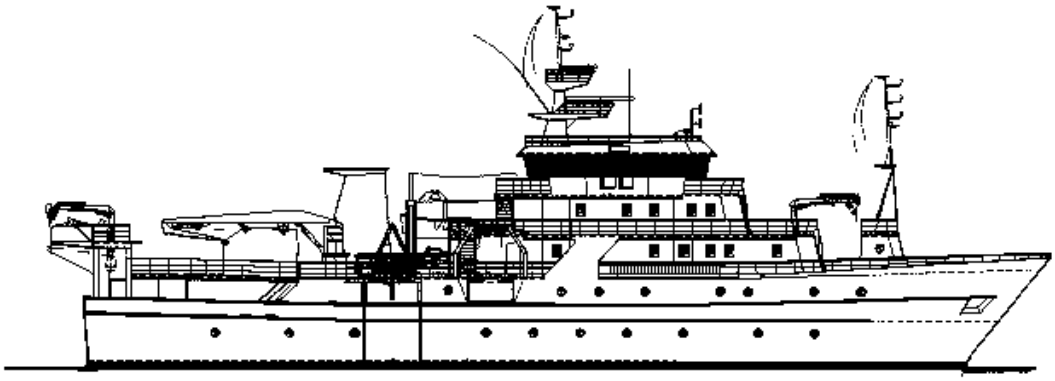

SURVEYS OF THE FISH RESOURCES OF ANGOLA

Survey of the pelagic resources
20 July – 19 August 2003

Including observations of marine seabirds and mammals

Institute of Marine Research
IMR
Bergen

Instituto Investigação Marinha
IIM
Luanda

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Survey of the pelagic resources
20 July – 19 August 2003

by

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Bergen, 2003

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CHAPTER 1 INTRODUCTION

1.1 Objectives

This survey is one of a series aimed at monitoring the pelagic fish resources of Angola, as agreed between the Nansen program and the Instituto de Investigação Marinha (IIM), Luanda.

The main objectives of the survey were the following:

- To estimate the abundance and to map the distribution of the main commercially important pelagic and semi-pelagic fish species in Angolan waters, including the two sardinella species *Sardinella aurita* and *S. maderensis*, the Cunene horse mackerel *Trachurus trecae*, the Cape horse mackerel *T. trachurus capensis*, the pilchard *Sardinops ocellatus* and other pelagic species, mainly carangids.

- To study the biological condition of the main species, including length-weight relationships, reproductive stages and stomach fullness. The refined method for determination of gonad maturity stages in *T. trecae* developed during the 2001 survey was applied.

- To collect gonads, stomachs and otoliths from both horse mackerel species and to collect depth stratified samples of zoo- and phytoplankton in order to continue the studies of horse mackerel feeding biology, relating stomach contents to estimated zooplankton compositions and densities. The distribution and aggregation patterns of sardinella will be correlated with phytoplankton distributions and hydrographical and meteorological conditions.

- 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. Higher sampling efforts will be allocated in the Benguela front area and in the main horse mackerel and sardinella distribution areas.

- On-the-job training for the Angolan participants on the main survey routines, including using the NAN-SIS and Hydrobase software, scrutinizing acoustical data (BEI) and producing acoustic biomass estimates. Dr. Marek Ostrowski (IMR) will instruct in database management and analysis of hydrographical data.

- When not in conflict with the other survey objectives, the survey should map the distribution of marine mammals and seabirds along the survey transects. Tamara Ron (UNDP) will look at distribution of marine mammals during the first leg, while Jean Paul Roux (MFMR) will look at marine mammals and sea birds during the second leg.

The aim of the time series that this survey is part of is to map fluctuations in stock levels in the main pelagic species and to improve the understanding of these fluctuations in terms of the biology of the main species in relation to the environment.

1.2 Participation

The scientific staff consisted of:

From IIM, Luanda:
N'Kosi LUYEYE (Team Leader, 20/7 – 1/8), Filomena VAZ-VELHO (Team Leader, 1/8 – 7/8), Francisco De ALMEIDA (20/7 – 19/8 Team Leader 7/8 – 19/8), António BARRADAS (20/7 – 19/8), Bomba BASIKA (20/7 – 19/8), Miguel ANDRE (20/7 – 19/8), Domingos AZEVEDO (1/8 – 19/8), and Andom LUSSEVSKUENO (20/7 – 1/8).

From Ministry of Environment, Luanda:
Albertina NZUZLUZI (20/7 – 1/8).

From UNDP, Luanda:
Tamara RON (20/7 – 1/8).

From MFMR, Lüderitz:
Jean-Paul ROUX (1/8 – 19/8).

From IMR, Bergen:
Jens-Otto KRAKSTAD (20/7 - 19/8, Cruise Leader 1/8 - 19/8), Bjørn Erik AXELSEN (Cruise leader, 20/7 - 1/8), Diana ZAERA (1/8 – 19/8), Marek OSTROWSKI (20/7 - 19/8), Tor Egil JOHANSSON (20/7 - 19/8), Jan Frode WILHELMSEN (20/7 - 19/8).

1.3 Narrative

The vessel departed Luanda 20 July at 10:00 UTC and steamed north towards the Congo River and the border between Angola and The Democratic Republic of the Congo (DRC), where it arrived on 21 August at 02:20 UTC. Following established practice, the surveyed area was divided into three regions: Congo River - north of Pta. das Palmerinhas (6° - 9°S) - ANGOLA NORTH, the region between 9°S and 13°S - ANGOLA CENTRAL, and the region limited by the parallel of 13°S and Cunene River (17°15'S) - ANGOLA SOUTH. The Northern region was completed on the 28 July at 17:00 UTC, and the Central region was started immediately after this. The coverage of the central region was temporarily interrupted on the 31 July 18:30 UTC for a change of scientific personnel in Luanda. The ship called on Luanda on 1 August at 07:50 UTC and departed 16:30 UTC the same day. The survey was resumed on the 2 August at 03:20 UTC. The last transect before the break off was repeated for the purpose of continuity. The coverage of the Central region was completed on the 7 August 23:35 and the vessel reached the end of the Southern region and the survey grid at the Cunene River outlet on 15 August at 20:20 UTC, The transducer keel was lowered on the 14 August 07:00 UTC because of rough weather, and subtracted after the end of the survey. The vessel docked in Walvis Bay 18 August at 11:00.

The sampling trawls, including the small pelagic trawl, the mid-sized (15 m vertical opening) pelagic trawl fitted with the codend multisampler and the demersal trawl (5 m vertical opening), were used during the survey. The acoustic transducers, 18, 38 and 120 kHz (split beam, EK500 1) and 200 kHz (single beam, EK500 2), were calibrated on the 8 August in Baía dos Elephantes. A second calibration was conducted at Pelican Point outside Walvis Bay in Namibia on the 17 August starting 08:30 in the morning, to reassure that all frequencies

was correctly calibrated after some discrepancy between the calibration at Baía dos Elephantes and previous calibrations, Note however that this discrepancy did not in any way affect the biomass calculations. The previous calibration of the 18 kHz and 200 kHz transducers was carried out 7 September 2002 in Baía dos Elephantes while the 38 kHz and 120 kHz was calibrated inside Pelican Point, Walvis Bay on the 22 April 2003.

Throughout the time series of the pelagic survey of Angola, different survey strategies have been applied regarding survey design, sampling intensity and degree of coverage. The choice of strategy has primarily been dependent on the available ship time and prior knowledge of the spatial distribution of the target species. A standardized survey strategy is now tried implemented, and this year, as in 2002, a systematic survey track with equally spaced transect lines (6 NM) perpendicular to the coast was followed as recommended in the survey report 2002. Although largely similar to surveys prior to 2002, this represents a modification from the prior survey design with parallel longitudinal acoustic transect lines with 5 NM (nautical miles) spacing. By applying the design with lines that are perpendicular to the coast the steamed distance can be reduced by 20 - 30% with little loss of sampling intensity, gaining time required for targeted trawling, hydrographical sampling and *ad-hoc* experiments such as collection of zoo- and phytoplankton samples. Besides, in 2001 it was experienced that although the longitudinal design largely was applicable, there were certain areas where the angle of the coastline deviated too much from the latitudinal direction, giving a near parallel design locally. Although semi-parallel, the perpendicular design is often recommended (e.g. McLennan and Simmonds 1992), and will be followed consequently in future surveys.

The acoustic transects generally cover a depth range of 20 - 500 m, but some lines extended to about 1 000 m depth to check for deeper distributions of midwater concentrations of horse mackerel. In certain areas in the central region surveying is stopped at about 50 m depth due to extreme steepness of the shelf. The shallowest part of the shelf between N'zeto and the Congo River is partly inaccessible for trawling due to oil platforms and wells, and was prior to 2001 not adequately covered. In 2001 and 2002 this section has been covered acoustically, but only small amounts of fish (sardinella) were recorded. This year this region was only partly covered.

CTD sections that have been covered routinely over the past few years are included in the new, standardized survey grid. ADCP (Acoustic Doppler Current Profiler) recordings were logged continuously along specific transects of the survey track, and on CTD stations. Additional CTD and ADCP stations were added on an *ad hoc* basis in areas were horse mackerel and sardinella were abundant. In these areas, zooplankton samples were obtained using *Hydrobios Multinet* plankton sampler.

1.4 Survey effort

Figures 1a - c show the cruise tracks with fishing and hydrographic stations for the northern, central and southern regions respectively. Table 1 summarizes the survey effort by regions.

Table 1. Summary of survey effort by regions, including number of demersal (BT) and pelagic (PT) trawl hauls, CTD casts, Multinet stations (2 - 5 zooplankton samples per station) and distance surveyed (log), disregarding the steaming from Luanda to Congo River.

Area	BT	PT	Total trawls	CTD casts	Multinet stations	Log (NM)
Pta. Palmerinhas - Congo River	7	14	21	79	3	1 452
Benguela - Pta. Palmerinhas	17	15	32	165	9	1 853
Cunene River - Benguela	19	10	29	104	7	1 091
Total	43	39	82	348	19	4 396

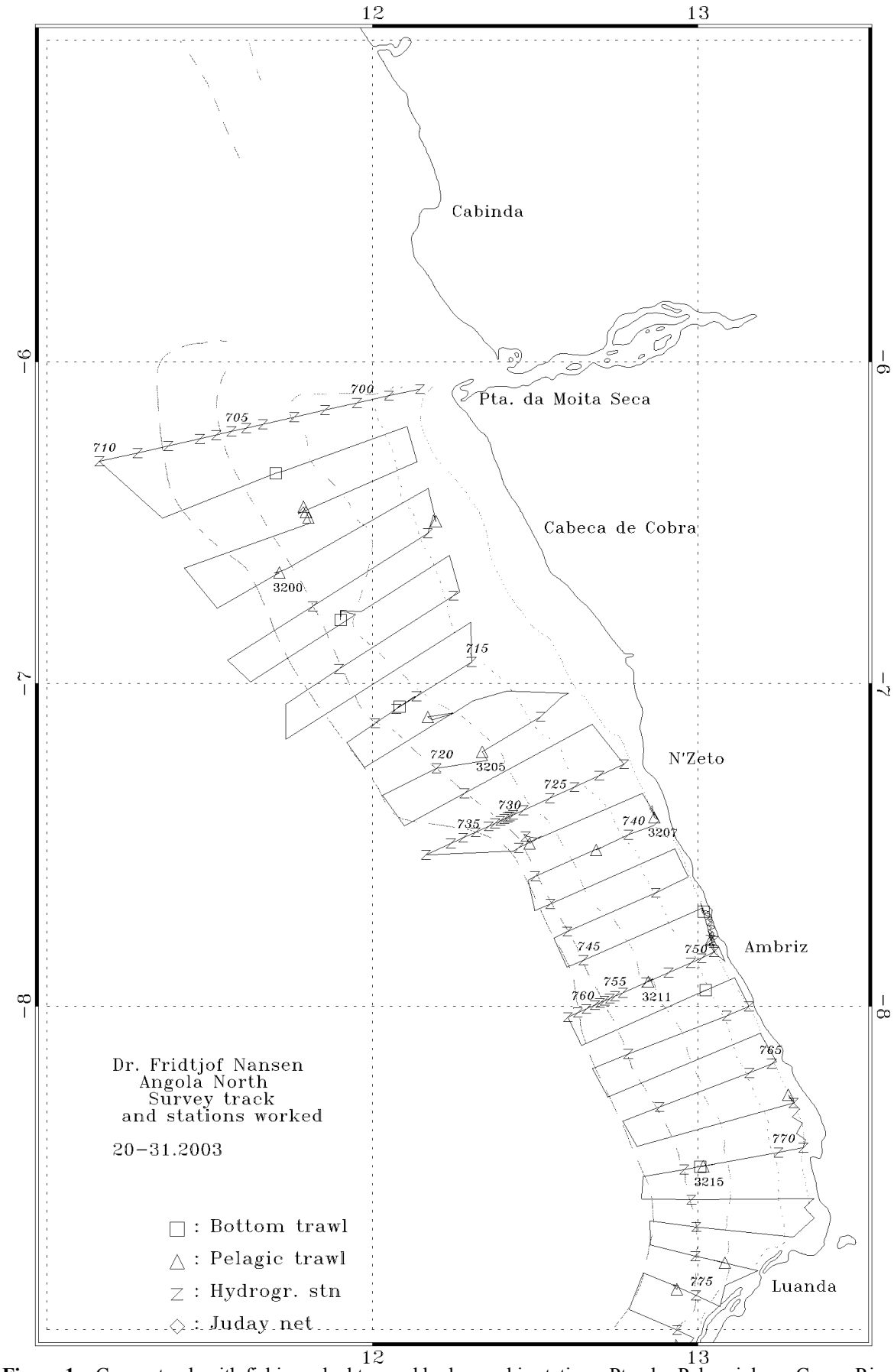


Figure 1a. Course track with fishing, plankton and hydrographic stations, Pta. das Palmerinhas - Congo River.

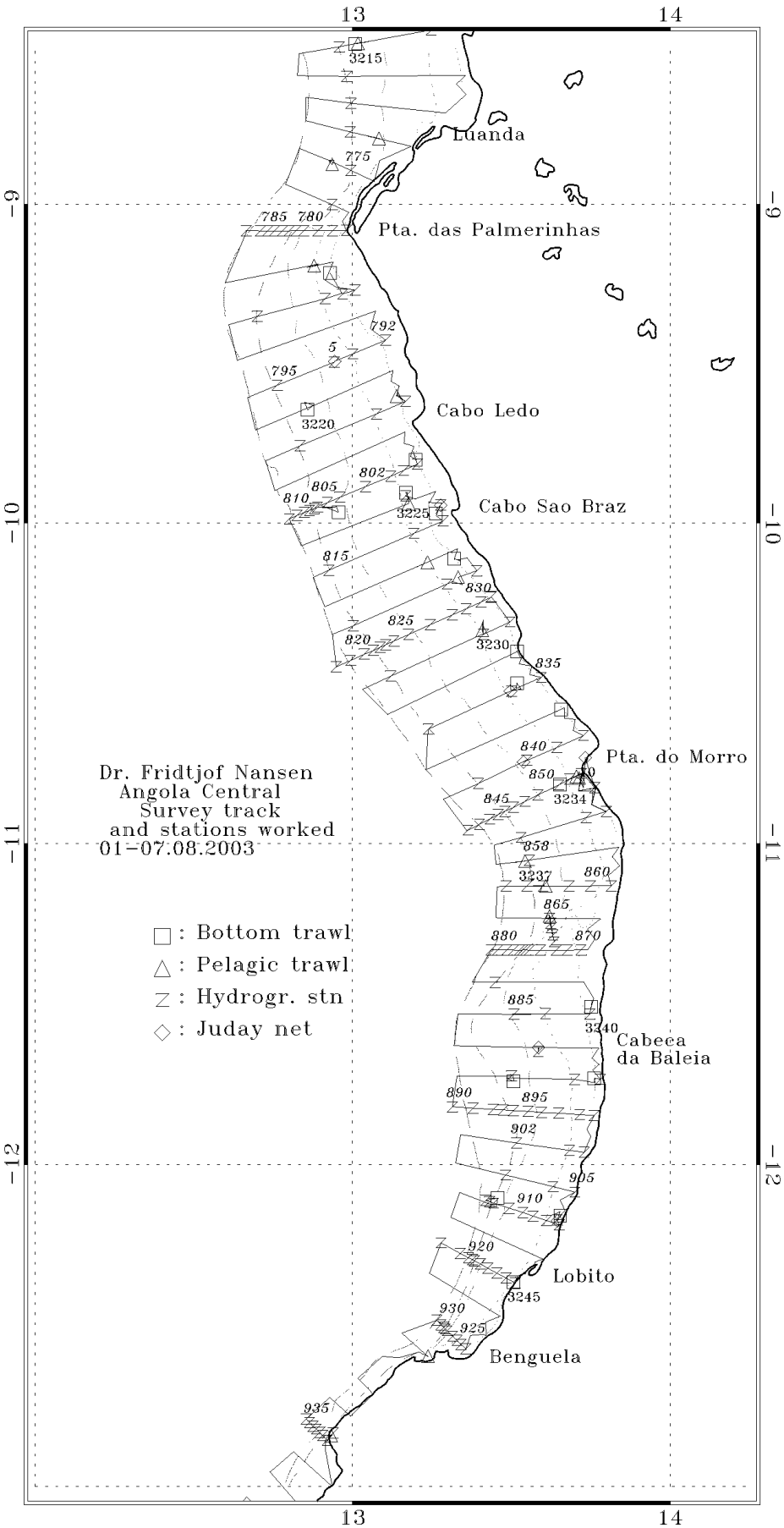


Figure 1b. Course track with fishing, plankton and hydrographic stations, Benguela - Pta. das Palmerinhas.

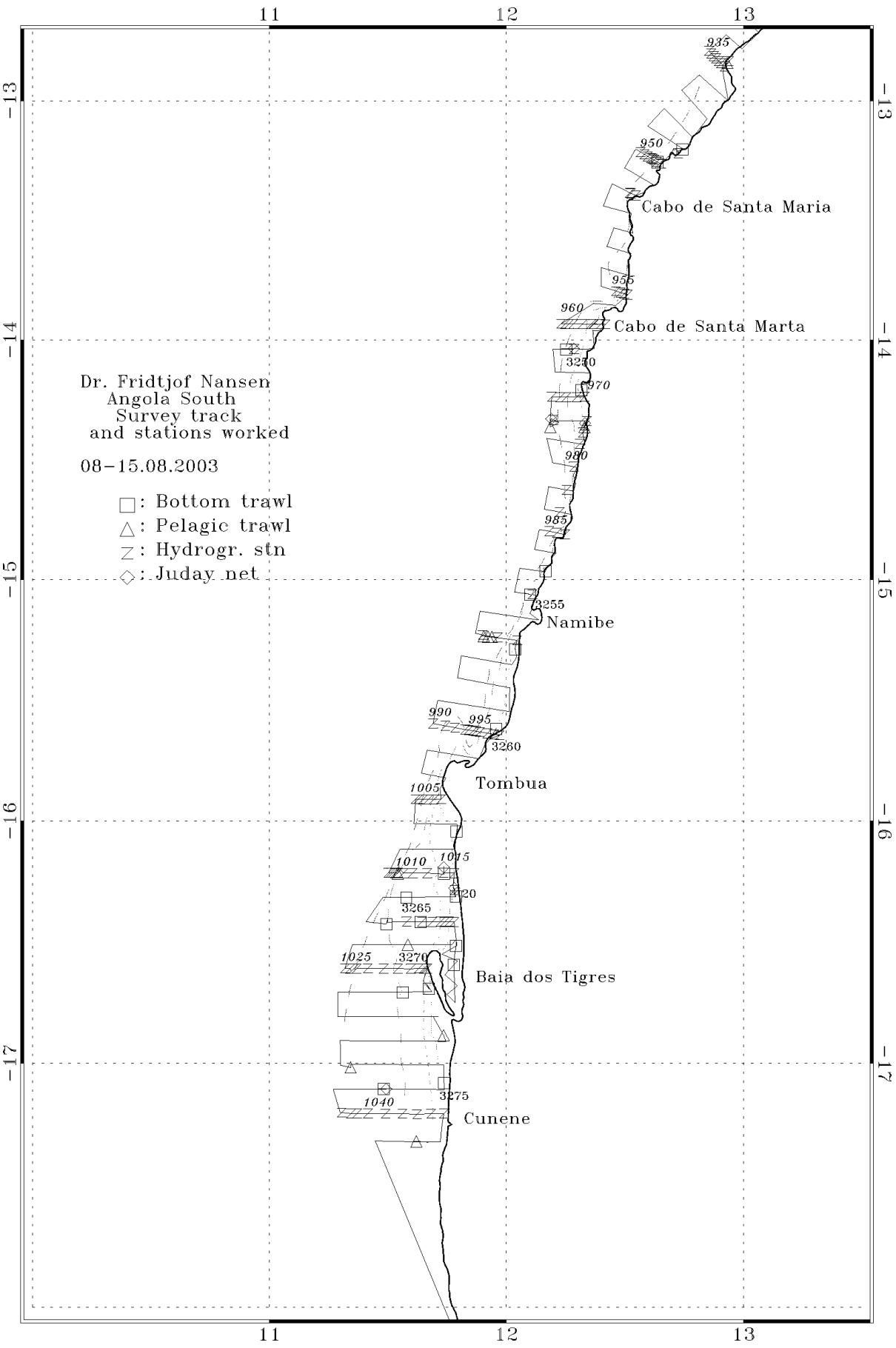


Figure 1c. Course track with fishing, plankton and hydrographic stations, Cunene - Benguela.

CHAPTER 2 METHODS

2.1 Hydrographic sampling

A Seabird 911+ CTD probe was used to obtain vertical profiles of temperature, salinity and oxygen. Real time logging was carried out using the PC based Seabird Seasave software. CTD casts were conducted along the cruise track in transects at about 20 NM distance, and *ad hoc* as deemed necessary. The casts were stopped a few meters above the bottom, and at a maximum of 500 m depth. Two water samples, one near the surface and one near the bottom, were collected using *Niskin* bottles at stations corresponding to the standard profiles. The samples were analysed for dissolved oxygen using the Winkler method in order to calibrate the oxygen sensor. Salinity of water samples could not be measured, as the Guildline Portasal salinometer was out of order, however, the salinometer has shown to be relatively stable in the past and this was not considered to be a problem.

A total of 77 samples were accepted for oxygen calibration on the 27 July 2003. A linear regression of the Winkler determinations on the CTD values produced the correction:

$$O_{2corrected} = a * O_{2recorded} + b \qquad (1)$$

where a = 0.708 and b = -0.004. A second calibration was conducted during the southern leg and applied before the start of the next survey.

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

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

2.2 Fish sampling

A brief description of the sampling trawls are provided in Annex I. All trawl catches were sampled for species composition by weights and numbers. Records of catch rates are given in Annex II.

Biological samples were obtained for sardinella and horse mackerel. Total length and body weight were determined to the nearest 1 cm and 1 g below, respectively. Sex and reproductive stages were determined by means of macroscopic examination, scoring each fish according to the five-point classification scale first proposed by Holden and Raitt (1974), with the addition of the refined description for Cunene horse mackerel identified and presented in the 2001 cruise report (Table 2).

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

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

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

2.3 Plankton sampling

Zooplankton
The zooplankton communities in the main distribution area of horse mackerel and on selected localities within the sardinella core areas were sampled in order to map the prey availability. The sampling was conducted by means of HYDROBIOS Multinet, enabling up to five depth-specific samples in one deployment. Each net (405 µm) was fitted with a flowmeter for estimation of sample volume. A SCANMAR depth sensor gave real-time information of the depth. Nets were opened and closed remotely from the bridge of the vessel.

Phytoplankton
Phytoplankton samples were collected using Niskin water samplers mounted in a circular array on the CTD probe.

2.4 Acoustic sampling

Acoustic equipment
The acoustic recordings were conducted using two Simrad EK 500 echosounders (Bodholt *et al*. 1989) running keel mounted transducers at nominal operating frequencies of 18, 38, 120 (EK500 1) and 200 kHz (EK500 2). Few locations along the Angolan coast are favourable for transceiver calibration (essentially Baía dos Tigres and Baía dos Elephantes), and the survey was therefore started without *a priori* calibration. All transceivers were calibrated in Baía dos Elephantes 8 August. However, the conditions during this calibration were not favourable, and only the calibration results from the 38 kHz where acceptable. It was therefore decided to do another calibration inside Pelican Point at Langstrand before docking in Walvis Bay, Namibia. This calibration was conducted on the 17 August and proved successful for all four frequencies. No changes in the calibration settings were done during the survey, the calibration values from Langstrand where inserted in the EK 500 menu settings after the survey.

The S_V transducer gain at the 38 kHz transceiver was recorded at 27.19 dB at Baía dos Elephantes and 27.04 dB at Langstrand, compared to 27.01 dB on the last calibration (Langstrand, 22.04.03). Since the change in S_V gain was within a 0.2 dB range, which is relatively low compared to the expected experimental error level; no ad-hoc re-computation of the data will be conducted. The TS transducer gain on the same transceiver was recorded at 27.22 dB at Baía dos Elephantes and 27,15 dB at Langstrand, compared to 27,14 dB at the last calibration before the survey.

Acoustic raw-data was logged on two different systems, the Sun - Unix based Bergen Echo Integrator (BEI) (Knudsen 1996) version 2000 and Sonardata Echolog® version 2.20.05. The technical specifications and operational settings of the echosounders used during the survey are given in Annex IV together with the results from the calibration in Baía dos Elephantes and Langstrand.

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

Table 3. Allocation of acoustic densities to taxii. 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	Sardinella sp	*S. aurita*
		S. madarensis
Horse mackerel	Trachurus sp.	*T. trecae*
		T. trachurus capensis
Pilchard	Sardinops	*S. ocellatus*
Big-eye grunt		*Brachydeuterus auritus*
Pelagic species 1	Clupeiformes$_1$	*Ilisha africana*
		Etrumeus whiteheadi
		Engraulis encrasicolus
Pelagic species 2	Carangidae$_2$	*Selene dorsalis*
		Chloroscombrus chrysurus
		Decapterus rhonchus
		Seriola carpenteri
	Scombridae	*Auxis thazard*
		Sarda sarda
		Scomber japonicus
	Sphyraenidae	*Sphyraena guachancho*
	Others	*Trichiurus lepturus*
		Lepidopus caudatus
Other demersal species	Sparidae$_3$	*Dentex angolensis*
		D. macrophthalmus
		D. congoensis
		D. canariensis
		D. barnardi
		Pagellus bellottii
		Sparus caeruleostictus
		S. pagrus africanus
	Other taxii	*Saurida brasiliensis*
		Arioma bondi
		Pomadasys incisus
		Galeoides decadactylus
Mesopelagic species	Myctophidae$_3$	*Diaphus dumerili*
	Other mesopelagic fish	*Trachinocephalus myops*
Plankton	Calanoidae	*Calanus sp.*
	Euphausiidae	*Meganyctiphanes sp.*
	Other plankton	

$_1$: other than *Sardinops* sp.; $_2$: other than *Trachurus* sp.; $_3$: main taxon in group.

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

$$TS = 20 \log L - 72 \text{ (dB)} \quad (2)$$

or

$$C_F = \frac{10^{7.2}}{4\pi} \cdot L^{-2} \quad (3)$$

where C_F is the conversion factor from acoustic density to fish biomass and L is the mean total fish length. This target strength function was originally established for North Sea herring, but has later been attributed to clupeids in general (Foote et al. 1986, Foote 1987). No specific target strength relations are presently available for the species at hand, and equation (3) has therefore been applied consequently for all targeted species in this time series. The biomass was calculated by multiplying the number of fish by the expected length at weight, estimated by regressing the log-length (total) against total weight. Separate length-weight relationships were worked for each region (north, central, south), pooling all data within each region.

The boundaries of encountered fish aggregations (post strata) were determined by means of contouring within the inner and outer zero-value limits of the transect lines. The strata contours were digitised using a CalBoard III digitising board / Atlas Draw v. 2.03 PC based software. Distribution plots and aerial calculations on the strata were carried out using IDL 5.6 for MS Windows. Sub-stratification was used to isolate areas of similar densities, using the following pre-defined, standard categories: 1: s_A = 0 - 300; 2: s_A = 300 - 1 000; 3: s_A = 1 000 - 3 000; 4: s_A >3 000.

Mean 5 - NM integrator values (s_A) computed along the transect lines were re-averaged for each stratum. The short spacing between the lines (6 NM) makes it impossible to exclude all between-transect values without removing some on-line contributions, particularly for sardinella on the inner shelf. The potential bias (positive) introduced by including between-line values is likely smaller than the bias (negative) that would have been introduced by excluding high on-line contributions. This bias is also counteracted by the shallow distribution pattern (partly above the integration limit) and vessel avoidance behaviour (Misund and Aglen 1992) of sardinella. All estimates should consequently be considered as relative indices of abundance.

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

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

where:

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

CHAPTER 3 OCEANOGRAPHIC CONDITIONS

The Angolan territory spans the two major geographical climatic zones: the tropics in the north and subtropics in the south. The environmental data collected during this survey clearly reflect this climatologic zonation during winter. The following description provides a summary of the observed features, presented for the each of the three coastal regions separately.

3.1 The Northern Region

The observed wind conditions were calm in the Northern region (Figure 2a). The predominant wind direction was from the south, southeast and southwest. The average wind speed for the entire region was less then 4.5 m/s. A period of stillness was encountered between 24 and 26 July when the ship was surveying the area around Ambriz located between 7°15'S and 8°00'S.

The distribution of sea surface temperature collected underway is depicted in Figure 3a. The dominant pattern seen in this figure is a change in the main isotherm direction from the cross-shelf orientation, observed to the north of N'Zeto, to the alongshore one, observed to the south. The shapes of the isotherms indicate an existence of two frontal zones: a cross-shelf front to the north of N'Zeto and an alongshore front at the shelf break in the south. The distribution also reveals a colder inshore temperature cell located inshore of N'Zeto.

Hydrographic sections
The Moita Seca section (Figure 4a) exhibits the features expected from the proximity of the major World's river. The upper 20 m of the water column were dominated by the Congo runoff water with temperatures of about 24°C and salinities in the range of 31.0 - 33.0 psu. The salinity increased seaward, but the temperature displayed little change across the shelf. Matching this observation with the sea surface temperature distribution (Figure 3a), one can conclude that the entire region to the north of the cross-shelf surface thermal front was dominated by the Congo River plume. The river plume appeared to have reached the more southerly locations offshore than inshore. The additional hydrographic stations taken along the 200 and 50 m isobaths, further conformed this by showing salinities 34.5 psu reaching the latitude 6°57'S offshore but only the latitude 6°32'S on the inshore end.

The Ambriz section (Figure 4b) is dominated by the proximity of the open tropical Atlantic water masses on its offshore end. The top 120 m of the water column are dominated by Tropical Surface Water, characterized by temperatures above 22 °C, oxygen values above 4 ml/l and generally poor in nutrients. A shallow thermocline at a depth about 20 m separates the surface layer from the underlying it South Atlantic Central water, characterized by temperatures and salinities slowly decreasing with depth, low oxygen concentrations (<2 ml/l) and rich in nutrients. The interface between the surface and subsurface water masses is not distinguishable in salinity, which remains in the same range of 35.7 - 35.8 psu on both sides of the thermocline.

The open ocean stratification reaches station 758. Between stations 758 and 759, there is an evidence of a surface thermal front, separating the oceanic surface water from the slightly colder surface water on the shelf. The alongshore position of this front along the shelf-break is

well manifested by the 22 °C isotherm on the sea surface temperature distribution map (Figure 3a). Except for this surface, the thermal front and a slow shoreward decrease in the sea temperature at the surface, the vertical structure of the water column on the shelf resemble the open ocean profile. The thermocline at approximately 20 m depth remains sharp across the entire shelf and the low in oxygen (and probably rich in nutrients) subsurface water reaches the inshore areas below a depth of about 25 m. Note that such inshore presence of the subsurface, nutrient-rich waters near the coast, in the subtropics and high latitudes would have only been possible in the presence of an alongshore wind, driving upwelling. In this case, the wind conditions were calm and this section clearly demonstrates an important feature of the tropical coastal ocean, in which supply of subsurface nutrients to the inshore regions is not related to the wind driven upwelling and takes place during calm weather conditions.

3.2 The Central Region

The wind conditions observed in the Central Region are depicted in Figure 2b. The average wind speed for the entire Central region did not exceed 4 m/s. The predominant wind direction was from the southern sectors (southwest, south and southeast), constituting the 75% of all 1 NM averaged observations. Thus, one can conclude that on average the wind conditions observed off the Central Region were even calmer than those observed the Northern Region.

The surface temperature distribution for the Central region is depicted in Figure 3b. The distributional patterns in this Figure may be divided into two major provinces. The first province occupied the northern part of the region, located between Pta. das Palmerinhas in the north and Pta. do Morro in the south. The temperature distribution was there characterized by alongshore orientation of isotherms, the presence of a surface waterfront at the shelf-break and pockets a colder water, confined to inshore. In many respects, the distributional patterns observed in this region match those observed south of N'Zeto in the northern region (Section 3). The second province in Figure 3b may be identified between Novo Redondo (11°15'S) in the north and Benguela in the south (12°30'S). Temperature in this province decreases uniformly towards the south with latitude but shows little variation across the shelf with the exception of a narrow colder band in the first two-three NM nearest to the shoreline. The two provinces are separated by a transitional located between 10°45'S (Pta. Moita Seca) in the north and 11°20'S (Quicombo) in the south.

Hydrographic sections

The northernmost hydrographic line in the central region was taken off Pta. das Palmerinhas, south of Luanda. Figure 4c depicts the result. The most evident feature is the presence of fresh water layer seen on the salinity distribution. This layer was originated northward outflow of the nearby Kwanza River. The mouth of the Kwanza River is located at 09°21'S, approximately 20 NM to the south to the Pta. das Palmerinhas section. The additional hydrographic stations had been taken between in the vicinity of the mouth (stations 788- 795, not included into this report) and these have shown that the Kwanza river plume transformed from a narrow and thick plume of fresh water near the river mouth to a broad 2 m thick surface layer of brackish water spread across the entire shelf off Palmerinhas section.

Two more coastal rivers were encountered by the survey on its way south in the Central Region: Rio Longa at 10°15'S and Rio Cuvo at 10°53'S. In the first case, no traces of a

brackish river were found; in the later case, the plume was clearly observed in the perimeter of approximately 10 NM inshore the Pta do Morro section.

Hydrographic conditions along the Pta. do Morro section are depicted in Figure d. The hydrographic patterns observed there were very similar to those observed on the Ambriz line in the northern region (Section 3.1). The main features consisted of (1) surface thermal front at the shelf break, (2) a mid-shelf depression of near-surface isotherms followed by an upward tilt towards the shore and (3) presence of the low-oxygen South Atlantic Central Water close inshore despite absence of wind. Similarly to the Ambriz section (Section 3.1) the upward shoreward tilt of isotherms suggested a northbound current near the coast. The acoustic current profiles taken in this region had conformed such a premise, by revealing a northward flow inshore of the 100 m depth contour and the opposite current seaward of this depth.

Crossing the latitude of 11°S, the survey entered the region where a significant indentation in the Angolan coastline takes place, and forms a deep depression in the topography of the shelf. Approaching this area from the north, one observes the slope falling gently and reaching the deepest point at approximately 11°15'S. To the south of the deepest point, the bottom rises sharply and forms an underwater cliff perpendicular to the coast, which culminates at about 50 m below the sea surface with a broad shallow bank with a flat bottom. As we have been unable to find standardized names for these two morphological features, in the subsequent discussion we will use the terms the Novo Redondo Depression and the Quicombo Bank, to denote the depression and the bank regions, respectively; based on the names of the coastal settlements located in their vicinity.

Additional hydrographic sections were made in this area and these evidenced on an eddy-like or a meandering surface circulation feature, developing over the Novo Redondo Depression and probably coupled to the northward coastal current, which was observed in the north. The two important features of a coastally trapped warm eddy were identified from the data: the warm core at its center and topographically controlled upwelling at the lateral boundaries.

Figure 4e displays the results from the Lobito section. This section is located to the south of the Quicombo Bank, in the region where the shelf becomes very narrow. The major change in the hydrographic regime in this area the absence of the shallow thermal front at the shelf break, which in the north separated the oceanic waters with temperatures above 22°C from the colder water on the shelf. On the Lobito section, the temperature of the offshore surface water is 20°C, the same as the inshore water. The observed drop in the offshore temperatures appears to have resulted in a shallower thermocline and a generally downward tilt of isotherms towards the coast. With the isotherms now tilted downward shoreward, the direction of the coastal current was expected to change from the north to the south. Indeed, the observations made with the acoustic current profiler in this region indicated a predominantly southward flow.

3.3 The Southern Region

After leaving Benguela, located in the southernmost extremity of the central Angolan shelf, the survey entered the southern region of the Angola's coast. Underwater topography in this region changes dramatically: the shelf narrows to less than a mile and, in many locations, there is no shelf zone at all whereby cliffs on the coast extend directly to the continental slope underwater. The only broader coastal offset between Benguela (12°30'S) and Namibe (15° S),

located between the mouths of two rivers: the Carunjamba (13°56'S) and Bentiaba (14°56'S), has alongshore extend of approximately 34 NM. This extremely narrow shelf, pierced with numerous underwater canyons and gullies, extends to the latitude (15°54'S); to the south of which it gradually broadens and eventually transforms to a broad shelf, typical to the northern Benguela.

Figure 2c demonstrates distribution of winds in the southern region. The main observed tendency is a step-wise increase in the wind speed as the survey progressed to the south. The first jump occurred as soon as the vessel left the Lobito Benguela shelf, whereby from almost no wind condition the survey was entered the region subjected to the 5 - 6 m/s wind from the south and southwest. The wind speed in that range was encountered more or less persistently along the survey track until the survey reached the Ponta Albina section at 15°56'S. Further south, the survey become exposed to a strong southerly gale, apparently connected to the intensification of the subtropical trade winds over the northern Benguela in winter. The wind speed increased to about 8 - 10 m/s and persisted at that level until the termination of the survey off the Cunene River (17°15'S). Our observations in this region appear to indicate that the wind in this region was dependent on the distance offshore, with stronger winds occurring deeper than the 100 m isobath. However, our observation may have been aliased by a day-night effect, a common occurrence on the Namibian shelf, manifested by a lower speed and direction reversals in the morning and intensification of the southerly wind in the afternoon.

Hydrographic sections

The Ponta Salinas section, located in the northern extremity of this survey area (Figure 4f) exhibits the structure of the water column characteristic for the tropics: a shallow surface layer with temperature above 20°C, a sharp thermocline about 15 - 20 meters of depth and low-oxygen layer immediately below the thermocline.

The Carunjaba section is shown in Figure 4g. This section is located on the northern edge of the aforementioned coastal offset, approximately one and half degree south of Ponta Salinas. The warm surface layer and strong thermocline, so characteristic to the tropics are evidently absent from this section. The 19° and 18° isotherms, consistently tilted downward in the tropics, on this section upslope shoreward, indicating for a typical coastal upwelling process.

The Ponta Albina section (15°56 S, Figure 4h) depicts transitional patterns between the narrow shelf region in the north and the northern closure of the Benguela type of shelf in the south. The distribution maps of seawater properties along this section bear no resemblance to the tropics. The top 50 m of the water column are occupied by a well-mixed upper layer with temperature 16°C and salinity 35.6 psu. A weak thermocline and halocline is developing below a depth of 50 m. From this structure, it is evident that the upper layer of the water column is strongly affected by the wind mixing.

The Baía dos Tigres section (Figure 4i) is located on a broad portion of the shelf and exposed to the southerly, upwelling-favourable wind. The signature of upwelling, however, is not distinct in the temperature and salinity distributions, because of strong wind mixing on the surface and, probably the current shear at the bottom, which destroy the vertical stratification. Nevertheless, the effect of upwelling is identifiable from the oxygen distribution in terms of near-bottom oxygen layer displaying concentrations less than 1 ml/l.

The southernmost section, located off Cunene River (Figure 4j), exhibits the water masses further transformed by an intense wind-driven vertical mixing and an increasing influence of

the Benguela current in the south. On this section, well-mixed water masses with temperatures between 13°C - 14°C, and salinities between 35.3 and 35.4 psu, occupy the whole length of the section, including the offshore stations, which on the Baía dos Tigres section still displayed traces of a vertically stratified water column.

3.4 Summary

With respect to hydrography, the survey documented a sharp change in hydrographic conditions along the coast, characterizing the winter pattern in the Angola's EEZ. The main coastal hydrographic boundaries of the system and their principal features are summarized in the table below:

#	Hydrographic regime	Latitudinal extend	Main features
1	The Congo River outflow area	6°00'S - 6°30'S	Presence of the Congo river outflow in the surface waters and mesoscale eddies formed at the edge of the river plume.
2	The Northern Tropical Shelf	6°30'S - 9°05'S	Warm upper water layer; thermocline at 15 – 20 m; low-oxygen subsurface inshore. Northward current inshore; thermal front offshore
3	The Central Tropical Shelf	9°05'S - 10°45'S	As above, but a separate circulation cell separated by the bottom topography off Pta. das Palmerinhas.
	The Novo Redondo Depression	10°45'S - 11°15'S	Topographically trapped high pressure cell, causing upwelling at the edges.
4	The Southern Tropical Shelf	11°15'S - 12°30'S	As 2 and 3 but no thermal fronts offshore, southward current inshore.
5	The Subtropical transformation zone	12°30'S - 15°50'S	Transition zone between the well stratified waters and geostrophic circulation in the tropics in the north to the well-mixed waters, and wind-driven circulation in the south.
6	The Northern Benguela extension.	15°50'S - 17°15'S	Seasonal coastal upwelling, driven by the south easterly trade winds.

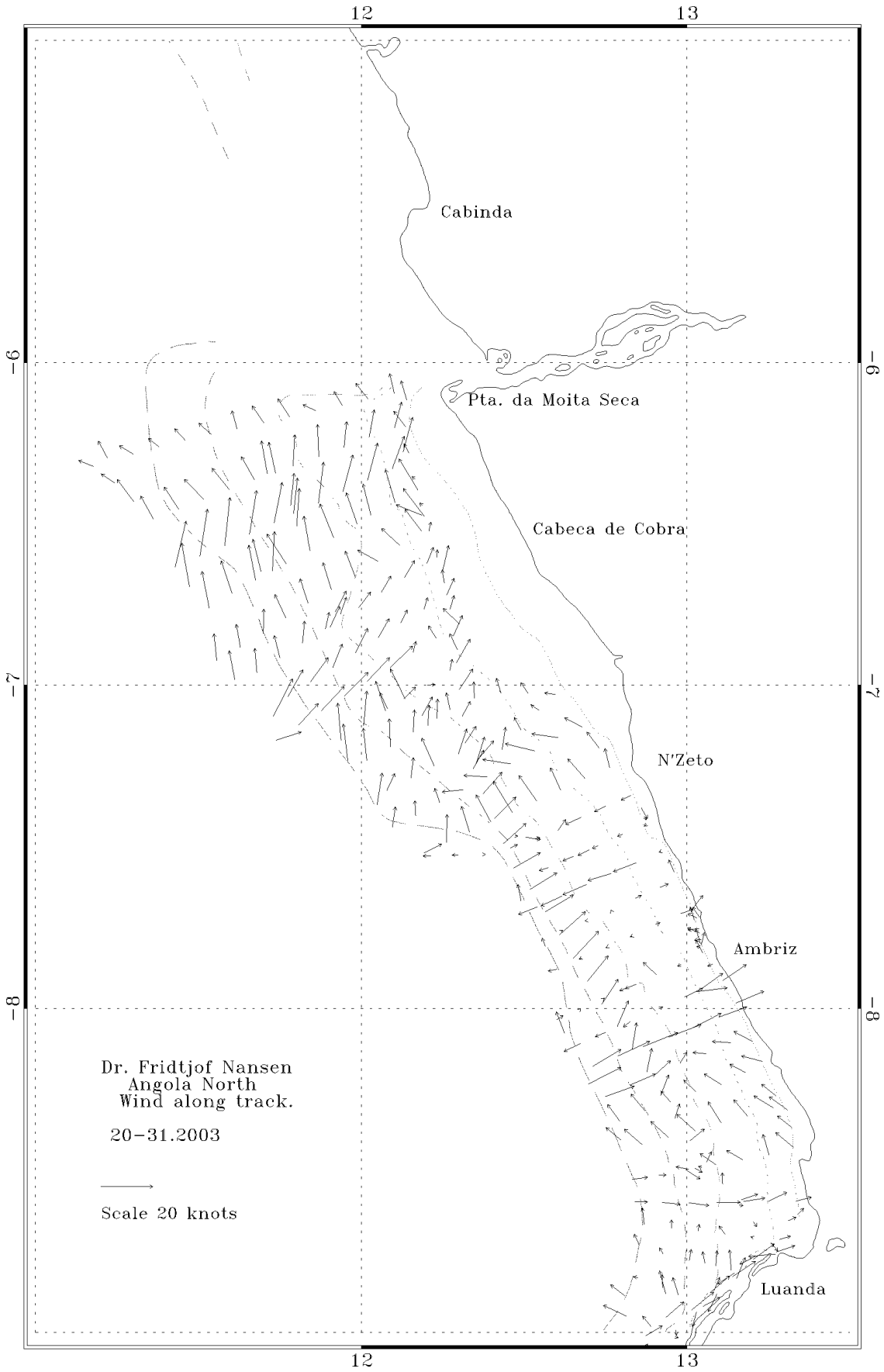


Figure 2a. Distribution of wind velocities along the survey track for the northern region

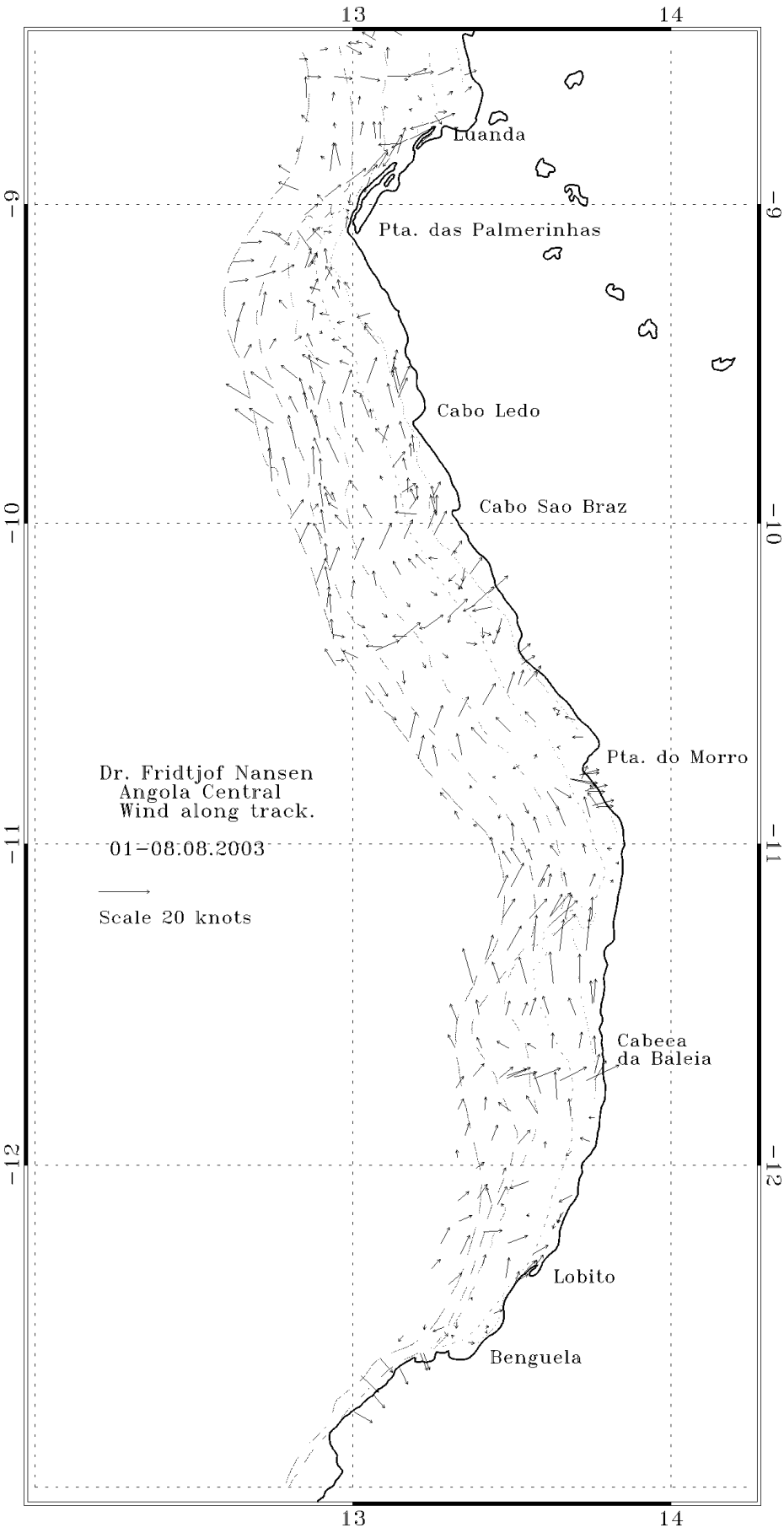


Figure 2b. Distribution of wind velocities along the survey track for the central region

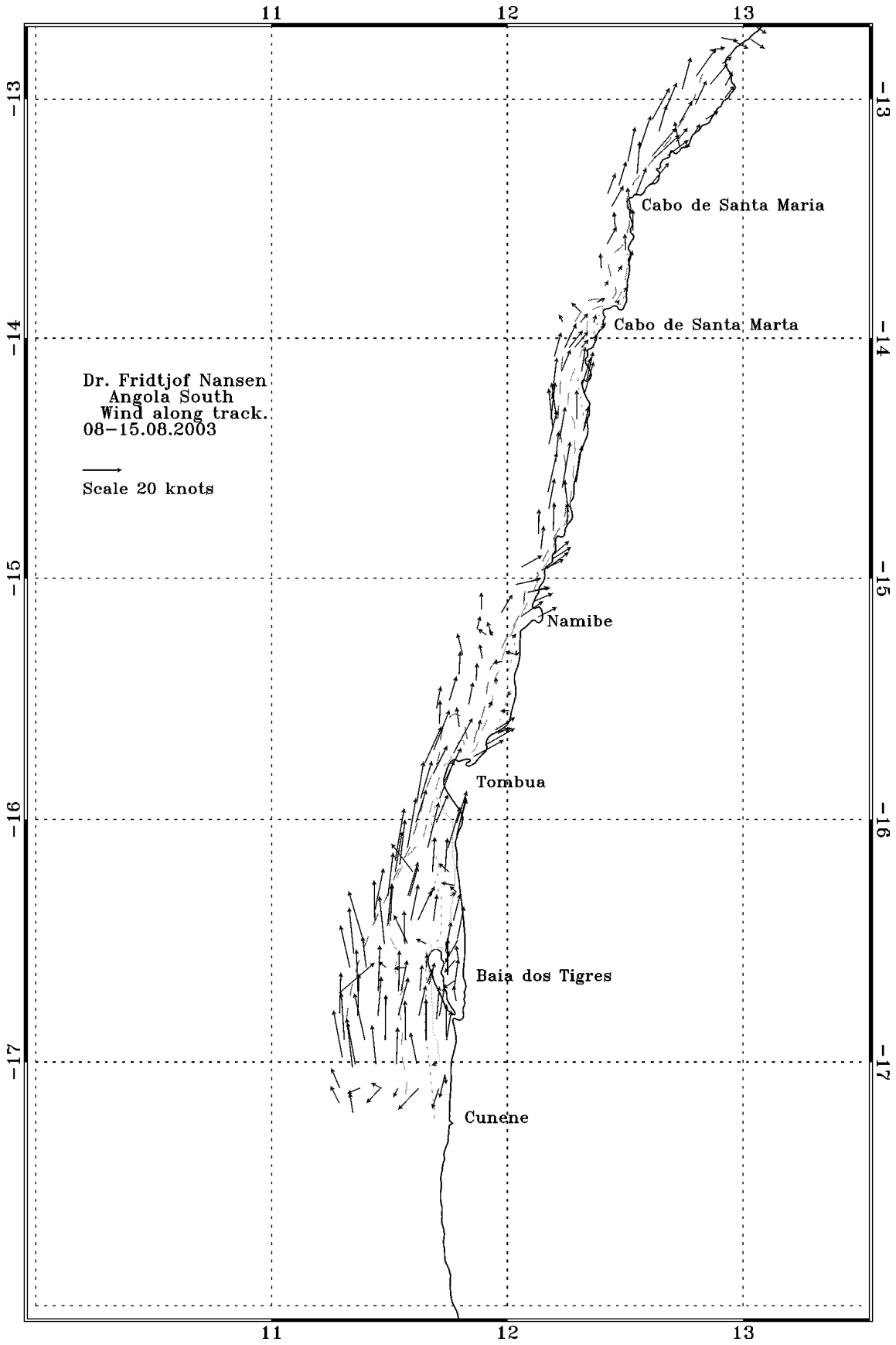


Figure 2c. Distribution of wind velocities along the survey track for the southern region

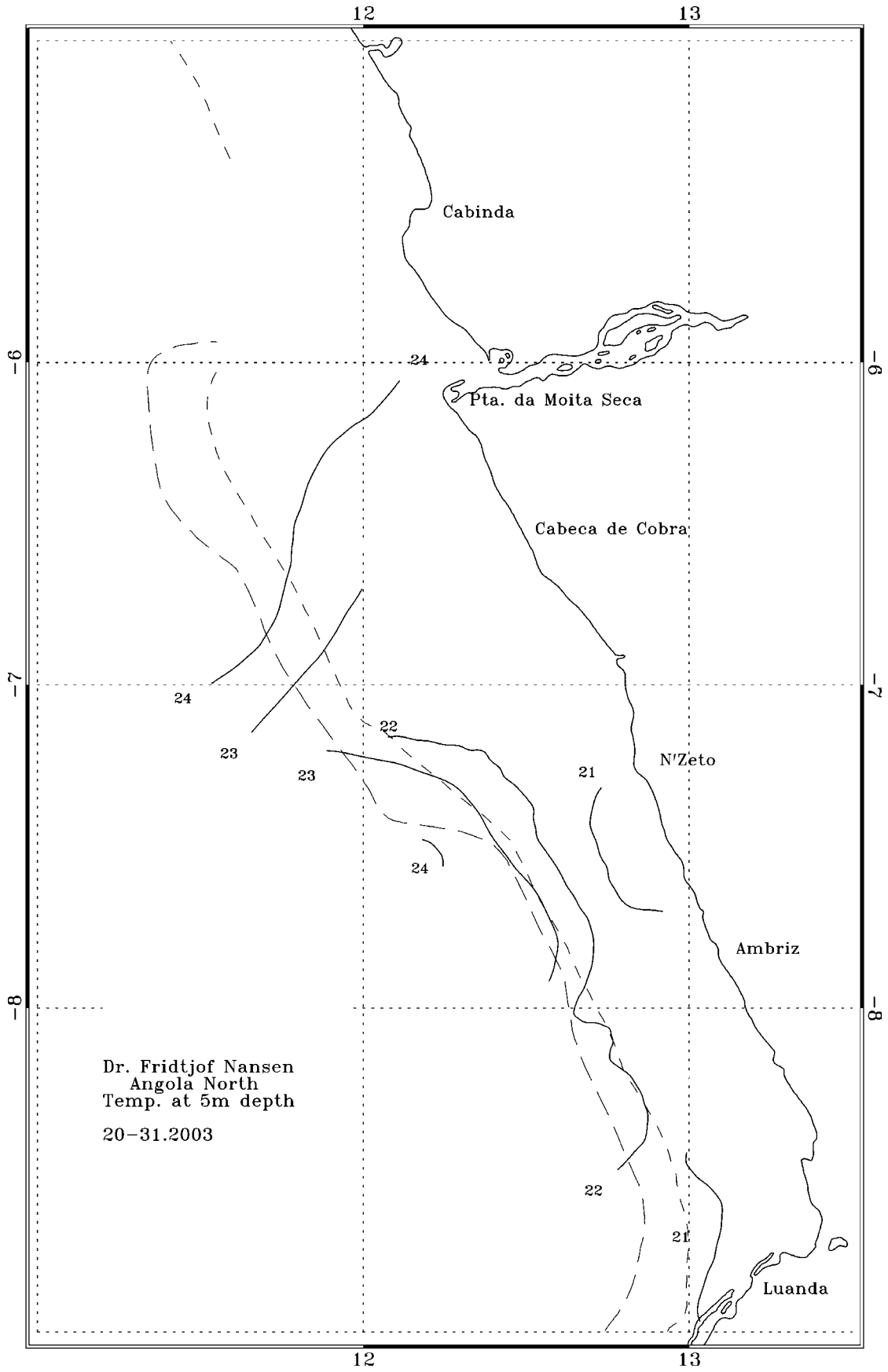


Figure 3a. Distribution of water temperatures at 5m depth in the northern region

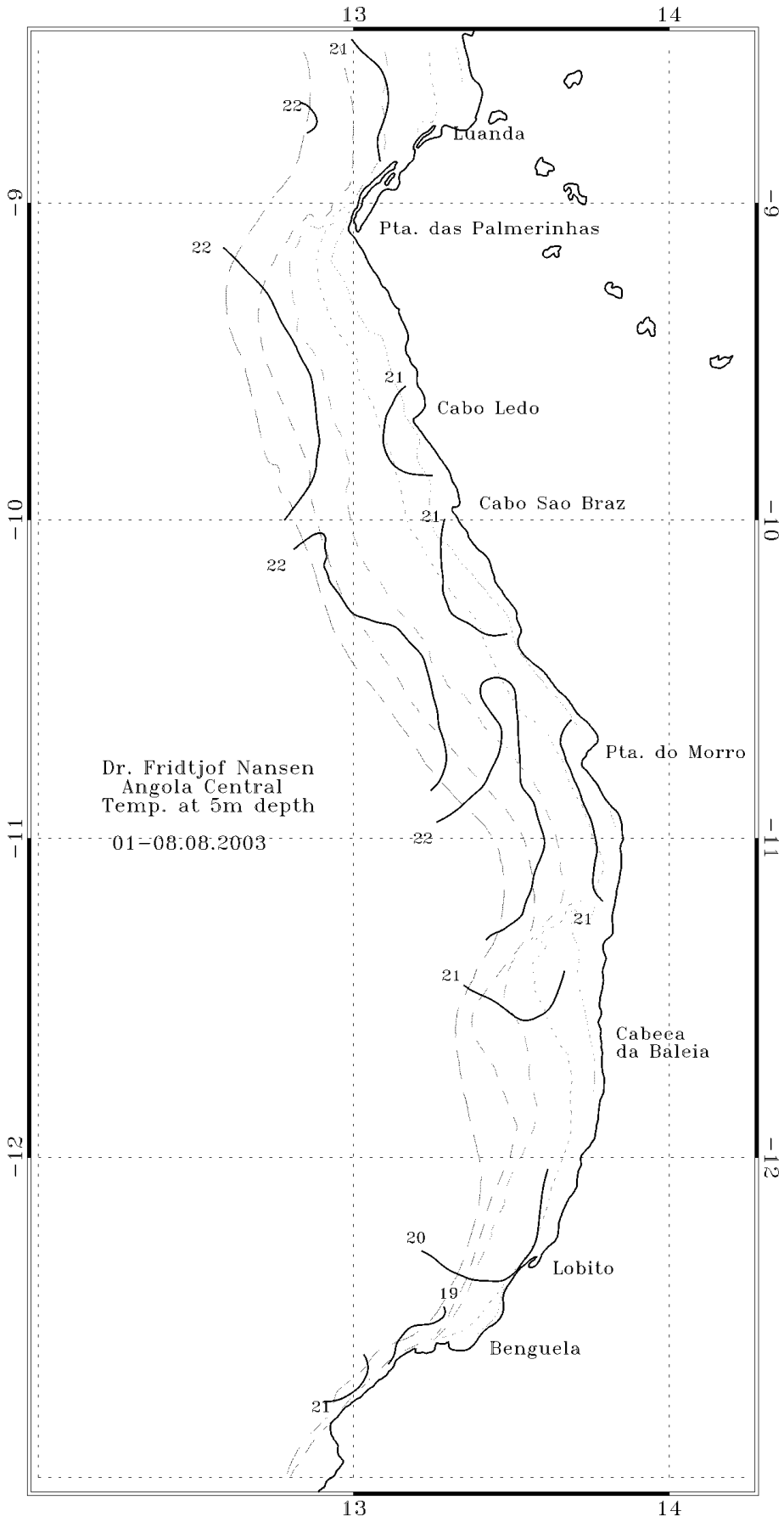


Figure 3b. Distribution of water temperatures at 5m depth in the central region

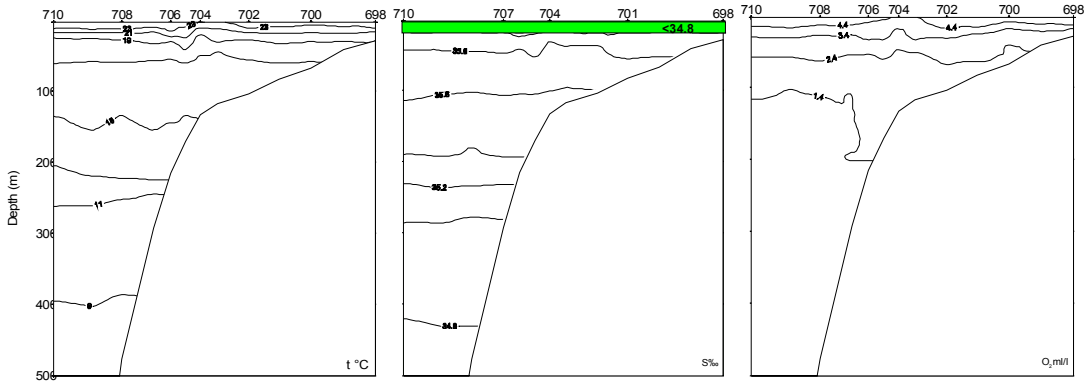


Figure 4a Vertical sections of temperature salinity and oxygen off Moita Seca.

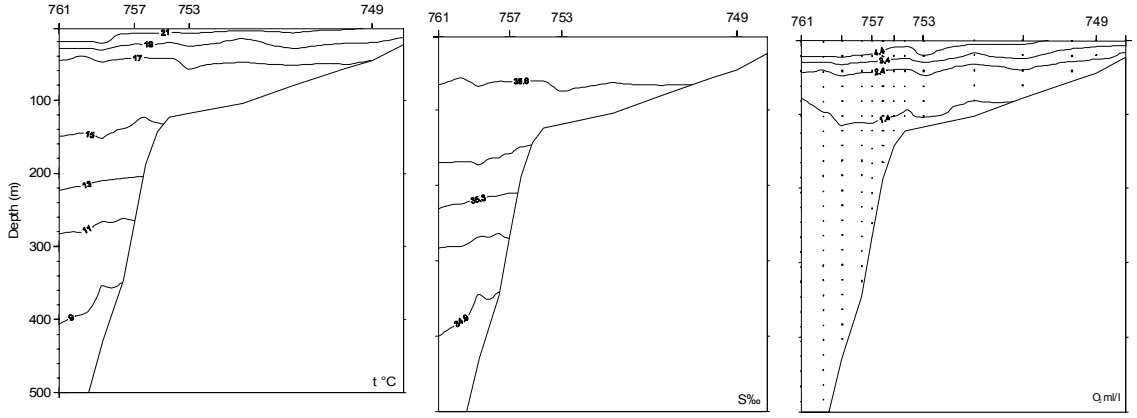


Figure 4b. Vertical sections of temperature, salinity, and oxygen off Ambriz.

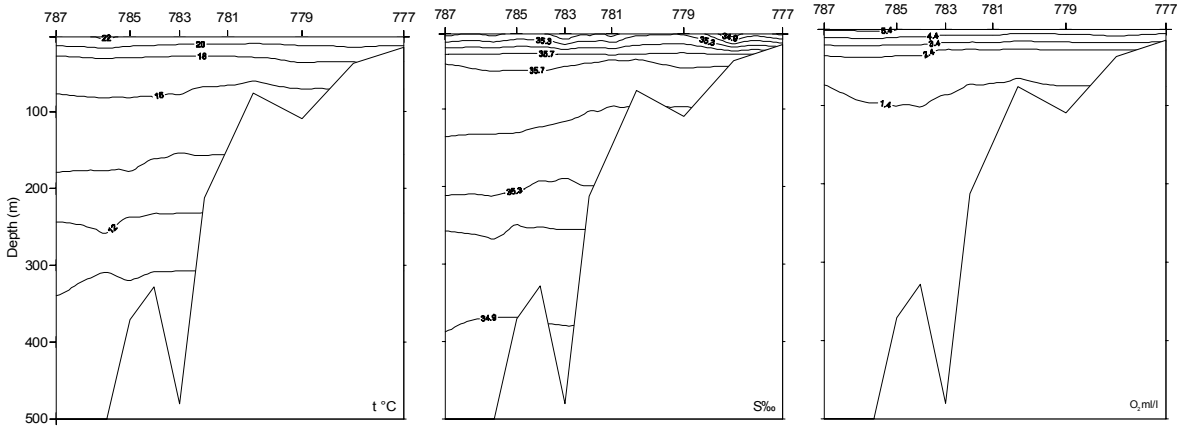


Figure 4c. Vertical sections of temperature salinity and oxygen off Palmerinhas

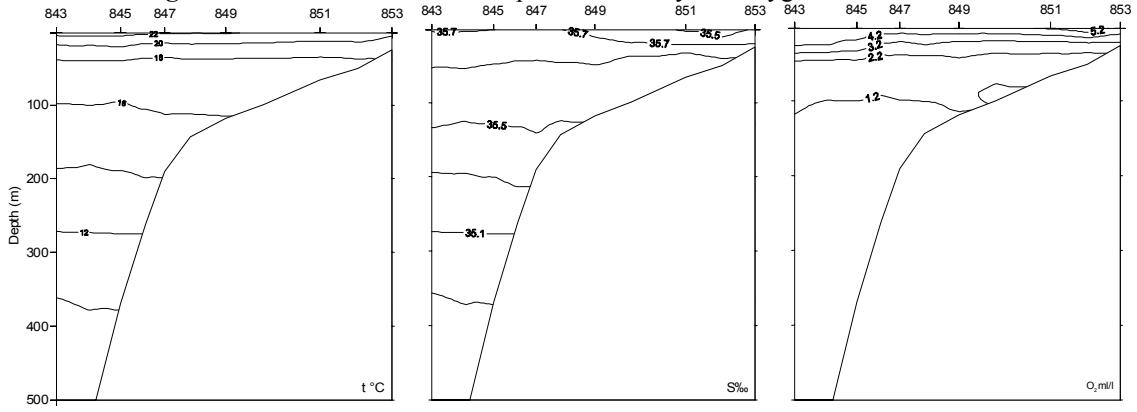


Figure 4d. Vertical sections of temperature salinity and oxygen off Pta. do Morro

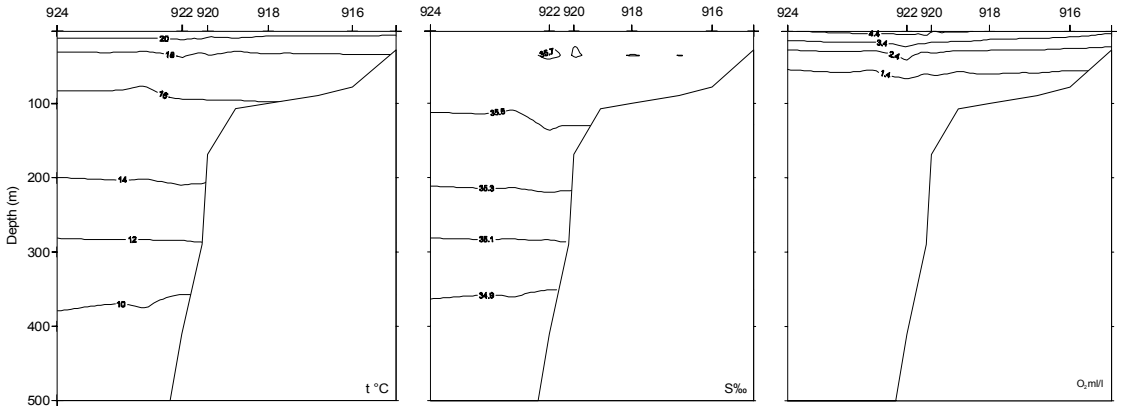


Figure 4e. Vertical sections of temperature salinity and oxygen off Lobito.

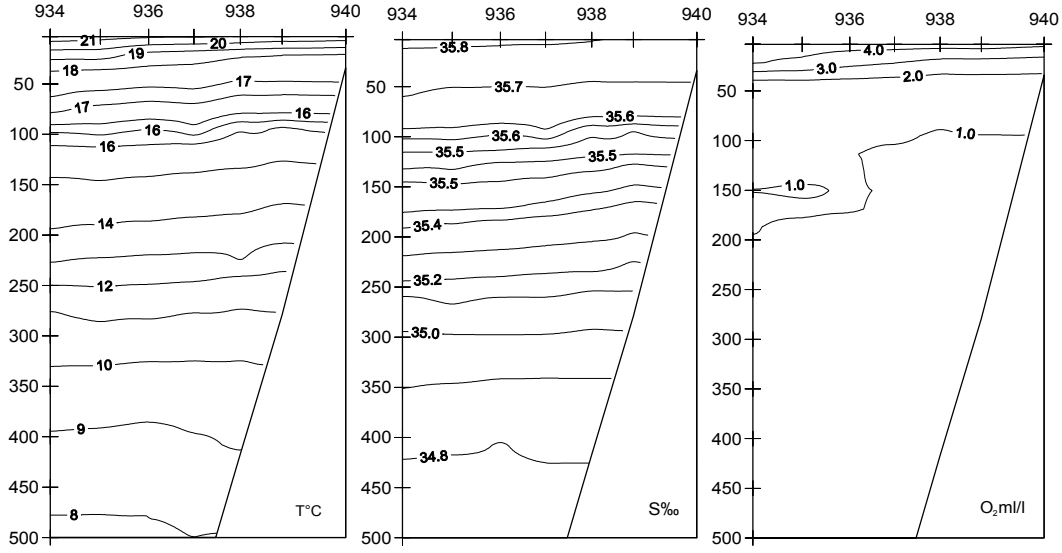


Figure 4f. Vertical sections of temperature salinity and oxygen off Ponta Salinas

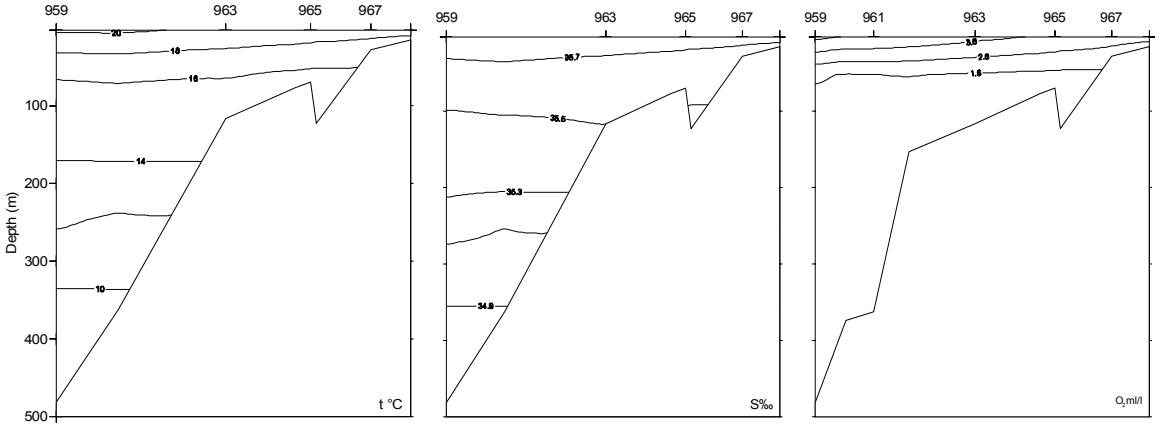


Figure 4g Vertical sections of temperature salinity and oxygen off Carunjamba

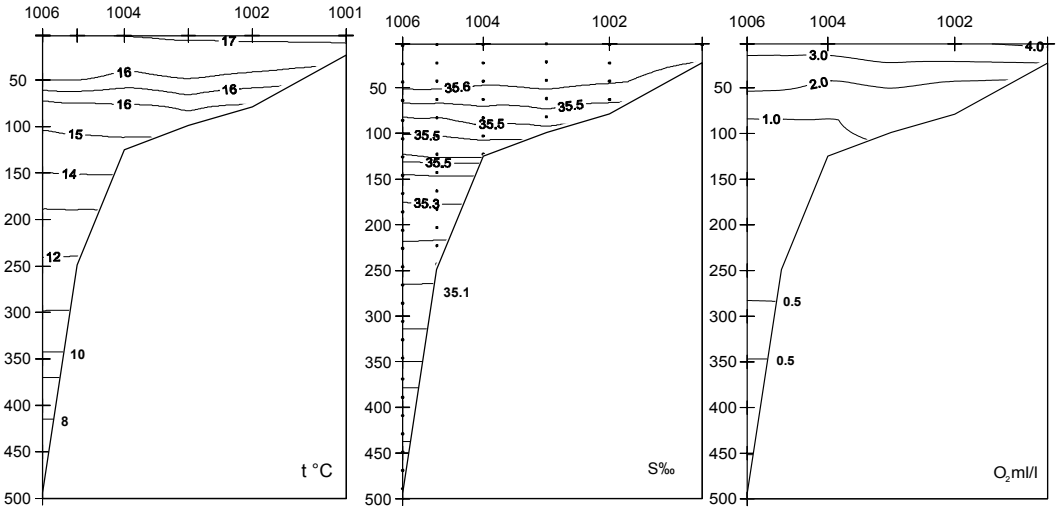


Figure 4h Vertical sections of temperature salinity and oxygen off Pta. Albina

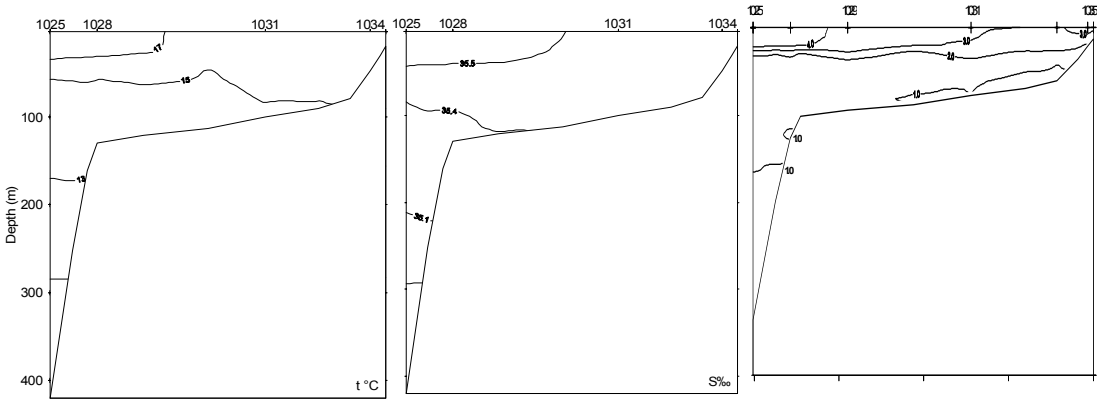


Figure 4i. Vertical sections of temperature salinity and oxygen off Baía dos Tigres

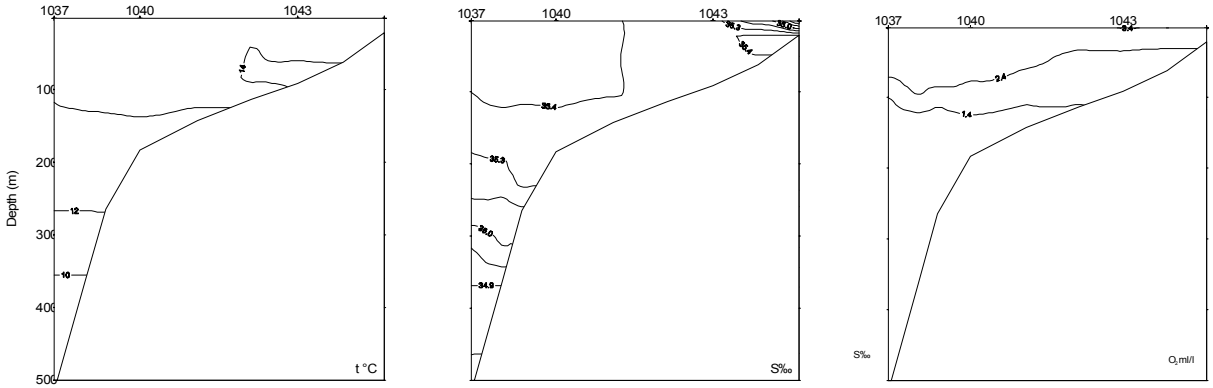


Figure 4j. Vertical sections of temperature salinity and oxygen off Cunene

CHAPTER 4 SEABIRDS AND MARINE MAMMALS

4.1 Aims

Make an inventory of seabird and marine mammal species present in the survey area
Analyse patterns of distribution and abundance in relation to oceanographic features and fish distribution.

4.2 Methods

Counts of seabirds were made during daylight hours from the top-deck of the vessel, which offers excellent viewing conditions. The viewing height above sea level, measured in Luanda harbour, was 14.96 m at mid-deck.

When possible, standard "10-minute counts" of the birds present around the vessel were affected while the vessel was steaming at constant speed and heading. During each count period, all birds detected were counted, discriminating between birds seen actively following the vessel (within an arc of 60^{o} aft), birds flying and birds sitting or feeding. During the counts, scans with binoculars were effected at least once every 2 min to detect inconspicuous species. Care was taken to count individual birds only once, particularly for species prone to follow or circle the vessel, and not to conduct 10 min counts soon after a station or a trawl that had attracted birds to the vessel.

Additional "incidental observations" were made, between counts when scarce or unusual species were observed and while the vessel was on station or during trawling. The time and duration of each observation and count was recorded with watches synchronized to the vessel's in order to match them with the data recorded by the electronic log (position, speed, depth, heading, sea temperature etc.) as well as environmental and biological parameters recorded during the survey. Sightings of marine mammals (Cape fur seals, whales and dolphins) and turtles were recorded following the same format.

4.3 Seabirds

A total of 225 "10-minute counts" were effected between 2 and 15 August 2003. In addition, 49 counts were effected during CTD stations, 18 during trawling and 47 incidental observations were logged. Additional information on the age classes of some species was noted (albatrosses, gannets, gulls). The summary of the species and numbers identified during the above is given in Table 4 for birds and seals, and in Table 5 for cetaceans The distribution of some of the species encountered has been illustrated in latitude-depth plots (Figure 5 to 9).

Table 4. Seabird species and numbers of individuals identified during the 10' observation periods and in total (including CTD, Trawl and incidental sightings). Cape fur seal numbers are also given.

Species	10' obs	total	species	10' obs	total
Diomedea cauta	1	2	*Stercorarius sp*	0	2
Diomedea melanophris	7	8	*Catharacta antarctica*	27	47
Diomedea chlororhynchos	98	154			
			Larus dominicanus	1068	2143
Daption capense	0	5	*Larus cirrocephalus*	5	7
Procellaria aequinoctialis	771	1296			
Puffinus griseus	59	114	*Sterna hirundo*	235	313
Puffinus puffinus	4	5	*Sterna paradisea*	3	3
			Sterna hirundo/paradisea	196	238
Oceanites oceanicus	2524	3156	*Sterna maxima*	4	15
			Sterna sandvicensis	1	2
Phalacrocorax capensis	95	182	*Chlidonias niger*	5	10
Phalacrocorax carbo	29	64			
			Arctocephalus pusillus	127	259
Morus capensis	4564	6449			

Diomedeidae*, Albatrosses:*
Three species of albatrosses were encountered, all migrants from the southern ocean. Most individuals seen at close rage were immature birds except four individual Yellow-nosed albatrosses (out of 154) which were adults. All birds of this species were from the Atlantic race *D. c. chlororhynchos* which breeds at Gough Island and Tristan da Cunha group. All sightings of albatrosses were made in the southern part of the region, south of 14°30'S, but becoming regular and more abundant only south of 16°S. Black-browed (*D. melanophris*) and Shy (*D. cauta*) albatrosses were very scarce and present only south of 16°S.

Procellariidae*, Petrels and Shearwaters:*
Out of four species of this group sighted during the survey, only the Manx shearwater (*Puffinus puffinus*) is a northern hemisphere visitor, all the others coming from the subantarctic region of the southern ocean. Only 5 sightings (of single birds) were made of the Manx shearwater, one at 12°30'S and all the others south of 16°S. The White-chinned petrel (*Procellaria aequinoctialis*) was found at low densities and only offshore between 10°30'S, 14°00'S, then became regular to abundant south of 14°S. All individuals sighed were from the nominal race and not the spectacled form (*P. a. conspicillata*) breeding at Inaccessible Island (Tristan da Cunha Group). The Cape petrel, *Daption capense*, was very scarce, only 4 sightings all south of 15°36'S. The Sooty shearwater was scarce between 11°S and 15°30'S (12 sightings of single birds) becoming more frequent further south. This species was restricted to deep waters beyond the shelf break in the northern half of the survey area, becoming more widespread onto the shelf south of 14°S.

Hydrobatidae*, Storm-petrels:*
Only one species of this group was recorded: the Wilson's storm petrel (*Oceanites oceanicus*), a migrant from the southern ocean. This species was widespread and abundant but with marked variations in densities. It was most abundant at the shelf break and offshore between 10°50'S and 12°45'S, and south of 17°00'S, while far less common between 13°00'S and 16°30'S. This species is a zooplankton surface feeder and its association with frontal zones and surface slicks is an indication of areas of zooplankton concentration at the surface.

Locally it was observed in extremely high densities associated with frontal zones, particularly in the Quicombo area (11°15'S, 110 m depth).

Sulidae*, Gannets:*
The Cape gannet, *Morus capensis*, proved to be the most abundant and widespread seabird during the survey. Interestingly, of the 1593 individuals that were aged, 60,4% were in adult plumage, 30,1% were immature or sub adults and 9.5% were juveniles. This proves that Angolan waters are an important feeding and wintering area for all age classes of this vulnerable southern African endemic species. The proportion of adults was slightly higher than during the 2002 survey (50%, N = 1197) this difference being most probably linked to the fact that the 2002 survey occurred one month later and that breeding adults start arriving at their breeding islands in Namibia during September. The highest densities of this species were observed primarily offshore between 11° 10'S and 12° 10'S as well as south of 16°S, while between 12° 30' and 16°S, numbers were generally much lower.

Phalacrocoracidae, Cormorants:
Only two cormorant species were recorded during the survey, and only in coastal waters. *Phalacrocorax carbo* is suspected to breed at several locations in the southern region from 13°15'S to Baía dos Tigres. The Cape cormorant *P. capensis*, an endemic species from the Benguela Current region, was observed only in the south (from about 15°S). This species is most probably breeding at Baía dos Tigres. A third species, the Reed cormorant, *Phalacrocorax africanus*, more associated with fresh inland waters, was observed in Luanda bay but not included in the survey.

Stercorariidae, Skuas:
Only one *Stercorarius* species (probably *Stercorarius parasiticus*) was recorded in extremely low numbers (only 2 individuals). This contrasts greatly with the 2002 results when 60 individuals of 3 species were sighted. This difference being certainly due to the earlier dates of the 2003 survey before the arrival of the bulk of these Palaearctic migrants in the region. The subantarctic skua, *Catharacta antarctica* on the other hand, a visitor from the southern ocean, was slightly more frequent than in 2002 (47 sightings versus 32 in 2002) and geographically distributed in the same widely separated areas as last year: with a concentration in the Quicombo region (11°08'S – 11°16'S) and south of 16°S.

Laridae*, Gulls:*
Of the four species of gulls recorded in 2002, two species, both palearctic migrants, were not sighted this year (*Larus fuscus* and *L. sabini*). The Grey-headed gull (*Larus cirrocephalus*), is a resident associated with coastal and inland waters which was sighted in the vicinity of estuaries. The Kelp gull (*L. dominicanus vetula*), is endemic from Southern Africa and was widespread throughout the survey area with a marked increase in abundance south of 16°S.

Sternidae*, Terns:*
Five of the six species recorded, are palearctic migrants (*Sterna hirundo, S. paradisaea, S. sandvicensis, and Chlidonias niger*). *S. hirundo* was widespread throughout the area but in much lower numbers than during the 2002 survey; again probably the effect of an earlier date on the abundance of palearctic migrants. *C. niger* was very scarce with only 3 sightings totaling only 10 individuals (more than 300 were sighted in September 2002).

The tropical *Sterna maxima* was observed on only four occasions (totalling 15 individuals) between 10°30'S and 12°42'S. Despite its scarcity, this matches well the distribution observed

during the 2002 survey when 85 individuals were sighted between 9°S and 13°25'S, with most of the sightings made north of 10°30'S (area not surveyed during this leg in 2003).

4.4 Marine mammals

Cape fur seal *Arctocephalus pusillus:*
Fur seals were present in small numbers north of 12°30'S, absent between 12°30'S and 14°S, and becoming regular and abundant south of 16°S. It is generally restricted to the shelf in waters of less than 200 m depth except between 14°S and 15°S were the shelf is extremely narrow.

Cetaceans:
The summary of the cetacean sightings made during this part of the survey is given in Table 5 and Figure 9.

Most of the rorqual sightings are believed to be of the Bryde's whale, *Balaenoptera edeni*, although only one individual could be positively identified at close range. Several rorquals including that of a *B. edeni* cow-calf pair were sighted in the same area during the September 2002 survey. These observations possibly indicate a regular breeding/feeding ground for this species in winter and spring in Angolan waters between 10°S and 12°S.

Four sightings of Humpback whales, *Megaptera novaeangliae*, were made during this survey, all between 100 and 200 m depth. The sighting of Killer whales, *Orcinus orca*, is believed to be only the second sighting of this species in Angolan waters (one sighting was made during the 2002 survey). The presence of the Heaviside's dolphin, endemic to the Benguela, in the Baía dos Tigres area is a confirmation of the suspected northern limit of distribution of this species and of its presence in the extreme south of Angolan waters.

Turtles:
Marine turtles were encountered during 15 sightings for a total of 24 individuals. From the shape of the carapace they were identified as either loggerhead (*Caretta caretta*) or Olive Ridley (*Lepidochelis olivacea*) turtles. The sightings were concentrated between 10° 23'S and 11°08'S and depths ranging from 85 m to 700 m. In addition, in the same area (11°03'S, 13° 30'E), during a night pelagic trawl over depths of 240 - 330 m, a turtle was caught, together with myctophids, and released alive. It was identified as *L. olivacea* (D. Zaera) and it is likely that the other sightings in this region are from the same species.

Table 5. Summary of cetacean sightings

Species	number	date	time	log	depth	Wtemp	lat	long	est. distance	remarks
			local		m		decimal	decimal	km	
Balaenoptera sp	1	2-aug-03	16:26	6076.0	20.6	21.6	-10.395	13.516		probable Bryde's whale
Balaenoptera sp	2	3-aug-03	07:02	6185.0	99.4	22	-10.756	13.522	1.8	Sei or Bryde's whale 1 mile apart
M. novaeangliae	2	3-aug-03	07:05	6186.0	106.2	22.1	-10.764	13.507		sounding in synchrony 5m apart
Stenella sp	60 - 80	3-aug-03	08:35	6199.2	502.2	21.9	-10.855	13.305	1	tight school
large baleen whale	1	3-aug-03	16:31	6247.0	35.6	21.3	-10.808	13.718	3.5	Only blow visible
Balaenoptera sp	1	3-aug-03	16:46	6248.9	42.6	21.2	-10.837	13.713	0.5	Sei or Bryde’s whale
O. orca	2	4-aug-03	11:00	6379.0	153.4	21.8	-11.134	13.598	1.8	travelling West
M. novaeangliae	1	5-aug-03	08:35	6540.0	140.7	20.6	-11.635	13.405	1.8	travelling North
M. novaeangliae	2	5-aug-03	09:05	6545.8	113.5	20.9	-11.637	13.503		20 m apart
Balaenoptera sp	1	6-aug-03	12:50	6747.9	298	20.7	-12.115	13.427	3.5	Sei or Bryde's whale
Balaenoptera sp	1	6-aug-03	14:16	6755.2	109.6	20.6	-12.127	13.454	7.5	possibly same as previous
Balaenoptera sp	1	6-aug-03	14:55	6759.0	474.9	20.6	-12.108	13.408	7.5	
Balaenoptera sp	2	6-aug-03	15:00	6761.0	621.9	20.9	-12.098	13.376	1.8	Sei or Bryde's whales, 200m apart
Balaenoptera sp	1	6-aug-03	15:30	6765.1	771.4	20.7	-12.114	13.329		Sei or Bryde's whale
Balaenoptera edeni	1	6-aug-03	15:34	6766.9	808.4	20.8	-12.142	13.318	0.03	ridges on rostrum visible
Balaenoptera sp	1	6-aug-03	16:40	6778.0	98.6	20.7	-12.229	13.458	3.5	same blow as Bryde's
T. truncatus	17 - 20	7-aug-03	14:57	6917.0	454.7	20.8	-12.629	13.068	0.6	travelling north
M. novaeangliae	3	12-aug-03	15:40	7560.4	195.6	16.4	-15.810	11.677	0.05	
C. heavisidii	4 - 6	14-aug-03	10:55	7836	38.3	15.5	-16.609	11.656		2 then 4 individuals 3 minutes apart
L. obscurus	6 -10	15-aug-03	09:15	8013.3	119.6	13.8	-17.105	11.504		one individual with barnacle on dorsal fin

4.5 Patterns of abundance:

On a broad scale and according to seabird and marine mammal distribution observed during the 2002 and 2003 surveys, southern Angolan waters can be divided in 4 distinct zones (the latitudinal limits given below are approximate and the description of the patterns only for late winter and spring).

a) 9°30'S to 12°30'S
This area is characterized by:

- Presence of the tropical Royal tern *Sterna maxima* inshore
- Presence of the Sooty shearwater *P. griseus* at low densities in deep waters only
- Presence of White-chinned petrel at low density at the shelf break and beyond
- Absence of Albatrosses, Cape Petrel, Cape cormorant
- Concentration of turtles (probably *Lepidochelis olivacea*) around the shelf break
- Low densities of the Cape fur seal *A. pusillus*, on the shelf
- Presence of *Balaenoptera sp* (probably *B. edeni*)

In the southern half of this zone, a small area stands out at around 11°10'S - 11°15'S (the "Quicombo area"). In this area exceptionally dense aggregations of Wilson's storm petrels can be found marking the steep shelf break (indicating concentrations of zooplankton along a frontal zone). Also associated with this feature is the unexpected presence of the Subantarctic skua (*C. antarctica*) noted during the 2002 and 2003 surveys. This species is otherwise found only south of the Angola - Benguela Front.

b) 12°30'S to 14°30'S
This area is noticeable because of the general low densities of all seabird species and is characterized by

- Absence of the tropical Royal tern
- Lowest density of the four most abundant and widespread species, Wilson's Storm petrel, White-chinned petrel, Kelp gull and Cape Gannet
- Absence of *Balaenoptera* sp and Turtles
- Absence of Cape fur seal to 14°S, and very low abundance to 14°30'S

c) 14°30'S to 16°00'S
This area seems to constitute a transition zone with the appearance at low density of some species more common further south such as Yellow-nosed albatross *Diomedea chlororhynchos*, Cape cormorant *Phalacrocorax capensis* and Cape petrel *Daption capense* and a slight increase in fur seal abundance.

d) 16°00'S to 17°15'S
South of 16°S, the avifauna changes dramatically and is marked by a large increase in density of many subantarctic species (Yellow-nosed albatross, Cape petrel, Sooty shearwater, Subantarctic skua, White-chinned petrel) as well as Benguela current region endemics (Cape gannet, Cape cormorant, Kelp gull). The density of Cape fur seal increases dramatically as well at around 16°S.

New sub-antarctic species more common in Namibian waters at this time of the year appear in this area (Black-browed albatross, Shy albatross) and marine mammals characteristic to the Benguela upwelling region are also present (Heaviside's dolphin, Dusky dolphin).

The following figures give examples of distribution of the main species using all records (Figure 5 to Figure 7) and of the highest densities of the most common and widespread species, using the 10-minute counts only (Figure 8). These data are plotted according to Latitude and depth (on a log scale). Figure 9 displays in the same format the sightings of cetaceans and turtles.

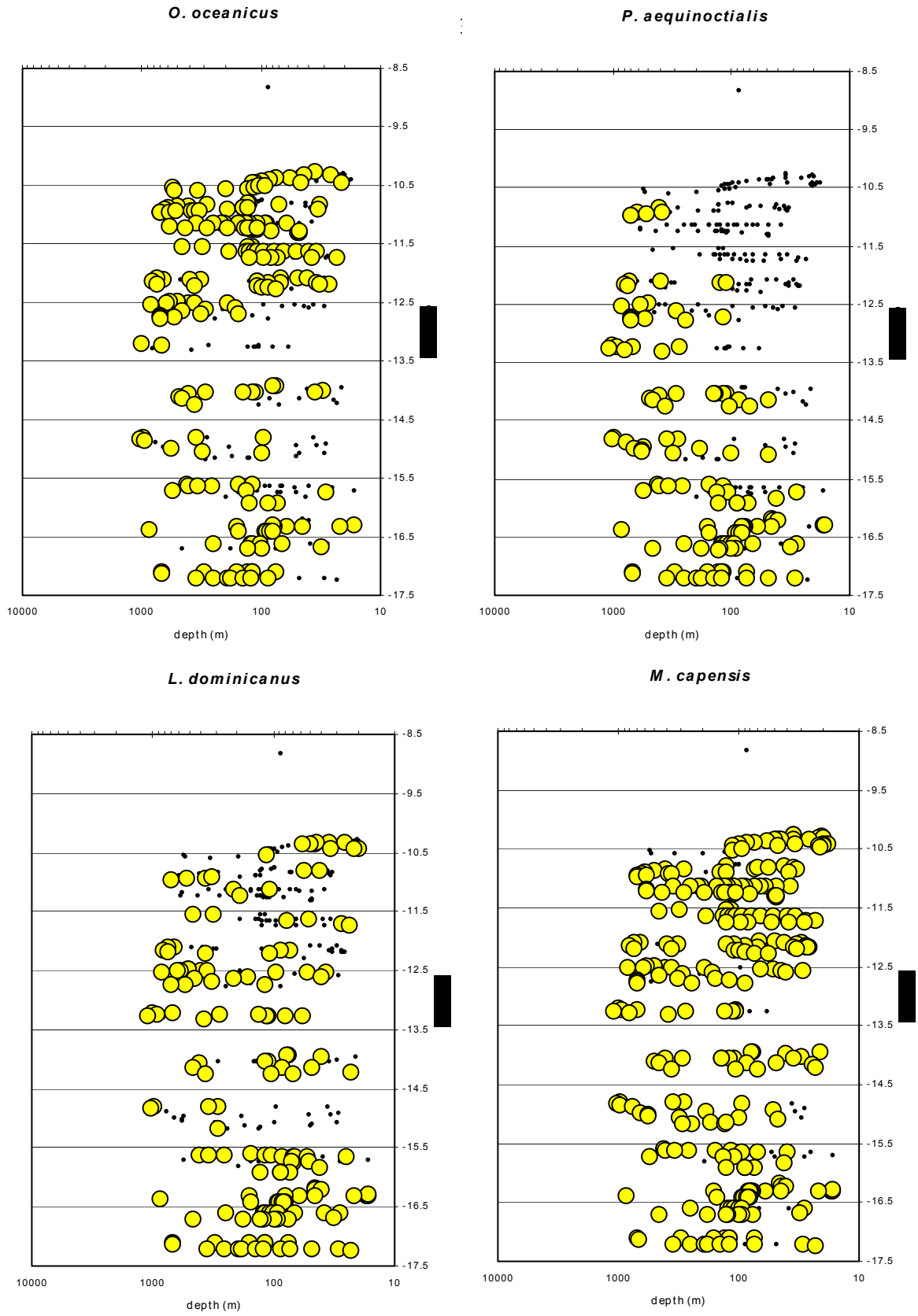


Figure 5. Distribution (presence/absence using all records) of Wilson's storm petrel, White-chinned petrel, Kelp gull and Cape gannet

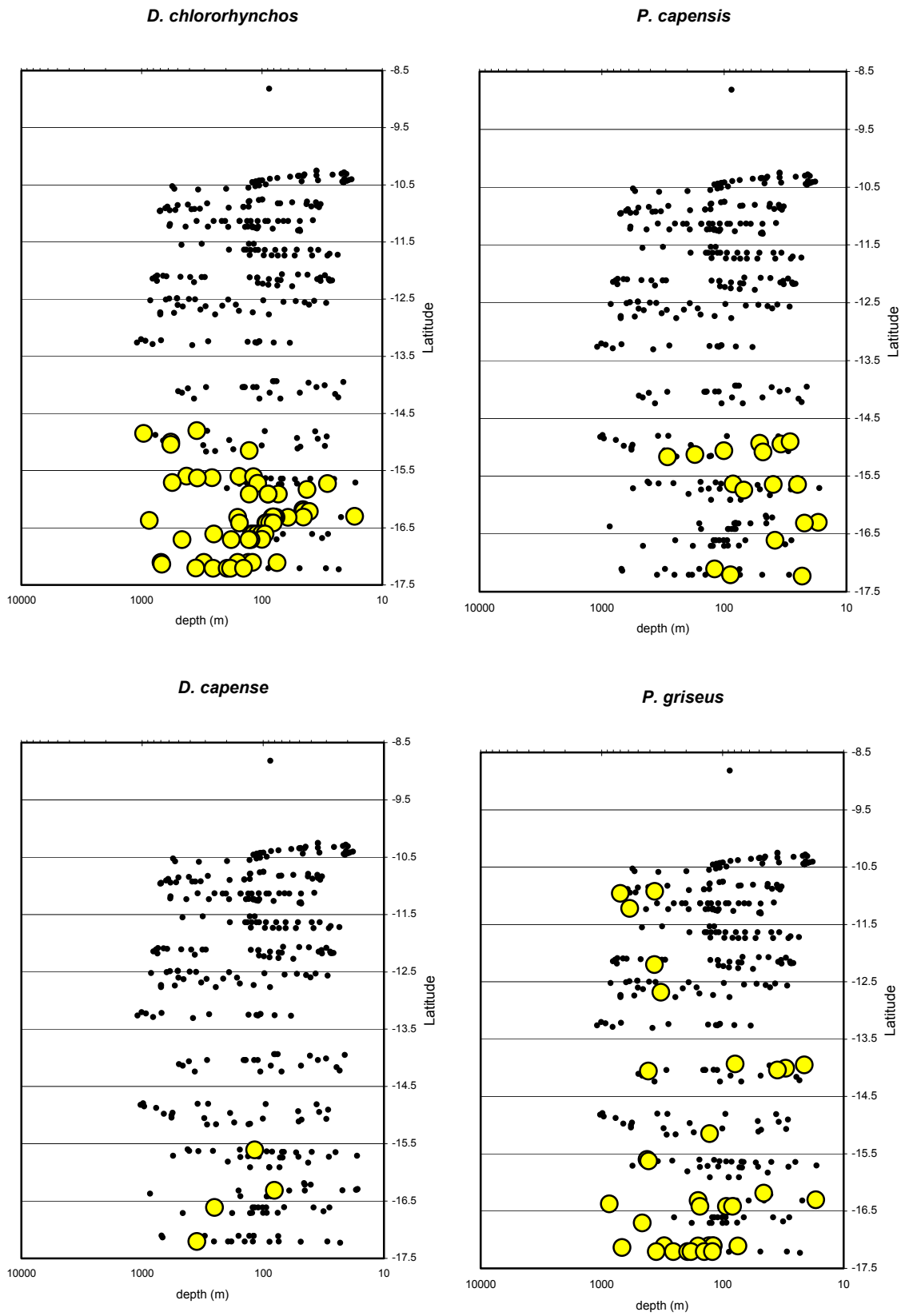


Figure 6. Distribution (presence/absence using all records) Yellow-nosed albatross, Cape cormorant, Cape petrel and Sooty shearwater

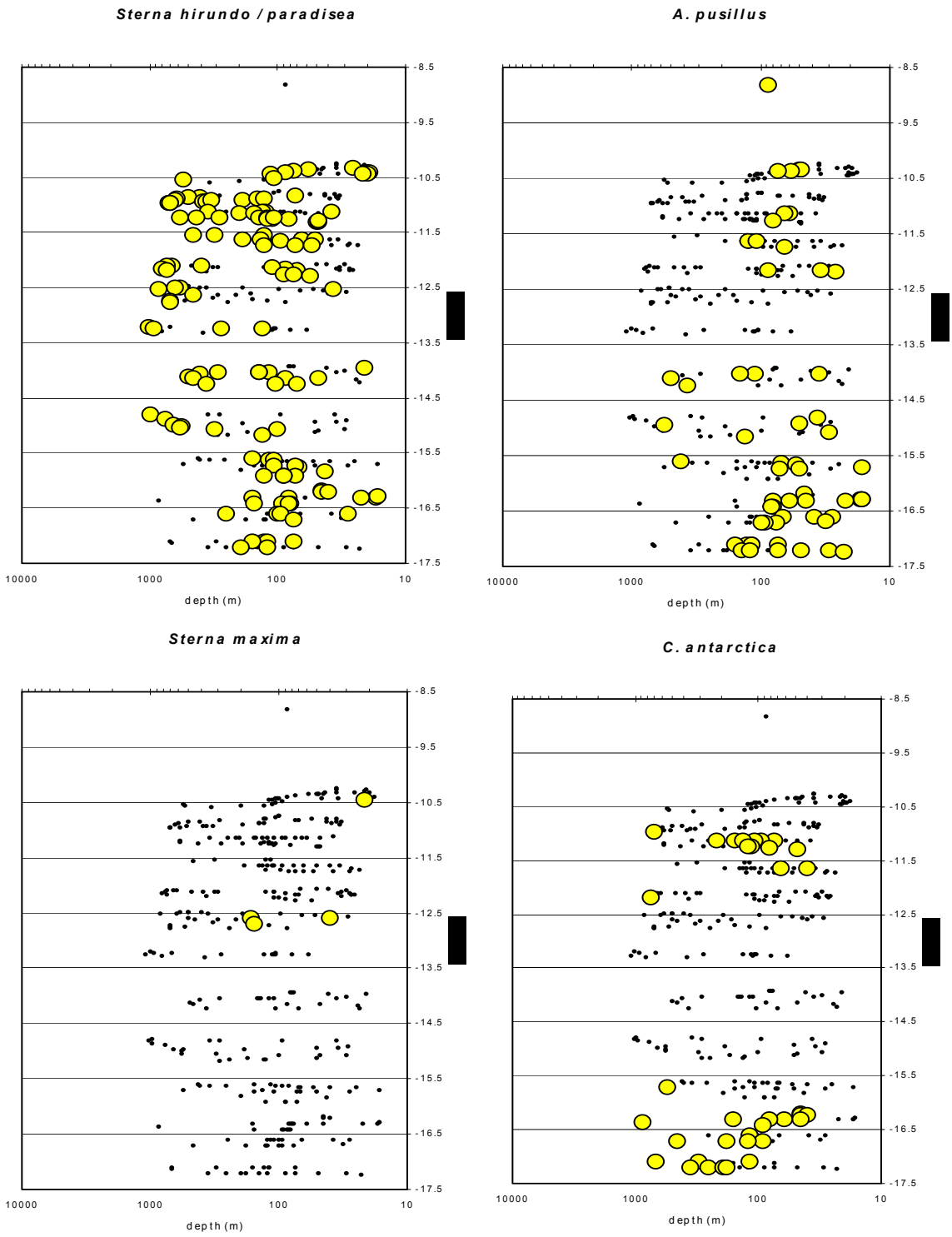


Figure 7. Distribution (presence/absence using all records) of Common/Arctic tern, Cape fur seal, Royal tern and Subantactic skua

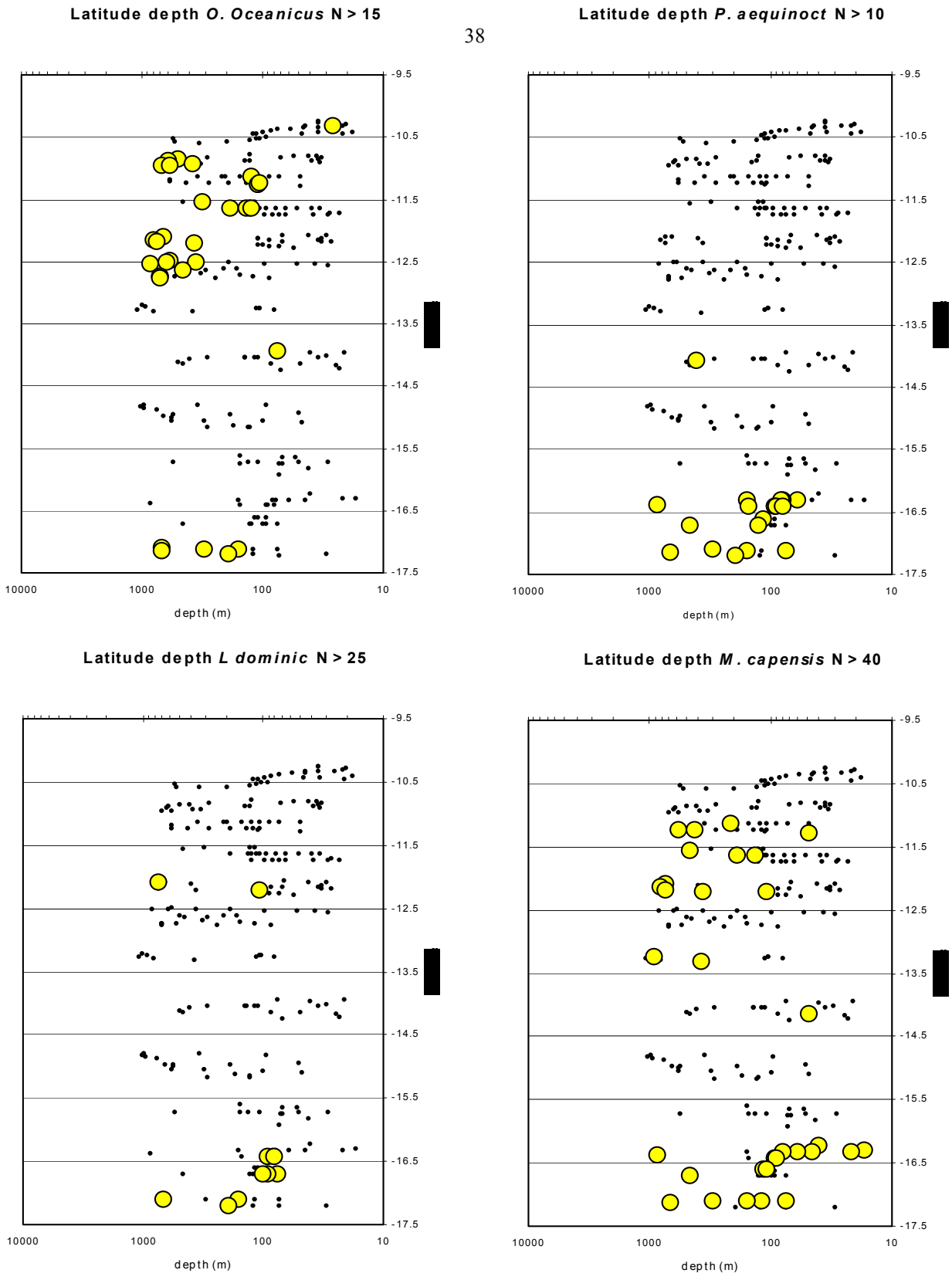


Figure 8. Distribution of high densities of Wilson's storm petrel, White-chinned petrel, Kelp gull and Cape gannet (data from 10 minute counts only)

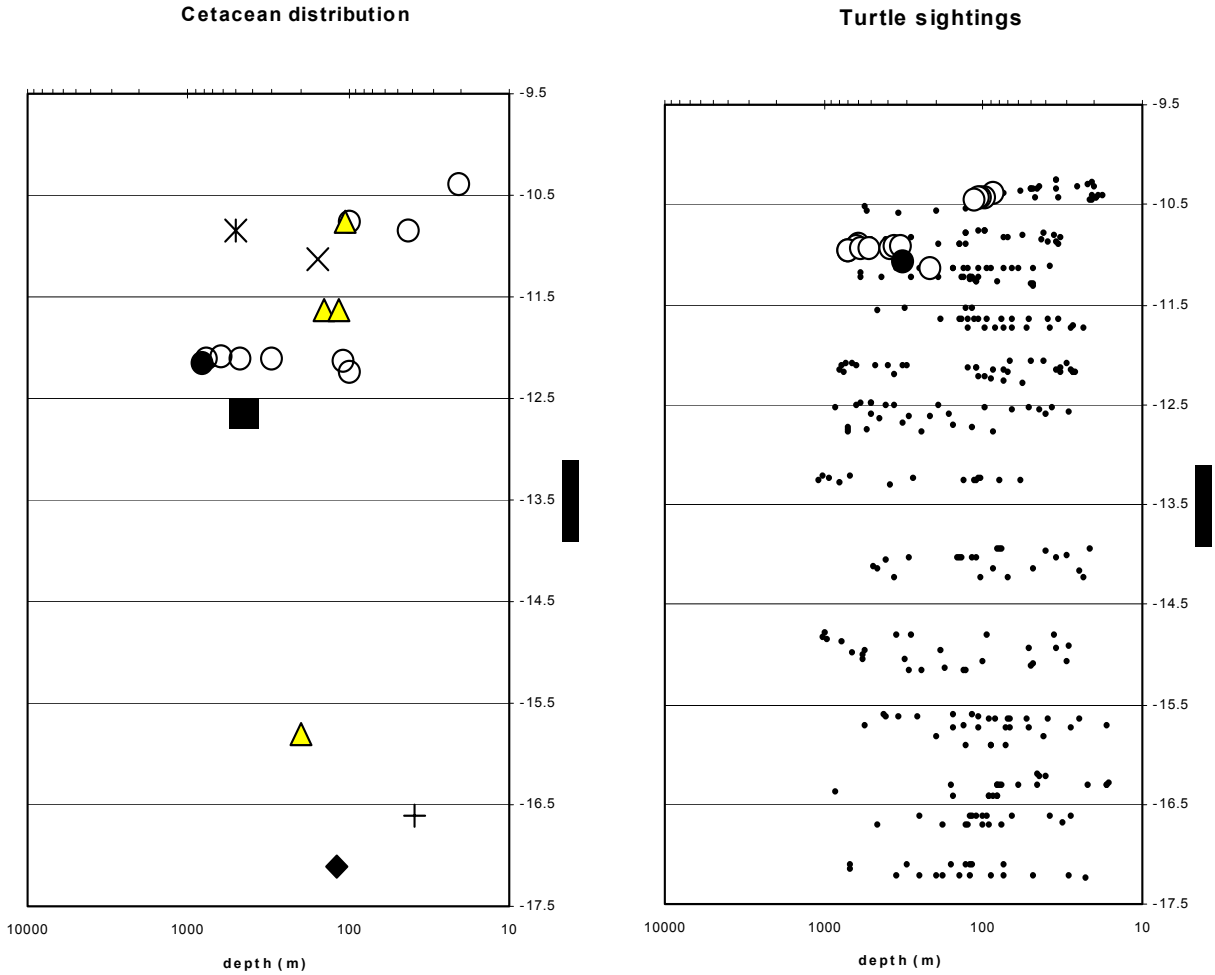


Figure 9. a) distribution of cetacean sightings: Balaenoptera sp. (open circles), Balaenoptera edeni (full circle), Megaptera novaeangliae (triangles), Orcinus orca (X), Stenella sp (*), Tursiops truncatus (square), Cephalorhynchus heavisidii (+) and Lagenorhynchus obscurus (diamond), b) distribution of turtle sightings (open circles) and catch position of Lepidochelis olivacea (full circle)

Storm petrel distribution and frontal zones

Throughout the survey Wilson's storm petrels were found associated with surface slicks (and the wake of the ship). It is thought that some of the visible slicks correspond to local zones of increased density of zooplankton near the surface. A finer analysis of the patterns of distribution of this species and its association with frontal zones (using oceanographic data, acoustic data and bird counts) will probably demonstrate the linkages between those oceanographic features, plankton distribution and bird density and behaviour. One of the most dramatic examples of the affinity of the Wilson's storm petrel for such features was observed in the Quicombo area as illustrated in Figure 10.

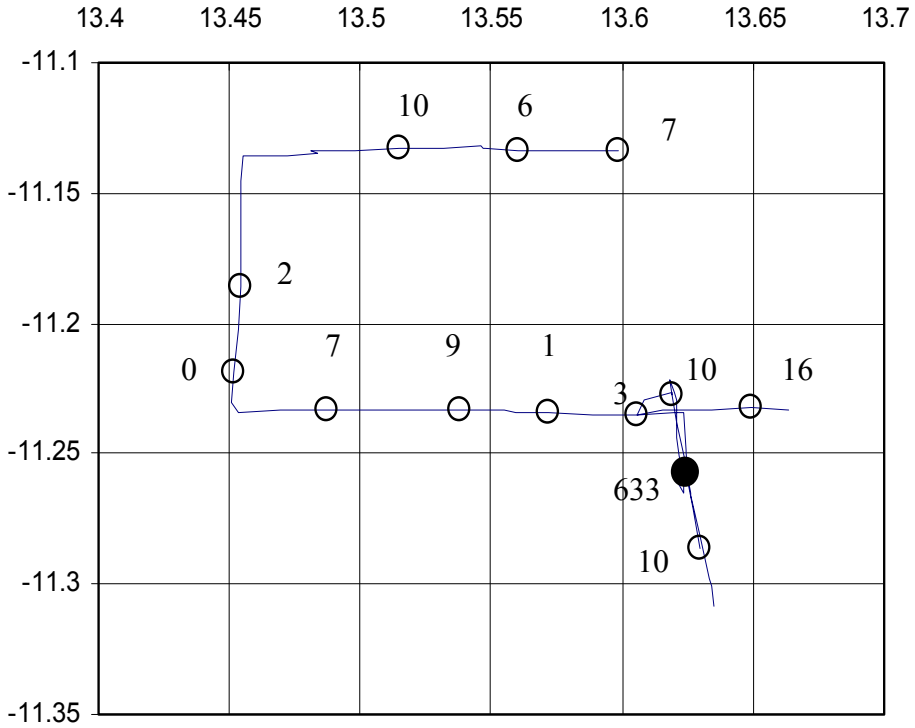


Figure. 10: Track of the vessel on 4 August 2003 in the Quicombo area. The circles show the position of the mid point of the 10 minute counts, the numbers of Wilson's storm petrels counted are indicated. The crossing of the "Quicombo divergence" occurred during the count indicated by the full circle

4.6 Conservation concern

A number of seabirds present in Angolan waters in winter and spring are susceptible to bycatch by longline fisheries (as well as direct catch from small crafts). These include particularly all species of albatrosses, petrels and shearwaters as well as the Cape gannet. Bycatch by long-line fisheries in the southern hemisphere has impacted widely on many species of seabirds and, despite major international efforts to limit the problem, is threatening the survival of several species of albatrosses and petrels. In Namibia, the Cape gannet continuing population decline and the deterioration of its conservation status (the population declined by half in the past decade) has been attributed to trophic factors (and particularly the decline in the pilchard stock) as well as increased bycatch by the long-line fishery that have developed in Namibia since the early 1990s.

The sightings during the 2002 survey of small vessels using floating lines to catch seabirds in the southern part of the area (and targeting both White-chinned petrels and gannets, together

with the realization of the importance of Angolan waters for all age classes of gannets at this time of the year causes some concern. The high incidence of Cape gannets sighted in southern Angola during this survey (particularly south of Tombua) with remnants of lines and hooks in their beaks attests to the reality of this potential threat which might be impacting negatively on the threatened Namibian gannet population.

CHAPTER 5 DISTRIBUTION, SIZE COMPOSITION AND BIOMASS ESTIMATES

5.1 Pta. das Palmerinhas - Congo River

Sardinella
Both sardinellas, *Sardinella maderensis* and *S. aurita,* were, as in previous surveys, found along the northern region between N'zeto and Luanda (Figure 11). Additionally patchy distributions of both species were found around the oilfields off Cabeça de Cobras, north of N'zeto, and south of Luanda in relatively deep water (>100 m depth). *S. maderensis* dominates in most of the distribution area. The acoustic densities in the northern region were generally low but with some high-density spots inshore. As observed in previous surveys, the sardinella was usually schooling near the surface during the day, while forming loose aggregations at night. Sardinella is hard to sample during dense schooling and most samples are therefore obtained at night. The area around Cabeça de Cobra was only partly surveyed because of the oil installations and some sardinella might have been missed inshore in this area.

Figure 12 shows the length frequency distribution of *S. maderensis* and *S. aurita*. This year relatively large juvenile cohorts are visible for both species. The *S. maderensis* ranged from 5 cm to 35 cm total length, with several modal peaks representing different year classes. The length distribution of *S. aurita* shows a juvenile cohort at 8 cm. No clear modal peak is apparent for the adult part of the stock. The high prevalence of fish <10 cm in the region suggest that these have been spawned in this area earlier this year as it is unlikely that they have migrated across the Congo river from the larger spawning areas there.

The biomass of sardinella was estimated at 153 000 tons, which is lower than the last two year's estimates, 178 000 tons in 2002 and 177 000 tons in 2001. Of this, about 117 000 tons was *S. maderensis*, compared to 99 000 tons last year, while 36 000 tons was *S. aurita*. This is half of last year estimate of 78 000 tons.

The splitting between species is, however, very sensitive to sampling intensity while the total estimate should be more robust. Figure 13 shows the cumulative distribution of the biomass for both species. For *S. maderensis*, the bulk of the biomass (90%) consisted of individuals >23 cm (2002: 26 cm), while most of the *S. aurita* was juveniles >10 cm compared to last year when 90% of the biomass was >24 cm.

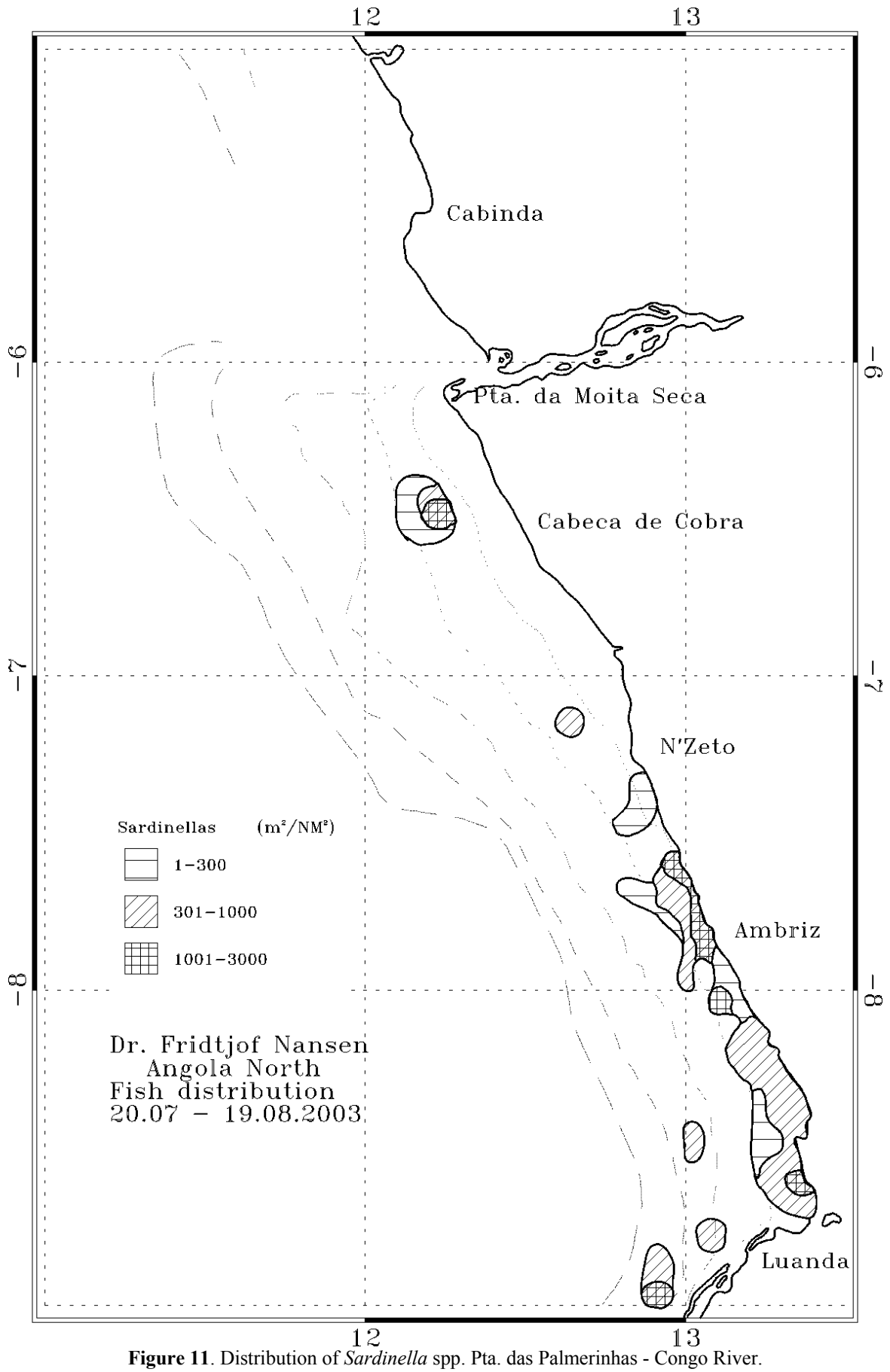
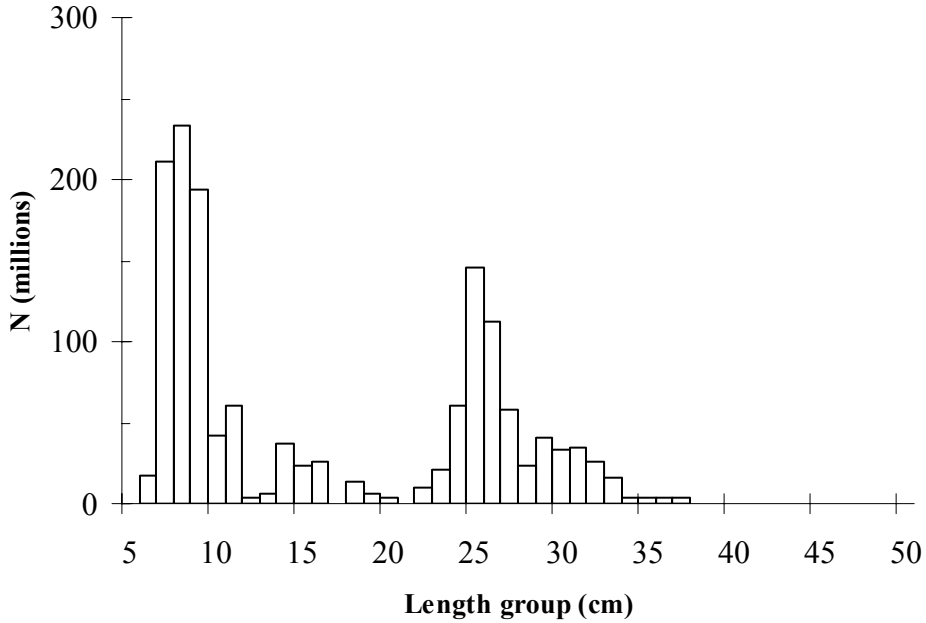


Figure 11. Distribution of *Sardinella* spp. Pta. das Palmerinhas - Congo River.

a) *Sardinella maderensis*



b) *Sardinella aurita*

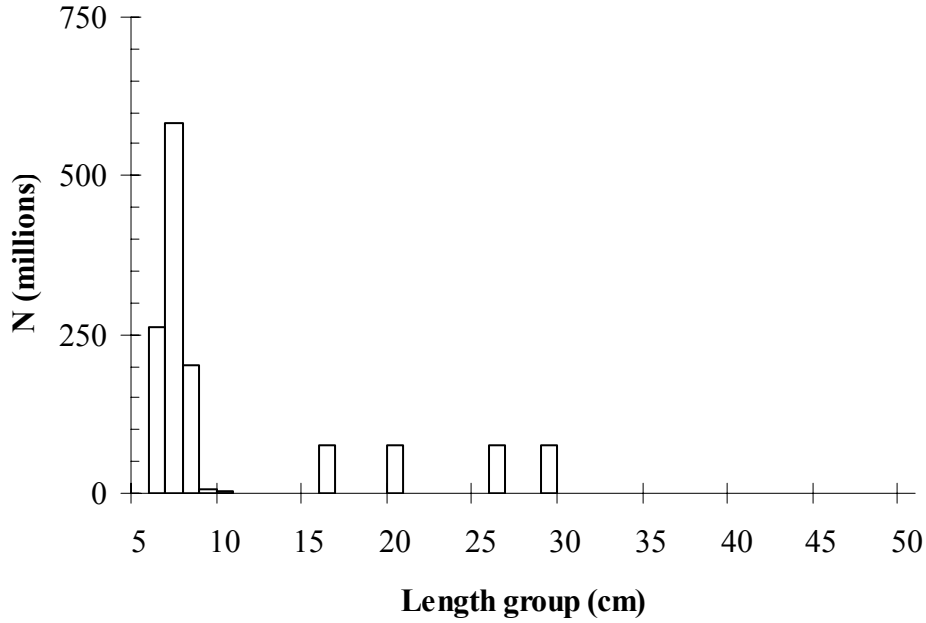
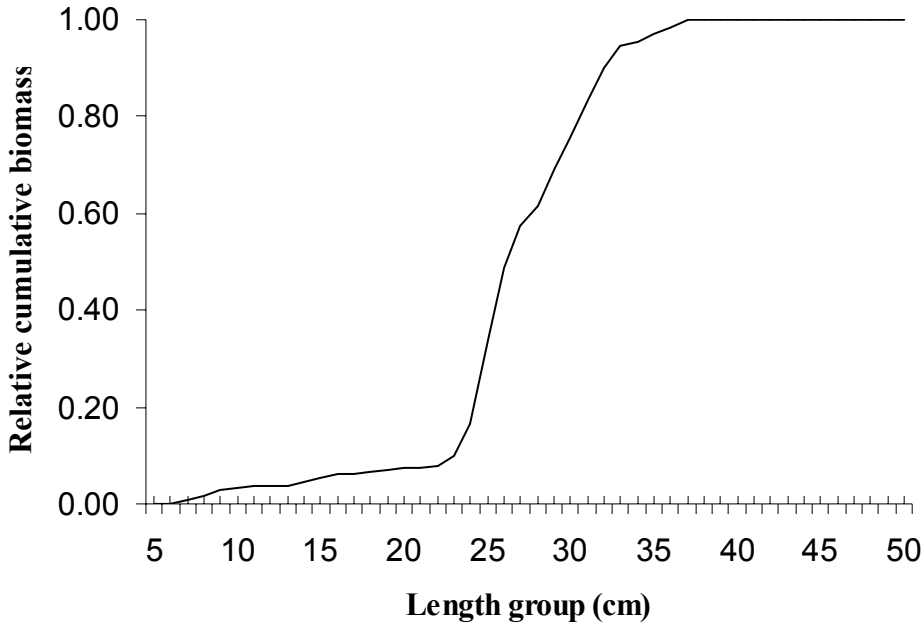


Figure 12. Total length distribution of *Sardinella maderensis* (a) and *S. aurita* (b), Pta. das Palmerinhas - Congo River

a) Sardinella maderensis



b) *Sardinella aurita*

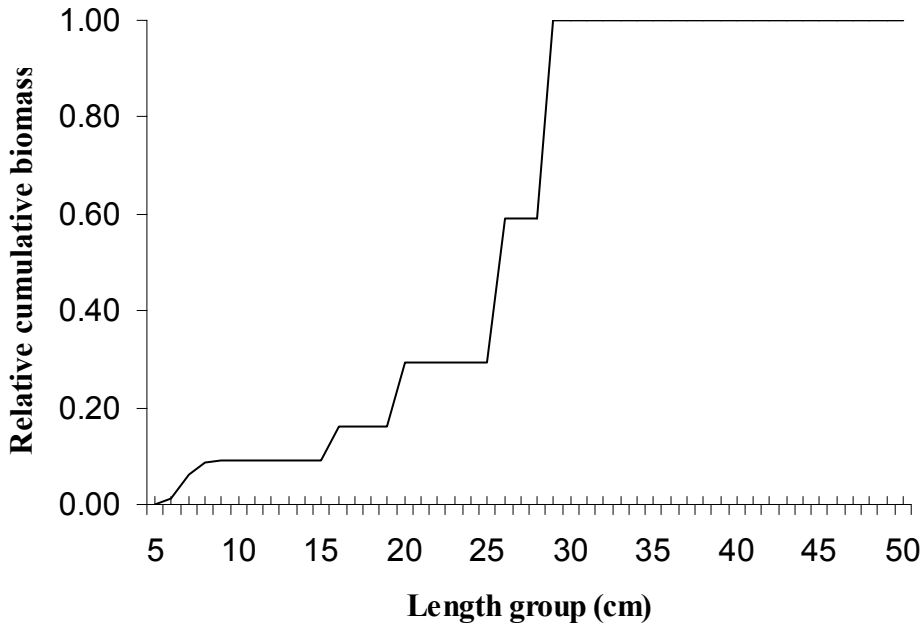


Figure 13. Relative cumulative biomass *Sardinella maderensis* (a) and *S. aurita* (b), Pta. das Palmerinhas - Congo River

Cunene horse mackerel

The Cunene horse mackerel, *T. trecae,* was found scattered in seven relatively small, low density (s_A<300 m^2 /NM^2) areas (Figure 14) along the shelf break between 100 and 200 m depth. The distribution pattern was similar to that during the survey in 2002.

Figure 15 shows the length frequency distribution of horse mackerel for the region. The modal peaks are visible in the size distribution with one mode around 7 cm representing fish spawned this year, one mode around 13 cm and one mode at about 30 cm.

The estimated biomass of *T. trecae* was 12 000 tons compared with 31 000 tons in 2002 and 3 000 tons in 2001. Most of the biomass (90%) was comprised of fish >12 cm total length (Figure 16), this is similar to last year (13 cm).

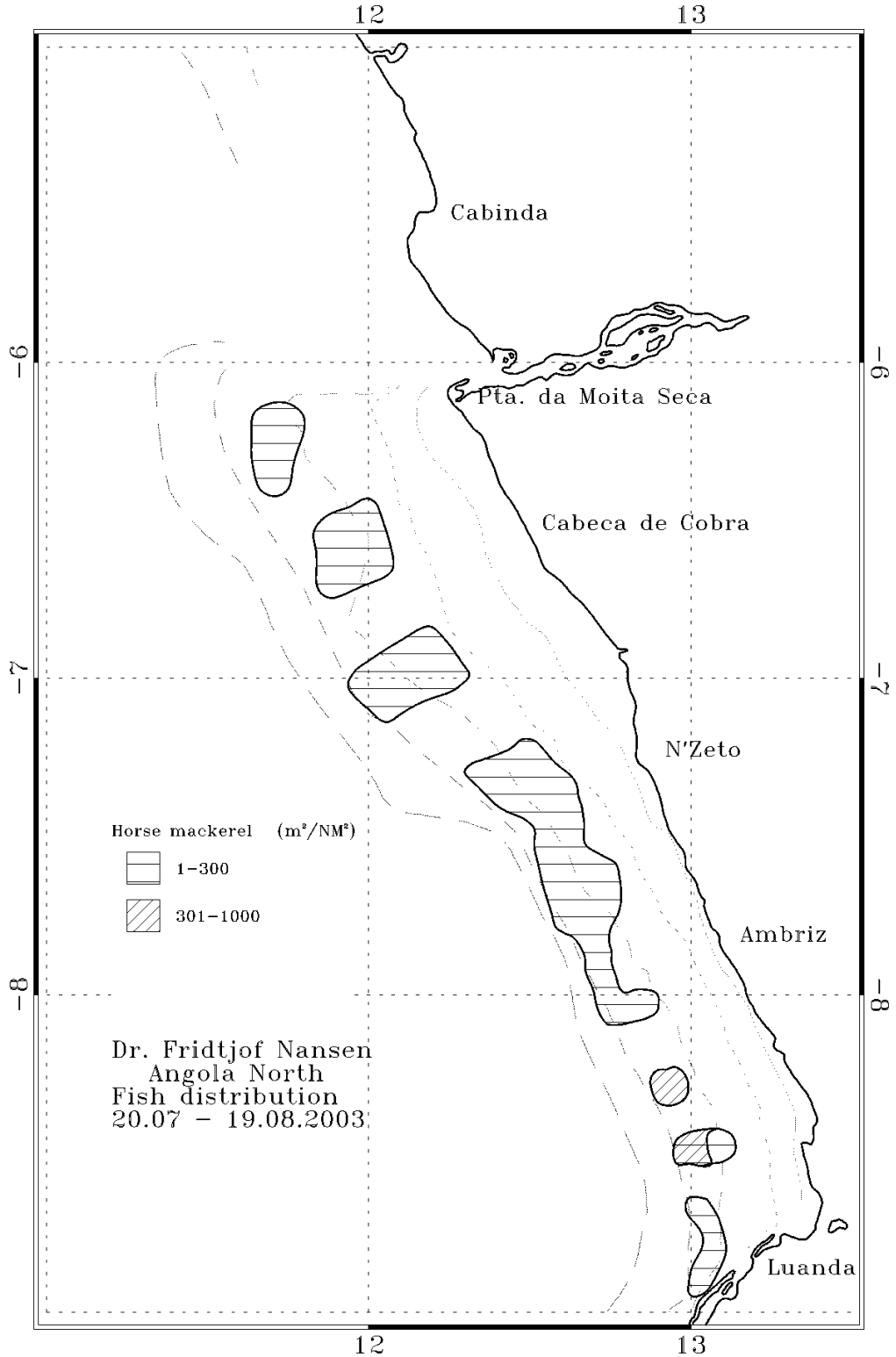


Figure 14. Distribution of Cunene horse mackerel (*Trachurus trecae*), Pta. das Palmerinhas - Congo River

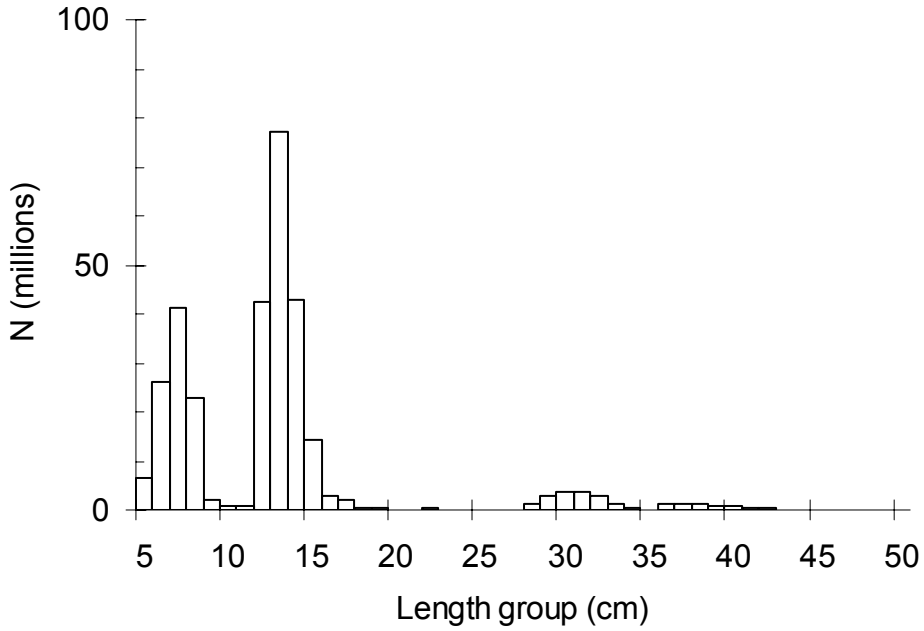


Figure 15. Total length distribution of Cunene horse mackerel (*Trachurus trecae*), Pta. das Palmerinhas - Congo River

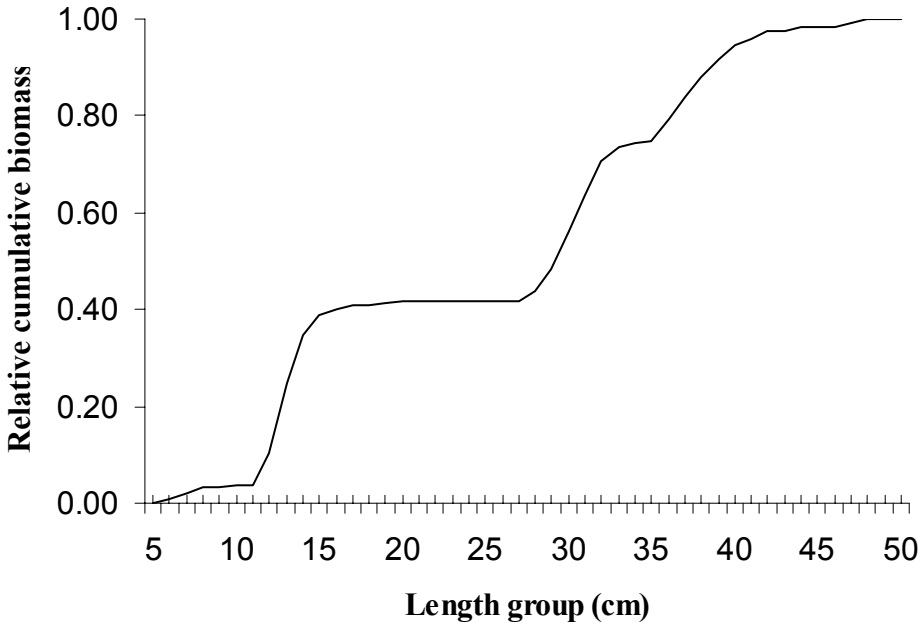


Figure 16. Cumulative percentage biomass by length group, *Trachurus trecae*. Pta. das Palmerinhas - Congo River

Pelagic species Group 1

Pelagic species group 1 was not abundant enough to be estimated in the northern region.

Pelagic species Group 2

This category, which includes members of the family Carangidae (other than *Trachurus* sp.), Scombridae, Sphyraenidae and *Trichiurus lepturus*, was found in four main areas throughout

the region (Figure 17). The hairtail (*T. lepturus*), *Decapterus rhonchus* and *Selene dorsalis* were the dominant species groups (Table 6).

The biomass of pelagic fish group 2 was estimated at 23 000 tons, based on an average length of 30 cm and a condition factor equal to 0.01. This is considerably more than the 1 600 tons estimated in 2002 but lower than the estimated 45 000 tons in 2001.

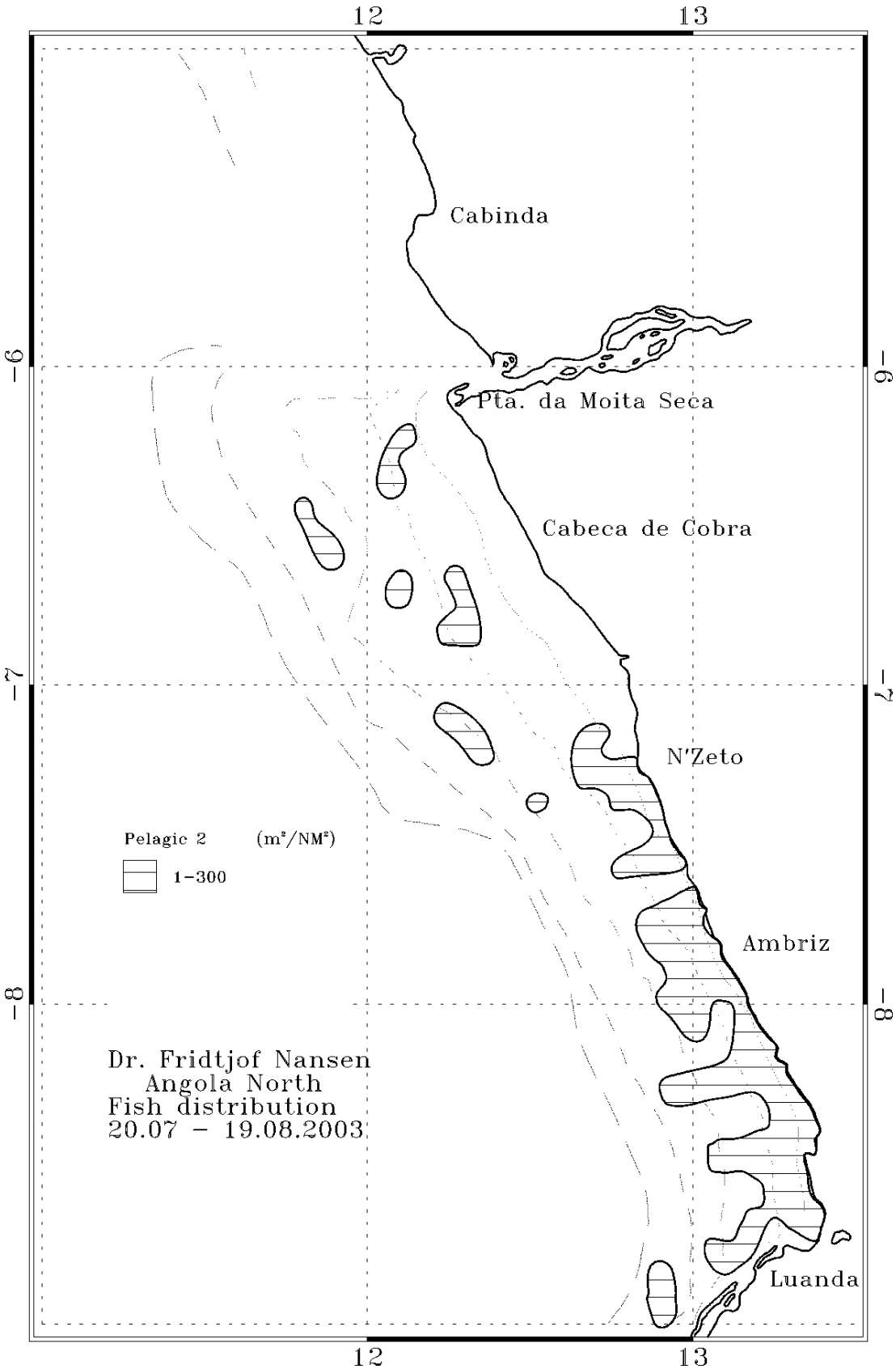


Figure 17. Distribution of pelagic species Group 2, Pta. das Palmerinhas - Congo River

Table 6. Catch rates (kg/h) of the main groups of pelagic fish, Pta. das Palmerinhas - Congo River

Station No.	Depth	Clupeids	Carangids	Scombrids	Hairtails	Barracudas	Other
3196	119		74.60				518.44
3197	110						
3198	88						
3199	40	0.41	1.66		0.04		1.99
3200	230		0.06	7.68			17.10
3201	23			11.74			0.20
3202	122		3.20				421.40
3203	123		229.30		1.62		307.26
3204	30						
3205	20		1.64				0.42
3206	30		13.95		35.70		56.55
3207	5	23.20	17.08			1.68	20.08
3208	45				6.88		0.46
3209	21	3.94	0.54		0.34		83.78
3210	10	1350.25	10.50		14.50	8.25	232.00
3211	48				4.95		0.40
3212	64		221.40	2.64	43.50		645.60
3213	15	13.80	6.76		2.40	7.10	30.50
3214	15	0.94					2.30
3215	126		126.86		14.70		276.36
3216	15	142.72	1.84	28.76	40.00		24.44
3217	185				1.24		17.96
3218	20	1.77	19.86		122.25		17.25
MEAN		66.83	31.71	2.21	12.53	0.74	116.28

5.2 Benguela - Pta. das Palmerinhas

Sardinella
Sardinella was, as last year, found throughout the region, primarily on the inner part of the continental shelf from the coast to the 50 m isobath. The distribution was continuous from north of Cabo Ledo to Cabeça da Baleia, and this area contained the main part of the biomass. Small patchy concentrations were found north and south of this area (Figure 18). High-density areas ($1000 > s_A < 3000$ m^2 /NM^2) were found at Cabo São Braz and at Pta. do Morro. *S. maderensis* dominated the two species also in the central area but smaller concentrations of *S. aurita* was caught in the northern part of the main distribution area to Pta. de Morro. The distribution pattern coincided with the inner mixing zone on the shelf and the fish was, especially during the day, confined in dense schools on the inside of this, while at night often dispersed in less defined shoals outside of this zone. The distribution also coincided with observations of northwards flowing nutrient-rich water on the inner shelf from north of Lobito.

The length distribution for sardinella is presented in Figures 19a and b for *S. maderensis* and *S. aurita*, respectively. The size distributions of *S. maderensis* showed a dominating distributional mode at 25 - 35 cm total length, peaking at 28 cm and a less defined mode between 10 and 20 cm with a peak around 15 cm. These modes are probably composed of several year classes of fish. *S. aurita* showed two modal peaks, the first around 10 - 15 cm,

and the other around 30 - 33 cm. Very little fish was found in the size range between 15 and 30 cm. Individuals <32 cm comprised most of the total biomass (90%) in *S. maderensis* (Figure 20).

The biomass for sardinella was estimated at a total of 276 000 tonnes, this is higher than the 165 000 tons found last year, and slightly higher than the 257 000 tons found in 2001. The biomass consisted of 216 000 tons *S. maderensis,* compared to 146 000 tons last year, and 60 000 tons of *S. aurita* comparable to the 19 000 tons found last year.

The avoidance reaction and changes in schooling pattern for sardinella oppose a problem for identification of sardinella schools especially in this area during this year's survey.

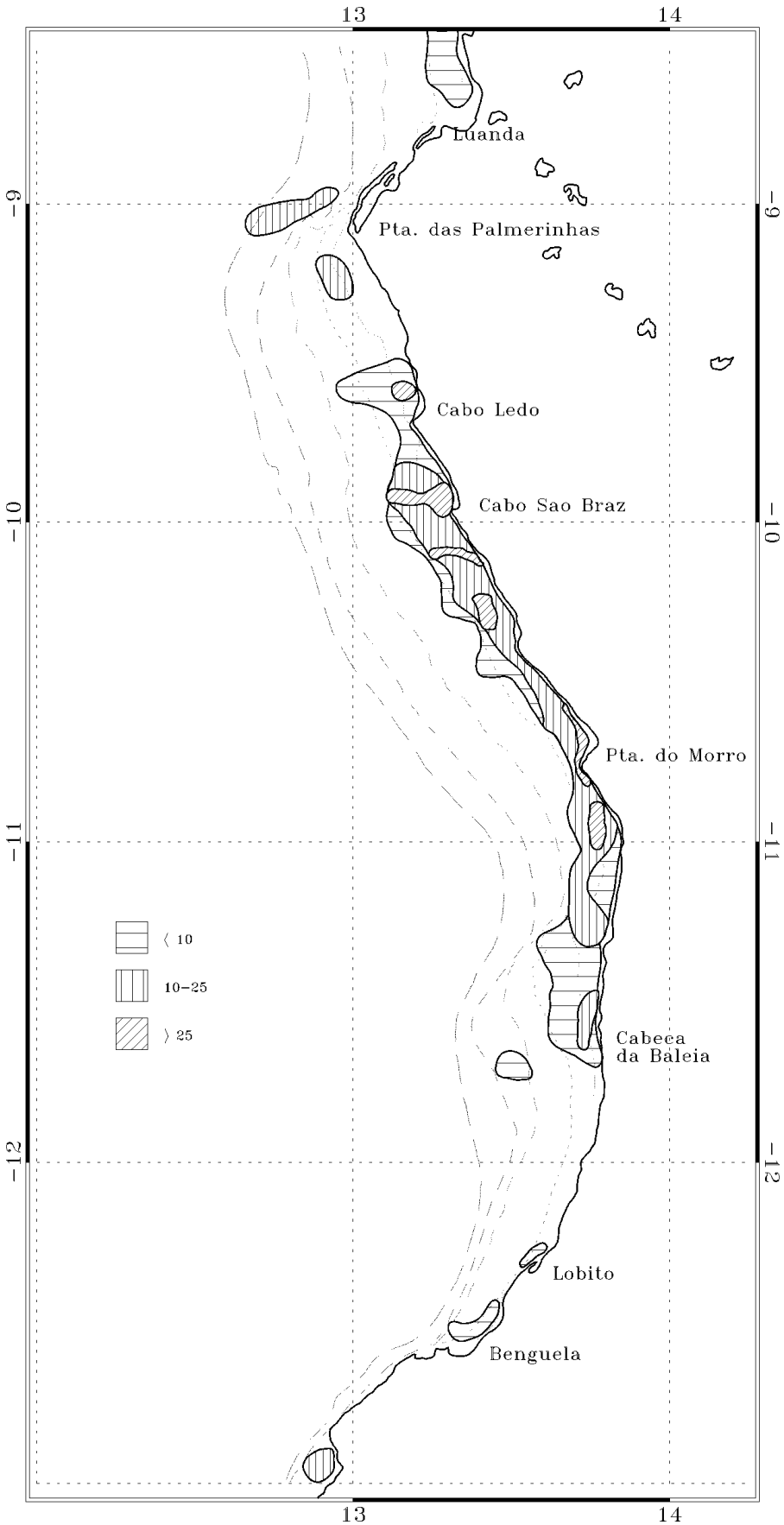
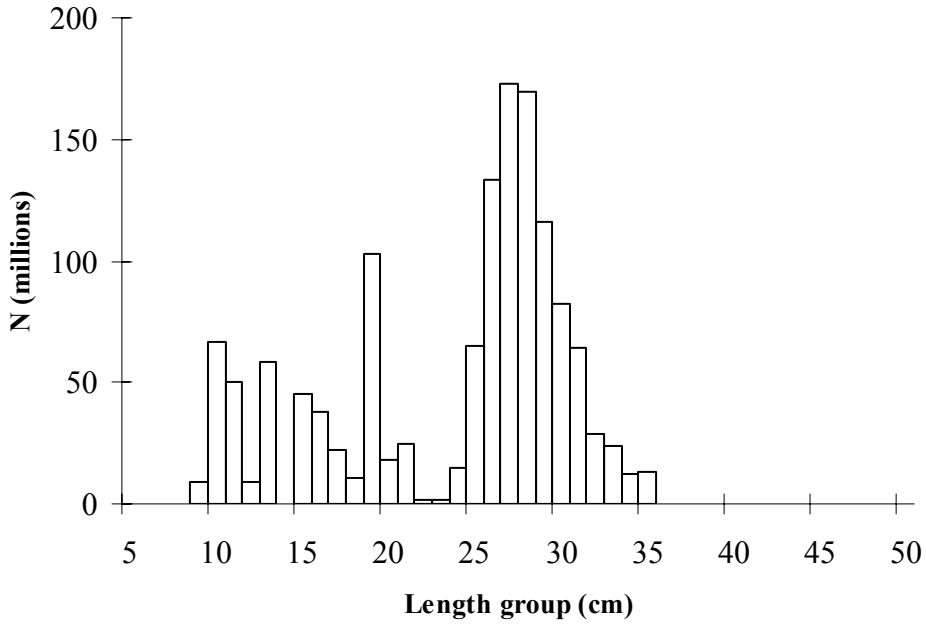


Figure 18. Distribution of *Sardinella* spp. Benguela - Pta. das Palmerinhas

a) *Sardinella maderensis*



b) *Sardinella aurita*

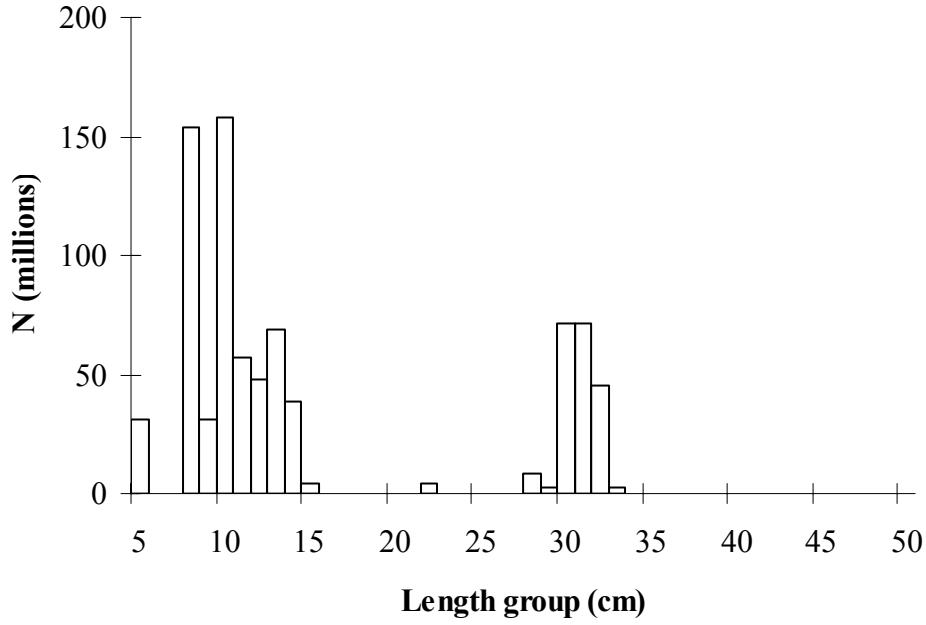
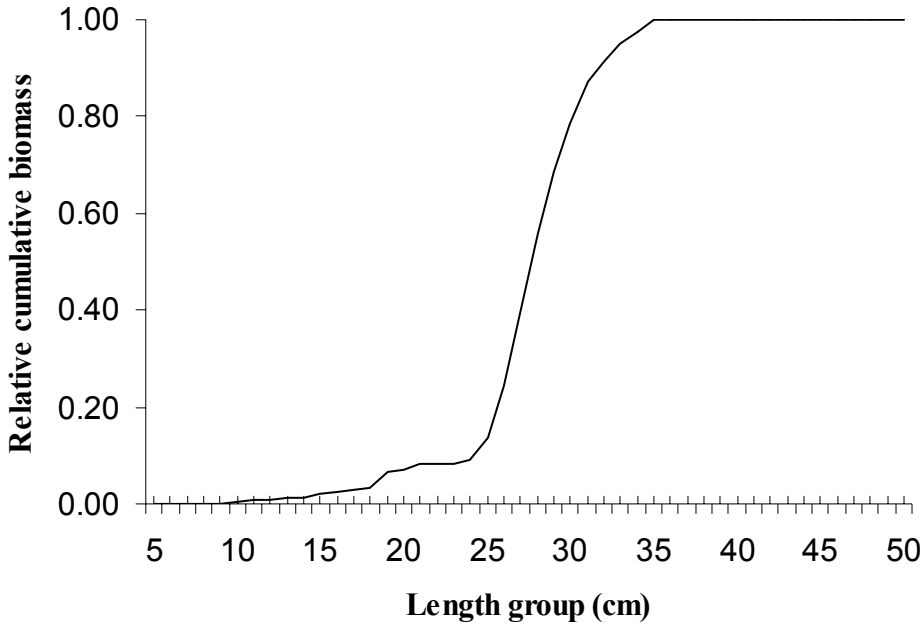


Figure 19. Total length distribution of *Sardinella maderensis* (a) and S. *aurita* (b). Benguela - Pta. das Palmerinhas

a) *Sardinella maderensis*



b*) Sardinella aurita*

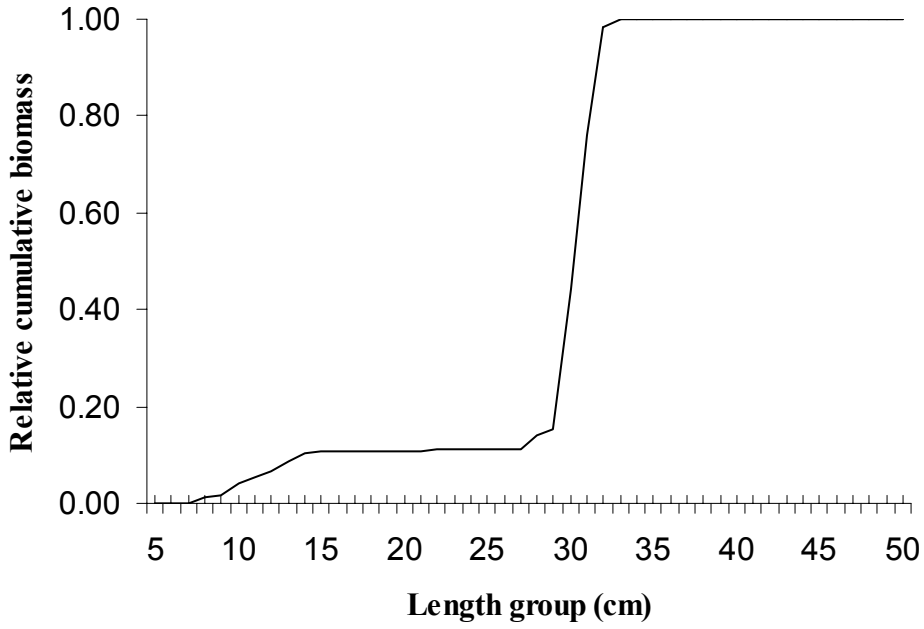


Figure 20. Relative cumulative biomass *Sardinella maderensis* (a) and *S. aurita* (b), Benguela - Pta. das Palmerinhas

Horse mackerel

Only *T. trecae* was encountered in this region. The distribution was patchy, with relatively low densities, s_A<300 m^2 /NM^2. Some small patches with medium, 301 <s_A<1000 m^2/$NM^{2,}$ and high, 1001 <s_A<3000 m^2 /$NM^{2,}$ densities where found throughout the region (Figure 21). In general the fish was found either on the shelf break at 90 - 150 m of water often in areas with hard bottom, or in shallow water close inshore. These two areas of distribution seem associated with the two observed mixing zones, at the shelf break, and at around 50 m depth.

Figure 22 shows the total length distribution of this species. The total length ranged from 5 to 48 cm, with the main modal peak at 13 cm corresponding to one year old fish. Additionally one peak at 18 cm and one at 24 cm can be observed. The relatively large, relatively to the total biomass, cohort of 15 cm fish observed during the survey last year should be around 20 cm this year. However few fish of this size group is left in the area. The mode of fish <10 cm is most likely under-sampled because of the design of the trawl gear.

The biomass of Cunene horse mackerel was estimated at 34 000 tons. This is higher than last years estimate of 13 000 tons. The 2002 estimate was however the lowest in this area during the time series, followed by the 22 000 tons estimated in 2001.

The bulk of the biomass (~90%) consisted of individuals <32 cm (Figure 23). Equivalently, 90% of the population in numbers were <22 cm.

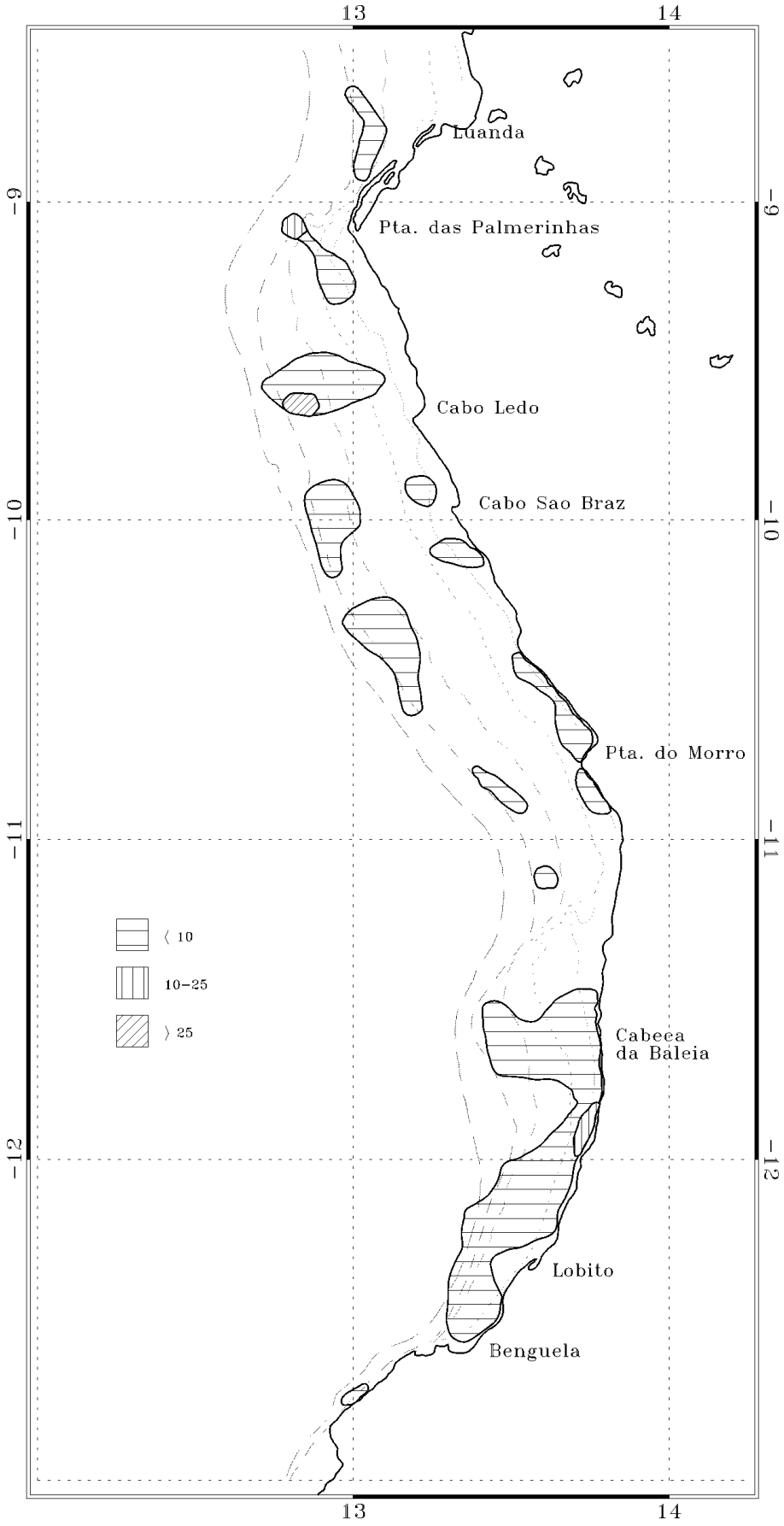


Figure 21. Distribution of horse mackerel (*Trachurus trecae*), Benguela - Pta. das Palmerinhas

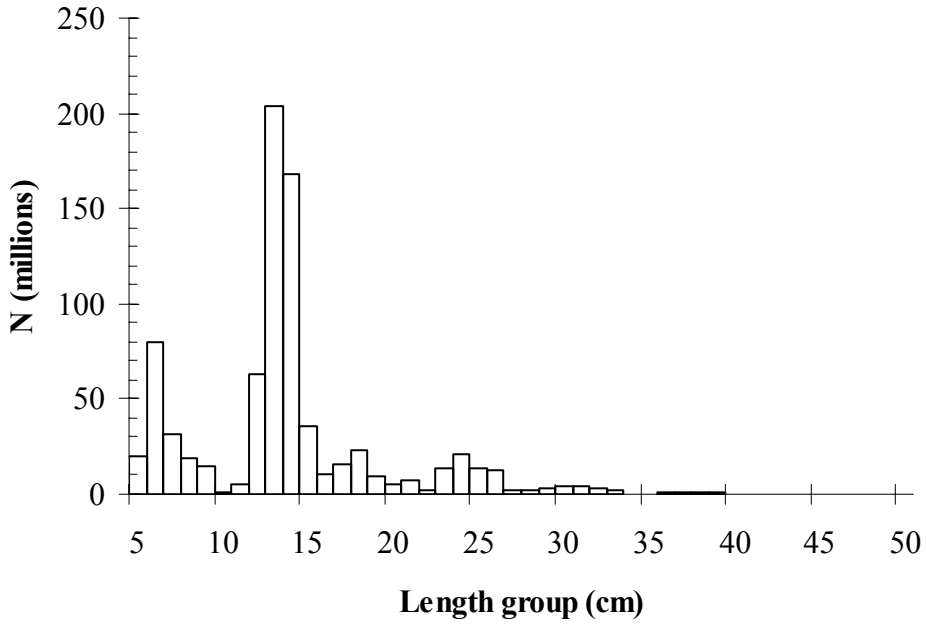


Figure 22. Total length distribution of horse mackerel (*T. trecae*), Benguela - Pta. das Palmerinhas

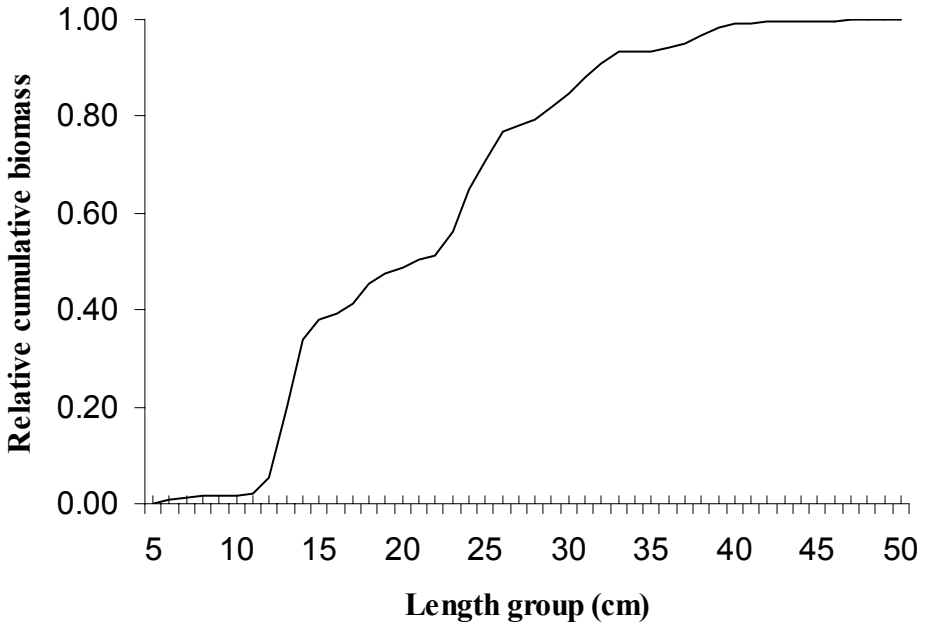


Figure 23. Relative cumulative biomass of horse mackerel (*T.trecae*), Benguela - Pta. das Palmerinhas

Pelagic species Group 1
No fish in pelagic species, group 1, were encountered in the region.

Pelagic species Group 2
Pelagic fish type 2 was encountered in several, low-density, s_A <300 m^2 /NM^2, areas from Luanda to Benguela (Figure 24). The most common species was hairtail (*Trichiurus lepturus*)

and *Selene dorsalis*. An overview of the main groups of pelagic fish in the central region is given in Table 7.

The biomass estimate, based on an average length of 30 cm and a condition factor equal to 0.01, was 35 000 tons compared with 75 000 tons in 2002 and 46 000 tons in 2001.

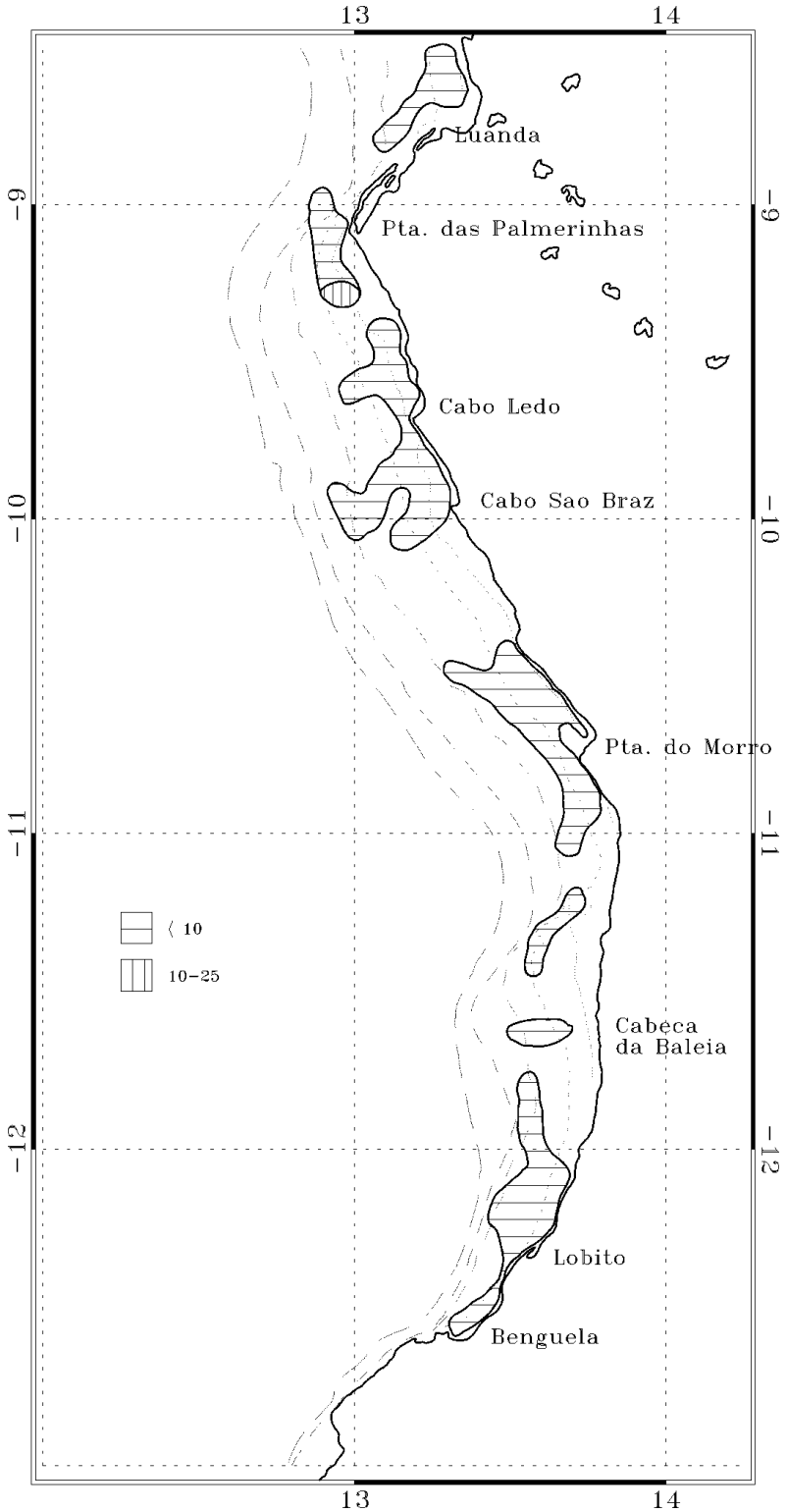


Figure 24. Distribution of other pelagic species, group 2. Benguela - Pta. das Palmerinhas

Table 7. Catch rates (kg/h) of the main groups of pelagic fish, Benguela - Pta. das Palmerinhas

Station No.	Depth	Clupeids	Carangids	Scombrids	Hairtails	Barracudas	Other
3219	20	14.26	2.14		25.50		79.40
3220	121	0.68	30.70		6.00		113.46
3221	10	2238.17	17.14		2.06	0.69	93.95
3222	26	1.18	4.52				131.56
3223	113		26.71		152.14		219.40
3224							
3225	41		136.24		19.74		218.10
3226	16	468.19	43.10		27.19		750.75
3227	1		0.88		144.88		9.90
3228	23	242.77	409.06		60.77	26.29	1462.08
3229	10	47.84	68.91	0.80	3.93	0.96	39.12
3230	20		1.00				
3231	19	11.44	11.62		8.60		801.76
3232	41	0.68	1.45		1.45		2734.96
3233	28	5.10	2.96		13.00		295.84
3234	71		0.70		292.00		202.20
3235	18	18.80	9.12	0.02	1.92	1.88	33.98
3236	10	744.23	33.02		158.93		3208.20
3237	5						518.20
3238	110		0.23		16.17		13.90
3239	70		0.14		1.28		20.52
3240	19	24.56	2.84		13.76		668.40
3241	24	13.44	2251.20		17.64	7.56	3167.44
3242	120		306.25				1671.72
3243	26		2248.93		6.94		1558.19
3244	110		207.20				768.46
3245	53				22.11		501.15
3246	1						
3247	5		1.20			11.45	546.37
3248	77		0.49		1.96		1503.16
3249	148		36				401.76
MEAN		127.71	195.13	0.03	33.27	1.63	724.46

5.3 Benguela - Cunene

Sardinella

Only four small patchy areas of *Sardinella maderensis* was found in this region without any apparent distribution pattern, no *S.* aurita was found (Figure 25). The biomass was estimated at 2 000 tons. Sardinella are rarely found in this region and both last year and in 2001 no sardinella was found.

The size distribution of the fish show three cohorts of sardinella, the larger ones occurred in the northern part of the region while the juvenile cohort was found outside Baía dos Tigres schooling together with pilchard, *Sardinops ocellatus*.

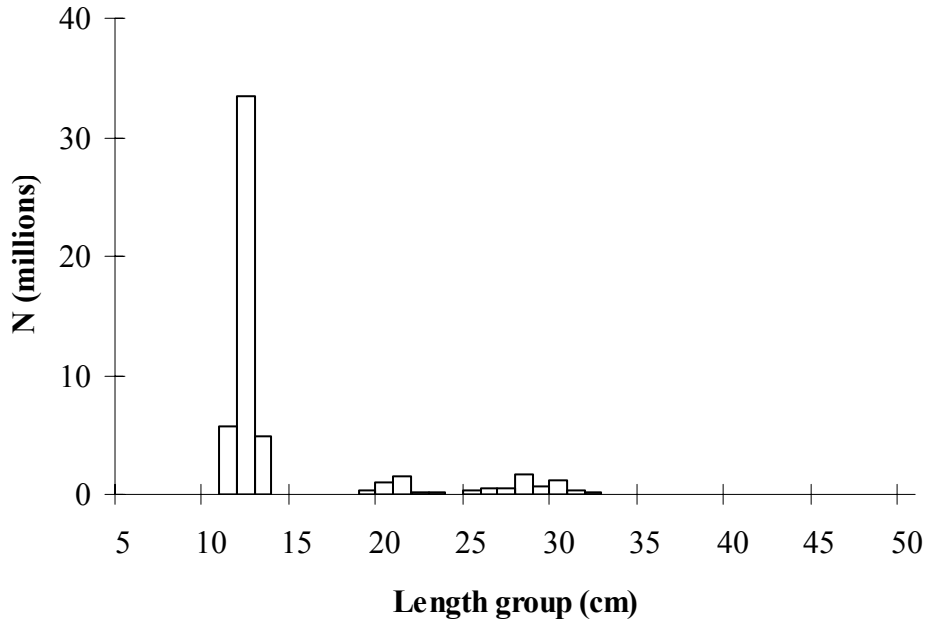


Figure 25. Distribution of *Sardinella maderensis* Cunene – Benguela

Horse mackerel

Like in previous years, both species of horse mackerel were found in the southern region. The fish occurred in two areas north of Cabo de Santa Maria and south of Cabo de Santa Marta to Praya do Calunga and in a continuous layer from north of Namibe (15º00'S) to the Cunene River (17º15'S, Figure 26). The density varied throughout the area, generally with denser concentrations further south, and with the highest recordings (s_A>3000 m^2 /NM^2) between Cunene River and north of Baía dos Tigres. The two horse mackerel species were mixed in the frontal area. The *T. trachurus capensis* gradually increased in density in the main density area from Baía dos Tigres and southwards, replacing *T. trecae*, first in the deeper areas. The distribution of juvenile *T. trecae* (<20 cm) continued inshore towards Cunene River, stopping short off the river mouth. The distribution of the two horse mackerel species in the border area between Namibia and Angola corresponds with changes in water masses, especially the intrusion of colder water from the Benguela current.

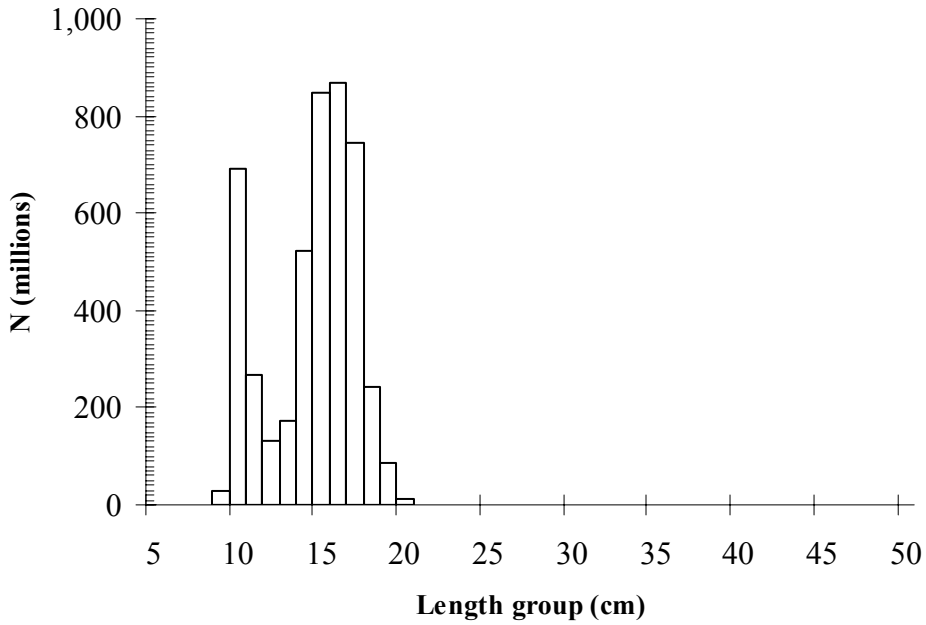
Figure 27 shows the size distributions of horse mackerels. The cohorts of *T. trecae* are overlapping, but a modal peak at 18 cm can be seen. There is also an indication of an adult cohort with modal peak at 22 cm. The *T. trachurus capensis* cohorts also overlap but show a modal peak at 17 cm, few fish above 20 cm were recorded. Last year, the southern area was completely dominated by juveniles of both species (6 - 15 cm total length), and *T. trecae* showed a modal peak at 14 and 17 cm.

The estimated biomass for horse mackerels in the southern region was 253 000 tons, The contribution from the two species was 120 000 tons of *T. trecae* and 133 000 tons of *T. trachurus capensis* respectively. Last year the estimated biomass in this region was 118 000 tons of *T. trecae* and 45 000 tons of *T. trachurus capensis,* while in 2001 the abundance of *T. trecae* and *T. trachurus capensis* respectively was 64 000 tons and 187 000 tons.

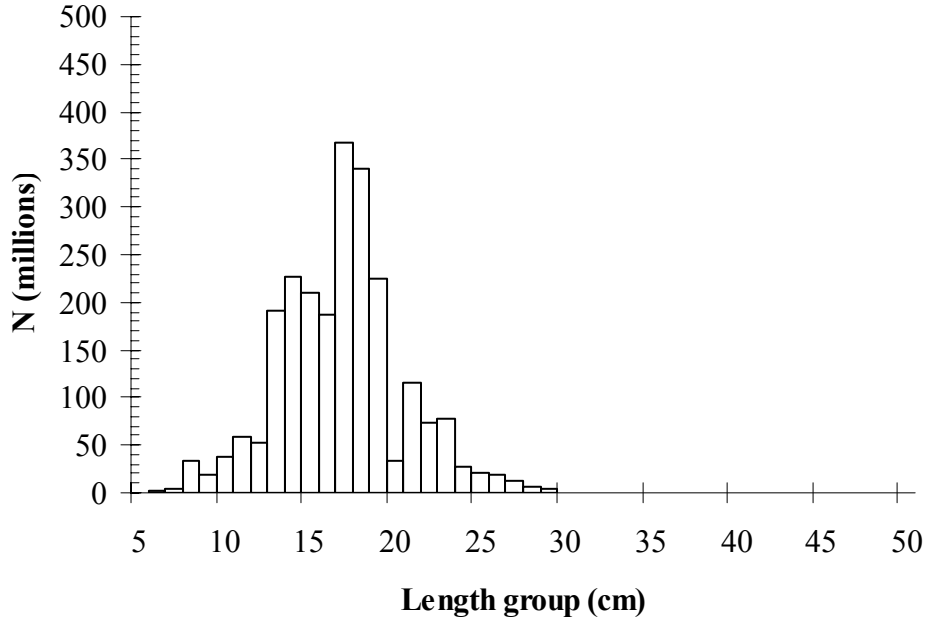
Figure 28 shows that 90% of the biomass of the *T. trecae* population in this area was <28 cm, the part of the horse mackerel stock found in this area was mainly comprised of juveniles, and

90% of the stock was <21 cm in numbers. The *T. trachurus capensis* population in the area was entirely comprised of juveniles, 100% was <20 cm.

Figure 26 Distribution of horse mackerel. Cunene - Benguela
a) *Trachurus trachurus capensis*



b) *Trachurus trecae*



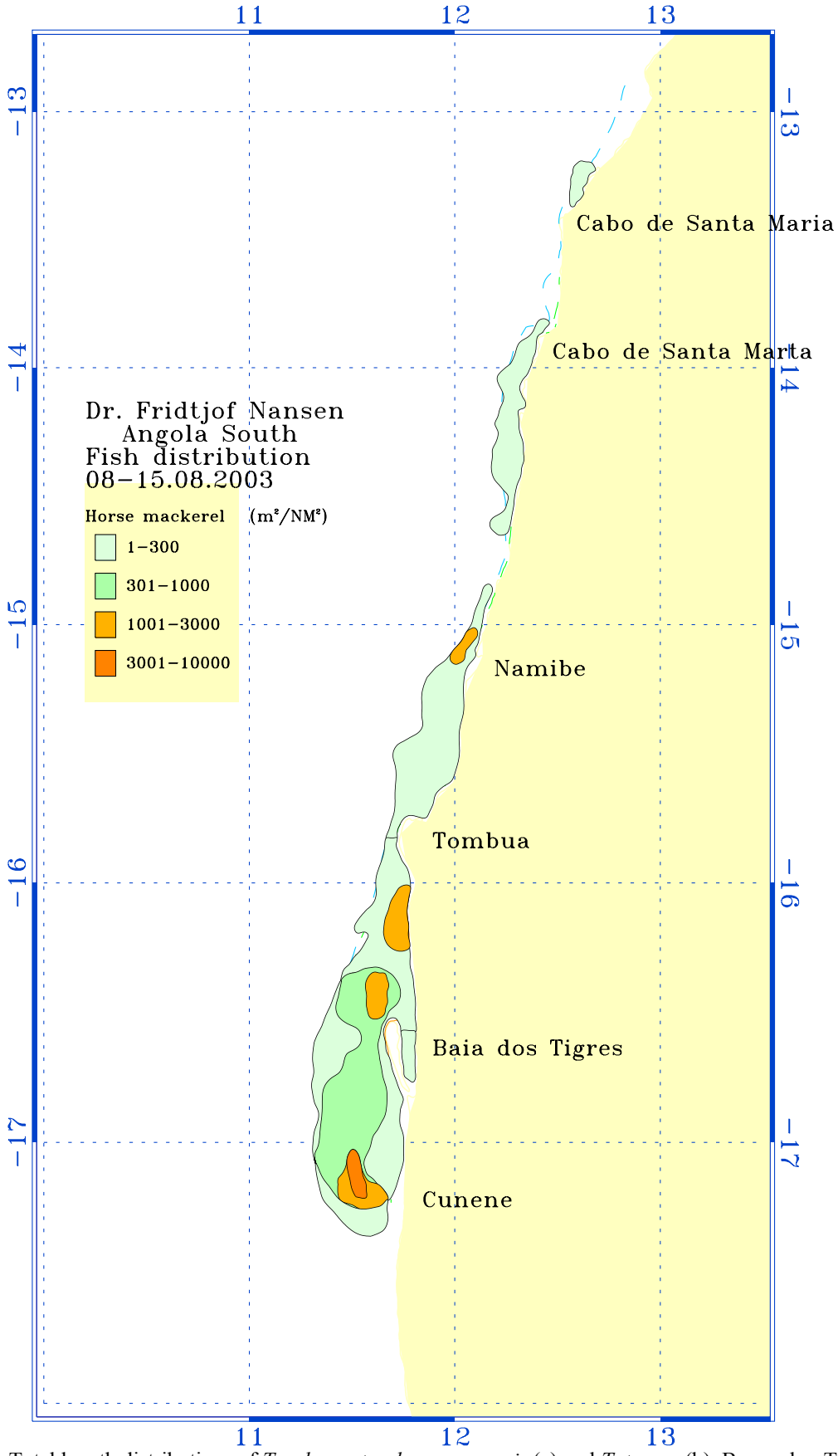
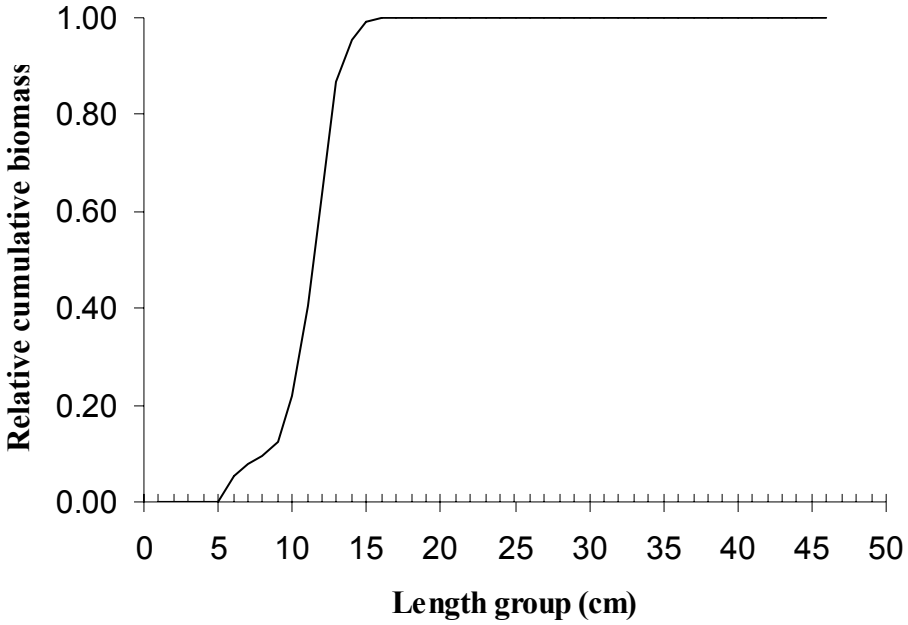


Figure 27. Total length distributions of *Trachurus trachurus capensis* (a) and *T. trecae* (b), Benguela - Tombua

a) *Trachurus trachurus capensis*



b) *Trachurus trecae*

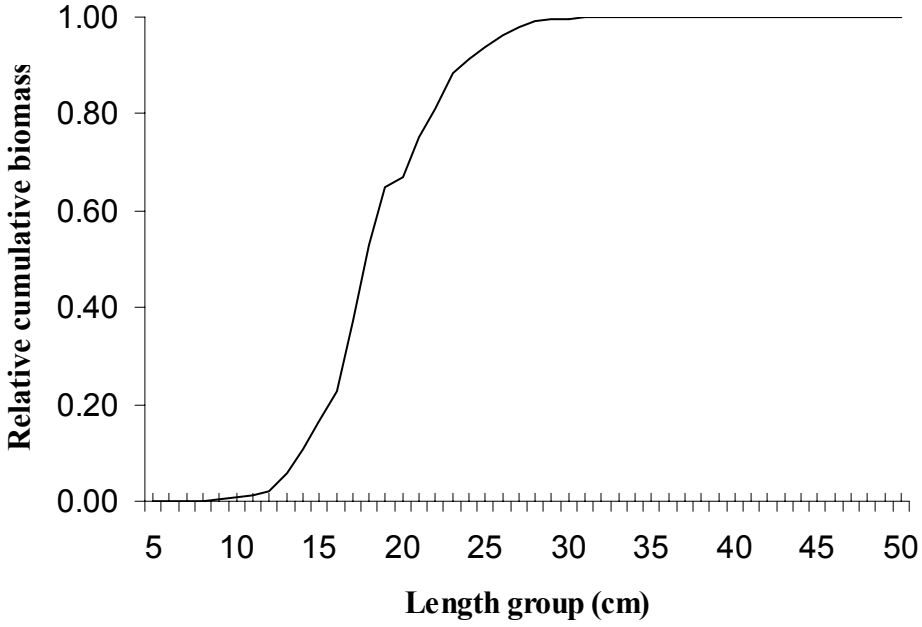


Figure 28. Relative cumulative biomass of *T. trachurus capensis* (a) and *T. trecae* (b)

Pelagic species Group 1
Pelagic fish, Group 1, was found in two aggregations, extending offshore from 500 m depth south of Tombua (16º00'S) to shallow water outside Baía dos Tigres and Cunene River (Figure 29). The acoustic densities were low (s_A <300 m^2 /NM^2), but with a high-density area (1000< s_A <3000 m^2 /NM^2) off Cunene River. Round herring, *Etrumeus whiteheadi,* and anchovy dominated the catches, *Engraulus encracicolus*, with anchovy dominating in the high-density areas. An overview of the main groups of pelagic fish in the southern region is given in Table 8.

The biomass was estimated at 66 000 tons based on an average length of 30 cm and a condition factor equal to 0.01. No biomass estimate was made in 2002 while in 2001 36 000 tons was found in this area

Pelagic species Group 2
Pelagic fish, group 2, was found in all together nine different patchy aggregations from north of Cabo de Santa Maria (13º00'S, Figure 30) to the Cunene River. The acoustic densities were low (s_A <300 m^2 /NM^2, see Table 8).

The biomass was estimated at 9 000 tons based on an average length of 30 cm and a condition factor equal to 0.01. No estimate was made in 2002 while the biomass in 2001 was 3 000 tons. The dominant species in the area were *Trichiurus lepturus* and *Decapterus rhonchus* (Table 8).

Table 8. Catch rates (kg/h) of the main groups of pelagic fish. Cunene - Benguela

Station No.	Depth	Clupeids	Carangids	Scombrids	Hairtails	Barracudas	Other
3250	130		743.79		20.38		219.72
3251	31	1.56	195.06				677.36
3252	25		11.11	0.82	28.39		8.26
3253	30		3550.14				
3254	48		1328.16			8.16	1777.74
3255	138		202.7				1377.29
3256	100						
3257	275						
3258	25		7.47				20.24
3259	33		7465.05		62.4		28.05
3260	72		282.96				2631.45
3261	22		660		2.68		387.4
3262	43	29.8	0.36				
3263	45	1.37	263.17		3.29		133.48
3264	17	30.02	1678.73				105.73
3265	82	105.06	7.08				106.76
3266	95						34.4
3267	82	113.2	5959.2				2054.08
3268	17		6268.2				212.04
3269	14	48.08	25.38				5.68
3270	48		4421.25				
3271	32	27	156.8		7.2		33.9
3272	97		3283.51		15.97		2346.01
3273	10	27997.2					
3274	100		765.6				9.84
3275	21	101.12	259.52		37.6		185.6
3276	124	40.07	377.71		4.29		276.65
3277	25	0.11	94.77				27.25
MEAN		1017.66	1357.42	0.03	6.51	0.29	452.10

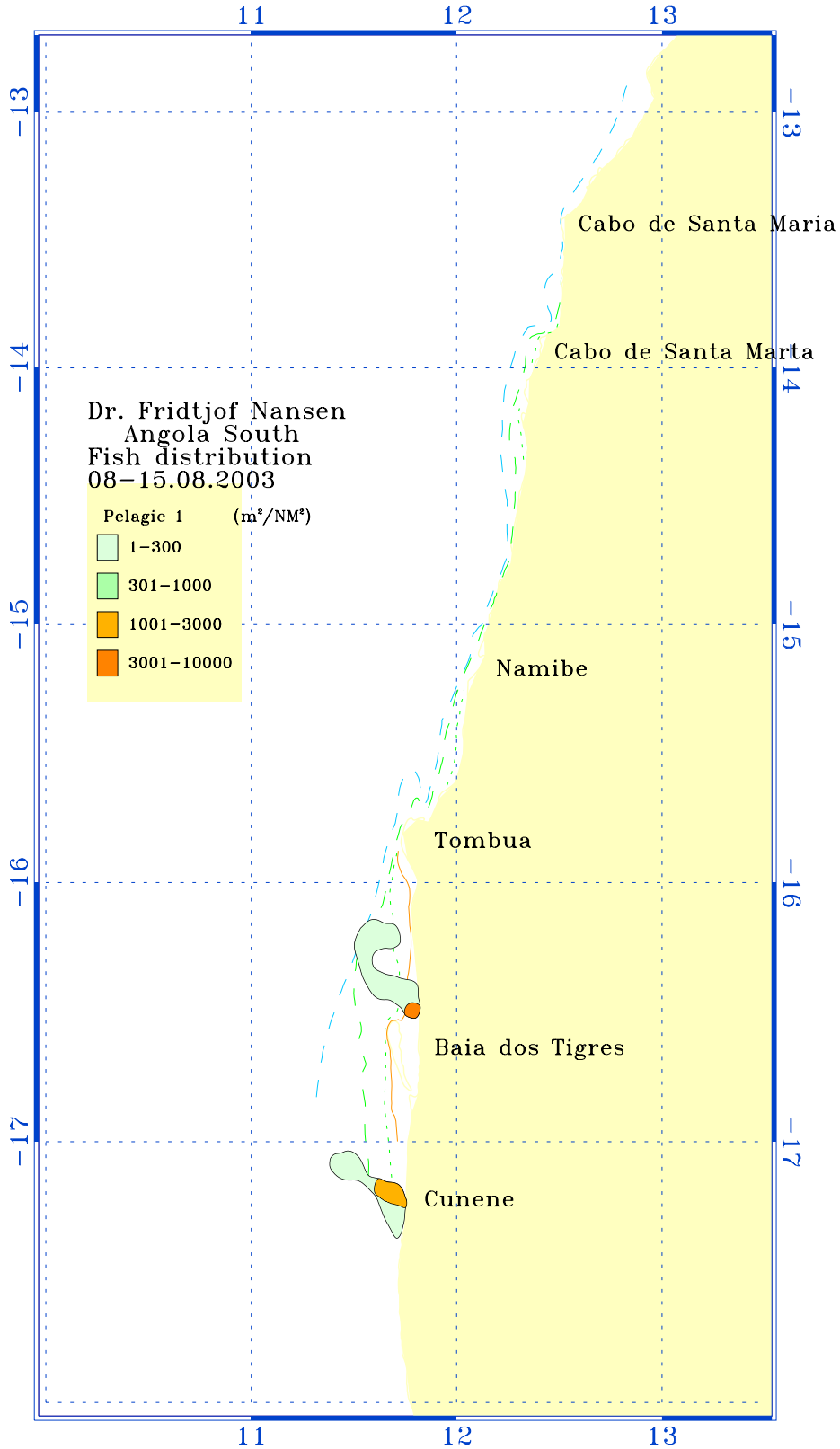


Figure 29. Distribution of other pelagic species group 1. Benguela – Pta. das Palmerinhas

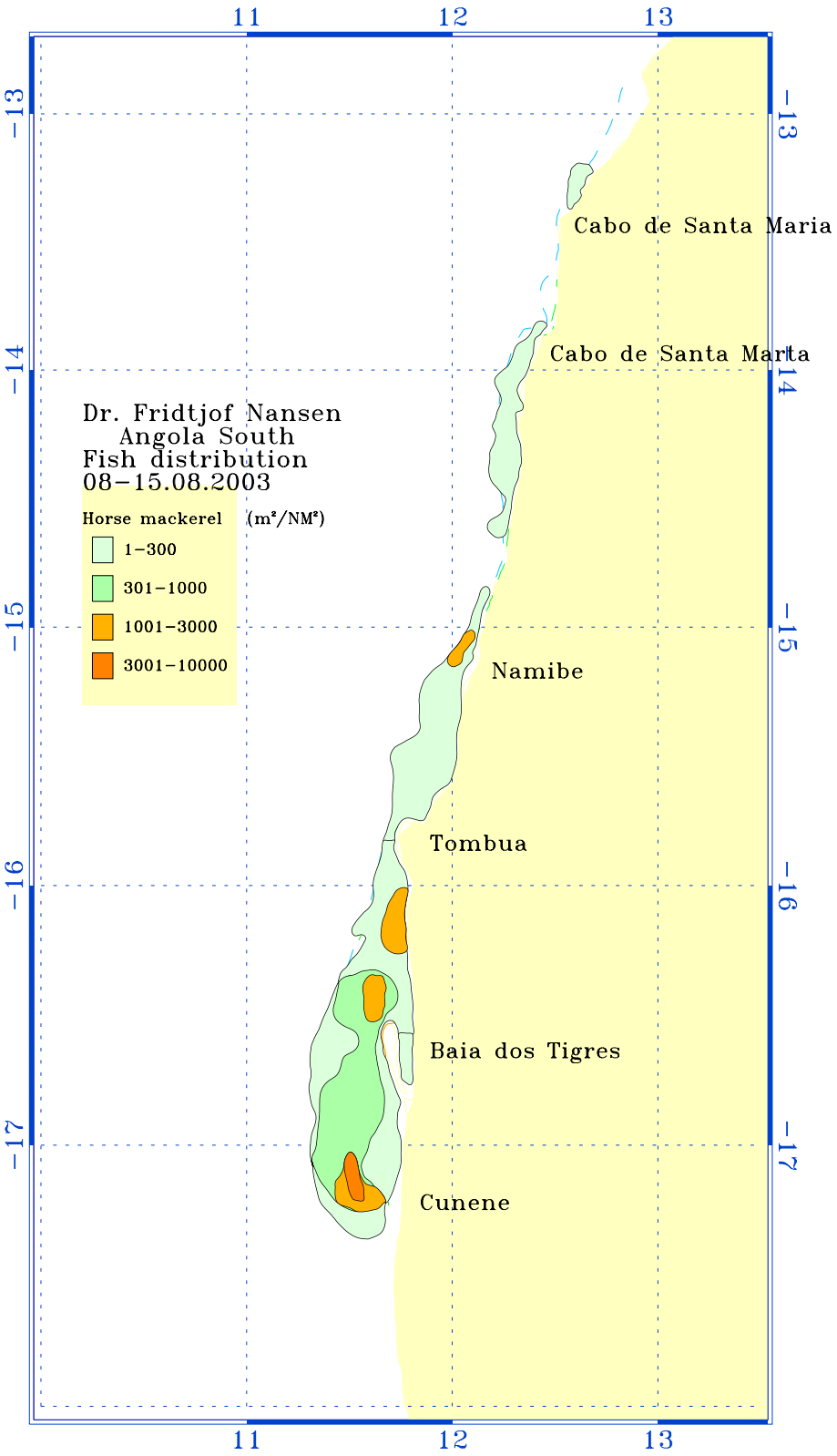


Figure 30. Distribution of other pelagic species group 2. Benguela – Pta. das Palmerinhas

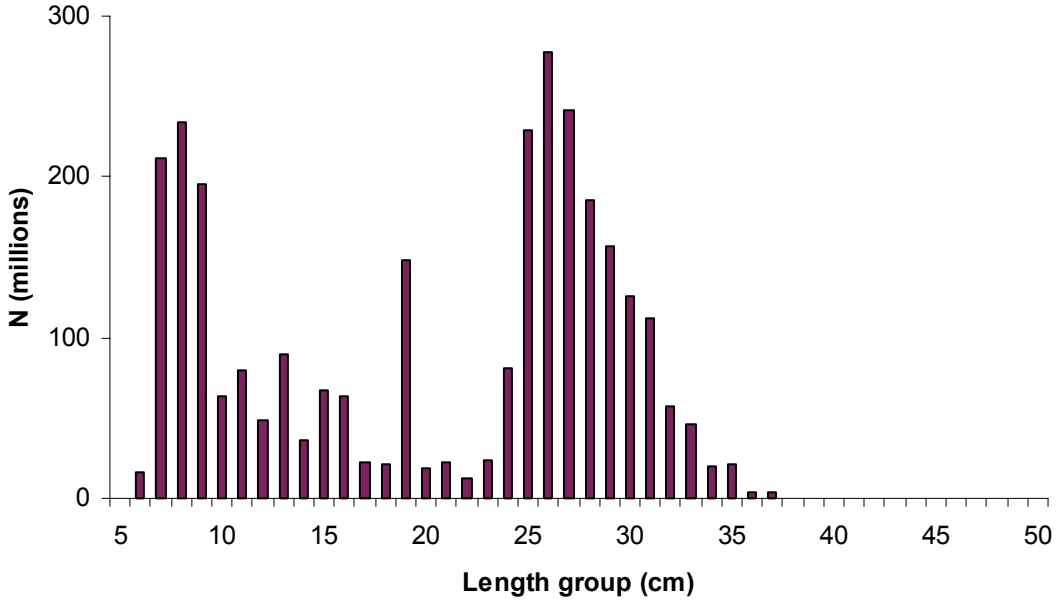
CHAPTER 6 SUMMARY OF SURVEY RESULTS

6.1 Sardinella

The total biomass estimate for sardinellas (432 000 tons) is higher than last year (343 000 tons) but similar to the estimate in 2001 (Table 9). However this relatively high biomass can mainly be attributed to a large biomass of *S. maderensis* (354 000 tons), while the biomass of *S. aurita* still is at a low level (76 000 tons). The major concentrations of sardinella (2/3 of the biomass) were found in the central area while 1/3 of the biomass was found in the north of Angola. The major part of the southern area is considered to cold for sardinella during this time of the year. However, a few schools were found scattered all the way to Baía dos Tigres, probably trapped in warm water cells.

Figure 31 shows the overall length frequency distribution and the cumulative biomass of *S. maderensis* recorded during the survey, while Figure 32 shows the same data for the *S. aurita* population. A strong cohort of juvenile *S. maderensis* is seen in Figure 31. It is expected that these will be a large contributor to the biomass next year. The main part of the biomass this year was fish between 25 – 35 cm.

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



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

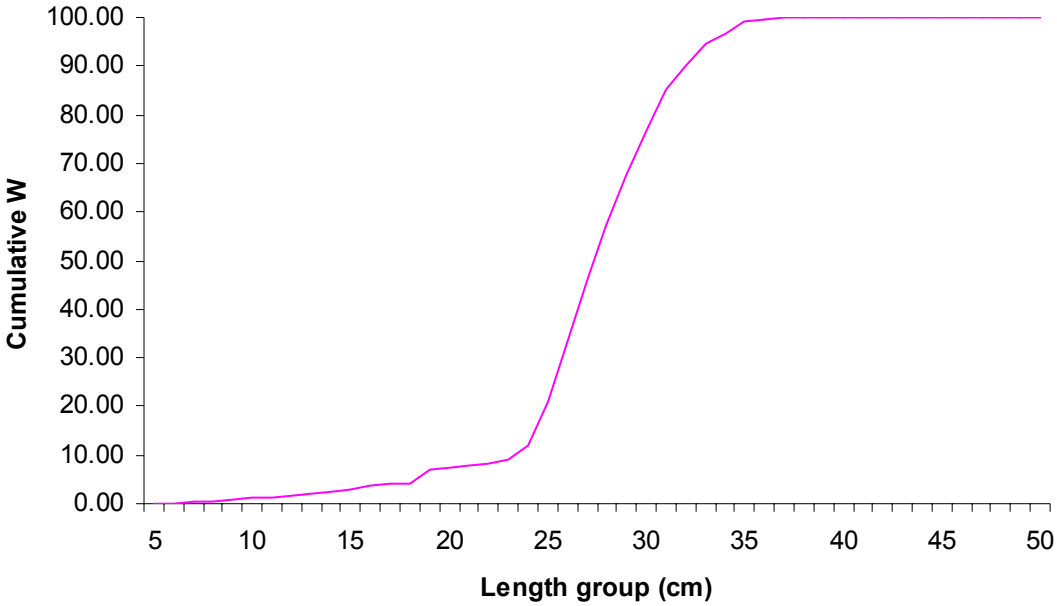
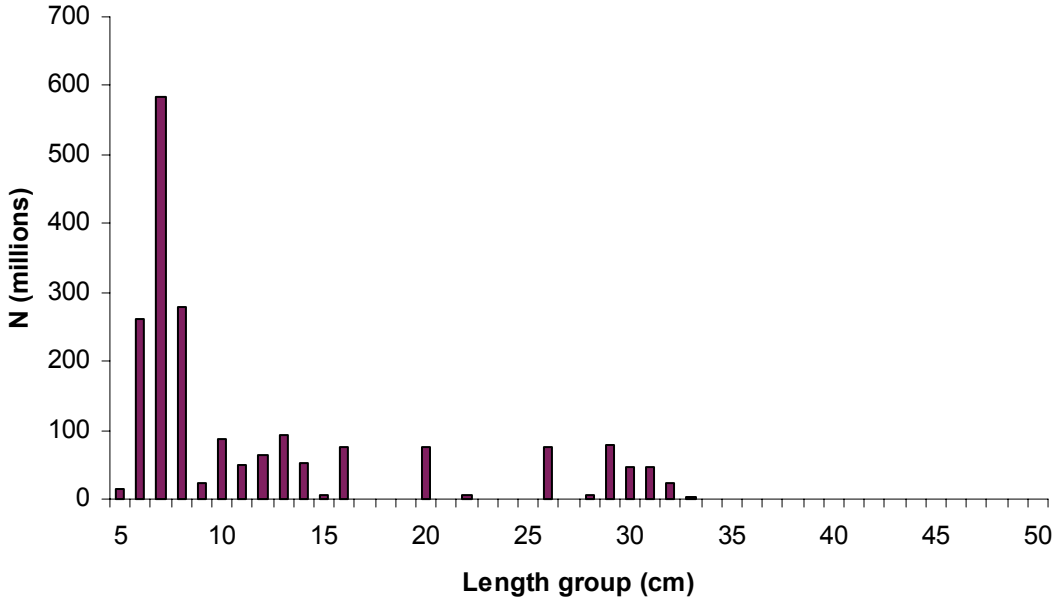


Figure 31. Overall length distribution (a) and relative cumulative biomass (b) of *S. maderensis*.

The length frequency data for *S. aurita* show a modal peak at 7 cm. However, few trawl samples makes difficult to draw any conclusions about the size distribution of *S. aurita* from this year's survey.

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



b) Relative cumulative biomass of *S. aurita*

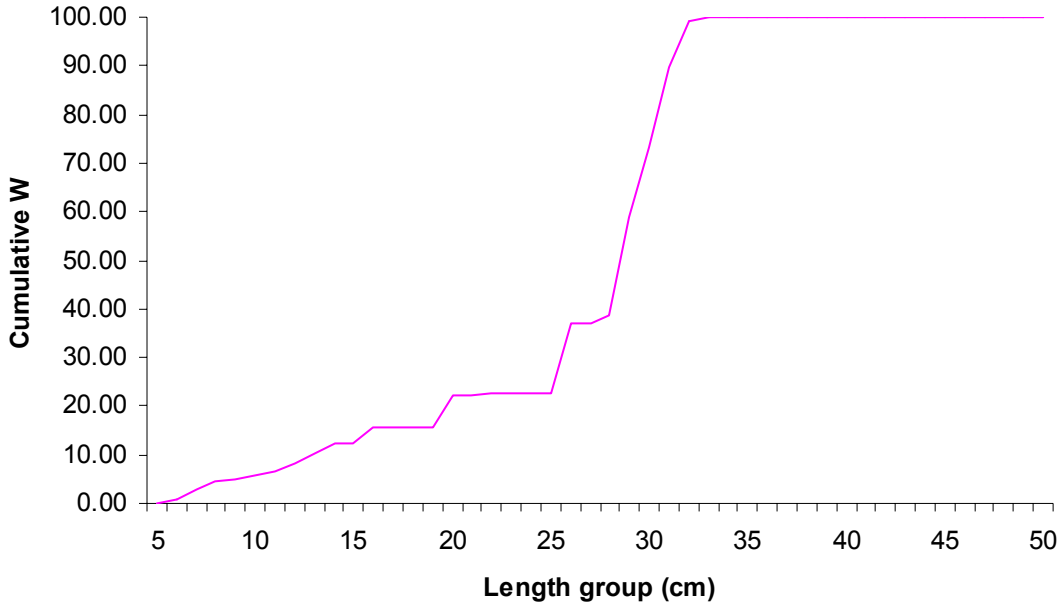


Figure 32. Overall length distribution (a) and relative cumulative biomass (b) of *S. aurita*

Sardinella has as previously mentioned a strong horizontal and vertical avoidance reaction both to the vessel and the trawl gear and biomass estimates are therefore particularly susceptible to bias. Therefore, care should be taken when interpreting the results. This has been reported from routine acoustic biomass surveys and experimental surveys over a period of several years. Their behavioural patterns is probably largely depend on the prevailing environmental conditions, such as intrusion of freshwater from the Congo River and other rivers into coastal waters as well as other inter-annual variation in the environment. It is therefore likely that the Dr. Fridtjof Nansen surveys are underestimating the size of the sardinella biomass considerably but it is still believed that the estimates provide an index of abundance showing the stock trends. It is probably time to evaluate the current knowledge on the sardinella species in Angola, and dependent on how accurate information is needed on the size of the sardinella biomass, in particular the *S. aurita* stock which is the commercially more important of the two species, to evaluate the survey strategy, and suggest new approaches. Several approaches could be considered including a combination of aerial and acoustic surveys similar to what has been suggested for the Namibian sardine stock or introduction of a long range fishery sonar to map the distribution of fish on the side of the vessel.

Table 9. Biomass estimates of sardinellas by regions and surveys (1 000 tons)

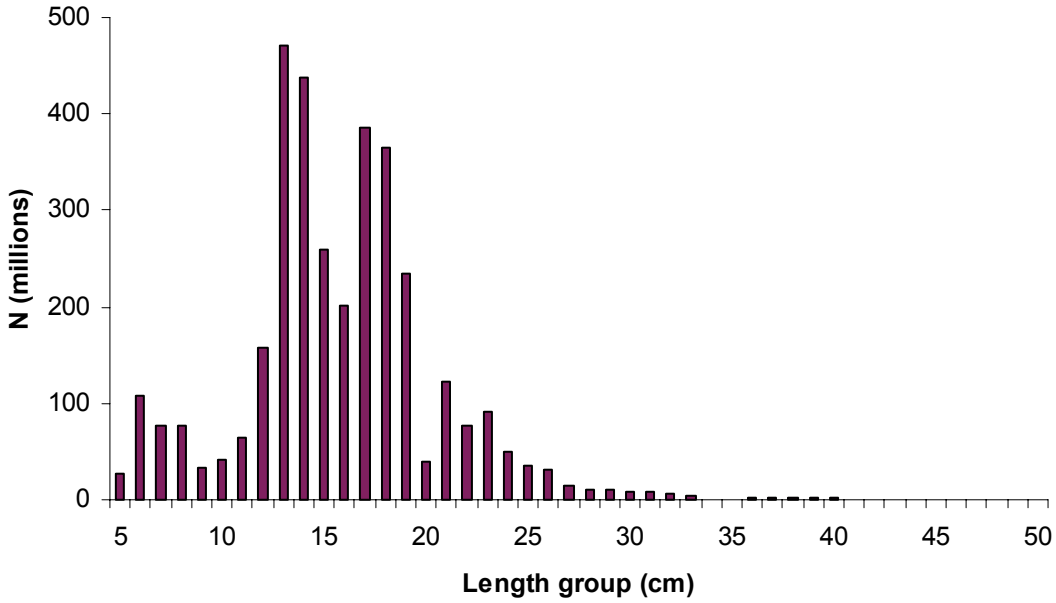
Survey	Cunene - Benguela	Benguela - Pta. Palm.	Pta Palm - Cabinda	Cabinda - Benguela	Cunene - Cabinda
1/85	25	220	80	300	325
2/85	110	190	180	370	480
3/85	0	70	190	260	260
4/85	0	200	110	310	310
1/86	10	140	110	250	260
2/86	10	130	130	260	270
1/89	40	200	60	260	300
2/89	20	40	130	170	190
3/89	40	100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

* not surveyed
† surveyed from Congo River - Pta das Palmerinhas

6.2 Cunene horse mackerel

The total biomass estimate for *T. trecae* (166 000 tons) has been stable since 2002 when it was estimated to be 160 000 tons, but although higher than the 89 000 recorded in 2001, which was the lowest biomass ever recorded during the time series, it has declined drastically from 2000 (333 000 tons). It is evident from Figure 32 that the juveniles (<20 cm total length) comprises the major part of the stock, 86% of the total stock estimate in numbers and 64% by weight respectively. From a geographical point of view most of the stock (>70%) was distributed in the southern part of Angola, south of 13°S - 17°15'S. The fish in this region comprised mainly of juveniles, 90% of the Cunene horse mackerel found in this area was <28 cm by weight, or <21 cm by numbers.

a) Overall length distribution of *T. Trecae* in 2003



b) Relative cumulative biomass of *T. trecae*

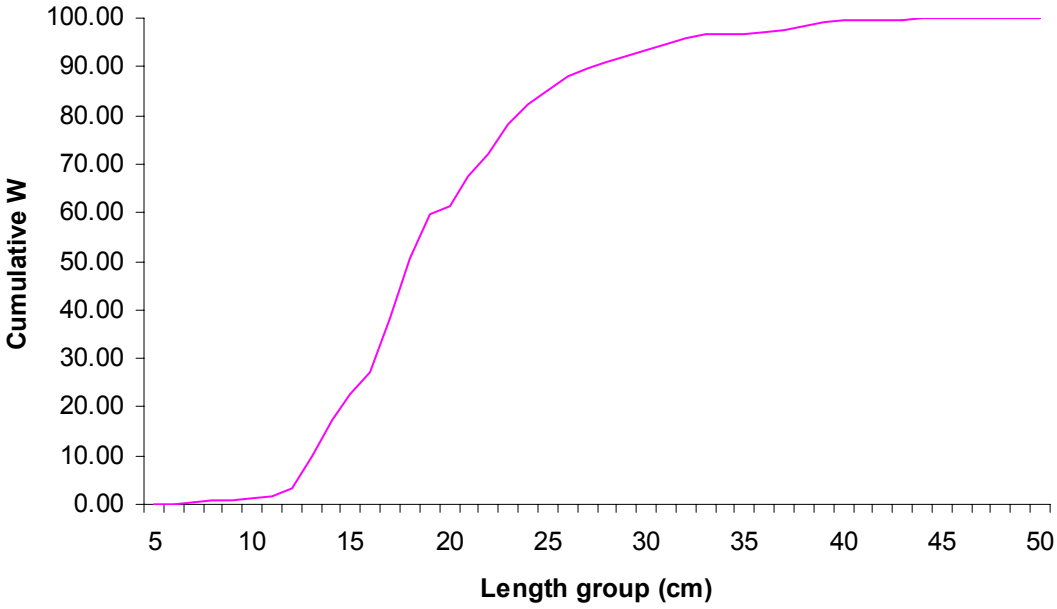


Figure 33. Overall length distribution in numbers (a) and relative cumulative biomass (b) of *T. trecae*

Figure 33 shows that the biomass estimate for *T. trecae* has been at historically low levels during the past three years, the stock is far from the level in 1997 when 427 000 tons where estimated.

Table 10. Biomass estimates of Cunene horse mackerel by regions and surveys (1 000 tons)

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

* not surveyed

† surveyed from Congo River- Pta. das Palmerinhas

6.3 Conclusions

The present biomass of sardinellas show a stable level. It should be emphasized that the biomass estimates of sardinellas may only be considered as relative indices rather than absolute estimates, and that the separation between the two species are considered very difficult. Therefore, it is extremely important that urgent steps are taken to evaluate present survey methods in order to improve the accuracy of the estimates.

The Cunene horse mackerel stock was estimated at a total of 166 000 tons. This is about 6 000 tons more than last years estimate, and corresponds well with this. The findings correspond well with previous years studies and underline the fact that the adult part of the stock harvested for human consumption is severely reduced.

However, there are signs of good recruitment both from last year and this year, with a strong cohort with a modal peak of 13 cm coming trough and indications of another around 5 - 6 cm spawned this year. These cohorts can, if managed carefully, contribute to a recovery of the stock. The cohort of 1-year-old fish noted last year is now around 18 - 19 cm and has reached the size when it is caught commercially by midwater trawlers.

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

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ANNEX I FISHING GEAR

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

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

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

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

ANNEX II RECORDS OF FISHING STATIONS

PROJECT STATION:3196
DATE:21/ 7/03 GEAR TYPE: BT No: 2 POSITION:Lat S 621
start stop duration Long E 1142
TIME :15:53:45 16:23:47 30 (min) Purpose code: 1
LOG :3790.41 3791.95 1.51 Area code : 3
FDEPTH: 120 118 GearCond.code:
BDEPTH: 120 118 Validity code: 3
Towing dir: 72ø Wire out: 380 m Speed: 30 kn*10

Sorted: 130 Kg Total catch: 296.52 CATCH/HOUR: 593.04

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Dentex congoensis	362.40	3732	61.11	
Dentex angolensis	79.20	436	13.35	
Trachurus trecae	74.60	2674	12.58	6742
Spicara alta	27.40	452	4.62	
Epinephelus goreensis	11.20	4	1.89	
Todarodes sagittatus	10.68	260	1.80	
Umbrina canariensis	6.40	4	1.08	
Ariomma bondi	4.52	72	0.76	
Zeus faber	4.44	4	0.75	
Zenopsis conchifer	4.32	12	0.73	
Pterothrissus belloci	4.04	36	0.68	
Chelidonichthys gabonensis	1.40	16	0.24	
Raja miraletus	1.04	4	0.18	
Uranoscopus polli	0.52	4	0.09	
Sepia orbignyana	0.48	4	0.08	
Scorpaena angolensis	0.32	4	0.05	
Citharus linguatula	0.08	4	0.01	
Total	593.04		100.00	

PROJECT STATION:3197
DATE:21/ 7/03 GEAR TYPE: PT No: 7 POSITION:Lat S 627
start stop duration Long E 1147
TIME :22:44:12 22:59:14 15 (min) Purpose code: 1
LOG :3851.57 3852.38 0.81 Area code : 3
FDEPTH: 110 110 GearCond.code:
BDEPTH: 121 121 Validity code:
Towing dir: 160ø Wire out: 280 m Speed: 30 kn*10

Sorted: Kg Total catch: CATCH/HOUR:

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

PROJECT STATION:3198
DATE:21/ 7/03 GEAR TYPE: PT No: 1 POSITION:Lat S 628
start stop duration Long E 1148
TIME :23:03:52 23:18:15 14 (min) Purpose code: 1
LOG :3852.66 3853.48 0.82 Area code : 3
FDEPTH: 90 85 GearCond.code:
BDEPTH: 121 121 Validity code:
Towing dir: 160ø Wire out: 220 m Speed: 40 kn*10

Sorted: Kg Total catch: CATCH/HOUR:

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

PROJECT STATION:3199
DATE:21/ 7/03 GEAR TYPE: PT No: 1 POSITION:Lat S 629
start stop duration Long E 1148
TIME :23:24:33 23:40:39 16 (min) Purpose code: 1
LOG :3853.82 3854.87 1.04 Area code : 3
FDEPTH: 40 40 GearCond.code:
BDEPTH: 122 123 Validity code:
Towing dir: 160ø Wire out: 160 m Speed: 35 kn*10

Sorted: Kg Total catch: 1.09 CATCH/HOUR: 4.09

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
J E L L Y F I S H	1.91	859	46.70	
Trachurus trecae	1.43	68	34.96	6743
Engraulis encrasicolus	0.41	90	10.02	
Caranx crysos	0.15	11	3.67	
Selene dorsalis	0.08	68	1.96	
Solea senegalensis	0.04	4	0.98	
Brotula barbata	0.04	15	0.98	
Trichiurus lepturus	0.04	4	0.98	
Total	4.10		100.25	

PROJECT STATION:3200
DATE:22/ 7/03 GEAR TYPE: PT No: 3 POSITION:Lat S 639
start stop duration Long E 1143
TIME :05:51:17 06:10:55 20 (min) Purpose code: 1
LOG :3909.07 3909.97 0.88 Area code : 3
FDEPTH: 230 230 GearCond.code:
BDEPTH: 278 299 Validity code: 3
Towing dir: 235ø Wire out: 550 m Speed: 30 kn*10

Sorted: Kg Total catch: 8.28 CATCH/HOUR: 24.84

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
MYCTOPHIDAE	16.86	13794	67.87	
Auxis thazard	7.68	36	30.92	
PARALEPIDIDAE	0.21	39	0.85	
Selene dorsalis	0.06	24	0.24	
Antigonia capros	0.03	3	0.12	
Total	24.84		100.00	

PROJECT STATION:3201
DATE:22/ 7/03 GEAR TYPE: PT No: 1 POSITION:Lat S 630
start stop duration Long E 1212
TIME :11:18:02 11:38:35 21 (min) Purpose code: 1
LOG :3954.54 3955.87 1.32 Area code : 3
FDEPTH: 20 25 GearCond.code:
BDEPTH: 43 43 Validity code: 3
Towing dir: 345ø Wire out: 100 m Speed: 40 kn*10

Sorted: Kg Total catch: 4.18 CATCH/HOUR: 11.94

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sarda sarda	11.74	9	98.32	
MYCTOPHIDAE	0.20	149	1.68	
Total	11.94		100.00	

PROJECT STATION:3202
DATE:22/ 7/03 GEAR TYPE: BT No: 2 POSITION:Lat S 648
start stop duration Long E 1154
TIME :20:47:38 21:17:42 30 (min) Purpose code: 1
LOG :4042.26 4044.06 1.80 Area code : 3
FDEPTH: 122 121 GearCond.code:
BDEPTH: 122 121 Validity code: 3
Towing dir: 360ø Wire out: 360 m Speed: 35 kn*10

Sorted: 61 Kg Total catch: 212.30 CATCH/HOUR: 424.60

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Umbrina canariensis	169.40	462	39.90	
Dentex congoensis	82.60	994	19.45	
Dentex angolensis	81.80	350	19.27	
Brotula barbata	22.40	20	5.28	
Chelidonichthys gabonensis	21.80	538	5.13	
Citharus linguatula	8.40	308	1.98	
Spicara alta	8.20	140	1.93	
Raja clavata	7.00	6	1.65	
Pterothrissus belloci	5.80	42	1.37	
Mystriophis rostellatus	3.60	34	0.85	
NETTASTOMATIDAE	3.60	182	0.85	
Microchirus frechkopi	3.60	14	0.85	
Caranx crysos	3.20	6	0.75	
Erythrocles monodi	1.60	20	0.38	
Todarodes sagittatus	1.20	28	0.28	
Arnoglossus imperialis	0.40	63	0.09	
Total	424.60		100.01	

PROJECT STATION:3203
DATE:23/ 7/03 GEAR TYPE: BT No: 2 POSITION:Lat S 704
start stop duration Long E 1205
TIME :11:55:36 12:25:18 30 (min) Purpose code: 1
LOG :4186.17 4187.58 1.39 Area code : 3
FDEPTH: 125 120 GearCond.code:
BDEPTH: 125 120 Validity code: 3
Towing dir: 58ø Wire out: 400 m Speed: 30 kn*10

Sorted: Kg Total catch: 269.09 CATCH/HOUR: 538.18

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Trachurus trecae	229.30	9074	42.61	6744
Umbrina canariensis	160.60	552	29.84	6745
Dentex angolensis	91.60	688	17.02	
Dentex congoensis	35.60	430	6.61	
Raja miraletus	6.20	10	1.15	
Brotula barbata	4.06	4	0.75	
Todarodes sagittatus	2.78	90	0.52	
Trichiurus lepturus	1.62	2	0.30	
Pterothrissus belloci	1.54	10	0.29	
Zeus faber	1.10	4	0.20	
Sepia sp.	1.04	8	0.19	
Spicara alta	1.02	30	0.19	
Dentex gibbosus	0.80	2	0.15	
Citharus linguatula	0.54	16	0.10	
Arnoglossus imperialis	0.26	12	0.05	
Saurida brasiliensis	0.12	20	0.02	
Total	538.18		99.99	

PROJECT STATION:3204
DATE:23/ 7/03 GEAR TYPE: PT No: 1 POSITION:Lat S 706
start stop duration Long E 1210
TIME :18:54:24 19:09:29 15 (min) Purpose code: 1
LOG :4238.59 4239.53 0.92 Area code : 3
FDEPTH: 30 30 GearCond.code:
BDEPTH: 120 120 Validity code: 3
Towing dir: 127ø Wire out: 145 m Speed: 35 kn*10

Sorted: Kg Total catch: CATCH/HOUR:

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

PROJECT STATION:3205
DATE:24/ 7/03 GEAR TYPE: PT No: 1 POSITION:Lat S 713
start stop duration Long E 1220
TIME :00:40:54 01:10:40 30 (min) Purpose code: 1
LOG :4288.84 4290.65 1.87 Area code : 3
FDEPTH: 20 20 GearCond.code:
BDEPTH: 115 117 Validity code:
Towing dir: 150ø Wire out: 80 m Speed: 38 kn*10

Sorted: Kg Total catch: 1.03 CATCH/HOUR: 2.06

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Trachurus trecae	1.62	72	78.64	6746
Saurida brasiliensis	0.30	100	14.56	
Alloteuthis africana	0.04	2	1.94	
MYCTOPHIDAE	0.02	16	0.97	
Lagocephalus laevigatus	0.02	4	0.97	
Hypoclydonia bella ?	0.02	32	0.97	
Selene dorsalis, juveniles	0.02	8	0.97	
Brotula barbata	0.02	18	0.97	
Total	2.06		99.99	

PROJECT STATION:3206

DATE:24/ 7/03 GEAR TYPE: PT No: 3 POSITION:Lat S 730

	start	stop	duration			Long E 1229
TIME	:21:07:13	21:27:29	20 (min)	Purpose code:	1	
LOG	:4443.00	4444.33	1.32	Area code :	3	
FDEPTH:	50	10		GearCond.code:		
BDEPTH:	123	121		Validity code:	3	

Towing dir: 330ø Wire out: 100 m Speed: 40 kn*10

Sorted: Kg Total catch: 35.40 CATCH/HOUR: 106.20

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
MYCTOPHIDAE	55.20	960	51.98	
Trichiurus lepturus	35.70	48	33.62	
Trachurus trecae	13.95	675	13.14	6747
Synagrops microlepis	0.78	57	0.73	
Sepia officinalis hierredda	0.36	24	0.34	
Saurida brasiliensis	0.21	39	0.20	
Total	106.20		100.01	

PROJECT STATION:3207

DATE:25/ 7/03 GEAR TYPE: PT No: 7 POSITION:Lat S 725

	start	stop	duration			Long E 1252
TIME	:01:48:54	02:18:31	30 (min)	Purpose code:	1	
LOG	:4478.87	4481.14	2.24	Area code :	3	
FDEPTH:	5	5		GearCond.code:		
BDEPTH:	23	18		Validity code:	3	

Towing dir: 360ø Wire out: 150 m Speed: 40 kn*10

Sorted: Kg Total catch: 31.03 CATCH/HOUR: 62.06

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Alectis alexandrinus	15.60	28	25.14	
Sardinella aurita - Juveniles	12.80	594	20.63	6751
Brachydeuterus auritus Juv.	11.50	304	18.53	
Sardinella maderensis	6.34	24	10.22	6750
Elops lacerta	6.22	10	10.02	
Sardinella maderensis - Juv.	2.04	484	3.29	6749
Sphyraena guachancho	1.68	6	2.71	
Rachycentron canadum	1.10	2	1.77	
Ilisha africana	1.00	16	1.61	
Galeoides decadactylus	0.70	12	1.13	
Engraulis encrasicolus	0.54	654	0.87	
Brachydeuterus auritus	0.54	6	0.87	
Chloroscombrus chrysurus	0.54	2	0.87	
Sardinella aurita	0.48	2	0.77	
Selene dorsalis	0.44	2	0.71	
Trachurus trecae, juvenile	0.30	176	0.48	6748
Decapterus rhonchus	0.20	4	0.32	
Parapenaeopsis atlantica	0.02	2	0.03	
Total	62.04		99.97	

PROJECT STATION:3208

DATE:25/ 7/03 GEAR TYPE: PT No: 1 POSITION:Lat S 731

	start	stop	duration			Long E 1241
TIME	:04:33:26	04:50:01	17 (min)	Purpose code:	1	
LOG	:4500.24	4501.23	0.98	Area code :	3	
FDEPTH:	35	55		GearCond.code:		
BDEPTH:	84	79		Validity code:	3	

Towing dir: 65ø Wire out: 190 m Speed: 40 kn*10

Sorted: Kg Total catch: 2.08 CATCH/HOUR: 7.34

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trichiurus lepturus	6.88	11	93.73	
Saurida brasiliensis	0.28	64	3.81	
Sepia officinalis hierredda	0.18	7	2.45	
Total	7.34		99.99	

PROJECT STATION:3209

DATE:25/ 7/03 GEAR TYPE: BT No: 2 POSITION:Lat S 742

	start	stop	duration			Long E 1301
TIME	:18:08:02	18:38:09	30 (min)	Purpose code:	1	
LOG	:4620.26	4622.02	1.75	Area code :	3	
FDEPTH:	22	20		GearCond.code:		
BDEPTH:	22	20		Validity code:	3	

Towing dir: 345ø Wire out: 100 m Speed: 33 kn*10

Sorted: 29 Kg Total catch: 44.26 CATCH/HOUR: 88.52

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Parapenaeus longirostris	27.60	7782	31.18	
Miracorvina angolensis	20.86	480	23.57	
Brachydeuterus auritus	12.80	1664	14.46	
Pentanemus quinquarius	6.78	102	7.66	
Pomadasys jubelini	6.48	48	7.32	
Pseudotolithus typus	3.46	24	3.91	
Sardinella aurita - Juveniles	3.34	1382	3.77	6753
Cynoglossus canariensis	2.20	12	2.49	
Galeoides decadactylus	1.36	8	1.54	
Stromateus fiatola	0.58	4	0.66	
Trachurus trecae, juvenile	0.54	112	0.61	6754
Arius parkii	0.48	4	0.54	
Solea senegalensis	0.42	10	0.47	
Trichiurus lepturus	0.34	12	0.38	
Sardinella maderensis - Juv.	0.34	44	0.38	6752
Mystriophis rostellatus	0.30	4	0.34	
Torpedo torpedo	0.30	4	0.34	
Sepia officinalis hierredda	0.16	4	0.18	
Engraulis encrasicolus	0.16	108	0.18	
Ilisha africana	0.10	28	0.11	
Total	88.60		100.09	

PROJECT STATION:3210

DATE:25/ 7/03 GEAR TYPE: PT No: 7 POSITION:Lat S 748

	start	stop	duration			Long E 1302
TIME	:19:55:21	20:07:33	12 (min)	Purpose code:	1	
LOG	:4631.68	4632.42	0.74	Area code :	3	
FDEPTH:	10	10		GearCond.code:		
BDEPTH:	24	26		Validity code:	3	

Towing dir: 245ø Wire out: 100 m Speed: 35 kn*10

Sorted: Kg Total catch: 323.10 CATCH/HOUR: 1615.50

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	1302.50	9075	80.63	6755
Brachydeuterus auritus	167.75	15275	10.38	
Ilisha africana	33.50	825	2.07	
Sepia orbignyana	26.50	25	1.64	
Penaeus notialis	18.50	425	1.15	
Trichiurus lepturus	14.50	175	0.90	
Sardinella aurita	12.50	100	0.77	6756
Stromateus fiatola	11.75	25	0.73	
Selene dorsalis	9.00	100	0.56	
Sphyraena guachancho	8.25	25	0.51	
Galeoides decadactylus	3.50	25	0.22	
Engraulis encrasicolus	1.75	125	0.11	
Miracorvina angolensis	1.50	25	0.09	
Raja miraletus	1.50	25	0.09	
Trachurus trecae	1.50	50	0.09	
Pentanemus quinquarius	1.00	25	0.06	
Total	1615.50		100.00	

PROJECT STATION:3211

DATE:26/ 7/03 GEAR TYPE: PT No: 1 POSITION:Lat S 755

	start	stop	duration			Long E 1251
TIME	:04:25:54	04:37:59	12 (min)	Purpose code:	1	
LOG	:4691.28	4692.03	0.74	Area code :	3	
FDEPTH:	40	55		GearCond.code:		
BDEPTH:	102	98		Validity code:	3	

Towing dir: 65ø Wire out: 180 m Speed: 38 kn*10

Sorted: Kg Total catch: 1.07 CATCH/HOUR: 5.35

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trichiurus lepturus	4.95	15	92.52	
Saurida brasiliensis	0.40	150	7.48	
Total	5.35		100.00	

PROJECT STATION:3212

DATE:26/ 7/03 GEAR TYPE: BT No: 2 POSITION:Lat S 757

	start	stop	duration			Long E 1301
TIME	:12:57:04	13:27:08	30 (min)	Purpose code:	1	
LOG	:4747.33	4748.91	1.57	Area code :	3	
FDEPTH:	59	68		GearCond.code:		
BDEPTH:	59	68		Validity code:	3	

Towing dir: 245ø Wire out: 210 m Speed: 30 kn*10

Sorted: Kg Total catch: 456.28 CATCH/HOUR: 912.56

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Brachydeuterus auritus	517.80	5340	56.74	
Decapterus rhonchus	168.60	162	18.48	
Trichiurus lepturus	43.50	132	4.77	
Pagellus bellottii	38.82	756	4.25	
Selene dorsalis	35.94	264	3.94	
Trachurus trecae	16.86	1068	1.85	6757
Stromateus fiatola	15.78	24	1.73	
Sepia officinalis hierredda	15.06	30	1.65	
Zeus faber	13.80	60	1.51	
Alloteuthis africana	11.16	2556	1.22	
Raja miraletus	9.06	18	0.99	
Pterothrissus belloci	4.80	6	0.53	
Atractoscion aequidens	4.08	12	0.45	
Dentex angolensis	3.30	102	0.36	
Scomber japonicus	2.64	6	0.29	
Dentex barnardi	2.52	36	0.28	
Pseudupeneus prayensis	2.40	6	0.26	
Citharus linguatula	1.80	78	0.20	
Solea senegalensis	1.74	12	0.19	
Brotula barbata	1.44	6	0.16	
Penaeus notialis	0.96	18	0.11	
Grammoplites gruveli	0.48	6	0.05	
Sepia orbignyana	0.36	12	0.04	
Serranus accraensis	0.24	6	0.03	
Total	913.14		100.08	

PROJECT STATION:3213

DATE:27/ 7/03 GEAR TYPE: PT No: 7 POSITION:Lat S 816

	start	stop	duration			Long E 1317
TIME	:06:17:14	06:47:04	30 (min)	Purpose code:	1	
LOG	:4907.79	4909.26	1.46	Area code :	3	
FDEPTH:	15	15		GearCond.code:		
BDEPTH:	26	25		Validity code:	3	

Towing dir: 155ø Wire out: 100 m Speed: 30 kn*10

Sorted: Kg Total catch: 30.28 CATCH/HOUR: 60.56

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Brachydeuterus auritus	17.80	1146	29.39	
Sardinella maderensis	13.08	184	21.60	6760
Sphyraena guachancho	7.10	18	11.72	
Stromateus fiatola	6.28	12	10.37	
Sepia orbignyana	5.20	18	8.59	
Trachurus trecae	4.10	156	6.77	6758
Selene dorsalis	2.66	26	4.39	
Trichiurus lepturus	2.40	62	3.96	
Raja miraletus	1.22	4	2.01	
Sardinella aurita - Juveniles	0.72	188	1.19	6759
Total	60.56		99.99	

PROJECT STATION:3214

DATE:27/ 7/03 GEAR TYPE: PT No: 1 POSITION:Lat S 830
start stop duration Long E 1301
TIME :11:15:44 11:45:50 30 (min) Purpose code: 1
LOG :4943.33 4945.39 2.06 Area code : 3
FDEPTH: 15 15 GearCond.code:
BDEPTH: 125 111 Validity code: 3
Towing dir: 79ø Wire out: 100 m Speed: 40 kn*10

Sorted: Kg Total catch: 1.62 CATCH/HOUR: 3.24

SPECIES	CATCH/HOUR weight	% OF TOT. C numbers	SAMP
Remora sp.	2.30	2	70.99
Sardinella maderensis	0.94	4	29.01
Total	3.24		100.00

PROJECT STATION:3215

DATE:27/ 7/03 GEAR TYPE: BT No: 2 POSITION:Lat S 830
start stop duration Long E 1300
TIME :12:37:32 13:07:22 30 (min) Purpose code: 1
LOG :4950.95 4952.50 1.54 Area code : 3
FDEPTH: 134 117 GearCond.code:
BDEPTH: 134 117 Validity code: 3
Towing dir: 79ø Wire out: 410 m Speed: 30 kn*10

Sorted: Kg Total catch: 208.96 CATCH/HOUR: 417.92

SPECIES	CATCH/HOUR weight	% OF TOT. C numbers	SAMP
Spicara alta	115.90	620	27.73
Trachurus trecae	95.20	194	22.78	6762
Dentex angolensis	48.20	218	11.53
Trachurus trecae, juvenile	31.50	1072	7.54	6761
Dentex barnardi	25.70	8	6.15
Umbrina canariensis	18.10	46	4.33
Trichiurus lepturus	14.70	16	3.52
Dentex macrophthalmus	13.60	38	3.25
Atractoscion aequidens	6.70	8	1.60
Zenopsis conchifer	5.70	6	1.36
Brotula barbata	5.00	8	1.20
Octopus vulgaris	4.80	8	1.15
Scorpaena angolensis	4.04	6	0.97
Boops boops	4.00	132	0.96
Zeus faber	3.90	16	0.93
Trigla lyra	3.70	32	0.89
Pterothrissus belloci	3.10	28	0.74
Dentex congoensis	2.76	20	0.66
Loligo vulgaris	1.86	48	0.45
Dentex canariensis	1.62	2	0.39
Pentheroscion mbizi	1.60	2	0.38
Torpedo torpedo	1.30	2	0.31
Chaetodon hoefleri	1.26	10	0.30
Anthias anthias	1.24	108	0.30
Epinephelus aeneus	0.86	2	0.21
Pontinus accraensis	0.34	2	0.08
Alloteuthis africana	0.32	16	0.08
Perulibatrachus elminensis	0.26	2	0.06
Chelidonichthys capensis	0.22	2	0.05
Citharus linguatula	0.22	6	0.05
Selene dorsalis	0.16	2	0.04
Uranoscopus albesca	0.02	2	
Arnoglossus imperialis	0.02	4	
Schedophilus pemarco	0.02	2	
Total	417.92		99.99

PROJECT STATION:3216

DATE:28/ 7/03 GEAR TYPE: PT No: 1 POSITION:Lat S 848
start stop duration Long E 1305
TIME :02:47:07 03:17:11 30 (min) Purpose code: 1
LOG :5068.16 5070.26 2.09 Area code : 3
FDEPTH: 15 15 GearCond.code:
BDEPTH: 107 130 Validity code: 3
Towing dir: 283ø Wire out: 100 m Speed: 40 kn*10

Sorted: Kg Total catch: 118.88 CATCH/HOUR: 237.76

SPECIES	CATCH/HOUR weight	% OF TOT. C numbers	SAMP
Sardinella maderensis	141.70	536	59.60	6763
Trichiurus lepturus	40.00	92	16.82
Sarda sarda	26.10	22	10.98
Pterothrissus belloci	24.30	2920	10.22
Scomber japonicus	2.66	6	1.12
Trachurus trecae	1.84	6	0.77
Sardinella aurita	1.02	4	0.43
Loligo vulgaris	0.10	8	0.04
MYCTOPHIDAE	0.02	16	0.01
Sepiella ornata	0.02	2	0.01
Total	237.76		100.00

PROJECT STATION:3217

DATE:28/ 7/03 GEAR TYPE: PT No: 1 POSITION:Lat S 853
start stop duration Long E 1256
TIME :07:36:56 07:51:50 15 (min) Purpose code: 1
LOG :5104.26 5105.05 0.79 Area code : 3
FDEPTH: 170 200 GearCond.code:
BDEPTH: 265 263 Validity code: 3
Towing dir: 22ø Wire out: 450 m Speed: 30 kn*10

Sorted: Kg Total catch: 4.80 CATCH/HOUR: 19.20

SPECIES	CATCH/HOUR weight	% OF TOT. C numbers	SAMP
MYCTOPHIDAE	17.96	14624	93.54
Trichiurus lepturus	1.24	16	6.46
Total	19.20		100.00

PROJECT STATION:3218

DATE:28/ 7/03 GEAR TYPE: PT No: 1 POSITION:Lat S 912
start stop duration Long E 1253
TIME :19:39:07 19:58:59 20 (min) Purpose code: 1
LOG :5190.21 5191.58 1.36 Area code : 3
FDEPTH: 20 20 GearCond.code:
BDEPTH: 55 72 Validity code: 3
Towing dir: 258ø Wire out: 120 m Speed: 40 kn*10

Sorted: Kg Total catch: 53.71 CATCH/HOUR: 161.13

SPECIES	CATCH/HOUR weight	% OF TOT. C numbers	SAMP
Trichiurus lepturus	122.25	309	75.87
Trachinotus ovatus	17.40	48	10.80
Bregmaceros sp.	8.31	9816	5.16
Brachydeuterus auritus	8.07	42	5.01
Trachurus trecae	2.46	12	1.53
Sardinella maderensis	1.77	6	1.10
Alloteuthis africana	0.54	141	0.34
Saurida brasiliensis	0.33	63	0.20
Total	161.13		100.01

PROJECT STATION:3219

DATE:28/ 7/03 GEAR TYPE: BT No: 2 POSITION:Lat S 913
start stop duration Long E 1256
TIME :23:13:16 23:43:07 30 (min) Purpose code: 1
LOG :5216.42 5217.95 1.52 Area code : 3
FDEPTH: 20 20 GearCond.code:
BDEPTH: 20 20 Validity code: 3
Towing dir: 147ø Wire out: 100 m Speed: 30 kn*10

Sorted: Kg Total catch: 60.65 CATCH/HOUR: 121.30

SPECIES	CATCH/HOUR weight	% OF TOT. C numbers	SAMP
Brachydeuterus auritus	40.90	226	33.72
Trichiurus lepturus	25.50	58	21.02
Sepia orbignyana	13.70	16	11.29
Ilisha africana	8.76	88	7.22
Chelidonichthys gabonensis	5.62	32	4.63
Pomadasys rogeri	4.92	14	4.06
Sardinella maderensis	4.88	24	4.02
Galeoides decadactylus	4.84	44	3.99
Mycteroperca rubra	3.52	2	2.90
Arius latiscutatus	3.28	4	2.70
Trachurus trecae, juvenile	2.14	582	1.76	6764
Pagellus bellottii	1.92	14	1.58
Monolene microstoma	0.70	4	0.58
Engraulis encrasicolus	0.62	74	0.51
Total	121.30		99.98

PROJECT STATION:3220

DATE:29/ 7/03 GEAR TYPE: BT No: 2 POSITION:Lat S 939
start stop duration Long E 1251
TIME :13:33:34 14:03:18 30 (min) Purpose code: 1
LOG :5341.65 5343.17 1.52 Area code : 2
FDEPTH: 120 121 GearCond.code:
BDEPTH: 120 121 Validity code: 3
Towing dir: 337ø Wire out: 370 m Speed: 30 kn*10

Sorted: Kg Total catch: 75.42 CATCH/HOUR: 150.84

SPECIES	CATCH/HOUR weight	% OF TOT. C numbers	SAMP
Dentex angolensis	44.60	150	29.57
Trachurus trecae	30.70	1178	20.35	6766
Dentex macrophthalmus	19.10	50	12.66
Loligo vulgaris	16.90	1256	11.20
Chelidonichthys gabonensis	6.40	42	4.24
Brotula barbata	6.30	10	4.18
Trichiurus lepturus	6.00	8	3.98
Zeus faber	4.70	20	3.12
Raja clavata	3.70	2	2.45
Umbrina canariensis	2.90	6	1.92
Dentex barnardi	2.40	10	1.59
Branchiostegus semifasciatus	1.80	2	1.19
Raja miraletus	1.20	2	0.80
Ommastrephes pteropus	0.90	32	0.60
Citharus linguatula	0.78	12	0.52
Engraulis encrasicolus	0.68	100	0.45
Pagellus bellottii	0.40	2	0.27
Dactylopterus volitans	0.38	2	0.25
Dentex gibbosus	0.32	2	0.21
Anthias anthias	0.26	10	0.17
Chaetodon hoefleri	0.22	2	0.15
Monolene microstoma	0.20	8	0.13
Total	150.84		100.00

PROJECT STATION:3221

DATE:29/ 7/03 GEAR TYPE: PT No: 7 POSITION:Lat S 936
start stop duration Long E 1308
TIME :19:20:33 19:27:52 7 (min) Purpose code: 1
LOG :5385.52 5385.95 0.43 Area code : 2
FDEPTH: 10 10 GearCond.code:
BDEPTH: 26 24 Validity code: 3
Towing dir: 20ø Wire out: 100 m Speed: 38 kn*10

Sorted: Kg Total catch: 274.40 CATCH/HOUR: 2352.00

SPECIES	CATCH/HOUR weight	% OF TOT. C numbers	SAMP
Sardinella maderensis	1973.14	9394	83.89	6767
Sardinella aurita	245.49	891	10.44	6768
Brachydeuterus auritus	54.86	343	2.33
Pomadasys incisus	33.26	171	1.41
Decapterus rhonchus	16.11	69	0.68
Ilisha africana	10.63	137	0.45
Boops boops	5.83	240	0.25
Sardinella aurita - Juveniles	4.46	789	0.19
Sardinella maderensis - Juv.	2.74	171	0.12
Trichiurus lepturus	2.06	34	0.09
Engraulis encrasicolus	1.71	446	0.07
Trachurus trecae, juvenile	1.03	720	0.04
Sphyraena guachancho	0.69	34	0.03
Total	2352.01		99.99

PROJECT STATION:3222

DATE:30/ 7/03 GEAR TYPE: BT No: 8 POSITION:Lat S 948
start stop duration Long E 1312
TIME :03:19:38 03:49:32 30 (min) Purpose code: 1
LOG :5459.57 5461.14 1.57 Area code : 2
FDEPTH: 25 27 GearCond.code:
BDEPTH: 25 27 Validity code: 3
Towing dir: 360ø Wire out: 110 m Speed: 30 kn*10

Sorted: Kg Total catch: 68.63 CATCH/HOUR: 137.26

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Brachydeuterus auritus	48.40	398	35.26	
Pagellus bellottii	30.72	790	22.38	
Pteroscion peli	17.00	184	12.39	
Pseudotolithus typus	8.70	16	6.34	
Solea senegalensis	8.48	146	6.18	
Cynoglossus senegalensis	5.54	22	4.04	
Trachurus trecae	4.52	404	3.29	
Pomadasys incisus	2.70	4	1.97	
Penaeus notialis	2.44	180	1.78	
Boops boops	1.92	30	1.40	
TORPEDINIDAE	1.36	8	0.99	
Sepia orbignyana	1.06	8	0.77	
Ilisha africana	0.96	10	0.70	
Lepidotrigla carolae	0.74	46	0.54	
Penaeus kerathurus	0.50	12	0.36	
Epinephelus aeneus	0.48	2	0.35	
Brachydeuterus auritus Juv.	0.46	182	0.34	
Citharus linguatula	0.42	6	0.31	
Chaetodon hoefleri	0.22	2	0.16	
Pseudupeneus prayensis	0.22	4	0.16	
Sardinella maderensis	0.22	10	0.16	
Squilla mantis	0.20	6	0.15	
Total	137.26		100.02	

PROJECT STATION:3223

DATE:30/ 7/03 GEAR TYPE: BT No: 8 POSITION:Lat S 958
start stop duration Long E 1257
TIME :08:27:59 08:48:37 21 (min) Purpose code: 1
LOG :5496.23 5497.32 1.08 Area code : 2
FDEPTH: 112 114 GearCond.code:
BDEPTH: 112 114 Validity code: 3
Towing dir: 350ø Wire out: 300 m Speed: 31 kn*10

Sorted: Kg Total catch: 139.38 CATCH/HOUR: 398.23

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trichiurus lepturus	152.14	220	38.20	
Dentex macrophthalmus	92.00	334	23.10	
Umbrina canariensis	53.86	129	13.52	
Trachurus trecae	26.71	843	6.71	6770
Dentex angolensis	18.09	89	4.54	
Loligo vulgaris	17.17	1449	4.31	
Zeus faber	12.57	31	3.16	
Branchiostegus semifasciatus	5.29	3	1.33	
Dentex congoensis	5.06	40	1.27	
Brachydeuterus auritus	3.86	31	0.97	
Dentex barnardi	3.49	14	0.88	
Dentex canariensis	3.29	11	0.83	
Saurida brasiliensis	1.63	331	0.41	
Trigla lyra	1.49	9	0.37	
Monolene microstoma	0.91	11	0.23	
Scorpaena normani	0.40	3	0.10	
Citharus linguatula	0.29	9	0.07	
Total	398.25		100.00	

PROJECT STATION:3224

DATE:30/ 7/03 GEAR TYPE: PT No: 1 POSITION:Lat S 956
start stop duration Long E 1311
TIME :14:21:43 14:51:33 30 (min) Purpose code: 1
LOG :5538.33 5540.41 2.05 Area code : 2
FDEPTH: 20 20 GearCond.code:
BDEPTH: 42 40 Validity code: 3
Towing dir: 15ø Wire out: 120 m Speed: 40 kn*10

Sorted: Kg Total catch: CATCH/HOUR:

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Total				

PROJECT STATION:3225

DATE:30/ 7/03 GEAR TYPE: BT No: 8 POSITION:Lat S 954
start stop duration Long E 1310
TIME :15:31:48 16:01:27 30 (min) Purpose code: 1
LOG :5543.82 5545.37 1.54 Area code : 2
FDEPTH: 41 40 GearCond.code:
BDEPTH: 41 40 Validity code: 3
Towing dir: 155ø Wire out: 160 m Speed: 30 kn*10

Sorted: 74 Kg Total catch: 187.04 CATCH/HOUR: 374.08

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Brachydeuterus auritus	145.50	1014	38.90	
Trachurus trecae, juvenile	111.00	4496	29.67	6771
Sepia orbignyana	38.74	274	10.36	
Trachurus trecae	25.24	120	6.75	6765
Trichiurus lepturus	19.74	54	5.28	
Fistularia tabacaria	11.24	34	3.00	
Pagellus bellottii	9.34	280	2.50	
Zeus faber	7.00	14	1.87	
Illex coindetii	3.74	1170	1.00	
Pseudupeneus prayensis	2.54	34	0.68	
Total	374.08		100.01	

PROJECT STATION:3226

DATE:30/ 7/03 GEAR TYPE: BT No: 8 POSITION:Lat S 958
start stop duration Long E 1316
TIME :19:40:21 20:02:32 22 (min) Purpose code: 1
LOG :5567.26 5568.52 1.27 Area code : 2
FDEPTH: 17 15 GearCond.code:
BDEPTH: 17 15 Validity code: 3
Towing dir: 40ø Wire out: 100 m Speed: 33 kn*10

Sorted: 61 Kg Total catch: 472.72 CATCH/HOUR: 1289.24

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	442.83	2558	34.35	6769
Brachydeuterus auritus	365.10	7505	28.32	
Galeoides decadactylus	228.05	2782	17.69	
Pentheroscion mbizi	71.59	4437	5.55	
Trachurus trecae	35.95	265	2.79	6772
Trichiurus lepturus	27.19	551	2.11	
Ilisha africana	25.36	469	1.97	
Penaeus notialis	18.19	2782	1.41	
Pseudotolithus typus	16.55	82	1.28	
Pagellus bellottii	12.05	41	0.93	
Stromateus fiatola	10.83	19	0.84	
Pseudotolithus senegalensis	9.19	19	0.71	
Selene dorsalis	7.15	265	0.55	
Solea senegalensis	4.91	101	0.38	
Pomadasys incisus	4.69	41	0.36	
Apsilus fuscus	3.68	41	0.29	
Pomadasys rogeri	3.27	19	0.25	
Pentanemus quinquarius	1.42	19	0.11	
Sepia officinalis hierredda	1.23	41	0.10	
Total	1289.23		99.99	

PROJECT STATION:3227

DATE:31/ 7/03 GEAR TYPE: PT No: 4 POSITION:Lat S 1007
start stop duration Long E 1314
TIME :03:39:06 04:12:53 34 (min) Purpose code: 1
LOG :5629.50 5631.69 2.17 Area code : 2
FDEPTH: 1 1 GearCond.code:
BDEPTH: 55 72 Validity code: 3
Towing dir: 245ø Wire out: 150 m Speed: 40 kn*10

Sorted: Kg Total catch: 88.21 CATCH/HOUR: 155.66

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trichiurus lepturus	144.88	349	93.07	
Lagocephalus laevigatus	6.09	9	3.91	
Stromateus fiatola	1.06	2	0.68	
Brachydeuterus auritus	1.02	7	0.66	
Sepia officinalis hierredda	0.97	2	0.62	
Trachinotus ovatus	0.88	2	0.57	
Octopus vulgaris	0.76	4	0.49	
Total	155.66		100.00	

PROJECT STATION:3228

DATE:31/ 7/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1007
start stop duration Long E 1319
TIME :05:58:43 06:19:14 21 (min) Purpose code: 1
LOG :5645.69 5646.86 1.15 Area code : 2
FDEPTH: 24 22 GearCond.code:
BDEPTH: 24 22 Validity code: 3
Towing dir: 112ø Wire out: 120 m Speed: 33 kn*10

Sorted: 67 Kg Total catch: 770.34 CATCH/HOUR: 2200.97

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Brachydeuterus auritus	1118.77	13831	50.83	
Chloroscombrus chrysurus	351.57	3943	15.97	
Ilisha africana	207.97	2331	9.45	
Galeoides decadactylus	166.91	689	7.58	
Pentheroscion mbizi	145.54	3286	6.61	
Trichiurus lepturus	60.77	1871	2.76	
Selene dorsalis	31.20	460	1.42	
Trachurus trecae, juvenile	26.29	623	1.19	6773
Sphyraena guachancho	26.29	31	1.19	
Sardinella aurita - Juveniles	17.40	854	0.79	6775
Sardinella maderensis - Juv.	17.40	557	0.79	6774
Pomadasys rogeri	15.43	31	0.70	
Pagellus bellottii	15.43	31	0.70	
Total	2200.97		99.98	

PROJECT STATION:3229

DATE:31/ 7/03 GEAR TYPE: PT No: 1 POSITION:Lat S 1010
start stop duration Long E 1320
TIME :08:37:20 09:04:42 27 (min) Purpose code: 1
LOG :5662.85 5664.55 1.58 Area code : 2
FDEPTH: 10 10 GearCond.code:
BDEPTH: 33 35 Validity code: 3
Towing dir: 148ø Wire out: 100 m Speed: 37 kn*10

Sorted: Kg Total catch: 72.70 CATCH/HOUR: 161.56

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Chloroscombrus chrysurus	66.33	422	41.06	
Sardinella maderensis	46.11	227	28.54	6776
Brachydeuterus auritus	37.67	351	23.32	
Trichiurus lepturus	3.93	7	2.43	
Selene dorsalis	2.47	31	1.53	
Sardinella aurita	1.73	7	1.07	6777
Galeoides decadactylus	1.11	2	0.69	
Sphyraena guachancho	0.96	2	0.59	
Auxis thazard	0.80	2	0.50	
Pagellus bellottii	0.27	2	0.17	
Trachurus trecae	0.11	2	0.07	
Sepia officinalis hierredda	0.07	2	0.04	
Total	161.56		100.01	

PROJECT STATION:3230

DATE: 2/ 8/03 GEAR TYPE: PT No: 1 POSITION:Lat S 1020
start stop duration Long E 1325
TIME :08:16:30 08:46:31 30 (min) Purpose code: 1
LOG :6009.48 6011.45 1.95 Area code : 2
FDEPTH: 20 20 GearCond.code:
BDEPTH: 48 41 Validity code: 3
Towing dir: ø Wire out: 120 m Speed: 38 kn*10

Sorted: Kg Total catch: 0.50 CATCH/HOUR: 1.00

SPECIES	CATCH/HOUR weight	% OF TOT. C numbers	SAMP
Decapterus rhonchus	1.00	4 100.00	
Total	1.00	100.00	

PROJECT STATION:3231

DATE: 2/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1024
start stop duration Long E 1331
TIME :15:31:06 16:01:09 30 (min) Purpose code: 1
LOG :6076.40 6077.92 1.49 Area code : 2
FDEPTH: 19 19 GearCond.code:
BDEPTH: 19 19 Validity code: 3
Towing dir: 170ø Wire out: 120 m Speed: 30 kn*10

Sorted: 95 Kg Total catch: 416.71 CATCH/HOUR: 833.42

SPECIES	CATCH/HOUR weight	% OF TOT. C numbers	SAMP
Brachydeuterus auritus	352.00	8936 42.24	
Galeoides decadactylus	233.06	1694 27.96	
Pentheroscion mbizi	110.08	952 13.21	
Pomadasys jubelini	40.24	86 4.83	
Miracorvina angolensis	20.04	130 2.40	
Pomadasys incisus	17.20	146 2.06	
Solea senegalensis	14.28	318 1.71	
Trachurus trecae	11.62	228 1.39	6778
Ilisha africana	9.54	130 1.14	
Trichiurus lepturus	8.60	94 1.03	
Parapenaeus longirostris	6.70	1728 0.80	
Sepia orbignyana	3.50	2 0.42	
Pentanemus quinquarius	3.02	44 0.36	
Sardinella maderensis - Juv.	1.90	92 0.23	6779
Sepiella ornata	1.64	34 0.20	
Total	833.42	99.98	

PROJECT STATION:3232

DATE: 2/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1030
start stop duration Long E 1331
TIME :18:18:15 18:42:32 24 (min) Purpose code: 1
LOG :6094.76 6096.06 1.29 Area code : 2
FDEPTH: 40 41 GearCond.code:
BDEPTH: 40 41 Validity code: 3
Towing dir: 145ø Wire out: 200 m Speed: 32 kn*10

Sorted: 94 Kg Total catch: 1095.41 CATCH/HOUR: 2738.53

SPECIES	CATCH/HOUR weight	% OF TOT. C numbers	SAMP
Brachydeuterus auritus	2428.90	22988 88.69	
Pagellus bellottii	204.10	928 7.45	
Raja alba	34.75	318 1.27	
Pentheroscion mbizi	27.80	405 1.02	
Pseudotolithus typus	20.28	58 0.74	
Umbrina canariensis	14.78	115 0.54	
Dentex canariensis	2.90	30 0.11	
Trachurus trecae	1.45	5 0.05	
Raja miraletus	1.45	58 0.05	
Trichiurus lepturus	1.45	145 0.05	
Sardinella maderensis	0.68	3 0.02	
Total	2738.54	99.99	

PROJECT STATION:3233

DATE: 3/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1035
start stop duration Long E 1339
TIME :01:44:49 02:14:34 30 (min) Purpose code: 1
LOG :6156.66 6158.19 1.51 Area code : 2
FDEPTH: 23 32 GearCond.code:
BDEPTH: 23 32 Validity code: 3
Towing dir: 245ø Wire out: 120 m Speed: 30 kn*10

Sorted: Kg Total catch: 158.45 CATCH/HOUR: 316.90

SPECIES	CATCH/HOUR weight	% OF TOT. C numbers	SAMP
Brachydeuterus auritus	101.00	1470 31.87	
Pteroscion peli	80.00	250 25.24	
Pomadasys incisus	28.24	244 8.91	
Pagellus bellottii	17.00	84 5.36	
Torpedo marmorata	16.74	30 5.28	
Rhinobatos albomaculatus	16.30	26 5.14	
Trichiurus lepturus	13.00	190 4.10	
Dasyatis margarita	8.70	34 2.75	
Pseudotolithus senegalensis	8.34	64 2.63	
Penaeus notialis	6.52	144 2.06	
Penaeus notialis	5.24	2884 1.65	
Sardinella aurita - Juveniles	4.10	224 1.29	6781
Trachurus trecae	2.92	26 0.92	6780
Ophichthus ophis	2.50	20 0.79	
Dentex barnardi	2.14	4 0.68	
Solea senegalensis	1.80	50 0.57	
Sardinella maderensis - Juv.	0.70	16 0.22	6782
Sepia orbignyana	0.34	24 0.11	
Ilisha africana	0.30	4 0.09	
Pentanemus quinquarius	0.24	4 0.08	
Chilomycterus spinosus mauret.	0.24	4 0.08	
Penaeus kerathurus	0.24	6 0.08	
SQUILLIDAE	0.14	30 0.04	
Selene dorsalis	0.04	4 0.01	
Cynoglossus canariensis	0.04	4 0.01	
Citharus linguatula	0.04	4 0.01	
Helicolenus dactylopterus	0.04	10 0.01	
Total	316.90	99.98	

PROJECT STATION:3234

DATE: 3/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1049
start stop duration Long E 1339
TIME :12:17:46 12:47:37 30 (min) Purpose code: 1
LOG :6228.84 6230.43 1.58 Area code : 2
FDEPTH: 65 77 GearCond.code:
BDEPTH: 65 77 Validity code: 3
Towing dir: 243ø Wire out: 210 m Speed: 30 kn*10

Sorted: Kg Total catch: 247.45 CATCH/HOUR: 494.90

SPECIES	CATCH/HOUR weight	% OF TOT. C numbers	SAMP
Trichiurus lepturus	292.00	3740 59.00	
Brachydeuterus auritus	63.68	352 12.87	
Pterothrissus belloci	27.20	322 5.50	
Brotula barbata	21.76	92 4.40	
Zeus faber	18.24	66 3.69	
Citharus linguatula	10.72	200 2.17	
Pseudotolithus typus	9.92	44 2.00	
Pagellus bellottii	8.48	50 1.71	
Dentex barnardi	8.16	66 1.65	
Raja miraletus	5.44	6 1.10	
Sepia orbignyana	5.36	16 1.08	
Dentex angolensis	4.96	18 1.00	
Solea senegalensis	3.74	28 0.76	
Umbrina canariensis	2.72	18 0.55	
Scorpaena normani	2.40	86 0.48	
Chelidonichthys gabonensis	2.10	16 0.42	
Chaetodon hoefleri	1.52	8 0.31	
Parapristipoma octolineatum	1.14	4 0.23	
Octopus vulgaris	1.12	4 0.23	
Cynoglossus browni	0.92	4 0.19	
Trachurus trecae	0.70	2 0.14	
FISH LARVAE	0.64	220 0.13	
Pteroscion peli	0.56	4 0.11	
Parapenaeus longirostris	0.54	144 0.11	
Merluccius polli	0.28	60 0.06	
Cynoponticus ferox	0.22	4 0.04	
Epinephelus alexandrinus *	0.18	4 0.04	
Epinephelus guaza ?	0.08	4 0.02	
GOBIIDAE	0.06	32 0.01	
Schedophilus pemarco	0.02	4	
Ephippion guttifer	0.02	4	
Scorpaena stephanica	0.02	4	
Total	494.90	100.00	

PROJECT STATION:3235

DATE: 3/ 8/03 GEAR TYPE: PT No: 1 POSITION:Lat S 1047
start stop duration Long E 1342
TIME :14:16:01 14:46:11 30 (min) Purpose code: 1
LOG :6238.74 6240.89 2.11 Area code : 2
FDEPTH: 15 20 GearCond.code:
BDEPTH: 39 56 Validity code: 3
Towing dir: 243ø Wire out: 120 m Speed: 40 kn*10

Sorted: Kg Total catch: 32.86 CATCH/HOUR: 65.72

SPECIES	CATCH/HOUR weight	% OF TOT. C numbers	SAMP
Galeoides decadactylus	28.10	52 42.76	
Sardinella maderensis	18.30	64 27.85	6783
Trachinotus ovatus	6.28	14 9.56	
Brachydeuterus auritus	3.36	28 5.11	
Chloroscombrus chrysurus	2.64	12 4.02	
Trichiurus lepturus	1.92	4 2.92	
Sphyraena guachancho	1.88	4 2.86	
Pomadasys rogeri	1.66	2 2.53	
Sepia officinalis hierredda	0.86	88 1.31	
Sardinella aurita	0.50	2 0.76	
Trachurus trecae	0.20	2 0.30	
Scomber japonicus	0.02	2 0.03	
Total	65.72	100.01	

PROJECT STATION:3236

DATE: 3/ 8/03 GEAR TYPE: PT No: 1 POSITION:Lat S 1048
start stop duration Long E 1343
TIME :18:41:17 19:13:09 32 (min) Purpose code: 1
LOG :6272.38 6274.46 2.00 Area code : 2
FDEPTH: 10 10 GearCond.code:
BDEPTH: 36 37 Validity code: 3
Towing dir: 160ø Wire out: 120 m Speed: 38 kn*10

Sorted: 95 Kg Total catch: 2210.32 CATCH/HOUR: 4144.35

SPECIES	CATCH/HOUR weight	% OF TOT. C numbers	SAMP
Brachydeuterus auritus	2868.38	2713 69.21	
Sardinella maderensis	740.78	2843 17.87	6784
Pomadasys jubelini	179.59	302 4.33	
Trichiurus lepturus	158.93	345 3.83	
Galeoides decadactylus	105.53	216 2.55	
Arius parkii	42.64	43 1.03	
Trachurus trecae	27.84	184 0.67	6785
Pteroscion peli	12.06	36 0.29	
Chloroscombrus chrysurus	5.18	43 0.12	
Sardinella aurita	3.45	43 0.08	
Total	4144.38	99.98	

PROJECT STATION:3237

DATE: 4/ 8/03 GEAR TYPE: PT No: 4 POSITION:Lat S 1103
start stop duration Long E 1333
TIME :02:01:58 02:32:14 30 (min) Purpose code: 1
LOG :6324.01 6325.82 1.79 Area code : 2
FDEPTH: 5 5 GearCond.code:
BDEPTH: 239 327 Validity code: 3
Towing dir: 261ø Wire out: 150 m Speed: 40 kn*10

Sorted: Kg Total catch: 259.10 CATCH/HOUR: 518.20

SPECIES	CATCH/HOUR weight	% OF TOT. C numbers	SAMP
MYCTOPHIDAE	388.20	282120 74.91	
Lepidochelys olivacea	130.00	2 25.09	
Total	518.20	100.00	

PROJECT STATION:3238

DATE: 4/ 8/03 GEAR TYPE: PT No: 1 POSITION:Lat S 1108
start stop duration Long E 1337
TIME :09:12:24 09:35:41 23 (min) Purpose code: 1
LOG :6374.69 6375.97 1.28 Area code : 2
FDEPTH: 110 110 GearCond.code:
BDEPTH: 141 116 Validity code: 3
Towing dir: 90ø Wire out: 300 m Speed: 34 kn*10

Sorted: Kg Total catch: 11.62 CATCH/HOUR: 30.31

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Trichiurus lepturus	16.17	21	53.35	
MYCTOPHIDAE	10.90	5084	35.96	
Todarodes sagittatus	2.09	788	6.90	
FISH LARVAE	0.91	300	3.00	
Selene dorsalis, juveniles	0.23	23	0.76	
Total	30.30		99.97	

PROJECT STATION:3239

DATE: 4/ 8/03 GEAR TYPE: PT No: 1 POSITION:Lat S 1114
start stop duration Long E 1337
TIME :15:08:20 15:38:15 30 (min) Purpose code: 1
LOG :6415.01 6416.93 1.91 Area code : 2
FDEPTH: 75 65 GearCond.code:
BDEPTH: 120 108 Validity code: 3
Towing dir: 173ø Wire out: 270 m Speed: 40 kn*10

Sorted: Kg Total catch: 10.97 CATCH/HOUR: 21.94

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
J E L L Y F I S H	16.70	938	76.12	
MYCTOPHIDAE	1.40	160	6.38	
Trichiurus lepturus	1.28	2	5.83	
FISH LARVAE	1.22	190	5.56	
Todaropsis sp.	1.20	160	5.47	
Trachurus trecae, juvenile	0.14	108	0.64	6786
Total	21.94		100.00	

PROJECT STATION:3240

DATE: 5/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1131
start stop duration Long E 1345
TIME :02:06:53 02:36:29 30 (min) Purpose code: 1
LOG :6492.32 6493.65 1.31 Area code : 2
FDEPTH: 19 18 GearCond.code:
BDEPTH: 19 18 Validity code: 3
Towing dir: 15ø Wire out: 100 m Speed: 30 kn*10

Sorted: Kg Total catch: 354.76 CATCH/HOUR: 709.52

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Brachydeuterus auritus	612.00	25512	86.26	
Sardinella maderensis	20.72	126	2.92	6788
Trichiurus lepturus	13.76	96	1.94	
Raja miraletus	13.56	12	1.91	
Galeoides decadactylus	10.08	96	1.42	
Pomadasys jubelini	8.76	12	1.23	
Sepia orbignyana	8.04	24	1.13	
Pteroscion sp.	5.16	228	0.73	
Pseudotolithus senegalensis	4.44	12	0.63	
Ilisha africana	3.84	84	0.54	
Trachurus trecae	2.36	54	0.33	6787
Pomadasys peroteti	2.16	24	0.30	
Pseudotolithus typus	1.44	12	0.20	
Pentanemus quinquarius	1.20	24	0.17	
Parapenaeus longirostris	0.84	60	0.12	
Solea senegalensis	0.72	12	0.10	
Selene dorsalis	0.48	12	0.07	
Total	709.56		100.00	

PROJECT STATION:3241

DATE: 5/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1144
start stop duration Long E 1346
TIME :12:20:48 12:35:37 15 (min) Purpose code: 1
LOG :6576.62 6577.42 0.81 Area code : 2
FDEPTH: 24 24 GearCond.code:
BDEPTH: 24 24 Validity code: 3
Towing dir: 180ø Wire out: 120 m Speed: 31 kn*10

Sorted: Kg Total catch: 1364.32 CATCH/HOUR: 5457.28

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Brachydeuterus auritus	2541.00	131292	46.56	
Trachurus trecae	2251.20	52584	41.25	6790
Pomadasys peroteti	315.00	4200	5.77	
Galeoides decadactylus	85.68	1848	1.57	
Pteroscion sp.	60.48	1680	1.11	
Miracorvina angolensis	43.68	168	0.80	
Pagellus bellottii	40.32	252	0.74	
Pomadasys rogeri	36.12	168	0.66	
Pseudotolithus typus	23.52	84	0.43	
Trichiurus lepturus	17.64	336	0.32	
Ilisha africana	13.44	168	0.25	
Umbrina canariensis	10.92	84	0.20	
Sphyraena guachancho	7.56	84	0.14	
Torpedo marmorata	5.32	4	0.10	
Boops boops	4.20	84	0.08	
Penaeus notialis	1.20	4	0.02	
Total	5457.28		100.00	

PROJECT STATION:3242

DATE: 5/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1145
start stop duration Long E 1330
TIME :15:45:20 16:09:43 24 (min) Purpose code: 1
LOG :6604.04 6605.25 1.20 Area code : 2
FDEPTH: 121 119 GearCond.code:
BDEPTH: 121 119 Validity code: 3
Towing dir: 360ø Wire out: 370 m Speed: 30 kn*10

Sorted: 49 Kg Total catch: 791.18 CATCH/HOUR: 1977.95

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Dentex macrophthalmus	1363.50	6548	68.94	
Trachurus trecae	306.25	1065	15.48	6791
Dentex angolensis	70.88	238	3.58	
Atractoscion aequidens	66.50	35	3.36	
Umbrina canariensis	54.68	135	2.76	
Branchiostegus semifasciatus	52.33	35	2.65	
Brotula barbata	33.08	35	1.67	
Lagocephalus laevigatus	22.95	35	1.16	
Illex coindetii	7.10	305	0.36	
Cynoglossus canariensis	0.35	35	0.02	
Chelidonichthys gabonensis	0.35	35	0.02	
Total	1977.97		100.00	

PROJECT STATION:3243

DATE: 6/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1209
start stop duration Long E 1339
TIME :07:52:27 08:06:22 14 (min) Purpose code: 1
LOG :6726.84 6727.65 0.79 Area code : 2
FDEPTH: 26 26 GearCond.code:
BDEPTH: 26 26 Validity code: 3
Towing dir: 210ø Wire out: 120 m Speed: 35 kn*10

Sorted: 65 Kg Total catch: 889.98 CATCH/HOUR: 3814.20

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Trachurus trecae	1964.27	38477	51.50	6792
Brachydeuterus auritus	1096.41	11687	28.75	6793
Selene dorsalis	284.66	2254	7.46	
Miracorvina angolensis	135.39	403	3.55	
Pagellus bellottii	118.03	1273	3.09	
Pomadasys incisus	104.74	1157	2.75	
Boops boops	50.91	866	1.33	
Dentex canariensis	35.31	463	0.93	
Dentex macrophthalmus	12.17	56	0.32	
Trichiurus lepturus	6.94	463	0.18	
Argyrosomus hololepidotus	5.23	56	0.14	
Total	3814.06		100.00	

PROJECT STATION:3244

DATE: 6/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1206
start stop duration Long E 1327
TIME :12:55:45 13:25:33 30 (min) Purpose code: 1
LOG :6753.89 6755.53 1.63 Area code : 2
FDEPTH: 110 109 GearCond.code:
BDEPTH: 110 109 Validity code: 3
Towing dir: 190ø Wire out: 320 m Speed: 31 kn*10

Sorted: Kg Total catch: 487.83 CATCH/HOUR: 975.66

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Dentex macrophthalmus	561.40	3752	57.54	
Trachurus trecae	207.20	620	21.24	6794
Boops boops	105.98	994	10.86	
Raja clavata	41.16	14	4.22	
Dentex angolensis	27.16	112	2.78	
Raja miraletus	14.42	14	1.48	
Dentex congoensis	5.32	28	0.55	
Spicara alta	5.18	28	0.53	
Zeus faber	4.90	14	0.50	
Illex coindetii	1.54	14	0.16	
Chelidonichthys gabonensis	1.40	14	0.14	
Total	975.66		100.00	

PROJECT STATION:3245

DATE: 6/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1222
start stop duration Long E 1330
TIME :18:00:43 18:20:03 19 (min) Purpose code: 1
LOG :6797.00 6798.09 1.10 Area code : 2
FDEPTH: 52 54 GearCond.code:
BDEPTH: 52 54 Validity code: 3
Towing dir: 45ø Wire out: 150 m Speed: 30 kn*10

Sorted: Kg Total catch: 165.70 CATCH/HOUR: 523.26

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Pagellus bellottii	208.42	1563	39.83	
Pterothrissus belloci	83.05	711	15.87	
Pomadasys incisus	54.79	411	10.47	
Chelidonichthys gabonensis	48.47	458	9.26	
Citharus linguatula	38.05	1263	7.27	
Trichiurus lepturus	22.11	332	4.23	
Umbrina canariensis	16.42	158	3.14	
Torpedo torpedo	15.16	16	2.90	
Brachydeuterus auritus	9.00	63	1.72	
Dentex canariensis	7.89	95	1.51	
Sepia orbignyana	5.37	205	1.03	
Brotula barbata	4.89	32	0.93	
Zeus faber	3.79	16	0.72	
Miracorvina angolensis	3.32	16	0.63	
Grammoplites gruveli	2.37	47	0.45	
Scorpaena angolensis	0.16	16	0.03	
Total	523.26		99.99	

PROJECT STATION:3246

DATE: 7/ 8/03 GEAR TYPE: PT No: 4 POSITION:Lat S 1236
start stop duration Long E 1314
TIME :12:10:34 12:33:15 23 (min) Purpose code: 1
LOG :6903.12 6904.60 1.26 Area code : 2
FDEPTH: 1 1 GearCond.code:
BDEPTH: 40 222 Validity code: 3
Towing dir: 280ø Wire out: 160 m Speed: 40 kn*10

Sorted: Kg Total catch: CATCH/HOUR:

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

PROJECT STATION:3247

DATE: 7/ 8/03 GEAR TYPE: PT No: 1 POSITION:Lat S 1250
start stop duration Long E 1256
TIME :20:05:01 20:18:28 13 (min) Purpose code: 1
LOG :6951.35 6952.28 0.92 Area code : 2
FDEPTH: 5 5 GearCond.code:
BDEPTH: 32 29 Validity code: 3
Towing dir: 217ø Wire out: 100 m Speed: 40 kn*10

Sorted: Kg Total catch: 121.12 CATCH/HOUR: 559.02

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
MYCTOPHIDAE	494.31	324831	88.42	
Pomatomus saltatrix	45.46	83	8.13	
Sphyraena guachancho	11.45	32	2.05	
Boops boops	5.63	152	1.01	
Trachurus trecae	1.20	32	0.21	
Synagrops microlepis	0.97	28	0.17	
Total	559.02		99.99	

PROJECT STATION:3248

DATE: 8/ 8/03 GEAR TYPE: BT No: POSITION:Lat S 1312
start stop duration Long E 1245
TIME :04:00:13 04:21:51 22 (min) Purpose code: 1
LOG :7023.98 7025.10 1.09 Area code : 2
FDEPTH: 77 77 GearCond.code:
BDEPTH: 77 77 Validity code: 3
Towing dir: 235ø Wire out: 340 m Speed: 30 kn*10

Sorted: 31 Kg Total catch: 552.06 CATCH/HOUR: 1505.62

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Dentex macrophthalmus	493.36	2405	32.77	
Pagellus bellottii	270.00	1669	17.93	
Umbrina canariensis	159.55	638	10.60	
Plectorhinchus macrolepis	121.25	835	8.05	
Dentex barnardi	119.78	589	7.96	
Chelidonichthys gabonensis	100.64	933	6.68	
Brotula barbata	85.42	98	5.67	
Boops boops	38.29	393	2.54	
Dentex angolensis	24.05	1178	1.60	
Anthias anthias	21.60	245	1.43	
Raja miraletus	21.60	49	1.43	
Citharus linguatula	21.60	1080	1.43	
Parapristipoma octolineatum	14.24	49	0.95	
Epinephelus haifensis	7.36	49	0.49	
Chaetodon hoefleri	2.95	49	0.20	
Trichiurus lepturus	1.96	49	0.13	
Bembrops sp.	1.47	98	0.10	
Trachurus trecae	0.49	49	0.03	
Total	1505.61		99.99	

PROJECT STATION:3249

DATE: 9/ 8/03 GEAR TYPE: BT No: POSITION:Lat S 1315
start stop duration Long E 1238
TIME :12:56:56 13:24:29 28 (min) Purpose code: 1
LOG :7044.10 7045.56 1.44 Area code : 2
FDEPTH: 111 184 GearCond.code:
BDEPTH: 111 184 Validity code: 3
Towing dir: 301ø Wire out: 360 m Speed: 30 kn*10

Sorted: 58 Kg Total catch: 204.29 CATCH/HOUR: 437.76

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Dentex macrophthalmus	296.61	2139	67.76	
Trachurus trecae	36.00	1059	8.22	6789
Umbrina canariensis	19.50	75	4.45	
Chelidonichthys gabonensis	18.39	150	4.20	
Zeus faber	16.80	30	3.84	
Dentex angolensis	14.10	45	3.22	
Anthias anthias	12.96	96	2.96	
Scorpaena angolensis	8.79	21	2.01	
Erythrocles monodi	5.70	15	1.30	
Pagrus caeruleostictus	3.15	6	0.72	
Loligo vulgaris	1.80	75	0.41	
Pagellus bellottii	1.50	15	0.34	
Chaetodon hoefleri	1.20	15	0.27	
Spicara alta	1.20	60	0.27	
Arnoglossus imperialis	0.06	6	0.01	
Total	437.76		99.98	

PROJECT STATION:3250

DATE:10/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1402
start stop duration Long E 1215
TIME :09:42:04 10:11:32 29 (min) Purpose code: 1
LOG :7190.35 7192.07 1.70 Area code : 1
FDEPTH: 139 120 GearCond.code:
BDEPTH: 139 120 Validity code: 3
Towing dir: 90ø Wire out: 400 m Speed: 33 kn*10

Sorted: 95 Kg Total catch: 475.55 CATCH/HOUR: 983.90

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	743.79	4097	75.60	6795
Dentex angolensis	64.14	259	6.52	
Atractoscion aequidens	63.10	41	6.41	
Raja clavata	31.86	10	3.24	
Trichiurus lepturus	20.38	21	2.07	
Todarodes sagittatus	15.00	238	1.52	
Dentex barnardi	13.24	31	1.35	
Chelidonichthys capensis	12.72	124	1.29	
Dentex macrophthalmus	9.10	41	0.92	
Erythrocles monodi	5.90	10	0.60	
Scorpaena angolensis	4.66	10	0.47	
Total	983.89		99.99	

PROJECT STATION:3251

DATE:10/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1413
start stop duration Long E 1219
TIME :14:01:01 14:31:06 30 (min) Purpose code: 1
LOG :7220.15 7221.61 1.45 Area code : 1
FDEPTH: 25 37 GearCond.code:
BDEPTH: 25 37 Validity code: 3
Towing dir: 350ø Wire out: 180 m Speed: 30 kn*10

Sorted: 67 Kg Total catch: 436.99 CATCH/HOUR: 873.98

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Brachydeuterus auritus	270.40	23948	30.94	
Gymnura altavela	132.60	12	15.17	
Selene dorsalis	129.40	1124	14.81	
Trachurus trecae	63.70	2236	7.29	6796
Pomadasys incisus	55.60	628	6.36	
Umbrina canariensis	51.40	116	5.88	
Boops boops	33.16	716	3.79	
Pteroscion peli	32.40	208	3.71	
Umbrina ronchus	31.80	26	3.64	
Galeoides decadactylus	31.20	156	3.57	
Pagellus bellottii	21.40	78	2.45	
Raja miraletus	9.60	12	1.10	
Diplodus cervinus cervinus	7.80	12	0.89	
Decapterus rhonchus	1.96	12	0.22	
Sardinella maderensis	1.56	40	0.18	
Total	873.98		100.00	

PROJECT STATION:3252

DATE:10/ 8/03 GEAR TYPE: PT No: 1 POSITION:Lat S 1422
start stop duration Long E 1211
TIME :18:48:49 19:13:23 25 (min) Purpose code: 1
LOG :7247.55 7248.93 1.38 Area code : 1
FDEPTH: 25 25 GearCond.code:
BDEPTH: 623 413 Validity code: 3
Towing dir: 360ø Wire out: 120 m Speed: 35 kn*10

Sorted: Kg Total catch: 20.24 CATCH/HOUR: 48.58

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trichiurus lepturus	28.39	151	58.44	
Trachurus trecae	11.11	62	22.87	6797
Ommastrephes pteropus	8.02	22	16.51	
Scomber japonicus	0.82	2	1.69	
MYCTOPHIDAE	0.24	322	0.49	
Total	48.58		100.00	

PROJECT STATION:3253

DATE:10/ 8/03 GEAR TYPE: PT No: 1 POSITION:Lat S 1422
start stop duration Long E 1220
TIME :21:27:13 21:47:38 20 (min) Purpose code: 1
LOG :7262.30 7263.56 1.24 Area code : 1
FDEPTH: 30 30 GearCond.code:
BDEPTH: 63 49 Validity code: 3
Towing dir: 20ø Wire out: 120 m Speed: 34 kn*10

Sorted: 83 Kg Total catch: 1183.38 CATCH/HOUR: 3550.14

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	3550.14	14244	100.00	6798
Total	3550.14		100.00	

PROJECT STATION:3254

DATE:11/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1458
start stop duration Long E 1210
TIME :10:47:06 10:57:05 10 (min) Purpose code: 1
LOG :7357.68 7358.29 0.60 Area code : 1
FDEPTH: 23 73 GearCond.code:
BDEPTH: 23 73 Validity code: 3
Towing dir: 20ø Wire out: 140 m Speed: 35 kn*10

Sorted: 62 Kg Total catch: 519.03 CATCH/HOUR: 3114.18

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Decapterus rhonchus	1320.90	5916	42.42	
Pagellus bellottii	1218.90	14994	39.14	
Dentex gibbosus	178.98	102	5.75	
Dasyatis centroura	150.42	150	4.83	
Dentex barnardi	95.88	354	3.08	
Lithognathus mormyrus	45.90	252	1.47	
Fistularia petimba	31.08	48	1.00	
Diplodus cervinus cervinus	23.46	48	0.75	
Trachinus araneus	19.38	48	0.62	
Anthias anthias	10.68	102	0.34	
Sphyraena guachancho	8.16	48	0.26	
Trachurus trecae	7.26	78	0.23	6799
Boops boops	3.06	48	0.10	
Total	3114.06		99.99	

PROJECT STATION:3255

DATE:11/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1504
start stop duration Long E 1206
TIME :13:25:52 13:50:21 24 (min) Purpose code: 1
LOG :7378.28 7379.55 1.26 Area code : 1
FDEPTH: 111 164 GearCond.code:
BDEPTH: 111 164 Validity code: 3
Towing dir: 280ø Wire out: 340 m Speed: 30 kn*10

Sorted: 134 Kg Total catch: 631.98 CATCH/HOUR: 1579.95

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Dentex macrophthalmus	933.53	6425	59.09	
Atractoscion aequidens	235.48	175	14.90	
Trachurus trecae	202.70	1423	12.83	6800
Dentex barnardi	62.28	165	3.94	
Dentex angolensis	38.90	165	2.46	
Umbrina canariensis	38.20	188	2.42	
Pagellus bellottii	27.63	60	1.75	
Squatina oculata	17.98	23	1.14	
Zeus faber	15.28	13	0.97	
Chelidonichthys gabonensis	4.48	48	0.28	
Spicara alta	3.53	13	0.22	
Total	1579.99		100.00	

PROJECT STATION:3256

DATE:11/ 8/03 GEAR TYPE: PT No: 1 POSITION:Lat S 1514
start stop duration Long E 1156
TIME :19:31:48 19:41:37 10 (min) Purpose code: 1
LOG :7419.32 7419.88 0.55 Area code : 1
FDEPTH: 100 100 GearCond.code:
BDEPTH: 207 262 Validity code: 9
Towing dir: 280ø Wire out: 250 m Speed: 35 kn*10

Sorted: Kg Total catch: CATCH/HOUR:

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

PROJECT STATION:3257

DATE:11/ 8/03 GEAR TYPE: PT No: 1 POSITION:Lat S 1514
start stop duration Long E 1155
TIME :19:49:01 19:59:00 10 (min) Purpose code: 1
LOG :7420.26 7420.84 0.58 Area code : 1
FDEPTH: 500 50 GearCond.code:
BDEPTH: 302 393 Validity code: 9
Towing dir: 280ø Wire out: 150 m Speed:350 kn*10

Sorted: Kg Total catch: CATCH/HOUR:

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

PROJECT STATION:3258

DATE:11/ 8/03 GEAR TYPE: PT No: 1 POSITION:Lat S 1514
start stop duration Long E 1154
TIME :20:06:38 20:17:18 11 (min) Purpose code: 1
LOG :7421.31 7421.99 0.68 Area code : 1
FDEPTH: 25 25 GearCond.code:
BDEPTH: 473 564 Validity code: 9
Towing dir: 280ø Wire out: 110 m Speed: 37 kn*10

Sorted: Kg Total catch: 5.08 CATCH/HOUR: 27.71

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Krill	13.80	19320	49.80	
Trachurus trecae	7.47	55	26.96	6801
MYCTOPHIDAE	6.44	2444	23.24	
Total	27.71		100.00	

PROJECT STATION:3259

DATE:11/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1517
start stop duration Long E 1202
TIME :22:40:19 22:44:10 4 (min) Purpose code: 1
LOG :7437.39 7437.56 0.15 Area code : 1
FDEPTH: 32 33 GearCond.code:
BDEPTH: 32 33 Validity code: 3
Towing dir: 350ø Wire out: 120 m Speed: 33 kn*10

Sorted: Kg Total catch: 503.70 CATCH/HOUR: 7555.50

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Decapterus rhonchus	7465.05	35700	98.80	
Trichiurus lepturus	62.40	120	0.83	
Boops boops	28.05	255	0.37	
Total	7555.50		100.00	

PROJECT STATION:3260

DATE:12/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1537
start stop duration Long E 1157
TIME :10:51:19 11:09:18 18 (min) Purpose code: 1
LOG :7530.36 7531.38 1.01 Area code : 1
FDEPTH: 73 71 GearCond.code:
BDEPTH: 73 71 Validity code: 3
Towing dir: 215ø Wire out: 250 m Speed: 31 kn*10

Sorted: Kg Total catch: 874.35 CATCH/HOUR: 2914.50

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Pagellus bellottii	1293.73	10293	44.39	
Dentex barnardi	469.33	2143	16.10	
Lithognathus mormyrus	329.63	1460	11.31	
Myliobatis aquila	251.90	217	8.64	
Trachurus trecae	250.33	2050	8.59	6802
Dasyatis centroura	104.17	30	3.57	
Atractoscion aequidens	57.53	123	1.97	
Spondyliosoma cantharus	54.40	277	1.87	
Loligo vulgaris	32.93	123	1.13	
Decapterus rhonchus	32.63	123	1.12	
Diplodus cervinus cervinus	13.67	30	0.47	
Argyrosomus hololepidotus	12.43	30	0.43	
Pomadasys jubelini	7.13	30	0.24	
Brachydeuterus auritus	3.70	30	0.13	
Citharus linguatula	0.90	30	0.03	
Total	2914.41		99.99	

PROJECT STATION:3261

DATE:12/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1603
start stop duration Long E 1147
TIME :20:29:10 20:46:23 17 (min) Purpose code: 1
LOG :7600.77 7601.88 1.09 Area code : 1
FDEPTH: 22 21 GearCond.code:
BDEPTH: 22 21 Validity code: 3
Towing dir: 15ø Wire out: 120 m Speed: 35 kn*10

Sorted: 66 Kg Total catch: 297.52 CATCH/HOUR: 1050.07

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	660.00	9162	62.85	6803
Myliobatis aquila	131.01	95	12.48	
Pagellus bellottii	90.04	2015	8.57	
Atractoscion aequidens	47.65	332	4.54	
Dentex canariensis	23.33	635	2.22	
Arius parkii	21.28	46	2.03	
Solea senegalensis	20.79	808	1.98	
Pomadasys incisus	15.88	540	1.51	
Raja miraletus	14.93	14	1.42	
Boops boops	7.31	109	0.70	
Umbrina canariensis	4.76	95	0.45	
Spondyliosoma cantharus	4.76	109	0.45	
Pomatomus saltatrix	2.86	14	0.27	
Trichiurus lepturus	2.68	78	0.26	
Trachinus armatus	0.78	14	0.07	
Sepia orbignyana	0.78	14	0.07	
Lithognathus mormyrus	0.78	14	0.07	
Penaeus notialis, male	0.46	14	0.04	
Total	1050.08		99.98	

PROJECT STATION:3262

DATE:13/ 8/03 GEAR TYPE: PT No: 1 POSITION:Lat S 1613
start stop duration Long E 1132
TIME :01:52:33 02:22:49 30 (min) Purpose code: 1
LOG :7634.05 7635.80 1.74 Area code : 1
FDEPTH: 45 40 GearCond.code:
BDEPTH: 110 208 Validity code: 3
Towing dir: 10ø Wire out: 150 m Speed: 38 kn*10

Sorted: Kg Total catch: 15.08 CATCH/HOUR: 30.16

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Etrumeus whiteheadi	29.80	452	98.81	
Trachurus capensis	0.36	4	1.19	
Total	30.16		100.00	

PROJECT STATION:3263

DATE:13/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1613
start stop duration Long E 1144
TIME :04:54:20 05:23:38 29 (min) Purpose code: 1
LOG :7650.75 7652.35 1.60 Area code : 1
FDEPTH: 45 45 GearCond.code:
BDEPTH: 45 45 Validity code: 3
Towing dir: 360ø Wire out: 160 m Speed: 33 kn*10

Sorted: Kg Total catch: 193.98 CATCH/HOUR: 401.34

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	263.17	4543	65.57	6804
Pagellus bellottii	41.40	1061	10.32	
Dentex canariensis	16.01	596	3.99	
Sepia orbignyana	13.84	43	3.45	
Solea senegalensis	12.54	701	3.12	
Merluccius polli	12.41	230	3.09	
Umbrina canariensis	9.12	248	2.27	
Arius parkii	6.89	19	1.72	
Atractoscion aequidens	6.70	62	1.67	
Trachinus armatus	5.40	211	1.35	
Trichiurus lepturus	3.29	56	0.82	
Loligo vulgaris	2.79	12	0.70	
Raja miraletus	2.23	6	0.56	
Trigla lyra	1.55	62	0.39	
Etrumeus whiteheadi	1.37	31	0.34	
Spondyliosoma cantharus	1.24	25	0.31	
Dentex macrophthalmus	0.93	137	0.23	
Penaeus notialis	0.43	2	0.11	
Total	401.31		100.01	

PROJECT STATION:3264

DATE:13/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1619
start stop duration Long E 1147
TIME :07:53:17 08:20:18 27 (min) Purpose code: 1
LOG :7665.08 7666.57 1.48 Area code : 1
FDEPTH: 16 17 GearCond.code:
BDEPTH: 16 17 Validity code: 3
Towing dir: 350ø Wire out: 120 m Speed: 33 kn*10

Sorted: Kg Total catch: 816.52 CATCH/HOUR: 1814.49

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	1678.44	101978	92.50	6805
Pomatomus saltatrix	49.40	144	2.72	
Sardinops ocellatus	29.44	260	1.62	6806
Myliobatis aquila	26.58	29	1.46	
Atractoscion aequidens	7.51	87	0.41	
Loligo vulgaris	7.22	144	0.40	
Spondyliosoma cantharus	6.07	116	0.33	
Pagellus bellottii	4.62	376	0.25	
Umbrina canariensis	2.02	29	0.11	
Solea senegalensis	1.44	87	0.08	
Dentex canariensis	0.87	58	0.05	
Etrumeus whiteheadi	0.58	29	0.03	
Trachurus capensis	0.29	58	0.02	
Total	1814.48		99.98	

PROJECT STATION:3265

DATE:13/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1619
start stop duration Long E 1135
TIME :10:49:29 11:04:23 15 (min) Purpose code: 1
LOG :7683.64 7684.48 0.83 Area code : 1
FDEPTH: 83 80 GearCond.code:
BDEPTH: 83 80 Validity code: 3
Towing dir: 90ø Wire out: 250 m Speed: 30 kn*10

Sorted: Kg Total catch: 54.85 CATCH/HOUR: 219.40

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Etrumeus whiteheadi	105.20	1756	47.95	6808
Sepia orbignyana	36.80	32	16.77	
Merluccius polli	32.20	152	14.68	
Dentex macrophthalmus	24.80	2412	11.30	
Trachurus capensis	7.08	480	3.23	6807
Raja miraletus	3.24	4	1.48	
Spondyliosoma cantharus	2.84	8	1.29	
Citharus linguatula	2.00	24	0.91	
Zeus faber	1.80	8	0.82	
Pagellus bellottii	1.16	4	0.53	
Trachinus armatus	0.68	224	0.31	
Chelidonichthys gabonensis	0.68	16	0.31	
Loligo vulgaris	0.56	28	0.26	
Sardinops ocellatus	0.36	4	0.16	
Total	219.40		100.00	

PROJECT STATION:3266

DATE:13/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1626
start stop duration Long E 1130
TIME :13:48:41 14:18:36 30 (min) Purpose code: 1
LOG :7706.91 7708.44 1.53 Area code : 1
FDEPTH: 96 93 GearCond.code:
BDEPTH: 96 93 Validity code: 3
Towing dir: 10ø Wire out: 310 m Speed: 30 kn*10

Sorted: Kg Total catch: 17.20 CATCH/HOUR: 34.40

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Dentex macrophthalmus	15.90	192	46.22	
Pagellus bellottii	5.66	26	16.45	
Sepia orbignyana	5.42	10	15.76	
Chelidonichthys gabonensis	2.32	30	6.74	
Squalus megalops	1.64	2	4.77	
Trigla lyra	1.56	10	4.53	
Zeus faber	1.46	4	4.24	
Anthias anthias	0.26	8	0.76	
Pontinus kuhlii	0.18	4	0.52	
Total	34.40		99.99	

PROJECT STATION:3267

DATE:13/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1625
start stop duration Long E 1138
TIME :16:02:36 16:17:47 15 (min) Purpose code: 1
LOG :7720.00 7720.77 0.76 Area code : 1
FDEPTH: 81 83 GearCond.code:
BDEPTH: 81 83 Validity code: 3
Towing dir: 270ø Wire out: 270 m Speed: 30 kn*10

Sorted: 93 Kg Total catch: 1965.62 CATCH/HOUR: 7862.48

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis	3738.00	84428	47.54	6810
Trachurus trecae	1957.20	25312	24.89	6809
Dentex macrophthalmus	1486.80	15224	18.91	
Merluccius polli	383.88	2172	4.88	
Atractoscion aequidens	142.20	420	1.81	
Etrumeus whiteheadi	113.20	2264	1.44	6811
Pagellus bellottii	41.20	420	0.52	
Total	7862.48		99.99	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:3267

DATE:13/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1625
start stop duration Long E 1138
TIME :16:02:36 16:17:47 15 (min) Purpose code: 1
LOG :7720.00 7720.77 0.76 Area code : 1
FDEPTH: 81 83 GearCond.code:
BDEPTH: 81 83 Validity code: 3
Towing dir: 270ø Wire out: 270 m Speed: 30 kn*10

Sorted: 93 Kg Total catch: 1965.62 CATCH/HOUR: 7862.48

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis	3738.00	84428	47.54	6810
Trachurus trecae	1957.20	25312	24.89	6809
Dentex macrophthalmus	1486.80	15224	18.91	
Merluccius polli	383.88	2172	4.88	
Atractoscion aequidens	142.20	420	1.81	
Etrumeus whiteheadi	113.20	2264	1.44	6811
Pagellus bellottii	41.20	420	0.52	
Total	7862.48		99.99	

PROJECT STATION:3268

DATE:13/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1636
start stop duration Long E 1147
TIME :23:31:14 23:40:55 10 (min) Purpose code: 1
LOG :7770.12 7770.62 0.49 Area code : 1
FDEPTH: 17 17 GearCond.code:
BDEPTH: 17 17 Validity code: 3
Towing dir: 360ø Wire out: 100 m Speed: 30 kn*10

Sorted: Kg Total catch: 1080.04 CATCH/HOUR: 6480.24

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis	6128.70	657882	94.58	6812
Rhinoptera marginata	187.86	372	2.90	
Decapterus rhonchus	139.50	10788	2.15	
Sepia orbignyana	16.74	558	0.26	
Pseudotolithus senegalensis	7.44	186	0.11	
Total	6480.24		100.00	

PROJECT STATION:3269

DATE:14/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1631
start stop duration Long E 1147
TIME :00:26:22 00:56:30 30 (min) Purpose code: 1
LOG :7774.96 7776.49 1.51 Area code : 1
FDEPTH: 14 13 GearCond.code:
BDEPTH: 14 13 Validity code: 3
Towing dir: 8ø Wire out: 100 m Speed: 30 kn*10

Sorted: Kg Total catch: 39.61 CATCH/HOUR: 79.22

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Engraulis encrasicolus	48.08	7524	60.69	6815
Trachurus trecae	23.30	2370	29.41	6813
Trachurus capensis	2.08	194	2.63	6814
Trachinus radiatus	1.52	8	1.92	
Loligo vulgaris	1.40	14	1.77	
Trachinus armatus	1.14	16	1.44	
Dasyatis centroura	1.04	2	1.31	
Sepia orbignyana	0.34	6	0.43	
Merluccius capensis	0.20	10	0.25	
Solea senegalensis	0.02	4	0.03	
Penaeus notialis	0.02	2	0.03	
Total	79.14		99.91	

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PROJECT STATION:3270

DATE:14/ 8/03 GEAR TYPE: PT No: 1 POSITION:Lat S 1631
start stop duration Long E 1135
TIME :02:48:49 03:05:10 16 (min) Purpose code: 1
LOG :7791.46 7792.44 0.97 Area code : 1
FDEPTH: 50 45 GearCond.code:
BDEPTH: 91 89 Validity code: 3
Towing dir: 90ø Wire out: 160 m Speed: 35 kn*10

Sorted: Kg Total catch: 1179.00 CATCH/HOUR: 4421.25

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	4002.75	88425	90.53	6816
Trachurus capensis	418.50	11610	9.47	6817
Total	4421.25		100.00	

PROJECT STATION:3271

DATE:14/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1642
start stop duration Long E 1140
TIME :11:14:05 11:44:19 30 (min) Purpose code: 1
LOG :7843.47 7844.80 1.30 Area code : 1
FDEPTH: 27 37 GearCond.code:
BDEPTH: 27 37 Validity code: 3
Towing dir: 350ø Wire out: 150 m Speed: 30 kn*10

Sorted: Kg Total catch: 112.49 CATCH/HOUR: 224.98

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	156.80	9800	69.70	6819
Merluccius polli	28.00	792	12.45	
Sardinops ocellatus	23.00	272	10.22	6818
Trichiurus lepturus	7.20	320	3.20	
Loligo vulgaris	3.92	80	1.74	
Sardinella maderensis	3.60	108	1.60	6820
Pteroscion peli	0.68	8	0.30	
Solea senegalensis	0.64	16	0.28	
Umbrina canariensis	0.58	24	0.26	
Engraulis encrasicolus	0.40	12	0.18	
Zeus faber	0.08	8	0.04	
Total	224.90		99.97	

PROJECT STATION:3272

DATE:14/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1642
start stop duration Long E 1134
TIME :13:14:02 13:36:49 23 (min) Purpose code: 1
LOG :7856.70 7857.80 1.10 Area code : 1
FDEPTH: 99 94 GearCond.code:
BDEPTH: 99 94 Validity code: 3
Towing dir: 90ø Wire out: 310 m Speed: 30 kn*10

Sorted: Kg Total catch: 2164.10 CATCH/HOUR: 5645.48

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis	2895.91	74528	51.30	6822
Dentex macrophthalmus	2026.70	27637	35.90	
Trachurus trecae	387.60	8337	6.87	6821
Merluccius polli	173.84	1863	3.08	
Pterothrissus belloci	56.77	532	1.01	
Loligo vulgaris	43.46	266	0.77	
Trigla lyra	38.14	89	0.68	
Trichiurus lepturus	15.97	266	0.28	
Zeus faber	7.10	89	0.13	
Total	5645.49		100.02	

PROJECT STATION:3273

DATE:14/ 8/03 GEAR TYPE: PT No: 7 POSITION:Lat S 1653
start stop duration Long E 1144
TIME :20:08:00 20:12:56 5 (min) Purpose code: 1
LOG :7917.38 7917.65 0.27 Area code : 1
FDEPTH: 10 10 GearCond.code:
BDEPTH: 19 18 Validity code: 3
Towing dir: 332ø Wire out: 120 m Speed: 32 kn*10

Sorted: Kg Total catch: 2333.10 CATCH/HOUR: 27997.20

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinops ocellatus	27997.20	100116	100.00	
Total	27997.20		100.00	

STATION:3274
DATE:15/ 8/03 GEAR TYPE: PT No: 1 POSITION:Lat S 1701
start stop duration Long E 1121
TIME :00:57:13 01:11:52 15 (min) Purpose code: 1
LOG :7957.77 7958.54 0.77 Area code : 1
FDEPTH: 100 100 GearCond.code:
BDEPTH: 158 154 Validity code: 3
Towing dir: 360ø Wire out: 340 m Speed: 35 kn*10

Sorted: Kg Total catch: 193.86 CATCH/HOUR: 775.44

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis	765.60	29864	98.73	6824
Arius parkii	9.84	24	1.27	
Total	775.44		100.00	

PROJECT STATION:3275
DATE:15/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1705
start stop duration Long E 1144
TIME :04:42:55 05:12:42 30 (min) Purpose code: 1
LOG :7988.55 7990.19 1.63 Area code : 1
FDEPTH: 21 21 GearCond.code:
BDEPTH: 21 21 Validity code: 3
Towing dir: 360ø Wire out: 100 m Speed: 34 kn*10

Sorted: 36 Kg Total catch: 291.92 CATCH/HOUR: 583.84

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	259.52	9056	44.45	6825
Sardinops ocellatus	101.12	1088	17.32	6826
Solea senegalensis	48.00	2274	8.22	
Galeorhinus galeus	43.04	32	7.37	
Trichiurus lepturus	37.60	2074	6.44	
Arius parkii	29.60	96	5.07	
Merluccius polli	19.84	560	3.40	
Atractoscion aequidens	19.36	304	3.32	
Pomatomus saltatrix	12.00	192	2.06	
Stromateus fiatola	8.00	32	1.37	
Sepia officinalis hierredda	1.92	32	0.33	
Torpedo nobiliana	1.44	32	0.25	
Pterothrissus belloci	1.12	32	0.19	
Umbrina canariensis	0.48	32	0.08	
Cynoglossus senegalensis	0.48	48	0.08	
Pteroscion peli	0.32	16	0.05	
Total	583.84		100.00	

PROJECT STATION:3276
DATE:15/ 8/03 GEAR TYPE: BT No: 8 POSITION:Lat S 1706
start stop duration Long E 1129
TIME :07:47:41 08:01:13 14 (min) Purpose code: 1
LOG :8011.91 8012.70 0.77 Area code : 1
FDEPTH: 126 122 GearCond.code:
BDEPTH: 126 122 Validity code: 3
Towing dir: 90ø Wire out: 400 m Speed: 35 kn*10

Sorted: 31 Kg Total catch: 157.90 CATCH/HOUR: 676.71

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis	355.71	16941	52.56	6827
Dentex macrophthalmus	221.79	3124	32.77	
Etrumeus whiteheadi	40.07	1264	5.92	
Merluccius polli	39.86	621	5.89	
Chelidonichthys capensis	9.86	21	1.46	
Trichiurus lepturus	4.29	107	0.63	
Solea senegalensis	3.00	214	0.44	
Todarodes sagittatus	2.14	21	0.32	
Total	676.72		99.99	

PROJECT STATION:3277
DATE:15/ 8/03 GEAR TYPE: PT No: 1 POSITION:Lat S 1719
start stop duration Long E 1925
TIME :18:07:00 18:47:00 40 (min) Purpose code: 1
LOG :8075.02 8077.02 2.00 Area code : 1
FDEPTH: 25 25 GearCond.code:
BDEPTH: 103 83 Validity code: 3
Towing dir: 90ø Wire out: 250 m Speed: 30 kn*10

Sorted: 23 Kg Total catch: 81.41 CATCH/HOUR: 122.12

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis, juvenile	94.77	12062	77.60	6828
Engraulis encrasicolus	24.20	1830	19.82	
Merluccius polli	2.00	63	1.64	
Trigla lyra	1.05	5	0.86	
Sardinops ocellatus	0.11	5	0.09	
Total	122.13		100.01	

ANNEX III BIOMASS AND NUMBER OF FISH PER LENGTH CLASS

Sardinella

Sardinella maderensis
North (Congo River to Luanda, 5°S-9°S) and, Central (Luanda to Benguela, 9°S–13°S) and, South (Benguela to Cunene River, 13°- 17°15'S)

	North		**Central**		**South**	
Length group (cm)	N	W	N	W	N	W
5						
6	17					
7	211	0.7				
8	234	1.2				
9	194	1.3	2		9	0.1
10	42	0.4	21	0.2	67	0.6
11	60	0.7	12	0.1	50	0.6
12	3	0.1	2		9	0.2
13	7	0.1	77	1.6	58	1.2
14	36	0.9				
15	23	0.7	45	1.4	45	1.4
16	26	1.0	37	1.5	37	1.5
17			22	1.0	22	1.1
18	13	0.7	8	0.5	11	0.6
19	7	0.4	142	9.3	103	6.7
20	3	0.2	15	1.2	18	1.4
21			22	1.9	25	2.2
22	10	0.9	2	0.2	2	0.2
23	22	2.4	2	0.2	2	0.2
24	61	7.5	20	2.6	15	2.0
25	146	20.4	84	12.5	65	9.7
26	112	17.6	165	27.9	134	22.5
27	57	10.1	183	34.7	173	32.7
28	23	4.6	161	34.0	170	35.9
29	41	8.9	115	27.1	116	27.3
30	33	7.9	92	23.9	82	21.4
31	35	9.3	77	22.1	64	18.5
32	26	7.5	32	10.1	29	9.3
33	17	5.3	29	10.2	23	8.2
34	3	1.1	17	6.4	12	4.7
35	4	1.6	17	6.9	13	5.6
36	4	1.7				
37	4	1.9				
38						
39						
40						
N (mill.)	1 474		1 400		1 355	
Biomass (k Tons)		117.2		237.5		215.6

Sardinella aurita
North (Congo River to Luanda, 5°S - 9°S), Central (Luanda to Benguela, 9°S – 13°S)

	North		Central	
Length group (cm)	N	W	N	W
5			16	0.0
6	262	0.5		
7	584	1.8		
8	201	0.9	79	0.4
9	8		16	0.1
10	3		85	0.8
11			50	0.6
12			63	1.0
13			92	1.8
14			52	1.3
15			6	0.2
16	75	2.5		
17				
18				
19				
20	75	4.9		
21				
22				
23				
24				
25				
26	75	10.7		
27				
28			7	1.4
29	75	14.8	2	0.5
30			46	11.1
31			46	12.3
32			24	7.1
33			2	0.8
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				
N (mill.)	1 359		798	
Biomass (k Tons)		36.0		59.9

Trachurus trecae

North (Congo River to Luanda, 5°S - 9°S), Central (Luanda to Benguela, 9°S – 13°S), and South (Benguela to Cunene River, 13° - 17°15'S)

	North		Central		South	
Length group (cm)	**N**	**W**	**N**	**W**	**N**	**W**
5	6		20			
6	26	0.1	80	0.2	2	0
7	41	0.2	31	0.1	4	0
8	23	0.1	19	0.1	34	0
9	2		14	0.1	18	0
10	1		1		39	0
11	1		6	0.1	58	1
12	42	0.8	63	1.2	52	1
13	77	1.8	203	4.8	191	4
14	43	1.2	168	4.9	228	6
15	14	0.5	36	1.3	210	7
16	3	0.1	11	0.5	188	7
17	2	0.1	16	0.8	368	17
18	1		23	1.4	341	19
19	1		9	0.6	224	14
20			5	0.4	34	3
21			7	0.7	116	10
22			2	0.2	73	7
23			13	1.6	78	9
24			21	2.9	28	4
25			13	2.0	21	3
26			12	2.1	19	3
27			2	0.4	12	2
28	1	0.2	2	0.4	7	1
29	3	0.6	3	0.8	3	1
30	4	0.9	4	1.1		
31	4	0.9	4	1.1		
32	3	0.9	3	1.0		
33	1	0.3	2	0.7		
34		0.1	0	0.1		
35		0.1	0			
36	1	0.6	1	0.3		
37	1	0.5	1	0.3		
38	1	0.5	1	0.6		
39	1	0.4	1	0.6		
40	1	0.4		0.2		
41		0.2		0.1		
42		0.2		0.1		
43						
44		0.1				
45						
46						
47		0.1		0.1		
48		0.1		0.1		
49						
50						
N (mill.)	305		801		2 348	
Biomass (k Tons)		12.2		33.8		120.3

Trachurus trachurus capensis
South (Benguela to Cunene River, 13° - 17°15'S)

	South	
Length group (cm)	**N**	**W**
5		
6		
7		
8		
9	28	0
10	690	7
11	268	3
12	132	2
13	174	4
14	522	13
15	849	25
16	868	31
17	744	31
18	244	12
19	88	5
20	14	1
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
N (mill.)	4 621	
Biomass (k Tons)		133.0

ANNEX IV ACOUSTIC INSTRUMENTS

Echo sounder

The SIMRAD EK500/38 kHz scientific sounder was used during the survey for fish abundance estimation. The lowering keel was not submerged during the survey. The Bergen Echo Integrator system (BEI) was used to scrutinise the acoustic records. The 38 kHz transducer was calibrated 09 August in Baía dos Elephantes. The settings of 38 kHz echo sounder were as follows:

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

Transducer depth	20.07-1508: 5.5 m (keel not submerged), 16.08-17.08: 8.0 m (subm.)
Absorption coeff.	10 dB/km
Pulse length	Medium (1 ms)
Bandwith	Wide
Max Power	2000 Watt
2-way beam angle	-21.0 dB
Sv Transducer gain	27.37 dB
TS Transducer gain	27.49 dB
Angle sensitivity	21.9
3 dB beamwidth	7.0 º alongship
	6.7 º athwardship
Alongship offset	0.14 º
Athwardship effect	-0.02 º

Display menu

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

Printer menu

Echogram	1 (38 kHz)
Range	100 m, 250 m, 500 m
Range start	0
Bottom range	12 m
Bottom range start	10 m
TVG	20 log R
Sv Colour min	- 67 dB

Bottom detection menu Minimum level -50 dB

ANNEX V

Análise do estado do manancial de Carapau do Cunene

Por: Nkosi Luyeye (IIM-Luanda), Jens Otto Krakstad (IMR-Bergen) e Bjørn Alexsen (IMR-Bergen)

Informação disponível

O manancial de carapau do Cunene é o mais importante recurso marinho que tem contribuido bastante na dieta alimentar da população Angolana. O *N/I Fridtjof Nansen* durante muitos anos atrás levou à cabo um conjunto de cruzeiros de hidro-acústica para a avaliação da abundância e do estado do manacial de carapau do Cunene. O presente cruzeiro foi conduzido de 20 de Julho à 19 de Agosto de 2003, e cobriu a costa de Angola a partir da foz do Rio Congo até a foz do Rio Cunene com as profundidades variando de 20 à 500 m.

Observações

O biomassa total do manacial de carapau do Cunene estimada no cruzeiro de 2003 foi cerca de 166 mil toneladas. Os juvenis (com menos de 20 cm do comprimento total), como parte da população representam 86% do número total do manancial e 64% do peso total do manancial. Em termos de distribuição geográfica, a maior parte do manancial (superior a 70%) foi localizada na parte sul de Benguela (13°S - 17°15´S). Relativamente ao carapau do Cunene encontrado nesta região 90% são juvenis.

As observações ou resultados deste cruzeiro são idênticas as observações de 2002 o que indica que o manacial adulto do carapau do Cunene, importante para o consumo da população está severamente reduzido.

Mas existem ainda bons sinais da presença de um bom recrutamento a partir do ano passado e deste ano, com a presença de um forte cohorte (classe etária formada por juvenis do ano passado) com a moda a volta de 13 cm e a cohorte do ano corrente com a moda a volta de 5-6 cm (Figura 1). A manutenção e a gestão cuidadosa destes dois cohortes poderão ajudar na recuperaração do manacial para atingir os níveis adequados à exploração.

O cohorte de peixes de 1 ano de idade observado no ano transacto apresenta actualmente indivíduos com cerca de 18-19 cm e possivelmente atingirão o tamanho para a pesca comercial no próximo ano.

Conclusões

Do observado, conclui-se que houve um declínio drástico do manancial de carapau do Cunene de cerca de 333 mil toneladas de biomassa estimada no ano de 2000. Os dados históricos nos dizem que nos últimos três anos o tamanho do manancial atingiu o nível mais baixo, havendo um risco real na falha de recrutamento neste periodo de tempo e falta de adultos na população

devido a pesca intensiva que tem se verificado nos últimos anos, colocando o manancial num alto risco podendo chegar a um colapso.

Em caso de acontecimento de um colapso, a recuperação será muito lenta e complicada. Os cohortes de juvenis observados apresentam uma oportunidade e esperança para recuperar e aumentar o manancial caso forem aplicadas boas medidas de gestão.

É de salientar que mesmo assim, estamos muito longe dos níveis alacançados em 1996 (Figura 2), quando a biomassa total do manancial de carapau do Cunene foi estimada em cerca de 500 mil toneladas, correspondendo a produção natural considerada acima de 700 mil toneladas.

Recomendações

A recuperação do manancial de carapau do Cunene na plataforma de Angola requer fortes medidas de gestão. Em termos biológicos, a redução do esforço de pesca é a principal medida para alcançar este propósito.

Existem três diferentes tipos de pescarias dirigidas ao carapau do Cunene em Angola: pesca artesanal, pesca semi-industrial e a pesca industrial com arrastões pelágicos (meia-àgua) e demersais. A última componente é responsável pela grande diminuição da biomassa deste manancial.

Para a recuperaração saúdavel e preservação da pesca de carapau do Cunene, recomenda-se como medida imediata a redução drástica do esforço das embarcações da pesca industrial, em particular os arrastões pelágicos a meia-água durante um periodo não inferior a dois anos, findo os quais a reintrodução das embarcações deverá ser feita paulatinamente.
Adicionalmente a retirada dos arrastões pelágicos, o acesso a plataforma continental deve ser limitado implementado uma restricção em termos de profundidades (ex. Até 150 m, mas não inferior a esta profundidade), uma vez que a regulamentação actual para os arrastões limita-se em seis (6) milhas naúticas a partir da linha costeira.

Para os arrastões de fundo (demersais), as quantidades acessórias de carapau do Cunene devem ser limitadas. Isso pode ser feito seguindo o exemplo da Namibia, onde os arrastões demersais são permitidos até 5% de captura em peso das espécies acessórias à bordo da embarcação, e abandonar imeditamente a área caso a proporção de peixe inferior a 17 cm exceda os 5% da captura total num lance.

Estas medidas permitirão aos dois cohortes de juvenis observados em 2002 e 2003 atigirem a maturidade sexual recomendada e tornarem-se atractivos para o consumo humano.

A região sul requer medidas de gestão específicas porque a maior parte do manancial de carapau do Cunene nesta região está misturada com o carapau do Cabo. Na área fronteiriça, as duas espécies são capturadas por arrastões pelágicos licenciados em Angola e Namibia respectivamente. Sendo assim, a gestão conjunta do manancial entre Angola e Namibia nesta região seria benéfica para ambos.

A implementação das medidas acima referidas requer uma fiscalização eficiente da Zona Económica Exclusiva de Angola pelo Direcção Nacional da Fiscalização por meio de embarcações rápidas de patrulhamento ao longo da costa em número de seis (6).

Adicionalmente a esta medida, a introdução de observadores de pesca à bordo das embarcações comerciais e a implementação de sistemas de monitorizaão são indispensáveis.

Figura 1. Composição por comprimentos de Carapau do Cunene (2001 –2003)

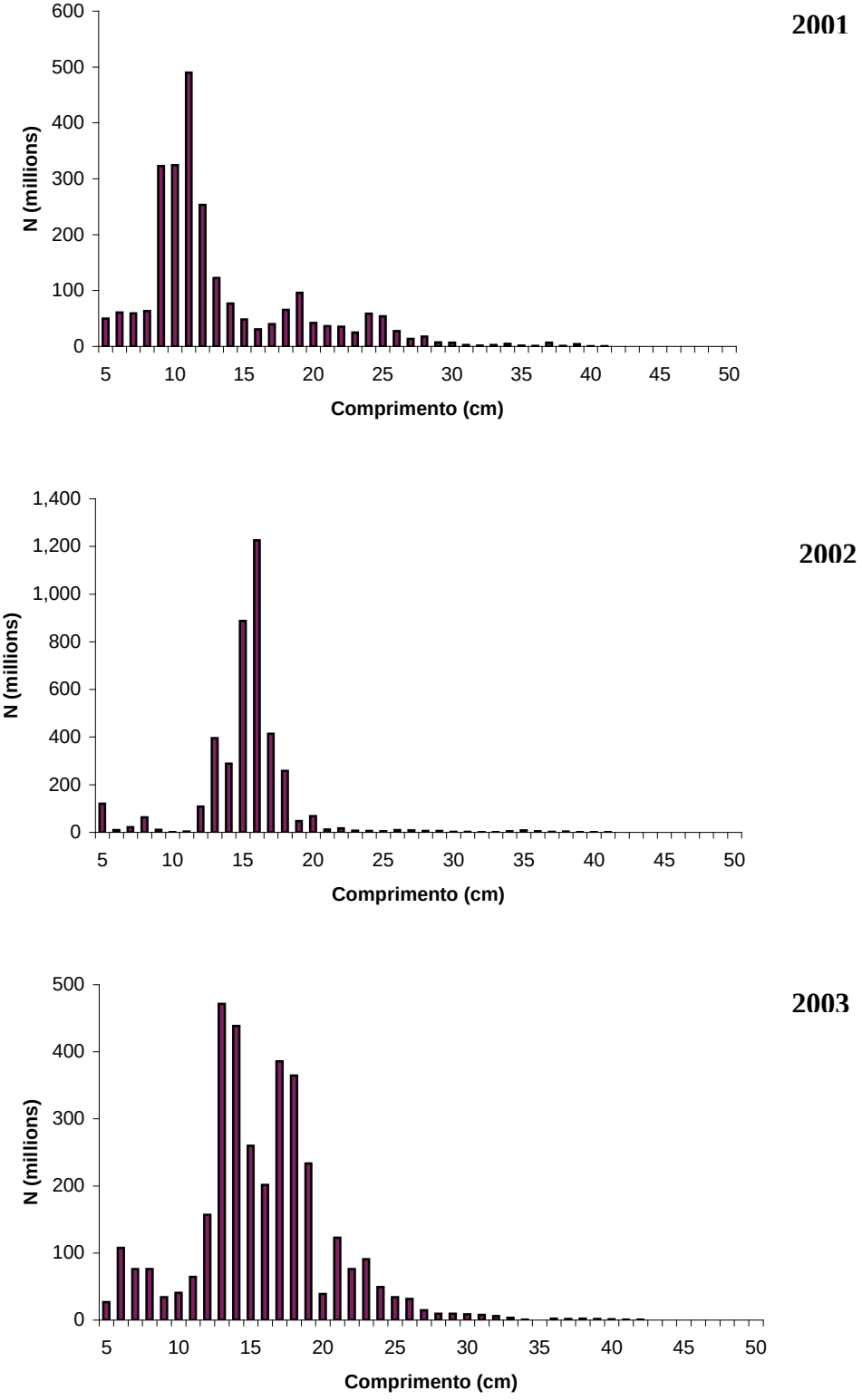
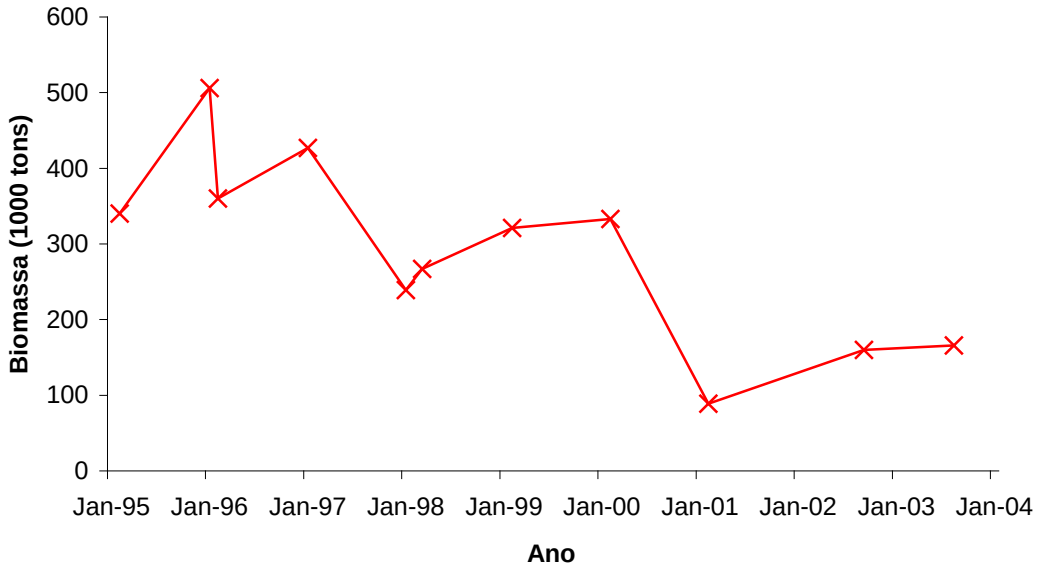


Figura 2. Carapau do Cunene: Estimações de biomassa a partir do N/I 'Dr. Fridtjof Nansen' 1995-2003



ANNEX VI

PRELIMINARY MARINE MAMMALS SURVEY, ALONG THE NORTHERN COAST LINE OF ANGOLA, 20-31 JULY 2003

BACKGROUND AND RATIONALE:

Current information on marine mammals inventory, distribution, status, and spatial behavior patterns, off-shore Angola, is scarce. Marine mammals form an important and indicative component of the marine ecosystems, and there is, therefore, a scientific interest in collecting information on these populations, as part of the efforts to compile current data on biodiversity in Angola.

One of the main defined objectives and approved activities, within the framework of UNDP Project ANG/02/005, of support to environmental planning, biodiversity conservation and capacity building in Angola, is the launching and establishing of community-based conservation initiatives, related to poverty alleviation. Marine mammals in this context are of special interest, due to their attractiveness to eco-tourists. Well-thought and carefully developed and managed eco-tourism initiatives may make use of the presence of marine-mammals close to Angola's coasts, in a manner that will secure benefit sharing with the resident fishermen communities along the coastal zone of Angola, as an alternative to the non-sustainable utilization of biodiversity.

The BCLME (Benguela Current Large Marine Ecosystem) project, funded by GEF, and implemented by UNDP and UNOPS, is a regional initiative by Angola, Namibia and South Africa, aiming to facilitate the integrated management, sustainable development and protection of this unique eastern boundary upwelling ecosystem. A sub project for the development of pilot projects with coastal community involvement, aiming to establish an effective plan for environmental management and conservation of large migratory and endangered marine species (marine-mammals, marine-birds and marine-turtles), by involving local coastal communities, was approved as part of the pilot activities of the BCLME.

This preliminary survey of marine mammals, along the northern part of the coast-line of Angola, was done as a preparatory activity for the referred BCLME sub-project, as well as within the

framework of UNDP project ANG/02/005, for a preliminary assessment of marine-mammals presence and visibility off-shore Angola, a preliminary feasibility assessment for a more comprehensive marine-mammal survey, and optional future development of related eco-tourism activities, as well as for training of Angolan technicians in this study field.

OBJECTIVES:

- Collect preliminary data on inventory, distribution, and rough status estimations of marine mammals, off-shore Angola.
- Assess feasibility of more comprehensive data collection on marine-mammals off-shore Angola, on board the Nansen fishing research vessel, and other vessels conducting transects off-shore Angola (for fishing research, oil explorations, etc.).
- Minimize costs of data collection on marine-mammals off-shore Angola, by opportunistic data collection on existing vessels.
- Train Angolan technicians in data-collection on marine-mammals, methodology, and species identification.
- Preliminary assessment of marine-mammals visibility off-shore Angola, and of feasibility of developing community-based “whale-watch” eco-tourism initiatives.

IMPLEMENTATION OF THE SURVEY:

The survey was implemented within the framework of the Nansen fishing research cruise. All costs (accommodation on board for two people) were covered by the Nansen project, and the Nansen team has assisted with the survey. The participation in the Nansen research cruise, was mediated through the Instituto de Investigação Marinha (IIM), the Ministry of Fisheries of Angola, who has supported the realization of this preliminary survey, as a part of the objectives of this fishing research cruise.

PARTICIPANTS:

This marine-mammal survey was done by the UNDP biodiversity CTA and Albertina Nzuzi, a technician indicated by the National Department of Natural Resources, the Ministry of Urban Affairs and Environment, as a trainee. The team of scientists of the Instituto de Investigação Marinha, on board, took part in the survey, when they were off their other tasks, in particular Antonio Barradas. The Nansen team provided invaluable help and advice. In particular Bjørn

Erik Axelsen and Jens-Otto Krakstad, of the Institute of Marine Research, Bergen, Ole Magnus Rottingen, the boat Captain, and Henning Sangolt ("the hawk-eye").

Jean-Paul Roux, of the Ministry of Environment and Tourism, Namibia, continued with the survey in the Southern part (from the Longa River mouth to the Cunene River mouth), and information will be joined to produce a full report and relevant publication.

METHODOLOGY:

Observation platform: fishing research vessel, Dr. F. Nansen, 56.75 m length.

Observation time: 21.7.-31.7.2003, every day from 08.00 to 18.00, most of the time by the two observers, about 25% of the time only by one observer, and occasionally by additional observers. A total of 110 observation hours.

Surveyed area: Off-shore Angola**,** from the Congo River mouth (6^0 South) to the Longa River mouth ($10^0$18'South), along transects perpendicular to the coast, and no further than $11^0$07 East. (see map, Annex B). Length of transect during all observation hours must still be calculated. Estimated width of transect is 4 km (possibility to observe whales from a distance of up to around 2 km to each direction).

Recording information: observations were done with 9X25 Nikon and 10X50 Pentax binoculars. Information was recorded on standard Cetacean sighting forms (see Annex A). Complimentary information was obtained from the vessel datalog. In several occasions the boat has followed the cetaceans, for closer observations and photos. It should be noted that weather and sea conditions and therefore, observation conditions, were optimal throughout the survey.

RESULTS:

Three species of Cetaceans (Order: *Cetacea*) were observed, as well as cape fur seals:

1. Humpback whale (*Megaptera novaengliae*): a baleen whale (sub-order: *Mysticeti*, family: *Balaenopteridae*). This species migrates annually along the coast line of Angola. (IUCN status: Vulnerable)
2. Short-finned pilot whale (*Globicephala macrorhynchus*): a toothed whale (sub-order: *Odontoceti*, family: *Delphinidae*). This species may be resident, in off-shore waters. (IUCN status: Insufficiently known)

3. Bottlenose dolphin (*Tursiops truncates*): a dolphin (sub-order: *Odontoceti* , family: *Delphinidae*). This is the most common dolphin species. The individuals observed were of the off-shore Atlantic form. This species may be resident. (IUCN status: Insufficiently known)

All bottlenose dolphins and pilot whales observed were associating in mixed groups of the two species.

4. South African (Cape) fur seal (*Arctocephalus pusillus*): (order: *Carnivora*, sub-order: *Pinnipedia*, family: *Ortariidae*). This species is common in southern Angola, Namibia and South Africa. (IUCN status: Insufficiently known).

A total of 61 humpback whales were recorded, in 20 different observations (0.18 observations/effort hour), and a total of 34 pilot whales and 68 bottlenose dolphins were recorded in 3 different observations. 2 seals were observed, each separately.

Humpback whales were observed at a depth of 20-340m, while pilot whales and bottlenose dolphins were observed at a depth of 410-800m. 80% of humpback whales were observed at a distance of up to 20 Nautical miles from the coast, while all pilot whales and bottlenose dolphins were observed at a distance of over 29 Nm from the coast. Most humpback whales were observed traveling in groups of 1-3 individuals, except for two larger groups of 15-25. Pilot whales were observed in groups of 6-16 individuals associating with 6-80 bottlenose dolphins.

Distribution of observations is presented in the map below (Annex II).

Further data analysis, and preliminary assessment of status of the observed species, will be done later, with the scientists of the Nansen, and J.P.Roux, to include the data from the southern part of the survey.

Bird species identified: Cape gannet (*Sula capensis*), Blackbrowed albatross (*Diomeda melanophris*), Giant petrel (*Macronectus gigantus*), Sooty shearwater (*Puffinus griseus*), European storm petrel (*Hydrobates pelagicus*), Kelp gull (*Larus dominicanus*), Caspian tern (*Hydroprogone caspia*), several smaller tern species (*Sterna* spp.).

TRAINING:

One of the main objectives of this survey was to train Angolan technicians in methodology of data-collection on marine-mammals observations, and species identification. One technician of

the National Department of Natural Resources, the Ministry of Urban Affairs and Environment, was trained during this survey. General training was also extended to the team of Angolan scientists participating in the fishing research. Information on marine mammal species that may occur off-shore Angola, from: "Jefferson. T. A., Leatherwood, S. and Webber, M.A. 1993. Marine Mammals of the World". UNEP and FAO, Rome." was left in the Nanasen's library, as well as standard Cetacean sighting forms (see Annex I). Another copy was given to the trainee.

CONCLUSIONS:

This preliminary survey was done mainly to assess the conditions for data collection on marine mammals, off-shore Angola, from an existing research vessel. The results demonstrate that there is clear interest in collecting information on marine mammals species, distribution and status, off-shore Angola, and this objective may be achieved at minimum costs, by use of existing vessels. The Nansen can provide an optimal platform for an on-going marine mammals survey, and indication on population dynamics over time. Presence and visibility of whales off-shore Angola also indicate that optional developing of community-based eco-tourism activities, based on "whale-watching" as a sustainable livelihood alternative for coastal communities, may be explored.

RECOMMENDATIONS AND THE WAY FORWARD:

1. Within the framework of establishing a data base on biodiversity in Angola, there is need to collect information on marine mammal populations, off-shore Angola – species inventory, status, distribution, spatial behaviour and migratory patterns, and threats, as well as long-term monitoring of populations dynamics. Marine-mammal populations form an important and indicative component of the marine-eco-system.

2. There is further specific interest in collecting information on marine-mammal populations off-shore Angola, in order to assess the possibility to develop community-based "whale-watch" eco-tourism initiatives, as part of the programme to develop sustainable alternatives to resident communities, to replace the current non-sustainable utilization of biodiversity and natural resources.

3. Preliminary data collection on marine mammal populations off-shore Angola, can be done within the framework of the "sub project for the development of pilot projects with

coastal community involvement", of the BCLME project, with the support of UNDP project ANG/02/005, the Nansen project, and IIM, and with the participation of MINUA and ANU.

4. A GIS data-base of all existing information on marine-mammals off-shore Angola should be established, and information gaps should be identified. Programmes for data-collection should then be developed.
5. To minimize costs, data collection can be based on existing vessels, and in particular, on collaboration with the Nansen project, for systematic data-collection, during the regular cruises of the vessel, twice a year.
6. A national coordinator should be nominated to lead and coordinate the data-collection on marine mammals off-shore Angola and to develop and populate the data-base. The coordinator must have an adequate level of education and experience, and can be trained within the framework of the BCLME sub-project. During the cruise there must be at least one or two trained people on board, dedicated only to collecting this information.
7. Further information should be collected from interviewing artisanal fishermen and coastal communities, commercial fishermen, teams of other vessels moving off-shore Angola (for example, the petroleum industry's vessels), etc.
8. There should be focus on collecting information on intentional catch of marine mammals, by-catch in fishing gear, and other threats.
9. Complimentary data collection programmes should be developed, including aerial surveys, and observations from on-shore and off-shore platforms.
10. The information collected should be used to develop recommendations for conservation measures, including recommendations for improving fishing gear to minimize by-catch, legislation and enforcement, identification of sensitive marine and coastal areas, and recommendations for establishing marine protected areas, etc.

11. Conservation programmes must involve the participation of coastal resident communities and include components of education, awareness campaigns and consultation with stakeholders.

12. The development of any eco-tourism initiatives related to “whale-watch”, off shore Angola must be controlled, with a legal basis, and must secure the benefit sharing with resident coastal communities, as well as adoption of global standard codes of behaviour to avoid any threat or disturbance to the whales and dolphins.

Tamar Ron, August 2003

ANNEX A - Cetacean Sighting Form

Date: **Observer (name and contact):**

Observation platform (specify):

Time: beginning of observation: **End of observation**

Position (use GPS): Latitude: **Longitude:**

Off-shore distance: **Depth:**

Weather: **Sea condition:** **Wind:**

Air temp.: **Water temp.:**

Species:

Group size: Min.: **Max.:** **Best estimation:** **No. of calves:**

Group formation (compact/dispersed):

Total distance between extreme group members:

Distance from observer: **Other species associated:**

Behaviour observed (T=travel: s=slow, m=medium, f=fast; S=socialize; B=bow-riding; F=surface feed; D=dive, R=rest, O=other: specify):

Special markings on individuals (specify any individual characteristics):

Photos taken (yes/no): **(Attach photos whenever possible)**

Notes:

ANNEX B – Map of observations

Legend:

…… Cruise route

____ Marine mammals transect (during observation hours)

start/end: Indicating place of beginning and end of observations, every day

Mn: *Megaptera novaengliae* (humpback whale)

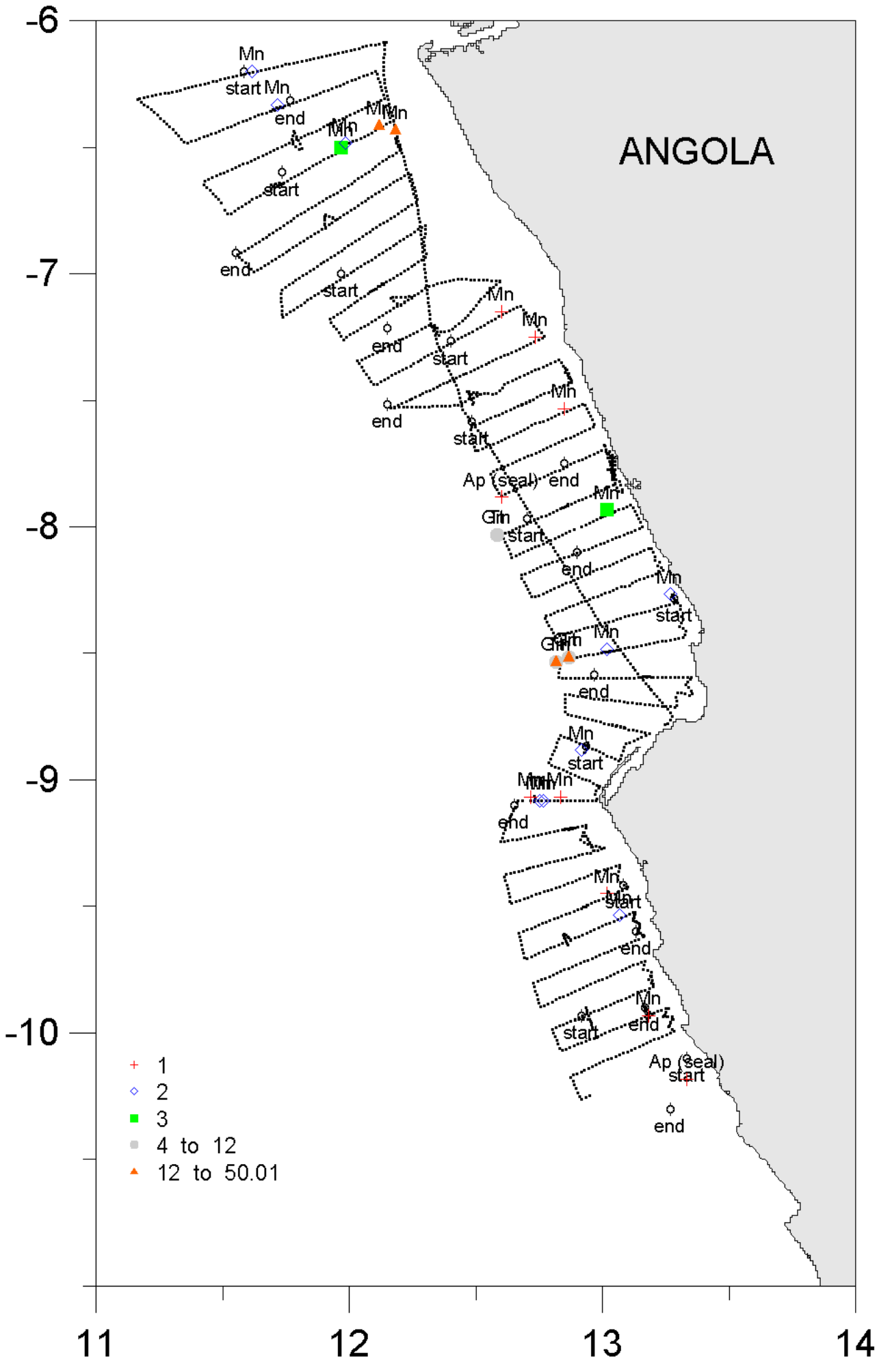
Gm: *Globicephala macrorhynchus* (short-finned pilot whale)

Tt: *Tursiops truncatus* (bottlenose dolphin)

Ap: *Arctocephalus pusillus* (cape fur seal)

Number of individuals observed in each observation is indicated (see legend in the map)

Location: $6^0 – 11^0$ South, $10^0$30’ – $13^0$30 East


ANGOLA
-6
-7
-8
-9
-10
11
12
13
14
Mn
start
end
Ap (seal)
Gm
1
2
3
4 to 12
12 to 50.01

ANNEX VII

Sharks' sampling off the Angolan coast

Diana Zaera

Shark sampling

In order to improve the available information on biology and bathymetric distribution of sharks in Angolan waters, and especially deep-water sharks, several samplings were taken during the Angolan surveys in 2002 and 2003.

During the present survey a total of 36 individuals were measured from 7 different species.

Methodology

Identification. The sharks caught were identified using Compagno (1984; 1989; 2001), Elst (1981), Bianchi (1986) and Fischer *et. al*. (1981).

Morphometric measurements. All specimens caught were measured, weighed (g) and sexed. For the purpose of morphometric analyses we followed Hubbs and Lager criteria. All fish length data are given as total lengths, since this is the measurement most often used as an independent variable and it is a standard measurement in the shark literature. The following morphometric parameters were taken:

- Total length (TL, cm) taken as the length from the snout tip to the upper tip of the upper caudal fin lobe, measured to nearest centimetre below; taken in the natural position without depressing the tail to place it in line with body axis
- Trunk height at pectoral fin insertion
- Snout length taken from outer nostrils
- Preoral length
- Eye's diameter
- Mouth's width
- Mouth's height
- Minimum internasal distance
- 1st gill opening's length
- 2nd gill opening's length
- 3rd gill opening's length
- 4th gill opening's length
- 5th gill opening's length
- 6th gill opening's length
- 7th gill opening's length
- 1st dorsal fin height
- 1st dorsal fin's base length
- 1st dorsal fin's inner margin length
- Upper caudal lobe's length
- Lower caudal lobe's length
- Pectoral fin length
- Pectoral fin inner margin length
- Pectoral's rear margin length

- Distance from tip of snout to 1st dorsal fin's origin
- Distance from tip of snout to upper caudal lobe origin (precaudal length)
- Distance from tip of snout to pectoral fin's origin
- Distance from tip of snout to pelvic fin's origin
- Distance from tip of snout to anal fin's origin
- Distance between dorsal and upper lobe of caudal fins' origins
- Distance between anal and lower lobe of caudal fins' origins
- Distance between pectoral and pelvic fins' origins
- Distance between pelvic and anal fins' origins
- Gonopods (claspers) length

Reproductive information related to fecundity and size at maturity. Maturity was assessed using the scale shown below as suggested by Stehmann (1987).

Male

Stage 1	Juvenile	Claspers undeveloped, gonads tiny, thread-like, whitish, sperm ducts straight
Stage 2	Sub-adult	Claspers soft, gonads enlarged, sperm ducts meandering
Stage 3	Adult	Claspers stiff, gonads rounded, sperm ducts tightly coiled, sperm flowing freely

Female

Stage 1	Juvenile	Ovaries small, oocytes not differentiated, evenly small, uteri thread-like
Stage 2	Ripening	Ovaries enlarged, wall transparent, oocytes of various sizes, uteri similar to stage 1
Stage 3	Ripe	Ovaries large, oocytes larger and of similar size, can be counted easily
Stage 4	Early gravid	Uteri filled with nonsegmented yolky matter
Stage 5	Mid-term gravid	Uteri filled with yolk sacs of small non pigmented embryos, easily counted
Stage 6	Late gravid	Embryos fully formed, easily counted, yolk sac reduced
Stage 7	Post-natal	Ovaries similar to stage 1, uteri dilated

Information related to feeding habits. The determination of stomach content was made macroscopically on board the vessel. The prey was identified to the lowest taxa possible. The data were quantified using the frequency of occurrence method (percentage of stomachs containing food with a particular prey item). To describe the stomach fullness, the following scale was used:

Empty (except for some water)
Very little content (the stomach has to be opened)
Some content (content appears clearly
Full (filled, but not expanded)
Expanded (stomach very expanded and tight)
Everted (turned inside out)

While to register the degree of digestion:
Digestion not started (content seems rather fresh)

Digestion just started (the species still can be identified)
Digestion advanced (the species cannot be identified, but systematic groups may be discriminated)
Digestion advanced considerably (bones, eyes and other hard parts of prey can be distinguished)
Digestion nearly terminated (content cannot be identified. Liquid or jelly like content)

Liver weight was recorded to calculate hepatosomatic (HSI) index.

About their distribution and ecology. To get a better understanding of the shark's ecology, data on salinity, oxygen content and specific temperature of the water in which they occur, will be used together with data on catch rates and frequency of occurrence with other species.

Aging. Vertebras were preserved frozen to be read at the Institute of Marine biology in Bergen

Dentition. Heads of some specimens were preserved frozen to count number and rows of teeth

List of species measured:

Species	Number
Mustelus mustelus	2
*Scylorhinus cervigon*i	2
Squalus megalops	13
Isistus brasiliensis	1
Galeorhinus galeus	12
Alopias vulpinus	2
Sphyrna zygaena	4