUTION,      SIZE      COMPOSITION      AND BIOMASS ESTIMATES

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### 4.1      Cabinda – Congo River (south of Pointe Noire)

#### *Pelagic species 2 (PEL2)*

We found only PEL2 in this region. This category includes members of the family Carangidae (other than *Trachurus* spp.), Scombridae, Sphyraenidae and Trichiuridae, both of shallow and deep waters. *Trichiurus lepturus* was by far the most common species caught, and it was found in a low-density-continuous distribution throughout the area up to the mouth of the Congo River ( $1 < s_A < 300 \text{ m}^2/\text{NM}^2$ ). The biomass of PEL2 was estimated at 7 900 tons. Figure 11 shows the distribution of this group.

Several areas inside the survey region could not be accessed due to oil exploitation activities. As a consequence the area of Cabinda was only partly surveyed.

### 4.2      Pta. das Palmerinhas - Congo River

#### *Sardinella*

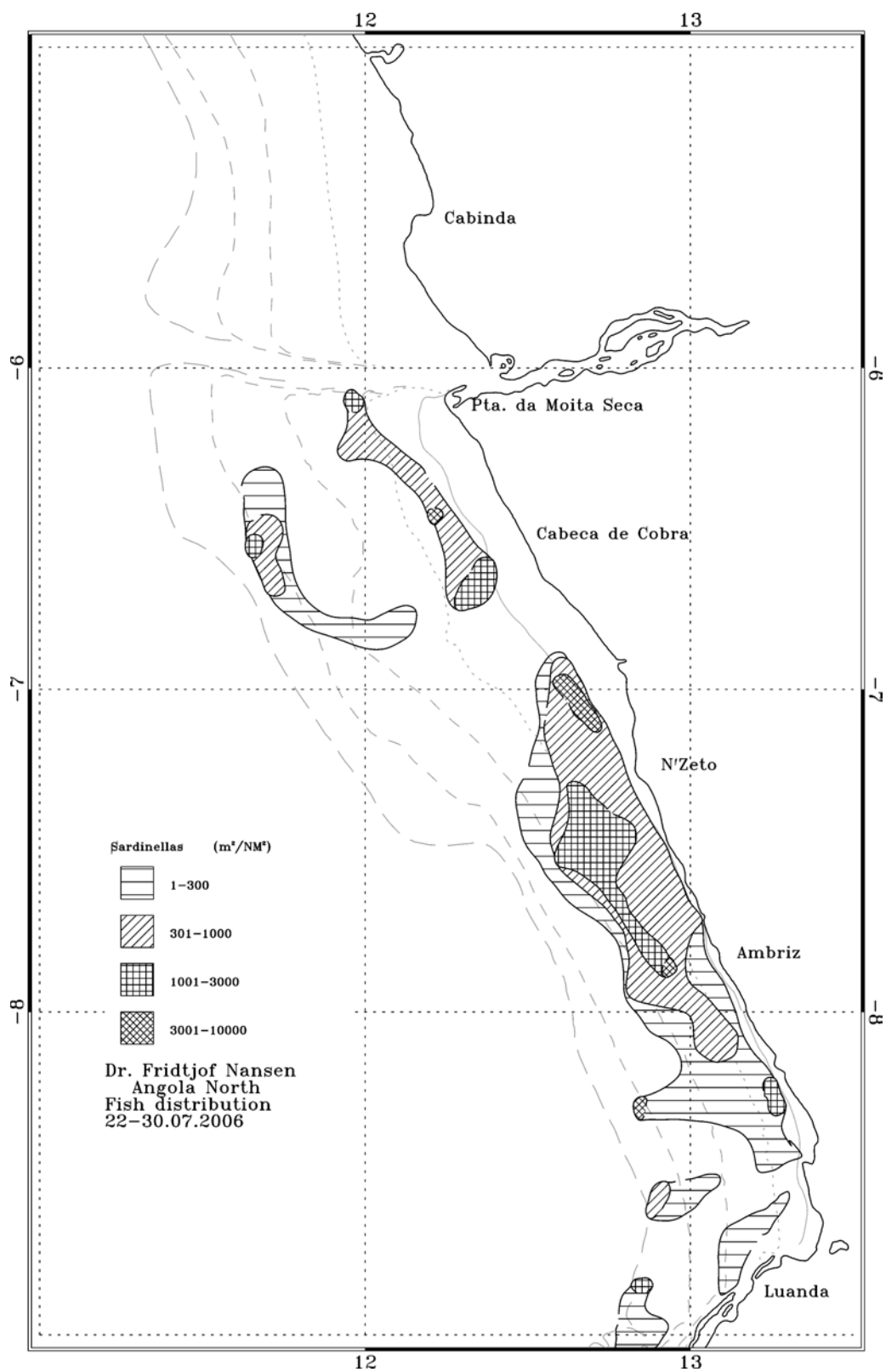
Both *Sardinella maderensis* and *S. aurita* were found throughout of the northern region (Figure 5). The distribution is almost continuous throughout the area. Compared with last year distribution, they were found more offshore and closer to the Congo River's mouth. We also found bigger areas of high density ( $1\ 001 < s_A < 3\ 000 \text{ m}^2/\text{NM}^2$ ), and some very dense areas ( $3\ 001 < s_A < 10\ 000 \text{ m}^2/\text{NM}^2$ ) off Cabeça de Cobra, north of N'zeto, and south of Ambriz.

As observed in the last year's surveys, the sardinella was usually schooling near the surface during daytime, and formed loose aggregations at night. During this survey, and in this area, it was not very difficult to catch sardinella during daytime, probably because they were ripe or spawning and thus easier to catch.

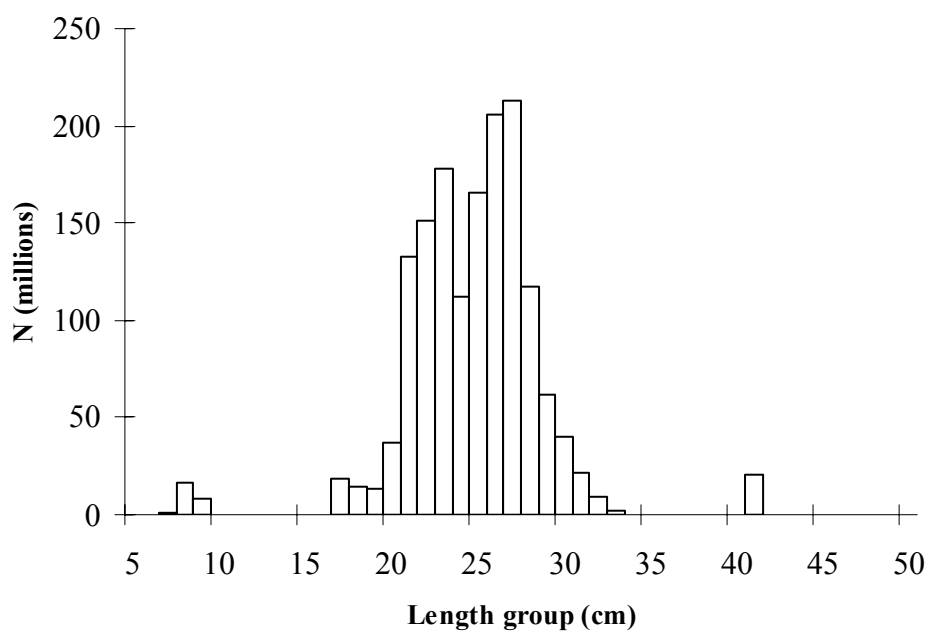
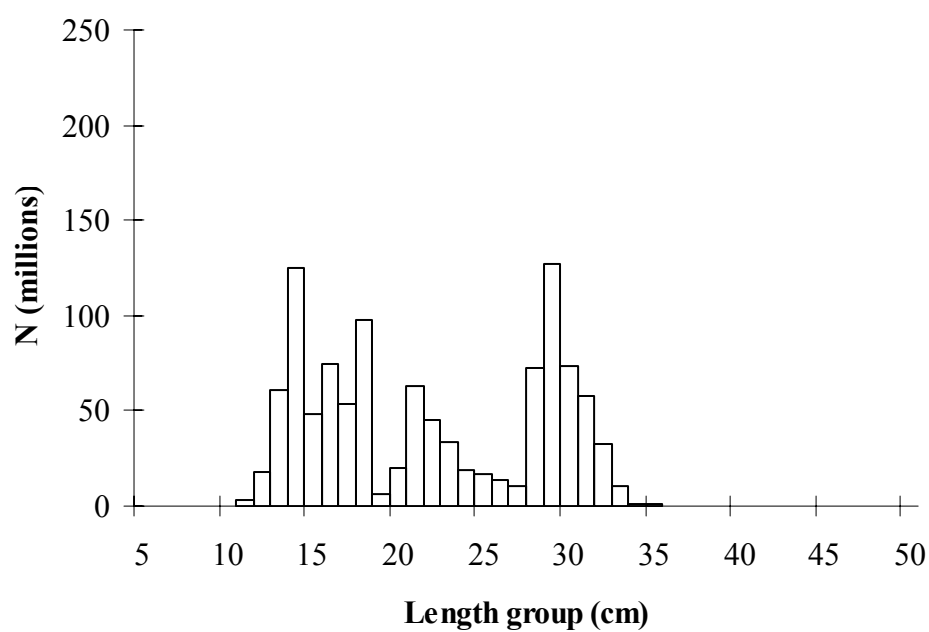
Figure 6 shows the length frequency distribution of *S. maderensis* and *S. aurita*. *S. maderensis* ranged from 17 to 33 cm total length (TL), with two apparent modal peaks at 23 and 27 cm TL. A very small cohort of juvenile with modal peak of around 8 cm TL, which represents less than 5% of total biomass was found in shallow waters (15m). The length distribution for *S. aurita* ranged from 11 to 35 cm TL, and shows three modal peaks at around 14, 21 and 29 cm TL.

The biomass of both sardinellas was estimated at 366 500 tons, which is almost 3,8 times higher than last year estimate (95 400 tons). This value is the highest ever recorded, and we have to go back to 1997 to find similar levels. *S. maderensis* dominated the catches contributing to the total with 231 000 tonnes (63%) while *S. aurita* contributed with 135 000 tonnes (around 37%). For both species the biomass consisted of individuals larger than 25 cm TL (Fig. 7).

The fact of having observed higher temperatures than the last two years could have affected the distribution of the species and favouring the presence of *S. maderensis*, which prefers hotter waters than *S. aurita*.



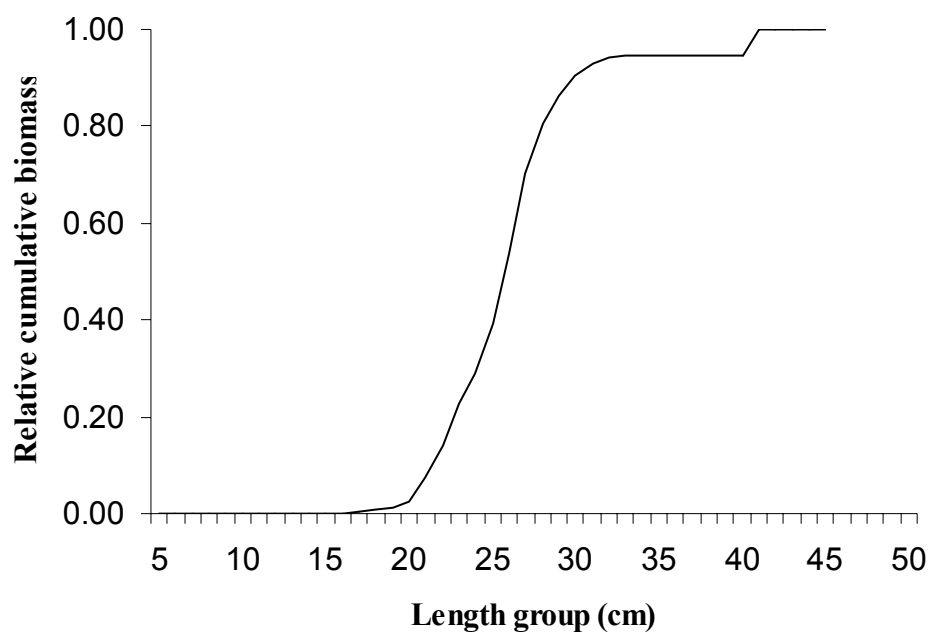
**Figure 5.** Distribution of *Sardinella* spp. Pta. das Palmerinhas-Congo River, including Cabinda. Depth contours at 20, 50, 100, 200, and 500m.

a) *Sardinella maderensis*b) *Sardinella aurita*

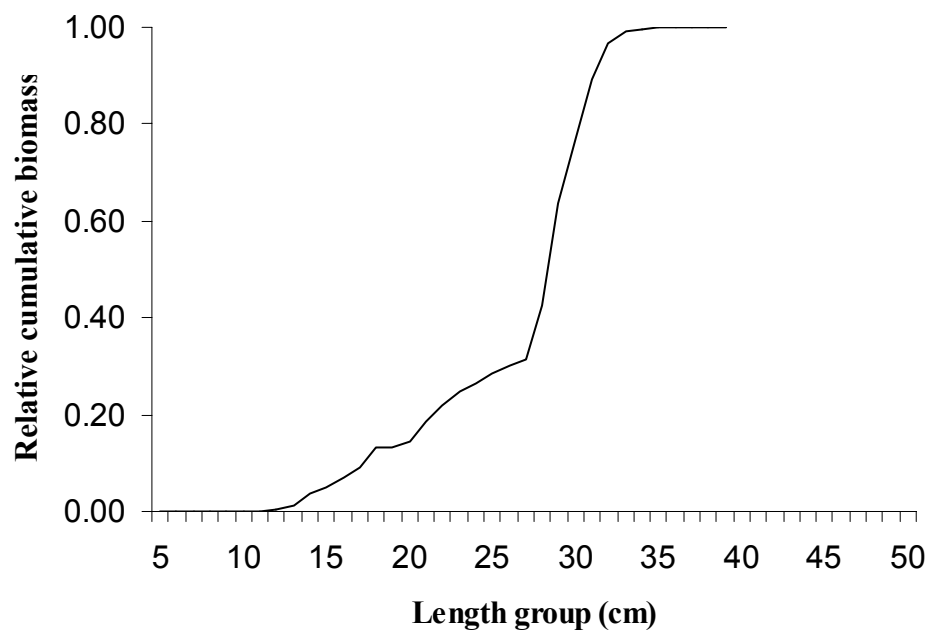
**Figure 6.** Total length distribution of *Sardinella maderensis* (a) and *S. aurita* (b), Pta. das Palmerinhas-Congo River.



a) *Sardinella maderensis*



b) *Sardinella aurita*



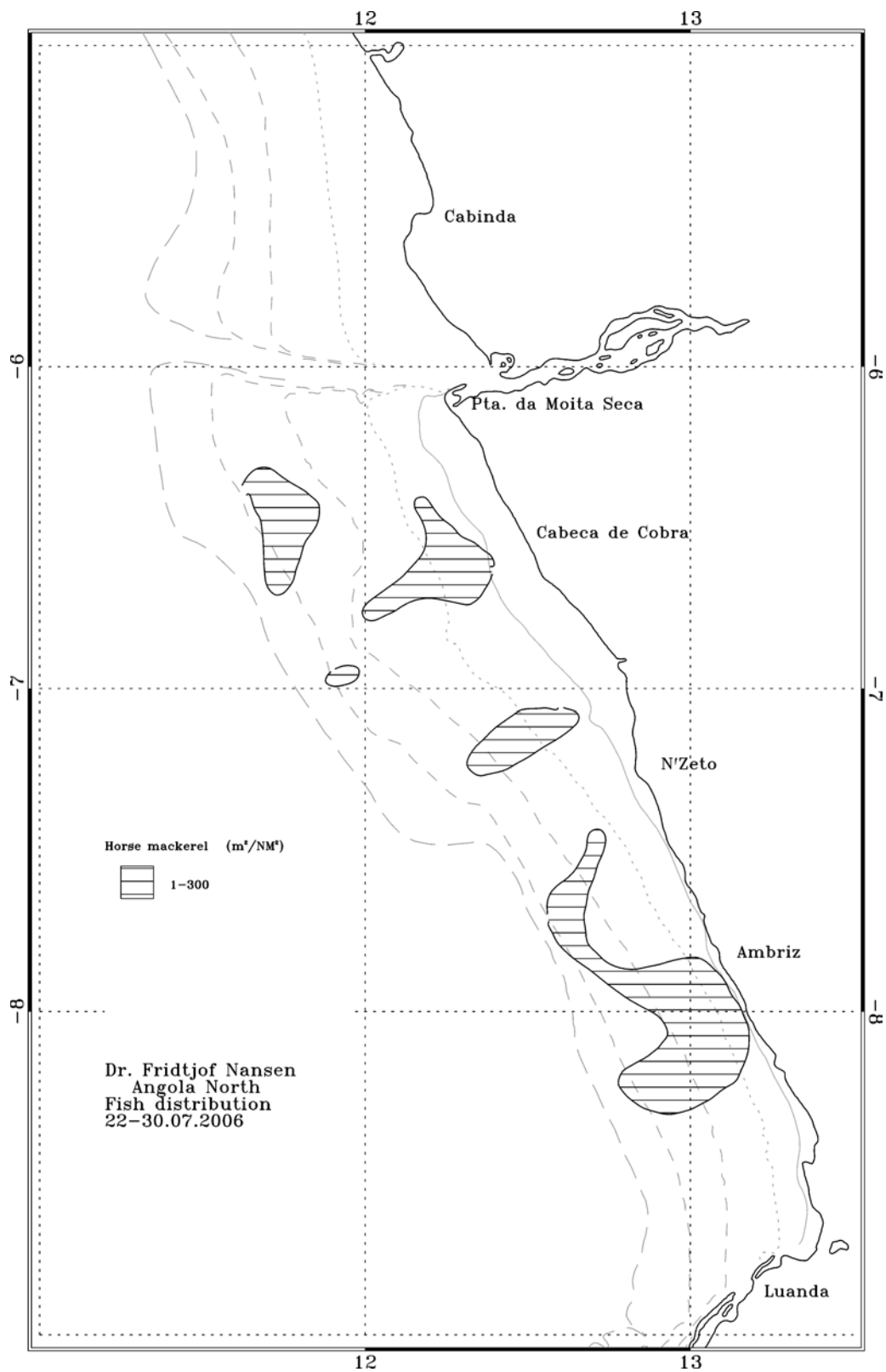
**Figure 7.** Relative cumulative biomass *Sardinella maderensis* (a) and *S. aurita* (b), Pta. das Palmerinhas-Congo River.

*Cunene horse mackerel*

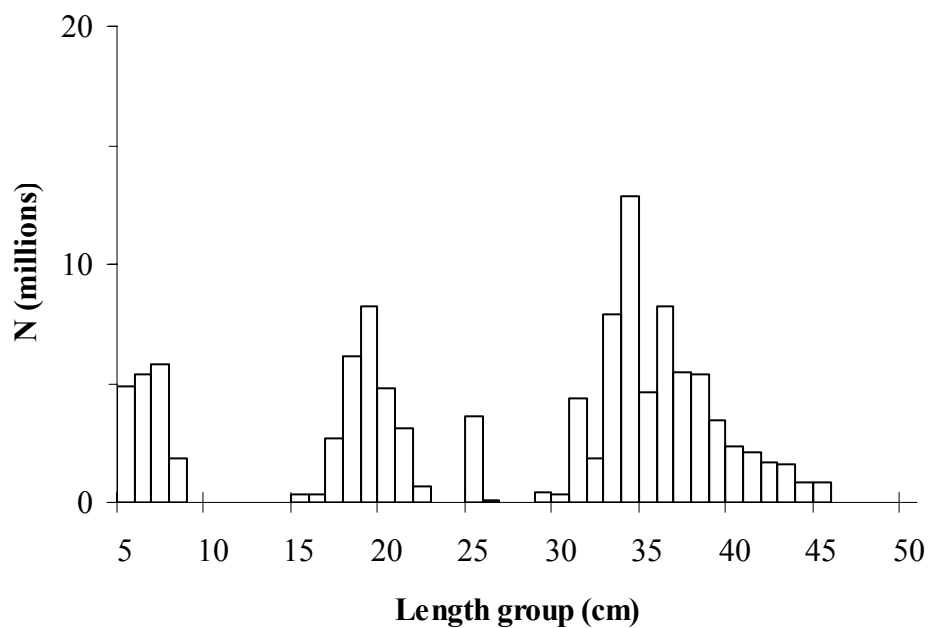
The Cunene horse mackerel, *T. trecae*, was found in five low-density patches ( $1 < s_A < 300$  m<sup>2</sup>/NM<sup>2</sup>) throughout the area (Figure 8).

Figure 9 shows the length frequency distribution of Cunene horse mackerel for the region. The distribution shows three well-defined length groups between 5 and 9 cm TL, 15 to 23 cm TL and the adult cohort of fish larger than 30 cm TL, with modes at about 7, 19 and 34 cm TL respectively.

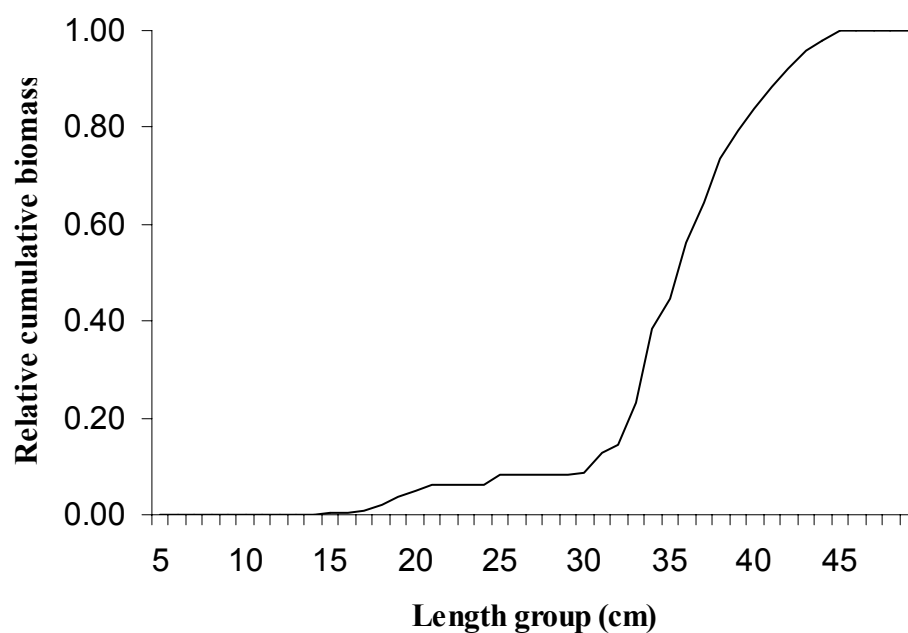
The estimated biomass of *T. trecae* was 31 000 tons and consisted mainly of individuals larger than 34 cm TL (Figure 10). This year's biomass is higher than last year in about 48% but one third of 2004 level.



**Figure 8.** Distribution of Cunene horse mackerel (*Trachurus trecae*), Pta. das Palmerinhas-Congo River, including Cabinda Depth contours at 20, 50, 100, 200, and 500m.



**Figure 9.** Total length distribution of Cunene horse mackerel (*Trachurus trecae*), Pta. das Palmerinhas-Congo River.



**Figure 10.** Cumulative percentage biomass by length group, *Trachurus trecae*. Pta. das Palmerinhas-Congo River.

#### *Other pelagic species*

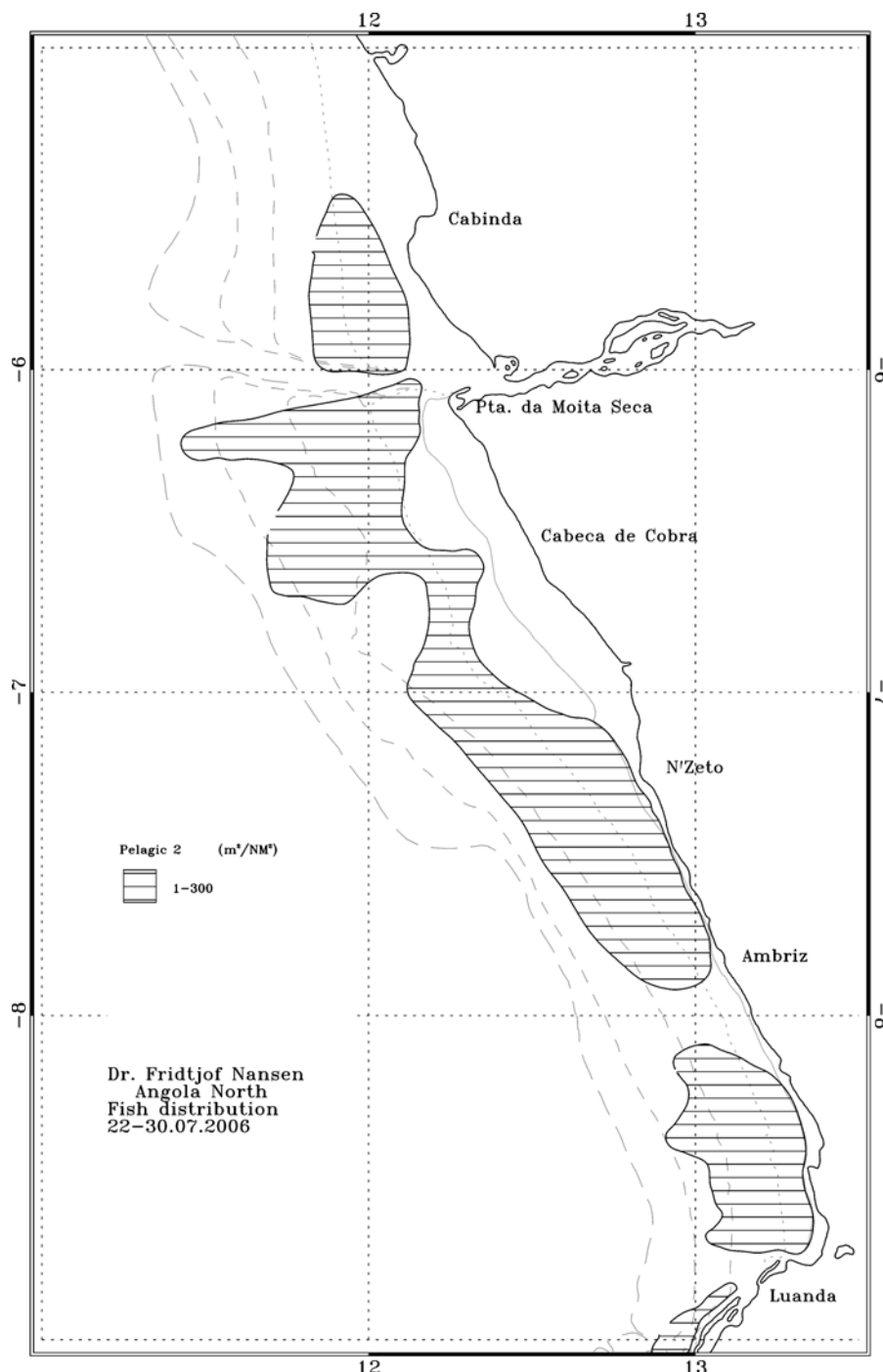
An overview of the main groups of other pelagic fish in the northern region is given in Table 4.

#### Pelagic species Group 1

This group was not abundant enough to estimate its biomass in the region. Only in one station a species (*Ilisha africana*) belonging to this group was recorded.

### Pelagic species Group 2

This group was found evenly distributed along the coast with low densities ( $1 < s_A < 300 \text{ m}^2/\text{NM}^2$ ) (Figure 11). Table 4 shows the catch rates for the different families. The biomass was estimated at 74 500 tons. The most abundant species was, by far, *Trichiurus lepturus*, followed by *Chloroscombrus chrysurus* and *Selene dorsalis*.



**Figure 11.** Distribution of Pelagic 2, Pta. das Palmerinhas-Congo River, including Cabinda. Depth contours at 20, 50, 100, 200 and 500m.

**Table 4.** Catch rates (kg/h) of the main groups of pelagic fish, Pta das Palmerinhas-Congo River, including Cabinda.

Station	Depth	Clupeids	Carangids	Scombrids	Hairtails	Barracudas	Other	Total
4086	50		219.0					219.0
4087	15	567.1	236.7	44.6	10.4		496.0	1354.8
4088	15				1.9			1.9
4089	5	379.5	118.0	41.6	259.2		341.4	1139.6
4090	15	2448.7	1.0				20.2	2470.0
4091	15	81.3	31.0		2.6	0.4	138.7	253.9
4092	5			270.9	81.0		339.4	691.3
4093	119		136.9		1.9		147.3	286.1
4094	10	333.2	521.1			5.7	69.7	929.7
4095	5	386.3	8.2				126.1	520.6
4096	5	22.4	0.7	12.5	2.8	5.0	125.9	169.2
4097	115		88.7		3.6		94.6	186.9
4098	20	7.3	14.3		2.0		262.2	285.9
4099	10	1.3	4.5		106.5		423.5	535.8
4100	40	122.7			388.6		7.1	518.4
4101	128		14.5		42.2		137.4	194.1
4102	93		0.5	12.3	22.2		68.9	103.8
Mean	39.1	255.9	82.1	22.5	54.4	0.6	164.6	580.1
STDEV		593.3	137.6	65.6	108.4	1.8	153.3	616.1
% Catch		44.1	14.1	3.9	9.4	0.1	28.4	

### 4.3 Pta. das Palmerinhas - Benguela

#### *Sardinella*

The distribution of sardinellas is very much like the one found in previous years. They were found in patches throughout the region. The largest continuous distribution was found from north off Cabo Ledo to south off Pta. do Morro (Figure 12). Most of the medium-high ( $1\ 001 < s_A < 3\ 000\ \text{m}^2/\text{NM}^2$ ) and high-density ( $s_A > 3\ 001\ \text{m}^2/\text{NM}^2$ ) areas were located inshore. Like in 2004, fish were recorded from north off Lobito to Benguela, with the highest densities off the latter. This year we found an area of fish off Pta. das Salinas with a small very-high density inshore patch.

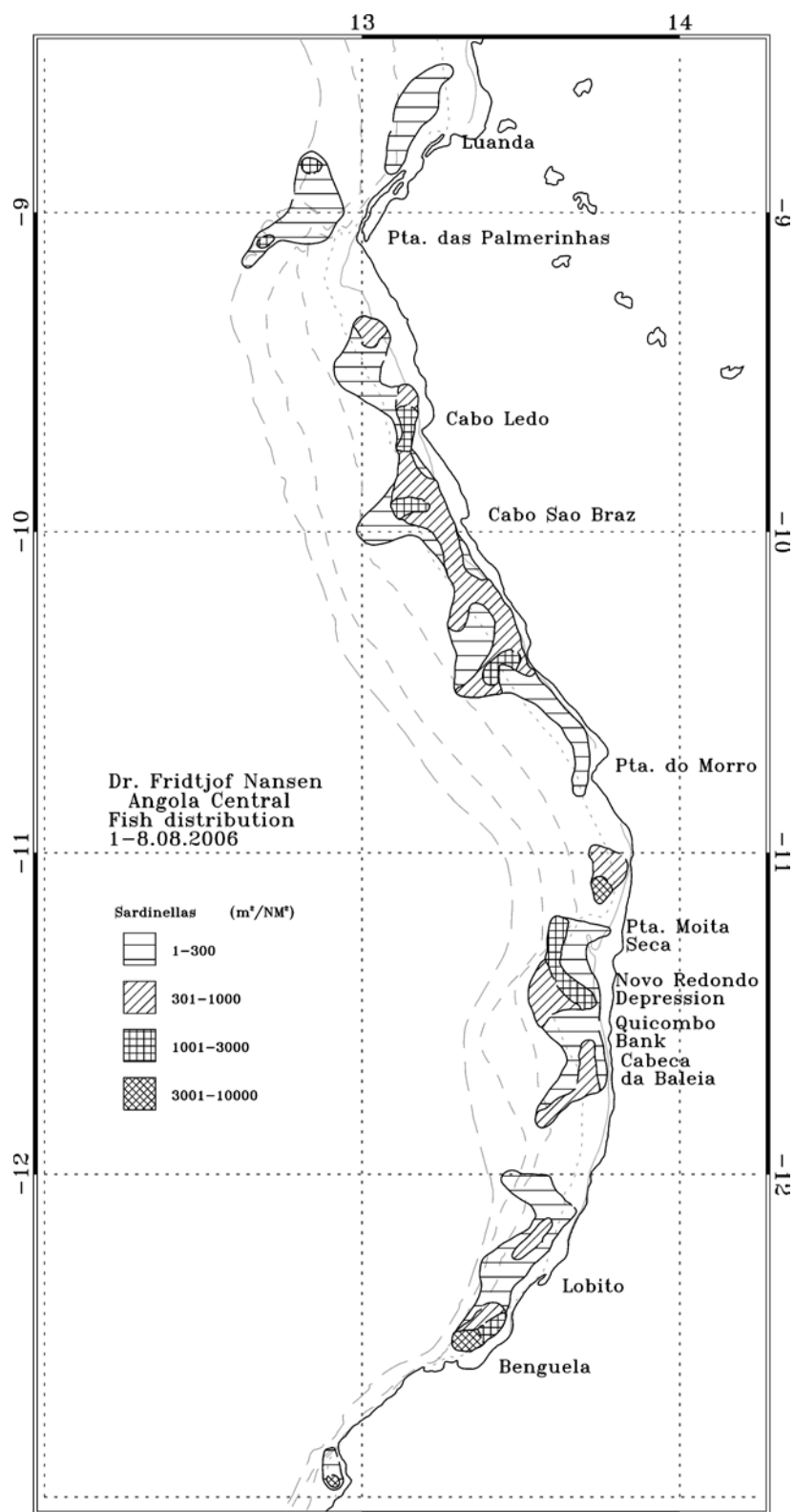
Figure 13 shows the length distribution for *S. maderensis* (Figure 13a) and *S. aurita* (Figure 13b). The main size distribution of *S. maderensis* ranged from 23 to 34 cm TL, and showed a dominating distribution at 23-29 cm TL with the mode of about 27 cm TL, and one more group between 30 and 34 cm TL, with its mode at 32 cm TL. Additionally very few small fish (divided in two groups 7 and 16-19 cm TL) were found. The length distribution for *S. aurita* shows three modal peaks at 21, 26 and 31 cm TL. It also was found a very small number of fish between 10 and 14 cm TL.

In this region most of the *S. maderensis* caught were in stages 3 to 5 (mature) while the majority of *S. aurita* was found in earlier stages (1 to 2).

The biomass for sardinella was estimated at 244 000 tonnes, which is higher than both in 2004 and 2005. From the catch composition the biomass of *S. maderensis* was estimated at 141 000 tonnes (59 000 tonnes last year) and 103 000 tonnes for *S. aurita* (89 000 tonnes for

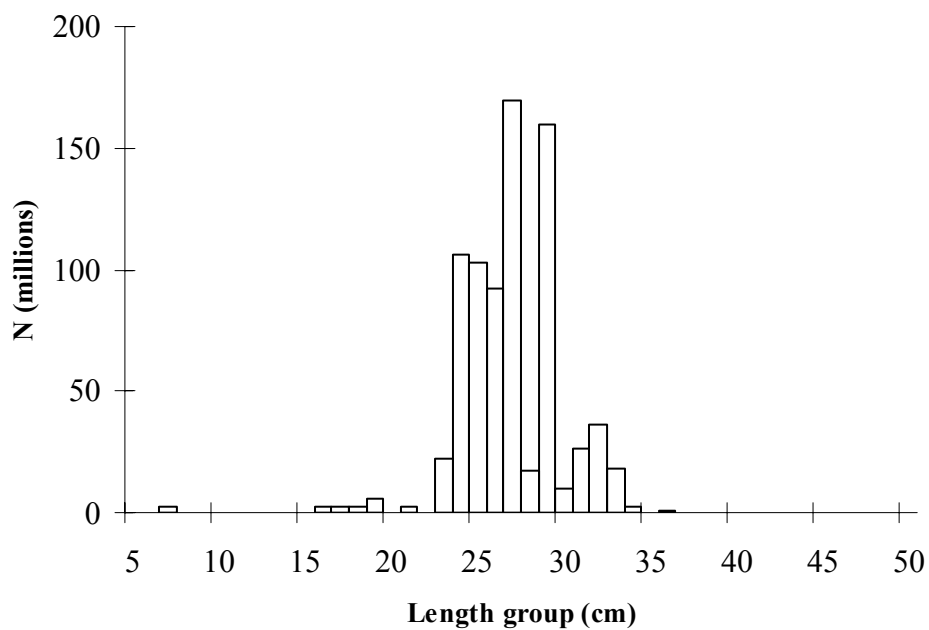
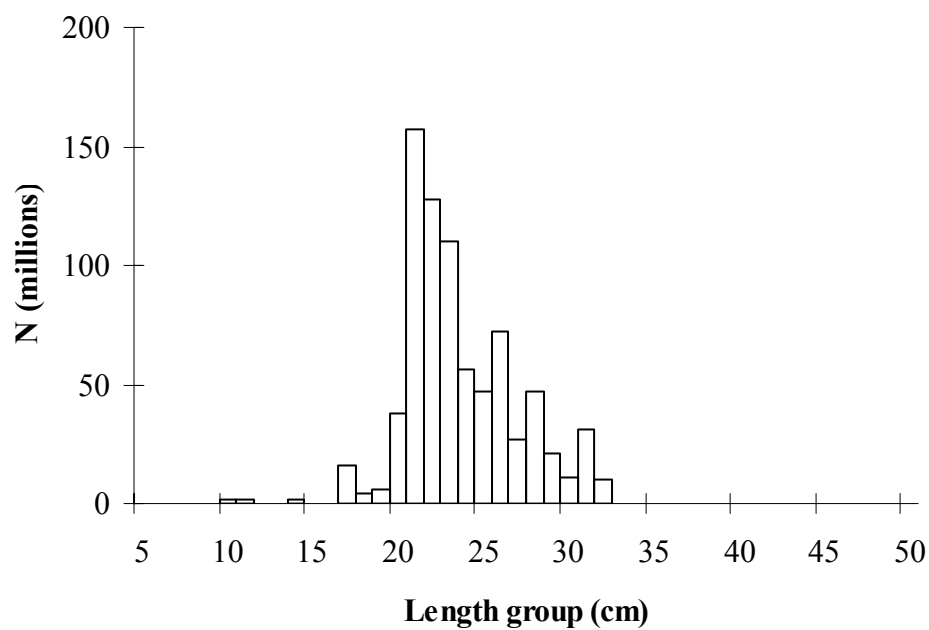
2005), which means that 58% of the total biomass belongs to *S. maderensis*, leaving 42% for *S. aurita*. Most of the biomass comprised individuals bigger than 26 cm TL for *S. maderensis* and bigger than 24 cm TL for *S. aurita* (Figure 14a and b respectively).

There was an anomalous station (st.4104): we caught offshore sardinella (bottom depth 358m) at 10m, between 03:00-03:30 UTC (density:  $301 < s_A < 1000 \text{ m}^2/\text{NM}^2$ ). *S. aurita* dominated the catch (87%). They were recorded in two well-localized schools within a restricted area. There were no indications of other sardinellas schools in the surroundings. This spot is not shown in the distribution map due to its small size, but it is included in the biomass calculations.



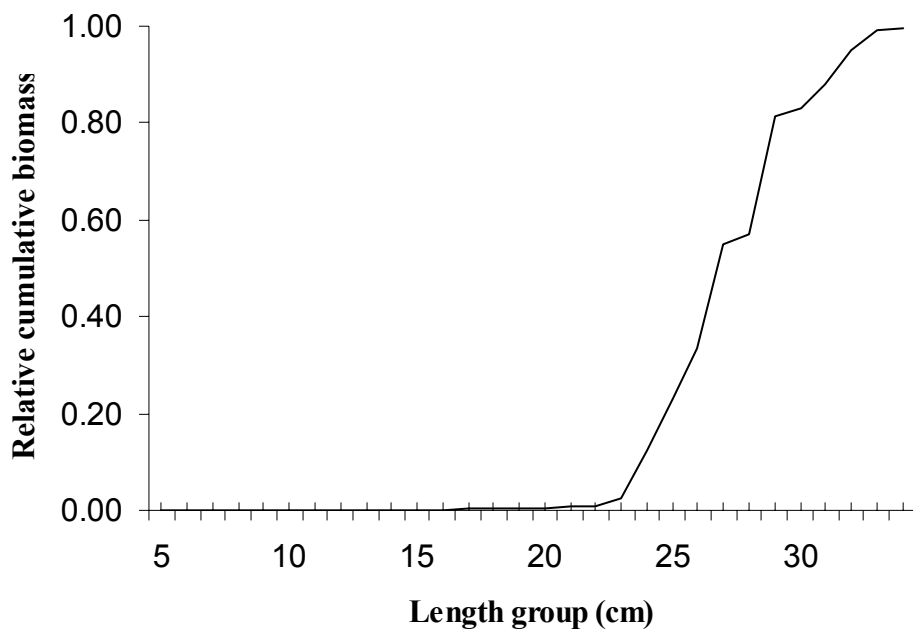
**Figure 12.** Distribution of *Sardinella* spp. Pta. das Palmerinhas- Benguela. Depth contours at 20, 50, 100 and 200 m.



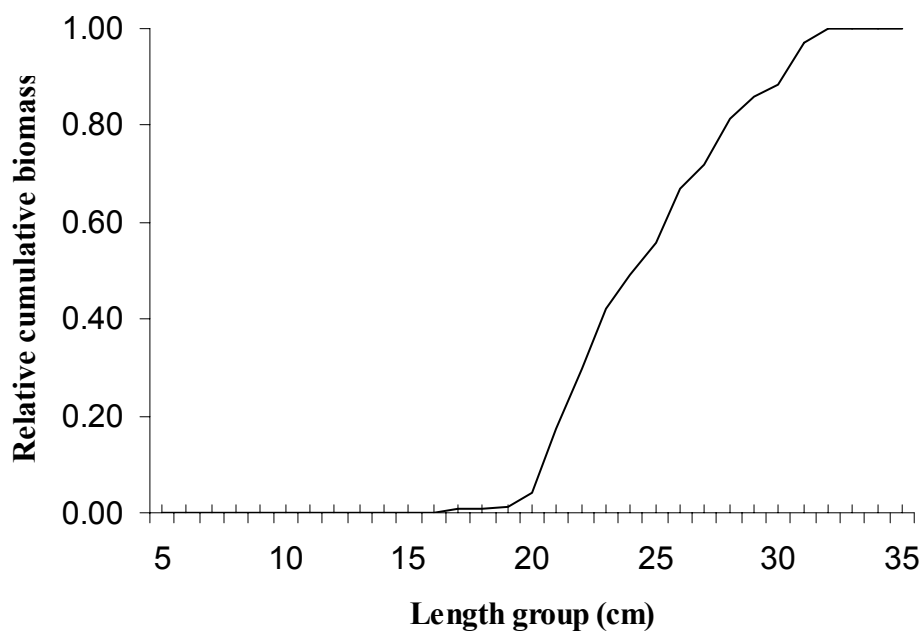
a) *Sardinella maderensis*b) *Sardinella aurita*

**Figure 13.** Total length distribution of *Sardinella maderensis* (a) and *S. aurita* (b). Pta. das Palmerinhas-Benguela.

a) *Sardinella maderensis*



b) *Sardinella aurita*



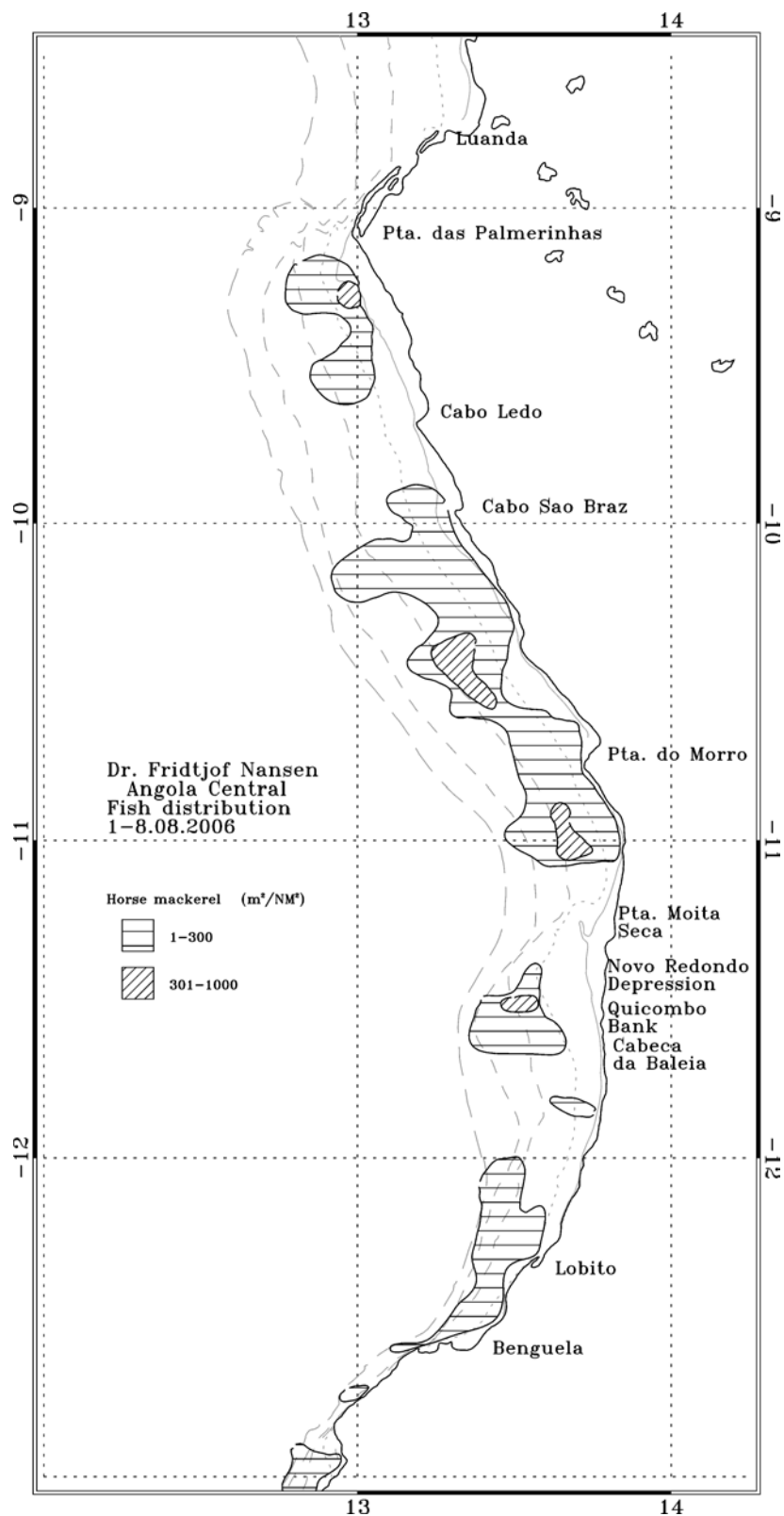
**Figure 14.** Relative cumulative biomass *Sardinella maderensis* (a) and *S. aurita* (b), Pta. das Palmerinhas-Benguela.

*Horse mackerel*

We found only Cunene horse mackerel, *T. trecae*, in this area. Fig. 15 shows its distribution. The average density was low ( $1 < s_A < 300 \text{ m}^2/\text{NM}^2$ ) and horse mackerel was found throughout the area.

The total length distribution (Figure 16) of this species in this area ranged from 5 to 36 cm TL and shows five fairly well defined cohorts with modes at 7, 15, 21, 27 and 32 cm TL.

The biomass of the Cunene horse mackerel for the area was calculated in 77 000 tonnes which is some 35% higher than last year (57 000 tonnes), but still lower than in 2004 (104 000 tonnes). Nevertheless this value is higher than the estimates of 2001 – 2003. Around 50% of the stock in this region was dominated by individuals  $>28 \text{ cm}$  (Figure 17).



**Figure 15.** Distribution of horse mackerel (*Trachurus trecae*). Pta. das Palmerinhas- Benguela. Depth contours at 20, 50, 100, 200 and 500 m.

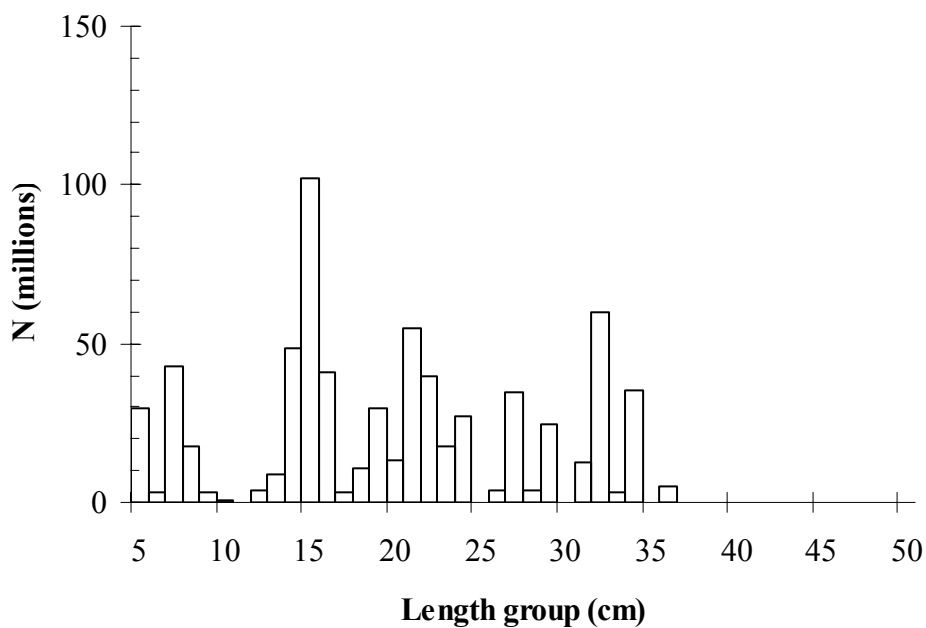


Figure 16. Total length distribution of horse mackerel (*Trachurus trecae*), Benguela - Pta. das Palmerinhas.

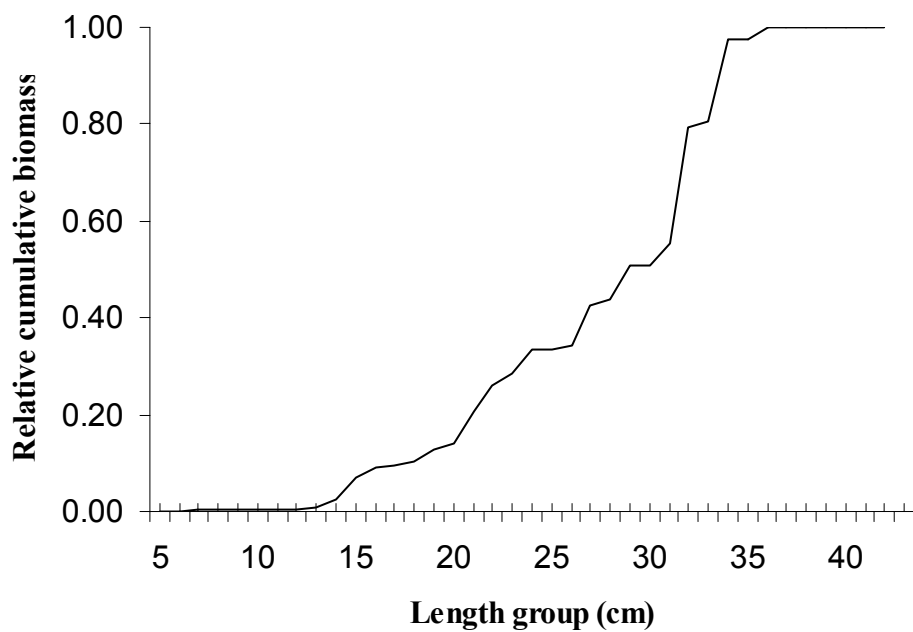


Figure 17. Relative cumulative biomass of horse mackerel (*Trachurus trecae*), Pta. das Palmerinhas- Benguela.

*Other pelagic species*

An overview of the main groups of other pelagic fish in the central region is given in Table 5.

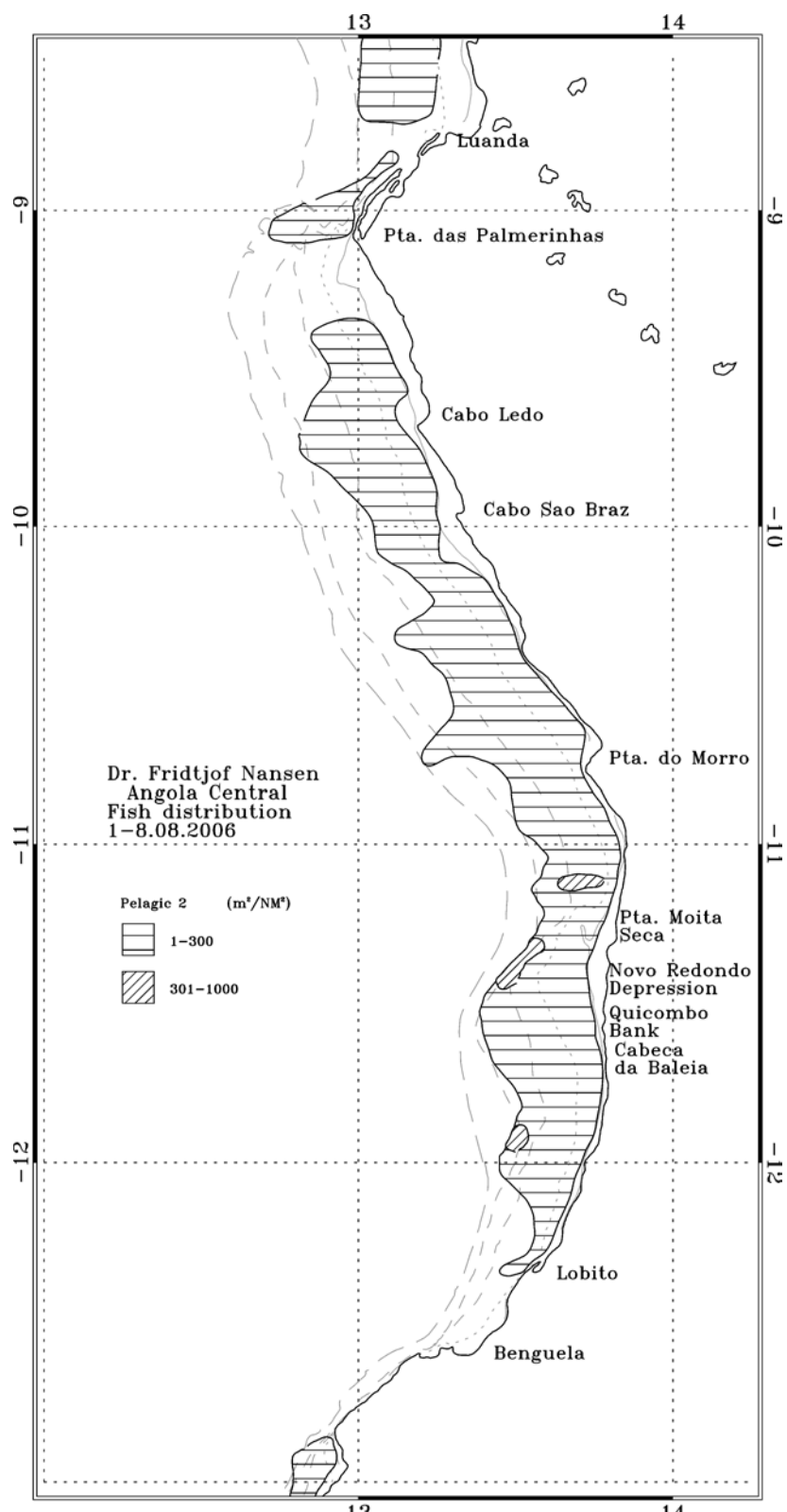
## Group 1

The only species belonging to this group found was *Ilisha africana*, found only in two stations.

## Group 2

This group, as opposite from previous years, was found continuously distributed along the coast up to Lobito. In general, the densities were low ( $1 < s_A < 300 \text{ m}^2/\text{NM}^2$ ) but with some small areas of medium density ( $301 < s_A < 1\ 000 \text{ m}^2/\text{NM}^2$ ) between Pta. Moita Seca and south of Cabeça da Baleia (Figure 18). The most common species was the hairtail (*Trichiurus lepturus*), which made 1% of the total catch (Table 5) and consisted mostly of juveniles.

The biomass estimate, based on an average length of 30 cm and a condition factor equal to 0.01, was 113 000 tonnes, value that is higher than the ones from previous years.



**Figure 18.** Distribution of other pelagic species, group 2. Pta. das Palmerinhas- Benguela. Depth contours at 20, 50, 100, 200 and 500 m.

**Table 5.** Catch rates (kg/h) of the main groups of pelagic fish, Pta. das Palmerinhas- Benguela.

Station	Depth	Clupeids	Carangids	Scombrids	Hairtails	Barracudas	Other	Total
4103	10	168.4	44.5		5.3		483.4	701.6
4104	10	291.3	13.7		94.1		17.5	416.6
4105	15	141.1	2.0					143.1
4106	15	104.0	2.4		21.1		119.9	247.4
4107	102		0.7		1.4		98.6	100.8
4108	90		637.5				130.4	767.9
4109	14	2 551.9	55.9		3.9		362.2	2 973.9
4110	49		841.8	1.8	22.9		1 542.4	2 408.9
4111	10						549.7	549.7
4112	78	0.5	219.6		104.8		140.6	465.4
4113	5	23 817.6			144.0			23 961.6
4114	220				0.1		43.8	44.0
4115	17						0.6	0.6
4116	10	3 880.9	341.9		0.7			4 223.5
4117	15	484.9	60.4				0.7	546.1
4118	15	274.2	476.0		153.3		158.6	1 062.1
Mean	44.0	1 982.2	168.5	0.1	34.5		228.0	2 413.3
STDEV		5 924.2	266.0	0.5	55.4		391.8	5 869.4
% Catch		82.1	7.0		1.4		9.4	

#### 4.4 Benguela - Cunene

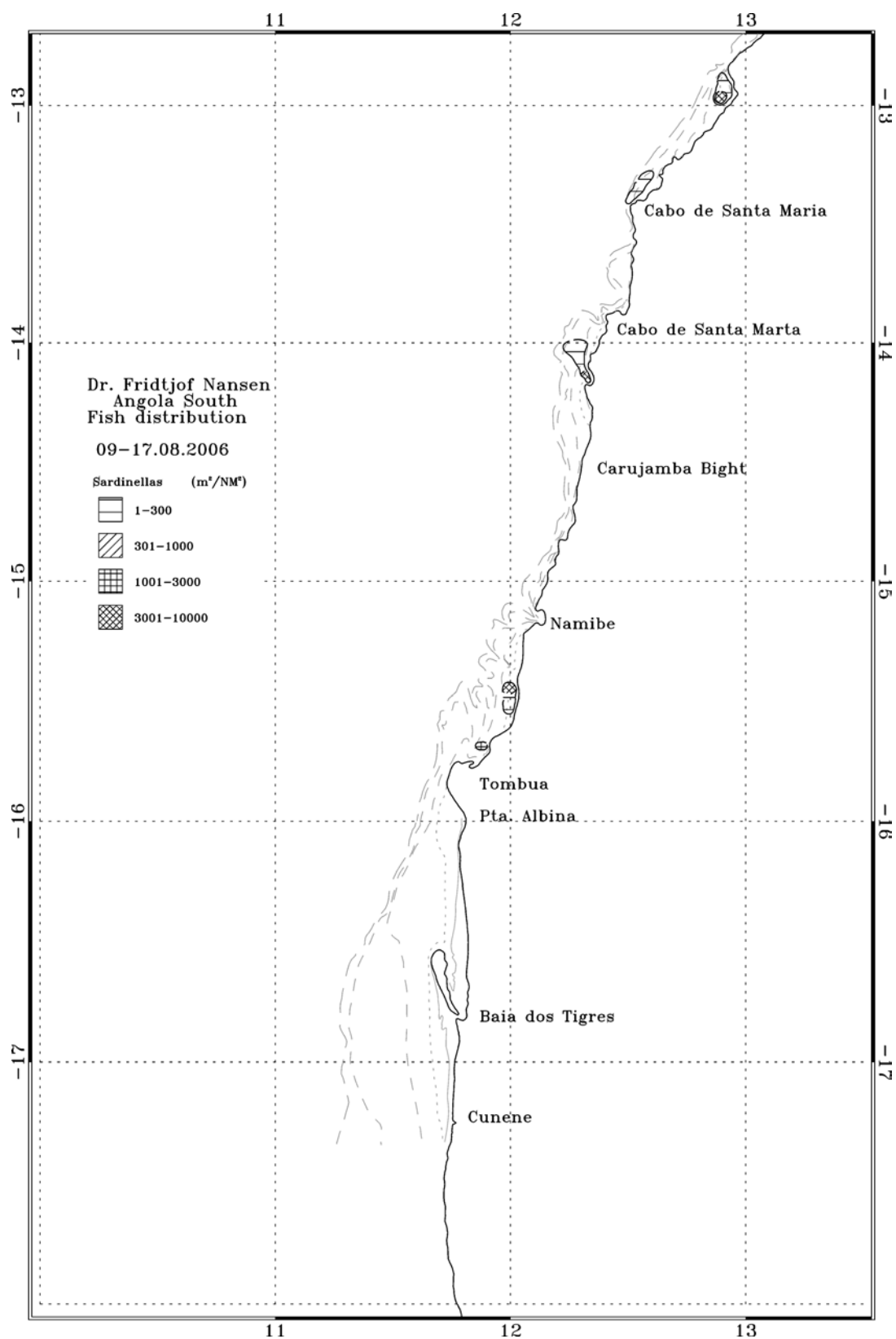
##### *Sardinella*

Only *S. aurita* was caught in this region (Figure 19). It was found in very localized spots, some very dense ( $301 < s_A < 1\ 000\ m^2/NM^2$ ). The distribution seems to follow the isotherm of 19°C. Between Cabo de Sta. Marta and Tombua surface schools could be observed but could not be acoustically registered.

The biomass was estimated at 20 000 tonnes. The previous years no sardinella was found in the region.

The size distribution showed three groups: between 15 and 19 cm TL, 23 to 24 cm TL and very few between 26 and 31 cm TL. None of the groups exhibit a clear mode. Over 80% of the fish caught was under 24 cm TL.





**Figure 19.** Distribution of *Sardinella aurita*. Cunene-Benguela. Depth contours at 10, 20, 50, 100, 200 and 500 m.

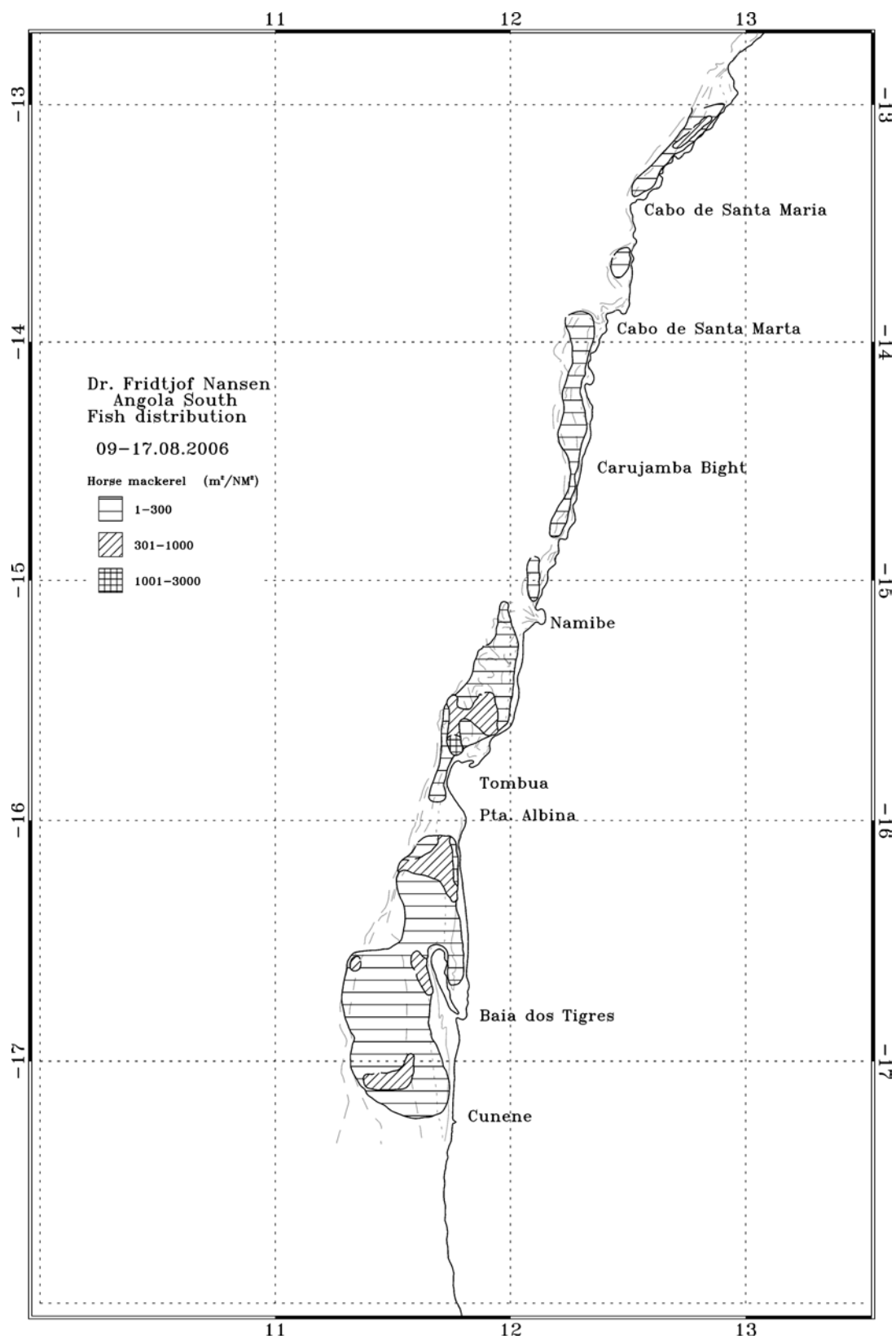
*Horse mackerel*

In the southern region the pelagic environment was dominated by horse mackerel. Like in previous years, both species of horse mackerel were found: Cunene horse mackerel (*T. trecae*), a species that distributes in most of the Angolan continental shelf and the Cape horse mackerel (*T. capensis*) a species associated with the cold waters of the Benguela current. Horse mackerel was found in patches throughout the area with an average density of  $1 < s_A < 300 \text{ m}^2/\text{NM}^2$  (Figure 20). From Pta. Albina to Baía dos Tigres the distribution appears more continuous, with patches of medium density ( $301 < s_A < 1\,000 \text{ m}^2/\text{NM}^2$ ). The highest density was found off Tombua ( $1\,001 < s_A < 3\,000 \text{ m}^2/\text{NM}^2$ ) In general, Cape horse mackerel was found dominating the slope area, while Cunene horse mackerel had a more inshore distribution.

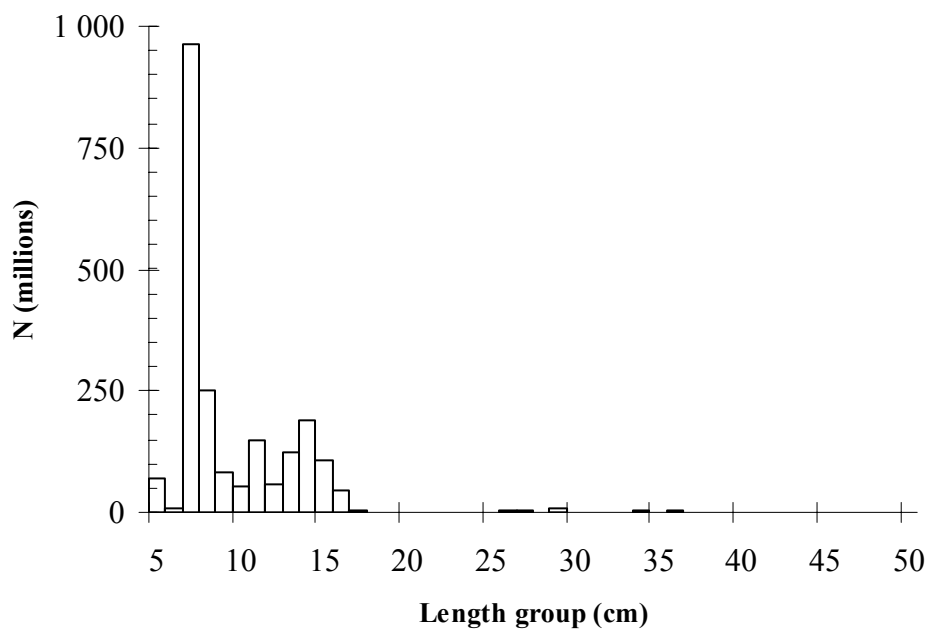
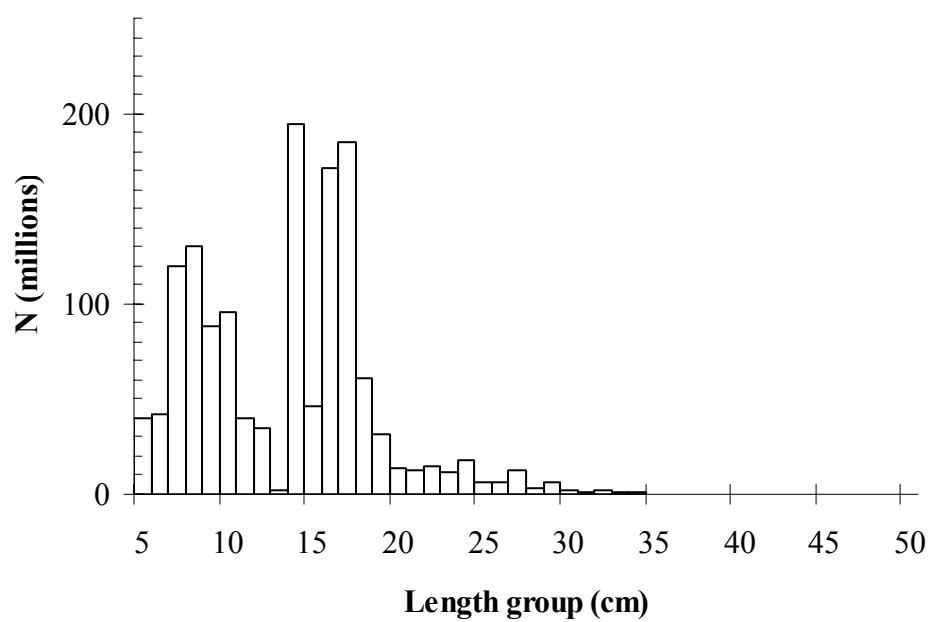
Figure 21 shows the size distributions of horse mackerel. *T. trachurus capensis* main size range lays between 5 and 17 cm TL, and it seems to have three cohorts with modal peaks around 7, 11 and 14 cm TL, with few fish above 20 cm TL recorded. The size distribution of *T. trecae* covers a wider size range (5 to 34 cm TL) and it has five cohorts, with modal peaks at 8, and 14 cm TL, for the smaller fish, and at 24, 27 and 29 cm TL for the small adult cohorts.

The estimated biomass for horse mackerel in the southern region was 71 000 tonnes, each species contributing with 45 400 tonnes (63%) for *T. trecae* and 25 600 tonnes (37%) for *T. trachurus capensis*. Last year the estimated biomass in this region was 102 000 tons of *T. trecae* and 226 000 tonnes of *T. trachurus capensis*.

As in previous years, and for both species the dominant were the juveniles (TL<15cm for *T. trachurus capensis* and TL<20 cm for *T. trecae*) (Figure 22).

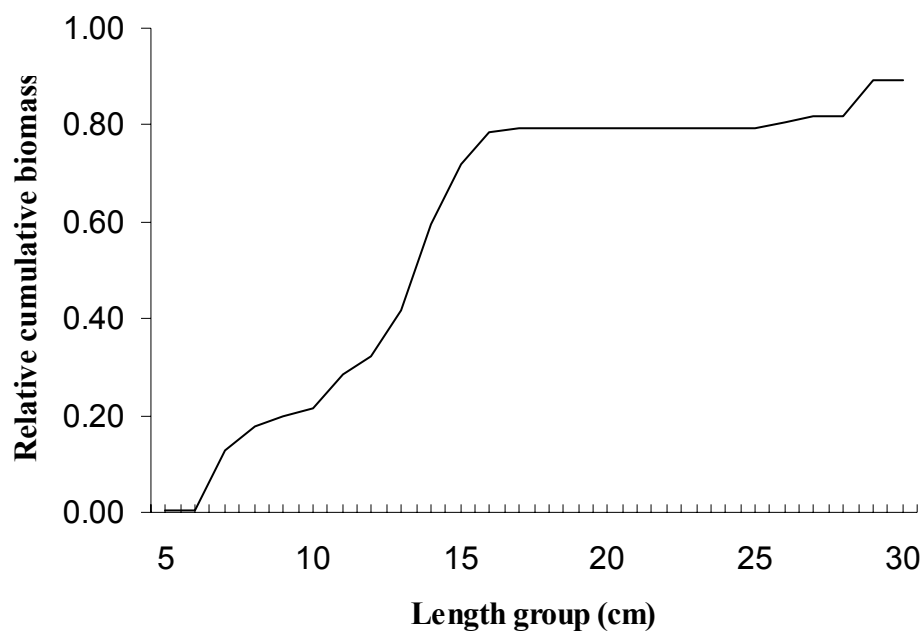


**Figure 20.** Distribution of horse mackerel. Cunene–Benguela. Depth contours at 10, 20, 50, 100, 200 and 500 m.

a) *Trachurus trachurus capensis*b) *Trachurus trecae*

**Figure 21** Total length distributions of (a) *Trachurus trachurus capensis* and (b) *T. trecae* (b), Benguela-Cunene.

a) *Trachurus trachurus capensis*



b) *Trachurus trecae*

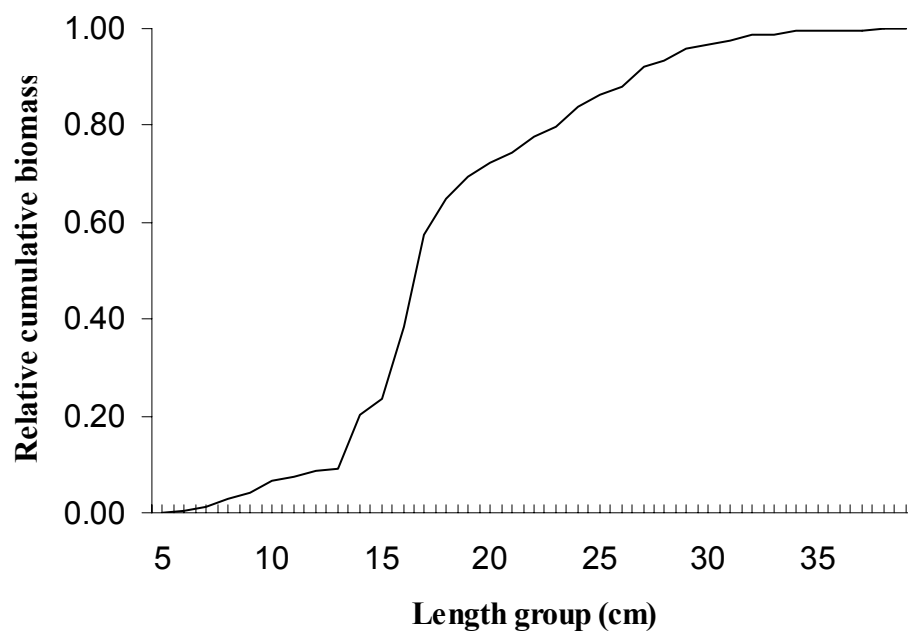


Figure 22. Relative cumulative biomass of (a) *T. trachurus capensis* and (b) *T. trecae*.

### Other pelagic

An overview of the main groups of other pelagic fish in the southern region is given in Table 6.

#### Group 1

*Etrumeus whiteheadi* was the only species of this group recorded. It was found in several patches between Carujamba Bight and Cunene River (Figure 23). In average the acoustic densities were low ( $1 < s_A < 300 \text{ m}^2/\text{NM}^2$ ) except south of Baía dos Tigres where densities reached up to  $s_A > 1000 \text{ m}^2/\text{NM}^2$ .

The length frequency distribution ranged from 8 to 21 cm TL showing two clear groups with modal peaks at 11 and 19 cm TL (Figure 24).

The total biomass was estimated at 28 700 tonnes. Most of the individuals caught were under the 11 cm TL (Figure 25).

#### Group 2

Members of this group, identified as *Decapterus rhonchus*, were caught only in low quantities (approximately 34 kg/h) and only in two stations.

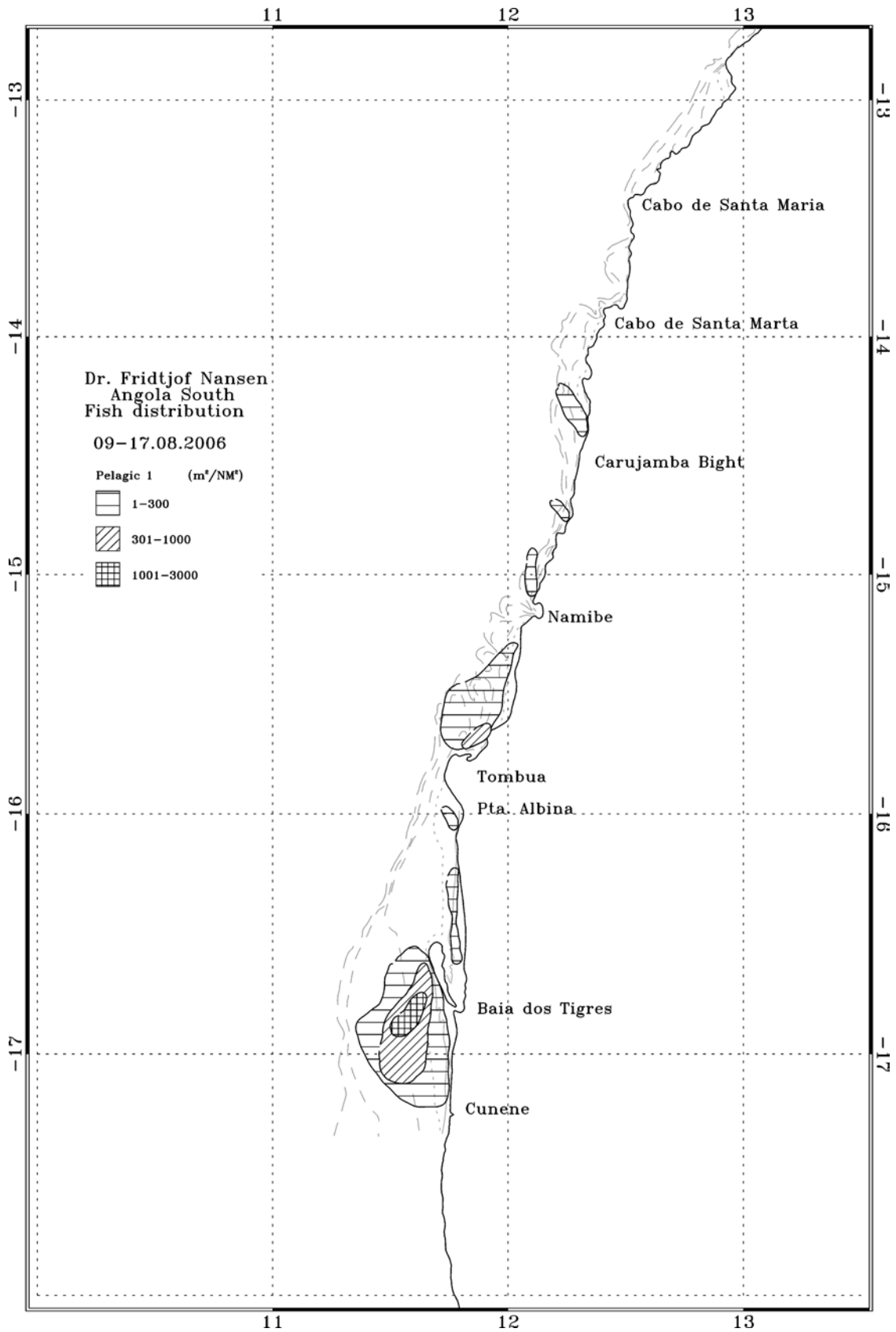


Figure 23. Distribution of Pelagic 1. Cunene–Benguela. Depth contours at 10, 20, 50, 100, 200 and 500 m.

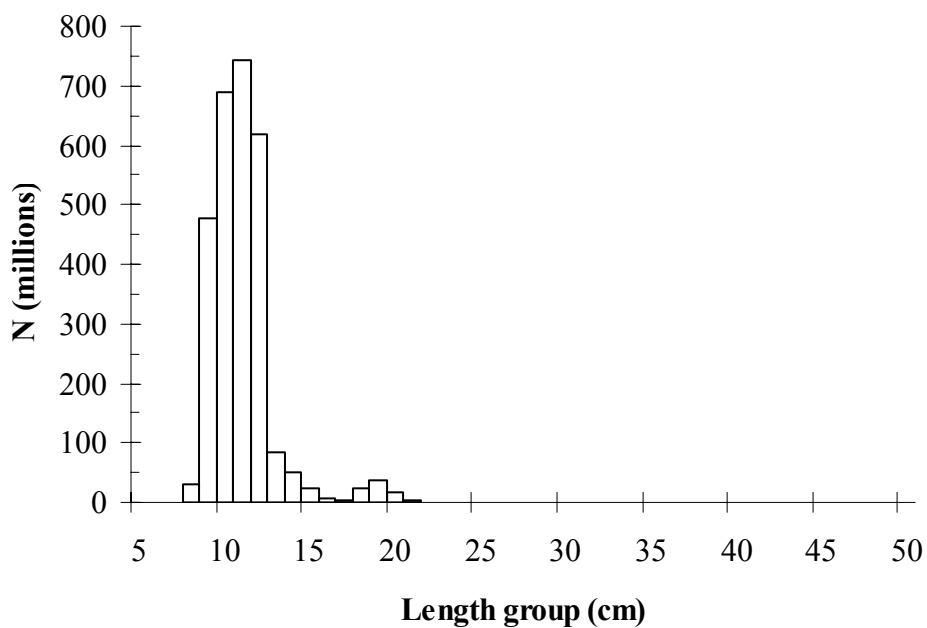


Figure 24 Total length distributions of *Etrumeus whiteheadi* (P1), Benguela-Cunene.

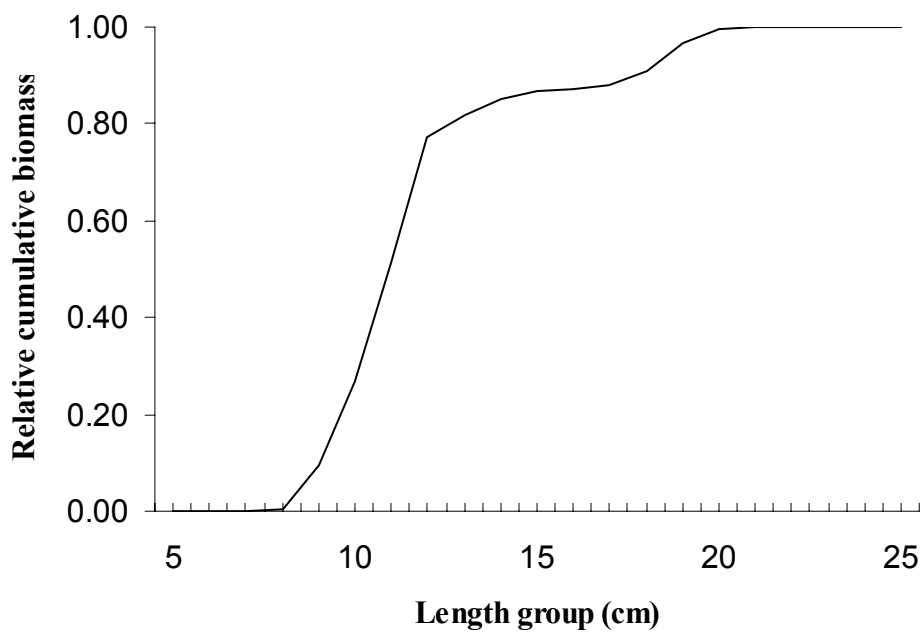


Figure 25. Relative cumulative biomass of *Etrumeus whiteheadi* (P1), Benguela-Cunene.



**Table 6.** Catch rates (kg/h) of the main groups of pelagic fish, Benguela-Cunene River.

Station	Depth	Clupeids	Carangids	Scombrids	Hairtails	Barracudas	Other	Total
4119	80							
4120	80							
4121	43		391.8				2.0	393.9
4122	117	26.9	35.5				164.7	227.0
4123	88	11.8	3 299.5				64.1	3 375.3
4124	20	5.0						5.0
4125	5							
4126	72	3.7	2 477.2				2 206.5	4 687.4
4127	14	117.1					2.9	120.0
4128	49	1.3	5 912.3				917.1	6 830.8
4129	22	35.4	19.3				479.3	534.0
4130	20	9.4	302.2				126.5	438.1
4131	96	473.1	9 728.6				996.0	11 197.7
4132	40	19.0	0.1				0.2	19.2
4133	35	2 111.4	4.2				7.2	2 122.8
4134	55	2 697.8	326.3				161.1	3 185.1
4135	88		286.5				87.7	374.1
4136	159		3 350.6				390.1	3 740.8
4137	40	7.3	56.1				1.9	65.3
Mean	59.1	290.5	1 378.4				295.1	1 964.0
STDEV		759.1	2 605.4				553.3	2 996.4
% Catch		14.8	70.2				15.0	

## CHAPTER 5 SUMMARY OF SURVEY RESULTS

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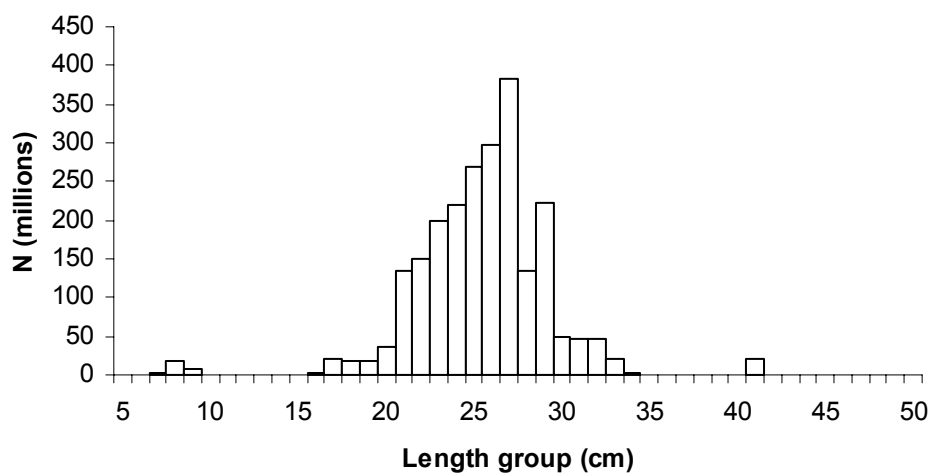
### 5.1 Sardinella

The total biomass estimate for sardinellas is 630 000 tonnes, which is higher than last year's estimate (242 000 tonnes) and one of the highest levels recorded (see Table 7). This increase may be attributed to changes on behaviour pattern of the species that depends on the prevailing environmental conditions. During the present survey we caught sardinella further north (up to Congo's river mouth) and further south (Tombua) than in previous years, in bigger aggregations and more offshore. From the acoustic records it seems that the sardinella was present throughout the region.

The proportion of biomass of the two species of Sardinella showed the typical pattern: 41% was *S. aurita* and 59% *S. maderensis*. This fact can be associated to environmental conditions, as surface temperatures in the northern and central region were slightly higher than last year. *S. aurita* was found further south than in previous years.

Figures 26 and 27 show the overall length frequency distribution of the two species of Sardinella. For *S. maderensis* (Fig. 26), two cohorts with modal peaks at 8 and 27 cm TL can be observed. The modal progression from last year is not obvious. *S. aurita* on other hand, shows (Figure 27) a more uniform distribution with four modal peaks at 14, 18, 23 and 29 cm TL. In both species the fraction of juveniles is insignificantly (Figures 26 and 27).

a) Overall length distribution of *S. maderensis* in numbers.



b) Relative cumulative biomass of *S. maderensis*.

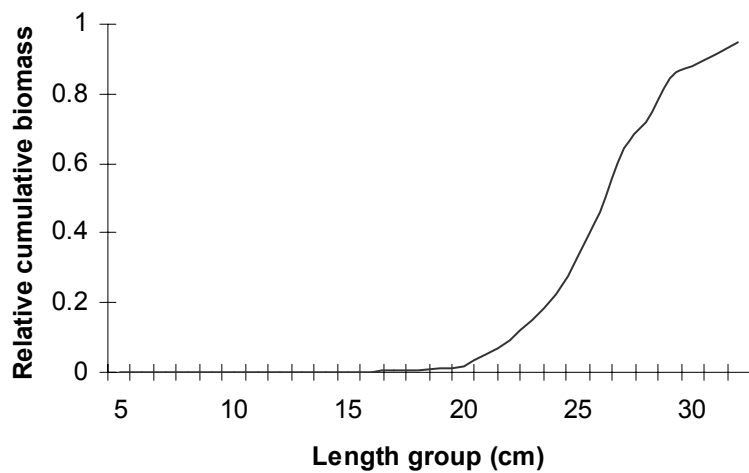
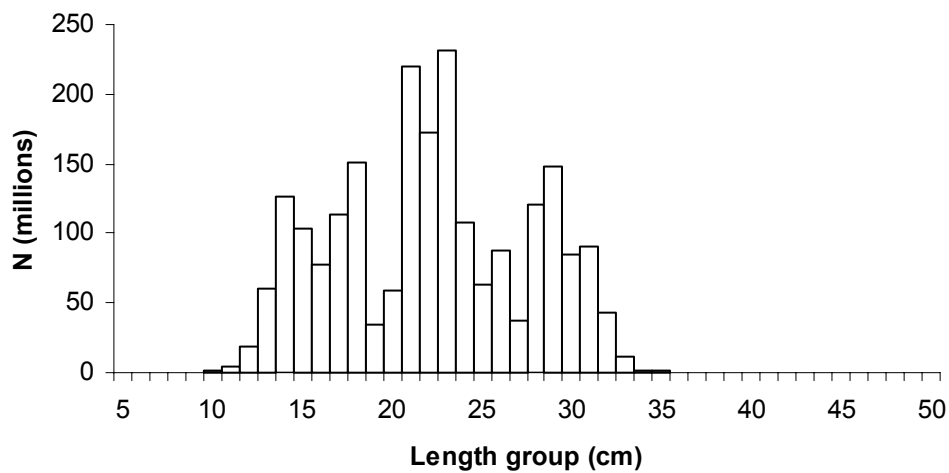
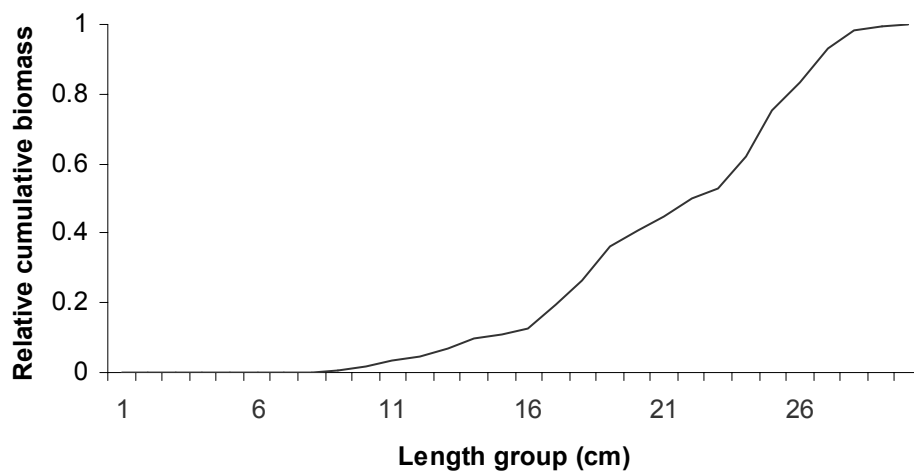


Figure 26 Overall length distribution (a) and relative cumulative biomass (b) of *S. maderensis*.

a) Overall length distribution of *S. aurita* by numbers



b) Relative cumulative biomass of *S. aurita*



**Figure 27** Overall length distribution (a) and relative cumulative biomass (b) of *S. aurita*

**Table 7** Biomass estimates of sardinellas by regions and surveys (1 000 tonnes).

Survey	Cunene- Benguela	Palmerinhas- Benguela	Cabinda- Palmerinhas	Benguela- Cabinda	Cunene- Cabinda
1/85	25	220	80	300	325
2/85	110	190	180	370	480
3/85	0	70	190	260	260
4/85	0	200	110	310	310
1/86	10	140	110	250	260
2/86	10	130	130	260	270
1/89	40	200	60	260	300
2/89	20	40	130	170	190
3/89	40	100	60	160	200
1/91	?	180	120	300	300
2/91	?	68	154	222	222
1/92	?	119	161	280	280
1/94	*	410	100	510	
2/94	*	245	290	535	
1/95	*	140	24	164	
2/95	?	277	297	574	574
1/96	49	175	70	245	294
2/96	0	130	233	363	363
1/97	0	195	300†	495	495
1/98	75	389	79†	468	543
3/98	0	233	159†	392	392
2/99	0	228	135†	363	363
2/2000	0	179	174†	353	353
2/2001	0	257	177†	434	434
9/2002	0	165	178	343	343
8/2003	2	277	153†	430	432
8/2004	0	175	187†	262	362
8/2005	0	148	95†	242	242
8/2006	20	244	366†	610	630

\* not surveyed

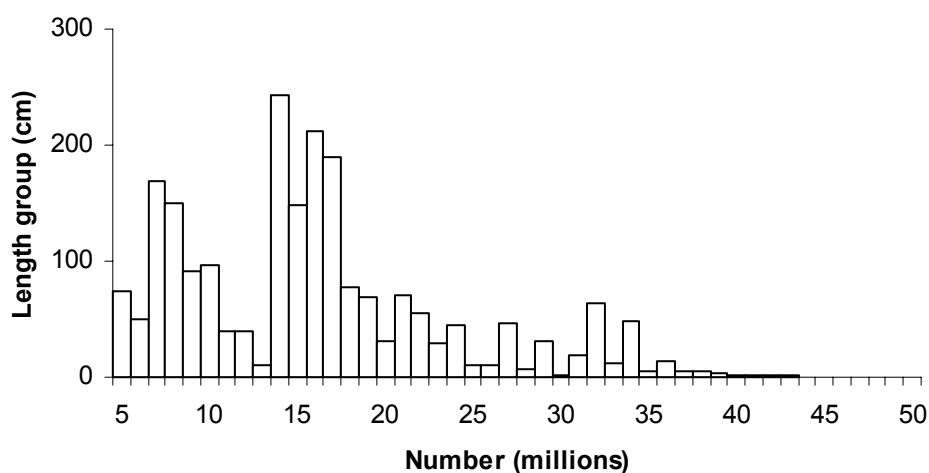
† surveyed from Congo River- Pta das Palmerinhas

## 5.2 Cunene horse mackerel

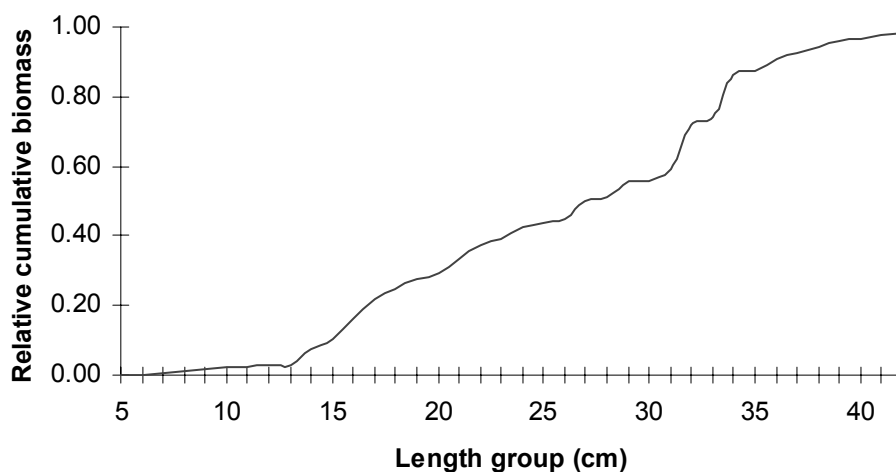
The total biomass of horse mackerel was estimated at 179 000 tonnes, lower than last year estimates (405 000 tonnes) mainly due to a decrease in the horse mackerel biomass in the south. Cunene horse mackerel stock was estimated at total of 153 000 tonnes which was slightly lower than the last year (Table 8) but within the levels of 2002-2003. However, the stock is far from the levels of the 90's.

The overall length distribution shows that fish of all classes were represented from the small (5 cm TL) fish to few bigger than 40 cm TL, although the distribution is dominated by fish < 20 cm TL (Figure 28). We probably, from the size distribution, can distinguish as much as six cohorts with modes at 7, 14, 24, 27 32 and 36 cm TL. Growth progression can be seen for some cohorts. As in previous surveys there was observed a good signal of recruitment.

a) Overall length distribution of *T. trecae*.



b) Relative cumulative biomass of *T. trecae*



**Figure 28** Overall length distribution in numbers (a) and relative cumulative biomass (b) of *T. trecae*.

### 5.3 Other species

Round herring, *Etrumeus whiteheadi*, was found in the southern region often associated with horse mackerel, with the former close to the surface and the later in the bottom.

Pilchard, *Sardinops ocellatus*, was found only in two stations with an average catch rate of 0.6 kg/h

**Table 8** Biomass estimates of Cunene horse mackerel by regions and surveys (1 000 tonnes)

Survey	Cunene- Benguela	Palmerinhas- Benguela	Cabinda- Palmerinhas	Benguela- Cabinda	Cunene- Cabinda
1/85	30	195	40	235	265
3/85	50	90	40	130	180
4/85/86	100	125	20	145	245
1/89	35	55	40	95	130
3/89	170	40	35	75	245
1/91	100	80	20	100	200
2/91	100	70	30	100	200
1/92	98	86	80	166	264
1/94	*	238	1	239	
2/94	*	130	120	250	
1/95	*	?	84	84	
2/95	70	160	110	270	340
1/96	286	214	6	220	506
2/96	140	157	63	220	360
1/97	234	55	138†	193	427
1/98	163	58	18†	76	239
3/98	118	112	37†	149	267
2/99	124	129	68†	197	321
2/2000	92	178	63†	241	333
2/2001	64	22	3†	25	89
9/2002	118	13	31†	44	162
8/2003	120	34	12†	46	166
8/2004	32	107	90†	197	229
8/2005	102	57	21†	78	180
8/2006	45	77	31†	108	153

\* not surveyed

† surveyed from Congo River- Pta das Palmerinhas

## 5.4 Conclusions

In the present survey the environmental conditions were characterized by strong wind, especially in the southern region and different temperatures as compared with previous years. The range of temperatures encountered in the central and northern regions was 19° to 22°C, (21° to 25°C), while in the south and in the main area of horse mackerel distribution temperatures were higher (17° to 19°C) compared with the previous years (15° to 16°C).

The environmental conditions affect the behaviour of the species, conditioning its distribution pattern. From the acoustic records it seems that *Sardinella* was present throughout the region with some dense schools recorded. The total biomass estimate for sardinellas (630 000 tonnes) was higher than last year (242 000 tonnes). During this survey the *Sardinella*'s distribution was expanded both to the north and south.

The proportion of biomass of the two *Sardinella* species showed the typical pattern, with *S. maderensis* more abundant (59%) than *S. aurita* (41%).

The total biomass of horse mackerel was estimated at 179 000 tonnes. The Cunene horse mackerel stock was estimated at total of 154 000 tonnes, which is slightly lower than last years, but within the levels of previous years. Cape horse mackerel was found only in the southern region with an estimate biomass of around 26 000 tonnes. The Cunene horse mackerel stock is, however, far from the levels of the 90's.

The overall length distribution of Cunene horse mackerel was still dominated by fish <30 cm, while last fish under 20 cm TL dominated it. Comparing last year's overall length distribution with this year's, we can notice a more even size distribution and a slight increase in the proportion of individuals >30 cm. This size increment is more evident in the north region.

The recovery of the Cunene horse mackerel stock in Angolan waters requires that strong management measures continue to be applied. From a biological perspective an overall effort reduction will be the main tool to achieve this goal.



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## **ANNEX I. Fishing gear**

The vessel has three different sized four-panel 'Åkrahamn' pelagic trawls and one 'Gisund super bottom trawl'. The two smallest pelagic trawls and the demersal trawl were used during the survey. The smallest pelagic trawl has 10-12 m vertical opening under normal operation, whereas the intermediate sized trawl has 15-18 m opening. The intermediate trawl was fitted with codend Multisampler for obtaining depth-specific samples.

The bottom trawl has a 31 m headline and a 47 m footrope fitted with a 12" rubber bobbins gear. The codend has 20 mm meshes, and has an inner net with 10 mm mesh size. The vertical opening is about 5.5 m. The distance between the wing tips is about 18 m during towing. The sweeps are 40 m long. The trawl doors are 'Thyborøen' combi, 8 m<sup>2</sup> and weigh 2000 kg. The door spreading is about 45 m when using restraining rope.

The SCANMAR system was used on all trawl hauls. This equipment consists of sensors, a hydrophone, a receiver, a display unit and a battery charger. Communication between sensors and ship is based on acoustic transmission. The doors are fitted with sensors to provide information on their distance and a height sensor is fitted on the bottom trawl to measure the trawl opening and provide information on clearance and bottom contact.

The pelagic trawls are equipped with a trawl eye that provides information about the trawl opening and the distance of the footrope to the bottom. A pressure sensor is used to show the depth on the headline.

# ANNEX II. Records of fishing stations

PROJECT STATION:4086  
 DATE:23/ 7/06 GEAR TYPE: PT No: 1 POSITION:Lat S 608  
 start stop duration Long E 1155  
 TIME :14:14:03 14:39:04 25 (min) Purpose code: 1  
 LOG :7857.44 7859.04 1.58 Area code : 3  
 FDEPTH: 50 50 GearCond.code: 1  
 BDEPTH: 73 69 Validity code: 1  
 Towing dir: ø Wire out: 160 m Speed: 40 kn\*10  
 Sorted: 26 Kg Total catch: 91.25 CATCH/HOUR: 219.00

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Selene dorsalis	214.80	1078	98.08	8972
Chloroscombrus chrysurus	4.20	19	1.92	8973
Total	219.00		100.00	

PROJECT STATION:4087  
 DATE:24/ 7/06 GEAR TYPE: PT No: 1 POSITION:Lat S 620  
 start stop duration Long E 1145  
 TIME :04:10:00 04:40:00 30 (min) Purpose code: 1  
 LOG :7951.63 7953.13 1.50 Area code : 3  
 FDEPTH: 15 15 GearCond.code: 1  
 BDEPTH: 120 120 Validity code: 1  
 Towing dir: 259ø Wire out: 120 m Speed: 30 kn\*10  
 Sorted: 96 Kg Total catch: 677.42 CATCH/HOUR: 1354.84

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella maderensis	487.32	1938	35.97	9017
Manta birostris	300.00	2	22.14	
Trachurus trecae	230.00	810	16.98	8975
Isurus oxyrinchus	196.00	2	14.47	
Sardinella aurita	79.80	276	5.89	8974
Euthynnus alletteratus	41.00	50	3.03	
Trichiurus lepturus	10.40	24	0.77	
Selene dorsalis	4.80	12	0.35	
Scomber japonicus	3.60	12	0.27	
Trachinotus ovatus	1.92	4	0.14	
Total	1354.84		100.01	

PROJECT STATION:4088  
 DATE:24/ 7/06 GEAR TYPE: PT No: 1 POSITION:Lat S 632  
 start stop duration Long E 1139  
 TIME :12:54:31 13:28:15 34 (min) Purpose code: 1  
 LOG :8021.71 8023.29 1.56 Area code : 3  
 FDEPTH: 15 15 GearCond.code: 1  
 BDEPTH: 245 202 Validity code: 1  
 Towing dir: 65ø Wire out: 120 m Speed: 30 kn\*10  
 Sorted: 1 Kg Total catch: 1.05 CATCH/HOUR: 1.85

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trichiurus lepturus	1.85	2	100.00	
Total	1.85		100.00	

PROJECT STATION:4089  
 DATE:24/ 7/06 GEAR TYPE: PT No: 2 POSITION:Lat S 635  
 start stop duration Long E 1142  
 TIME :19:13:27 19:44:57 32 (min) Purpose code: 1  
 LOG :8072.77 8074.45 1.64 Area code : 3  
 FDEPTH: 5 5 GearCond.code: 1  
 BDEPTH: 222 221 Validity code: 1  
 Towing dir: 160ø Wire out: 120 m Speed: 35 kn\*10  
 Sorted: 97 Kg Total catch: 607.86 CATCH/HOUR: 1139.74

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella maderensis	351.90	1434	30.88	8977
MYCTOPHIDAE	340.20	244519	29.85	
Trichiurus lepturus	259.16	1159	22.74	
Trachurus trecae	108.75	240	9.54	8976
Scomber japonicus	41.57	84	3.65	
Sardinella aurita	27.64	116	2.43	8978
Selene dorsalis	9.26	21	0.81	
Synagrops microlepis	1.16	53	0.10	
Total	1139.64		100.00	

PROJECT STATION:4090  
 DATE:25/ 7/06 GEAR TYPE: PT No: 1 POSITION:Lat S 629  
 start stop duration Long E 1213  
 TIME :00:18:03 00:45:49 28 (min) Purpose code: 1  
 LOG :8113.79 8115.24 1.42 Area code : 3  
 FDEPTH: 15 15 GearCond.code: 1  
 BDEPTH: 41 40 Validity code: 1  
 Towing dir: 320ø Wire out: 120 m Speed: 34 kn\*10  
 Sorted: 104 Kg Total catch: 1152.67 CATCH/HOUR: 2470.01

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella maderensis	1282.29	5704	51.91	8980
Sardinella aurita	1094.79	4502	44.32	8979
Engraulis encrasicolus	36.30	5327	1.47	
Sardinella maderensis - Juv.	35.36	5233	1.43	8981
Alloteuthis africana	9.11	896	0.37	
Bregmaceros sp.	8.10	2027	0.33	
Pagellus bellottii	2.01	1414	0.08	
Sepia orbignyana	1.01	94	0.04	
Trachurus trecae, juvenile	1.01	589	0.04	8982
Total	2469.98		99.99	

PROJECT STATION:4091  
 DATE:25/ 7/06 GEAR TYPE: PT No: 1 POSITION:Lat S 634  
 start stop duration Long E 1218  
 TIME :11:29:24 11:56:43 27 (min) Purpose code: 1  
 LOG :8205.94 8207.44 1.48 Area code : 3  
 FDEPTH: 15 15 GearCond.code: 1  
 BDEPTH: 30 31 Validity code: 1  
 Towing dir: 250ø Wire out: 120 m Speed: 34 kn\*10  
 Sorted: 114 Kg Total catch: 114.26 CATCH/HOUR: 253.91

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Brachydeuterus auritus	70.67	6260	27.83	
J E L Y F I S H	63.56	242	25.03	
Sardinella maderensis	44.89	258	17.68	8986
Sardinella aurita	36.44	160	14.35	8985
Chloroscombrus chrysurus	22.00	227	8.66	
Trachurus trecae, juvenile	5.31	1302	2.09	8984
Trichiurus lepturus	2.56	64	1.01	8987
Selene dorsalis	2.53	22	1.00	
Sepia orbignyana	1.24	4	0.49	
Atractoscion aequidens	1.16	2	0.46	
Galeoides decadactylus	1.11	9	0.44	
Trachurus trecae	0.96	11	0.38	8983
Lagocephalus laevigatus	0.80	7	0.32	
Sphyaena guachancho	0.40	7	0.16	
Decapterus rhonchus	0.16	2	0.06	
Pagellus bellottii	0.13	42	0.05	
Total	253.92		100.01	

PROJECT STATION:4092  
 DATE:25/ 7/06 GEAR TYPE: PT No: 1 POSITION:Lat S 658  
 start stop duration Long E 1153  
 TIME :19:27:03 19:56:12 29 (min) Purpose code: 1  
 LOG :8262.30 8264.41 2.11 Area code : 3  
 FDEPTH: 5 5 GearCond.code: 1  
 BDEPTH: 463 580 Validity code: 1  
 Towing dir: 220ø Wire out: 120 m Speed: 40 kn\*10  
 Sorted: 74 Kg Total catch: 334.13 CATCH/HOUR: 691.30

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
MYCTOPHIDAE	339.37	260117	49.09	
Euthynnus alletteratus	270.93	1043	39.19	
Trichiurus lepturus	81.00	112	11.72	
Total	691.30		100.00	

PROJECT STATION:4093  
 DATE:26/ 7/06 GEAR TYPE: BT No:19 POSITION:Lat S 714  
 start stop duration Long E 1221  
 TIME :08:19:14 08:45:39 26 (min) Purpose code: 3  
 LOG :8369.82 8371.23 1.40 Area code : 3  
 FDEPTH: 116 122 GearCond.code: 1  
 BDEPTH: 116 122 Validity code: 1  
 Towing dir: 240ø Wire out: 360 m Speed: 30 kn\*10  
 Sorted: 124 Kg Total catch: 123.98 CATCH/HOUR: 286.11

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trachurus trecae	136.87	309	47.84	8988
Dentex congoensis	62.88	600	21.98	8989
Umbrina canariensis	27.92	76	9.76	8990
Dentex angolensis	23.42	58	8.19	
Loligo vulgaris	11.70	482	4.09	
Pagellus bellottii	11.70	482	4.09	
Raja alba	3.09	2	1.05	
Alloteuthis africana	2.12	547	0.74	
Chelidonichthys gabonensis	1.98	12	0.69	
Trichiurus lepturus	1.94	2	0.68	
Brotula barbata	1.29	2	0.45	
Zeus faber	0.67	2	0.23	
Drepane africana	0.39	2	0.14	
Citharus linguatula	0.12	2	0.04	
Total	286.09		100.00	

PROJECT STATION:4094  
 DATE:26/ 7/06 GEAR TYPE: PT No: 7 POSITION:Lat S 657  
 start stop duration Long E 1236  
 TIME :13:54:07 14:23:24 29 (min) Purpose code: 1  
 LOG :8414.93 8416.53 1.55 Area code : 3  
 FDEPTH: 10 10 GearCond.code: 1  
 BDEPTH: 22 22 Validity code: 1  
 Towing dir: 320ø Wire out: 120 m Speed: 33 kn\*10  
 Sorted: 104 Kg Total catch: 449.36 CATCH/HOUR: 929.71

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Chloroscombrus chrysurus	467.07	4322	50.24	8993
Sardinella maderensis	171.25	1297	18.42	8992
Sardinella aurita	161.92	737	17.42	8991
J E L Y F I S H	60.93	6573	6.55	
Caranx crysos	34.59	132	3.72	
Selar crumenophthalmus	12.81	43	1.38	
Decapterus rhonchus	6.66	43	0.72	
Sphyaena guachancho	5.69	17	0.61	
Stromateus fiatola	4.61	8	0.50	
Brachydeuterus auritus	4.18	35	0.45	
Total	929.71		100.01	

PROJECT STATION:4095  
 DATE:26/ 7/06 GEAR TYPE: PT No: 7 POSITION:Lat S 704  
 start stop duration Long E 1240  
 TIME :17:51:51 18:11:02 19 (min) Purpose code: 1  
 LOG :8448.03 8449.08 1.03 Area code : 3  
 FDEPTH: 5 5 GearCond.code: 1  
 BDEPTH: 24 27 Validity code: 1  
 Towing dir: 260ø Wire out: 120 m Speed: 30 kn\*10  
 Sorted: 54 Kg Total catch: 164.85 CATCH/HOUR: 520.58

PROJECT STATION:4100  
 DATE:29/ 7/06 GEAR TYPE: PT No: 2 POSITION:Lat S 831  
 start stop duration Long E 1313  
 TIME :07:41:21 08:02:15 21 (min) Purpose code: 1  
 LOG :8904.92 8906.31 1.38 Area code : 3  
 FDEPTH: 40 40 GearCond.code: 1  
 BDEPTH: 63 63 Validity code: 1  
 Towing dir: 360ø Wire out: 160 m Speed: 40 kn\*10  
 Sorted: 182 Kg Total catch: 181.47 CATCH/HOUR: 518.49

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella maderensis	269.53	1866	51.77	8994
Brachydeuterus auritus	126.00	1999	24.20	8996
Sardinella aurita - Juveniles	72.95	2340	14.01	8995
Sardinella aurita	43.77	332	8.41	8998
Trachurus trecae	6.44	114	1.24	8997
Trachinotus ovatus	1.80	19	0.35	
Pagellus bellottii	0.09	38	0.02	
<b>Total</b>	<b>520.58</b>		<b>100.00</b>	

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trichiurus lepturus	388.57	791	74.94	
Sardinella maderensis	76.43	443	14.74	9010
Sardinella aurita	46.29	174	8.93	9011
Stromateus fiatola	5.09	11	0.98	
Brachydeuterus auritus	1.97	31	0.38	
<b>Total</b>	<b>518.35</b>		<b>99.97</b>	

PROJECT STATION:4096  
 DATE:27/ 7/06 GEAR TYPE: PT No: 7 POSITION:Lat S 727  
 start stop duration Long E 1254  
 TIME :09:15:35 09:39:35 24 (min) Purpose code: 1  
 LOG :8556.00 8557.60 1.60 Area code : 3  
 FDEPTH: 5 5 GearCond.code: 1  
 BDEPTH: 23 23 Validity code: 1  
 Towing dir: 160ø Wire out: 120 m Speed: 40 kn\*10  
 Sorted: 29 Kg Total catch: 67.66 CATCH/HOUR: 169.15

PROJECT STATION:4101  
 DATE:29/ 7/06 GEAR TYPE: BT No:19 POSITION:Lat S 834  
 start stop duration Long E 1302  
 TIME :10:53:34 11:23:07 30 (min) Purpose code: 3  
 LOG :8928.68 8930.22 1.55 Area code : 3  
 FDEPTH: 128 128 GearCond.code: 1  
 BDEPTH: 128 128 Validity code: 1  
 Towing dir: 355ø Wire out: 435 m Speed: 30 kn\*10  
 Sorted: 97 Kg Total catch: 97.04 CATCH/HOUR: 194.08

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Brachydeuterus auritus Juv.	105.75	6495	62.52	9001
Sardinella maderensis	20.25	110	11.97	8999
Sarda sarda	12.45	15	7.36	
Stromateus fiatola	11.25	15	6.65	
Pomadasy s peroteti	5.40	10	3.19	
Sphyræna guachancho	4.55	10	2.69	
Zeus faber	3.50	15	2.07	
Trichiurus lepturus	2.75	5	1.63	
Sardinella aurita	2.15	15	1.27	9000
Trachinotus ovatus	0.70	5	0.41	
Sphyræna sphyræna	0.40	5	0.24	
<b>Total</b>	<b>169.15</b>		<b>100.00</b>	

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trichiurus lepturus	42.20	128	21.74	
Pterothrissus belloci	25.90	292	13.35	
Umbrina canariensis	23.00	58	11.85	
Dentex angolensis	21.60	110	11.13	9013
Brotula barbata	18.50	20	9.53	
Synagrops microlepis	15.20	1050	7.83	
Trachurus trecae	13.80	90	7.11	9012
Zeus faber	7.40	26	3.81	
Miracorvina angolensis	7.28	40	3.75	
Illex coindetii	5.22	380	2.69	
Spicara alta	3.16	26	1.63	
Dentex macrophthalmus	2.06	6	1.06	
Citharus linguatula	2.00	58	1.03	
Octopus vulgaris	1.70	4	0.88	
Saurida brasiliensis	1.26	346	0.65	
Chelidonichthys gabonensis	0.78	8	0.40	
Trachinotus ovatus	0.66	4	0.34	
Parapenaeus longirostris	0.64	224	0.33	
Scorpaena normani	0.60	4	0.31	
Todaropsis eblanæ	0.38	16	0.20	
Bembrops heterurus	0.34	4	0.18	
Dentex congolensis	0.18	4	0.09	
Boops boops	0.18	4	0.09	
Merluccius polli	0.04	6	0.02	
<b>Total</b>	<b>194.08</b>		<b>100.00</b>	

PROJECT STATION:4097  
 DATE:27/ 7/06 GEAR TYPE: BT No:19 POSITION:Lat S 742  
 start stop duration Long E 1238  
 TIME :13:32:22 14:02:29 30 (min) Purpose code: 3  
 LOG :8589.21 8590.70 1.48 Area code : 3  
 FDEPTH: 115 115 GearCond.code: 1  
 BDEPTH: 115 115 Validity code: 1  
 Towing dir: 330ø Wire out: 345 m Speed: 30 kn\*10  
 Sorted: 94 Kg Total catch: 93.45 CATCH/HOUR: 186.90

PROJECT STATION:4102  
 DATE:29/ 7/06 GEAR TYPE: BT No:19 POSITION:Lat S 838  
 start stop duration Long E 1308  
 TIME :15:50:48 16:22:15 31 (min) Purpose code: 1  
 LOG :8965.32 8967.06 1.72 Area code : 3  
 FDEPTH: 93 92 GearCond.code: 1  
 BDEPTH: 93 92 Validity code: 1  
 Towing dir: 2ø Wire out: 310 m Speed: 33 kn\*10  
 Sorted: 84 Kg Total catch: 83.83 CATCH/HOUR: 162.25

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trachurus trecae	88.70	158	47.46	9002
Umbrina canariensis	56.50	106	30.23	9003
Dentex angolensis	31.00	116	16.59	9004
Trichiurus lepturus	3.62	4	1.94	
J E L Y F I S H	2.88	6	1.54	
Zeus faber	1.80	4	0.96	
Loligo vulgaris	0.80	44	0.43	
Dentex barnardi	0.58	2	0.31	
Chelidonichthys gabonensis	0.40	2	0.21	
Dentex congolensis	0.36	4	0.19	
Pagellus bellottii	0.26	2	0.14	
<b>Total</b>	<b>186.90</b>		<b>100.00</b>	

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Brotula barbata	46.84	50	28.87	
Trichiurus lepturus	42.97	108	26.48	
Miracorvina angolensis	16.35	79	10.08	
Synagrops microlepis	10.45	4361	6.44	
Zeus faber	8.71	17	5.37	
Umbrina canariensis	7.35	14	4.53	
Dentex angolensis	6.19	31	3.82	9015
Pterothrissus belloci	5.77	37	3.56	
Chelidonichthys gabonensis	4.53	33	2.79	
Pagellus bellottii	4.20	19	2.59	
Citharus linguatula	1.95	29	1.20	
Raja miraletus	1.65	2	1.02	
Fistularia petimba	1.03	2	0.63	
Parapenaeus longirostris	0.87	381	0.54	
Trachinotus ovatus	0.81	2	0.50	
Alloteuthis africana	0.66	165	0.41	
Scorpaena normani	0.64	2	0.39	
Boops boops	0.54	21	0.33	
Merluccius polli	0.50	381	0.31	
Bregmaceros nectabanus	0.12	105	0.07	
Trachurus trecae, juvenile	0.12	74	0.07	9016
<b>Total</b>	<b>162.25</b>		<b>100.00</b>	

PROJECT STATION:4098  
 DATE:28/ 7/06 GEAR TYPE: PT No: 7 POSITION:Lat S 759  
 start stop duration Long E 1307  
 TIME :07:31:25 08:09:38 38 (min) Purpose code: 1  
 LOG :8718.60 8720.80 2.36 Area code : 3  
 FDEPTH: 20 20 GearCond.code: 1  
 BDEPTH: 33 33 Validity code: 1  
 Towing dir: 333ø Wire out: 120 m Speed: 30 kn\*10  
 Sorted: 59 Kg Total catch: 181.06 CATCH/HOUR: 285.88

PROJECT STATION:4103  
 DATE: 1/ 8/06 GEAR TYPE: PT No: 7 POSITION:Lat S 921  
 start stop duration Long E 1302  
 TIME :21:12:16 21:41:33 29 (min) Purpose code: 1  
 LOG :9238.50 9240.28 1.76 Area code : 2  
 FDEPTH: 10 10 GearCond.code: 1  
 BDEPTH: 22 28 Validity code: 1  
 Towing dir: 240ø Wire out: 120 m Speed: 35 kn\*10  
 Sorted: 126 Kg Total catch: 339.12 CATCH/HOUR: 701.63

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Brachydeuterus auritus	248.45	6868	86.91	9007
Trachurus trecae	12.08	171	4.23	9005
Pomadasy jubelini	11.46	19	4.01	
Sardinella aurita	6.49	66	2.27	9006
Selene dorsalis	2.23	38	0.78	
Mustelus mustelus	2.05	2	0.72	
Trichiurus lepturus	1.99	33	0.70	
Sardinella maderensis	0.85	14	0.30	
Sepia elegans	0.28	28	0.10	
<b>Total</b>	<b>285.88</b>		<b>100.02</b>	

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Brachydeuterus auritus	400.80	5758	57.12	9021
Ilisha africana	71.50	747	10.19	
Sardinella aurita	58.92	463	8.40	9020
Trachurus trecae	43.84	457	6.25	9018
Sepia orbignyana	41.34	27	5.89	
Sardinella maderensis	37.99	205	5.41	9019
Galeoides decadactylus	30.43	244	4.34	
Pagellus bellottii	5.92	33	0.84	
Trichiurus lepturus	5.30	37	0.76	
Boops boops	4.92	83	0.70	
Decapterus rhonchus	0.66	6	0.09	
<b>Total</b>	<b>701.62</b>		<b>99.99</b>	

PROJECT STATION:4099  
 DATE:28/ 7/06 GEAR TYPE: PT No: 5 POSITION:Lat S 812  
 start stop duration Long E 1308  
 TIME :19:04:40 19:28:37 24 (min) Purpose code: 1  
 LOG :8801.76 8803.29 1.51 Area code : 3  
 FDEPTH: 10 10 GearCond.code: 1  
 BDEPTH: 61 70 Validity code: 1  
 Towing dir: 248ø Wire out: 120 m Speed: 40 kn\*10  
 Sorted: 53 Kg Total catch: 214.32 CATCH/HOUR: 535.80

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Brachydeuterus auritus	421.50	4190	78.67	9009
Trichiurus lepturus	106.50	260	19.88	
Trachurus trecae	4.48	15	0.84	9008
Synagrops microlepis	1.50	1160	0.28	
Sardinella aurita	1.33	5	0.25	
Alloteuthis africana	0.50	310	0.09	
<b>Total</b>	<b>535.81</b>		<b>100.01</b>	

PROJECT STATION:4104  
 DATE: 2/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 942  
 start stop duration Long E 1243  
 TIME :02:55:06 03:23:56 29 (min) Purpose code: 1  
 LOG :9282.90 9284.43 1.48 Area code : 2  
 FDEPTH: 10 10 GearCond.code:  
 BDEPTH: 388 327 Validity code:  
 Towing dir: 68ø Wire out: 120 m Speed: 33 kn\*10  
 Sorted: 75 Kg Total catch: 201.37 CATCH/HOUR: 416.63

PROJECT STATION:4109  
 DATE: 4/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 1013  
 start stop duration Long E 1324  
 TIME :01:46:14 02:16:09 30 (min) Purpose code: 1  
 LOG :9613.69 9615.53 1.81 Area code : 2  
 FDEPTH: 15 12 GearCond.code:  
 BDEPTH: 28 33 Validity code:  
 Towing dir: 280ø Wire out: 120 m Speed: 36 kn\*10  
 Sorted: 84 Kg Total catch: 1486.93 CATCH/HOUR: 2973.86

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella aurita	253.61	875	60.87	9023
Trichiurus lepturus	94.12	267	22.59	9022
Sardinella maderensis	37.70	155	9.05	9024
MYCTOPHIDAE	17.03	11623	4.09	
Trachinotus ovatus	13.68	39	3.28	
Sepiella ornata	0.50	33	0.12	
<b>Total</b>	<b>416.64</b>		<b>100.00</b>	

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella aurita	2327.78	12814	78.27	9036
Sardinella maderensis	201.78	1416	6.79	9037
Brachydeuterus auritus Juv.	140.90	8496	4.74	9039
Brachydeuterus auritus	104.44	1380	3.51	9040
Pomadasys incisus	82.84	460	2.79	
Trachurus trecae	55.94	1344	1.88	9038
Galeoides decadactylus	22.30	106	0.75	
Ilisha africana	22.30	354	0.75	
Pteroscion pelli	8.50	248	0.29	
Trichiurus lepturus	3.90	34	0.13	
Parapenaeus longirostris	3.18	70	0.11	
<b>Total</b>	<b>2973.86</b>		<b>100.01</b>	

PROJECT STATION:4105  
 DATE: 2/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 944  
 start stop duration Long E 1309  
 TIME :15:04:59 15:35:09 30 (min) Purpose code: 1  
 LOG :9381.07 9382.80 1.70 Area code : 2  
 FDEPTH: 15 15 GearCond.code:  
 BDEPTH: 36 46 Validity code:  
 Towing dir: 254ø Wire out: 120 m Speed: 33 kn\*10  
 Sorted: 72 Kg Total catch: 71.54 CATCH/HOUR: 143.08

PROJECT STATION:4110  
 DATE: 4/ 8/06 GEAR TYPE: BT No:19 POSITION:Lat S 1028  
 start stop duration Long E 1328  
 TIME :11:48:49 12:16:45 28 (min) Purpose code: 1  
 LOG :9692.61 9694.17 1.55 Area code : 2  
 FDEPTH: 50 48 GearCond.code:  
 BDEPTH: 50 48 Validity code:  
 Towing dir: 345ø Wire out: 170 m Speed: 34 kn\*10  
 Sorted: 241 Kg Total catch: 1124.15 CATCH/HOUR: 2408.89

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella maderensis	84.90	556	59.34	9026
Sardinella aurita	56.20	316	39.28	9025
Caranx crysos	1.06	4	0.74	
Trachinotus ovatus	0.64	2	0.45	
Chloroscombrus chrysurus	0.28	2	0.20	
<b>Total</b>	<b>143.08</b>		<b>100.01</b>	

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trachurus trecae	721.54	7836	29.95	9042
Brachydeuterus auritus	670.78	7796	27.85	9044
Brachydeuterus auritus Juv.	533.76	17910	22.16	9043
Pseudupeneus prayensis	125.76	178	5.22	
Trachurus trecae, juvenile	120.26	1843	4.99	9041
Dentex barnardi	63.09	285	2.62	9046
Pagellus bellottii	38.34	424	1.59	9045
Pomadasys incisus	33.21	88	1.38	
Epinephelus aeneus	25.97	6	1.08	
Trichiurus lepturus	22.86	49	0.95	
Umbrina canariensis	13.69	79	0.57	
Torpedo torpedo	8.76	11	0.36	
Octopus vulgaris	8.12	4	0.34	
Stromateus fiatola	5.42	11	0.22	
Alloteuthis africana	3.94	917	0.16	
Zeus faber	2.76	11	0.11	
Boops boops	2.36	69	0.10	
Plectorhynchus mediterraneus	2.27	11	0.09	
Epinephelus sp.	1.86	11	0.08	
Sarda sarda	1.84	2	0.08	
Fistularia petimba	1.48	11	0.06	
Chaetodon hoefleri	0.79	11	0.03	
<b>Total</b>	<b>2408.86</b>		<b>99.99</b>	

PROJECT STATION:4106  
 DATE: 3/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 957  
 start stop duration Long E 1307  
 TIME :02:09:54 02:38:05 28 (min) Purpose code: 1  
 LOG :9449.62 9451.30 1.66 Area code : 2  
 FDEPTH: 15 15 GearCond.code:  
 BDEPTH: 67 77 Validity code:  
 Towing dir: 240ø Wire out: 120 m Speed: 38 kn\*10  
 Sorted: 115 Kg Total catch: 115.45 CATCH/HOUR: 247.39

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Brachydeuterus auritus	108.11	804	43.70	9030
Sardinella maderensis	85.18	521	34.43	9029
Trichiurus lepturus	21.11	39	8.53	
Sardinella aurita	18.86	84	7.62	9028
Alloteuthis africana	8.29	1894	3.35	
Sepia orbignyana	3.36	6	1.36	
Trachurus trecae	2.38	30	0.96	9027
Saurida brasiliensis	0.11	17	0.04	
<b>Total</b>	<b>247.40</b>		<b>99.99</b>	

PROJECT STATION:4107  
 DATE: 3/ 8/06 GEAR TYPE: BT No:19 POSITION:Lat S 1012  
 start stop duration Long E 1306  
 TIME :10:52:12 11:20:56 29 (min) Purpose code: 3  
 LOG :9518.17 9519.63 1.45 Area code : 2  
 FDEPTH: 102 101 GearCond.code:  
 BDEPTH: 102 101 Validity code:  
 Towing dir: 340ø Wire out: 330 m Speed: 31 kn\*10  
 Sorted: 49 Kg Total catch: 48.71 CATCH/HOUR: 100.78

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Dentex angolensis	32.48	211	32.23	9032
Dentex macropthalmus	22.24	68	22.07	9031
Chelidonichthys gabonensis	11.90	77	11.81	
Zeus faber	9.56	29	9.49	
Dentex barnardi	7.49	33	7.43	
Alloteuthis africana	4.26	1181	4.23	
Torpedo torpedo	2.94	4	2.92	
Pagellus bellottii	2.46	10	2.44	
Branchiostegus semifasciatus	1.51	2	1.50	
Raja miraletus	1.49	2	1.48	
Trichiurus lepturus	1.43	2	1.42	
Lagocephalus laevigatus	1.30	2	1.29	
Trachurus trecae	0.72	2	0.71	
Chaetodon hoefleri	0.52	4	0.52	
Citharus linguatula	0.17	2	0.17	
Anthias anthias	0.14	2	0.14	
Cepola pauciradiatus	0.06	2	0.06	
Illex coindetii	0.06	2	0.06	
Loligo vulgaris	0.04	2	0.04	
<b>Total</b>	<b>100.77</b>		<b>100.01</b>	

PROJECT STATION:4111  
 DATE: 5/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 1051  
 start stop duration Long E 1320  
 TIME :00:43:10 01:12:32 29 (min) Purpose code: 1  
 LOG :9801.30 9802.99 1.65 Area code : 2  
 FDEPTH: 10 10 GearCond.code:  
 BDEPTH: 407 481 Validity code:  
 Towing dir: 245ø Wire out: 120 m Speed: 36 kn\*10  
 Sorted: 39 Kg Total catch: 265.70 CATCH/HOUR: 549.72

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
MYCTOPHIDAE	368.28	149162	66.99	
Isurus oxyrinchus	144.83	2	26.35	
Parapenaeus longirostris	31.45	46314	5.72	
Carcharhinus signatus	5.17	4	0.94	
<b>Total</b>	<b>549.73</b>		<b>100.00</b>	

PROJECT STATION:4108  
 DATE: 3/ 8/06 GEAR TYPE: BT No:19 POSITION:Lat S 1015  
 start stop duration Long E 1312  
 TIME :15:37:30 16:07:13 30 (min) Purpose code: 3  
 LOG :9554.24 9555.96 1.71 Area code : 2  
 FDEPTH: 91 89 GearCond.code:  
 BDEPTH: 91 89 Validity code:  
 Towing dir: 320ø Wire out: 320 m Speed: 35 kn\*10  
 Sorted: 118 Kg Total catch: 383.96 CATCH/HOUR: 767.92

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trachurus trecae	637.52	1800	83.02	9033
Umbrina canariensis	61.42	118	8.00	9034
Stromateus fiatola	33.80	46	4.40	9035
Zeus faber	13.18	40	1.72	
Chelidonichthys gabonensis	5.72	40	0.74	
Raja miraletus	4.48	6	0.58	
Sepia bertheloti	3.64	26	0.47	
Alloteuthis africana	3.30	708	0.43	
Dentex angolensis	2.92	26	0.38	
Dentex barnardi	1.94	14	0.25	
<b>Total</b>	<b>767.92</b>		<b>99.99</b>	

PROJECT STATION:4112  
 DATE: 5/ 8/06 GEAR TYPE: BT No:19 POSITION:Lat S 1103  
 start stop duration Long E 1342  
 TIME :15:23:17 15:51:12 28 (min) Purpose code: 1  
 LOG :9896.46 9898.00 1.53 Area code : 2  
 FDEPTH: 76 79 GearCond.code:  
 BDEPTH: 76 79 Validity code:  
 Towing dir: 335ø Wire out: 230 m Speed: 33 kn\*10  
 Sorted: 217 Kg Total catch: 217.25 CATCH/HOUR: 465.54

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trachurus trecae	214.82	1339	46.14	9047
Trichiurus lepturus	104.89	422	22.53	
Synagrops microlepis	46.07	13031	9.90	
Brotula barbata	29.14	49	6.26	
Brachydeuterus auritus	14.89	214	3.20	9048
Sepia orbignyana	13.71	13	2.94	
Pterothrissus belloci	11.57	101	2.49	
Pagellus bellottii	10.18	47	2.19	9049
Trachurus trecae, juvenile	4.78	1485	1.03	9050
Atractoscion aequidens	4.71	2	1.01	
Thorogobius angolensis	2.57	330	0.55	
Zeus faber	2.34	13	0.50	
Merluccius polli, juveniles	2.01	349	0.43	
Branchiostegus semifasciatus	1.46	2	0.31	
Dentex barnardi	0.77	4	0.17	
Umbrina canariensis	0.64	4	0.14	
Miracoerina angolensis	0.49	2	0.11	
Sardinella maderensis	0.47	2	0.10	
<b>Total</b>	<b>465.51</b>		<b>100.00</b>	

PROJECT STATION:4113  
 DATE: 5/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 1115  
 start stop duration Long E 1340  
 TIME :22:55:47 23:00:58 5 (min) Purpose code: 1  
 LOG : 9955.92 9956.26 0.34 Area code : 2  
 FDEPTH: 5 5 GearCond.code:  
 BDEPTH: 40 48 Validity code:  
 Towing dir: 359ø Wire out: 120 m Speed: 40 kn\*10

Sorted: 125 Kg Total catch: 1996.80 CATCH/HOUR: 23961.60

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Sardinella aurita	22761.60	227712	94.99 9051
Sardinella maderensis	1056.00	5184	4.41 9052
Trichurus lepturus	144.00	384	0.60
Total	23961.60	100.00	

PROJECT STATION:4114  
 DATE: 6/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 1135  
 start stop duration Long E 1319  
 TIME :13:48:23 14:18:09 30 (min) Purpose code: 1  
 LOG : 53.91 55.66 1.74 Area code : 2  
 FDEPTH: 230 210 GearCond.code:  
 BDEPTH: 496 470 Validity code:  
 Towing dir: 16ø Wire out: 700 m Speed: 34 kn\*10

Sorted: 22 Kg Total catch: 21.99 CATCH/HOUR: 43.98

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
MYCTOPHIDAE	39.50	24342	89.81
J E L L Y F I S H	3.26	580	7.41
Chauliodus sloani	1.06	112	2.41
Lepidopus caudatus	0.14	10	0.32
Argyrolepeus aculeatus	0.02	60	0.05
Total	43.98	100.00	

PROJECT STATION:4115  
 DATE: 7/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 1210  
 start stop duration Long E 1333  
 TIME :13:07:07 13:37:48 31 (min) Purpose code: 1  
 LOG : 228.99 230.62 1.62 Area code : 2  
 FDEPTH: 17 17 GearCond.code:  
 BDEPTH: 85 73 Validity code:  
 Towing dir: 110ø Wire out: 120 m Speed: 32 kn\*10

Sorted: Kg Total catch: 0.34 CATCH/HOUR: 0.66

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
J E L L Y F I S H	0.66	15	100.00
Total	0.66	100.00	

PROJECT STATION:4116  
 DATE: 7/ 8/06 GEAR TYPE: PT No: 4 POSITION:Lat S 1216  
 start stop duration Long E 1331  
 TIME :17:54:49 18:00:12 5 (min) Purpose code: 1  
 LOG : 261.56 261.91 0.33 Area code : 2  
 FDEPTH: 10 10 GearCond.code:  
 BDEPTH: 79 81 Validity code:  
 Towing dir: 266ø Wire out: 120 m Speed: 40 kn\*10

Sorted: 128 Kg Total catch: 351.96 CATCH/HOUR: 4223.52

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Sardinella aurita	3270.36	25152	77.43 9056
Sardinella maderensis	610.56	2904	14.46 9055
Trachurus trecae	338.28	1812	8.01 9053
Trachurus trecae, juvenile	3.60	204	0.09 9054
Trichurus lepturus	0.72	36	0.02
Total	4223.52	100.01	

PROJECT STATION:4117  
 DATE: 8/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 1227  
 start stop duration Long E 1326  
 TIME :04:32:15 05:00:06 28 (min) Purpose code: 1  
 LOG : 319.28 320.85 1.54 Area code : 2  
 FDEPTH: 15 15 GearCond.code:  
 BDEPTH: 56 81 Validity code:  
 Towing dir: 320ø Wire out: 120 m Speed: 34 kn\*10

Sorted: 127 Kg Total catch: 254.84 CATCH/HOUR: 546.09

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Sardinella maderensis	422.79	1783	77.42 9057
Sardinella aurita	62.14	330	11.38 9058
Trachurus trecae	60.43	334	11.07 9059
Sepia orbignyana	0.73	13	0.13
Total	546.09	100.00	

PROJECT STATION:4118  
 DATE: 8/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 1257  
 start stop duration Long E 1255  
 TIME :13:17:06 13:34:37 18 (min) Purpose code: 1  
 LOG : 398.19 399.17 0.96 Area code : 2  
 FDEPTH: 15 15 GearCond.code:  
 BDEPTH: 32 30 Validity code:  
 Towing dir: 354ø Wire out: 120 m Speed: 32 kn\*10

Sorted: 319 Kg Total catch: 318.63 CATCH/HOUR: 1062.10

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Trachurus trecae	456.67	2890	43.00 9061
Sardinella maderensis	269.17	890	25.34 9060
Trichurus lepturus	153.33	3593	14.44 9063
Atractoscion aequidens	75.17	110	7.08
Lithognathus morumyrus	42.33	190	3.99
Decapterus rhonchus	19.33	57	1.82
J E L L Y F I S H	19.17	3	1.80
Pomatomus saltatrix	19.00	30	1.79
Sardinella aurita	5.00	17	0.47 9062
Brachydeuterus auritus	2.93	47	0.28
Total	1062.10	100.01	

PROJECT STATION:4119  
 DATE:10/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 1341  
 start stop duration Long E 1231  
 TIME :14:36:15 14:54:08 18 (min) Purpose code: 1  
 LOG : 519.02 520.10 1.07 Area code : 1  
 FDEPTH: 80 80 GearCond.code:  
 BDEPTH: 108 96 Validity code:  
 Towing dir: 18ø Wire out: 240 m Speed: 34 kn\*10

Sorted: Kg Total catch: CATCH/HOUR:

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
N O C A T C H	0.00		
Total			

PROJECT STATION:4120  
 DATE:10/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 1344  
 start stop duration Long E 1230  
 TIME :16:31:17 16:59:10 28 (min) Purpose code: 1  
 LOG : 531.92 533.54 1.62 Area code : 1  
 FDEPTH: 80 80 GearCond.code:  
 BDEPTH: 106 110 Validity code:  
 Towing dir: 345ø Wire out: 300 m Speed: 40 kn\*10

Sorted: Kg Total catch: CATCH/HOUR:

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
N O C A T C H	0.00		
Total			

PROJECT STATION:4121  
 DATE:11/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 1402  
 start stop duration Long E 1214  
 TIME :03:10:23 03:39:37 29 (min) Purpose code: 1  
 LOG : 600.08 602.06 1.96 Area code : 1  
 FDEPTH: 45 40 GearCond.code:  
 BDEPTH: 144 136 Validity code:  
 Towing dir: 85ø Wire out: 150 m Speed: 41 kn\*10

Sorted: 190 Kg Total catch: 190.36 CATCH/HOUR: 393.85

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Trachurus capensis	354.99	927	90.13 9064
Trachurus trecae	36.83	201	9.35 9065
Ommastrephes pteropus	1.16	2	0.29
MYCTOPHIDAE	0.87	346	0.22
Total	393.85	99.99	

PROJECT STATION:4122  
 DATE:11/ 8/06 GEAR TYPE: BT No:19 POSITION:Lat S 1421  
 start stop duration Long E 1215  
 TIME :08:44:32 09:06:33 22 (min) Purpose code: 1  
 LOG : 646.71 647.84 1.13 Area code : 1  
 FDEPTH: 118 115 GearCond.code:  
 BDEPTH: 118 115 Validity code:  
 Towing dir: 360ø Wire out: 380 m Speed: 30 kn\*10

Sorted: 83 Kg Total catch: 83.25 CATCH/HOUR: 227.05

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Dentex angolensis	66.14	275	29.13 9067
Trachurus trecae	29.59	117	13.03 9066
Etrumeus whiteheadi	26.86	434	11.83 9069
Atractoscion aequidens	26.32	33	11.59
Dentex barnardi	18.95	65	8.35
Spondyliosoma cantharus	11.73	25	5.17
Zeus faber	9.05	16	3.99
Chelidonichthys gabonensis	7.34	68	3.23
Raja miraletus	7.09	11	3.12
Trachurus capensis	5.86	16	2.58 9068
Boops boops	4.88	30	2.15
Myliobatis aquila	3.60	3	1.59
Brotula barbata	3.55	3	1.56
Sparus pagrus africanus *	1.96	3	0.86
Squatina oculata	1.23	3	0.54
Dentex macrophthalmus	0.82	3	0.36
Pagellus bellottii	0.79	3	0.35
Sepia orbignyana	0.68	3	0.30
Trigla lyra	0.60	3	0.26
Total	227.04	99.99	

PROJECT STATION:4123  
 DATE:11/ 8/06 GEAR TYPE: BT No:19 POSITION:Lat S 1425  
 start stop duration Long E 1219  
 TIME :11:13:48 11:34:05 20 (min) Purpose code: 1  
 LOG : 664.50 665.61 1.11 Area code : 1  
 FDEPTH: 87 88 GearCond.code:  
 BDEPTH: 87 88 Validity code:  
 Towing dir: 180ø Wire out: 280 m Speed: 32 kn\*10

Sorted: 160 Kg Total catch: 1125.11 CATCH/HOUR: 3375.33

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Trachurus trecae	3264.45	32046	96.71 9070
Boops boops	43.05	315	1.28
Decapterus rhonchus	35.07	105	1.04
Atractoscion aequidens	17.43	21	0.52
Sardinella aurita	11.76	126	0.35 9071
Chelidonichthys gabonensis	3.57	21	0.11
Total	3375.33	100.01	

PROJECT STATION:4124  
 DATE:12/ 8/06 GEAR TYPE: PT No: 7 POSITION:Lat S 1529  
 start stop duration Long E 1200  
 TIME :07:04:10 07:28:46 25 (min) Purpose code: 1  
 LOG : 823.81 825.30 1.48 Area code : 1  
 FDEPTH: 20 20 GearCond.code:  
 BDEPTH: 37 33 Validity code:  
 Towing dir: 13ø Wire out: 120 m Speed: 40 kn\*10

Sorted: 2 Kg Total catch: 2.07 CATCH/HOUR: 4.97

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Sardinella aurita	4.97	70	100.00 9072
Total	4.97	100.00	

PROJECT STATION:4125  
 DATE:12/ 8/06 GEAR TYPE: PT No: 4 POSITION:Lat S 1533  
 start stop duration Long E 1158  
 TIME :08:43:19 09:15:06 32 (min) Purpose code: 1  
 LOG : 834.52 836.66 2.14 Area code : 1  
 FDEPTH: 5 5 GearCond.code:  
 BDEPTH: 71 94 Validity code:  
 Towing dir: 278° Wire out: 240 m Speed: 45 kn\*10  
 Sorted: Kg Total catch: CATCH/HOUR:

PROJECT STATION:4130  
 DATE:13/ 8/06 GEAR TYPE: BT No:19 POSITION:Lat S 1618  
 start stop duration Long E 1146  
 TIME :17:08:19 17:27:14 19 (min) Purpose code: 1  
 LOG :1062.43 1063.40 0.97 Area code : 1  
 FDEPTH: 20 19 GearCond.code:  
 BDEPTH: 20 19 Validity code:  
 Towing dir: 175° Wire out: 120 m Speed: 30 kn\*10  
 Sorted: 82 Kg Total catch: 138.74 CATCH/HOUR: 438.13

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
N O C A T C H	0.00		
Total			

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Trachurus trecae, juvenile	302.24	46667	68.98 9083
J E L L Y F I S H	84.88	3303	19.37
Sepia orbignyana	21.54	28	4.92
Dentex barnardi	16.26	2157	3.71 9084
Etrumeus whiteheadi	9.41	1042	2.15 9085
Dicologlossa cuneata	2.05	92	0.47
Trachinus armatus	0.92	32	0.21
Loligo vulgaris	0.82	38	0.19
Total	438.12		100.00

PROJECT STATION:4126  
 DATE:12/ 8/06 GEAR TYPE: BT No:19 POSITION:Lat S 1537  
 start stop duration Long E 1157  
 TIME :13:09:01 13:21:23 12 (min) Purpose code: 1  
 LOG : 873.30 873.97 0.68 Area code : 1  
 FDEPTH: 72 72 GearCond.code:  
 BDEPTH: 72 72 Validity code:  
 Towing dir: 210° Wire out: 240 m Speed: 32 kn\*10  
 Sorted: 176 Kg Total catch: 937.47 CATCH/HOUR: 4687.35

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Trachurus trecae	2451.25	47140	52.30 9073
Dentex macropthalmus	1794.00	26790	38.27 9074
Boops boops	154.45	1775	3.30
Dentex barnardi	120.60	580	2.57 9075
Thyrsites atun	38.15	130	0.81
Decapterus rhonchus	25.95	80	0.55
Umbrina canariensis	24.35	210	0.52
Atractoscion aequidens	21.95	55	0.47
Sparus pagrus africanus *	17.75	5	0.38
Spondyllosoma cantharus	16.70	80	0.36
Zeus faber	11.90	25	0.25
Pagellus bellottii	4.50	25	0.10
Etrumeus whiteheadi	3.70	50	0.08
Pomadasys incisus	2.10	25	0.04
Total	4687.35		100.00

PROJECT STATION:4131  
 DATE:14/ 8/06 GEAR TYPE: BT No:19 POSITION:Lat S 1637  
 start stop duration Long E 1134  
 TIME :08:22:05 08:29:14 7 (min) Purpose code: 1  
 LOG :1164.41 1164.76 0.34 Area code : 1  
 FDEPTH: 96 96 GearCond.code:  
 BDEPTH: 96 96 Validity code:  
 Towing dir: 360° Wire out: 310 m Speed: 30 kn\*10  
 Sorted: 65 Kg Total catch: 1306.40 CATCH/HOUR: 11197.71

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Trachurus capensis, juvenile	9702.86	349371	86.65 9086
Etrumeus whiteheadi	473.14	13200	4.23 9088
Dentex macropthalmus	382.29	9943	3.41 9089
Merluccius capensis	150.86	514	1.35
Trigla lyra	138.86	343	1.24
J E L L Y F I S H	132.00	686	1.18
Zeus faber	113.14	514	1.01
Sepia orbignyana	78.86	171	0.70
Trachurus trecae, juvenile	25.71	857	0.23 9087
Total	11197.72		100.00

PROJECT STATION:4127  
 DATE:12/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 1543  
 start stop duration Long E 1153  
 TIME :14:46:33 15:15:13 29 (min) Purpose code: 1  
 LOG : 884.59 886.60 1.89 Area code : 1  
 FDEPTH: 14 14 GearCond.code:  
 BDEPTH: 101 87 Validity code:  
 Towing dir: 36° Wire out: 140 m Speed: 42 kn\*10  
 Sorted: 58 Kg Total catch: 57.98 CATCH/HOUR: 119.96

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Etrumeus whiteheadi	82.66	1334	68.91
Sardinella aurita	34.14	494	28.46 9076
J E L L Y F I S H	2.88	48	2.40
Sardinops ocellatus	0.29	4	0.24
Total	119.97		100.01

PROJECT STATION:4132  
 DATE:16/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 1700  
 start stop duration Long E 1133  
 TIME :04:44:06 05:10:06 26 (min) Purpose code: 1  
 LOG :1376.40 1378.17 1.76 Area code : 1  
 FDEPTH: 40 40 GearCond.code:  
 BDEPTH: 105 106 Validity code:  
 Towing dir: 275° Wire out: 120 m Speed: 40 kn\*10  
 Sorted: 8 Kg Total catch: 8.30 CATCH/HOUR: 19.15

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Etrumeus whiteheadi	18.95	1154	98.96 9091
J E L L Y F I S H	0.16	9	0.84
Trachurus capensis, juvenile	0.05	14	0.26 9090
Total	19.16		100.06

PROJECT STATION:4128  
 DATE:13/ 8/06 GEAR TYPE: BT No:19 POSITION:Lat S 1613  
 start stop duration Long E 1143  
 TIME :07:53:40 08:02:58 9 (min) Purpose code: 1  
 LOG : 990.84 991.29 0.45 Area code : 1  
 FDEPTH: 49 49 GearCond.code:  
 BDEPTH: 49 49 Validity code:  
 Towing dir: 360° Wire out: 180 m Speed: 30 kn\*10  
 Sorted: 107 Kg Total catch: 1024.61 CATCH/HOUR: 6830.73

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Trachurus trecae, juvenile	5902.07	415487	86.40 9077
Sepia orbignyana	531.20	127	7.78
Spicara alta	252.80	57727	3.70 9079
J E L L Y F I S H	101.13	7293	1.48
Trigla lyra	13.47	67	0.20
Trachurus capensis, juvenile	10.27	707	0.15 9078
Todarodes sagittatus	9.60	127	0.14
Umbrina canariensis	4.47	127	0.07
Trachinus armatus	3.20	67	0.05
Etrumeus whiteheadi	1.27	67	0.02
Pegusa lascaris	1.27	67	0.02
Total	6830.75		100.01

PROJECT STATION:4133  
 DATE:16/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 1701  
 start stop duration Long E 1136  
 TIME :07:09:32 07:26:42 17 (min) Purpose code: 1  
 LOG :1387.37 1388.52 1.14 Area code : 1  
 FDEPTH: 35 35 GearCond.code:  
 BDEPTH: 84 93 Validity code:  
 Towing dir: 260° Wire out: 169 m Speed: 40 kn\*10  
 Sorted: 71 Kg Total catch: 601.46 CATCH/HOUR: 2122.80

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Etrumeus whiteheadi	2110.48	212220	99.42 9093
J E L L Y F I S H	7.20	212	0.34
Trachurus capensis, juvenile	4.20	872	0.20 9092
Sardinops ocellatus	0.92	32	0.04
Total	2122.80		100.00

PROJECT STATION:4129  
 DATE:13/ 8/06 GEAR TYPE: BT No:19 POSITION:Lat S 1623  
 start stop duration Long E 1146  
 TIME :10:13:47 10:33:41 20 (min) Purpose code: 1  
 LOG :1006.58 1007.53 0.93 Area code : 1  
 FDEPTH: 22 22 GearCond.code:  
 BDEPTH: 22 22 Validity code:  
 Towing dir: 360° Wire out: 120 m Speed: 30 kn\*10  
 Sorted: 177 Kg Total catch: 177.99 CATCH/HOUR: 533.97

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
J E L L Y F I S H	473.55	14373	88.68
Etrumeus whiteheadi	35.40	2040	6.63 9081
Trachurus trecae, juvenile	19.32	3444	3.62 9080
Lithognathus mormyrus	2.40	3	0.45
Loligo vulgaris	1.44	102	0.27
Diplodus sargus *	0.96	6	0.18
Dicologlossa cuneata	0.33	15	0.06
Spondyllosoma cantharus	0.30	3	0.06
Pagellus bellottii	0.27	48	0.05 9082
Total	533.97		100.00

PROJECT STATION:4134  
 DATE:16/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 1706  
 start stop duration Long E 1136  
 TIME :11:30:15 11:34:30 4 (min) Purpose code: 1  
 LOG :1414.75 1415.01 0.24 Area code : 1  
 FDEPTH: 55 55 GearCond.code:  
 BDEPTH: 92 90 Validity code:  
 Towing dir: 90° Wire out: 170 m Speed: 35 kn\*10  
 Sorted: 71 Kg Total catch: 212.34 CATCH/HOUR: 3185.10

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Etrumeus whiteheadi	2697.75	276345	84.70 9095
Trachurus capensis, juvenile	326.25	65880	10.24 9094
J E L L Y F I S H	159.75	2430	5.02
Loligo vulgaris	1.35	45	0.04
Total	3185.10		100.00

PROJECT STATION:4135  
 DATE:16/ 8/06 GEAR TYPE: BT No:19 POSITION:Lat S 1707  
 start stop duration Long E 1137  
 TIME :12:23:37 12:52:50 29 (min) Purpose code: 1  
 LOG :1418.60 1420.27 1.66 Area code : 1  
 FDEPTH: 87 89 GearCond.code:  
 BDEPTH: 87 89 Validity code:  
 Towing dir: 342ø Wire out: 280 m Speed: 34 kn\*10  
 Sorted: 48 Kg Total catch: 180.82 CATCH/HOUR: 374.11

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trachurus capensis, juvenile	187.76	32431	50.19	9098
Dentex macrophthalmus	66.72	480	17.83	9100
Trachurus trecae, juvenile	55.47	12801	14.83	9099
Trachurus capensis	30.33	1101	8.11	9097
Trachurus trecae	12.89	426	3.45	9096
Atractoscion aequidens	6.52	39	1.74	
J E L L Y F I S H	4.10	85	1.10	
Arius heudeloti	2.79	8	0.75	
Merluccius paradoxus	2.71	31	0.72	
Chelidonichthys capensis	2.09	17	0.56	
Pterothrissus belloci	1.01	23	0.27	
Squalus megalops	0.62	2	0.17	
Dicologlossa cuneata	0.62	62	0.17	
Pomadasys incisus	0.39	8	0.10	
Brotula barbata	0.08	8	0.02	
Total	374.10		100.01	

PROJECT STATION:4136  
 DATE:16/ 8/06 GEAR TYPE: BT No:19 POSITION:Lat S 1706  
 start stop duration Long E 1122  
 TIME :15:04:39 15:27:49 23 (min) Purpose code: 1  
 LOG :1437.19 1438.35 1.15 Area code : 1  
 FDEPTH: 160 158 GearCond.code:  
 BDEPTH: 160 158 Validity code:  
 Towing dir: 342ø Wire out: 480 m Speed: 31 kn\*10  
 Sorted: 117 Kg Total catch: 1433.96 CATCH/HOUR: 3740.77

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trachurus capensis	3350.64	147597	89.57	9101
Dentex macrophthalmus	330.73	2778	8.84	9102
Merluccius paradoxus	46.96	190	1.26	
Zeus faber	8.61	63	0.23	
Saurida brasiliensis	3.83	159	0.10	
Total	3740.77		100.00	

PROJECT STATION:4137  
 DATE:16/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 1712  
 start stop duration Long E 1134  
 TIME :22:41:54 23:00:26 19 (min) Purpose code: 1  
 LOG :1473.16 1474.20 1.03 Area code : 1  
 FDEPTH: 40 40 GearCond.code:  
 BDEPTH: 106 108 Validity code:  
 Towing dir: 350ø Wire out: 150 m Speed: 30 kn\*10  
 Sorted: 20 Kg Total catch: 20.68 CATCH/HOUR: 65.31

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trachurus capensis, juvenile	56.05	6559	85.82	9103
Etrumeus whiteheadi	7.33	382	11.22	9104
J E L L Y F I S H	1.58	51	2.42	
Squalus megalops	0.35	3	0.54	
Total	65.31		100.00	



## ANNEX III

### Biomass and Number of fish per length class

#### Sardinella

*Sardinella aurita*

North (Congo River to Luanda, 5°S-9°S) and, Central (Luanda to Benguela, 9°S-13°S), and South (Benguela to Cunene river, 13° – 17° 15'S). N = numbers, W = weight.

Length group (cm)	North		Central		South	
	N	W	N	W	N	W
5						
6						
7						
8						
9						
10			1	0.0		
11	3	0.0	1	0.0		
12	18	0.3				
13	61	1.3				
14	125	3.4	1	0.0		
15	49	1.6			55	1.9
16	74	3.0			3	0.1
17	53	2.5	16	0.7	45	2.1
18	98	5.5	4	0.2	49	2.6
19	7	0.4	6	0.4	21	1.3
20	20	1.5	38	2.9		
21	64	5.6	157	13.6		
22	45	4.5	128	12.8		
23	34	3.9	110	12.5	88	8.2
24	19	2.4	56	7.2	33	3.4
25	16	2.4	47	6.8		
26	14	2.3	72	11.8	1	0.1
27	11	1.9	27	4.9		
28	72	14.7	47	9.6	2	0.2
29	127	28.7	21	4.7		
30	73	18.6	11	2.7		
31	58	16.4	31	8.6	1	0.2
32	33	9.9	10	3.1		
33	11	3.5	0	0.1		
34	2	0.6				
35	1	0.3				
Number (millions)	1087		784		297	
Biomass (kTons)		135.2		102.7		20.1

*Sardinella maderensis*

North (Congo River to Luanda, 5°S - 9°S), and Central (Luanda to Benguela, 9°S - 13°S). N = numbers, W = weight.

Length group (cm)	North		Central	
	N	W	N	W
5				
6				
7	1	0.0	3	0.0
8	17	0.1		
9	8	0.1		
10				
11				
12				
13				
14				
15				
16			3	0.1
17	19	0.9	3	0.1
18	14	0.8	3	0.2
19	14	0.9	6	0.4
20	37	2.8		
21	132	11.5	3	0.3
22	151	15.1		
23	178	20.2	22	2.5
24	112	14.4	106	13.8
25	166	24.0	103	15.0
26	205	33.2	92	14.8
27	213	38.5	169	30.1
28	117	23.5	17	3.3
29	62	13.7	159	34.3
30	40	9.8	10	2.4
31	21	5.7	27	6.8
32	9	2.8	36	10.2
33	2	0.6	18	5.5
34	0	0.1	3	0.9
35				
36			1	0.4
37				
38				
39				
40				
41	21	12.6		
42				
Number (millions)	1539		784	
Biomass (kTons)		231.3		141.1

*Trachurus trecae*

North (Congo River to Luanda, 5°S - 9°S), Central (Luanda to Benguela, 9°S – 13°S), and South (Benguela to Cunene River, 13° - 17°15'S).  
 N = numbers, W = weight.

Length group (cm)	North		Central		South	
	N	W	N	W	N	W
5	5	0.0	30	0.0	40	0.1
6	5	0.0	3	0.0	42	0.1
7	6	0.0	43	0.2	120	0.4
8	2	0.0	18	0.1	130	0.7
9			3	0.0	88	0.7
10			1	0.0	96	1.0
11					40	0.5
12			4	0.1	35	0.6
13			9	0.2	2	0.0
14			49	1.4	194	5.1
15	0	0.0	102	3.5	46	1.6
16	0	0.0	41	1.7	171	6.7
17	3	0.1	3	0.2	184	8.6
18	6	0.4	10	0.6	61	3.2
19	8	0.6	30	2.0	32	2.1
20	5	0.4	13	1.0	13	1.3
21	3	0.3	55	4.9	12	1.1
22	1	0.1	40	4.1	14	1.4
23			18	2.1	12	1.1
24			27	3.6	18	1.9
25	4	0.6	0	0.0	7	1.0
26	0	0.0	4	0.6	6	0.8
27			35	6.5	13	1.9
28			4	0.8	3	0.5
29	0	0.1	24	5.6	6	1.2
30	0	0.1	0	0.0	2	0.4
31	4	1.2	13	3.6	1	0.3
32	2	0.6	60	18.3	2	0.5
33	8	2.7	3	1.0	1	0.2
34	13	4.8	35	12.8	1	0.3
35	5	1.9			0	0.1
36	8	3.6	5	2.1		
37	5	2.6				
38	5	2.8			0	0.1
39	3	1.9				
40	2	1.4				
41	2	1.3				
42	2	1.1			0	0.2
43	2	1.2			0	0.1
44	1	0.6				
45	1	0.7				
Number (millions)	112		679		1394	
Biomass (kTons)	31.0		77.0		45.4	

*Trachurus capensis*

South ( Benguela to Cunene River, 13° - 17°15'S). N = numbers, W = weight.

Length group (cm)	South	
	N	W
5	72	0.1
6	9	0.0
7	963	3.2
8	252	1.2
9	81	0.6
10	52	0.5
11	148	1.8
12	58	0.9
13	125	2.5
14	188	4.6
15	107	3.2
16	45	1.6
17	5	0.2
18	0	0.0
19		
20		
21		
22	0	0.0
23		
24	0	0.0
25		
26	2	0.3
27	2	0.4
28		
29	9	1.8
30		
31		
32	0	0.1
33		
34	4	1.2
35		
36	3	1.3
37		
38	0	0.2
Number (mill.)	2125	
Biomass kTons)		25.6

*Sardinops ocellatus*

South (Benguela to Cunene River, 13° - 17°15'S). N = numbers, W = weight.

South		
Length group (cm)	N	W
5		
6		
7		
8		
9		
10		
11	131	2.7
12	424	10.8
13	196	6.0
14		
15	114	4.9
16		
17	3	0.2
18	39	2.6
19	3	0.2
20	41	3.5
21	139	13.2
22	440	46.8
23	1 000	118.4
24	342	44.8
25	5	0.7
26		
Number (mill.)	2 876	
Biomass (kTons)		254.9

## ANNEX IV. Acoustic instruments

### Echo sounder

The SIMRAD EK500/38 kHz scientific sounder was used during the survey for fish abundance estimation. The keel was submerged during the survey. The Bergen Echo Integrator system (BEI) was used to scrutinise the acoustic records. The settings of 38 kHz echo sounder were as follows:

#### Tranceiver-1 menu (38 kHz, mounted in lowering keel)

Transducer depth	5.5 m (keel not submerged)
Absorption coeff.	10 dB/km
Pulse length	Medium (1 ms)
Bandwidth	Wide
Max Power	2000 Watt
2-way beam angle	-21.0 dB
Sv Transducer gain	29.96 dB
TS Transducer gain	27.07 dB
Angle sensitivity	21.9
3 dB beam width	6.9 ° along ship 6.8 ° athwardship
Along ship offset	-0.07 °
Athwardship effect	0.08 °

#### Display menu

Echogram	1 (38 kHz)
Bottom range	15 m
Bottom range start	10 m
Sv colour min	-67 dB

#### Printer menu

Echogram	1 (38 kHz)
Range	50 m, 100 m, 150 m, 250 m, 500 m
Range start	0
Bottom range	12 m
Bottom range start	10 m
TVG	20 log R
Sv Colour min	- 63 dB

**Bottom detection menu**      Minimum level -50 dB