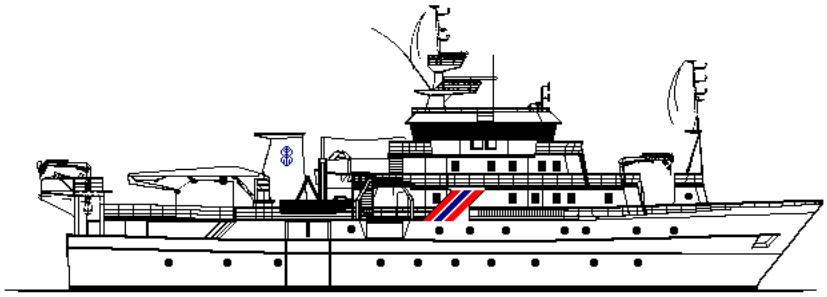
BCLME Project: LMR/NANSEN/02/05 Cruise reports "Dr. Fridtjof Nansen"



BCLME SURVEY NO. 2 2005

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

Cruise report No 2/2005

13 – 23 August 2005

by

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Bergen, 2006

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Summary

The study has demonstrated that studied species are to large extents transboundary in the cold season and underpin recent reports of alarmingly low abundance levels of Cunene horse mackerel and sardine. Cunene horse mackerel was found as far south as Cape Frio (19º00' S), but the densities found south of the Angolan-Namibian border were too low to substantiate any kind of biomass estimation. The biomass of Cunene horse mackerel in Angola was 44 000 tons. Cape horse mackerel were found throughout the transboundary area. The biomass was 253 000 tons (64 %) in Angolan waters and 140 000 in Namibian waters (36 %), i.e. 393 000 tons in total.

Scattered individuals of sardine (pilchard) were found in some of the samples on both sides of the border during the high-density search grid for clupeids, but no aggregations of sardine were recorded, neither acoustically nor with the sampling gear (pelagic sample trawls). Any sizeable aggregation in the area would almost certainly have been discovered during such an intensive surveying exercise and it is therefore concluded that no sizeable aggregations of sardine were present in neither in Angola nor the transboundary area at the time of the survey. Other clupeid species (round herring and anchovy) were only found in scattered, low-density aggregations insufficient to produce any estimates of abundance.

All target species were found in small size groups. Cunene horse mackerel was generally less than 25 cm, and for Cape Horse mackerel 80% of the fish were less than 15 cm total length. The little that was found of the various clupeids was generally, small size groups.

The main recommendations are:

1 The survey should be repeated at the same of the year in order to establish whether the observed pattern is persistent over time and to monitor development trends in the transboundary area over time, if any.
2 The investigation should also be conducted in the warm season. The distribution pattern of all species under investigation here will likely be quite different in the alternate season. Horse mackerel distributions over the transboundary area generally follow the position of the Angolan-Benguelan front (ABF), i.e. both species have more southern distribution in the warm season. This will, in turn lead to expectations of more Cunene horse mackerel in Namibian waters and less Cape horse mackerel in Angolan waters during summer.

3 The two countries involved should consider cooperating on continuing to monitor the transboundary area and to coordinate management of the fish resources there; all stocks under study here are to some extent transboundary and most stocks are in low abundance. Only fish smaller than 25 cm were found throughout the transboundary area.

Acknowledgements

A special thank goes to the officers and crew on the R/V 'Dr Fridtjof Nansen' for their efforts and good cooperation at sea.

List of Abbreviations

Parameter	Name	Units
ρ_i	Estimated number of fish in length group i	
ABF	Angola-Benguela Front	
ADCP	Acoustic Doppler Current Profiler	
A_s	Horizontal area of stratum s	[m^2]
BT	Bottom Trawl (demersal)	
C_F	Correction Factor	
CTD	Conductivity, Temperature and Density	
CF	Condition Factor	
CV	Coefficient of Variance	
DO	Dissolved Oxygen	[ml l^{-1}]
L_i	Length group i	[cm]
LT	Local Time (= UTC + 1 hour)	
n.mi	Nautical miles = 1852 m	
PT	Pelagic Trawl	
S	Salinity	
s_A	Area backscattering coefficient	[m^2 $n.mi^{-2}$]
SSS	Sea Surface Salinity	
SST	Sea Surface Temperature	[°C]
S_V	10 log(s_v)	[dB re 1 m^{-1}]
T	Temperature	[°C]
$t_{i,j}$	Proportion of species j sampled in length group i	
TS	Target Strength	[dB re 1 m^2]
u_i	Proportion of fish sampled in length group i	
UTC	Greenwich Middle Time (earlier GMT)	

1 Introduction

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

The overall transboundary area was defined from Ponta Albina near Tombua in the north (15°50' S) southwards to the Cape Frio upwelling cell (19°00' S). This definition is based primarily on evident geographical delimiters (points) that divide the coastal area into natural ecological zones. The northern boundary represents the northernmost extreme of the Tiger Bank, where the continental shelf narrows in to virtually nothing. The southern boundary represents a natural biological boundary in Namibian waters due to the presence of the massive upwelling cell near Cape Frio. The definition of the transboundary area applied is expected to be wide enough to cover the likely distribution area of fish migrating from Namibia into Angolan waters and vice verse, at both warm and cold seasons.

There has been reported a decline in both abundance and mean size in all main commercial pelagic species, particularly for sardine and horse mackerel both in Angola and Namibia. The zone across the Angolan-Namibian border is particularly important as this area hosts co-occurring population of carangids, i.e. Cape horse mackerel *Trachurus trachurus capensis* and Cunene horse mackerel *Trachurus trecae*, as well as clupeids, including sardine (Pilchard) *Sardinops ocellatus*, round herring (Redeye) *Etrumeus whiteheadi* and anchovy *Engraulis encrasicolus*. There is special concern about the situation in the transboundary area since most of these stocks are believed to be in low abundance, in particular the sardine and the Cunene horse mackerel, while there at the same is an intensive fisheries going on in the border area. All of these populations are, to a lesser or greater extents, distributed across the border and there is known to be considerable movements between seasons and years.

The main purpose of this survey is to map the distribution and estimate the abundance of the most commercially important pelagic species across the Namibian-Angolan transboundary area during the cold season. The study will complement the pelagic survey in Angola by

extending the survey grid into Namibian waters, using the same sampling resolution terms of acoustic transect lines, fish sampling (pelagic and demersal trawling) and hydrographical mapping as in Angolan waters. A high-resolution survey grid was designed, targeting inshore aggregations of clupeids, particularly sardine. The results are expected to provide a snapshot of the relative distribution of the most important species across the border area in the cold season, and will also provide important information about the abundance and biological state of these species in the area. When assessed together with the results from the pelagic survey in Angola, the results will provide a complete coverage of the Cunene horse mackerel, including the proportion of the stock present in Namibian waters at the time of the pelagic survey in Angola, if any. For sardine, the results will not cover the entire distribution area, but will indicate total biomass in Angolan waters and in Namibian waters south to 19°00' S.

1.1 Objectives

The main objectives of the survey were the following:

- To estimate the abundance and to map the distribution of the main commercially important pelagic fish species, with special emphasis on the two horse mackerel Cunene horse mackerel *Trachurus trecae* and Cape horse mackerel *Trachurus capensis*, sardine "Pilchard" *Sardinops ocellatus* and other small pelagic species, including anchovy *Engraulis encrasicolus* and round herring *Etrumeus whiteheadi*.

- To study the biological state of the main species, including length frequencies, length-weight relationships and reproductive stages.

- To collect depth-stratified samples of zooplankton in order to determine zooplankton vertical distribution and abundance.

- To map the meteorological and hydrographical conditions in the survey area by means of continuous recordings of weather data (Sea-surface temperature SST, Sea-surface salinity SSS, wind speed and-direction, CTD-casts (Temperature, Salinity and Oxygen), stratified current measurements (Acoustic Doppler Current Profiler ADCP).

- On-the-job training of local participants on the main survey routines, including using the biological database NAN-SIS, scrutinizing acoustical data (BEI) and producing acoustical biomass estimates. A one-day training course in theoretical and applied acoustics will be given aboard during the survey.

1.2 Participation

The following scientific staff participated in the survey:

From INIP, Angola:

Filomena VAZ-VELHO (Angolan Team Leader), Pedro TCHIPALANGA, Manuel DOMINGOS, Miguel ANDRÉ, Pedro PANZO, Vanaquissa JONICO, José DA SILVA and Esteves ALFONSO.

From NatMIRC, Swakopmund:

Martha UUMATI (Namibian Team Leader) and Helvi MUPUPA.

From Lüderitz Marine Research:

Jean-Paul ROUX and Benedict DUNDEE.

From IMR, Norway:

Bjørn Erik AXELSEN (Cruise Leader), Diana ZAERA, Tore MØRK and Jan Frode WILHELMSEN.

1.3 Survey schedule

A full transceiver calibration was carried out prior to the survey in Baía dos Elephantes on 5th August. The sampling trawls used included the smallest pelagic sample trawl (10 m vertical opening), the mid-sized pelagic sample trawl (12 m) fitted with a remote operated codend multisampler and the demersal sample trawl (5 m). All acoustic transducers (18, 38, 120 and 200 kHz) were operated continuously throughout the survey.

The vessel completed the pelagic survey in Angola and reached the Angolan-Namibian border at the Cunene River (17°15' S) on the 13th of August. Extending the survey grid into Namibian waters, the same general survey design was followed, i.e. equally spaced transect lines (6 nautical miles (n.mi) apart) perpendicular to the coastline (isobaths). The acoustic transects generally covered a depth range of 20-500 meters. However, some of the lines

had to be abrupt at 30-35 m due to steeply inclining bottom near the shore in some areas. The lines in the border area were extended offshore to about 2 000 m in order to check for possible offshore horse mackerel aggregations. Hydrographical sections were carried out at Pta. Albina, Baía dos Tigres and Cunene River (17°15' S) standard sections, and on every full degree latitude line up to 19°00' S. The transboundary area southwards to 19°00' S was completed on 18 August.

A high-resolution survey grid was designed in order to target inshore aggregations of pelagic fish, particularly focusing on sardine, but also the other clupeids. In order to cover the transboundary area with the highest possible density, a triangular survey design with a spacing of 4-5 n.mi was chosen. The transfer steaming back to Tombua took about 12 hours. During this survey, only potential clupeid aggregations were sampled, but all targets that resembled clupeids were trawled in order to check the species composition. The second coverage was completed (19°00 S) on the 22 August. The ship then steamed to Walvis Bay and docked 23 August.

1.4 Survey effort

Figure 1(a and b) shows the cruise tracks with fishing and hydrographical stations in the survey area. For this transboundary study, data from southern Angola (15°00'-17°15' S) obtained during the previous survey (the pelagic resource survey in Angola 16 July-13 August 2005) are included. The study area for the present survey, defined as 16°00' - 19°00' S), covers the full overlapping zone of all target species, cut off at natural geographical delimiters (Ponta Albina near Tombua in the north and the upwelling cell south of Cape Frio). Table 1 gives a summary of the sampling effort throughout the survey. However, note that samples obtained during the pelagic survey in Angola are reported as well.

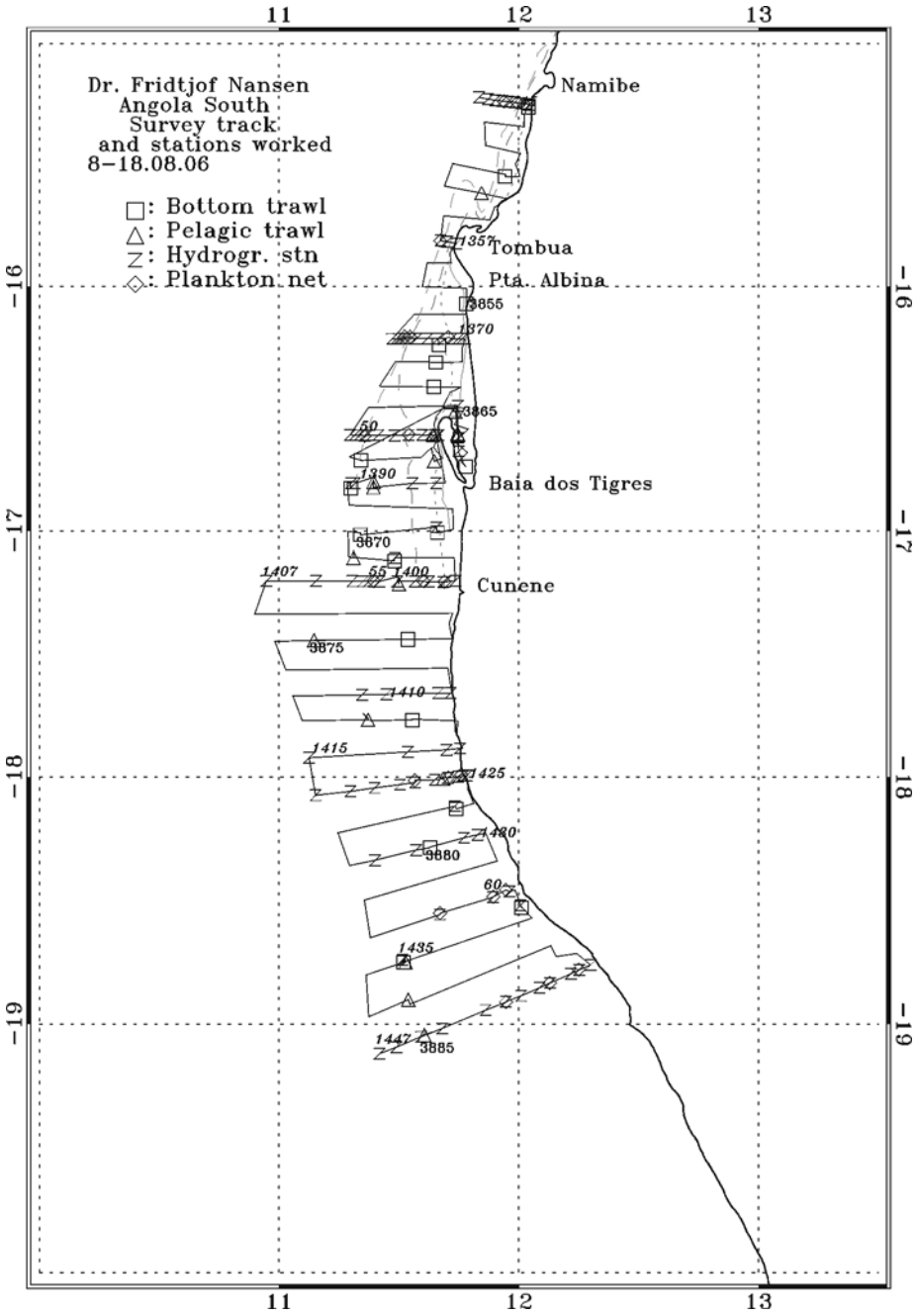


Figure 1a. Course track with fishing, plankton and hydrographic stations. Depth contours at 20, 50, 100, 200 and 500 m.

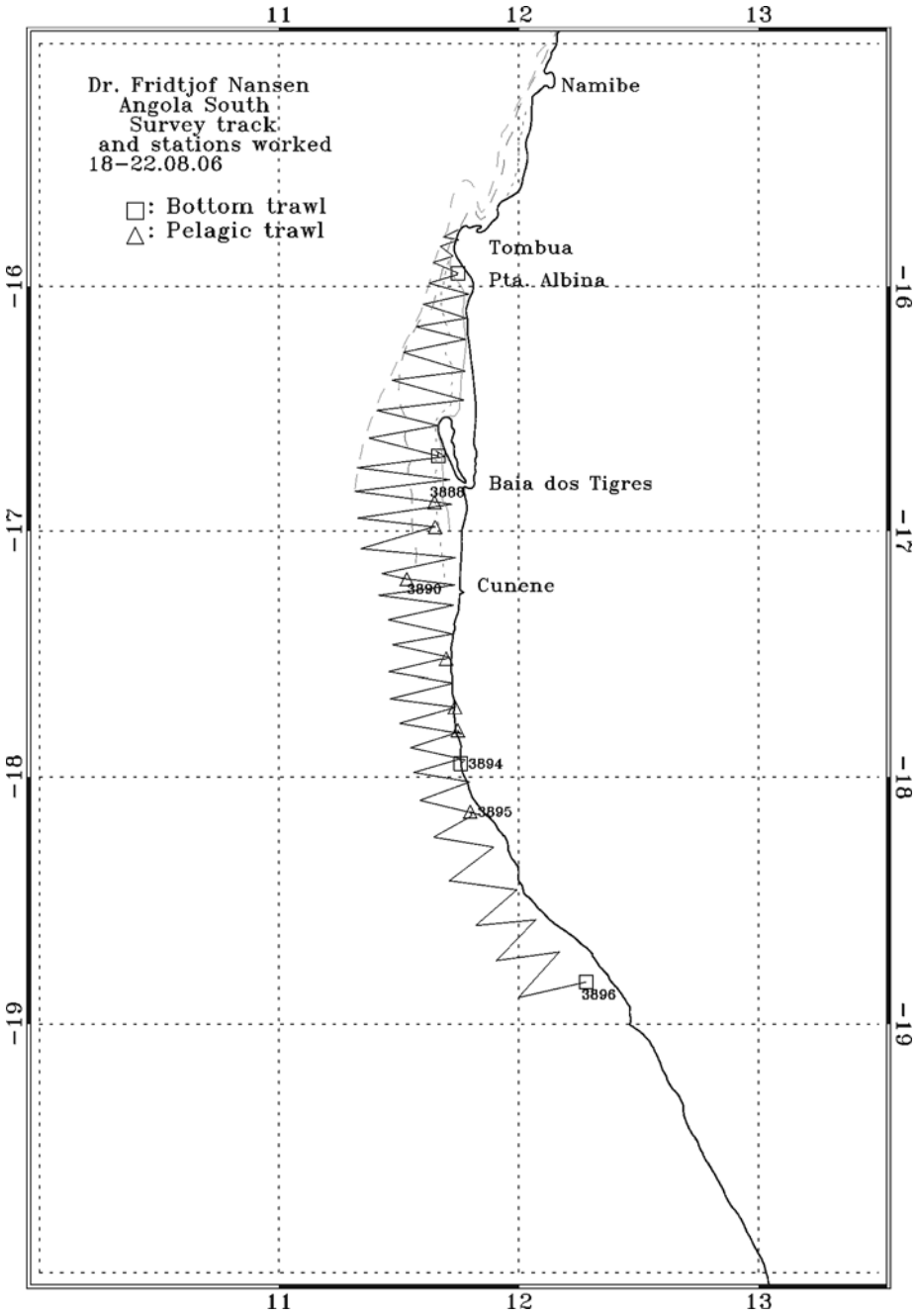


Figure 1b. Course track with fishing stations. Depth contours at 20, 50, 100, 200 and 500 m.

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

Area	BT	PT	Total trawls	CTD casts	Multinet stations	Log (n.mi)
Angola South (16°00'S - 17°15' S)	12	11	23	62	13	915
Namibia North (17°15'S -19°00' S)	8	11	19	39	9	1 296
Total	**20**	**22**	**42**	**102**	**22**	**2 211**

2 Materials and methods

During the Angolan pelagic survey the vessel has carried out continuous coverage from Congo (Pointe Noire) through Cabinda to the Angolan-Namibian border at Cunene. During the transboundary survey this coverage was extended southwards to Cape Frio in north of Namibia. The overall transboundary area was defined from Ponta Albina near Tombua in the north (15°50' S) southwards to the Cape Frio upwelling cell (19°00' S). This definition is based primarily on evident geographical delimiters (points) that divide the coastal area into natural ecological zones. The northern boundary represents the northernmost extreme of the Tiger Bank, where the continental shelf narrows in to virtually nothing. The southern boundary represents a natural biological boundary in Namibian waters due to the presence of the massive upwelling cell near Cape Frio. The definition of the transboundary area applied is expected to be wide enough to cover the likely distribution area of fish migrating from Namibia into Angolan waters and vice verse, at both warm and cold seasons. The transboundary area was covered twice, using two survey grids. The 1st grid was an extension of the Angolan survey up to Cape Frio and the 2nd grid a high-density inshore coverage targeting clupeids.

Survey grid 1:

The survey design of equidistant pseudo-parallel transects (6 nautical miles apart) perpendicular to the coastline (isobaths) applied in Angola was also followed in the extension into Namibian waters (Fig 1a). The acoustic transects generally covered a depth range of 20-500 meters. However, some of the lines had to be abrupt at 30-35 m due to the

steeply inclining bottom near the shoreline in some areas. The transect lines in the border area were extended to the 2 000 m isobaths in order to check for possible offshore aggregations of horse mackerel. This strategy ensured that the Namibian component of the transboundary area was covered in a way that was comparable to the data already collected in Angola. This way, distribution maps and biomass estimates could be drawn across the border area.

Survey grid 2:

The 2nd coverage was an intensive, inshore oriented coverage covering the entire transboundary area. The ship steamed northwards in order to start surveying from Tombua, hence reducing the time for transfer steaming to Walvis Bay towards the end of the survey. The main focus of this coverage was to search the study area for possible fish aggregations that were missed by grid 1. This pertains particularly to the near depleted sardine stocks that were not found at all neither during the Angola pelagic survey nor transboundary grid 1. The survey grid consisted of triangular transect spaced 4-5 n.mi (Fig 1b). The lines covered from inshore at about 20 m to the 300 m isobath. While the main focus was on acoustic searching for sardine an other schools, trawling intensity was reduced to only include potential clupeid schools. All observed candidates were, however, sampled using the pelagic trawls. No biomass estimates or distribution maps were produced on the basis of the data from the second coverage.

2.1 Acoustical sampling

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). All the transceivers were calibrated shortly prior to the survey, in Baía dos Elephantes on the 5th of August. Acoustic data were logged and processed using the Sun-Unix based Bergen Echo Integrator (BEI) (Knudsen 1996) version 2000. The technical specifications, operational settings of the echosounders and calibration parameters used during the survey are given in Annex IV.

The acoustic data were scrutinized using the post-processing module of the BEI software. Scatterers were displayed at 38 kHz, standardized to 5 n.mi echograms with 1 000 pings (horizontal) by 500 bins (vertical). The mean 5 n.mi area backscattering coefficients s_A ($m^2/n.mi^2$) were allocated to a predefined set of acoustic target groups by an experienced team of operators on the basis of scrutiny of characteristic echogram features in conjunction with information about the species- and size compositions as derived from the trawl catches. Definitions of the acoustic target groups are given in Table 2.

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

Acoustic group	**Taxonomical group**	**Species**
Horse mackerel	*Trachurus* sp.	*T. trecae* *T. t. capensis*
Sardinella	*Sardinella* sp.	*S. aurita* *S. maderensis*
Pilchard	Sardinops	*Sardinops ocellatus*
Big-eye grunt		*Brachydeuterus auritus*
Pelagic species 1	Clupeiformes$_{1}$	*Ilisha africana* *Engraulis encrasicolus* *Etrumeus whiteheadi*
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* *Merluccius spp.*
Mesopelagic species	Myctophidae$_{3}$	*Diaphus dumerili*
	Other mesopelagic fish	*Trachinocephalus myops*
Plankton	Copepoda	*Calanus* sp**.**
	Euphausiacea	*Meganyctiphanes sp.*
	Chaetognatha	
	Other plankton	

$_{1}$: other than *Sardinops* sp.; $_{2}$: other than *Trachurus* sp.; $_{3}$: main species group.

Estimation of biomass and CV

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

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

or

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

where C_F is the conversion factor from acoustic density to fish biomass and L is the mean total fish length. This target strength function was originally established for North Sea herring, but has later been attributed to clupeids in general (Foote *et al.* 1986, Foote 1987). No specific target strength relations presently are available for the species at hand, and equation (2) has therefore been applied consequently for all targeted species in this time series, following the established practice in Namibia. All estimates should consequently be considered as relative indices of abundance. The biomass was calculated by multiplying the number of fish by the expected length at weight, as estimated by regression of the log-length (total) against total weight.

The boundaries of encountered fish aggregations (post strata) were determined by means of contouring within the inner and outer zero-value limits of the transect lines. 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 = 1000-3 000; 4: s_A > 3 000. Mean 5-n.mi integrator values (s_A) computed along the transect lines were re-averaged for each stratum. The overall length frequency distributions within strata were estimated by weighting the sample-distributions with the nearest valid 5 n.mi integrator value, or the average of two adjacent values. The total number of fish in each length group was estimated as:

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

where:

ρ_i	=	estimated number of fish in length group i
$<s_A>$	=	mean recorded area backscattering coefficient ($m^2/n.mi^2$)
$t_{i,j}$	=	proportion of species j sampled in length group i

u_i = proportion of fish sampled in length group i

A_s = horizontal area of stratum s

C_{Fi} = conversion factor for length group i

L_i = length group i (nearest full cm below total length)

L_i+0.5 = mean length in L_i.

2.2 Trawl sampling procedures

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

Biological sampling

Samples of the main target species *Trachurus capensis*, *Trachurus trecae* and *Sardinops ocellatus* were collected and measured for length and weight. Total length and body weight were determined to the nearest 1 cm and 1 g below, respectively. Sex and reproductive stages were determined by means of macroscopic examination, scoring each fish according to the five-point classification scale first proposed by Holden and Raitt (1974) (Angolan species) and the seven-point classification according to Tom Hecht (Namibian species). For the condition factor, which is the index of the length to weight proportion giving an idea on the body condition of the fish, the length-weight relationship of target species was determined from the regression analysis of length and weight for all stations sampled.

CF = observed weight /expected weight*100

Expected weight = $a*L^{b,}$

Zooplankton sampling

The zooplankton communities were sampled along the hydrographical sections at fixed, predefined depths of 200, 100 and 50 m, following the sampling routine used during the prior Angola survey. The depth ranges sampled were 0-25 m, 25-50 m, 50-75 m, 75-100 m, and 100-200 m. 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.

2.3 Meteorological and hydrographical sampling

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

A Seabird 911+ CTD probe was used to obtain vertical profiles of the temperature, salinity and oxygen. Real time logging was carried out using the PC based Seabird Seasave software. CTD casts were conducted along the cruise track in transects at CTD lines with 60 NM distance and on every 2nd transect at 200 and 50 m depth. The casts were stopped a few meters above the bottom.

A new SBE 21 Seacat Thermosalinograph was installed during the survey of the eastern Gulf of Guinea in 2004. Initial temperature comparisons between the CTD at 5 m and the thermosalinograph showed temperatures 0.25 – 0.3°C warmer for the thermosalinograph because of heating in the pipes, but this has been corrected by addition of another temperature sensor mounted on the water inlet.

The ship-born Acoustic Doppler Current Profiler (ADCP) was running continuously during the survey. The ADCP has significant interference on the 120 and 200 kHz echosounder data, and this was tried counteracted by changing the ping synchronisation routine (trig pulse from EK500 I), but this cannot be done without installing an external trigger unit, which will be done at a later stage.

3 Results

Coverage 1

In this coverage *T. trecae* was found only in the Angolan waters (Fig. 2). The distribution was patchy and in low densities (1 to S_A 300 m^2 \ $n.mi^2$), on the inshore. Densities in the range of 300-1000 were found in the Namibe area and inside Baia dos Tigres. The biomass of *T. trecae* was estimated to 44 000 tonnes, all of which was located in Angola. From this figure, 80 % of was comprised of individuals smaller than 25 cm .

Cape horse mackerel were found continuously from south of Pta. Albina in Angola to south of Cape Frio in Namibia (Fig. 3). Highest concentrations (S_A >10 000 m^2 $n.mi^{-2}$) were recorded outside of Baia dos Tigres on the inshore and at about 100 m bottom depth. The concentration appeared to decrease southwards with two areas with intermediate densities north and south of the 18° S line. The total biomass estimate of Cape horse mackerel was estimated to be 393 000 tonnes, 253 000 tonnes of which were recorded in Angola and 140 000 in Namibia. From the total biomass 80 % consisted of fish less than 15 cm total length.

The total length of Cape horse mackerel in the transboundary area ranged from 5 to 22 cm. The length frequency distributions of the sampled fish are shown in Fig. 4. The length frequency distribution of *T. trecae* in Angola (Fig. 4a) shows two well-defined cohorts with peaks at 9 and 21 cm in total length. The length distributions of *T. capensis* in the transboundary area showed, however, a mono-modal distribution with a peak around 15 cm total length in Angola (Fig. 4b), and a less clear pattern with peaks around 10, 17 and 22 cm in Namibia (Fig. 4c). Length-weight relationships are given in Annex III.

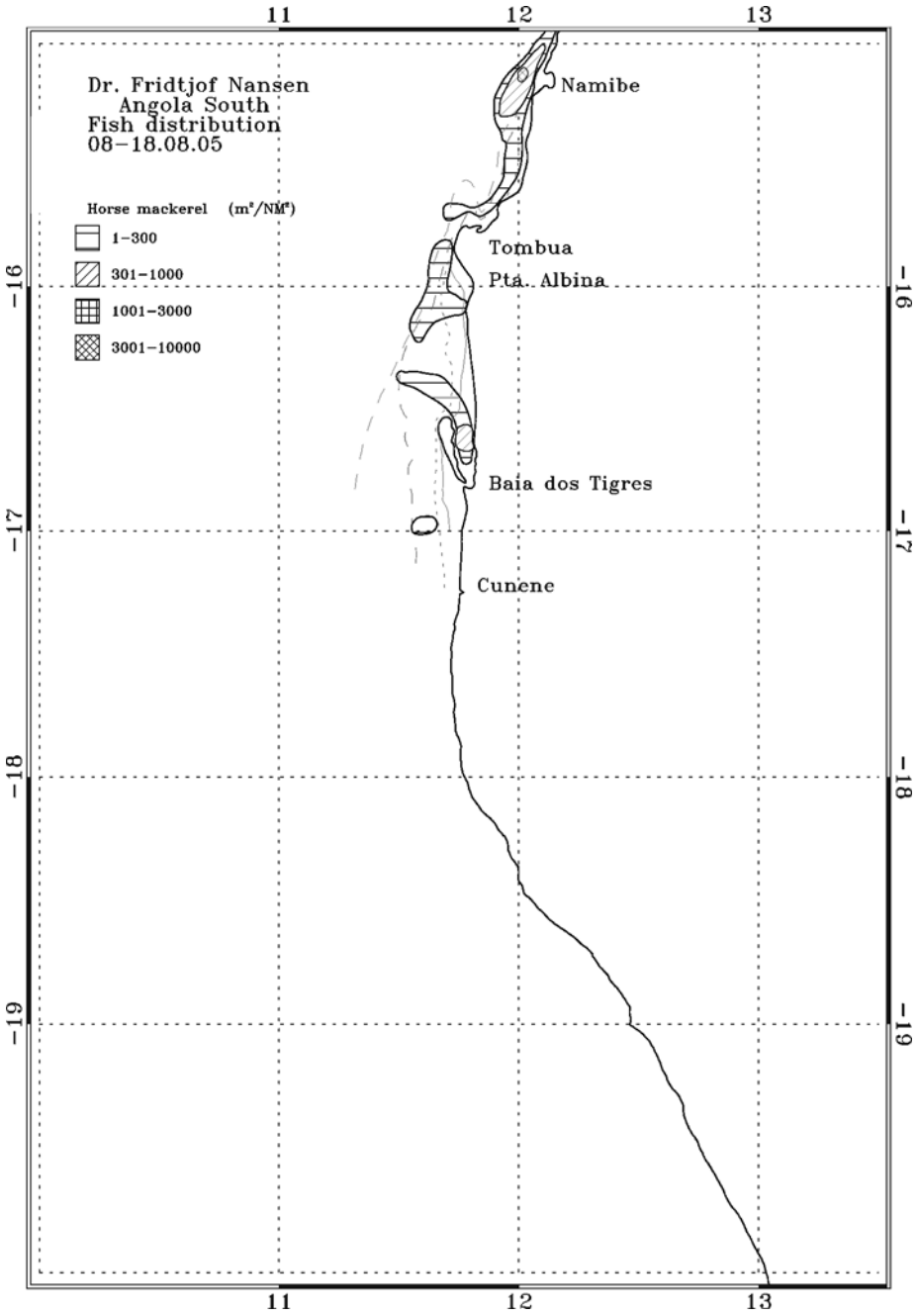


Figure 2. Distribution of *T.trecae* in the Angola-Namibian transboundary area. Depth contours at 20, 50, 100, 200 and 500 m.

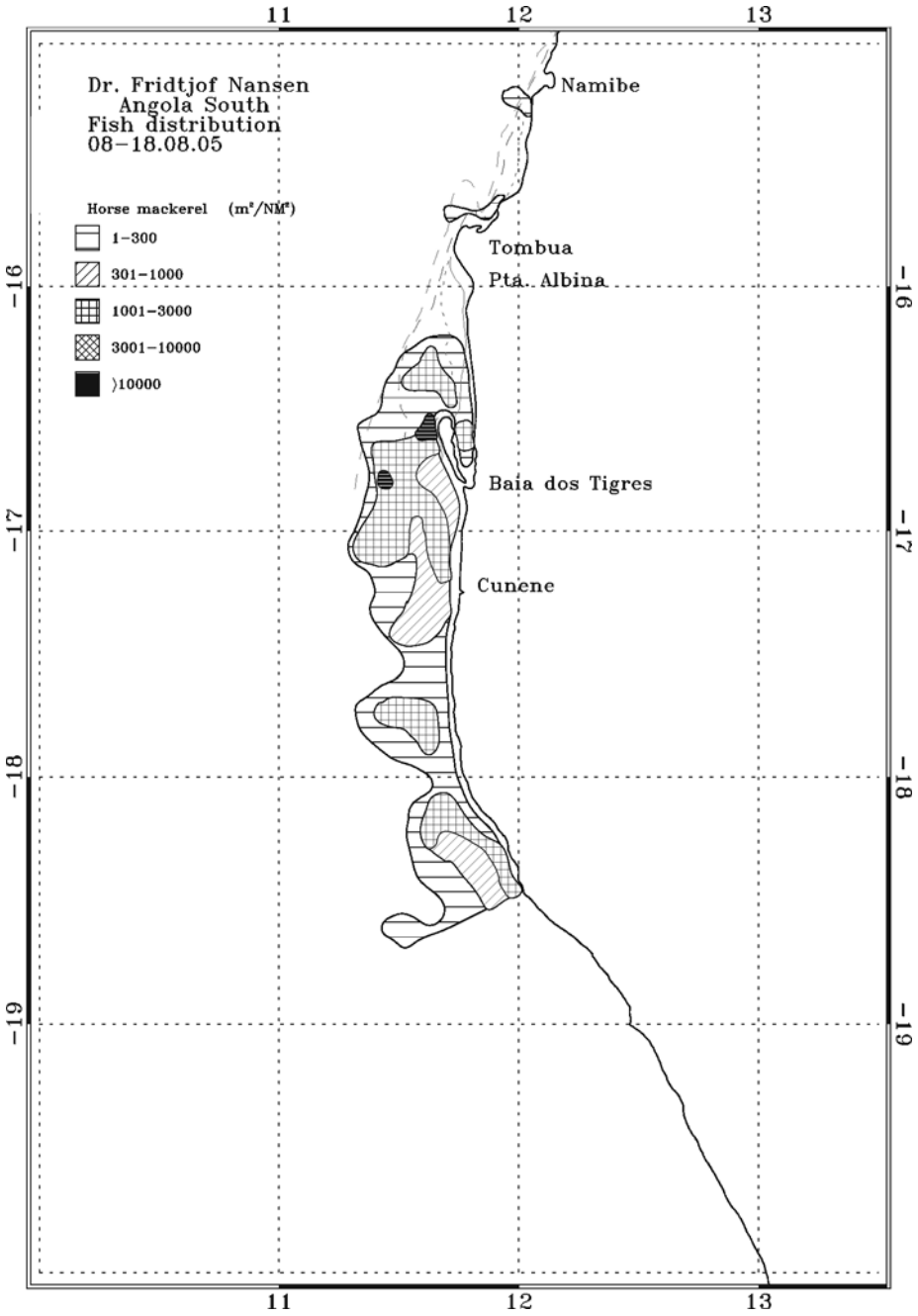
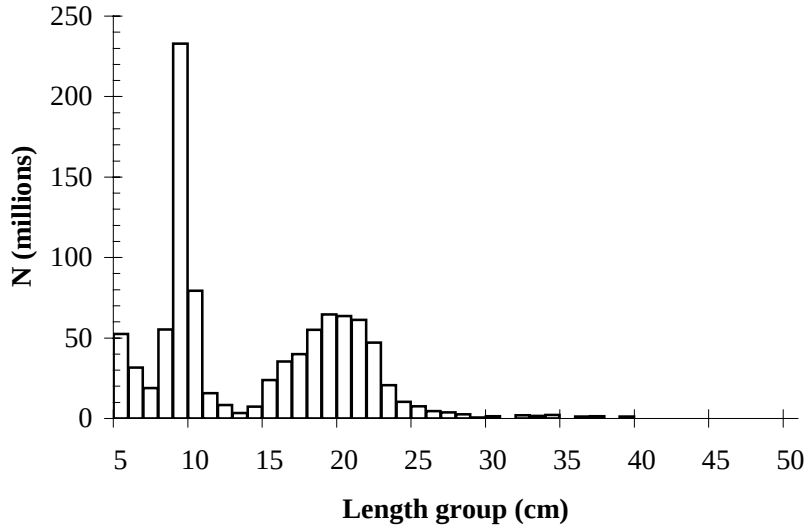
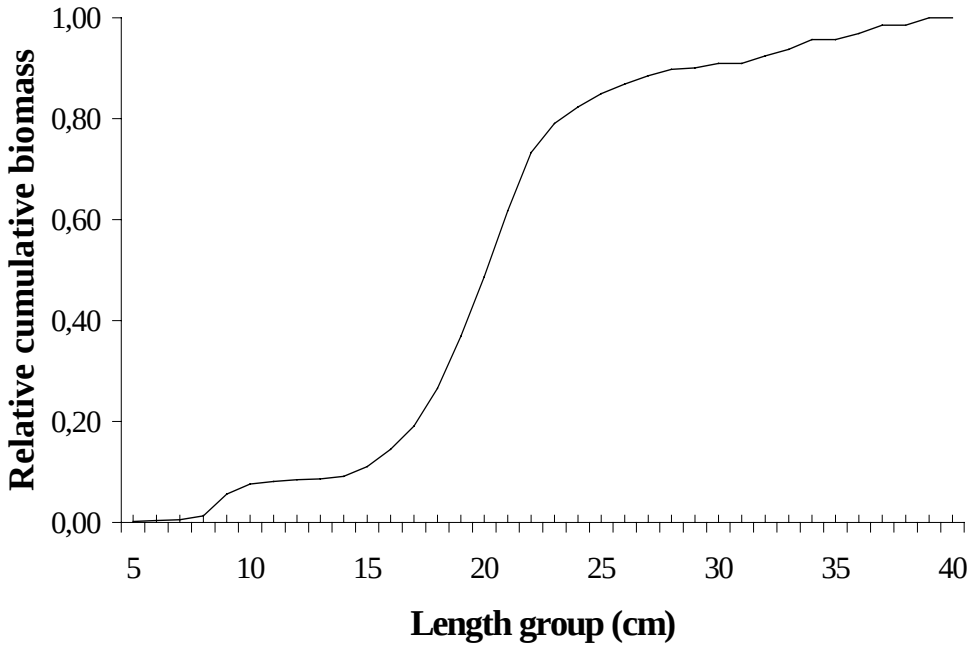


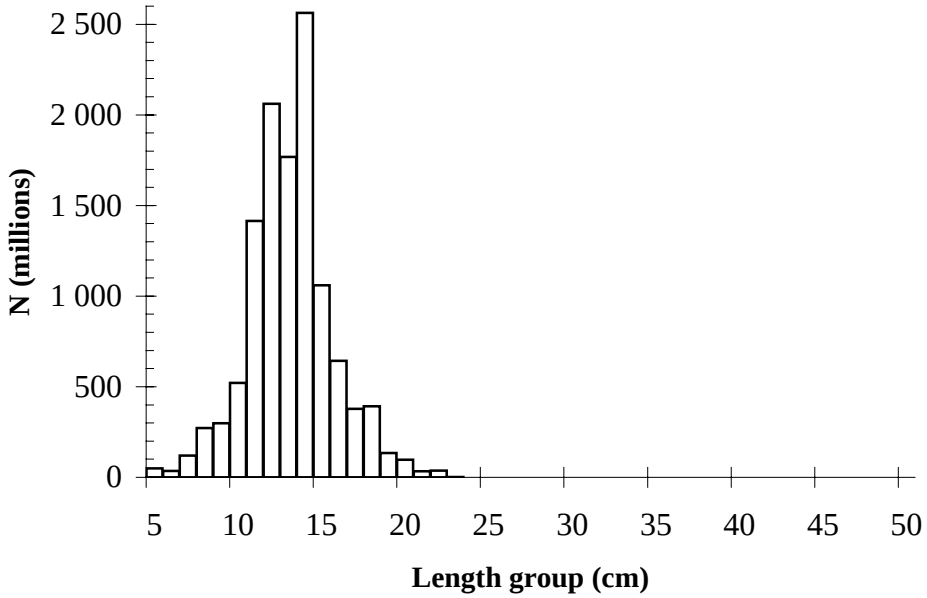
Figure 3. Distribution of *T.capensis* in the Angola-Namibian transboundary area. Depth contours at 20, 50, 100, 200 and 500 m.

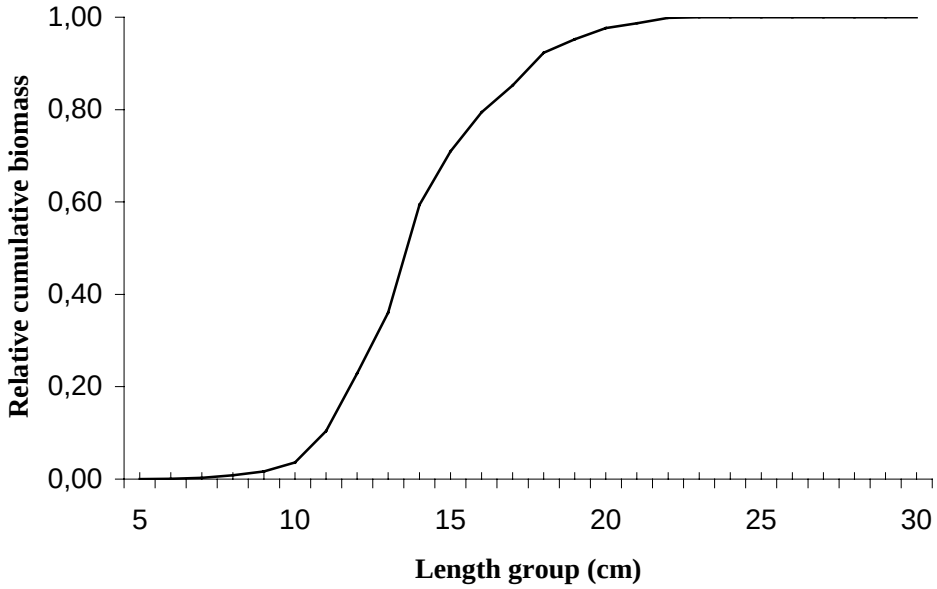
a)


250
200
150
100
50
0
N (millions)
5
10
15
20
25
30
35
40
45
50
Length group (cm)


1,00
0,80
0,60
0,40
0,20
0,00
Relative cumulative biomass
5
10
15
20
25
30
35
40
Length group (cm)

b)


2 500
2 000
1 500
1 000
500
0
N (millions)
5
10
15
20
25
30
35
40
45
50
Length group (cm)


1,00
0,80
0,60
0,40
0,20
0,00
Relative cumulative biomass
5
10
15
20
25
30
Length group (cm)

c)

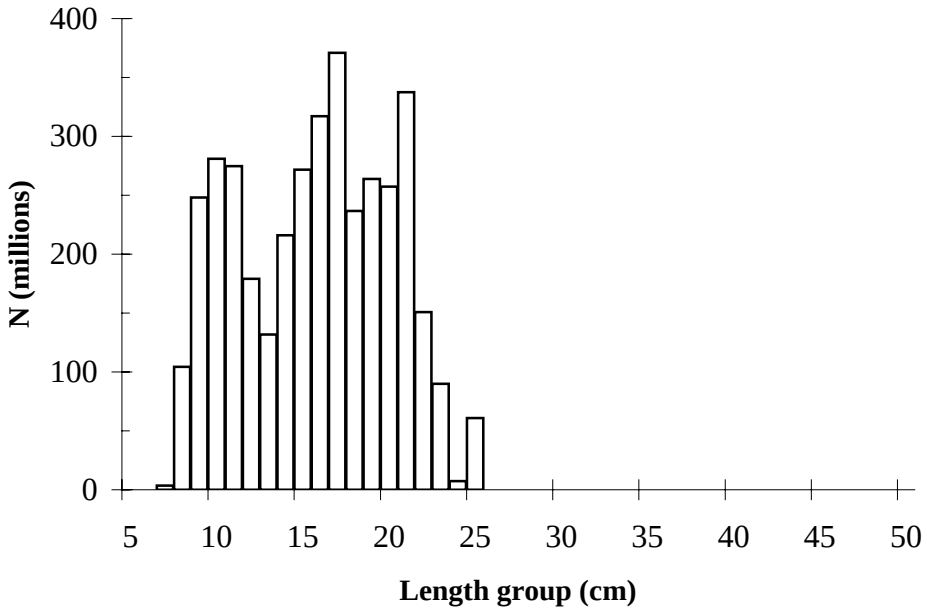


Figure 4. Length frequencies of *T. trecae* sampled in Angola (a) and *T. capensis* sampled in Angola (b) and Namibia (c).

Coverage 2

Also during the second coverage, the two horse mackerel dominated the biomass of pelagic fish in the transboundary area, as expected showing a similar distribution pattern to the first coverage. Cunene horse mackerel was, however, found in small quantities on four trawl stations around Cape Frio. The trawl catches prove that Cunene horse mackerel were present in this area, while the trawl catch rates were, however, too low (0,08 to 31.20 kg/hour, Annex II) to substantiate any kind of biomass estimation.

Sardine was found in very low densities inshore in some of the trawl samples obtain during this coverage. In the northern area scattered individuals were found in Baia dos Tigres (catch rate of 0,67 kg/hr) and near the Cunene River (catch rate 0,46 kg/hr). In the southern area sardine was recorded in two of the stations at about 18°S (catch rates of 2,3 and 0,17 kg/hr, respectively). Length-weight relationship of sampled sardine is given in Annex III. Scattered individuals of anchovy and round herring were also found in some of the trawl samples.

4 Oceanographic Conditions

Sections off Namibe (Fig. 5a). This section exhibits highest surface temperatures and salinities with evident tropical water mass stratification indicated by isolines. The inshore surface elevation of isolines over a steep and narrow shelf region points to some weak upwelling process in shallow depths (up to 100m) close to the coast.

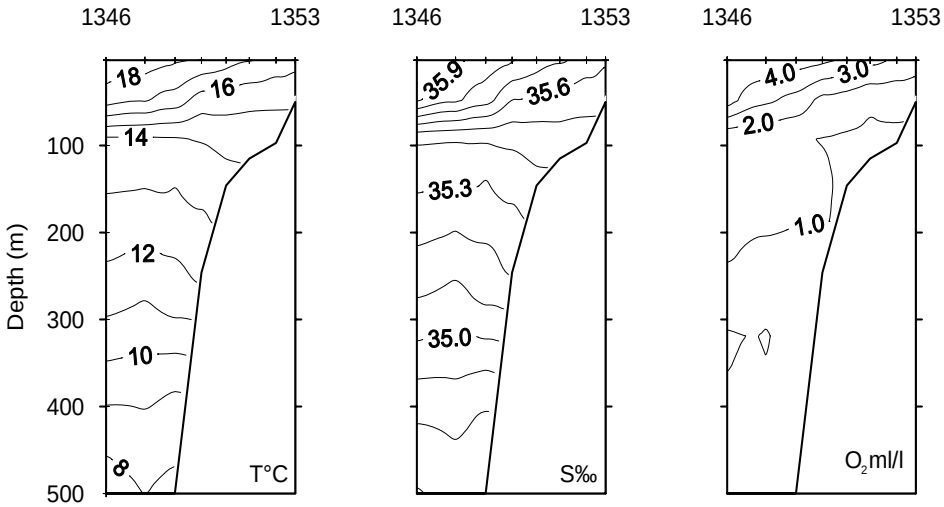


Figure 5a. Vertical sections of temperature, salinity and oxygen off Namibe

Pta. Albina (Fig. 5b) is separated from Namibe by approximately one degree of latitude. Though both sections exhibit a high level of stratification through the water mass at depth, there is a sharp decrease in both surface temperature and salinities from Namibe (T =18°C, S = 35.9 psu) to Pta. Albina (T =15°C, S = 35.5 psu). This most likely marks the transition in stratification dynamics from tropical to subtropical water masses.

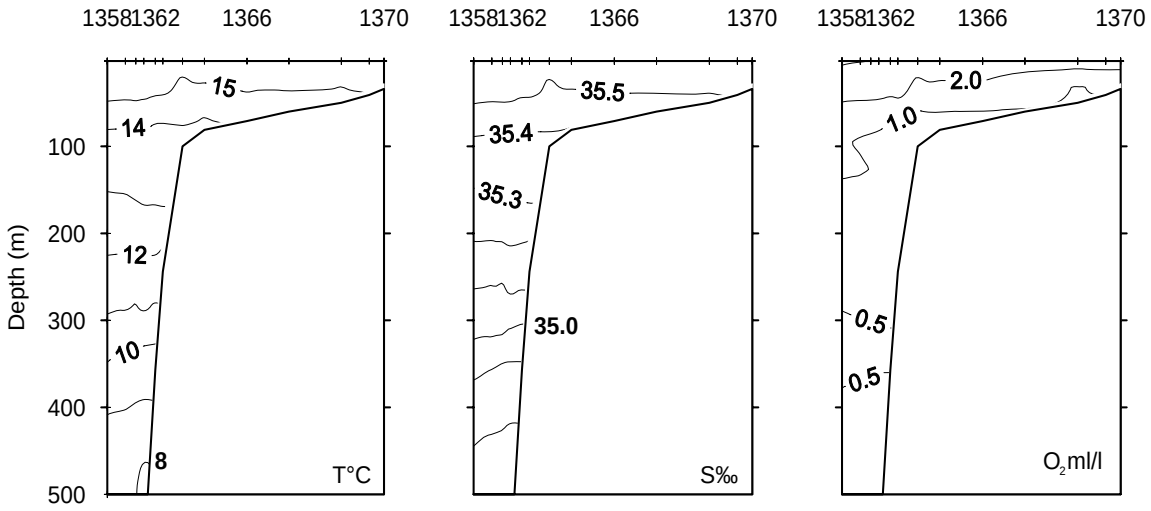


Figure 5b. Vertical sections of temperature, salinity and oxygen off Pta. Albina

Section off Baia dos Tigres (Fig. 5c): Relatively quiescent conditions prevailed near Baia dos Tigres, and the parameters in this area showed similar water mass stratification at depth as found off Pta. Albina. There were indications of very weak coastal upwelling close inshore, as evidenced by elevated isolines (T, S, 0_2) at depths above 100m.

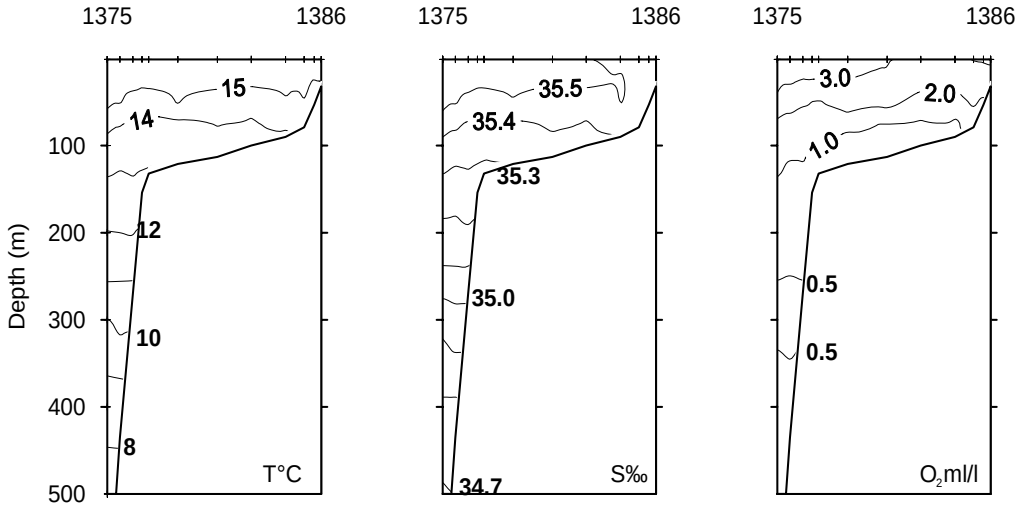


Figure 5c. Vertical sections of temperature, salinity and oxygen off Baía dos Tigres.

Section off Cunene River (Fig. 5d): Off the shelf edge the elevated isolines in the temperature; salinity and oxygen profiles indicate the presence of an open ocean upwelling process. The strong shoreward tilt of the isolines points towards the existence of an equator ward undercurrent. There was no detectable impact from the river outflow on the properties of the measured hydrographical parameters near the river mouth. This may be due to the seasonal reduction in the river outflow. A similar oxygen minimum of 0.5 ml/l is found at depths below 250 m off the shelf in regions off Pta. Albina, Baia dos Tigres and Cunene River.

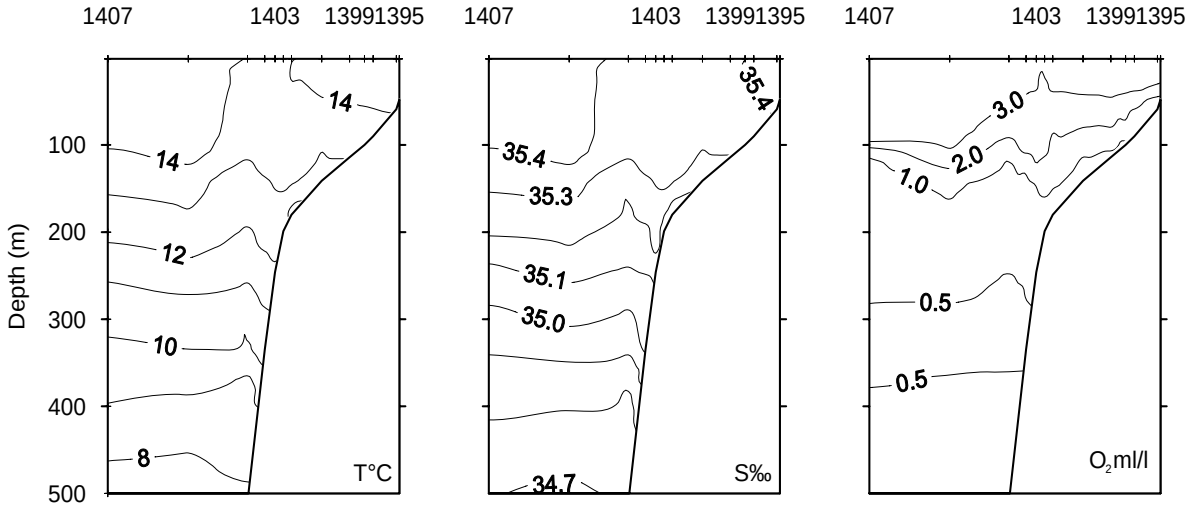


Figure 5d. Vertical sections of temperature, salinity and oxygen off Cunene River.

Section off Cape Frio (Fig. 5e): All the isolines clearly demonstrate a typical coastal upwelling regime off Cape Frio, with the uplift of isolines near the coast indicating the intrusion of cooler, less saline and low oxygen water from the subsurface onto the shelf.

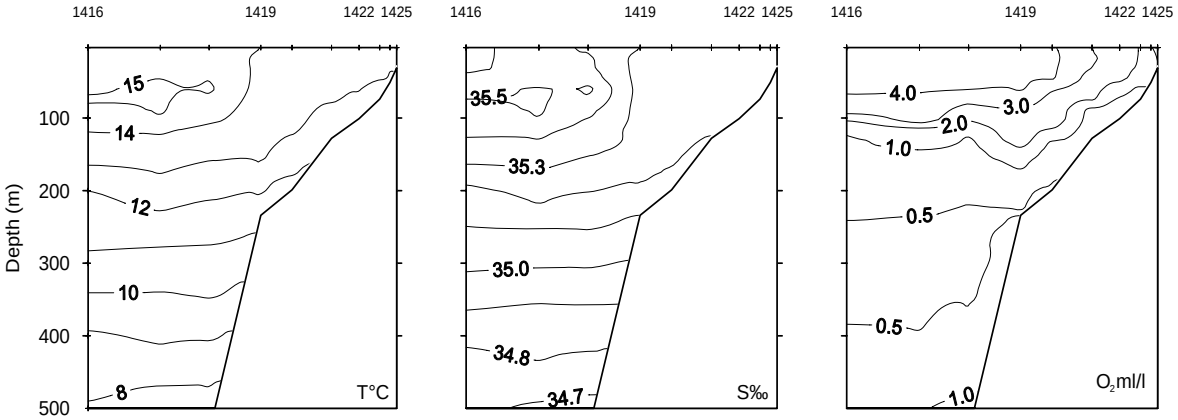


Figure 5e. Vertical sections of temperature, salinity and oxygen off Cape Frio.

Section off 19°S (Fig. 5f): The hydrographical conditions here are similar to those at Cape Frio, also indicating coastal upwelling. There was a decrease observed in sea temperature of 1°C and in the salinity of 0.2psu,from Cape Frio to 19°S, demonstrating typical progression into the Benguela proper.

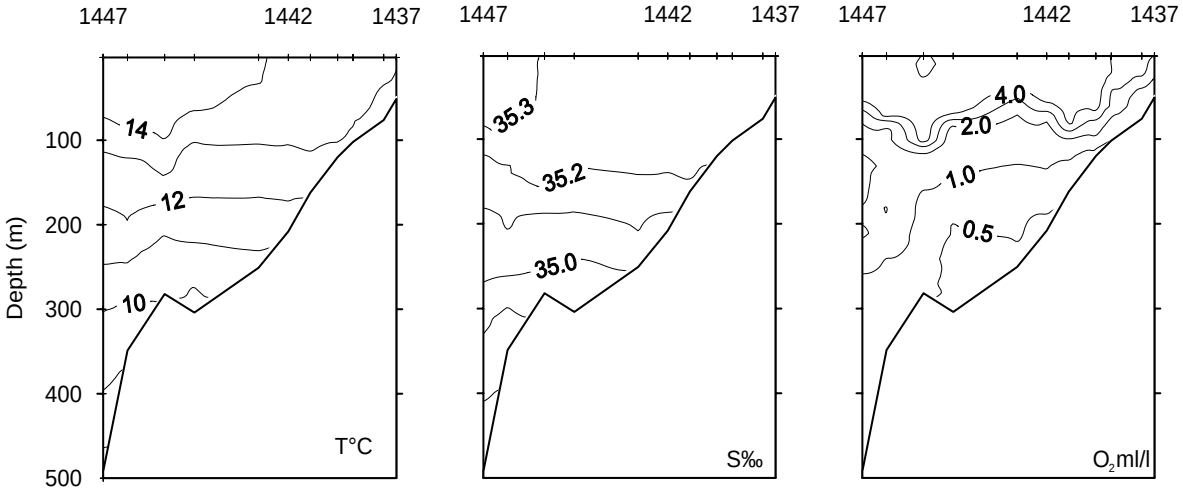


Figure 5f. Vertical sections of temperature, salinity and oxygen off 19ºS

Fig. 6 shows the sea surface temperature (SST ºC) (a) and sea surface salinity (SSS) (b) recorded at 5 m depth in the transboundary area recorded using the thermosalinograph.

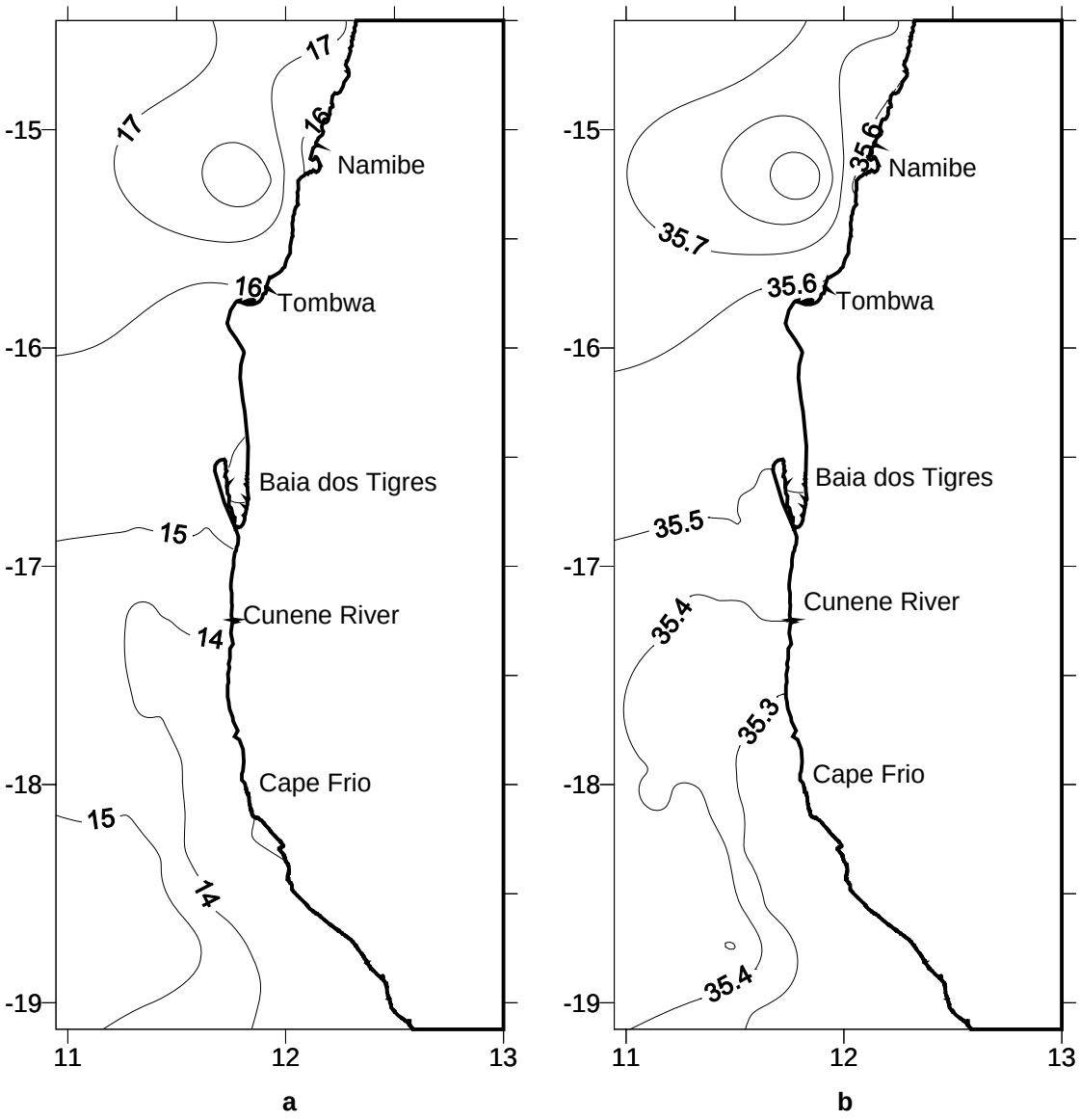


Figure 6. Sea surface temperature (SST ºC) (a) and sea surface salinity (SSS) (b) recorded in the transboundary area using the thermosalinograph.

5 Conclusion and recommendations

The results clearly show the transboundary nature of the fish resources studied. The results also strongly support the recent reports of alarmingly low abundance levels of Cunene horse mackerel and sardine.

The main conclusions from the survey can be summarized as:

1) Cunene horse mackerel was found as far south as Cape Frio (19º00' S), but the densities found south of the Angolan-Namibian border were too low to substantiate any kind of biomass estimation. The biomass of Cunene horse mackerel in Angola was 44 000 tons.
2) Cape horse mackerel were found in significant amounts throughout the transboundary area. The biomass was 253 000 tons (64 %) in Angolan waters and 140 000 in Namibian waters (36 %), *i.e*. 393 000 tons in total.
3) Scattered individuals of sardine (pilchard) were found in some of the samples on both sides of the border during the high-density search grid for clupeids, but no aggregations of sardine were recorded, neither acoustically nor with the sampling gear (pelagic sample trawls). Any sizeable aggregation in this area would almost certainly have been discovered during such an intensive surveying exercise and it is therefore concluded that no sizeable aggregations of sardine were present in Angola or the transboundary area at the time of the survey.
4) Other clupeid species (round herring and anchovy) were only found in scattered, low-density aggregations insufficient to produce any estimates of abundance.
5) All target species found were small in size. Both horse mackerel species were less than 25 cm, and the little that was found of various clupeids were generally of small size groups.

The main recommendations are:

1) The survey should be repeated at the same time of the year in order to establish whether the observed pattern is persistent over time and to monitor development trends in the transboundary area over time, if any.
2) The investigation should also be conducted in the warm season. The distribution pattern of all species under investigation here will likely be quite different in the alternate season. Horse mackerel distributions over the transboundary area generally

follow the position of the Angolan-Benguelan front (ABF), i.e. both species have more southern distribution in the warm season. This will, in turn lead to expectations of more Cunene horse mackerel in Namibian waters and less Cape horse mackerel in Angolan waters during summer.

3) The two countries involved should consider cooperating on continuing to monitor the transboundary area and to coordinate management of the fish resources there; all stocks under study here are to some extent transboundary and most stocks are in low abundance. Only fish smaller than 25 cm were found throughout the transboundary area and Cape horse mackerel were predominantly less than 15 cm.

6 References

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Annex I Records of fishing stations

PROJECT STATION:3855
DATE: 9/ 8/05 GEAR TYPE: BT No:14 POSITION:Lat S 1604
start stop duration Long E 1147
TIME :13:11:20 13:21:14 10 (min) Purpose code: 1
LOG :3920.48 3921.00 0.51 Area code : 1
FDEPTH: 26 25 GearCond.code:
BDEPTH: 26 25 Validity code:
Towing dir: 2ø Wire out: 140 m Speed: 30 kn*10

Sorted: 238 Kg Total catch: 2975.97 CATCH/HOUR: 17855.82

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	9954.00	211950	55.75	8196
JELLYFISH	7524.00	118200	42.14	
Atractoscion aequidens	203.22	1428	1.14	
Dicologoglossa cuneata	116.22	5730	0.65	
Rhinobatos albomaculatus	26.22	78	0.15	
Trichiurus lepturus	14.22	528	0.08	
Umbrina canariensis	9.00	300	0.05	
Sardinops ocellatus	6.72	150	0.04	
Raja miraletus	2.22	78	0.01	
Total	17855.82		100.01	

PROJECT STATION:3856
DATE: 9/ 8/05 GEAR TYPE: 0T No:14 POSITION:Lat S 1614
start stop duration Long E 1140
TIME :22:34:26 22:41:44 7 (min) Purpose code: 1
LOG :3964.82 3965.17 0.34 Area code : 1
FDEPTH: 60 60 GearCond.code:
BDEPTH: 60 60 Validity code:
Towing dir: 355ø Wire out: 200 m Speed: 30 kn*10

Sorted: 65 Kg Total catch: 1846.53 CATCH/HOUR: 15827.40

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis, juvenile	15365.57	850114	97.08	8197
Dentex macrophthalmus Juv.	346.89	29803	2.19	8198
Sepia orbignyana	92.83	1714	0.59	
Serranus accraensis	7.37	489	0.05	
Trigla lyra	7.37	489	0.05	
Dicologoglossa cuneata	7.37	249	0.05	
Total	15827.40		100.01	

PROJECT STATION:3857
DATE:10/ 8/05 GEAR TYPE: BT No:14 POSITION:Lat S 1619
start stop duration Long E 1139
TIME :01:53:56 02:03:40 10 (min) Purpose code: 1
LOG :3986.45 3986.91 0.46 Area code : 1
FDEPTH: 73 70 GearCond.code:
BDEPTH: 73 70 Validity code:
Towing dir: 90ø Wire out: 245 m Speed: 30 kn*10

Sorted: 206 Kg Total catch: 4123.00 CATCH/HOUR: 24738.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis, juvenile	23832.00	1839972	96.34	8199
Dentex macrophthalmus Juv.	273.60	28548	1.11	8200
Dicologoglossa cuneata	202.80	12360	0.82	
Mustelus mustelus	162.00	240	0.65	
Merluccius polli, juveniles	136.80	840	0.55	
Sepia orbignyana	44.40	360	0.18	
Atractoscion aequidens	34.80	240	0.14	
Diaphus dumerili	21.60	7680	0.09	
Trachurus trecae	18.00	360	0.07	
Chelidonichthys capensis	10.80	240	0.04	
Serranus accraensis	1.20	120		
Total	24738.00		99.99	

PROJECT STATION:3858
DATE:10/ 8/05 GEAR TYPE: BT No:14 POSITION:Lat S 1625
start stop duration Long E 1139
TIME :05:47:00 05:54:06 7 (min) Purpose code: 1
LOG :4020.00 4020.33 0.32 Area code : 1
FDEPTH: 79 80 GearCond.code:
BDEPTH: 79 80 Validity code:
Towing dir: 270ø Wire out: 245 m Speed: 30 kn*10

Sorted: 51 Kg Total catch: 253.70 CATCH/HOUR: 2174.57

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis, juvenile	1861.89	162900	85.62	8202
Trachurus trecae	235.71	5786	10.84	8203
Merluccius capensis	27.00	129	1.24	
Dentex macrophthalmus	26.14	1286	1.20	8201
Monolene microstoma	11.57	514	0.53	
Calappa sp.	9.00	386	0.41	
GOBIIDAE	3.00	1629	0.14	
Chelidonichthys capensis	0.43	86	0.02	
Total	2174.74		100.00	

PROJECT STATION:3859
DATE:10/ 8/05 GEAR TYPE: BT No:14 POSITION:Lat S 1644
start stop duration Long E 1147
TIME :14:21:49 14:33:07 11 (min) Purpose code: 1
LOG :4067.93 4068.55 0.60 Area code : 1
FDEPTH: 15 16 GearCond.code:
BDEPTH: 15 16 Validity code:
Towing dir: 322ø Wire out: 100 m Speed: 30 kn*10

Sorted: 148 Kg Total catch: 888.24 CATCH/HOUR: 4844.95

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
MISCELLANEOUS	3471.05		71.64	
Trachurus trecae, juvenile	968.73	16331	19.99	8204
Dicologoglossa cuneata	110.62	4615	2.28	
Arius parkii	79.85	164	1.65	
Callorhinchus capensis	76.58	33	1.58	
Trichiurus lepturus	69.05	2520	1.43	
Atractoscion aequidens	49.09	753	1.01	
Sepia orbignyana	17.67	229	0.36	
Umbrina canariensis	2.29	164	0.05	
Total	4844.93		99.99	

PROJECT STATION:3860
DATE:10/ 8/05 GEAR TYPE: PT No: 7 POSITION:Lat S 1637
start stop duration Long E 1145
TIME :17:52:55 18:12:41 20 (min) Purpose code: 1
LOG :4086.28 4087.46 1.17 Area code : 1
FDEPTH: 10 10 GearCond.code:
BDEPTH: 24 25 Validity code:
Towing dir: 357ø Wire out: 140 m Speed: 34 kn*10

Sorted: Kg Total catch: 25.36 CATCH/HOUR: 76.08

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
J E L L Y F I S H	71.10	723	93.45	
Trachurus capensis, juvenile	2.01	258	2.64	8207
Engraulis encrasicolus	1.83	219	2.41	8205
Trachurus trecae, juvenile	1.14	168	1.50	8206
Total	76.08		100.00	

PROJECT STATION:3861
DATE:27/ 7/03 GEAR TYPE: PT No: 7 POSITION:Lat S 818
start stop duration Long E 1318
TIME :07:05:14 07:16:30 11 (min) Purpose code: 1
LOG :4910.08 4910.52 0.14 Area code : 1
FDEPTH: 0 0 GearCond.code:
BDEPTH: 24 24 Validity code: 1
Towing dir: 155ø Wire out: 50 m Speed: 20 kn*10

Sorted: 36 Kg Total catch: 356.50 CATCH/HOUR: 1944.55

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis, juvenile	1577.45	248236	81.12	8208
JELLYFISH	208.36	3327	10.72	
Etrumeus whiteheadi	158.73	9000	8.16	8209
Total	1944.54		100.00	

PROJECT STATION:3862
DATE:11/ 8/05 GEAR TYPE: PT No: 1 POSITION:Lat S 1643
start stop duration Long E 1139
TIME :08:08:08 08:15:36 7 (min) Purpose code: 1
LOG :4170.75 4171.21 0.45 Area code : 1
FDEPTH: 30 30 GearCond.code:
BDEPTH: 60 62 Validity code:
Towing dir: 340ø Wire out: 130 m Speed: 34 kn*10

Sorted: 65 Kg Total catch: 719.73 CATCH/HOUR: 6169.11

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis, juvenile	5721.26	667449	92.74	8210
Etrumeus whiteheadi	318.69	11786	5.17	8211
JELLYFISH	129.17		2.09	
Total	6169.12		100.00	

PROJECT STATION:3863
DATE:17/ 9/10 GEAR TYPE: BT No:15 POSITION:Lat S 1643
start stop duration Long E 1121
TIME :11:12:30 11:22:32 10 (min) Purpose code: 1
LOG :4196.18 4196.68 0.50 Area code : 1
FDEPTH: 140 140 GearCond.code:
BDEPTH: 140 140 Validity code:
Towing dir: 360ø Wire out: 400 m Speed: 35 kn*10

Sorted: 199 Kg Total catch: 2495.36 CATCH/HOUR: 14972.16

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis, juvenile	14148.00	548802	94.50	8212
Dentex macrophthalmus	315.00	2250	2.10	8213
Etrumeus whiteheadi	165.00	2928	1.10	
Zeus faber	66.78	300	0.45	
Pterothrissus belloci	54.78	528	0.37	
Merluccius polli	43.50	150	0.29	
Zenopsis conchifer	43.50	300	0.29	
Scorpaena normani	38.40	450	0.26	
Mustelus mustelus	34.20	6	0.23	
Trigla lyra	19.50	150	0.13	
Squalus megalops	18.00	30	0.12	
Sepia orbignyana	16.50	78	0.11	
Monolene microstoma	9.00	300	0.06	
Total	14972.16		100.0	

PROJECT STATION:3864
DATE:11/ 8/05 GEAR TYPE: PT No: 7 POSITION:Lat S 1636
start stop duration Long E 1145
TIME :16:44:15 17:19:01 35 (min) Purpose code: 1
LOG :4249.17 4251.58 2.40 Area code : 1
FDEPTH: 1 1 GearCond.code:
BDEPTH: 25 24 Validity code:
Towing dir: 358ø Wire out: 150 m Speed: 40 kn*10

Sorted: 62 Kg Total catch: 62.59 CATCH/HOUR: 107.30

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
J E L L Y F I S H	106.97	1565	99.69	
Trachurus capensis, juvenile	0.24	45	0.22	8214
Trachurus trecae, juvenile	0.09	9	0.08	8215
Total	107.30		99.99	

PROJECT STATION:3865
DATE:11/ 8/05 GEAR TYPE: PT No: 4 POSITION:Lat S 1631
start stop duration Long E 1144
TIME :18:04:09 18:26:37 22 (min) Purpose code: 1
LOG :4254.73 4256.19 1.36 Area code : 1
FDEPTH: 1 1 GearCond.code:
BDEPTH: 29 52 Validity code:
Towing dir: 335ø Wire out: 150 m Speed: 40 kn*10

Sorted: 36 Kg Total catch: 431.28 CATCH/HOUR: 1176.22

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae, juvenile	416.29	54251	35.39	8217
J E L L Y F I S H	333.16	4582	28.32	
Trachurus capensis, juvenile	332.51	41793	28.27	8216
Etrumeus whiteheadi	89.35	4876	7.60	8218
Engraulis encrasicolus	4.91	785	0.42	8219
Total	1176.22		100.00	

PROJECT STATION:3866
DATE:11/ 8/05 GEAR TYPE: PT No: 2 POSITION:Lat S 1649
start stop duration Long E 1124
TIME :23:39:17 23:59:21 20 (min) Purpose code: 1
LOG :4298.47 4299.54 1.07 Area code : 1
FDEPTH: 100 100 GearCond.code:
BDEPTH: 128 127 Validity code:
Towing dir: 360ø Wire out: m Speed: kn*10

Sorted: 19 Kg Total catch: 18.62 CATCH/HOUR: 55.86

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis, juvenile	29.46	1782	52.74	8220
Etrumeus whiteheadi	13.38	321	23.95	8221
Chelidonichthys capensis	9.84	9	17.62	
Trigla lyra	3.24	33	5.80	
Total	55.92		100.11	

PROJECT STATION:3867
DATE:12/ 8/05 GEAR TYPE: PT No: 2 POSITION:Lat S 1648
start stop duration Long E 1124
TIME :00:04:59 00:24:38 20 (min) Purpose code: 1
LOG :4299.81 4300.93 1.11 Area code : 1
FDEPTH: 50 50 GearCond.code:
BDEPTH: 128 128 Validity code:
Towing dir: 360ø Wire out: 160 m Speed: 40 kn*10

Sorted: Kg Total catch: 0.31 CATCH/HOUR: 0.93

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Centrolophus niger	0.90	3	96.77	
Pteroscion peli	0.03	36	3.23	
Total	0.93		100.00	

PROJECT STATION:3868
DATE:12/ 8/05 GEAR TYPE: BT No:15 POSITION:Lat S 1650
start stop duration Long E 1118
TIME :02:09:43 02:37:03 27 (min) Purpose code: 1
LOG :4311.71 4313.11 1.38 Area code : 1
FDEPTH: 353 362 GearCond.code:
BDEPTH: 353 362 Validity code:
Towing dir: 360ø Wire out:1000 m Speed: 30 kn*10

Sorted: 32 Kg Total catch: 1617.50 CATCH/HOUR: 3594.44

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Merluccius capensis	1355.56	2556	37.71	8222
Scorpaena normani	1184.44	164000	32.95	
Nematocarcinus africanus	238.89	184556	6.65	
Pterothrissus belloci	234.44	1333	6.52	
Aristeus varidens	217.78	2667	6.06	
Hoplostethus cadenati	125.56	5556	3.49	
Gadella imberbis	102.22	1889	2.84	
Chlorophthalmus atlanticus	76.67	2222	2.13	
Dentex macrophthalmus	35.56	111	0.99	
MARME03	23.33	667	0.65	
Total	3594.45		99.99	

PROJECT STATION:3869
DATE:12/ 8/05 GEAR TYPE: BT No:15 POSITION:Lat S 1700
start stop duration Long E 1140
TIME :08:11:58 08:30:29 19 (min) Purpose code: 1
LOG :4357.04 4357.97 0.49 Area code : 1
FDEPTH: 57 57 GearCond.code:
BDEPTH: 57 57 Validity code:
Towing dir: 350ø Wire out: 200 m Speed: 30 kn*10

Sorted: 65 Kg Total catch: 293.67 CATCH/HOUR: 927.38

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
J E L L Y F I S H	371.46	60	40.05	
Trachurus trecae, juvenile	250.67	7775	27.03	8223
Engraulis encrasicolus	108.85	6666	11.74	8225
Dicologoglossa cuneata	98.05	12322	10.57	
Trachurus capensis, juvenile	91.52	6041	9.87	8224
Maja squinado	5.12	512	0.55	
Atractoscion aequidens	1.26	16	0.14	
Trichiurus lepturus	0.41	28	0.04	
Total	927.34		99.99	

PROJECT STATION:3870
DATE:12/ 8/05 GEAR TYPE: BT No:15 POSITION:Lat S 1701
start stop duration Long E 1120
TIME :11:25:36 11:34:19 9 (min) Purpose code: 1
LOG :4380.46 4380.90 0.44 Area code : 1
FDEPTH: 159 158 GearCond.code:
BDEPTH: 159 158 Validity code:
Towing dir: 360ø Wire out: 515 m Speed: 30 kn*10

Sorted: 95 Kg Total catch: 1357.44 CATCH/HOUR: 9049.60

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis, juvenile	5931.60	207733	65.55	8226
Dentex macrophthalmus	2074.40	14300	22.92	8227
Merluccius capensis	266.93	1713	2.95	8228
Scorpaena normani	241.13	2193	2.66	
J E L L Y F I S H	239.27	8007	2.64	
Dentex angolensis	112.47	193	1.24	
Cynoglossus capensis	97.20	12300	1.07	
Pterothrissus belloci	20.00	380	0.22	
Zeus faber	20.00	287	0.22	
Umbrina canariensis	18.07	93	0.20	
Dicologoglossa cuneata	10.47	2480	0.12	
Trigla lyra	9.53	287	0.11	
Bothus podas africanus	7.60	193	0.08	
Chlorophthalmus atlanticus	0.93	193	0.01	
Total	9049.60		99.99	

PROJECT STATION:3871
DATE:12/ 8/05 GEAR TYPE: PT No: 1 POSITION:Lat S 1707
start stop duration Long E 1119
TIME :13:28:12 13:58:19 30 (min) Purpose code: 1
LOG :4395.29 4397.05 1.75 Area code : 1
FDEPTH: 200 200 GearCond.code:
BDEPTH: 441 387 Validity code:
Towing dir: 360ø Wire out: 600 m Speed: 40 kn*10

Sorted: 134 Kg Total catch: 133.54 CATCH/HOUR: 267.08

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
J E L L Y F I S H	146.96	3010	55.02	
Trachurus capensis, juvenile	120.12	2458	44.98	8229
Total	267.08		100.00	

PROJECT STATION:3872
DATE:12/ 8/05 GEAR TYPE: BT No:15 POSITION:Lat S 1707
start stop duration Long E 1129
TIME :16:06:34 16:16:13 10 (min) Purpose code: 1
LOG :4413.55 4414.08 0.54 Area code : 1
FDEPTH: 129 127 GearCond.code:
BDEPTH: 129 127 Validity code:
Towing dir: 360ø Wire out: 325 m Speed: 30 kn*10

Sorted: 132 Kg Total catch: 785.40 CATCH/HOUR: 4712.40

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis, juvenile	4005.36	176484	85.00	8230
Dentex macrophthalmus	385.92	2988	8.19	8231
Merluccius capensis	231.12	1404	4.90	8232
Synagrops microlepis	34.20	5220	0.73	
Trigla lyra	21.24	108	0.45	
Zeus faber	19.08	72	0.40	
Saurida brasiliensis	15.48	540	0.33	
Total	4712.40		100.00	

PROJECT STATION:3873
DATE:13/ 8/05 GEAR TYPE: PT No: 1 POSITION:Lat S 1713
start stop duration Long E 1130
TIME :23:52:20 00:22:22 30 (min) Purpose code: 1
LOG :4455.03 4456.84 1.81 Area code : 1
FDEPTH: 100 100 GearCond.code:
BDEPTH: 140 135 Validity code:
Towing dir: 360ø Wire out: 300 m Speed: 40 kn*10

Sorted: Kg Total catch: 160.78 CATCH/HOUR: 321.56

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
J E L L Y F I S H	295.20	5496	91.80	
Trachurus capensis, juvenile	26.36	1582	8.20	8233
Total	321.56		100.00	

PROJECT STATION:3874

DATE:13/ 8/05 GEAR TYPE: BT No:15 POSITION:Lat S 1727
start stop duration Long E 1132
TIME :15:26:38 15:27:48 1 (min) Purpose code: 1
LOG :4568.73 4568.74 0.01 Area code : 5
FDEPTH: 147 147 GearCond.code:
BDEPTH: 147 147 Validity code:
Towing dir: 360ø Wire out: m Speed: kn*10

Sorted: 183 Kg Total catch: 183.88 CATCH/HOUR: 11032.80

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea aequorea	7597.80	90960	68.87	
Chrysaora hysoscella	2700.60	9480	24.48	
Trachurus capensis, juvenile	717.60	19740	6.50	8234
Merluccius capensis	15.00	120	0.14	
Dentex macrophthalmus	1.80	60	0.02	
Total	11032.80		100.01	

PROJECT STATION:3875

DATE:13/ 8/05 GEAR TYPE: PT No: 1 POSITION:Lat S 1727
start stop duration Long E 1109
TIME :18:51:37 19:36:14 45 (min) Purpose code: 1
LOG :4598.22 4600.99 2.76 Area code : 5
FDEPTH: 200 100 GearCond.code:
BDEPTH: 1058 841 Validity code:
Towing dir: 90ø Wire out: 700 m Speed: 40 kn*10

Sorted: 7 Kg Total catch: 7.02 CATCH/HOUR: 9.36

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
ALEPOCEPHALIDAE	3.68	392	39.32	
OPLOPHORIDAE	1.57	996	16.77	
Gonostoma elongatum	0.84	75	8.97	
TRACHICHTHYIDAE	0.80	3	8.55	
MISCELLANEOUS	0.76		8.12	
MYCTOPHIDAE	0.32	120	3.42	
Nemichthys scolopaceus	0.32	84	3.42	
Argyropelecus affinis	0.28	101	2.99	
Schedophilus huttoni	0.21	1	2.24	
OCTOPOTEUTHIDAE	0.15	4	1.60	
Trachurus capensis	0.12	1	1.28	
CARISTIIDAE	0.07	3	0.75	
BATHYLAGIDAE	0.05	11	0.53	
LYCOTEUTHIDAE	0.05	4	0.53	
Hoplostethus cadenati	0.05	1	0.53	
MELANOCETIDAE	0.03	7	0.32	
OMMASTREPHIDAE	0.01	3	0.11	
PARALEPIDIDAE	0.01	1	0.11	
Illex coindetii	0.01	5	0.11	
Bregmaceros atlanticus	0.01	3	0.11	
Total	9.34		99.78	

PROJECT STATION:3876

DATE:14/ 8/05 GEAR TYPE: PT No: 1 POSITION:Lat S 1746
start stop duration Long E 1122
TIME :09:53:12 10:21:29 28 (min) Purpose code: 1
LOG :4732.37 4734.27 1.90 Area code : 5
FDEPTH: 200 225 GearCond.code:
BDEPTH: 309 391 Validity code:
Towing dir: 333ø Wire out: 800 m Speed: 40 kn*10

Sorted: 7 Kg Total catch: 6.78 CATCH/HOUR: 14.53

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
J E L L Y F I S H	4.65	58	32.00	
Trachipterus sp.	3.75	4	25.81	
MYCTOPHIDAE	2.55	1513	17.55	
Trachurus capensis	1.67	21	11.49	8235
PARALEPIDIDAE	1.03	75	7.09	
Yarrella blackfordi	0.51	58	3.51	
Nemichthys scolopaceus	0.36	133	2.48	
Total	14.52		99.93	

PROJECT STATION:3877

DATE:14/ 8/05 GEAR TYPE: BT No:15 POSITION:Lat S 1746
start stop duration Long E 1133
TIME :12:37:41 12:41:50 4 (min) Purpose code: 1
LOG :4750.69 4750.92 0.22 Area code : 5
FDEPTH: 165 167 GearCond.code:
BDEPTH: 165 167 Validity code:
Towing dir: 360ø Wire out: 510 m Speed: 30 kn*10

Sorted: 57 Kg Total catch: 170.63 CATCH/HOUR: 2559.45

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
J E L L Y F I S H	1083.15	37305	42.32	
Trachurus capensis	1083.15	27000	42.32	8236
Merluccius capensis	195.60	795	7.64	8237
Chrysaora hysoscella	94.50	225	3.69	
Dentex macrophthalmus	61.65	585	2.41	
Synagrops microlepis	22.05	5625	0.86	
Chlorophthalmus atlanticus	8.55	720	0.33	
Sufflogobius bibarbatus	7.65	540	0.30	
Pterothrissus belloci	2.25	45	0.09	
Dicologoglossa cuneata	0.90	45	0.04	
Total	2559.45		100.00	

PROJECT STATION:3878

DATE:15/ 8/05 GEAR TYPE: PT No: 1 POSITION:Lat S 1800
start stop duration Long E 1141
TIME :03:49:11 03:53:40 4 (min) Purpose code: 1
LOG :4854.30 4854.58 0.28 Area code : 5
FDEPTH: 90 90 GearCond.code:
BDEPTH: 117 118 Validity code:
Towing dir: 340ø Wire out: 270 m Speed: 45 kn*10

Sorted: 97 Kg Total catch: 97.05 CATCH/HOUR: 1455.75

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Chrysaora hysoscella	1072.20	11235	73.65	
Trachurus capensis, juvenile	296.40	15300	20.36	8238
Aequorea aequorea	73.80	1605	5.07	
Merluccius capensis	8.85	15	0.61	
Sufflogobius bibarbatus	2.85	30	0.20	
PARALEPIDIDAE	1.65	45	0.11	
Total	1455.75		100.00	

PROJECT STATION:3879

DATE:15/ 8/05 GEAR TYPE: BT No:15 POSITION:Lat S 1808
start stop duration Long E 1144
TIME :08:13:58 08:18:16 4 (min) Purpose code: 1
LOG :4877.66 4877.88 0.22 Area code : 5
FDEPTH: 98 99 GearCond.code:
BDEPTH: 98 99 Validity code:
Towing dir: 333ø Wire out: 300 m Speed: 30 kn*10

Sorted: 66 Kg Total catch: 232.61 CATCH/HOUR: 3489.15

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis	1644.30	81855	47.13	8239
Chrysaora hysoscella	990.15	4260	28.38	
Merluccius capensis	86.10	735	2.47	8240
Aequorea aequorea	30.40	9320	0.87	
Pterothrissus belloci	18.90	375	0.54	
Sufflogobius bibarbatus	6.30	1845	0.18	
Total	2776.15		79.57	

PROJECT STATION:3880

DATE:15/ 8/05 GEAR TYPE: BT No:15 POSITION:Lat S 1817
start stop duration Long E 1138
TIME :16:11:00 16:13:55 3 (min) Purpose code: 1
LOG :4937.92 4938.08 0.16 Area code : 5
FDEPTH: 156 157 GearCond.code:
BDEPTH: 156 157 Validity code:
Towing dir: 350ø Wire out: 490 m Speed: 30 kn*10

Sorted: 175 Kg Total catch: 350.08 CATCH/HOUR: 7001.60

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea aequorea	3080.00	76200	43.99	
Chrysaora hysoscella	1732.00	8200	24.74	
Trachurus capensis	1526.40	31220	21.80	8241
Merluccius capensis	421.60	2160	6.02	8242
Dentex macrophthalmus	177.20	1640	2.53	8243
Synagrops microlepis	30.40	9320	0.43	
Sufflogobius bibarbatus	28.00	11080	0.40	
Pterothrissus belloci	5.60	280	0.08	
Calappa rubroguttata	0.40	280	0.01	
Total	7001.60		100.00	

PROJECT STATION:3881

DATE:16/ 8/05 GEAR TYPE: BT No:15 POSITION:Lat S 1832
start stop duration Long E 1201
TIME :09:28:16 09:34:01 6 (min) Purpose code: 1
LOG :5050.53 5050.78 0.25 Area code : 5
FDEPTH: 44 46 GearCond.code:
BDEPTH: 44 46 Validity code:
Towing dir: 333ø Wire out: 150 m Speed: 30 kn*10

Sorted: 60 Kg Total catch: 182.58 CATCH/HOUR: 1825.80

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis, juvenile	1160.40	127830	63.56	8244
Chrysaora hysoscella	591.60	5130	32.40	
Dicologoglossa cuneata	52.50	2400	2.88	
Chelidonichthys gabonensis	18.60	30	1.02	
Calappa sp.	2.10	60	0.12	
Pterothrissus belloci	0.60	20	0.03	
Total	1825.80		100.01	

PROJECT STATION:3882

DATE:16/ 8/05 GEAR TYPE: BT No:15 POSITION:Lat S 1845
start stop duration Long E 1131
TIME :13:54:51 14:05:12 10 (min) Purpose code: 1
LOG :5089.74 5090.29 0.54 Area code : 1
FDEPTH: 257 257 GearCond.code:
BDEPTH: 257 257 Validity code:
Towing dir: 345ø Wire out: 767 m Speed: 30 kn*10

Sorted: 56 Kg Total catch: 588.85 CATCH/HOUR: 3533.10

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Merluccius capensis	2502.36	8316	70.83	8245
Dentex macrophthalmus	509.04	2646	14.41	8246
Pterothrissus belloci	281.58	2772	7.97	
Chlorophthalmus atlanticus	56.04	3342	1.59	
PORTUNIDAE	40.32	2712	1.14	
Helicolenus dactylopterus	37.80	2394	1.07	
Synagrops microlepis	34.80	4476	0.98	
Schedophilus pemarco	24.54	66	0.69	
Galeus polli	18.90	318	0.53	
Sufflogobius bibarbatus	17.64	5922	0.50	
Lophius vomerinus	10.08	192	0.29	
Total	3533.10		100.00	

PROJECT STATION:3883

DATE:16/ 8/05 GEAR TYPE: PT No: 1 POSITION:Lat S 1845
start stop duration Long E 1132
TIME :15:39:39 16:00:51 21 (min) Purpose code: 1
LOG :5097.46 5098.80 1.33 Area code : 5
FDEPTH: 250 240 GearCond.code:
BDEPTH: 255 254 Validity code:
Towing dir: 345ø Wire out: 737 m Speed: 40 kn*10

Sorted: 24 Kg Total catch: 23.85 CATCH/HOUR: 68.14

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
MYCTOPHIDAE	51.11	25174	75.01	
Aequorea aequorea	14.29	326	20.97	
Chrysaora hysoscella	2.31	14	3.39	
Dentex macrophthalmus	0.43	3	0.63	
Total	68.14		100.00	

PROJECT STATION:3884

DATE:16/ 8/05 GEAR TYPE: PT No: 1 POSITION:Lat S 1854
start stop duration Long E 1132
TIME :20:53:31 21:12:00 18 (min) Purpose code: 1
LOG :5135.67 5136.87 1.20 Area code : 5
FDEPTH: 250 30 GearCond.code:
BDEPTH: 271 271 Validity code:
Towing dir: 170ø Wire out: 150 m Speed: 40 kn*10

Sorted: 75 Kg Total catch: 75.20 CATCH/HOUR: 250.67

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
MYCTOPHIDAE	220.80	218040	88.08	
Brama brama	16.00	13	6.38	
Chrysaora hysoscella	13.60	80	5.43	
PARALEPIDIDAE	0.27	93	0.11	
Total	250.67		100.00	

PROJECT STATION:3885

DATE:17/ 8/05 GEAR TYPE: PT No: 1 POSITION:Lat S 1903
start stop duration Long E 1136
TIME :11:36:53 12:06:21 29 (min) Purpose code: 1
LOG :5236.31 5238.11 1.79 Area code : 5
FDEPTH: 150 140 GearCond.code:
BDEPTH: 282 286 Validity code:
Towing dir: 64ø Wire out: 450 m Speed: 35 kn*10

Sorted: 35 Kg Total catch: 69.32 CATCH/HOUR: 143.42

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea aequorea	106.10	3103	73.98	
MYCTOPHIDAE	31.12	24894	21.70	
Chrysaora hysoscella	6.21	21	4.33	
Total	143.43		100.01	

PROJECT STATION:3886

DATE:18/ 8/05 GEAR TYPE: BT No:15 POSITION:Lat S 1557
start stop duration Long E 1145
TIME :12:38:08 12:43:50 6 (min) Purpose code: 1
LOG :5478.45 5478.77 0.30 Area code : 1
FDEPTH: 21 22 GearCond.code:
BDEPTH: 21 22 Validity code:
Towing dir: 285ø Wire out: 100 m Speed: 32 kn*10

Sorted: 32 Kg Total catch: 347.27 CATCH/HOUR: 3472.70

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae, juvenile	3282.40	203170	94.52	8247
Arius parkii	83.60	110	2.41	
Mustelus mustelus	53.90	110	1.55	
Umbrina canariensis	15.40	440	0.44	
Dentex barnardi	9.90	220	0.29	
Pomadasys incisus	8.80	330	0.25	
Trichiurus lepturus	7.70	330	0.22	
Galeus polli	6.60	110	0.19	
Dicologoglossa cuneata	4.40	110	0.13	
Total	3472.70		100.00	

PROJECT STATION:3887

DATE:19/ 8/05 GEAR TYPE: BT No:15 POSITION:Lat S 1642
start stop duration Long E 1140
TIME :09:26:02 09:46:50 21 (min) Purpose code: 1
LOG :5685.13 5686.18 1.05 Area code : 1
FDEPTH: 37 40 GearCond.code:
BDEPTH: 37 40 Validity code:
Towing dir: 349ø Wire out: 140 m Speed: 30 kn*10

Sorted: 27 Kg Total catch: 162.66 CATCH/HOUR: 464.74

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	242.06	7646	52.09	8248
JELLYFISH	180.00	2451	38.73	
Umbrina canariensis	9.43	343	2.03	
Rhinobatos rhinobatos	8.40	17	1.81	
Sepia officinalis hierredda	7.54	17	1.62	
Engraulis encrasicolus	5.31	411	1.14	8251
Raja miraletus	4.63	17	1.00	
Loligo vulgaris	4.29	703	0.92	
Trachurus capensis, juvenile	2.06	240	0.44	8250
Sardinops ocellatus	1.03	11	0.22	8249
Total	464.75		100.00	

PROJECT STATION:3888

DATE:19/ 8/05 GEAR TYPE: PT No: 1 POSITION:Lat S 1653
start stop duration Long E 1139
TIME :19:35:22 19:53:27 18 (min) Purpose code: 1
LOG :5779.28 5780.56 1.28 Area code : 1
FDEPTH: 30 30 GearCond.code:
BDEPTH: 56 70 Validity code:
Towing dir: 260ø Wire out: 170 m Speed: 40 kn*10

Sorted: 75 Kg Total catch: 75.49 CATCH/HOUR: 251.63

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Chrysaora hysoscella	138.53	670	55.05	
Engraulis encrasicolus	82.33	19080	32.72	8252
Aequorea aequorea	17.13	133	6.81	
Trachurus capensis, juvenile	7.43	430	2.95	8253
Etrumeus whiteheadi	5.53	307	2.20	8255
Sardinops ocellatus	0.67	57	0.27	8254
Total	251.62		100.00	

PROJECT STATION:3889

DATE:20/ 8/05 GEAR TYPE: PT No: 1 POSITION:Lat S 1659
start stop duration Long E 1139
TIME :01:10:37 01:26:07 16 (min) Purpose code: 1
LOG :5830.54 5831.66 0.15 Area code : 1
FDEPTH: 15 14 GearCond.code:
BDEPTH: 60 70 Validity code:
Towing dir: 276ø Wire out: 100 m Speed: 45 kn*10

Sorted: 37 Kg Total catch: 73.60 CATCH/HOUR: 276.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Engraulis encrasicolus	207.90	18975	75.33	8257
Aequorea aequorea	34.58	473	12.53	
Chrysaora hysoscella	33.08	428	11.99	
Trachurus capensis	0.45	98	0.16	8256
Total	276.01		100.01	

PROJECT STATION:3890

DATE:20/ 8/05 GEAR TYPE: PT No: 1 POSITION:Lat S 1712
start stop duration Long E 1132
TIME :09:05:31 09:22:26 17 (min) Purpose code: 1
LOG :5909.11 5910.18 1.07 Area code : 1
FDEPTH: 50 50 GearCond.code:
BDEPTH: 120 129 Validity code:
Towing dir: 290ø Wire out: 200 m Speed: 40 kn*10

Sorted: 48 Kg Total catch: 47.50 CATCH/HOUR: 167.65

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea aequorea	109.91	198	65.56	
Etrumeus whiteheadi	56.89	646	33.93	8259
Sardinops ocellatus	0.46	11	0.27	8260
Trachurus capensis, juvenile	0.39	49	0.23	8258
Total	167.65		99.99	

PROJECT STATION:3891

DATE:20/ 8/05 GEAR TYPE: PT No: 1 POSITION:Lat S 1731
start stop duration Long E 1142
TIME :21:00:25 21:19:32 19 (min) Purpose code: 1
LOG :6026.07 6027.42 1.34 Area code : 1
FDEPTH: 30 30 GearCond.code:
BDEPTH: 59 82 Validity code:
Towing dir: 260ø Wire out: 160 m Speed: 40 kn*10

Sorted: 33 Kg Total catch: 33.19 CATCH/HOUR: 104.81

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
J E L L Y F I S H	72.25		68.93	
Etrumeus whiteheadi	14.43	714	13.77	8263
Trachurus capensis, juvenile	13.45	1427	12.83	8261
Trachurus trecae, juvenile	4.67	1197	4.46	8262
Total	104.80		99.99	

PROJECT STATION:3892

DATE:21/ 8/05 GEAR TYPE: PT No: 1 POSITION:Lat S 1743
start stop duration Long E 1144
TIME :03:21:03 03:21:20 9 (min) Purpose code: 1
LOG :6089.23 6089.83 0.61 Area code : 1
FDEPTH: 15 15 GearCond.code:
BDEPTH: 44 55 Validity code:
Towing dir: 274ø Wire out: 100 m Speed: 45 kn*10

Sorted: 38 Kg Total catch: 115.11 CATCH/HOUR: 767.40

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Etrumeus whiteheadi	531.60	42000	69.27	8266
Chrysaora hysoscella	189.60	2640	24.71	
Sardinops ocellatus	33.20	2260	4.33	8264
Trachurus capensis, juvenile	13.00	2680	1.69	8265
Total	767.40		100.00	

PROJECT STATION:3893

DATE:21/ 8/05 GEAR TYPE: PT No: 1 POSITION:Lat S 1749
start stop duration Long E 1145
TIME :06:41:22 06:41:36 6 (min) Purpose code: 1
LOG :6124.46 6124.95 0.48 Area code : 5
FDEPTH: 20 20 GearCond.code:
BDEPTH: 41 39 Validity code:
Towing dir: 160ø Wire out: 120 m Speed: 40 kn*10

Sorted: 77 Kg Total catch: 459.59 CATCH/HOUR: 4595.90

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Chrysaora hysoscella	2635.20	20340	57.34	
Etrumeus whiteheadi	882.00	60570	19.19	8273
Trachurus capensis, juvenile	746.40	128220	16.24	8275
Engraulis encrasicolus	298.80	15840	6.50	8274
Trachurus trecae, juvenile	31.20	7620	0.68	8271
Sardinops ocellatus	2.30	80	0.05	8272
Total	4595.90		100.00	

PROJECT STATION:3894

DATE:21/ 8/05 GEAR TYPE: BT No:15 POSITION:Lat S 1757
start stop duration Long E 1145
TIME :11:29:29 11:50:51 21 (min) Purpose code: 1
LOG :6157.05 6158.23 1.17 Area code : 5
FDEPTH: 55 56 GearCond.code:
BDEPTH: 55 56 Validity code:
Towing dir: 355ø Wire out: 140 m Speed: 40 kn*10

Sorted: 33 Kg Total catch: 65.42 CATCH/HOUR: 186.91

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis, juvenile	79.66	15320	42.62	8276
Chrysaora hysoscella	60.46	994	32.35	
Aequorea aequorea	37.31	920	19.96	
Etrumeus whiteheadi	8.57	829	4.59	8278
Trachurus trecae, juvenile	0.74	194	0.40	8277
Sardinops ocellatus	0.17	3	0.09	8279
Total	186.91		100.01	

PROJECT STATION:3895

DATE:21/ 8/05 GEAR TYPE: PT No: 1 POSITION:Lat S 1808
start stop duration Long E 1148
TIME :17:50:52 18:07:11 16 (min) Purpose code: 1
LOG :6215.43 6216.49 1.04 Area code : 5
FDEPTH: 20 20 GearCond.code:
BDEPTH: 52 51 Validity code:
Towing dir: 165ø Wire out: 120 m Speed: 40 kn*10

Sorted: 33 Kg Total catch: 68.65 CATCH/HOUR: 257.44

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
J E L L Y F I S H	161.25	3540	62.64	
Trachurus capensis, juvenile	69.30	11014	26.92	8267
Etrumeus whiteheadi	16.88	1778	6.56	8268
Chelidonichthys capensis	7.73	8	3.00	
Callorhinchus capensis	1.46	4	0.57	
Engraulis encrasicolus	0.75	75	0.29	8269
Trachurus trecae, juvenile	0.08	11	0.03	8270
Total	257.45		100.01	

PROJECT STATION:3896

DATE:22/ 8/05 GEAR TYPE: BT No:15 POSITION:Lat S 1850
start stop duration Long E 1217
TIME :08:46:02 08:57:26 11 (min) Purpose code: 1
LOG :6361.30 6361.86 0.55 Area code : 5
FDEPTH: 62 67 GearCond.code:
BDEPTH: 62 67 Validity code:
Towing dir: 256ø Wire out: 200 m Speed: 30 kn*10

Sorted: 56 Kg Total catch: 223.56 CATCH/HOUR: 1219.42

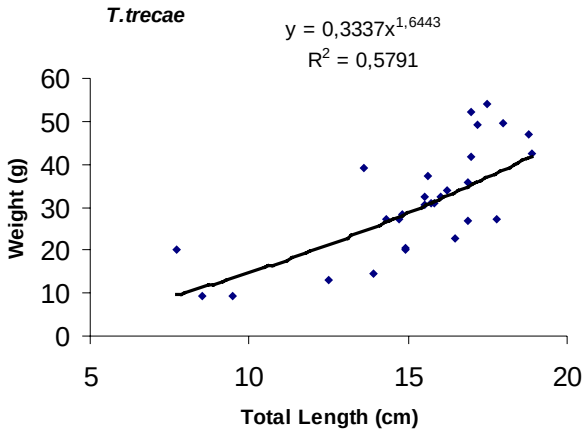
SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis	740.51	27284	60.73	8280
J E L L Y F I S H	228.65	2400	18.75	
Chelidonichthys capensis	108.87	240	8.93	
Myliobatis aquila	107.35	22	8.80	
Monolene microstoma	16.36	458	1.34	
Merluccius capensis	13.09	153	1.07	
Squalus megalops	3.49	22	0.29	
CONGRIDAE	1.09	305	0.09	
Total	1219.41		100.00	

Annex II Catch rates

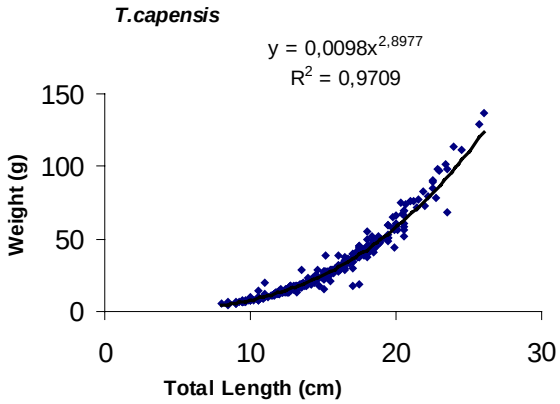
Station	Depth (m)	*T.trecae*	*T.capensis*	Sardinops	Anchovy	Round herring	Others	Total
3855	26	9 954,00		6,72			7 895,10	7 901,82
3856	60		15 365,57				461,83	15 827,40
3857	72	18,00	23 832,00				888,00	24 720,00
3858	80	235,71	1 861,89				77,14	1 939,03
3859	16	968,73					3 876,20	3 876,20
3860	10	1,14	2,01		1,83		71,10	74,94
3861	15		1 577,45			158,73	208,36	1 944,54
3862	30		5 721,26			318,69	129,17	6 169,12
3863	140		14 148,00			165,00	659,16	14 972,16
3864	1	0,09	0,24				106,97	107,21
3865	1	416,29	332,51		4,91	89,35	333,16	759,93
3866	100		29,46			13,38	13,08	55,92
3867	50						0,93	0,93
3868	358						3 594,45	3 594,45
3869	57	250,67	91,52		108,85		476,30	676,67
3870	159		5 931,60				3 118,00	9 049,60
3871	200		120,12				146,96	267,08
3872	128		4 005,36				707,04	4 712,40
3873	100		26,36				295,20	321,56
3874	147		717,60				10 315,20	11 032,80
3875	150		0,12				9,22	9,34
3876	213		1,67				12,85	14,52
3877	166		1 083,15				1 476,30	2 559,45
3878	90		296,40				1 159,35	1 455,75
3879	99		1 644,30				1 131,85	2 776,15
3880	157		1 526,40				5 475,20	7 001,60
3881	45		1 160,40				665,40	1 825,80
3882	257						3 533,10	3 533,10
3883	245						68,14	68,14
3884	140						250,67	250,67
3885	145						143,43	143,43
3886	22	3 282,40					190,30	190,30
3887	39	242,06	2,06	1,03	5,31		214,29	222,69
3888	30		7,43	0,67	82,33	5,53	155,66	251,62
3889	15		0,45		207,90		67,66	276,01
3890	50		0,39	0,46		56,89	109,91	167,65
3891	30	4,67	13,45			14,43	72,25	100,13
3892	15		13,00	33,20		531,60	189,60	767,40
3893	20	31,20	746,00	2,30	298,80	882,00	2 635,20	4 564,30
3894	56	0,74	79,66	0,17		8,57	97,77	186,17
3895	20	0,08	69,30		0,75	16,88	170,44	257,37
3896	65		740,51				478,90	1 219,41
Mean	90,93	366,80	1 932,09	1,06	16,92	53,83	1 230,50	3 234,40
STDEV		1 604,08	4 805,41	5,20	58,26	164,15	2 211,10	5 212,53
% Catch		11,34	59,74	0,03	0,52	1,66	38,04	

Annex III Length weight relationships, gonad maturity and Length distribution

(a)



(b)



(c)

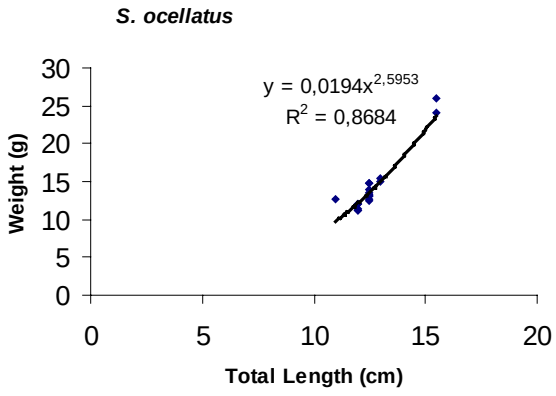


Figure 1.-Length-Weight relationship of *T. trecae* (a), *T. capensis* (b) and *S. ocellatus* (c).

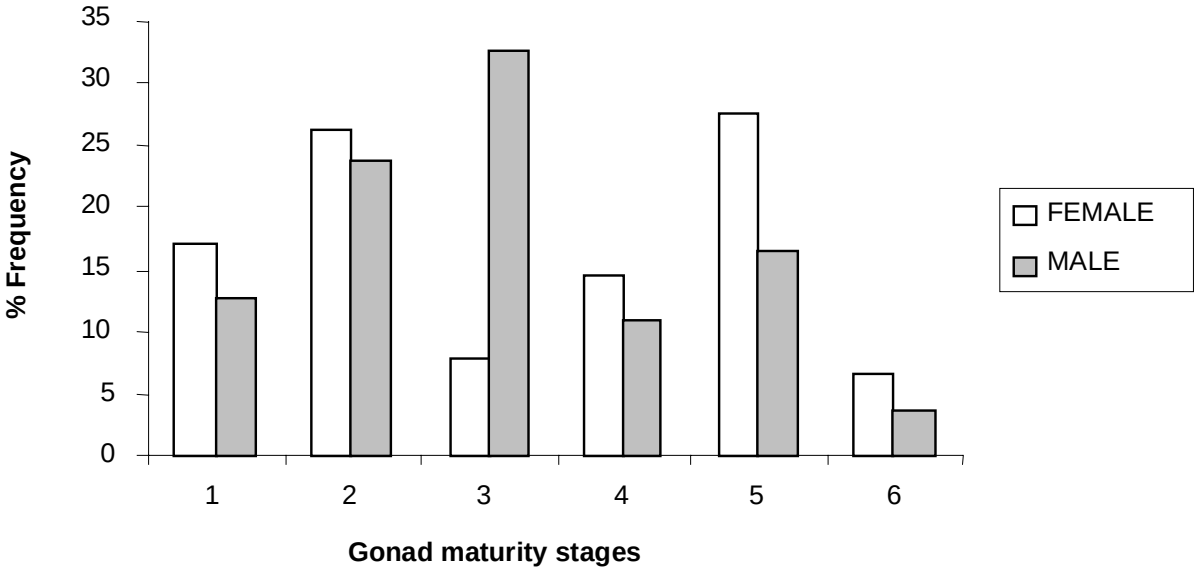
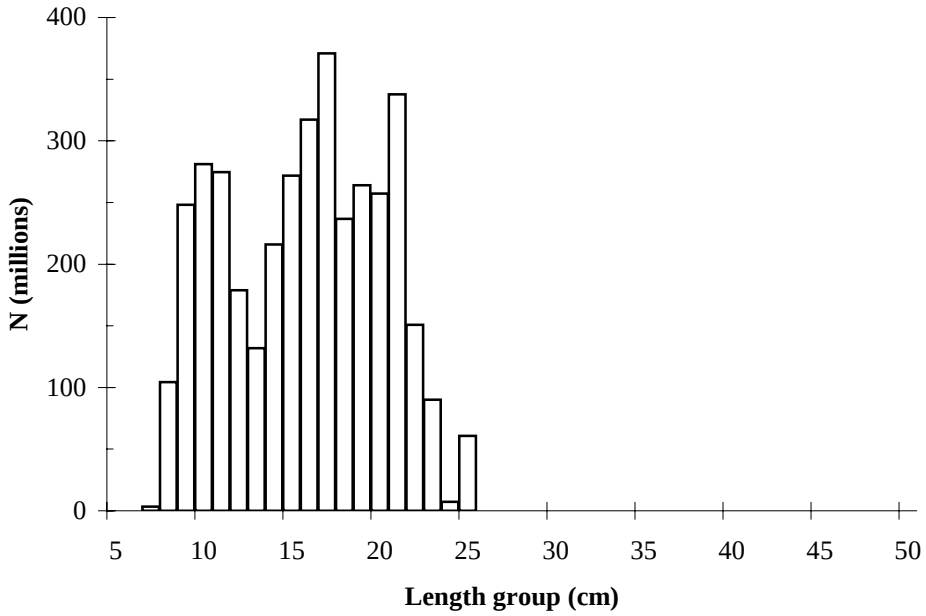


Figure 2.- Gonad maturity stages by sex of *T. capensis*.

(a)



(b)

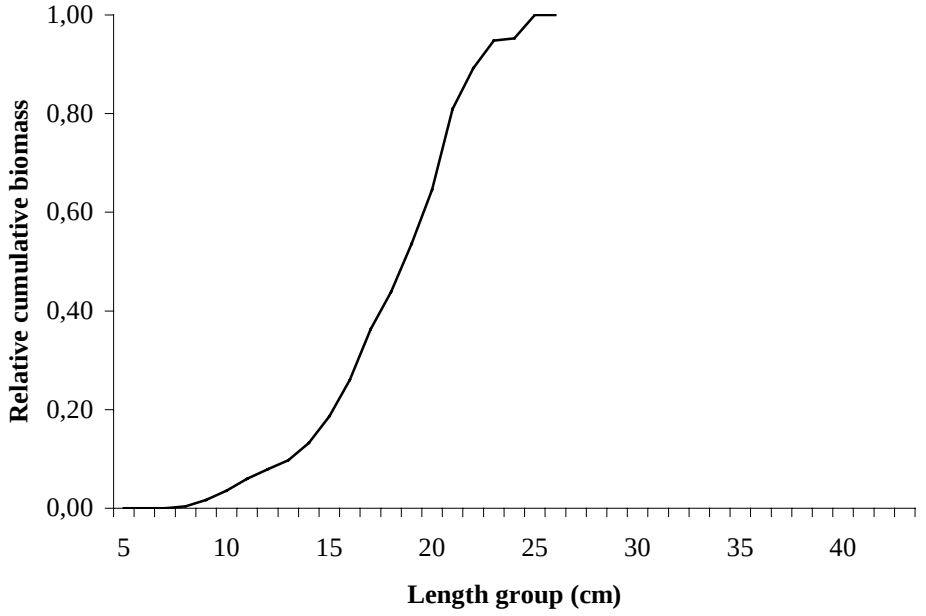


Figure 3.- Overall length distribution in numbers (a)) and relative cumulative biomass (b) of *T. capensis* in Namibia.

Annex IV Instruments and fishing gear

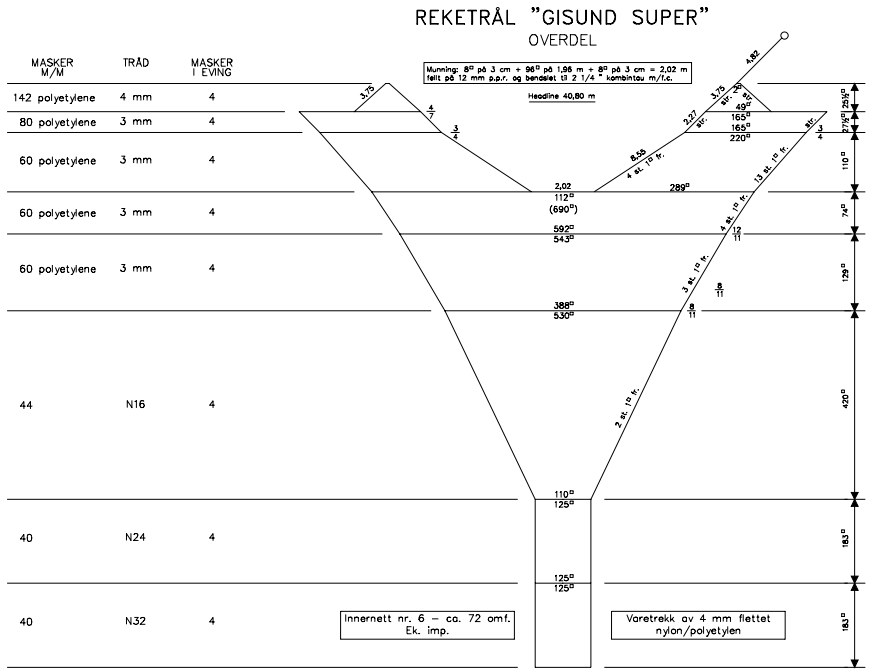
The Simrad EK-500, 38 kHz echo scientific sounder was used during the survey for fish abundance estimation, in addition data from the 18 kHz, 120 kHz and the 200 kHz transducers were logged for possible future multi frequency target estimation. The Bergen Echo Integrator system (BEI) logging the echogram raw data from the sounder, was used to scrutinize the acoustic records, and to allocate integrator data to fish species. All raw data were stored to tape, and a backup of the database of scrutinized data. The details of the settings of the 38 kHz were as follows:

Transceiver-1 menu	Transducer depth	5.5 m
	Absorption coeff.	10 dB/km
Pulse length	medium (1ms)	
	Bandwidth	wide
	Max power	2000 Watt
	2-way beam angle	-21.0 dB
	SV transducer gain	27.19 dB
	TS transducer gain	27.22 dB
	Angle sensitivity	21.9
	3 dB beamwidth along.	6.9°
	3 dB beamwidth athw.	6.8°
	Alongship offset	-0.01°
	Athwardship offset	0.03°
Display menu	Echogram	1
	Bottom range	10 m
	Bottom range start	9 m
	TVG	20 log R
	Sv colour min	-67 dB
	TS Colour minimum	-60 dB
Printer- menu	Range	0 - 50, 0 - 100, 0 - 150, 0 - 250 or 0 - 500m
	TVG	20 log R
	Sv colour min	-60 dB
Bottom detection menu	Minimum level	-40 dB

A calibration experiment using a standard copper sphere was performed in Baía dos Elephantes, Angola 5th August 2005. These settings used during the survey.

Fishing gear

The vessel has two different sized "Åkrahamn" pelagic trawls and one "Gisund super" bottom trawl. For all trawls, the Tyborøn, 7.8m² (1670 kg) trawl doors were used.



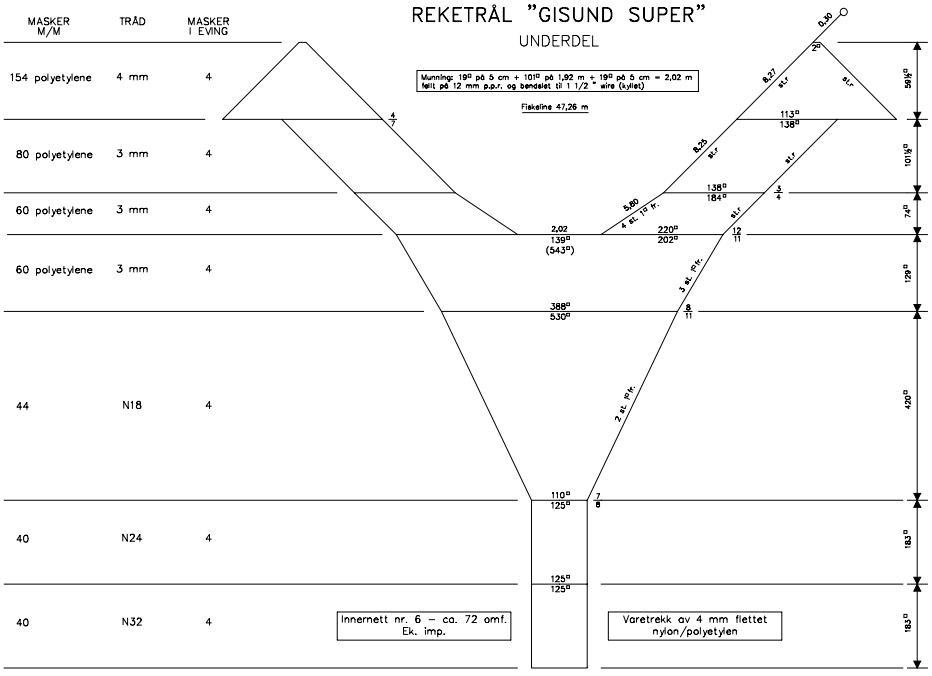


Figure 1 Design of the trawl used.

ANNEX V Seabirds and Marine Mammals distribution and patterns of abundance

(Contribution to the 'Top Predador' BCLME Project LMR/EAF/03/02)

Participants from 28 July 2005:

Jean-Paul Roux, MFMR Lüderitz,
Trainees: Benedictus Dundee, MFMR Lüderitz
Jose da Silva, University Agostinho Neto, Luanda

AIMS

1. Make an inventory of seabird and marine mammal species present in the survey area
2. Estimate relative density of the different seabird species along the transect lines
3. Analyse patterns of distribution and abundance in relation to oceanographic features and fish distribution
4. Training on bird identification at sea and seabird survey methods
5. Record additional visual information on surface oceanographic features (slicks, water discoloration, flotsam lines) and fish (presence of pelagic sharks, surface aggregations of pelagic fish).

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 effected 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 two minutes 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 minute counts soon after a station or a trawl which have attracted birds to the vessel. This method was chosen in order to record all species

seen including the scarce and rare species. The results of this method give a species-specific index of abundance rather than absolute densities.

Additional “incidental observations” were made, between counts when scarce or unusual species were observed and while the vessel was on station or during trawling when standardized quantification of abundance was not possible. 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 and weather station (position, speed, depth, heading, sea temperature etc.) as well as environmental and biological parameters recorded during the survey. Additional information on the age classes of some species was noted (albatrosses, gannets, gulls).

Sightings of Cape fur seals were recorded following the same format. Each cetacean sighting was recorded in a way similar to the ‘incidental sightings’ of uncommon bird species above. A measure of effort was obtained by recording the periods of continuous observations (and relating them to the vessel route) to be modified by estimated sea state and visibility.

Fish schools visible at the surface were recorded following an estimated relative four-point scale: small (a few to 100 m^2), medium (between 100 and 250 m^2) large (between 250 and 500 m^2) and very large (> 500 m^2). Pelagic shark sightings were also recorded. Additional visual information as flotsam lines, slicks, water discoloration etc. was also logged in the same format as well as photographically documented.

RESULTS

A total of 266 “10-minute counts” were effected between 28 July and 16 August. In addition, 130 incidental observations were logged, including 12 during Multinet sampling, 23 during CTD stations, and 18 during trawling. The summary of the distribution of the observations is given in Fig 1.

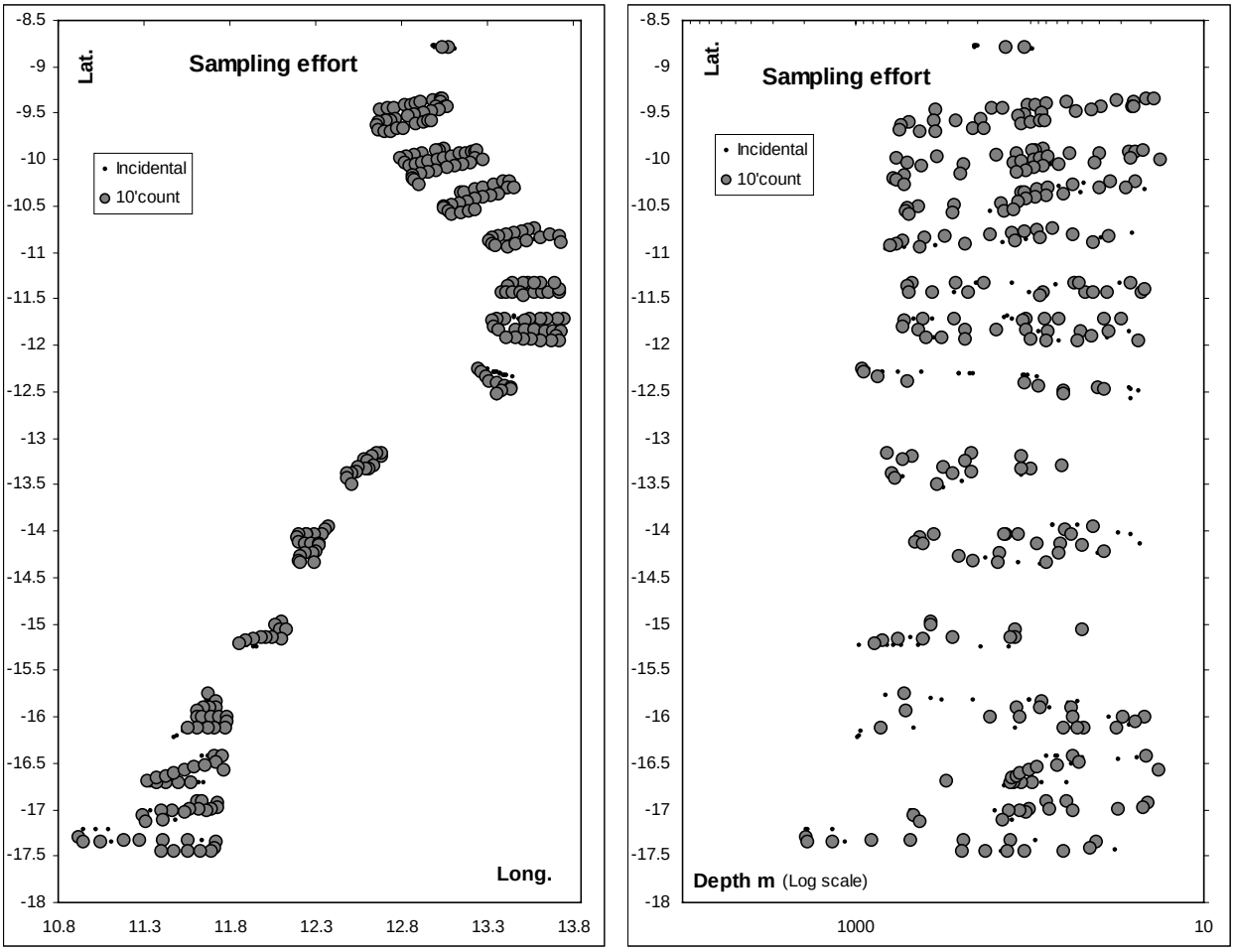


Figure 1. Distribution of the sampling effort (10 min counts and incidental observations on the left and Latitude-Depth plot (log scale) on the right.

Species accounts

The list species and numbers identified during the survey are given in Table 1 for birds and seals.

Table 1: Seabird species and numbers of individuals identified during the 10' observation periods and in total (including incidental sightings). The overall percentage of occurrence (% FO) in the 10-minute count periods (N=266) and Cape fur seal numbers are also given. *Several tens of thousands of Cape cormorant roosting and feeding in Baia dos Tigres excluded.

Species		Bird numbers		10' count
		All records	10 min counts	FO %
Thalassarche melanophris	Black-browed albatross	4	2	0.75
Thalassarche chlororhynchos	Yellow-nosed albatross	231	127	14.66
Thalassarche chrysostoma	Grey-headed albatross	1	1	0.38
Daption capense	Pintado petrel	8	5	1.88
Procellaria aequinoctialis	White-chinned petrel	2296	1396	36.84
Puffinus gravis	Great shearwater	1	0	0.00
Puffinus griseus	Sooty shearwater	30	10	3.76
Puffinus puffinus	Manx shearwater	7	3	1.13
Pterodroma mollis	Soft-plumaged petrel	2	1	0.38
Oceanites oceanicus	Wilson's storm-petrel	1930	1567	55.26
*Phalacrocorax capensis**	Cape cormorant	889	648	4.51
Phalacrocorax lucidus	White-breasted cormorant	31	26	0.75
Morus capensis	Cape gannet	6299	5106	74.81
Stercorarius sp.	jaegger sp.	2	2	0.38
Stercorarius pomarinus	Pomarine jaeger	2	1	0.38
Stercorarius parasiticus	Arctic jaeger	1	0	0.00
Catharacta antarctica	Subantarctic skua	77	36	8.27
Xema sabini	Sabine's gull	4	1	0.38
Larus dominicanus vetula	Kelp gull	992	400	23.68
Larus cirrocephalus	Grey-headed gull	16	9	1.13
Sterna hirundo/paradisaea	Common/Arctic tern	194	110	18.42
Sterna maxima	Royal tern	2	1	0.38
Sterna sandvicensis	Sandwich tern	8	3	0.75
Chlidonias niger	Black tern	5	5	1.88
Arctocephalus pusillus	Cape fur seal	417	255	28.57

***Diomedeidae*, Albatrosses:**

Three species of albatrosses were encountered, all migrants from the southern ocean. The Atlantic Yellow-nosed albatross *T. chlororhynchos* breeds at Gough Island and Tristan da Cunha group. They were absent in the north of the survey area, a few sightings of *T. chlororhynchos* were made in deep water between 12°13'S and 13°25'S but the species became regular only south of 15°S in water deeper than 100m and was absent in shallow water (< 50 m). Most individuals seen at close range were immature and juvenile birds, but the proportion of adults increased with latitude. The Black-browed albatross was very scarce, seen only four times (all juveniles) in the extreme south of the survey area (south of 17°S) and the Shy albatross (*Thalassarche cauta*) recorded in previous surveys in the same area was not sighted during this survey.

The Grey-headed albatross (*Thalassache chrysostoma*) was seen once at 16°07'S in about 50 m of water. This latitude probably constitutes the northernmost limit of the normal winter range of this species.

***Procellariidae*, Petrels and Shearwaters:**

Out of six species of this group sighted during the survey, the Manx shearwater (*Puffinus puffinus*) is a northern hemisphere migrant; the Great shearwater (*Puffinus gravis*) is endemic to the Tristan and Gough group of Islands in the south Atlantic. The other species are migrants from the sub-Antarctic region of the southern ocean.

The Pintado petrel (*Daption capense*) was very scarce and present only in the south, with 7 sightings (of 8 birds in total) all south of 16°26'S.

Only 7 sightings (of single birds) were made of the Manx shearwater (*P. puffinus*), four between 12°15'S and 15°09'S off the shelf in water deeper than 400m. The others sightings were all south of 16°S.

Only one sighting of Great shearwater (*P. gravis*) was made, the first one in Angolan waters during the last four surveys. The sighting was of a single bird at 12°19'S over mid shelf (108m depth).

The Sooty shearwater (*Puffinus griseus*), migrant from the sub-Antarctic, was uncommon on the outer shelf and beyond the shelf break becoming more widespread over the shelf south of 16°S south. There was, however, a noticeable cluster of sightings (10 out of 24) in deep water (9 sightings between 500m and 920m) between 12°13'S and 12°23'S.

The White-chinned petrel (*Procellaria aequinoctialis*) was one of the most abundant and widespread species encountered. It was found at low densities and mostly offshore (outer-shelf and shelf break) north of 13°S. South of 15°S this species is found regularly also inshore and in higher densities at depth greater than 100m and to the south.

The Soft-plumaged petrel (*Pterodroma mollis*) was seen for the first time during these surveys, only in the extreme south of the survey area (17°20'S) and in very deep water (the two sightings were in 1915 m and 1154 m respectively). This species is not normally seen on the shelf.

***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°30'S, and south of 15°00'S, while far less common between 12°30 and 15°00'S. This species is mainly a zooplankton surface-feeder and its association with frontal zones and surface slicks is an indication of areas of zooplankton concentration at the surface. The observed distribution pattern is remarkably similar to that found during previous surveys, an indication that the zones of zooplankton availability at the surface are stable in space from year to year.

***Sulidae*, Gannets:**

The Cape gannet, *Morus capensis*, proved to be the most abundant and widespread seabird during the survey, present in nearly 75% of the observations. The proportion of young birds accounted for nearly half the total (3.3% of subadults, 27.5% of immatures and 14.2% of juveniles out of 1346 aged birds) and this is consistent with observations made during previous cruises. This proves that Angolan waters are an important feeding and wintering area for all age classes and might be a key area for the survival of young birds of this vulnerable southern African endemic species. North of 10°30'S and between 12°30' and 14°30'S densities were low. The highest densities were observed in two clusters, one on the inner shelf (water shallower than 50 m) between 10°30'S and 11°30'S as well as on the outer shelf south of 15°S.

***Phalacrocoracidae*, Cormorants:**

Only two cormorant species were recorded during the survey, and only in coastal waters. The White-breasted cormorant (*Phalacrocorax [carbo] lucidus*) is suspected to breed at several locations in the southern region from 13°15 to Baia dos Tigres. The Cape cormorant (*P. capensis*), an endemic species from the Benguela Current region, was observed only in the south (from about 14°13'S) and becoming abundant around Baia dos Tigres. This species breeds and roosts in large numbers at Baia dos Tigres and feeding aggregations counting tens of thousand birds were observed in the bay as during previous years.

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.

***Pelecanidae;* Pelicans:**

The Great-white pelican (*Pelecanus onocrotalus*) was not seen at sea during this survey, but several birds were seen onshore on the southeastern part of the Island at Baia dos Tigres and this species probably breeds there. During previous surveys the species has been seen in the same area as well as off several estuaries.

***Stercoraridae*, Skuas and Jaegers:**

Two species of Jaegers (*Stercorarius*) were recorded in extremely low numbers, the Pomarine jaeger (*S. pomarinus*) and the Arctic jaeger (*S. parasiticus*), with 2 and 1 record of single individuals respectively. One additional record of two jaegers, which could not be identified to species level, refers to probably *St. parasiticus* or possibly to *S. longicaudus*. All three species have been recorded in previous surveys and the low number of observations during the present survey is probably due to the seasonality of migration of these northern hemisphere migrants. The bulk of the palaearctic migrants is expected to pass through the region in September to October.

The Subantarctic skua, *Catharacta antarctica* on the other hand, a visitor from the southern ocean, was slightly more frequent than in previous surveys (48 sightings of 77 individuals). The geographical distribution was remarkably similar to the previous surveys: this species has a discontinuous distribution in Angolan waters at this time of the year. South of 16°S, as further south in Namibian waters, the Subantarctic skua is fairly common over the shelf. It is scarce but regular between 15°S and 16°S and absent further north. This corresponds to the known northernmost distribution of the species in the Southeast Atlantic. However a small isolated area

about 350km further north, centered around the northern edge of the Quicombo Bank (around 11°20'S) has been the site of a small cluster of observations of this species during all previous surveys. This year seven sightings of single individuals were made between 10°52'S and 12°13'S. Figure 2 illustrates this unusual distribution pattern observed in the past 4 surveys.

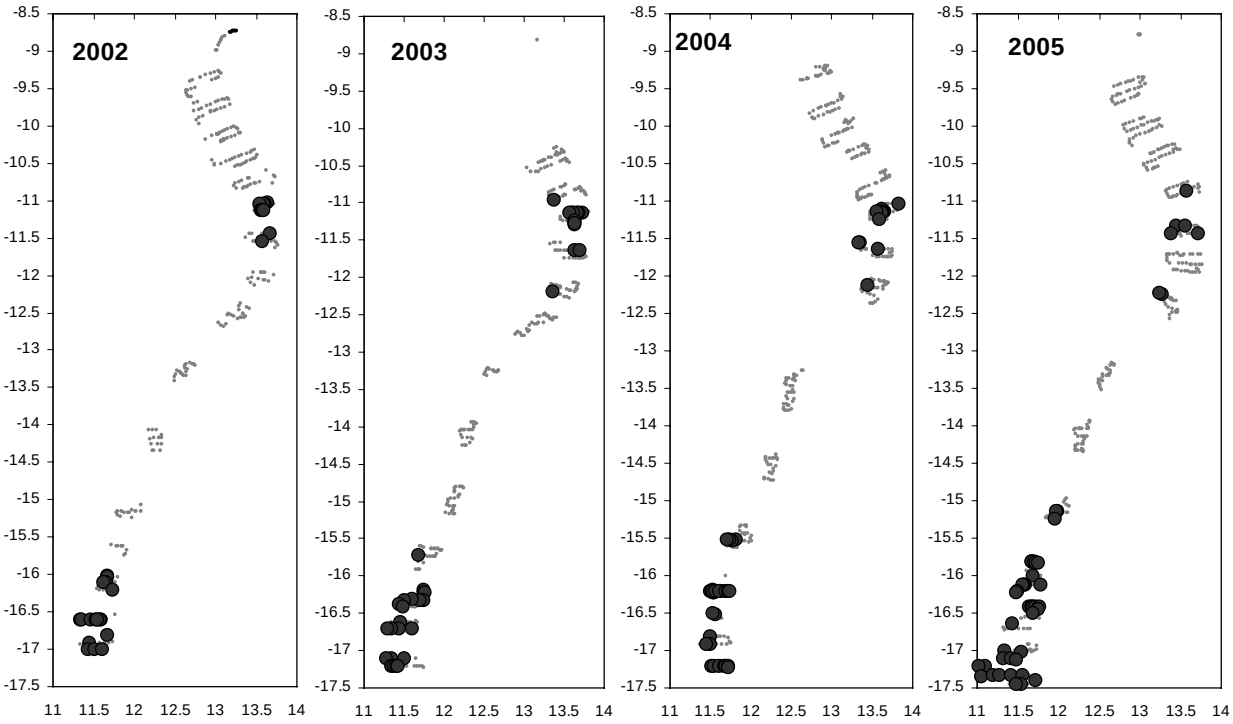


Figure 2. Geographical distribution (Latitudes and Longitudes in decimal degrees) of the subantarctic skua, *Catharacta antarctica*, during the past four surveys illustrating the discontinuous distribution of this species in Angolan waters.

***Laridae*, Gulls:**

The Grey-headed gull (*Larus cirrocephalus*), is a resident associated with coastal and inland waters as well as along the coast in the vicinity of estuaries. It was sighted on 5 occasions in shallow water (24 to 53m), around 12°29'S in the vicinity of a river mouth and in the Baia dos Tigres area between 16°07'S and 16°29'S.

The Kelp gull (*L. dominicanus vetula*), is an endemic subspecies from Southern Africa and the Benguela system was widespread throughout the survey area. Kelp gulls were scarce in the north, becoming regular from 11°30'S and abundant particularly inshore south of 16°S.

The Sabine's gull (*Xema sabini*), a northern hemisphere migrant, was sighted only 3 times with a total of 4 individuals at 13°20'S, 16°07'S and 17°06'S. This low abundance is probably due to the early date of the survey as this species' southward migration through the area is peaking in September-October.

***Sternidae*, Terns:**

Four of the five tern 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 in some of the previous surveys; again probably the effect of an earlier date on the abundance of palearctic migrants. *C. niger* was very scarce with only 5 sightings of single individuals. August must correspond to the extreme beginning of the migration through this area (more than 300 individuals were sighted in September 2002).

The Royal tern (*Sterna maxima*) is a tropical species breeding in West Africa and dispersing to southern Angola in summer. During the survey it was sighted only twice at 14°19'S and 15°08'S. This low occurrence contrasts with previous surveys when the species was regularly seen north of 13°S.

Marine mammals:

Cape fur seal: *Arctocephalus pusillus*:

Fur seals were distributed fairly uniformly in small numbers in the entire study area but were more frequent over the inner shelf (depth < 150 m). Higher densities were found south of 15°S and particularly near Baia dos Tigres which harbours a fairly large non-breeding colony.

Cetaceans:

The summary of the cetacean sightings made during this part of the survey is given in Table 2 and Fig 3.

The sightings of Killer whales (*Orcinus orca*) confirm the presence of this species in Angolan waters. They have been observed in two previous surveys (2002 and 2003), which were the first confirmed records for this area.

The presence of Dusky dolphins (*Lagenorhynchus obscurus*) on the shelf in the area of Baia dos Tigres is also a confirmation that the previous sightings of this species in the same region during the last two surveys and represents the northern limit of their normal range in the Southeast Atlantic. This species is probably the most

common small odontocete on the shelf of the Benguela upwelling ecosystem from South Africa and Namibia. Its extended distribution in southern Angola south of the Benguela-Angola Front is not surprising, however had not been documented before.

The lack of observation of dolphins of the genera *Delphinus* and *Stenella* was surprising during this survey, and possibly a consequence of the anomalously cold conditions prevalent in the region at the time of this survey.

Turtles:

Only one sighting of one single unidentified marine turtle was made during this survey in (40m of water at 10^{o}18'S, 13^{o}25'E). This is in sharp contrast with previous surveys when turtle sightings were regular particularly Olive Ridley (*Lepidochelis olivacea*) turtles in approximately the same area, between 10^{o} 23'S and 11^{o}08'S.

Patterns of abundance:

On a broad scale and according to seabird and marine mammal distribution observed during the previous 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^{o}30'S to 12^{o}30'S

This area is characterized at this time of the year by:

- Presence of the Sooty shearwater *P. griseus* at low densities in deep water
- *Presence of White-chinned petrel at low density over the outer shelf and beyond*
- Absence of Albatrosses, Cape Petrel, Cape cormorant
- Low densities of the Cape fur seal *A. pusillus*, on the shelf,
- Presence of Bryde's whale, *Balaenoptera edeni*.

In the southern half of this zone, a small area stands out at around 11^{o}10'S –11^{o}15'S (the northwestern edge of the Quicombo bank). In this area seabird densities are generally higher than either north or south of it. This is particularly the case for Cape gannets and Wilson's storm petrels. This indicates a high availability of zooplankton near the surface as well as higher availability of pelagic fish characteristics of a divergent frontal zone, or local upwelling. This interpretation is supported by the

negative sea temperature anomaly extending offshore observed in this area year after year. In addition the sightings of flotsam lines offshore in this area (contrasting with flotsam being seen inshore further north or south) seems to indicate a surface offshore transport located there. Also associated with this feature is the unexpected presence of the Subantarctic skua (*C. antarctica*) noted during the previous 3 surveys as well as during this one (Fig X2). This species is otherwise found only south of the Angola-BenguelaFront.

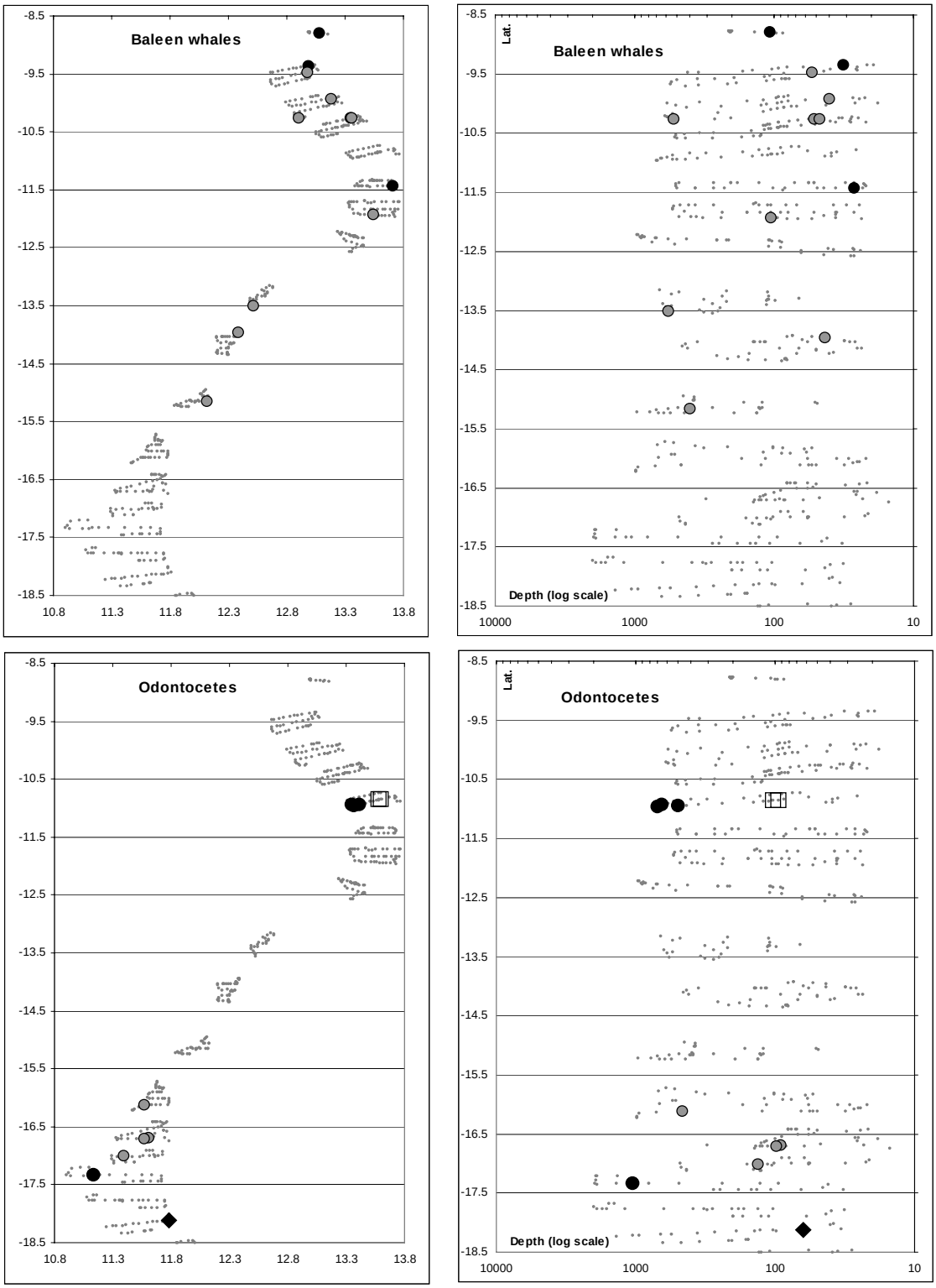


Figure 3. Humpback (grey circles) and Bryde's whale (black circles) distribution (Top) and Pilot whale (black circles), Orca (open squares), Dusky dolphin (grey circles) and Bottlenose dolphin (black diamond) distribution (Bottom).

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

- 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* edeni 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 *Thalassarche chlororhynchos* , Cape cormorant *Phalacrocorax capensis* and Pintado petrel *Daption capense* and a slight increase in fur seal abundance.

d) South of 16°00'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, Pintado 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 inshore, Dusky dolphin on the shelf).

Table 2. Summary of cetacean sightings.

Species	Number	Date	Local time	Log	Depth	SST	Lat (dec ')	Long (dec ')	Remarks
Balaenoptera edeni	1	28-Jul-05	15:56	1951	108	19.1	-8.792	13.074	
Balaenoptera sp.	2	29-Jul-05	8:44	2092.3	32	19.4	-9.352	12.986	*B.sp* probable *B. Edeni*
Megaptera novaeangliae	1	29-Jul-05	11:02	2115	54	19.3	-9.475	12.977	Small size (sub adult)
Megaptera novaeangliae	1	30-Jul-05	11:40	2326.5	40	19.5	-9.923	13.177	Breaching
Unid.	2	30-Jul-05	15:18	2358	85	20	-10.062	13.115	Large baleen whale too far for ID
Megaptera novaeangliae	1	30-Jul-05	17:27	2381.2	529	22.1	-10.267	12.906	2 nm south
Megaptera novaeangliae	1	30-Jul-05	17:46	2384	265	22.1	-10.251	12.947	Possibly same individual as above
Megaptera novaeangliae	2	31-Jul-05	9:56	2497	52	19.5	-10.259	13.349	2 adults 10 m apart sounding in synchrony
Megaptera novaeangliae	2	31-Jul-05	10:08	2497.8	47	19.4	-10.252	13.358	2 adults possibly same individuals as above
Globicephala sp.	6-10	1-Aug-05	9:41	2698.2	650	20.1	-10.930	13.348	Associated with 8 *Tursiops*
Tursiops truncatus	8	1-Aug-05	9:41	2698.2	650	20.1	-10.930	13.348	Associated with *Globicephala*
Globicephala sp.	9	1-Aug-05	9:52	2700	696	19.7	-10.955	13.363	2 tight groups (4 and 5 indiv.) 200 m apart
Globicephala sp.	13-20	1-Aug-05	10:47	2703	495	19.4	-10.940	13.407	
Orcinus orca	4	1-Aug-05	13:30	2717	103	18.9	-10.853	13.580	2 ad females, 1 large male, 1 young
Orcinus orca	2	1-Aug-05	13:43	2718	95	19.2	-10.844	13.595	2 medium size (ad Females?) 1' South of previous group
Balaenoptera edeni	1	2-Aug-05	13:04	2919	27	18.1	-11.432	13.704	About 300 m
Megaptera novaeangliae	1	3-Aug-05	16:52	3128	105	19.9	-11.931	13.545	
Megaptera novaeangliae	4	6-Aug-05	17:24	3450	580	17.8	-13.506	12.515	4 large adults in a tight group
Megaptera novaeangliae	1	7-Aug-05	8:24	3538.9	43	17.1	-13.951	12.379	
Megaptera novaeangliae	1	8-Aug-05	10:30	3725.2	404	16.6	-15.156	12.110	Breaching
Lagenorhynchus obscurus	6	9-Aug-05	16:03	3937	468	15.9	-16.113	11.568	Minimum count
Lagenorhynchus obscurus	15-20	11-Aug-05	10:00	4177	91	15.3	-16.691	11.601	15 to 20 duskies
Lagenorhynchus obscurus	30-50	11-Aug-05	10:08	4179	98	15.2	-16.700	11.570	In 2 groups 100 m apart
Lagenorhynchus obscurus	24	12-Aug-05	11:40	4375	132	14.3	-17.003	11.396	One group
Globicephala sp.	12	13-Aug-05	10:47	4516	1058	14.4	-17.336	11.133	At least 1 very small young

Conservation aspects:

A number of seabirds present in Angolan waters in winter and spring are susceptible to by catch by long line fisheries (as well as direct catch from small crafts). These include particularly all species of albatrosses, and some petrels and shearwaters as well as the Cape gannet. By catch 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 sardine stock) as well as increased by catch by long-line fisheries, which 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 Cape 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. A high incidence of Cape gannets sighted in southern Angola during the 2003 and 2004 surveys (particularly around 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.

The results gathered during the four surveys have shown that southern Angola is a key area for wintering gannets and particularly important for young birds. The Cape gannet is an endemic to the region with only six breeding sites worldwide, including three in Namibia. The Namibian population has declined drastically in the past decade and the recruitment of young birds seems to be insufficient to sustain the population. Given the importance of southern Angola to young gannets revealed by the last four surveys it seems important that Angola be included and involved together with Namibia and South Africa in a joint conservation effort regarding these seabirds.

The following figures give examples of distribution of the main species using all records (presence absence) and of the highest densities of the most common and widespread species, using the 10-minute counts only. These data are plotted against geographical coordinates as well as in latitude-depth (on a log scale) plots to visualize the distribution patterns on and off the shelf.

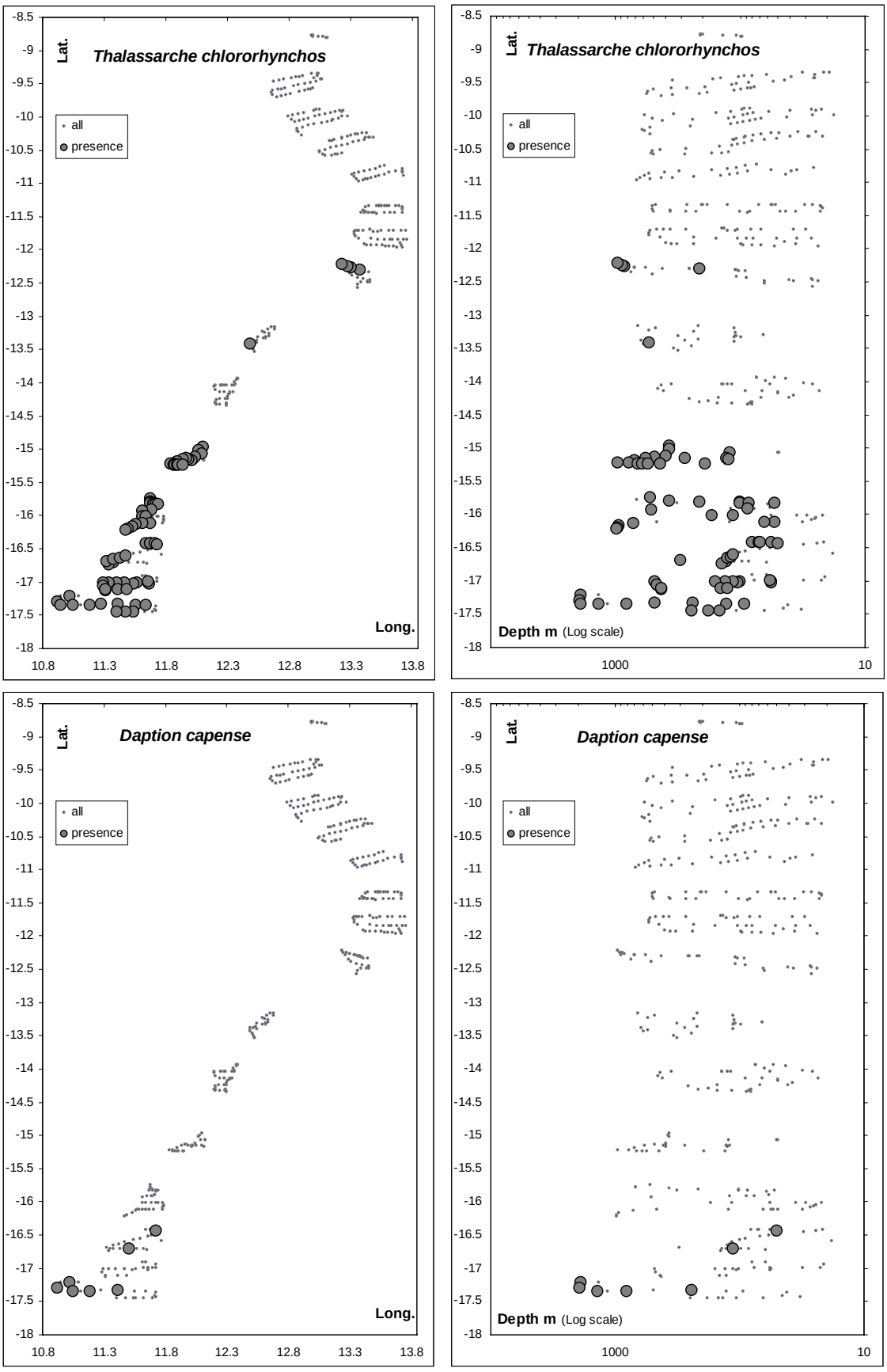


Figure 4. Distribution of the Yellownosed albatross (top) and the Pintado petrel (bottom).

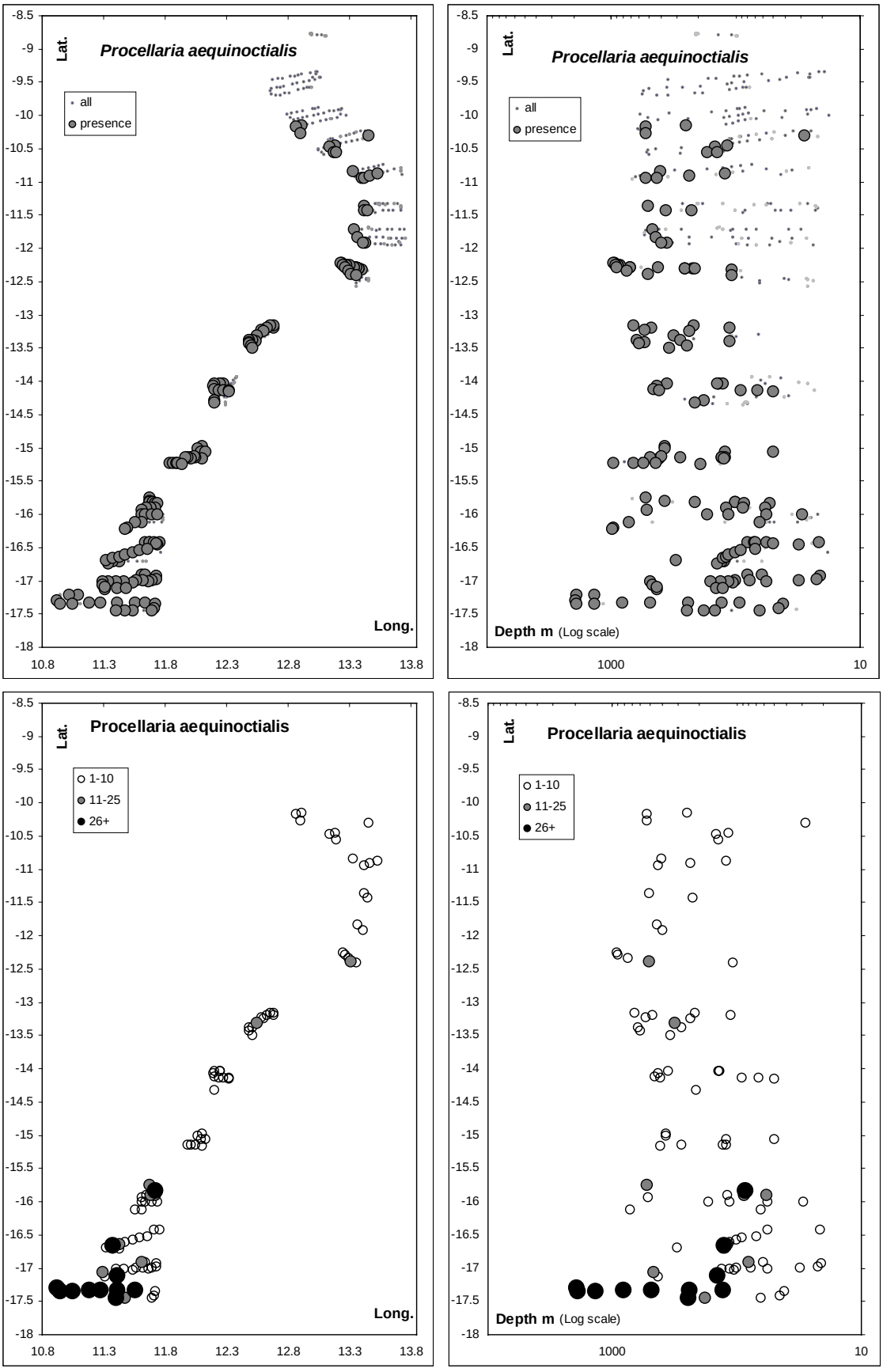


Figure 5. Distribution and patterns of abundance of the White-chinned petrel.

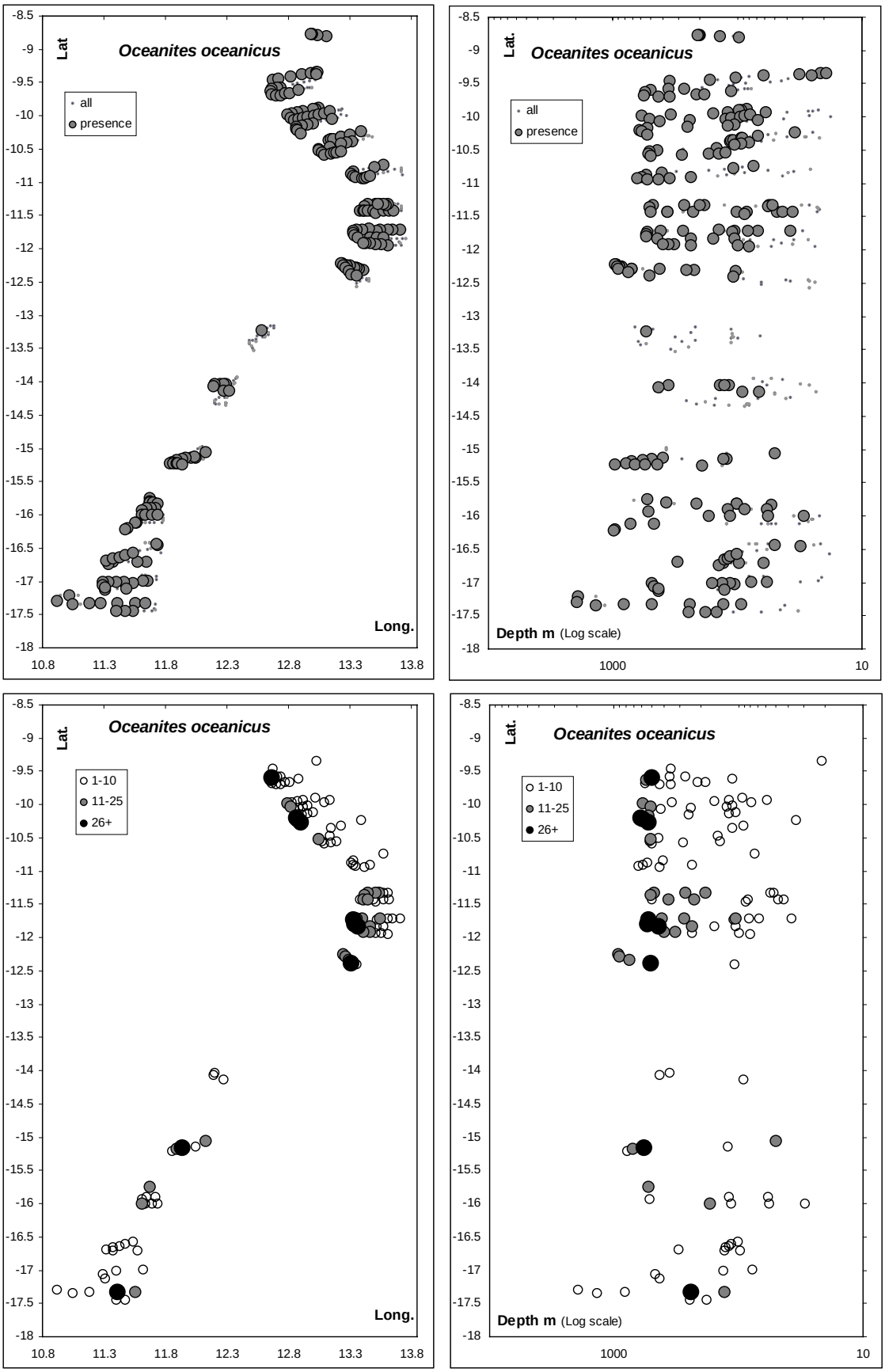


Figure 6. Distribution and patterns of abundance of the Wilson's storm-petrel.

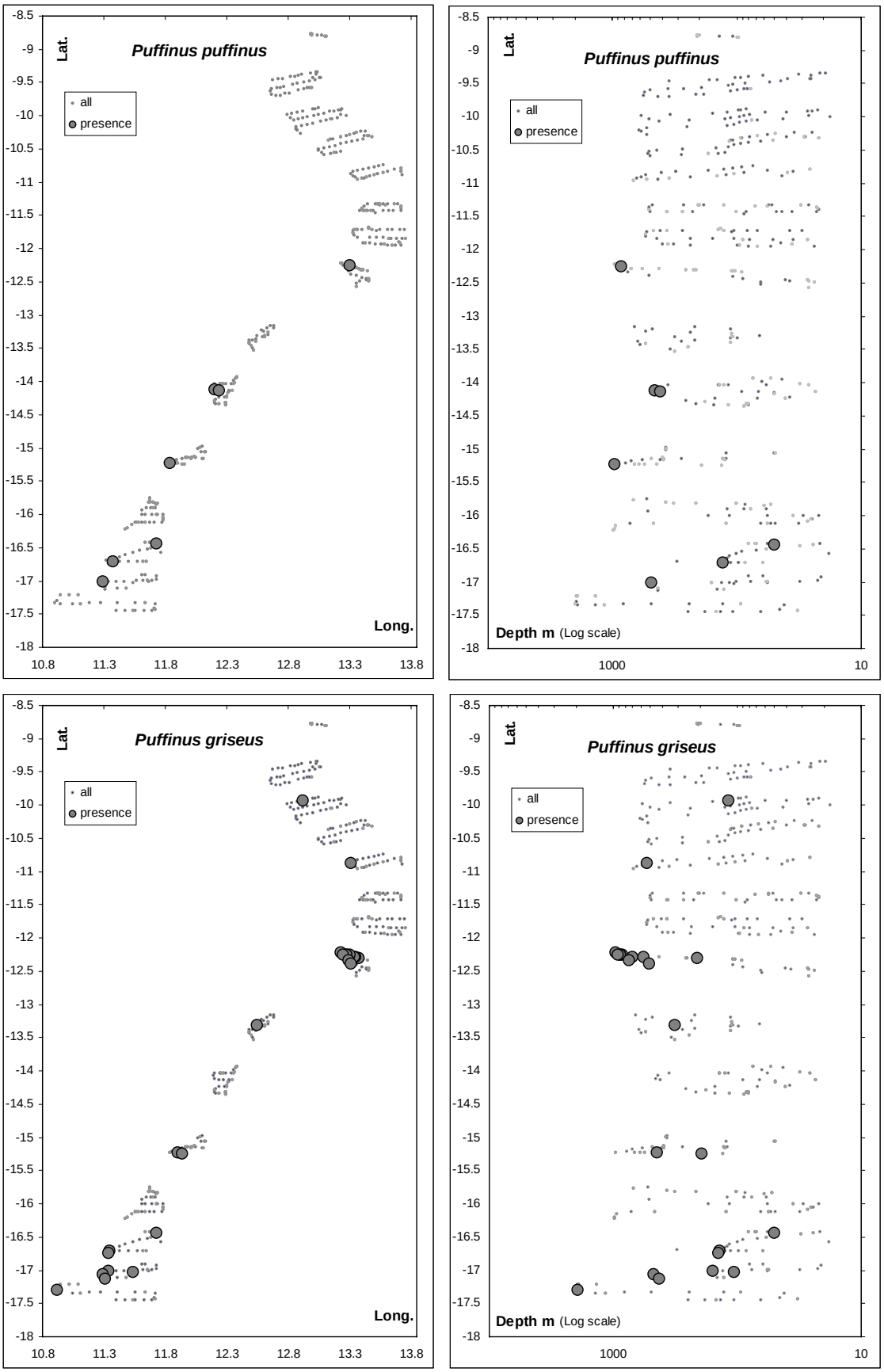


Figure 7. Distribution of the Manx shearwater (top) and the Sooty shearwater (bottom).

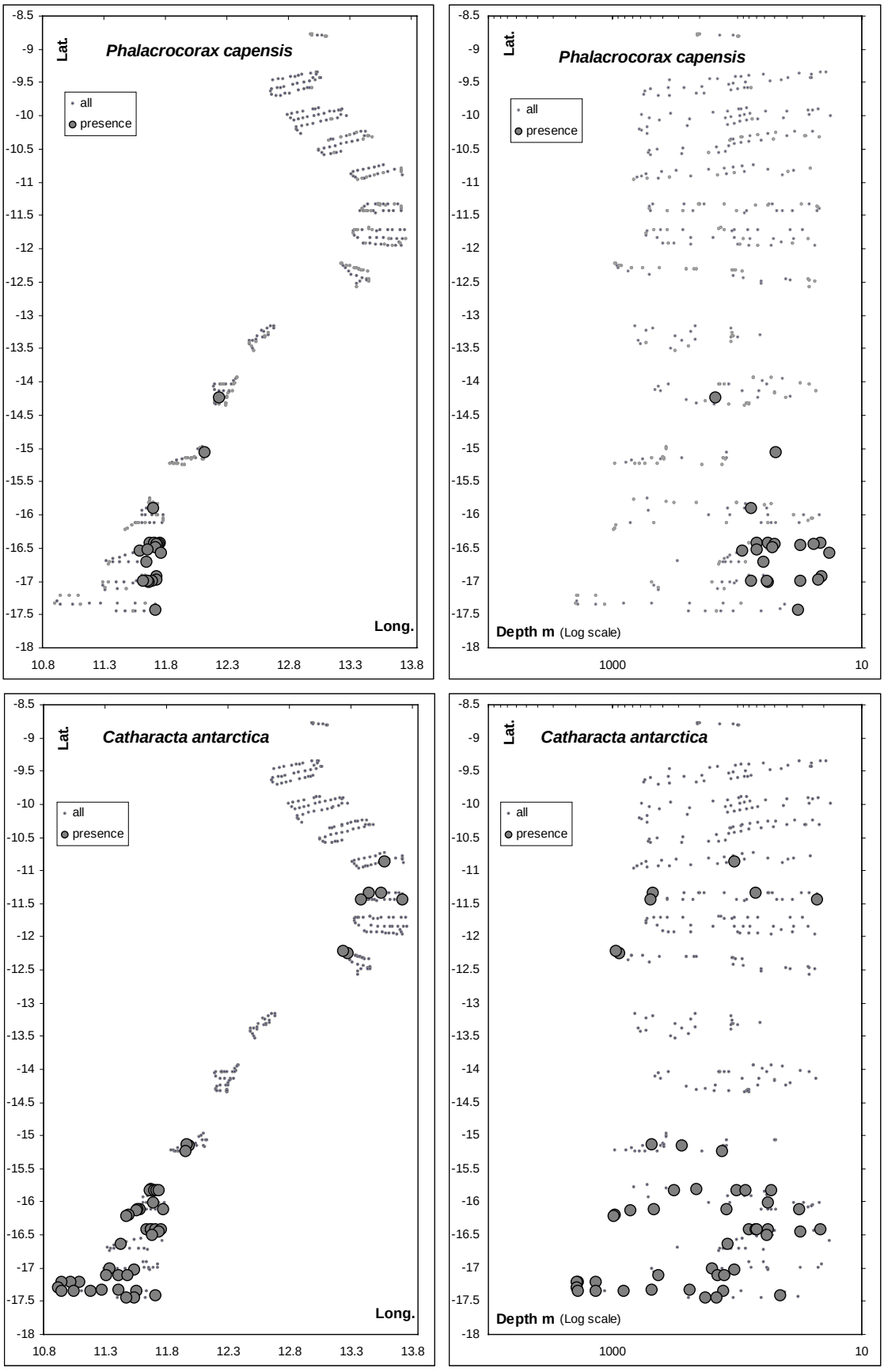


Figure 8. Distribution of the Cape cormorant (top) and the Subantarctic skua (bottom).

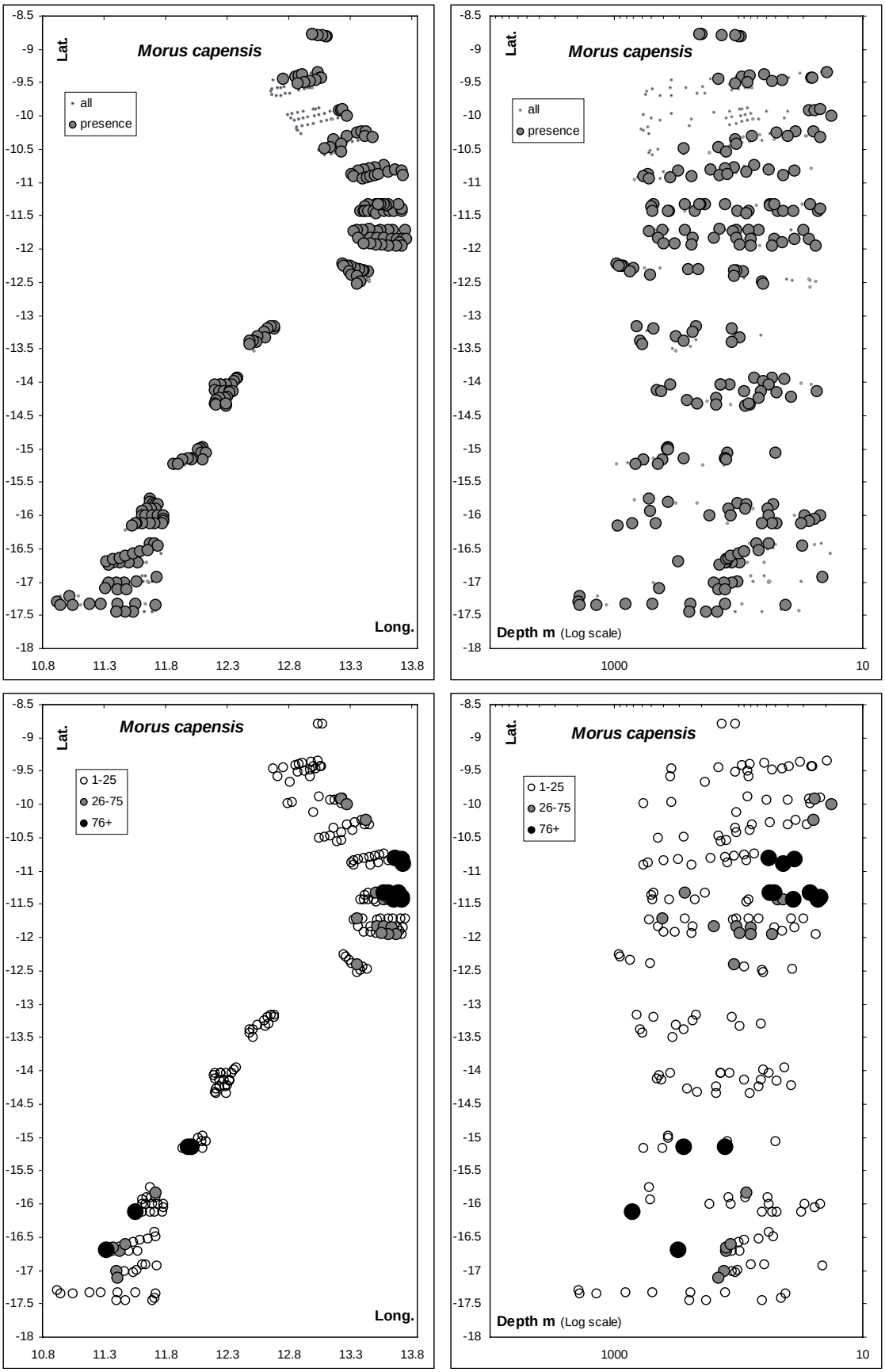


Figure 9. Distribution and patterns of abundance of the Cape gannet.

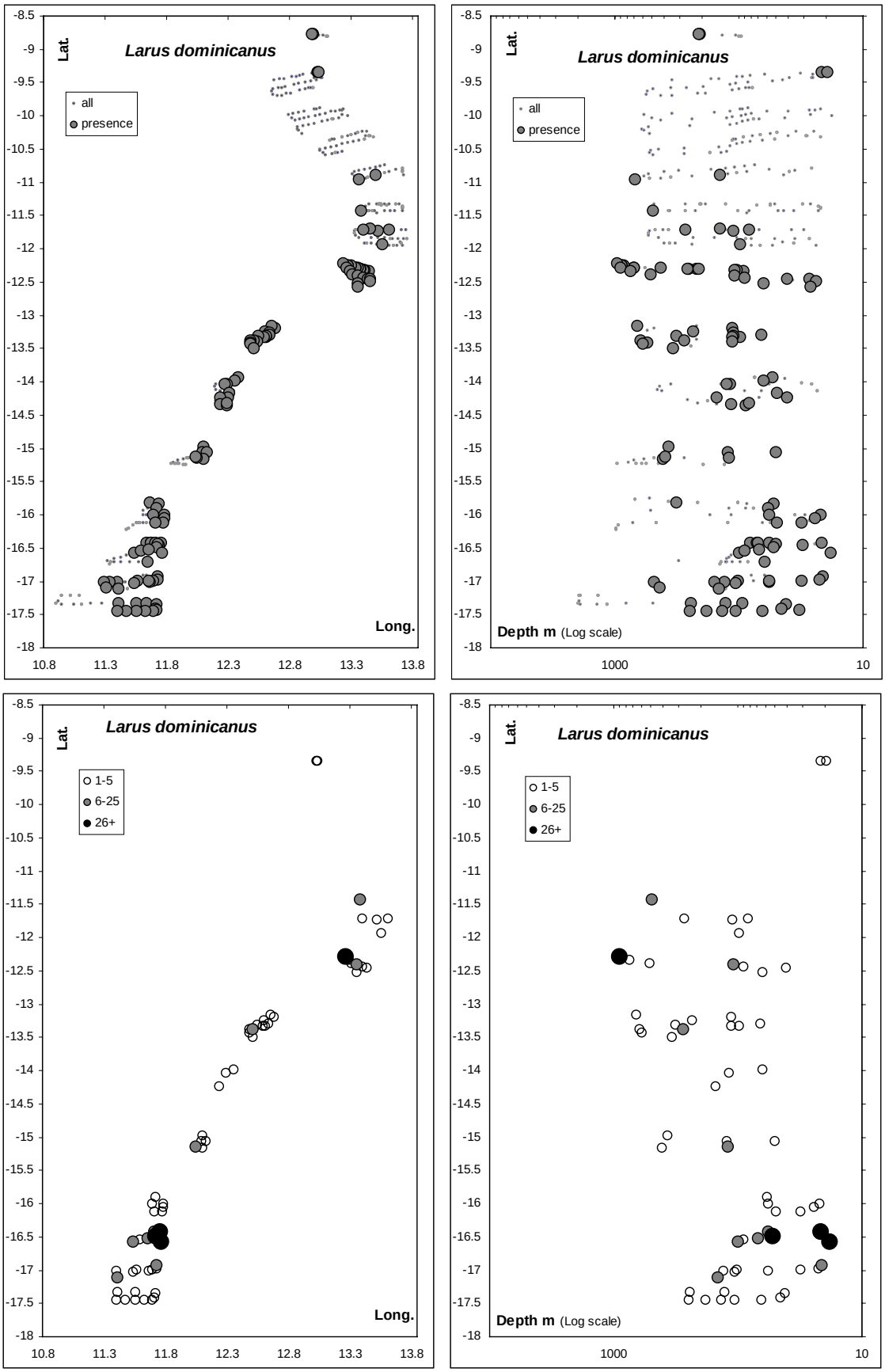


Figure 10. Distribution and patterns of abundance of the Kelp gull.

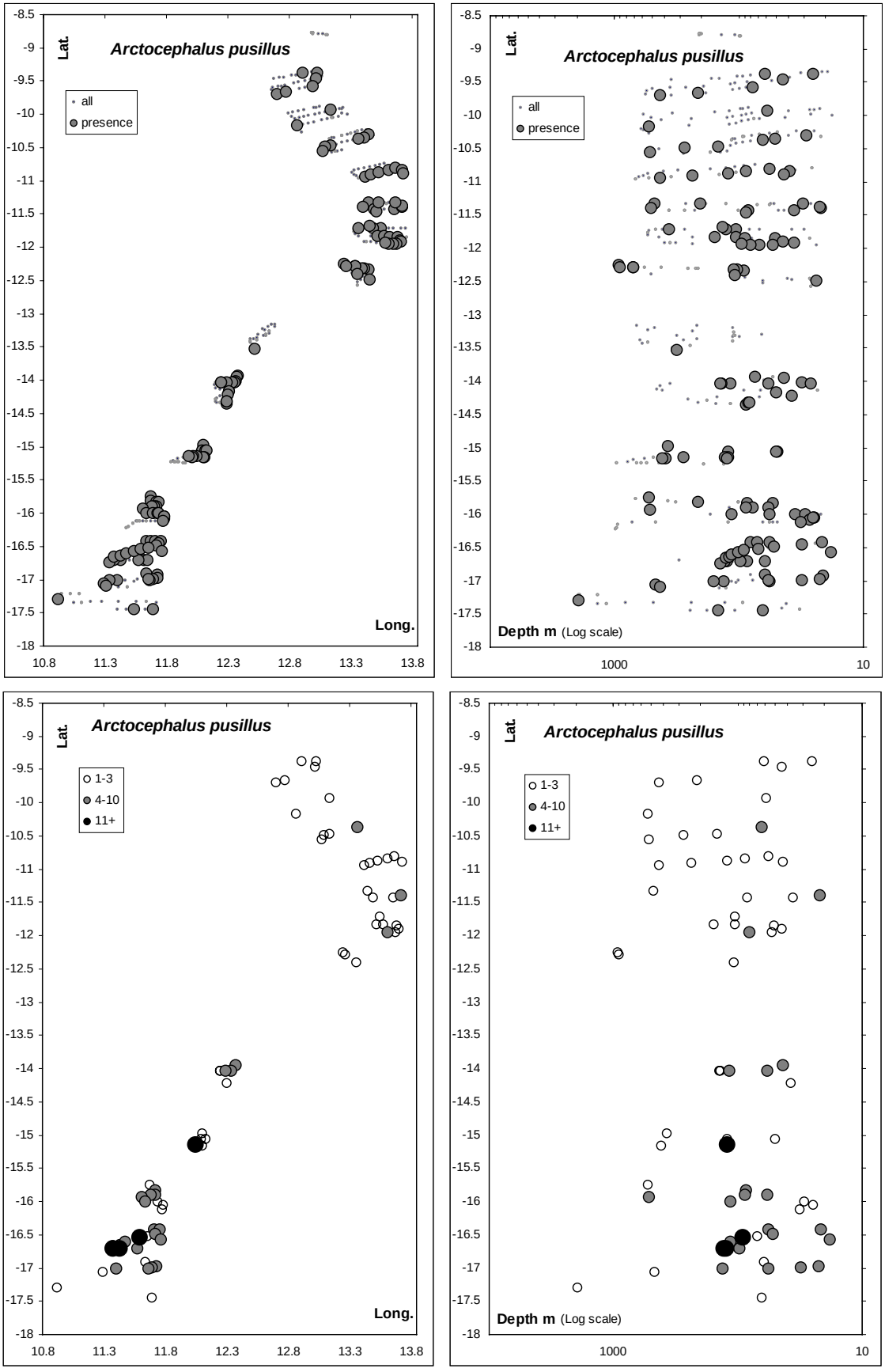


Figure 11. Distribution and patterns of abundance of the Cape fur seal.