

## **SURVEYS OF THE PELAGIC FISH RESOURCES OF GABON, CONGO, DRC, ANGOLA and NAMIBIA**

Part I. GABON and CONGO

18 – 30 June 2010

*FINAL DRAFT*

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by

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**Bergen, 2010**

## **THE EAF-NANSEN PROJECT**

FAO started the implementation of the project “Strengthening the Knowledge Base for and Implementing an Ecosystem Approach to Marine Fisheries in Developing Countries (EAF-Nansen GCP/INT/003/NOR)” in December 2006 with funding from the Norwegian Agency for Development Cooperation (NORAD). The EAF-Nansen project is a follow-up to earlier projects/programmes in a partnership involving FAO, NORAD and the Institute of Marine Research (IMR), Bergen, Norway on assessment and management of marine fishery resources in developing countries. The project works in partnership with governments and also GEF-supported Large Marine Ecosystem (LME) projects and other projects that have the potential to contribute to some components of the EAF-Nansen project.

The EAF-Nansen project offers an opportunity to coastal countries in sub-Saharan Africa, working in partnership with the project, to receive technical support from FAO for the development of national and regional frameworks for the implementation of Ecosystem Approach to Fisheries management and to acquire additional knowledge on their marine ecosystems for their use in planning and monitoring. The project contributes to building the capacity of national fisheries management administrations in ecological risk assessment methods to identify critical management issues and in the preparation, operationalization and tracking the progress of implementation of fisheries management plans consistent with the ecosystem approach to fisheries.

## **LE PROJET EAF-NANSEN**

La FAO a initié la mise en œuvre du projet "Renforcement de la base des connaissances pour mettre en œuvre une approche écosystémique des pêcheries marines dans les pays en développement (EAF-Nansen GCP/INT/003/NOR)" en décembre 2006. Le projet est financé par de l'Agence norvégienne de coopération pour le développement (NORAD). Le projet EAF-Nansen fait suite aux précédents projets/ programmes dans le cadre du partenariat entre la FAO, NORAD et l'Institut de recherche marine (IMR) de Bergen en Norvège, sur l'évaluation et l'aménagement des ressources halieutiques dans les pays en développement. Le projet est mis en œuvre en partenariat avec les gouvernements et en collaboration avec les projets grands écosystèmes marins (GEM) soutenus par le Fonds pour l'Environnement Mondial (FEM) et d'autres projets régionaux qui ont le potentiel de contribuer à certains éléments du projet EAF-Nansen.

Le projet EAF-Nansen offre l'opportunité aux pays côtiers de l'Afrique subsaharienne partenaires de recevoir un appui technique de la FAO pour le développement de cadres nationaux et régionaux visant une approche écosystémique de l'aménagement des pêches et la possibilité d'acquérir des connaissances complémentaires sur leurs écosystèmes marins. Ces éléments seront utilisés pour la planification et le suivi des pêcheries et de leurs écosystèmes. Le projet contribue à renforcer les capacités des administrations nationales responsables de l'aménagement des pêches en introduisant des méthodes d'évaluation des risques écologiques pour identifier les questions d'aménagement d'importance majeure ainsi que la préparation, la mise en œuvre et le suivi des progrès de la mise en œuvre de plans d'aménagement des ressources marines conformes à l'approche écosystémique des pêches.

## TABLE OF CONTENTS

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TABLE OF CONTENTS .....	3
CHAPTER 1 INTRODUCTION.....	4
1.1 Objectives.....	4
1.2 Participation .....	4
1.3 Narrative.....	5
1.4 Survey effort.....	6
CHAPTER 2 METHODS .....	8
2.1 Hydrographical sampling .....	8
2.2 Sediment sampling .....	8
2.3 Plankton sampling.....	9
2.4 Fish sampling .....	9
2.5 Acoustic sampling.....	10
CHAPTER 3 OCEANOGRAPHIC CONDITIONS.....	13
3.1 Surface distribution .....	13
3.2 Vertical sections .....	17
CHAPTER 4 FISH DISTRIBUTION, SIZE AND BIOMASS ESTIMATES .....	21
4.1 Gabon .....	21
4.2 Congo .....	23
CHAPTER 5 SUMMARY OF SURVEY RESULTS .....	26
5.1 Sardinellas .....	26
5.2 Other Clupeids.....	28
5.3 Trachurus trecae .....	28
5.4 Other pelagic fish .....	30
CHAPTER 6 RESUME DES RESULTATS DE CAMPAGE EN FRANCAIS.....	33
CHAPTER 7 REFERENCES.....	36
Annex I Records of fishing stations .....	37
Annex II. Length frequencies of main species.....	42
Annex III Biomass and number per length group .....	44
Annex IV Instruments and fishing gear used .....	47



## 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 Gabon, Congo, Democratic Republic of Congo (DCR), Angola and northern Namibia, as agreed between the Food and Agriculture Organisation of the United Nations (FAO) and Institute of Marine Research in Norway (IMR). The program is funded and organised by the FAO under the program agreement “NORAD/FAO PROJECT GCP/INT/003/NOR”. The goal of the program is to improve the understanding and knowledge in terms of the biology, ecology and population dynamics of the main species in relation to the environment and the whole ecosystem. The objectives of the survey were briefly discussed and agreed upon during a pre-survey meeting held in onboard the R/V *Dr. Fridtjof Nansen* in Port Gentil, Gabon, prior to the survey where representatives from GCLME and all countries surveyed were present together with representatives from IMR.

The specific 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 the region, including the two sardinella species *Sardinella aurita* and *S. maderensis*, the Cunene horse mackerel *Trachurus trecae* and other pelagic species.
- To collect stomach contents and gonads of important pelagic fish species in the region to increase knowledge on feeding and reproductive pattern
- 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.
- To collect bottom sediment samples.
- On-the-job training for the local and regional participants on the main survey routines.

### 1.2 Participation

The scientific staff consisted of:

From Direction Générale des Pêches et de l’Aquaculture, Gabon:  
Pulcherie MENGUE M’ADZABA, Marcelle Guylène NKOANE NDOUTOUME  
and Jean de Dieu LEWEMBE

From Direction Générale de la Pêche Maritime, Congo:  
Claude Benoît ATSANGO and Romuald Tite AKENZE

From Department of Biology, University of Kinshasa and ISP-Gombe, R.D. Congo:  
Séraphin Ifuta Ndey BIBUYA.

From Department of Biology, UPN, Kinshasa, R.D. Congo:  
Jolie KIPIMBYE LUKONDE

From Direcção das Pescas, São Tomé e Príncipe:  
Virginia Carvalho D’Almeida GODINHO and José Dias de Sousa LOPES (co-cruise leader)

From Nigerian Institute for Oceanography and Marine Research, Lagos:  
Ndubuisi AJUONU

From Department of Oceanography and Fisheries, University of Ghana:  
Eunice KONADU-TWUM

From UNIDO/GCLME, RCU, Ghana  
Socrates APETORGBOR

From Instituto Nacional de Investigação das Pescas (INIP), Angola  
Aristóteles Patrício da Silva AMARO

From Institute of Marine Research (IMR), Bergen:  
Sigbjørn MEHL (cruise leader), Diana ZAERA, Tore MØRK and Ole Sverre FOSSHEIM

### **1.3 Narrative**

The vessel left Port Gentil 18<sup>th</sup> June at 1700 and steamed north to the border between Equatorial Guinea and Gabon, where the coverage of Gabon started at 0600 the next day. The shelf was surveyed with parallel course tracks perpendicular to the coast, 10 NM (nautical miles) apart. The acoustic transects generally covered a depth range of 20 - 500 m. The vessel reached Cape Lopez on 21<sup>st</sup> June, and continued southwards covering the southern part of Gabon. The first transect in Congo was started 27<sup>th</sup> June. On 30<sup>th</sup> June, the last transect was completed and the first part of the survey finished. The vessel arrived in Pointe Noire at 0900 the same day for change of scientific crew. After leaving Point Noire on 1<sup>st</sup> June the vessel steamed south to start the survey off Angola.

Continuous acoustic recordings and analysis were carried throughout the survey. Pelagic and bottom trawling for species identification and biological sampling were done on registrations and additional random blind hauls were carried out during dark hours.

Hydrographical profiles were carried out using a CTD, from the surface and down to the bottom, at standard depths (20, 50, 100, 200, 500 and 1000 m) and repeating the 2008 transects: Corisco, Equator, Cape Lopez, Iguela, Setté Cama and Pte. Panga in Gabon and Madingo and Pointe Noire in Congo. South of Cape Lopez, additional stations were taken between these transects, about every 20 NM, at 20 and 500 m.

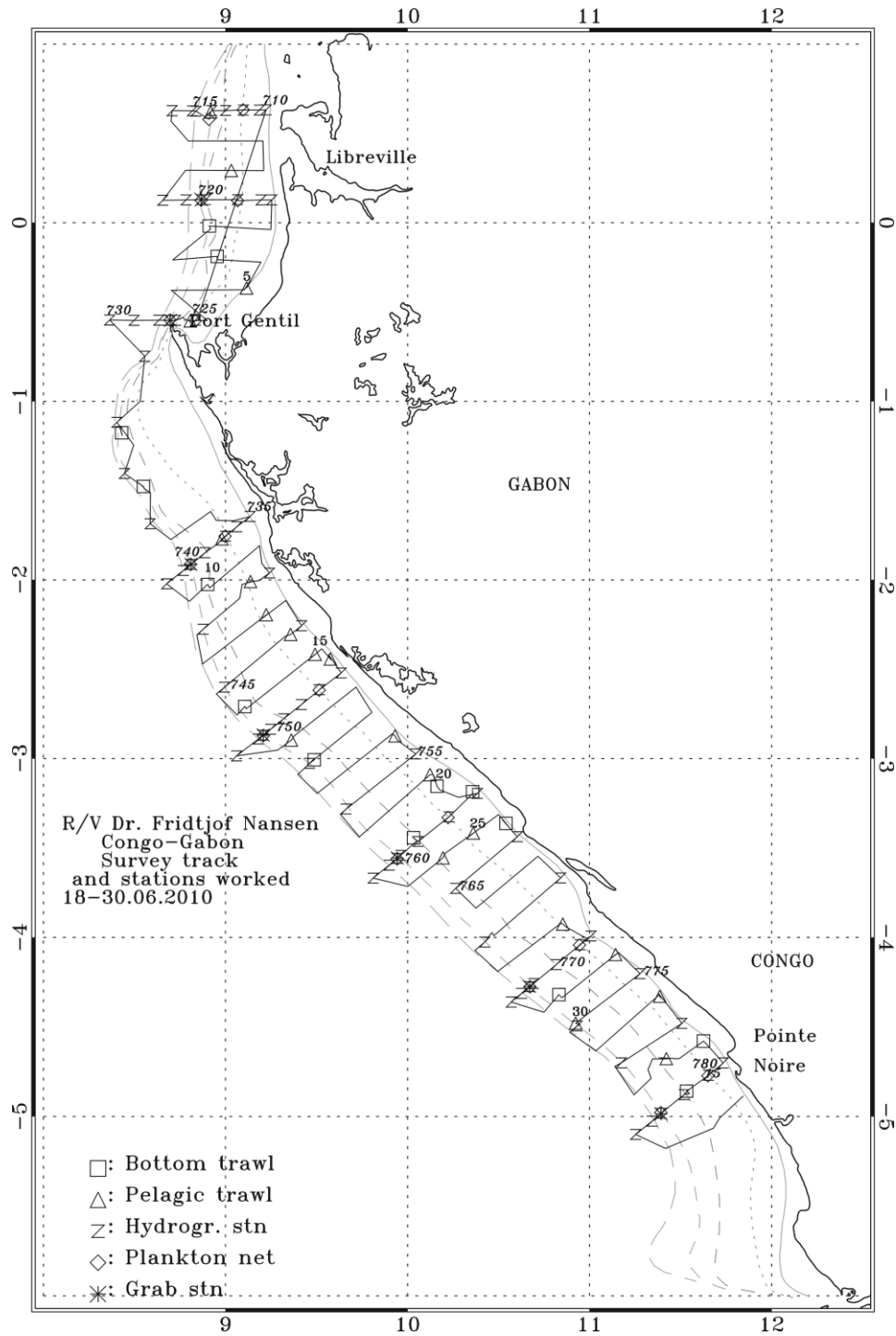
Plankton sampling was done during the hydrographical transects at approximately 50 and 200 m depth. Grab samples were also taken at most hydrographical transects at 200 m depth for training purposes and to supplement already existing samples from the area.

#### 1.4 Survey effort

Figure 1.1 shows the cruise tracks with fishing, plankton, grab and hydrographical stations. Areas shallower than 20 m are not accessible to the vessel, e.g. south of Port Gentil. Other areas were not accessible to the bottom trawl due to rocky bottom. For sampling the pelagic species, a small and a mid-sized pelagic trawl were used, supplemented with bottom trawl hauls. Table 1.1 summarizes the survey effort by country.

**Table 1.1 Total number of pelagic trawl (PT), bottom trawl (BT), hydrographical (CTD), plankton (P) and grab (G) stations and distance surveyed in NM (nautical miles) by country.**

Country	PT	BT	CTD	P	G	NM
Gabon	15	11	58	12	5	1426
Congo	5	3	17	4	2	415
Total	20	14	75	16	7	1841



**Figure 1.1. Gabon-Congo. Course track with fishing, plankton, grab and hydrographical stations. Depth contours at 20, 50, 100, 200, and 500m.**

## CHAPTER 2      METHODS

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### 2.1      Hydrographical sampling

#### *CTD*

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 60 NM distance, and additional stations were taken between these transects, about every 20 NM, at 20 and 500 m. The casts were stopped a few meters above the bottom, and at a maximum of 1000 m depth. The oxygen sensor has shown to be very stable, and no calibration was conducted during the survey. Attached to the CTD was also a Chelsea fluorometer of the type Mk III Aquatrack. It measures chlorophyll  $\alpha$  in micrograms per litre with an uncertainty of 3%. Factory slope and offset was 0.921 and -0.02.

#### *Thermosalinograph*

The SBE 21 Seacat thermosalinograph was running routinely during the survey, obtaining samples of sea surface salinity and relative temperature and fluorescence (5 m depth) every 10 seconds. An attached in-line Turner Design SCUFA Fluorometer was continuously measuring Chlorophyll levels [RFU] at 5 m below the sea surface while underway during the entire cruise. The instrument is configured with a bright blue photodiode, a 420 nm Excitation filter and a 680 nm Emission filter. It is calibrated against the secondary orange standard dye. The maximum output is equivalent to 5Volt = 100%. It has a linear temperature compensation of 2.14%/°C.

#### *Current speed and direction measurements (ADCP)*

A vessel-mounted Acoustic Doppler Current Profiler (VMADCP) from RD Instruments was run continuously during the survey in broadband mode shallower than about 400 m and in narrow band mode in deeper waters. The frequency of the VMADCP is 150 kHz, and data were averaged and stored in 3 m or 4 m vertical bins. All data were stored on files for post survey processing.

#### *Meteorological observations*

Meteorological data logged from the Norwegian Meteorological Institute (DNMI) included air temperature, humidity, air pressure, wind direction and speed, and sea surface temperature (SST). All data were averaged by unit distance sailed (1 NM).

### 2.2      Sediment sampling

Due to lack of experienced personnel, only simplified sediment samples were taken, mainly for training purposes. The samples were taken with a van Veen grab with adjustable weight and a surface area of 0.1 m<sup>2</sup>. The total volume of the grab was 21 litres. At each site, except the first one, 2 grab samples were taken.

Samples were sieved through round holes sieves with a mesh size of 5 mm and 1 mm, stored in plastic bottles and preserved in a formalin and borax solution. Each sample was marked and stored for further analyses onshore.

## **2.3 Plankton sampling**

### *Phytoplankton*

South of Cape Lopez phytoplankton was collected with the same interval as the zooplankton stations. Samples were taken from the surface (5 m depth) with the ship's seawater pump, fixed in buffered formaldehyde solution and stored for further analyses onshore.

### *Zooplankton*

The zooplankton sampling was conducted by means of HYDROBIOS Multinet (150-180  $\mu\text{m}$ ), at up to five depths intervals; 0-25, 25-50, 50-75, 75-100 and 100-200 m, at about 50 and 200 m depth in each hydrographical transect.

## **2.4 Fish sampling**

A brief description of the fishing gear is provided in Annex IV. All trawl catches were sampled for species composition by weights and numbers. Records of catch rates are given in Annex I. Total length (TL) frequencies were taken for the commercial pelagic species such as sardinellas, horse mackerel, and various species of carangids and other pelagic fish (Annex II).

Biological samples were obtained for sardinellas and horse mackerel. Total length (TL) and body weight were determined to the nearest 1 cm and 1 g below, respectively. Sex and reproductive stages were determined according to the scale adapted by INIP for the classification of maturity stage for both horse mackerel and sardinellas in Angola (Table 2.1). Stomach samples were taken of both sardinella species and horse mackerel, and in addition stomachs were sampled from a few demersal species.

**Table 2.1** Maturity stage scale adapted by INIP for the classification of maturity stage for both horse mackerel and sardinellas in Angola (partial spawners).

Stage	Maturity stage	Description
I	Immature	Small gonads, do not occupy more than 1/3 of abdominal cavity length. Ovary pinkish; testis whitish. Ovary not visible to naked eye
II	Maturing virgin and recovering spent	The gonads begin to develop, increasing substantially in size; about ½ length of the abdominal cavity. Gonads more opaque, small points visible to the naked eye (oocytes at the beginning of vitellogenese). The gonads in rest/recovery more flaccid with some more conspicuous blood than the gonads in development.
III	Mature. Before pre-spawning	At the beginning, oocytes more conspicuous giving the gonad a granular aspect. Ovary yellow-orange, testis creamy. Visible sperm in testis if open. Gonads quite swollen in the beginning of the reproduction period. Gonads that have spawned once lose consistency, but opaque oocytes present, and sperm in testis if cut. At the end of the stage is possible to find some translucent oocytes. Gonads occupy about 2/3 of abdominal cavity.
IV	Mature Pre-spawning	The gonads occupy about 2/3 of abdominal cavity. Ovaries orange in colour with visible blood vessels. Most oocytes translucent, testis creamy, flat and brilliant texture. The gonads stop flowing oocytes and sperm flows at low pressure.
V	Mature. In spawning	The gonads occupy about 2/3 or less of abdominal cavity. Ovaries orange in colour with the conspicuous blood vessels, blood stained mainly in one end. Most oocytes translucent; testis creamy, flat and brilliant texture. The gonads stop flowing oocytes and sperm flows at low pressure. Pink stains at the end of gonad.
VI	Post-spawning	The gonads decrease in size and occupy about ½ or less, of abdominal cavity. Gonads flaccid and bloody. Ovary can contain remaining oocytes that were not emitted. Testis may have sperm remaining in the seminal duct. Pinkish areas in the whole extension of the gonad.

## 2.5 Acoustic sampling

### *Acoustic equipment*

Acoustic data were recorded using a Simrad ER60 scientific echo sounder equipped with keel-mounted transducers at nominal operating frequencies of 18, 38, 120 and 200 kHz. No calibration was conducted during the survey. Acoustic data were logged and post-processed using the latest acoustic data post-processing software, the Large Scale Survey System (LSSS) Version 1.32. The technical specifications and operational settings of the echo sounders used during the survey are given in Annex IV.

### *Allocation of acoustic energy to species group*

The acoustic data were scrutinized using the LSSS. Scatters were displayed at 38 kHz. The mean 5 NM area backscattering coefficient  $s_A$  ( $m^2/NM^2$ ) was allocated to a predefined set of species groups on the basis of a visual scrutiny of the behaviour pattern as deduced from echo diagrams, LSSS analysis and catch composition. Acoustic groups with its respective species are listed in Table 2.2.

**Table 2.2 Allocation of acoustic densities to species groups. Note that for sardinella, horse mackerel and big-eye grunt groups, all encountered species are listed, while only main species are listed for the remaining groups.**

Group	Taxon	Species
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>
Big-eye grunt		<i>Brachydeuterus auritus</i>
Pelagic species 1	Glupeiformes <sup>1</sup>	<i>Ilisha africana</i> <i>Engraulis encrasicolus</i>
Pelagic species 2	Carangidae <sup>2</sup>	<i>Alectis alexandrinus</i> <i>Caranx hippos</i> <i>Chloroscombrus chrysurus</i> <i>Decapterus rhonchus</i> <i>Decapterus punctatus</i> <i>Selar crumenophthalmus</i> <i>Selene dorsalis</i>
	Scombridae	<i>Sarda sarda</i> <i>Scomber japonicus</i> <i>Scomberomorus tritor</i>
	Sphyraenidae	<i>Sphyraena guachancho</i> <i>Sphyraena sphyraena</i>
	Others	<i>Trichiurus lepturus</i>
Other demersal species	Sparidae <sup>3</sup>	<i>Dentex angolensis</i> <i>D. congoensis</i> <i>Pagellus bellottii</i> <i>Boops boops</i>
	Other taxii	<i>Saurida brasiliensis</i> <i>Arioma bondi</i>
Mesopelagic species	Myctophidae <sup>3</sup>	<i>Lampanyctodes hectoris</i>
	Other mesopelagic fish	<i>Trachinocephalus myops</i>
Plankton	Calanoidae	<i>Calanus</i> sp.
	Euphausiidae	<i>Meganyciphanes</i> sp.
	Other plankton	

<sup>1</sup> other than *Sardinops* sp., <sup>2</sup> other than *Trachurus* sp., <sup>3</sup> 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 are presently 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 regression of the log-length (total) against total weight. Separate length-weight relationships were worked for each region, 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 NansisMapTool Version 1.51, and distribution plots and area calculations on the strata were carried out with the same software. 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:  $s_A > 3\ 001$  ( $m^2/NM^2$ ).

Mean 5-NM integrator values ( $s_A$ ) computed along the transect lines were re-averaged for each stratum. The short spacing between the lines (10 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:

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

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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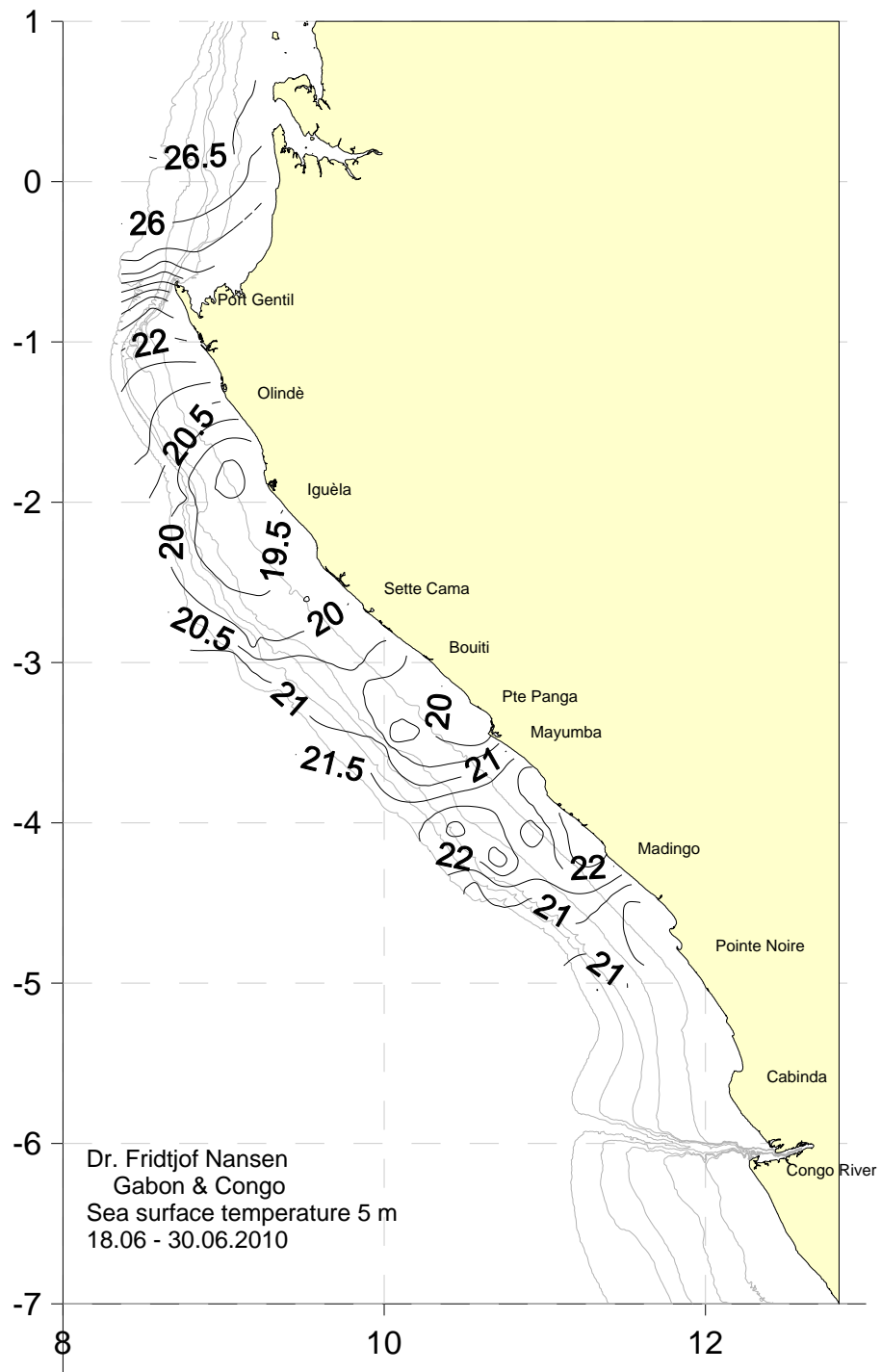
### 3.1 Surface distribution

The sea surface temperature (SST, 5 m depth), the sea surface salinity, (SSS, 5 m depth) and sea surface Fluorescence (SSF, 5 m depth) were continuously recorded during the cruise. Figures 3.1 – 3.3 show the horizontal distribution of SST, SSS and SSF, respectively, for Gabon and Congo.

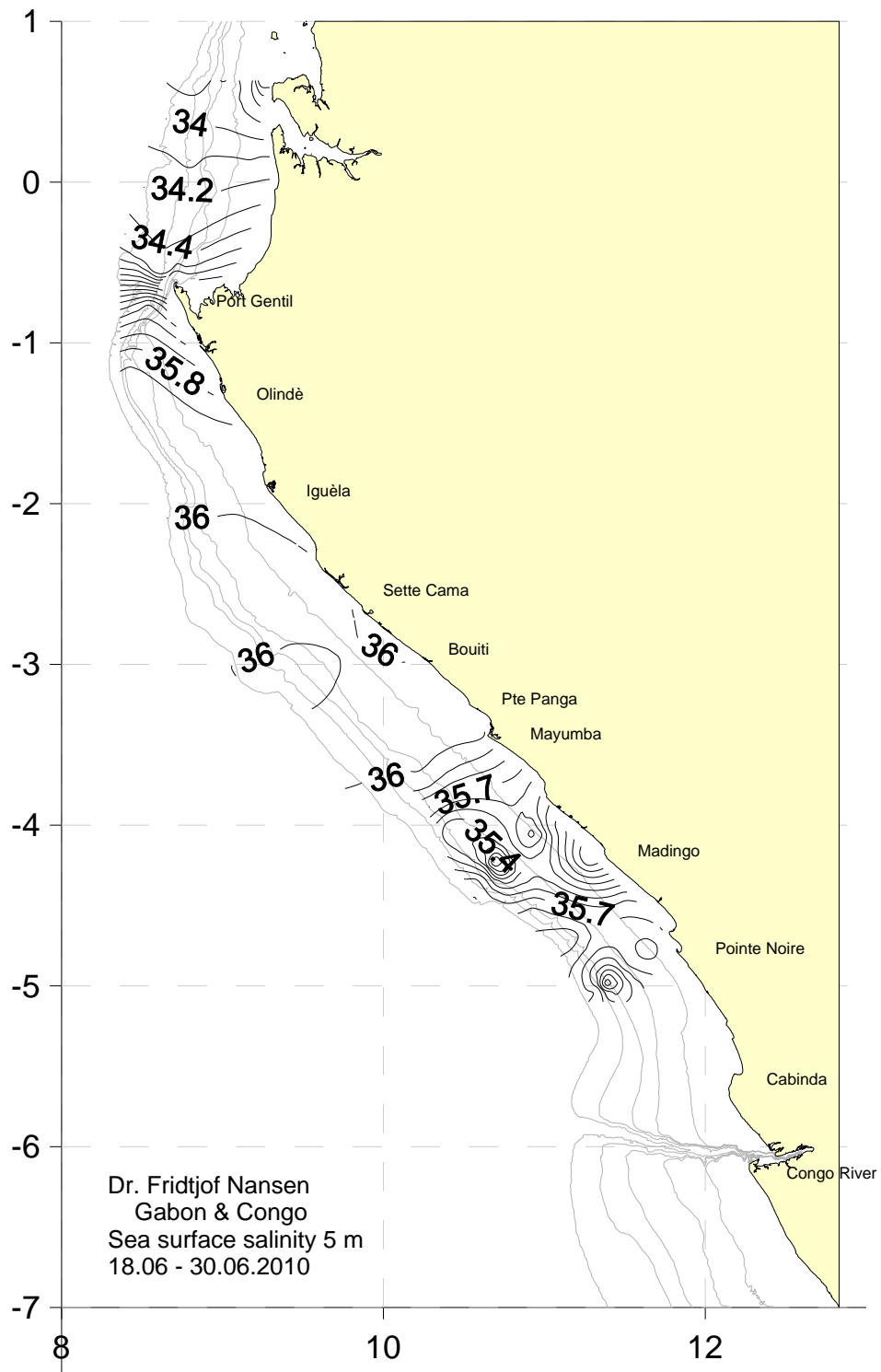
The SST in northern Gabon reached up to 26.5°C, diminishing towards the south with a minimum temperature at around 19°C. A temperature gradient was found across the shelf with a front around Cape Lopez separating warm less saline waters in the north from colder and more saline waters in the south. In the southernmost part of the region, towards Congo, temperature increases, with values of about 22°C off Madingo (Congo). The distribution is similar to the one found in previous surveys conducted during the same time of the year.

Salinity in the region ranged between 34 in the north, and 36 in the south. As with the SST, a SSS gradient was observed across the shelf with a front around Cape Lopez, where less saline waters extend to the north. Salinity values increased towards the south, with a maximum of 36 between Iguéla and Pte. Panga (Gabon). The area off Libreville showed the lowest salinity value (34), probably as a consequence of the discharge of the rivers in the area. This year's SSS pattern is comparable with those found previously during the surveys conducted during the same month, although temperatures are slightly higher. There seems to be a constant area of higher salinity between Iguéla and Pte. Panga.

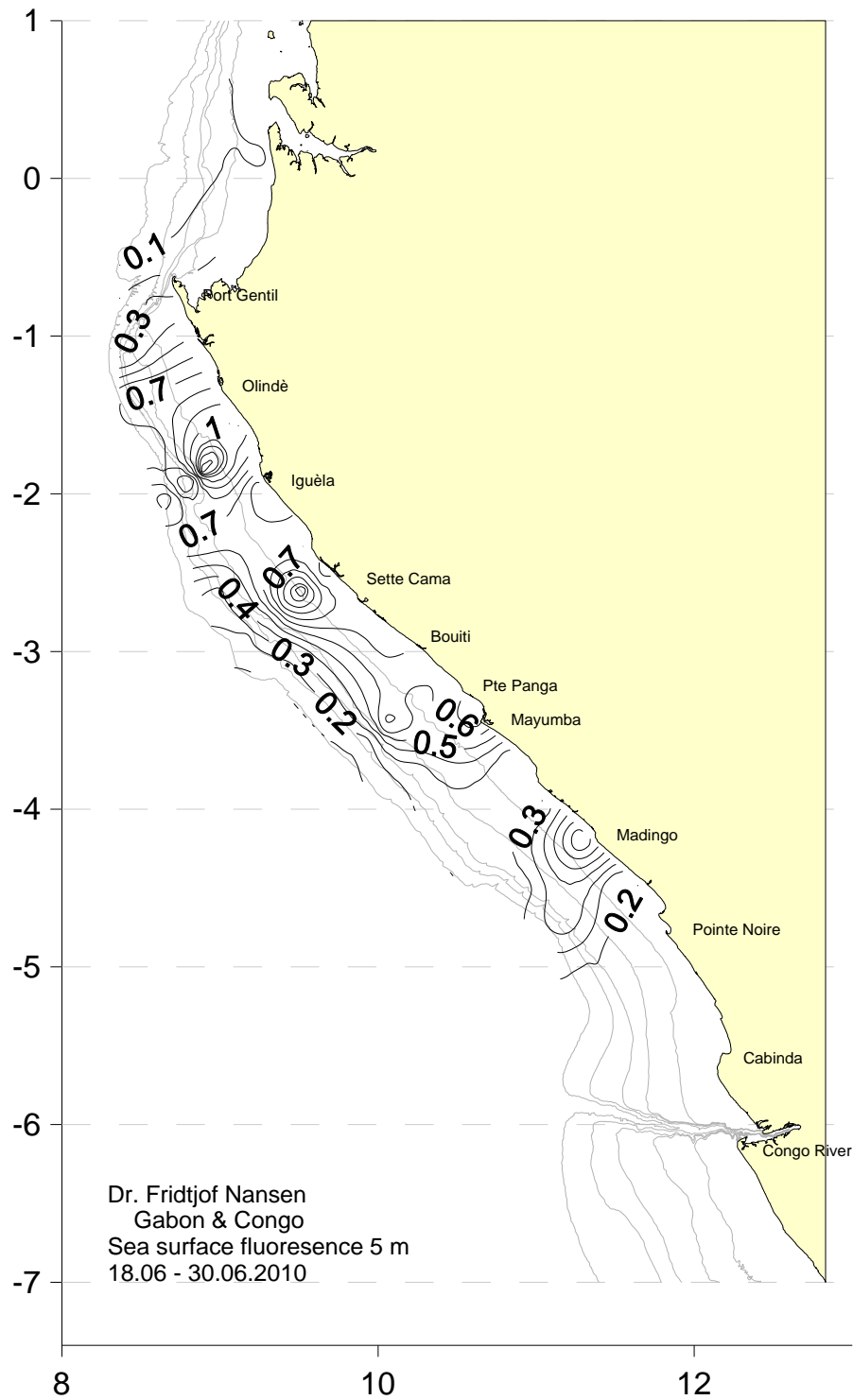
A SSF gradient was also observed across the shelf. The lowest values were observed off Libreville and south to Cape Lopez (0.1 µg/l). From here, the chlorophyll values increased to a maximum of 1 µg/l between Olindè and Iguéla, to decrease again towards Congo in the south. In the area between Iguéla and Mayumba, the highest values were recorded inshore.



**Figure 3.1** Horizontal distribution of SST off Gabon and Congo.



**Figure 3.2** Horizontal distribution of SSS off Gabon and Congo.



**Figure 3.3** Horizontal distribution of SSF off Gabon and Congo.

### 3.2 Vertical sections

Figure 3.4 (a-h) shows the vertical distribution of temperature, salinity, dissolved oxygen and chlorophyll in Gabon and Congo, as recorded on the hydrographical transects worked during the survey. The chlorophyll sensor data recorded are not directly comparable with recorded data on Sea Surface Fluorescence recordings depicted in Figure 3.3.

#### *Gabon*

Surface temperature at Corisco, Equator and Cape Lopez section was between 25 - 26°C. On average the temperatures in the upper layers were about 2-3°C lower than in May 2008. A thermocline was observed at about 25 m depth. Isolines were generally parallel with depth and the temperatures decreased steadily to around 17°C at 100 m depth and reached 8 °C at 400-500 m depth. The profiles south of Cape Lopez at Iguela, Setté Cama and Pointe Panga were similar in appearance to those in the northern part of Gabon. Temperatures were lower and ranged from around 19°C – 21°C in the surface, declining to around 17°C at 100 m depth. A temperature minimum around 8°C was found at 500 m depth as in previous years.

The very high fresh water influence found on transects north of Cape Lopez in May 2008 was not seen during the present survey. Surface and upper layer values of 34.2-35.9 were recorded in the Corisco, Equator and Cape Lopez transects. Salinity decreased in deeper waters to minimum values of 34.7-34.9 around 500 m depth. South of Cape Lopez the salinity recordings near surface were slightly higher than in north with maximum recordings of around 36.0. Minimum salinity of 34.7 was found at 400-500 m depth.

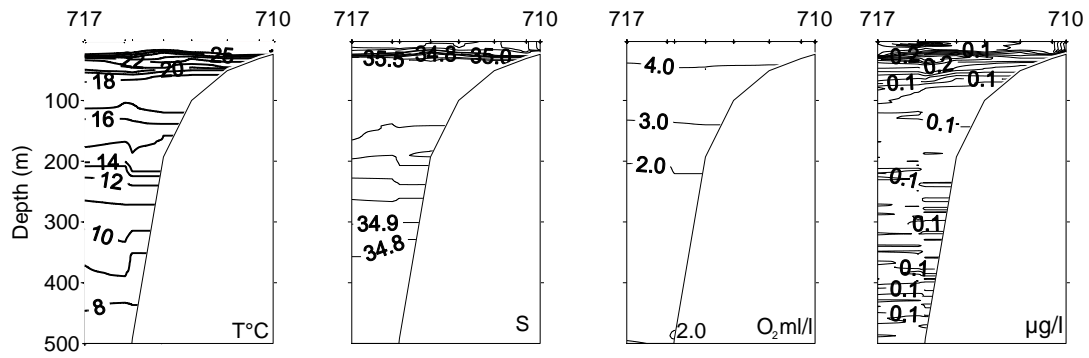
North of Cape Lopez dissolved oxygen values decreased gradually from 4.0 at the surface to 2.0 ml/l below 200 m depth. Further south surface values were similar to those on northern Gabon, but off Setté Cama minimum dissolved oxygen values decreased gradually from about 4.0 ml/l in surface waters to 1.4 ml/l around 200 m depth and increased slightly again in deeper waters.

Chlorophyll recordings ranged from 0.1 to 1 µg/l in the upper layers, with lowest values north of Cape Lopez and highest off Setté Cama. In deeper layers the values were about 0.1 µg/l.

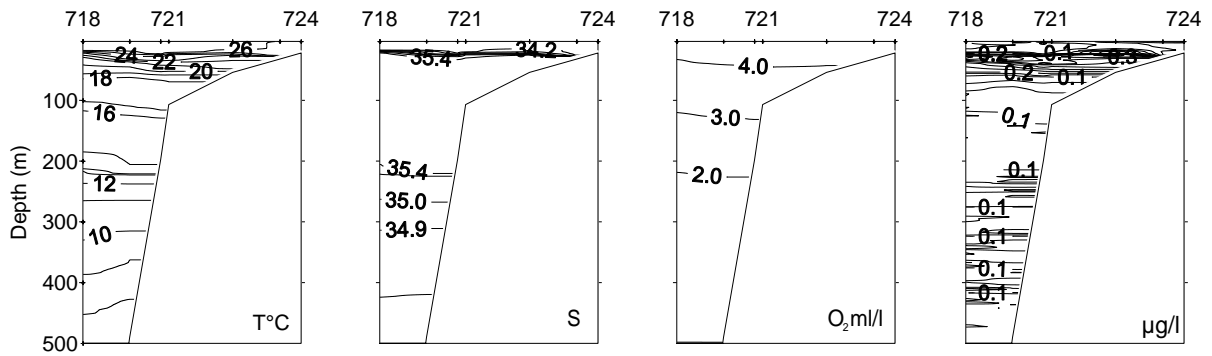
#### *Congo*

The temperature profile at Madingo showed surface temperatures around 22°C. Temperature at 100 m depth was 16°C. At Pointe Noire surface temperature was 20°C decreasing to 17°C at 100 m depth. Both profiles showed bottom temperature at 500 m around 8°C. Temperature profiles were generally similar to those found further north.

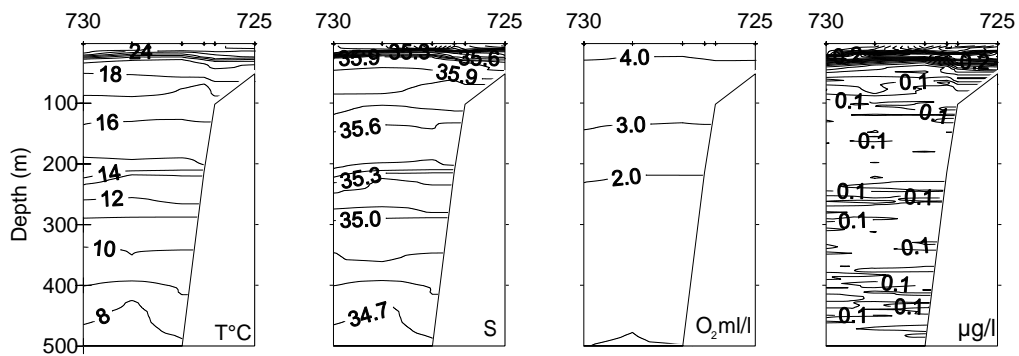
Maximum surface salinity was 35.9 at Madingo and at Pointe Noire. Salinity in the bottom waters around 500 m depth was 34.7. Dissolved oxygen at the surface at Madingo and Pointe Noire was around 4 ml/l, dropping to between 3 and 2 ml/l at 100 m depth and 2 ml/l in deeper layers. Measurements of chlorophyll  $\alpha$  at the Madingo transect show highest concentrations near the surface, with recordings of 0.5 µg/l, declining to 0.1 µg/l at 50 m and deeper. At Point Noire the surface values was only 0.2 µg/l, declining to 0.1 µg/l at 50 m.



a. Corisco, Gabon

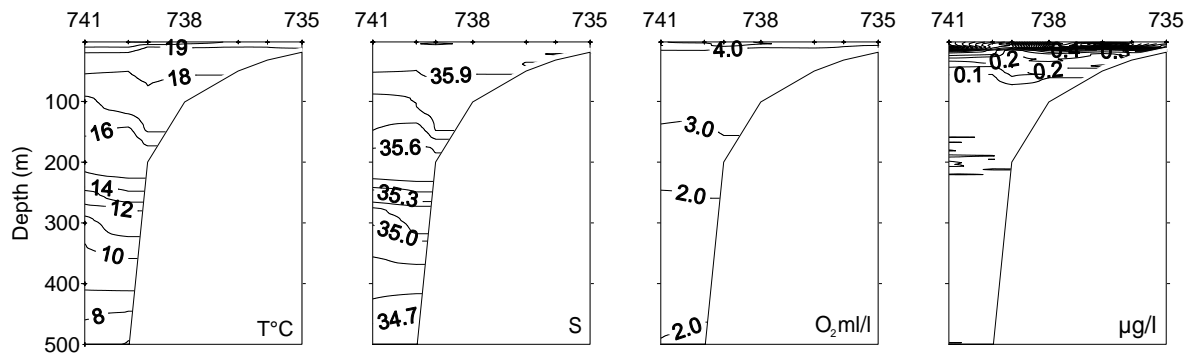


b. Equator, Gabon

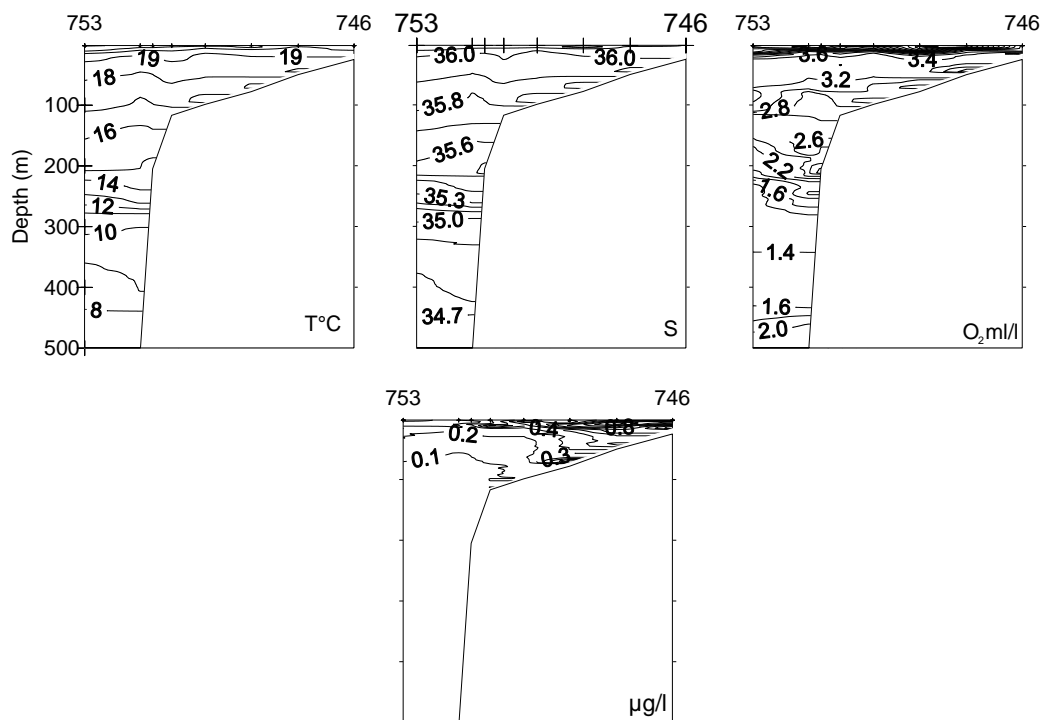


c. Cape Lopez, Gabon

**Figure 3.4a-h.** Vertical sections of temperature, salinity, oxygen and fluorescence in Gabon and Congo



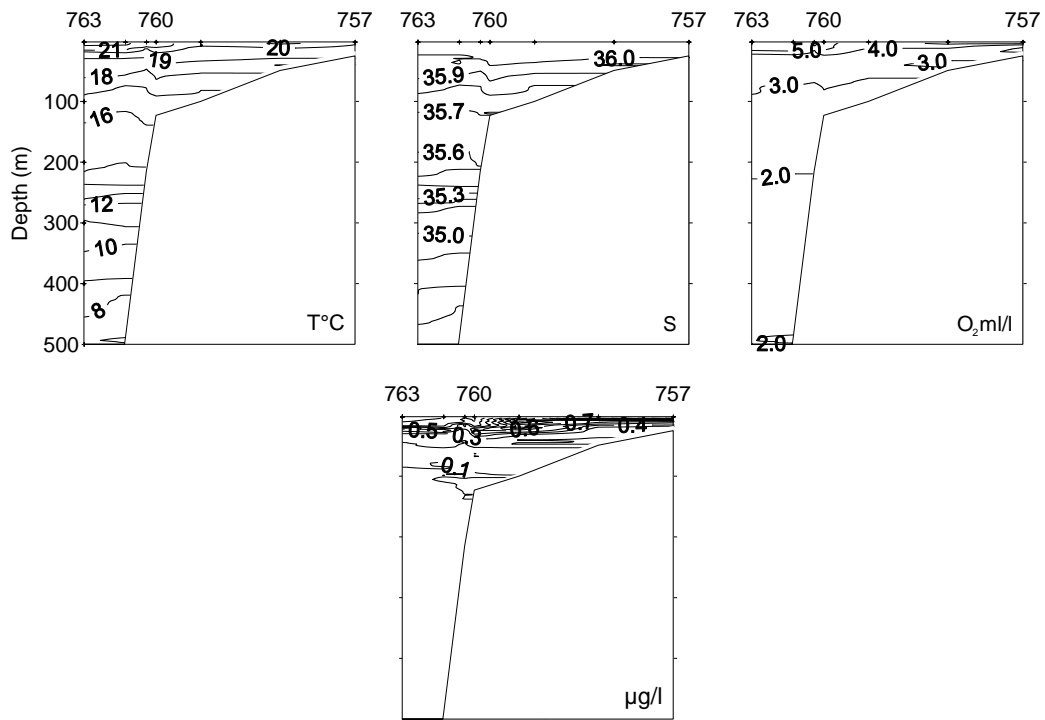
d. Iguela, Gabon



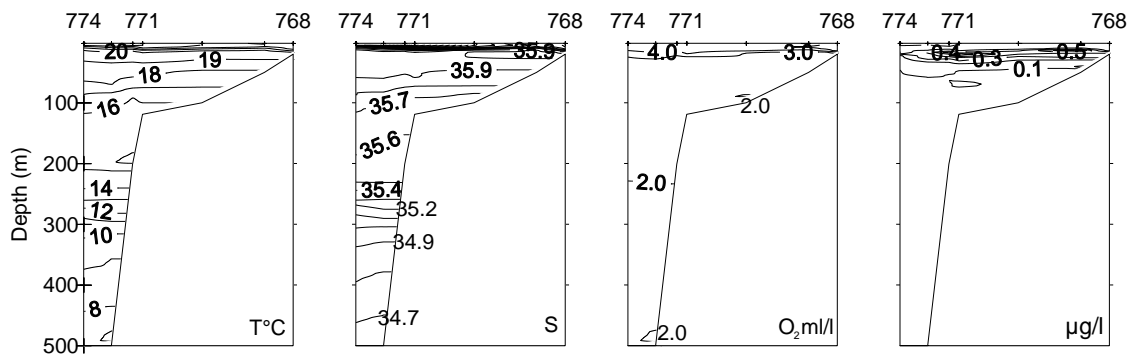
e. Setté Cama, Gabon

**Figure 3.4a-h.** Continuation...

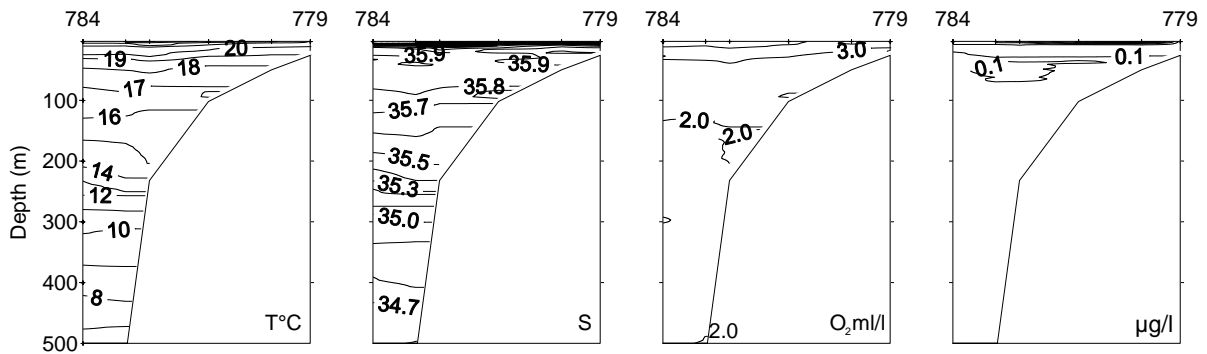




f. Pte. Panga, Gabon



g. Madingo, Congo



h. Pointe Noire, Congo

**Figure 3.4a-h.** Continuation... Vertical sections of temperature, salinity, oxygen and fluorescence in Gabon and Congo.

## CHAPTER 4 FISH DISTRIBUTION, SIZE AND BIOMASS ESTIMATES

### 4.1 Gabon

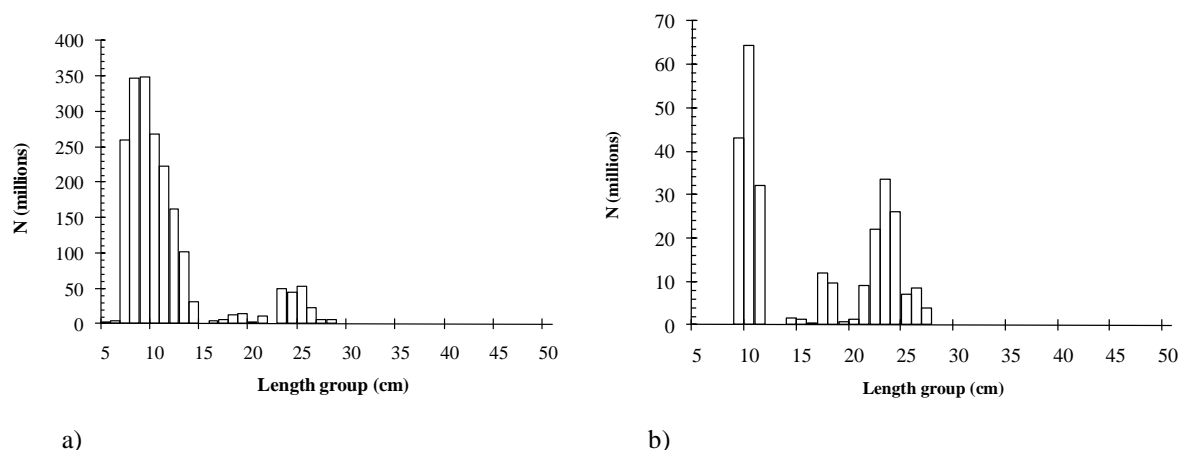
Generally, both catch rates and the acoustic detections of all species of pelagic fish north of Cape Lopez were very low. The region between Cape Lopez and the border with Congo also had lower than usual catch rates and acoustic detections. Table 4.1 shows the catch rates of the main pelagic groups in kg/h. Carangids were the most dominant pelagic group followed by clupeoids, while scombrids, hairtails and barracudas were less abundant.

#### Sardinellas

North of Cape Lopez only a few schools of *Sardinella maderensis* were detected in a limited area and a small pelagic catch showed specimens of 17 – 22 cm TL. *S. aurita* was also caught in low numbers in a couple of trawl hauls in the region. Further south there were more continuous registrations, particularly between Lagune Nkomi and Lagune N'Dogo, mainly between 20 and 50 m depth. Here *S. aurita* was most common, while a couple of catches of *S. maderensis* were made close to the coast.

The length distribution of both sardinellas is depicted in Figure 4.1(a-b). The catches of *S. aurita* consisted mainly of juvenile fish, with a peak around 8-9 cm. *S. maderensis* had a larger contribution of adults with peaks around 10 and 23 cm.

The total biomass estimate of *S. aurita* in Gabon was 42 000 tonnes while the estimated biomass of *S. maderensis* was 16 000 tonnes. In 2008 the estimates were about 19 000 tonnes and 13 000 tonnes for *S. aurita* and *S. maderensis*, respectively.



**Figure 4.1.** Total length distribution of a) *Sardinella aurita* and b) *S. maderensis* in Gabon

#### Other clupeids

*Ilisha africana* was caught in 3 trawl stations in a limited area close to the coast at Nyanga. However, the abundance was low and no biomass estimate was calculated.

## Anchovy

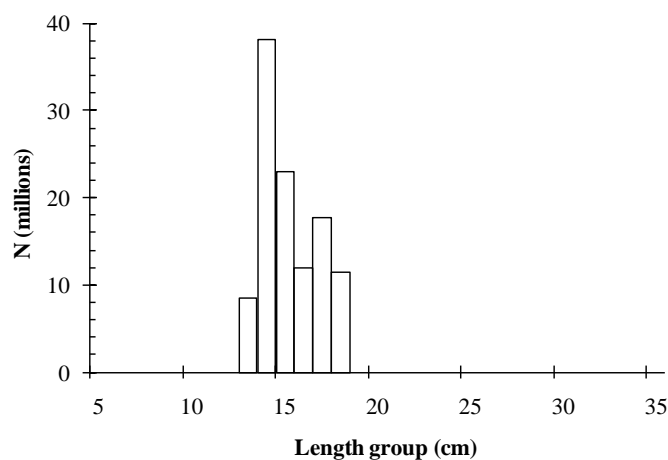
Small amounts of *Engraulis encrasicolus* were caught in 4 trawl stations close to the coast in the southern part of Gabon. No biomass estimate was calculated.

## Horse mackerel

North of Cape Lopez horse mackerel, *Trachurus trecae*, was caught on one pelagic and one bottom trawl station. A few low density schools were allocated to this species. South of Cape Lopez a few low density schools of *T. trecae* were found in a small area along the shelf break off Lagune N'Dogo. Horse mackerel was generally caught with bottom trawl mixed with demersal species.

Length distribution of *Trachurus trecae* found in the area is shown in Figure 4.2. The length (TL) ranged from 13 cm to 18 cm.

The estimated biomass of *Trachurus trecae* in Gabon was 4 200 tonnes, compared to 5 000 tonnes in 2008.



**Figure 4.2.** Length frequency of *Trachurus trecae* in Gabon.

## PEL2

North of Cape Lopez the Pelagic group PEL 2, mainly consisting of carangids, but also including scombrids, barracudas and hairtails, were distributed over major parts of the shelf, from about 100 m depth to the coast. Further south the group was distributed along the coast from Lagune Nkomi to the border with Congo. The main species caught, belonging to this group, were *Scomber japonicus*, *Decapterus punctatus*, *D. rhonchus*, *Selene dorsalis*, *Sphyraena guachancho* and *Trichiurus lepturus*. However, catches of PEL 2 species were generally low in the area.

The biomass in the area was based on an average fish size of 23 cm and average condition factor of 0.88 and was estimated to be 33 000 tonnes, while the estimate for 2008 was 32 000 tonnes.

**Table 4.1.** Catch rates in kg/h of main pelagic groups in Gabon

Station	Gear depth	Clupeoids	Carangids	Scombrids	Hairtails	Barracuda	Other	Total
1	30		0.2				1.5	1.8
2	15	13.2	69.0				38.0	120.2
3	134						2688.3	2688.3
4	67	2.4	7.2				1032.7	1042.3
5	26	5.3	2.3	4.9		15.6	1.9	29.9
6	5	0.4	2.9		4.0		38.1	46.1
7	118						57.8	57.8
8	133						2368.4	2368.4
9	0	9.0	101.8	3.6			3.2	117.6
10	103		19.1				652.7	671.7
11	30							
12	44	3.7	1.0	124.7	0.8		16.3	146.6
13	0	15.4	1.4	3.4		2.1	23.7	46.0
14	124		1400.2				9879.3	11279.6
15	18	56.7						56.7
16	10	43.8	0.5		0.3	2.2	0.3	47.1
17	0				5.9		1.0	7.0
18	157						168.9	168.9
19	31	11.6	2.3	6.8	0.6	86.0	48.8	156.2
20	25	0.4	1.5	2.6	96.9	36.4	10.4	148.2
21	42	4.6	63.9	4.7	13.8	2.8	625.2	715.1
22	28	7.9	28.3	0.5		45.4	141.8	224.0
23	101		0.1		2.9		169.6	172.7
24	0				13.0		12.6	25.6
25	10	1.4	4.1		8.3	7.3	24.0	45.2
26	21	851.2	3.4	0.5		0.8	69.6	925.5
Mean	49	39.5	65.7	5.8	5.6	7.7	695.2	819.6
Std dev		166.1	273.4	24.3	19.0	19.6	1998.5	2242.6
% catch		4.8	8.0	0.7	0.7	0.9	84.8	

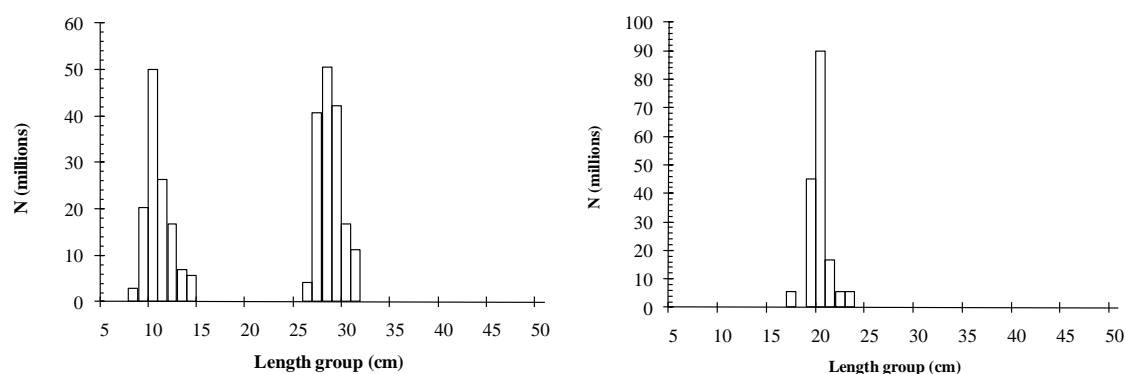
## 4.2 Congo

The region has a similar species distribution as the one found in Gabon. Table 4.2 gives the catch rates in kg/h.

### Sardinellas

The sardinellas, mainly *S. aurita*, were found in a continuous area close to the coast. The acoustic registrations were mainly of low density with a few medium density schools. Of the 8 trawls conducted in this area, 4 contained *S. aurita* while only 2 contained *S. maderensis*. The length distribution of the sardinellas is depicted in Figure 4.3 (a-b). The catches of *S. aurita* consisted of both juvenile and adult fish, with peaks around 10 and 28 cm, while *S. maderensis* consisted of fish between 17 and 24 cm with a peak around 21 cm.

The biomass estimate for *S. aurita* in Congo was 36 000 tonnes and for *S. maderensis* 13 000 tonnes, while in 2008 60 000 tonnes and 50 000 tonnes were estimated of *S. aurita* and *S. maderensis*, respectively.



**Figure 4.3.** Total length distribution of a) *Sardinella aurita* and b) *S. maderensis* in Congo.

#### Other clupeids

*Ilisha africana* was caught in 2 trawl stations close to the coast south of Madingo. However, the abundance was low and no biomass estimate was calculated.

#### Anchovy

Small amounts of *Engraulis encrasicolus* were caught in 2 trawl stations close to the coast in the central part of Congo. No biomass estimate was calculated.

#### Horse mackerel

*Trachurus trecae* was caught on 4 trawl stations, 3 of them offshore around 100 m depth, and some low density schools were detected. The total biomass was estimated to be 3 600 tonnes, while in 2008 the estimate was 600 tonnes.

#### PEL2

The PEL2 species of fish were distributed across most of the territorial waters of Congo from the coast to approximately 100 m depth. The main species caught representing this group were *Chloroscombrus chrysurus*, *Sphyrna guachancho*, *Selene dorsalis* and *Trichiurus lepturus*.

The biomass estimated in the area was based on an average fish size of 23 cm and average condition factor of 0.88 and was estimated to be 12 000 tonnes, compared to 8 500 tonnes in 2008.

**Table 4.2.** Catch rates in kg/h of main pelagic groups in the region in Congo.

Station	Gear depth	Clupeoids	Carangids	Scombrids	Hairtails	Barracuda	Other	Total
27	42	9.8	0.4		93.2	1.1	62.9	167.4
28	117	45.1					354.4	399.5
29	15	37.3	2927.3	16.6	0.8		21.6	3003.7
30	145				1.9		6.3	8.2
31	10	0.2	426.0		21.6		42.5	490.3
32	55						0.6	0.6
33	25	113.5	81.7		93.1	0.1	499.3	787.7
34	95	908.7		4.7	26.4		96.9	1036.7
Mean	63	139.3	429.4	2.7	29.6	0.2	135.6	736.8
Std dev		313.2	1020.0	5.9	40.5	0.4	186.5	985.8
% catch		18.9	58.3	0.4	4.0		18.4	

## CHAPTER 5 SUMMARY OF SURVEY RESULTS

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The survey of Congo and Gabon was conducted from June 18<sup>th</sup> to June 30<sup>th</sup> 2010. During the survey the vessel covered a total of 1 841 NM, with 20 pelagic hauls, 14 demersal, 75 CTD stations, 16 plankton and 7 grab stations taken.

In the present survey the environmental conditions were characterized as stable. Little wind was observed in the survey area and the conditions were favourable for acoustic estimations. SST ranged from 19° to 26°C, while salinity fluctuated between 35-36.

Several areas in Congo and Gabon have restricted access due to oil exploitation activities, particularly the area off Olinde (Gabon), which is large and can possibly contain high abundance of pelagic fish. The area is not included in the present abundance calculations.

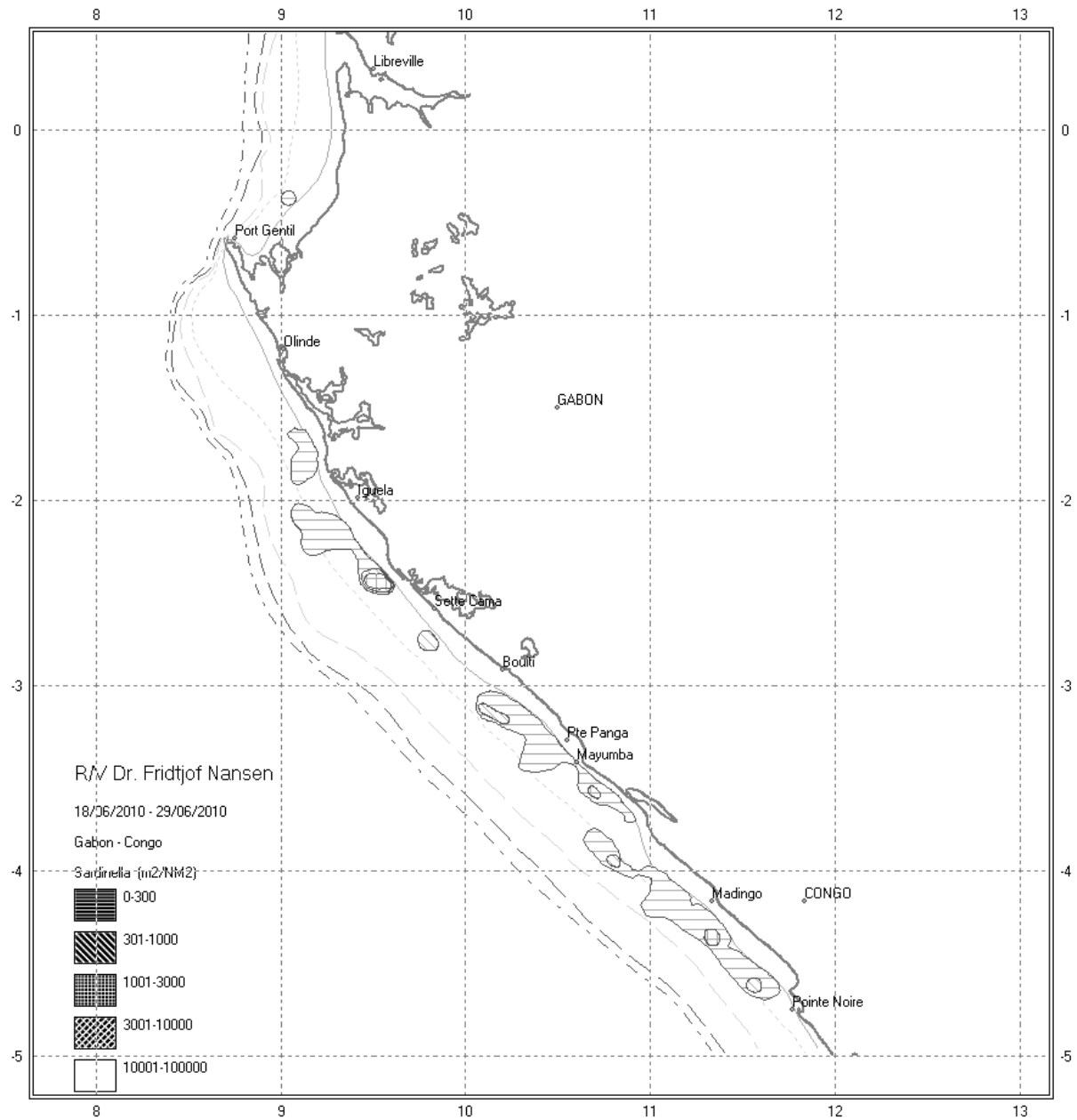
### 5.1 Sardinellas

The sardinellas were distributed in several low density areas ( $s_A < 300$ ) with few areas of medium density ( $300 < s_A < 1\,000$ ) along the coast of both Gabon and Congo, between 20 and 100 m depth (Figure 5.1). Concentrations increased in the southern part of the survey area. The two species were often separated: *S. aurita* was found further offshore than *S. maderensis*.

Figure 5.2 (a-b) shows the length distribution for both sardinellas. *S. aurita* ranged from 5 to 31 cm total length (TL), with four apparent modal peaks around 10, 19, 25 and 28 cm. Although juveniles of *S. aurita* (fish <15cm TL) dominated the catches they represented around 20% of the total biomass (Figure 5.3(a-b)). The length distribution for *S. maderensis* ranged from 9 to 28 cm TL, with four apparent modal peaks at around 10, 20, 24 and 26 cm. The cohort of smallest fish (9-11 cm TL) of *S. maderensis* represents less than 5% of the total biomass (Figure 5.3(a-b)).

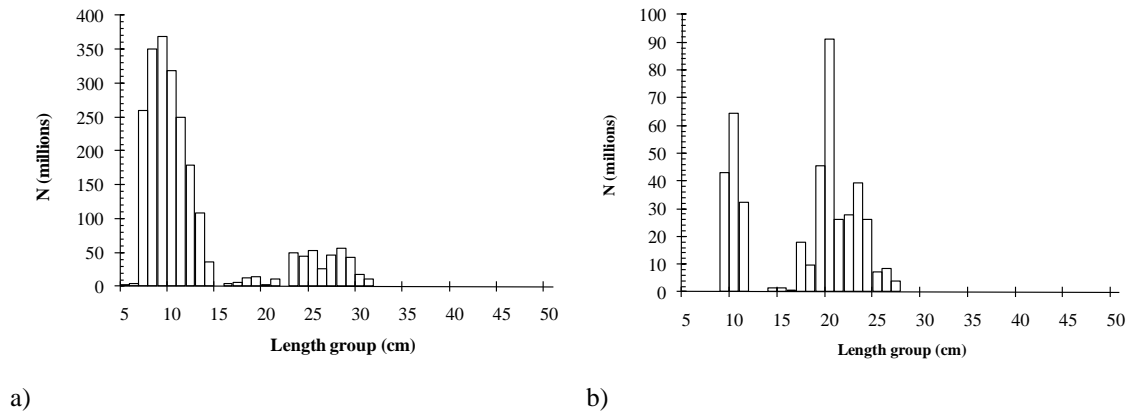
The biomass for both sardinellas was estimated at 108 000 tonnes (79 000 tonnes of *S. aurita* and 29 000 tonnes of *S. maderensis*), which is less than the 142 000 tonnes estimated in 2008 (80 000 tonnes of *S. aurita* and 62 000 tonnes of *S. maderensis*). The proportion of *S. aurita*, in relation to *S. maderensis*, was higher this year as compared with last year: 73% of the Sardinella was calculated to be *S. aurita*, compared to 56% in 2008.

The highest abundance in the time series for the region was recorded at 416 000 tonnes in 2005. Since then the sardinellas' biomass has been declining with the lowest value found during the present survey.

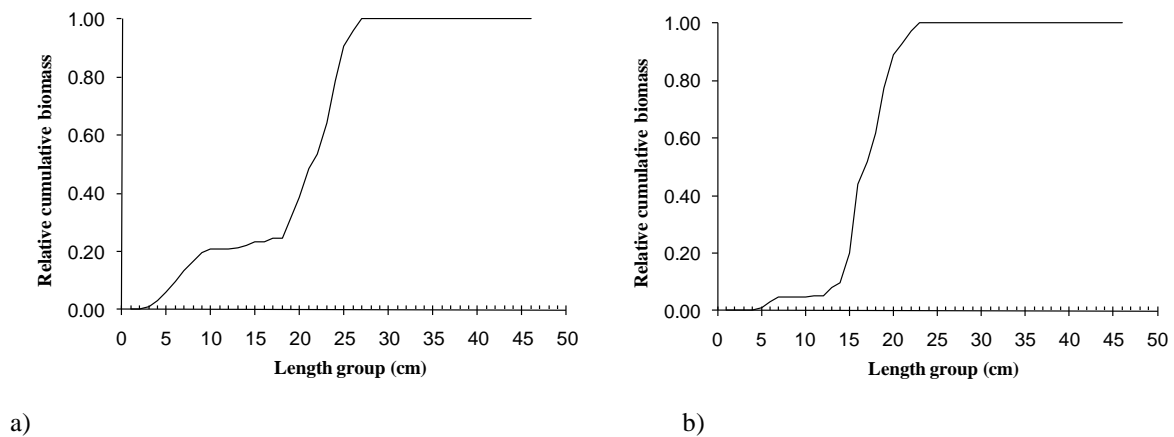


**Figure 5.1.** Distribution of sardinellas off Gabon and Congo.





**Figure 5.2.** Total length distribution of a) *Sardinella aurita* and b) *S. maderensis* off Gabon and Congo



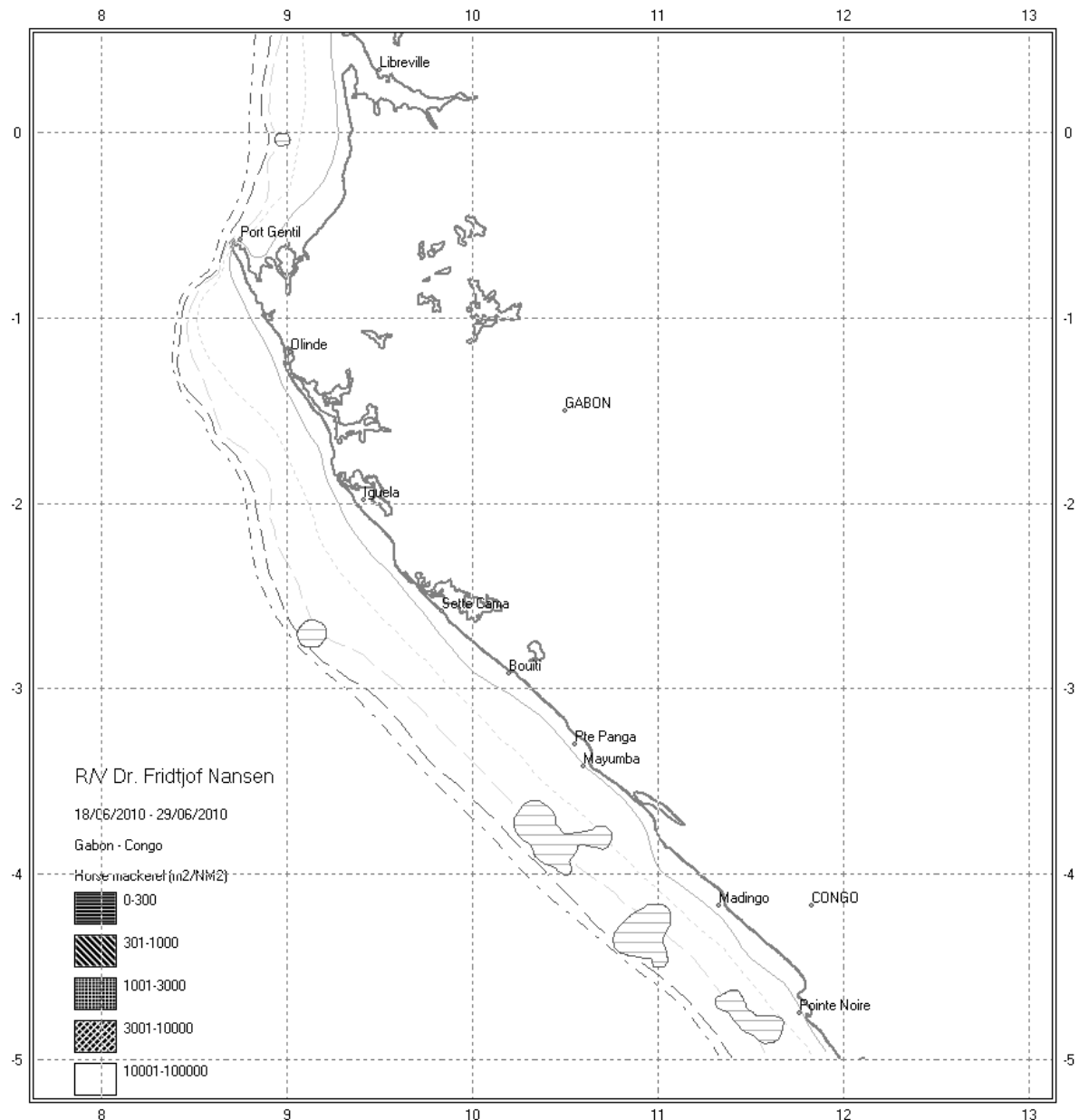
**Figure 5.3.** Relative cumulative biomass of a) *Sardinella aurita* and b) *S. maderensis* off Gabon and Congo

## 5.2 Other Clupeids

As last year some *Ilisha africana* were found inshore along the coast associated with brackish water areas. The abundance was low and no abundance estimate or distribution map was produced. Anchovy, *Engraulis encrasicolus*, was found on 6 trawl stations close to the coast in both Gabon and Congo. No acoustic values were allocated to these species and no biomass estimate was calculated.

## 5.3 *Trachurus trecae*

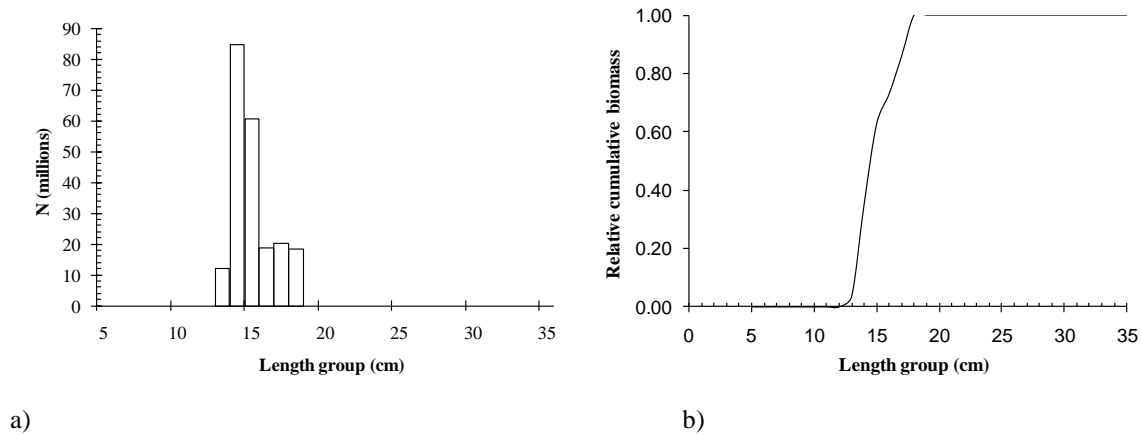
The horse mackerel *Trachurus trecae* was distributed on the mid shelf mostly off southern Gabon and in Congo, between 50 m and 100 m depth. Five low density ( $S_A < 300$ ) areas were detected (Figure 5.4). The species was observed mainly on the shelf edge mixed with other demersal species. It was generally found close to the bottom making it sometimes difficult for acoustic species separation.



**Figure 5.4** Distribution of *Trachurus trecae* off Gabon and Congo.

The length distribution (Figure 5.5 a) shows only one cohort of fish with a peak at 14 cm. The cumulative biomass (Figure 5.5 b) also reflects that only one cohort was present in the survey area. 50% of the biomass consisted of fish >15 cm.

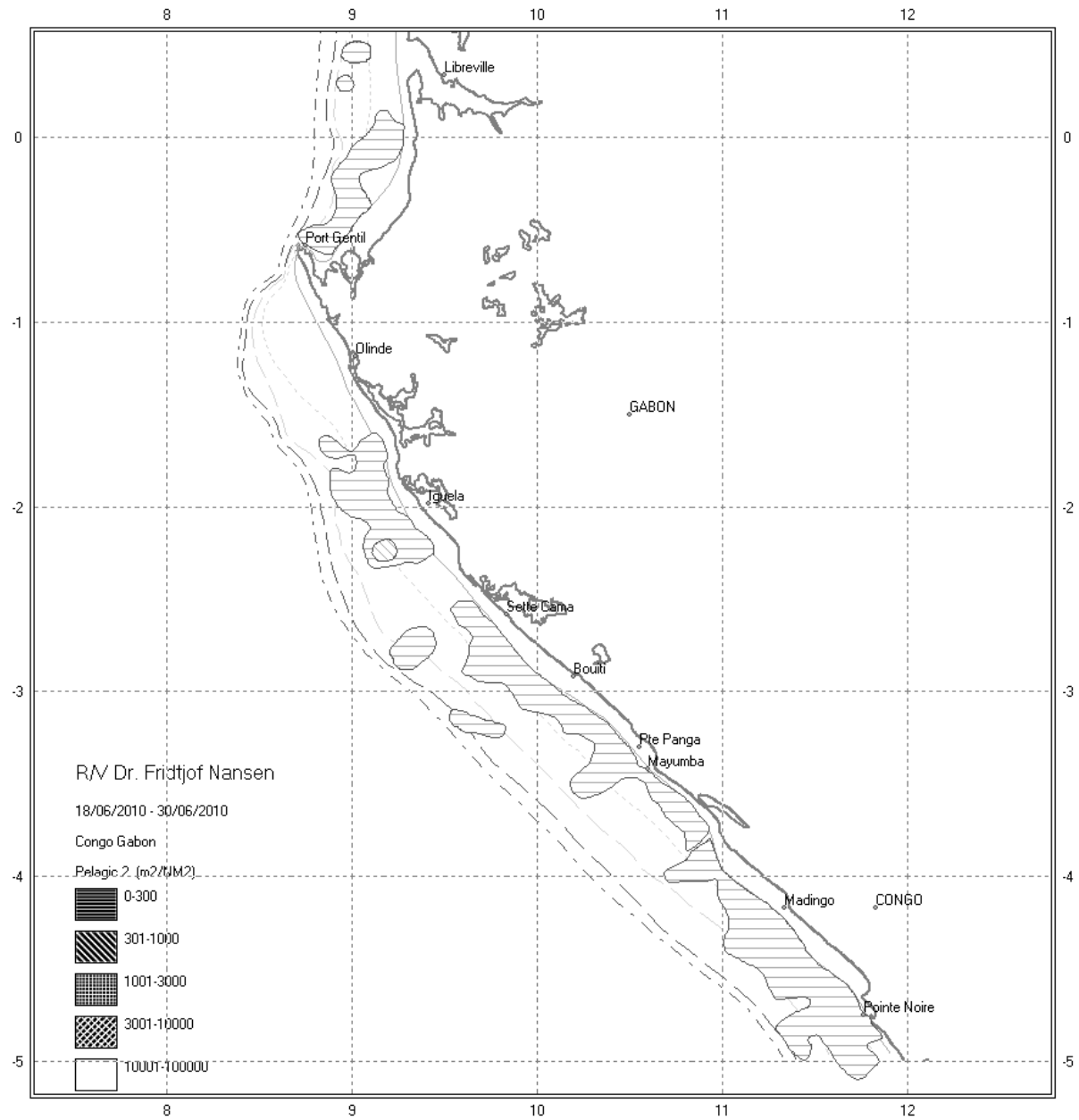
The total biomass of *T. trecae* in the distribution area was 7 800 tonnes. This is slightly higher than the 5 600 tonnes estimated in 2008. The 2007 estimate (400 tonnes) was the lowest recorded in the region during the last seven years (Table 5.1). The biomass is still very low and no new recruitment was observed this year (Figure 5.5 a).



**Figure 5.5.** a) Total length distribution and b) Relative cumulative biomass of *Trachurus trecae* off Gabon and Congo

#### 5.4 Other pelagic fish

The Pelagic group PEL 2 (carangids, scombrids, barracudas and hairtails) was more or less continuously distributed along the coast of Gabon and Congo (Figure 5.6), from around 20 m to approximately 100 m depth. The fish were generally scattered and density was low ( $s_A < 300$ ). Catch rates were separately analysed for Gabon and Congo (Tables 4.1-4.2). Assuming an average total length of 23 cm for all the species and a measured condition factor of 0.88, the biomass of PEL 2 was estimated to 45 000 tonnes; 33 000 tonnes in Gabon and 12 000 tonnes in Congo. In 2008 the total PEL2 biomass was estimated to about 40 000 tonnes: 32 000 tonnes in Gabon while 8 000 tonnes were found in Congo.



**Figure 5.6** Distribution of PEL 2 species off Gabon and Congo.

**Table 5.1** Summary table of biomass estimates for the main species groups and countries for the surveys conducted in 2004 -2010.

Species group	Year	Congo	Gabon	Sum
Sardinella	2010	49 000	59 000	108 000
	2008	110 000	32 000	142 000
	2007	28 000	130 000	158 000
	2006	19 000	225 000	244 000
	2005	128 000	288 000	416 000
	2004			360 000*
P1		-		-
	2010		-	-
	2008	-	-	-
	2007	-	-	37 000
	2006	18 000	19 000	-
	2005	-	-	-
	2004	-	-	-
P2	2010	12 000	33 000	45 000
	2008	8 000	32 000	40 000
	2007	9 000	48 000	57 000
	2006	8 000	36 000	44 000
	2005	7 000	30 000	37 000
	2004			69 000*
Horse mackerel	2010	3 600	4 200	7 800
	2008	600	5 000	5 600
	2007	-	400	400
	2006	1 000	7 000	8 000
	2005	4 000	11 000	11 000
	2004			11 000*

- No biomass calculated because of low / no abundance

\*Surveys of Congo and Gabon in 2004 also covered Cabinda in Angola

## CHAPTER 6      RESUME DES RESULTATS DE CAMPAGE EN FRANÇAIS

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La campagne Gabon-Congo a été effectuée du 18 au 30 juin 2010. Au cours de cette campagne, le navire a couvert une distance de 1.841 mn avec 20 traits de chalut pélagique et 14 traits de chalut démersal auxquels s'ajoutent 75 stations hydrologiques CTD, 16 pour le phytoplancton et 7 de prélèvement de sédiments. Les échantillons de sédiments prélevés dans les stations seront analysés en Ghana.

Durant cette campagne, les conditions de l'environnement étaient relativement stables. La température de surface - à 5 m de profondeur - (SST) variait entre 19.0°C – 26.5°C. La salinité de surface - à 5 m de profondeur - (SSS) variait entre 34 et 35.7 entre les deux extrêmes nord et sud de l'aire couverte respectivement, alors que la partie centrale du Gabon présentait un taux de salinité autour de 36.

Cette année on a mesuré les niveaux du chlorophylle de surface - à 5 m de profondeur - (SSF). Les valeurs sont étés entre 0.1 µg/l et 1 µg/l. Le valeur plus bas s'a trouvé entre Libreville et Cape Lopez, et le plus haut entre Olindè et Iguela.

Cape Lopez marque l'encontre de deux types d'eaux: ce plus chaud et moins saline au nord, et ce plus froid et plus saline au sud.

La campagne a eu lieu 1 mois plus tard par rapport aux année précédente. Et cela a certainement influencé nos observations sur la SST et la SSS sur une vaste étendue.

Les espèces pélagiques, particulièrement les sardinelles, étaient relativement moins abondantes par rapport aux années précédentes. Aussi, certaines zones sont interdites d'accès à cause de l'exploitation pétrolière. C'est le cas notamment de la zone hors d'Olinde, au Gabon, qui doit contenir probablement beaucoup d'espèces pélagiques. Cette zone a été exclue dans l'évaluation faite.

### Sardinelles

Les sardinelles étaient distribuées à faible densité dans plusieurs petites zones à travers toute la région prospectée du Gabon au Congo. Et cela partant de 20 m de profondeur de la côte jusqu'à 100 m au large (Figure 5.1). Cependant, les concentrations augmentaient dans la partie sud de la zone de prospection. L'échantillon typique de sardinelles a été moins important que d'ordinaire. Cela à cause de la dominance des juvéniles. De les deux espèces, *Sardinella aurita* s'á rencontrée généralement dans les eaux plus en profondes que *S. maderensis*, et ont présenté une nette séparation dans la distribution.

La Figure 5.2 (a et b) montre la fréquence de taille dans la distribution des sardinelles. Pour *S. aurita*, cette année la part essentielle du poisson était composée d'individus de taille inférieurs à 15 cm avec un mode de 10 cm. Un autre mode autour de 24 cm a pu être observé pour le poisson adulte. La distribution de taille de *Sardinella maderensis* indique quatre modes, avec un maximum de 23 cm, mais souvent de 8, 17 et 26 cm.

La biomasse relative cumulative des sardinelles peut être observée dans la Figure 5.3. Les juvéniles de *Sardinella aurita* ont dominé, en nombre, dans la zone prospectée mais en terme de biomasse une cohorte d'adultes représentait approximativement 70 %. Pour *Sardinella maderensis*, environ 20 % de la biomasse était représentée par individus de taille supérieure à 25 cm.

Cette année il y a eu des signes de recrutement dans les captures de *Sardinella aurita*, comme à ce qui avait été observé précédemment dans la région.

La biomasse au Gabon et au Congo a été estimée à 87.000 tonnes pour *Sardinella aurita* et à 33.000 tonnes pour *Sardinella maderensis*. L'année dernière, la biomasse des sardinelles était estimée, dans l'ensemble, à 143.000 tonnes, dont 80.000 tonnes de *S. aurita* contre 63.000 tonnes de *S. maderensis*. Cette année, par rapport à ce qui a été observé l'année dernière, les deux espèces ont présenté une proportion légèrement supérieure de *S. maderensis* dans la zone prospectée. 56 % de sardinelles estimées étaient *S. aurita*. L'abondance des sardinelles connaît une baisse dans la région par rapport à 2005 qui avait connu le grand record.

#### Autres Clupeidés

Comme l'année dernière, quelques *Ilisha africana* associés aux autres espèces d'eau saumâtre étaient localisées près de la côte. Aucune estimation d'abondance fut produite à cause du niveau très faible.

Cette année, dans 6 stations de chalutage il y a été enregistré d'anchois (*Engraulis encrasicolus*) dans la zone prospectée.

#### *Trachurus trecae*

Un banc de chinchard (*Trachurus trecae*) a été localisé principalement dans la moitié sud du Gabon et au Congo dans les profondeurs situées entre 50m et 100m dans cinq zones à faible densité ( $sA < 300$ ). Cette année les espèces étaient principalement observées dans le bord de la plateaux continental, mélangées avec d'autres espèces démersales et plus souvent observées dans les fonds où la perception acoustique était difficile.

La distribution de taille (Fig 5.5a) indique seulement un seul groupe de poisson avec un maximum de mode de 14 cm. L'année dernière, la distribution de taille comprenait les poissons de dimension similaire avec un mode maximum de 18 cm.

La biomasse cumulée (Fig 5.5b) démontre seulement la présence d'un seul groupe dans la zone prospectée. 50% de la biomasse était supérieure à 15cm.

La biomasse de *Trachurus trecae* dans la zone de distribution était de 7.600 tonnes ; ce qui est environ dans le même niveau observé l'année dernière de 5 600 tonnes.

L'année 2007 a connu le plus bas record des estimations dans la région par rapport aux cinq dernières années. La biomasse est encore très faible avec l'absence des grandes captures.

#### Autres poissons pélagiques

Le groupe des pélagiques PEL 2 (Carangidés autres que *Trachurus* sp., Scombridés, Sphyraenidés et Trichiuridés) a été plus ou moins constant au Gabon et au Congo ensembles (Figure 5.6). La principale distribution s'étend de l'intérieur de la zone jusqu'à approximativement 100 m de profondeur dans l'ensemble de la zone prospectée.

Le poisson était éparpillé avec une faible densité dans la zone prospectée ( $Sa < 300$ ). Le taux de capture a été analysé pour les zones gabonaises au nord et au sud de Cap Lopez et au Congo (Tableau 4.1 et Tableau 4.2). La distribution de taille des différentes espèces du groupe est illustrée en l'annexe II. En admettant une moyenne totale de taille de 23 cm pour toutes les espèces et le facteur de condition de mesure de 0,88; la biomasse de PEL 2 a été estimée à 45.000 tonnes dont 11.000 tonnes sont localisées au Congo. Dans 2008, environ 40.000 tonnes de P2 avaient été estimées au total, dont 32.000 tonnes étaient au Gabon et 12.000 tonnes seulement au Congo.



## CHAPTER 7      REFERENCES

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MISUND, O. A. and A. AGLEN 1992 — Swimming behaviour of fish schools in the North Sea during acoustic surveying and pelagic trawl sampling. *ICES J. Mar. Sci.* **49**: 3

# ANNEX I Records of fishing stations

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 1  
DATE :19.06.2010 GEAR TYPE: PT NO: 1 POSITION:Lat N 0°37.20  
start stop duration Lon E 8°55.08  
TIME :08:42:00 09:12:33 30.5 (min) Purpose : 1  
LOG : 1789.48 1791.53 2.0 Region : 3300  
FDEPTH: 20 40 Gear cond.: 0  
BDEPTH: 212 238 Validity : 0  
Towing dir: 0° Wire out : 120 m Speed : 4.0 kn  
Sorted : 1 Total catch: 0.91 Catch/hour: 1.79

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Invertebrate	1.32	0	73.46	
Trachurus sp.	0.18	271	10.09	
Leptocephalus	0.14	33	7.68	
Selene dorsalis	0.06	83	3.51	
SALPS	0.04	100	2.19	
FISH LARVAE	0.03	242	1.54	
BOTHIDAE	0.02	88	1.21	
Loligo sp.	0.01	8	0.33	
Ariomma sp.	0.00	8	0.00	
Alectis alexandrinus	0.00	2	0.00	
Sphyaena sp.	0.00	4	0.00	
Brama sp.	0.00	2	0.00	
Fistularia sp.	0.00	12	0.00	
TETRAODONTIDAE	0.00	2	0.00	
TRIGLIDAE	0.00	8	0.00	
Total	1.79		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 2  
DATE :19.06.2010 GEAR TYPE: PT NO: 4 POSITION:Lat N 0°17.59  
start stop duration Lon E 9°1.91  
TIME :19:10:43 19:40:52 30.2 (min) Purpose : 1  
LOG : 1865.92 1867.60 1.7 Region : 3300  
FDEPTH: 15 15 Gear cond.: 0  
BDEPTH: 56 62 Validity : 0  
Towing dir: 0° Wire out : 120 m Speed : 3.4 kn  
Sorted : 60 Total catch: 60.42 Catch/hour: 120.20

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Decapterus punctatus	61.77	1426	51.39	1
Ariomma bondi	21.19	647	17.63	
Priacanthus arenatus	16.11	840	13.41	
Sardinella aurita	13.19	159	10.97	2
Caranx hippos	7.26	115	6.04	
Echeneis naucrates	0.58	2	0.48	
EXOCETIDAE	0.10	2	0.08	
Total	120.20		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 3  
DATE :20.06.2010 GEAR TYPE: BT NO: 24 POSITION:Lat S 0°1.13  
start stop duration Lon E 8°54.68  
TIME :09:16:08 09:36:12 20.1 (min) Purpose : 1  
LOG : 1967.42 1968.45 1.0 Region : 3300  
FDEPTH: 135 133 Gear cond.: 0  
BDEPTH: 135 133 Validity : 0  
Towing dir: 0° Wire out : 350 m Speed : 3.1 kn  
Sorted : 144 Total catch: 899.25 Catch/hour: 2688.34

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Dentex angolensis	1878.62	12592	69.88	3
Spicara alta	366.22	7791	13.62	
Priacanthus arenatus	263.44	5716	9.80	
Ariomma bondi	128.91	2428	4.80	
Antigonia capros	24.84	1306	0.92	
Raja miraletus	7.65	57	0.28	
Lagocephalus laevisgatus	6.91	75	0.26	
Lepidotrigla cadmani	3.92	93	0.15	
Zenopsis conchifer	2.60	18	0.10	
Illex coindetii	2.06	18	0.08	
Trachinocephalus myops	1.67	18	0.06	
Scorpaena normani	1.32	36	0.05	
Citharus linguatula	0.18	18	0.01	
Total	2688.34		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 4  
DATE :20.06.2010 GEAR TYPE: BT NO: 24 POSITION:Lat N 0°11.30  
start stop duration Lon E 8°57.20  
TIME :13:53:37 14:15:30 22.0 (min) Purpose : 1  
LOG : 2007.59 2008.66 1.1 Region : 3300  
FDEPTH: 68 66 Gear cond.: 0  
BDEPTH: 68 66 Validity : 0  
Towing dir: 0° Wire out : 170 m Speed : 2.9 kn  
Sorted : 153 Total catch: 382.16 Catch/hour: 1042.25

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Ariomma bondi	786.46	24886	75.46	
Dentex congoensis	192.60	5774	18.48	
Priacanthus arenatus	21.46	736	2.06	
Sepia officinalis	6.95	87	0.67	
Pseudupeneus prayensis	6.60	115	0.63	
Decapterus rhonchus	5.32	164	0.51	
Pagellus bellottii	4.83	169	0.46	
Lepidotrigla cadmani	4.64	232	0.44	
Raja miraletus	3.33	14	0.32	
Sardinella aurita	2.37	33	0.23	
Torpedo torpedo	2.24	5	0.21	
Dentex angolensis	2.05	55	0.20	
Trachurus trecae	1.36	27	0.13	11
Trachinocephalus myops	0.87	14	0.08	
Caranx carangus	0.55	14	0.05	
Antigonia capros	0.33	14	0.03	
Alloteuthis africana	0.19	109	0.02	
Dactylopterus volitans	0.05	14	0.01	
Citharus linguatula	0.05	5	0.01	
Total	1042.25		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 5  
DATE :20.06.2010 GEAR TYPE: PT NO: 14 POSITION:Lat N 0°21.90  
start stop duration Lon E 9°6.90  
TIME :17:25:27 17:55:04 30.0 (min) Purpose : 1  
LOG : 2035.45 2037.33 1.9 Region : 3300  
FDEPTH: 24 27 Gear cond.: 0  
BDEPTH: 25 26 Validity : 0  
Towing dir: 0° Wire out : 110 m Speed : 3.8 kn  
Sorted : 2 Total catch: 14.94 Catch/hour: 29.88

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sphyaena guachancho	15.60	16	52.21	
Sardinella maderensis	5.26	96	17.60	4
Scomberomorus tritor	4.88	10	16.33	
Brachydeuterus auritus	1.48	42	4.95	
Selar crumenophthalmus	1.14	6	3.82	
Caranx senegallus	0.92	2	3.08	
Pomadasy jubelini	0.38	2	1.27	
Selene dorsalis	0.22	4	0.74	
Total	29.88		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 6  
DATE :21.06.2010 GEAR TYPE: PT NO: 1 POSITION:Lat N 0°33.00  
start stop duration Lon E 8°48.40  
TIME :23:54:13 00:24:20 30.1 (min) Purpose : 0  
LOG : 2087.90 2089.90 2.0 Region : 3300  
FDEPTH: 5 5 Gear cond.: 0  
BDEPTH: 65 77 Validity : 0  
Towing dir: 0° Wire out : 110 m Speed : 4.0 kn  
Sorted : 23 Total catch: 23.14 Catch/hour: 46.13

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Saurida brasiliensis	23.72	5882	51.43	
Ariomma bondi	8.51	323	18.45	
Trichiurus lepturus	4.03	22	8.73	
Brachydeuterus auritus	2.77	522	6.01	
Trachurus trecae	1.75	38	3.80	
Lampanyctodes hectoris	1.34	301	2.90	
Selar crumenophthalmus	1.16	30	2.51	
Illex coindetii	0.78	98	1.69	
Sphyaena sphyaena	0.64	4	1.38	
Epigonus telescopus	0.56	54	1.21	
Sardinella maderensis	0.40	8	0.86	
Pteroscion peli	0.24	34	0.52	
Alloteuthis africana	0.16	199	0.35	
Priacanthus arenatus	0.06	2	0.13	
Selene dorsalis	0.01	8	0.03	
Sepia officinalis	0.01	2	0.01	
Total	46.13		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 7  
 DATE :21.06.2010 GEAR TYPE: BT NO: 24 POSITION:Lat N 1°10.60  
 start stop duration Lon E 8°25.80  
 TIME :12:06:40 12:36:53 30.2 (min) Purpose : 1  
 LOG : 2167.44 2168.98 1.5 Region : 3300  
 FDEPTH: 118 118 Gear cond.: 0  
 BDEPTH: 118 118 Validity : 0  
 Towing dir: 0° Wire out : 280 m Speed : 3.0 kn  
 Sorted : 29 Total catch: 29.12 Catch/hour: 57.84

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Ariomma bondi	34.57	860	59.76	
Illex coindetii	6.06	366	10.48	
Lepidotrigla cadmani	4.95	121	8.55	
Dentex congoensis	3.40	70	5.87	
Squatina oculata	3.06	4	5.29	
Dentex angolensis	1.89	12	3.26	
Sepia officinalis	1.47	10	2.54	
Zeus faber	1.39	8	2.40	
Priacanthus arenatus	0.77	6	1.34	
Psettodes belcheri	0.08	2	0.14	
Lagocephalus laevigatus	0.08	2	0.14	
Dicologlossa hexophthalma	0.08	2	0.14	
Citharus linguatula	0.04	6	0.07	
Syacium micrurum	0.01	2	0.02	
Total		57.84	100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 8  
 DATE :21.06.2010 GEAR TYPE: BT NO: 24 POSITION:Lat S 1°28.63  
 start stop duration Lon E 8°32.92  
 TIME :16:17:36 16:34:59 17.4 (min) Purpose : 1  
 LOG : 2197.80 2198.63 0.8 Region : 3300  
 FDEPTH: 133 133 Gear cond.: 0  
 BDEPTH: 133 133 Validity : 0  
 Towing dir: 0° Wire out : 310 m Speed : 2.8 kn  
 Sorted : 110 Total catch: 686.45 Catch/hour: 2368.43

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Spicara alta	1644.39	18348	69.43	
Dentex angolensis	603.80	1035	25.49	5
Priacanthus arenatus	29.53	152	1.25	
Loligo vulgaris	26.74	863	1.13	
Umbrina canariensis	20.67	86	0.87	
Ariomma bondi	14.22	345	0.60	
Raja miraletus	11.21	21	0.47	
Lepidotrigla carolae	9.70	259	0.41	
Boops boops	3.86	86	0.16	
Synodus sp.	2.59	128	0.11	
Citharus linguatula	1.73	128	0.07	
Total		2368.43	100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 9  
 DATE :22.06.2010 GEAR TYPE: PT NO: 4 POSITION:Lat N 1°46.20  
 start stop duration Lon E 8°58.80  
 TIME :01:09:40 01:39:42 30.0 (min) Purpose : 1  
 LOG : 2266.11 2268.05 1.9 Region : 3300  
 FDEPTH: 0 0 Gear cond.: 0  
 BDEPTH: 55 60 Validity : 0  
 Towing dir: 0° Wire out : 110 m Speed : 3.9 kn  
 Sorted : 59 Total catch: 58.82 Catch/hour: 117.64

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trachurus trecae	101.80	3104	86.54	
Sardinella aurita	8.72	314	7.41	6
Scomber japonicus	3.58	42	3.04	
Alloteuthis africana	1.72	916	1.46	
Lagocephalus laevigatus	1.50	22	1.28	
Engraulis encrasicolus	0.32	26	0.27	
Total		117.64	100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 10  
 DATE :22.06.2010 GEAR TYPE: BT NO: 24 POSITION:Lat N 2°1.50  
 start stop duration Lon E 8°54.10  
 TIME :08:53:33 09:19:17 25.7 (min) Purpose : 1  
 LOG : 2313.70 2315.01 1.3 Region : 3300  
 FDEPTH: 107 98 Gear cond.: 0  
 BDEPTH: 107 98 Validity : 0  
 Towing dir: 0° Wire out : 250 m Speed : 3.1 kn  
 Sorted : 128 Total catch: 287.72 Catch/hour: 671.72

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Dentex angolensis	290.73	9224	43.28	
Ariomma bondi	225.57	5346	33.58	
Boops boops	59.09	1361	8.80	
Lepidotrigla cadmani	24.51	731	3.65	
Sepia officinalis	13.45	147	2.00	
Lagocephalus laevigatus	12.02	9	1.79	
Trachurus trecae	9.67	336	1.44	12
Trachurus capensis	9.39	341	1.40	
Fistularia petimba	6.98	21	1.04	
Raja miraletus	5.51	16	0.82	
Alloteuthis africana	4.72	1450	0.70	
Zeus faber	3.25	9	0.48	
Priacanthus arenatus	2.45	16	0.36	
Spicara alta	0.98	294	0.15	
Illex coindetii	0.93	21	0.14	
Perulibatrachus elminensis	0.68	5	0.10	
Citharus linguatula	0.63	16	0.09	
Chlorophthalmus atlanticus	0.51	9	0.08	
Pseudupeneus prayensis	0.30	5	0.05	
Saurida brasiliensis	0.21	58	0.03	
Antigonia capros	0.14	30	0.02	
Total		671.72	100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 11  
 DATE :22.06.2010 GEAR TYPE: PT NO: 1 POSITION:Lat S 2°0.53  
 start stop duration Lon E 9°8.24  
 TIME :14:38:48 14:52:18 13.5 (min) Purpose : 1  
 LOG : 2358.42 2359.26 0.8 Region : 3300  
 FDEPTH: 25 35 Gear cond.: 0  
 BDEPTH: 46 45 Validity : 0  
 Towing dir: 0° Wire out : 80 m Speed : 3.7 kn  
 Sorted : 0 Total catch: 0.00 Catch/hour: 0.00

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
N O C A T C H	0.00	0	0.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 12  
 DATE :22.06.2010 GEAR TYPE: PT NO: 4 POSITION:Lat S 2°11.71  
 start stop duration Lon E 9°13.44  
 TIME :22:06:17 22:24:08 17.9 (min) Purpose : 1  
 LOG : 2425.74 2426.80 1.1 Region : 3300  
 FDEPTH: 42 45 Gear cond.: 0  
 BDEPTH: 44 46 Validity : 0  
 Towing dir: 0° Wire out : 120 m Speed : 3.6 kn  
 Sorted : 44 Total catch: 43.61 Catch/hour: 146.59

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Scomber japonicus	87.56	602	59.73	7
Sarda sarda	37.14	40	25.34	
Bregmaceros sp.	9.58	12773	6.54	
Saurida brasiliensis	3.39	975	2.32	
Sardinella aurita	2.08	346	1.42	13
Engraulis encrasicolus	1.65	632	1.12	
Brachydeuterus auritus	1.51	178	1.03	
Echeneis naucrates	1.21	3	0.83	
Decapterus rhonchus	1.04	37	0.71	
Trichiurus lepturus	0.84	3	0.57	
Alloteuthis africana	0.44	138	0.30	
Sepia officinalis	0.13	3	0.09	
Total		146.59	100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 13  
 DATE :23.06.2010 GEAR TYPE: PT NO: 4 POSITION:Lat S 2°18.30  
 start stop duration Lon E 9°21.47  
 TIME :01:28:47 01:58:53 30.1 (min) Purpose : 1  
 LOG : 2451.59 2453.55 2.0 Region : 3300  
 FDEPTH: 0 0 Gear cond.: 0  
 BDEPTH: 33 41 Validity : 0  
 Towing dir: 0° Wire out : 120 m Speed : 3.9 kn  
 Sorted : 24 Total catch: 23.06 Catch/hour: 45.98

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Boops boops	18.74	20213	40.76	
Sardinella aurita	15.23	6963	33.13	14
Sepia officinalis	2.39	12	5.20	
Sphyræna sphyræna	2.09	6	4.55	
Sarda sarda	1.97	2	4.29	
Decapterus rhonchus	1.40	285	3.04	
Scomber japonicus	1.40	8	3.04	
Bregmaceros sp.	1.38	2167	2.99	
Alloteuthis africana	0.90	351	1.95	
Engraulis encrasicolus	0.20	4	0.43	
Saurida brasiliensis	0.20	74	0.43	
Brachydeuterus auritus	0.08	10	0.17	
Total		45.98	100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 14  
 DATE :23.06.2010 GEAR TYPE: BT NO: 24 POSITION:Lat S 2°42.54  
 start stop duration Lon E 9°6.36  
 TIME :07:19:14 07:35:52 16.6 (min) Purpose : 1  
 LOG : 2500.48 2501.34 0.9 Region : 3300  
 FDEPTH: 124 123 Gear cond.: 0  
 BDEPTH: 124 123 Validity : 0  
 Towing dir: 0° Wire out : 320 m Speed : 3.1 kn  
 Sorted : 463 Total catch: 3126.32 Catch/hour: 11279.57

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Spicara alta	5248.11	56215	46.53	
Dentex angolensis	2170.17	27734	19.24	
Trachurus trecae	1400.24	40001	12.41	15
Ariomma bondi	988.57	23112	8.76	
Erythrocles monodi	947.08	382	8.40	
Boops boops	197.28	3359	1.75	
Fistularia petimba	111.49	159	0.99	
Antigonia capros	85.69	2435	0.76	
Torpedo torpedo	34.92	47	0.31	
Raja miraletus	31.17	112	0.28	
Sepia officinalis	14.43	180	0.13	
Raja clavata	13.75	22	0.12	
Lepidotrigla cadmani	12.84	339	0.11	
Loligo vulgaris	11.47	159	0.10	
Zeus faber	7.87	22	0.07	
Aulopus cadenati	2.45	22	0.02	
Citharus linguatula	2.02	43	0.02	
Total		11279.57	100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 15  
 DATE :23.06.2010 GEAR TYPE: PT NO: 7 POSITION:Lat S 2°24.97  
 start stop duration Lon E 9°29.53  
 TIME :11:41:26 12:11:23 30.0 (min) Purpose : 1  
 LOG : 2532.44 2534.28 1.8 Region : 3300  
 FDEPTH: 15 20 Gear cond.: 0  
 BDEPTH: 31 36 Validity : 0  
 Towing dir: 0° Wire out : 90 m Speed : 3.7 kn  
 Sorted : 28 Total catch: 28.29 Catch/hour: 56.67

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella maderensis	56.39	511	99.51	8
Sardinella aurita	0.28	2	0.49	
Total	56.67		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 16  
 DATE :23.06.2010 GEAR TYPE: PT NO: 7 POSITION:Lat S 2°26.56  
 start stop duration Lon E 9°34.56  
 TIME :13:54:27 14:24:01 29.6 (min) Purpose : 1  
 LOG : 2546.50 2548.40 1.9 Region : 3300  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 22 20 Validity : 0  
 Towing dir: 0° Wire out : 150 m Speed : 3.8 kn  
 Sorted : 23 Total catch: 23.19 Catch/hour: 47.05

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella aurita	31.86	217	67.70	10
Sardinella maderensis	11.97	335	25.44	9
Sphyræna barracuda	2.17	51	4.61	
Chloroscombrus chrysurus	0.51	8	1.08	
Trichiurus lepturus	0.26	2	0.56	
Illex coindetii	0.18	2	0.39	
Sepia officinalis	0.08	10	0.17	
Lagocephalus laevisgatus	0.02	2	0.04	
Total	47.05		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 17  
 DATE :24.06.2010 GEAR TYPE: PT NO: 4 POSITION:Lat S 2°53.77  
 start stop duration Lon E 9°21.69  
 TIME :03:04:05 03:34:31 30.4 (min) Purpose : 1  
 LOG : 2625.51 2627.39 1.9 Region : 3300  
 FDEPTH: 0 0 Gear cond.: 0  
 BDEPTH: 124 109 Validity : 0  
 Towing dir: 0° Wire out : 100 m Speed : 3.7 kn  
 Sorted : 4 Total catch: 3.53 Catch/hour: 6.96

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trichiurus lepturus	5.91	12	84.99	
Ariomma bondi	1.01	91	14.45	
Saurida brasiliensis	0.04	14	0.57	
Total	6.96		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 18  
 DATE :24.06.2010 GEAR TYPE: BT NO: 24 POSITION:Lat S 3°0.43  
 start stop duration Lon E 9°29.22  
 TIME :12:25:14 12:50:39 25.4 (min) Purpose : 1  
 LOG : 2693.69 2695.07 1.4 Region : 3300  
 FDEPTH: 137 176 Gear cond.: 0  
 BDEPTH: 137 176 Validity : 0  
 Towing dir: 0° Wire out : 390 m Speed : 3.2 kn  
 Sorted : 72 Total catch: 71.55 Catch/hour: 168.95

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Dentex congoensis	73.67	1360	43.61	
Antigonia capros	46.40	1119	27.46	
Spicara alta	25.38	413	15.02	
Dentex angolensis	8.00	80	4.74	16
Squatina oculata	3.64	2	2.15	
Squalus megalops	2.62	2	1.55	
Lepidotrigla cadmani	2.22	43	1.31	
Ariomma bondi	1.72	43	1.02	
Zeus faber	1.16	2	0.68	
Citharus linguatula	0.94	2	0.56	
Trigla lyra	0.78	28	0.46	
Illex coindetii	0.73	9	0.43	
Pterothrissus belloci	0.66	5	0.39	
Lagocephalus laevisgatus	0.61	5	0.36	
Trachinocephalus myops	0.21	2	0.13	
Scorpaena normani	0.19	2	0.11	
Total	168.95		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 19  
 DATE :24.06.2010 GEAR TYPE: PT NO: 4 POSITION:Lat S 2°52.36  
 start stop duration Lon E 9°55.89  
 TIME :19:05:21 19:35:03 29.7 (min) Purpose : 1  
 LOG : 2743.98 2745.59 1.6 Region : 3300  
 FDEPTH: 30 31 Gear cond.: 0  
 BDEPTH: 29 32 Validity : 0  
 Towing dir: 0° Wire out : 110 m Speed : 3.3 kn  
 Sorted : 77 Total catch: 77.33 Catch/hour: 156.17

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sphyræna guachancho	86.03	321	55.09	
Brachydeuterus auritus	45.44	1101	29.10	
Ilisha africana	5.65	170	3.62	
Sardinella maderensis	4.73	46	3.03	18
Euthynnus alletteratus	4.64	8	2.97	
Selene dorsalis	2.04	26	1.31	
Sepia officinalis	1.90	40	1.22	
Scomberomorus tritor	1.51	2	0.97	
Sardinella aurita	1.25	12	0.80	17
Galeoides decadactylus	1.13	10	0.72	
Scomber japonicus	0.67	4	0.43	
Trichiurus lepturus	0.59	71	0.38	
Dentex barnardi	0.30	2	0.19	
Decapterus punctatus	0.28	73	0.18	
Total	156.17		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 20  
 DATE :25.06.2010 GEAR TYPE: PT NO: 1 POSITION:Lat S 3°5.40  
 start stop duration Lon E 10°7.42  
 TIME :07:52:09 08:31:33 39.4 (min) Purpose : 1  
 LOG : 2829.01 2831.67 2.7 Region : 3300  
 FDEPTH: 20 30 Gear cond.: 0  
 BDEPTH: 37 35 Validity : 0  
 Towing dir: 0° Wire out : 110 m Speed : 4.1 kn  
 Sorted : 97 Total catch: 97.35 Catch/hour: 148.25

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trichiurus lepturus	96.93	145	65.38	
Sphyræna guachancho	36.40	79	24.55	
Stromateus fiatola	9.43	15	6.36	
Sarda sarda	1.60	2	1.08	
Selene dorsalis	1.10	15	0.74	
Euthynnus alletteratus	0.99	2	0.67	
Sepia officinalis	0.53	44	0.36	
Lagocephalus laevisgatus	0.44	3	0.30	
Trachinotus ovatus	0.43	2	0.29	
Engraulis sp.	0.41	21	0.28	
Total	148.25		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 21  
 DATE :25.06.2010 GEAR TYPE: BT NO: 24 POSITION:Lat S 3°9.30  
 start stop duration Lon E 10°9.72  
 TIME :10:10:39 10:40:30 29.9 (min) Purpose : 1  
 LOG : 2841.94 2843.57 1.6 Region : 3300  
 FDEPTH: 41 42 Gear cond.: 0  
 BDEPTH: 41 42 Validity : 0  
 Towing dir: 0° Wire out : 120 m Speed : 3.3 kn  
 Sorted : 165 Total catch: 355.76 Catch/hour: 715.10

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Brachydeuterus auritus	490.81	17974	68.64	
Trachurus trecae	52.96	591	7.41	20
Pomadasyus incisus	43.20	225	6.04	
Pagellus bellottii	16.32	74	2.28	
Pomadasyus jubelini	14.93	16	2.09	
Trichiurus lepturus	13.85	74	1.94	
Drepane africana	10.63	8	1.49	
Dasyatis marmorata	10.49	4	1.47	
Pseudotolithus senegalensis	8.98	8	1.26	
Galeoides decadactylus	8.36	48	1.17	
Decapterus rhonchus	6.15	760	0.86	
Selene dorsalis	4.80	60	0.67	
Scomber japonicus	4.72	30	0.66	
Umbrina canariensis	4.28	8	0.60	
Dentex barnardi	3.90	12	0.55	
Sphyræna guachancho	2.81	4	0.39	
Ilisha africana	2.77	56	0.39	
Pteroscion peli	2.55	30	0.36	
Raja miraletus	2.51	4	0.35	
Squilla cadenati	2.17	8	0.30	
Sardinella aurita	1.73	299	0.24	19
Trachinus radiatus	1.59	4	0.22	
Lagocephalus laevisgatus	0.90	4	0.13	
Boops boops	0.82	44	0.12	
Alloteuthis africana	0.68	573	0.10	
Trachinocephalus myops	0.56	8	0.08	
Citharus linguatula	0.56	4	0.08	
Peristedion cataphractum	0.46	8	0.06	
Uranoscopus polli	0.46	4	0.06	
Engraulis encrasicolus	0.08	18	0.01	
Total	715.10		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 22  
 DATE :25.06.2010 GEAR TYPE: BT NO: 24 POSITION:Lat S 3°11.10  
 start stop duration Lon E 10°21.47  
 TIME :13:37:14 13:51:26 14.2 (min) Purpose : 1  
 LOG : 2862.09 2862.80 0.7 Region : 3300  
 FDEPTH: 27 28 Gear cond.: 0  
 BDEPTH: 27 28 Validity : 0  
 Towing dir: 0° Wire out : 80 m Speed : 3.0 kn  
 Sorted : 53 Total catch: 53.01 Catch/hour: 223.99

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Brachydeuterus auritus	55.56	9663	24.81	
Sphyræna guachancho	45.42	308	20.28	
Epinephelus aeneus	21.34	4	9.53	
Selene dorsalis	16.48	258	7.36	
Trachurus trecae	11.79	385	5.26	21
Dentex barnardi	9.89	55	4.41	
Galeoides decadactylus	9.51	55	4.24	
Pomadasy incisus	9.38	85	4.19	
Pseudupeneus prayensis	8.03	46	3.58	
Pomadasy jubelini	6.76	8	3.02	
Pagellus bellottii	5.24	51	2.34	
Stromateus fiatola	5.03	8	2.24	
Engraulis encrasicolus	4.48	1492	2.00	
Balistes punctatus	4.35	4	1.94	
Pagrus caeruleostictus	3.42	4	1.53	
Ilisha africana	2.11	249	0.94	
Chaetodipterus goreensis	1.65	4	0.74	
Sepia officinalis	1.56	8	0.70	
Sardinella aurita	0.93	127	0.42	22
Scomber japonicus	0.55	4	0.25	
Sardinella maderensis	0.42	13	0.19	
Calappa rubroguttata	0.08	4	0.04	
Total	223.99		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 23  
 DATE :25.06.2010 GEAR TYPE: BT NO: 24 POSITION:Lat S 3°26.55  
 start stop duration Lon E 10°1.94  
 TIME :17:42:45 18:12:03 29.3 (min) Purpose : 1  
 LOG : 2891.22 2892.75 1.5 Region : 3300  
 FDEPTH: 101 100 Gear cond.: 0  
 BDEPTH: 101 100 Validity : 0  
 Towing dir: 0° Wire out : 250 m Speed : 3.1 kn  
 Sorted : 84 Total catch: 84.31 Catch/hour: 172.65

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Chelidonichthys gabonensis	44.44	1540	25.74	
Dentex congoensis	40.75	508	23.60	
Trigla lyra	30.72	1925	17.79	
Sepia officinalis	18.02	141	10.44	
Bathyrroconger vicinus	7.37	23	4.27	
Rhinobatos rhinobatos	4.51	2	2.61	
Fistularia petimba	3.99	10	2.31	
Torpedo torpedo	3.62	8	2.10	
Umrina canariensis	3.46	6	2.00	
Citharus linguatula	3.19	184	1.85	
Trichiurus lepturus	2.95	8	1.71	
OPHIDIIDAE	2.46	252	1.42	
Saurida brasiliensis	1.92	295	1.11	
Grammolites gruvelli	1.17	27	0.68	
Octopus vulgaris	1.04	4	0.60	
Dicologlossa hexophthalma	0.88	27	0.51	
Priacanthus arenatus	0.51	33	0.30	
Illex coindetii	0.49	12	0.28	
Spicara alta	0.43	143	0.25	
Uranoscopus polli	0.43	6	0.25	
Ophisurus serpens	0.16	6	0.09	
Trachurus trecae	0.12	2	0.07	
Zeus faber	0.00	4	0.00	
Total	172.65		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 24  
 DATE :26.06.2010 GEAR TYPE: PT NO: 4 POSITION:Lat S 3°33.32  
 start stop duration Lon E 10°11.70  
 TIME :01:45:20 02:15:36 30.3 (min) Purpose : 1  
 LOG : 2942.80 2944.61 1.8 Region : 3300  
 FDEPTH: 0 0 Gear cond.: 0  
 BDEPTH: 89 85 Validity : 0  
 Towing dir: 0° Wire out : 110 m Speed : 3.6 kn  
 Sorted : 13 Total catch: 12.92 Catch/hour: 25.61

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trichiurus lepturus	12.98	20	50.70	
Saurida brasiliensis	8.05	4200	31.42	
Echeneis naucrates	3.37	6	13.16	
Alloteuthis africana	1.09	258	4.26	
Illex coindetii	0.08	22	0.31	
Sepia officinalis	0.02	2	0.08	
Arionomma bondi	0.02	2	0.08	
Total	25.61		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 25  
 DATE :26.06.2010 GEAR TYPE: PT NO: 4 POSITION:Lat S 3°25.00  
 start stop duration Lon E 10°21.69  
 TIME :04:03:55 04:34:07 30.2 (min) Purpose : 1  
 LOG : 2958.94 2960.88 2.0 Region : 3300  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 44 49 Validity : 0  
 Towing dir: 0° Wire out : 110 m Speed : 3.9 kn  
 Sorted : 23 Total catch: 22.72 Catch/hour: 45.15

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Boops boops	19.10	10044	42.30	
Trichiurus lepturus	8.35	12	18.49	
Sphyræna guachancho	7.29	10	16.15	
Trachurus trecae	4.13	700	9.15	
Echeneis naucrates	2.19	2	4.84	
Alloteuthis africana	2.13	980	4.71	
Sardinella aurita	1.37	103	3.04	
Saurida brasiliensis	0.60	248	1.32	
Total	45.15		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 26  
 DATE :26.06.2010 GEAR TYPE: BT NO: 24 POSITION:Lat S 3°21.75  
 start stop duration Lon E 10°32.45  
 TIME :07:02:27 07:32:14 29.8 (min) Purpose : 1  
 LOG : 2979.34 2981.18 1.8 Region : 3300  
 FDEPTH: 21 21 Gear cond.: 0  
 BDEPTH: 21 21 Validity : 0  
 Towing dir: 0° Wire out : 120 m Speed : 3.7 kn  
 Sorted : 35 Total catch: 459.38 Catch/hour: 925.55

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella aurita	851.24	105030	91.97	23
Brachydeuterus auritus	49.50	8277	5.35	
Stromateus fiatola	17.55	52	1.90	
Trachinotus ovatus	3.14	26	0.34	
Lagocephalus laevigatus	1.83	52	0.20	
Sphyræna guachancho	0.79	26	0.08	
Lepidotrigla cadmani	0.71	26	0.08	
Scomber japonicus	0.52	26	0.06	
Decapterus punctatus	0.26	26	0.03	
Total	925.55		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 27  
 DATE :27.06.2010 GEAR TYPE: PT NO: 4 POSITION:Lat S 3°55.53  
 start stop duration Lon E 10°51.19  
 TIME :20:45:08 21:15:05 30.0 (min) Purpose : 1  
 LOG : 3149.33 3150.90 1.6 Region : 3400  
 FDEPTH: 42 42 Gear cond.: 0  
 BDEPTH: 43 42 Validity : 0  
 Towing dir: 0° Wire out : 110 m Speed : 3.1 kn  
 Sorted : 84 Total catch: 83.54 Catch/hour: 167.36

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trichiurus lepturus	93.16	521	55.66	
MOBULIDAE	60.10	2	35.91	
Alectis alexandrinus	9.84	12	5.88	
Sepia officinalis	1.96	98	1.17	
Sphyræna guachancho	1.14	2	0.68	
Remora remora	0.80	4	0.48	
Sardinella aurita	0.36	2	0.22	
Total	167.36		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 28  
 DATE :28.06.2010 GEAR TYPE: BT NO: 24 POSITION:Lat S 4°19.14  
 start stop duration Lon E 10°49.91  
 TIME :08:01:09 08:31:09 30.0 (min) Purpose : 1  
 LOG : 3222.45 3223.93 1.5 Region : 3400  
 FDEPTH: 117 117 Gear cond.: 0  
 BDEPTH: 117 117 Validity : 0  
 Towing dir: 0° Wire out : 280 m Speed : 3.0 kn  
 Sorted : 200 Total catch: 199.74 Catch/hour: 399.48

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Umrina canariensis	117.20	288	29.34	
Dentex angolensis	104.00	628	26.03	
Dentex congoensis	53.00	758	13.27	
Trachurus trecae	45.10	1110	11.29	24
Arionomma bondi	24.60	984	6.16	
Spicara alta	18.50	188	4.63	
Scorpaena scrofa	7.10	22	1.78	
Brotula barbata	6.22	8	1.56	
Cymbium glans	5.00	4	1.25	
Lepidotrigla cadmani	4.40	66	1.10	
Raja miraletus	2.32	6	0.58	
Loligo vulgaris	2.14	172	0.54	
Zeus faber	1.54	10	0.39	
Chaetodon hoefleri	1.34	8	0.34	
Octopus vulgaris	1.30	4	0.33	
Anthias anthias	1.30	8	0.33	
Sepia officinalis	1.18	16	0.30	
Fistularia petimba	1.00	2	0.25	
Branchiostegus semifasciatus *	0.88	2	0.22	
Priacanthus arenatus	0.60	2	0.15	
Citharus linguatula	0.52	26	0.13	
Chlorophthalmus atlanticus	0.24	2	0.06	
Total	399.48		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 29  
 DATE :28.06.2010 GEAR TYPE: PT NO: 7 POSITION:Lat S 4°5.73  
 start stop duration Lon E 11°8.60  
 TIME :11:33:37 11:50:58 17.4 (min) Purpose : 1  
 LOG : 3248.99 3250.10 1.1 Region : 3400  
 FDEPTH: 14 15 Gear cond.: 0  
 BDEPTH: 25 28 Validity : 0  
 Towing dir: 0° Wire out : 80 m Speed : 3.8 kn  
 Sorted : 869 Total catch: 868.56 Catch/hour: 3003.67

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella aurita	2904.90	25186	96.71	25
Selene dorsalis	26.56	498	0.88	
Brachydeuterus auritus	18.26	581	0.61	
Scomber japonicus	16.60	83	0.55	
Engraulis encrasicolus	11.62	1826	0.39	
Trachurus trecae	10.79	332	0.36	
Sardinella maderensis	10.79	249	0.36	
Sepia officinalis	3.32	581	0.11	
Trichiurus lepturus	0.83	249	0.03	
Total	3003.67		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 30  
 DATE :28.06.2010 GEAR TYPE: PT NO: 1 POSITION:Lat S 4°28.72  
 start stop duration Lon E 10°55.43  
 TIME :17:02:54 17:31:28 28.6 (min) Purpose : 1  
 LOG : 3292.82 3294.52 1.7 Region : 3400  
 FDEPTH: 158 132 Gear cond.: 0  
 BDEPTH: 157 133 Validity : 0  
 Towing dir: 0° Wire out : 200 m Speed : 3.6 kn  
 Sorted : 4 Total catch: 3.90 Catch/hour: 8.19

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
MYCTOPHIDAE	6.15	15383	75.13	
Trichiurus lepturus	1.89	6	23.08	
Loligo vulgaris	0.15	2	1.79	
Selene dorsalis	0.00	2	0.00	
Total	8.19		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 31  
 DATE :29.06.2010 GEAR TYPE: PT NO: 7 POSITION:Lat S 4°19.70  
 start stop duration Lon E 11°23.10  
 TIME :23:12:24 23:26:27 14.0 (min) Purpose : 1  
 LOG : 3341.54 3342.58 1.0 Region : 3400  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 24 23 Validity : 0  
 Towing dir: 0° Wire out : 110 m Speed : 4.5 kn  
 Sorted : 114 Total catch: 114.40 Catch/hour: 490.29

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella aurita	409.93	2383	83.61	26
Brachydeuterus auritus	39.39	1599	8.03	
Trichiurus lepturus	21.64	463	4.41	
Sardinella maderensis	14.79	219	3.02	27
Pteroscion peli	1.24	34	0.25	
Ilshia africana	1.16	189	0.24	
Sepia officinalis	0.64	133	0.13	
Cynoglossus monodi	0.34	4	0.07	
Galeoides decadactylus	0.26	9	0.05	
Parapanaeus longirostris	0.21	249	0.04	
Selene dorsalis	0.21	13	0.04	
Citharus linguatula	0.13	9	0.03	
Stromateus fiatola	0.13	9	0.03	
Illex coindetii	0.09	77	0.02	
Engraulis encrasicolus	0.09	103	0.02	
Fodiator acutus	0.04	4	0.01	
Total	490.29		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 32  
 DATE :29.06.2010 GEAR TYPE: PT NO: 1 POSITION:Lat S 4°40.62  
 start stop duration Lon E 11°25.31  
 TIME :07:25:26 07:51:20 25.9 (min) Purpose : 1  
 LOG : 3416.26 3417.95 1.7 Region : 3400  
 FDEPTH: 50 60 Gear cond.: 0  
 BDEPTH: 84 88 Validity : 0  
 Towing dir: 0° Wire out : 180 m Speed : 3.9 kn  
 Sorted : 0 Total catch: 0.28 Catch/hour: 0.65

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
SALPS	0.65	0	0.00	
Selene dorsalis	0.00	2	0.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 33  
 DATE :29.06.2010 GEAR TYPE: BT NO: 24 POSITION:Lat S 4°34.73  
 start stop duration Lon E 11°37.53  
 TIME :10:35:12 11:05:40 30.5 (min) Purpose : 1  
 LOG : 3437.95 3439.43 1.5 Region : 3400  
 FDEPTH: 25 25 Gear cond.: 0  
 BDEPTH: 25 25 Validity : 0  
 Towing dir: 0° Wire out : 120 m Speed : 2.9 kn  
 Sorted : 0 Total catch: 400.03 Catch/hour: 787.72

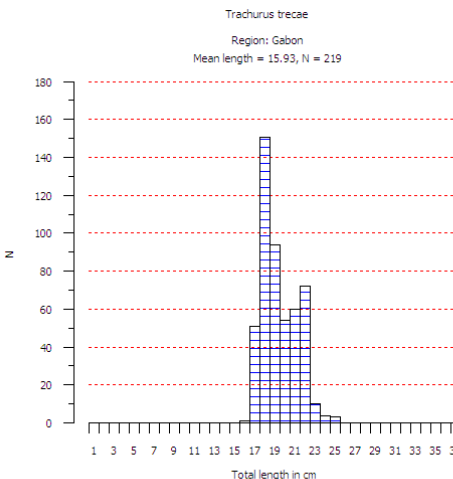
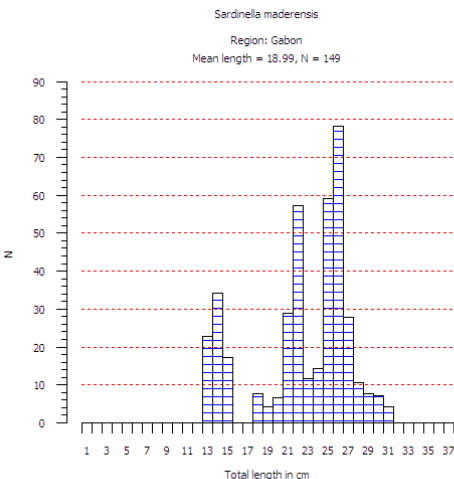
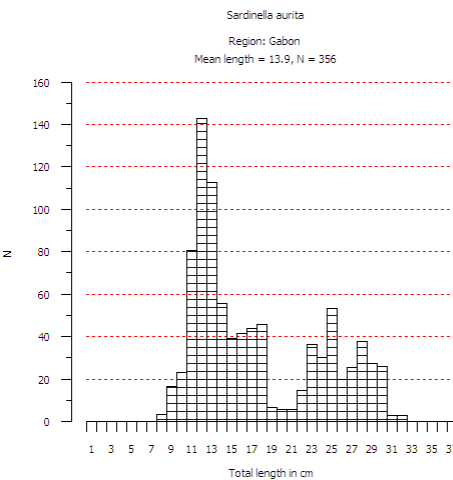
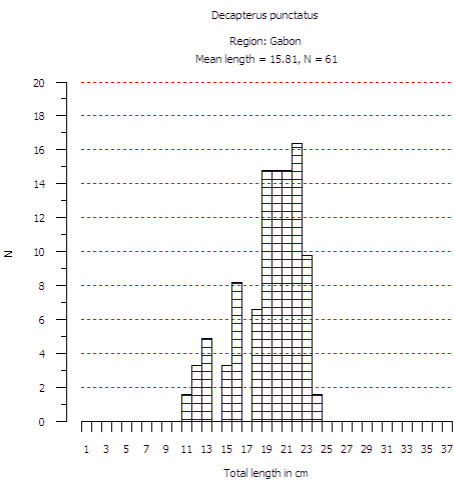
SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Brachydeuterus auritus	352.38	9850	44.73	
Selene dorsalis	102.08	2786	12.96	
Trichiurus lepturus	93.14	2739	11.82	
Ilshia africana	56.36	1250	7.15	
Pseudolithus typus	36.78	565	4.67	
Pteroscion peli	34.22	1506	4.34	
Pentanemus quinquarius	31.47	884	3.99	
Sardinella aurita	25.30	118	3.21	28
Stromateus fiatola	22.11	51	2.81	
Trachurus trecae	11.44	118	1.45	
Parapanaeus longirostris	8.96	1778	1.14	
Dicologlossa cuneata	3.86	173	0.49	
Portunus validus	2.21	124	0.28	
Galeoides decadactylus	2.17	22	0.27	
Ophisurus serpens	1.73	4	0.22	
Batrachoides sp.	1.06	85	0.13	
Sepia officinalis	1.06	161	0.13	
Cynoglossus canariensis	0.45	16	0.06	
Arius parkii	0.37	4	0.05	
Pomadasy inciscus	0.24	4	0.03	
Alloteuthis africana	0.12	43	0.01	
Sphyræna barracuda	0.12	12	0.01	
Lagocephalus laevigatus	0.08	18	0.01	
Total	787.72		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010406 STATION: 34  
 DATE :29.06.2010 GEAR TYPE: BT NO: 24 POSITION:Lat S 4°51.51  
 start stop duration Lon E 11°31.97  
 TIME :14:28:49 14:53:49 25.0 (min) Purpose : 1  
 LOG : 3464.86 3466.13 1.3 Region : 3400  
 FDEPTH: 95 94 Gear cond.: 0  
 BDEPTH: 95 94 Validity : 0  
 Towing dir: 0° Wire out : 230 m Speed : 3.1 kn  
 Sorted : 93 Total catch: 431.95 Catch/hour: 1036.68

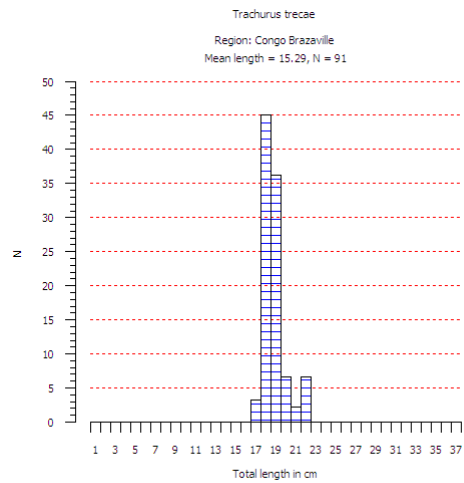
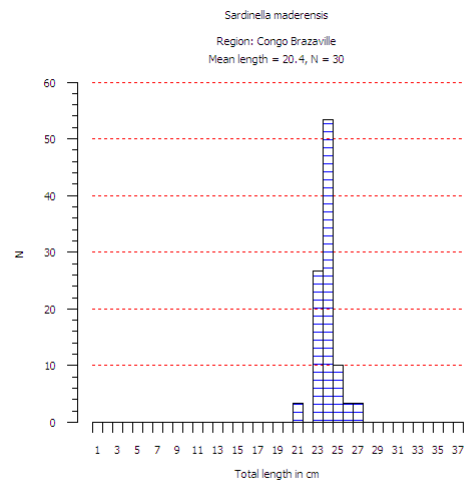
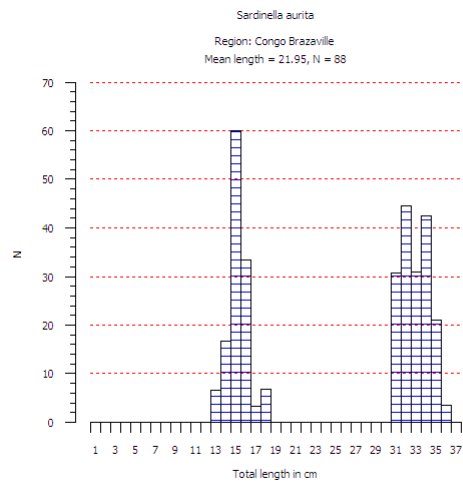
SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trachurus trecae	908.69	13632	87.65	
Pteroscion peli	63.74	593	6.15	
Trichiurus lepturus	26.38	559	2.54	
Brotula barbata	11.83	77	1.14	
Illex coindetii	6.36	144	0.61	
Scomber japonicus	4.68	34	0.45	
Fistularia petimba	4.58	10	0.44	
GOBIIDAE	4.25	526	0.41	
Parapanaeus longirostris	2.45	458	0.24	
Saurida brasiliensis	1.56	413	0.15	
Octopus vulgaris	0.98	10	0.09	
Citharus linguatula	0.65	22	0.06	
Sepia officinalis	0.31	67	0.03	
Alloteuthis africana	0.22	96	0.02	
Total	1036.68		100.00	

# ANNEX II. Length frequencies of main species

## Gabon



## Congo





## ANNEX III      Biomass and number per length group

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*Sardinella aurita*

Length group (cm)	N (millions)	W (tonnes)
5	3	0.0
6	5	0.0
7	260	0.8
8	351	1.6
9	369	2.4
10	318	2.8
11	249	2.9
12	179	2.7
13	109	2.1
14	37	0.9
15		
16	4	0.1
17	6	0.3
18	13	0.7
19	15	0.9
20	3	0.2
21	12	1.0
22		
23	49	5.4
24	45	5.6
25	53	7.5
26	26	4.2
27	46	8.4
28	56	11.3
29	42	9.4
30	17	4.2
31	11	3.1
32		
33		
34		
35		
<b>Sum</b>	<b>2277</b>	<b>78.6</b>

*Sardinella maderensis*

<b>Length group (cm)</b>	<b>N (millions)</b>	<b>W (tonnes)</b>
5		
6		
7		
8		
9	43	0.3
10	64	0.6
11	32	0.4
12		
13		
14	1	0.0
15	1	0.0
16	0	0.0
17	18	0.8
18	10	0.5
19	46	3.0
20	91	7.0
21	26	2.3
22	28	2.8
23	39	4.6
24	26	3.4
25	7	1.1
26	8	1.4
27	4	0.7
28		
29		
30		
31		
32		
33		
34		
35		
<b>Sum</b>	<b>445</b>	<b>29.3</b>

*Horse mackerel*

Length group (cm)	N (millions)	W (tonnes)
5		
6		
7		
8		
9		
10		
11		
12		
13	12	0.3
14	85	2.5
15	61	2.1
16	19	0.8
17	20	1.0
18	18	1.1
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
<b>Sum</b>	<b>215</b>	<b>7.8</b>

## **ANNEX IV                      Instruments and fishing gear used**

---

The Simrad ER-60/18, 38, 120 and 200 kHz scientific sounder was run during the survey only for observation of fish and bottom conditions.

Standard sphere calibrations were carried out using 38.1 mm diameter tungsten carbide sphere for 18, 38, 120 and 200 kHz. The last calibrations took place 07.03.2010, Baia dos Elefantes. The details of the settings of the 38 kHz echo sounder where as follows:

### **Transceiver-2 menu (38 kHz)**

Transducer depth	5.50 m
Absorption coefficient	8.7 dB/km
Pulse length	medium (1,024ms)
Bandwidth	2.43 kHz
Max power	2000 Watt
2-way beam angle	-20,6dB
Gain	25.38 dB
SA correction	-0.48 dB
Angle sensitivity	21.9
3 dB beam width	7.12° along ship 7.24° athwart ship
Along ship offset	0.17°
Athwart ship offset	0.05°

### **Bottom detection menu**

Minimum level	-45 dB
---------------	--------

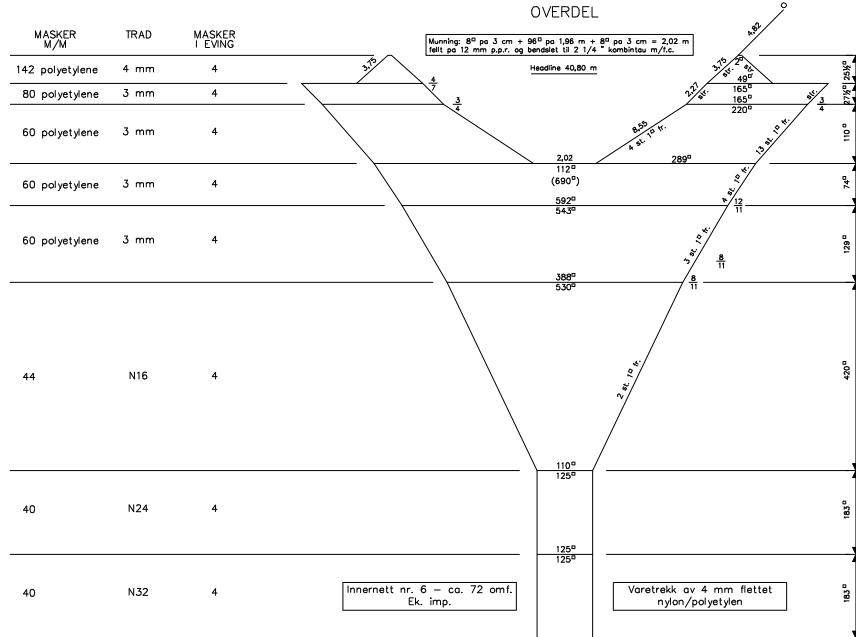
### **Fishing gear**

The vessel has two different sized "Åkrahamn" pelagic trawls and one "Gisund super bottom trawl". Trawls were used for identification of acoustic targets only.

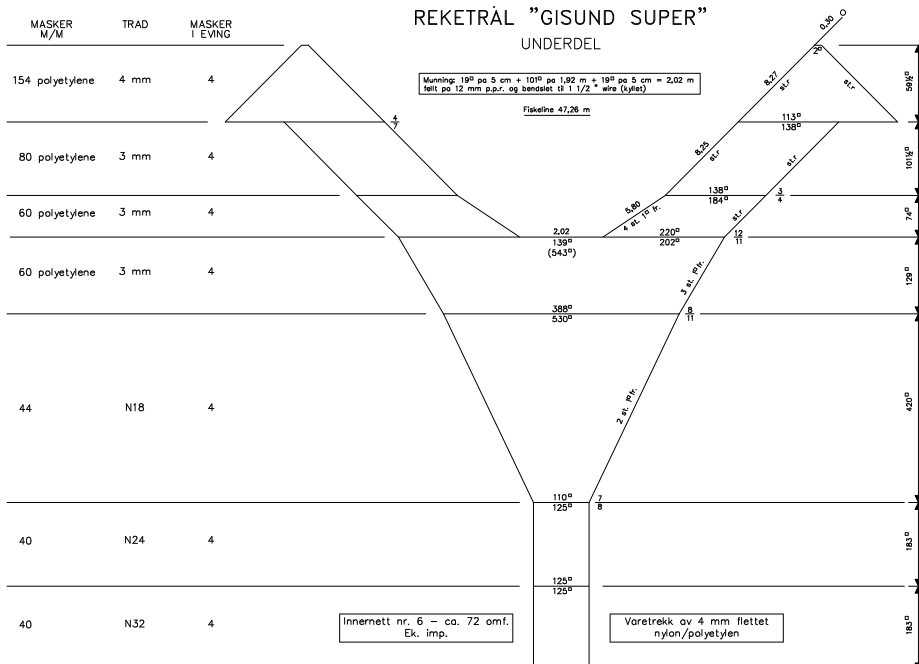
The bottom trawl has a headline of 31 m, footrope 47 m and 20 mm mesh size in the cod end with an inner net of 10 mm mesh size. The trawl height was about 4.5 m and distance between wings during towing about 21 m. The sweeps are 40 m long. The trawl is equipped with a 12" rubber bobbins gear. New doors are 'Thyborøn' combi type, 7.41 m<sup>2</sup>, 1720 kg. These have been in use onboard since 19.02.08.

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 the trawl was equipped with a trawl eye that provides information about the trawl opening. A catch sensor on the cod-end indicated the size of the catch.

# REKETRÅL "GISUND SUPER" OVERDEL



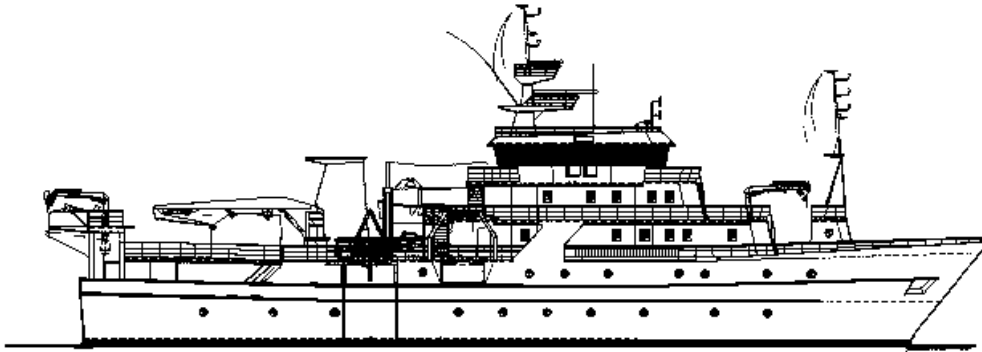
# REKETRÅL "GISUND SUPER" UNDERDEL



Design of the trawl used

**NORAD/FAO PROJECT GCP/INT/730/NOR  
INIP**

**CRUISE REPORTS DR. FRIDTJOF NANSEN**



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

**Cruise Report No 2/2010**

**Survey of the pelagic resources  
1 – 30 July 2010**

**DRAFT  
.2010**

**Institute of Marine Research  
IMR  
Bergen**

**Instituto Nacional de Investigação Pesqueira  
INIP  
Luanda**

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**by**

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# TABLE OF CONTENTS

<i>CHAPTER 1</i>	<i>INTRODUCTION</i>	3
1.1	Objectives	3
1.2	Participation	3
1.3	Narrative	4
1.4	Survey effort	4
<i>CHAPTER 2</i>	<i>METHODS</i>	9
2.1	Hydrographical sampling	9
2.2	Fish sampling	10
2.3	Plankton sampling	11
2.4	Acoustic sampling	11
<i>CHAPTER 3</i>	<i>OCEANOGRAPHIC CONDITIONS</i>	14
3.1	Surface distribution	14
3.2	Standard sections	29
<i>CHAPTER 4</i>	<i>DISTRIBUTION, SIZE COMPOSITION AND BIOMASS ESTIMATES</i>	37
4.1	Congo River - Pta. Palmerinhas	37
4.2	Pta. das Palmerinhas - Benguela	43
4.3	Benguela - Cunene	50
<i>CHAPTER 5</i>	<i>SUMMARY OF SURVEY RESULTS</i>	58
5.1	Sardinella	58
5.2	Cunene horse mackerel	60
5.3	Conclusions	
<i>REFERENCES</i>		64

Annex I	Fishing stations
Annex II	Length frequency of main pelagic species
Annex III	Biomass and number per length group
Annex IV	Acoustic instruments and fishing gear used



## CHAPTER 1 INTRODUCTION

---

### 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, and to improve the understanding and knowledge in terms of the biology, ecology and population dynamics of the main pelagic species in relation to the environment and the whole ecosystem. Acoustic surveying using the echo integration is the principal tool for estimating stock abundance of pelagic species, and the survey estimates, therefore form the basis for recommendation on the Total Allowable Catch (TAC).

The specific objectives of the survey were the following:

- To estimate the abundance and 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 capensis* and other pelagic species.
- To collect stomachs, otoliths and genetic samples from both horse mackerel species.
- 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 of cruise participants on the main survey routines, including using the new Nansis database and scrutinizing acoustical data with the post-processing system, Large Scale Survey System (LSSS).

### 1.2 Participation

The scientific staff consisted of:

From INIP, Luanda:

01.07-15.07: António BARRADAS (Co-cruise leader), Andom LUSSEVAKUENO, Aristóteles AMARO, Manuel DOMINGOS, Florêncio ANDRÉ, Quilanda FIDEL.  
 15.07-11.08: Filomena VAZ VELHO (Co-cruise leader), Geraldina ASSUNÇÃO, Wsaso ANDRÉ, Domingos Pedro, Bomba BAZIKA, Eusébio dos SANTOS, Sténia ISAIS, José Mateus da SILVA, Benvindo KALUKEMBA, Mabibe MANUEL (TPA).

From NatMIRC-Namibia: David Natangwe KAAANDUNGE, Ipeinge Etuwete MUNDJULU.

From Namibia: Hilka NDJAULA.

From IMR, Bergen:

01.07-15.07: Sigbjørn MEHL (Cruise leader), Diana ZAERA, Tore MØRK, Ole Sverre FOSSHEIM.

15.07-11.08: Bjørn Erik AXELSEN (Cruise leader), Silje Elisabeth SEIM, Thor Egil JOHANSSON, Jan Frode WILHELMSEN.

### **1.3 Narrative**

The vessel departed Pointe Noire on the 1<sup>st</sup> of July at 10:00 UTC and steamed south of Congo River where the survey started doing the monitoring line off Moita Seca at 23:30 UTC the same day. The survey area is divided into three regions:

- (a) Congo River - North of Pta. das Palmerinhas (6°-9°S): ANGOLA NORTH;
- (b) The region between 9°S and 13°S: ANGOLA CENTRAL;
- (c) The region between 13°S and Cunene River (17°15'S): ANGOLA SOUTH.

The northern region was completed on the 10<sup>th</sup> of July with the monitoring line of Pta. das Palmerinhas, and the vessel carried on covering the central region south to Cabo Ledo. On the evening of 13<sup>th</sup> of July the vessel steamed to Luanda for a crew change. The survey restarted on the 17<sup>th</sup> of July, and the central region was completed on the 22<sup>th</sup> of July. The coverage of the Southern region and the shelf of Angola at Cunene River was completed on the 29<sup>th</sup> of July.

Calibration of the Simrad ER 60 Scientific echo sounder (18, 38, 120, 200 kHz transducers) was done in Baía dos Elephantes on 23<sup>th</sup> July.

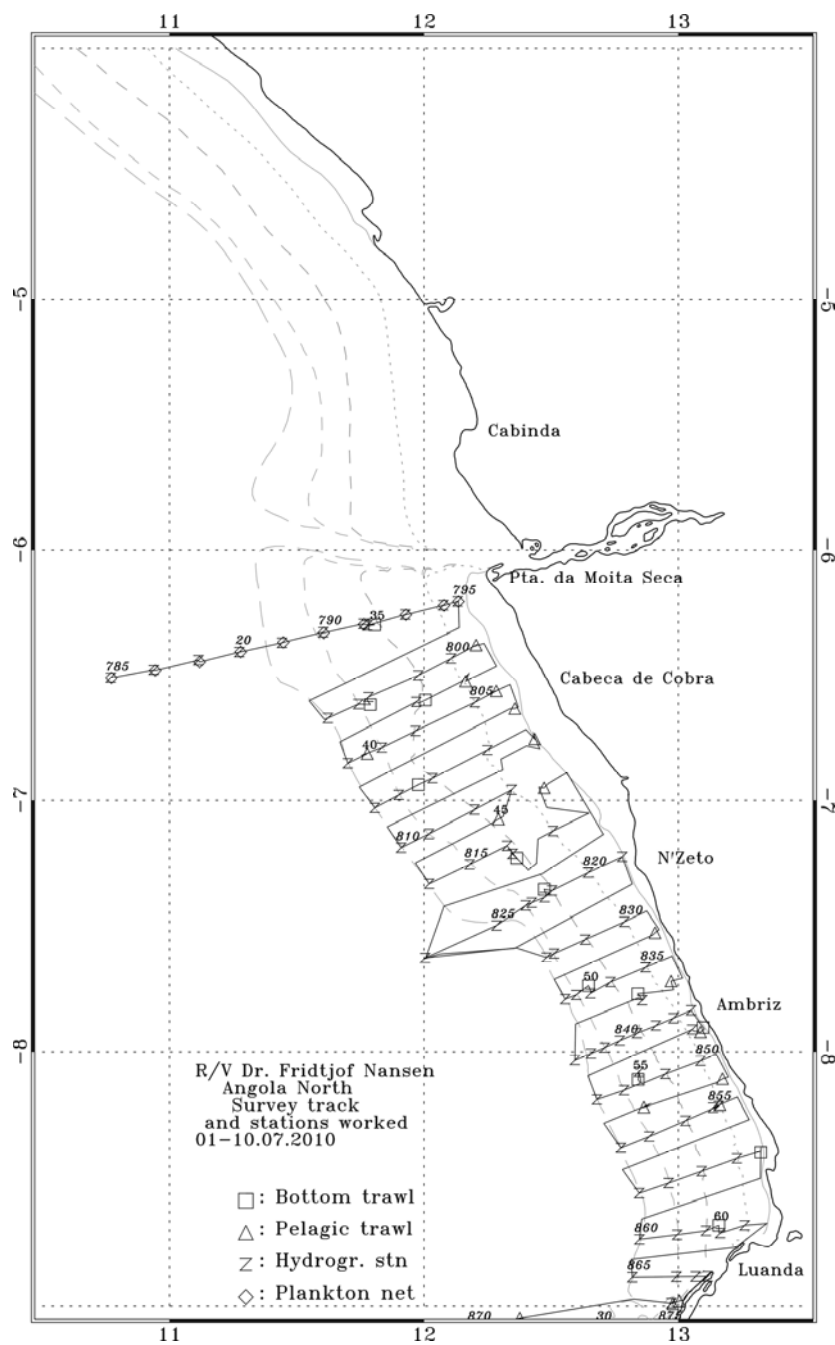
A systematic survey track implemented in 2002 with equally spaced transect lines (6 nautical miles apart) perpendicular to the coast was followed during the survey. The Cabinda region was not included in this survey due to stricter enforcement of regulations implied by the oil companies in the area.

### **1.4 Survey effort**

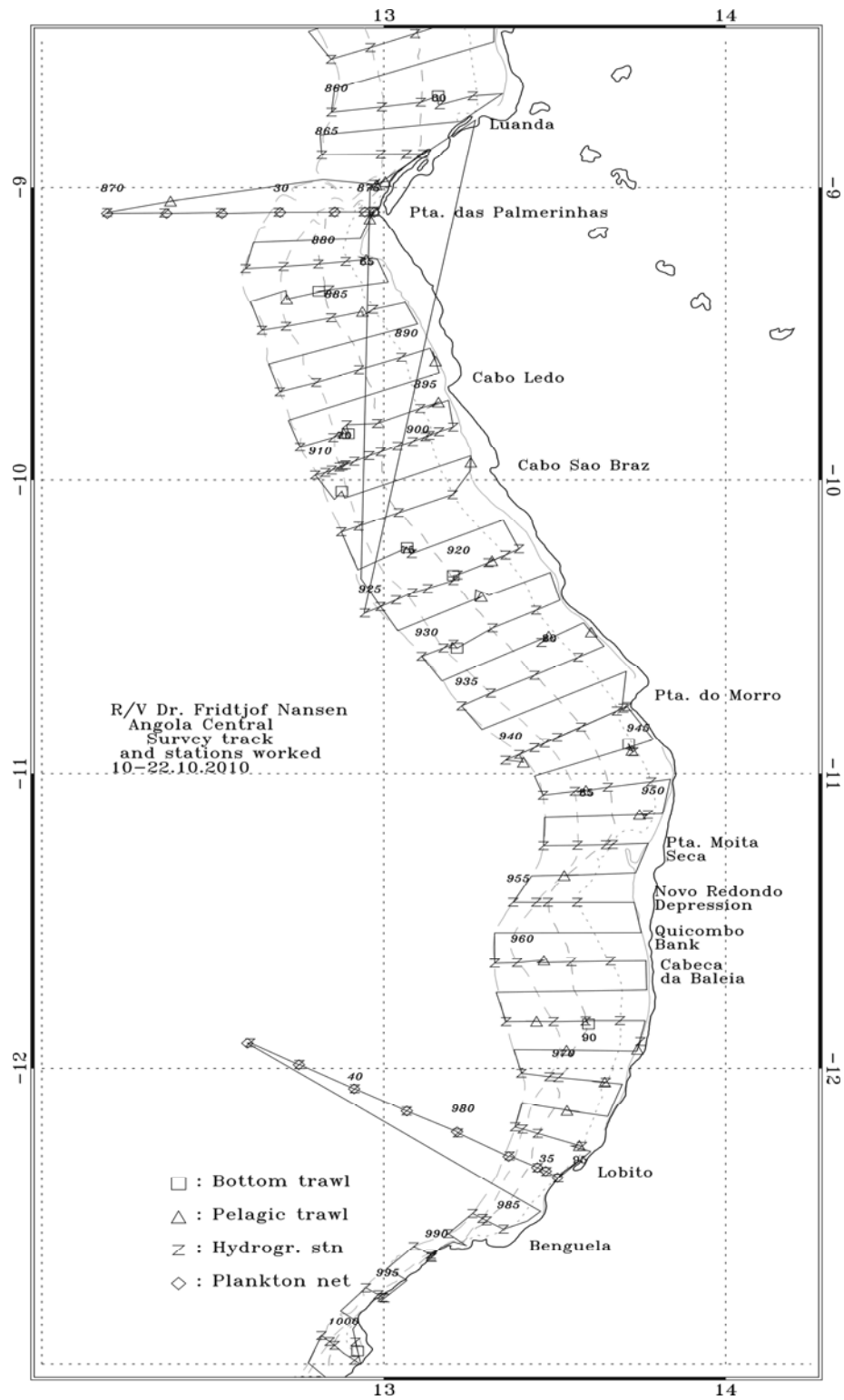
Figure 1(a-c) shows the cruise tracks with fishing, plankton and hydrographical stations for the northern, central and southern regions of Angola. The sampling trawls, including the small (10 m vertical opening) , the mid-sized (15 m vertical opening) pelagic trawls and the demersal trawl (5 m), were used during the survey. 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).

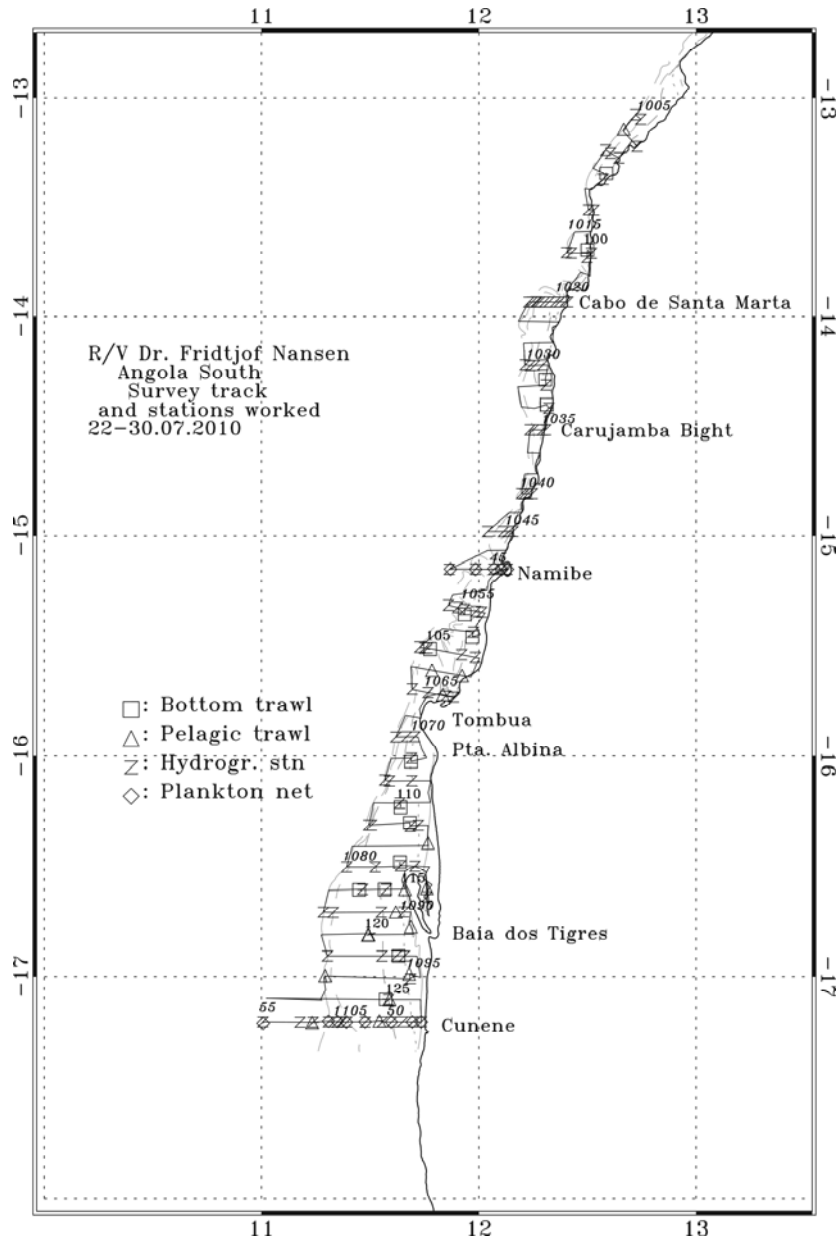
Area	BT	PT	Total Trawls	CTD casts	Multinet stations	Log (NM)
Congo River - Pta. Palmerinhas	12	16	28	92	17	1551.8
Pta. Palmerinhas - Benguela	9	27	36	77	10	
Benguela - Cunene River	17	16	33	106	13	6926.57
Total	38	59	97	275	40	



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



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



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

## CHAPTER 2      METHODS

---

### 2.1      Hydrographical sampling

#### *CTD*

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 at standard INIP transects and monitoring lines. The casts were stopped a few meters above the bottom, and at a maximum of 1500 m depth. The oxygen sensor has shown to be stable, and no calibration was conducted during the survey. Additional CTD stations were added on every second cruise track between the standard transects and monitoring lines at bottom depths 50, 100, 200 and 500 m.

The transects off Congo River, Pta. das Palmerinhas, Lobito, Namibe and Cunene River were carried out in accordance with the monitoring lines run by INIP.

Attached to the CTD was also a Chelsea fluorometer of the type Mk III Aquatrack. It measures chlorophyll A in microgram per litre with an uncertainty of 3%. Factory slope and offset was 0.921 and -0.02.

#### *Thermosalinograph*

The SBE 21 Seacat thermosalinograph was running routinely during the survey, obtaining samples of sea surface salinity and relative temperature and fluorescence (5 m depth) every 10 sec. An attached in-line Turner Design SCUFA Fluorometer was continuously measuring Chlorophyll levels [RFU] at 5 m below the sea surface while underway during the entire cruise. The instrument was configured with a bright blue photodiode, a 420 nm Excitation filter and a 680 nm Emission filter. It was calibrated against the secondary orange standard dye. The maximum output was equivalent to 5Volt = 100%. It had a linear temperature compensation of 2.14%/°C

#### *Current speed and direction measurements (ADCP)*

A vessel-mounted Acoustic Doppler Current Profiler (VMADCP) from RD Instruments was run continuously during the survey in broadband mode shallower than about 400 m and in narrow band mode in deeper waters. The frequency of the VMADCP is 150 kHz, and data were averaged and stored in 3 m or 4 m vertical bins. All data were stored on files for post survey processing.

#### *Meteorological observations*

Meteorological data logged from the Norwegian Meteorological Institute's (DNMI) meteorological station on board, included air temperature, humidity, air pressure, wind direction and speed, and sea surface temperature (SST). All data were averaged by unit distance sailed (1 NM).

## 2.2 Fish sampling

A brief description of the fishing gear is provided in Annex II. All trawl catches were sampled for species composition by weights and numbers. Records of catch rates are given in Annex I. Total length (TL) frequencies were taken for the commercial pelagic species such as sardinella, horse mackerel, sardine, round herring, anchovy, *Brachydeuterus auritus* and demersal species, mainly *Dentex spp.*

Biological samples were obtained for sardinella, horse mackerel, *Sardinops ocellatus* and *Scomber japonicus*. Total length (TL) 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 six-point classification scale first proposed by INIP (Table 2).

**Table 2.** Adapted scale by INIP for the classification of maturity stage for both horse mackerel and sardinella in Angola (partial spawners)

Stage	Maturity stage	Description
I	Immature	Small gonads, do not occupy more than 1/3 of abdominal cavity length. Ovary pinkish; testis whitish. Ovary not visible to naked eye
II	Maturing virgin and recovering spent	The gonads begin to develop, increasing substantially in size; about ½ length of the abdominal cavity. Gonads more opaque, small points visible to the naked eye (oocytes at the beginning of vitellogenese). The gonads in rest/recovery more flaccid with some more conspicuous blood than the gonads in development.
III	Mature. Before pre-spawning	At the beginning, oocytes more conspicuous giving the gonad a granular aspect. Ovary yellow-orange, testis creamy. Visible sperm in testis if open. Gonads quite swollen in the beginning of the reproduction period. Gonads that have spawned once lose consistency, but opaque oocytes present, and sperm in testis if cut. At the end of the stage is possible to find some translucent oocytes. Gonads occupy about 2/3 of abdominal cavity.
IV	Mature Pre-spawning	The gonads occupy about 2/3 of abdominal cavity. Ovaries orange in colour with visible blood vessels. Most oocytes translucent, testis creamy, flat and brilliant texture. The gonads stop flowing oocytes and sperm flows at low pressure.
V	Mature. In spawning	The gonads occupy about 2/3 or less of abdominal cavity. Ovaries orange in colour with the conspicuous blood vessels, blood stained mainly in one end. Most oocytes translucent; testis creamy, flat and brilliant texture. The gonads stop flowing oocytes and sperm flows at low pressure. Pink stains at the end of gonad.
VI	Post-spawning	The gonads decrease in size and occupy about ½ or less, of abdominal cavity. Gonads flaccid and bloody. Ovary can contain remaining oocytes that were not emitted. Testis may have sperm remaining in the seminal duct. Pinkish areas in the whole extension of the gonad.



Stomach samples of horse mackerel were collected for further analysis at INIP, Luanda. Feeding biology will be investigated in more details at a later stage by relating the stomach contents to recorded availability of zooplankton. In addition otoliths and genetic samples were collected from horse mackerel.

### **2.3 Plankton sampling**

#### *Phytoplankton*

Samples of phytoplankton were collected on monitoring lines using the CTD bottles at 5, 15, 25, 50 and 75 meter depths.

#### *Zooplankton*

The zooplankton sampling was conducted by means of HYDROBIOS Multinet (180  $\mu\text{m}$ ), at four depths intervals, 0-25, 25-50, 50-75, 75-100 and 100-200 m, at transects off Congo River, Pta. das Palmerinhas, Lobito, Namibe and Cunene River (monitoring lines). Data from the flow meter was recorded electronically from the Multinet receiver unit. 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*

Acoustic data were recorded using a Simrad ER60 scientific echo sounder equipped with keel-mounted transducers at nominal operating frequencies of 18, 38, 120 and 200 kHz. The survey was started without *a priori* calibration. All transceivers were calibrated in Baía dos Elefantes the 23 of July.

Acoustic data were logged and post-processed using the latest acoustic data post-processing software, the Large Scale Survey System (LSSS) Version 1.25. The technical specifications and operational settings of the echo sounder used during the survey are given in Annex II.

#### *Allocation of acoustic energy to species group*

The acoustic data were scrutinized using the LSSS version 1.25. Scatters were displayed at 38 kHz. The mean 5 nautical miles (NM) area backscattering coefficient  $s_A$  ( $\text{m}^2/\text{NM}^2$ ) was allocated to a predefined set of species groups on the basis established echogram features. Acoustic groups and respective species 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 species groups. 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.

Group	Taxon	Species
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 <sup>1</sup>	<i>Ilisha africana</i> <i>Etrumeus whiteheadi</i> <i>Engraulis encrasicolus</i>
Pelagic species 2	Carangidae <sup>2</sup>	<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 <sup>3</sup>	<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	

<sup>1</sup> other than *Sardinops* sp.; <sup>2</sup> other than *Trachurus* sp.; <sup>3</sup> 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 regression of 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 Nansis Maptool Version 1.51. 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:  $s_A > 3\ 001$  ( $m^2/NM^2$ ).

Mean 5-NM integrator values ( $s_A$ ) computed along the transect lines were re-averaged for each stratum. The short spacing between the lines (6 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:

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

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

Wind, sea surface temperature (SST, 5m depth), sea surface salinity (SSS, 5m depth) and sea surface fluorescence (SSF, 5m depth) were continuously recorded, during the survey. Figures 2-5 show the horizontal distribution of these parameters, respectively.

#### *Northern region*

The wind observed in this region during the survey was variable, both in intensity and direction, with an average velocity of around 5 m/s (10 knots) (Figure 2a). In the area around the Congo River (Pta. de Moita Seca) wind velocity varied between 3 and 9 m/s to gradually increase towards N'Zeto, where velocities could reach 17 m/s. Further south, between N'Zeto and north of Luanda, wind velocity varied from calm areas (2 - 3 m/s) to more windy areas (up to 17 m/s). Off Luanda wind was strong again (10 and 16 m/s). Although the direction varied along the area surveyed, it generally came from the south.

Off Congo River mouth the sea surface temperature ranged from 22.5°C inshore to 24°C offshore (Figure 3a). The isolines run parallel to the coast. Colder waters were found further south at N'Zeto and as far south as Luanda, with values ranging between 21°C and 22.5°C. Generally lower values were found closer to the coast and temperature increased offshore.

A salinity gradient was found across the shelf, and values ranged from 35.4 to 35.9 (Figure 4a). Although the influence of the Congo River can be shown off Pta. de Moita Seca where the lowest salinity values were found (35.4), it is not so obvious since the survey was carried out in the transition from rainy to dry season. Salinity values along the surveyed area increased offshore and towards the south, with a maximum between N'Zeto and south of Ambriz (35.8).

A fluorescence gradient was found parallel to the coast with low values pockets off Ambriz (Fig. 5a). Values were highest close to the coast and ranged between 0.4  $\mu\text{l}$  (north of Luanda) and 0.7  $\mu\text{l}$  (off N'Zeto), while offshore values were lower (0.1  $\mu\text{l}$ ).

#### *Central Region*

In this region the wind was very variable both in strength and direction (Figure 2b) with emphasis north and north east. The moderate winds (around 10-12 knots) were registered in major part of central region and the weakest wind occurred on the north off Lobito until 12 ° 05 'S

The spatial distribution of temperature and salinity in this region is characterized by the zonal transport of tropical waters (moderate temperatures and high levels of salinity) from offshore to the coast under the influence of Angola Current. However, the zonal transport towards to the coast, scenario significantly visible in the two figures, became a barrier of upwelled water. This fact is revealed by the configuration of isolines along the coast creating a thermal front between warmer water from offshore and cooler water from inshore (figure 1a).

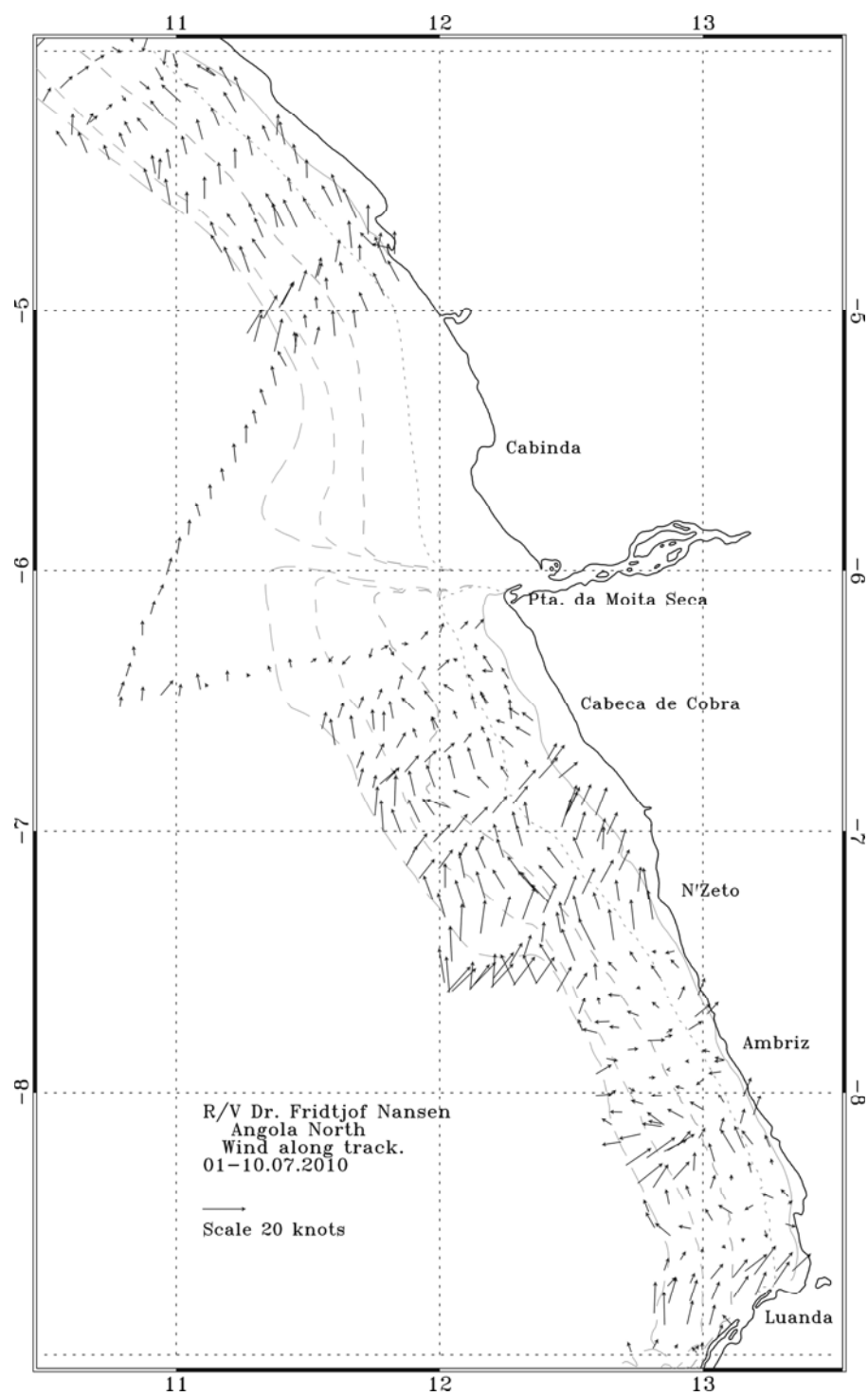
Analyzing the surface sea water, also it was observed that the plume of coastal water body, possibly caused by the intrusion of water from the Kwanza River, is restricted only in the area between the mouth of the Kwanza River and Northern of Palmeirinha during this cruise. The highest values of temperature (22.5°C) and salinity ( $S \geq 36$ ) were found in the region between 10° and 12° 40'S

Surface highest values (0.6 – 1.0 µl/l) of fluorescence were found in vicinity of Cabo São Braz and between Benguela and Benguela town. In general, low values of fluorescence (0.2µl/l) were found in the entire region (Figure 5b).

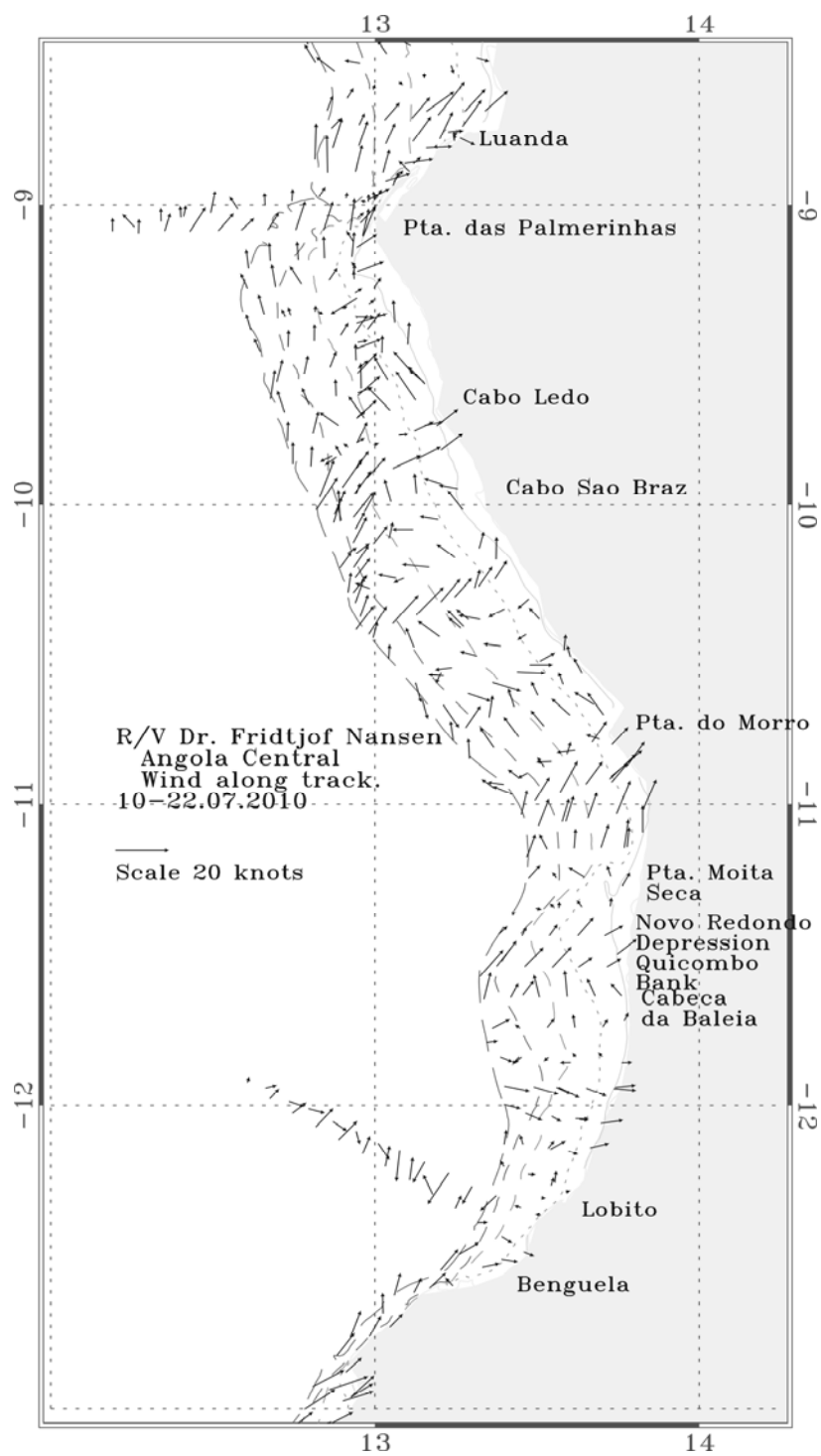
### *Southern Region*

The wind in this region was stronger and predominantly northwards, NE from 15° 30'S to Namibe, and some time north westerly (NW) from Namibe to Cabo Santa Marta (Figure 2c). Between Baía dos Tigres and Cunene River's the Northern winds were very weak, the speeds registered in this area did not reach more than 5 knots. This area with weak wind coincide with the intrusion of both Angola and Benguela currents water showing the main channel of Angola-Benguela front.

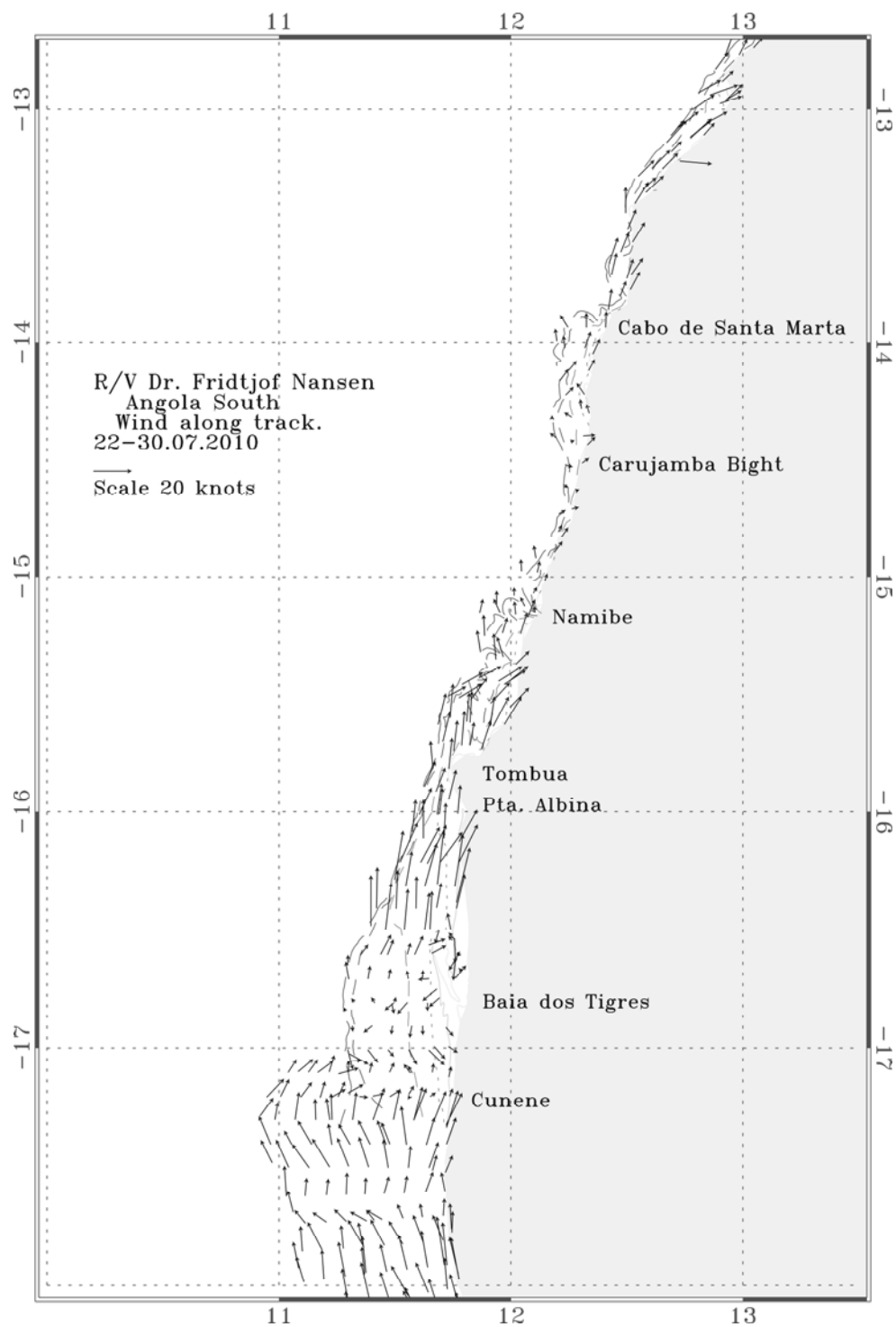
The maximum wind velocity was registered from Tômbwa 16° 25'S and predominantly northwards reaching 25-30 knots and between Cunene and 18°S the winds were moderate with approximately 20 knots.



**Figure 2a.** Distribution of wind velocities along the survey track for the northern region. 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.



### *Horizontal Distribution*

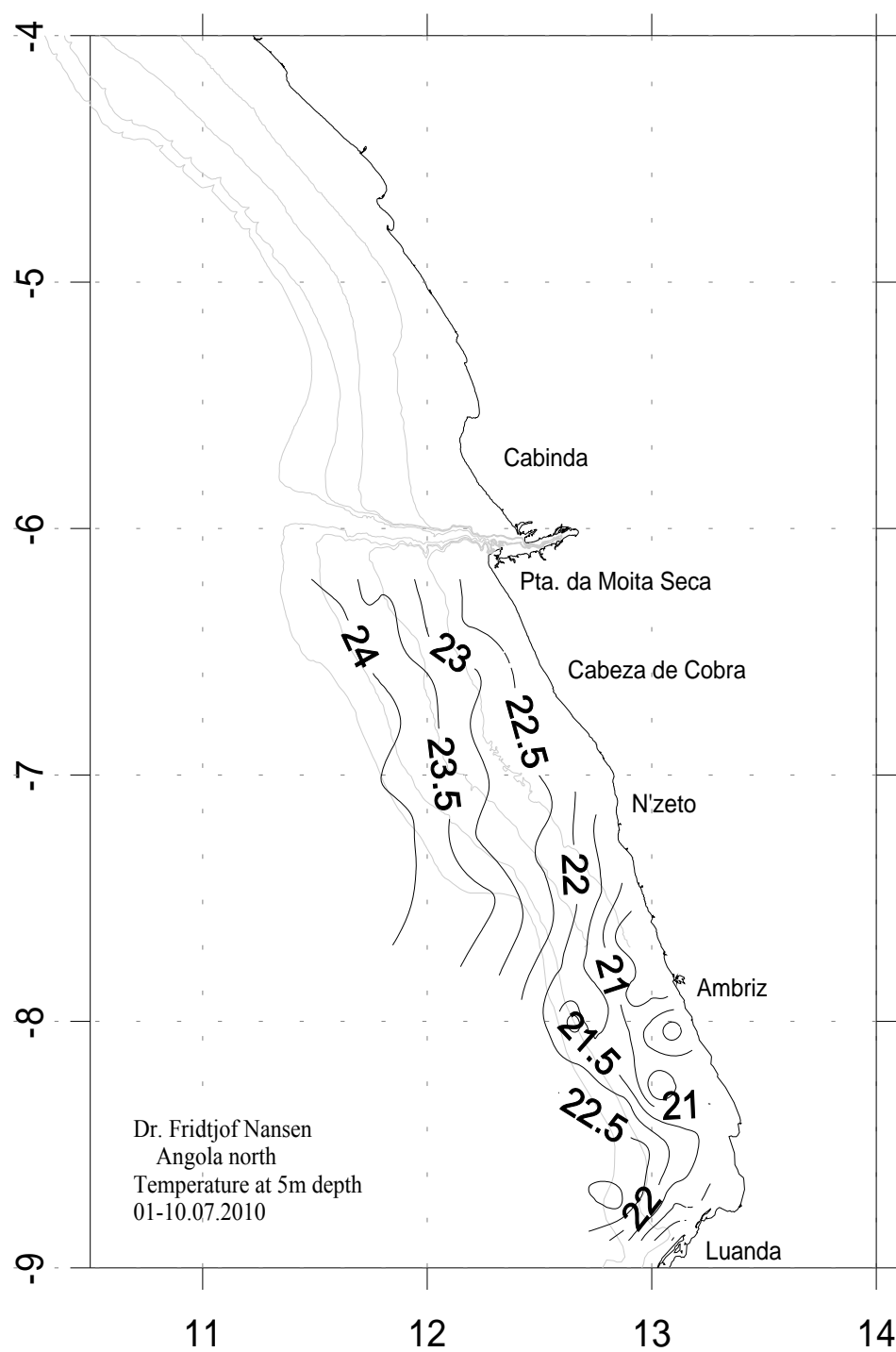
The main features of spatial hydrographic conditions encountered during the present survey are presented by figures 3c-5c. The warm and saline body of water ( $T^{\circ} > 20.5^{\circ}\text{C}$ ,  $S > 36.1$ ) transport visible in the Tômbwa area (Fig 3c and 4c) bears temperature and salinity signature of the southward flowing probably Angola current. Under this current, in the shelf break of this region, upwelling process was not detectable due the stratification of isotherm and isohaline which encountered a strong pressure from this inshorewards transport. This was the only zone where the temperature reached around  $20.5-19^{\circ}\text{C}$  and highest salinity value ( $S > 36.3$ ) nearly the coastal zone. Values of relatively high temperature ( $20.5^{\circ}\text{C}$ ) which are not characteristic for this time of year are seen on offshore carrying saline water typical of tropical waters. The impact of this transport was more pronounced in the Tômbwa area where the above upwelling phenomenon was almost inhibited (Figs 3c and 4c).

Analyzing the horizontal distributions of sea surface temperature (Fig.3c), the minimum temperature value ( $15^{\circ}\text{C}$ ) observed was nearly the Kunene River, which protrudes through a tongue of low temperatures to the NW, suggesting the remote influence the upwelling phenomenon which in generally has been observed in this season.

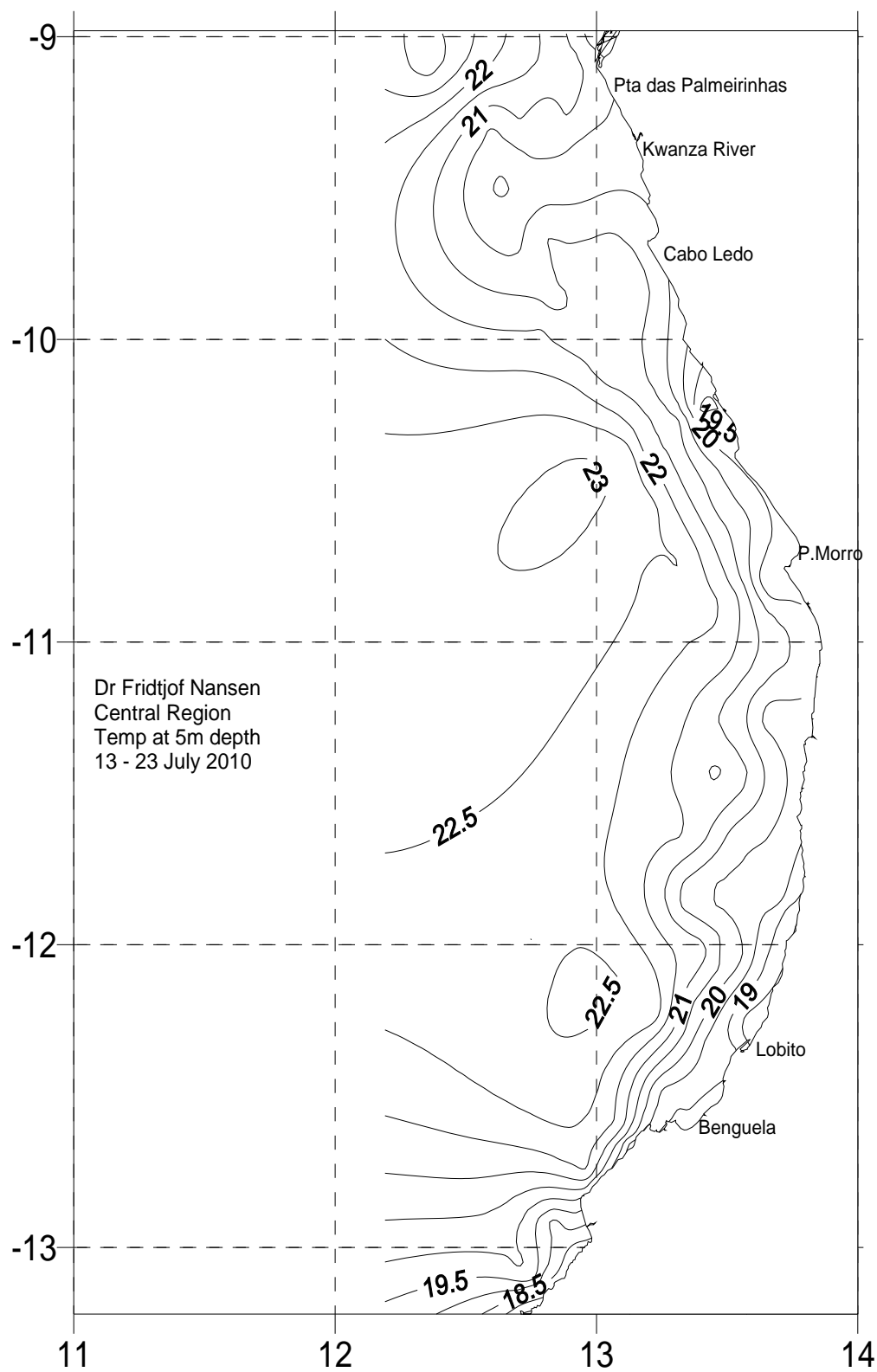
As observed in the sea surface temperature distribution, the surface salinity (Fig. 4c) also presented stratification from the northern of Tômbwa to Baía dos Tigres with the lowest salinity in the coastal zone (35.4) and higher salinities ( $S > 36$ ) located on offshore. A strong thermal and haline front was observed in the area between Tômbwa and Kunene River. The track of the Angola-Benguela front was so limited (Tômbwa-Kunene River) this year possibly due to influence the intensity of the phenomenon of upwelling was ongoing during the time of data collection.

However in most of southern region the upwelled water extended offshorewards as far as break shelf, were it reached the depth of  $> 500\text{m}$ . Further inshore, in south and north of Tômbwa, a light decrease of temperature and salinity towards the coast was observed. Temperature ranged from  $17^{\circ}\text{C}$  inshore to  $20^{\circ}\text{C}$  offshore (Cabo de Santa Marta) and from  $15^{\circ}\text{C}$  inshore to  $17^{\circ}\text{C}$  offshore (Baía dos Tigres&Kunene area). Salinity ranged from 35.7 inshore (Cabo de Santa Marta) to 36 and in the south from 35.3 to 35.8 offshore (Kunene River area).

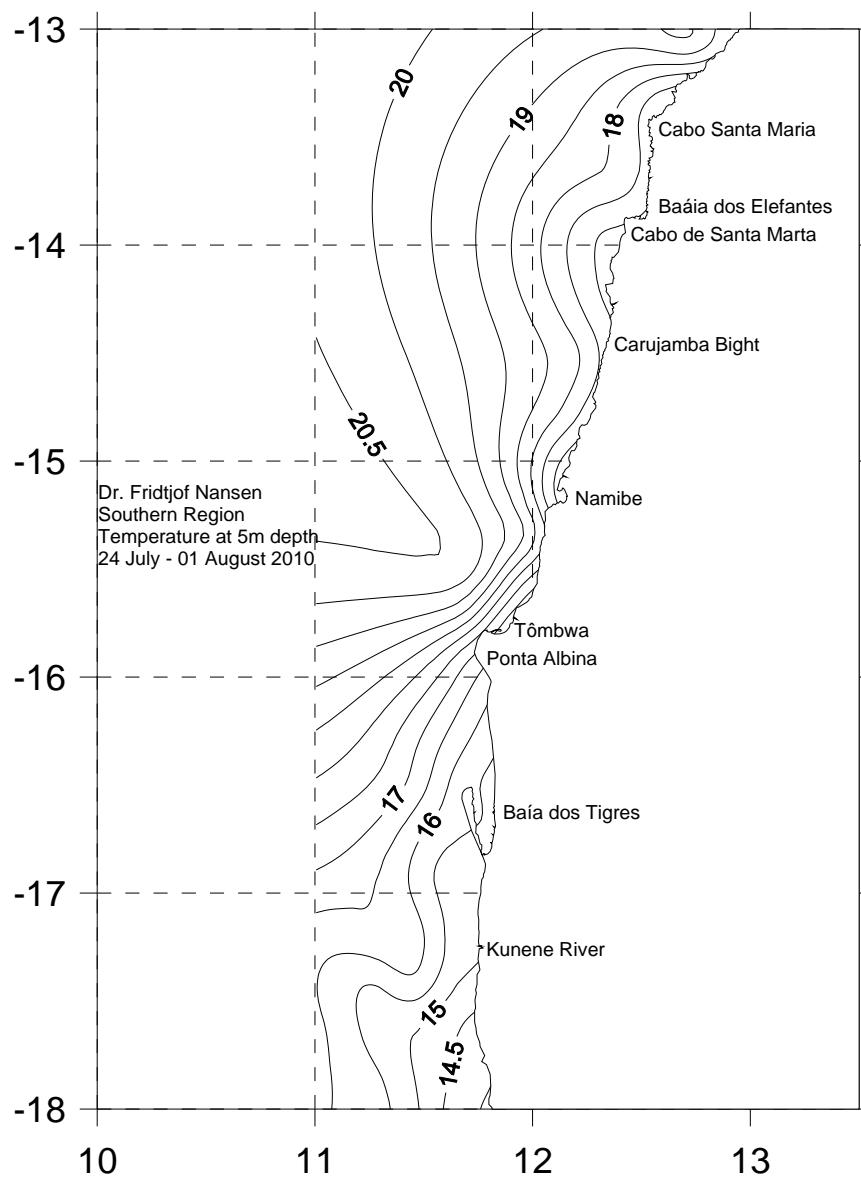
The fluorescence appears to be a good indicator of upwelling process and also the thermal front to show a larger influence in the area of major intrusion of the two currents flowing in opposite directions. In this area was observed a gradual increase of fluorescence values in both directions (see Fig fluorescence) and the local on which occurrence of intensive upwelling was ongoing, revealed decrease in fluorescence values ( $0.3\mu\text{l/l}$  on the southern Kunene River and Carujamba Bight area with  $0.2\mu\text{l/l}$ ). This gradual increase of fluorescence values observed in this cruise there was more in the area of highest incidence of Angola and Benguela currents and areas with lower impact of coastal upwelling.



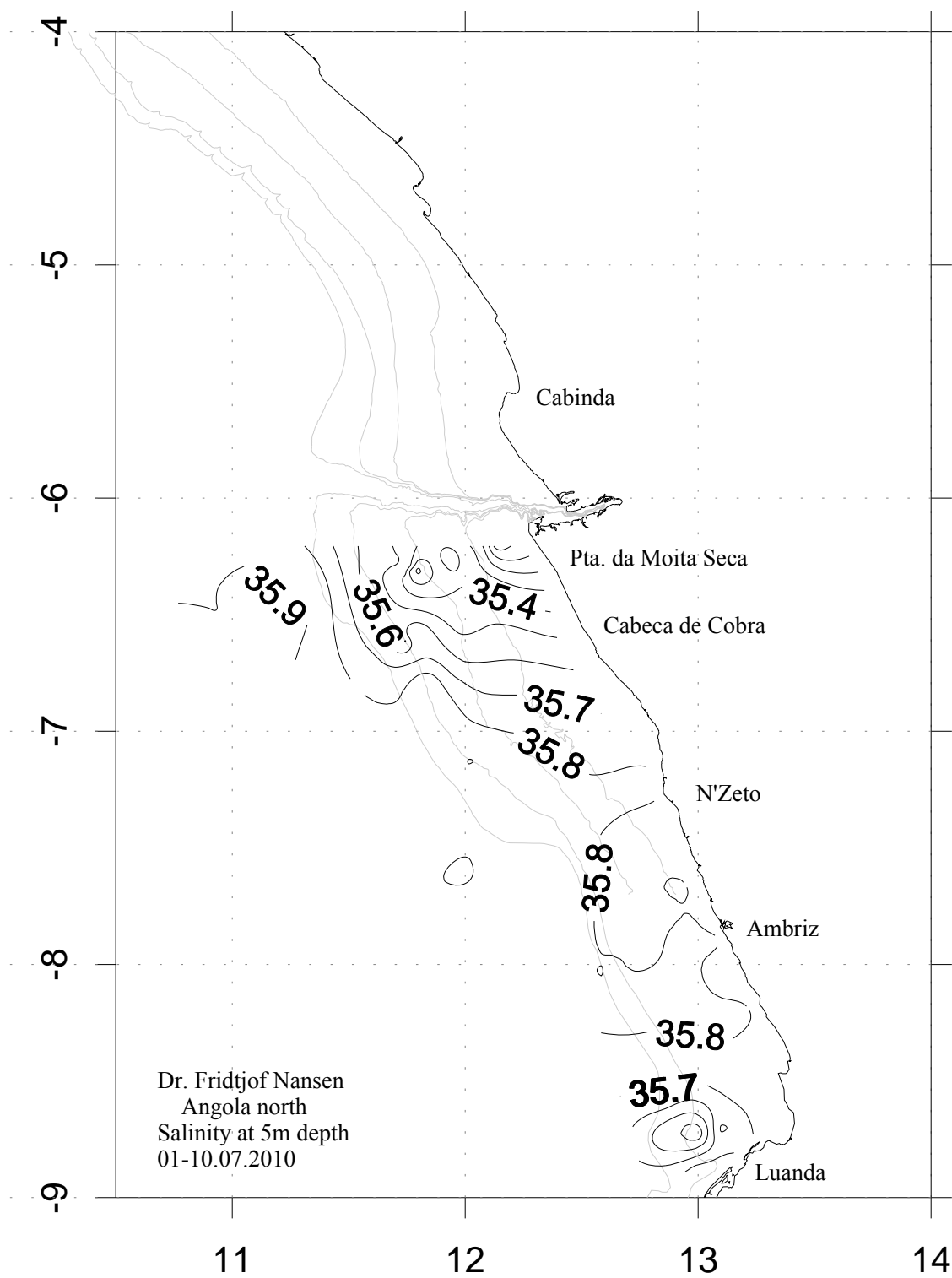
**Figure 3a.** Distribution of water temperatures at 5m depth in the northern region. Depth contours at 20, 50, 100, 200, and 500m.



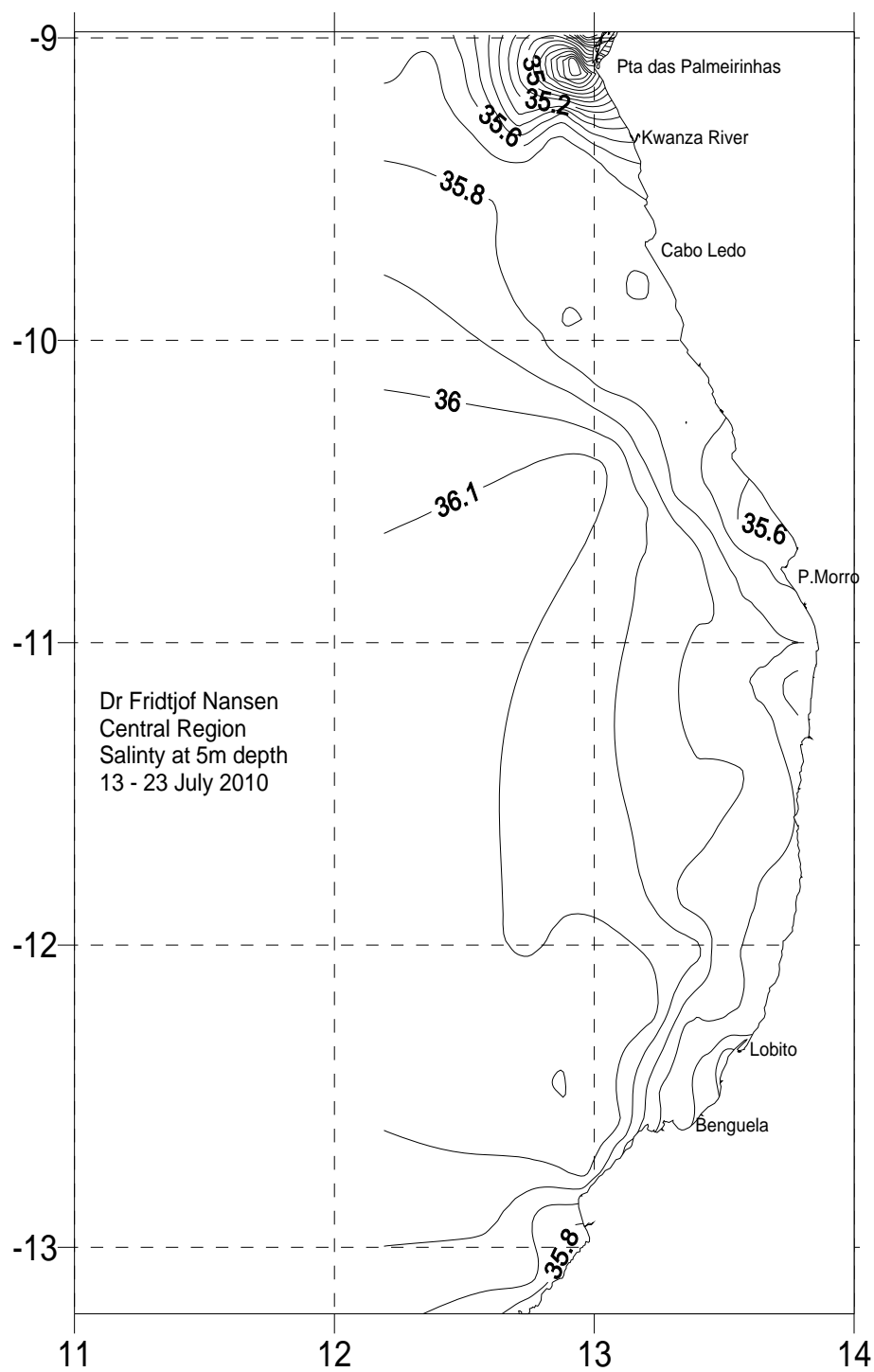
**Figure 3b.** Distribution of water temperatures at 5m depth in the central region. Depth contours at 20, 50, 100, 200, and 500m.



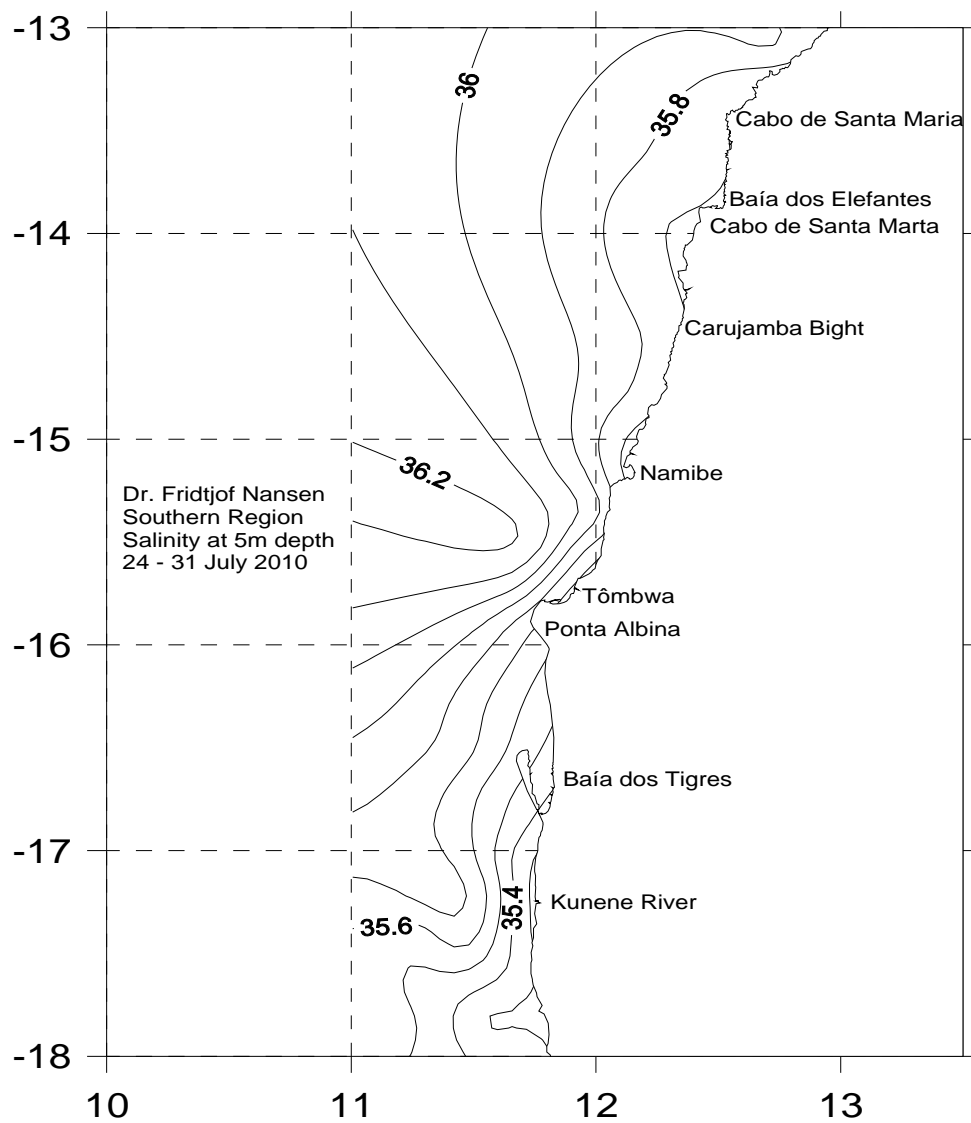
**Figure 3c.** Distribution of water temperatures at 5m depth in the southern region. Depth contours at 20, 50, 100, 200, and 500m.



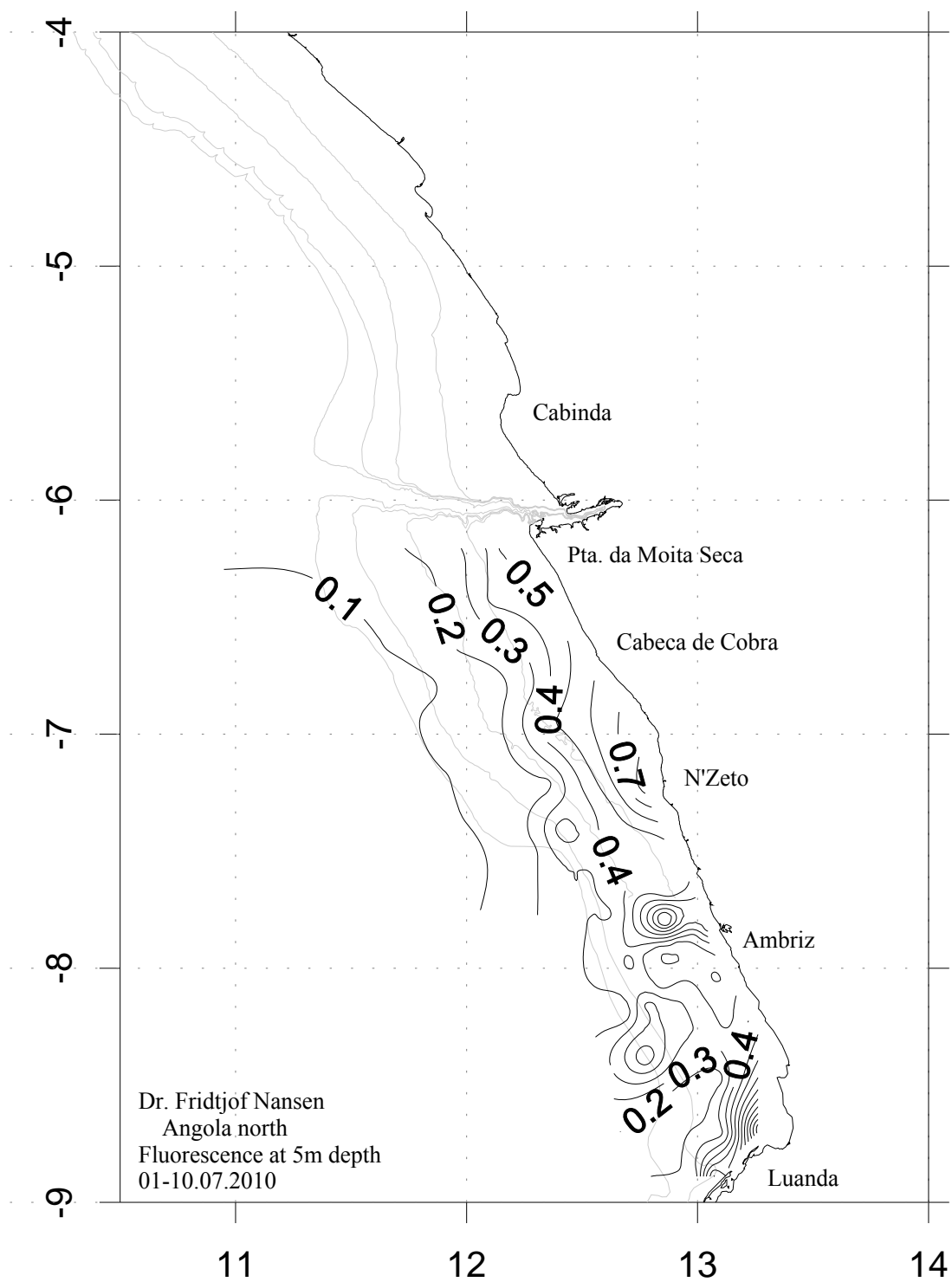
**Figure 4a.** Distribution of salinity at 5m depth in the northern region. Depth contours at 20, 50, 100, 200, and 500m.



**Figure 4b.** Distribution of salinity at 5m depth in the central region. Depth contours at 20, 50, 100, 200, and 500m.

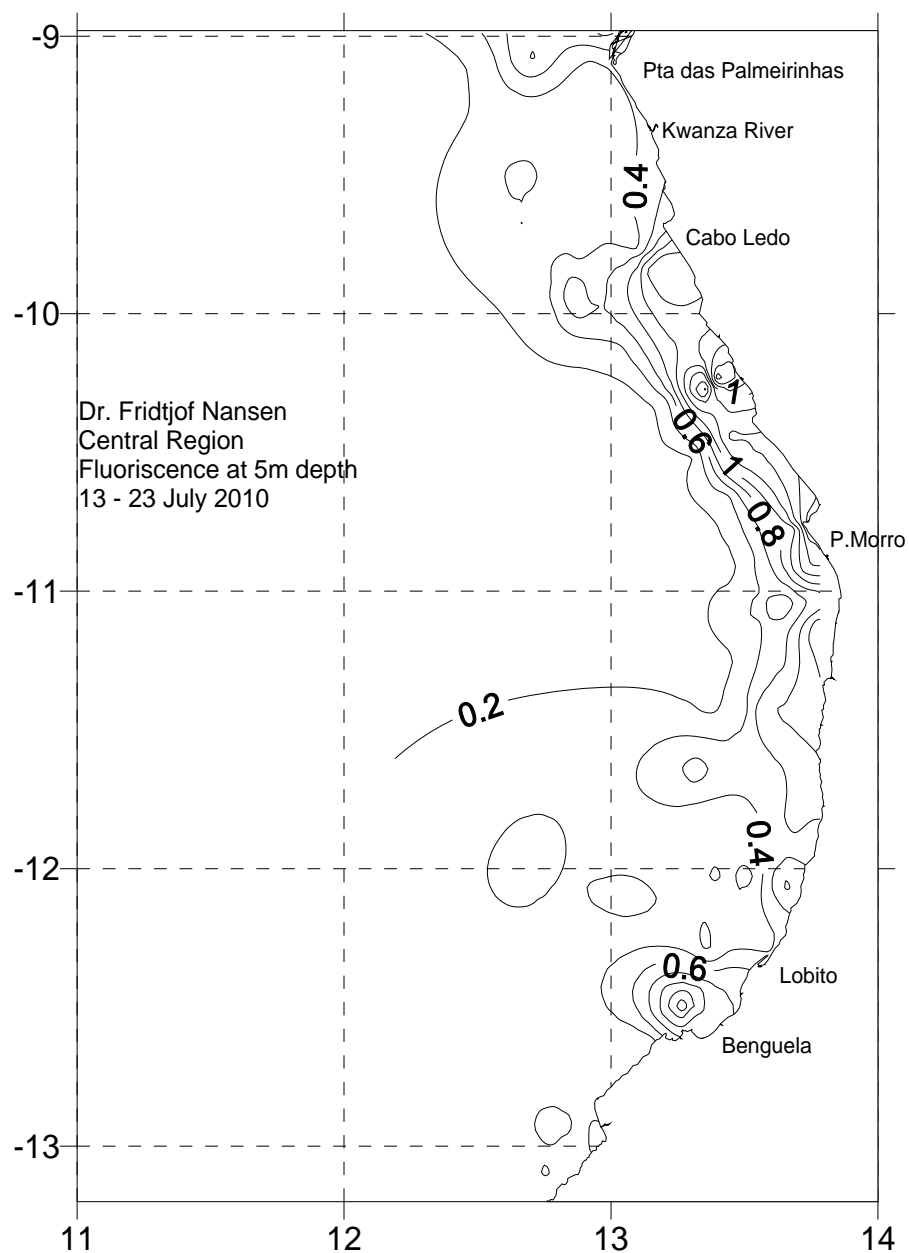


**Figure 4c.** Distribution of salinity at 5m depth in the southern region. Depth contours at 20, 50, 100, 200, and 500m.

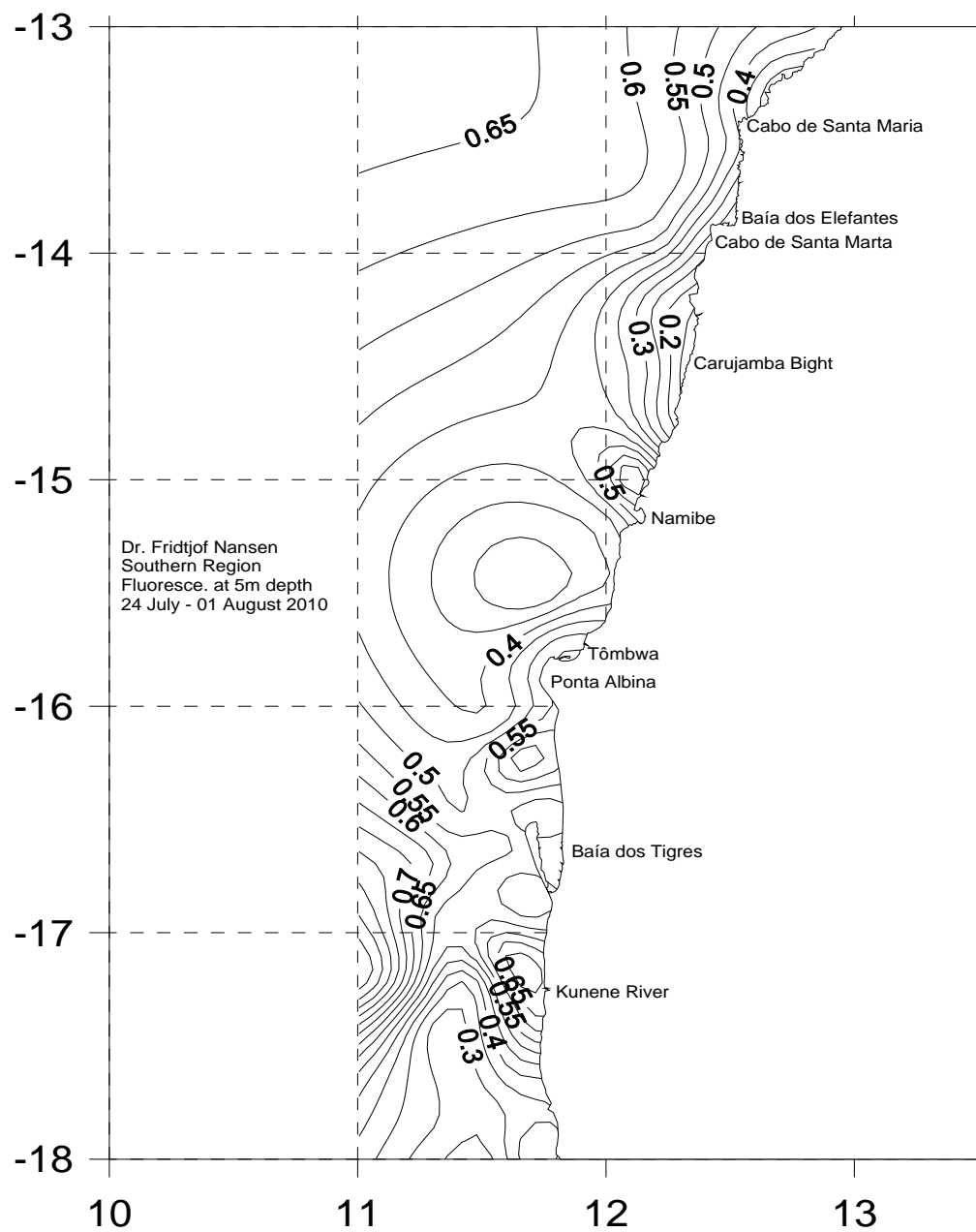


**Figure 5a.** Distribution of fluorescence at 5m depth in the northern region. Depth contours at 20, 50, 100, 200, and 500m.





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



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

### 3.2 Standard sections

The section off **Moita Seca** (Figure 6a) is located just south of the Congo River's mouth. Although the survey was carried out during the dry season, the influence of the river can be shown in the profiles by a sharp change in the isolines' depth pattern (stations 791 and 792).

A maximum temperature of 24°C was found offshore near the surface, while further south, the sections off **N'Zeto** (Figure 6b) and **Ambriz** (Figure 6c) had lower surface temperatures, about 22°C and 21°C, respectively. Temperatures decreased to 16°C at about 100 m depth and 8°C at 400-500 m. Surface salinity ranged from 35.4 (inshore) to 35.9 (offshore) in the section off **Moita Seca**, and in the two next the values were about 35.8 at the surface. At 500 m depth the salinity was 34.7 in all three sections. The oxygen content was 4 ml/l at the surface, decreasing to 1.0 ml/l at 500 m depth in all three sections. Surface fluorescence varied from 0.1 µg/l to 0.7 µg/l in the upper layers, and was highest inshore off N'Zeto and lowest offshore. At around 100 m depth all the measured parameters were similar in all three sections and stratified throughout the water column.

In the section off **Pta. of Palmerinhas** south for Luanda, (Figure 6d) the sea surface temperature were slightly lower (20°C) than in the previous sections, while the salinity, oxygen and fluorescence distribution were quite similar. The water column in this section also showed stratification.

Section off **Cabo Ledo** (Figure 6e) is located south off Kwanza river's mouth. As in the previous section there is appearance of the high salinity (35.8-35.9) and temperature (20-19°C). At surface layer the oxygen ranged between 5-4.0 ml/l.

Section off **Cabo São Braz** (Figure 6f). The distribution of oceanographic parameters is very different to the previous section also for the last year. From bottom to surface uplift of isoline occurred on the entire water column showing sign of a intensive coastal upwelling in the section off Cabo São Braz. Salinity decreased from 36.0 offshore to 35.9 inshore. There is The surface fluorescence ranged from 0.1 µl/l offshore to 0.9 µl/l inshore

#### Section off Ponta do Morro

The vertical distributions of the three parameters investigated (temperature, salinity and oxygen) showed an elevation of the sub-surface water indicating the occurrence of upwelling. The thermocline and oxycline, both well-defined by the isolines were located at 25 m depth in offshore and 15m at the coast. Also the layer between the surface water and the baseline of the thermocline/oxycline was observed the major stratification showing the effect of mixing of different water mass including coastal waters and tropical waters flowing in opposite.

In general this cruise (July 2010) was characterized by low temperatures. The highest value of temperature (22°C) and salinity ( $S \leq 35.9$ ) and oxygen ( $\leq 5$  ml/l) were found in Offshore. The deep layer (400-500 m) showed the same characteristics the last three years in this period being the temperature ranged between 8°C and 9°C, salinity between 34.8 and 34.9 and oxygen  $\leq 0.5$  ml/l.

#### Section off Lobito

From offshore to shelf break, the surface water layer located above the 15 m depth was

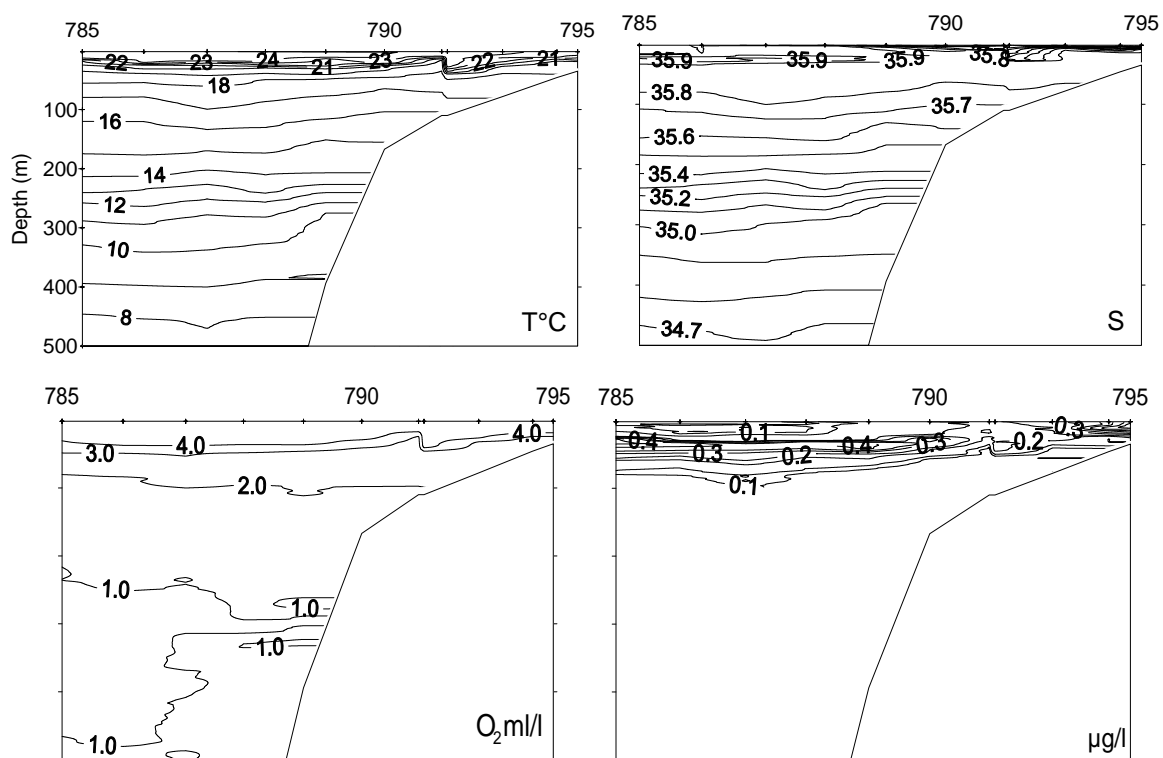
dominated by the transport of tropical waters ( $t \leq 22^{\circ}\text{C}$  and  $S \geq 36$ ) towards the coast. This phenomenon of transport of tropical waters in the form of tongue of saline water with high values of temperature is a common feature during the last three years this area. The thermocline, the halocline as well as the oxycline were clearly defined and were located at 20 m depth showing a marked stratification.

### **Southern Region**

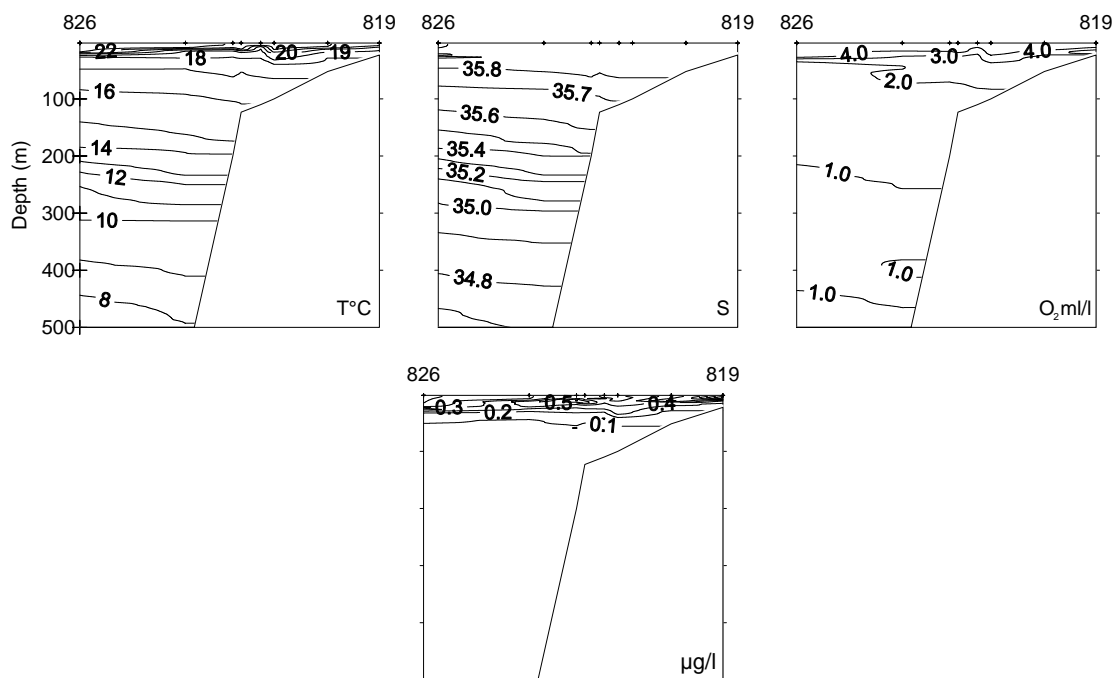
Figures 6e-l show the vertical distribution of temperature, salinity, oxygen dissolved and fluorescence in the southern region. The lowest temperature of  $16^{\circ}\text{C}$  was recorded in the both last southern sections (Baía dos Tigres and Cunene River) dominating from offshore to up break shelf and the highest of  $19^{\circ}\text{C}$  in the Tômbwa area (Fig.6k). Transects of Namibe and Tômbwa showed a gradual increase of sea surface temperature (SST) being this increase of temperature probably associated to the highest salinity values ( $S \geq 35.9$ ) in this region.

The most common pattern during cruise was the sub-surface upwelled water observed in each section. The thermocline, which is known to be comparatively weak at this period of year, was absentee in all southern transects showing how more intensive is ongoing the coastal upwelling process. The stratification of up 100 m layer in terms of dissolved oxygen and fluorescence parameters and also the format of uplift-isolines was another indicator of intensive upwelling phenomena with emphasis in Namibe-Cunene River area.

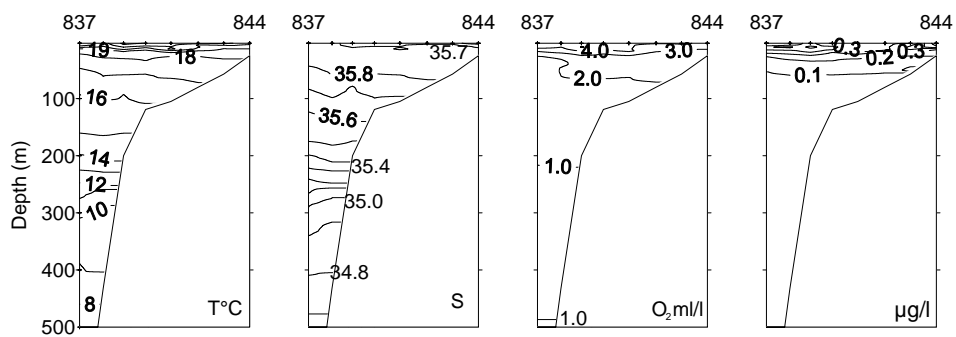
Temperature ranged from  $16^{\circ}\text{C}$  (off Baía dos Tigres&Cunene) and  $19^{\circ}\text{C}$  (off Tômbwa) at surface to  $8^{\circ}\text{C}$  at 500 m depth. Salinity ranged from 35.7 (also off Baía dos Tigres&Cunene) and 36 (Tômbwa) at surface to 34.8 at 500m depth. Dissolved oxygen values ranged between 0.5 ml/l (off Baía dos Tigres&Cunene) at 400-500 m layer and 4.0 ml/l at surface. There was no sign of lowest bottom oxygen content ( $<0.5$  ml/l) as expected during intensive upwelling event in this region. And fluorescence ranged between 0.1  $\mu\text{l/l}$  at approximately 80 m depth in each section and 0.60.1  $\mu\text{l/l}$  at surface. In general dissolved oxygen and fluorescence sections presented similar features.



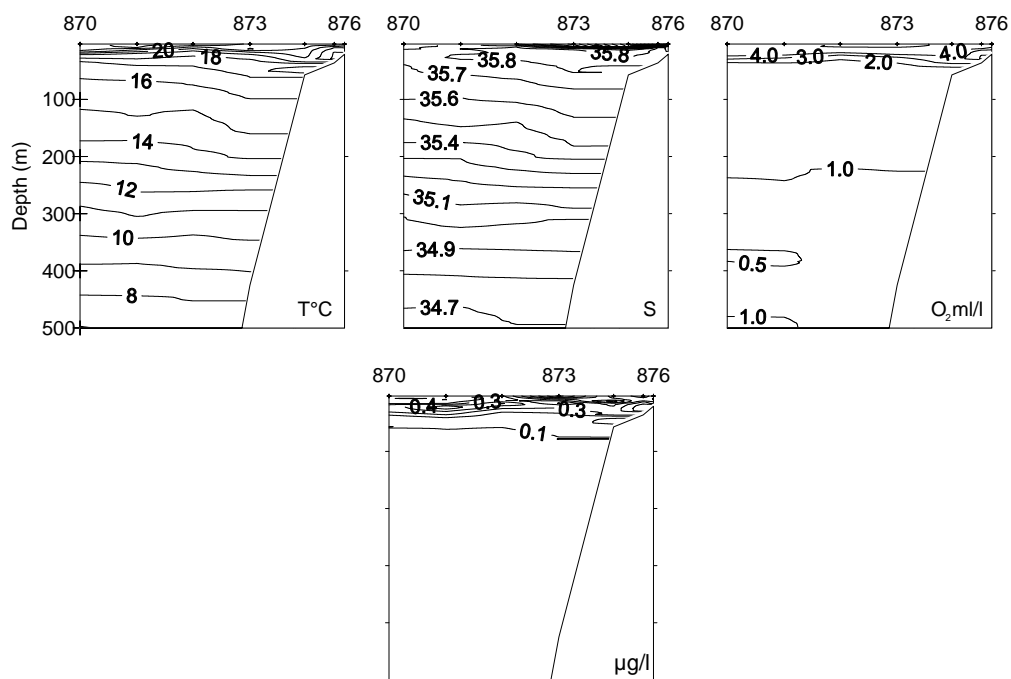
**Figure 6a.** Vertical sections of temperature, salinity, oxygen and fluorescence off Pta. da Moita Seca, Congo River.



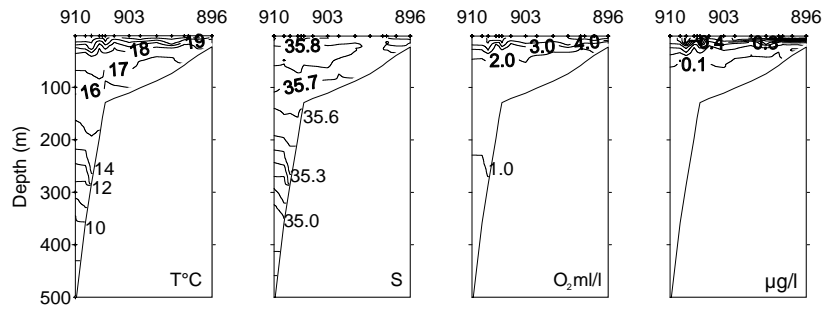
**Figure 6b.** Vertical sections of temperature, salinity, oxygen and fluorescence off N'Zeto.



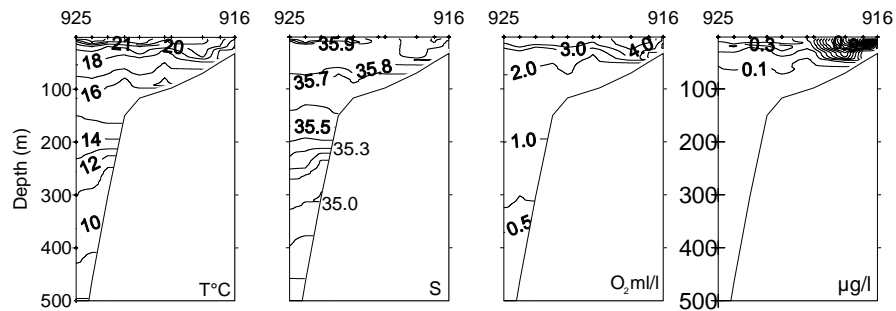
**Figure 6c.** Vertical sections of temperature, salinity, oxygen and fluorescence off Ambriz.



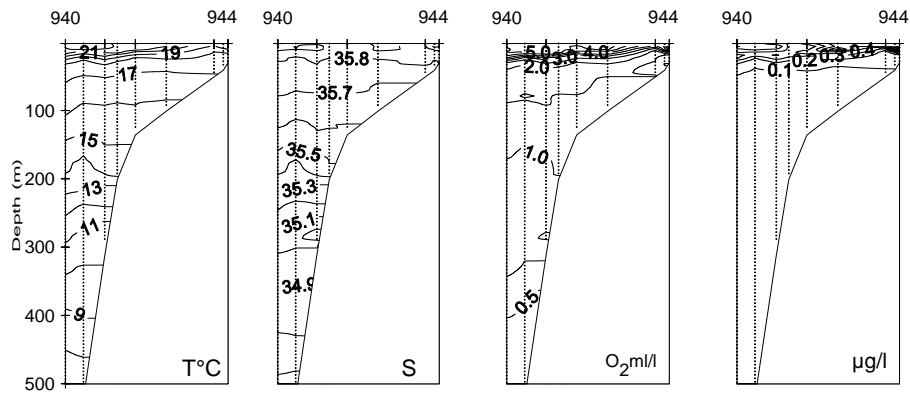
**Figure 6d.** Vertical sections of temperature, salinity, oxygen and fluorescence off Pta. Palmerinhas.



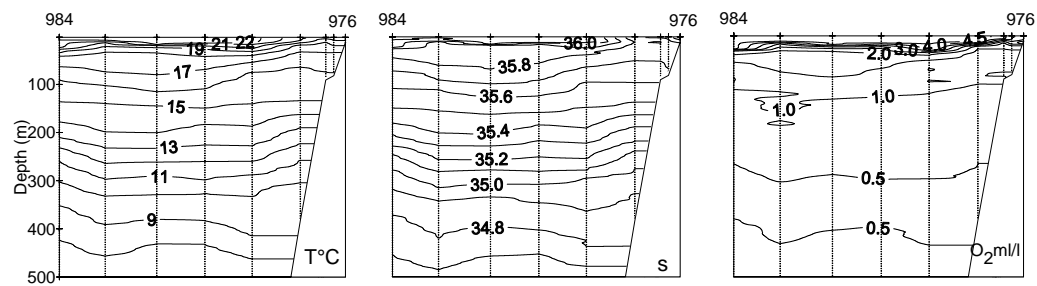
**Figure 6e.** Vertical sections of temperature, salinity, oxygen and fluorescence off Cabo Ledo.



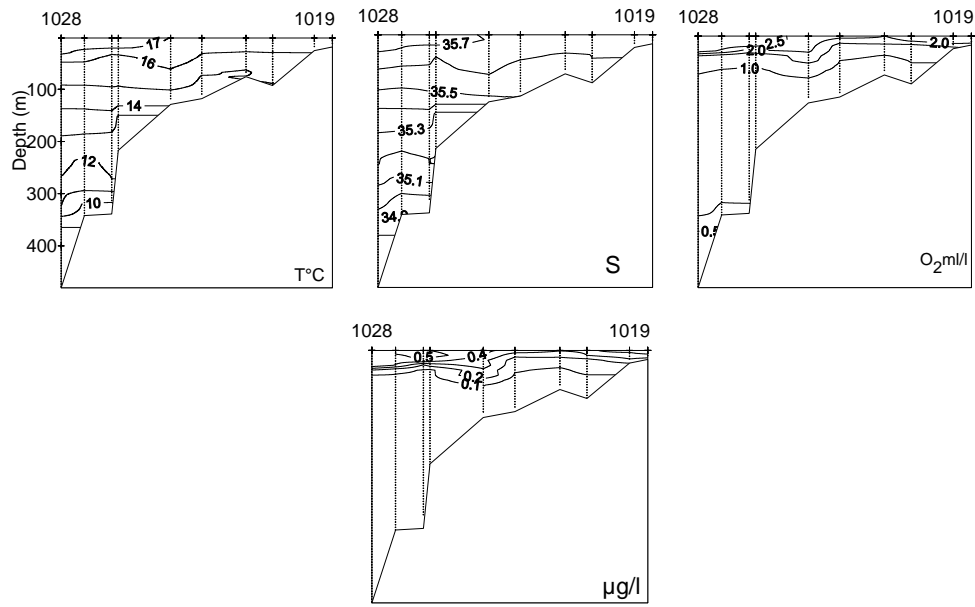
**Figure 6f.** Vertical sections of temperature, salinity and oxygen off south Cabo São Braz.



**Figure 6g.** Vertical sections of temperature salinity and oxygen off Pta. do Morro.

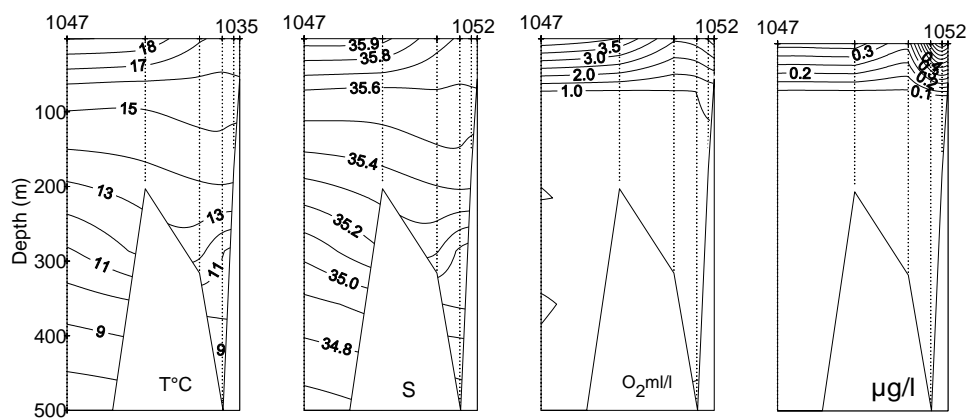


**Figure 6h.** Vertical sections of temperature salinity and oxygen off Lobito.

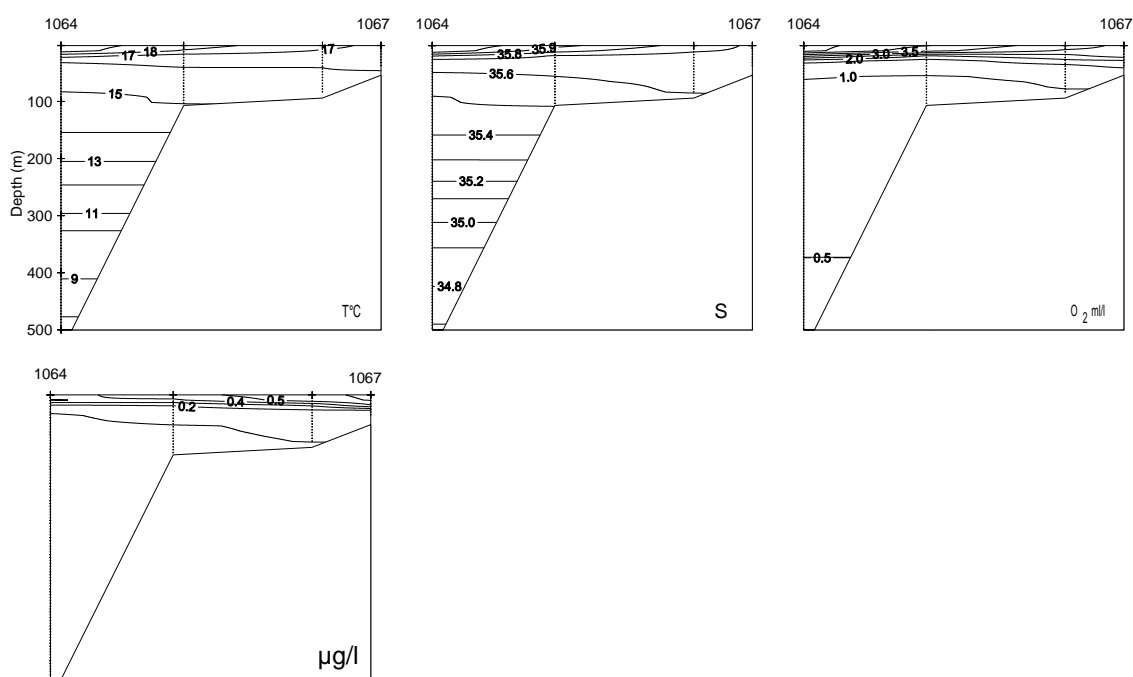


**Figure 6i.** Vertical sections of temperature salinity and oxygen off Santa Marta.

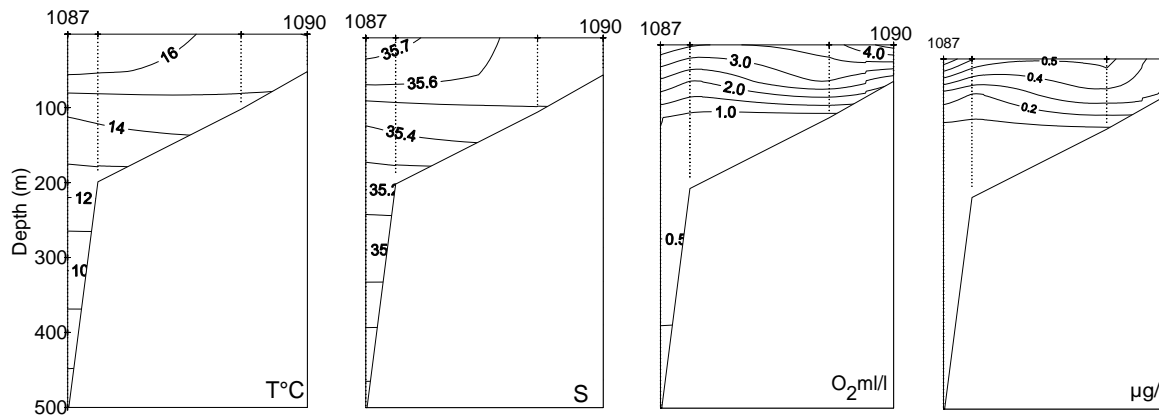




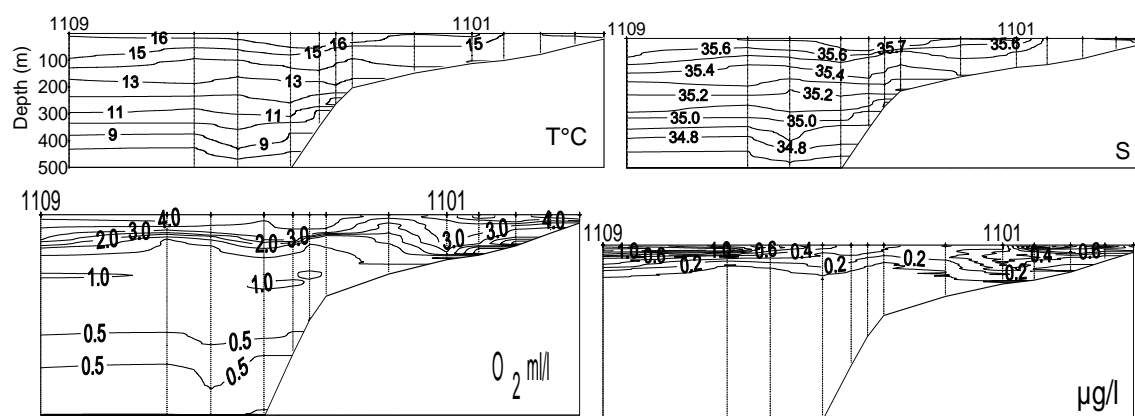
**Figure 6j** . Vertical sections of temperature salinity and oxygen off Namibe.



**Figure 6k** Vertical sections of temperature salinity and oxygen off Tômbwa



**Figure 6l** Vertical sections of temperature salinity and oxygen off Baía dos Tigres



**Figure 6m.** Vertical sections of temperature salinity and oxygen off Cunene River.

## CHAPTER 4 DISTRIBUTION, SIZE COMPOSITION AND BIOMASS ESTIMATES

### 4.1 Congo River - Pta. Palmerinhas

#### *Sardinella*

*Sardinella* was continuously distributed from north of Cabeça da Cobra to Luanda (Figure 7). Mainly low density ( $0 < s_A < 300 \text{ m}^2/\text{NM}^2$ ) registrations were made, with some medium density ( $301 < s_A < 1\,000 \text{ m}^2/\text{NM}^2$ ) schools and one of high density ( $1\,001 < s_A < 3\,000 \text{ m}^2/\text{NM}^2$ ).

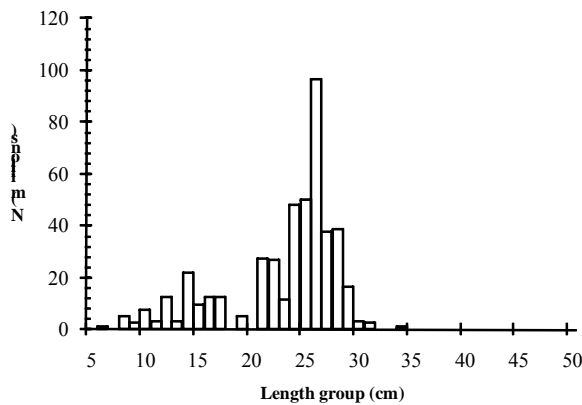


**Figure 7.** Distribution of *Sardinella* spp. Pta. das Palmerinhas-Congo River. Depth contours at 20, 50, 100, 200, and 500m.

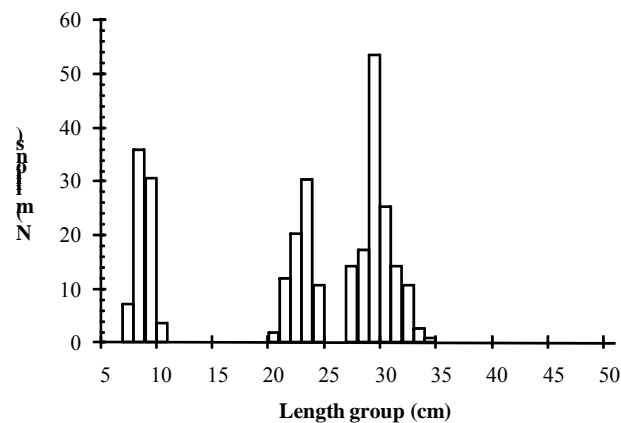
Figure 8 shows the length distribution of the sardinella in the northern region. The size distribution of *S. maderensis* showed two modal peaks around 14 and 26 cm (Figure 8 a), while *S. aurita* had three modal peaks around 8, 24 and 29 cm (Figure 8 b). The last cohorts dominated the distributions for both species.

The estimated biomass for this region was 93 000 tons, which is around 55% lower than the biomass estimated in 2009 (206 000 tons) and the lowest since 1998. *S. maderensis* dominated the total biomass, contributing around 60% (56 000 tonnes) and *S. aurita* 40 % (37 000 tonnes).

The biological samples showed that 42% of the *S. maderensis* and 52% of the *S. aurita* were immature.



a) *Sardinella maderensis*



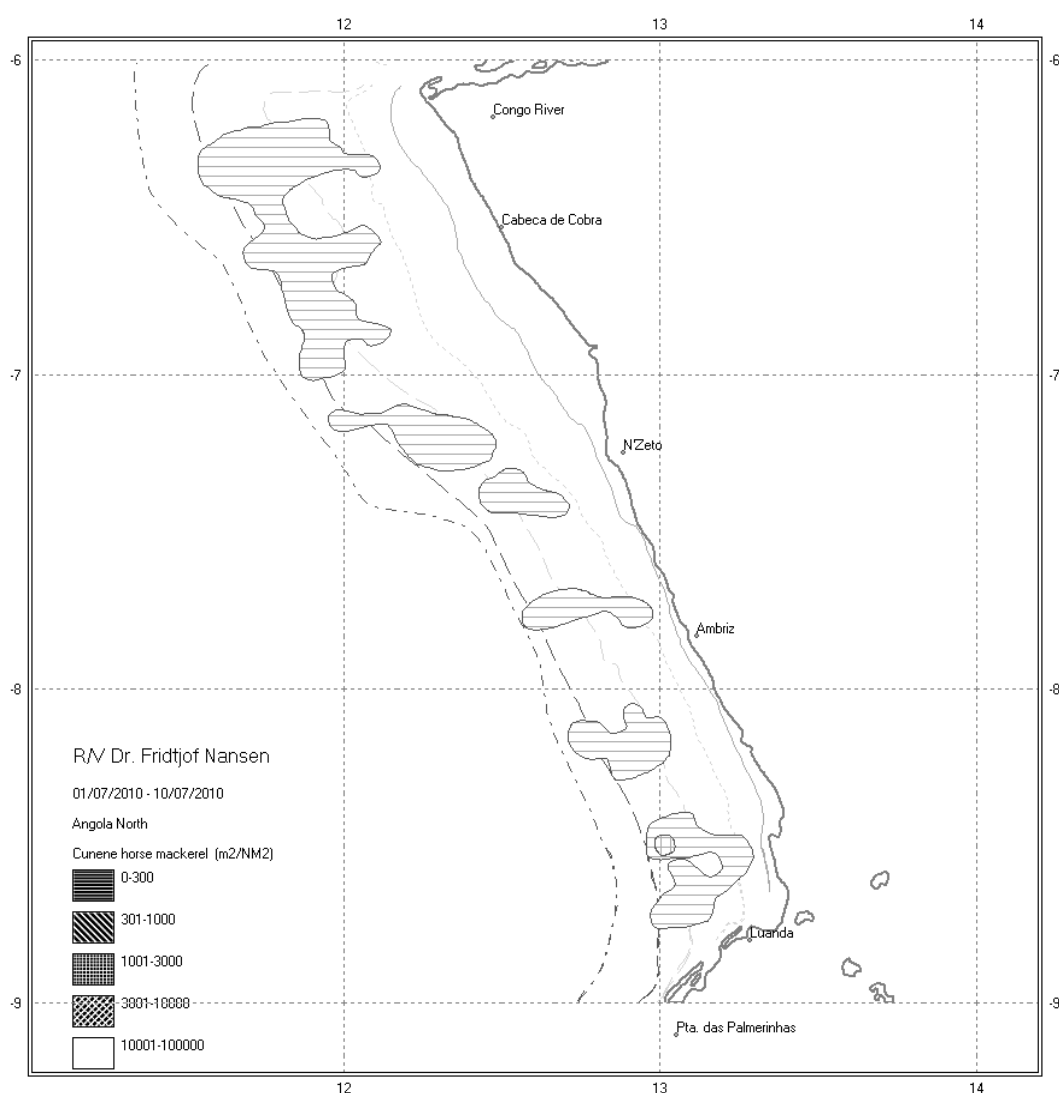
b) *Sardinella aurita*

**Figure 8.** Total length distribution of *Sardinella maderensis* (a) and *S. aurita* (b), Pta. das Palmerinhas-Congo River.

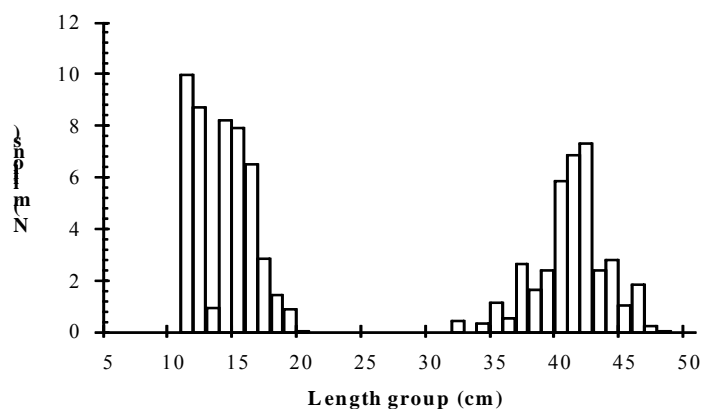
### Horse mackerel

Cunene horse mackerel, *T. trecae*, was found in low-density areas offshore from Pta. da Moita to Luanda, with one high density northwest of Luanda (Figure 9). The horse mackerel was generally caught with bottom trawl mixed with demersal species.

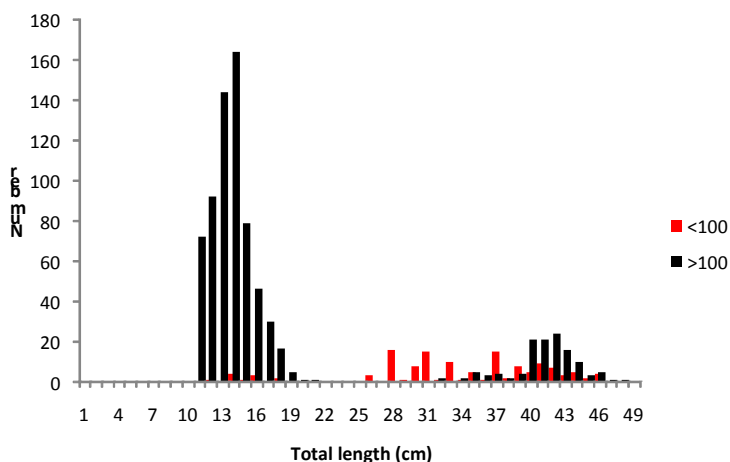
The size distribution of Cunene horse mackerel showed two tops, one at about 11 to 16 cm and another at 41-42 cm (Figure 10). Most of the fish, both juveniles and adults, was caught at depths strata beyond 100 m (Figure 11). In 2008 and 2009 the acoustic densities were found too low to yield a valid biomass estimate, while in the present survey more registrations were made of this species. The biomass was estimated to 21 000 tonnes, which is about 50% of the average for the time series 1997-2007, i.e. the years when only Congo River - Pta. das Palmerinhas has been covered.



**Figure 9.** Distribution of Cunene horse mackerel (*Trachurus trecae*), Pta. das Palmerinhas-Congo River. Depth contours at 20, 50, 100, 200, and 500m.



**Figure 10.** Total length frequency distribution of Cunene horse mackerel, Congo River - Pta. das Palmerinhas



**Figure 11** Length distribution (simple adding) of Cunene horse mackerel (*Trachurus trecae*) by depths strata, Pta. das Palmerinhas-Congo River (depths > 100 and < 100 m)

### *Pelagic species Group 1*

A few low density registrations were made of *Ilisha africana* and *Engraulis encrasicolus* near the shore. However, they were not abundant enough to estimate the biomass in the region.

### *Pelagic species Group 2*

This group was continuously distributed in low densities from south of Congo River to Pta. das Palmerinhas (Figure 12). The dominant species belongs to the Carangids (Table 4) with *Chloroscombrus chrysurus* and *Selene dorsalis* being the dominating species. The biomass in the area was based on an average fish size of 30 cm and average condition factor of 0.01 and was estimated to be 36 000 tons, which is 50% higher than previous year's estimate of 24 000 tonnes.



**Figure 12.** Distribution of Pelagic 2, Pta. das Palmerinhas-Congo River. 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.

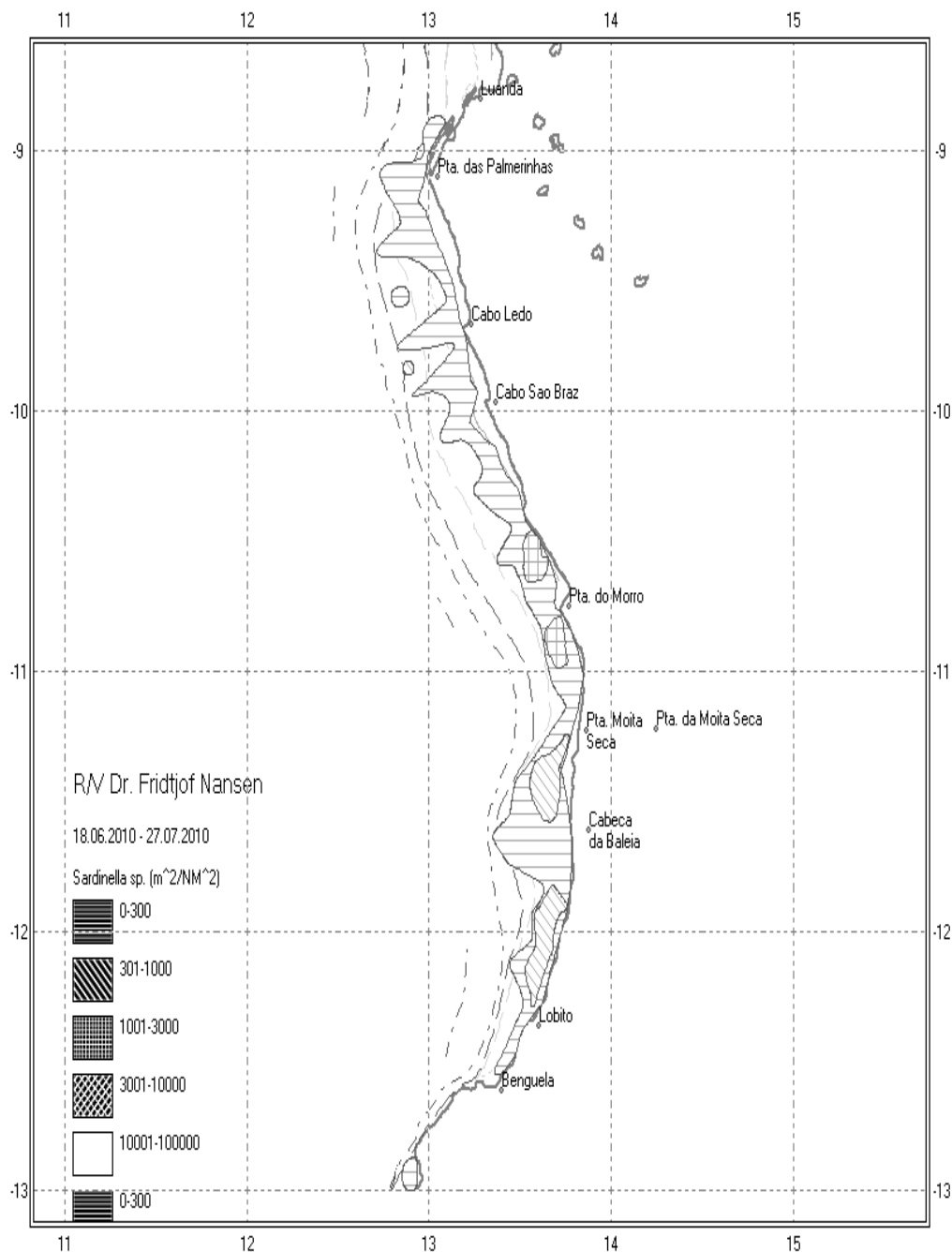
Station	Gear depth	Horse mackerel	Carangids	Sardinellas	Clupeiods	Scombrids	Hairtails	Barracuda	Other	Total
35	107.5	17.2					15.6		53.7	86.5
36	154	195.7				0.9	1.8		305.8	504.2
37	10		471	34.1	0.9	9.6	13.2	131.4	14.6	674.8
38	25									
39	99.5	13.6					22.5		128.2	164.3
40	14						104.3		131	235.4
41	10	0.2	1.1	69.9	35.7		8.1	2	64	180.9
42	0		547.6	69.4	50.9		10.6	15.8	335.6	1029.8
43	112	2.1	122.8						180.7	305.6
44	10		235.3	13.2		4.2	1.7	5.4	50.6	310.3
45	0	0.3							2.6	2.9
46	114	10.9					28.1		102.1	141
47	25		2.3	9.4			0.3	2.8	5.8	20.6
48	107	73	4.5				0.7		199.2	277.4
49	0			5.4	211.3		26.4	11.9	315.4	570.4
50	120	114.6					10.1		80.9	205.6
51	24.5		8	161			0.5		1.7	171.2
52	82	16.7	3.7			2.4	124.4		91	238.1
53	22				8.4		25.7		816.6	850.6
54	0	24.4	5.9	0.6	67.6		82.3		74	254.8
55	118	96.4	17.9				6.1		122.8	243.2
56	5	3.9	139.8	49.5	0.3				183	376.5
57	80									
58	18	109.6	1.1	167.3	0.4		49.1		334.1	661.7
59	23	0.7			56.2		12.2		703.9	772.9
60	83.5	28.8					68.7		107.3	204.9
61	0	0.3	0.1	0.4	0.2		13.8		125.4	140.3
62	21.5			1.4			16.4		10.9	28.7
Mean	49.5	25.3	55.7	20.8	15.4	0.6	22.9	6	162.2	309
Std dev		48.1	139.5	45.3	42.9	2	33.1	24.8	198.6	275.3
%Catch		8.2	18.0	6.7	5.0	0.2	7.4	1.9	52.5	100.0



## 4.2 Pta. das Palmerinhas - Benguela

### *Sardinella*

*Sardinella* in this region has a continuous distribution, in general with low densities ( $1 < s_A < 300 \text{ m}^2/\text{NM}^2$ ) (Figure 13). Medium densities ( $301 < s_A < 1000 \text{ m}^2/\text{NM}^2$ ) were found inshore south of Cabeça da Baleia and south of Lobito. High-density patches ( $s_A > 1000 \text{ m}^2/\text{NM}^2$ ) were found inshore around Pta do Morro. The sardinella was distributed between 17 m depths and offshore to approximately 200 m depths and caught during the night in loose aggregation.

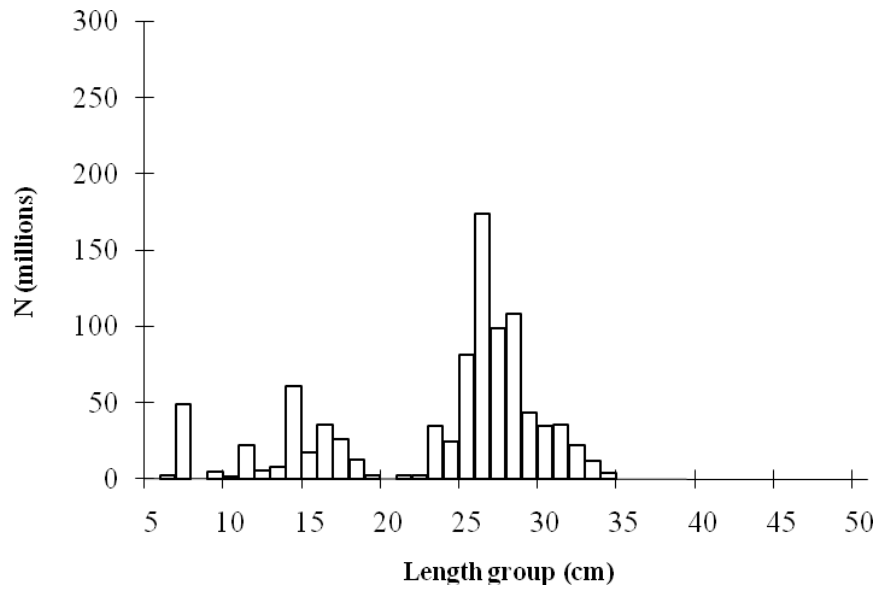
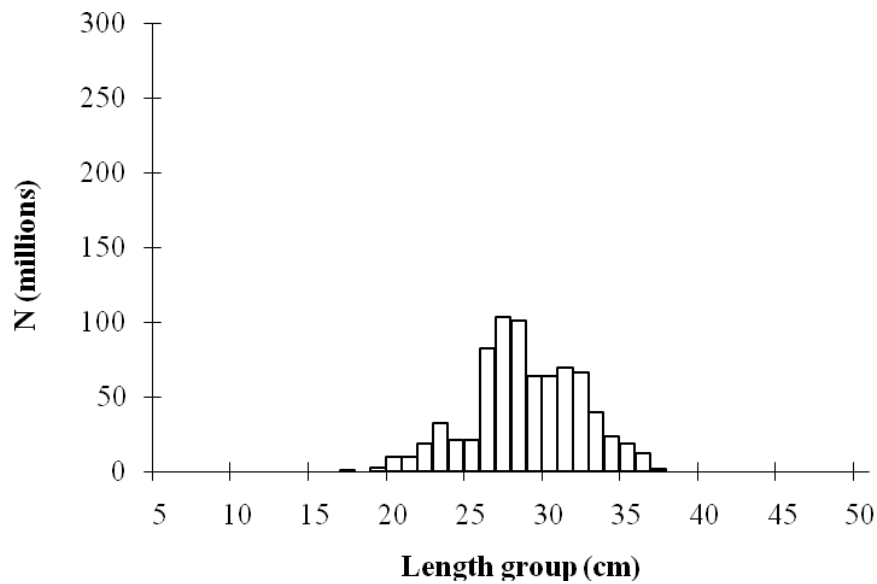


**Figure 13.** Distribution of *Sardinella* spp. Pta. das Palmerinhas- Benguela. Depth contours at 20, 50, 100 and 200 m.

The length distribution of *S. maderensis* showed two clear cohorts, peaking at 14 and 26cm. Individuals <10cm were found south Luanda close to the coast (Figure 14 a). The distribution of *S. aurita* was dominated by the adult population showing two clear modal peaks at 23 and 27cm, being the 27cm cohort the dominant one (Figure 14b). This year was not observed a signal of recruitment of *S. aurita* in this region.

The biomass for sardinella was estimated at total of 293 000 tonnes. This is higher than the 232 000 tons estimated last year, however the current estimation falls within range of the biomass estimation for the last four years, with an exception of 2007 which was twice the rest of the time series.

In the last four years the biomass of sardinella in this region was dominated by *S. maderensis*, representing around 55% of the total biomass. This year however, the proportions of the two sardinella species consist of 164 000 of *S. aurita* and 129 000 of *S. maderensis*.

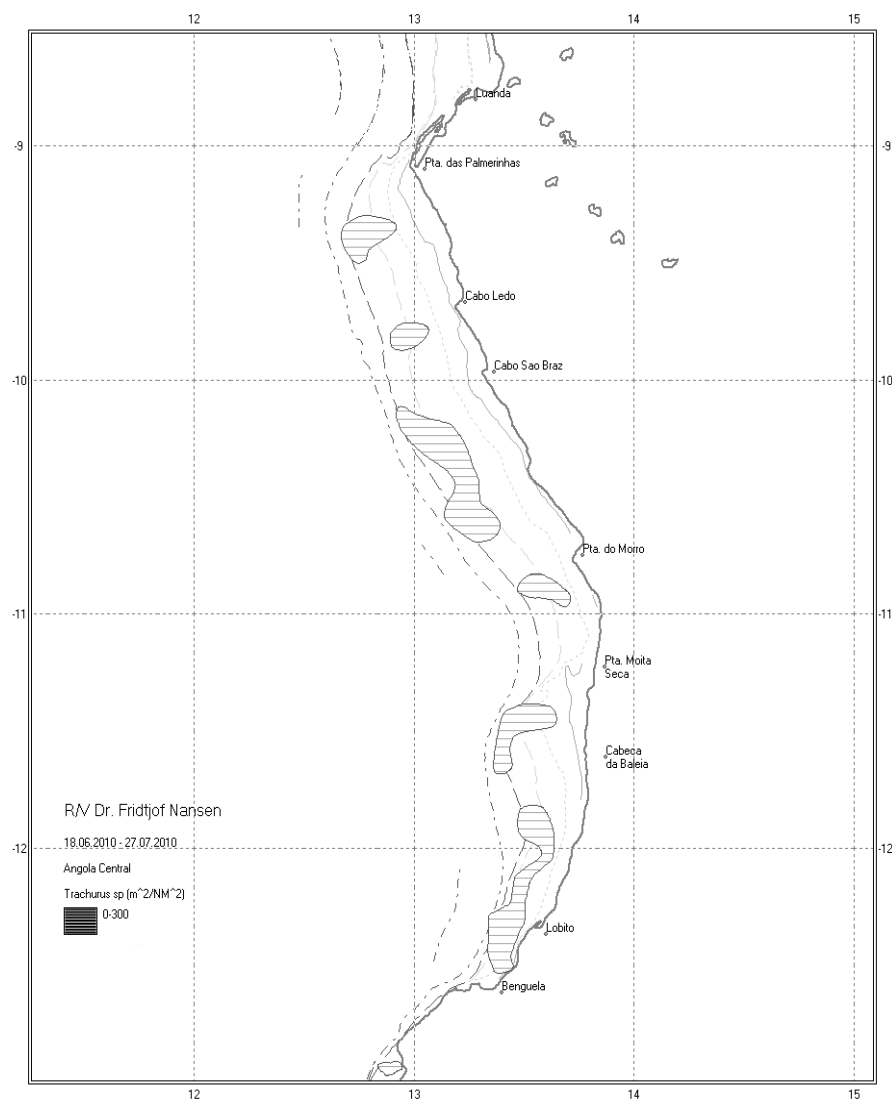
a) *Sardinella maderensis*b) *Sardinella aurita*

**Figure 14.** Total length distribution of *Sardinella maderensis* (a) and *S. aurita* (b). Pta. das Palmerinhas- Benguela.

*Horse mackerel*

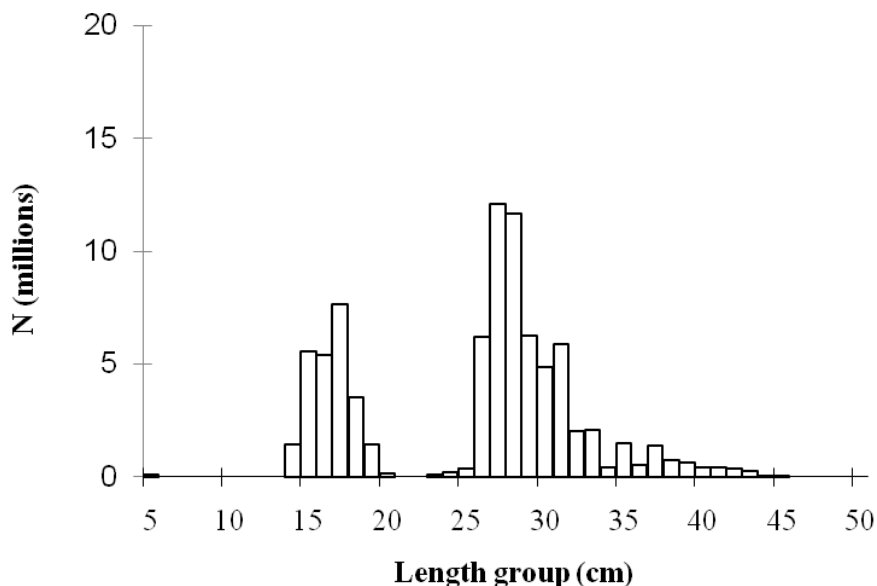
Only the Cunene horse mackerel was found in this region. Like the past ten year, it was found in

low-densities patches ( $s_A < 300$ ) more offshore, except in Benguela area where was observed a small concentration close to the coast. (Figure 15).

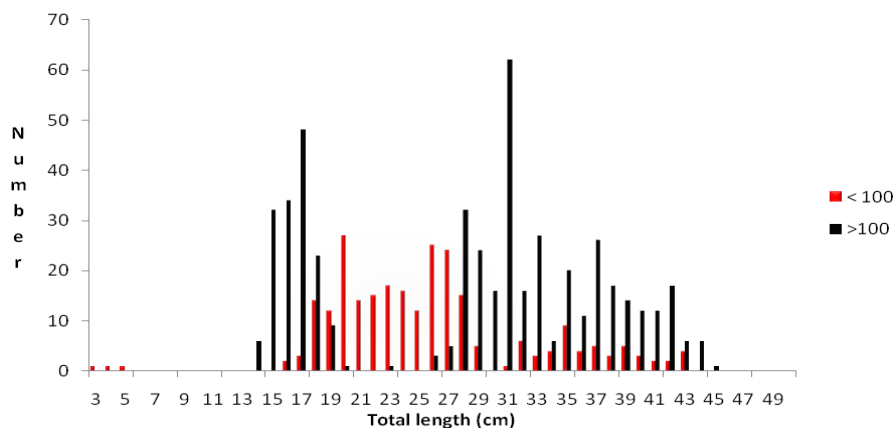


**Figure 15.** Distribution of horse mackerel (*Trachurus trecae*). Pta. das Palmerinhas- Benguela. Depth contours at 20, 50, 100, 200 and 500 m.

Figure 16 shows the total length frequency distribution. The population has two well defined cohorts, with the main peaks around 16cm and 28cm. This year the proportion of bigger fish ( $> 30\text{cm}$ ) is higher compared with 2009 and the large proportion of this length class were caught at depths greater than 100 m, during the day at bottom (Figure 17).

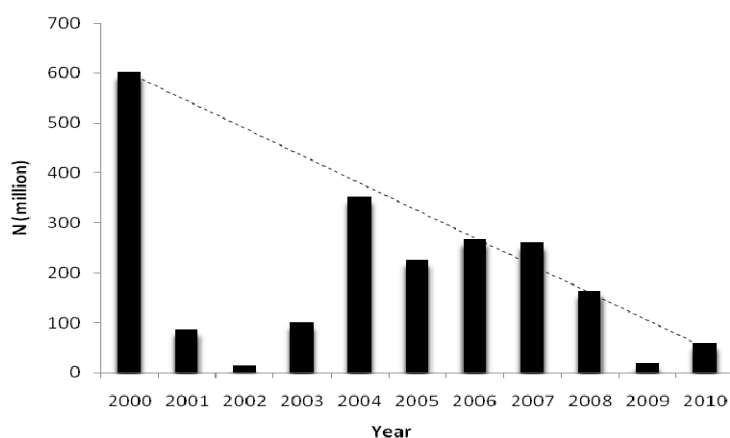


**Figure 16.** Total length distribution of horse mackerel (*Trachurus trecae*), Pta. das Palmerinhas- Benguela.



**Figure 17.** Length distribution (simple adding) of Cunene horse mackerel (*Trachurus trecae*) by depths strata Pta. das Palmerinhas- Benguela (depths <100m and >100 m)

The biomass of Cunene horse mackerel was estimated at 15 000 tons, and is higher than last year (7 000 tons). There is slight increase in biomass in weight, however this year the number in millions of the fishable proportion of the population (TL >22 cm) is still 75% lower than the average, which was estimated for the last five years, except in 2009 ( Figure 18).



**Figure 18.** Number of the fishable proportion of the population (TL > 22 cm) of Cunene horse mackerel (*Trachurus trecae*). Pta. das Palmerinhas- Benguela.

### *Other pelagic species*

#### Pelagic species Group 2

This group is distributed at low densities ( $1 < s_A < 300 \text{ m}^2/\text{NM}^2$ ) in three continuous areas, between Pta das Palmerinhas to south of Cabo São Braz, north of Pta do Morro to Lobito and south of Benguela (Figure 19). The most common species in this group was the Hairtails found between 50-60 meters depths and the Caranginae inshore (Table 5), dominated by *Chloroscombrus chrysurus* and *Decapterus rhonchus*.

**Figure 19.** 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.

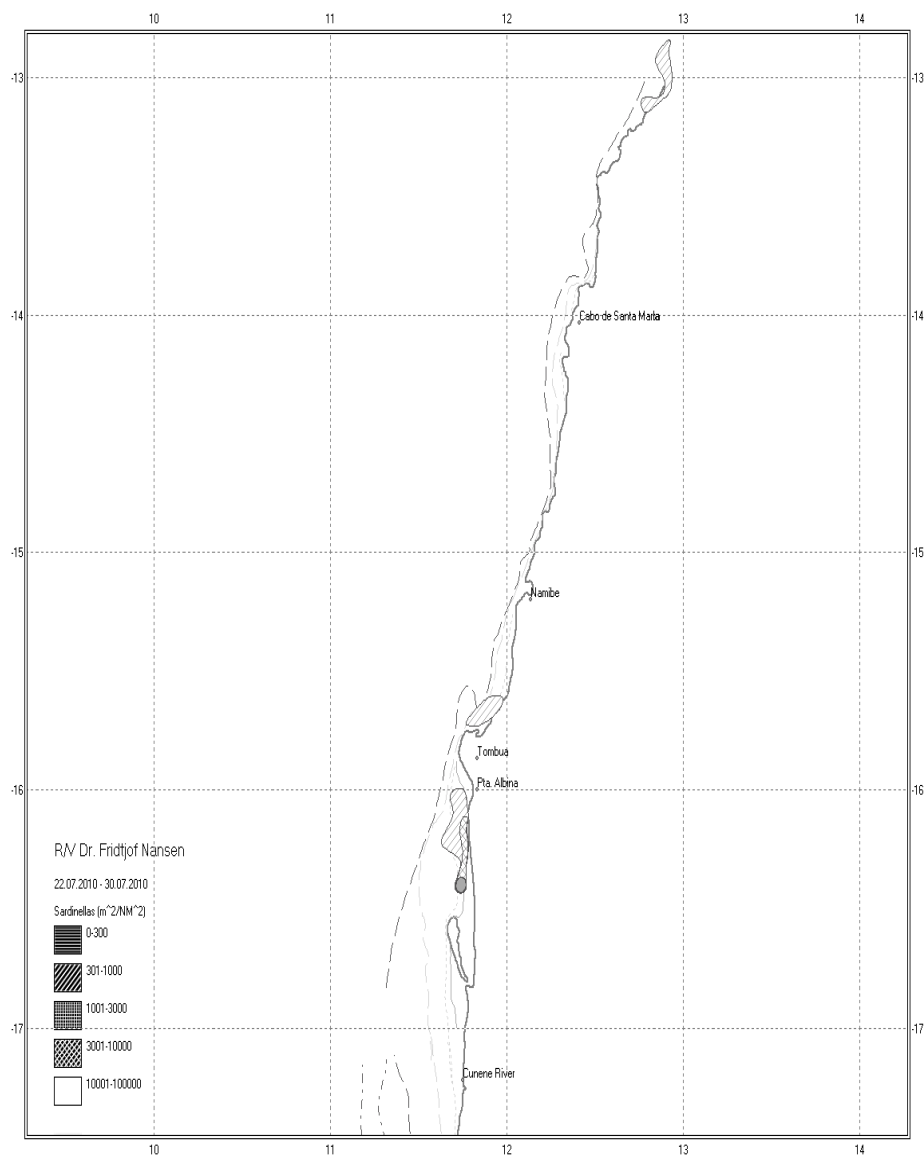
Station	Gear depth	Barracuda	Carangids	Clupeiods	Hairtails	Scombrids	Other	Total
64	14	2.2	0.6		0.9		26.8	30.5
65	14		7.2					7.2
66	102		103.9		11.5		201.5	316.9
67	15						0.1	0.1
69	10	52.3	10.2	120.6	8.8		189.2	381.1
70	30					26.7		26.7
71	121						168.0	168.0
72	25						2.9	2.9
73	254						609.7	609.7
74	10		0.1	39.7	4.7		277.6	322.1
75	111				3.8		195.9	199.7
76	25						0.1	0.1
77	101						398.4	398.4
78	10			5.3	2.1	2.4	1.9	11.7
79	139						251.0	251.0
80	0						0.5	0.5
81	0				3.6		149.3	152.9
82	0						79.5	79.5
83	30					1.3		1.3
84	54				208.8		180.5	389.3
85	10				92.4		113.2	205.6
86	10				14.4		27.1	41.5
88	0				14.8	71.6	31.9	118.3
90	101				4.2		193.3	197.5
91	10	8.3	88.5	16.4	0		522.5	635.7
93	10	0.1			3.7		10.7	14.5
94	10				10.7		6	16.7
95	10				40.1		1.6	41.7
96	32				6.5		3507.9	3514.4
Mean	43	15.73	35.08	45.50	25.35	25.50	246.45	280.53
Std dev		24.63	47.75	52.08	52.26	32.89	647.65	648.24
%catch		0.80	2.59	2.24	5.22	1.25	44.72	

The biomass estimate, based on an average length of 25 cm and a condition factor equal to 0.01, was 12 000 tons, lower than the estimated 25000 tons in 2009.

### 4.3 Benguela - Cunene

#### *Sardinella*

*S. aurita* was the dominated sardinella species found in this region (Figure 19). *S. maderensis* was found at only one station south of Cabo de Santa Marta inshore. *S. aurita* was found in very small patchy areas. A dense patch ( $3001 < s_A < 10\,000\text{ m}^2/\text{NM}^2$ ) areas were found at around south of inshore and south of Tombua at 100 m depths.

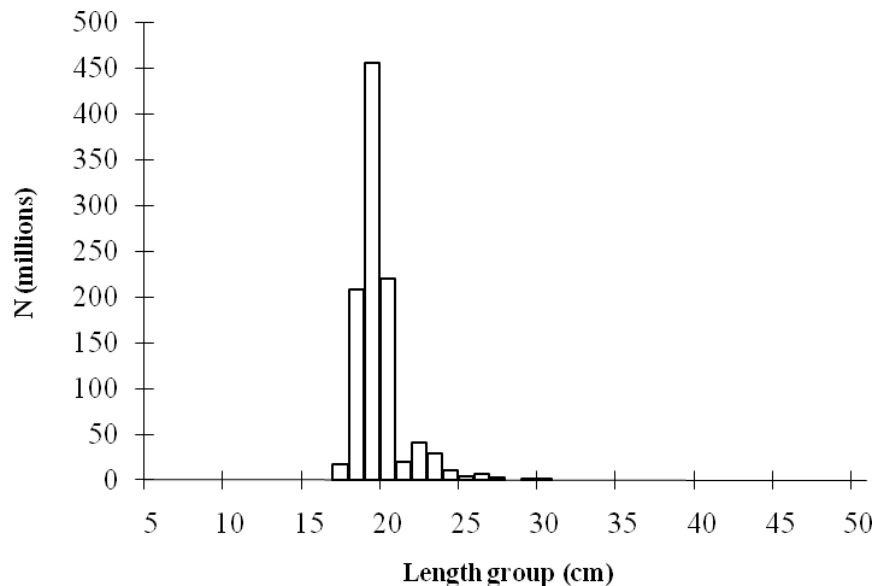


**Figure 20** Distribution of *Sardinella*. Benguela –Cunene. Depth contours at 10, 20, 50, 100, 200 and 500 m.



Figure 20 shows the length frequency distribution of *S. aurita* that ranged from 24 to 34 cm total length (TL) with two modal peaks at around 19 and 22cm, the latter dominated the distribution.

The biomass of *S. aurita* was estimated at 42 000 tons, which is 47% lower than the biomass estimated in 2009.

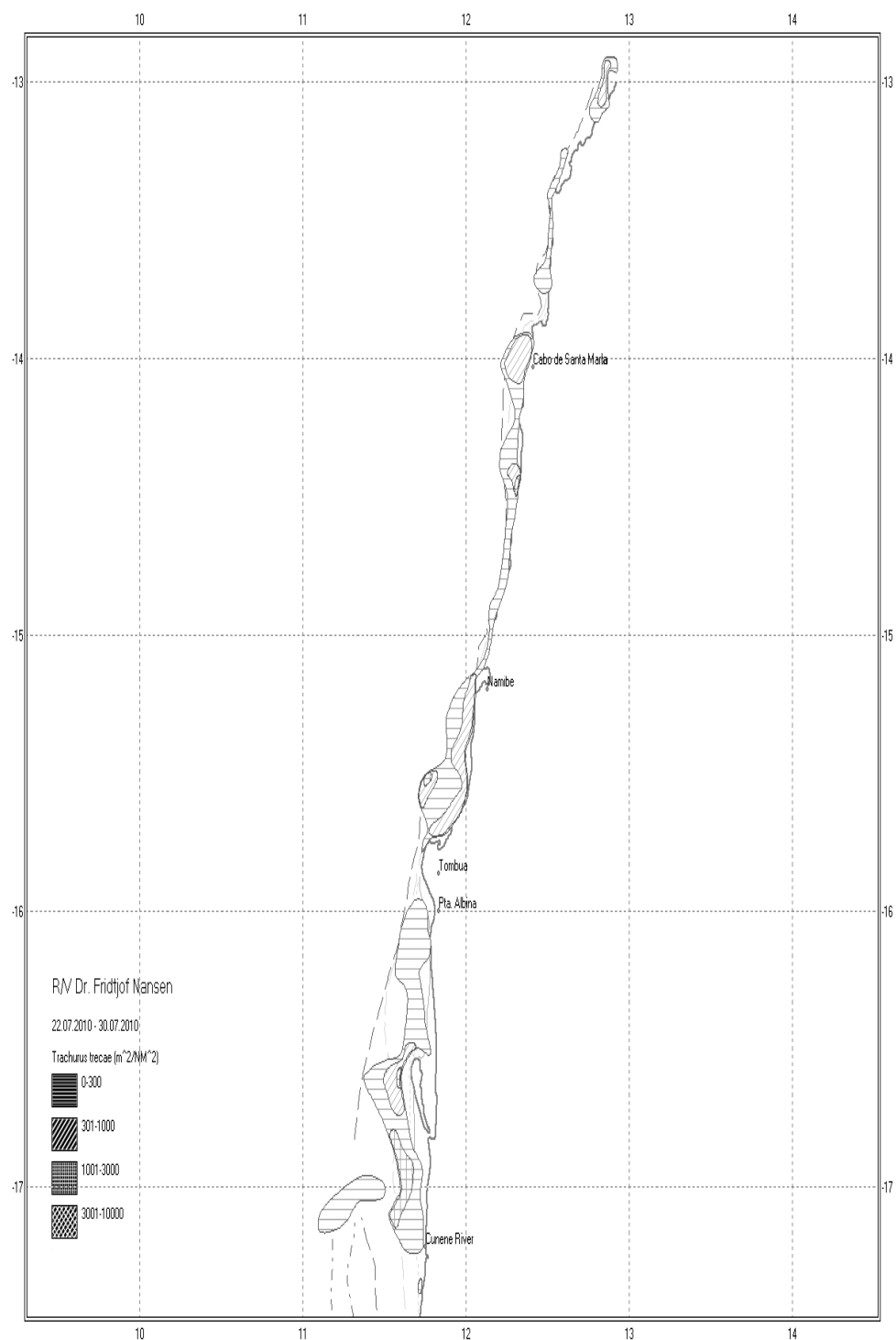


**Figure 20.** Total length distribution of *Sardinella aurita* Benguela-Cunene

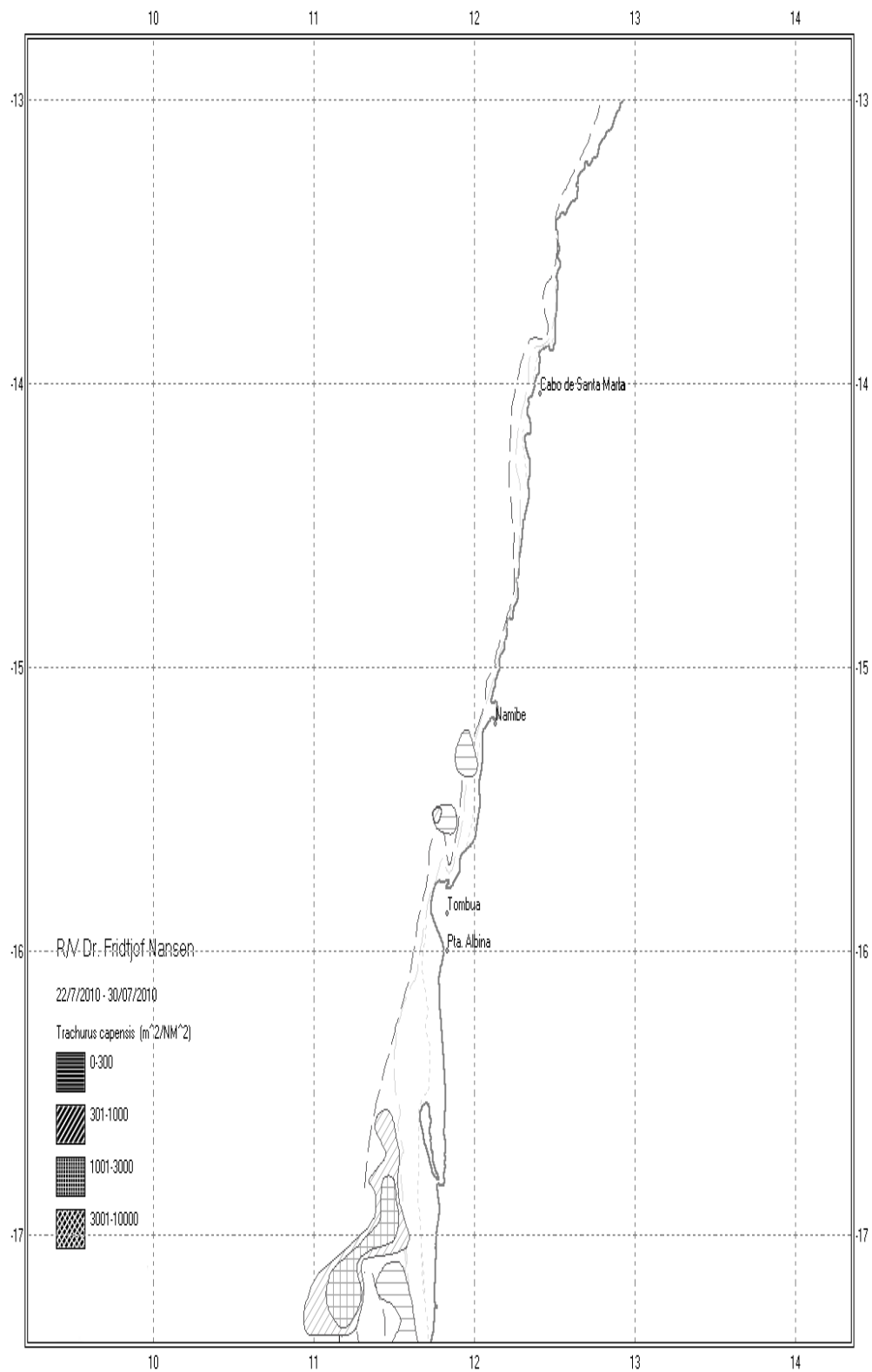
### *Horse mackerel*

Both species of horse mackerel, the Cape horse mackerel *Trachurus capensis* and the Cunene horse mackerel *Trachurus trecae* were found off southern Angola. Cunene horse mackerel presented a continuous distribution pattern throughout of the southern region (Figure 21) with areas with medium densities ( $300 < s_A < 1000 \text{ m}^2/\text{NM}^2$ ) inshore of Cabo de Santa Marta and between Namibe and Tombwa. A small areas with higher densities ( $300 < s_A < 1000 \text{ m}^2/\text{NM}^2$ ) are found offshore south of Tombwa and south of Cunene River.

From south of Pta Albina Cape horse mackerel presented a very patch distribution, with small areas with lower densities ( $1 < s_A < 300 \text{ m}^2/\text{NM}^2$ ) between Namibe and Tombwa (Figure 22). From Baia dos Tigres the distribution was more continuous up to Namibia waters with large area found offshore up to 1000m depths with higher density ( $300 < s_A < 1000 \text{ m}^2/\text{NM}^2$ ). According to the information of the trawls in the offshore area Cape horse mackerel was caught mainly at 200m depths, mixed with mesopelagic species and euphasiids.



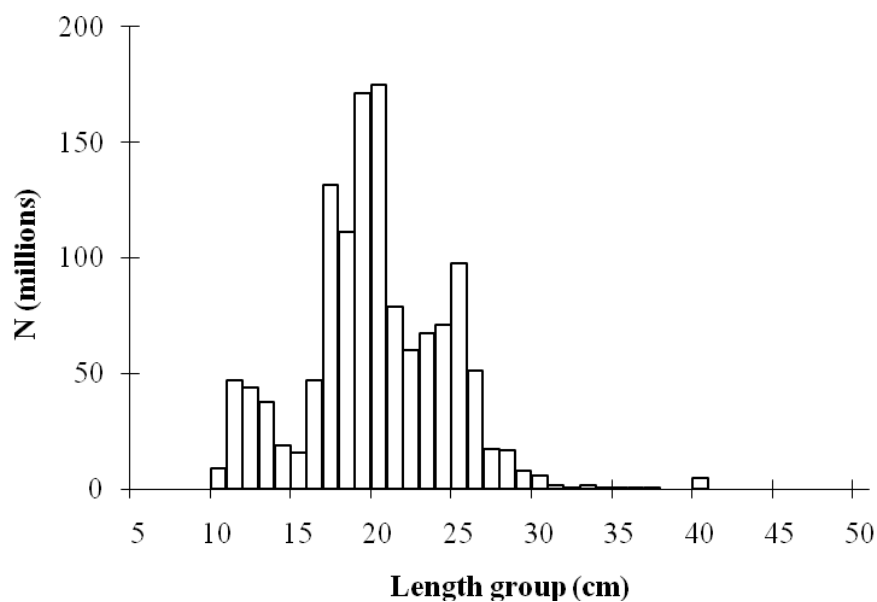
**Figure 21.** Distribution of Cunene horse mackerel. Benguela–Cunene. Depth contours at 10, 20, 50, 100, 200 and 500 m.

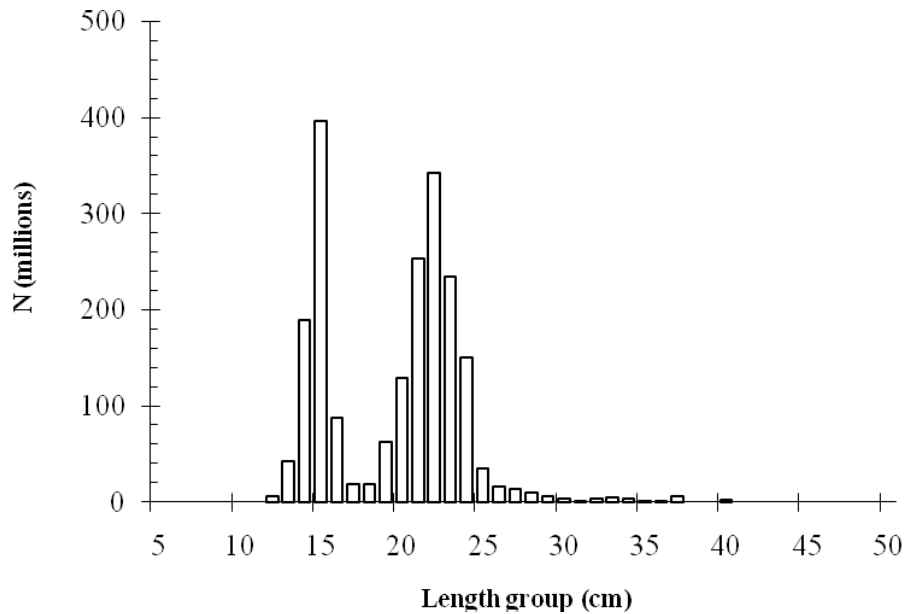


**Figure 22.** Distribution of Cape horse mackerel. Benguela–Cunene. Depth contours at 10, 20, 50, 100, 200 and 500 m.

Figure 22 a and b show the length frequency distribution of the Cape and Cunene horse mackerels, respectively. Cunene horse mackerel has three well defined modes, peaking at about 11, 19 and 25 cm (Figure 22 a). Larger fish (TL >30 cm) represented only 1% of the total biomass and were found at depths <100m (Figure 23). Cape horse mackerel showed bimodal distribution peaking at around 15 and 22 cm (Figure 22 a). The fish (TL>25 cm) almost disappear from the distribution.

a) *Trachurus trecae*



b) *Trachurus capensis*

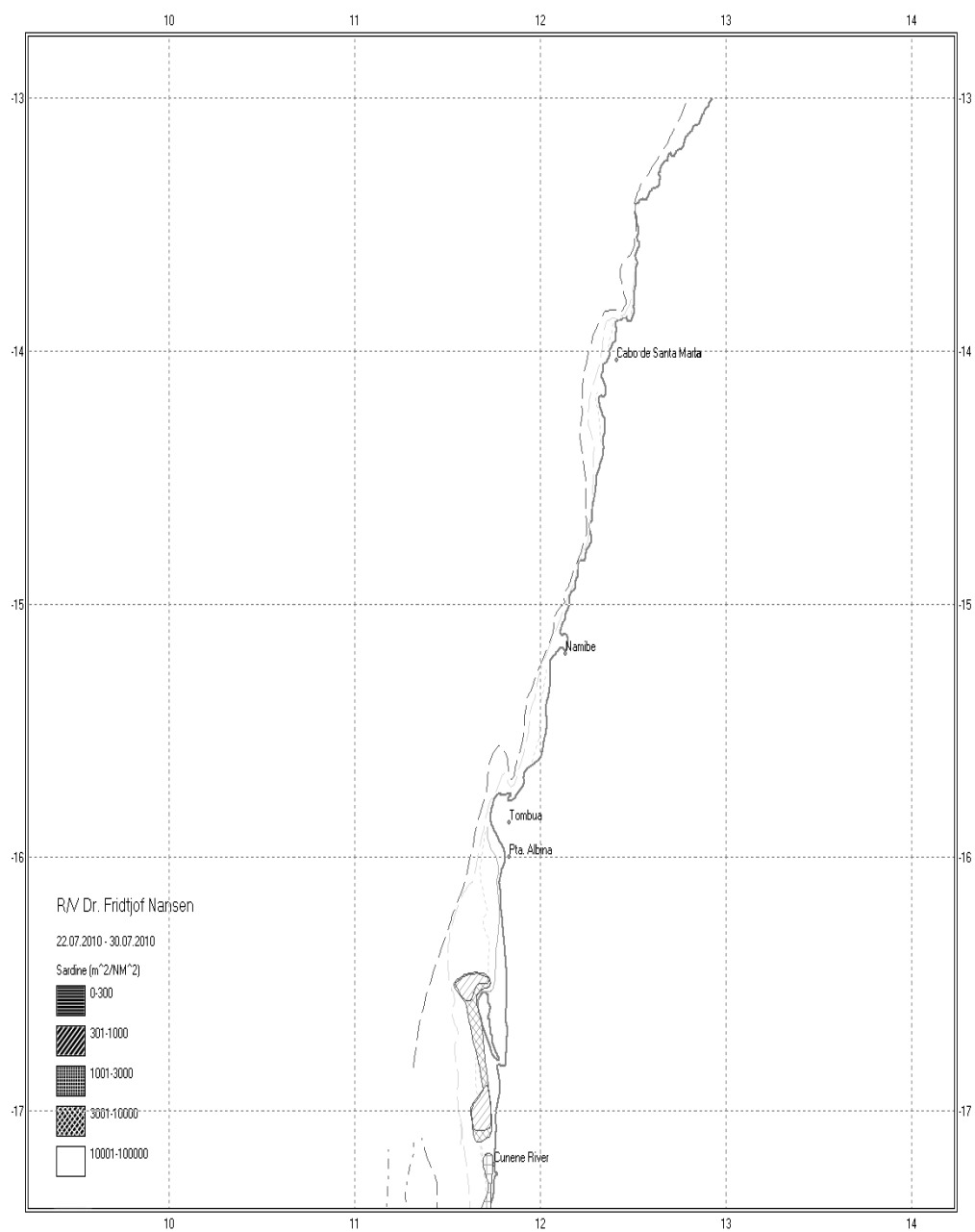
**Figure 22** Total length distributions of (a) *Trachurus trecae* and (b) *T. capensis* (b), Benguela-Cunene.

The biomass estimate for horse mackerel in the region was 241 000 which is % higher than the biomass estimated in 2009. The biomass of Cunene horse mackerel was estimated to 100 000 tones and the Cape horse mackerel the biomass was estimated to 141000 which is the 60% higher than the average biomass estimated in the last ten years.

It is important to consider that the biomass of the two species of horse mackerel cannot be evaluated without taking considering the seasonal fluctuations on the position of the Angola-Benguela front and the upwelling intensity in this region. For this year as described in the present report a strong superficial upwelling observed could facilitate the offshore northward migration of the two species. This process was evident for the Cape horse mackerel, considering that 86% of total biomass of this species is from the offshore component estimated between Tigre Bay and Cunene River and its distribution extends into to Namibian waters.

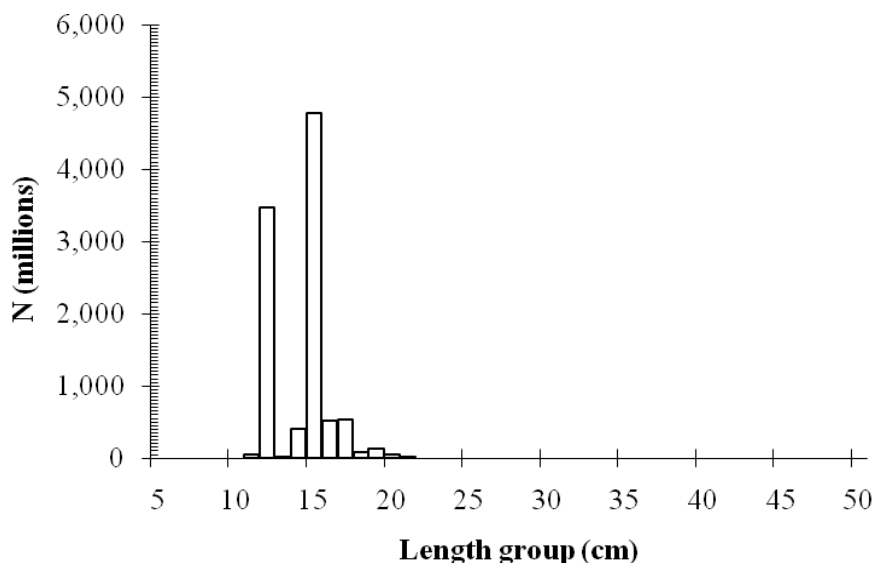
### *Sardine*

Sardine (*Sardinops sagax*) showed a continuous distribution from Tigre Bay to Cunene river inshore with higher densities, ( $300 < s_A < 1000 \text{ m}^2/\text{NM}^2$ ).



**Figure 24.** Distribution of Sardine. Benguela–Cunene. Depth contours at 10, 20, 50, 100, 200 and 500

The length distribution ranged from 11 to 21cm total length with two clear modes peaking at 12 and 15 cm. The 2009, 20cm cohort this year almost disappears from the distribution.



**Figure 22** Total length distributions of *Sardinops sagax*, Benguela-Cunene.

The total biomass of pilchard was estimated at 86 000tonnes, which represents 63% of the total biomass estimated in the transboundary area. This results should be looked with cautions, because it is very important to wait for the upcoming pelagic survey with the R/V Welwitchia

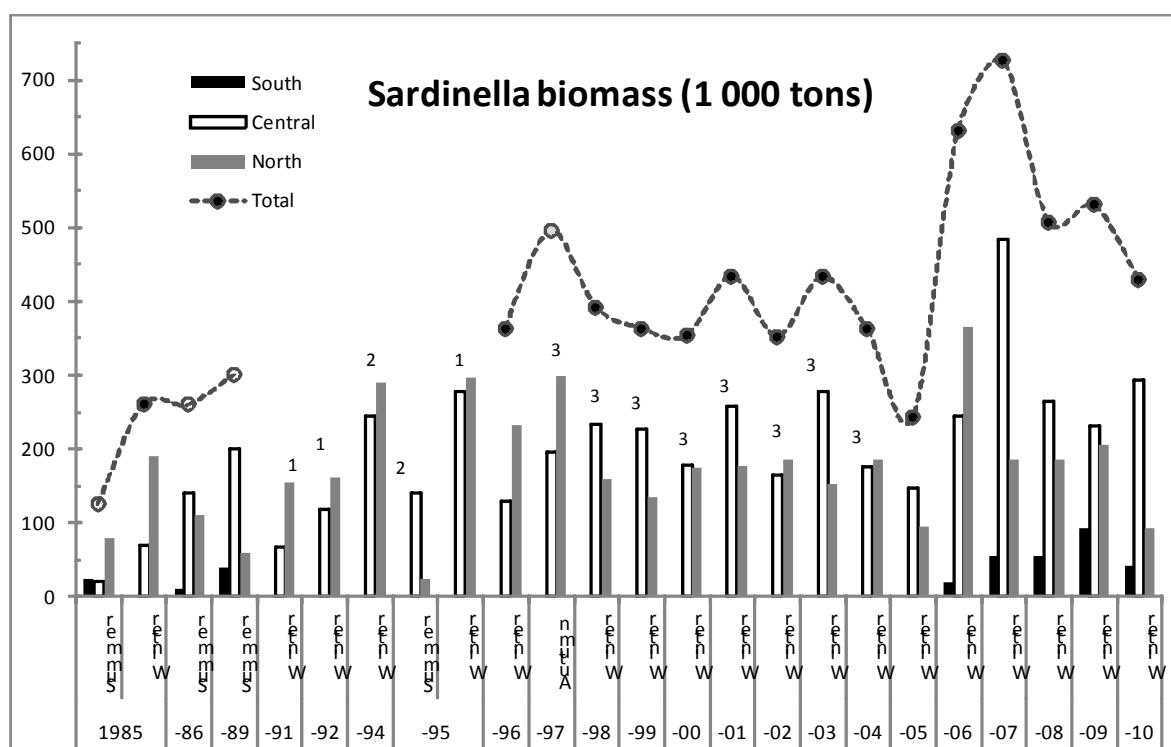
#### Other species

The pelagic 1 was dominating group in this region and the most common species were round herring (*Etrumeus whiteheadi*) and anchovy (*Engraulis encrasicolus*). The biomass estimates for this group of species are presented in the 2009 trans-boundary report (REF).

## CHAPTER 5 SUMMARY OF SURVEY RESULTS

### 5.1 Sardinella

The estimated biomass of sardinella shows a cyclically fluctuating pattern throughout the time series (Figure 23). This is commonly found in pelagic species, usually reflecting actual changes in abundance but also variation in the availability of the surveyed populations, often caused by changes in the environmental conditions. On the overall, the *Sardinella* stocks presently seem to be in reasonably good condition. The total biomass estimate for sardinellas was 428 000 tons. This is, however, about 20% lower than the biomass estimated in 2009 (529 000 tonnes, and continues the downward trend since 2007. The current downward trend warrants for some caution in the management of these stocks. It is therefore now important to follow the landings of these stocks carefully, and the development of the biomass levels over the next years should be followed closely. At this point in time, it is not advisable to increase the fishing pressure on these stocks.



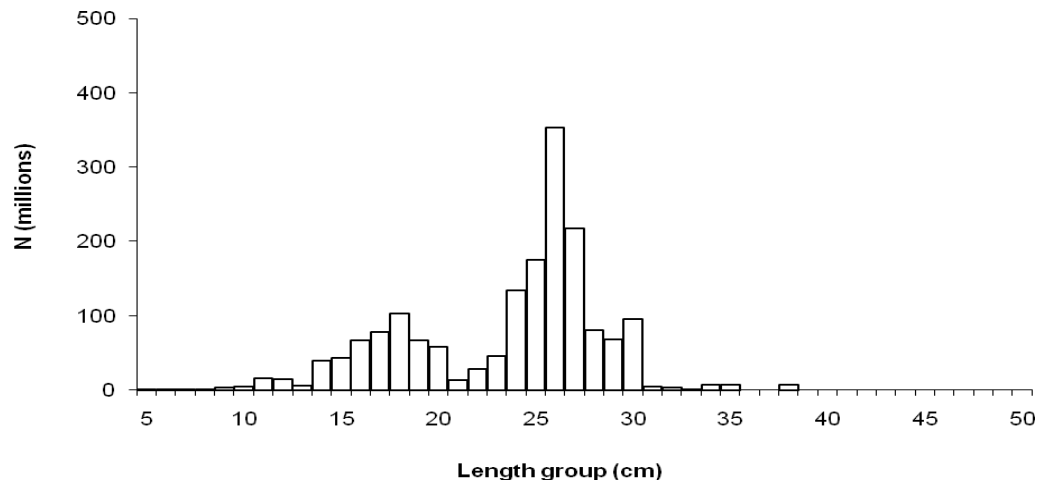
**Figure 23** Biomass estimates of *Sardinella* by regions and surveys (1 000 tons). 1: Data error (Southern region); 2: Southern region not surveyed; 3: Cabinda not surveyed.

In contrast to what has been found for most years, *S. aurita* dominated the relative proportion of the total biomass (62 %). *S. aurita* was found primarily in the central and southern regions, while *S. maderensis* was found only in the northern region.

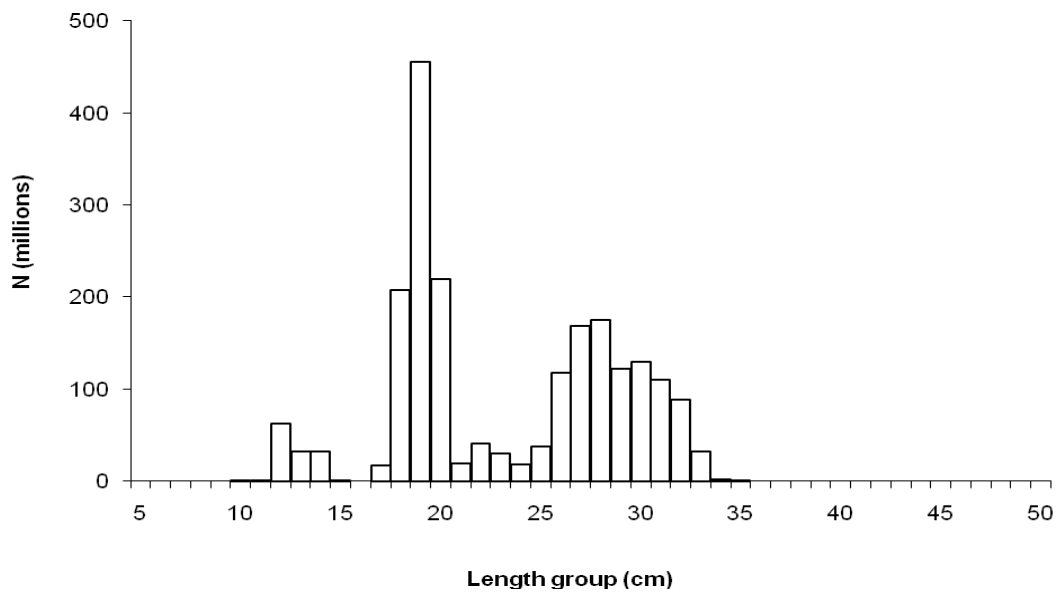


The overall length frequency distributions of the two *Sardinella* species were dominated by two juvenile and one adult cohort (Figure 24). The distribution of *S. maderensis* shows well-defined cohorts with modal peaks around 11, 18 and 26 cm total length. For *S. aurita*, the distribution showed three modal peaks at 12, 19 and 28 cm. The distributions also indicate that the two species enter into the fishery at around 10 cm total length.

a) *S. maderensis*.



b) *S. aurita*.



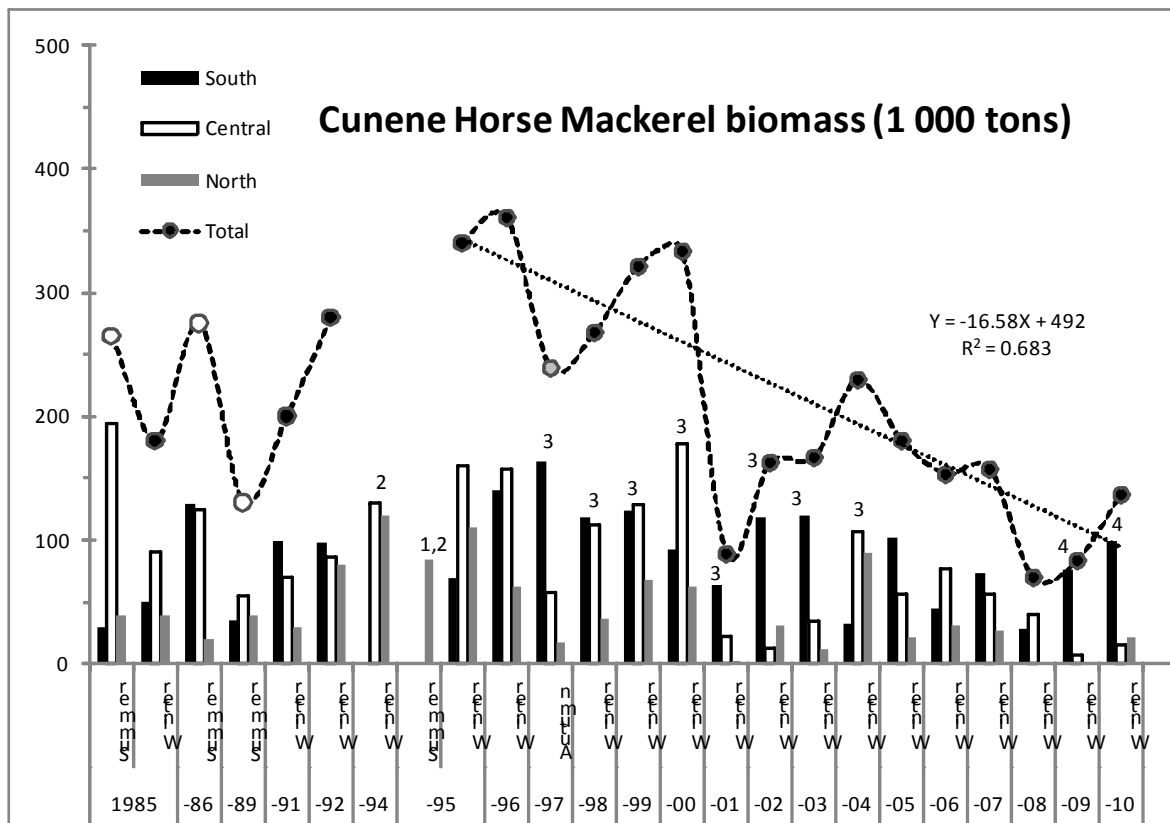
**Figure 24.** Overall total length distribution of *S. maderensis* (a) and *S. aurita* (b).

## 5.2 Cunene horse mackerel

The total biomass of Cunene horse mackerel was estimated at 136 000 tonnes. This is a low estimate in the time series, although somewhat higher than the lowest estimate in the timeseries in 2008 (69 000 tonnes).

The bulk of the biomass was this year found in the southern part of the Southern region (100 000 tonnes), and the overall increase is therefore almost entirely due to an increase in the Cunene horse mackerel biomass there. Evidently, the biomass levels in the northern and central regions are still at a very low level, contributing only 36 000 tonnes to the total biomass. This is 42% lower than biomass estimated in 2007 (84 000 tonnes), which was the last survey in the time series that was carried out in the same July-August period.

The current Cunene horse mackerel biomass is below the 2006 and 2007 levels estimated at respectively 150 000 and 154 000 tonnes, and very low compared to the levels of the 1990's. In the reference year 1996 when the biomass was estimated at around 360 000 tonnes in the winter survey (Figure 25) and 506 000 tonnes in the autumn survey (Annex III), which is the highest estimate on record.



**Figure 25** Biomass estimates of Cunene horse mackerel by regions and surveys (1 000 tons). 1 Data error (Central and Northern Regions); 2: Southern region not surveyed; 3: Cabinda not surveyed; 4: Fish density too low to estimate abundance (Northern Region).

The reported biomass levels should be considered with considerable caution. The estimates are relative indices rather than absolute estimates of abundance, and the cyclic variation pattern may be accentuated by changes in behaviour related to the environmental conditions. This variation is particularly evident in the Benguela Current frontal zone in the Southern region, where the cold Benguela meets the warm, subtropical Angola current. The biomass found in this area in 2010 was 20% higher than the average for the last three years.

The results show an indication that the stock is increasing from its historic low in 2007. This trend should, however, be interpreted with great caution as the increase in biomass this year almost entirely represent an increase in the near-border area in the south. This trend is not necessarily reflecting an ongoing recovery of the stock, but could as well be a result of the influence of the strong superficial upwelling observed throughout the Southern region. The Angolan-Benguela front (ABF) was at the time of the survey located far north, around the Tombwa region. The upwelling caused by the northern position of the ABF seemed to facilitate offshore migration of Cunene horse mackerel, potentially making the fish more available than in previous years, as the transect lines that were extended far offshore to map the offshore component. The northern position of the ABF has also likely caused Cunene horse mackerel in Namibian waters to migrate northwards and into Angolan waters. The northwards migration of pelagic fish from Namibia and into Angolan waters at the time of the survey is also seen from the high abundance of Cape horse mackerel found in Angolan waters and the presence of *Sardinops sagax* in Angolan waters.

Favourable conditions may increase the availability to fishing gear. This is important for the management of the stocks, as increased availability may be taken as a sign of increased abundance, which is not always the case. Increased availability does not necessarily mean increased abundance, sometimes availability may even increase with decreasing abundance. Continuing to fish on the basis of high availability therefore involves risk. This risk is particularly evident for Cunene horse mackerel as 75% of the total biomass is confined to the Southern region and, as for previous surveys, 99 % of the biomass in this region is comprised by juveniles (TL < 21 cm).

Other biological references also clearly indicate that the Cunene horse mackerel stock is still under considerable pressure. From the reference year 1996, the length distributions have been shifting towards smaller fish, indicating high fishing pressure on the adult stock (Figure 26). In addition to this estimates for the last five years have shown clear indications of recruitment failure. Similarly, the size at first maturity for this stock has been declining steadily in the recent years, from 23 cm in 1996 to 14 cm in 2010 (Figure 27), another clear indicator of overfishing.

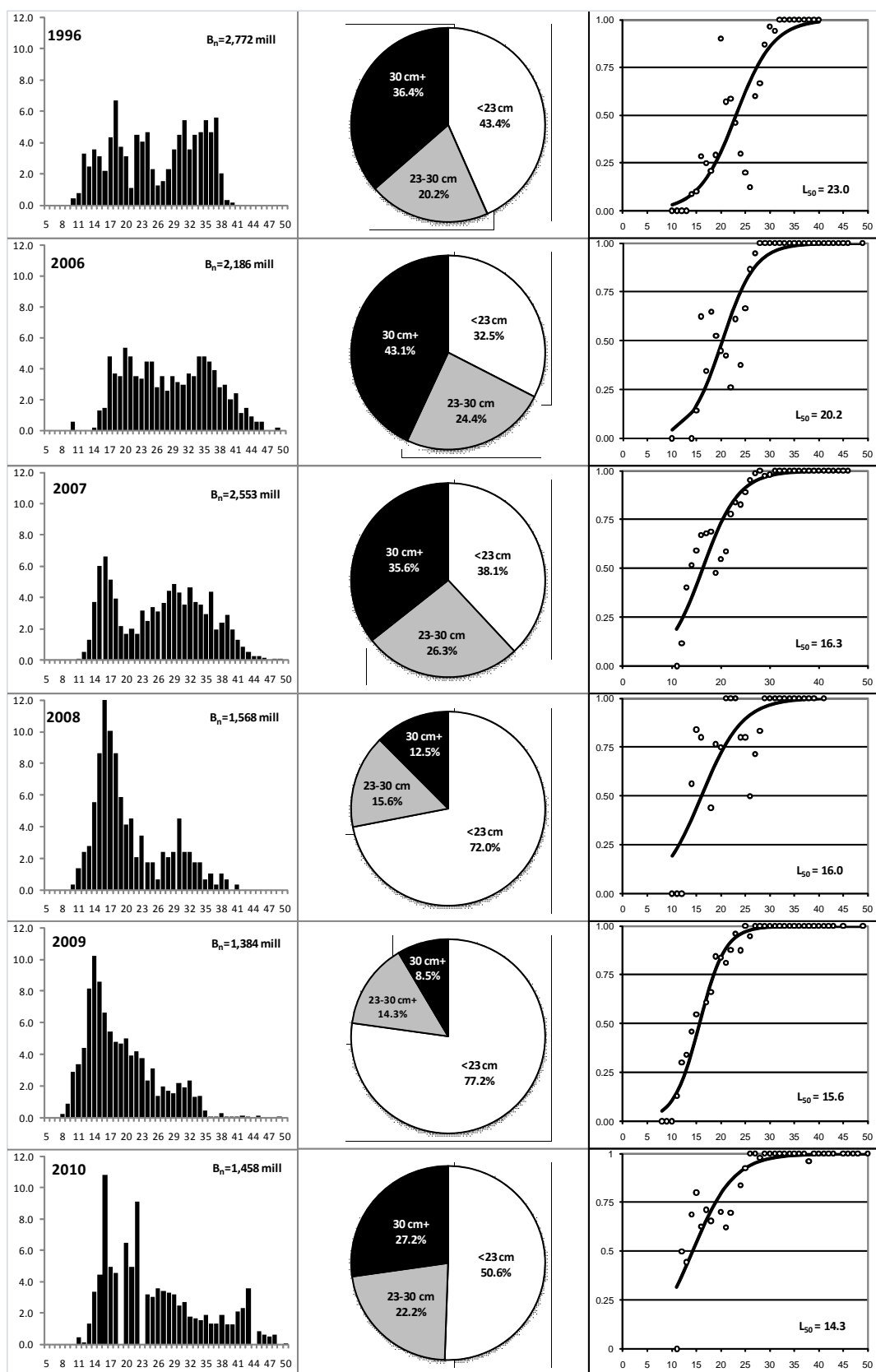
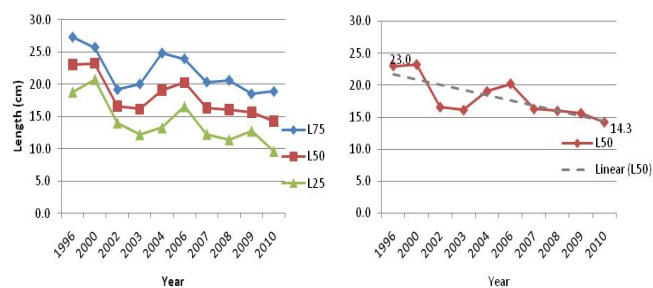


Figure 26 Population structure of Cunene horse mackerel (first column), percentage composition (second column) and maturity ogives (third column) for the biological samples over the years.



c

Figura 27. Length of maturity of Cunene horse mackerel at length at 50%, 25% and 75%,

In this situation, increasing fishing pressure could involve a high risk for failure of the long-term recovery the of the Cunene horse mackerel stock.

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# ANNEX II. FISHING STATIONS

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 35  
 DATE : 02.07.2010 GEAR TYPE: BT NO: 24 POSITION: Lat S 6°17.93  
 start stop duration Lon E 11°48.40  
 TIME : 15:06:48 15:37:12 30.4 (min) Purpose : 1  
 LOG : 3759.32 3760.82 1.5 Region : 4000  
 FDEPTH: 105 110 Gear cond.: 0  
 BDEPTH: 105 110 Validity : 0  
 Towing dir.: 0° Wire out : 250 m Speed : 3.0 kn  
 Sorted : 44 Total catch: 43.83 Catch/hour: 86.51

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Dentex angolensis	27.04	144	31.26
Trachurus trecae	17.17	523	19.85
Trichurus lepturus	15.59	16	18.02
Dentex congogensis	5.59	51	6.46
Zeus faber	4.91	14	5.68
Ariomma bondi	3.36	41	3.88
Dentex barnardi	3.34	10	3.86
Illex coindetii	2.55	107	2.94
Protula barbata	2.07	2	2.40
Chelidonichthys gabonensis	1.56	18	1.80
Fistularia petimba	1.38	4	1.60
Rajamiraletus	0.95	2	1.10
Umbriacanariensis	0.95	2	1.10
Syacum micrum	0.06	2	0.07
Total	86.51	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 39  
 DATE : 03.07.2010 GEAR TYPE: BT NO: 24 POSITION: Lat S 6°35.91  
 start stop duration Lon E 12°0.32  
 TIME : 13:02:49 13:32:52 30.1 (min) Purpose : 1  
 LOG : 3924.38 3926.07 1.7 Region : 4000  
 FDEPTH: 94 105 Gear cond.: 0  
 BDEPTH: 94 105 Validity : 0  
 Towing dir.: 0° Wire out : 270 m Speed : 3.4 kn  
 Sorted : 82 Total catch: 82.28 Catch/hour: 164.29

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Dentex congogensis	112.41	1086	68.42
Trichurus lepturus	22.46	32	13.67
Trachurus trecae	13.58	20	8.26
Mustelus mustelus	3.87	2	2.36
Fistularia petimba	3.19	6	1.94
Dentex angolensis	3.19	18	1.94
Zeus faber	1.72	6	1.05
Boops boops	1.62	68	0.98
Squatina oculata	1.58	2	0.96
Scorpaena normani	0.28	4	0.17
Spiracanth	0.20	24	0.12
Illex coindetii	0.12	6	0.07
Peristedion cataphractum	0.06	2	0.04
Total	164.29	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 36  
 DATE : 03.07.2010 GEAR TYPE: BT NO: 24 POSITION: Lat S 6°37.04  
 start stop duration Lon E 11°47.32  
 TIME : 02:48:08 03:18:12 30.1 (min) Purpose : 1  
 LOG : 3850.99 3852.49 1.5 Region : 4000  
 FDEPTH: 154 154 Gear cond.: 0  
 BDEPTH: 154 154 Validity : 0  
 Towing dir.: 0° Wire out : 380 m Speed : 3.0 kn  
 Sorted : 253 Total catch: 252.71 Catch/hour: 504.24

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Trachurus trecae	195.74	487	38.82
Pterothrissus bellioi	190.95	1824	37.87
Dentex angolensis	40.90	233	8.11
Pteroscion pelli	22.25	219	4.41
Chelidonichthys gabonensis	11.87	231	2.35
Sepia orbigynna	7.14	62	1.42
Cynoponticus ferox	5.47	32	1.08
Octopus vulgaris	5.35	18	1.06
Protula barbata	4.39	8	0.87
Syacum micrum	3.63	96	0.72
Grammolites gruvelli	2.39	80	0.47
Umbriacanariensis	2.37	4	0.47
Micracorvina angolensis	2.00	4	0.40
Scyliorhinus cervigoni	1.82	2	0.36
Trichurus lepturus	1.82	2	0.36
Uranoscopus cadenati	1.50	8	0.30
Torpedo torpedo	1.18	2	0.23
Scomber japonicus	0.88	2	0.17
Arnoglossus imperialis	0.82	90	0.16
Pontinus accraensis	0.56	2	0.11
Parapaneus longirostris	0.52	184	0.10
Gadella maraldi	0.40	22	0.08
Dicologlossa cuneata	0.28	26	0.06
Solenocera africana	0.02	4	0.00
Total	504.24	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 40  
 DATE : 03.07.2010 GEAR TYPE: PT NO: 5 POSITION: Lat S 6°48.77  
 start stop duration Lon E 11°46.63  
 TIME : 18:15:56 18:45:23 29.5 (min) Purpose : 1  
 LOG : 3960.73 3962.31 1.6 Region : 4000  
 FDEPTH: 14 14 Gear cond.: 0  
 BDEPTH: 328 372 Validity : 0  
 Towing dir.: 0° Wire out : 100 m Speed : 3.2 kn  
 Sorted : 0 Total catch: 115.52 Catch/hour: 235.35

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
MYCTOPHIDAE	121.26	78	51.52
Trichurus lepturus	104.31	124	44.32
Pteroscion pelli	3.42	196	1.45
Loligo vulgaris	3.42	1369	1.45
JELLYFISH	2.44	98	1.04
Scopelus asotus	0.49	196	0.21
Total	235.35	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 37  
 DATE : 03.07.2010 GEAR TYPE: PT NO: 4 POSITION: Lat S 6°22.67  
 start stop duration Lon E 12°12.28  
 TIME : 07:29:47 07:36:23 6.6 (min) Purpose : 1  
 LOG : 3884.14 3884.60 0.5 Region : 4000  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 32 33 Validity : 0  
 Towing dir.: 0° Wire out : 120 m Speed : 4.2 kn  
 Sorted : 74 Total catch: 74.23 Catch/hour: 674.82

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Chloroscombrus chrysurus	454.55	4218	67.36
Sphyræna guanchancho	131.36	127	19.47
Sardinella maderensis	34.09	200	5.05
Selene dorsalis	16.45	118	2.44
Trichurus lepturus	13.18	36	1.95
Brachydeuterus auratus	12.73	182	1.89
Scomberomorus torquatus	9.64	9	1.43
Pomadasys incisus	1.91	9	0.28
Ilisha africana	0.91	18	0.13
Total	674.82	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 41  
 DATE : 03.07.2010 GEAR TYPE: PT NO: 4 POSITION: Lat S 6°33.73  
 start stop duration Lon E 12°17.04  
 TIME : 23:34:55 00:04:50 29.9 (min) Purpose : 1  
 LOG : 4000.22 4002.13 1.9 Region : 4000  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 34 42 Validity : 0  
 Towing dir.: 0° Wire out : 110 m Speed : 3.8 kn  
 Sorted : 90 Total catch: 90.21 Catch/hour: 180.90

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Sardinella maderensis	69.28	515	38.30
Ilisha africana	35.59	136	19.68
Brachydeuterus auratus	33.19	2260	18.35
Stromateus fiatola	17.25	24	9.53
Trichurus lepturus	8.06	14	4.46
Galeodes decadactylus	7.12	70	3.26
Sepia orbigynna	2.35	8	1.30
Sphyræna guanchancho	1.97	6	1.09
Pagellus bellottii	1.54	8	0.85
Penaeus notialis	1.40	2	0.78
Boops boops	1.16	74	0.64
Chloroscombrus chrysurus	0.76	8	0.42
Sardinella aurata	0.66	4	0.37
Selene dorsalis	0.30	2	0.17
Trachurus trecae	0.20	2	0.11
Engraulis encrasicolus	0.06	10	0.03
Total	180.90	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 42  
 DATE : 04.07.2010 GEAR TYPE: PT NO: 4 POSITION: Lat S 6°37.97  
 start stop duration Lon E 12°21.44  
 TIME : 02:01:39 02:21:41 20.0 (min) Purpose : 1  
 LOG : 4015.29 4016.40 1.1 Region : 4000  
 FDEPTH: 0 0 Gear cond.: 0  
 BDEPTH: 26 27 Validity : 0  
 Towing dir.: 0° Wire out : 110 m Speed : 3.3 kn  
 Sorted : 344 Total catch: 343.79 Catch/hour: 1029.83

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Chloroscombrus chrysurus	478.80	442	46.49
Brachydeuterus auratus	246.95	905	23.98
Sardinella maderensis	67.10	473	6.52
Selene dorsalis	62.97	689	6.11
Ilisha africana	50.89	983	4.94
Pagellus bellottii	41.19	1099	4.00
Galeodes decadactylus	29.78	249	2.89
Sphyræna guanchancho	15.85	42	1.54
Trichurus lepturus	10.57	21	1.03
Decapterus rhonchus	5.81	66	0.56
Boops boops	5.61	0	0.54
Pteroscion pelli	5.27	66	0.51
Sepia orbigynna	3.65	12	0.35
Trachinus ovatus	2.70	21	0.26
Sardinella aurata	2.28	12	0.22
Dentex barnardi	0.21	21	0.02
Penaeus kerathurus	0.21	12	0.02
Total	1029.83	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 38  
 DATE : 03.07.2010 GEAR TYPE: PT NO: 1 POSITION: Lat S 6°31.35  
 start stop duration Lon E 12°9.82  
 TIME : 10:21:38 10:57:57 36.3 (min) Purpose : 1  
 LOG : 3904.98 3907.28 2.3 Region : 4000  
 FDEPTH: 20 30 Gear cond.: 0  
 BDEPTH: 50 46 Validity : 0  
 Towing dir.: 0° Wire out : 120 m Speed : 3.8 kn  
 Sorted : 0 Total catch: 0.00 Catch/hour: 0.00

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
NO CATCH	0.00	0	0.00

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 43  
DATE : 04.07.2010 GEAR TYPE: BT NO: 24 POSITION: Lat S 6°56.29  
start stop duration Lon E 11°58.67  
TIME : 09:45:57 09:50:12 4.3 (min)  
LOG : 4071.11 4076.24 0.1  
FDEPTH: 112 112  
BDEPTH: 112 112  
Towing dir: 0° Wire out : 270 m  
Sorted : 22 Total catch: 21.65 Speed : 1.8 kn  
Catch/hour: 305.65

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Seriola carpenteri	122.82	14	40.18	
Dentex angolensis	85.41	438	27.94	45
Dentex congoensis	85.41	706	27.94	46
Dentex barnardi	6.21	28	2.03	
Chelidonichthys gabonensis	2.40	14	0.79	
Trachurus trecae	2.12	28	0.69	44
Spirocara alta	1.13	14	0.37	
Parapandalus narval	0.14	85	0.05	
Total		305.65	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 44  
DATE : 04.07.2010 GEAR TYPE: PT NO: 7 POSITION: Lat S 6°45.22  
start stop duration Lon E 12°26.11  
TIME : 13:54:20 14:25:56 31.6 (min)  
LOG : 4109.66 4111.64 2.0  
FDEPTH: 10 10  
BDEPTH: 21 19  
Towing dir: 0° Wire out : 130 m  
Sorted : 163 Total catch: 163.43 Speed : 3.8 kn  
Catch/hour: 310.31

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Chloroscombrus chrysurus	226.52	1519	73.00	50
Brachydeuterus auritus	34.84	420	11.23	51
Sardinella maderensis	13.20	80	4.25	49
Galeodes decadactylus	7.73	25	2.49	
Selene dorsalis	7.54	46	2.43	47
Sphyræna guachancho	5.37	17	1.73	
Stromateus fiatola	4.94	6	1.59	
Scomberomorus torquatus	4.23	6	1.36	48
Trichurus lepturus	1.65	2	0.53	
Arius parkii	1.35	2	0.33	
Selar crumenophthalmus	1.22	4	0.39	
Hemirhamphus intermedius	1.06	4	0.34	
Pagellus bellottii	0.66	4	0.21	
Total		310.31	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 45  
DATE : 05.07.2010 GEAR TYPE: PT NO: 4 POSITION: Lat S 7°4.44  
start stop duration Lon E 12°17.60  
TIME : 00:59:15 01:29:21 30.0 (min)  
LOG : 4202.77 4204.59 1.8  
FDEPTH: 0 0  
BDEPTH: 89 98  
Towing dir: 0° Wire out : 110 m  
Sorted : 1 Total catch: 1.44 Speed : 3.6 kn  
Catch/hour: 2.88

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sepia orbi gnyana	1.24	2	43.06	
Saurida brasiliensis	0.78	1004	27.08	52
Trachurus trecae	0.28	8	9.72	
Loligo vulgaris	0.26	76	9.03	
Allotheutis africana	0.22	24	7.64	
Lagocephalus laevis	0.08	4	2.78	
Selene dorsalis	0.02	6	0.69	
Total		2.88	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 46  
DATE : 05.07.2010 GEAR TYPE: BT NO: 24 POSITION: Lat S 7°13.70  
start stop duration Lon E 12°21.88  
TIME : 08:18:53 08:38:40 19.8 (min)  
LOG : 4258.62 4259.64 1.0  
FDEPTH: 115 113  
BDEPTH: 115 113  
Towing dir: 0° Wire out : 270 m  
Sorted : 46 Total catch: 46.48 Speed : 3.1 kn  
Catch/hour: 140.98

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Dentex angolensis	51.72	258	36.68	53
Umbra canariensis	35.64	58	25.28	54
Trichurus lepturus	28.06	36	19.90	
Trachurus trecae	10.84	30	7.70	55
Brotula barba	10.31	9	7.32	
Chelidonichthys gabonensis	2.85	15	2.02	
Bregmaceros sp.	1.21	24	0.86	
Dentex congoensis	0.27	3	0.19	
Illex coindetii	0.05	58	0.04	
Total		140.98	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 47  
DATE : 05.07.2010 GEAR TYPE: PT NO: 1 POSITION: Lat S 6°57.01  
start stop duration Lon E 12°28.36  
TIME : 15:09:21 15:56:16 46.9 (min)  
LOG : 4312.18 4315.30 3.1  
FDEPTH: 20 30  
BDEPTH: 40 35  
Towing dir: 0° Wire out : 100 m  
Sorted : 16 Total catch: 16.11 Speed : 4.0 kn  
Catch/hour: 20.60

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardinella maderensis	7.93	38	38.49	57
Brachydeuterus auritus	3.03	26	14.71	
Sphyræna guachancho	2.77	6	13.47	
Stromateus fiatola	2.72	4	13.22	
Caranx crysos	2.20	1	10.68	
Sardinella aurata	1.48	8	7.20	56
Trichurus lepturus	0.33	1	10.61	
Selene dorsalis	0.10	1	0.50	
Engraulis encrasiolus	0.03	19	0.12	58
Total		20.60	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 47  
DATE : 05.07.2010 GEAR TYPE: PT NO: 1 POSITION: Lat S 6°57.01  
start stop duration Lon E 12°28.36  
TIME : 15:09:21 15:56:16 46.9 (min)  
LOG : 4312.18 4315.30 3.1  
FDEPTH: 20 30  
BDEPTH: 40 35  
Towing dir: 0° Wire out : 100 m  
Sorted : 16 Total catch: 16.11 Speed : 4.0 kn  
Catch/hour: 20.60

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardinella maderensis	7.93	38	38.49	57
Brachydeuterus auritus	3.03	26	14.71	
Sphyræna guachancho	2.77	6	13.47	
Stromateus fiatola	2.72	4	13.22	
Caranx crysos	2.20	1	10.68	
Sardinella aurata	1.48	8	7.20	56
Trichurus lepturus	0.33	1	10.61	
Selene dorsalis	0.10	1	0.50	
Engraulis encrasiolus	0.03	19	0.12	58
Total		20.60	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 48

DATE : 06.07.2010 GEAR TYPE: BT NO: 24 POSITION: Lat S 7°21.21  
start stop duration Lon E 12°28.38  
TIME : 11:23:43 11:54:21 30.6 (min)  
LOG : 4477.68 4479.29 1.6  
FDEPTH: 106 108  
BDEPTH: 106 108  
Towing dir: 0° Wire out : 260 m  
Sorted : 142 Total catch: 141.56 Speed : 3.1 kn  
Catch/hour: 277.39

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Umbra canariensis	114.04	188	41.11	61
Trachurus trecae	72.99	2273	26.31	59
Dentex angolensis	46.15	470	16.64	60
Chelidonichthys gabonensis	19.11	129	6.89	
Dentex congoensis	6.74	135	2.43	63
Selene dorsalis	4.47	12	1.61	62
Lagocephalus laevis	4.04	6	1.46	
Illex coindetii	2.49	167	0.70	
Zeus faber	2.16	6	0.78	
Fistularia petimba	1.57	4	0.57	
Raja miraletus	0.74	2	0.27	
Trichurus lepturus	0.73	2	0.26	
Ornithoteuthis sp.	0.49	153	0.18	
Uranoscopus polli	0.43	2	0.16	
Dentex barnardi	0.39	2	0.14	
Chaetodon hoefleri	0.29	2	0.11	
Citharus linguatula	0.22	8	0.08	
Pagellus bellottii	0.12	4	0.04	
Sepia orbi gnyana	0.12	2	0.04	
Arnoglossus imperialis	0.08	6	0.03	
Saurida brasiliensis	0.04	4	0.01	
Total		277.39	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 49  
DATE : 07.07.2010 GEAR TYPE: PT NO: 4 POSITION: Lat S 7°31.41  
start stop duration Lon E 12°54.47  
TIME : 02:15:57 02:29:49 13.9 (min)  
LOG : 4576.11 4576.88 0.8  
FDEPTH: 0 0  
BDEPTH: 30 34  
Towing dir: 0° Wire out : 110 m  
Sorted : 132 Total catch: 131.85 Speed : 3.3 kn  
Catch/hour: 570.37

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Stromateus fiatola	175.63	407	30.79	
Engraulis encrasiolus	151.62	34551	26.58	64
Brachydeuterus auritus	110.31	3314	19.34	67
Illex africana	59.70	943	10.47	
Trichurus lepturus	26.39	78	4.63	
Sepia orbi gnyana	19.64	13	3.44	
Sphyræna guachancho	11.90	22	2.09	
Pagellus bellottii	4.59	195	0.80	
Sardinella maderensis	3.59	112	0.63	66
Pomadasys peroteti	3.03	9	0.53	
Sardinella aurata	1.82	195	0.32	65
Pomadasys rogeri	1.25	4	0.22	
Pteroscopus peli	0.48	4	0.08	
Galeodes decadactylus	0.43	4	0.08	
Total		570.37	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 50  
DATE : 07.07.2010 GEAR TYPE: BT NO: 24 POSITION: Lat S 7°44.14  
start stop duration Lon E 12°38.81  
TIME : 07:43:25 08:13:28 30.1 (min)  
LOG : 4617.00 4618.58 1.6  
FDEPTH: 119 121  
BDEPTH: 119 121  
Towing dir: 0° Wire out : 290 m  
Sorted : 103 Total catch: 102.99 Speed : 3.2 kn  
Catch/hour: 205.57

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Trachurus trecae	114.57	677	55.73	68
Dentex angolensis	42.02	329	20.44	69
Umbra canariensis	16.17	36	7.86	71
Trichurus lepturus	10.08	16	4.90	
Chelidonichthys gabonensis	7.74	46	3.77	
Illex coindetii	4.65	168	2.26	
Dentex barnardi	3.51	66	1.71	70
Branchiostegus semipinnatus	2.48	2	1.20	
Lophodes kemp	1.22	4	0.59	
Zeus faber	1.06	4	0.51	
Dentex barnardi	0.98	2	0.48	
Lagocephalus laevis	0.56	2	0.27	
Ariomma bondi	0.34	10	0.17	
Sepia orbi gnyana	0.16	2	0.08	
Todarodes sagittatus	0.04	2	0.02	
Total		205.57	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 51  
DATE : 07.07.2010 GEAR TYPE: PT NO: 1 POSITION: Lat S 7°43.04  
start stop duration Lon E 12°58.26  
TIME : 12:30:58 13:03:45 32.8 (min)  
LOG : 4651.34 4653.49 2.2  
FDEPTH: 24 25  
BDEPTH: 40 42  
Towing dir: 0° Wire out : 0 m  
Sorted : 94 Total catch: 93.55 Speed : 3.9 kn  
Catch/hour: 171.23

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardinella maderensis	159.06	1462	92.89	72
Chloroscombrus chrysurus	5.58	46	3.26	74
Caranx crysos	2.42	2	1.41	
Sardinella aurata	1.98	16	1.15	73
Stromateus fiatola	1.68	2	0.98	
Trichurus lepturus	0.51	2	0.30	
Total		171.23	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 52  
DATE : 07.07.2010 GEAR TYPE: BT NO: 24 POSITION: Lat S 7°46.13  
start stop duration Lon E 12°50.44  
TIME : 14:35:46 15:01:52 26.1 (min)  
LOG : 4664.58 4666.06 1.5  
FDEPTH: 81 81  
BDEPTH: 83 81  
Towing dir: 0° Wire out : 220 m  
Sorted : 104 Total catch: 103.53 Speed : 3.4 kn  
Catch/hour: 238.09

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Trichurus lepturus	124.42	271	52.26	
Umbra canariensis	43.00	51	18.06	76
Stromateus fiatola	22.31	32	9.37	
Trachurus trecae	16.67	52	7.00	75
Octopus vulgaris	4.60	9	1.93	
Selene dorsalis	3.68	7	1.55	
Dentex congoensis	3.29	41	1.38	
Fistularia petimba	2.27	9	1.17	
Pseudotolithus senegalensis	2.51	2	1.05	
Allotheutis africana	2.41	874	1.01	
Euthynnus alletteratus	2.37	2	0.99	
Torpedo torpedo	2.12	5	0.89	
Zeus faber	2.01	7	0.80	
Raja miraletus	1.38	2	0.58	
Pagellus bellottii	1.24	9	0.52	
Pseudupeneus prayensis	1.08	14	0.45	
Dentex macrophthalmus	0.67	28	0.19	
Dentex angolensis	0.46	5	0.19	
Chelidonichthys capensis	0.39	2	0.16	
Illex coindetii	0.18	5	0.08	
Boops boops	0.14	2	0.06	



Total	238.09	100.00		
R/V Dr. Fridtjof Nansen	SURVEY: 2010406	STATION: 53		
DATE : 07.07.2010	GEAR TYPE: BT NO: 24	POSITION: Lat S 7°54.13		
TIME : 23:31:04 00:01:08	start stop duration	Lon E 13°5.84		
LOG : 4729.21 4730.82	1.6	Purpose : 1		
FDEPTH: 22 22	Region : 4000	Gear cond.: 0		
BDEPTH: 22 22	Valid ity : 0	Speed : 3.2 kn		
Towing dir: 0°	Wire out : 80 m	Catch/hour: 850.63		
Sorted : 118	Total catch: 426.17			
SPECIES	CATCH/HOUR	% OF TOT. C	SAMP	
Pomadasy s jubelini	weight numbers			
Pseudotolithus senegalensis	375.09 503	44.10	78	
Myliobatis aquila	157.01 733	18.46	79	
Pentaneus quinarius	95.57 8	11.24		
Pteroscion peli	50.30 431	5.91		
Brachydeuterus auritus	34.28 437	4.03	77	
Trichurus lepturus	30.18 575	3.55		
Arius parkii	25.65 577	3.02		
Parapenaeus longirostris	18.25 50	2.15		
Aetobatus narinari	17.32 790	2.04		
Ililsha africana	17.32 8	2.04		
Cynoglossus browni	8.41 257	0.99		
Rajamiralatus	7.98 14	0.94		
Stromateus fiatola	5.39 8	0.63		
Drepane africana	4.02 6	0.47		
	3.88 8	0.46		
Total	850.63	100.00		

R/V Dr. Fridtjof Nansen	SURVEY: 2010406	STATION: 54		
DATE : 08.07.2010	GEAR TYPE: PT NO: 4	POSITION: Lat S 7°55.20		
TIME : 00:49:08 01:19:34	start stop duration	Lon E 13°5.21		
LOG : 4734.87 4736.53	30.4 (min)	Purpose : 1		
FDEPTH: 0 0	Region : 4000	Gear cond.: 0		
BDEPTH: 29 39	Valid ity : 0	Speed : 3.3 kn		
Towing dir: 0°	Wire out : 108 m	Catch/hour: 254.80		
Sorted : 129	Total catch: 129.27			
SPECIES	CATCH/HOUR	% OF TOT. C	SAMP	
Trichurus lepturus	weight numbers			
Ililsha africana	82.29 201	32.30		
Brachydeuterus auritus	67.61 1060	26.53		
Trachurus trecae	48.59 72	19.07	82	
Stromateus fiatola	24.44 49	9.59	80	
Sepla orbignyana	15.99 51	6.27		
Allectes alexandrinus	8.50 8	3.33		
Galioedecadactylus	5.64 2	2.21		
Sardinella maderensis	0.73 2	0.29	81	
Chloroscombrus chrysurus	0.61 8	0.24		
Rajamiralatus	0.22 2	0.09		
Allotheuthis africana	0.12 2	0.05		
	0.08 49	0.03		
Total	254.80	100.00		

R/V Dr. Fridtjof Nansen	SURVEY: 2010406	STATION: 55		
DATE : 08.07.2010	GEAR TYPE: BT NO: 24	POSITION: Lat S 8°6.65		
TIME : 07:33:33 08:00:20	start stop duration	Lon E 12°50.52		
LOG : 4786.69 4788.14	26.8 (min)	Purpose : 1		
FDEPTH: 118 118	1.5	Region : 4000		
BDEPTH: 118 118	Gear cond.: 0	Valid ity : 0		
Towing dir: 0°	Wire out : 290 m	Speed : 3.2 kn		
Sorted : 109	Total catch: 108.52	Catch/hour: 243.23		
SPECIES	CATCH/HOUR	% OF TOT. C	SAMP	
Trachurus trecae	weight numbers			
Dentex angolensis	96.38 356	39.62	85	
Selene dorsalis	74.41 404	30.59		
Umbri na canariensis	17.93 40	7.37	84	
Dentex congolensis	8.74 27	3.59	86	
Trichurus lepturus	7.93 110	3.26	87	
Dentex angolensis	6.14 9	2.52		
Rajamiralatus	4.86 13	2.00		
Brotula barbata	4.37 7	1.80		
Torpedo marmorata	3.65 2	1.50		
Illex coindetii	3.50 2	1.44		
Arius parkii	2.82 105	1.16		
Dentex macrophthalmus	2.73 9	1.12		
Allotheuthis africana	2.38 4	0.98		
Splacarus alba	2.35 717	0.97		
Chaetodon marcellae	1.46 27	0.60		
Zeus faber	1.23 7	0.51		
Chelidoniichthys gabonensis	0.87 2	0.36		
Saurida brasiliensis	0.47 2	0.19		
Todaropsis eblanae	0.31 49	0.13		
Boops boops	0.31 11	0.13		
Citharus linguatula	0.29 2	0.12		
Parapenaeopsis atlantica	0.04 2	0.02		
	0.02 4	0.01		
Total	243.23	100.00		

R/V Dr. Fridtjof Nansen	SURVEY: 2010406	STATION: 56		
DATE : 08.07.2010	GEAR TYPE: PT NO: 4	POSITION: Lat S 8°6.46		
TIME : 11:56:33 12:25:36	start stop duration	Lon E 13°10.40		
LOG : 4818.63 4820.66	29.1 (min)	Purpose : 1		
FDEPTH: 5 5	2.0	Region : 4000		
BDEPTH: 34 44	Gear cond.: 0	Valid ity : 0		
Towing dir: 0°	Wire out : 140 m	Speed : 4.1 kn		
Sorted : 78	Total catch: 182.31	Catch/hour: 376.54		
SPECIES	CATCH/HOUR	% OF TOT. C	SAMP	
Allectes alexandrinus	weight numbers			
Pomadasy s peroteti	139.83 78	37.13		
Pomadasy s rogeri	131.77 297	35.00		
Sardinella maderensis	30.77 99	8.17		
Sardinella aurita	29.85 159	7.93	89	
Galioedecadactylus	19.62 93	5.21	88	
Stromateus fiatola	9.91 21	2.63		
Trachurus trecae	9.34 21	2.48		
Hemirhamphus intermedius	3.92 10	1.04	90	
Ililsha africana	1.20 8	0.32		
	0.33 4	0.09		
Total	376.54	100.00		

R/V Dr. Fridtjof Nansen	SURVEY: 2010406	STATION: 57		
DATE : 08.07.2010	GEAR TYPE: PT NO: 2	POSITION: Lat S 8°13.18		
TIME : 15:41:37 16:04:04	start stop duration	Lon E 12°51.87		
LOG : 4841.88 4843.20	22.4 (min)	Purpose : 1		
FDEPTH: 70 90	1.3	Region : 4000		
BDEPTH: 120 118	Gear cond.: 0	Valid ity : 0		
Towing dir: 0°	Wire out : 280 m	Speed : 3.5 kn		
Sorted : 0	Total catch: 0.00	Catch/hour: 0.00		
SPECIES	CATCH/HOUR	% OF TOT. C	SAMP	
Brachydeuterus auritus	weight numbers			
Sardinella maderensis	334.07 2527	50.49	94	
Trachurus trecae	126.15 577	19.06	93	
Trichurus lepturus	109.63 378	16.57	91	
	49.15 4	7.43		
R/V Dr. Fridtjof Nansen	SURVEY: 2010406	STATION: 58		
DATE : 08.07.2010	GEAR TYPE: PT NO: 4	POSITION: Lat S 8°12.56		
TIME : 22:01:58 22:29:06	start stop duration	Lon E 13°9.79		
LOG : 4890.54 4892.08	27.1 (min)	Purpose : 1		
FDEPTH: 18 18	1.5	Region : 4000		
BDEPTH: 50 58	Gear cond.: 0	Valid ity : 0		
Towing dir: 0°	Wire out : 110 m	Speed : 3.4 kn		
Sorted : 166	Total catch: 299.30	Catch/hour: 661.69		
SPECIES	CATCH/HOUR	% OF TOT. C	SAMP	
Brachydeuterus auritus	weight numbers			
Sardinella maderensis	334.07 2527	50.49	94	
Trachurus trecae	126.15 577	19.06	93	
Trichurus lepturus	109.63 378	16.57	91	
	49.15 4	7.43		

Sardinella aurita	41.19	144	6.22	92
Selene dorsalis	1.07	4	0.16	
Ililsha africana	0.44	4	0.07	
Total	661.69	100.00		
R/V Dr. Fridtjof Nansen	SURVEY: 2010406	STATION: 59		
DATE : 09.07.2010	GEAR TYPE: BT NO: 24	POSITION: Lat S 8°23.90		
TIME : 08:43:59 09:03:20	start stop duration	Lon E 13°19.44		
LOG : 4976.27 4977.34	19.3 (min)	Purpose : 1		
FDEPTH: 23 23	1.1	Region : 4000		
BDEPTH: 23 23	Gear cond.: 0	Valid ity : 0		
Towing dir: 0°	Wire out : 120 m	Speed : 3.3 kn		
Sorted : 60	Total catch: 772.93	Catch/hour: 772.93		
SPECIES	CATCH/HOUR	% OF TOT. C	SAMP	
Brachydeuterus auritus	weight numbers			
Ililsha africana	662.05 9084	85.65	96	
JELLYFISH	56.15 658	7.26		
Trichurus lepturus	17.53 31	2.27		
Pomadasy s peroteti	12.16 496	1.57		
Sepla orbignyana	11.79 62	1.53		
Stromateus fiatola	10.27 19	1.33		
Pteroscion peli	10.27 87	0.18		
Trachurus trecae	0.87 12	0.11		
Trachurus trecae	0.74 12	0.10	95	
Metal waste	0.00 0	0.00		
Total	772.93	100.00		

R/V Dr. Fridtjof Nansen	SURVEY: 2010406	STATION: 60		
DATE : 09.07.2010	GEAR TYPE: BT NO: 24	POSITION: Lat S 8°41.17		
TIME : 16:47:19 17:17:29	start stop duration	Lon E 13°9.55		
LOG : 5041.14 5042.79	30.2 (min)	Purpose : 1		
FDEPTH: 84 83	1.6	Region : 4000		
BDEPTH: 84 83	Gear cond.: 0	Valid ity : 0		
Towing dir: 0°	Wire out : 210 m	Speed : 3.3 kn		
Sorted : 103	Total catch: 103.02	Catch/hour: 204.87		
SPECIES	CATCH/HOUR	% OF TOT. C	SAMP	
Trichurus lepturus	weight numbers			
Pterothriss belloci	68.71 280	33.54		
Trachurus trecae	46.04 352	22.47		
Dentex angolensis	28.84 50	14.08	98	
Brotula barbata	14.12 70	6.89	97	
Allotheuthis africana	14.02 22	6.84		
Octopus vulgaris	5.65 1442	2.76		
Epinephelus goreensis	4.04 4	1.97		
Sepla orbignyana	3.20 4	1.56		
Pentheroscion mizzi	2.70 2	1.32		
Epinephelus aeneus	2.55 8	1.24		
Torpedo torpedo	2.17 2	1.06		
Fistularia petimba	1.89 4	0.92		
Parapandalus narval	1.79 2	0.87		
Branchiostegus semifasciatus *	1.61 577	0.79		
Dentex barnardi	1.39 2	0.68		
Chaetodon hoeferi	1.37 4	0.67		
Zeus faber	0.89 4	0.44		
Illex coindetii	0.82 4	0.40		
Dicologlossa cuneata	0.82 18	0.40		
Citharus linguatula	0.72 4	0.35		
Antennarius striatus	0.66 12	0.32		
Boops boops	0.32 4	0.16		
Saurida brasiliensis	0.28 8	0.14		
Gobiidae	0.17 58	0.08		
	0.12 16	0.06		
Total	204.87	100.00		

R/V Dr. Fridtjof Nansen	SURVEY: 2010406	STATION: 61		
DATE : 10.07.2010	GEAR TYPE: PT NO: 4	POSITION: Lat S 8°58.00		
TIME : 02:55:43 03:25:45	start stop duration	Lon E 13°0.30		
LOG : 5120.68 5122.55	120.0 (min)	Purpose : 1		
FDEPTH: 0 0	1.9	Region : 4000		
BDEPTH: 105 155	Gear cond.: 0	Valid ity : 0		
Towing dir: 0°	Wire out : 0 m	Speed : 3.7 kn		
Sorted : 62	Total catch: 280.53	Catch/hour: 140.26		
SPECIES	CATCH/HOUR	% OF TOT. C	SAMP	
Brachydeuterus auritus	weight numbers			
Trachinus ovatus	102.60 848	73.15	99	
Trichurus lepturus	19.47 168	13.88		
Saurida brasiliensis	13.84 54	9.86		
JELLYFISH	1.58 387	1.12		
Sardinella maderensis	1.58 11	1.12		
Trachurus trecae	0.42 2	0.30	100	
Engraulis encrasiolus	0.35 0	0.25	101	
Pteroscion peli	0.20 38	0.14		
Selene dorsalis	0.11 7	0.08		
MYCTOPHIDAE	0.07 11	0.05		
	0.07 4	0.05		
Total	140.26	100.00		

R/V Dr. Fridtjof Nansen	SURVEY: 2010406	STATION: 62		
DATE : 10.07.2010	GEAR TYPE: PT NO: 1	POSITION: Lat S 8°59.45		
TIME : 04:18:34 04:41:26	start stop duration	Lon E 12°58.70		
LOG : 5127.22 5128.59	22.9 (min)	Purpose : 1		
FDEPTH: 20 23	1.4	Region : 4000		
BDEPTH: 150 185	Gear cond.: 0	Valid ity : 0		
Towing dir: 0°	Wire out : 0 m	Speed : 3.6 kn		
Sorted : 11	Total catch: 10.94	Catch/hour: 28.70		
SPECIES	CATCH/HOUR	% OF TOT. C	SAMP	
Trichurus lepturus	weight numbers			
JELLYFISH	3.19 50	63.37		
SALP	1.55 570	30.17		
Trachurus trecae	0.20 447	4.07	103	
Selene dorsalis	0.09 117	1.74	102	
Leptocephalus	0.00 15	0.00		
BRAMIDAE	0.00 6	0.00		
Ariomma bondi	0.00 9	0.00		
SOLEIDAE	0.00 6	0.00		
TRIGLIDAE	0.00 32	0.00		
TRICHIURIDAE	0.00 3	0.00		
Total	5.03	100.00		

R/V Dr. Fridtjof Nansen		SURVEY: 2010406		STATION: 63	
DATE : 10.07.2010	GEAR TYPE: PT NO: 1	POSITION: Lat S 9°2.75		E 12°22.59	
TIME : 09:21:27	start stop	duration	Purpose :	1	
LOG : 5169.49	09:41:58	20.5 (min)	Region :	4000	
FDEPTH: 15	5170.81	1.3	Gear cond.:	Valid ity : 0	
BDEPTH: 1397	1360		Speed :	3.9 kn	
Towing dir: 0°	Wire out :	110 m	Catch/hour:	5.03	
Sorted : 2	Total catch:	1.72			
SPECIES					
			CATCH/HOUR	% OF TOT. C	SAMP
			weight	numbers	
JELLYFISH			3.19	50	63.37
SALPS			1.55	570	30.81
Trachurus trecae			0.20	447	4.07
Selene dorsalis			0.09	117	1.74
Leptocephalus			0.00	15	0.00
BRAMI DAE			0.00	6	0.00
Ariomma bondi			0.00	9	0.00
SOLEI DAE			0.00	6	0.00
TRI GLI DAE			0.00	32	0.00
TRI CHI URI DAE			0.00	3	0.00
Total			5.03	100.00	

LOG : 5237.84 5239.19 1.4  
FDEPTH: 14 14  
BDEPTH: 23 23  
Towing dir: 0° Wire out : 100 m  
Sorted : 0 Total catch: 20.48

Region : 4000  
Gear cond.: 0  
Valid it y : 0  
Speed : 2.8 kn  
Catch/hour: 42.10

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	wei ght numbers		
Brachydeuterus auritus	26.72 549	63.48	107
Trachurus trecae	9.27 117	22.02	104
Sardinella maderensis	2.16 25	5.13	105
Sphyræna sphyræna	1.54 23	3.66	
Trichurus lepturus	0.86 31	2.05	
Sphyræna guachancho	0.68 2	1.61	
Selene dorsalis	0.58 10	1.37	106
Sardinella auri ta	0.21 4	0.49	
Sepiella ornata	0.04 6	0.10	
Saurida brasiliensis	0.02 2	0.05	
Ilisha africana	0.02 2	0.05	
Total	42.10	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 65  
DATE : 11.07.2010 GEAR TYPE: PT NO: 7 POSITION: Lat S 9°14.73  
start stop duration Lon E 12°56.92

TIME : 05:24:36 05:54:07 29.5 (min)  
LOG : 5293.54 5295.06 1.5  
FDEPTH: 14 14  
BDEPTH: 24 24  
Towing dir: 0° Wire out : 110 m  
Sorted : 0 Total catch: 24.51

Purpose : 1  
Region : 4000  
Gear cond.: 0  
Valid it y : 0  
Speed : 3.1 kn  
Catch/hour: 49.82

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	wei ght numbers		
Sardinella maderensis	38.52 232	77.32	108
Selæna crumenophthalmus	7.11 18	14.28	
Sardinella auri ta	4.11 18	8.24	109
Decapterus punctatus	0.08 2	0.16	
Total	49.82	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 66  
DATE : 11.07.2010 GEAR TYPE: BT NO: 24 POSITION: Lat S 9°21.24  
start stop duration Lon E 12°48.61

TIME : 08:39:02 09:10:22 31.3 (min)  
LOG : 5318.11 5319.68 1.6  
FDEPTH: 105 98  
BDEPTH: 105 98  
Towing dir: 0° Wire out : 260 m  
Sorted : 192 Total catch: 192.00

Purpose : 1  
Region : 4000  
Gear cond.: 0  
Valid it y : 0  
Speed : 3.0 kn  
Catch/hour: 367.58

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	wei ght numbers		
Selene dorsalis	103.86 565	28.26	113
Trachurus trecae	48.15 130	13.10	110
Dentex angolensis	42.79 174	11.64	112
JELLYFISH	35.90 52	9.77	
Apogon sp.	20.94 17058	6.24	
Zeus faber	13.88 40	3.78	
Octopus sp.	11.77 4	3.20	
Trichurus lepturus	11.49 23	3.13	
Chelidoniichthys gabonensis	10.05 59	2.73	
Brotula barbatâ	9.19 8	2.50	
Uranoscopus cadenati	7.43 65	2.02	
Citharus linguatula	7.28 100	1.98	
Lagocephalus laevis	5.38 6	1.46	
Pagellus belottii	5.19 11	1.41	
Sepia orbignyana	5.15 0	1.40	
Scorpaena normani	4.21 27	1.15	
Alloteuthis africana	3.71 1164	1.01	
Saurida brasiliensis	3.10 605	0.84	
Pterothrissus belloci	2.32 10	0.63	
Sardinella auri ta	2.20 10	0.60	111
Branchiostegus semifasciatus *	2.14 2	0.58	
Ilix coindetii	2.01 15	0.55	
Rajamiraletus	1.68 4	0.46	
Dentex barnardi	1.38 6	0.38	
Lophius vaillanti	1.11 4	0.30	
Brachydeuterus auritus	0.86 4	0.23	
Torpedo torpedo	0.63 2	0.17	
Boops boops	0.50 2	0.14	
Syacium micrurum	0.48 15	0.13	
Sardinella maderensis	0.34 2	0.09	
Parapenaeus longirostris	0.19 40	0.05	
Merluccius polli	0.11 10	0.03	
C R A B S	0.08 10	0.02	
GOBIIDAE	0.08 4	0.02	
Total	367.58	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 67  
DATE : 11.07.2010 GEAR TYPE: PT NO: 2 POSITION: Lat S 9°22.93  
start stop duration Lon E 12°42.98

TIME : 10:54:22 11:25:51 31.5 (min)  
LOG : 5330.23 5332.34 2.1  
FDEPTH: 0 30  
BDEPTH: 164 168  
Towing dir: 0° Wire out : 200 m  
Sorted : 0 Total catch: 0.07

Purpose : 1  
Region : 4000  
Gear cond.: 0  
Valid it y : 0  
Speed : 4.0 kn  
Catch/hour: 0.13

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	wei ght numbers		
Trachurus trecae	0.02 4	0.00	
JELLYFISH	0.10 6	0.00	
Selene dorsalis	0.02 2	0.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 68  
DATE : 11.07.2010 GEAR TYPE: PT NO: 1 POSITION: Lat S 9°25.51  
start stop duration Lon E 12°56.26

TIME : 16:02:28 16:19:18 16.8 (min)  
LOG : 5365.93 5367.13 1.2  
FDEPTH: 20 30  
BDEPTH: 61 62  
Towing dir: 0° Wire out : 110 m  
Sorted : 0 Total catch: 0.00

Purpose : 1  
Region : 4000  
Gear cond.: 0  
Valid it y : 0  
Speed : 4.3 kn  
Catch/hour: 0.00

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	wei ght numbers		
N O C A T C H	0.00	0	0.00

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 69  
DATE : 12.07.2010 GEAR TYPE: PT NO: 7 POSITION: Lat S 9°35.64  
start stop duration Lon E 13°9.10

TIME : 01:40:14 02:10:03 29.8 (min)  
LOG : 5446.34 5448.23 1.9  
FDEPTH: 10 10  
BDEPTH: 22 22  
Towing dir: 0° Wire out : 110 m  
Sorted : 67 Total catch: 366.15

Purpose : 1  
Region : 4000  
Gear cond.: 0  
Valid it y : 0  
Speed : 3.8 kn  
Catch/hour: 736.72

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	wei ght numbers		
Sardinella maderensis	358.63 2082	48.27	114
Ilisha africana	117.71 3179	15.98	
Brachydeuterus auritus	52.31 1056	7.10	115
Sphyræna guachancho	52.31 60	7.10	
Boops boops	37.73 1761	5.12	

Galeoides decadactylus	32.90	825	4.47
Pteroscione peli	28.87	513	3.92
Stromateus fiatola	12.47	40	1.69
Sepia orbignyana	11.27	16	1.53
Decapterus punctatus	10.16	111	1.38
Trichurus lepturus	8.75	543	1.19
Rajamiraletus	6.94	10	0.94
Priacanthus arenatus	3.92	80	0.53
Engraulis encrasiolus	2.92	905	0.40
Eucinostomus melanopterus	1.61	0	0.22
Pomadasys uncius	0.70	10	0.10
Pseudupeneus prayensis	0.50	10	0.07
Total	736.72	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 70  
DATE : 12.07.2010 GEAR TYPE: PT NO: 2 POSITION: Lat S 9°50.33  
start stop duration Lon E 12°52.94

TIME : 08:37:43 08:44:21 6.6 (min)  
LOG : 5500.19 5500.59 0.4  
FDEPTH: 25 35  
BDEPTH: 129 137  
Towing dir: 0° Wire out : 120 m  
Sorted : 45 Total catch: 45.06

Purpose : 1  
Region : 4000  
Gear cond.: 0  
Valid it y : 0  
Speed : 3.7 kn  
Catch/hour: 407.17

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	wei ght numbers		
Sardinella maderensis	280.57 1301	68.91	117
Sardinella auri ta	99.85 361	24.52	116
Sarda sarda	26.75 18	6.57	118
Total	407.17	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 71  
DATE : 12.07.2010 GEAR TYPE: BT NO: 24 POSITION: Lat S 9°50.44  
start stop duration Lon E 12°53.79

TIME : 09:57:28 10:22:59 25.5 (min)  
LOG : 5507.62 5508.95 1.3  
FDEPTH: 120 122  
BDEPTH: 120 122  
Towing dir: 0° Wire out : 310 m  
Sorted : 185 Total catch: 369.54

Purpose : 1  
Region : 4000  
Gear cond.: 0  
Valid it y : 0  
Speed : 3.1 kn  
Catch/hour: 868.82

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	wei ght numbers		
Trachurus trecae	700.86 2107	80.67	119
Dentex angolensis	108.86 52	12.53	120
Branchiostegus semifasciatus *	14.39 24	1.66	
Erythrocles monodi	14.39 24	1.66	
Lagocephalus laevis	6.07 9	0.70	
Squatina oculata	5.50 5	0.63	
Rajamiraletus	4.70 5	0.54	
Sepia orbignyana	3.95 19	0.45	
Dentex macrophthalmus	3.15 19	0.36	
Chelidoniichthys gabonensis	1.60 9	0.18	
Todarodes sagittatus	1.36 66	0.16	
Anthias anthias	0.99 24	0.11	
Syacium micrurum	0.75 24	0.09	
Citharus linguatula	0.71 14	0.08	
Uranoscopus scyllium	0.71 9	0.08	
Dentex congolensis	0.56 9	0.06	
Ilix coindetii	0.28 5	0.03	
Total	868.82	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 72  
DATE : 12.07.2010 GEAR TYPE: PT NO: 1 POSITION: Lat S 9°43.99  
start stop duration Lon E 13°9.61

TIME : 13:21:42 13:51:45 30.0 (min)  
LOG : 5528.27 5530.20 1.9  
FDEPTH: 20 30  
BDEPTH: 33 43  
Towing dir: 0° Wire out : 110 m  
Sorted : 95 Total catch: 218.48

Purpose : 1  
Region : 4000  
Gear cond.: 0  
Valid it y : 0  
Speed : 3.9 kn  
Catch/hour: 436.37

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	wei ght numbers		
Sardinella maderensis	383.36 2569	87.85	121
Sardinella auri ta	50.07 230	11.47	122
Lagocephalus laevis	1.24 14	0.28	
Remora remora	1.10 4	0.25	
Brachydeuterus auritus	0.60 1	0.14	
Total	436.37	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 73  
DATE : 12.07.2010 GEAR TYPE: BT NO: 24 POSITION: Lat S 10°2.32  
start stop duration Lon E 12°52.65

TIME : 22:22:05 22:52:24 30.3 (min)  
LOG : 5582.86 5584.33 1.5  
FDEPTH: 257 250  
BDEPTH: 257 250  
Towing dir: 0° Wire out : 640 m  
Sorted : 39 Total catch: 308.00

Purpose : 1  
Region : 4000  
Gear cond.: 0  
Valid it y : 0  
Speed : 2.9 kn  
Catch/hour: 609.70

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	wei ght numbers		
Synagrops microlepis	96.92 95	15.90	
Pterothrissus belloci	75.22 554	12.34	
Merluccius polli	71.16 190	12.00	
Zenopsis conchifer	67.30 111	11.04	
Chlorophthalmus atlanticus	67.15 1219	11.01	
Centrophorus granulosus	58.59 16	9.61	
Hoplostethus mediterraneus	57.01 79	9.35	
Bembrops greyi	28.03 253	4.60	
Micracoroni angolensis	26.92 16	4.42	
Pontinus accraensis	17.10 190	2.81	
Erythrocles monodi	16.31 16	2.68	
Aristeus varidens	8.55 1235	1.40	
Gadella maraldi	7.76 95	1.27	
Nezumia aequalis	5.23 63	0.86	
Egionus telescopus	3.80 32	0.62	
Diphus dumerilii	0.63 507	0.10	
Total	609.70	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 74  
DATE : 13.07.2010 GEAR TYPE: PT NO: 7 POSITION: Lat S 9°56.39  
start stop duration Lon E 13°15.27

TIME : 02:13:00 02:43:23 30.4 (min)  
LOG : 5610.71 5612.42 1.7  
FDEPTH: 10 10  
BDEPTH: 20 20  
Towing dir: 0° Wire out : 140 m  
Sorted : 195 Total catch: 194.82

Purpose : 1  
Region : 4000  
Gear cond.: 0  
Valid it y : 0  
Speed : 3.4 kn  
Catch/hour: 384.77

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	wei ght numbers		
Galeoides decadactylus	105.46 1215	27.41	
Brachydeuterus auritus	95.10 3229	24.72	124
Sardinella maderensis	62.21 2619	16.17	123
Ilisha africana	37.86 1191	9.84	
Eucinostomus melanopterus	16.71 219	4.34	
Pteroscione peli	12.92 758	3.33	
Lagocephalus laevis	12.50 6	3.25	
Sepia orbignyana	7.23 24	1.88	
Ephippion guttifer	7.11 6	1.85	
Pomadasys rogeri	7.05 18	1.83	
Stromateus fiatola	5.81 12	1.51	

Trichiurus lepturus	4.68	427	1.22
Parapenaeus longirostris	4.21	936	1.09
Pomadasy s incli sus	2.31	18	0.60
Engrauli s encrasi col us	1.84	569	0.48
Boops boops	1.01	41	0.26
Sardinella auri ta	0.47	6	0.12
Pentanemus qui nquari us	0.24	6	0.06
Selene dorsali s	0.06	18	0.02
Total	384.77	100.00	

R/V Dr. Fridtjof Nansen	SURVEY: 2010406	STATION: 75
DATE : 13.07.2010	GEAR TYPE: BT NO: 24	POSITION: Lat S 10°13.88
		Lon E 13°4.11
TIME : 09:19:41 09:40:10	duration 20.5 (min)	Purpose : 1
LOG : 5661.79 5662.89	1.1	Region : 4000
FDEPTH: 111	110	Gear cond.: 0
BDEPTH: 111	110	Validi ty : 0
Towing dir.: 0°	Wire out : 280 m	Speed : 3.2 kn
Sorted : 77	Total catch: 76.65	Catch/hour: 224.45

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Dentex angol ensi s	71.45	483	31.83	127
Chel idoni chthys gabonensi s	45.68	343	20.35	
Lagocephal us laevi gatus	28.40	61	12.65	
Trachurus trecae	24.74	442	11.02	125
Allotheuthi s afri cana	7.14	1414	3.18	
Pagell us bel lotti i	7.03	32	3.13	126
Zeus faber	6.73	18	3.00	
Dentex barnardi	6.03	18	2.69	
Dentex macrophthal mus	3.84	12	1.71	
Trichiurus lepturus	3.84	6	1.71	
Raja mi ral etus	3.66	6	1.63	
Illex coi ndeti i	2.87	129	1.28	
Umbrina canari ensi s	1.84	3	1.25	
Torpedo torpedo	2.05	3	0.91	
Uranoscopus polli i	1.96	6	0.87	
Fitularia petimba	1.67	3	0.74	
Sepia orbi gnyana	1.29	18	0.57	
Ariomma bondi	1.17	41	0.52	
Pontius accraensi s	1.08	12	0.48	
Citharus linguatula	0.53	23	0.23	
Chaetodon hoefleri	0.47	3	0.21	
Total	224.45	100.00		

R/V Dr. Fridtjof Nansen	SURVEY: 2010406	STATION: 76
DATE : 13.07.2010	GEAR TYPE: PT NO: 1	POSITION: Lat S 10°16.51
		Lon E 13°18.97
TIME : 13:51:30 14:22:10	duration 30.7 (min)	Purpose : 1
LOG : 5694.60 5696.58	2.0	Region : 4000
FDEPTH: 20	30	Gear cond.: 0
BDEPTH: 65	54	Validi ty : 0
Towing dir.: 0°	Wire out : 120 m	Speed : 3.9 kn
Sorted : 0	Total catch: 0.05	Catch/hour: 0.10

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sepiella ornata	0.10	4	0.00	

R/V Dr. Fridtjof Nansen	SURVEY: 2010406	STATION: 77
DATE : 13.07.2010	GEAR TYPE: PT NO: 24	POSITION: Lat S 10°19.50
		Lon E 13°12.19
TIME : 16:17:34 16:31:11	duration 13.6 (min)	Purpose : 1
LOG : 5709.07 5709.75	0.7	Region : 4000
FDEPTH: 100	101	Gear cond.: 0
BDEPTH: 100	101	Validi ty : 0
Towing dir.: 0°	Wire out : 250 m	Speed : 3.0 kn
Sorted : 96	Total catch: 96.34	Catch/hour: 424.41

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Pagell us bel lotti i	135.90	771	32.02	129
Dentex angol ensi s	105.07	542	24.76	130
Chel idoni chthys gabonensi s	56.61	348	13.34	
Squatina oculata	26.21	4	6.18	
Trachurus trecae	25.99	106	6.12	128
Dentex barnardi	15.73	53	3.71	
Boops boops	15.33	308	3.61	
Allotheuthi s afri cana	10.66	3233	2.51	
Dentex macrophthal mus	9.65	26	2.27	
Zeus faber	8.77	22	2.07	
Lagocephal us laevi gatus	8.59	18	2.02	
Raja mi ral etus	3.30	4	0.78	
Citharus linguatula	1.10	22	0.26	
Chaetodon hoefleri	0.75	4	0.18	
Illex coi ndeti i	0.75	40	0.18	
Total	424.41	100.00		

R/V Dr. Fridtjof Nansen	SURVEY: 2010406	STATION: 78
DATE : 17.07.2010	GEAR TYPE: PT NO: 4	POSITION: Lat S 10°23.81
		Lon E 13°17.15
TIME : 03:23:32 03:52:30	duration 29.0 (min)	Purpose : 1
LOG : 5982.44 5983.92	1.5	Region : 4000
FDEPTH: 10	10	Gear cond.: 0
BDEPTH: 91	97	Validi ty : 0
Towing dir.: 0°	Wire out : 135 m	Speed : 3.1 kn
Sorted : 6	Total catch: 5.78	Catch/hour: 11.97

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Engrauli s encrasi col us	5.34	1054	44.64	
Sarda sarda	2.44	2	20.42	
Trichiurus lepturus	2.13	2	17.82	
Allotheuthi s afri cana	0.72	220	6.06	
Illex coi ndeti i	0.60	35	5.02	
Lagocephal us laevi gatus	0.56	6	4.67	
Trachurus trecae	0.17	4	1.38	
Total	11.97	100.00		

R/V Dr. Fridtjof Nansen	SURVEY: 2010406	STATION: 79
DATE : 17.07.2010	GEAR TYPE: PT NO: 24	POSITION: Lat S 10°34.39
		Lon E 13°12.87
TIME : 10:29:45 11:00:27	duration 30.7 (min)	Purpose : 1
LOG : 6036.11 6037.67	1.6	Region : 4000
FDEPTH: 141	137	Gear cond.: 0
BDEPTH: 141	137	Validi ty : 0
Towing dir.: 0°	Wire out : 370 m	Speed : 3.1 kn
Sorted : 311	Total catch: 310.74	Catch/hour: 607.51

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Trachurus trecae	300.78	1083	49.51	131
Dentex macrophthal mus	90.22	362	14.85	133
Dentex angol ensi s	86.71	409	14.27	132
Trachurus trachurus	55.72	113	9.17	
Zenopsis conchi fer	19.75	20	3.25	
Loligo vulgaris	13.49	452	2.22	
Brotula barbata	12.02	8	1.98	
Atractoscion aequidens	4.65	2	0.77	
Citharus linguatula	4.38	68	0.72	
Spicaral ta	3.42	27	0.56	
Lagocephal us laevi gatus	3.36	6	0.55	
Illex coi ndeti i	2.54	29	0.42	
Raja mi ral etus	1.78	2	0.29	
Chel idoni chthys gabonensi s	1.76	14	0.29	
Raja straeleni	1.76	2	0.29	
Squatina oculata	1.21	2	0.20	
Solea senegal ensi s	1.00	31	0.16	
Pterothrissus bel ioci	0.84	6	0.14	
J E L L Y F I S H	0.59	10	0.10	
Sepia orbi gnyana	0.45	6	0.07	
Anthias anthias	0.41	2	0.07	
Umbrina canari ensi s	0.37	2	0.06	
Uranoscopus cadenati	0.23	2	0.04	
Peristedion cataphractum	0.06	4	0.01	
Total	607.51	100.00		

R/V Dr. Fridtjof Nansen	SURVEY: 2010406	STATION: 80
DATE : 17.07.2010	GEAR TYPE: PT NO: 4	POSITION: Lat S 10°31.91
		Lon E 13°28.94
TIME : 16:15:18 16:46:37	duration 31.3 (min)	Purpose : 1
LOG : 6073.71 6075.23	1.5	Region : 4000
FDEPTH: 0	0	Gear cond.: 0
BDEPTH: 55	62	Validi ty : 0
Towing dir.: 0°	Wire out : 140 m	Speed : 2.9 kn
Sorted : 15	Total catch: 15.33	Catch/hour: 29.37

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardinella auri ta	23.85	96	81.21	134
Sardinella maderensi s	5.00	34	17.03	135
Trachinotus ovatus	0.52	4	1.76	
Total	29.37	100.00		

R/V Dr. Fridtjof Nansen	SURVEY: 2010406	STATION: 81
DATE : 17.07.2010	GEAR TYPE: PT NO: 7	POSITION: Lat S 10°31.11
		Lon E 13°36.42
TIME : 18:44:55 19:07:18	duration 22.4 (min)	Purpose : 1
LOG : 6088.24 6089.41	1.2	Region : 4000
FDEPTH: 0	0	Gear cond.: 0
BDEPTH: 23	22	Validi ty : 0
Towing dir.: 0°	Wire out : 140 m	Speed : 3.1 kn
Sorted : 99	Total catch: 496.30	Catch/hour: 1329.97

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardinella auri ta	840.78	5601	63.22	136
Sardinella maderensi s	334.22	2090	25.13	137
Brachydeuterus auri tus	140.69	6906	10.58	138
Galeol des decadactyl us	4.02	94	0.30	
Trichiurus lepturus	3.62	27	0.27	
Lagocephal us laevi gatus	2.55	5	0.19	
Sphyræna sphyraena	2.01	121	0.15	
Pomadasy s incli sus	2.01	5	0.15	
Total	1329.89	99.99		

R/V Dr. Fridtjof Nansen	SURVEY: 2010406	STATION: 82
DATE : 17.07.2010	GEAR TYPE: PT NO: 7	POSITION: Lat S 10°31.11
		Lon E 13°36.42
TIME : 18:44:55 19:07:18	duration 22.4 (min)	Purpose : 1
LOG : 6088.24 6089.41	1.2	Region : 4000
FDEPTH: 0	0	Gear cond.: 0
BDEPTH: 23	22	Validi ty : 0
Towing dir.: 0°	Wire out : 140 m	Speed : 3.1 kn
Sorted : 0	Total catch: 29.66	Catch/hour: 79.48

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
MYCTOPHIDAE	63.51	6351	79.91	
J E L L Y F I S H	15.89	3644	19.99	
Zu cristatus	0.08	3	0.10	
Total	79.48	100.00		

R/V Dr. Fridtjof Nansen	SURVEY: 2010406	STATION: 83
DATE : 18.07.2010	GEAR TYPE: PT NO: 1	POSITION: Lat N 10°55.20
		Lon E 13°43.60
TIME : 14:30:43 14:50:42	duration 20.0 (min)	Purpose : 1
LOG : 6233.77 6235.06	1.3	Region : 4000
FDEPTH: 30	30	Gear cond.: 0
BDEPTH: 53	53	Validi ty : 0
Towing dir.: 0°	Wire out : 110 m	Speed : 3.9 kn
Sorted : 0	Total catch: 57.29	Catch/hour: 171.87

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardinella maderensi s	170.55	954	99.23	139
Sarda sarda	1.32	3	0.77	
Total	171.87	100.00		

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 84  
DATE : 18.07.2010 GEAR TYPE: BT NO: 24 POSITION: Lat S 10°53.95  
start stop duration Lon E 13°42.99  
TIME : 15:27:44 15:58:04 Purpose : 1  
LOG : 6237.00 6238.47 Region : 4000  
FDEPTH: 53 Gear cond.: 0  
BDEPTH: 53 54 Validity : 0  
Towing dir.: 0° Wire out : 175 m Speed : 2.9 kn  
Sorted : 99 Total catch: 203.13 Catch/hour: 401.71

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Trichiurus lepturus	208.83	1780	51.99	
Brachydeuterus aurius	35.20	320	8.76	142
Bembröps heterurus	17.36	1744	4.32	
Sepia orbigyana	17.21	16	4.28	
Gobiidae	15.74	28	3.92	
Rhinobatos albomaculatus	14.04	8	3.50	
Pagellus bellottii	12.89	79	3.21	141
Citharus linguatula	12.50	700	3.11	
Trachurus trecae	12.36	53	3.08	140
Scorpaena normani	11.87	386	2.95	
Rajamiraletus	7.67	16	1.91	
Torpedo torpedo	7.48	20	1.86	
Pterothrissus bellotti	7.24	63	1.80	
Brotula barbata	4.23	20	1.05	
Pseudotolithus senegalensis	4.23	4	1.05	
Parapenaeus longirostris	3.32	1721	0.83	
Pegusa lascaris	2.14	8	0.53	
Umbriacanariensis	1.66	12	0.41	
Argyrosomus hololepidotus	1.27	4	0.32	
Pomadysus incisus	1.27	8	0.32	
Pentheroscion mbi zi	1.27	16	0.32	
Serranus cabrilla	0.99	40	0.25	
Merluccius polli	0.44	123	0.11	
ANTENNARIDAE	0.32	12	0.08	
Zenopsis conchifer	0.08	12	0.02	
Ephippion guttifer	0.04	16	0.01	
Squilla mantis	0.04	16	0.01	
Scyllarides herklotsii	0.04	40	0.01	
Total		401.71	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 85  
DATE : 19.07.2010 GEAR TYPE: PT NO: 4 POSITION: Lat N 11°3.40  
start stop duration Lon E 13°35.50  
TIME : 20:32:28 21:02:07 Purpose : 1  
LOG : 6270.99 6272.55 Region : 4000  
FDEPTH: 10 10 Gear cond.: 0  
BDEPTH: 148 189 Validity : 0  
Towing dir.: 0° Wire out : 150 m Speed : 0.0 kn  
Sorted : 0 Total catch: 106.24 Catch/hour: 212.48

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
MYCTOPHIDAE	113.20	110278	53.28	
Trichiurus lepturus	92.40	84	43.49	
Sardinella maderensis	4.20	22	1.98	143
Trachurus trecae	2.66	6	1.25	
Synagrops microlepis	0.02	2	0.01	
Total		212.48	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 86  
DATE : 19.07.2010 GEAR TYPE: PT NO: 4 POSITION: Lat S 11°8.35  
start stop duration Lon E 13°44.89  
TIME : 00:53:31 01:14:23 Purpose : 1  
LOG : 6302.81 6303.85 Region : 4000  
FDEPTH: 10 10 Gear cond.: 0  
BDEPTH: 65 65 Validity : 0  
Towing dir.: 0° Wire out : 120 m Speed : 3.0 kn  
Sorted : 16 Total catch: 99.82 Catch/hour: 286.98

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardinella maderensis	161.57	607	56.30	144
Sardinella aurata	83.95	256	29.25	145
Trichiurus lepturus	14.37	40	5.01	
Brachydeuterus aurius	11.99	89	4.18	
Synagrops microlepis	9.34	4169	3.26	
MYCTOPHIDAE	3.42	3559	1.19	
Trachinotus ovatus	1.49	6	0.52	
Bregmaceros sp.	0.57	359	0.20	
Allotheutis africana	0.26	388	0.09	
Total		286.98	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 87  
DATE : 19.07.2010 GEAR TYPE: PT NO: 1 POSITION: Lat S 11°20.68  
start stop duration Lon E 13°31.67  
TIME : 09:28:43 10:07:32 Purpose : 1  
LOG : 6366.71 6369.12 Region : 4000  
FDEPTH: 25 25 Gear cond.: 0  
BDEPTH: 166 56 Validity : 0  
Towing dir.: 0° Wire out : 80 m Speed : 3.7 kn  
Sorted : 0 Total catch: 0.00 Catch/hour: 0.00

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
NOCATCH	0.00	0	0.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 88  
DATE : 20.07.2010 GEAR TYPE: PT NO: 4 POSITION: Lat N 11°38.00  
start stop duration Lon E 13°28.10  
TIME : 20:42:58 21:12:47 Purpose : 1  
LOG : 6453.33 6454.84 Region : 4000  
FDEPTH: 0 30 Gear cond.: 0  
BDEPTH: 122 128 Validity : 0  
Towing dir.: 0° Wire out : 140 m Speed : 3.0 kn  
Sorted : 107 Total catch: 106.97 Catch/hour: 215.38

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardinella maderensis	52.05	183	24.17	146
Trachurus trecae	45.10	97	20.94	147
Sarda sarda	37.15	32	17.25	
Scomber japonicus	32.01	79	14.86	148
MYCTOPHIDAE	27.66	8299	12.84	
Trichiurus lepturus	14.80	32	6.87	
Trachinotus ovatus	3.52	12	1.64	
Auxis thazard	2.40	6	1.11	
Hemiramphus balao	0.68	6	0.32	
Total		215.38	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 89  
DATE : 20.07.2010 GEAR TYPE: PT NO: 1 POSITION: Lat S 11°50.32  
start stop duration Lon E 13°26.80  
TIME : 04:56:10 05:26:36 Purpose : 1  
LOG : 6518.98 6520.77 Region : 4000  
FDEPTH: 30 30 Gear cond.: 0  
BDEPTH: 281 343 Validity : 0  
Towing dir.: 0° Wire out : 110 m Speed : 3.5 kn  
Sorted : 0 Total catch: 0.00 Catch/hour: 0.00

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
NOCATCH	0.00	0	0.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 90  
DATE : 20.07.2010 GEAR TYPE: BT NO: 24 POSITION: Lat S 11°50.88  
start stop duration Lon E 13°35.93  
TIME : 07:33:50 08:03:41 Purpose : 1  
LOG : 6534.63 6536.14 Region : 4000  
FDEPTH: 99 102 Gear cond.: 0  
BDEPTH: 99 102 Validity : 0  
Towing dir.: 0° Wire out : 260 m Speed : 3.0 kn  
Sorted : 0 Total catch: 166.94 Catch/hour: 335.56

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Trachurus trecae	138.03	746	41.13	149
Dentex macrophthalmus	66.03	366	19.68	150
Trigla lyra	21.01	163	6.26	
Pagellus bellottii	16.38	103	4.88	153
Dentex barnardi	16.32	58	4.86	151
Dentex angolensis	15.78	143	4.70	152
Zeus faber	10.45	26	3.11	
Branchiostegus semifasciatus	7.26	8	2.16	
Sepia orbigyana	6.87	12	2.05	
Rajamiraletus	6.53	10	1.95	
Chaetodon hoefleri	4.30	24	1.28	
Trichiurus lepturus	4.22	6	1.26	
Lagocephalus laevis	4.04	12	1.21	
Citharus linguatula	3.56	80	1.06	
Zenopsis conchifer	3.50	2	1.04	
Allotheutis africana	2.33	442	0.69	
Octopus vulgaris	1.99	2	0.59	
Uranoscopus cadonati	1.89	6	0.56	
Umbriacanariensis	1.87	8	0.56	
Scorpaena normani	1.47	16	0.44	
Boops boops	1.25	12	0.37	
Saurida brasiliensis	0.34	38	0.10	
Syacium micrurum	0.14	6	0.04	
Total		335.56	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 91  
DATE : 20.07.2010 GEAR TYPE: PT NO: 7 POSITION: Lat N 11°56.10  
start stop duration Lon E 13°44.50  
TIME : 10:26:57 10:52:56 Purpose : 1  
LOG : 6555.00 6556.28 Region : 4000  
FDEPTH: 10 10 Gear cond.: 0  
BDEPTH: 17 22 Validity : 1  
Towing dir.: 0° Wire out : 160 m Speed : 3.0 kn  
Sorted : 149 Total catch: 981.52 Catch/hour: 2265.04

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardinella aurata	1622.40	18743	71.63	154
Pomadysus lubini	175.02	990	7.73	
Brachydeuterus aurius	134.40	5008	5.93	
Galeodes decadactylus	97.62	678	4.31	
Sepia orbigyana	79.02	120	3.49	
Allotheutis alexandrinus	66.35	53	2.93	
Eucinostomus melanopterus	20.68	118	0.91	
Ilisha africana	16.39	886	0.72	
Decapterus rhonchus	10.93	74	0.48	
Pomadysus incisus	8.57	88	0.38	
Selene dorsalis	8.57	235	0.38	
Sphyræna guachancho	8.27	60	0.37	
Stromateus fiatola	4.73	14	0.21	
Trachurus trecae	4.14	104	0.18	155
Sardinella maderensis	2.81	14	0.12	
Caranx senegalus	2.66	14	0.12	
Lagocephalus laevis	1.48	14	0.07	
Pteroscion peli	1.03	30	0.05	
Total		2265.04	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 92  
DATE : 20.07.2010 GEAR TYPE: PT NO: 2 POSITION: Lat S 11°56.31  
start stop duration Lon E 13°32.06  
TIME : 13:08:22 14:28:40 Purpose : 1  
LOG : 6572.59 6577.14 Region : 4000  
FDEPTH: 65 93 Gear cond.: 0  
BDEPTH: 106 164 Validity : 0  
Towing dir.: 0° Wire out : 195 m Speed : 3.4 kn  
Sorted : 0 Total catch: 0.00 Catch/hour: 0.00

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
NOCATCH	0.00	0	0.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 93  
DATE : 20.07.2010 GEAR TYPE: PT NO: 4 POSITION: Lat S 12°2.76  
start stop duration Lon E 13°38.79  
TIME : 18:40:15 19:10:57 Purpose : 1  
LOG : 6606.21 6607.97 Region : 4000  
FDEPTH: 10 10 Gear cond.: 0  
BDEPTH: 51 70 Validity : 0  
Towing dir.: 0° Wire out : 0 m Speed : 3.4 kn  
Sorted : 0 Total catch: 30.70 Catch/hour: 60.00

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardinella maderensis	36.94	213	61.56	156
Sepia orbigyana	10.65	6	17.75	
Trachurus trecae	8.50	41	14.17	157
Trichiurus lepturus	3.73	20	6.22	
Sphyræna guachancho	0.10	2	0.16	
Allotheutis africana	0.08	33	0.13	
Total		60.00	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 94  
DATE : 20.07.2010 GEAR TYPE: PT NO: 4 POSITION: Lat S 12°8.58  
start stop duration Lon E 13°32.17  
TIME : 21:47:54 22:23:11 Purpose : 1  
LOG : 6629.16 6631.12 Region : 4000  
FDEPTH: 10 10 Gear cond.: 0  
BDEPTH: 89 77 Validity : 0  
Towing dir.: 0° Wire out : 110 m Speed : 3.3 kn  
Sorted : 0 Total catch: 215.56 Catch/hour: 366.60

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardinella maderensis	308.67	1786	84.20	158
Sardinella aurata	10.71	219	10.95	159
Trichiurus lepturus	40.14	39	2.92	
Sepia orbigyana	3.74	2	1.02	
Trachurus trecae	1.04	7	0.28	
Allotheutis africana	0.94	182	0.24	
Lagocephalus laevis	0.92	2	0.25	
Saurida brasiliensis	0.44	77	0.12	
Total		366.60	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 95  
DATE : 21.07.2010 GEAR TYPE: PT NO: 4 POSITION: Lat S 12°15.63  
start stop duration Lon E 13°34.31  
TIME : 02:42:47 03:10:06 Purpose : 1  
LOG : 6660.67 6662.06 Region : 4000  
FDEPTH: 10 10 Gear cond.: 0  
BDEPTH: 57 70 Validity : 0  
Towing dir.: 0° Wire out : 120 m Speed : 3.0 kn  
Sorted : 0 Total catch: 135.51 Catch/hour: 297.61

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardinella maderensis	150.00	870	50.40	160
Trachurus trecae	92.79	529	31.18	161
Trichiurus lepturus	40.08	40	13.47	
Sardinella aurata	13.18	77	4.43	162
Sepia orbigyana	1.16	7	0.39	

AlIoteuthis africana 0.40 114 0.13  
Total 297.61 100.00

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 96  
DATE : 22.07.2010 GEAR TYPE: BT NO: 24 POSITION: Lat S 12°57.38  
start stop duration Lon E 12°55.44  
TIME : 12:21:28 12:49:48 28.3 (min) Purpose : 1  
LOG : 6878.73 6880.28 1.6 Region : 4000  
FDEPTH: 110 107 Gear cond.: 0  
BDEPTH: 34 30 Validity : 0  
Towing dir.: 0° Wire out : 110 m Speed : 3.3 kn  
Sorted : 237 Total catch: 2087.08 Catch/hour: 4420.22

SPECIES	CATCH/HOUR weight numbers	% OF TOT. C	SAMP
Brachydeuterus auritus	1018.54	8590	23.04 164
Pomadasy jubelin	961.69	2232	21.76
Trachurus trecae	892.74	6157	20.20 163
Pseudotolithus typus	809.74	894	18.32
Galeodes decadactylus	236.70	2815	5.35
Pomatopus salatrix	154.69	280	3.50
Liethognathus mormyrus	126.73	335	2.87
Pagellus bellottii	60.57	354	1.37
Atractoscion aequidens	52.00	131	1.18
Pomadasy incisus	20.69	148	0.47
Umbri na canariensis	20.31	148	0.46
Sardinella aurata	12.86	74	0.29
Mugil bananensis	12.30	19	0.28
Rajamiralatus	11.74	19	0.27
Sepiella ornata	8.76	19	0.20
Trichiurus lepturus	6.52	19	0.15
Citharus linguatula	4.66	55	0.11
Pteroscion pelli	4.66	19	0.11
Bembrops heterurus	2.05	19	0.05
Chelidoniichthys gabonensis	1.86	19	0.04
AlIoteuthis africana	0.19	38	0.00
Total	4420.00		100.00

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 97  
DATE : 22.07.2010 GEAR TYPE: BT NO: 24 POSITION: Lat S 13°6.23  
start stop duration Lon E 12°46.92  
TIME : 19:10:13 19:31:12 21.0 (min) Purpose : 1  
LOG : 6922.23 6923.24 1.0 Region : 4000  
FDEPTH: 104 102 Gear cond.: 0  
BDEPTH: 104 102 Validity : 0  
Towing dir.: 0° Wire out : 270 m Speed : 2.9 kn  
Sorted : 86 Total catch: 87.55 Catch/hour: 250.38

SPECIES	CATCH/HOUR weight numbers	% OF TOT. C	SAMP
Dentex macrophthal mus	74.07	558	29.58 165
Trigla lyra	51.91	549	20.73
Umbri na canariensis	31.32	106	12.51 166
Citharus linguatula	12.44	263	4.97
Brotula barbata	12.15	6	4.85
Scorpaena normani	11.75	160	4.69
Rajaclavata	11.44	3	4.57
Sepia orbignyana	8.55	51	3.42
Boops boops	8.21	57	3.28
Trachurus trecae	4.00	29	1.60 167
Uranoscopus cadenati	3.66	20	1.46
Dentex angolensis	3.57	17	1.43
Octopus vulgaris	3.35	3	1.34
Chelidoniichthys gabonensis	2.77	17	1.11
Rajamiralatus	2.63	6	1.05
Nematocarcinus africanus	1.92	786	0.77
Uranoscopus pöllii	1.60	3	0.64
Ophiurus serpens	0.94	11	0.38
Dentex barnardi	0.89	3	0.35
Serranus accraensis	0.86	6	0.34
Trichiurus lepturus	0.77	3	0.31
Syacium micrurum	0.49	29	0.19
Chaetodon hoefleri	0.46	3	0.18
Dicologlossa cuneata	0.40	6	0.16
Illex coindetii	0.23	6	0.09
Total	250.38		100.00

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 98  
DATE : 22.07.2010 GEAR TYPE: BT NO: 4 POSITION: Lat S 13°8.53  
start stop duration Lon E 12°40.04  
TIME : 21:41:51 22:14:16 32.4 (min) Purpose : 1  
LOG : 6934.84 6936.89 2.0 Region : 4000  
FDEPTH: 10 10 Gear cond.: 0  
BDEPTH: 482 586 Validity : 0  
Towing dir.: 0° Wire out : 110 m Speed : 3.8 kn  
Sorted : 0 Total catch: 70.19 Catch/hour: 129.90

SPECIES	CATCH/HOUR weight numbers	% OF TOT. C	SAMP
MYCTOPHIDAE	80.14	56480	61.69
Shrimps, small, non comm.	48.30	363485	37.18
Isistius brasiliensis	1.31	4	1.01
Zuelongatus	0.15	2	0.11
Total	129.90		100.00

R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 99  
DATE : 24.07.2010 GEAR TYPE: BT NO: 24 POSITION: Lat S 13°20.71  
start stop duration Lon E 12°35.23  
TIME : 11:28:46 11:58:23 29.6 (min) Purpose : 1  
LOG : 6975.22 6976.74 1.5 Region : 4000  
FDEPTH: 114 113 Gear cond.: 0  
BDEPTH: 114 113 Validity : 0  
Towing dir.: 0° Wire out : 295 m Speed : 3.1 kn  
Sorted : 93 Total catch: 180.79 Catch/hour: 366.22

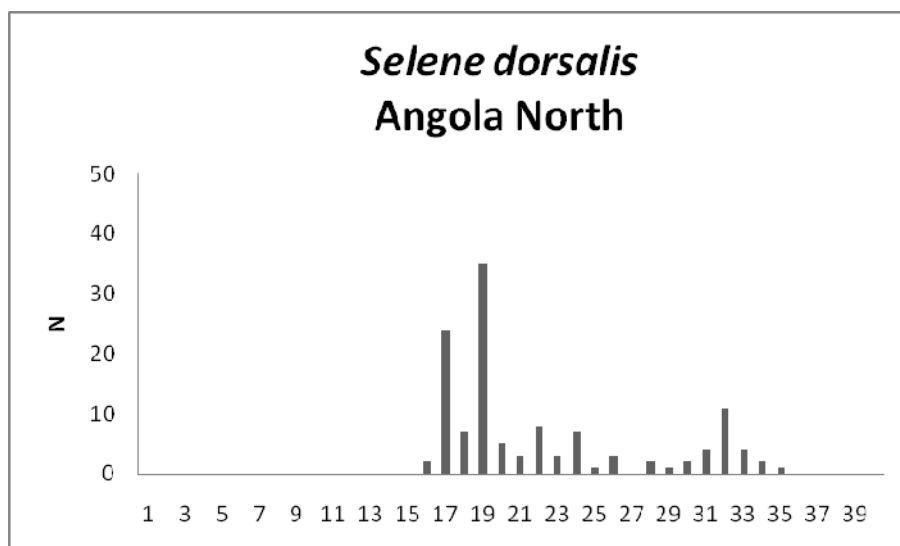
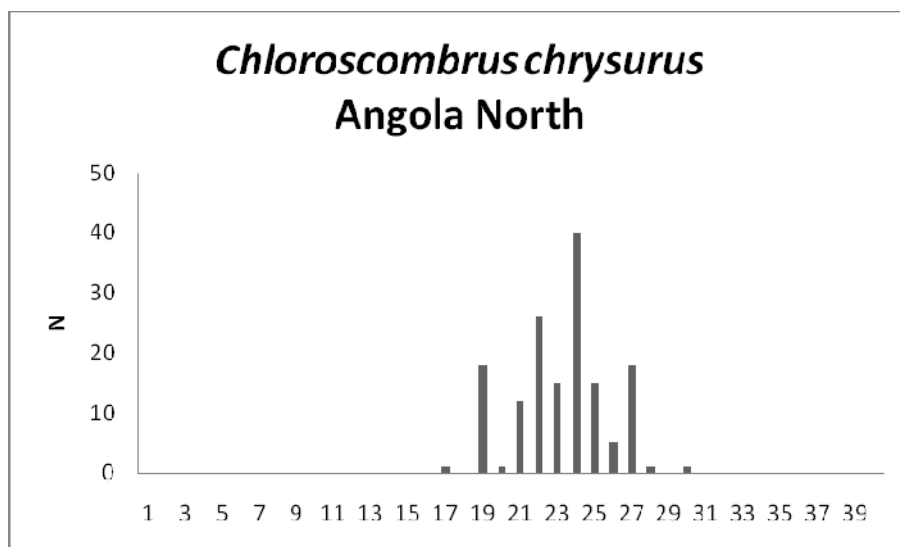
SPECIES	CATCH/HOUR weight numbers	% OF TOT. C	SAMP
Dentex macrophthal mus	151.69	156	41.42 169
Trachurus trecae	88.83	962	24.25 168
Trigla lyra	48.73	444	13.31
Rhinobatos bomaculatus	19.80	6	5.41
Dentex angolensis	14.84	53	4.05
Umbri na canariensis	14.46	34	3.95
Rajalaba	9.44	4	2.58
Zeus faber	3.34	4	0.91
Pagellus bellottii	3.10	18	0.85
Dentex barnardi	2.82	6	0.77
Octopus vulgaris	1.48	4	0.40
Boops boops	1.48	14	0.40
Lagocephalus laevis	1.45	4	0.39
Citharus linguatula	1.27	20	0.35
Sepia orbignyana	0.65	4	0.18
Chaetodon hoefleri	0.55	4	0.15
Todaropsis eblanae	0.52	6	0.14
Uranoscopus albesca	0.46	4	0.12
Engraulis sp.	0.38	38	0.11
AlIoteuthis africana	0.38	103	0.10
Sardinella aurata	0.38	4	0.10
Illex coindetii	0.17	4	0.05
Total	366.22		100.00

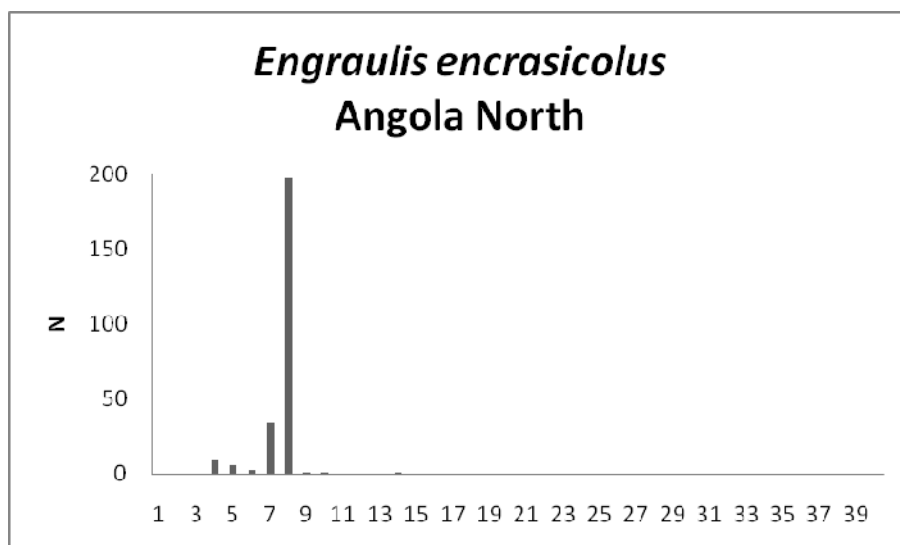
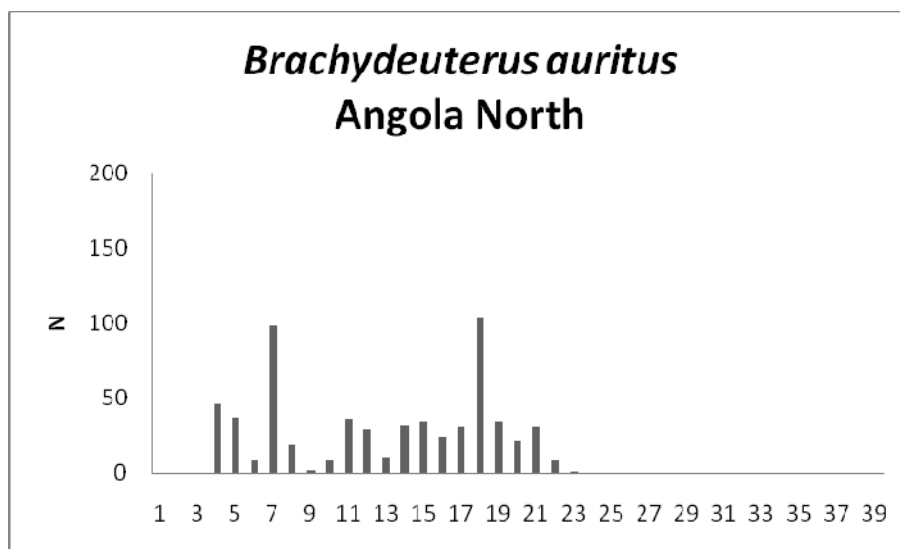
R/V Dr. Fridtjof Nansen SURVEY: 2010406 STATION: 100  
DATE : 24.07.2010 GEAR TYPE: BT NO: 24 POSITION: Lat S 13°41.79  
start stop duration Lon E 12°30.01  
TIME : 18:03:28 18:33:49 30.4 (min) Purpose : 1  
LOG : 7019.29 7020.86 1.6 Region : 4000  
FDEPTH: 110 107 Gear cond.: 0  
BDEPTH: 110 107 Validity : 0  
Towing dir.: 0° Wire out : 285 m Speed : 3.1 kn  
Sorted : 0 Total catch: 423.16 Catch/hour: 836.56

SPECIES	CATCH/HOUR weight numbers	% OF TOT. C	SAMP
Trachurus trecae	196.11	1487	23.44 171
Umbri na canariensis	170.61	712	20.39 173
Pagellus bellottii	166.06	1214	19.85 174
Trigla lyra	83.23	834	9.95
Dentex barnardi	50.23	136	6.00 176
Dentex macrophthal mus	35.19	221	4.21 172
Boops boops	28.71	267	3.43
Rajamiralatus	17.99	20	2.15
Lagocephalus laevis	17.99	40	2.15
Dentex angolensis	14.63	65	1.75 175
Brotula barbata	9.25	20	1.11
Atractoscion aequidens	7.51	6	0.90
Chelidoniichthys gabonensis	6.98	34	0.83
Citharus linguatula	6.70	176	0.80
Trichiurus lepturus	6.39	26	0.76
Uranoscopus cadenati	4.35	26	0.52
Pontinus kuhlii	4.23	6	0.51
Nematocarcinus africanus	3.06	105	0.37
Zeus faber	2.47	6	0.30
Octopus vulgaris	2.17	6	0.26
Sepia orbignyana	1.58	6	0.19
Serranus cabrilla	0.99	6	0.12
Syacium micrurum	0.12	14	0.01
Total	836.56		100.00

## ANNEX II. LENGTH FREQUENCY OF THE MOST COMMON PELAGIC SPECIES

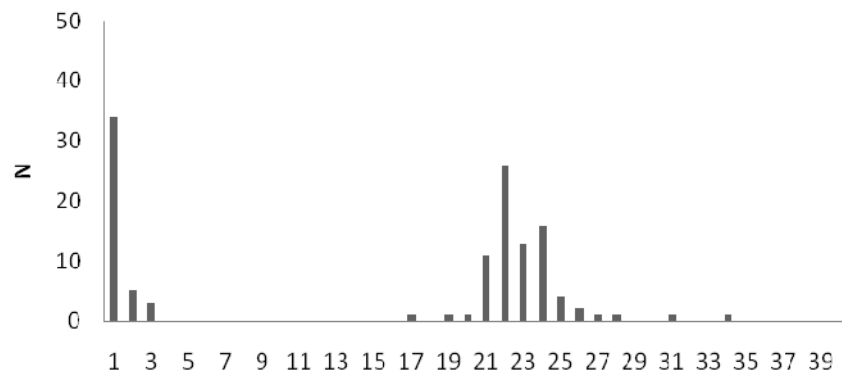
Angola North: Congo River – Pta. Palmerinhas



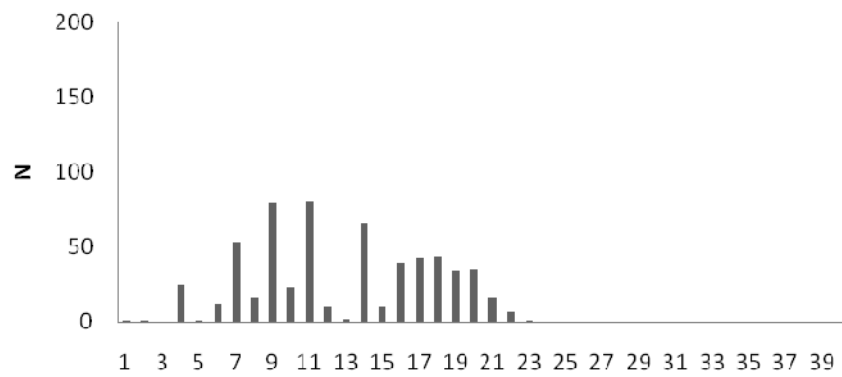


**Angola Central: Pta. Palmerinhas – Benguela**

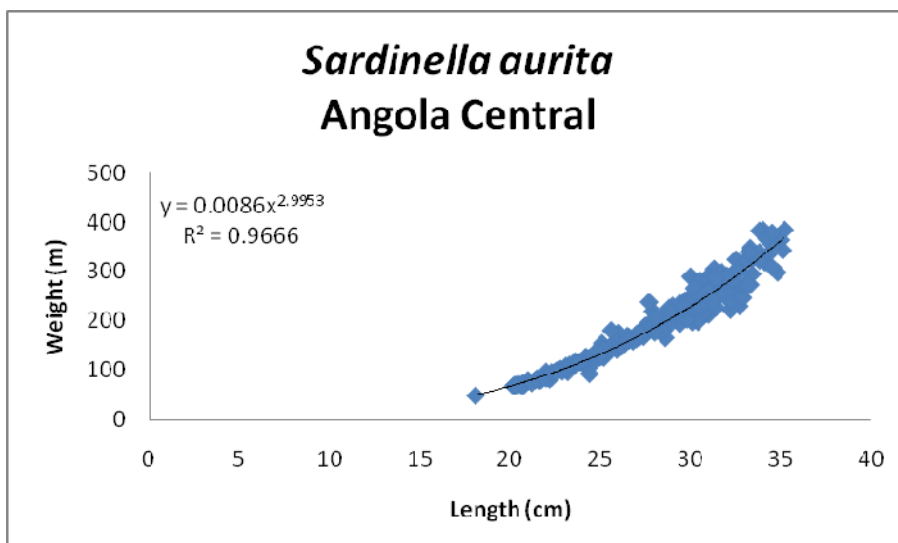
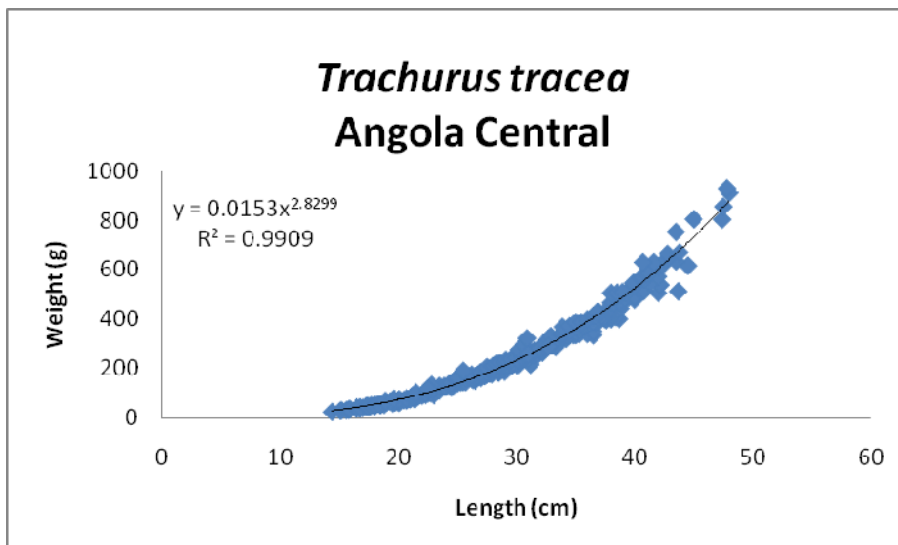
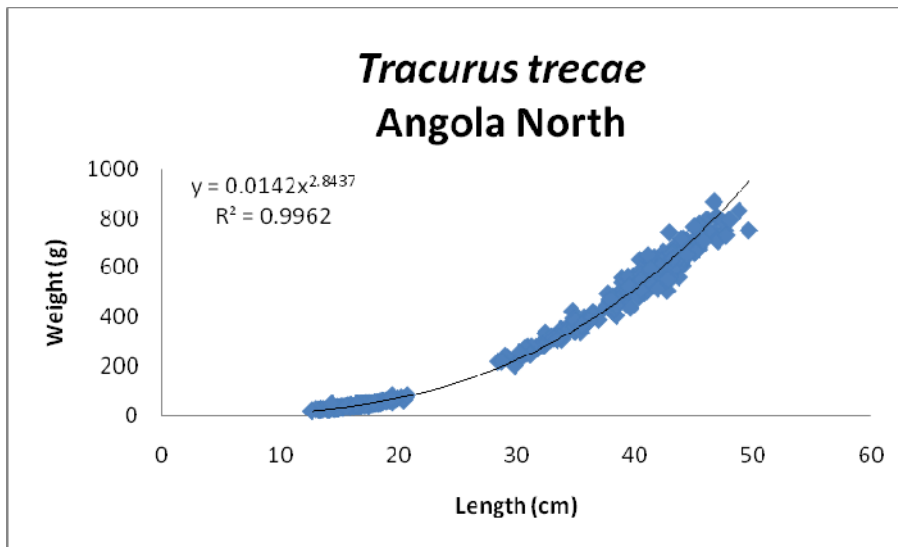
***Selene dorsalis***  
**Angola Central**



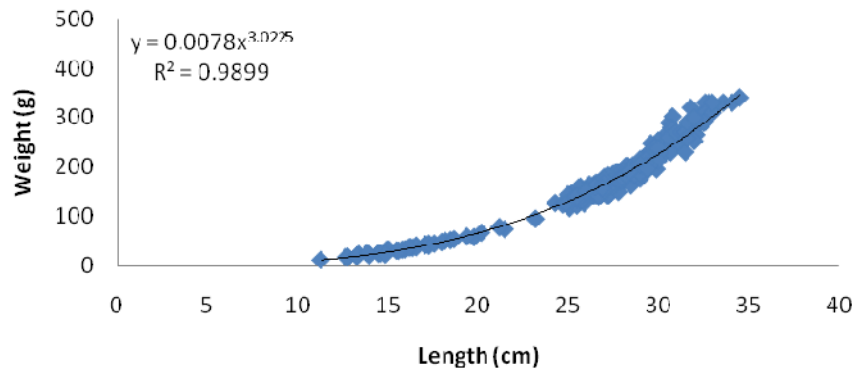
***Brachydeuterus auritus***  
**Angola Central**



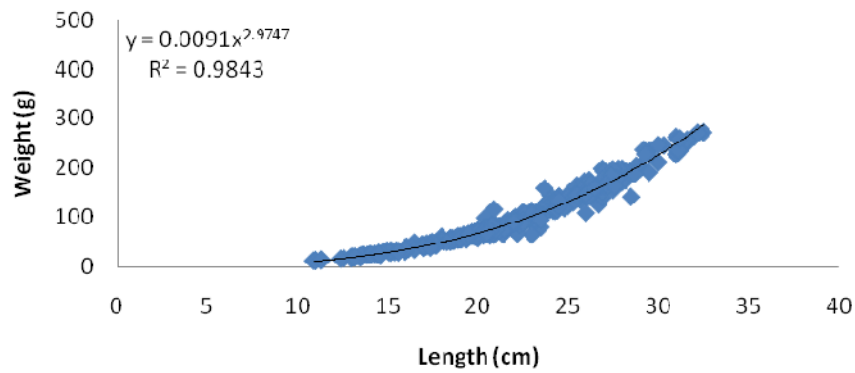




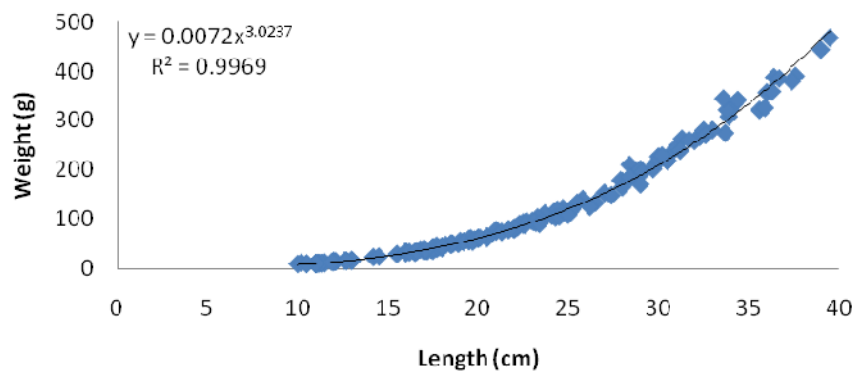
***Sardinella maderensis***  
**Angola Central**



***Trachurus trecae***  
**Angola South**



***Trachurus capensis***  
**South**





## ANNEX III      BIOMASS    AND    NUMBER    PER    LENGTH GROUP

---

Table of Sardinella biomass (1 000 tons) estimated from acoustic indexes from surveys with research vessel Dr. Fridtof Nansen from 1985-2010.

Year	Season	Dates	Survey number	South Cunene-Benguela	Central Palmerinhas-Benguela	North Cabinda-Palmerinhas	Total Cunene-Cabinda	Notes
1985	Summer	28.01-26.02	1	25	20	80	125	
1985	Autumn	23.04-28.05	2	110	190	180	480	
1985	Winter	08.08-10.09	3	0	70	190	260	
1985	Spring	05.11-05.12	4	0	200	110	310	
1986	Summer	22.01-10.03	1	10	140	110	260	
1986	Autumn	22.04-05.06	2	10	130	130	270	
1989	Summer	13.02-16.03	1	40	200	60	300	
1989	Autumn	23.04-29.05	2	20	40	130	190	
1989	Spring	17.11-12.12	3	40	100	60	200	
1991	Autumn	04.05-19.06	1		180	120	300	1
1991	Winter	06.08-18.09	2		68	154	222	1
1992	Winter	05.08-22.09	1		119	161	280	1
1994	Autumn	21.02-16.03	ANG1		410	100	510	2
1994	Winter	02.08-17.08	ANG2		245	290	535	2
1995	Summer	28.02-02.04	ANG1		140	24	164	2
1995	Winter	10.08-20.09	ANG4		277	297	574	1
1996	Autumn	23.02-31.03	ANG1	49	175	70	294	
1996	Winter	16.07-06.09	ANG2	0	130	233	363	
1997	Autumn	22.02-20.03	ANG1	0	195	300	495	3
1998	Autumn	02.03-28.03	ANG1	75	389	79	543	3
1998	Winter	07.05-22.05	ANG3	0	233	159	392	3
1999	Winter	02.08-26.08	ANG2	0	228	135	363	3
2000	Winter	28.07-20.07	ANG2	0	179	174	353	3
2001	Winter	20.07-17.08	ANG2	0	257	177	434	3
2002	Winter	17.08-16.09	ANG2	0	165	187	352	3
2003	Winter	20.07-19.08	ANG2	2	277	153	432	3
2004	Winter	28.07-27.08	ANG2	0	175	187	362	3
2005	Winter	16.07-24.08	2005408	0	148	95	243	
2006	Winter	21.07-21.08	2006408	20	244	366	630	
2007	Winter	07.07-10.08	2007406	55	483	187	725	
2008	Winter	15.05-02.07	2008404	56	264	186	506	
2009	Winter	23.05-04.07	2009406	92	232	206	530	
2010	Winter	18.06-11.08	2010406	43	293	93	429	3

1 Data error (Southern Region)

2 Southern Region not surveyed

3 Cabinda not surveyed

Table of Cunene Horse Mackerel biomass (1 000 tons) estimated from acoustic indexes from surveys from 1985-2010.

Year	Season	Dates	Survey number	South Cunene-Benguela	Central Palmerinhas-Benguela	North Cabinda-Palmerinhas	Total Cunene-Cabinda	Notes
1985	Summer	28.01-26.02	1	30	195	40	265	
1985	Autumn	23.04-28.05	2	55				1
1985	Winter	08.08-10.09	3	50	90	40	180	
1985	Spring	05.11-05.12	4	70	125	20	215	
1986	Summer	22.01-10.03	1	130				5
1986	Autumn	22.04-05.06	2	30				1

1989	Summer	13.02-16.03	1	35	55	40	130	
1989	Autumn	23.04-29.05	2	25				1
1989	Spring	17.11-12.12	3	170	40	35	245	
1991	Autumn	04.05-19.06	1	100	80	20	200	
1991	Winter	06.08-18.09	2	100	70	30	200	
1992	Winter	05.08-22.09	1	98	86	80	280	
1994	Autumn	21.02-16.03	ANG1		238	1	239	
1994	Winter	02.08-17.08	ANG2		130	120	250	
1995	Summer	28.02-02.04	ANG1		?	84	84	
1995	Winter	10.08-20.09	ANG4	70	160	110	340	
1996	Autumn	23.02-31.03	ANG1	286	214	6	506	
1996	Winter	16.07-06.09	ANG2	140	157	63	360	
1997	Autumn	22.02-20.03	ANG1	234	55	138	193	3
1998	Autumn	02.03-28.03	ANG1	163	58	18	239	3
1998	Winter	07.05-22.05	ANG3	118	112	37	267	3
1999	Winter	02.08-26.08	ANG2	124	129	68	321	3
2000	Winter	28.07-20.07	ANG2	92	178	63	333	3
2001	Winter	20.07-17.08	ANG2	64	22	3	89	3
2002	Winter	17.08-16.09	ANG2	118	13	31	162	3
2003	Winter	20.07-19.08	ANG2	120	34	12	166	3
2004	Winter	28.07-27.08	ANG2	32	107	90	229	3
2005	Winter	16.07-24.08	2005408	102	57	21	180	
2006	Winter	21.07-21.08	2006408	45	77	31	153	
2007	Winter	07.07-10.08	2007406	73	57	27	157	
2008	Winter	15.05-02.07	2008404	29	40		69	4
2009	Winter	23.05-04.07	2009406	76	7		83	4
2010	Winter	18.06-11.08.	2010406	100	15	21	136	3

1 Data error (Central and Northern Regions)

2 Southern region not surveyed

3 Cabinda not surveyed

4 Fish density too low to estimate abundance (Northern Region)

5 Estimates reported together with previous report

## **ANNEX IV                      INSTRUMENTS AND FISHING GEAR USED**

---

The Simrad ER-60/18, 38, 120 and 200 kHz scientific sounder was run during the survey only for observation of fish and bottom conditions.

Standard sphere calibrations were carried out using 38.1 mm diameter tungsten carbide sphere for 18, 38, 120 and 200 kHz. The last calibrations took place 07.03.2010, Baia dos Elefantes. The details of the settings of the 38 kHz echo sounder were as follows:

### **Transceiver-2 menu (38 kHz)**

Transducer depth	5.50 m
Absorption coefficient	8.7 dB/km
Pulse length	medium (1,024ms)
Bandwidth	2.43 kHz
Max power	2000 Watt
2-way beam angle	-20,6dB
Gain	25.38 dB
SA correction	-0.48 dB
Angle sensitivity	21.9
3 dB beam width	7.12° along ship 7.24° athwart ship
Along ship offset	0.17°
Athwart ship offset	0.05°

### **Bottom detection menu**

Minimum level	-45 dB
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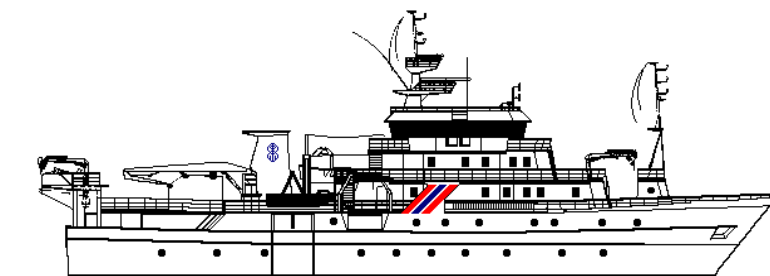
### **Fishing gear**

The vessel has two different sized "Åkrahamn" pelagic trawls and one "Gisund super bottom trawl". Trawls were used for identification of acoustic targets only.

The bottom trawl has a headline of 31 m, footrope 47 m and 20 mm mesh size in the cod end with an inner net of 10 mm mesh size. The trawl height was about 4.5 m and distance between wings during towing about 21 m. The sweeps are 40 m long. The trawl is equipped with a 12" rubber bobbins gear. New doors are 'Thyborøn' combi type, 7.41 m<sup>2</sup>, 1720 kg. These have been in use onboard since 19.02.08.

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 the trawl was equipped with a trawl eye that provides information about the trawl opening. A catch sensor on the cod-end indicated the size of the catch.

**BCC Project: LMR/NANSEN/1/10 Cruise reports “Dr. Fridtjof Nansen”**



**BCC SURVEY NO.1 2010**

**A TRANSBOUNDARY STUDY OF THE PELAGIC FISH STOCKS OF SOUTHERN  
ANGOLA AND NORTHERN NAMIBIA**

**Cruise report No 01/2010**

**29 July – 11 August 2010**

**by**

**Bjørn Erik Axelsen<sup>1)</sup>, Filomena Vaz-Velho<sup>2)</sup>, Hilikka Ndjaula<sup>3)</sup> and Ipeinge Etuwete Mundjulu<sup>4)</sup>**

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**<sup>4)</sup> National Marine Information and Research Centre, Swakopmund, Namibia**

## TABLE OF CONTENTS

1	Introduction .....	3
1.1	Objectives .....	4
1.2	Participation .....	5
1.3	Survey schedule and effort.....	6
2	Materials and methods.....	10
2.1	Survey grid.....	10
2.2	Acoustical sampling .....	10
2.3	Trawl sampling procedures.....	13
2.4	Meteorological and hydrographical sampling .....	14
3	Results .....	15
3.1	Transboundary area .....	15
3.2	Northern Namibia (19-22 ° South) .....	31
	Oceanographic Conditions .....	35
4	Conclusions and Recommendations .....	46
5	References.....	50
	Annex I Records of fishing stations.....	51
	Annex II Catch rates.....	56
	Annex III Instruments and fishing gear .....	57
	Annex IV Gonad Maturity stages .....	59



# 1 Introduction

The transboundary pelagic survey is a dedicated research survey covering the pelagic fish resources and hydrographical conditions in the region ranging from southern Angola to northern Namibia. The main focus of the work was to assess the biomass of all commercially important pelagic fish stocks in the transboundary region, with emphasis on the horse mackerel stocks. The overall ship time of twelve days available were integrated into the yearly pelagic survey of Angola by the 'R/V Dr Fridtjof Nansen' in order to be able to continue the coverage carried out as part of the Angolan effort and to utilize the ship time optimally the survey was extended southwards in central Namibia to Cape Cross at 22°50' S.

The overall transboundary area is defined from Ponta Albina near Tombua in the north (15°50' S) southwards to the Cape Frio upwelling cell (around 19°00' S). The northern boundary is located at the northernmost part of the Tiger Bank, from where the continental shelf starts widening and the southern boundary represents a natural biological boundary in Namibian waters due to the presence of the massive upwelling cell near Cape Frio. Ecological delimiters also included the distributions of the species, *Sardinella* sp. and *Trachurus* sp. Based on ecological delimiters the northern boundary of the transboundary area could be described as the northern limits of the distribution of Cape horse mackerel, while the southern limits of the distribution of the Sardinellas and/or Cunene horse mackerel indicated its southern extend. The definition of the transboundary area applied is expected to be wide enough to cover the likely distribution area of fish migrating from Namibia into Angolan waters and vice verse, at both warm and cold seasons.

The zone across the Angolan-Namibian border is particularly important as this area hosts co-occurring population of carangids, i.e. Cape horse mackerel *Trachurus trachurus capensis* and Cunene horse mackerel *Trachurus trecae*, as well as clupeids, including sardine (Pilchard) *Sardinops sagax*, round herring (Redeye) *Etrumeus whiteheadi* and anchovy *Engraulis capensis*. There is special concern about the situation in the transboundary area since these stocks are known to be in low abundance, while they are at the same intensively fished in the border area.

Usually, very little pelagic fish is found in central Namibian waters south to Cape Cross (22°50'S). However, in order to obtain a check of the occurrence and abundance of fish in

this area, the transect lines were extended to Cape Cross, following a similar survey design of pseudo-parallel transect with 15 n.mi spacing between each line, following the practice established on the transboundary surveys carried out since 2007.

The main purpose of this survey was to map the distribution and estimate the abundance of the most commercially important pelagic species in the Namibia-Angola transboundary area during the cold season. The study was complemented to the pelagic survey in Angola by extending the survey grid into Namibian waters. The survey and fish sampling strategy (pelagic and demersal trawling on acoustic targets) as well as the hydrographical mapping in the transboundary area follow the established standard for the yearly pelagic surveys in Angolan waters (Dr. Fridtjof Nansen Survey Report of the Angolan Pelagic Resources No. 2/2010), thus the transboundary survey provide a complete coverage of the Cunene horse mackerel, including the proportion of the stock present in Namibian waters at the time of the pelagic survey in Angola. For sardine and the other clupeids as well as Cape horse mackerel, however, the survey would not cover the entire distribution area of the species.

The estimates presented are relative indices of the proportion of the stock units distributed within the transboundary area at the time of the survey, not absolute estimates of abundance, and so the population estimates should not be interpreted in absolute terms. For sardine, Cape horse mackerel and other pelagic (clupeids) the estimates do not cover the entire distribution of the sardine stock, of which e.g. sardine is known to migrate between Angolan and Namibian waters, and changes from one year to another may well be caused by migration rather than population changes. As for all acoustic estimates, the indices presented here are prone to survey errors such as statistical sampling errors, vessel avoidance and the availability to acoustic sampling (Anon. 2003, 2004).

## 1.1 Objectives

The main objectives of the survey were the following:

- To map the distribution and estimate the abundance of the most commercially important pelagic species in the Namibia-Angola transboundary area 16°00'-19°00', following the survey design utilized in Angolan waters (6 n.mi spacing between transect lines), with special emphasis on the two horse mackerel Cunene horse mackerel *Trachurus trecae* and Cape horse mackerel *Trachurus capensis*, sardine "Pilchard" *Sardinops sagax* and other small pelagic species, including anchovy *Engraulis capensis* and round herring *Etrumeus whiteheadi*.
- To map the distributions and estimate the abundance of the same species in central Namibia south to Cape Cross (21°50' S), following the established survey design with 15 n.mi spacing between the transect lines.
- To study the biological state of the main species, including length frequencies, length-weight relationships, reproductive stages and length-at-maturity.
- To map the meteorological and hydrographical conditions in the survey area by means of continuous recordings of weather data such as Sea-surface temperature (SST), Sea-surface salinity (SSS), wind speed and direction, using CTD-casts (Temperature, Salinity and Oxygen).

## 1.2 Participation

The following scientific staff participated in the survey:

From INIP, Angola:

Filomena VAZ-VELHO (Angolan Team Leader), Idina ASSUNÇÃO, Wsaso ANDRÉ, Domingos PEDRO, Bomba BAZIKA, Eusébio dos SANTOS, Sténia ISAIS, José Mateus da SILVA, Benvindo KALUKEMBA, TPA and Mabibe MANUEL, TPA.

From Namibia:

Hilkka NDJAULA, BCC (Namibian Team Leader), Ipeinge Etuwete MUNDJULU (NatMIRC) and David KANANDUNGE (NatMIRC).

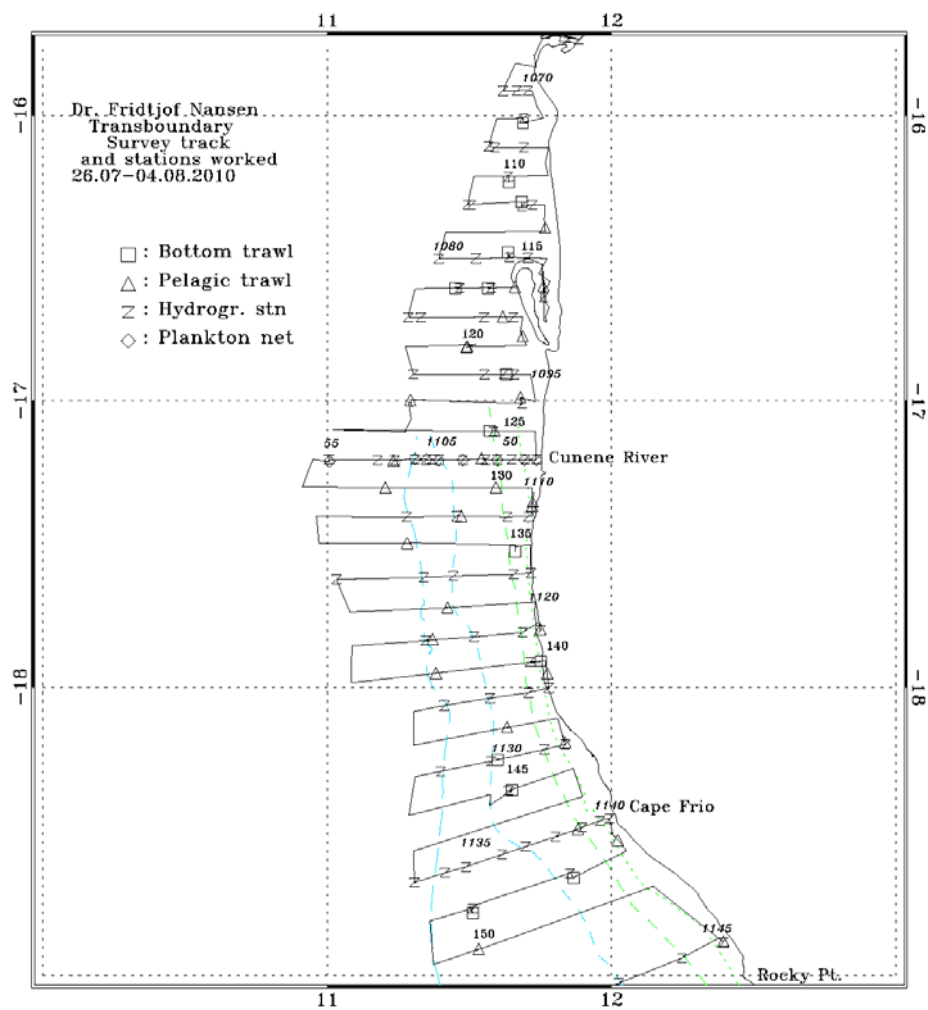
From IMR, Norway:

Bjørn Erik Axelsen (Cruise Leader), Silje Elisabeth SEIM, Jan Frode WILHELMSEN (Instrument chief) and Kaare TVEIT.

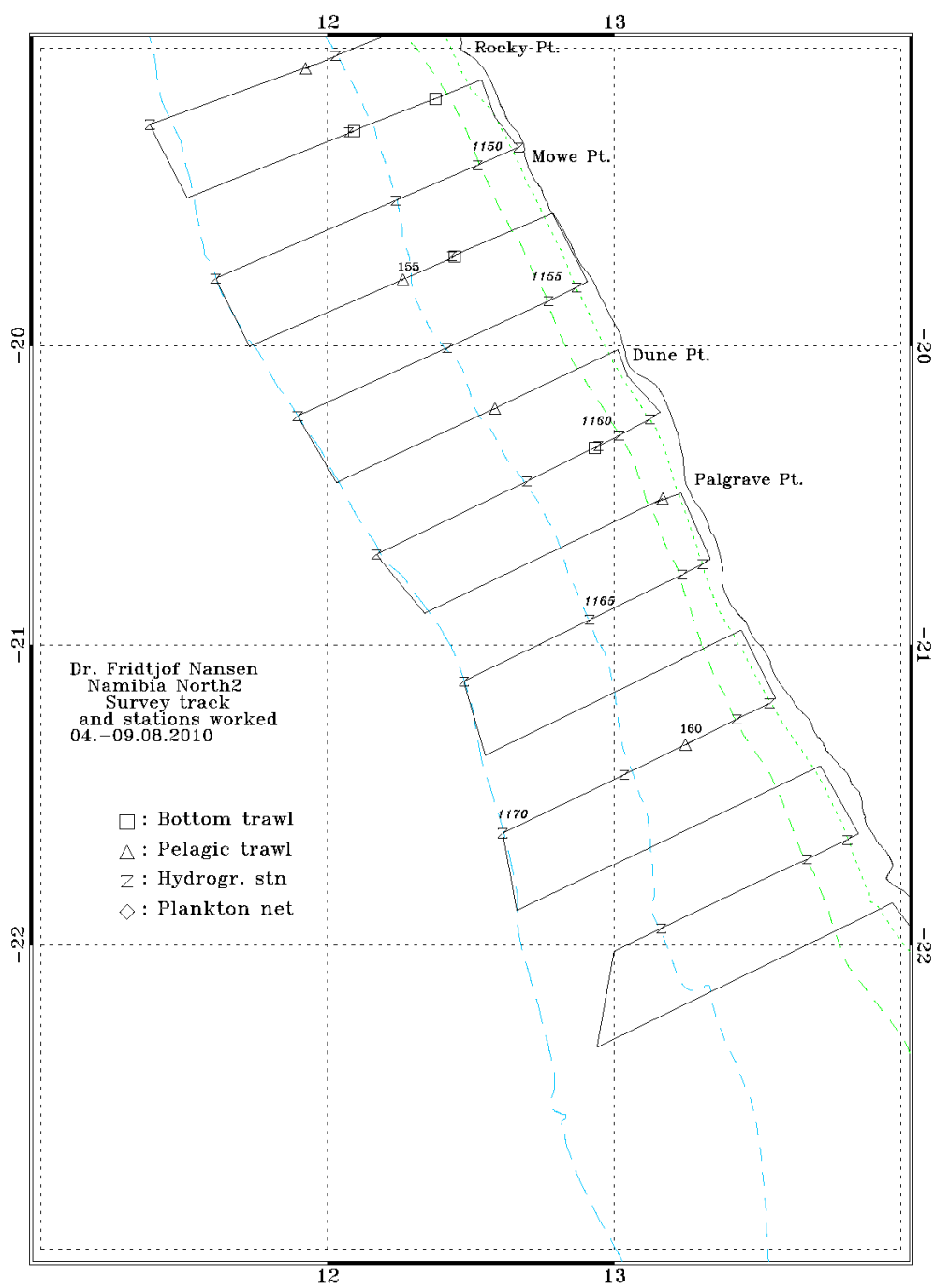
### 1.3 Survey schedule and effort

A full transceiver calibration of all frequencies (18, 38, 120 and 200 kHz) was carried out prior to the survey. The calibration was done in Baía dos Elephantes, Angola on 23<sup>rd</sup> of July. The vessel completed the pelagic survey in Angola, including the Angolan part of the transboundary area, and reached the Angolan-Namibian border at the Cunene River (17°15' S) on the 29<sup>th</sup> of July. The coverage of the transboundary area south to Cape Frio at 18°44'S was completed on 8<sup>th</sup> July. The survey was extended southwards to south of Cape Cross at 21°50'S where the course track was completed on the 10<sup>th</sup> July. The vessel docked in Walvis Bay on the same day.

Figure 1 shows the cruise track with pelagic and demersal trawl stations and CTD stations in the transboundary survey area (15°50'-19°00' S) and figure 2 shows cruise track with pelagic and demersal trawl stations and CTD stations in northern Namibia (19-22 °S). The survey effort in terms of distance sailed, stations trawled and ctd stations are summarised in Table 1 below.



**Figure 1** Course track with pelagic and demersal trawl stations and CTD stations in the trans-boundary area (15°50'-19°00' S).



**Figure 2.** Course track with pelagic and demersal trawl stations and CTD stations in Northern Namibia (19-22 °South).

**Table 1.** Summary of survey effort, including number of demersal (BT) and pelagic (PT) trawl haul deployments, CTD casts and distance surveyed (Log, in n.mi).

<b>Area</b>	<b>BT trawls</b>	<b>PT trawls</b>	<b>Total trawls</b>	<b>CTD casts</b>	<b>Log distance (n.mi)</b>
Transboundary Angola (15°50'S - 17°15' S)	8	11	19	39	494
Transboundary Namibia (17°15'S -19°00' S)	6	17	23	37	866
Northern Namibia (19°00'S -22°00' S)	4	4	8	27	979
<b>Total</b>	<b>18</b>	<b>32</b>	<b>50</b>	<b>103</b>	<b>2,339</b>

## 2 Materials and methods

### 2.1 Survey grid

The survey design of equidistant pseudo-parallel transects (6 nautical miles apart) perpendicular to the coastline as applied in Angola was also followed in the extension into Namibian waters (Fig. 1), following the established practice for the transboundary surveys. Transects generally covered a depth range of 20-500 meters. As before, some of the lines had to be stopped at 30-35 m depth due to the steeply inclining bottom near the shoreline in some areas. Transect lines in the border area from the Cunene River to Cape Frio were extended to the 2000 m isobaths in order to check for possible offshore aggregations of horse mackerel. This strategy ensured that the Namibian component of the transboundary area was covered in a way that was comparable to the data already collected in Angola. This way, distribution maps and biomass estimates could be drawn across the border area.

### 2.2 Acoustical sampling

A standard sphere calibrations were carried out at Baía do Elefantes in Angola on 23<sup>rd</sup> of July 2010, before commencement of the survey. Standard calibration procedures were followed using the appropriate and calibration spheres for all frequencies (18, 38, 120 and 200 kHz). There were no significant deviations from the previous calibrations and subsequently no changes in the calibration parameters were made prior to the survey. The acoustic recordings were conducted using two Simrad ER 60 echosounders with keel mounted transducers at nominal operating frequencies of 18, 38, 120 and 200 kHz. Acoustic data were logged and post-processed using the latest acoustic data post-processing software, the Large Scale Survey System (LSSS) Version 1.25. The technical specifications and operational settings of the echosounder used during the survey are given in Annex II.

The acoustic data were scrutinized at 38 kHz using the LSSS, Version 1.25. The mean 5 n.mi area backscattering coefficients  $s_A$  ( $m^2/n.mi^2$ ) were allocated to a predefined set of acoustic target groups on the basis of characteristic echogram features in conjunction with information about the species- and size compositions as derived from the trawl catches. Definitions of the acoustic target groups are given in Table 2 below.



**Table 2.** Allocation of acoustic backscattering coefficients to acoustic target groups and their definitions. Note that for horse mackerel and pilchard all encountered species are listed, while only examples are listed for the remaining groups.

Acoustic group	Taxonomical group	Species
Horse mackerel	<i>Trachurus</i> sp.	<i>T. trecae</i> <i>T. t. capensis</i>
Sardinella	<i>Sardinella</i> sp.	<i>S. aurita</i> <i>S. maderensis</i>
Pilchard	<i>Sardinops</i>	<i>Sardinops sagax</i>
Pelagic species 1	Clupeiformes <sub>1</sub>	<i>Engraulis capensis</i> <i>Etrumeus whiteheadi</i>
Other demersal species	Sparidae <sub>2</sub>	<i>Dentex macrophthalmus</i> <i>Pagellus bellottii</i>
	Others	<i>Merluccius</i> spp. <i>Brama brama</i> <i>Chelidionichthys capensis</i>
Mesopelagic species	Myctophidae <sub>3</sub> Lantern fish <sub>3</sub>	
	Other mesopelagic fish	
Plankton		

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

### Estimation of fish abundance

The following target strength (TS) to length relationship was used to convert mean area backscattering coefficient  $s_A$  (m<sup>2</sup>/n.mi<sup>2</sup>) at 38 kHz to number of fish:

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

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, following the established practice in the Namibian and Angolan national surveys. All estimates should consequently be considered as relative indices of abundance. The biomass was calculated by multiplying the number of fish by the expected length at weight, as estimated by regression of the log-length (total) against total weight.

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 using the Nansis Maptool software. Unfortunately, severe problems with the Nansis Maptool software precluded the definition of the aggregation polygons and therefore considerably delayed the process of finalizing the abundance estimates. Distribution plots and aerial calculations on the strata were carried out using IDL 5.6 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:  $s_A = 300-1,000$ ; 3:  $s_A = 1,000-3,000$ ; 4:  $s_A > 3,000$ . Mean 5-n.mi integrator values ( $s_A$ ) computed along the transect lines were re-averaged for each stratum. The overall length frequency distributions within strata were estimated by weighting the sample-distributions with the nearest valid 5 n.mi integrator value, or the average of two adjacent values. The total number of fish in each length group was estimated as:

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

where:

- $\rho_i$  = estimated number of fish in length group  $i$
- $\langle s_A \rangle$  = mean recorded area backscattering coefficient ( $m^2/n.mi^2$ )
- $t_{i,j}$  = proportion of species  $j$  sampled in length group  $i$
- $u_i$  = proportion of fish sampled 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  $L_i$ .

## 2.3 Trawl sampling procedures

Targeted trawling was carried out on identified acoustic targets using the smallest pelagic sample trawl (10 m vertical opening), the mid-sized pelagic sample trawl (12 m) and the demersal sample trawl (5 m). Samples were taken in baskets on deck and then weighed, and the number of fish of each species was determined from a subsample of the collected sample.

All trawl catches were sampled for species composition by weight and numbers. Records of catch rates are given in Annex II. Other species (mostly of commercial value) were collected and identified to species level and length measurements were taken (Annex III). A brief description and illustrations of the sampling trawls are provided in Annex IV.

### **Biological sampling**

Samples of the main target species *Trachurus capensis*, *Trachurus trecae* and *Sardinops sagax*, as well as *Etrumeus whiteheadi* and *Engraulis capensis* were collected and measured for length and weight. 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 six-point classification scale used during Angolan national surveys (Annex V). Length-weight relationships of target species were determined from the regression analysis (power fit, a, b) of the total weight to the total length recorded for all sampled specimens.

$$W = a L^b$$

Scanmar sensors provided real-time information of the depth of the head rope, the vertical opening of the mouth of the trawl and the clearance between the ground gear and the bottom. The trawl eye and catch sensor gave information of fish entering into the trawl and the catch retained in the codend, respectively.

## 2.4 Meteorological and hydrographical sampling

Wind direction and speed, air temperature, global radiation and sea surface temperature (5 m depth) were recorded using the Norwegian Meteorological Institute's (DNMI) meteorological station on board. Values averaged over 10 min intervals were logged continuously. The weather station data were logged continuously throughout the survey. The results presented in this report are based on a standard output from the logging system, i.e. one nautical mile averages along the ship's track.

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 CTD lines with 60 n.mi distance and on every 2<sup>nd</sup> transect at 200, 100 and 50 m depths. The casts were stopped a few meters above the bottom.

Hydrographical sections were carried out at Pta. Albina, Baía dos Tigres, Cunene River (17°15' S), Cape Frio and standard sections, including Cape Cross in the area south of the transboundary area, as well as on every full degree latitude line.

### 3 Results

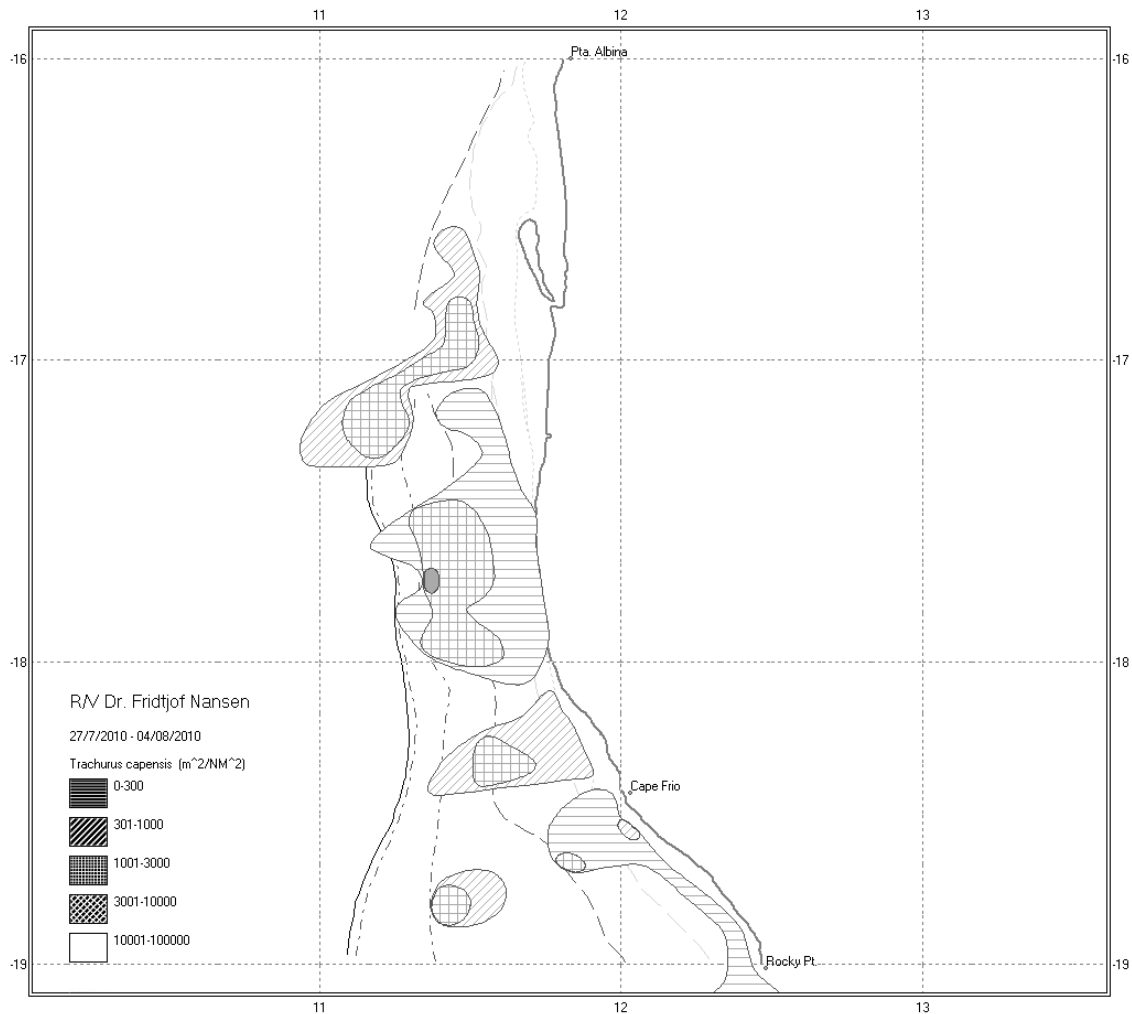
#### 3.1 Transboundary area

##### **Cape horse mackerel (*Trachurus trachurus capensis*)**

As for the 2009 survey, the first observation was made at about 16°40' S offshore of Baía dos Tigres. However, unlike in 2009 the distribution of *T. t. capensis* was discontinuous throughout the transboundary area, and was distributed somewhat more offshore, particularly in the northern part of the transboundary area and off Cape Frio (Figure 3). No *T. t. capensis* were found inside the bay this year. Immediately south of the border area, the aggregation extended offshore beyond the 2,000 m isobath. This aggregation overlapped with a more inshore aggregation that extended southwards to just south of the 18° latitude line, with the highest densities found between the 200 and 500 m isobaths.

Three smaller, distinct aggregations were found further south: one inshore-offshore between 18°10' and 18°20' S, and two off Cape Frio (18°25' S): one low-density inshore aggregations extending southwards to Rocky Point (19 °S) and one small high density aggregation between the 400 and 500 isobaths around 18°45' S. The highest-density concentration of *T. capensis* in the transboundary area was, as in 2009, found south of the Cunene River at about 17°45' S.

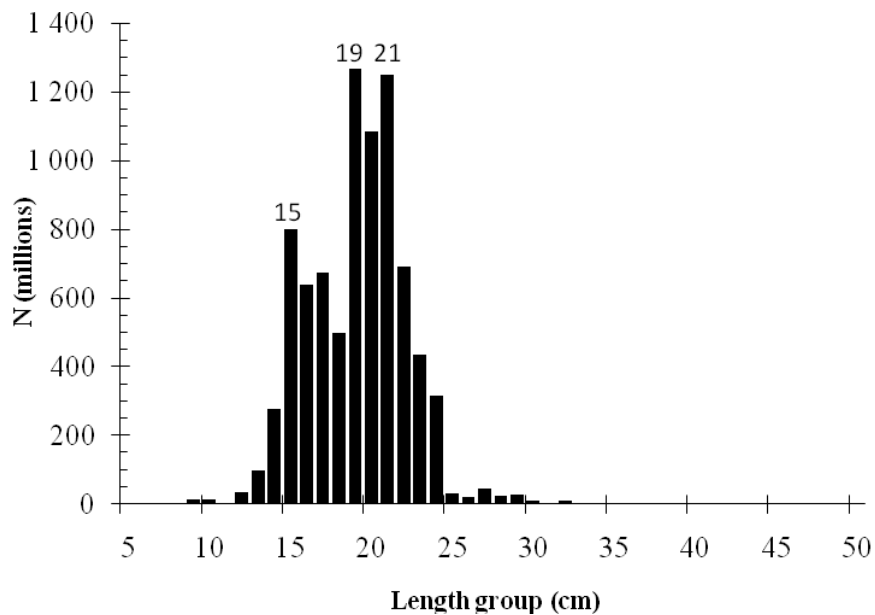
The total biomass estimate of Cape horse mackerel in the transboundary area was 516,600 tonnes, which is about 2.5 times the biomass estimated in the same area in 2009 (202,300 tonnes). From this, about 84 % of the fish in weight were adults (>17 cm total length), compared to 71 % in 2009. As for previous years (2008: 10 %; 2009: 11 %), only approximately 13 % (by weight) of the total biomass of *T. t capensis* was found on the Angolan side of the transboundary area in 2010, contrasting the relative distribution found in Angola during the first transboundary survey in 2005, in which 64 % of the Cape horse mackerel biomass was found in Angolan waters.



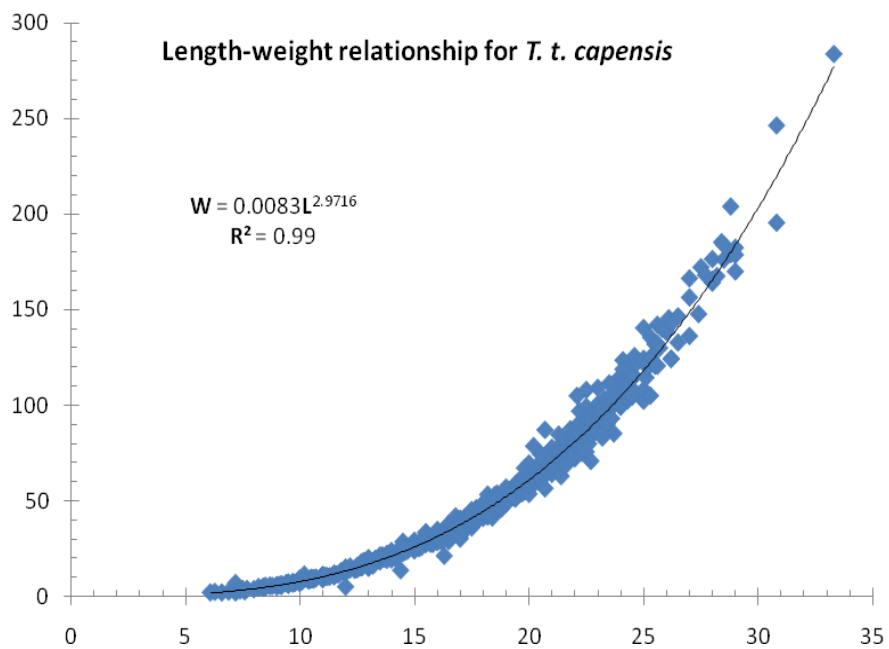
**Figure 3** Distribution of the Cape horse mackerel (*T. t. capensis*) in the Angola-Namibia transboundary area (15°50'-19°00' S). Isobaths are indicated at 100, 200, 500, 1,000 and 2,000 m depths.

The size composition from the acoustic estimate showed a multi-modal distribution with modal peaks at 15 cm, 19 cm and 21 cm total lengths (Figure 4). The mean estimated total fish length from the acoustic estimate was 19.6 cm, corresponding to an estimated mean expected weight of 57.6 g (N= 8,345 mill. ind).

A total of 715 fish were sampled for length-weight and biological analyses, yielding a mean total sample length of 17.9 cm, corresponding to an estimated mean expected weight of 43.8 g, and a mean individual total weight of 53.7 g. The length weight relationship for *T. t. capensis* showed a very good fit ( $R^2=0.99$ ), where  $a$  and  $b$  were estimated at 0.0083 and 2.9716, respectively (Figure 5).



**Figure 4** Estimated length frequency of *T. t. capensis* in the transboundary area (15°50'-19°00' S) (N= 8,345 mill. ind).



**Figure 5** Length-weight relationship for *T. t. capensis* in the transboundary area (15°50'-19°00' S) (n= 715 ind).

Out of the 715 biological samples, a total of 553 *T. capensis* were matured of which 320 were females and 233 were males. The majority of the fish were found in maturity stage 2, followed by stage 5 (Fig. 6). Females dominated most of the maturity stages, except stages 5, which were dominated by females, unlike in 2009, when males dominated both groups. See Annex IV for a description of the maturity stages. The distribution of mature *T.t capensis* indicated that the dominant maturity stage was among the 18 cm to 23 cm fish cohort for both males and females (Fig. 6).

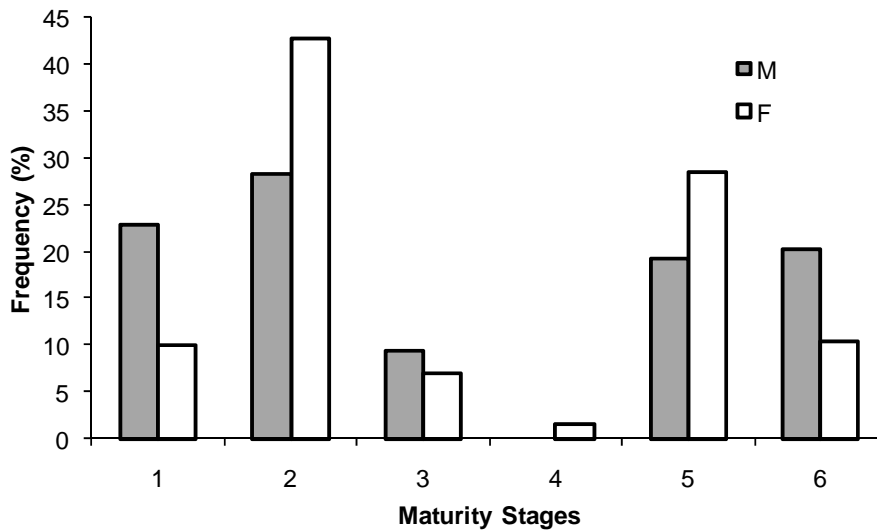


Figure 6 : Frequency of *T. capensis* maturity stages by sex found in the Transboundary area



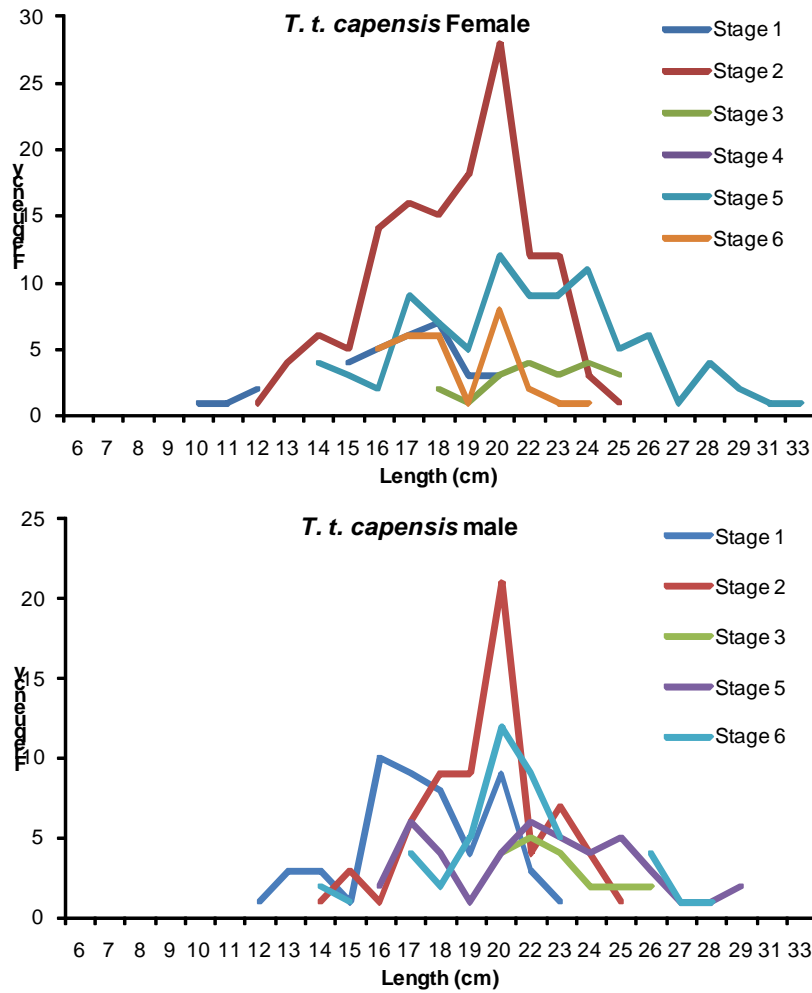


Figure 7 : Size frequency of *T. t. capensis* at various maturity stages by sex found in the Transboundary area

### **Cunene horse mackerel (*Trachurus trecae*)**

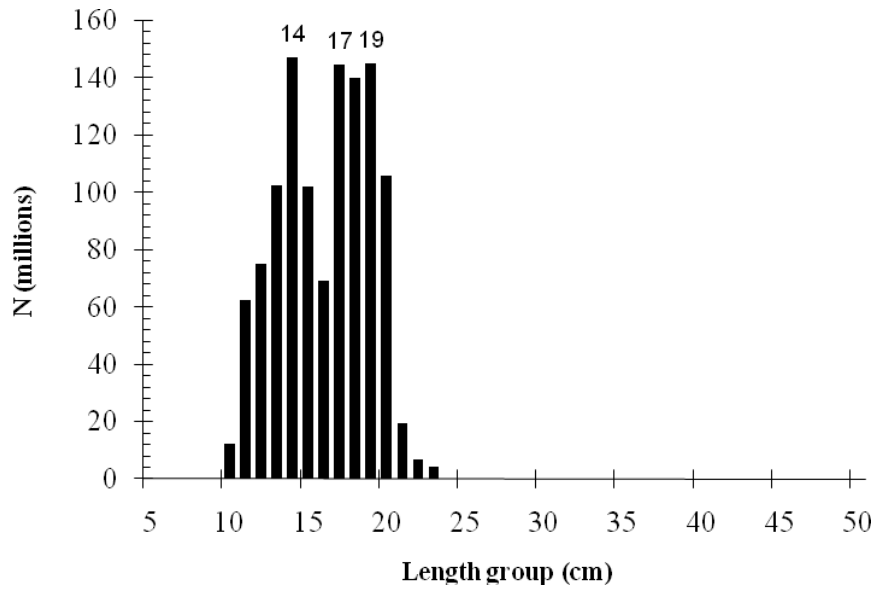
*T. trecae* was mostly encountered in low densities ( $S_A < 1000$ ) except for the two areas of high density ( $S_A = 1778$  and  $1262$ ) (Figure 6). The distribution of the species was continuous from the Angolan side of the transboundary across the border until latitude  $17^{\circ}30' S$ . The total biomass of *T. trecae* was estimated at 45,500 tonnes, compared to 50,700 tonnes in 2009. About 70 % of the fish in weight were adults ( $>17$  cm total length), compared to 84 % for *T. t. capensis*, while 30% fish of the *T. trecae* were estimated to be juveniles (10-16 cm total length). As for 2009 (78 %), the majority of the biomass (approximately 34,100 tonnes or 75 %) was found in the Angolan part of the transboundary area. The distribution pattern was strikingly similar to the one found in 2009, with the main distribution starting inshore from Pta Albina ( $15^{\circ}55' S$ ) and extending southwards towards the Angolan-Naibian border ( $17^{\circ}20' S$  in 2010 and  $17^{\circ}30' S$  in 2009), and with one disjoint, offshore aggregation near the border ( $17^{\circ}00' - 17^{\circ}15' S$ ) and another disjoint, inshore aggregation further south ( $17^{\circ}45' - 18^{\circ}05'$  in 2010 and  $17^{\circ}55' - 17^{\circ}20'$  in 2009).

The size composition from the acoustic estimate showed a bi-modal distribution with modal peaks around 14 cm and 17-19 cm total lengths (Figure 7). The mean estimated total fish length from the acoustic estimate was 16.6 cm, corresponding to an estimated mean expected weight of 36.0 g ( $N = 1,135$  mill. ind).

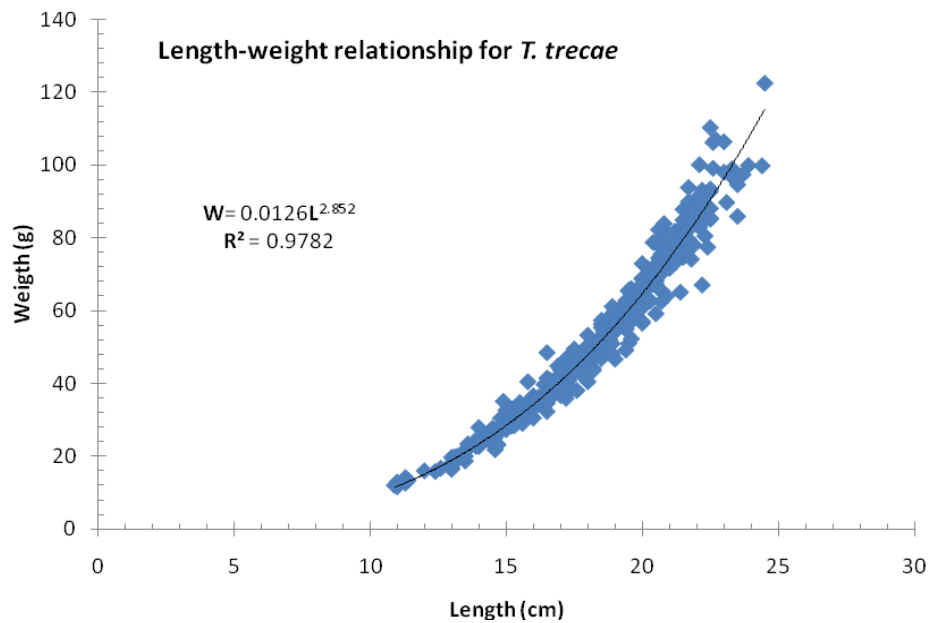
A total of 935 fish with an overall size distribution ranging from 10-23 cm total length were sampled for length-weight and biological analyses, yielding a mean total sample length of 16.4 cm, corresponding to an estimated mean expected weight of 35.0 g, and a mean individual total weight of 40.0 g. The length weight relationship for *T. trecae* showed a very good fit ( $R^2 = 0.99$ ), where  $a$  and  $b$  were estimated at 0.0076 and 3.0158, respectively (Figure 8).



**Figure 6** Distribution of the Cunene horse mackerel (*T. trecae*) in the Angola-Namibia transboundary area (15°50'-19°00' S). Isobaths are indicated at 100, 200, 500, 1,000 and 2,000 m depths. [due to problems with Nansis software, density regions within the strata are not indicated]



**Figure 7** Overall length frequency of *T. trecae* in the transboundary area (15°50'-19°00' S) (N= 1,135 mill. ind).



**Figure 8** Length-weight relationship for *T. trecae* in the transboundary area (15°50'-19°00' S) (n=935).

Out of the 368 biological samples, a total of 343 *T. trecae* were matured of which 155 were females and 368 were males. The majority of the fish were found in maturity stage 2, followed by stage 5 (Fig. 9). Males dominated most of the maturity stages, except stages 2 and 3, which were dominated by females, unlike in 2009. See Annex IV for a description of the maturity stages. The distribution of mature *T. trecae* indicated that the dominant maturity stage was among the 18 cm to 23 cm fish cohort for both males and females (Fig. 10) and this is similar to what is observed in *T. t. capensis*.

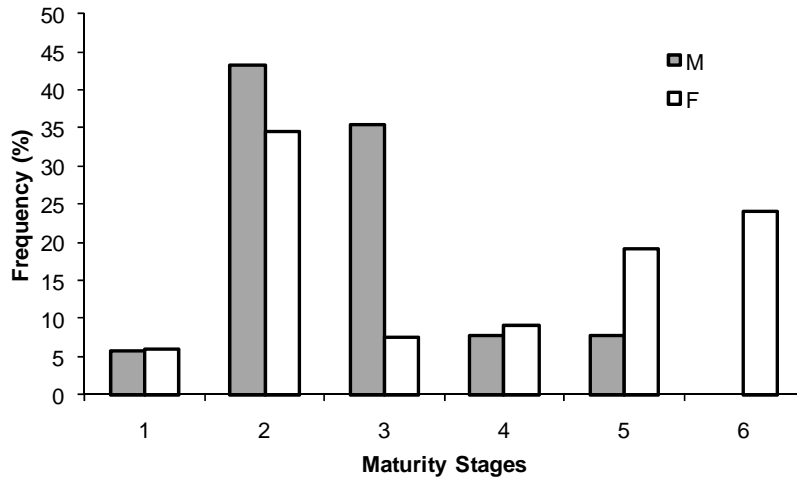


Figure 9 : Frequency of *T. trecae* maturity stages by sex found in the Transboundary area

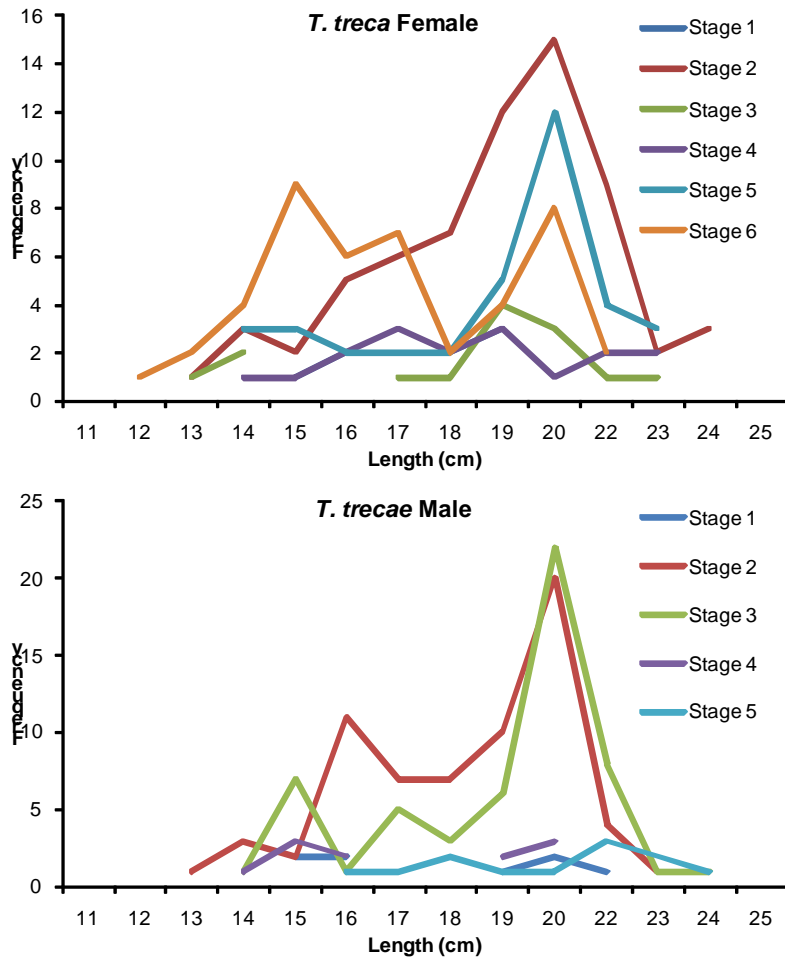


Figure 9 : Size frequency of *T. trecae* at various maturity stages by sex found in the Transboundary area

### **Sardine (*Sardinops sagax*, “Pilchard”) and Sardinella (*Sardinella aurita*)**

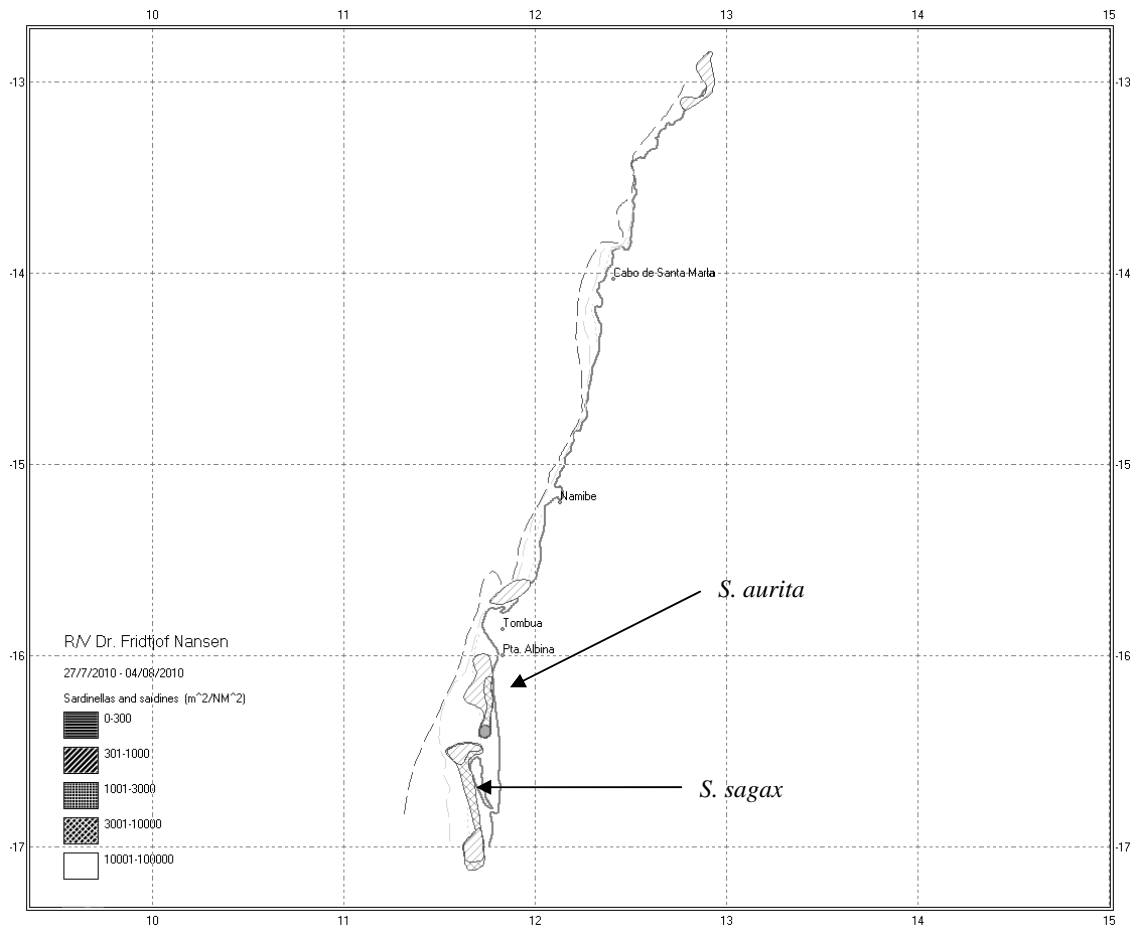
The distributions of *Sardinops sagax* and *Sardinella aurita* are shown in Figure 9 below.

*S. sagax* was found in a single inshore, continuous aggregation distribution in Angolan waters that started immediately north of the Ilha dos Tigres (Tiger Island) at approximately 16°30' S and extended southwards in the nearshore region to the border area at 17°15' S. The densities of *S. sagax* strata varied from intermediate ( $300 < S_A < 1,000$ ) to high ( $3000 < S_A < 10,000$ ). The total biomass of *S. sagax* was estimated at 399,000 tonnes, which is a considerable increase from the 2009 survey (35,700 tonnes). However, although this is a positive sign for the state of the sardine stock, please note that extreme caution should be taken to interpret this dramatic change as an increase in stock size. Firstly, the estimates are relative indices, not absolute estimates of abundance and so the population estimate should not be interpreted in absolute terms. Second, this was not a dedicated sardine survey both acoustic and net sampling was limited, thus warranting some uncertainty associated to this estimate (ref Chapter 1 Introduction and the stated survey objectives). The estimates of the sardine do not cover the entire distribution of the sardine stock, which is known to migrate between Angolan and Namibian waters, and changes from one year to another may be caused by migration rather than population changes. Finally, the estimates of the relative indices of the proportion of the stock distributed within the transboundary area are, as for all acoustic estimates, prone to survey errors such as statistical sampling errors (caused by distribution in relatively small, high-density patches typical for sardine), vessel avoidance and the availability to acoustic sampling (upper blind zone errors) at the time of the survey (Anon. 2003, 2004).

The total length of *S. sagax* ranged from 11-22 cm and was tri-modal with modal peaks at 12 cm, 15 cm and 20 cm total length (Figure 10). The mean estimated total fish length from the acoustic estimate was 15.5 cm, corresponding to an estimated mean expected weight of 28.3 g ( $N = 12,771$  mill. ind). A total of 172 *S. sagax* were sampled for length-weight and biological analyses, yielding a mean total sample length of 17.2 cm, corresponding to an estimated mean expected weight of 39.3 g, and a mean individual total weight of 43.5 g. The length-weight relationship for *S. sagax* showed a very good fit ( $R^2 = 0.99$ ), where  $a$  and  $b$  were estimated at 0.0041 and 3.225, respectively (Figure 11).

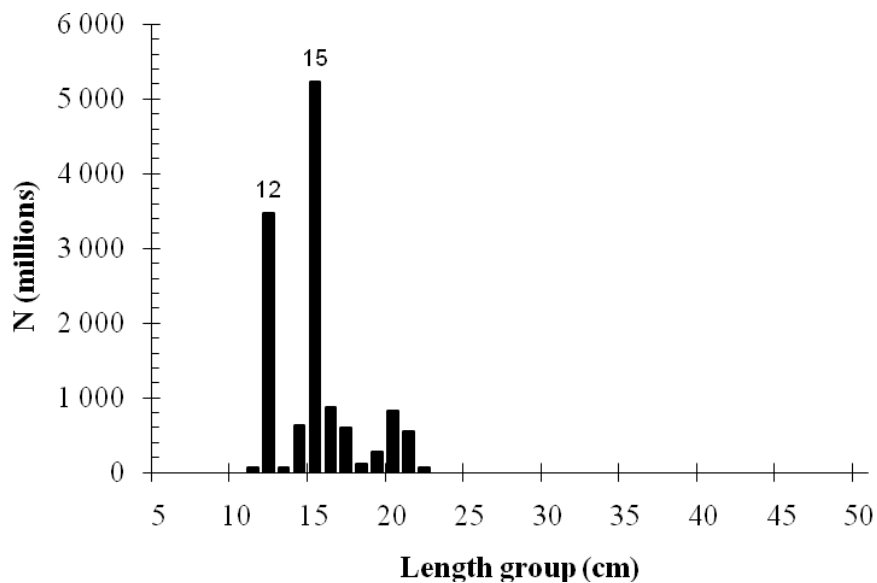
*S. aurita* was only found in a single aggregation just south of Pt. Albina in Angola. The densities of *S. aurita* varied strata from intermediate ( $300 < S_A < 1,000$ ) to very high ( $S_A > 10,000$ ). The total biomass of *S. aurita* was estimated at 57,500 tonnes.

The total length of *S. aurita* ranged from 17-22 cm and was uni-modal with a single modal peak at 19 cm total length (Figure 12). The mean estimated total fish length from the acoustic estimate was 19.6 cm, corresponding to an estimated mean expected weight of 61.7 g (N= 927 mill. ind). A total of 112 *S. aurita* were sampled for length-weight and biological analyses, yielding a mean total sample length of 22.9 cm, corresponding to an estimated mean expected weight of 97.3 g, and a mean individual total weight of 102.0 g. The length-weight relationship for *S. aurita* showed a reasonably good fit ( $R^2=0.96$ ), where *a* and *b* were estimated at 0.0099 and 2.938, respectively (Figure 13).

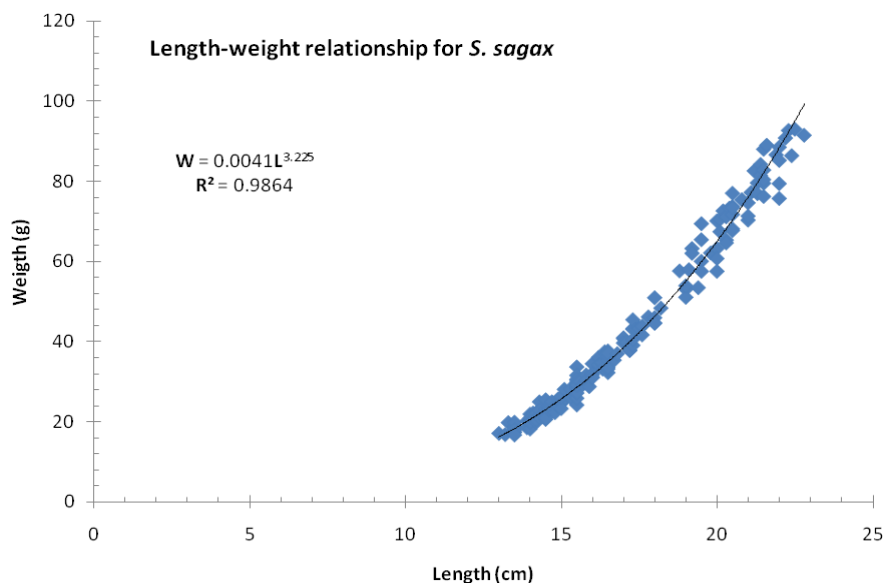


**Figure 9** Distribution of *Sardinella aurita* (south of Pta. Albina) and *Sardinops sagax* (off the Tiger Island and southwards) in the Angola-Namibian transboundary area (15°50'-19°00' S). Isobaths are indicated at 50, 100, 200 and 500 m depths. [due to problems with the Nansis software, the areal delimiters deviate from the standard presentation]

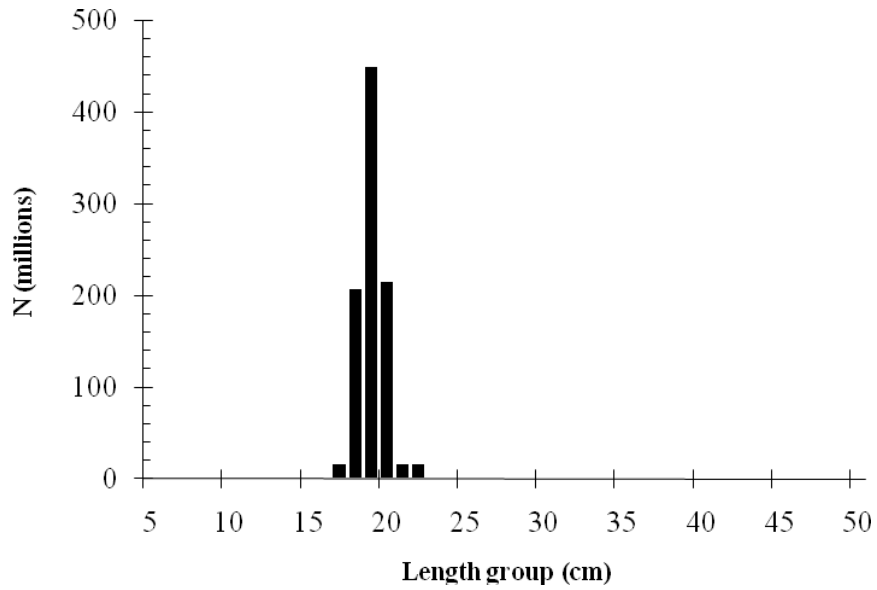




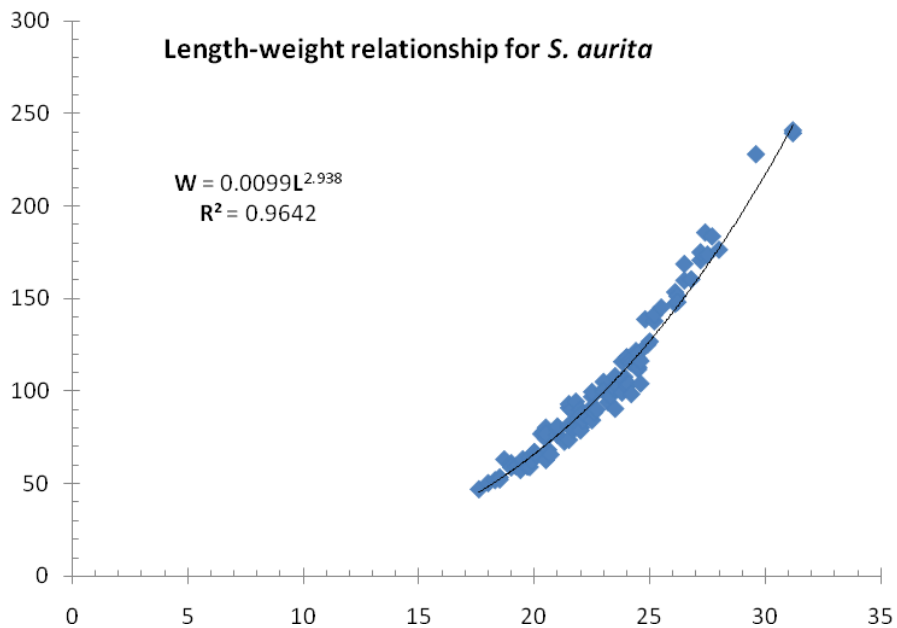
**Figure 10** Overall length frequency of *S. sagax* in the transboundary area (15°50'-19°00' S) (N= 12,771 mill. ind).



**Figure 11** Length-weight relationship for *S. sagax* in the transboundary area (15°50'-19°00' S) (n=172).



**Figure 12** Overall length frequency of *S. aurita* in the transboundary area (15°50'-19°00' S) (N= 927 mill. ind).

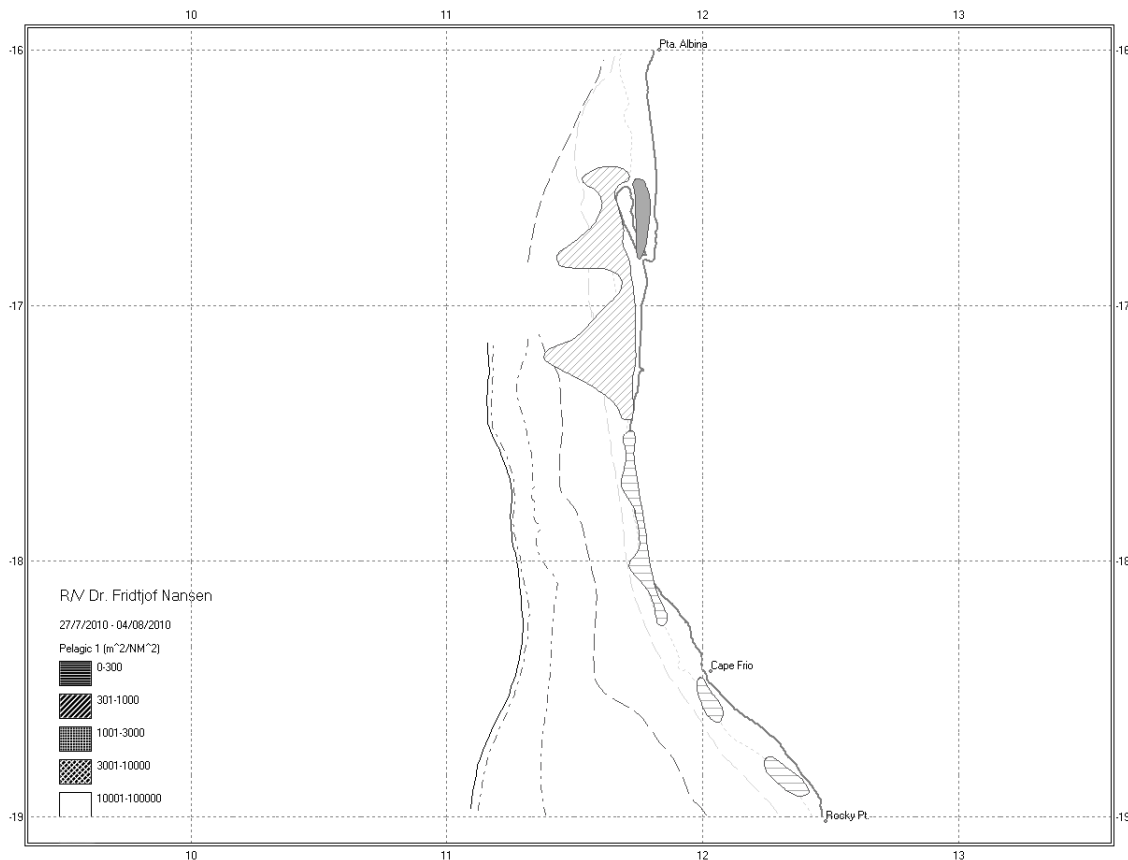


**Figure 13** Length-weight relationship for *S. aurita* in the transboundary area (15°50'-19°00' S) (n=112).

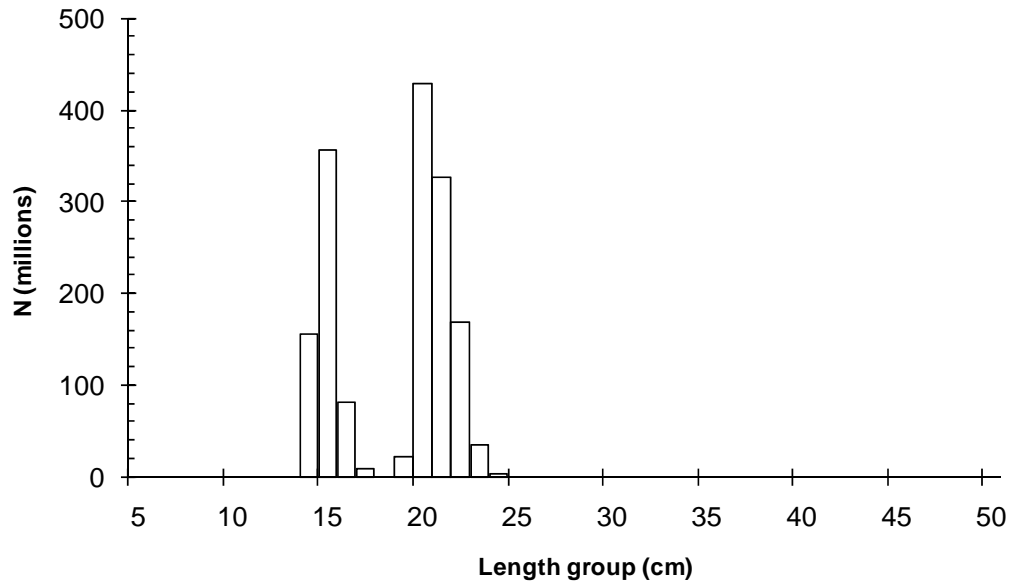
### **Pelagic 1 (*Etrumeus whiteheadii* and *Engraulis capensis*)**

*E. whiteheadii* and *E. capensis* were as usual mostly found in mixed shoals and were thus recorded jointly as Pelagic Species 1 (other clupeids, Table 1). The distribution of *E. whiteheadii* and *E. capensis* is given in Figure 14 below. These species were found from the Tiger Bank area and southwards. A high-density within the Tiger Bay and another, disjoint medium density aggregation was located from the northern tip of Tiger Island extending southwards to about 17°25' S. Another low-density, nearshore aggregation extended southwards from about 17°25' S to 18°15' S. Smaller, low density patches were found inshore south of Cape Frio (18°35' S) and north of Rocky Point (18°50' S).

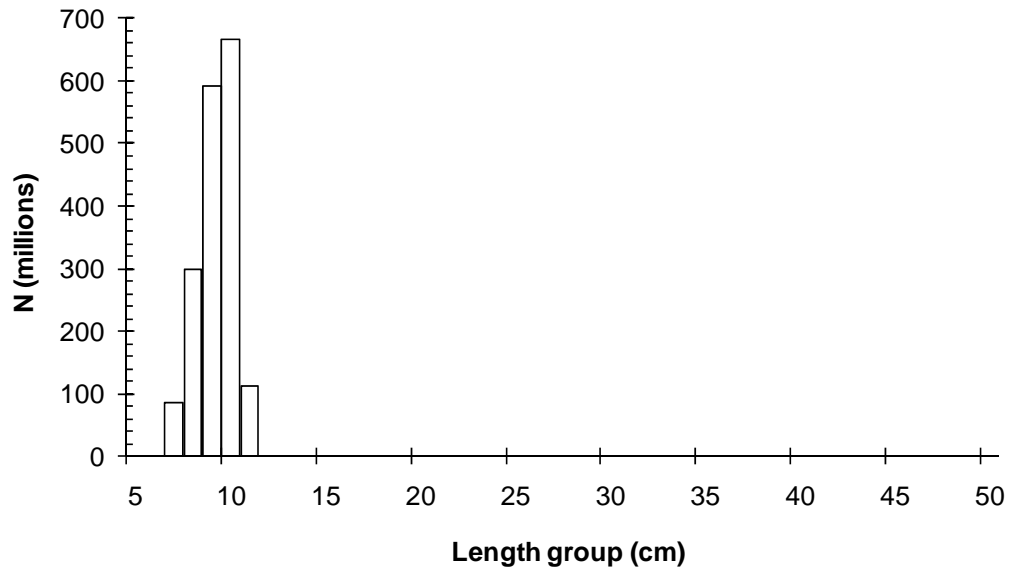
Due to problems with the Nansis software, no biomass estimate is available for the transboundary area.



**Figure 14** Distribution of *E. whiteheadii* and *E. capensis* (Pelagic Species 1) in the Angola-Namibia transboundary area (15°50'-19°00' S). Isobaths are indicated at 50, 100, 200, 500, 1,000 and 2,000 m depths.



**Figure 15** Overall length frequency of *E. whiteheadii* in the transboundary area (15°50'-19°00' S).



**Figure 16** Overall length frequency of *E. capensis* in the transboundary area (15°50'-19°00' S).

### 3.2 Northern Namibia (19-22 ° South)

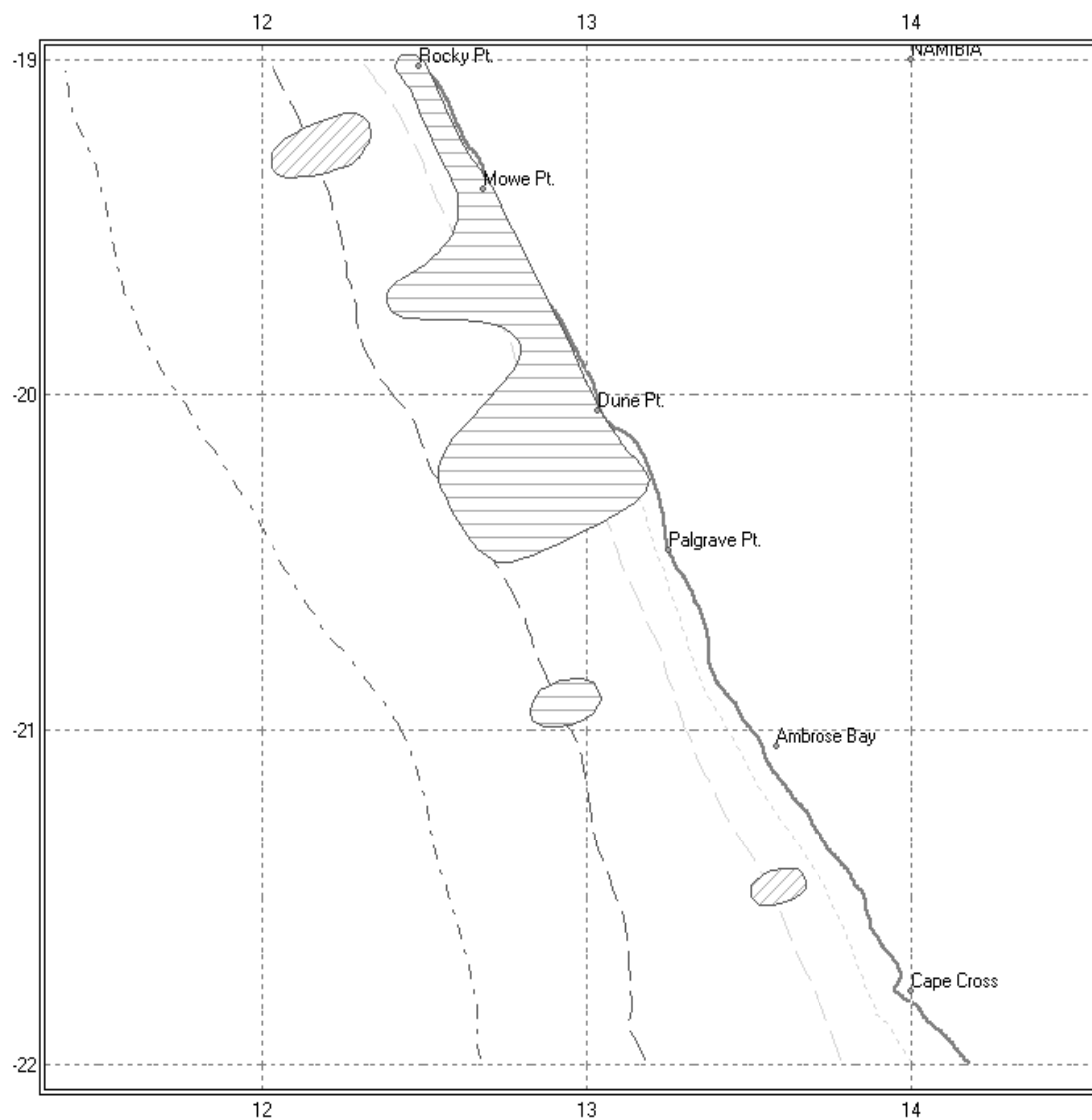
#### **Horse mackerel (*Trachurus trachurus capensis*):**

No *T. trecae* was encountered south of the transboundary area in 2010, compared to about 5,300 tonnes found in this region during the 2009 transboundary survey. The distribution of *T. t. capensis* is shown in Figure 17 below.

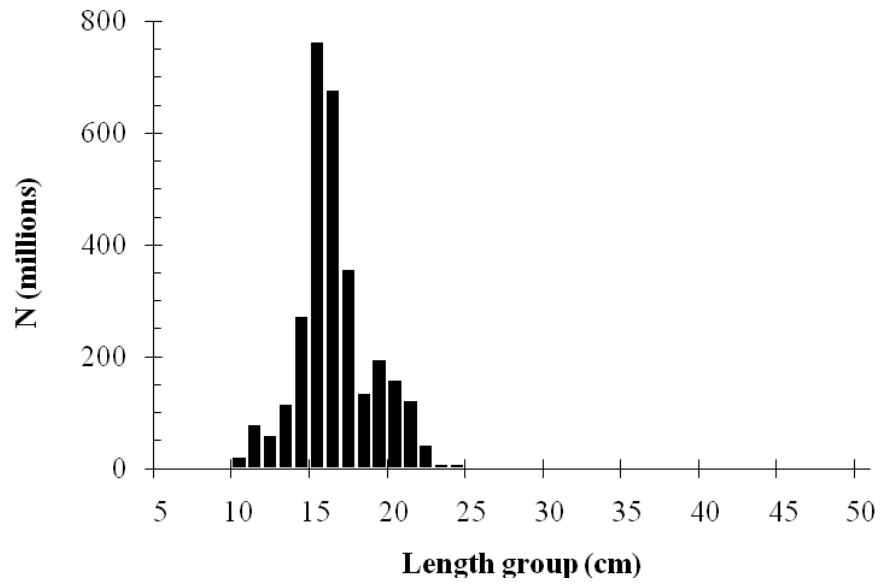
The main distribution of *T. t. capensis* was continuous from Rocky Point (17 °S) to just north of Palgrave Point at 20°30' S, with a primarily inshore distribution extending offshore in an undulating fashion up to about 200 m isobaths north of Palgrave Point ( $s_A$  mean: 334 m<sup>2</sup> nmi<sup>-2</sup>). Densities were generally higher further offshore. Smaller, scattered aggregations were found off 19°20' S at about 150-200 m depth ( $s_A$  mean: 924 m<sup>2</sup> nmi<sup>-2</sup>), off Ambrose Bay (20°55' S) at about 180-210 m depth ( $s_A$  mean: 329 m<sup>2</sup> nmi<sup>-2</sup>) and off 21°25' S at about 60-110 m depth ( $s_A$  mean: 868 m<sup>2</sup> nmi<sup>-2</sup>). The total biomass of *T. t. capensis* in northern Namibia (19-22° S) was estimated at 113,400 tonnes, which is somewhat lower than the estimate in the same area for 2009 (140,100 tonnes).

The estimated size distribution of *T. t. capensis* (10-24 cm total length) was tri-modal with modal peaks at 11 cm, 15 cm and 19 cm total length (Figure 18). The mean estimated total fish length from the acoustic estimate was 16.6 cm, corresponding to an estimated mean expected weight of 35.3 g (N= 3,026 mill. ind).

*T. t. Capensis* were caught in a total of 5 trawl hauls both inshore and offshore up to bottom depths of just over 200 m. Due to the relatively low number of stations and the geographical proximity, the length-weight relationship obtained in the transboundary area were used for the estimation of weight by length (Figure 5).



**Figure 17** Distribution of Cape horse mackerel *T. t. capensis* in Northern Namibia (19-22 °South). Isobaths are indicated at 50, 100, 200 and 500 m depths. [due to problems with Nansis software, density regions within the strata are not indicated ]

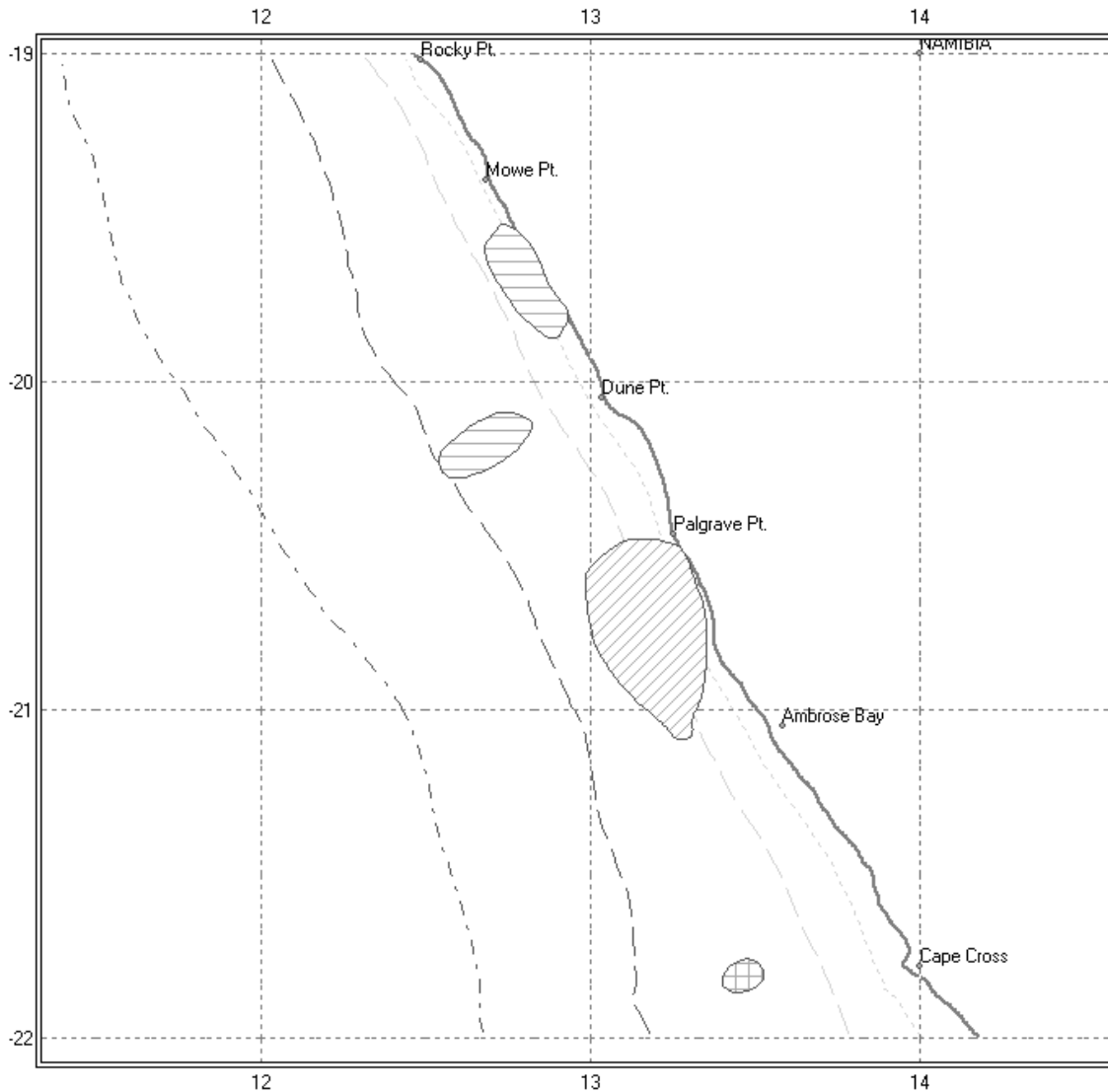


**Figure 18** Overall length frequency of *T. t. capensis* in Northern Namibia (19-22 °S) (N= 3,026 mill. ind).

### **Pelagic 1 (*Etrumeus whiteheadii* and *Engraulis capensis*)**

The distribution of Pelagic 1 (*Etrumeus whiteheadii* and *Engraulis capensis*) is shown in Figure 19 below. The total biomass of *E. whiteheadii* and *E. Capensis* is estimated at 81,100 tonnes.

*E. whiteheadii* and *E. capensis* were only caught in two sample trawls in the region, and the estimate is therefore based on the mean total sample length found in the transboundary area (12.5 cm) and an average condition factor of 0.0,1 as for previous surveys.



**Figure 19** Distribution of *E. whiteheadii* and *E. capensis* in Northern Namibia (19-22 °S), Isobaths are indicated at 50, 100, 200 and 500 m depths. [due to problems with Nansis software, density regions within the strata are not indicated ]



## Oceanographic Conditions

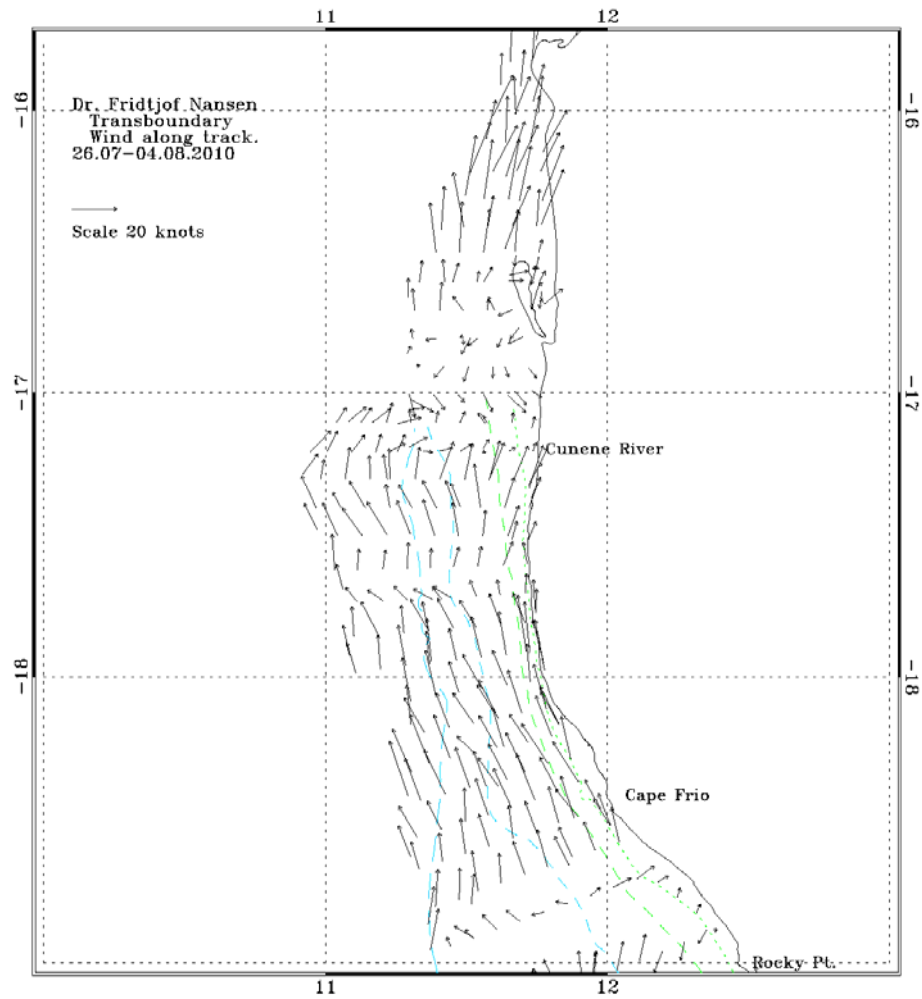
### Wind

The wind stress in the transboundary area during the survey period was relatively high, averaging 13 knots (6.7 m/s) (Figure 20).

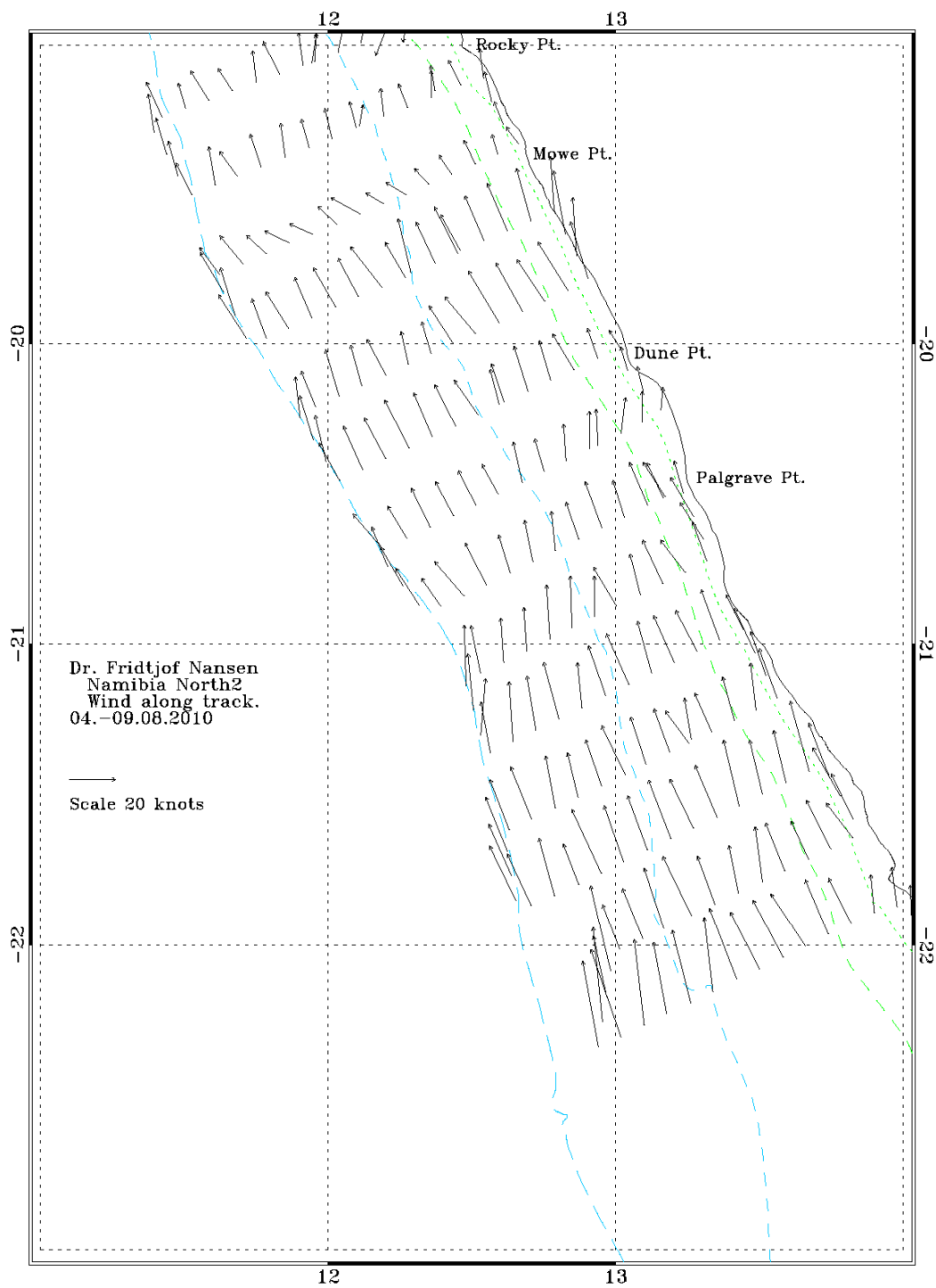
The northern part of the transboundary area was characterized with predominantly north-northeasterly winds reaching velocities up to 26 knots in the area north of Baia dos Tigres (15°50' S - 16°30' S), while calm conditions (average 9 knots) with variable wind directions were prevailing in the area south of Baia dos Tigres towards the border (16°30' S - 17°15' S).

The central and southern parts of the transboundary area (17°15' S - 19°00' S) were characterized by more stable north-westerly winds (average 14 knots), typical for this area at this time of the year, apart from inshore near Cape Frio, where the wind stress reduced to moderate, north-easterly winds on the last offshore-inshore transect line on the 8<sup>th</sup> July.

In northern Namibia (19-22 °S) there were predominantly gale force (average 18 knots) north-westerly winds (Figure 21).



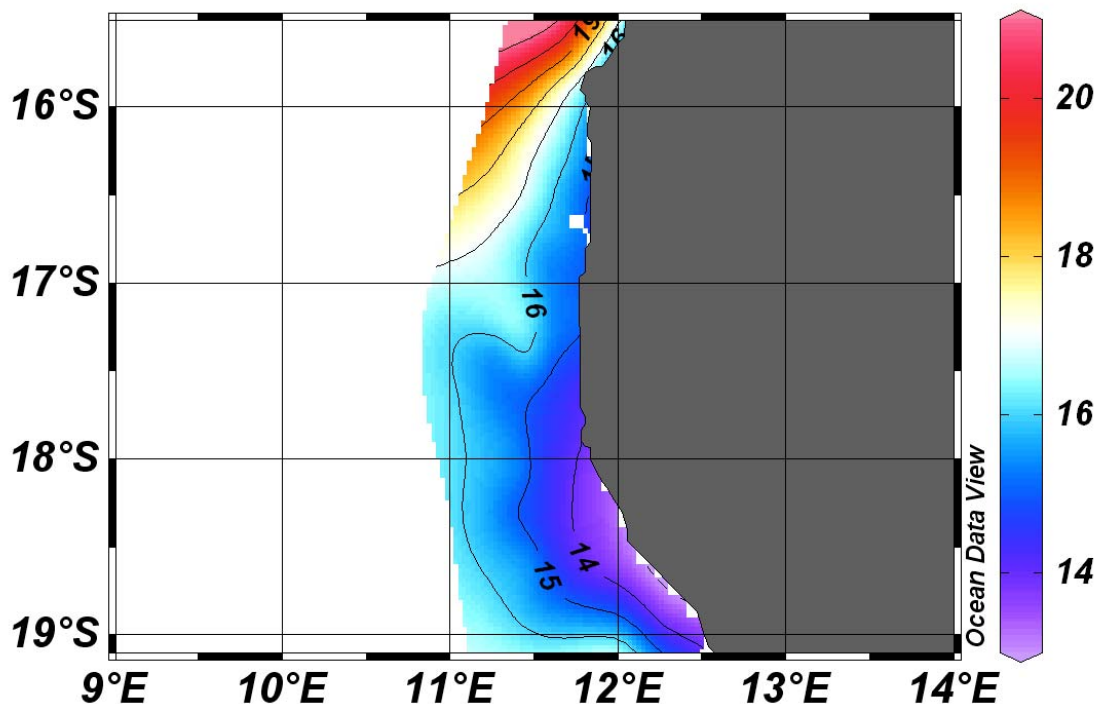
**Figure 20** Wind stress recorded in the transboundary area (15°50'-19°00' S) during the survey.



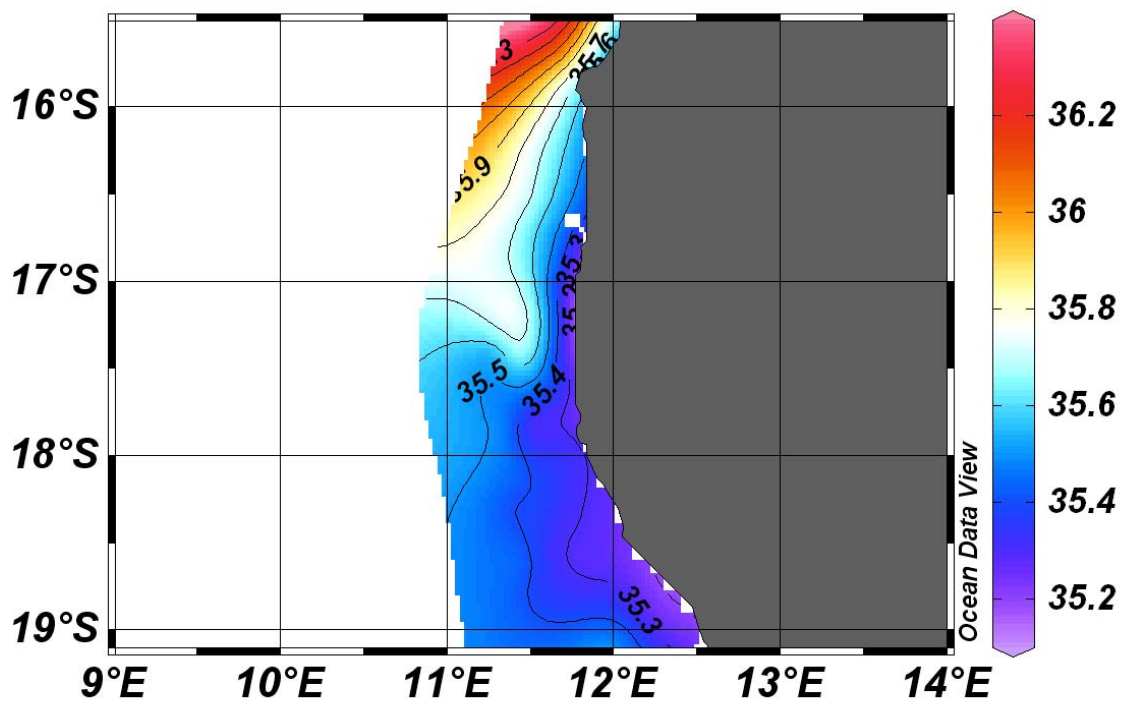
**Figure 21** Wind stress recorded in Northern Namibia (19-22 ° S) during the survey.

## Surface distributions

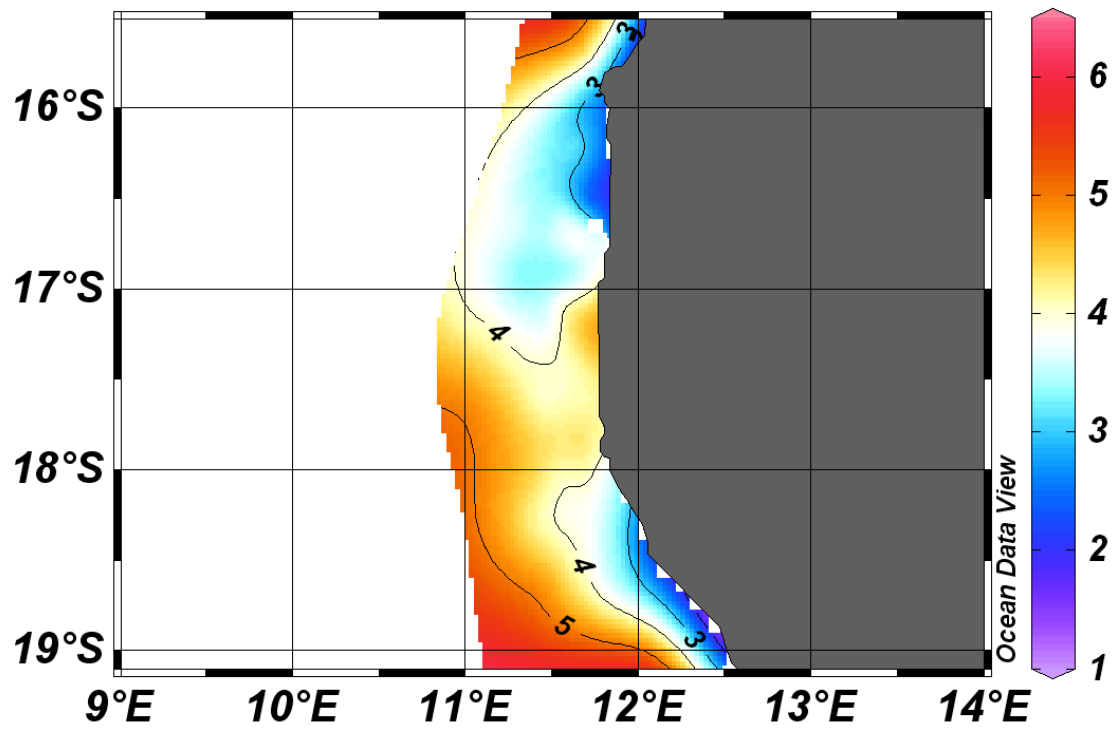
Figure 22 below shows the sea surface temperature (°C) (Figure 22a), the sea surface salinity (psu) (Figure 22b) and the dissolved oxygen (DO, ml/l) (Figures 22c) recorded at 5 m depth from the CTD stations in the transboundary area. The position of the well defined Angola-Benguela frontal zone (ABF) can be readily identified in the northernmost part of the transboundary area (15°50' - 16°00') S. Surface waters north of the ABF (15° -16° S) are warm (>18 °C), saline (>35.7 psu) and relatively oxygenated (> 3 ml/l), while surface waters south of the ABF are generally cooler (14-17 °C) and less saline (35.2-35.7 psu). The coolest waters (13.5 °C) were found inshore near Cape Frio (18°30' S), indicating some upwelling there. Oxygen levels south of the ABF were highest (5-6 ml/l) offshore Cape Frio and south of the Cunene River (17-18° S), and lowest on the Tiger Bank (16-17°) and inshore off Cape Frio.



**Figure 22a** Sea surface temperature (°C) at 5 m depth in the transboundary area (15°50'-19°00' S) derived from the CTD stations.



**Figure 22b** Sea surface salinity (psu) at 5 m depth in the transboundary area (15°50'-19°00' S) derived from the CTD stations.

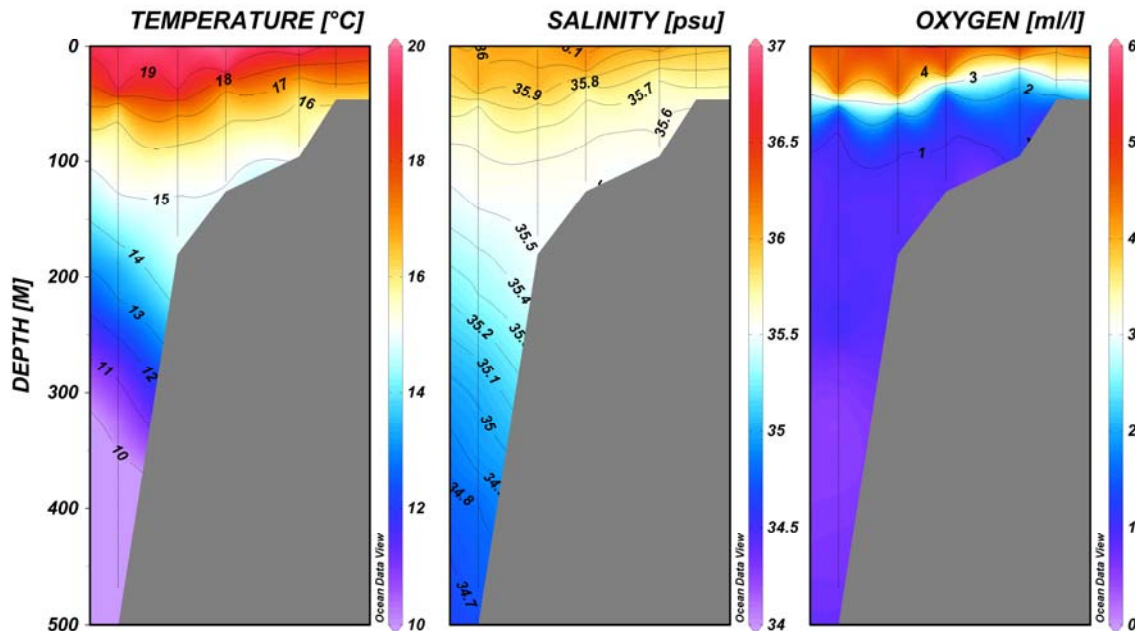


**Figure 22c** Sea surface dissolved Oxygen (ml/l) at 5 m depth in the transboundary area (15°50'-19°00' S) derived from the CTD stations.

## Vertical hydrographical sections

### *Namibe (Figure 23)*

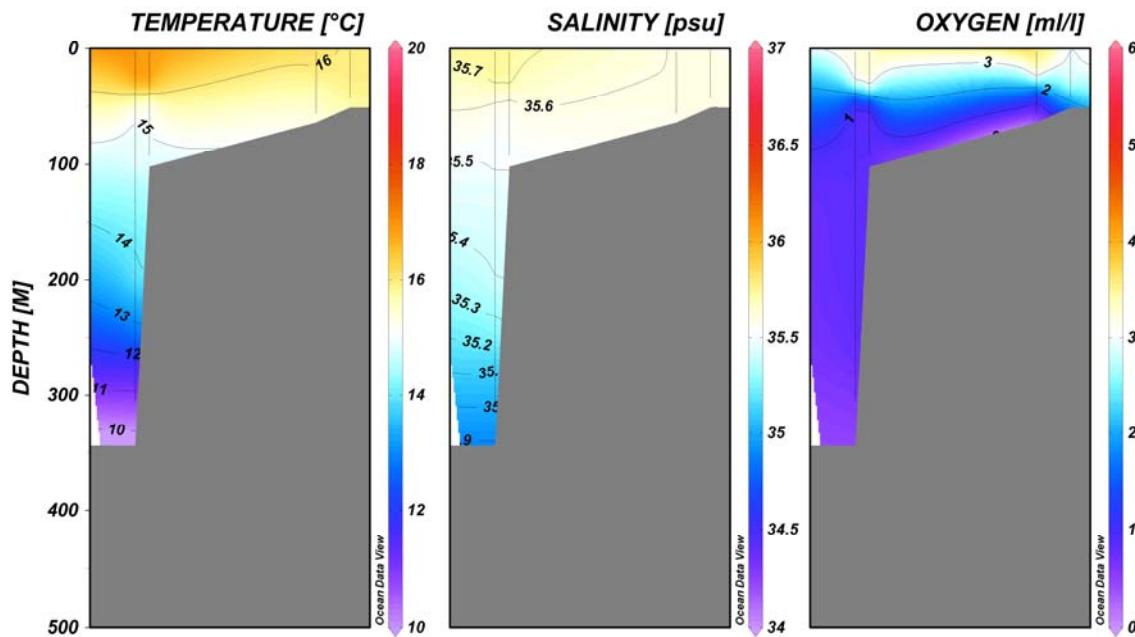
On the monitoring section off Namibe a relatively high degree of stratification of the water masses was found, albeit with some fluctuations near the surface, with relatively high temperatures (18-20 °C), salinity (>35.9 psu) and dissolved oxygen (> 4 ml/l) in the near-surface layer. The water masses on the shelf remained relatively warm (> 14 °C) and saline (>35.5 psu) down to about 200 m depth, while the DO dropped below 2 ml/l at about 50 m depth.



**Figure 23** Vertical sections of temperature, salinity and dissolved oxygen off Namibe.

***Pta. Albina* (Figure 24):**

The water masses of *Pta. Albina* were fairly stratified, with relatively warm (15-17 °C) and saline (35.5-35.7 psu) waters on the shelf plateau (about 100 m deep). The temperature was fairly stable down to about 200 m (14 °C) and the entire water column was fairly saline (>35 psu). Surface waters were fairly oxygenated (3-4 ml/l) above 25 m depth, while hypoxic conditions (<1 ml/l) prevailed near the bottom, as for previous years, deeper than approximately 75 m.

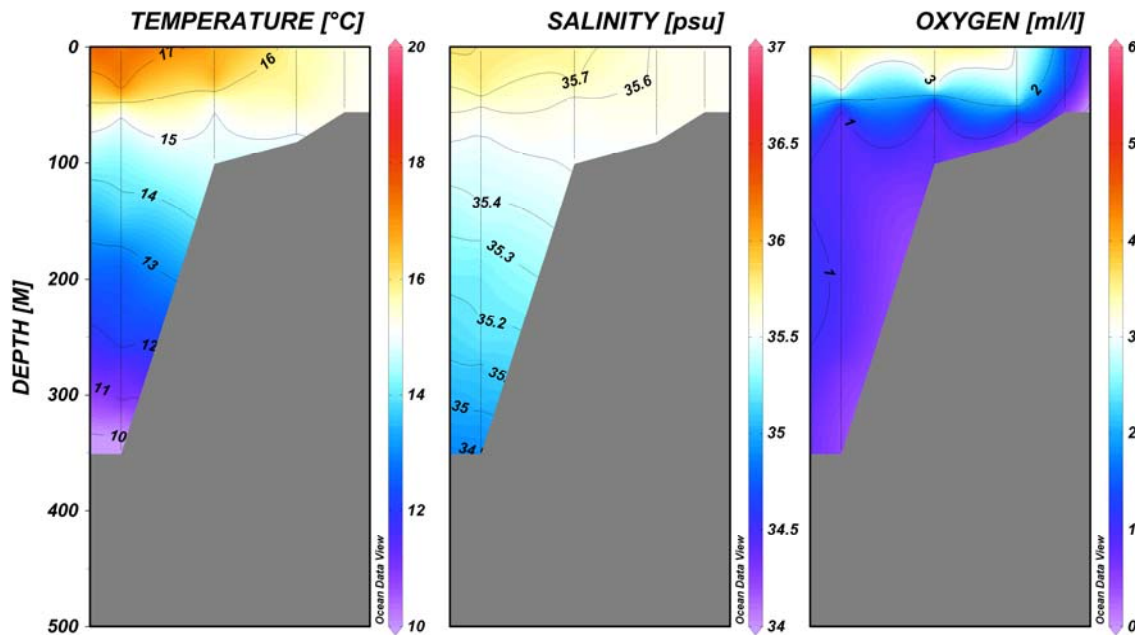


**Figure 24** Vertical sections of temperature, salinity and dissolved oxygen off *Pta. Albina*



**Baia dos Tigres (Figure 25):**

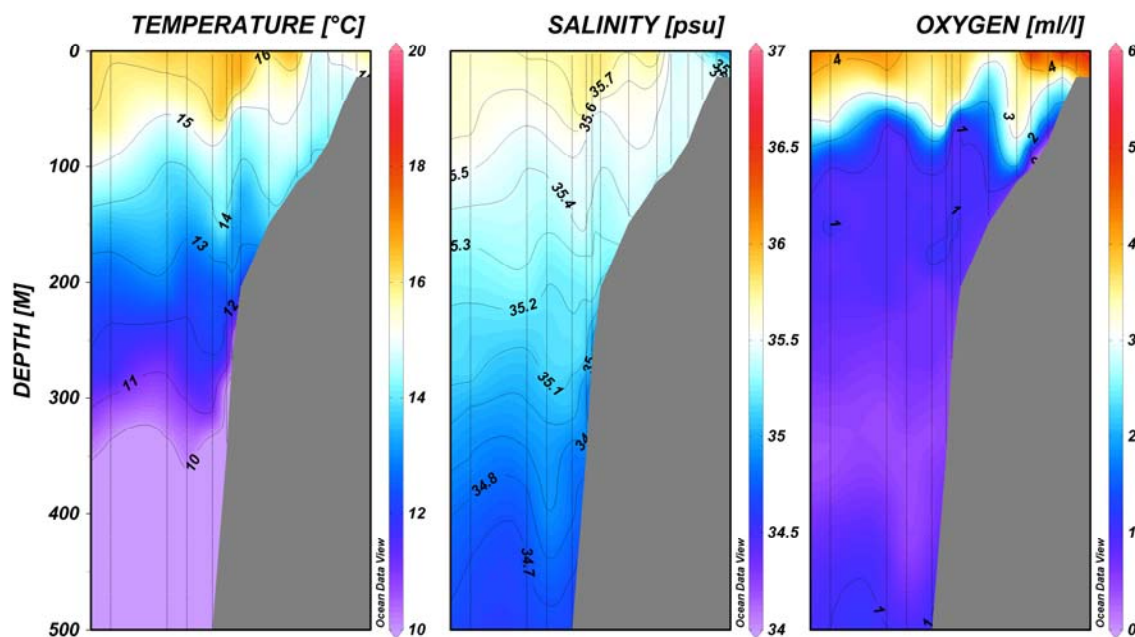
Surface waters off Baia dos Tigres were warm (15-16 °C) and saline (> 35.5), and fairly well oxygenated (3-4 ml/l) offshore of the 90 m isobath. Inshore water masses were characterized by moderate upwelling shallower than 100 m.



**Figure 25** Vertical sections of temperature, salinity and dissolved oxygen off Baía dos Tigres

**Cunene River (Figure 26):**

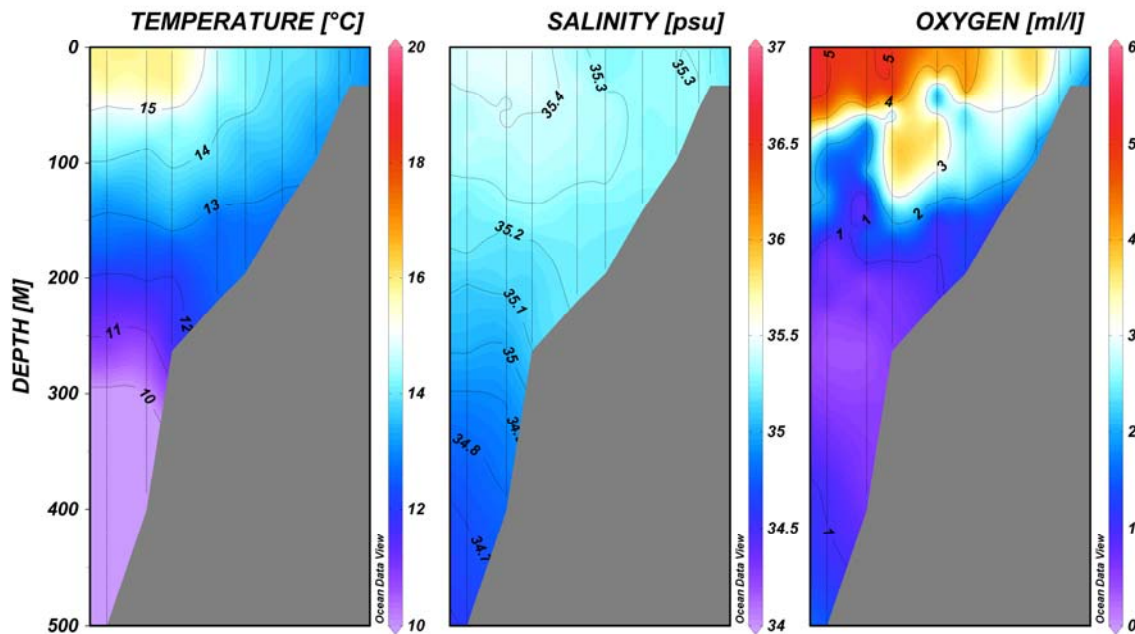
Off Cunene River water masses showed undulating trends, as reflected in temperature, salinity and dissolved oxygen. Surface temperatures ranged from 15-17 °C, while salinities ranged from 35.6-35.8 psu, apart from a shallow inshore pocket of lower salinity (35.1 psu) caused by freshwater discharge from the Cunene River. The oxygen level was high in surface waters, ranging from 3 to 5 ml/l. At 200 m depth, temperatures dropped to about 13 °C and the salinity went below 35.2 psu. Waters deeper than 100 m were generally hypoxic (< 1 ml/l).



**Figure 26** Vertical sections of temperature, salinity and dissolved oxygen off Cunene River.

**Cape Frio (Figure 27):**

Off Cape Frio sea surface temperatures and salinity levels were similar to 2009, with temperatures in the range of 14-15 °C and salinity levels of 35.3-35.4 psu. As for last year there were indications of coastal upwelling inshore, indicated by steeply elevated isolines for temperature, salinity and to DO at depths shallower than 100 m, with cooler water closer to the shoreline than offshore.



**Figure 27** Vertical sections of temperature, salinity and dissolved oxygen off Cape Frio.

## 4 Conclusions and Recommendations

Once more, the results from this years' survey show the transboundary nature of the fish resources under study. The results portray a more positive picture in terms of biomass for *T. t. capensis* and *S. Sagax* than in recent reports, but caution should taken as changes from year to year may well reflect migration in and out of the transboundary area rather than increases in the biomass levels. It should also be noted that the estimates are relative indices, not absolute estimates of abundance, and that all estimates, in particular for the densely and patchily aggregated sardine, are prone to acoustical survey errors (Anon. 2003, 2004).

As for previous years, the results also show that the *T. t. capensis* population is in comparatively much better condition than the *T. trecae* in terms of estimated biomass within the transboundary areas. It should, however, be emphasized that the time series of the transboundary region cannot be interpreted as timeseries of the stock units, as many of the populations have distribution areas that go far beyond the transboundary area and are characterized by migrations in and out of the transboundary area due to environmental factors and, in particular, the positioning of the Angola-Benguela Front (ABF). Fluctuations in the abundance estimates within the transboundary area do thus not necessarily reflect fluctuations in the stock units.

*Sardinella aurita* has so far not been considered a transboundary species, but was in 2010 for the first time in the transboundary time series encountered in sizeable aggregations within the transboubdary area (Angola).

The domination of small specimens of *T. t. capensis* and *T. trecae* found in the transboundary area are indicative of severely reduced adult populations, and thus of the spawning stock biomasses (SSB). The size distribution of *S. sagax* was somewhat distorted (as for 2009) in terms of relatively high abundance levels for some length groups, possibly due to relatively few samples obtained combined with sampling errors introduced by fishing gear avoidance.

**The main findings from the survey can be summarized as:**

- 1) The estimate of Cape horse mackerel was higher (516,000 tonnes) than in previous years (2005: 393,000 tonnes; 2008: 205,000 tonnes; 2009: 202,300 tonnes).

- 2) Approximately 13 % (by weight) of the Cape horse mackerel in the transboundary area was found in Angolan waters, which is similar to those found for recent years (2008: 10 %; 2009: 11 %), but contrasting the comparatively high proportion found in Angola during the first transboundary survey in 2005 (64 %).
- 3) The variation in abundance of Cape horse mackerel in the transboundary area and the relative distribution of the biomass in Angolan and Namibian waters between years show that the aggregation dynamics is highly dynamic within the transboundary area at this time of the year, and that both the total biomass and the relative distribution in the countries may fluctuate considerably over time, largely reflecting the impacts of a changing positioning of the Angola-Benguela Front (ABF).
- 4) The estimate of Cunene horse mackerel (45,500 tonnes) was similar to those found in previous years (2005: 44,000 tonnes, 2008: 20,000 tonnes, 2009: 50,700 tonnes).
- 5) The distribution pattern of Cunene horse mackerel was strikingly similar to that of 2009, with the majority of the biomass (75 %) found in Angolan waters, compared to 78 % in 2009, 80 % in 2008 and 100 % in 2005, suggesting similar environmental regimes in 2009 and 2010.
- 6) Given yearly fluctuations due to oceanographic conditions (the position of the ABF), it seems that main bulk of the Cunene horse mackerel biomass within the transboundary is presently found predominantly in Angolan waters (>75%), while the bulk of the Cape horse mackerel biomass (>87 %) is found in Namibian waters.
- 7) The biomass of Sardine (*Sardinops sagax*, “Pilchard”) was rather high (399,000 tonnes) in 2010 compared to previous years (2005: 0; 2008: 0; 2009: 35,700 tonnes). It should however be noted that these estimates are relative indices, not absolute estimates of abundance and so the population estimate should not be interpreted in absolute terms. Similarly, this was not a dedicated sardine survey both acoustic and net sampling was limited, thus warranting some uncertainty associated to this estimate, as discussed above.
- 8) In 2010, the entire Sardine biomass was found in a single, fairly homogenous aggregation located in Angolan waters, contrasting the situation in 2009, when many small and scattered, high-density aggregations of Sardine were distributed across the

border area (appr. 75 % in Angolan waters). As for Cape horse mackerel, both the aggregation pattern and the relative distribution between Angolan and Namibian zones within the transboundary area appear to fluctuate dramatically with environmental conditions between years. However, the more inshore-bound and short-lived life-history of the sardine compared to the carangid horse mackerels, combined with the fact that the sardine is still in a recovery phase from heavy fishing over the past decades, may add further to the dynamic picture for Sardine compared to Horse mackerel, rendering a yet more volatile and less predictable scenario in terms of abundance and distribution pattern for sardine compared to Horse mackerel within the transboundary area.

- 9) This year, 57,500 tonnes of *Sardinella aurita* were found in the transboundary area (Angola), unlike any of the previous years where no *S. aurita* have been encountered this far south (apart from a small aggregation in 2009 for which no biomass estimate was presented). Currently, therefore, this species does not appear to have a transboundary distribution pattern.
- 10) The other clupeid species (Round herring and Anchovy) were found in extended, homogenous aggregation, contrasting the situation in 2009 where scattered, high-density aggregations were found.
- 11) Both horse mackerel species were estimate to be small in size (Cape horse mackerel <33 cm total length, Cunene horse mackerel <24 cm total length), compared to respectively <25 cm and <27 cm for these species in 2009. This is a note of some concern, and is consistent with the finding that the mean length at 50 % maturity for Cunene horse mackerel has dropped quite dramatically from the reference year 1996 (23.0 cm total length) to 2010 (14.3 cm), indicating a severely reduced stock units due to high fishing pressure (Survey report for the pelagic resources in Angola, 2010).
- 12) The observed strong peaks of stage 2 in both horse mackerel species can be interpreted as a sign of a strong spawning season; by the time that cohort has reached spawning at stage 5. Such analyses in future surveys together with gonad maturation studies could help in identifying spawning seasons and grounds.

## Recommendations

The main recommendations are:

- 1) The time series should be continued, at the same time of the year, in order to monitor changes within the transboundary area over time and to establish whether the observed patterns are persistent over time.
- 2) Additional surveys should be conducted also in the warm season, as the distribution patterns of all the targeted species are likely quite different in the alternate season. Horse mackerel distributions over the transboundary area generally follow the position of the Angolan-Benguelan front (ABF), i.e. both species have more southern distribution in the warm season, leading expectations of more Cunene horse mackerel in Namibian waters and less Cape horse mackerel in Angolan waters during summer.
- 3) Angola and Namibia should, through the BCC, put in place mechanisms for continuing the monitoring of the transboundary area and expand on the established collaboration in the management of the transboundary pelagic fish resources there; all populations studied are to some extent transboundary, and most are in low abundance.
- 4) Collaborative monitoring should focus on joint training and harmonization of survey techniques, irrespective of the future of the transboundary surveys.
- 5) The quality and use of transboundary surveys will improve if participants are trained in biological sampling, mostly on maturity and stomach fullness staging. Such information is subjective and requires consistency. That combined with retention of participants could help in data precision.

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# Annex I Records of fishing stations

SPECIES										CATCH/HOUR		% OF TOT. C		SAMP	
										weight	numbers				
Trachurus capensis										18374.13	314195	48.25		183	
Trachurus trecae										17401.22	245362	45.69		182	
Etrumeus whiteheadi										1501.06	24182	3.94		184	
Sardinops ocellatus										378.08	0	0.99		185	
Dentex macrophthalmus										141.80	0	0.37			
Scomber japonicus										136.12	0	0.36			
Merluccius capensis										97.29	0	0.26			
Todaropsis eblanai										44.51	0	0.12			
PATELLIDAE										8.35	0	0.02			
Total										38082.55		100.00			

R/V Dr. Fridtjof Nansen										SURVEY: 2009406		STATION: 84		S 16°42.42	
DATE : 17.06.2009										GEAR TYPE: PT NO: 1		POSITION: Lat		S 16°42.42	
TIME : 23:24:22										start stop		duration		Lon E 11°35.06	
LOG : 9763.52										14.4 (min)		Purpose : 1			
FDEPTH: 0										40		Region : 4050			
BDEPTH: 38										42		Gear cond.: 0			
Towing dir.: 0°										Wire out : 145 m		Valid it y : 0			
Sorted : 96										Total catch: 894.23		Speed : 3.6 kn			
										Catch/hour: 3728.55					
SPECIES										CATCH/HOUR		% OF TOT. C		SAMP	
										weight	numbers				
Trachurus trecae										3617.89	51415	97.03		174	
Sardinella aurata										46.28	388	1.24		175	
Scomber japonicus										26.35	259	0.71			
Loligo vulgaris										19.01	271	0.51			
Pagellus bellottii										17.47	309	0.47			
Saurida brasiliensis										1.54	38	0.04			
Total										3728.55		100.00			

R/V Dr. Fridtjof Nansen										SURVEY: 2009406		STATION: 79		S 16°12.83	
DATE : 18.06.2009										GEAR TYPE: BT NO: 21		POSITION: Lat		S 16°12.83	
TIME : 07:05:11										start stop		duration		Lon E 11°36.80	
LOG : 9809.62										20.4 (min)		Purpose : 1			
FDEPTH: 73										76		Region : 4050			
BDEPTH: 73										76		Gear cond.: 0			
Towing dir.: 0°										Wire out : 190 m		Valid it y : 0			
Sorted : 137										Total catch: 1365.50		Speed : 3.1 kn			
										Catch/hour: 4016.18					
SPECIES										CATCH/HOUR		% OF TOT. C		SAMP	
										weight	numbers				
Trachurus trecae										3330.88	78059	82.94		176	
Dentex macrophthalmus										307.35	8265	7.65		177	
Merluccius polli										215.00	1412	5.35			
Stelustus mustelus										73.53	29	1.83			
Argyrosomus hololepis										42.06	29	1.05			
Octopus vulgaris										21.47	29	0.53			
Loligo vulgaris										14.71	971	0.37			
Sepia orbignyana										10.29	29	0.26			
Clathrus linguatula										0.88	29	0.02			
Total										4016.18		100.00			

R/V Dr. Fridtjof Nansen										SURVEY: 2009406		STATION: 80		S 16°42.14	
DATE : 18.06.2009										GEAR TYPE: PT NO: 7		POSITION: Lat		S 16°42.14	
TIME : 12:43:15										start stop		duration		Lon E 11°45.70	
LOG : 9856.20										30.1 (min)		Purpose : 1			
FDEPTH: 10										10		Region : 4050			
BDEPTH: 19										15		Gear cond.: 0			
Towing dir.: 0°										Wire out : 100 m		Valid it y : 0			
Sorted : 9										Total catch: 8.64		Speed : 3.6 kn			
										Catch/hour: 17.23					
SPECIES										CATCH/HOUR		% OF TOT. C		SAMP	
										weight	numbers				
JELLYFISH										11.70	287	67.94			
Pomatomus saltatrix										3.13	42	18.17			
Sardinella aurata										1.32	26	7.64		179	
Trachurus trecae										0.96	80	5.56		178	
Starfish										0.04	24	0.23			
Maja squinado										0.02	2	0.12			
Trachurus capensis										0.02	2	0.12			
Lagocephalus laevis										0.02	2	0.12			
Engraulis capensis										0.02	2	0.12			
Total										17.23		100.00			

R/V Dr. Fridtjof Nansen										SURVEY: 2009406		STATION: 81		S 16°18.26	
DATE : 18.06.2009										GEAR TYPE: PT NO: 1		POSITION: Lat		S 16°18.26	
TIME : 18:13:13										start stop		duration		Lon E 11°31.90	
LOG : 9902.22										10.9 (min)		Purpose : 1			
FDEPTH: 0										40		Region : 4050			
BDEPTH: 84										85		Gear cond.: 0			
Towing dir.: 0°										Wire out : 125 m		Valid it y : 0			
Sorted : 138										Total catch: 482.76		Speed : 4.0 kn			
										Catch/hour: 2667.18					
SPECIES										CATCH/HOUR		% OF TOT. C		SAMP	
										weight	numbers				
Trachurus trecae										2486.74	151989	93.23		180	
Todaropsis eblanai										74.45	309	2.79			
Sepia orbignyana										55.69	39	2.09			
Dentex macrophthalmus										41.60	1028	1.56			
Merluccius capensis										5.61	22	0.21			
Scomber japonicus										1.74	22	0.07			
Etrumeus whiteheadi										1.35	22	0.05			
Total										2667.18		100.00			

R/V Dr. Fridtjof Nansen										SURVEY: 2009406		STATION: 82		S 16°38.63	
DATE : 18.06.2009										GEAR TYPE: PT NO: 7		POSITION: Lat		S 16°38.63	
TIME : 23:32:33										start stop		duration		Lon E 11°46.05	
LOG : 9947.08										0.3 (min)		Purpose : 1			
FDEPTH: 10										10		Region : 4050			
BDEPTH: 19										19		Gear cond.: 0			
Towing dir.: 0°										Wire out : 100 m		Valid it y : 0			
Sorted : 9										Total catch: 9.01		Speed : 4.2 kn			
										Catch/hour: 146.50					
SPECIES										CATCH/HOUR		% OF TOT. C		SAMP	
										weight	numbers				
Engraulis capensis										63.90	67984	43.62			
SEMELIDAE										25.04	9154	17.09			
Trachurus trecae										20.98	2455	14.32		181	
JELLYFISH										20.33	163	13.87			
Loligo vulgaris										6.50	49	4.22			
POTAMIDIDAE										4.72	553	3.44			
NATIDIDAE										2.28	341	1.55			
BIVALVES										1.46	65	1.00			
Trichurus lepturus										0.98	16	0.67			
Dicolopoglossa cuneata										0.33	33	0.22			
Total										146.50		100.00			

R/V Dr. Fridtjof Nansen										SURVEY: 2009406		STATION: 83		S 16°36.81	
DATE : 19.06.2009										GEAR TYPE: BT NO: 21		POSITION: Lat		S 16°36.81	
TIME : 10:47:28										start stop		duration		Lon E 11°24.52	
LOG : 19.24										7.9 (min)		Purpose : 1			
FDEPTH: 120										123		Region : 4050			
BDEPTH: 120										123		Gear cond.: 0			
Towing dir.: 0°										Wire out : 330 m		Valid it y : 0			
Sorted : 154										Total catch: 5014.21		Speed : 3.3 kn			
										Catch/hour: 38082.61					
SPECIES										CATCH/HOUR		% OF TOT. C		SAMP	
										weight	numbers				
Etrumeus whiteheadi										1335.65	105235	68.36		195	
Trachurus capensis										464.35	61670	23.77		194	
JELLYFISH										100.17	1722	5.13			
Sardinops ocellatus										32.87	1513	1.68		196	
Trachurus trecae										12.52	1878	0.64		193	
Zeus faber										5.74	52	0.29			
Scomber japonicus										2.61	104	0.13			
Total										1953.91		100.00			

R/V Dr. Fridtjof Nansen										SURVEY: 2009406		STATION: 89		S 17°24.63	
DATE : 21.06.2009										GEAR TYPE: BT NO: 21		POSITION: Lat		S 17°24.63	
TIME : 21:06:00										start stop		duration		Lon E 11°34.86	
LOG : 19.24										13.8 (min)		Purpose : 1			
FDEPTH: 10										10		Region : 4050			
BDEPTH: 10										10		Gear cond.: 0			
Towing dir.: 0°										Wire out : 140 m		Valid it y : 0			
Sorted : 37										Total catch: 449.40		Speed : 3.3 kn			
										Catch/hour: 1953.91					
SPECIES										CATCH/HOUR		% OF TOT. C		SAMP	
										weight	numbers				
Etrumeus whiteheadi										1335.65	105235	68.36		195	
Trachurus capensis										464.35	61670	23.77		194	
JELLYFISH										100.17	1722	5.13			
Sardinops ocellatus										32.87	1513	1.68		196	
Trachurus trecae										12.52	1878	0.64		193	
Zeus faber										5.74	52	0.29			
Scomber japonicus										2.61	104	0.13			
Total										1953.91		100.00			

TIME : 09:55:17	10:02:29	7.2 (min)	Purpose : 1
LOG : 374.03	374.41	0.4	Region : 5010
FDEPTH: 123	125		Gear cond.: 0
BDEPTH: 123	125		Validi ty : 0
Towing dir: 0°	Wire out : 310 m		Speed : 3.2 kn
Sorted : 107	Total catch: 990.36		Catch/hour: 8253.00

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
Trachurus capensis	weight 6649.50 numbers 125233	80.57	197
Chrysaora hysoscella	906.75 6592	10.99	
Merluccius capensis	303.83 2250	3.68	
Synagrops macleodensis	242.58 49758	2.94	
Dentex macrophthalmus	67.42 542	0.82	
Aequorea sp.	49.58 2092	0.60	
Sepia officinalis hierredda	17.08 75	0.21	
Trigla capensis *	16.25 75	0.20	
Total	8253.00	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 90  
DATE : 21.06.2009 GEAR TYPE: BT NO: 21 POSITION: Lat S 17°30.48  
start stop duration Purpose : 1  
TIME : 12:49:14 12:55:32 6.3 (min) Region : 5010  
LOG : 396.09 396.42 0.3 Gear cond.: 0  
FDEPTH: 106 106 Validity : 0  
BDEPTH: 106 106 Speed : 3.2 kn  
Towing dir.: 0° Wire out : 280 m Catch/hour: 19919.81  
Sorted : 100 Total catch: 2091.58

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers			
Chrysaora hyoscelia	10840.00	46400	54.42
Trachurus capensis	5620.00	278400	28.21
Trachurus trecae	1110.00	46000	5.57
C R U S T A C E A N S	822.00	708000	4.13
Merluccius capensis	482.00	4200	2.42
VENERIDAE	284.00	6200	1.43
SEMELIDAE	268.57	3000	1.35
Synagrops microlepis	140.00	30000	0.70
Diologoglossa cuneata	84.00	4600	0.42
POTAMIDIDAE	63.24	3400	0.32
Bathynectes piperitus	60.00	5000	0.30
Sardinops ocellatus	44.00	1400	0.22
Ophiurus serpens	42.00	600	0.21
Etrumeus whiteheadi	34.00	1600	0.17
Gobiidae	14.00	1800	0.07
Scomber japonicus	12.00	200	0.06
Total	19919.81		100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 91  
DATE : 21.06.2009 GEAR TYPE: PT NO: 2 POSITION: Lat S 17°30.16  
start stop duration Purpose : 1  
TIME : 17:00:18 17:30:10 29.9 (min) Region : 5010  
LOG : 430.34 432.13 1.8 Gear cond.: 0  
FDEPTH: 180 150 Validity : 0  
BDEPTH: 1336 1201 Speed : 3.6 kn  
Towing dir.: 0° Wire out : 500 m Catch/hour: 4.65  
Sorted : 0 Total catch: 2.32

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers			
Tetragonurus atlanticus	1.15	6	24.62
Shrimps, small, non comm.	0.77	1218	16.63
MYCTOPHIDAE	0.68	209	14.69
Trachurus capensis	0.60	4	12.96
Aequorea sp.	0.54	44	11.66
REGALECIDAE	0.28	4	6.05
Krill	0.22	76	4.75
Chrysaora hyoscelia	0.20	4	4.32
Todaropsis sp.	0.14	8	3.02
Paralepis sp.	0.06	14	1.30
Total	4.65		100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 92  
DATE : 21.06.2009 GEAR TYPE: PT NO: 2 POSITION: Lat S 17°36.41  
start stop duration Purpose : 1  
TIME : 21:13:21 21:47:37 34.0 (min) Region : 5010  
LOG : 466.39 468.30 1.9 Gear cond.: 0  
FDEPTH: 100 90 Validity : 0  
BDEPTH: 554 386 Speed : 3.3 kn  
Towing dir.: 0° Wire out : 250 m Catch/hour: 64.73  
Sorted : 0 Total catch: 36.96

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers			
Trachurus capensis	35.38	412	54.65
MYCTOPHIDAE	15.18	6263	23.46
REGALECIDAE	9.11	7	14.07
Krill	4.13	7921	6.39
Todaropsis sp.	0.79	11	1.22
Octopus sp.	0.14	2	0.22
Total	64.73		100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 93  
DATE : 22.06.2009 GEAR TYPE: PT NO: 2 POSITION: Lat S 17°48.94  
start stop duration Purpose : 1  
TIME : 08:08:54 08:42:53 34.0 (min) Region : 5010  
LOG : 564.78 566.49 1.7 Gear cond.: 0  
FDEPTH: 100 150 Validity : 0  
BDEPTH: 186 200 Speed : 3.0 kn  
Towing dir.: 0° Wire out : 350 m Catch/hour: 133.76  
Sorted : 0 Total catch: 75.75

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers			
Chrysaora hyoscelia	96.32	1374	72.01
Trachurus capensis	33.55	447	25.08
Aequorea sp.	3.88	155	2.90
Total	133.76		100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 94  
DATE : 22.06.2009 GEAR TYPE: BT NO: 21 POSITION: Lat S 17°48.28  
start stop duration Purpose : 1  
TIME : 10:04:41 10:10:30 5.8 (min) Region : 5010  
LOG : 576.70 576.99 0.3 Gear cond.: 0  
FDEPTH: 119 121 Validity : 0  
BDEPTH: 119 121 Speed : 3.0 kn  
Towing dir.: 0° Wire out : 320 m Catch/hour: 20958.08  
Sorted : 127 Total catch: 2029.44

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers			
Trachurus capensis	13549.05	344509	64.65
Chrysaora hyoscelia	4676.08	60971	22.31
Merluccius capensis	1445.78	8262	6.90
Aequorea forskalea	740.24	28090	3.53
Synagrops microlepis	251.15	60971	1.20
Chelidonichthys capensis	186.71	661	0.89
Dentex macrophthalmus	61.14	1818	0.29
Sufflogobius barbatus	11.57	1983	0.06
Todarodes angolensis	9.91	330	0.05
Diologoglossa cuneata	8.26	330	0.04
Zeus faber	8.26	165	0.04
Bathynectes piperitus	4.96	661	0.02
Squilla mantis	4.96	165	0.02
Total	20958.07		100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 95  
DATE : 22.06.2009 GEAR TYPE: PT NO: 4 POSITION: Lat S 17°54.47  
start stop duration Purpose : 1  
TIME : 12:55:50 13:24:46 28.9 (min) Region : 5010  
LOG : 596.74 598.52 1.8 Gear cond.: 0  
FDEPTH: 10 10 Validity : 0  
BDEPTH: 120 127 Speed : 3.7 kn  
Towing dir.: 0° Wire out : 150 m Catch/hour: 1100.55  
Sorted : 40 Total catch: 530.65

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers			
Aequorea forskalea	617.53	14505	56.11
Chrysaora hyoscelia	477.22	2568	43.39
Trachurus capensis	5.81	900	0.53
Total	1100.55		100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 96  
DATE : 22.06.2009 GEAR TYPE: PT NO: 4 POSITION: Lat S 17°56.84  
start stop duration Purpose : 1  
TIME : 17:02:01 17:33:35 31.6 (min) Region : 5010  
LOG : 632.25 633.96 1.7 Gear cond.: 0  
FDEPTH: 10 10 Validity : 0  
BDEPTH: 1972 2123 Speed : 3.3 kn  
Towing dir.: 0° Wire out : 150 m Catch/hour: 0.00  
Sorted : 0 Total catch: 0.00

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers			
N O C A T C H	0.00	0	0.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 97  
DATE : 22.06.2009 GEAR TYPE: PT NO: 4 POSITION: Lat S 18°4.19  
start stop duration Purpose : 1  
TIME : 22:52:04 23:14:14 22.2 (min) Region : 5010  
LOG : 681.33 682.49 1.2 Gear cond.: 0  
FDEPTH: 0 0 Validity : 0  
BDEPTH: 35 42 Speed : 3.2 kn  
Towing dir.: 0° Wire out : 150 m Catch/hour: 21.91  
Sorted : 8 Total catch: 8.10

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers			
Engraulis capensis	9.14	2543	41.73
Sardinops ocellatus	6.36	701	29.01
Etrumeus whiteheadi	5.87	414	26.79
Loligo vulgaris	0.41	11	1.85
Trachurus trecae	0.08	8	0.37
Trachurus capensis	0.05	5	0.25
Total	21.91		100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 98  
DATE : 23.06.2009 GEAR TYPE: BT NO: 21 POSITION: Lat S 18°12.18  
start stop duration Purpose : 1  
TIME : 07:32:28 07:37:57 5.5 (min) Region : 5010  
LOG : 759.30 759.59 0.3 Gear cond.: 0  
FDEPTH: 137 136 Validity : 0  
BDEPTH: 137 136 Speed : 3.1 kn  
Towing dir.: 0° Wire out : 360 m Catch/hour: 4079.56  
Sorted : 68 Total catch: 373.28

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers			
Trachurus capensis	2903.28	49410	71.17
Chrysaora hyoscelia	769.40	4033	18.86
Aequorea sp.	355.19	917	8.71
Merluccius capensis	44.48	186	1.09
Calinectes sp.	3.61	120	0.09
BOTHIDAE	2.40	66	0.06
Synagrops microlepis	1.20	120	0.03
Total	4079.56		100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 99  
DATE : 23.06.2009 GEAR TYPE: BT NO: 21 POSITION: Lat S 18°17.90  
start stop duration Purpose : 1  
TIME : 10:12:03 10:22:33 10.5 (min) Region : 5010  
LOG : 780.14 780.69 0.6 Gear cond.: 0  
FDEPTH: 61 55 Validity : 0  
BDEPTH: 61 55 Speed : 3.1 kn  
Towing dir.: 0° Wire out : 160 m Catch/hour: 5707.42  
Sorted : 106 Total catch: 999.75

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers			
Trachurus capensis	3535.26	158872	61.94
JELLYFISH	2020.93	26078	35.41
Trachurus trecae	36.08	1564	0.63
Merluccius capensis	35.57	637	0.62
Maja squinado	23.69	913	0.42
Chelidonichthys capensis	17.75	103	0.31
'Undidenti' crab	17.24	1616	0.30
Etrumeus whiteheadi	12.90	754	0.23
Scomber japonicus	4.28	51	0.08
Diologoglossa cuneata	3.77	51	0.07
Total	5707.48		100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 100  
DATE : 23.06.2009 GEAR TYPE: PT NO: 4 POSITION: Lat S 18°18.24  
start stop duration Purpose : 1  
TIME : 11:30:33 12:01:10 30.6 (min) Region : 5010  
LOG : 787.93 789.89 2.0 Gear cond.: 0  
FDEPTH: 5 5 Validity : 0  
BDEPTH: 117 132 Speed : 3.8 kn  
Towing dir.: 0° Wire out : 150 m Catch/hour: 63.33  
Sorted : 0 Total catch: 32.32

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers			
Aequorea forskalea	36.54	756	57.70
Chrysaora hyoscelia	26.79	272	42.30
Total	63.33		100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 101  
DATE : 23.06.2009 GEAR TYPE: PT NO: 2 POSITION: Lat S 18°26.77  
start stop duration Purpose : 1  
TIME : 17:34:22 18:04:12 29.8 (min) Region : 5010  
LOG : 839.99 841.96 2.0 Gear cond.: 0  
FDEPTH: 40 40 Validity : 0  
BDEPTH: 978 1144 Speed : 4.0 kn  
Towing dir.: 0° Wire out : 100 m Catch/hour: 75.57  
Sorted : 0 Total catch: 37.57

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers			
Chrysaora hyoscelia	25.85	445	34.20
Aequorea sp.	20.07	694	26.56
Dasyatis violacea	15.39	2	20.36
MYCTOPHIDAE	11.51	3271	15.22
Trachurus capensis	1.93	18	2.56
Todaropsis eblanae	0.66	36	0.80
Paralepis sp.	0.16	18	0.21
Total	75.57		100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 102  
DATE : 23.06.2009 GEAR TYPE: PT NO: 2 POSITION: Lat S 18°24.38  
start stop duration Purpose : 1  
TIME : 21:29:41 22:02:07 32.4 (min) Region : 5010  
LOG : 871.62 873.35 1.7 Gear cond.: 0  
FDEPTH: 100 95 Validity : 0  
BDEPTH: 146 153 Speed : 3.2 kn  
Towing dir.: 0° Wire out : 280 m Catch/hour: 415.91  
Sorted : 56 Total catch: 224.80

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers			
Chrysaora hyoscelia	225.50	407	53.74
Aequorea sp.	192.41	3560	46.26
Total	415.91		100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 103  
 DATE : 24.06.2009 GEAR TYPE: PT NO: 4 POSITION: Lat S 18°27.04  
 start stop duration Lon E 11°57.60  
 TIME : 00:44:21 00:49:16 Purpose : 1  
 LOG : 894.43 894.88 0.5 Region : 5010  
 FDEPTH: 5 5 Gear cond.: 0  
 BDEPTH: 39 51 Validity : 0  
 Towing dir.: 0° Wire out : 140 m Speed : 5.5 kn  
 Sorted : 0 Total catch: 0.00 Catch/hour: 0.00

SPECIES CATCH/HOUR % OF TOT. C SAMP  
 weight numbers  
 N O C A T C H 0.00 0 0.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 104  
 DATE : 24.06.2009 GEAR TYPE: PT NO: 4 POSITION: Lat S 18°26.57  
 start stop duration Lon E 11°56.94  
 TIME : 01:11:31 01:36:34 Purpose : 1  
 LOG : 896.27 897.64 1.4 Region : 5010  
 FDEPTH: 5 5 Gear cond.: 0  
 BDEPTH: 51 36 Validity : 0  
 Towing dir.: 0° Wire out : 140 m Speed : 3.3 kn  
 Sorted : 71 Total catch: 496.18 Catch/hour: 1188.46

SPECIES CATCH/HOUR % OF TOT. C SAMP  
 weight numbers  
 Chrysaora sp. 652.93 7444 54.94  
 Sardinops ocellatus 303.47 47466 25.54 209  
 Engraulis capensis 155.93 27681 13.12 210  
 Aequorea sp. 76.12 1744 6.40  
 Total 1188.46 100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 105  
 DATE : 24.06.2009 GEAR TYPE: PT NO: 2 POSITION: Lat S 18°40.28  
 start stop duration Lon E 11°22.20  
 TIME : 08:57:45 09:35:50 Purpose : 1  
 LOG : 941.81 943.90 2.1 Region : 5010  
 FDEPTH: 50 95 Gear cond.: 0  
 BDEPTH: 509 475 Validity : 0  
 Towing dir.: 0° Wire out : 300 m Speed : 3.3 kn  
 Sorted : 56 Total catch: 398.59 Catch/hour: 628.03

SPECIES CATCH/HOUR % OF TOT. C SAMP  
 weight numbers  
 Chrysaora hysoscella 335.85 629 53.48  
 MYCTOPHIDAE 271.32 200360 43.20  
 Thyrsites atun 13.31 14 2.12  
 Aequorea sp. 5.51 199 1.04  
 Brama brama 0.85 2 0.14  
 Trachurus capensis 0.19 2 0.03  
 Total 628.03 100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 106  
 DATE : 24.06.2009 GEAR TYPE: PT NO: 21 POSITION: Lat S 18°36.02  
 start stop duration Lon E 11°50.51  
 TIME : 13:47:37 13:54:28 Purpose : 1  
 LOG : 978.78 979.15 0.4 Region : 5010  
 FDEPTH: 146 146 Gear cond.: 0  
 BDEPTH: 146 146 Validity : 0  
 Towing dir.: 0° Wire out : 400 m Speed : 3.3 kn  
 Sorted : 66 Total catch: 360.36 Catch/hour: 3156.44

SPECIES CATCH/HOUR % OF TOT. C SAMP  
 weight numbers  
 Trachurus capensis 1156.20 9153 36.63 211  
 Aequorea forskalea 1055.04 24280 33.42  
 Chrysaora hysoscella 688.91 4818 21.83  
 Merluccius capensis 250.51 1253 7.94  
 Synagrops micropus 4.82 1060 0.15  
 Gobiidae 0.96 53 0.03  
 Total 3156.44 100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 107  
 DATE : 24.06.2009 GEAR TYPE: PT NO: 21 POSITION: Lat S 18°40.01  
 start stop duration Lon E 11°58.00  
 TIME : 17:24:59 17:32:25 Purpose : 1  
 LOG : 1006.51 1006.89 0.4 Region : 5010  
 FDEPTH: 117 116 Gear cond.: 0  
 BDEPTH: 117 116 Validity : 0  
 Towing dir.: 0° Wire out : 310 m Speed : 3.1 kn  
 Sorted : 91 Total catch: 6998.87 Catch/hour: 56518.47

SPECIES CATCH/HOUR % OF TOT. C SAMP  
 weight numbers  
 Trachurus capensis 48192.19 771561 85.27 212  
 Chrysaora hysoscella 7435.15 6557 13.16  
 Merluccius capensis 634.08 1090 1.12  
 Aequorea forskalea 240.57 8746 0.43  
 Synagrops micropus 10.90 1090 0.02  
 Engraulis capensis 5.49 1090 0.01  
 Total 56518.38 100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 108  
 DATE : 24.06.2009 GEAR TYPE: PT NO: 2 POSITION: Lat S 18°44.92  
 start stop duration Lon E 11°43.18  
 TIME : 20:06:02 20:36:52 Purpose : 1  
 LOG : 1025.16 1026.89 1.7 Region : 5010  
 FDEPTH: 70 67 Gear cond.: 0  
 BDEPTH: 256 245 Validity : 0  
 Towing dir.: 0° Wire out : 210 m Speed : 3.4 kn  
 Sorted : 0 Total catch: 601.55 Catch/hour: 1170.71

SPECIES CATCH/HOUR % OF TOT. C SAMP  
 weight numbers  
 J E L L Y F I S H 700.62 47264 59.85  
 MYCTOPHIDAE 467.08 37273 39.90  
 Brama brama 3.02 2 0.26  
 Total 1170.71 100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 109  
 DATE : 25.06.2009 GEAR TYPE: PT NO: 1 POSITION: Lat S 18°54.98  
 start stop duration Lon E 11°31.91  
 TIME : 01:38:29 02:09:17 Purpose : 1  
 LOG : 1069.03 1070.77 1.7 Region : 5010  
 FDEPTH: 150 198 Gear cond.: 0  
 BDEPTH: 272 277 Validity : 0  
 Towing dir.: 0° Wire out : 540 m Speed : 3.4 kn  
 Sorted : 8 Total catch: 428.27 Catch/hour: 833.75

SPECIES CATCH/HOUR % OF TOT. C SAMP  
 weight numbers  
 J E L L Y F I S H 833.75 999 100.00  
 Total 833.75 100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 110  
 DATE : 25.06.2009 GEAR TYPE: PT NO: 1 POSITION: Lat S 18°43.29  
 start stop duration Lon E 12°5.58  
 TIME : 07:01:21 07:20:54 Purpose : 1  
 LOG : 1108.70 1109.76 1.1 Region : 5010  
 FDEPTH: 45 56 Gear cond.: 0  
 BDEPTH: 89 93 Validity : 0  
 Towing dir.: 0° Wire out : 150 m Speed : 3.3 kn  
 Sorted : 35 Total catch: 731.43 Catch/hour: 2244.80

SPECIES CATCH/HOUR % OF TOT. C SAMP  
 weight numbers  
 Chrysaora hysoscella 876.52 5414 39.05  
 Trachurus capensis 757.29 85590 33.74  
 Aequorea sp. 563.94 13470 25.12  
 Engraulis capensis 47.05 1565 2.10  
 Total 2244.80 100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 111  
 DATE : 25.06.2009 GEAR TYPE: PT NO: 7 POSITION: Lat S 18°43.87  
 start stop duration Lon E 12°15.84  
 TIME : 08:55:16 09:04:45 Purpose : 1  
 LOG : 1121.32 1121.88 0.6 Region : 5010  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 32 31 Validity : 0  
 Towing dir.: 0° Wire out : 155 m Speed : 3.5 kn  
 Sorted : 23 Total catch: 317.76 Catch/hour: 2009.02

SPECIES CATCH/HOUR % OF TOT. C SAMP  
 weight numbers  
 Engraulis capensis 1223.96 163878 60.92 213  
 Sardinops ocellatus 445.54 71867 22.18 214  
 Chrysaora hysoscella 339.52 6828 16.90  
 Total 2009.02 100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 112  
 DATE : 26.06.2009 GEAR TYPE: PT NO: 2 POSITION: Lat S 19°25.60  
 start stop duration Lon E 12°16.71  
 TIME : 06:17:35 06:44:21 Purpose : 1  
 LOG : 1305.96 1307.35 1.4 Region : 5010  
 FDEPTH: 110 120 Gear cond.: 0  
 BDEPTH: 150 138 Validity : 0  
 Towing dir.: 0° Wire out : 0 m Speed : 3.1 kn  
 Sorted : 64 Total catch: 1209.00 Catch/hour: 2711.78

SPECIES CATCH/HOUR % OF TOT. C SAMP  
 weight numbers  
 Chrysaora hysoscella 1774.21 4986 65.43  
 Trachurus capensis 717.76 16683 26.47  
 Aequorea sp. 219.36 6987 8.09  
 Total 2711.33 99.98

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 113  
 DATE : 26.06.2009 GEAR TYPE: PT NO: 7 POSITION: Lat S 19°42.21  
 start stop duration Lon E 12°51.36  
 TIME : 21:30:27 22:00:58 Purpose : 1  
 LOG : 1446.40 1447.98 1.6 Region : 5010  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 32 32 Validity : 0  
 Towing dir.: 0° Wire out : 160 m Speed : 3.1 kn  
 Sorted : 16 Total catch: 54.34 Catch/hour: 106.90

SPECIES CATCH/HOUR % OF TOT. C SAMP  
 weight numbers  
 Chrysaora hysoscella 89.61 325 83.82  
 Trachurus capensis 11.17 212 10.45  
 Thyrsites atun 2.10 4 1.97  
 Galeichthys feliceps 1.50 4 1.40  
 Engraulis capensis 1.46 354 1.36  
 Merluccius capensis 1.06 35 0.99  
 Total 106.90 100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 114  
 DATE : 27.06.2009 GEAR TYPE: PT NO: 2 POSITION: Lat S 20°10.60  
 start stop duration Lon E 12°26.64  
 TIME : 10:56:11 11:47:01 Purpose : 1  
 LOG : 1562.07 1564.56 2.5 Region : 5010  
 FDEPTH: 200 218 Gear cond.: 0  
 BDEPTH: 226 246 Validity : 0  
 Towing dir.: 0° Wire out : 560 m Speed : 2.9 kn  
 Sorted : 75 Total catch: 4070.06 Catch/hour: 4803.38

SPECIES CATCH/HOUR % OF TOT. C SAMP  
 weight numbers  
 Trachurus capensis 2926.53 52514 60.93 218  
 J E L L Y F I S H 1800.94 8554 37.49  
 Hippus valiantii 517 65 1.04  
 Hyperoglyphe moselii 25.73 65 0.54  
 Total 4803.38 100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 115  
 DATE : 27.06.2009 GEAR TYPE: PT NO: 1 POSITION: Lat S 20°1.81  
 start stop duration Lon E 12°49.03  
 TIME : 15:23:12 15:57:56 Purpose : 1  
 LOG : 1592.82 1594.95 2.1 Region : 5010  
 FDEPTH: 30 30 Gear cond.: 0  
 BDEPTH: 107 116 Validity : 0  
 Towing dir.: 0° Wire out : 90 m Speed : 3.7 kn  
 Sorted : 37 Total catch: 334.26 Catch/hour: 577.47

SPECIES CATCH/HOUR % OF TOT. C SAMP  
 weight numbers  
 Aequorea forskalea 509.99 11413 88.31  
 Chrysaora hysoscella 60.33 249 10.45  
 Trachurus capensis 7.15 1104 1.24  
 Total 577.47 100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 116  
 DATE : 27.06.2009 GEAR TYPE: PT NO: 7 POSITION: Lat S 20°0.48  
 start stop duration Lon E 12°59.60  
 TIME : 17:54:11 18:07:51 Purpose : 1  
 LOG : 1611.12 1611.82 0.7 Region : 5010  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 37 38 Validity : 0  
 Towing dir.: 0° Wire out : 150 m Speed : 3.1 kn  
 Sorted : 0 Total catch: 37.71 Catch/hour: 165.52

SPECIES CATCH/HOUR % OF TOT. C SAMP  
 weight numbers  
 Chrysaora hysoscella 83.83 1005 50.65  
 Trachurus trecae 27.83 1049 16.81 222  
 Trachurus capensis 21.46 386 12.97 220  
 Merluccius capensis 14.48 250 8.75  
 J E L L Y F I S H 11.37 4 6.87  
 Engraulis capensis 6.36 909 3.85  
 Gobiidae 0.18 4 0.11  
 Total 165.52 100.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 117  
 DATE : 27.06.2009 GEAR TYPE: BT NO: 21 POSITION: Lat S 20°21.46  
 start stop duration Lon E 12°39.44  
 TIME : 22:54:12 23:07:56 Purpose : 1  
 LOG : 1653.54 1654.34 0.8 Region : 5010  
 FDEPTH: 156 150 Gear cond.: 0  
 BDEPTH: 156 150 Validity : 0  
 Towing dir.: 0° Wire out : 430 m Speed : 3.5 kn  
 Sorted : 98 Total catch: 550.73 Catch/hour: 2404.93

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Trachurus capensis	1401.75	25873	58.29
Chrysaora hyoscellia	524.02	1515	21.79
Merluccius capensis	362.45	3694	15.07
Aequorea forskalea	39.87	734	1.66
Lophius valli	32.05	218	1.33
Todarodes angolensis	14.67	26	0.61
Chelidonichthys capensis	13.45	26	0.56
Austroglossus micropus	10.04	26	0.42
GOBIIDAE	5.35	1345	0.21
Pterothrissaloides	1.48	26	0.06
Total	2404.93	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 118  
 DATE : 28.06.2009 GEAR TYPE: PT NO: 4 POSITION: Lat S 20°26.78  
 start stop duration Lon E 13°12.51  
 TIME : 10:35:36 11:06:11 Purpose : 1  
 LOG : 1768.14 1769.85 1.7 Region : 5010  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 44 63 Validity : 0  
 Towing dir.: 0° Wire out : 140 m Speed : 3.3 kn  
 Sorted : 74 Total catch: 448.68 Catch/hour: 880.34

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Engraulis capensis	460.89	53494	52.35
JELLYFISH	372.60	2990	42.32
Etrumeus whiteheadi	28.14	1766	3.20
Sardinops ocellatus	10.83	177	1.23
Trachurus capensis	5.18	259	0.59
Chelidonichthys capensis	2.71	47	0.31
Total	880.34	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 119  
 DATE : 28.06.2009 GEAR TYPE: PT NO: 4 POSITION: Lat S 20°32.46  
 start stop duration Lon E 13°15.59  
 TIME : 12:25:39 12:36:53 Purpose : 1  
 LOG : 1777.83 1778.57 0.7 Region : 5010  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 37 36 Validity : 0  
 Towing dir.: 0° Wire out : 140 m Speed : 3.9 kn  
 Sorted : 37 Total catch: 834.21 Catch/hour: 4453.08

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Etrumeus whiteheadi	3726.25	525667	83.68
Chrysaora hyoscellia	265.20	1719	5.96
Engraulis capensis	195.21	35530	4.38
Chelidonichthys capensis	95.77	123	2.15
Sardinops ocellatus	90.85	7612	2.04
Trachurus capensis	79.80	10436	1.79
Total	4453.08	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 120  
 DATE : 28.06.2009 GEAR TYPE: BT NO: 21 POSITION: Lat S 20°44.66  
 start stop duration Lon E 12°58.65  
 TIME : 16:24:04 16:33:56 Purpose : 1  
 LOG : 1807.63 1808.11 0.5 Region : 5010  
 FDEPTH: 143 144 Gear cond.: 0  
 BDEPTH: 143 144 Validity : 0  
 Towing dir.: 0° Wire out : 370 m Speed : 2.9 kn  
 Sorted : 7 Total catch: 434.40 Catch/hour: 2640.73

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Chrysaora hyoscellia	926.44	1641	35.08
Trachurus capensis	840.73	26006	31.84
Aequorea sp.	625.53	14736	23.69
Merluccius capensis	192.22	2609	7.28
GOBIIDAE	55.81	10140	2.11
Total	2640.73	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 121  
 DATE : 29.06.2009 GEAR TYPE: BT NO: 21 POSITION: Lat S 20°54.31  
 start stop duration Lon E 13°23.93  
 TIME : 03:17:46 03:35:25 Purpose : 1  
 LOG : 1915.43 1916.33 0.9 Region : 5010  
 FDEPTH: 31 30 Gear cond.: 0  
 BDEPTH: 31 30 Validity : 0  
 Towing dir.: 0° Wire out : 110 m Speed : 3.1 kn  
 Sorted : 28 Total catch: 139.45 Catch/hour: 474.05

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Trachurus capensis	255.81	8227	53.96
Chrysaora hyoscellia	103.34	1615	21.80
Chelidonichthys capensis	41.81	204	8.82
Aequorea sp.	32.63	663	6.88
Callorhynchus capensis	25.16	17	5.31
Galeichthys feliceps	11.22	34	2.37
Merluccius capensis	2.55	85	0.54
Dicologlossa cuneata	1.53	51	0.32
Total	474.05	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 122  
 DATE : 29.06.2009 GEAR TYPE: PT NO: 1 POSITION: Lat S 21°11.27  
 start stop duration Lon E 13°16.95  
 TIME : 07:02:09 07:18:14 Purpose : 1  
 LOG : 1944.64 1945.54 0.9 Region : 5010  
 FDEPTH: 50 60 Gear cond.: 0  
 BDEPTH: 126 120 Validity : 0  
 Towing dir.: 0° Wire out : 140 m Speed : 3.3 kn  
 Sorted : 37 Total catch: 408.76 Catch/hour: 1525.22

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Aequorea sp.	703.92	12231	46.15
Chrysaora hyoscellia	591.04	3981	38.75
Etrumeus whiteheadi	212.61	24586	13.94
Sardinops ocellatus	10.67	1108	0.70
Trachurus capensis	6.57	944	0.43
Engraulis capensis	0.41	123	0.03
Total	1525.22	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 123  
 DATE : 29.06.2009 GEAR TYPE: PT NO: 1 POSITION: Lat S 21°10.46  
 start stop duration Lon E 13°20.42  
 TIME : 09:00:20 09:31:14 Purpose : 1  
 LOG : 1949.29 1951.04 1.8 Region : 5010  
 FDEPTH: 40 40 Gear cond.: 0  
 BDEPTH: 107 115 Validity : 0  
 Towing dir.: 0° Wire out : 120 m Speed : 3.4 kn  
 Sorted : 0 Total catch: 0.00 Catch/hour: 0.00

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
NOCATCH	0.00	0	0.00

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 124  
 DATE : 29.06.2009 GEAR TYPE: PT NO: 7 POSITION: Lat S 21°21.91  
 start stop duration Lon E 13°41.00  
 TIME : 22:24:20 22:54:43 Purpose : 1  
 LOG : 2076.64 2078.30 1.7 Region : 5010  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 27 32 Validity : 0  
 Towing dir.: 0° Wire out : 150 m Speed : 3.3 kn  
 Sorted : 34 Total catch: 137.32 Catch/hour: 271.20

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
JELLYFISH	218.43	1722	80.54
Chelidonichthys capensis	41.16	893	15.18
Callorhynchus capensis	10.90	8	4.02
Etrumeus whiteheadi	0.47	39	0.17
Trachurus capensis	0.16	8	0.06
GOBIIDAE	0.08	8	0.03
Total	271.20	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 125  
 DATE : 30.06.2009 GEAR TYPE: PT NO: 2 POSITION: Lat S 21°55.84  
 start stop duration Lon E 12°42.28  
 TIME : 07:03:55 07:51:17 Purpose : 1  
 LOG : 2156.22 2158.77 2.5 Region : 5010  
 FDEPTH: 180 210 Gear cond.: 0  
 BDEPTH: 416 354 Validity : 0  
 Towing dir.: 0° Wire out : 500 m Speed : 3.2 kn  
 Sorted : 0 Total catch: 159.60 Catch/hour: 202.11

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Chrysaora hyoscellia	89.21	34	44.14
Brama brama	87.51	99	43.30
MYCTOPHIDAE	25.39	16157	12.56
Total	202.11	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 126  
 DATE : 30.06.2009 GEAR TYPE: PT NO: 5 POSITION: Lat S 21°48.16  
 start stop duration Lon E 13°48.87  
 TIME : 17:49:45 18:05:04 Purpose : 1  
 LOG : 2247.24 2248.07 0.8 Region : 5010  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 75 70 Validity : 0  
 Towing dir.: 0° Wire out : 150 m Speed : 3.3 kn  
 Sorted : 66 Total catch: 230.38 Catch/hour: 902.25

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Chrysaora hyoscellia	489.36	1277	54.24
Aequorea sp.	406.45	7198	45.05
Trachurus capensis	3.43	384	0.38
JELLYFISH	3.02	16	0.33
Total	902.25	100.00	

R/V Dr. Fridtjof Nansen SURVEY: 2009406 STATION: 127  
 DATE : 01.07.2009 GEAR TYPE: PT NO: 4 POSITION: Lat S 22°25.62  
 start stop duration Lon E 14°14.58  
 TIME : 16:37:02 16:45:15 Purpose : 1  
 LOG : 2465.64 2466.16 0.5 Region : 5010  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 62 59 Validity : 0  
 Towing dir.: 0° Wire out : 140 m Speed : 3.8 kn  
 Sorted : 35 Total catch: 140.24 Catch/hour: 1024.90

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Aequorea sp.	955.91	4706	93.27
GOBIIDAE	58.47	52619	5.70
Chrysaora hyoscellia	10.52	205	1.03
Total	1024.90	100.00	

## Annex II Catch rates

Station	Bottom depth	<i>T. capensis</i>	<i>T. trecae</i>	<i>S. sagax</i>	<i>E. whiteheadi</i>	<i>E. capensis</i>	Others	Total
78	40.00	0.00	3617.89	0.00	0.00	0.00	110.65	3728.54
79	74.00	0.00	3330.88	0.00	0.00	0.00	685.29	4016.17
80	17.00	0.02	0.96	0.00	0.00	0.02	16.25	17.25
81	84.00	0.00	2486.74	0.00	1.35	0.00	179.09	2667.18
82	19.00	0.00	20.98	0.00	0.00	63.90	125.54	210.42
83	122.00	18374.13	17401.22	378.08	1501.06	0.00	428.07	38082.56
84	47.00	0.00	0.00	0.00	0.78	0.00	2.84	3.62
85	22.00	0.00	476.80	0.28	3.97	0.00	140.53	621.58
86	87.00	0.00	0.00	4.72	436.30	0.00	35.29	476.31
87	128.00	5927.29	767.45	0.00	0.00	0.00	2497.73	9192.47
88	64.00	464.35	12.52	32.87	1335.65	0.00	108.52	1953.91
89	124.00	6649.50	0.00	0.00	0.00	0.00	1603.49	8252.99
90	106.00	5620.00	1110.00	44.00	34.00	0.00	13111.81	19919.81
91	1268.00	0.60	0.00	0.00	0.00	0.00	4.04	4.64
92	470.00	35.38	0.00	0.00	0.00	0.00	29.35	64.73
93	193.00	33.55	0.00	0.00	0.00	0.00	100.20	133.75
94	120.00	13549.05	0.00	0.00	0.00	0.00	7409.02	20958.07
95	124.00	5.81	0.00	0.00	0.00	0.00	1094.75	1100.56
96	2048.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
97	38.00	0.05	0.08	6.36	5.87	9.14	9.55	31.05
98	136.00	2903.28	0.00	0.00	0.00	0.00	1176.28	4079.56
99	58.00	3535.26	36.08	0.00	12.90	0.00	2123.23	5707.47
100	124.00	0.00	0.00	0.00	0.00	0.00	63.33	63.33
101	1061.00	1.93	0.00	0.00	0.00	0.00	73.64	75.57
102	150.00	0.00	0.00	0.00	0.00	0.00	415.91	415.91
103	45.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104	44.00	0.00	0.00	303.47	0.00	155.93	884.98	1344.38
105	492.00	0.19	0.00	0.00	0.00	0.00	627.84	628.03
106	146.00	1156.20	0.00	0.00	0.00	0.00	2000.24	3156.44
107	116.00	48192.19	0.00	0.00	0.00	5.49	8326.19	56523.87
108	250.00	0.00	0.00	0.00	0.00	0.00	1170.72	1170.72
109	274.00	0.00	0.00	0.00	0.00	0.00	833.75	833.75
110	91.00	757.29	0.00	0.00	0.00	47.05	1487.51	2291.85
111	32.00	0.00	0.00	445.54	0.00	1223.96	1563.48	3232.98
Mean	241.59	3153.12	860.64	35.74	98.00	44.28	1424.68	5616.46
St DEV	413.28	8811.14	3019.72	107.54	338.79	207.37	2743.28	11736.77
% Catch		56.14	15.32	0.64	1.74	0.79	25.37	

## Annex III Instruments and fishing gear

The Simrad EK-60, 38 kHz echo scientific sounder was used during the survey for fish abundance estimation, in addition data from the 18 kHz, 120 kHz and the 200 kHz transducers were logged for possible future multi frequency target estimation. The Large Scale Survey System (LSSS) Version 1.25 logging the echogram raw data from the sounder, was used to scrutinize the acoustic records, and to allocate integrator data to fish species. All raw data were stored to tape, and a backup of the database of scrutinized data. The details of the settings of the 38 kHz were as follows:

### Transceiver-2 menu (38 kHz)

Transducer depth	5.50 m
Absorbtion coeff.	8,7 dB/km
Pulse length	medium (1,024ms)
Bandwidth	2,43 kHz
Max power	2000 Watt
2-way beam angle	-20,6dB
gain	25,04 dB
SA correction	-0,46 dB
Angle sensitivity	21.9
3 dB beamwidth	7,76° along ship 7,86° athwardship
Alongship offset	-0.12°
Athwardship offset	0.06°

**Bottom detection menu**      Minimum level -40 dB

### Fishing gear

The vessel has two different sized "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 bottom trawl has a headline of 31 m, footrope 47 m and 20 mm meshsize in the codend with an innernet of 10 mm meshsize. The trawl height was about 4.5 m and distance between wings during towing about 21 m. The sweeps are 40 m long. The trawl is equipped with a 12" rubber bobbins gear. New doors are 'Thyborøn' combi type, 7.41 m<sup>2</sup>, 1720 kg. These have been in used onboard since 19.02.08. During the present survey the door distance was kept nearly

constant at about 50 m at all depths by the use of a 9.5 m strap between the wires at 120 m distance from the doors (normally applied at depths greater than 80 m).

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 the trawl was 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. A catch sensor on the cod-end indicated the size of the catch.



## Annex IV Gonad Maturity stages

Stage	Maturity stage	Description
I	Immature	Small gonads, do not occupy more than 1/3 of abdominal cavity length. Ovary pinkish; testis whitish. Ova not visible to naked eye
II	Maturing virgin and recovering spent	The gonads begin to develop, increasing substantially in size; about ½ length of the abdominal cavity. Gonads more opaque, small points visible to the naked eye (oocytes at the beginning of vitelogenese).The gonads in rest/recovery more flaccid with some more conspicuous blood than the gonads in development.
III	Mature. Before pre-spawning	At the beginning, oocyte more conspicuous giving the gonad a granular aspect. Ovary yellow-orange, testis creamy. Visible sperm in testis if open. Gonads quite swollen in the beginning of the reproduction period. Gonads that have spawned once lose consistency, but opaque oocytes present, and sperm in testis if cut. At the end of the stage is possible to find some translucent oocytes. Gonads occupy about 2/3 of abdominal cavity.
IV	Mature Pre-spawning	The gonads occupy about 2/3 of abdominal cavity. Ovaries orange in colour with visible blood vessels. Most oocytes translucent, testis creamy, flat and brilliant texture. The gonads stop flowing oocytes and sperm flows at low pressure.
V	Mature. In spawning	The gonads occupy about 2/3 or less of abdominal cavity. Ovaries orange in colour with the conspicuous blood vessels, blood stained mainly in one end. Most oocytes translucent; testis creamy, flat and brilliant texture. The gonads stop flowing oocytes and sperm flows at low pressure. Pinky stains at the end of gonad.
VI	Post-spawning	The gonads decrease in size and occupy about ½ or less, of abdominal cavity. Gonads flaccid and bloody. Ovary can contain remaining oocytes that were not emitted. Testis may have sperm remaining in the seminal duct. Pinkish areas in the whole extension of the gonad.