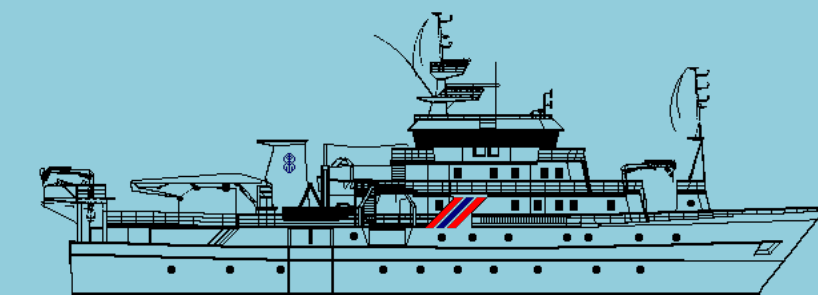


## Cruise Report "Dr. Fridtjof Nansen"



### Survey of the pelagic resources Angola

01 March – 30 March 2012

by

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*Bergen, 2012*



## **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 oeuvre 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 oeuvre 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 oeuvre et le suivi des progrès de la mise en oeuvre de plans d'aménagement des ressources marines conformes à l'approche écosystémique des pêches.

**Survey of the pelagic resources  
01 March– 30 March 2012**

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# CHAPTER 1 INTRODUCTION

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## 1.1 Objectives

This survey is part of the time series of the pelagic living resources, aiming at monitoring the pelagic fish resources of Angola. The first surveys of the pelagic resources were carried out in 1985, with surveys both during winter and summer. The next surveys were carried out in 1986 and 1989 (summer surveys), before the time series of the winter surveys commenced in 1991. With the exception of 1993 (no survey) and 1997 (summer survey only) the winter time series has carried out without interruption from 1991-2011.

For 2012, surveys are planned for both the winter and summer seasons in order to investigate the intra-annual (seasonal variation) in the distribution and estimated abundance of the pelagic species. The only previous years with concurrent surveys in the winter and summer seasons were 1985, 1995 and 2011.

The surveys are carried out on behalf of Instituto Nacional de Investigação Pesqueira (INIP), Luanda, who also staffs the vessel with a local co-cruise leader, as well as fisheries and oceanographical researchers. The IMR provides the IMR cruise leader, a survey technician and two instrument operators, according to the standard operating procedures, in accordance with the tri-partite agreement between Norad, FAO and IMR, and with the MoU on the execution of the survey between INIP and FAO.

The surveys aim at improving the general knowledge of the biology, ecology and population dynamics of the main pelagic species in relation to the environment and the ecosystem as such. Acoustic echo integration is used to estimate the stock abundance of the pelagic species, and in the absence of reliable fisheries statistics the survey estimates therefore form the main basis for the recommendations of the Total Allowable Catch (TAC).

The specific objectives of the present survey were:

- 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 *Sardinella maderensis*, the Cunene horse mackerel *Trachurus trecae*, the Cape horse mackerel *Trachurus capensis*.
- To collect stomach samples from both horse mackerel species for analyses of diet composition.
- To collect stomach samples and otoliths from both sardinella species for analyses of diet composition and length-age relationships.
- To collect depth-stratified samples of zoo- and phytoplankton in order to continue the studies on feeding biology including relating stomach content to estimated zooplankton composition and observed density.

- 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 Nansis database and scrutinizing acoustical data using IMR the post-processing system, the Large Scale Survey System (LSSS).
- To collect seal scats from the breeding fur seal colonies (with pups) in the Tiger Bay area in order to study their diet composition as basis for subsequent evaluations of their impacts on the fish communities in the region\*\*\*.

## 1.2 Participation

The scientific staff consisted of:

From INIP, Luanda:

01.03-21.03: Aristóteles AMARO (Co-cruise leader ), Bomba Basika SANGOLAY, Fátima DELICADO, Francisco de ALMEIDA, Eusébio dos SANTOS, Geraldina SALVADOR, Tito MILAGRE, Cesaltina DIAS and João MORAIS

21.03-30.03: Filomena VAZ VELHO (Co-cruise leader), Aristóteles AMARO, Quilanda FIDEL, Eusébio dos SANTOS, Geraldina SALVADOR, Tito MILAGRE, Cesaltina DIAS e João MORAIS and Domingos PEDRO.

From IMR, Bergen:

01.03-30.03: Knut KORSBREKKE (Cruise leader), Tore MØRK and Magne OLSEN

15.03-29.03: Knut KORSBREKKE (Líder do cruzeiro), Magne Olsen and Ole Sverre FOSSHEIM

## 1.3 Narrative

The vessel departed from Walvis Bay on the 01<sup>th</sup> of March at 16:00 UTC and steamed northwards to the Cunene River where the survey started with the hydrographical section off Cunene River at 06:00 UTC on the 02<sup>th</sup> of March. The survey area is divided into three standard regions:

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

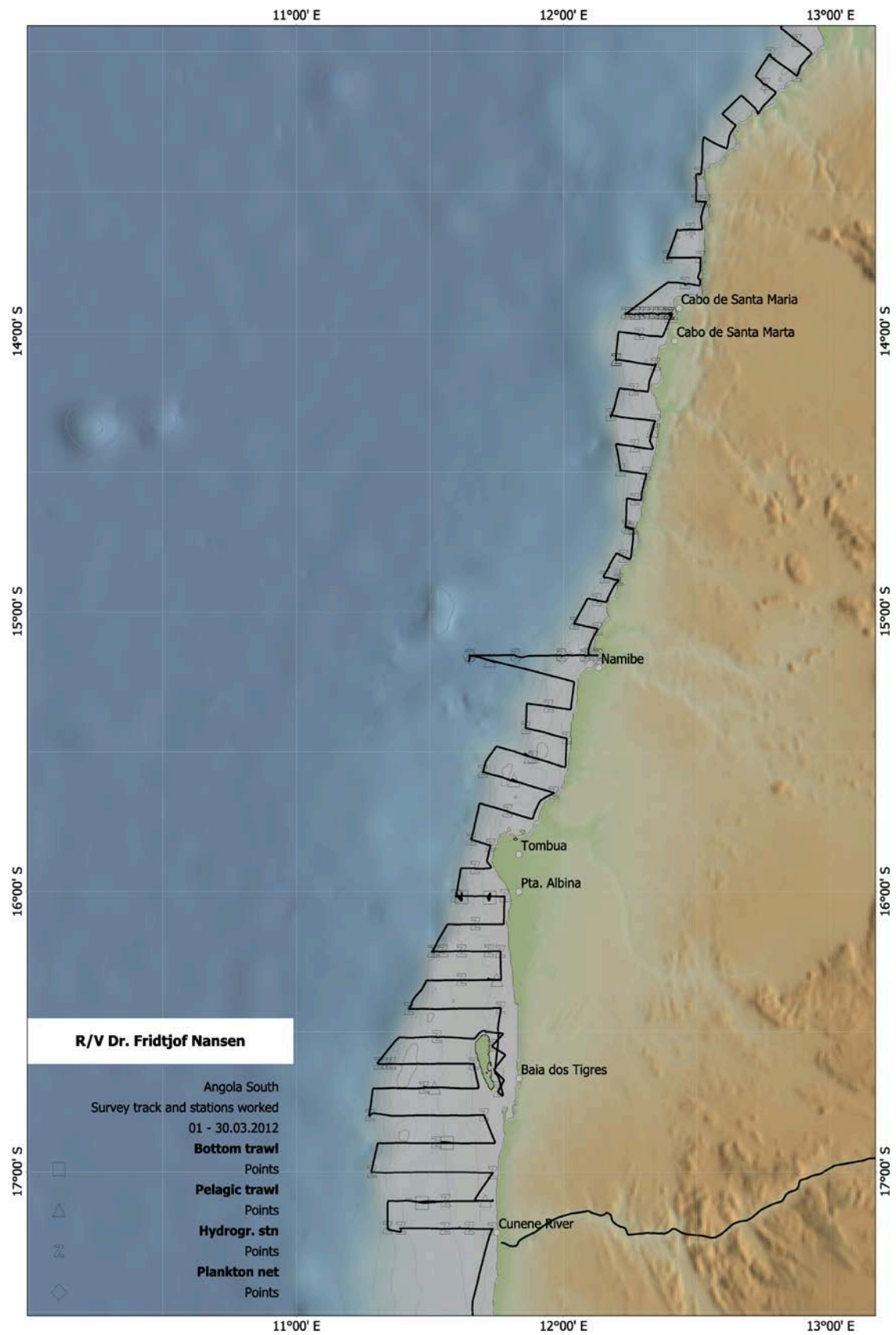
The Southern region was completed on the 07<sup>th</sup> (22:00 UTC) of March in the Baía dos elefantes, where the instruments calibration was carried out. The ship steamed to central region and Pta do Morro the vessel steamed to for a crew change on the 15<sup>th</sup> of March. The vessel steamed southwards from Point Noire started the coverage of the northern region on 17<sup>h</sup> (04:00 UTC). The vessel then worked its way south until 21<sup>th</sup> March (01:00 UTC) before a call in Luanda for change of personnel. The remaining part of the survey area was covered from south latitude 10o'30'S up to 8oS in the period 23<sup>th</sup> (01:00 UTC) to 28<sup>th</sup> March (03:00 UTC). The remaining survey time was spent with repeated dense coverage a limited survey are (an investigation of day/night effects on survey results).

#### 1.4 Survey effort

Figure 1-Figure 3 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 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 (Sum of transect lengths). Table 1 summarizes the survey effort by regions. It is important to mention that due to lack of time and in order to be able to cover acoustically the whole survey area, it was necessary to reduce the number of CTD casts and the multinet stations.

**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 (Sum of transect lengths).**

Area	BT	PT	Total Trawls	CTD casts	Multinet stations	Sum of transect lengths (nm)
Cunene River-Elephant Bay	6	8	14	89	5	512
Elephant Bay -Pta. Palmerinhas	7	12	19	88	13	830
Pta. Palmerinhas-Congo River	4	12	16	129	9	832
Total	17	32	49	306	27	2174



**Figure 1** Course track with fishing, plankton and hydrographical stations, Cunene River – Baía dos Elefantes. Depth contours at 20, 50, 100, 200, and 500m.



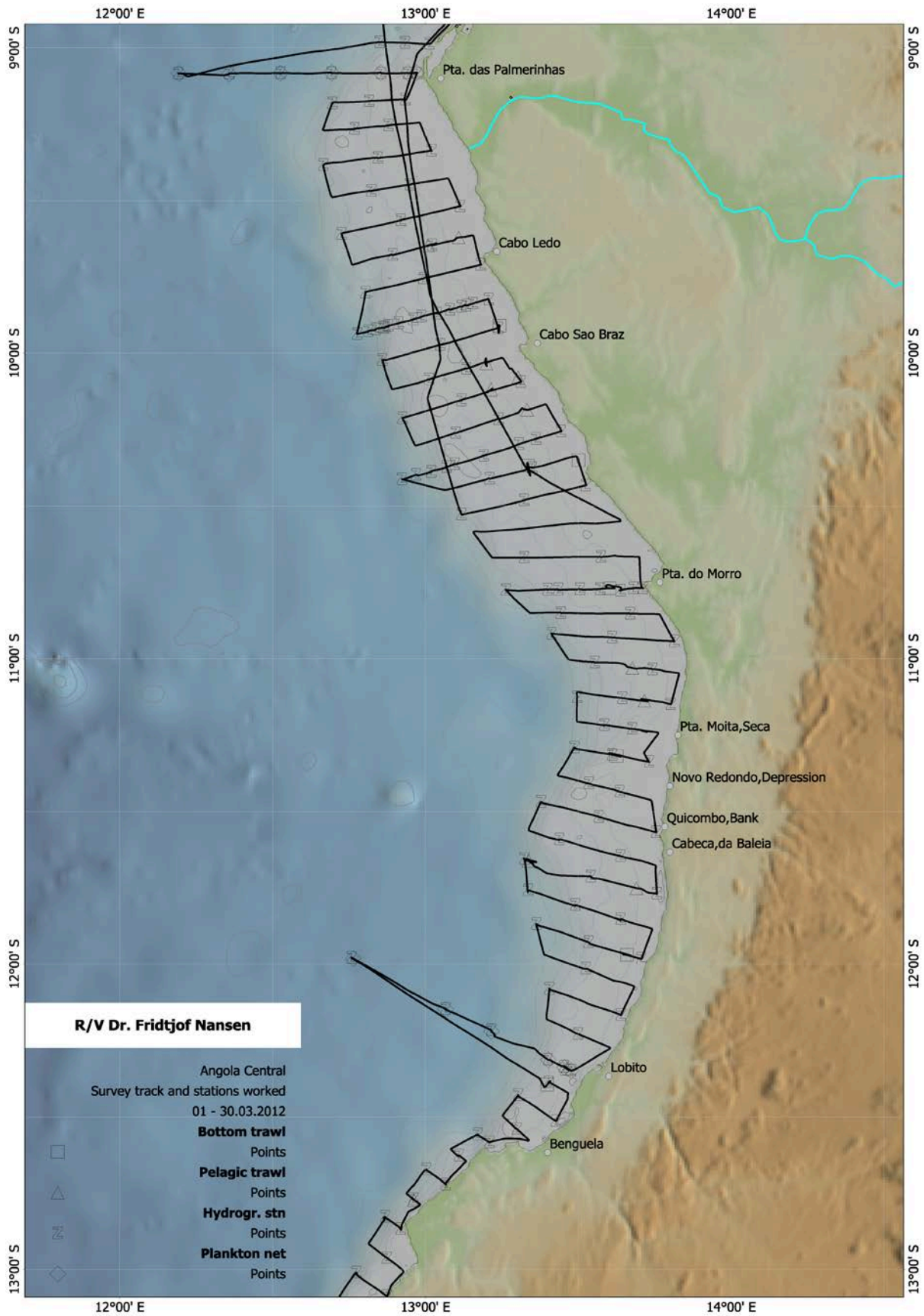


Figure 2 Course track with fishing, plankton and hydrographical stations, Benguela - Pta. das Palmerinhas. Depth contours at 20, 50, 100, 200, and 500m.

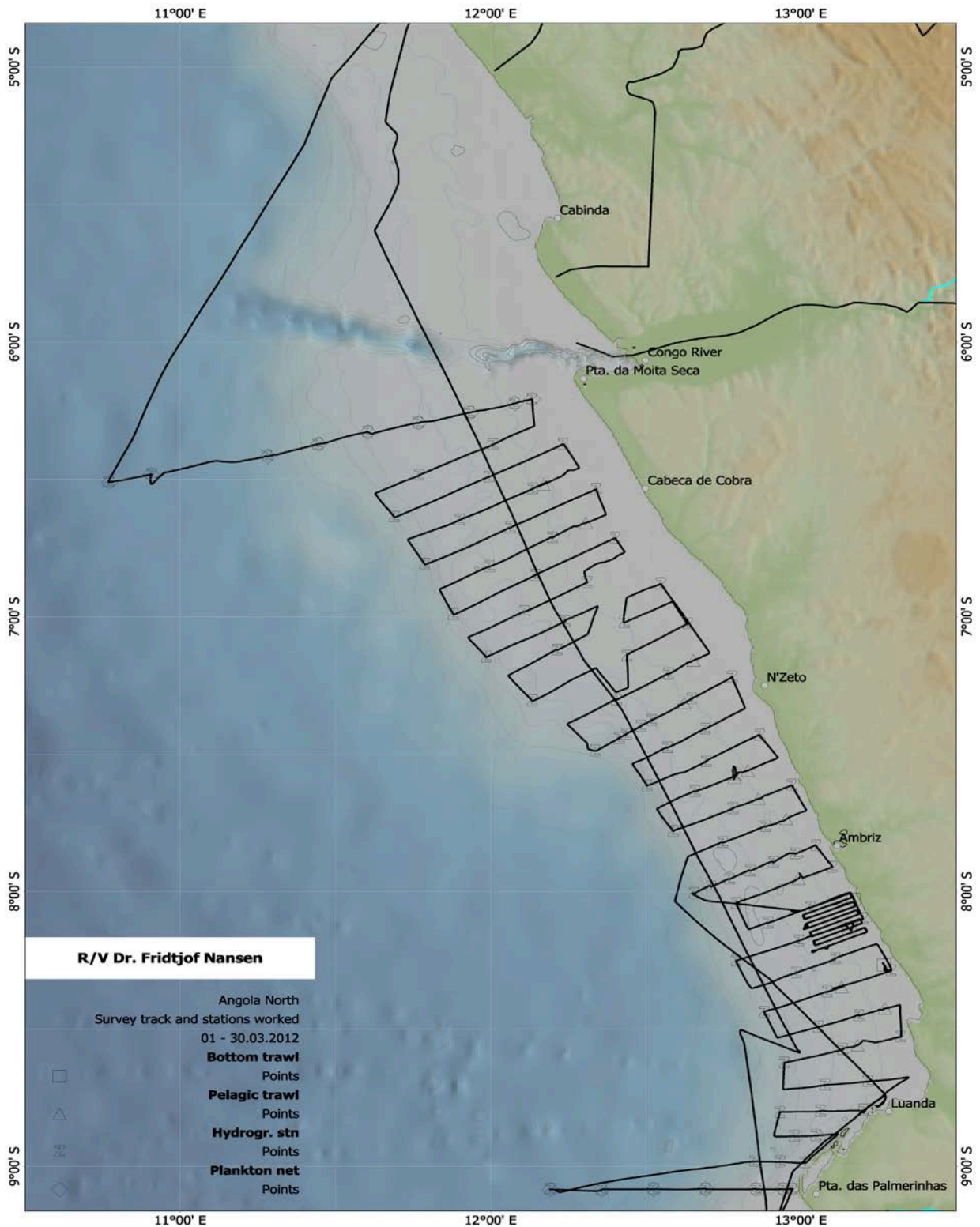


Figure 3 Course track with fishing, plankton and hydrographical stations, Pta. das Palmerinhas- Congo River. Depth contours at 20, 50, 100, 200, and 500m.

## CHAPTER 2 SAMPLING AND ESTIMATION 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 (Annex V). The casts were stopped a few meters above the bottom. Additional CTD stations were added on every sixth cruise track between the standard transects and monitoring lines at 20, 50, 100, 200 and 500 m bottom depth.

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 (in PSU) 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 nautical mile, 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 and tuna species, *Brachydeuterus auritus* and demersal species, mainly *Dentex spp.*

Biological samples were obtained for two species of sardinella and horse mackerel, *Sardinops ocellatus*, *Etrumeus whiteheadi*, *Engraulis encrasicolus*, *Selene dorsalis* and *Chloroscombrus chrysurus*. 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 used by INIP (Annex I).

Stomach samples of horse mackerel and both sardinellas 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 gills were collected from *Sardinella aurita* and *S. maderensis*.

## 2.3 Plankton sampling

### *Phytoplankton*

Samples of phytoplankton were collected on monitoring lines; standard and biological sections using the CTD bottles at 5, 15, 25, 50 and 75 meter depth (Annex V). The samples were preserved in formalin 2%.

### *Zooplankton*

The zooplankton sampling was conducted by means of HYDROBIOS Multinet (180  $\mu\text{m}$ ), at five depth intervals, 0-25, 25-50, 50-75, 75-100 and 100-200 m, on 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.

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 1 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 Annex II. The identification of and allocation of echo values to different species groups was based on visual scrutinization of echograms combined with information from targeted pelagic and demersal trawling.

### *Estimation of Echo Abundance*

Mean area backscattering values ( $s_A$  values) was output from LSSS and used in the estimation of echo abundance for the three regions (south, central and north).

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 was:

$$TS = 20\text{Log}(L) - 72 \text{ (dB)}$$

This corresponds to a conversion factor:

$$CF = \frac{10^{-7.2}}{4\pi} \cdot L^{-2}$$

Or on a much simpler form:

$$CF = \frac{1.261218 \cdot 10^6}{\bar{L}^2}$$

The conversion factor is the multiplier transforming echo abundance into numbers of fish where  $\bar{L}^2$  is the average of  $L^2$  from the observed length distribution (and not the square of average  $L$ ). The conversion factor is used as follows:

$$N = \text{Echo abundance} \cdot CF$$

The target strength parameters used 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 relation is available for the horse mackerel species, but it seems that using the same relationship as for clupeids is common. The chosen target strength parameters for horse mackerel should be considered conservative and there are indications that target strength of horse mackerel may be strongly dependent on depth.

The primary sampling units in this survey are parallel acoustic transects with 6 nautical mile (nm) spacing. The echo integrator output is  $s_A$  values observed along 1 nm pieces along the survey track. These values are traditionally assumed to have negligible measurement error, but will contain errors related to the scrutinizing process. That is the partly subjective process of manually distribute echo values between different species or speciesgroups. The two species of horse mackerel are not acoustically distinguishable and neither are the sardinella species. Biological samples from the trawl stations are used to split the speciesgroups during the index estimation. The observed value (in  $m^2/nm^2$ ) is a measure of “echo density” and must be multiplied with some measure of area in order to represent echo abundance. The transects “cut” through the survey area and the sum of density observations along the transects (or average density multiplied with the length of the transect) represents an integration along the transects and is thus reducing the dimension of our sampling to one. It may be intuitively easier to let each transect represent a “strip” or rectangular part of the survey area with a length equal the length of the transect and width equal the distance between transects. The echo abundance estimate for such a rectangle is then:

$$y_i = \sum_{j=1}^{n_i} s_{A,j,i} \cdot d \quad \text{or} \quad y_i = \bar{s}_{A,i} \cdot n_i \cdot d$$

where  $i$  denotes transect number,  $n_i$  is the number of acoustic density (1nm) observations along the transect and  $\bar{s}_{A,i}$  is the average density of the observations on the transect. Total echo abundance is then:

$$Y = \sum_i y_i = \sum_i \sum_{j=1}^{n_i} s_{Aji} \cdot d = \sum_i \bar{s}_{A,i} \cdot n_i \cdot d = \bar{s}_A \cdot \sum_i n_i \cdot d = \bar{s}_A \cdot A$$

with the survey area  $A$  estimated as the distance of transects multiplied with the distance between transects.

The transects are assumed to be strictly parallel which they are not, but from the practical side the difference is quite modest and should be treated as negligible compared to the sampling uncertainty. The above equation shows that the length of transects has no direct influence (assuming the stock is covered) on the estimate, but we will in the following section show how the length of transects has an effect on the estimate of sampling variance.

### *Estimation of variance*

The only source of sampling variance addressed in this report relates to the echo abundance. We have made no effort to estimate the effect of trawl sampling on the biological estimates and this should be considered an interesting topic for further research.

The survey is a systematic and not random survey and estimates of variance may be biased. We say “may be biased” since (as a theoretical example) if the resource is homogeneously and randomly scattered both approaches will lead to unbiased estimates of variance. The species investigated form larger concentrations and is highly structured. More complex statistical modelling can be able to better trace geographical variation and will produce abundance indices with lower variance given that some additional assumptions are met. The observed structures are still relatively small relative to the distance between samples (e.g. the distance between transects) and it does not seem straightforward to develop complex geostatistical models. The statistical modelling including the use of explanatory variables will benefit from analysing several years of consistently sampled information and represents an important challenge for future research.

In our estimation of variance we assume that our observations are proportional to the length of transects. This has no influence on the abundance estimate, but on the estimate of the variance.

Our approach to estimate the sampling variance is described here:

1. A visual inspection of the transect values formed the basis for an ad hoc post stratification within each of the existing three geographical strata. When a clear pattern was not present or the post stratification did not yield any improvement in the variance estimate, the post stratification approach was not used.
2. Our sample based estimate (by stratum) is  $Var(Y) = \frac{1}{n-1} \sum_i (\bar{s}_{A,i} - \bar{s}_A)^2 \cdot n_i^2 \cdot d^2$  with  $n$  being the number of transects.
3. Overall variance of the estimated total echo abundance is the sum of the estimated variances for each stratum since the total estimate is the sum of echo abundance estimate from each stratum (and it is reasonable to assume that the errors between strata are uncorrelated).

### *Estimation of Abundance Indices*

The Echo abundance estimate was converted to numbers using the conversion factor described in subsection “Estimation of Echo Abundance”. The following procedure was used to estimate the length distribution with the corresponding  $\bar{L}^2$  (one per geographical stratum):



1. Observed length distribution by species group was first converted to a percentage distribution station by station.  $p_{j,i} = \frac{f_{j,i} \cdot 100}{\sum_i f_{j,i}}$  where  $i$  denotes lengthgroup (and on this survey 1 cm length groups) and  $j$  station number.
2. Observed species composition was converted to a percentage station by station.  $s_{k,j,i} = \frac{f_{k,j,i} \cdot 100}{\sum_i f_{j,i}}$  where  $f_{k,j,i}$  is the observed length frequency of species  $k$
3. Each station is initially given a weight equal the average echo abundance in a quadratic area 25 nm by 25 nm and with centre at the trawl station ( $w_j$ ). The weighting factors themselves are not stochastic variables (at least not with identifiable properties) since they are only partly defined from the sample design and in part determined by the subjective choice of doing a trawl station. The “distribution” of weighting factors is rather skewed so we truncated at the upper 90<sup>th</sup> percentile and lower 25<sup>th</sup> percentile.
4. Average length distributions and species composition by length is calculated for each geographical stratum.  $p_i = \frac{\sum_j p_{i,j} \cdot w_j}{\sum_j w_j}$  and  $s_{k,i} = \frac{\sum_j s_{k,i,j} \cdot w_j}{\sum_j w_j}$ .
5. The mean squared length for each species group is  $\bar{L}^2 = \frac{\sum_i p_i \cdot i^2}{\sum_i p_i}$ .
6. Using the estimated echo abundance and the conversion factor, the index of abundance ( $N$ ) of the species group is estimated for the geographical stratum in question. Abundance indices by length ( $i$ ) and species ( $k$ ) is calculated as  $I_{k,i} = N \cdot p_i \cdot s_{k,i} \cdot 10^{-4}$

The procedure used to give different weights to different trawl stations should be explored further. Important issues are the size of the area used to calculate echo abundance based weights and the degree of “structure” in the biological information including the use of explanatory variables (the smallest fish are more inshore etc).

#### *Estimation of some biological properties*

Indices of numbers of fish are common input to a long range of stock assessment models. Such models will usually at some stage contain a conversion from numbers of fish into biomass. The most common approach to this conversion is a length to weight conversion based on single fish observations. We are also using such a conversion on our indices to produce biomass indices. And since our abundance indices are estimated in length groups we gain more insight in how biomass is distributed between the different size groups in the stock.

We applied the following length to weight regression:

$$\text{Log}(W) = \alpha + \beta \cdot \text{Log}(L) + \varepsilon$$

with the last term being an error term. This corresponds to the conversion

$$W = e^{\alpha} L^{\beta}$$

More complex models including area and species groups were explored and the simplest model showing a good fit was applied. All such models give very similar results and future research should consider applying different weighting factors to the single fish observations.

Such weighting factors would be more important if one were to estimate additional population parameters like maturity at length, stomach content or variation in sex composition (as examples).



## CHAPTER 3 OCEANOGRAPHIC CONDITIONS

---

### 3.1 Surface distribution

Wind, sea surface temperature (SST, 5m depth), sea surface salinity (SSS, 5 depth) and sea surface fluorescence, SSF) were continuously recorded during the survey. Figure 4 - Figure 6 shows the horizontal distribution of temperatures and salinity.

#### *Southern region*

Figure 4 shows a relatively clear front between colder water appearing from the south and reaching considerably warmer waters off Namibe. The temperatures are considerably lower (3-5 °C) than in March 2011 when the front could be found just north of Baia dos Tigres.

In March 2011 the salinity showed an increasing gradient from north south (within the southern region) while this year the picture was different with higher variation and the lowest salinity observed close to Baia dos Tigres.

#### *Central region*

In March 2011 the surface warm water was mixed very well throughout the region with a seawards gradient of 0.5°C varying from 29.5°C near the coast to 30°C offshore. This year the inshore waters were considerably colder than and as low as 26 ° C at Benguela.

The colder water observed this year had higher salinity than warmer water which is likely to be related to rainfall (especially in the vicinity of Pta das Palmerinhas).

#### *Northern region*

Slight variations in temperatures at 5 meters depth was observed in 2011 ranging from 27 °C closer to Congo river and 29 °C near Luanda. The situation was rather similar this year. The same can be said about the observed salinity including pockets of reduces salinity in the northernmost parts due to fresh water from the Congo River.

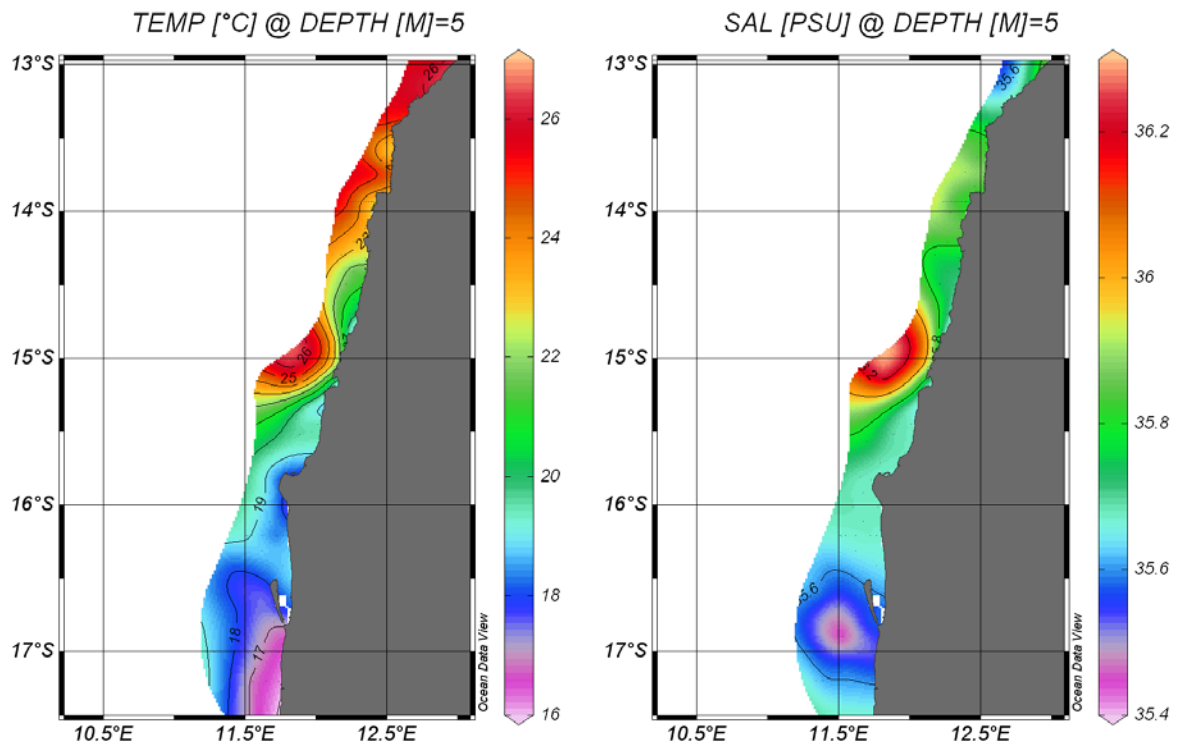


Figure 4 Distribution of water temperatures and salinity at 5m depth in the southern region.

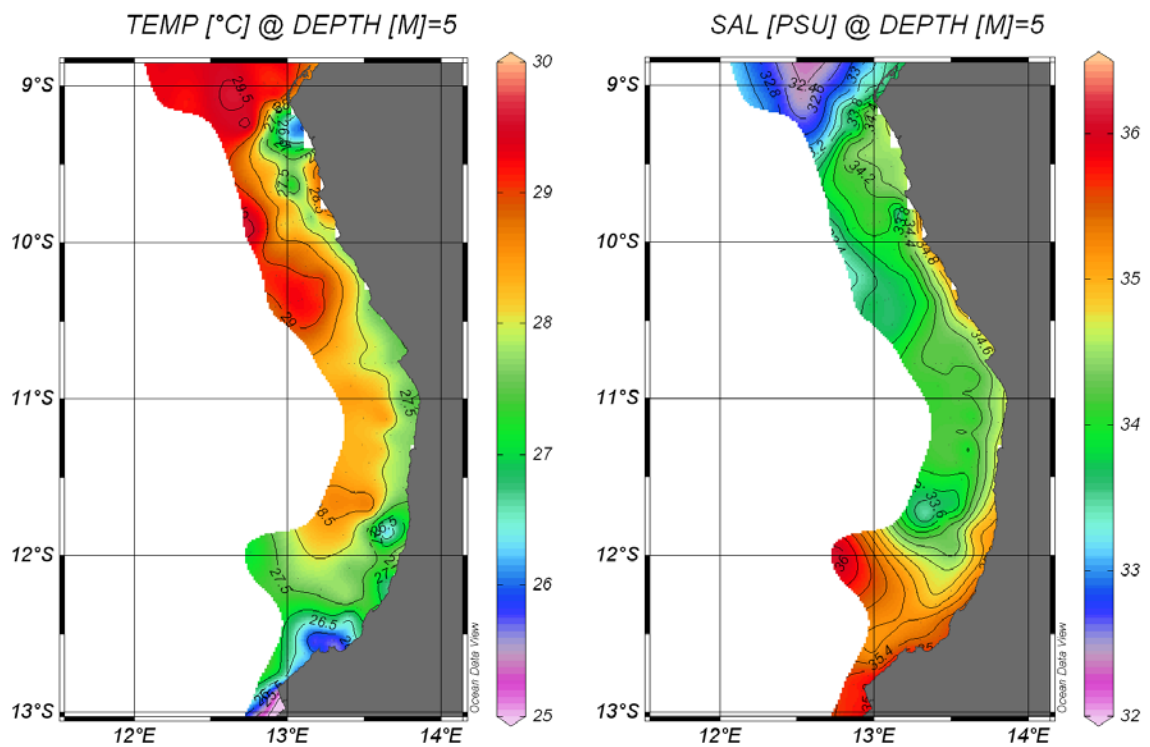
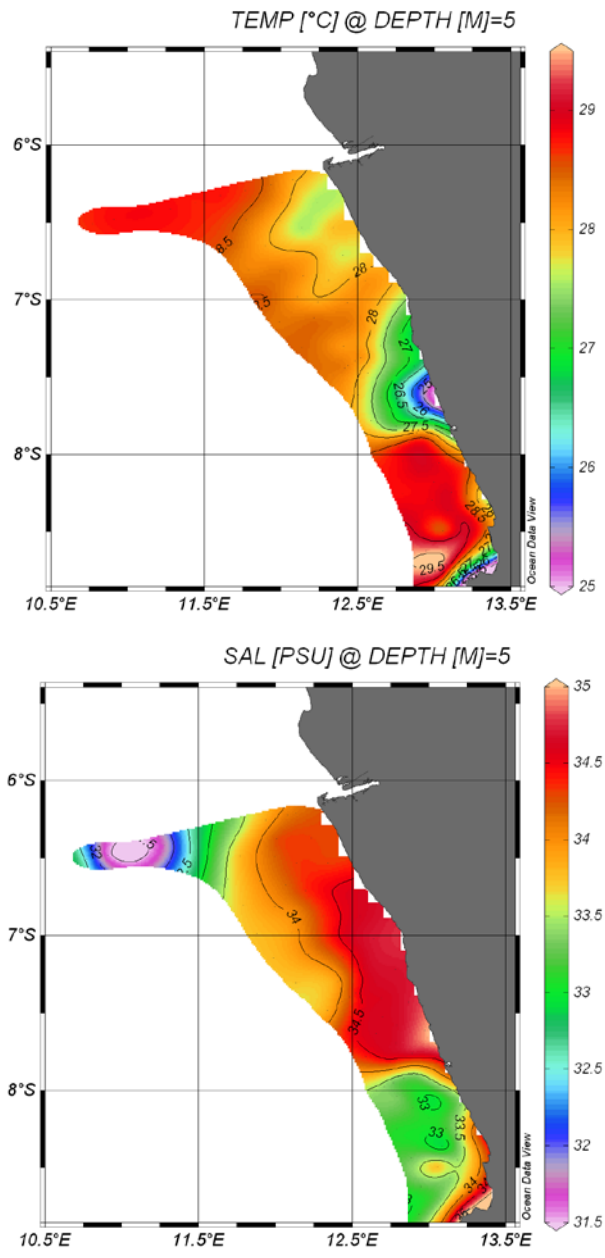


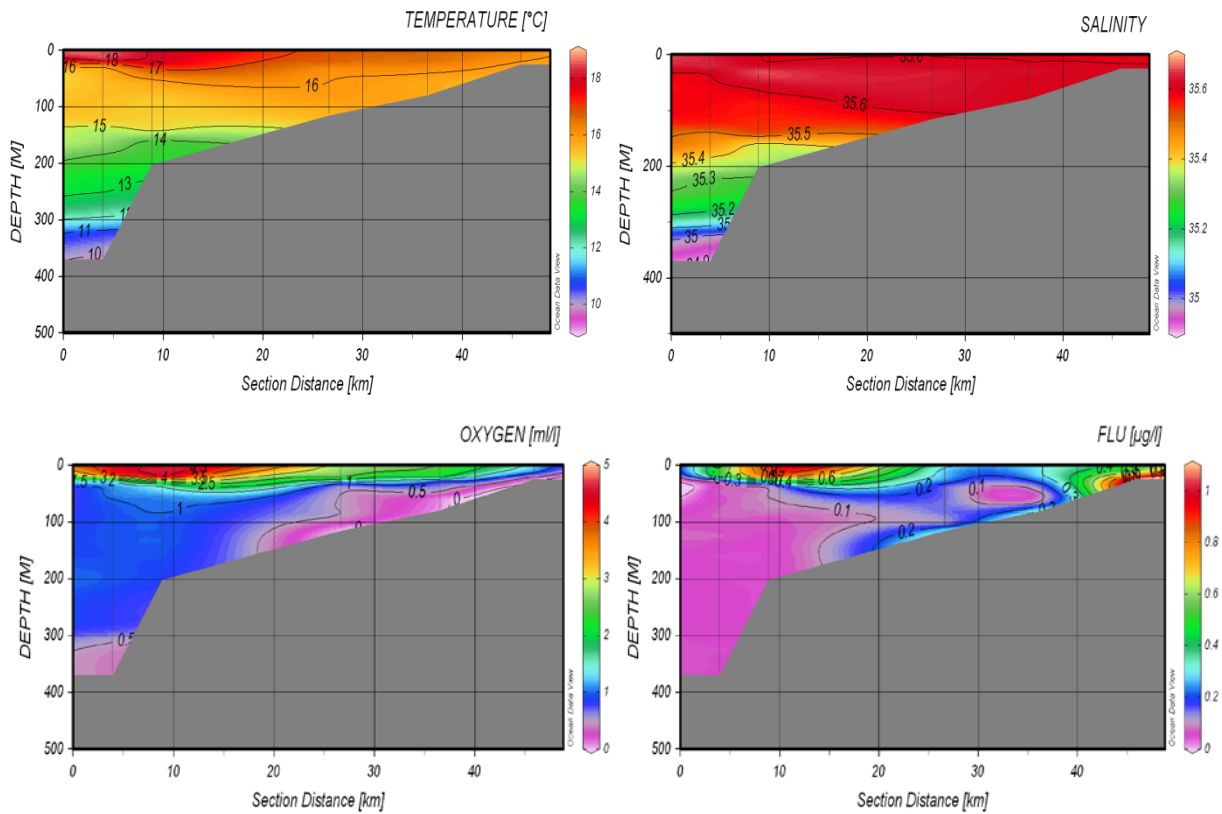
Figure 5 Distribution of water temperatures and salinity at 5m depth in the central region.



**Figure 6 Distribution of water temperatures and salinity at 5m depth in the northern region.**

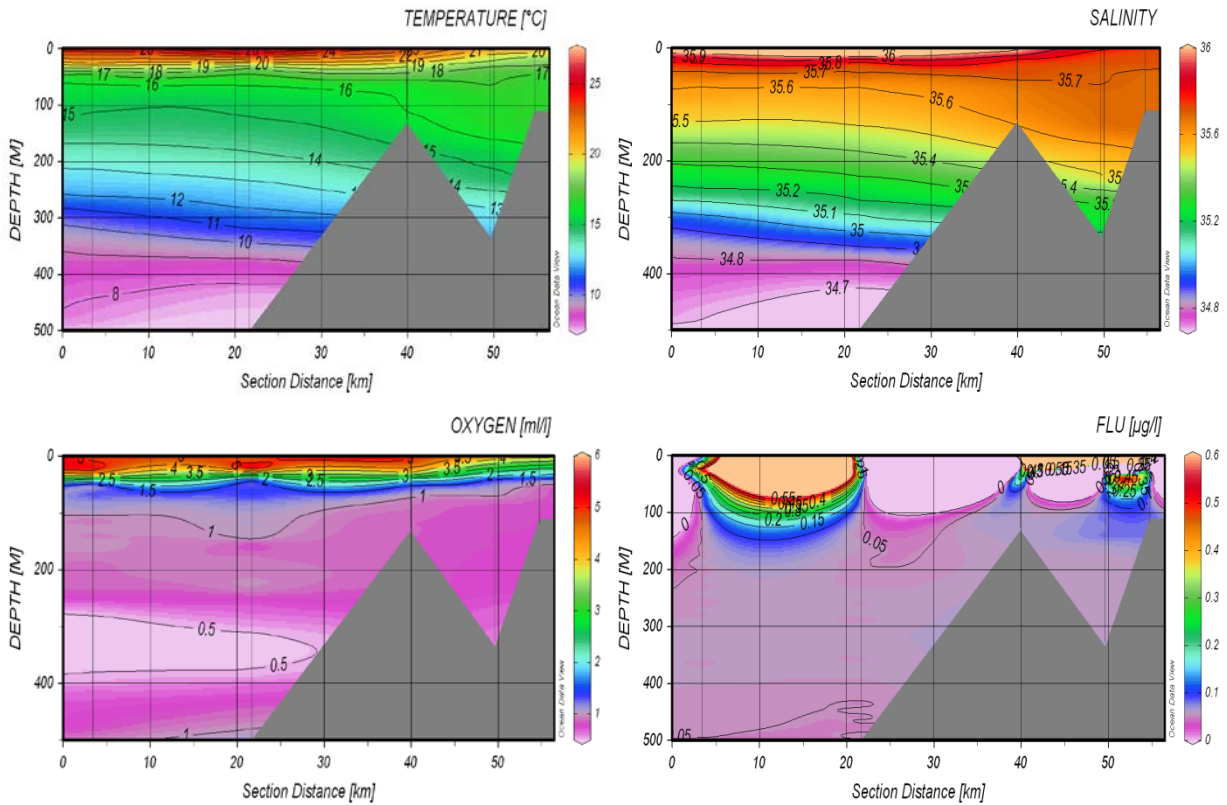
### 3.2 Standard sections

The vertical distribution of temperature, salinity, oxygen and fluorescence in Cunene section shows an aspect of authentic occurrence of upwelling which was characterized by low values of all parameters inshore and higher values in offshore. The temperature ranged from 16°C to 17°C, salinity from 35.5 to 35.6 and the surface oxygen concentration was about 4.5ml/l offshore and 1ml/l near the coast. The lowest value of oxygen (0.5ml/l) was found at 70-130m layer, value usually found between 250m and 500m depth. The thermocline was located below 120m depth.



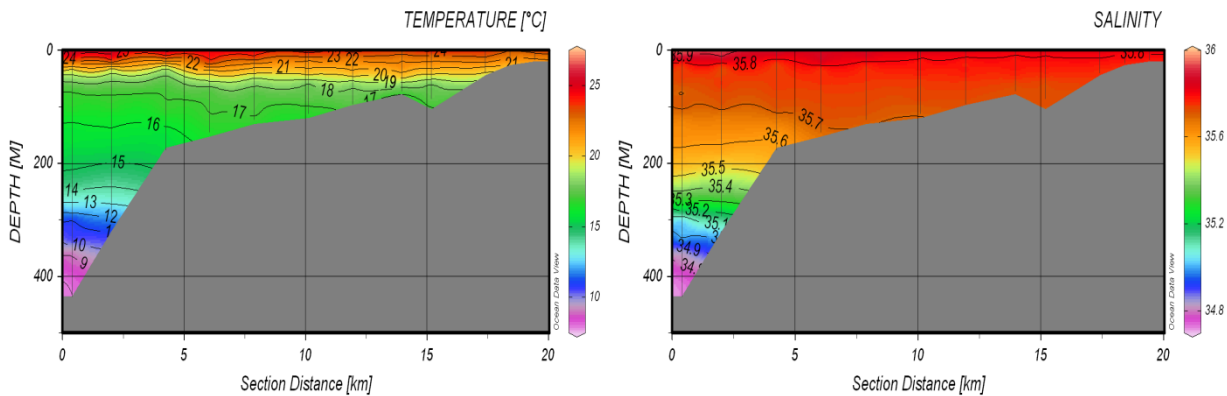
**Figure 7 Vertical sections of temperature, salinity, oxygen and fluorescence off Cunene River.**

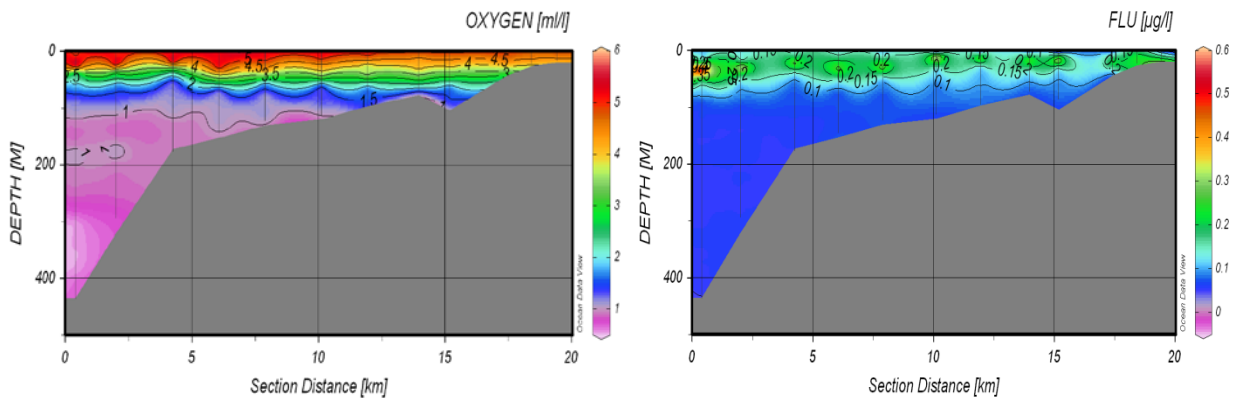
In Namibe section, it was also observed a slight effect of upwelling highlighting the area of the isotherm of 19°C throughout the continental shelf. The maximum salinity of 35.8, characteristic of tropical waters, was found above the 50m depth also with the dominance at whole continental shelf. The low of oxygen values (0.5ml/l) was located in the characteristic layer (300-450m) off the Angolan coast.



**Figure 8 sections of temperature, salinity, oxygen and fluorescence off Namibe.**

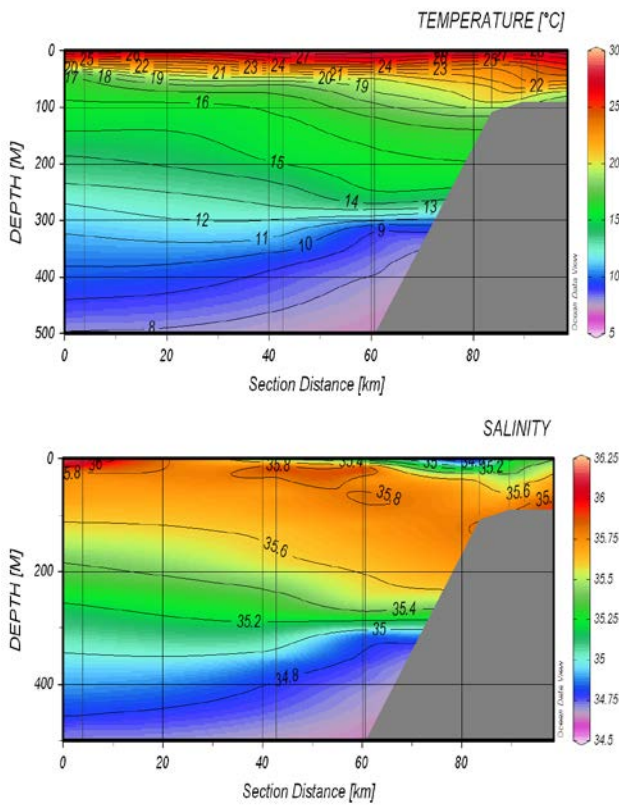
The oceanographic conditions of the section off Santa Marta indicated a stable condition. Parallel stratification isolines of all the parameters occurred indicating the absence of a vertical mixing process of water bodies in this region. It was also found that higher values of temperature ( $24^{\circ}\text{C}$ ), salinity ( $S \geq 35.8$ ), oxygen ( $4.5\text{ml/l}$ ) and fluorescence ( $0.2\mu\text{g/l}$ ) dominated along the entire continental shelf.

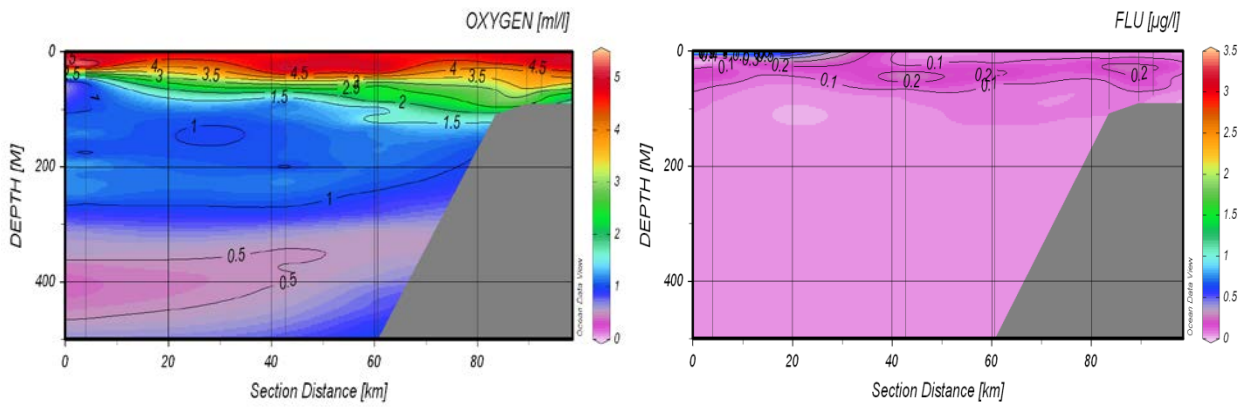




**Figure 9 Vertical sections of temperature, salinity, oxygen and fluorescence off Cabo Santa Marta.**

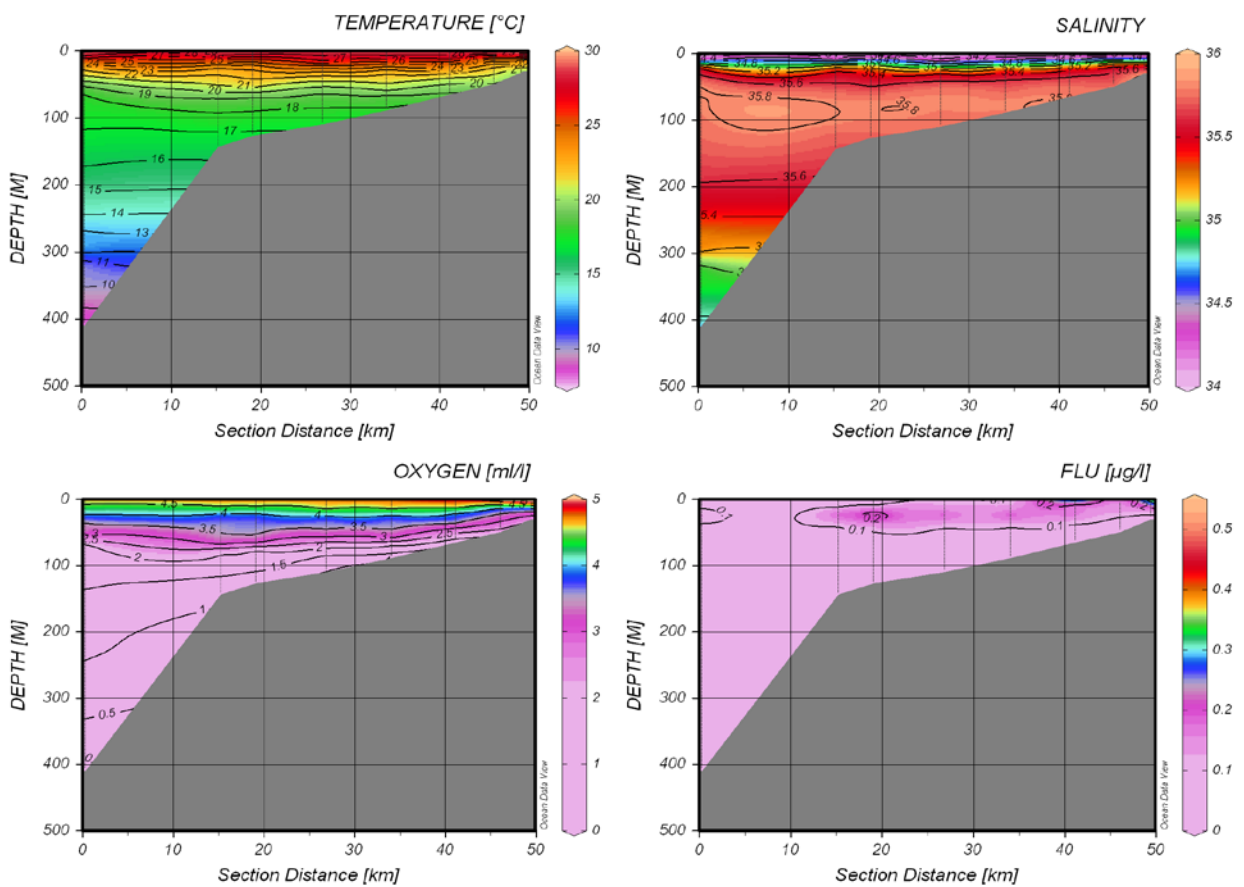
The environmental parameters of the section off Lobito described totally a different scenario regarding all transects in the southern region. The result revealed an aspect of the sinking/downwelling of the waters near the coast with emphasis on a deeper thermocline. In the two coastal stations the presence of low salinity levels observed, possibly due the outflow of Catumbela River. As noted in the Namibe section, the low oxygen content was located between 400 and 500m depth at Lobito transect.





**Figure 10 sections of temperature, salinity, oxygen and fluorescence off Lobito.**

In the section of section of Pta do Morro, the layer of 0 to 30m was characterized by high values of all parameters. In this layer, the temperature varied between 28°C and 21°C, salinity dominated by less saline water showed a range of values from 34.2 to 35.6, the concentration of oxygen ranged from 4.5ml/l to 3ml/l and then fluorescence ranged between 0.1µg/l and 0.2µg/l being the maximum of the fluorescence has been recorded close the coast. The minimum oxygen content was found at 320m depth and the maximum value of salinity ( $S \geq 35.8$ ) was located at 50 - 100m layer.



**Figure 11 Vertical sections of temperature, salinity, oxygen and fluorescence off Pta do Morro.**

## CHAPTER 4 DISTRIBUTION, SIZE COMPOSITION AND BIOMASS ESTIMATES

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### 4.1 Cunene River-Benguela

#### *Sardinella*

The *S. aurita* was the dominate species throughout the southern region from Baía dos Tigres to south of Baía dos Elephants (Figure 12). *Sardinella maderensis* was caught only in the one station and was not enough to estimate the proportion *S. maderensis* in the region.

The distribution *S. aurita* was patch with small areas with high density acoustic densities inside of Baía dos Tigres and north and south of Pta. Albina. Two areas with very acoustics densities ( $s_A > 10\,000\text{ m}^2/\text{NM}^2$ ) were recorded off Tombwa at 23 e 43 meters depths. From Cabo de Santa Marta to Baía dos Elefantes de *S. aurita* were found in very low acoustic densities



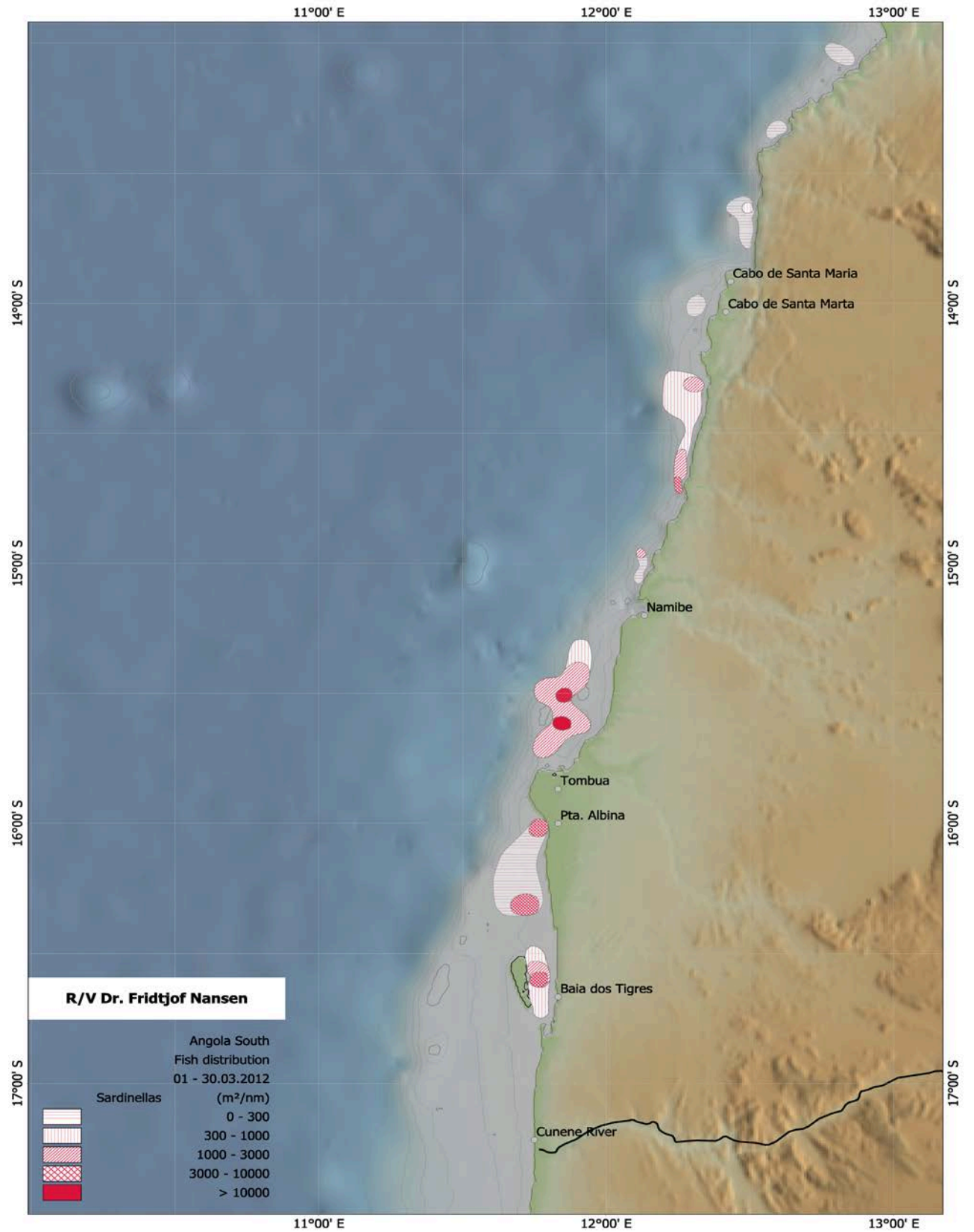
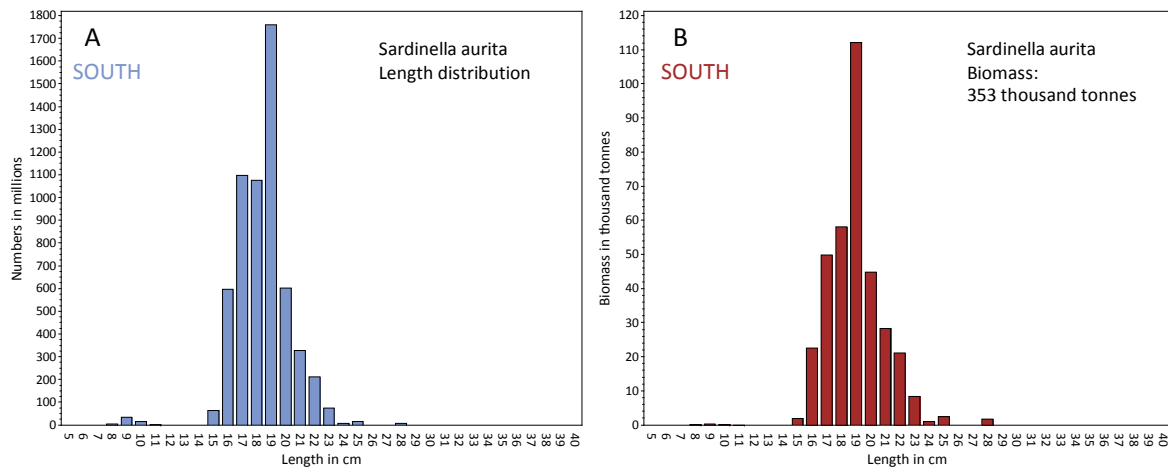


Figure 12 Distribution of *Sardinella* spp. Cunene River-Benguela. Depth contours at 10, 20, 50, 100, 200 and 500 m

*S. aurita* shows a unimodal distribution with a modal peak at around 19cm found at shallow waters. The few large *S. aurita* recorded in the area were found offshore. The length frequency of *S.maderensis* is dominated by the fish greater than 24cm.

The estimated total biomass for the two sardinella species was 353000 tons and *S. aurita* contributes more than 95% of the total

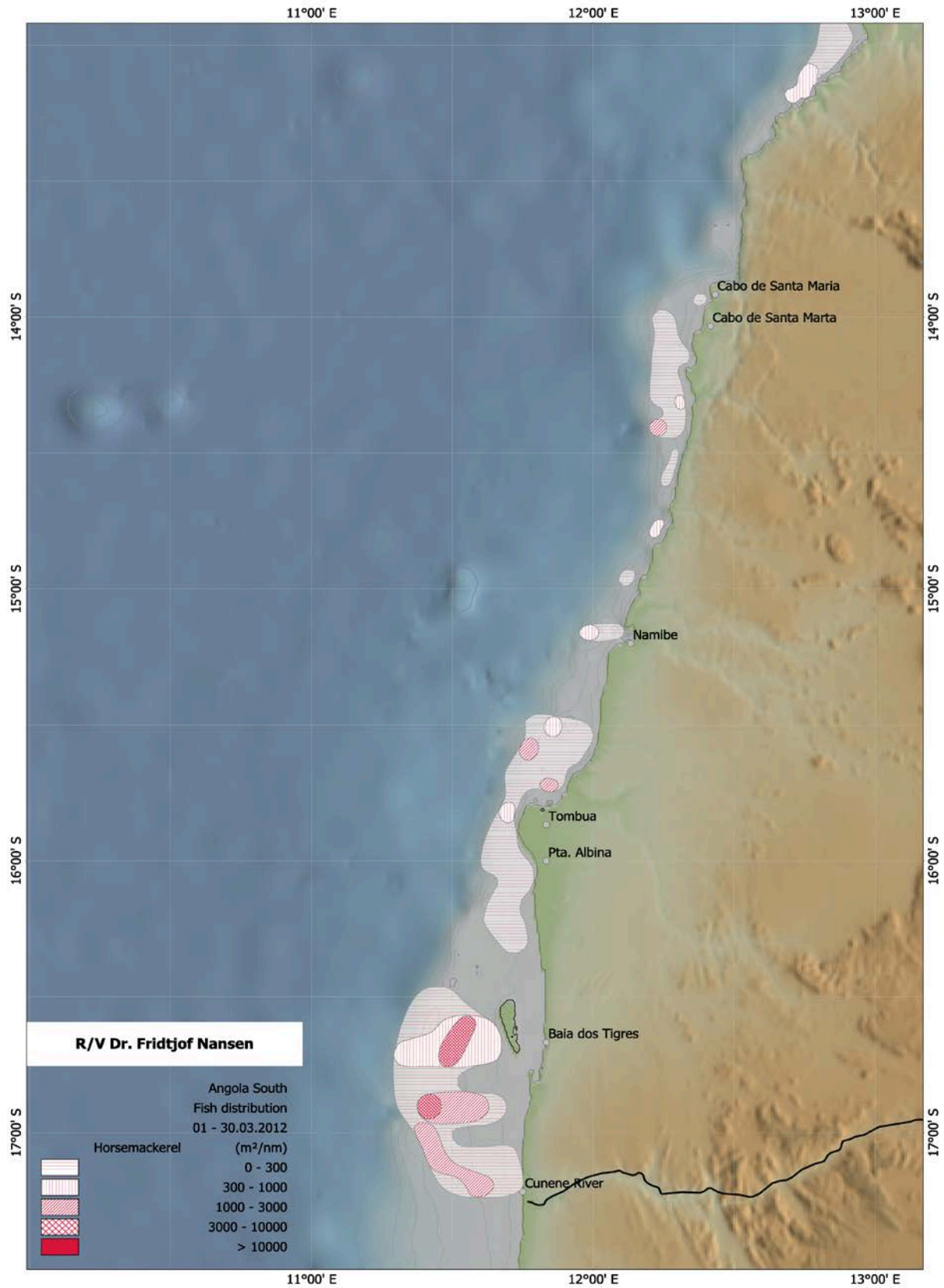


**Figure 13 Total length distribution and biomass per length group of *Sardinella aurita* Cunene River-Benguela.**

### *Horse mackerel*

Like in previous surveys both species of horse mackerel were found in the area. Cunene horse mackerel *Trachurus trecae* a species that distributes in most of the Angolan continental shelf and the Cape horse mackerel *Trachurus capensis* a species associated with cold waters of the Benguela current.

Cunene horse mackerel presented a continuous from Cunene river to north of Tombwa (Figure 14). The highest acoustics densities were recorded offshore from Cunene River to Baía dos Tigres. From Namibe to the limit of southern region the horse mackerel distribution is patch with low acoustic densities. Cape horse mackerel was caught only up to 16° S.



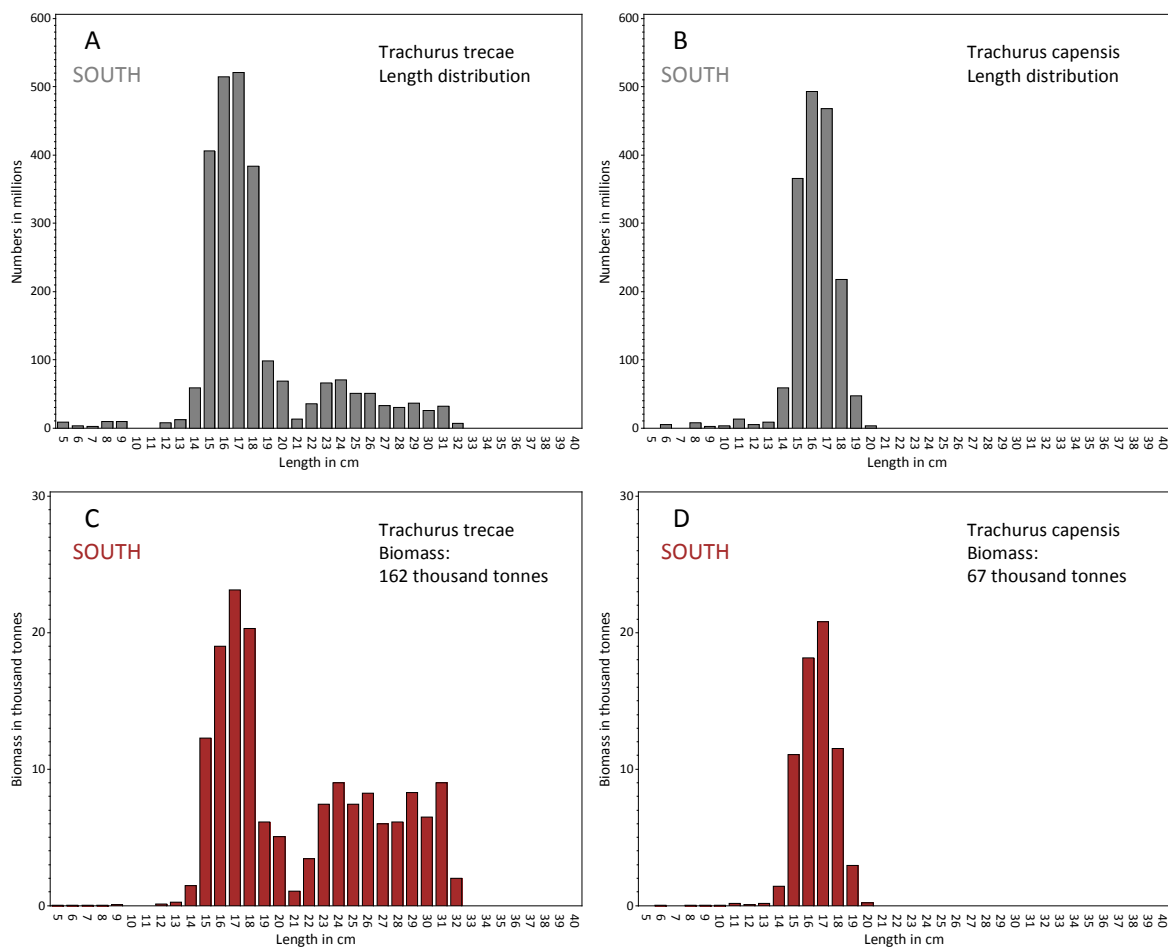
**Figure 14** Distribution of Cunene horse mackerel. Benguela–Cunene. Depth contours at 10, 20, 50, 100, 200 and 500 m.

The size distribution of size of Cunene horse mackerel covers wider size range (5-33cm). Although the distribution of Cunene horse mackerel is dominated by a group of modal peak

around 16cm, the group of fish larger than 21cm contributes more than 50% of the total biomass in the southern region. The Cape horse mackerel shows a unimodal distribution with modal peak around 17cm. Few fish of both species below 10cm were caught in the southern area.

The biomass for both horse mackerel was estimated at 239 000 tonnes which is 76% higher than the biomass estimate last year in this season. The biomass of Cunene horse mackerel was estimated at 162 000 tonnes and the Cape horse mackerel was 67 000 tonnes.

Although the present biomass for Cunene horse mackerel is estimated at some level of the 1998 summer season biomass (163 000) the length distribution in 1998 was dominated by the adult fish (> 23cm LT).



**Figure 15 Total length distributions and biomass per length groups of *Trachurus trecae* and *Trachurus capensis* Cunene River- Benguela.**

### *Sardine*

The distribution of *Sardine ocellatus* was between Baía dos Tigres and Cunene River with highest acoustic densities south of Baía dos Tigres.

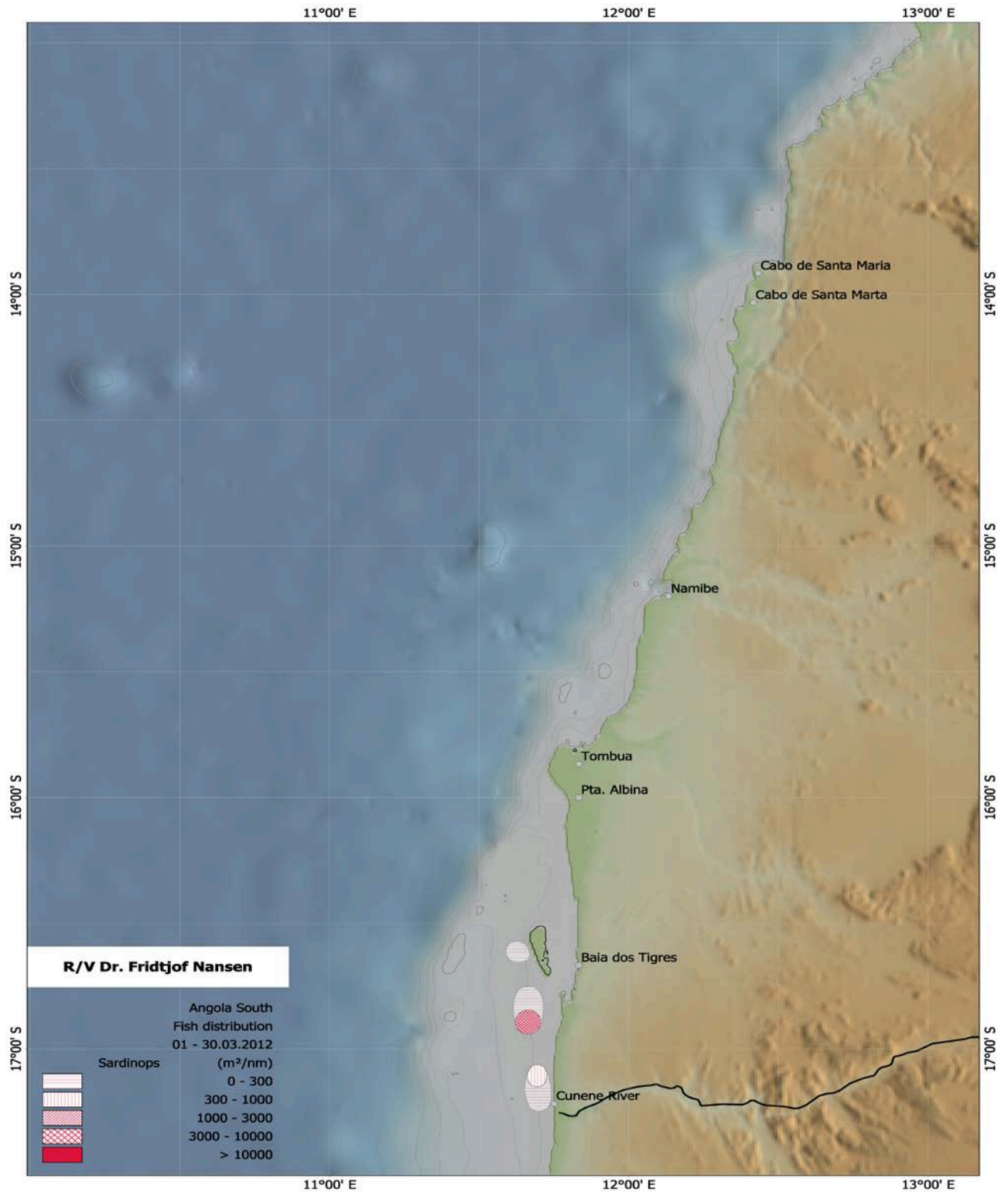


Figure 16 Distribution of Cunene horse mackerel. Benguela–Cunene. Depth contours at 10, 20, 50, 100, 200 and 500 m.

#### Other species

Species belonging to the pelagic 1 group (e.g. round herring, *Etrumeus whiteheadi*, and anchovy, *Engraulis encrasicolus*) were found scattered in low densities ( $0 > s_A > 300$ ) along the southern region and therefore no biomass was estimated for this group. .

## **4.2 Benguela-Pta. das Palmerinhas**

### *Sardinella*

Like in previous summer survey sardinella was found in the area with continuous distribution north of Lobito to Cabo São Braz. In the area around Benguela and Lobito was recorded in low acoustics densities. The highest acoustics densities in the central region were recorded south of Cabeça da Cobra and off Ponta da Moita Seca.



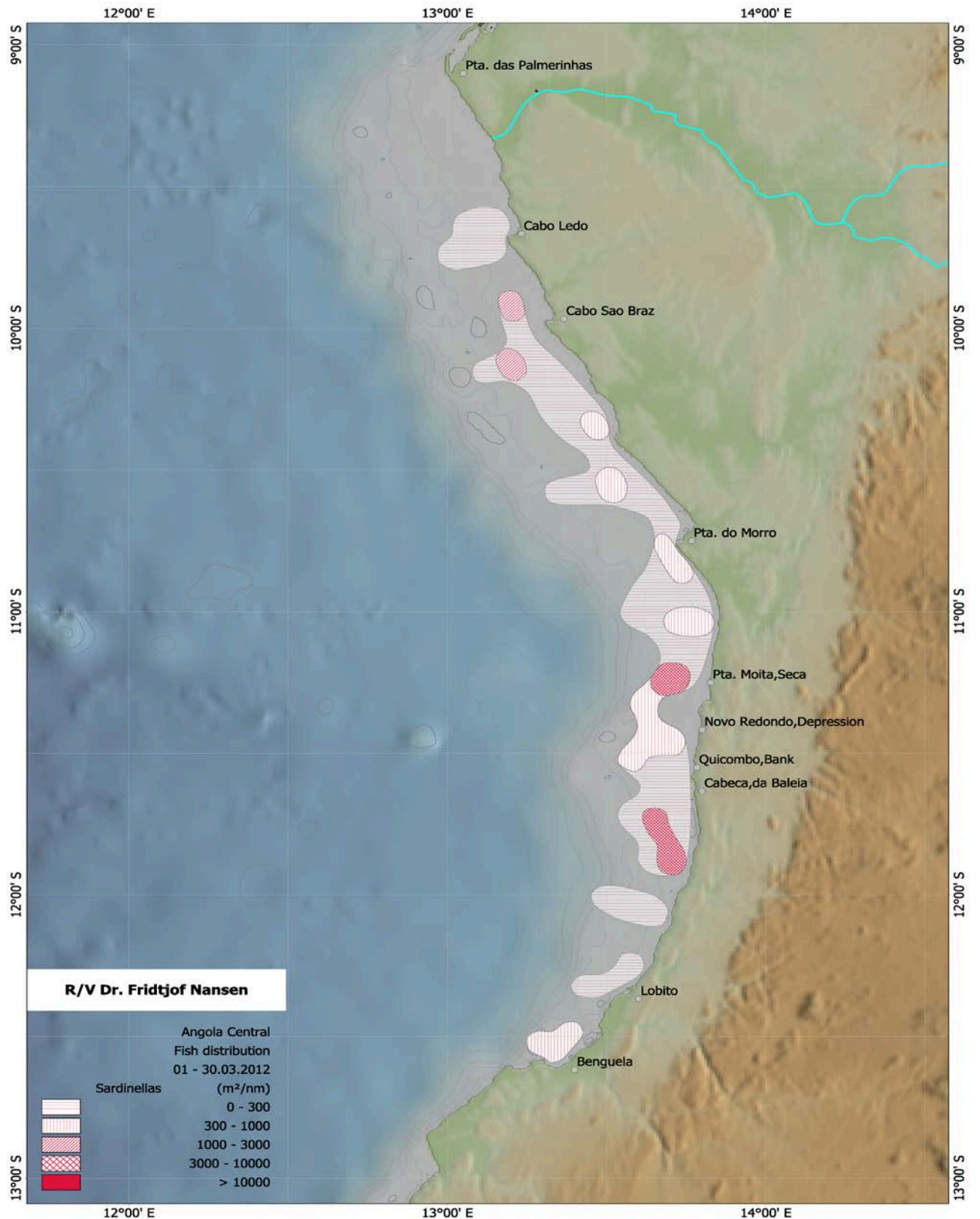
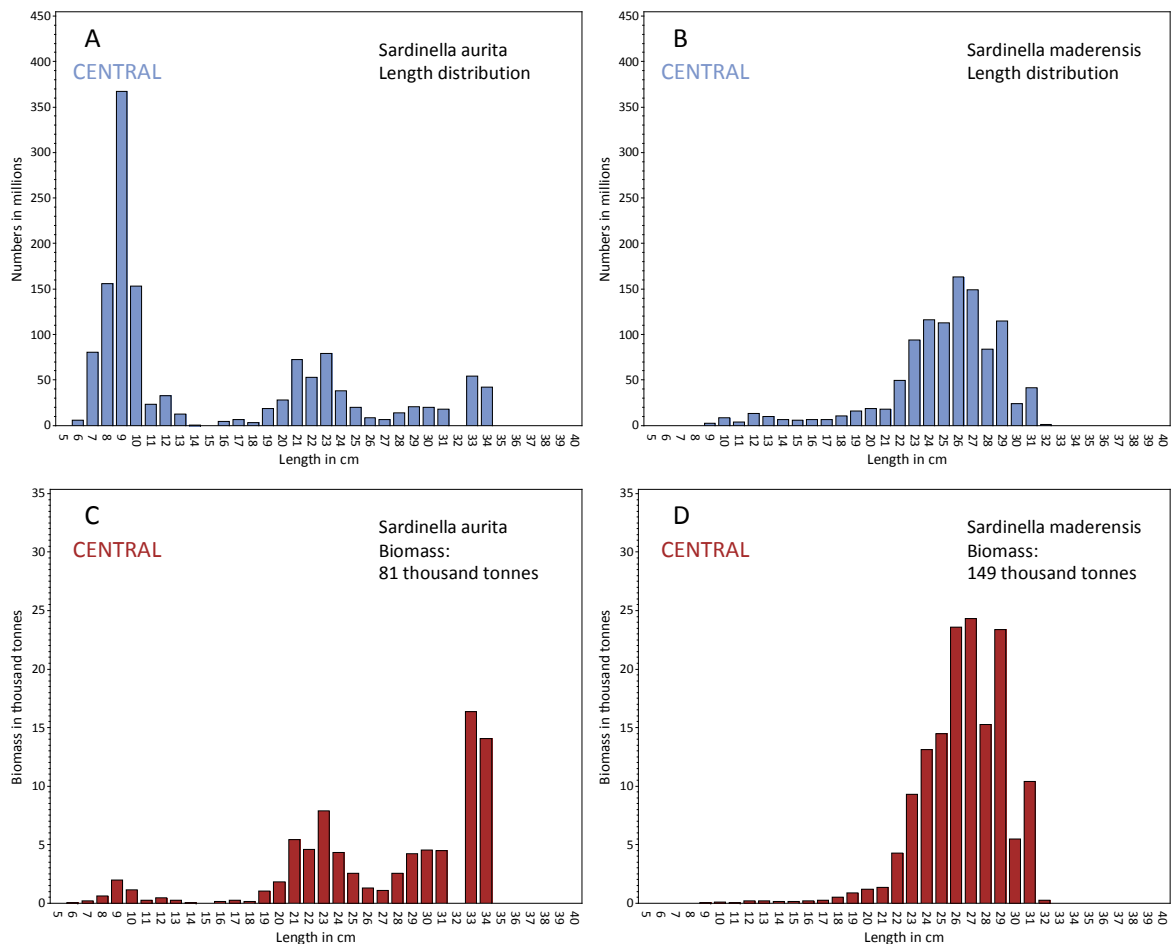


Figure 17 Distribution of *Sardinella* spp. Benguela-Pta. das Palmerinhas. Depth contours at 20, 50, 100 and 200 m.

The distribution of *S. maderensis* was dominated by adults (>21 cm TL) with a modal peak at around 26 cm TL (Figure 18). The length distribution of *S. aurita* shows two clear at 9 and 23cm.

However, the small fish between 6 and 10cm dominated the size spectrum of *S.aurita* the fish larger than 20cm has the highest contribution for the biomass of the species. .

The biomass for both sardinellas was estimated at 230 tonnes, where *S. maderensis* dominating and contributing with 65% (149 000 tonnes) of proportion of the biomass and *S. aurita* with 35% (81 000 tonnes). These figures are less than those estimated during the 1998 summer survey, when the total Sardinella biomass was calculated in 389 000 tonnes (106 000 for *S. aurita* and 283 000 for *S. maderensis*).



**Figure 18 Total length distribution of *Sardinella maderensis* and *S. aurita* Benguela-Pta. das Palmerinhas.**

### *Horse mackerel*

The only species of horse mackerel found in this region was the Cunene horse mackerel (*T. trecae*). It was found throughout the area in low acoustics densities. Offshore south off Ponta da Moita Seca and the Novo Redondo Depression was recorded in two small areas with high densities (Figure 19).



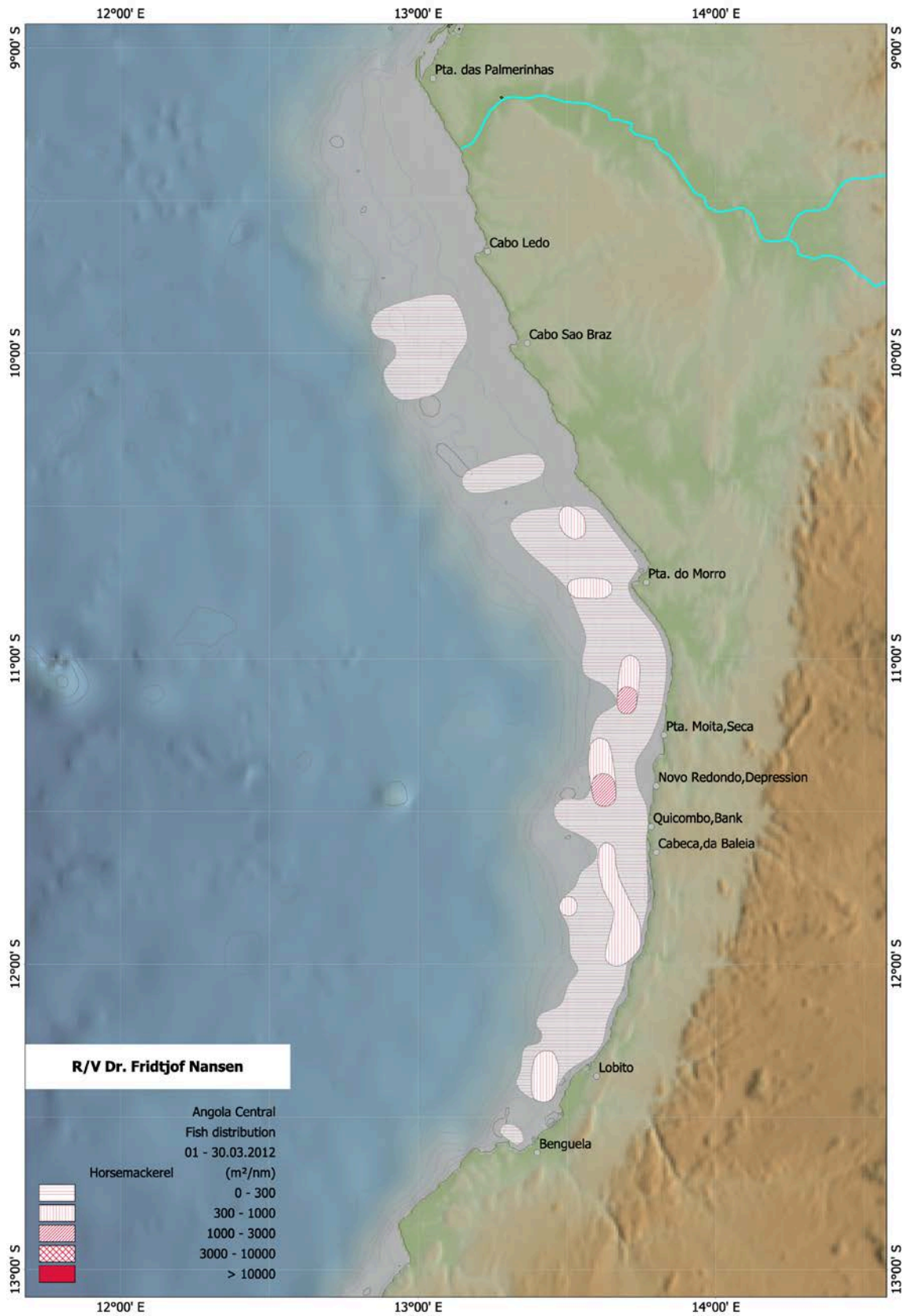
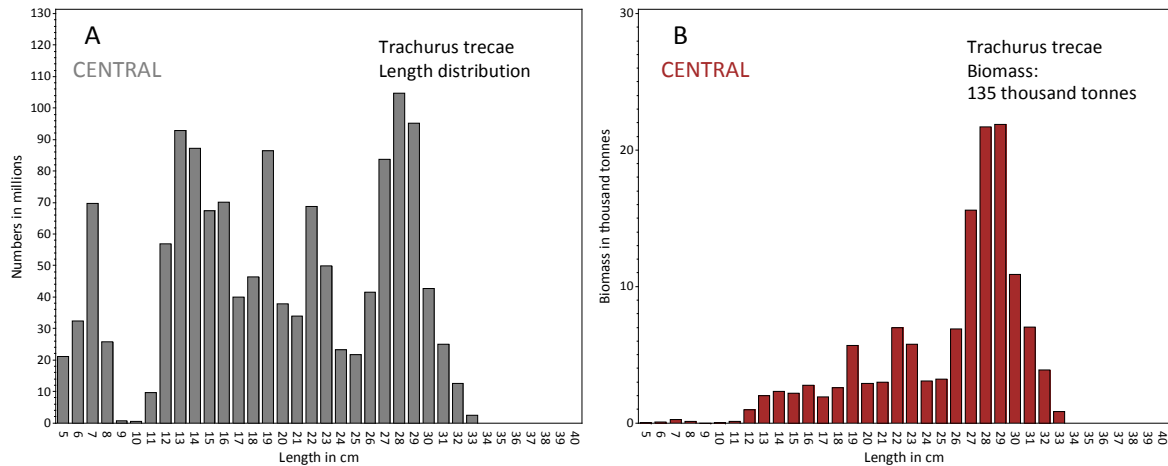


Figure 19 Distribution of *Cunene* horse mackerel (*Trachurus trecae*) Benguela-Pta. das Palmerinhas. Depth contours at 20, 50, 100 and 200 m.

Figure 20 shows the total length frequency distribution. The population has three well defined modal peaks around 7, 14 and 29 cm TL, which may be represent different cohorts.

The biomass of Cunene horse mackerel was estimated at 135 000. This biomass is higher than the estimated last year for this season (68 000 tonnes) and 34% lower compared with biomass estimated in the warmer season in 1998.



**Figure 20 Total length distribution and biomass per length groups of Cunene horse mackerel (*Trachurus trecae*), Benguela-Pta. das Palmerinhas.**

#### *Other pelagic species*

#### Pelagic species Group 1

### 4.3 Pta. Palmerinhas - Congo River

#### *Sardinella*

*Sardinella* was found in continuous from Luanda to Nzeto. Small areas with high acoustic densities were recorded offshore Cabeça da Cobra, Ambriz and Luanda.

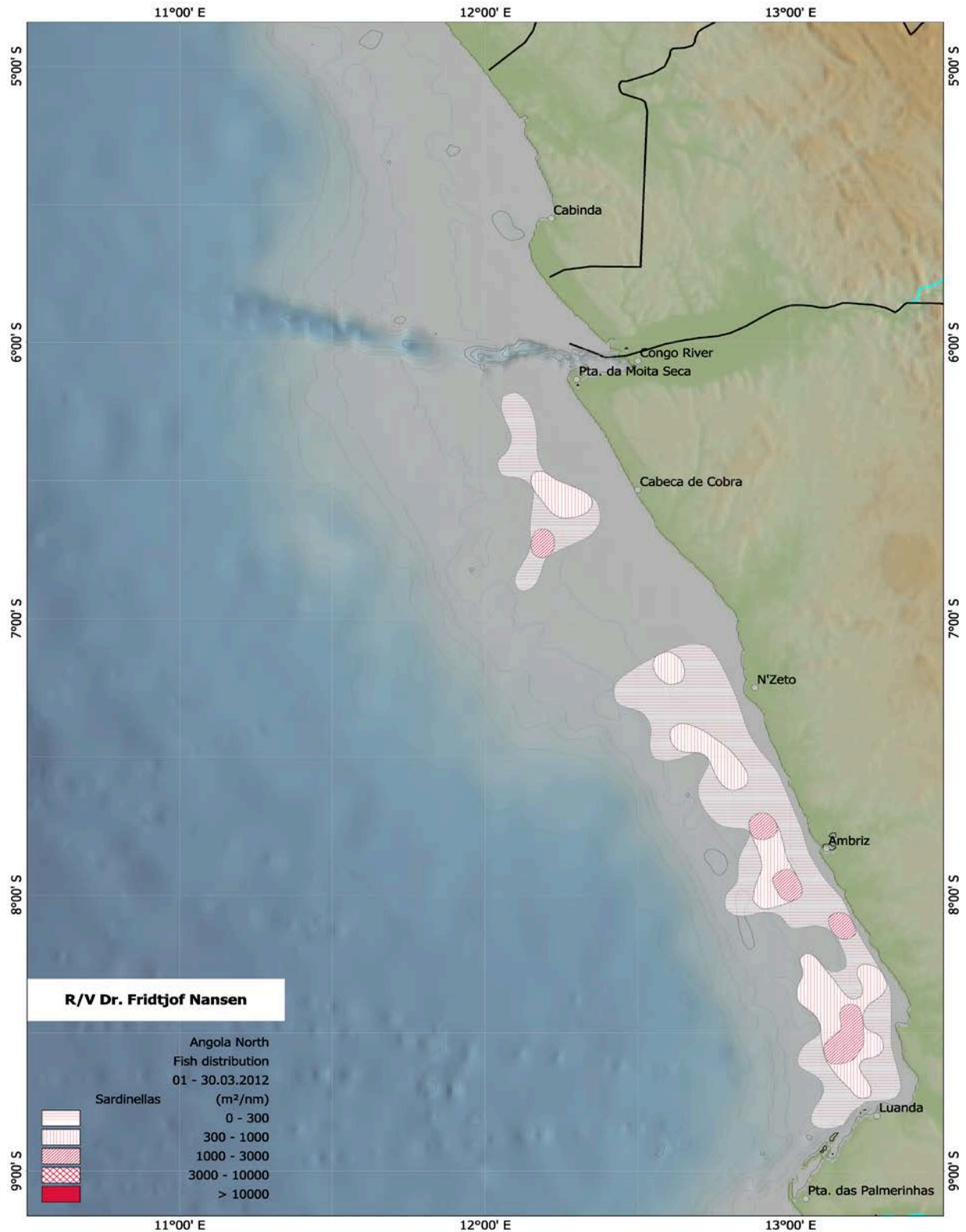


Figure 21 Distribution of *Sardinella* spp. Pta. das Palmerinhas-Congo River. Depth contours at 20, 50, 100, 200, and 500m.

For both species of sardinella the length distribution shows three clear modal lengths. For *S. aurita* peaking at around 7, 17 and 24cm and for *S. maderensis* at 9, 16 and 25cm.

The estimated biomass for this region was 156 000 tonnes, with *S. maderensis* representing around 60% of the total biomass, while *S. aurita* contributed with 40%. These figure is lower than the biomass estimated in 1998 (79 000 tonnes), where 71% of the total biomass was estimated in central region.

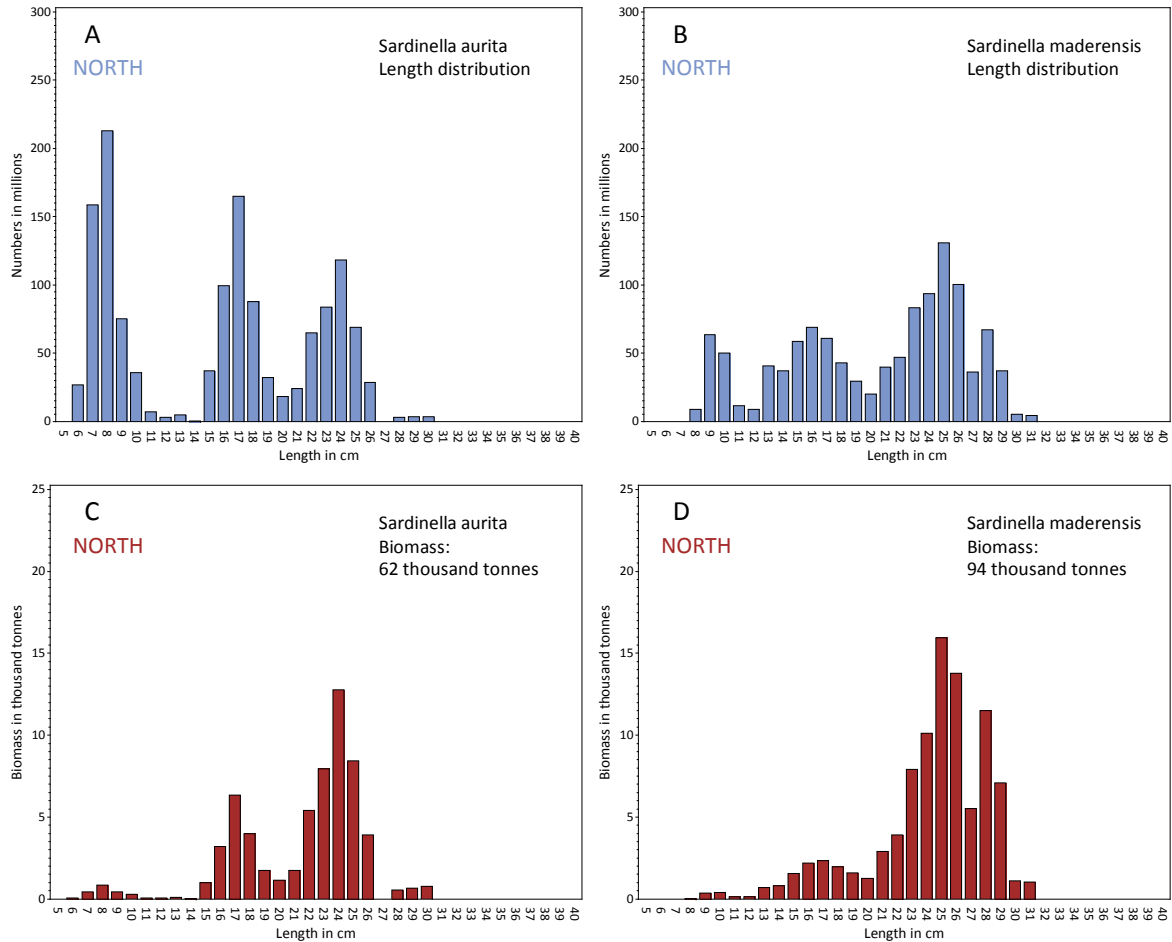


Figure 22 length distribution of *Sardinella maderensis* and *S. aurita*, Pta. das Palmerinhas-Congo River.

### Horse mackerel

In northern region Cunene horse mackerel, *T. trecae*, was found in low- acoustics densities areas ( $0 < S_A < 300 \text{ m}^2/\text{NM}^2$ ) between Cabeça da cobra to Luanda (Figure 23). The Cunene horse mackerel was primarily caught in bottom trawls mixed with demersal species.

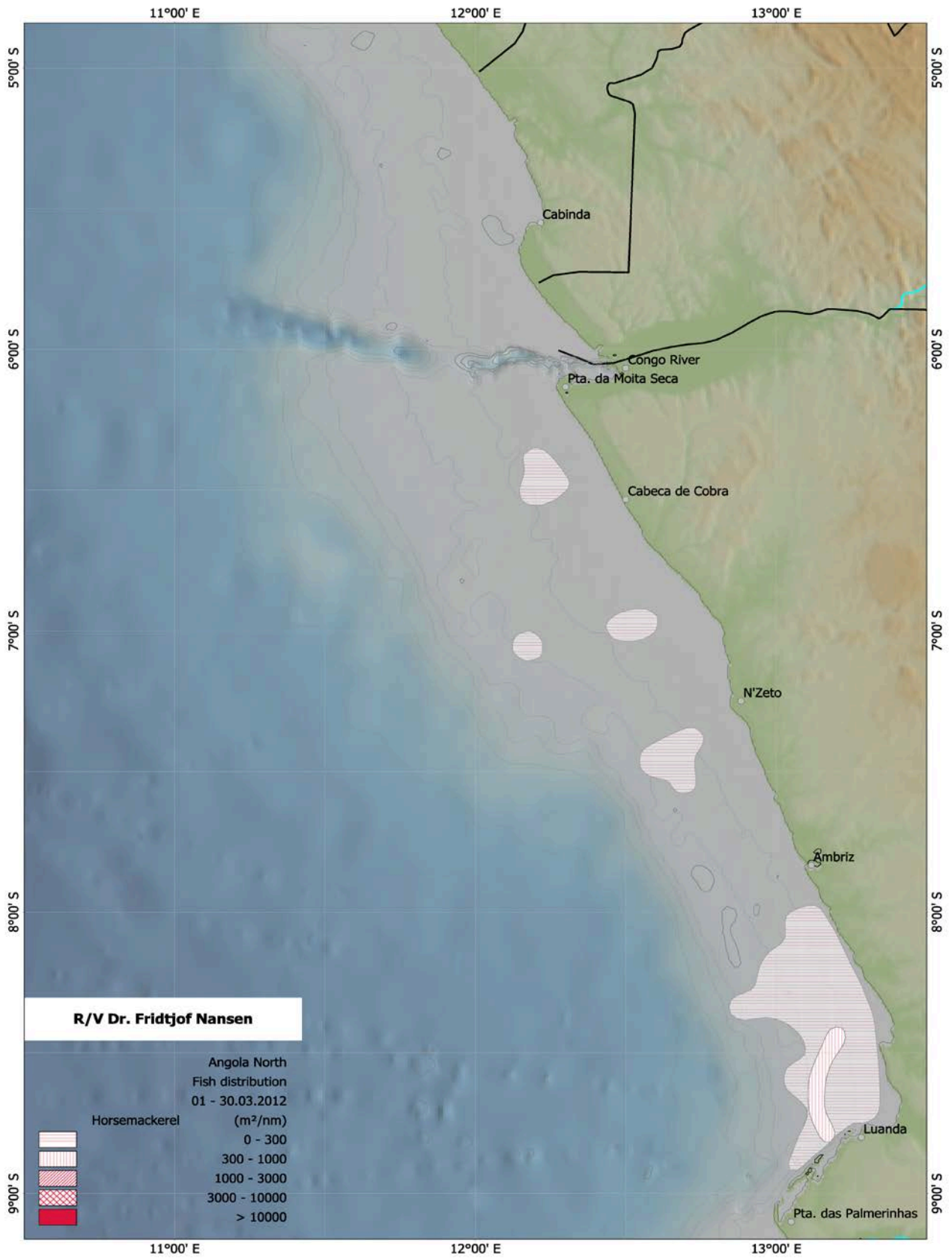
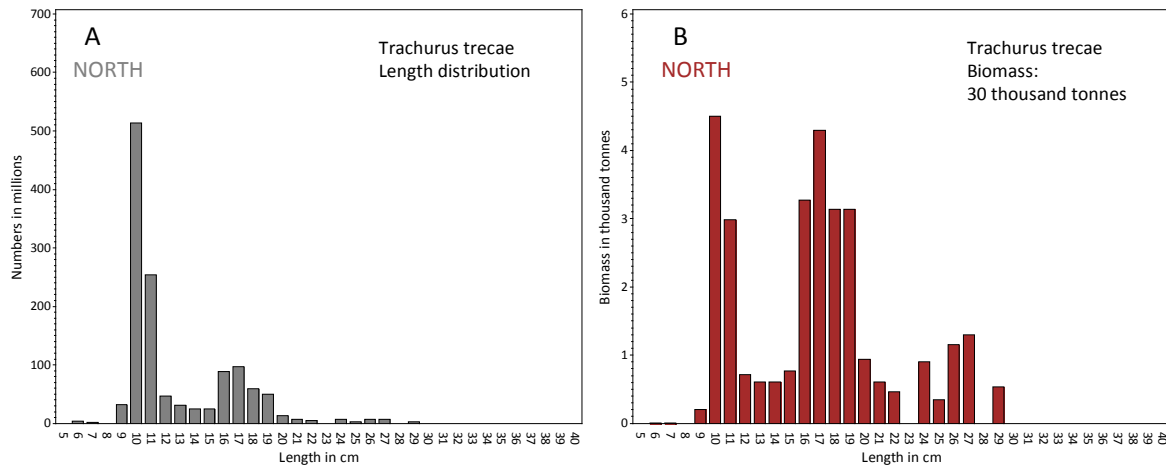


Figure 23 Distribution of Cunene horse mackerel (*Trachurus trecae*), Pta. das Palmerinhas-Congo River. Depth contours at 20, 50, 100, 200, and 500m.

The size distribution of Cunene horse mackerel showed two length modes, one at about 10cm TL and another at 17 cm TL (Figure 24).

The biomass of horse mackerel was estimated at 30 000 tonnes, which half of the biomass estimated in 1998 in summer season.



**Figure 24 Total length frequency distribution and biomass per length group of Cunene horse mackerel, Pta. das Palmerinhas-Congo River**

*Pelagic species Group 1*

Only minor catches/registration was recorded and it was not possible to produce any estimate with an acceptable sampling error. No further results will be presented for this species group.

*Pelagic species Group 2*

As for pelagic species group 1 only minor catches/registration was recorded. It was not possible to produce any estimate with an acceptable sampling error. No further results will be presented for this species group.

## **CHAPTER 5 SUMMARY OF SURVEY RESULTS**

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The overall high temperatures and low salinity observed in March 2011 was replaced with more “normal” conditions this year. Last year’s report included a hypothesis that the rather modest observations of target species abundance could be explained by them being more dispersed and thus less available to acoustic estimation. This year’s results show considerable higher biomass of the target species, but we would like to point out the acoustic survey is only covering a fraction of the resources. Considerable amounts can be distributed in more shallow waters (less than 20 meters) and closer to the surface. In particular is this a problem for the sardinella species. In such circumstances it is common to view estimates as conservative, but we would like to remind the reader that the choice of single fish target strength may have introduced a bias in the estimate. More research is needed to gain more insight into the fraction of the stocks not covered by the survey and into single fish target strength (possibly being dependent on depth and/or diurnal migrations).

Table 2 summarizes the results for the target species in this survey with the corresponding plot in Figure 25. The estimates of standard deviations are only including sampling variation from the acoustic transects, while the length distributions used to convert echo abundance to numbers of fish is assumed known without error (as is the length to weight relationship). The coefficient of variation (CV) is defined as  $\frac{100 \cdot St.dev}{Mean} \%$

A coefficient of variation makes it easier to compare the quality of several estimates and our results corresponds to (for the total) a CV for *Sardinella aurensis* of 25%, *Sardinella maderensis* 20%, *Trachurus trecae* 18% and *Trachurus capensis* 33%. It should be a clear objective of future survey strategies to produce estimates with a CV well below 20%. Results with a CV above 30% are not informative and are not suited as basis for decision making.



**Table 2 Biomass estimates including estimates of standard deviation (acoustic sampling error only) of the target species.**

<b>Area</b>	<b>Species</b>	<b>Biomass</b>	<b>St. dev.</b>
South	Sardinella aurita	353	118.7
Central	Sardinella aurita	81	23.9
North	Sardinella aurita	62	13.3 <sup>1)</sup>
<b>Total</b>	<b>Sardinella aurita</b>	<b>496</b>	<b>121.8</b>

Central	Sardinella maderensis	149	44.0
North	Sardinella maderensis	94	20.2 <sup>1)</sup>
<b>Total</b>	<b>Sardinella maderensis</b>	<b>243</b>	<b>48.4</b>

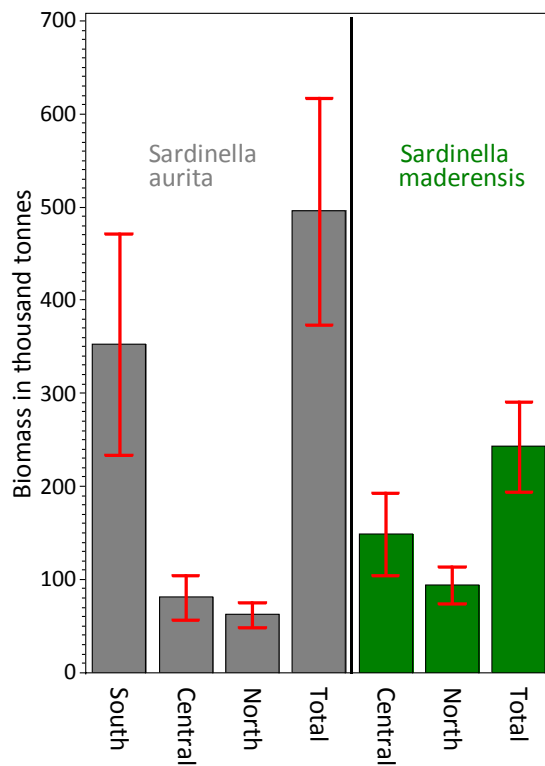
<sup>1)</sup> Estimate based on post stratification

<b>Area</b>	<b>Species</b>	<b>Biomass</b>	<b>St. dev</b>
South	Trachurus trecae	162	52.7 <sup>1)</sup>
Central	Trachurus trecae	135	24.9
North	Trachurus trecae	30	4.8 <sup>1)</sup>
<b>Total</b>		<b>327</b>	<b>58.5</b>

South	Trachurus capensis	67	21.8 <sup>1)</sup>
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<sup>1)</sup> Estimate based on post stratification

Estimate: *Sardinella* sp.



Estimate: *Trachurus* sp.

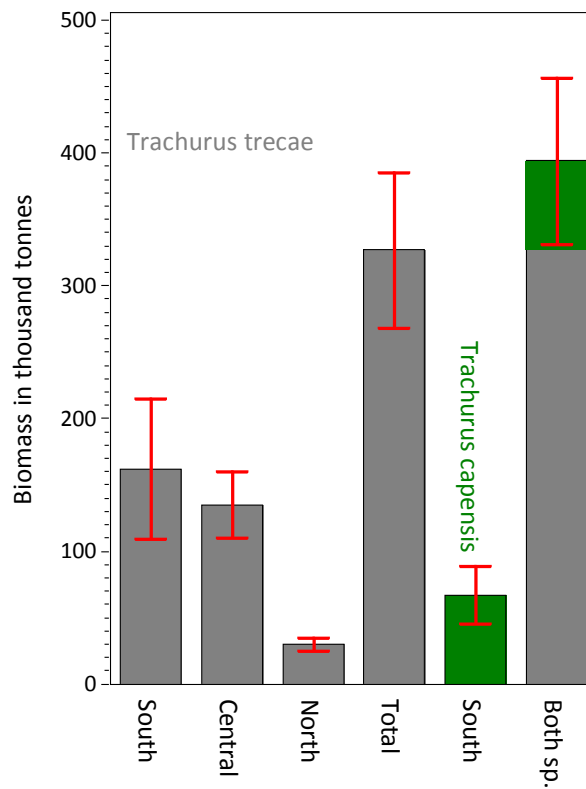


Figure 25 Biomass estimates of the target species. Vertical error bars corresponds to  $\pm 1$  standard deviation.

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## ANNEX I

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

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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 1/2 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, 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 1/2 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.

## ANNEX II

### 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>Pomadasyss 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.

### ANNEX III

#### Length to weight conversion

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Length to weight conversions was made using linear regressions on logarithms of length and weight. For both species groups the difference between regions (south, ventral and north) was significant and considerably larger than between species. The following model was used:

$$\text{Log}(W) = \alpha + \beta \cdot \text{Log}(L)$$

This corresponds to:

$$W = a \cdot L^b$$

where  $a = e^\alpha$  and  $b = \beta$

The following table summarizes the parameter estimates used in length to weight conversion on this survey:

Area	Sardinella sp.:		Trachurus sp.	
	a	b	a	b
South	0.00820588	3.042155163	0.007537668	3.064123827
Central	0.006005381	3.096964071	0.010814219	2.959238703
North	0.00795056	2.994538093	0.007688773	3.057245832

## ANNEX IV

### Length and biomass distributions

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#### SARDINELLA SP.

Length	Area: South			Area: Central			Area: North		
	N_est	Biomass	P	N_est	Biomass	P	N_est	Biomass	P
6	0.00	0.00		6.11	0.01	1.00	26.84	0.05	1.00
7	0.00	0.00		80.25	0.20	1.00	158.54	0.43	1.00
8	4.48	0.02	1.00	155.97	0.59	1.00	221.75	0.89	0.96
9	34.27	0.22	1.00	369.66	2.00	0.99	138.98	0.80	0.54
10	15.37	0.14	1.00	162.12	1.22	0.95	85.90	0.67	0.42
11	0.32	0.00	1.00	26.80	0.27	0.86	18.65	0.19	0.38
12	0.00	0.00		46.27	0.61	0.71	11.91	0.16	0.26
13	0.00	0.00		22.55	0.38	0.56	45.18	0.78	0.10
14	0.00	0.00		7.05	0.15	0.10	37.57	0.81	0.01
15	63.78	1.98	1.00	5.68	0.15	0.00	95.65	2.53	0.39
16	595.30	22.49	1.00	10.65	0.34	0.39	168.23	5.40	0.59
17	1098.50	49.90	1.00	12.94	0.50	0.49	225.76	8.68	0.73
18	1075.76	58.15	1.00	13.60	0.63	0.21	130.67	5.96	0.67
19	1760.16	112.16	1.00	34.54	1.89	0.53	61.68	3.31	0.52
20	602.60	44.88	1.00	46.52	2.99	0.60	38.00	2.38	0.48
21	328.33	28.37	1.00	90.46	6.76	0.80	64.14	4.64	0.38
22	212.74	21.18	1.00	102.43	8.84	0.52	111.85	9.31	0.58
23	73.07	8.33	1.00	173.42	17.17	0.46	166.73	15.85	0.50
24	8.12	1.05	1.00	154.42	17.45	0.25	211.83	22.88	0.56
25	16.24	2.38	1.00	132.75	17.02	0.15	199.73	24.38	0.35
26	0.00	0.00		171.79	24.87	0.05	128.80	17.68	0.22
27	0.00	0.00		155.93	25.37	0.04	35.98	5.53	0.00
28	8.12	1.68	1.00	97.94	17.84	0.14	70.35	12.06	0.05
29	0.00	0.00		135.83	27.58	0.15	40.64	7.74	0.08
30	0.00	0.00		44.35	10.00	0.45	8.82	1.86	0.41
31	0.00	0.00		59.53	14.86	0.30	4.36	1.01	0.00
32	0.00	0.00		0.88	0.24	0.00	0.00	0.00	
33	0.00	0.00		53.95	16.34	1.00	0.00	0.00	
34	0.00	0.00		42.31	14.06	1.00	0.00	0.00	
Sum	5897	353		2417	230		2509	156	

P is the proportion *Sardinella aurita* (while the proportion *Sardinella maderensis* is 1-p)

**TRACHURUS SP.**

Length	Area: South			Area: Central			Area: North		
	N_est	Biomass	P	N_est	Biomass	P	N_est	Biomass	P
5	8.86	0.01	1.00	21.08	0.03	1.00			
6	7.80	0.01	0.40	32.47	0.07	1.00	3.56	0.01	1.00
7	2.22	0.01	1.00	69.65	0.24	1.00	2.03	0.01	1.00
8	17.44	0.08	0.56	25.85	0.13	1.00	0.00	0.00	
9	11.32	0.07	0.82	0.66	0.00	1.00	31.71	0.20	1.00
10	3.37	0.03	0.00	0.60	0.01	1.00	513.34	4.50	1.00
11	13.47	0.16	0.00	9.72	0.13	1.00	253.96	2.98	1.00
12	12.54	0.19	0.63	56.88	0.96	1.00	46.87	0.72	1.00
13	20.79	0.41	0.58	92.80	1.99	1.00	31.18	0.61	1.00
14	118.10	2.89	0.50	87.23	2.32	1.00	24.83	0.61	1.00
15	771.27	23.34	0.53	67.34	2.20	1.00	25.23	0.76	1.00
16	1007.56	37.16	0.51	70.13	2.77	1.00	88.71	3.27	1.00
17	988.93	43.92	0.53	39.92	1.89	1.00	96.58	4.29	1.00
18	601.39	31.82	0.64	46.46	2.60	1.00	59.22	3.13	1.00
19	145.51	9.09	0.67	86.53	5.69	1.00	50.31	3.14	1.00
20	71.95	5.26	0.96	37.80	2.89	1.00	12.86	0.94	1.00
21	12.75	1.08	1.00	33.92	3.00	1.00	7.11	0.60	1.00
22	35.28	3.45	1.00	68.71	6.98	1.00	4.74	0.46	1.00
23	66.45	7.45	1.00	49.96	5.79	1.00	0.00	0.00	
24	70.55	9.01	1.00	23.28	3.06	1.00	7.11	0.91	1.00
25	51.20	7.41	1.00	21.64	3.21	1.00	2.37	0.34	1.00
26	50.59	8.26	1.00	41.48	6.90	1.00	7.11	1.16	1.00
27	32.82	6.02	1.00	83.76	15.59	1.00	7.11	1.30	1.00
28	29.91	6.13	1.00	104.80	21.72	1.00	0.00	0.00	
29	36.22	8.26	1.00	95.15	21.88	1.00	2.37	0.54	1.00
30	25.68	6.50	1.00	42.75	10.87	1.00	0.00	0.00	
31	32.10	8.98	1.00	25.04	7.01	1.00	0.00	0.00	
32	6.42	1.98	1.00	12.61	3.88	1.00	0.00	0.00	
33	0.00	0.00		2.53	0.85	1.00	0.00	0.00	
Sum	4252	229		1351	135		1278	30	

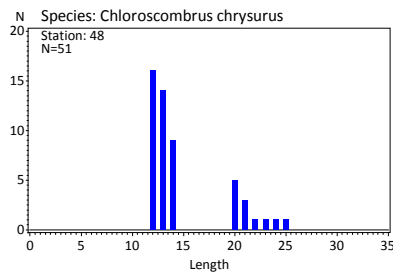
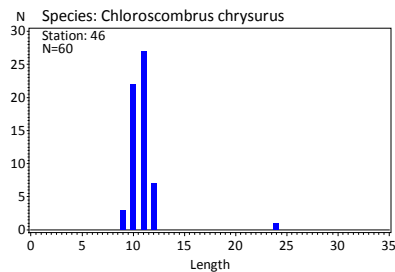
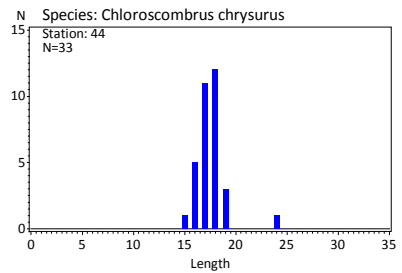
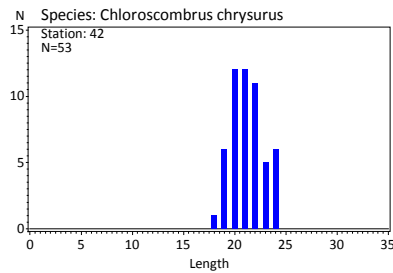
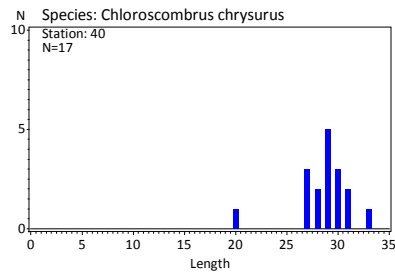
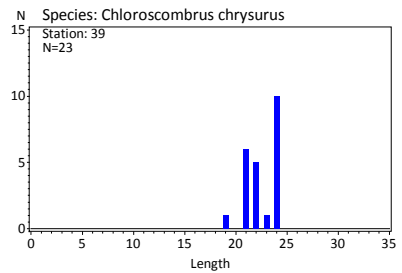
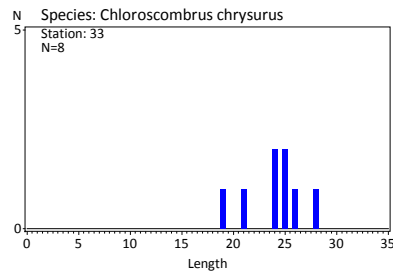
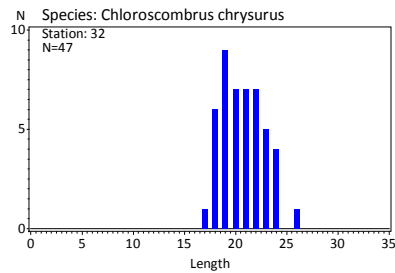
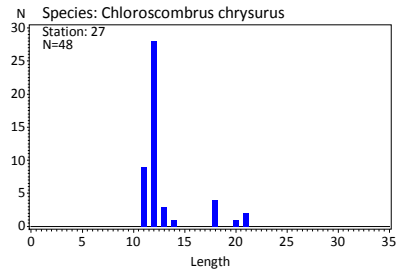
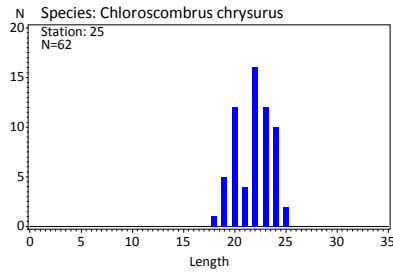
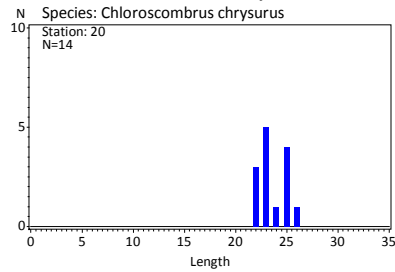
P is the proportion *Trachurus trecae* (while the proportion *Trachurus capensis* is 1-p)



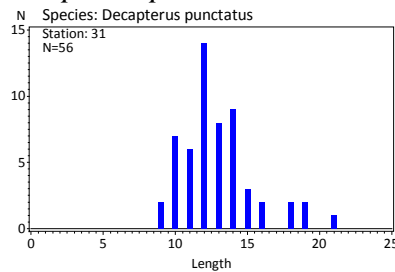
# ANNEX V

## Observed length distributions by species and station

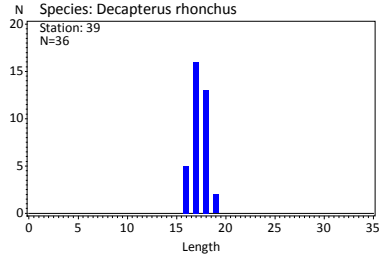
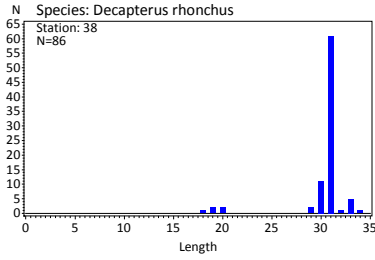
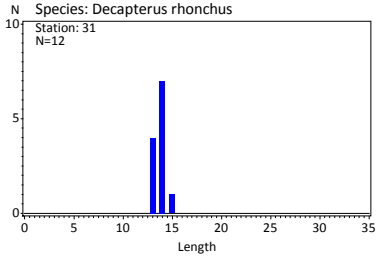
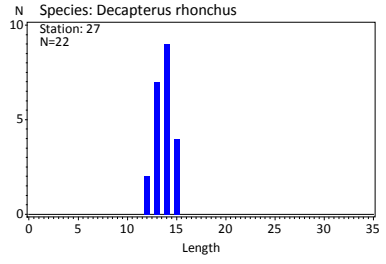
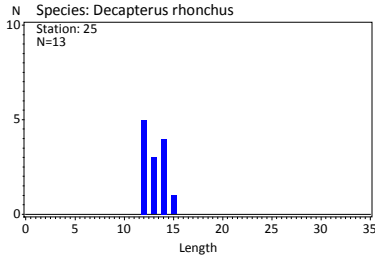
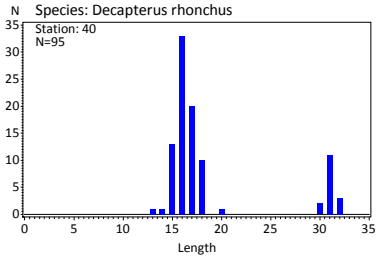
### *Chloroscombrus chrysurus*



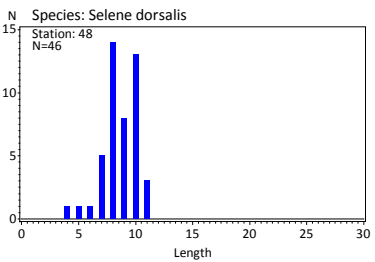
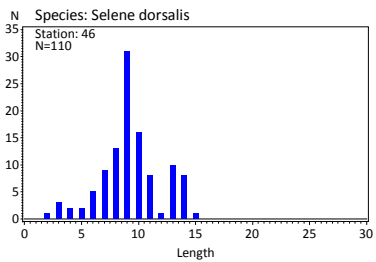
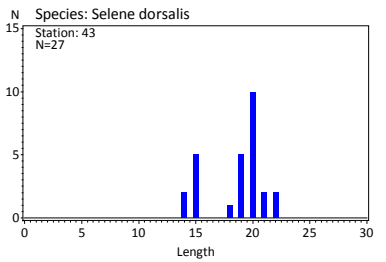
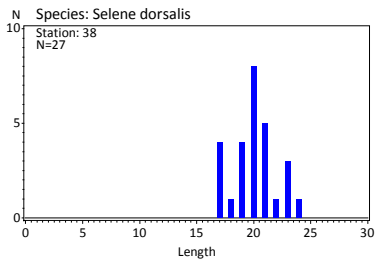
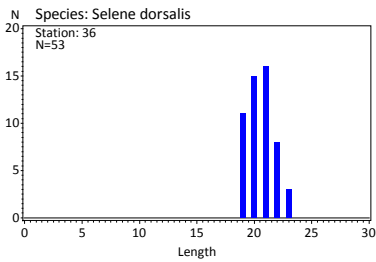
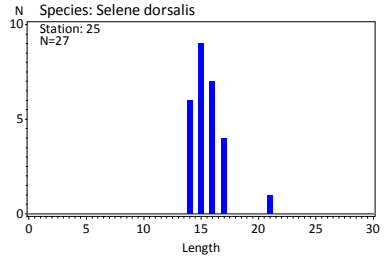
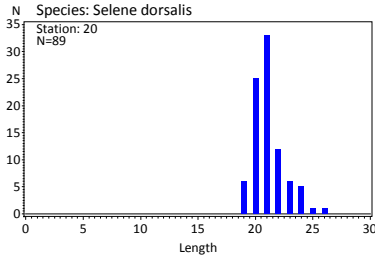
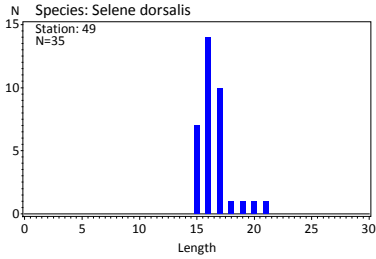
### *Decapterus punctatus*



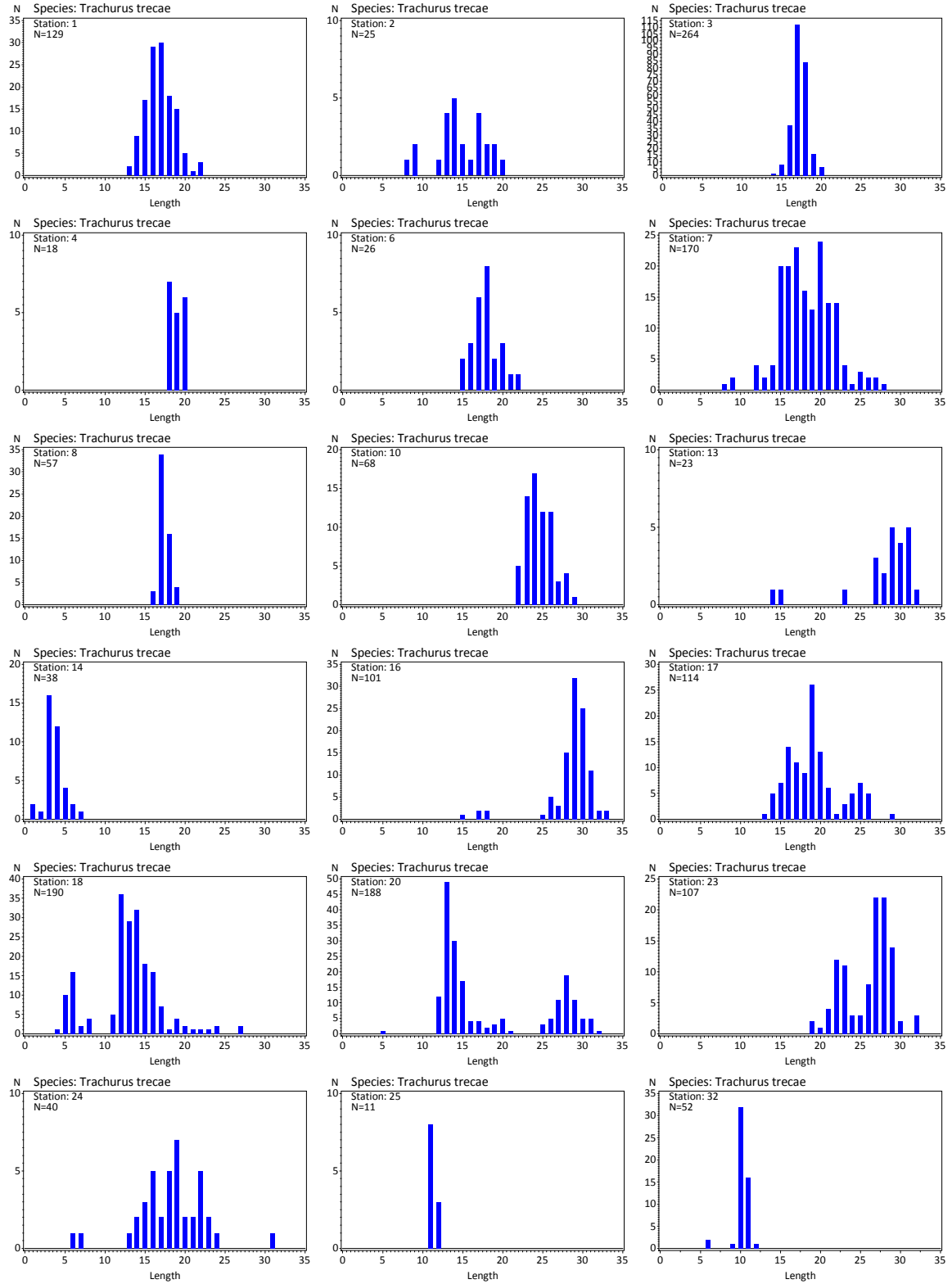
## *Decapterus rhonchus*

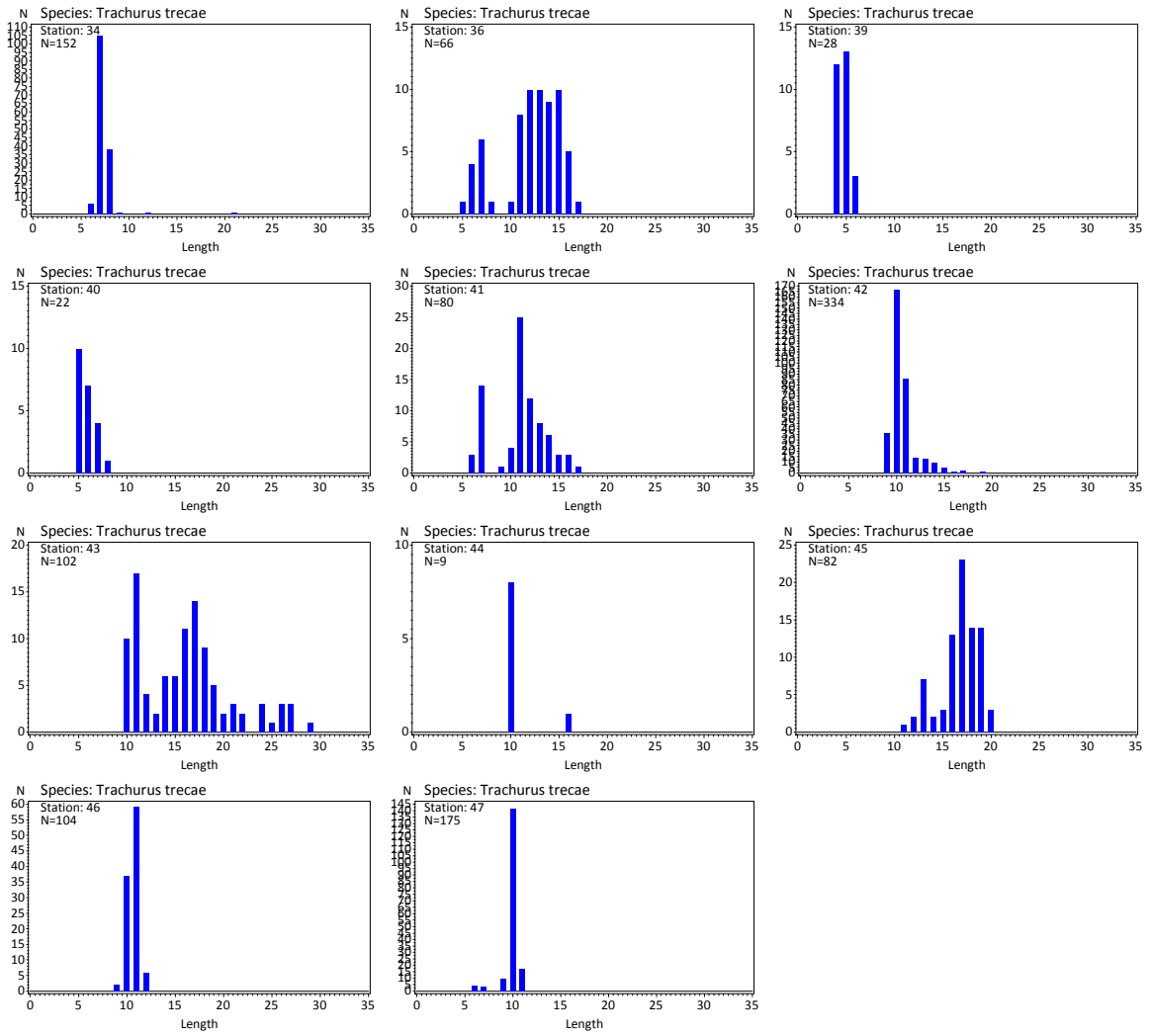


## *Selene Dorsalis*

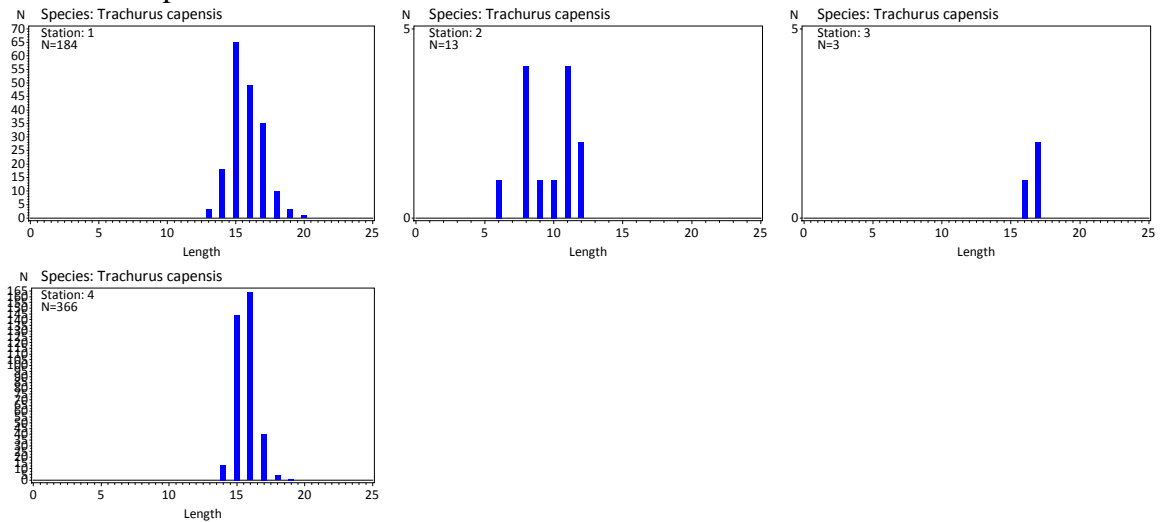


*Trachurus trecae*

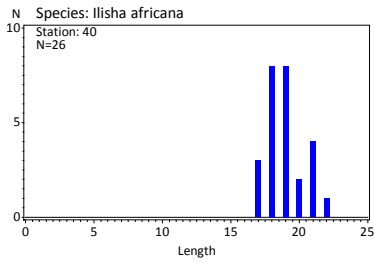
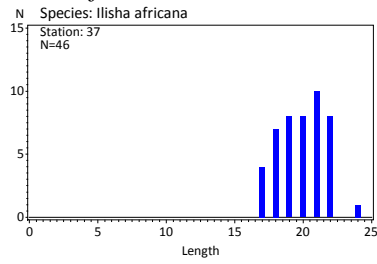




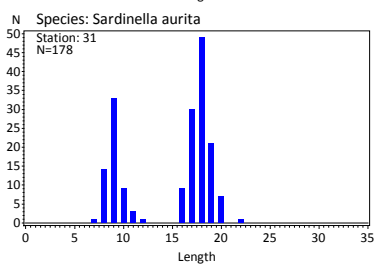
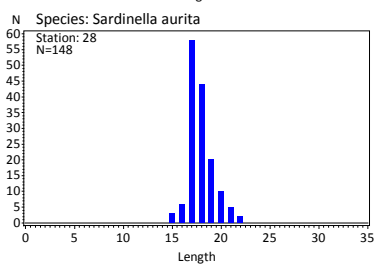
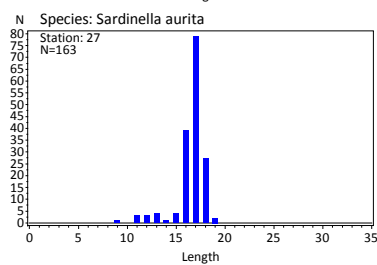
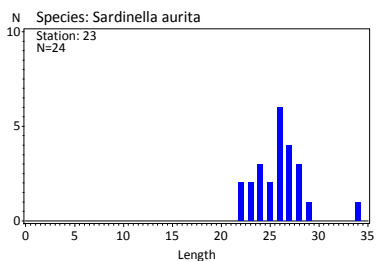
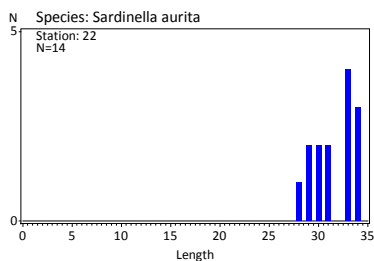
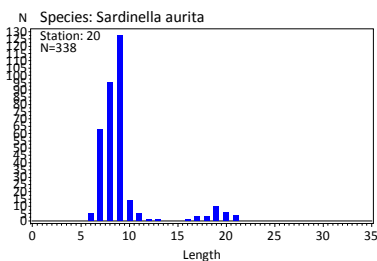
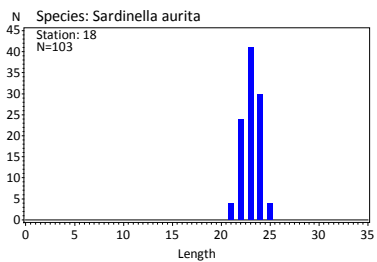
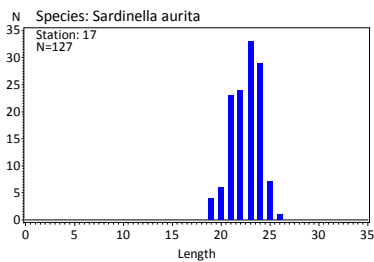
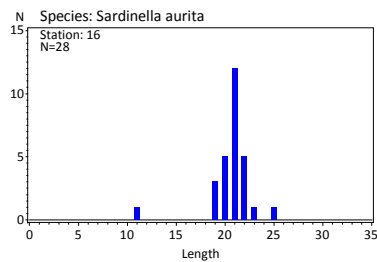
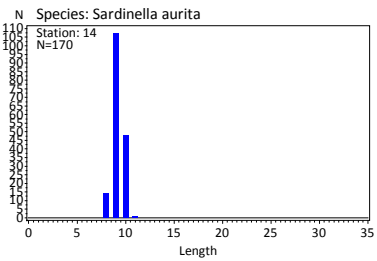
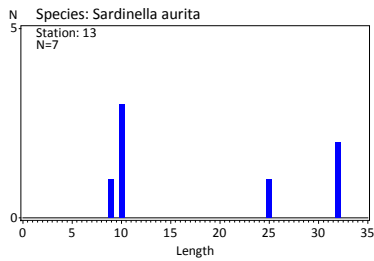
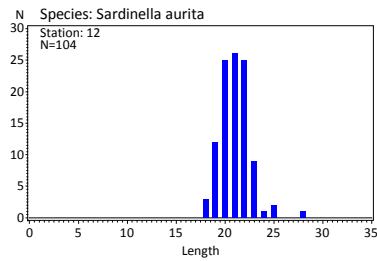
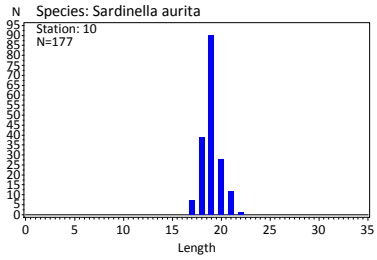
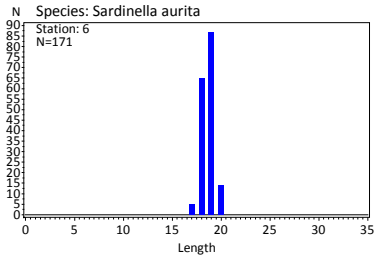
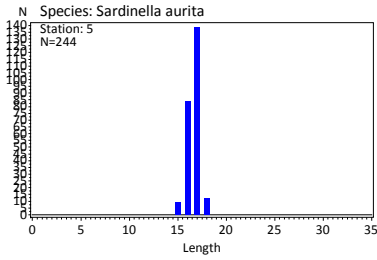
### Trachurus capensis

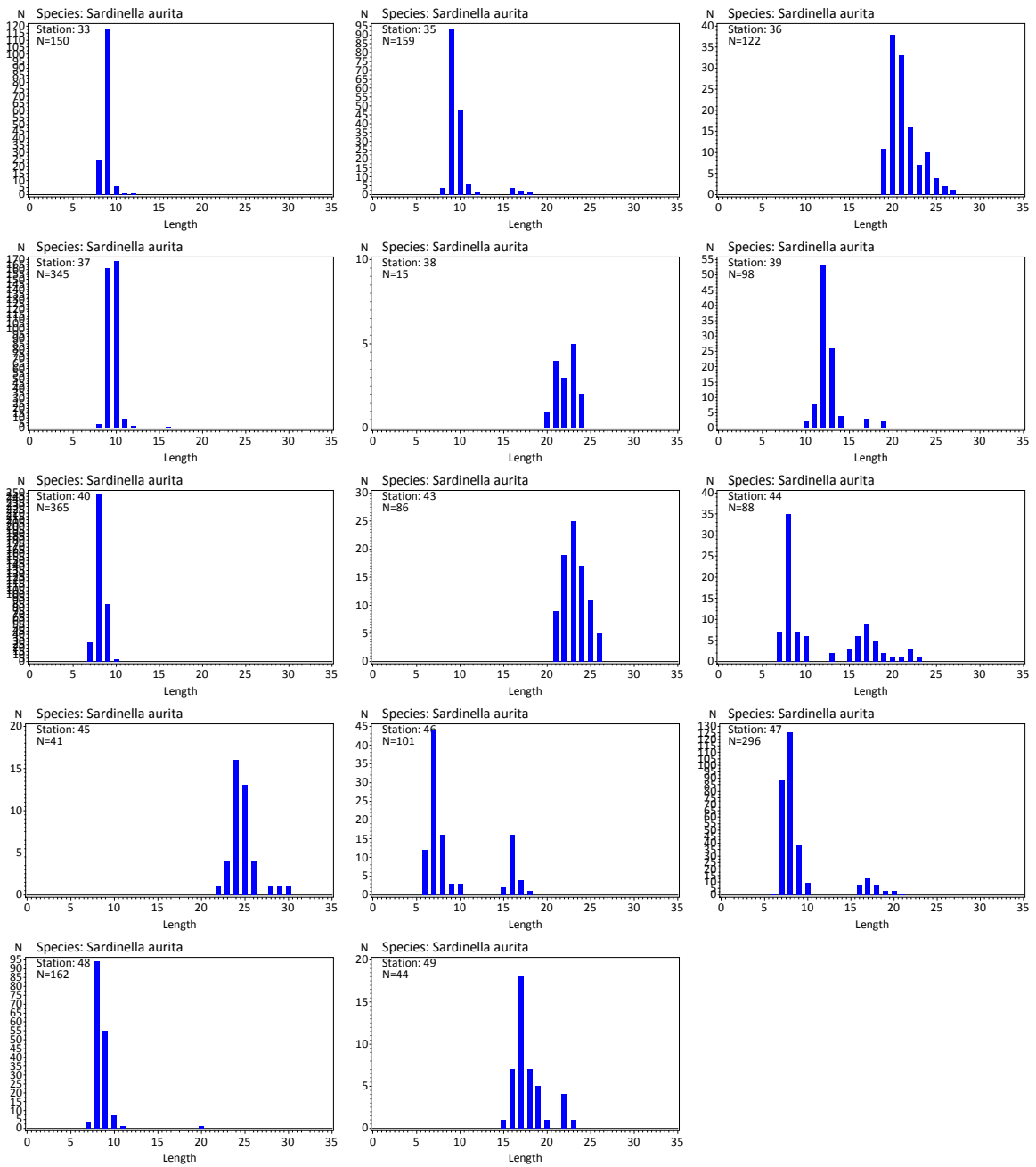


*Ilisha africana*

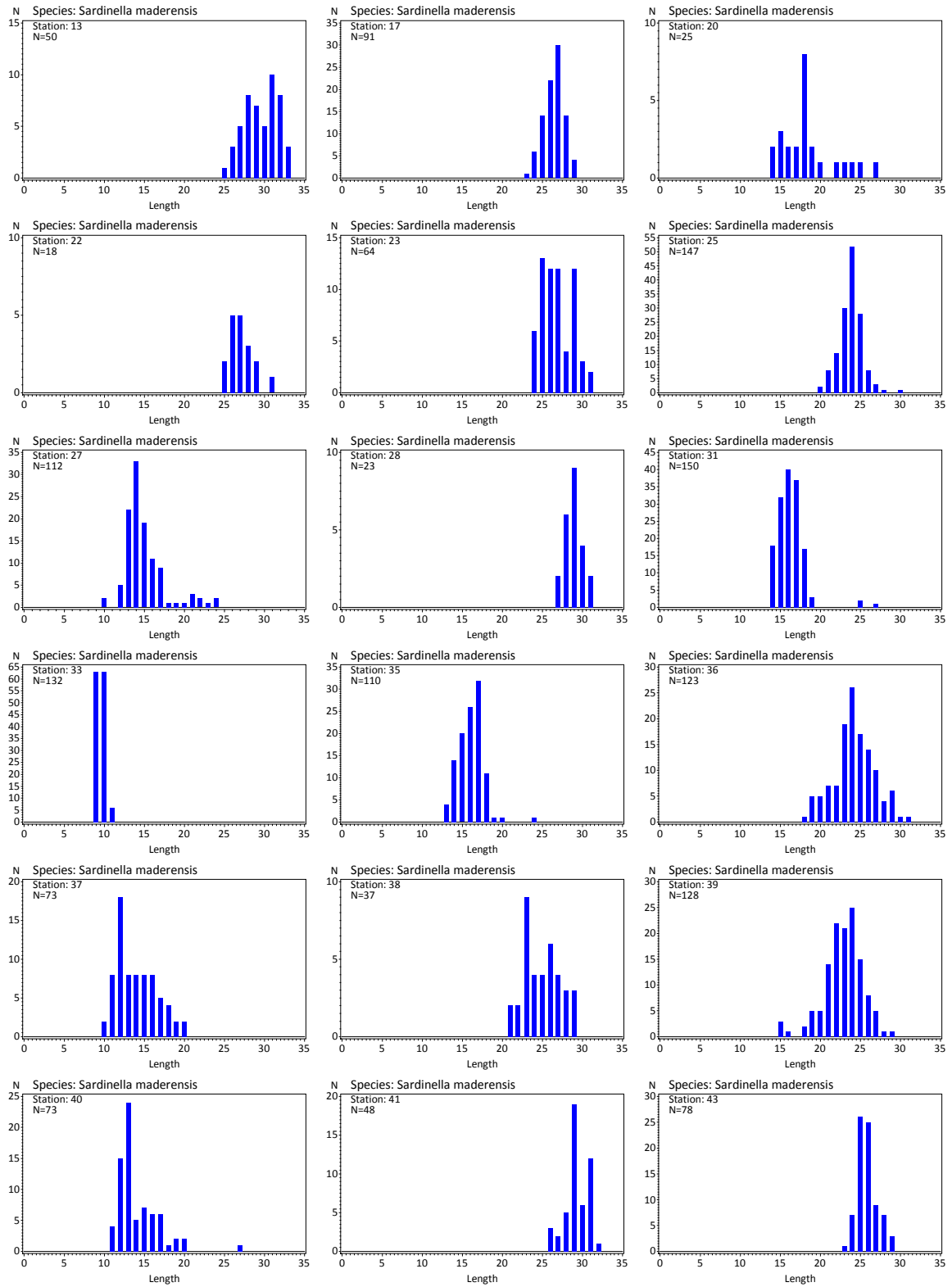


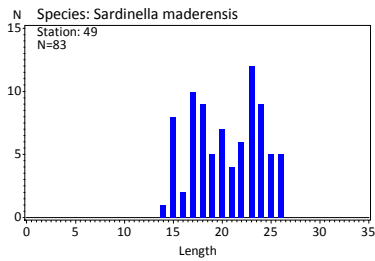
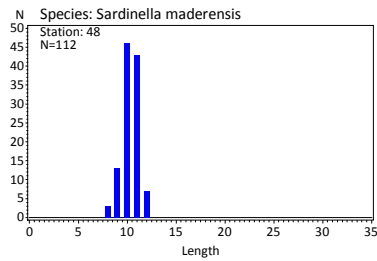
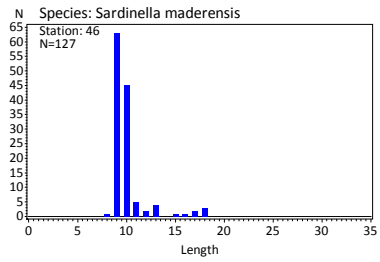
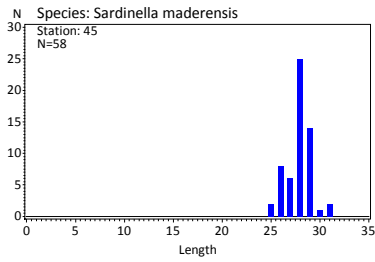
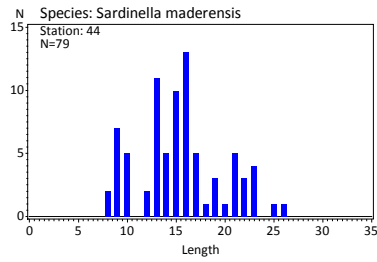
*Sardinella aurita*



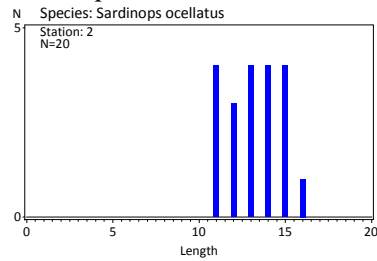


# *Sardinella maderensis*

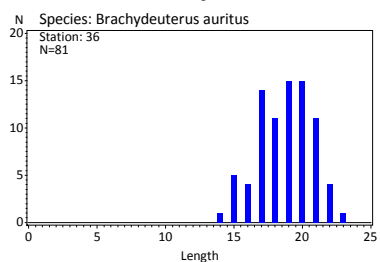
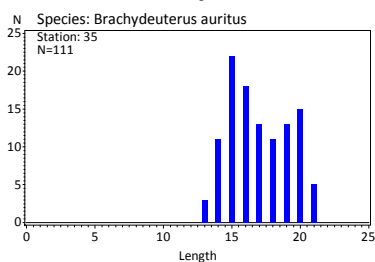
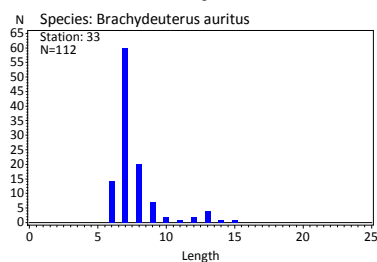
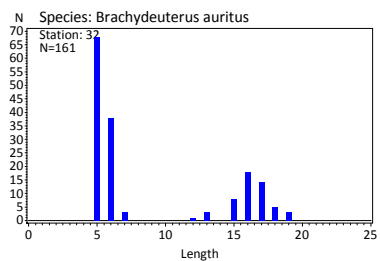
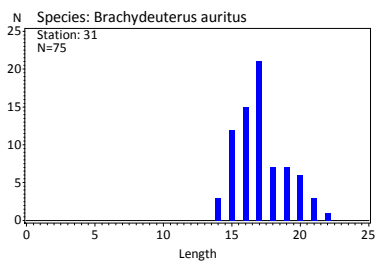
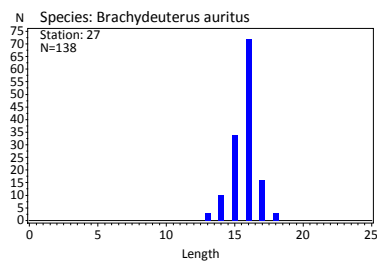
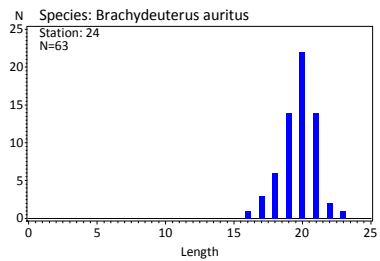
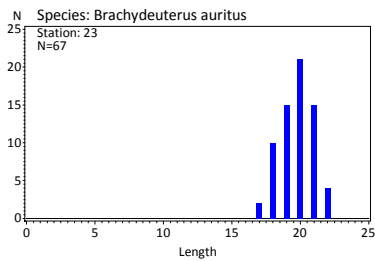
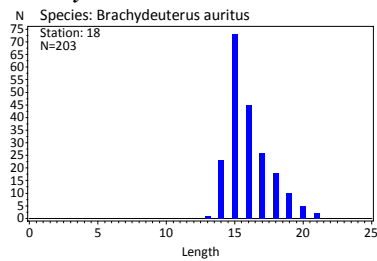




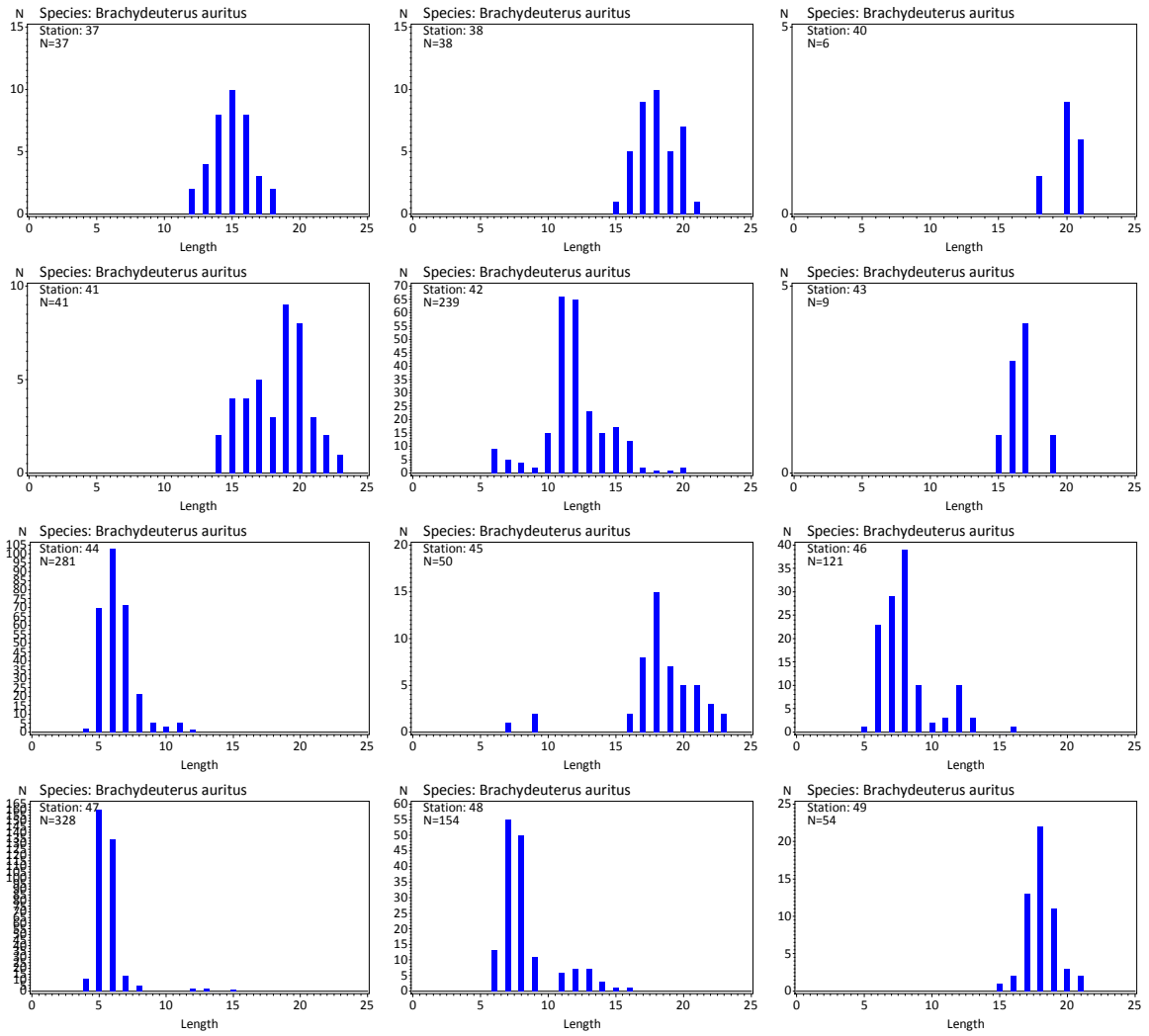
*Sardinops ocellatus*



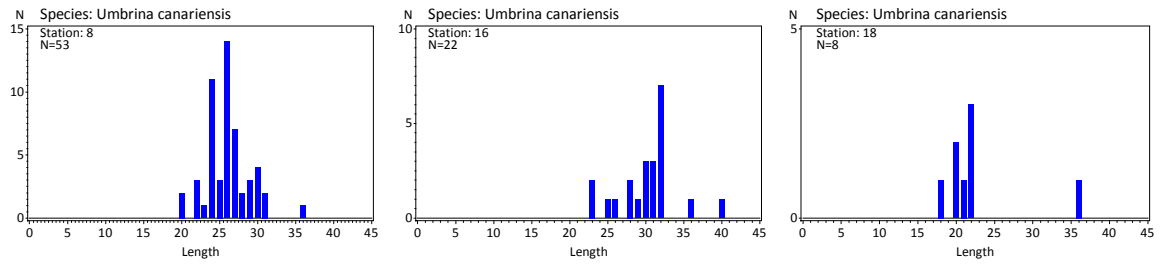
*Brachydeuterus auritus*



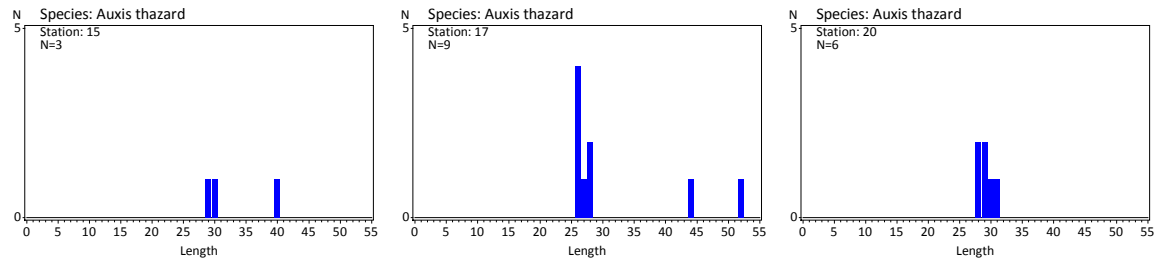




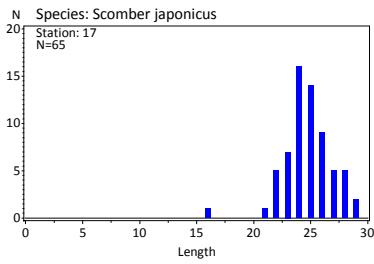
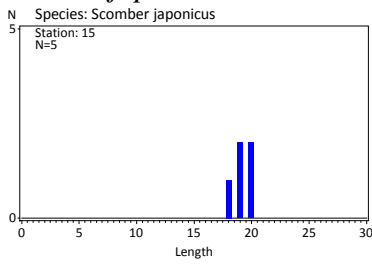
*Umbrina canariensis*



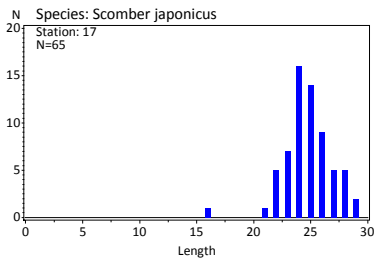
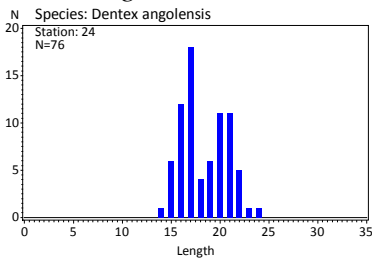
*Auxis thazard*



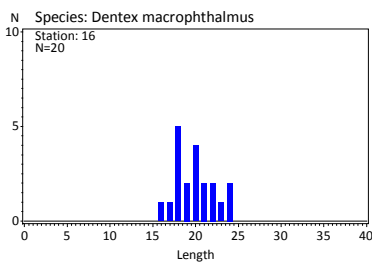
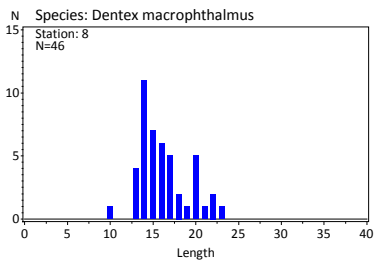
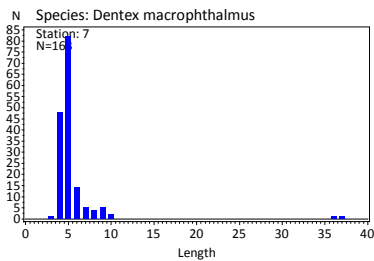
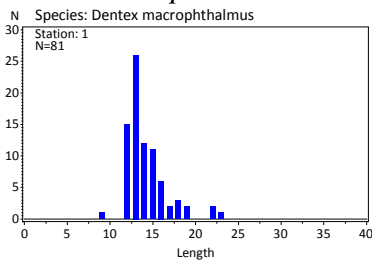
*Scomber japonicus*



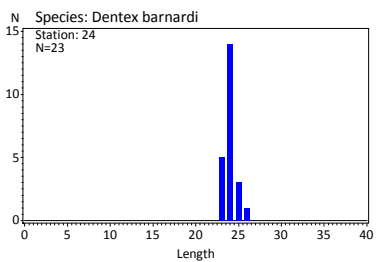
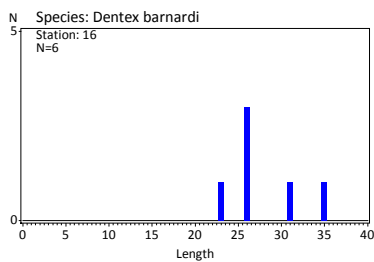
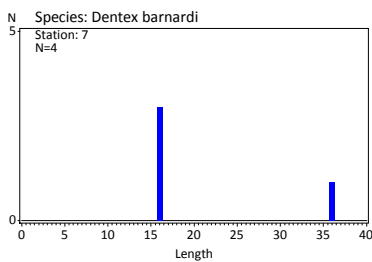
*Dentex angolensis*



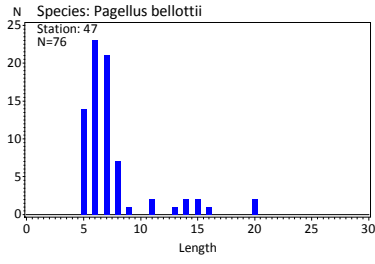
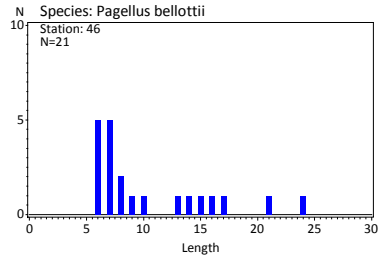
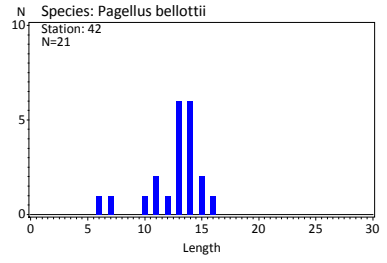
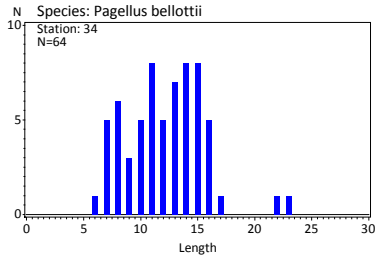
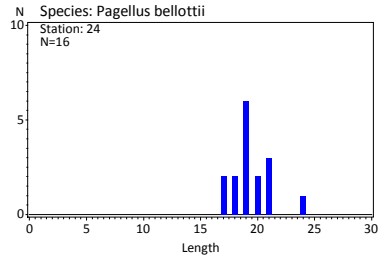
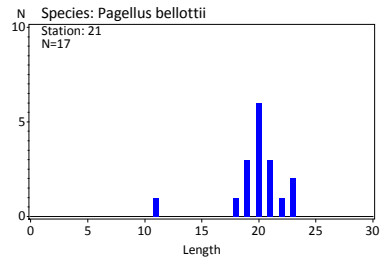
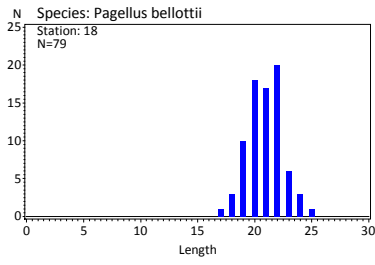
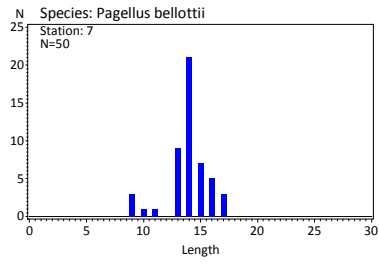
*Dentex macrophthalmus*



*Dentex barnardi*



*Pagellus bellottii*



# ANNEX VI

## Records of fishing stations

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 1  
 DATE :03.03.2012 GEAR TYPE: BT NO: 6 POSITION:Lat S 17°6,00  
 start stop duration Purpose : 1  
 LOG : 4510,05 4511,65 1,6 Region : 4020  
 FDEPTH: 127 129 Gear cond.: 0  
 BDEPTH: 127 129 Validity : 0  
 Towing dir: 0° Wire out : 385 m Speed : 3,2 kn  
 Sorted : 0 Total catch: 2115,20 Catch/hour: 4230,40

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trachurus capensis	1496,96	34880	35,39	2
Dentex macrocephalus	1136,00	22016	26,85	3
Trachurus trecae	912,00	17254	21,56	1
Merluccius capensis	255,36	2752	6,04	
Dicologlossa cuneata	84,16	2112	1,99	
Brotula barbata	82,56	1632	1,95	
Raja miraletus	60,16	96	1,42	
Arius parkii	36,48	96	0,86	
Pterothrissus belloci	34,56	1536	0,67	
Sea anemone sp	28,48	22250	0,61	
Squilla mantis	25,92	192	0,61	
Perulibatrachus rossignoli	22,08	32	0,52	
Unidentified Sea Plant	19,20	96	0,45	
G A S T R O P O D S	14,40	48	0,34	
Thorogobius angolensis	8,00	1568	0,19	
Octopus vulgaris	6,72	32	0,16	
Zeus faber	6,08	64	0,14	
Pontinus accraensis	1,28	32	0,03	
Total	4230,40		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 2  
 DATE :03.03.2012 GEAR TYPE: PT NO: 1 POSITION:Lat S 17°6,21  
 start stop duration Purpose : 1  
 LOG : 10:40:09 11:11:58 31,8 (min) Region : 4020  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 31 55 Validity : 0  
 Towing dir: 0° Wire out : 80 m Speed : 3,3 kn  
 Sorted : 0 Total catch: 907,39 Catch/hour: 1710,44

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
J E L L Y F I S H	739,83	4935	43,25	
Engraulis encrasicolus	469,86	26354	27,47	
Etrumeus whiteheadi	311,44	7278	18,21	
Chelidonichthys capensis	148,88	850	8,70	
Trachurus trecae	22,60	518	1,32	5
Sardinops ocellatus	9,54	415	0,56	4
Loligo vulgaris	5,39	166	0,32	
Trachurus capensis	2,90	270	0,17	6
Total	1710,44		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 3  
 DATE :03.03.2012 GEAR TYPE: BT NO: 6 POSITION:Lat S 16°53,83  
 start stop duration Purpose : 1  
 LOG : 17:59:08 18:16:48 17,7 (min) Region : 4020  
 FDEPTH: 98 102 Gear cond.: 0  
 BDEPTH: 98 102 Validity : 0  
 Towing dir: 0° Wire out : 300 m Speed : 3,2 kn  
 Sorted : 0 Total catch: 114,61 Catch/hour: 389,17

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trachurus trecae	225,13	4204	57,85	7
Sea anemone sp	35,99	10336	9,25	0
G A S T R O P O D S	30,22	12088	7,77	
J E L L Y F I S H	27,03	122	6,95	
Merluccius capensis	24,24	211	6,23	
Calappa rubroguttata	15,21	353	3,91	
Squilla mantis	12,80	475	3,29	
Unidentified Sea Plant	8,76	10075	2,25	
Dicologlossa cuneata	5,16	228	1,33	
Thorogobius angolensis	2,48	411	0,64	
Sea anemone sp	0,81	14	0,21	
Raja miraletus	0,61	3	0,16	
Trachurus capensis	0,48	10	0,12	8
Octopus vulgaris	0,24	7	0,06	
Total	389,17		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 4  
 DATE :04.03.2012 GEAR TYPE: PT NO: 1 POSITION:Lat S 16°41,97  
 start stop duration Purpose : 1  
 LOG : 01:45:48 02:15:02 29,2 (min) Region : 4020  
 FDEPTH: 10 0 Gear cond.: 0  
 BDEPTH: 108 114 Validity : 0  
 Towing dir: 0° Wire out : 0 m Speed : 3,4 kn  
 Sorted : 0 Total catch: 1539,68 Catch/hour: 3160,48

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trachurus capensis	3100,29	68365	98,10	10
Trachurus trecae	39,64	528	1,25	9
J E L L Y F I S H	15,85	29	0,50	
Lagocephalus laevis	4,70	29	0,15	
Total	3160,48		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 5  
 DATE :04.03.2012 GEAR TYPE: BT NO: 6 POSITION:Lat S 16°39,31  
 start stop duration Purpose : 1  
 LOG : 15:44:40 16:05:23 20,7 (min) Region : 4020  
 FDEPTH: 23 25 Gear cond.: 0  
 BDEPTH: 23 25 Validity : 0  
 Towing dir: 0° Wire out : 120 m Speed : 3,4 kn  
 Sorted : 0 Total catch: 1059,00 Catch/hour: 3066,60

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Dead shells	2866,80	2866795	93,48	
Sardinella aurita	183,42	3585	5,98	11
Myliobatis aquila	16,33	9	0,53	
Trachurus trecae	0,29	3	0,01	
Total	3066,83		100,01	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 6  
 DATE :04.03.2012 GEAR TYPE: PT NO: 4 POSITION:Lat S 16°18,87  
 start stop duration Purpose : 1  
 LOG : 22:43:51 23:14:24 30,6 (min) Region : 4020  
 FDEPTH: 1 0 Gear cond.: 0  
 BDEPTH: 40 50 Validity : 0  
 Towing dir: 0° Wire out : 100 m Speed : 2,9 kn  
 Sorted : 0 Total catch: 1589,46 Catch/hour: 3121,69

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
J E L L Y F I S H	2120,43	14689	67,93	
Sardinella aurita	906,58	11684	29,04	12
Trachurus trecae	45,21	731	1,45	13
Sepia orbignyana	24,43	57	0,78	
Pomatomus saltatrix	15,73	84	0,50	
Myliobatis aquila	7,23	2	0,23	
Arius parkii	1,14	2	0,04	
Octopus vulgaris	0,94	2	0,03	
Total	3121,69		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 7  
 DATE :05.03.2012 GEAR TYPE: BT NO: 21 POSITION:Lat S 16°1,23  
 start stop duration Purpose : 1  
 LOG : 06:46:16 06:57:40 11,4 (min) Region : 4020  
 FDEPTH: 40 37 Gear cond.: 0  
 BDEPTH: 40 37 Validity : 0  
 Towing dir: 0° Wire out : 120 m Speed : 3,3 kn  
 Sorted : 0 Total catch: 780,35 Catch/hour: 4107,11

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
J E L L Y F I S H	1317,11	31653	32,07	
Trachurus trecae	1246,58	17995	30,35	15
Dentex macrocephalus	457,95	98195	11,15	16
Pagellus bellottii	265,84	2026	6,47	14
Boops boops	198,16	3442	4,82	
Lithognathus mormyrus	134,53	526	3,28	
Argyrosomus hololepidotus	108,21	284	2,63	
Loligo vulgaris	95,26	358	2,32	
Atractoscion aequidens	72,95	242	1,78	
Sepia orbignyana	54,32	116	1,32	
Dicologlossa cuneata	44,16	1379	1,08	
Dasyatis marmorata	25,16	16	0,61	
Sea urchin	24,74	974	0,60	
Myliobatis aquila	13,26	11	0,32	
Dentex barnardi	11,74	163	0,29	17
Raja miraletus	9,74	42	0,24	
Torpedo torpedo	7,68	42	0,19	
Spondyliosa cantharus	6,47	121	0,16	
Octopus vulgaris	6,00	5	0,15	
Maja squinado	3,26	363	0,08	
Umbrina canariensis	2,42	42	0,06	
Trachinus armatus	1,58	42	0,04	
Total	4107,11		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 8  
 DATE :05.03.2012 GEAR TYPE: BT NO: 21 POSITION:Lat S 16°1,14  
 start stop duration Purpose : 1  
 LOG : 08:53:42 09:01:25 7,7 (min) Region : 4020  
 FDEPTH: 134 132 Gear cond.: 0  
 BDEPTH: 134 132 Validity : 0  
 Towing dir: 0° Wire out : 400 m Speed : 2,7 kn  
 Sorted : 0 Total catch: 152,08 Catch/hour: 1181,97

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Umbrina canariensis	305,91	1251	25,88	21
Dentex macrocephalus	238,52	2751	20,18	18
Squalus megalops	224,46	505	18,99	
Trachurus trecae	91,40	1702	7,73	19
Coral	91,09	12746	7,71	
Trigla lyra	62,33	637	5,27	
Dentex angolensis	52,07	187	4,41	20
Raja alba	24,48	62	2,07	
Zenopsis conchifer	20,36	101	1,72	
Myliobatis aquila	15,78	8	1,33	
Pontinus accraensis	15,00	8	1,27	
Loligo vulgaris	8,32	62	0,70	
Raja miraletus	7,23	124	0,61	
Scorpaena stephanica	5,98	16	0,51	
Sea cucumber	4,51	16	0,38	
Synagrops microlepis	3,19	396	0,27	
Saurida brasiliensis	1,87	256	0,16	
Peristedion cataphractum	1,79	16	0,15	
Monolele microstoma	1,55	62	0,13	
Anthias anthias	1,17	16	0,10	
Pterothrissus belloci	0,85	8	0,07	
Dicologlossa cuneata	0,62	23	0,05	
Total	1181,97		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 9  
 DATE :05.03.2012 GEAR TYPE: PT NO: 4 POSITION:Lat S 15°36,11  
 start stop duration Purpose : 1  
 LOG : 16:36:14 16:48:50 12,6 (min) Region : 4020  
 FDEPTH: 10 24 Gear cond.: 0  
 BDEPTH: 110 109 Validity : 0  
 Towing dir: 0° Wire out : 100 m Speed : 3,1 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:2012402 STATION: 10  
 DATE :05.03.2012 GEAR TYPE: PT NO: 4 POSITION:Lat S 15°31,05  
 start stop duration duration Lon E 11°52,50  
 TIME :20:05:41 20:18:30 12,8 (min) Purpose : 1  
 LOG : 4967,45 4968,16 0,7 Region : 4020  
 FDEPTH: 5 5 Gear cond.: 0  
 BDEPTH: 379 669 Validity : 0  
 Towing dir: 0° Wire out : 100 m Speed : 3,3 kn  
 Sorted : 0 Total catch: 4388,05 Catch/hour: 20536,90

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella aurita	19019,30	242874	92,61	
Trachurus trecae	1517,60	9866	7,39	22
Total	20536,90		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 11  
 DATE :06.03.2012 GEAR TYPE: PT NO: 1 POSITION:Lat S 15°10,41  
 start stop duration duration Lon E 11°43,48  
 TIME :04:24:05 04:37:58 13,9 (min) Purpose : 1  
 LOG : 5035,33 5036,14 0,8 Region : 4020  
 FDEPTH: 25 18 Gear cond.: 0  
 BDEPTH: 1621 1518 Validity : 0  
 Towing dir: 0° Wire out : 80 m Speed : 3,5 kn  
 Sorted : 0 Total catch: 30,25 Catch/hour: 130,77

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
SALPS	101,15	6860	77,35	
MYCTOPHIDAE	22,39	28548	17,12	
Gempylus serpens	3,76	13	2,88	
Trachipterus jacksonensis	3,24	4	2,48	
Trichurus lepturus	0,17	13	0,13	
Trachurus trecae	0,04	4	0,03	
Total	130,76		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 12  
 DATE :06.03.2012 GEAR TYPE: PT NO: 4 POSITION:Lat S 14°42,00  
 start stop duration duration Lon E 12°14,81  
 TIME :19:29:56 19:39:37 9,7 (min) Purpose : 1  
 LOG : 5126,72 5127,23 0,5 Region : 4020  
 FDEPTH: 5 5 Gear cond.: 0  
 BDEPTH: 265 114 Validity : 0  
 Towing dir: 0° Wire out : 80 m Speed : 3,2 kn  
 Sorted : 0 Total catch: 5978,64 Catch/hour: 37057,69

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella aurita	37057,69	396353	100,00	
Total	37057,69		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 13  
 DATE :07.03.2012 GEAR TYPE: PT NO: 1 POSITION:Lat S 14°21,21  
 start stop duration duration Lon E 12°20,02  
 TIME :01:56:55 02:11:51 14,9 (min) Purpose : 1  
 LOG : 5171,03 5172,01 1,0 Region : 4020  
 FDEPTH: 20 20 Gear cond.: 0  
 BDEPTH: 55 68 Validity : 0  
 Towing dir: 0° Wire out : 80 m Speed : 3,9 kn  
 Sorted : 0 Total catch: 21,10 Catch/hour: 84,80

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella maderensis	55,22	201	65,12	25
Trachurus trecae	22,06	92	26,02	26
Sardinella aurita	3,09	28	3,65	27
Pomatomus saltatrix	2,61	4	3,08	
Trichurus lepturus	1,09	8	1,28	
Alloteuthis africana	0,72	543	0,85	
Total	84,80		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 14  
 DATE :07.03.2012 GEAR TYPE: PT NO: 21 POSITION:Lat S 13°56,66  
 start stop duration duration Lon E 12°24,13  
 TIME :11:16:49 12:09:48 53,0 (min) Purpose : 1  
 LOG : 5239,16 5240,79 1,6 Region : 4020  
 FDEPTH: 23 27 Gear cond.: 0  
 BDEPTH: 23 27 Validity : 0  
 Towing dir: 0° Wire out : 130 m Speed : 1,9 kn  
 Sorted : 0 Total catch: 54,69 Catch/hour: 61,94

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
SALPS	50,46	6208	81,48	
Sardinella aurita	5,10	661	8,23	28
Stromateus fiatola	1,77	2	2,85	
Diplodus cervinus cervinus	1,59	2	2,56	
Galeoides decadactylus	0,86	3	1,39	
Selene dorsalis	0,77	5	1,24	
Citharichthys stampflii	0,63	6	1,02	
Chelidonichthys gabonensis	0,29	2	0,48	
Coral	0,20	2	0,33	
Pagellus bellottii	0,11	3	0,18	
Trichurus lepturus	0,08	6	0,13	
Trachurus trecae	0,06	54	0,09	29
Spherooides marmoratus	0,01	1	0,02	
Total	61,94		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 15  
 DATE :08.03.2012 GEAR TYPE: PT NO: 4 POSITION:Lat S 12°46,32  
 start stop duration duration Lon E 12°57,76  
 TIME :19:47:36 19:54:28 6,9 (min) Purpose : 1  
 LOG : 5410,25 5410,60 0,4 Region : 4020  
 FDEPTH: 5 5 Gear cond.: 0  
 BDEPTH: 288 244 Validity : 0  
 Towing dir: 0° Wire out : 100 m Speed : 3,1 kn  
 Sorted : 0 Total catch: 9,10 Catch/hour: 79,48

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
MYCTOPHIDAE	42,53	91144	53,52	
Auxis thazard	16,86	26	21,21	30
Trachinotus ovatus	16,33	61	20,55	
Scomber japonicus	2,97	44	3,74	31
SALPS	0,52	52	0,66	
Trichurus lepturus	0,26	26	0,33	
Total	79,48		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 16  
 DATE :09.03.2012 GEAR TYPE: PT NO: 21 POSITION:Lat S 12°23,65  
 start stop duration duration Lon E 13°23,94  
 TIME :06:30:44 06:37:50 7,1 (min) Purpose : 1  
 LOG : 5485,18 5485,56 0,4 Region : 4020  
 FDEPTH: 101 101 Gear cond.: 0  
 BDEPTH: 101 101 Validity : 0  
 Towing dir: 0° Wire out : 250 m Speed : 3,3 kn  
 Sorted : 2 Total catch: 108,59 Catch/hour: 917,66

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trachurus trecae	381,97	1656	41,62	32
SALPS	246,08	36313	26,82	
Trichurus lepturus	92,96	346	10,13	
Umbrina canariensis	75,21	186	8,20	34
Dentex macrophthalmus	27,55	169	3,00	33
Dentex barnardi	19,61	51	2,14	35
Sardinella aurita	19,35	237	2,11	36
Lepidotrigla cadmani	14,54	110	1,58	
Spherooides pachyaster	14,20	51	1,55	
Boops boops	6,08	101	0,66	
Citharus linguatula	5,32	118	0,58	
Zeus faber	4,48	8	0,49	
Uranoscopus polli	3,38	8	0,37	
Scorpaena normani	1,86	17	0,20	
Dentex angolensis	1,86	8	0,20	
Brotula barbata	1,77	8	0,19	
Illex coindetii	1,01	51	0,11	
Saurida brasiliensis	0,42	59	0,05	
Total	917,66		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 17  
 DATE :09.03.2012 GEAR TYPE: PT NO: 4 POSITION:Lat S 12°20,51  
 start stop duration duration Lon E 13°27,75  
 TIME :19:58:34 20:07:58 9,4 (min) Purpose : 1  
 LOG : 5580,70 5581,20 0,5 Region : 4020  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 87 90 Validity : 0  
 Towing dir: 0° Wire out : 100 m Speed : 3,2 kn  
 Sorted : 0 Total catch: 413,99 Catch/hour: 2642,49

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella maderensis	1011,64	5260	38,28	37
Sardinella aurita	651,45	6319	24,65	38
Trachurus trecae	580,79	6721	21,98	39
Scomber japonicus	358,47	1864	13,57	40
SALPS	16,09	1609	0,61	
Auxis thazard	13,98	57	0,53	41
Katsuwonus pelamis	10,09	6	0,38	
Total	2642,49		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 18  
 DATE :10.03.2012 GEAR TYPE: PT NO: 21 POSITION:Lat S 11°58,17  
 start stop duration duration Lon E 13°39,59  
 TIME :08:32:53 08:41:09 8,3 (min) Purpose : 1  
 LOG : 5678,25 5678,71 0,5 Region : 4020  
 FDEPTH: 60 62 Gear cond.: 0  
 BDEPTH: 60 62 Validity : 0  
 Towing dir: 0° Wire out : 160 m Speed : 3,3 kn  
 Sorted : 0 Total catch: 295,51 Catch/hour: 2143,97

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trichurus lepturus	507,13	1836	23,65	
Brachydeuterus auritus	497,99	6842	23,23	44
Pagellus bellottii	360,29	2409	16,80	45
Pomadasy incisus	270,76	2532	12,63	
Sardinella aurita	239,71	2155	11,18	43
Trachurus trecae	47,59	1386	2,22	42
Dasyatis marmorata	37,15	15	1,73	
Pseudupeneus prayensis	36,42	138	1,70	
Raja miraletus	26,63	65	1,24	
Chloroscombrus chrysurus	17,85	131	0,83	
Pomadasy rogeri	14,29	29	0,67	
Umbrina canariensis	14,07	58	0,66	46
Pomadasy jubelini	10,01	22	0,47	
Pseudolithus senegalensis	10,01	22	0,47	
Atractoscion aequidens	8,56	15	0,40	
Pseudolithus typus	7,04	22	0,33	
Citharus linguatula	6,09	385	0,28	
Selene dorsalis	5,59	36	0,26	
Scopelogadus maderensis	5,59	51	0,26	
Trachinotus ovatus	4,72	15	0,22	
Sardinella maderensis	3,85	22	0,18	
Chelidonichthys capensis	3,63	36	0,17	
Lithognathus mormyrus	3,48	7	0,16	
Lagocephalus laevis	1,67	7	0,08	
Octopus vulgaris	1,09	7	0,05	
Grammolites gruvelli	1,09	22	0,05	
Cynopictus ferox	0,87	7	0,04	
Serranus accraensis	0,80	15	0,04	
Pomadasy multimaclatum	0,00	0	0,00	
Total	2143,97		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 19  
 DATE :10.03.2012 GEAR TYPE: PT NO: 2 POSITION:Lat S 11°39,68  
 start stop duration duration Lon E 13°20,22  
 TIME :15:32:07 15:40:10 8,1 (min) Purpose : 1  
 LOG : 5726,17 5726,52 0,4 Region : 4020  
 FDEPTH: 300 270 Gear cond.: 0  
 BDEPTH: 460 483 Validity : 0  
 Towing dir: 0° Wire out : 560 m Speed : 2,6 kn  
 Sorted : 0 Total catch: 14,68 Catch/hour: 109,42

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
MYCTOPHIDAE	54,78	56243	50,07	
SALPS	32,42	2981	29,63	
Aristaeomorpha sp.	12,82	11866	11,72	
Euphausiacea	3,65	6209	3,34	
Trichurus lepturus	3,65	231	3,34	
JELLYFISH	0,75	30	0,68	
STOMILDE	0,75	15	0,68	
Todaropsis eblanae	0,30	7	0,27	
Nemichthys curvirostris	0,22	7	0,20	
GONOSTOMATIDAE	0,07	37	0,07	
Total	109,42		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 20  
 DATE :10.03.2012 GEAR TYPE: PT NO: 4 POSITION:Lat S 11°45,09  
 start stop duration start stop duration  
 TIME :19:41:14 19:50:56 9,7 (min) Purpose : 1  
 LOG : 5749,88 5750,43 0,6 Region : 4020  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 60 54 Validity : 0  
 Towing dir: 0° Wire out : 100 m Speed : 3,4 km  
 Sorted : 0 Total catch: 64,62 Catch/hour: 399,71

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Trachurus trecae	110,60	1163	27,67
Trichurus lepturus	91,92	278	23,00
Selene dorsalis	79,42	551	19,87
Sardinella aurita	37,61	3489	9,41
Auxis thazard	12,87	37	3,22
Caranx crysos	12,00	12	3,00
Sardinella maderensis	10,82	155	2,71
Chloroscombrus chrysurus	10,39	87	2,60
Sphyræna guachancho	9,15	25	2,29
Lagocephalus laevigatus	6,80	6	1,70
Selar crumenophthalmus	6,06	31	1,52
Sepia orbignyana	4,21	87	1,05
Brachydeuterus auritus	3,77	37	0,94
Trachinotus ovatus	1,92	6	0,48
Illex coindetii	1,48	309	0,37
Ilisha africana	0,68	6	0,17
Total	399,71		100,00

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 21  
 DATE :11.03.2012 GEAR TYPE: BT NO: 21 POSITION:Lat S 11°19,05  
 start stop duration start stop duration  
 TIME :09:11:37 09:36:34 25,0 (min) Purpose : 1  
 LOG : 5856,65 5857,94 1,3 Region : 4020  
 FDEPTH: 52 54 Gear cond.: 0  
 BDEPTH: 52 54 Validity : 0  
 Towing dir: 0° Wire out : 150 m Speed : 3,1 km  
 Sorted : 0 Total catch: 141,08 Catch/hour: 339,27

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Lagocephalus laevigatus	135,54	99	39,95
Sepia orbignyana	74,04	60	21,82
Pseudopenaeus prayensis	55,17	48	16,26
Raja miraletus	30,49	58	8,99
Rhinobatos albomaculatus	7,31	5	2,15
Caranx crysos	6,73	10	1,98
Chelidonichthys capensis	5,48	46	1,62
Pagellus bellottii	5,29	41	1,56
Syacium micrurum	3,58	24	1,06
Chilomycterus spinosus mauret.	3,41	14	1,01
Decapterus rhonchus	2,50	7	0,74
Scorpaena stephanica	1,85	12	0,55
Trachinotus ovatus	1,76	5	0,52
Trachinocephalus myops	1,73	14	0,51
Citharus linguatula	1,25	125	0,37
Arnoglossus imperialis	0,87	60	0,26
Dentex barnardi	0,79	7	0,23
Trachurus trecae	0,53	2	0,16
Grammolites gruvelli	0,53	12	0,16
Fistularia petimba	0,12	5	0,04
Bothus podas africanus	0,12	2	0,04
Alloteuthis africana	0,12	53	0,04
Spherooides marmoratus	0,02	2	0,01
Thorogobius angolensis	0,02	2	0,01
Total	339,27		100,00

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 22  
 DATE :11.03.2012 GEAR TYPE: PT NO: 1 POSITION:Lat S 11°08,29  
 start stop duration start stop duration  
 TIME :16:24:41 16:29:00 4,3 (min) Purpose : 1  
 LOG : 5912,15 5912,38 0,2 Region : 4020  
 FDEPTH: 0 47 Gear cond.: 0  
 BDEPTH: 78 80 Validity : 0  
 Towing dir: 0° Wire out : 140 m Speed : 3,1 km  
 Sorted : 0 Total catch: 16,62 Catch/hour: 230,83

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Trachinotus ovatus	107,64	292	46,63
Sardinella aurita	61,94	194	26,84
Sardinella maderensis	46,11	250	19,98
Trachurus trecae	9,17	28	3,97
Trichurus lepturus	5,97	28	2,59
Total	230,83		100,00

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 23  
 DATE :11.03.2012 GEAR TYPE: PT NO: 4 POSITION:Lat S 11°1,82  
 start stop duration start stop duration  
 TIME :19:19:42 19:37:50 18,1 (min) Purpose : 1  
 LOG : 5934,25 5935,23 1,0 Region : 4020  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 90 98 Validity : 0  
 Towing dir: 0° Wire out : 100 m Speed : 3,3 km  
 Sorted : 0 Total catch: 436,80 Catch/hour: 1445,56

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Brachydeuterus auritus	808,96	6533	55,96
Sardinella maderensis	289,81	1436	20,05
Trachurus trecae	246,95	1338	17,08
Sardinella aurita	53,51	278	3,70
Lagocephalus laevigatus	22,24	23	1,54
Sepia orbignyana	10,06	13	0,70
Trichurus lepturus	8,57	23	0,59
Trachinotus ovatus	3,01	13	0,21
Scomber japonicus	2,45	13	0,17
Total	1445,56		100,00

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 24  
 DATE :12.03.2012 GEAR TYPE: BT NO: 21 POSITION:Lat S 10°46,16  
 start stop duration start stop duration  
 TIME :09:03:19 09:12:05 8,8 (min) Purpose : 1  
 LOG : 6037,38 6037,89 0,5 Region : 4020  
 FDEPTH: 76 79 Gear cond.: 0  
 BDEPTH: 76 79 Validity : 0  
 Towing dir: 0° Wire out : 250 m Speed : 3,5 km  
 Sorted : 0 Total catch: 88,09 Catch/hour: 602,67

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Stromateus fiatola	164,61	239	27,31
Dentex angolensis	136,56	992	22,66
Trichurus lepturus	104,40	992	17,32
Brachydeuterus auritus	53,77	431	8,92
Dentex barnardi	34,41	157	5,71
Trachurus trecae	23,06	274	3,83
Illex coindetii	21,48	16495	3,56
Citharus linguatula	15,39	294	2,55
Pagellus bellottii	14,71	109	2,44
Raja miraletus	8,28	21	1,37
Octopus vulgaris	6,70	7	1,11
Sardinella maderensis	4,45	21	0,74
Brotula barbata	3,69	14	0,61
Fistularia petimba	3,42	14	0,57
Pegusa lascaris	1,78	14	0,30
GOBIIDAE	1,37	534	0,23
Maja squinado	1,37	534	0,23
Sepia orbignyana	1,16	75	0,19
ANTENNARIIDAE	0,89	48	0,15
Sardinella aurita	0,55	7	0,09
Boops boops	0,34	34	0,06
Spherooides marmoratus	0,21	7	0,03
Saurida brasiliensis	0,07	14	0,01
Total	602,67		100,00

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 25  
 DATE :18.03.2012 GEAR TYPE: PT NO: 1 POSITION:Lat S 6°31,09  
 start stop duration start stop duration  
 TIME :04:44:38 04:49:16 4,6 (min) Purpose : 1  
 LOG : 6850,38 6850,63 0,3 Region : 4020  
 FDEPTH: 30 21 Gear cond.: 0  
 BDEPTH: 48 48 Validity : 0  
 Towing dir: 0° Wire out : 110 m Speed : 3,3 km  
 Sorted : 0 Total catch: 133,20 Catch/hour: 1722,41

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Sardinella maderensis	1586,38	13888	92,10
Chloroscombrus chrysurus	86,64	802	5,03
Selene dorsalis	18,36	349	1,07
Caranx crysos	14,61	13	0,85
Trichurus lepturus	7,76	13	0,45
Decapterus rhonchus	4,27	168	0,25
Trachurus trecae	2,33	142	0,14
Sardinella aurita	1,29	13	0,08
Sphyræna sphyraena	0,78	13	0,05
Total	1722,41		100,00

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 26  
 DATE :18.03.2012 GEAR TYPE: PT NO: 1 POSITION:Lat S 6°39,48  
 start stop duration start stop duration  
 TIME :14:13:31 14:43:26 29,9 (min) Purpose : 1  
 LOG : 6934,71 6936,61 1,9 Region : 4020  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 34 40 Validity : 0  
 Towing dir: 0° Wire out : 110 m Speed : 3,8 km  
 Sorted : 0 Total catch: 25,60 Catch/hour: 51,34

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Alectis alexandrinus	25,07	38	48,83
Caranx senegalensis	14,84	20	28,91
Trachinotus ovatus	11,43	34	22,27
Total	51,34		100,00

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 27  
 DATE :19.03.2012 GEAR TYPE: PT NO: 4 POSITION:Lat S 7°09,52  
 start stop duration start stop duration  
 TIME :19:46:01 19:56:15 10,2 (min) Purpose : 1  
 LOG : 7204,88 7205,47 0,6 Region : 4020  
 FDEPTH: 0 0 Gear cond.: 0  
 BDEPTH: 37 39 Validity : 0  
 Towing dir: 0° Wire out : 110 m Speed : 3,5 km  
 Sorted : 0 Total catch: 453,31 Catch/hour: 2658,71

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Brachydeuterus auritus	2101,35	35613	79,04
Sardinella aurita	334,84	8710	12,59
Sphyræna guachancho	82,64	311	3,11
Sardinella maderensis	81,11	2170	3,05
Chloroscombrus chrysurus	25,92	927	0,98
Decapterus rhonchus	13,72	428	0,52
Ilisha africana	11,38	211	0,43
Sphyræna sphyraena	6,22	18	0,23
Selene dorsalis	1,35	41	0,05
Decapterus punctatus	0,18	18	0,01
Total	2658,71		100,00

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 28  
 DATE :20.03.2012 GEAR TYPE: PT NO: 1 POSITION:Lat S 7°18,84  
 start stop duration start stop duration  
 TIME :03:21:20 03:32:18 11,0 (min) Purpose : 1  
 LOG : 7263,33 7263,99 0,7 Region : 4020  
 FDEPTH: 24 29 Gear cond.: 0  
 BDEPTH: 63 67 Validity : 0  
 Towing dir: 0° Wire out : 112 m Speed : 3,6 km  
 Sorted : 0 Total catch: 21,65 Catch/hour: 118,41

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Sardinella aurita	81,06	1526	68,45
Sardinella maderensis	29,86	126	25,22
Saurida brasiliensis	2,13	716	1,80
Scomber japonicus	1,86	11	1,57
Brachydeuterus auritus	1,37	16	1,15
Sepia orbignyana	0,88	5	0,74
Alloteuthis africana	0,38	98	0,32
Boops boops	0,33	16	0,28
Trachurus trecae	0,27	5	0,23
Parexocoetus brachypterus	0,27	5	0,23
Total	118,41		100,00

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 29  
 DATE :20.03.2012 GEAR TYPE: PT NO: 1 POSITION:Lat S 7°33,58  
 start stop duration Region : 4020  
 TIME :13:39:42 14:06:59 27,3 (min) Purpose : 1  
 LOG : 7352,04 7353,52 1,5 Gear cond.: 0  
 FDEPTH: 20 50 Validity : 0  
 BDEPTH: 52 60 Speed : 3,3 kn  
 Towing dir: 0° Wire out : 110 m Catch/hour: 7,57  
 Sorted : 0 Total catch: 3,44

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
Alectis alexandrinus	7,57	9	100,00
Total	7,57		100,00

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 30  
 DATE :20.03.2012 GEAR TYPE: PT NO: 1 POSITION:Lat S 7°34,99  
 start stop duration Region : 4020  
 TIME :14:48:43 15:17:44 29,0 (min) Purpose : 1  
 LOG : 7356,43 7358,35 1,9 Gear cond.: 0  
 FDEPTH: 20 30 Validity : 0  
 BDEPTH: 72 65 Speed : 4,0 kn  
 Towing dir: 0° Wire out : 120 m Catch/hour: 0,58  
 Sorted : 0 Total catch: 0,28

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
Brachydeuterus auritus	0,27	2	0,00
Sardinella maderensis	0,31	2	0,00

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 31  
 DATE :20.03.2012 GEAR TYPE: PT NO: 4 POSITION:Lat S 7°39,72  
 start stop duration Region : 4020  
 TIME :20:21:04 20:31:37 10,6 (min) Purpose : 1  
 LOG : 7401,81 7402,42 0,6 Gear cond.: 0  
 FDEPTH: 10 10 Validity : 0  
 BDEPTH: 53 50 Speed : 3,4 kn  
 Towing dir: 0° Wire out : 110 m Catch/hour: 936,45  
 Sorted : 0 Total catch: 164,66

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
Sardinella maderensis	459,64	10328	49,08
Sardinella aurita	226,41	6654	24,18
Sphyræna sphyræna	97,82	267	10,45
Brachydeuterus auritus	63,64	728	6,80
Ilisha africana	40,49	717	4,32
Decapterus punctatus	15,01	540	1,60
Trichiurus lepturus	14,62	57	1,56
Chloroscombrus chrysurus	7,34	57	0,78
Decapterus rhonchus	3,75	114	0,40
Apogon apogonides	2,50	1075	0,27
Engraulis encrasicolus	1,82	330	0,19
Selene dorsalis	1,48	28	0,16
Saurida brasiliensis	1,14	222	0,12
Boops boops	0,51	114	0,05
Alloteuthis africana	0,17	80	0,02
Bregmaceros sp.	0,11	57	0,01
Total	936,45		100,00

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 32  
 DATE :20.03.2012 GEAR TYPE: PT NO: 4 POSITION:Lat S 7°44,17  
 start stop duration Region : 4020  
 TIME :22:42:57 22:55:02 12,1 (min) Purpose : 1  
 LOG : 7419,42 7420,13 0,7 Gear cond.: 0  
 FDEPTH: 10 10 Validity : 0  
 BDEPTH: 45 47 Speed : 3,5 kn  
 Towing dir: 0° Wire out : 110 m Catch/hour: 1700,02  
 Sorted : 0 Total catch: 342,27

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
Brachydeuterus auritus	1114,37	44861	65,55
Chloroscombrus chrysurus	326,18	3591	19,19
Ilisha africana	149,16	2851	8,77
Sphyræna sphyræna	69,34	224	4,08
Trichiurus lepturus	17,38	84	1,02
Trachurus trecae	12,12	854	0,71
Selene dorsalis	8,69	363	0,51
Lagocephalus laevigatus	1,49	5	0,09
Sepia orbignyana	1,14	5	0,07
Boops boops	0,15	15	0,01
Total	1700,02		100,00

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 33  
 DATE :23.03.2012 GEAR TYPE: PT NO: 21 POSITION:Lat S 10°20,99  
 start stop duration Region : 4020  
 TIME :07:57:16 08:07:51 10,6 (min) Purpose : 1  
 LOG : 7663,55 7664,12 0,6 Gear cond.: 0  
 FDEPTH: 22 23 Validity : 0  
 BDEPTH: 22 23 Speed : 3,3 kn  
 Towing dir: 0° Wire out : 120 m Catch/hour: 2353,38  
 Sorted : 0 Total catch: 414,98

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
Sardinella aurita	1290,57	120981	54,84
Brachydeuterus auritus	546,41	50989	23,22
Sardinella maderensis	284,12	31265	12,07
Sphyræna guanchancho	91,08	306	3,87
Chloroscombrus chrysurus	29,85	216	1,27
Arius laticutatus	22,46	6	0,95
Selene dorsalis	20,26	1809	0,86
Rhinobatos albomaculatus	17,69	11	0,75
Gymnura micrura	15,03	6	0,64
Sphyræna sphyræna	8,90	28	0,38
Galeoides decadactylus	7,88	85	0,33
Pseudotolithus senegalensis	7,66	11	0,33
Pteroscion pelli	3,06	216	0,13
Epinephelus aeneus	2,67	6	0,11
Trichiurus lepturus	2,50	85	0,11
Trachinotus goreensis	2,38	6	0,10
Peneus notialis	0,51	11	0,02
Ilisha africana	0,28	6	0,01
Trachurus trecae	0,06	6	0,00
Total	2353,36		100,00

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 34  
 DATE :23.03.2012 GEAR TYPE: PT NO: 21 POSITION:Lat S 10°22,08  
 start stop duration Region : 4020  
 TIME :09:51:47 10:22:07 30,3 (min) Purpose : 1  
 LOG : 7677,70 7679,37 1,7 Gear cond.: 0  
 FDEPTH: 74 78 Validity : 0  
 BDEPTH: 74 78 Speed : 3,3 kn  
 Towing dir: 0° Wire out : 200 m Catch/hour: 127,93  
 Sorted : 0 Total catch: 64,67

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
Raja miraletus	41,94	73	32,78
Lepidotrigla cadmani	31,63	249	24,73
Pagellus bellottii	11,28	295	8,81
Alloteuthis africana	9,91	1416	7,75
Fistularia petimba	4,23	8	3,31
Trachurus trecae	4,21	582	3,29
Rhinobatos albomaculatus	3,52	4	2,75
Citharus linguatula	3,17	127	2,47
Cynoponticus ferox	2,93	2	2,29
Pseudupeneus prayensis	2,08	45	1,62
Sepia officinalis	1,90	47	1,48
Saurida brasiliensis	1,36	283	1,07
Brachydeuterus auritus	1,36	20	1,07
Trichiurus lepturus	1,36	2	1,07
Serranus accraensis	1,33	20	1,04
Grammolites gruvelli	1,03	24	0,80
Dentex barnardii	0,81	20	0,63
Lagocephalus laevigatus	0,71	6	0,56
Dentex angolensis	0,55	34	0,43
Torpedo torpedo	0,44	2	0,34
Microchirus frechkopi	0,42	8	0,32
Chelidonichthys capensis	0,38	2	0,29
Chilomycterus spinosus mauret.	0,34	2	0,26
Todaropsis eblanæ	0,28	2	0,22
Zeus faber	0,24	2	0,19
Lepidotrigla carolæ	0,14	16	0,11
Arnoglossus imperialis	0,14	14	0,11
Brotula barbata	0,12	2	0,09
Gobiidae sp. 'bars'	0,06	4	0,05
Pteroscion pelli	0,04	2	0,03
Sphoeroides marmoratus	0,04	6	0,03
Total	127,93		100,00

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 35  
 DATE :23.03.2012 GEAR TYPE: PT NO: 4 POSITION:Lat S 10°11,11  
 start stop duration Region : 4020  
 TIME :19:22:35 19:33:30 10,9 (min) Purpose : 1  
 LOG : 7749,42 7750,01 0,6 Gear cond.: 0  
 FDEPTH: 5 5 Validity : 0  
 BDEPTH: 38 40 Speed : 3,2 kn  
 Towing dir: 0° Wire out : 110 m Catch/hour: 290,37  
 Sorted : 0 Total catch: 52,75

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
Sardinella aurita	100,73	8659	34,69
Sphyræna guanchancho	56,59	94	19,49
Brachydeuterus auritus	48,44	611	16,68
Sardinella maderensis	31,38	606	10,81
Pomadourys commersonni	11,01	17	3,79
Lagocephalus laevigatus	10,29	28	3,55
Selene dorsalis	8,09	94	2,79
Alectis alexandrinus	7,65	11	2,64
Sphyræna sphyræna	6,83	28	2,35
Saurida brasiliensis	3,30	3435	1,14
Alloteuthis africana	3,19	765	1,10
Decapterus rhonchus	1,76	11	0,61
Pseudupeneus prayensis	1,10	66	0,38
Total	290,37		100,00

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 36  
 DATE :24.03.2012 GEAR TYPE: PT NO: 1 POSITION:Lat S 10°7,13  
 start stop duration Region : 4020  
 TIME :01:30:11 01:42:14 12,1 (min) Purpose : 1  
 LOG : 7797,55 7798,27 0,7 Gear cond.: 0  
 FDEPTH: 22 20 Validity : 0  
 BDEPTH: 64 70 Speed : 3,6 kn  
 Towing dir: 0° Wire out : 110 m Catch/hour: 516,60  
 Sorted : 0 Total catch: 103,75

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
Sardinella maderensis	289,49	2076	56,04
Selene dorsalis	96,40	264	18,66
Sardinella aurita	51,09	607	9,89
Brachydeuterus auritus	47,30	403	9,16
Sphyræna guanchancho	12,25	20	2,37
Trachurus trecae	8,96	329	1,73
Saurida brasiliensis	4,98	1549	0,96
Alectis alexandrinus	3,78	5	0,73
Alloteuthis africana	1,99	528	0,39
Sepia officinalis	0,35	5	0,07
Total	516,60		100,00

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 37  
 DATE :24.03.2012 GEAR TYPE: PT NO: 7 POSITION:Lat S 10°4,73  
 start stop duration Region : 4020  
 TIME :03:03:50 03:23:11 19,4 (min) Purpose : 1  
 LOG : 7806,74 7807,85 1,1 Gear cond.: 0  
 FDEPTH: 23 22 Validity : 0  
 BDEPTH: 23 22 Speed : 3,5 kn  
 Towing dir: 0° Wire out : 120 m Catch/hour: 158,70  
 Sorted : 0 Total catch: 51,18

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
Sardinella aurita	62,45	7665	39,35
Ilisha africana	55,01	679	34,66
Sardinella maderensis	16,37	462	10,32
Brachydeuterus auritus	7,13	115	4,49
Sphyræna guanchancho	5,71	16	3,60
Selene dorsalis	3,38	34	2,13
Sphyræna sphyræna	3,07	19	1,93
Lagocephalus laevigatus	2,02	12	1,27
Trachurus trecae	1,02	34	0,64
Chloroscombrus chrysurus	0,87	6	0,55
Galeoides decadactylus	0,71	3	0,45
Pareucocetus brachypterus	0,71	3	0,45
Scomber japonicus	0,16	6	0,10
Engraulis encrasicolus	0,06	16	0,04
Sepia officinalis	0,03	9	0,02
Total	158,70		100,00

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 38  
 DATE :24.03.2012 GEAR TYPE: PT NO: 1 POSITION:Lat S 10°2,00  
 start stop duration Lon E 13°11,97  
 TIME :04:41:45 04:50:43 9,0 (min) Purpose : 1  
 LOG : 7816,61 7817,07 0,5 Region : 4020  
 FDEPTH: 34 32 Gear cond.: 0  
 BDEPTH: 48 49 Validity : 0  
 Towing dir: 0° Wire out : 120 m Speed : 3,1 km  
 Sorted : 0 Total catch: 93,97 Catch/hour: 627,86

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Decapterus rhonchus	492,03	688	78,37	107
Sardinella maderensis	34,21	247	5,45	104
Sphyraena guachancho	28,20	47	4,49	
Brachydeuterus auritus	27,86	254	4,44	106
Selene dorsalis	24,52	180	3,91	105
Sardinella aurita	8,89	100	1,42	103
Caranx crysos	6,61	7	1,05	
Trichiurus lepturus	1,80	7	0,29	
Ruthynnus alletteratus	1,80	7	0,29	
Alloteuthis africana	1,47	381	0,23	
Saurida brasiliensis	0,47	214	0,07	
Total	627,86		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 39  
 DATE :24.03.2012 GEAR TYPE: PT NO: 21 POSITION:Lat S 9°54,56  
 start stop duration Lon E 13°14,56  
 TIME :10:56:15 11:17:28 21,2 (min) Purpose : 1  
 LOG : 7868,49 7869,75 1,3 Region : 4020  
 FDEPTH: 22 23 Gear cond.: 0  
 BDEPTH: 22 23 Validity : 0  
 Towing dir: 0° Wire out : 120 m Speed : 3,5 km  
 Sorted : 0 Total catch: 80,27 Catch/hour: 226,97

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Rhinobatos albomaculatus	69,56	51	30,65	
Sardinella maderensis	45,13	362	19,88	108
Sardinella aurita	33,59	1798	14,80	112
Chloroscombrus chrysurus	24,49	206	10,79	109
Eucinostomus melanopterus	19,91	303	8,77	
Cynoglossus browni	6,05	8	2,67	
Decapterus rhonchus	5,88	102	2,59	110
Lagocephalus laevigatus	5,37	28	2,37	
Pseudupeneus prayensis	5,26	34	2,32	
Raja miraletus	2,12	3	0,93	
Drepane africana	1,98	3	0,87	
Pagellus bellottii	1,95	6	0,86	
Sphyraena guachancho	1,67	3	0,74	
Trichiurus lepturus	1,58	6	0,70	
Dicologlossa cuneata	0,79	6	0,35	
Sepia officinalis	0,34	3	0,15	
Penaeus notialis	0,34	11	0,15	
Pythonichthys microphthalmus	0,34	3	0,15	
Caranx crysos	0,25	3	0,11	
Trachurus trecae	0,23	79	0,10	111
Selene dorsalis	0,14	3	0,06	
Total	226,97		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 40  
 DATE :24.03.2012 GEAR TYPE: PT NO: 4 POSITION:Lat S 9°37,25  
 start stop duration Lon E 13°6,52  
 TIME :22:03:17 22:18:08 14,9 (min) Purpose : 1  
 LOG : 7945,36 7946,19 0,8 Region : 4020  
 FDEPTH: 5 5 Gear cond.: 0  
 BDEPTH: 37 41 Validity : 0  
 Towing dir: 0° Wire out : 110 m Speed : 3,3 km  
 Sorted : 0 Total catch: 219,66 Catch/hour: 887,52

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella aurita	592,48	84477	66,76	114
Decapterus rhonchus	117,58	1152	13,25	115
Sphyraena guachancho	46,79	291	5,27	
Chloroscombrus chrysurus	42,67	206	4,81	117
Sardinella maderensis	27,27	885	3,07	116
Pomadasy peroteti	21,58	24	2,43	
Ilisha africana	19,27	315	2,17	113
Brachydeuterus auritus	10,67	73	1,20	119
Boops boops	3,15	703	0,36	
Engraulis encrasicolus	1,70	436	0,19	
Pagellus bellottii	1,09	400	0,12	
Alloteuthis africana	0,97	315	0,11	
Selene dorsalis	0,85	12	0,10	
Trachurus trecae	0,85	267	0,10	118
Saurida brasiliensis	0,48	339	0,05	
Pseudupeneus prayensis	0,12	24	0,01	
Total	887,52		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 41  
 DATE :24.03.2012 GEAR TYPE: PT NO: 1 POSITION:Lat S 9°38,82  
 start stop duration Lon E 13°0,54  
 TIME :23:28:49 23:51:04 22,3 (min) Purpose : 1  
 LOG : 7953,35 7954,76 1,4 Region : 4020  
 FDEPTH: 28 26 Gear cond.: 0  
 BDEPTH: 83 74 Validity : 0  
 Towing dir: 0° Wire out : 110 m Speed : 3,8 km  
 Sorted : 0 Total catch: 71,59 Catch/hour: 193,05

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella maderensis	110,99	453	57,49	122
Brachydeuterus auritus	36,13	318	18,72	120
Trachurus trecae	17,58	785	9,11	121
Saurida brasiliensis	14,75	1408	7,64	
Alectis alexandrinus	6,12	5	3,17	
Lagocephalus laevigatus	3,18	3	1,65	
Trichiurus lepturus	2,62	3	1,35	
Alloteuthis africana	1,21	421	0,63	
Decapterus rhonchus	0,32	3	0,17	
Plesionika martia	0,13	235	0,07	
Total	193,05		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 42  
 DATE :26.03.2012 GEAR TYPE: PT NO: 21 POSITION:Lat S 8°47,60  
 start stop duration Lon E 13°12,54  
 TIME :13:37:50 13:47:53 10,1 (min) Purpose : 1  
 LOG : 8255,92 8256,45 0,5 Region : 4020  
 FDEPTH: 56 52 Gear cond.: 0  
 BDEPTH: 56 52 Validity : 0  
 Towing dir: 0° Wire out : 140 m Speed : 3,2 km  
 Sorted : 0 Total catch: 210,57 Catch/hour: 1257,13

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Brachydeuterus auritus	270,45	6860	21,51	124
Trachurus trecae	253,61	13839	20,17	123
Galeoides decadactylus	242,63	1224	19,30	
Chloroscombrus chrysurus	185,07	1749	14,72	125
Lithognathus mormyrus	111,52	197	8,87	
Gymnura micrura	56,48	18	4,49	
Zeus faber	28,00	42	2,23	
Sphyraena guachancho	21,13	42	1,68	
Pomadasy peroteti	15,10	30	1,20	
Raja miraletus	9,55	12	0,76	
Pagellus bellottii	8,30	125	0,66	126
Pseudupeneus prayensis	7,94	90	0,63	
Scorpaena stephanica	7,64	54	0,61	
Plastic bags	5,97	18	0,47	
Sepia officinalis	5,67	18	0,45	
Chaetodon hoefleri	4,30	24	0,34	
Epinephelus aeneus	3,52	6	0,28	
Citharus linguatula	3,46	54	0,28	
Pomadasy incisus	3,46	36	0,28	
Fistularia petimba	3,28	18	0,26	
Dentex barnardi	2,57	30	0,20	
Pseudolithus typus	2,21	6	0,18	
Dicologlossa cuneata	1,25	6	0,10	
Pagrus caelestictus	1,19	6	0,09	
Boops boops	0,96	18	0,08	
Selene dorsalis	0,90	18	0,07	
Grammolites gruvelli	0,48	18	0,04	
Torpedo torpedo	0,24	6	0,02	
Sardinella aurita	0,24	6	0,02	
Total	1257,13		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 43  
 DATE :26.03.2012 GEAR TYPE: PT NO: 4 POSITION:Lat S 8°33,53  
 start stop duration Lon E 13°11,00  
 TIME :20:09:20 20:19:44 10,4 (min) Purpose : 1  
 LOG : 8311,67 8312,28 0,6 Region : 4020  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 75 71 Validity : 0  
 Towing dir: 0° Wire out : 110 m Speed : 3,5 km  
 Sorted : 0 Total catch: 403,95 Catch/hour: 2330,48

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella aurita	997,62	8983	42,81	127
Sardinella maderensis	991,38	6629	42,54	128
Chloroscombrus chrysurus	115,96	1038	4,98	130
Trachurus trecae	112,50	1765	4,43	129
Selene dorsalis	50,54	467	2,17	131
Trichiurus lepturus	22,15	52	0,95	
Alectis alexandrinus	19,04	17	0,82	
Brachydeuterus auritus	12,46	156	0,53	132
Lagocephalus laevigatus	6,06	17	0,26	
Scomber japonicus	2,77	17	0,12	
Total	2330,48		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 44  
 DATE :26.03.2012 GEAR TYPE: PT NO: 4 POSITION:Lat S 8°25,50  
 start stop duration Lon E 13°16,24  
 TIME :22:28:11 22:38:35 10,4 (min) Purpose : 1  
 LOG : 8330,44 8331,04 0,6 Region : 4020  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 39 41 Validity : 0  
 Towing dir: 0° Wire out : 110 m Speed : 3,5 km  
 Sorted : 0 Total catch: 45,17 Catch/hour: 260,35

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sphyraena guachancho	100,98	207	38,79	
Brachydeuterus auritus	61,44	8945	23,60	136
Sardinella maderensis	54,99	1147	21,12	133
Sardinella aurita	21,79	888	8,37	134
Chloroscombrus chrysurus	11,53	190	4,43	137
Selene dorsalis	2,48	81	0,95	
Trichiurus lepturus	1,90	40	0,73	
Bregmaceros sp.	1,56	865	0,60	
Ilisha africana	1,27	23	0,49	
Trachurus trecae	1,04	52	0,40	
Alloteuthis africana	0,81	254	0,31	
Engraulis encrasicolus	0,52	86	0,20	
Caranx crysos	0,06	35	0,02	
Total	260,35		100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 45  
 DATE :27.03.2012 GEAR TYPE: PT NO: 1 POSITION:Lat S 8°20,78  
 start stop duration Lon E 13°7,90  
 TIME :04:16:21 04:36:54 20,6 (min) Purpose : 1  
 LOG : 8375,69 8376,96 1,3 Region : 4020  
 FDEPTH: 20 25 Gear cond.: 0  
 BDEPTH: 78 85 Validity : 0  
 Towing dir: 0° Wire out : 110 m Speed : 3,7 km  
 Sorted : 0 Total catch: 98,86 Catch/hour: 288,50

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trichiurus lepturus	116,09	85	40,24	
Sardinella aurita	81,71	625	28,32	140
Sardinella maderensis	61,87	344	21,44	138
Brachydeuterus auritus	13,98	146	4,85	141
Trachurus trecae	12,26	239	4,25	139
Sphyraena guachancho	1,31	3	0,46	
Saurida brasiliensis	0,90	406	0,31	
Alloteuthis africana	0,23	108	0,08	
Selene dorsalis	0,15	3	0,05	
Total	288,50		100,00	



R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 46  
 DATE :27.03.2012 GEAR TYPE: BT NO: 21 POSITION:Lat S 8°16,03  
 start stop duration Lon E 13°16,09  
 TIME :06:29:28 06:49:14 19,8 (min) Purpose : 1  
 LOG : 8392,41 8393,53 1,1 Region : 4020  
 FDEPTH: 29 31 Gear cond.: 0  
 BDEPTH: 29 31 Validity : 0  
 Towing dir: 0° Wire out : 110 m Speed : 3,4 kn  
 Sorted : 0 Total catch: 139,37 Catch/hour: 423,19

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers			
Drepane africana	181,03 1536	42,78	
Galeoides decadactylus	47,91 1102	11,32	
Sardinella aurita	37,56 2599	8,88	147
Pseudotolithus senegalensis	21,32 349	5,04	
Panaeus notialis	21,16 844	5,00	
Eucinostomus melanopterus	18,92 237	4,47	
Myliobatis aquila	14,57 15	3,44	
Selene dorsalis	13,42 768	3,17	149
Sepia orbignyana	13,06 49	3,09	
Trachurus tracas	9,99 726	2,36	142
Sardinella maderensis	9,93 887	2,35	143
Brachydeuterus auritus	8,65 844	2,04	145
Chloroscombrus chrysurus	8,38 419	1,98	146
Pagellus bellottii	5,16 146	1,22	144
Torpedo marmorata	2,58 27	0,61	
Alectis alexandrinus	2,25 15	0,53	
Dicologlossa cuneata	1,79 49	0,42	
Cynoglossus canariensis	1,46 15	0,34	
Grammolites gruvelli	1,24 21	0,29	
Lagocephalus laevigatus	1,12 21	0,27	
Calappa rubroguttata	0,97 15	0,23	
Ilisha africana	0,76 15	0,18	
Trichurus lepturus	0,49 36	0,11	
Epinephelus seneus	0,27 6	0,06	
Maja squinado	0,21 55	0,05	
Starfish	0,14 6	0,03	
Pseudupeneus prayensis	0,07 36	0,02	
GOBIIDAE	0,07 6	0,02	
Total	424,50	100,31	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 49  
 DATE :27.03.2012 GEAR TYPE: PT NO: 4 POSITION:Lat S 7°57,13  
 start stop duration Lon E 12°59,54  
 TIME :21:06:35 21:17:08 10,6 (min) Purpose : 1  
 LOG : 8514,54 8515,16 0,6 Region : 4020  
 FDEPTH: 10 10 Gear cond.: 0  
 BDEPTH: 69 66 Validity : 0  
 Towing dir: 0° Wire out : 110 m Speed : 3,5 kn  
 Sorted : 0 Total catch: 192,41 Catch/hour: 1094,27

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers			
Sardinella maderensis	569,86 7064	52,08	160
Sardinella aurita	300,63 2866	27,47	161
Selene dorsalis	106,12 1979	9,70	159
Trichurus lepturus	46,07 119	4,21	
Brachydeuterus auritus	35,49 921	3,24	162
Ilisha africana	15,47 136	1,41	
Chloroscombrus chrysurus	10,07 85	0,92	
Sphyraena guachancho	7,68 34	0,70	
Saurida brasiliensis	1,54 648	0,14	
Engraulis encrasicolus	1,36 171	0,12	
Total	1094,27	100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 47  
 DATE :27.03.2012 GEAR TYPE: BT NO: 21 POSITION:Lat S 8°8,03  
 start stop duration Lon E 13°9,32  
 TIME :14:19:29 14:34:39 15,2 (min) Purpose : 1  
 LOG : 8460,00 8460,80 0,8 Region : 4020  
 FDEPTH: 43 45 Gear cond.: 0  
 BDEPTH: 43 45 Validity : 0  
 Towing dir: 0° Wire out : 130 m Speed : 3,2 kn  
 Sorted : 0 Total catch: 204,64 Catch/hour: 809,39

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers			
Brachydeuterus auritus	244,43 72886	30,20	151
Galeoides decadactylus	208,83 336	25,80	
Sardinella aurita	119,84 9560	14,81	150
Alectis alexandrinus	54,19 87	6,69	
Trachurus tracas	41,73 3057	5,16	153
Sphyraena guachancho	33,34 51	4,12	
Pomadasya rogeri	26,22 59	3,24	
Stromateus fiatola	11,67 20	1,44	
Pagellus bellottii	11,07 751	1,37	152
Pagrus caeruleostictus	9,41 32	1,16	
Caranx hippos	8,11 12	1,00	
Raja miraletus	7,51 12	0,93	
Chloroscombrus chrysurus	7,24 40	0,89	
Cynoglossus browni	6,72 40	0,83	
Sepia orbignyana	4,35 12	0,54	
Citharus linguatula	2,57 79	0,32	
Grammolites gruvelli	2,29 59	0,28	
Selene dorsalis	2,06 12	0,25	
Sepia officinalis	2,06 12	0,25	
Pseudupeneus prayensis	2,06 12	0,25	
Lagocephalus laevigatus	1,27 12	0,16	
Eucinostomus melanopterus	0,99 12	0,12	
Decapterus rhonchus	0,51 12	0,06	
Engraulis encrasicolus	0,40 71	0,05	
Total	809,39	100,00	

R/V Dr. Fridtjof Nansen SURVEY:2012402 STATION: 48  
 DATE :27.03.2012 GEAR TYPE: BT NO: 21 POSITION:Lat S 8°1,64  
 start stop duration Lon E 13°10,21  
 TIME :16:02:24 16:12:45 10,4 (min) Purpose : 1  
 LOG : 8470,87 8471,38 0,5 Region : 4020  
 FDEPTH: 23 23 Gear cond.: 0  
 BDEPTH: 23 23 Validity : 0  
 Towing dir: 0° Wire out : 120 m Speed : 3,0 kn  
 Sorted : 0 Total catch: 369,98 Catch/hour: 2144,81

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers			
Ilisha africana	869,57 3472	40,54	
Brachydeuterus auritus	329,74 30783	15,37	156
Galeoides decadactylus	249,74 2435	11,64	
Pteroscion pelli	185,74 754	8,66	
Sardinella maderensis	139,48 11304	6,50	154
Sardinella aurita	137,04 21148	6,39	155
Chloroscombrus chrysurus	64,35 1774	3,00	157
Trichurus lepturus	51,48 800	2,40	
Ephippion guttifer	31,65 70	1,48	
Pseudotolithus senegalensis	18,78 70	0,88	
Selene dorsalis	14,96 1600	0,70	158
Trachinotus teraia	14,38 6	0,67	
Drepane africana	10,78 35	0,50	
Panaeus notialis	7,30 104	0,34	
Eucinostomus melanopterus	5,57 70	0,26	
Dicologlossa cuneata	4,52 104	0,21	
Pentaneus quinarius	4,52 104	0,21	
Sepia officinalis	2,78 243	0,13	
Sphyraena sphyraena	1,74 35	0,08	
Torpedo marmorata	0,70 35	0,03	
Total	2144,81	100,00	