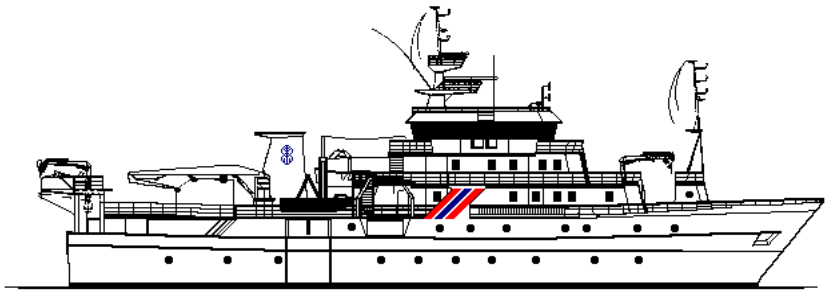

BENEFIT SURVEYS

Acoustic survey of the mesopelagic fish resources of the Benguela region

23 August - 12 September 2006

Ministry of Fisheries & Marine Resources
Swakopmund
Namibia

Marine and Coastal Management
Cape Town
South-Africa

Institute of Marine Research
Bergen
Norway

CRUISE REPORTS "DR. FRIDTJOF NANSEN"

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Acoustic survey of the mesopelagic resources of the Benguela region

23 August - 12 September 2006

by

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CHAPTER 1. INTRODUCTION

1.1. BACKGROUND

Fisheries acoustic surveys in the Benguela region have in the past only focused on commercially important species such as sardine, anchovy, horse mackerel and round herring (Barange *et al*. 1999, Boyer and Hampton 2001). Recently they have also been used to estimate the biomass and target strength of jellyfish in Namibian waters (Brierley *et al*. 2001) and have at times been used to correct estimates of hake biomass obtained from bottom trawl surveys (Iilende *et al*. 2001). Given the synoptic nature of acoustic surveys and improved technology available, these surveys are also ideal for estimating the biomass of non-commercial species such as lanternfish and lightfish in a relatively short time. Despite the perceived high biomass of mesopelagic fish biomass in both the northern and southern Benguela (Armstrong and Prosch (1991) and their associated importance in the food web (Shannon and Jarre-Teichmann 1999), very little effort has, however, been spent on estimating the biomass and target strength of mesopelagic fish.

The combined biomass of the myctophid *Lampanyctodes hectoris* (the lanternfish) and the sternoptychid *Maurolicus muelleri* (the lightfish) in the southern Benguela was estimated by Armstrong and Prosch (1991) to be in the order of one million tons during two surveys in 1983 and 1987. *L hectoris* is by far the most abundant myctophid in the northern Benguela and is distributed over the outer shelf from Walvis Bay to the Orange River and further south into South Africa's west coast area. The biomass of lanternfish in the northern Benguela has previously been estimated at around 800 000 tons, although negative biases such as under sampling during the day and net avoidance at night were noted for this estimate (Hewitson and Cruikshank 1993). Several acoustic surveys conducted each year in the Benguela region are restricted to the inner shelf area (approximately 200 m isobath) and therefore not suitable for providing simultaneous mesopelagic fish biomass estimates, as the distributional range of both lanternfish and lightfish extends out to at least a bottom depth of 500 m (Hulley and Prosch 1987).

Several attempts to model trophic flows in the southern and northern Benguela have had to incorporate uncertainty about many of the parameter estimates in the mass balanced models used (Jarre-Teichmann *et al*. 1998, Shannon *et al*. 2004, Roux and Shannon 2004). Whereas biomass estimates of the commercially important fish species are available, data on mesopelagic production and consumption have not been updated since the mid 1980s. Results from trophic

flow models of the region have, however, confirmed that mesopelagic fish play an important role in the food web of the Benguela, particularly as a link between zooplankton and hake (Jarre-Teichmann *et al*. 1998, Shannon and Jarre-Teichmann 1999). Apart from hake, mesopelagic fish are also consumed by other demersal fish and large horse mackerel, cephalopods, large pelagic such as tuna and snoek and even by seabirds.

In addition, round herring (*Etrumeus whiteheadi*) is currently not of commercial importance in Namibia and there is limited information on the species from that region. Round herring is also considered to be of little importance to the trophic flow of the northern Benguela and is basically eliminated from the trophic flow models (Jarre-Teichmann *et al*. 1998) due to there being little information available. During May 2004, however, an acoustic survey of the LUCORC region by the R. S. Africana found substantial amounts of round herring (260 000 tons) in the area between Lüderitz and the Orange River (MCM unpublished data). These fish could be an important food source to other top predators such as large pelagic fish (Shannon and Jarre-Teichmann 1999), condrichthyans (Jarre-Teichmann *et al*. 1998), seals and seabirds (Crawford *et al*. 1991), yet not enough information is available to include them into ecosystem models.

Given recent endeavours to move away from single-stock assessments procedures towards an integrated ecosystems approach to fisheries management, some fundamental uncertainties need to be addressed for several species groups. These include greater effort to improve indices of biomass, consumption, predator selectivity and the variability in these related to absolute abundances of prey species (Shannon *et al*. 2004, Roux and Shannon 2004). This proposal aims to address some of the questions related to the mesopelagic species located in the northern and southern Benguela through a dedicated acoustic survey, with bottom and midwater trawling for target identification, of the entire shelf out to a depth of 500 m between Walvis Bay and Cape Point.

1.2. OBJECTIVES OF THE SURVEY

1. Assessing the biomass and distribution patterns of mesopelagic fish species in the southern and Northern Benguela?

2. Determine the target strength of mesopelagic fish species in the Benguela region in-situ using high resolution multi-frequency techniques

3. Collect oceanographic variables (temperature, salinity and oxygen) to determine their

influence on the distribution and behaviour of mesopelagic fish species in the Benguela region

4. Collect mesopelagic egg and larvae to quantify their abundance and map their horizontal distribution.

5. Collect acoustic and trawl data on diel vertical migration of mesopelagic fish species during its diel cycle.

1.3. PARTICIPATION

The participants consisted of scientific staff from:

MCM, South Africa:
Janet Coetzee (Project Leader), Johan De Goede, Dagmar Merkle, Nadipah Twatwa, Jan Van Der Westhuizen, Marc Hendricks and Mareck Lipinski

The University of Bergen, Norway
Arved Staby

NatMIRC, Namibia:
Uatjavi Uanivi, Birgit Goeck, Erasmus Kakonya, Twali Akawa and Martha Uumati

Institute of Marine Research, Norway:
Jens Otto Krakstad (Cruise Leader), Erling Kåre Stenevik, Tor Egil Johannson and Ole Sverre Fossheim

1.4. NARRATIVE

The ship left Walvis Bay on Wednesday 23rd August at 20:00 UTC (Local time = UTC+1). The first acoustic transect was reached at 01:50 UTC the following morning. There was a break in the survey outside Lüderitz on the early morning of the 30th after the eight transect due to bad weather. The survey was resumed at 08:00 on the morning of the 1st September after a crew change in Lüderitz on the 31st August. Another break in the acoustic survey was made on the

morning of the 2nd September to allow for a 36 h diel station. The station was completed and the survey resumed on the 3rd at midday. The border between Namibia and South Africa at the Orange River was reached on the late evening of the 4th September. The survey was terminated off Cape Town on the 12th at 01:30 after the last Multinet station, and the vessel thereafter steamed to Cape Town where we arrived at 08:30 in the morning, local time.

The survey area was divided into five different strata based on the expected density of mesopelagics within each region. Within each stratum acoustic data was collected routinely on randomly spaced parallel transects between 500 m bottom depth to the coast at 20 m depth, or to the end of the fish distribution. Bottom and pelagic trawl catches were used to identify acoustic targets and collect length frequency data and biological data on the sampled populations.

CTD's and Hydro bios plankton nets were conducted with 15 NM intervals on predetermined transects spaced approximately 60 NM apart. CTD's were taken to 250 m depth.

All together 90 Pelagic trawl stations, 6 bottom trawl stations, 47 plankton net stations, 52 hydrographical stations were completed during the survey.

1.5. SURVEY EFFORT

The survey design consisted of a series of pre-stratified, randomly spaced, parallel transects, designed to obtain unbiased estimates of stock size and sampling variance (Jolly and Hampton 1990). The survey area was divided into five strata: Walvis Bay to Easter Point, Easter Point to the Orange River, Orange River to Hondeklip Bay, Hondklip Bay to Doring Bay, Doring Bay to Cape Columbine and Cape Columbine to Cape Point (Fig. 1). Survey effort in the area south of Luderitz was adjusted downward during the survey in order to complete coverage of the entire area.

Figure 1 shows the cruise tracks with fishing stations and Figure 2 shows plankton and hydrographical stations. Table 1 summarizes the survey effort by strata.

Table 1. Summary of survey efforts by regions, including number of demersal and pelagic trawl hauls, CTD casts, Multinet stations and distance surveyed.

Area	BT	PT	Total Trawls	CTD casts	Multinet stations	Log (nm)
Walvis Bay - Easter Point	1	21	22	11	11	661.6
Easter Point - The Orange River	4	35	39	14	14	758.9
Orange River - Hondklip Bay	0	11	11	8	8	389.4
Hondklip Bay - Doring Bay	0	12	12	7	7	346.1
Doring Bay - Cape Columbine	1	8	9	6	6	336
Cape Columbine - Cape Point	0	3	3	2	2	200
Total	6	90	96	48	48	2692

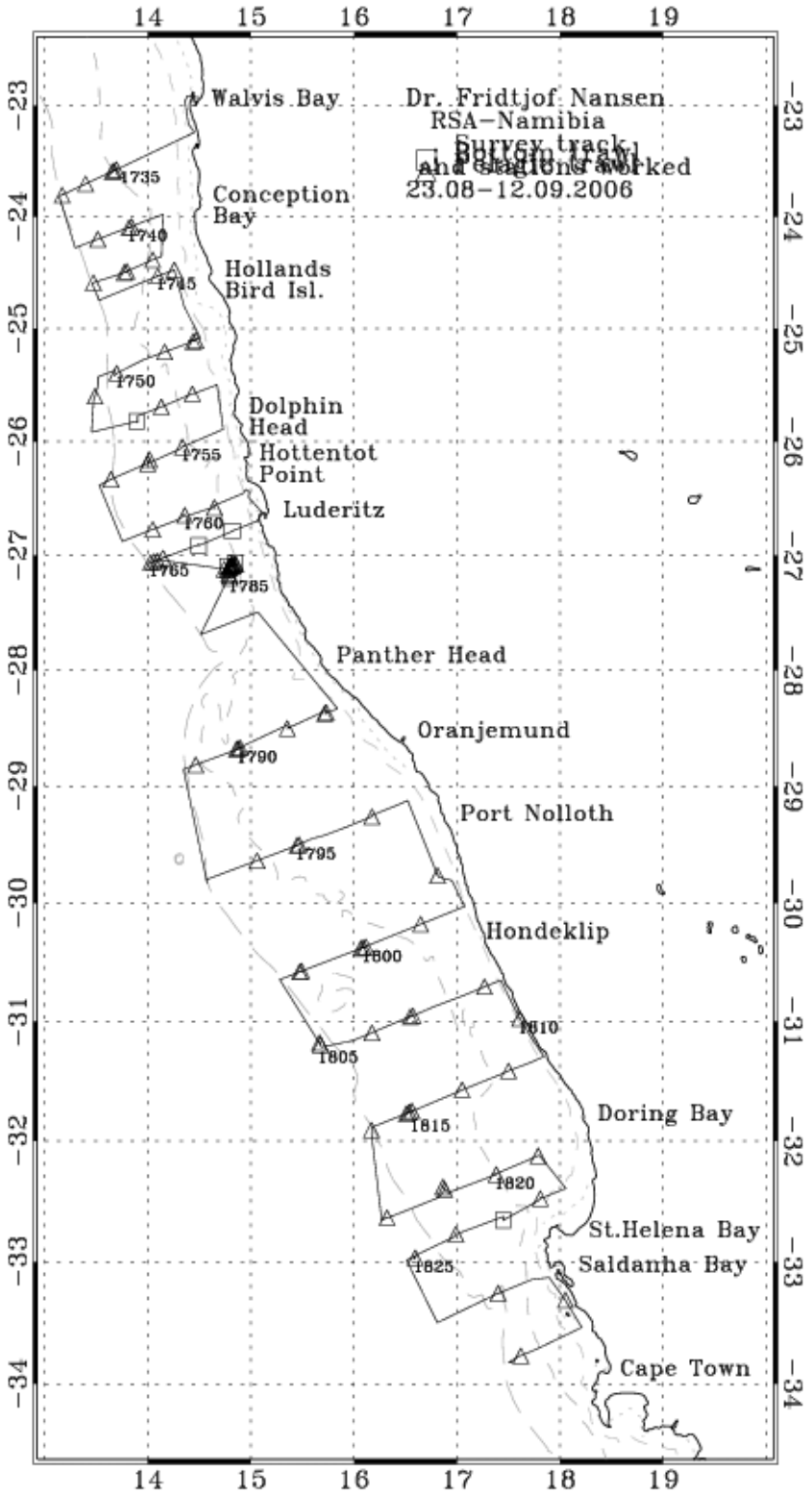


Figure 1. Course track with fishing stations in the survey area. Depth contours are indicated

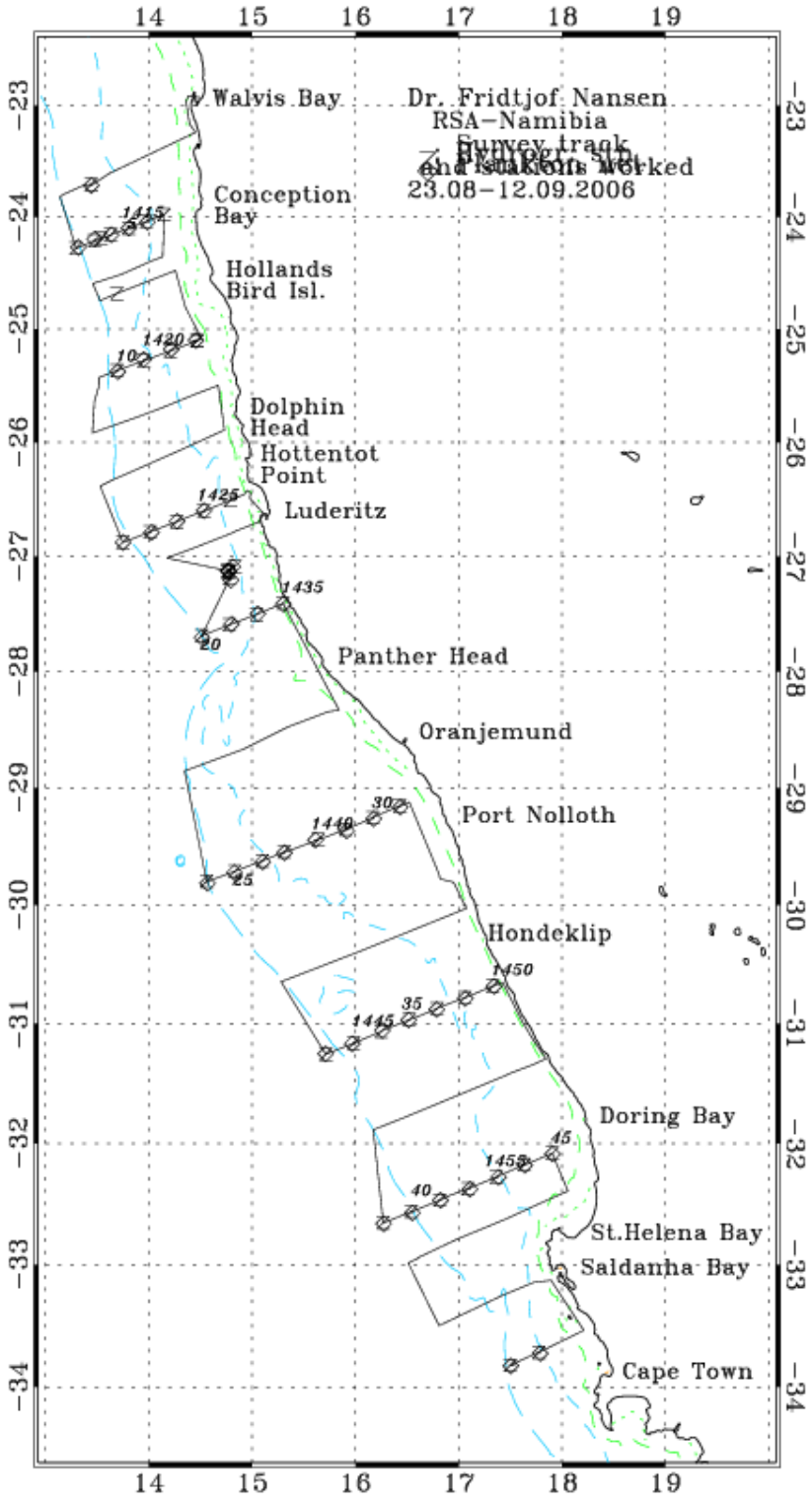


Figure 2. Course track with plankton and hydrographical stations in the survey area. Depth contours are indicated

CHAPTER 2. METHODS

2.1. HYDROGRAPHIC SAMPLING

A Seabird 911+ CTD probe was used to obtain vertical profiles of the temperature, salinity and oxygen. Real time logging was carried out using the PC based Seabird Seasave software. CTD casts were conducted on predetermined environmental sampling transects. The casts were stopped a few meters above the bottom, and at a maximum of 500 m depth. An underwater low-light sensor attached to the CTD provided information of light extinction with depth.

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

A SBE 21 Seacat Thermosalinograph was continuously logging surface salinity data from 5 m depth during the survey.

2.2. TRAWL SAMPLING

Fishing gear

The vessel has two different sized four-panel 'Åkrahamn' pelagic trawls and one ‘Gisund super bottom trawl’ that were used during the survey. The smallest pelagic trawl has 10-12 m vertical opening under normal operation, whereas the large trawl has 15-18 m opening, and a typical wing distance of 35 m. The larger Åkrahamn pelagic trawl was connected with the multisampler during the survey. The multisampler is advantageous because it has three codends that can be opened and closed at any depth. It can therefore take three separate discrete samples in each hauls. Each net was typically open for 10 –15 m during trawling.

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

identification only and no restraining rope was therefore used during the survey. Typical trawl time was 30 min.

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

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

2.3. MULTINET PLANKTON SAMPLER AND CUFES

The Hydrobios Multinet was used to collect depth stratified Zoo- and ichtyoplankton samples. The plankton sampler has an opening of 0.5 x 0.5 m and five nets with a mesh size of 405 μm. A flow meter was mounted at the opening of each net. A Scanmar depth recorder with acoustic transmission to the vessel was mounted on top of the Multinet. The plankton sampler was retrieved at a speed of 0.5 - 1.0 m/sec while the vessel maintained a speed of 2 - 2.5 knots, and typical towing time per net was three minutes. The depth intervals used during this survey were 0 - 50 m, 50 – 100 m, 100 – 150 m, 150 – 200 m and 200 – 250 m when bottom depths were greater than 100 m, and 0 – 25 m, 25 – 50 m, 50 –75 m and 75 – 100 m above bottom when bottom depth was less than 100 m.

The CUFES (Continues Underway Fish Egg Sampler) system was mounted onboard prior to the survey. Samples from the system was regularly collected every 30 min (5 nm) during the whole survey The species composition of the samples were determined and the number of eggs of each species counted and registered together with the middle position of the sampled area.

2.3.1. Processing of ichthyoplankton from the multinet

After removing the cups from the Multinet the samples were transferred into petridishes and examined under a stereomicroscope. All fish larvae and fish eggs were removed from the sample. The eggs and larvae were identified using the key of Olivar and Fortuño (1991) and counted.

2.4. BUOYANCY MEASUREMENTS OF FISH EGGS AND LARVAE

The onboard equipment from Martin Instrument Co. Ltd. was used to measure specific gravity of fish eggs. The equipment consists of three glass cylinders, 50 mm internal diameter and 700 mm high, submersed in a temperature-controlled transparent water container. The temperature was kept constant by a ship-mounted cooling unit. A linear salinity gradient was set up in each column by filling the columns from two conical flasks, each filled with 830 ml salt water solution, connected by a plastic tube at the bottom, one with low-salinity and the other with high-salinity. The filling of each column took about 30 min.

The columns were calibrated by inserting glass floats with known specific gravities ranging from about 1.021 to 1.027 g cm^{-3}, into each column. Table 1 shows the Id. number and the exact specific gravities at 11.5°C and 15°C for each float. The specific gravity of the floats was given with an accuracy of +/- 0.0002 g cm^{-3}.

The fish eggs to be measured were inserted into the columns with a pipette just below the surface and were allowed to settle before the first measurement of the vertical position in the column was taken. Only wild caught eggs were measured. Neutral buoyancy of the eggs was expressed in salinity units by calculating the salinity gradient in the column from the absolute densities of the floats and from the temperature in the columns.

Table 1: Exact specific gravities, ρ, at 11.5°C and 15°C of glass floats in the three columns.

Column I			**Column II**			**Column III**		
Id. No	**ρat**		**Id. No**	**ρat**		**Id. No**	**ρat**	
	11.5°C	**15.0°C**		**11.5°C**	**15.0°C**		**11.5°C**	**15.0°C**
22635	1.0233	1.0232	23745	1.0228	1.0228	22633	1.0218	1.0217
20381	1.0243	1.0242	20377	1.0248	1.0247	20380	1.0241	1.0240
20375	1.0255	1.0254	20372	1.0262	1.0261	20374	1.0256	1.0255
20366	1.0270	1.0269	20358	1.0281	1.0280	20362	1.0276	1.0275

2.5. MULTIFREQUENCY ACOUSTIC SAMPLING AND ANALYSIS

Equipment

Two synchronised Simrad EK 500 echosounders connected to four transducers with operating frequencies of 18 kHz, 38 kHz, 120 kHz (split beam) and 200 kHz (single beam) were used during the survey. All acoustic transducers were calibrated successfully in Elefant Bay in Angola

prior to the survey. No major deviation from prior calibrations was observed. The calibration report with the technical specifications and operational settings used can be found in Annex II. To minimise differences in sampling resolution, the pulse length and band width setting of the transducers were set to short/wide (18 kHz; 0.7 ms), medium/wide (38 kHz; 1.0 ms) and long/narrow respectively (120 kHz and 200 kHz; 1.0 ms). Data were logged continuously on transects and during trawls with Windows based Sonar Data_Echolog v3.4 software. Analysis and post processing of logged data was done using Sonar Data_Echoview software, v3.4.

Target strength estimation

Target strength (TS) is the scaling factor required to convert the mean area backscattering coefficient s_A (NASC; m^2/NM^2) to fish density. No specific target strength relationships are presently available for the dominant mesopelagic fish species of the central and southern Benguela region. For this reason we attempted to collect *in situ* TS data during the course of the survey at 38 kHz (the principle survey frequency for biomass estimation in the region).

Due to data volume restrictions, acoustic data collected during steaming between stations and between trawls was limited to binned data (i.e., no sample data) of all four frequencies. During trawling and during the reciprocal steam back to the start of the trawling position, sample power and angle telegrams of the 38 kHz and 200 kHz transducers were also collected. During these times, the pulse duration of the 200 kHz transducer was changed from 0.6 ms (long/narrow) to 0.2 ms (medium/wide) in order to reduce the pulse length and the resolvable pulse volume. In order to match the target strength and biological data as closely as possible, the analysis was restricted to files collected either during or directly before or after successful identification of acoustic targets by aimed trawling. Data collection was mainly (but not exclusively) restricted to night time recordings in areas where mesopelagic fish dispersed in various sound scattering layers in mid-water or close to the surface. Furthermore, data collection was restricted to areas where trawl samples indicated dominance (>80%) of one species only and the catch rate of that species exceeded 20 $kg.hr^{-1}$. Targeting of specific layers (depth discrete sampling) was made possible with the multi-sampler and enabled us to successfully extract target strength information from various species-specific depth bands in close proximity to the trawl.

The echogram of each of the selected experiments was visually inspected to select regions where fish densities appeared to be low enough for the extraction of echoes from single targets. These regions often did not coincide completely with the depth at which the trawl samples were collected, as these were often aimed at the densest part of the concentrations. Instead, selections were made around the periphery of these concentrations, where lower densities enabled successful extraction of single targets.

The methods used to extract and analyse single target detections differed depending on the data (sample data or binned data) collected and the transducer type (hull mounted or submersible) used to collect the data. Three methods of single target detection were used:

(i) When only binned data were collected, individual targets detected at 38 kHz and 120 kHz by the EK500 internal target detection algorithm, based on the phase and echo duration, were exported for further analysis as explained below.

(ii) During trawling and immediately after trawling, the sample data collected were used in Sonar data Echo view's virtual echogram module to create a new echogram based on the single target detection (split beam method II) algorithm (see echo view help documentation). The algorithm acts on power data on a ping-by-ping basis. It calculates power data from TS values using the following formula:

$$P_i = TS_i - 40\mathrm{Log}(R_i) - 2aR_i \qquad (1)$$

Where:

TSi = target strength of sample i

Ri = the corrected range of the sample defined as Ri = ri - at

a = absorption coefficient (dB/m)

and where:

ri =range of sample *i*

a = TVG range correction offset

t = sample thickness

(iii) The target-tracking module of Sonar data Echo view was used to track single target detections from the submersible 38 kHz split beam transducer while the ship was stationary.

Further screening of the 38 kHz data collected was carried out by comparing signals at 38 and 200 kHz (when the data originated from the keel mounted transducers). The 120 kHz data was not used as it was anticipated that the shorter pulse duration setting used during and after trawling at 200 kHz (medium/wide; 0.2ms) would make this data more effective for data screening. The screening was based on the fact that the keel-mounted 38 and 200 kHz transducers are in close physical proximity to each other resulting in significant beam overlap and the ability to detect the same targets at both frequencies simultaneously. If the transmissions are synchronised, (in this case the 200 kHz transducer was triggered from the 38 kHz transducer) a target should therefore appear at very nearly the same range in both sounders. By accepting only 38 kHz targets which have been detected as single by the 200 kHz transducer, which has a higher range resolution (~15 cm at 0.2 ms) the discrimination at 38 kHz can in principle be improved substantially.

Single targets detected during stationary data collection with the 38 kHz submersible transducer through both the Simrad EK500 single target detection method and from the Sonar data Echo view virtual split beam method II algorithm were compared both to each other and to the single targets contained within single target tracks. The aim of this comparison was to estimate the effectiveness of all three methods in screening out multiple targets.

TS histograms were generated for both the screened and un-screened (by 200 kHz) 38 kHz single target data and related to the mean length of the particular species contained in the associated trawl. To estimate the peak in the TS histogram, it was assumed that the back-scattering cross-section follows a lognormal distribution. A normal probability density function was calculated and fitted to the observed data. The standard deviation (σ) was first estimated by fitting a one-tailed normal distribution to the left tail of the histogram. Next the mean of the PDF was calculated by adjusting the mean (μ) until the peak of the function was aligned with the peak of the data distribution. The form of the fitted function is:

$$f_i = \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-(x_i-\mu)^2}{2\sigma^2}} \qquad (2)$$

Where μ and σ are the mean and standard deviation (in dB) of the TS distribution.

Calculation of the mean TS of species *j* is by numerical integration of the function itself (after transformation to the linear domain), rather than from the actual data. A regression of mean TS versus mean fish standard length (L) obtained from the trawl sample gave the TS as a function of fish size according to the form:

$$TS_j = a + b \log L_j \qquad (3)$$

Mean TS per kg of fish for species *j* was also derived for biomass estimation by dividing the mean TS per individual by the mean weight $(W)_j$ of 1 fish of species *j* as follows:

$$(TS_{kg})_j = TS_j - 10 \log W \quad (4)$$

Where W is the weight in kg of 1 fish of species *j*

Regression of $(TS_{kg})_j$ against mean length of species *j* then gives the length related TS_{kg} for species *j* of the following form:

$$(TS_{kg})_j = a + b \text{ Log } L_j \quad (5)$$

For species *j*, this expression is converted to the linear form $(\overline{\sigma}_{kg})_j$; the mean back scattering cross section per kg which is used in equation (8) below for density estimation as follows:

$$(\overline{\sigma}_{kg})_j = \frac{\sum n_i \cdot 10^{0.1 b_j} \cdot l_i^{\frac{a_j}{10}}}{\sum n_i} \quad (6)$$

Where l_i = length class *i*

n_i = number of fish in length class *i*

b_j and a_j are constants in the TS_{kg} versus length relationship

TS estimation was attempted for the 3 most dominant mesopelagic fish species found during the survey, i.e., two myctophids *Lampanyctodes hectoris* (also known locally as the lanternfish) and *Symbolophorous boobs* and the sternoptychid *Maurolicus muelleri* (also known locally as the lightfish). Target strength relationships for pelagic fish found during this survey (sardine, anchovy and horse mackerel) have been estimated previously (Barange et al 1996) and were applied accordingly. For round herring, the target strength was assumed to be the same as that applied for sardine.

Estimation of biomass

Target species of the same genus are generally not acoustically distinguishable. When more than one species of fish (each with a different TS) is present within an ESDU (elementary sampling distance unit), it is necessary to partition the echo intensity between the species. The contribution of species *j* to the total s_A (mean back scattering coefficient) is given by:

$$(s_A)_j = F_j . s_A \quad (7)$$

Where $$F_j = \frac{n_i \overline{\sigma}_j}{\sum n_j \overline{\sigma}_j} \quad (8)$$

And $\overline{\sigma}_j$ = mean back scattering cross section for species $_j$

n_j = number of fish of species j in the sample

where $$n_j = \frac{W_j}{\overline{w}} \quad (9)$$

where $\overline{w}_j$ = mean weight of species $_j$ and

W_j = is the weight of species $_j$ in the sample

Therefore: $$(s_A)_j = \frac{\frac{W_j}{\overline{w}_j}\overline{\sigma}_j.s_A}{\sum_j^m \frac{W_j}{\overline{w}_j}\overline{\sigma}_j} \quad (10)$$

$$= \quad (s_A)_j = \frac{W_j(\overline{\sigma}_{kg})_j.s_A}{\sum_j^m W_j(\overline{\sigma}_{kg})_j} \quad (11)$$

The area density (kg.m^{-2}) for fish of species *j* is given by:

$$\rho_{kg} = \frac{(s_A)_j}{4\pi.1852^2(\overline{\sigma}_{kg})_j} \quad (12)$$

By substitution of equation (11) into (12), the density is

$$\rho_{kg} = \frac{W_j(\overline{\sigma}_{kg})_j.s_A}{4\pi.1852^2\sum_j^m W_j(\overline{\sigma}_{kg})_j.(\overline{\sigma}_{kg})_j} \quad (13)$$

Which simplifies to:

$$\rho_{kg} = \frac{W_j.s_A}{4\pi.1852^2\sum_j^m W_j(\overline{\sigma}_{kg})_j} \quad (14)$$

Mean density estimates obtained from equation (14) above per species per ESDU, (variable length, but mostly around 10 nm) were then averaged per transect and stratum according to the stratified random method of Jolly and Hampton 1990. Detail of the method is provided below for

completeness:

The mean density (kg.m^{-2}) of a transect $_j$ is given by

$$\overline{\rho}_j = \frac{\sum \rho_i \cdot L_i}{\sum L_i} \tag{15}$$

Where ρ_i is the measured density and L_i is the length (nm) of each ESDU on transect $_j$

The mean density of the stratum$_k$ is then given by

$$\overline{\rho}_k = \frac{\sum \rho_j \cdot L_j}{\sum L_j} \tag{16}$$

Where L_j is the length of each transect in nautical miles

And the biomass of each species in stratum$_k$ is

$$B_k = \overline{\rho}_k \cdot A_k \tag{17}$$

Where A_k is the surface area in km^2 of the surveyed area of stratum *k*.

The variance s_k^2 of the mean density estimate of stratum$_k$ is given as

$$s_k^2 = \frac{n_k}{n_k - 1} \cdot \frac{\sum \left[\left(\overline{\rho}_j - \overline{\rho}_k \right) \cdot L_i \right]^2}{\left(\sum L_j \right)^2} \tag{18}$$

Where n_k is the number of transects in stratum *k*

The CV of the mean density estimate of stratum $_k$ is then given by

$$CV_k = \frac{\sqrt{s_k^2}}{\overline{\rho}_k} \tag{19}$$

The variance of the biomass of stratum$_k$ is calculated as

$$\sigma_k^2 = \left(CV_k \cdot B_k \right)^2 \tag{20}$$

And the biomass for the entire survey area is simply the sum of the biomass of all strata, while the CV of this total biomass estimate is calculated by simple summation across all strata

$$CV_{total\ biomass} = \frac{\sqrt{\sum_{k}^{m} \sigma_k^2}}{\sum_{k}^{m} B_k} \tag{21}$$

The surface area occupied by the survey derived biomass for each stratum was computed by projecting a density surface (which includes all sampled positions) onto a plane and calculating the positive area of the projection in squared degrees using Surfer 8 mapping software. The relationship between latitude and distance is constant, whereas the distance expressed as degrees of longitude varies with the cosine of the latitude. Conversion of squared degrees to km^2 was therefore according to

$$A_{km^2} = \deg^2 \cdot 60(60 \cos lat) \cdot 1.852^2 \tag{22}$$

Where *lat* is taken as the mean latitude of the stratum.

Trawl samples were pooled per stratum to obtain size compositions of the entire populations surveyed. Individual trawl length distributions were weighted according to the acoustically estimated biomass in the vicinity of the trawl. Weighted size frequencies were computed for all strata and summed to produce a size frequency for the survey. The method of weighting of the length frequencies is given below:

For stratum *i*, $(T)_{ij}$ is the vector of numbers in sample *j*, where the elements of the vector correspond to length classes. The acoustic weighting for each trawl sample is given by:

$$Z_{ij} = \sum L_{ijk} \cdot \rho_{ijk} \tag{23}$$

Where L_{ijk} and ρ_{ijk} are the mean length and mean acoustic density respectively for sample *j* and interval (ESDU) *k* in stratum *i*.

To weigh individual trawls, one needs to convert the acoustic weighting factor (in terms of mass) into a factor in terms of numbers. The trawl-weighting factor, Q_{ij}, is given by:

$$Q_{ij} = \frac{Z_{ij}}{X_{ij}} \tag{24}$$

Where X_{ij} is the length frequency mass of sample *j*.

Weighted length frequency in stratum *i* is the vector $(T)_i$:

$$(T)_i = \sum (T)_{ij} \cdot Q_{ij} \tag{25}$$

To get total numbers $(N)_i$ in stratum *i*, multiply the weighted length frequency by:

$$(N)_i = (T)_i \sum Z_{ij} \cdot B_i \tag{26}$$

Where B*i* is the biomass in stratum *i*. Then sum the numbers at length across strata to obtain the total numbers at length in the survey.

Fish distribution maps were derived from data interpolation using standard Kriging routines in Surfer 8.

2.6. DIEL STATIONS

One diel cycle station was conducted during the survey. During this cycle the vessel was anchored during a period each dusk and dawn, and the submersible transducer was lowered to a depth < 50 m above the fish aggregations of interest, and followed this layer over the migration period. The purpose of this was to capture the migration phase of the mesopelagic fish, and follow single fish during the migration phase to collect data on target strength and individuals swimming behaviour. Trawling and plankton sampling with the Multinet was conducted between each diel period in order to collect biological data and information on the size distribution and species composition of the fish in the area. Approximately 36h was spent with the diel experiment, and one dusk situation and two dawn situations were recorded.

The prerequisites for the 48hr station were calm waters and the presence of sufficient amounts of mesopelagic fish at a bottom depth of 250-300 m. In the early hours of September the 2nd, weather conditions were favourable, and a pelagic trawl towed at 55 m depth contained sufficient amounts of mesopelagic fish (*Lampanyctodes hectoris*) to proceed with the experiment. A depth stratified multinet and a CTD were conducted, before the vessel was

anchored at $27^0$07'S $14^0$44'E at approximately 250 m bottom depth. The submersible transducer was lowered to just beneath the surface, and the settings on both the Ek-500 sounders changed so that the 38kHz on the Ek500-2 and the 120kHz on the Ek500-1 were active and transmitted the desired raw data. A detailed list of the settings is given in Appendix II. Initially the ping rate of the submersible transducer was low, which was increased by changing the settings in the operation menu from externally triggered to normal. At 04h00 UCT the transducer was lowered to a depth of 25 m, close to a distinct layer lying between 30-50 m depth. The descent of this layer started at 04h20 UCT and the transducer was subsequently lowered to a depth of 170 m at 05h00 UCT, trying to record individual fish targets while they descended through the beam. At 05h15 this continuous thread of mesopelagic fish started scattering a bit more at a depth of 185 m, and not long after went deeper than 200 m. By 06h00 UCT the fish had settled close to the bottom and no noticeable changes in the layer structure could be observed. Data collection with 'station settings' was stopped at 07h00 UCT, the transducer heaved onboard and the transducer settings changed to 'trawl-settings'. A succession of trawls, CTDs and multinets followed before the vessel anchored again in the afternoon at 15h00 UCT to observe the dusk period until 20h00 UCT. This was followed by another period of targeted trawling, CTD and Multinet stations before the vessel anchored for the third migration period at 03h00 UCT. The experiment was terminated around midday on the 3rd after a last cycle of targeted trawling, CTD and Multinet station. Weather conditions had deteriorated and made the collection of good data impossible, thus omitting the observation of the second dusk migration.

CHAPTER 3. RESULTS

3.1. OCEANOGRAPHIC CONDITIONS

The sea surface temperature (SST, 5 m depth) was continuously recorded during the survey. Figure 3 shows the horizontal distribution of SST in the surveyed region. The most prominent feature in the survey area was the upwelling cell off Lüderitz. Water masses in this area had a temperature between 10 and 16°C. Temperature isolines were recorded along the coast. Lowest water temperatures of 10°C were recorded from Lüderitz and north indicating the most intense up-welling area. The highest temperatures of 15°C were recorded offshore, with occasional pockets of 16°C waters.

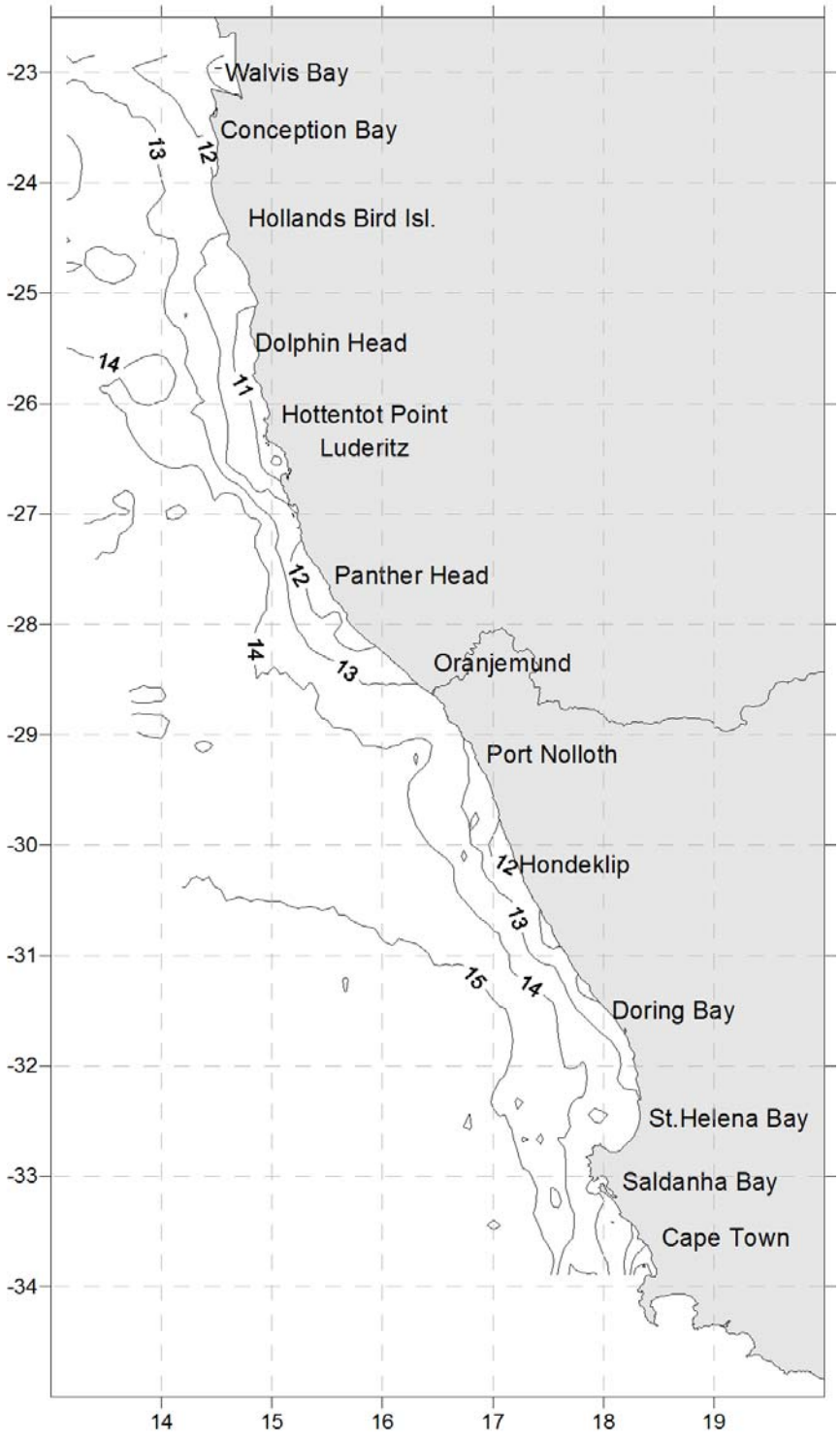


Figure 3. Horisontal distribution of surface temperature (5 m depth) in the survey area

The sea surface salinity (SSS, 5 m depth) was continuously recording from the thermosalinograph during the survey. Figure 4 shows the horizontal distribution of SSS in the surveyed region. Low salinity values along the coast of Southern Namibia corresponds with low

SST and illustrates the low salinity water masses linked with the upwelling situation off the southern Namibian shelf. The isolines were typically distributed along the coast in the survey area, with the lowest salinity recordings found inshore in the survey area, and in particular north of Lüderitz were minimum salinity of 34.4 PSU were recorded in a small area. Highest salinity values were recorded offshore of the 200 m isobath with PSU >35.0 off Namibia increasing to 35.4 PSU off Saldanha Bay in South Africa.

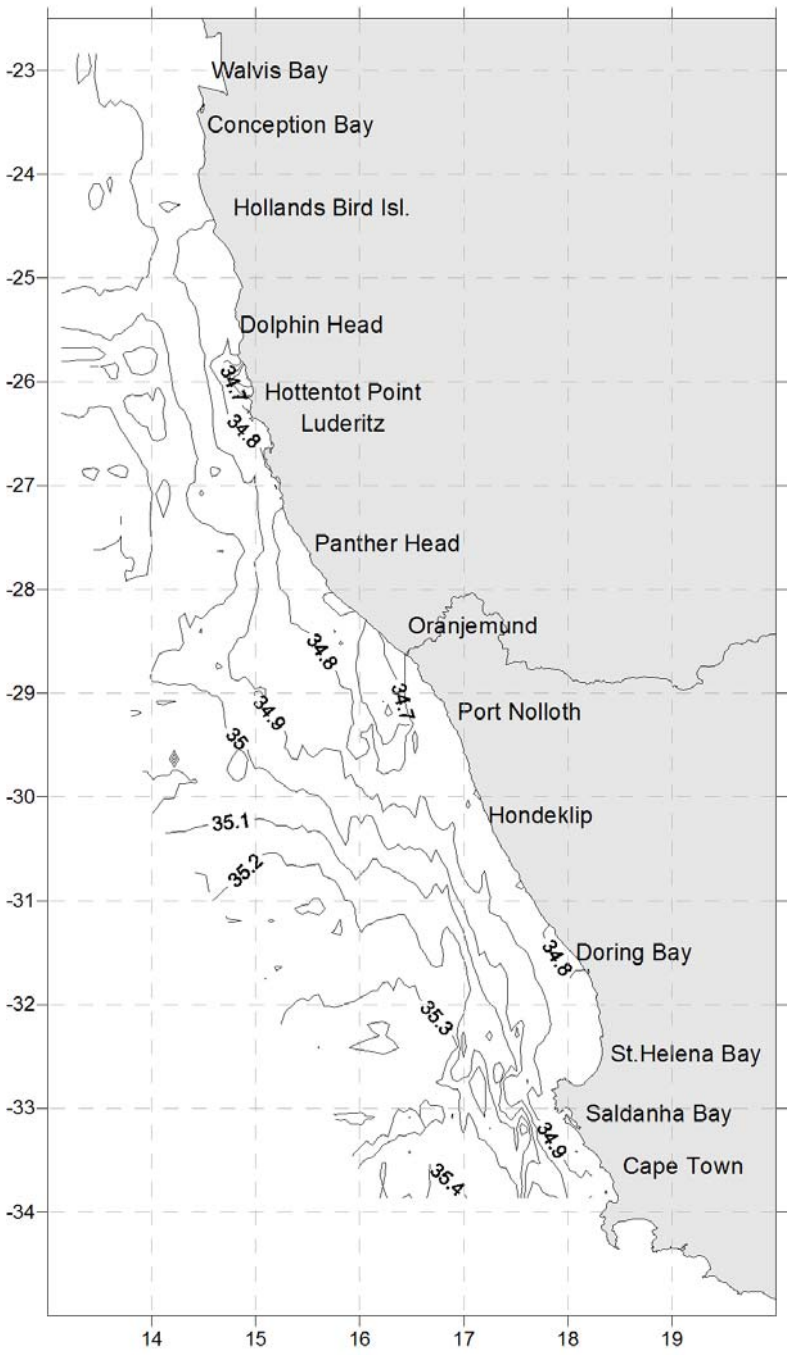
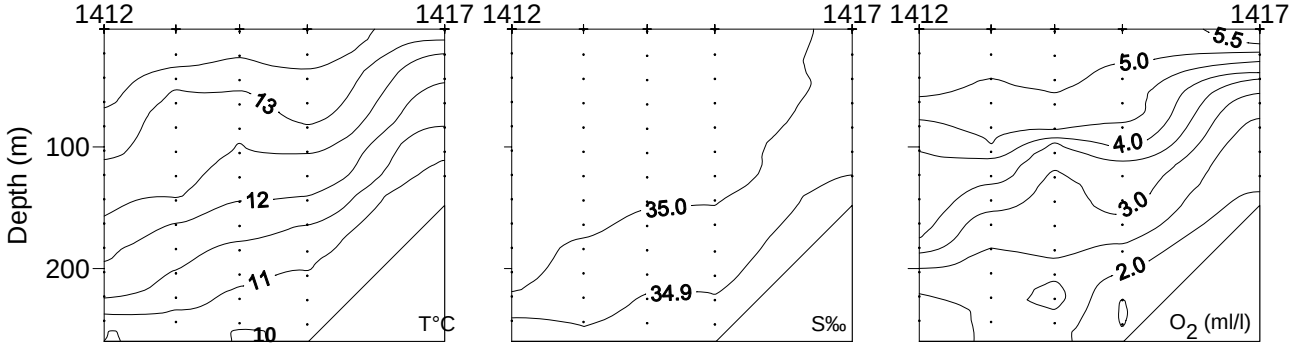


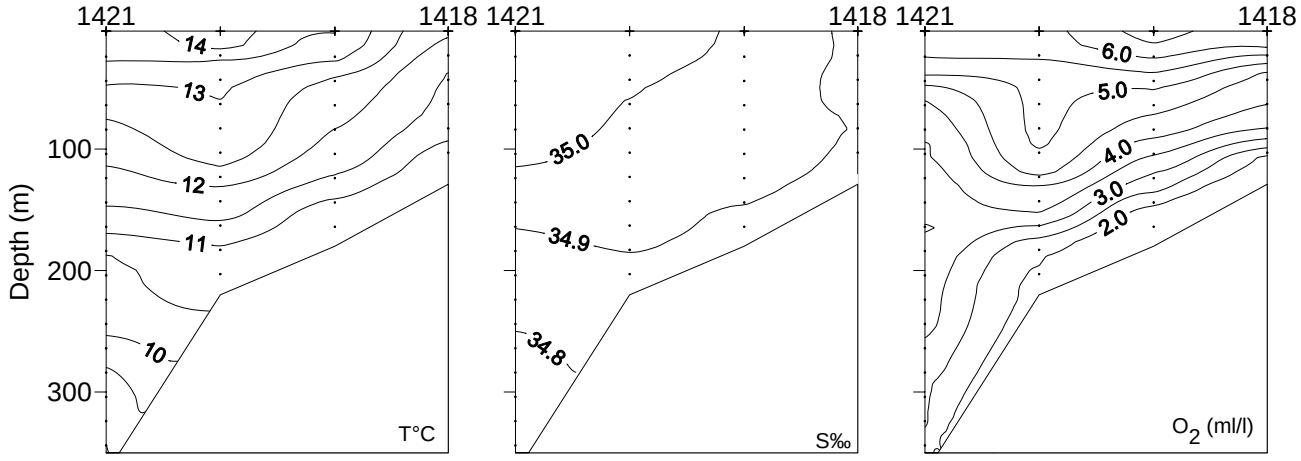
Figure 4. Horizontal distribution of surface salinity (5 m depth) in the survey area

Figure 5 shows the vertical distribution of temperature salinity and oxygen recorded on the hydrographical transects conducted during the survey. Data were recorded from the surface to 250 m depth at each station. The profiles show that there was pronounced upwelling along the whole coast with subsurface waters of low temperature and salinity coming to the surface inshore. The coldest surface water temperatures <12° C were found inshore in the central part of the survey area on line 5, 8 and 10, with surface waters typically increasing inshore further south. Offshore surface temperatures were typically 14°C increasing to >16°C on line 16. Bottom water temperatures at 250 m depth were typically 10°C in the northern part of the area decreasing to 8°C in the south. Salinity measurement corresponded with the temperature values. Lowest salinity values around 34.9 PSU were found inshore in the most intense upwelling area with values around 35.0 PSU north and south of this. Offshore salinity values increased southwards from >35.0 PSU in the northern part towards > 35.4 PSU on line 16. Bottom salinity values at 250 m depth decreased southwards with salinity around 34.9 in the northern part of the area to 34.6 PSU in the south leading to a much larger salinity gradient on the southern cross shelf transects. It is clear from the measurements on line 14 and 16 that a different water body with other characteristics are present offshore in the upper 100 m and a clear frontal zone (salinity and temperature) is present between these water masses and the more costal water masses. Water masses in the whole survey area were well oxygenised with oxygen concentrations up to 6 ml/l in the surface layers, decreasing towards 2 ml/l in bottom waters. Slightly more oxygenated waters were found in the south of the survey area.

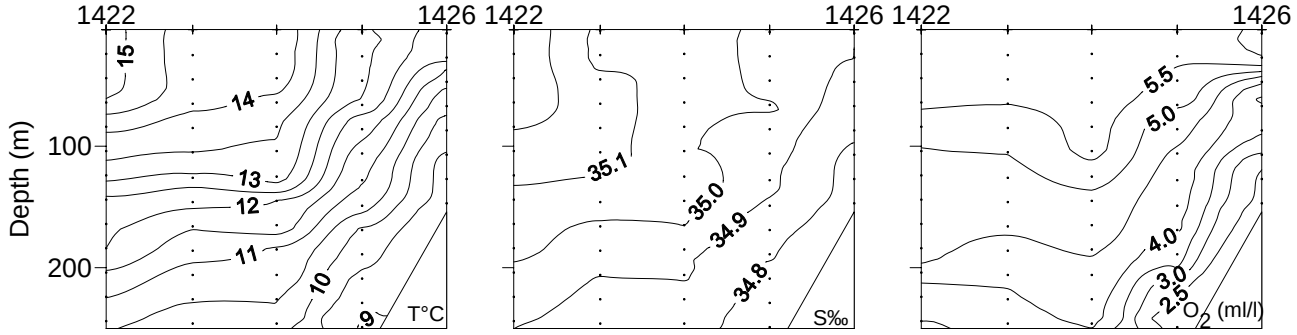
a) Line 2



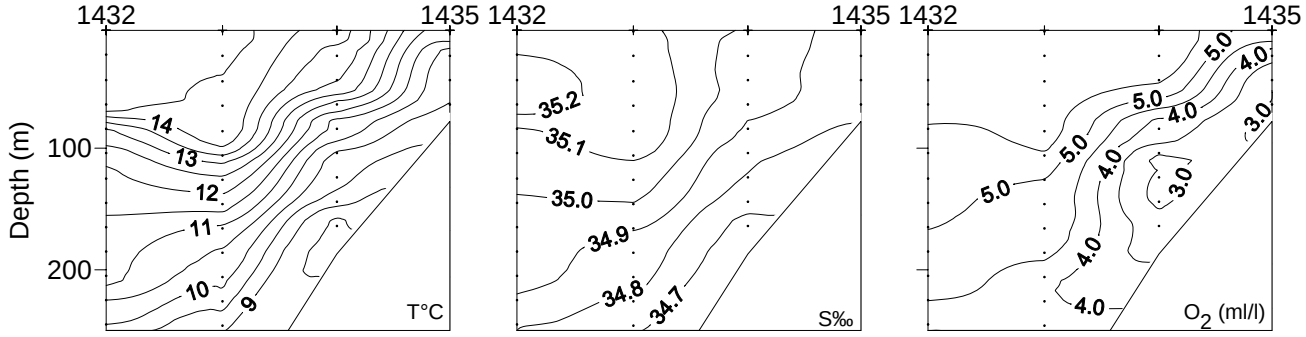
b) Line 5



c) Line 8



d) Line 10



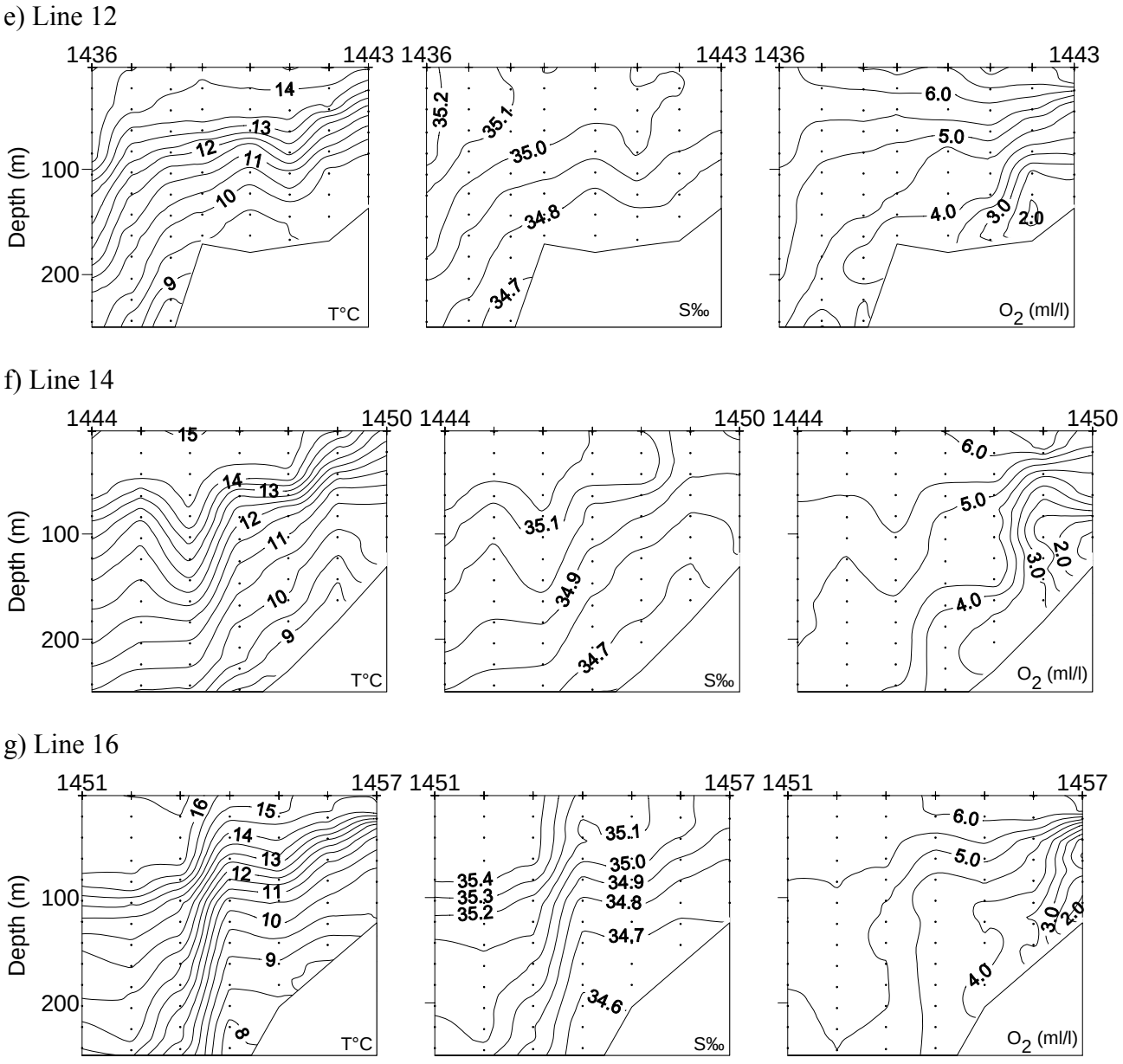


Figure 5. Vertical sections of temperature, salinity and oxygen in the survey area. The name of the section refers to the transect number of the survey.

3.2. TARGET STRENGTH ESTIMATION

Preliminary analysis of the *in situ* target strength data collected was performed on board. The only data presented here is the single target data collected at 38 kHz from the keel mounted transducer. Screening of single targets was performed by comparing the depth of single targets collected simultaneously by the keel mounted 200 kHz transducer as described in the methods. Given the higher frequency and the relative low TS of the mesopelagic targets, the 200 kHz data

was only reliable up to a depth of approximately 100m. Further analysis of all TS data collected will be performed in due course.

Lampanyctodes hectoris

During this survey the lanternfish, *Lampanyctodes hectoris* was found dispersed in layers close to the surface at night, making it relatively easy to extract TS data for this species. Often, however, the density in these layers was very high and TS data could only be extracted around the periphery of dense layers. In this preliminary analysis data associated with 11 trawl samples (Table 2), thought to have been suited to TS measurement, have been analysed.

Table 2. Details of trawl samples associated with *L. hectoris* target strength data collections.

Trawl no	Trawl Depth (m)	Mean Length (Lt)	Mean TS_{ind} (dB)	% *L. hecoris*	Other species present
1741	25	5.20	-53.00	99.2	Juvenile hake, squid sp.
1748	30	6.50	-51.63	96.0	Juvenile hake, gobies, squid sp.
1749	10	4.16	-54.21	58.6	Snoek, Krill, squid sp.
1750	43	5.38	-53.30	77.2	*S. boops*, snoek, *M.muelleri*
1753	25	4.78	-53.97	87.5	*M.muelleri*
1754	25	4.32	-54.51	100.0	-
1755	60	5.36	-53.33	77.1	Snoek, *M.muelleri*
1759	80	5.80	-52.97	82.0	*S. boops*, squid sp.
1761	75	5.79	-52.31	99.2	*S. boops*, squid sp., *M. Muelleri*
1778	30	5.20	-53.73	98.5	Squid sp.
1792	10	5.20	-53.15	93.0	S. boops

The regression of mean TS_{ind} versus Fish length (Log L_t) was highly significant ($P<<0.001$) with a standard error of 0.32. A scatterplot of TS_{ind} versus fish length for *L. hectoris* is shown in Figure 6. Also shown is the fitted regression according to the equation $TS = a + b \text{ Log } L_t$ and the average b_{20} constant. A summary of the regression constants as well as the TS_{kg} fitted equation for all three species is given in Table V.

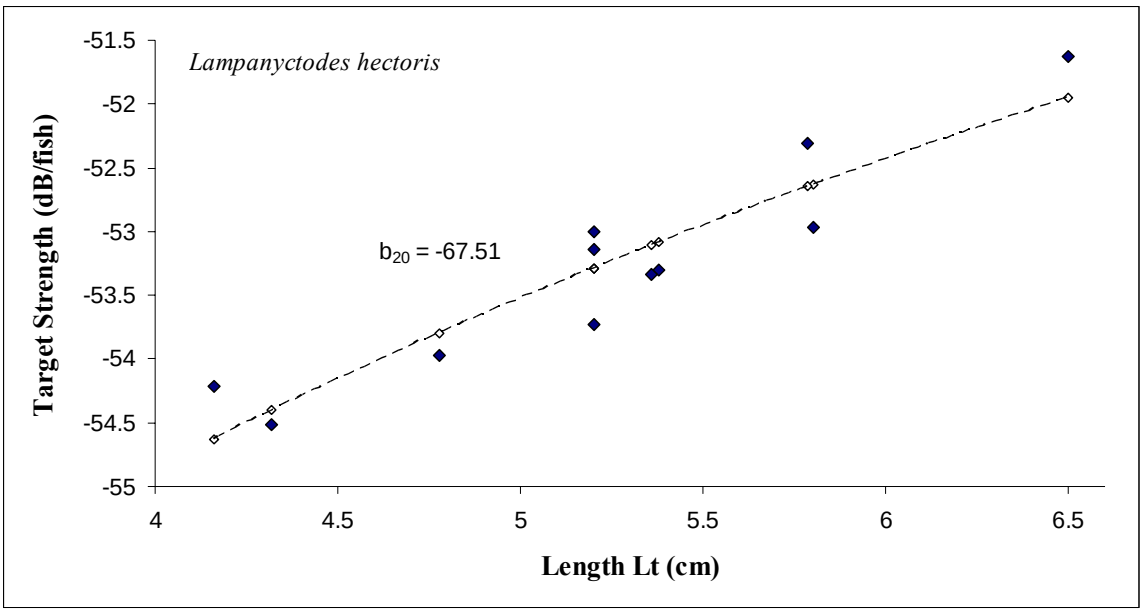


Figure 6. Scatterplot of TS_{ind} (dB) versus fish length for *Lampanyctodes hectoris*.

Maurolicus Muelleri

During this survey it was mostly very difficult to find mono-specific dispersed layers of *M. muelleri* close to the surface at night. An attempt to extract single targets from the periphery of dense schools during the day was also attempted, but failed. All single targets detected at 38 kHz in the vicinity of schools were rejected after screening by the 200 kHz single target data. For this reason we had to relax our criteria of selecting suitable data files for target extraction. In some cases, when other species were present, or dominant in the catch, the TS distributions showed clearly separated peaks and it was possible to match a certain peak to a certain organism. The data set analysed thus far is promising, but lacks sufficient data for larger *M. muelleri*. In this preliminary analysis data associated with 9 trawl samples (Table 3), thought to have been suited to TS measurement, have been analysed.

Table 3. Details of trawl samples associated with *M. muelleri* target strength data collections.

Trawl no	Trawl Depth (m)	Mean Length (Lt)	Mean TS_{ind} (dB)	% *M. muelleri*	Other species present
1789	110	5.20	-51.71	96.7	squid
1797	85	4.28	-53.55	92.1	Round herring, horse mackerel, shrimps
1798	58	4.48	-53.30	43.1	Round herring, horse mackerel
1801	30	4.10	-54.23	47.1	Round herring, horse mackerel, squid
1803	20	4.33	-53.84	100	-
1807	30	4.36	-53.77	96.7	Round herring, squid
1809	25	4.62	-53.08	5.81	Round herring, krill, snoek, squid
1812	10	4.63	-53.05	2.25	*Round herring*
1815	20	4.00	-54.31	13.7	*Angelfish*

The regression of mean TS_{ind} versus Fish length (Log L_t) was also highly significant (P<<0.001) with a standard error of 0.15. A scatterplot of TS_{ind} versus fish length for *M. muelleri* is shown in Figure 7. Also shown is the fitted regression according to the equation TS = a + b Log L_t and the average b_{20} constant. A summary of the regression constants as well as the TS_{kg} fitted equation for all three species is given in Table V.

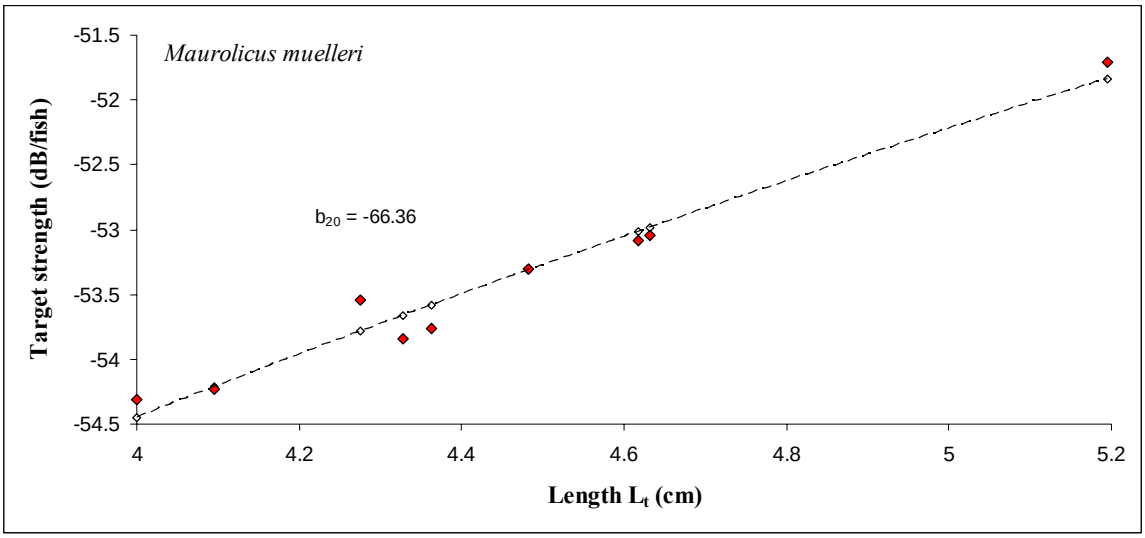


Figure 7. Scatterplot of TS_{ind} (dB) versus fish length for *Maurolicus muelleri*.

Symbolophorous boops

Although *Symbolophorous boops* was found in many trawl samples, especially on the outer regions of the shelf, it was mainly found in mixed layers associated with *Lampanyctodes hectors* and other fish species. A few trawls associated with some larger catches of *S. Boops* were

selected and a preliminary TS expression has been calculated based on these. The slope of the regression is very high, however, and more data of larger fish need to be collected to verify these results. In this preliminary analysis data associated with 5 trawl samples (Table 4), thought to have been suited to TS measurement, have been analysed.

Table 4. Details of trawl samples associated with *S. boops* target strength data collections.

Trawl no	Trawl Depth (m)	Mean Length (Lt)	Mean TS_{ind} (dB)	% *S. boops*	Other species present
1737	10	10.97	-50.65	98.6	squid
1744	45	10.55	-51.80	87.1	myctophids, squid
1759	80	11.44	-46.63	18.0	*L. hectoris*, other myctophids
1767	30	11.88	-46.77	73.1	myctophids, shrimps
1816	5	12.80	-42.59	69.1	Myctophids, *M muelleri*, horse mackerel

The regression of mean TS_{ind} versus Fish length (Log L_t) was also significant ($P<0.005$) with a standard error of 0.93. A scatterplot of TS_{ind} versus fish length for *S. boops* is shown in Figure 8. Also shown is the fitted regression according to the equation $TS = a + b \text{ Log } L_t$ and the average b_{20} constant. A summary of the regression constants as well as the TS_{kg} fitted equation for all three species is given in Table 5.

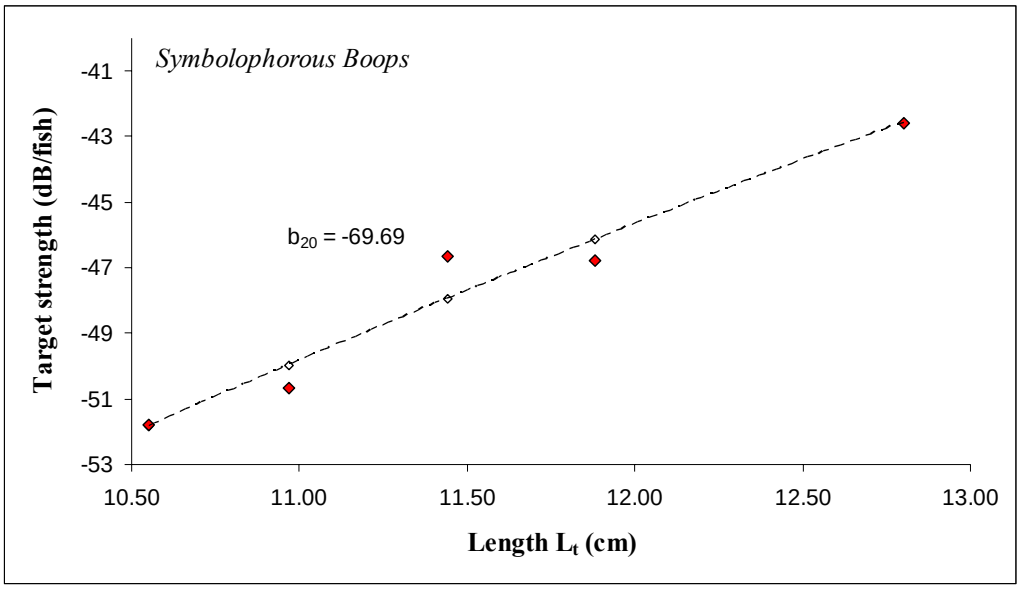


Figure 8. Scatterplot of TS_{ind} (dB) versus fish length for *Maurolicus muelleri*

Table 5. Parameters of the regression equations fitted to the TS data for *Lampanyctodes hectoris*, *maurolicus muelleri* and *symbolophorous boobs*.

	(dB individual^{-1})		(dB kg^{-1})
	$Y=20 \log L_t - b_{20}$	$Y=a \log L_t - b$	$Y=a \log L_t - b$
Lampanyctodes hectoris	n = 11	a = 13.82	a = -14.63
	b_{20} = 67.51	b = -63.18	b = -12.53
	s.e.m = 0.52	r^2 = 0.86	r^2 = 0.88
		s.e of Y = 0.32	s.e = 0.32
Maurolicus muelleri	n = 9	a = 23.01	a = -1.59
	b_{20} = 66.36	b = -68.31	b = -21.47
	s.e.m = 0.48	r^2 = 0.97	r^2 = 0.12
		s.e of Y= 0.15	s.e = 0.15
Symbolophorus boops	n = 5	a = 110.28	a = 79.87
	b_{20} = 69.69	b = -164.67	b = -112.99
	s.e.m = 0.64	r^2 = 0.95	r^2 = 0.95
		s.e of Y= 0.93	s.e = 0.93

The length weight regressions used to fit the TS_{kg} equation was derived from on-board measurements of length (l_t, cm) and weight (g). Figure 9 shows a scatterplot of length versus weight for all three species for which a TS measurement has been calculated. Also shown are the regressions fitted to the data.

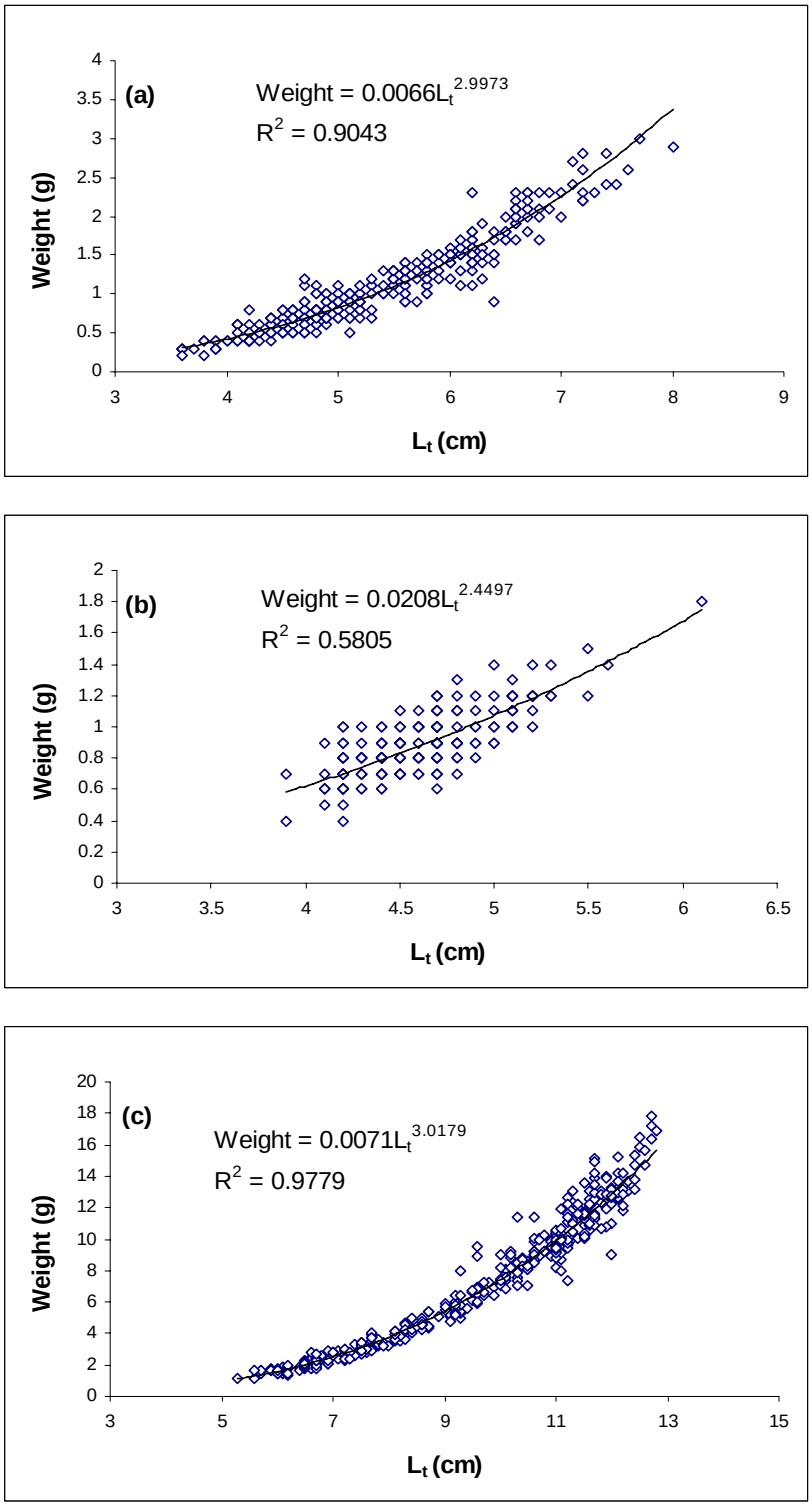


Figure 9. Scatterplot of fish weight versus fish length for *lampanyctodes hectoris* (a), *Maurolicus muelleri* (b) and *Symbolophorous boops* (c). Also shown are the fitted regressions.

3.3. DISTRIBUTION, SIZE COMPOSITION AND BIOMASS ESTIMATES

Following the calculation of preliminary estimates of target strength for the myctophids *Lampanyctodes hectoris* (the lanternfish) and symbolophorous boops (the bogue lanternfish) and the sternoptychid *Maurolicus muelleri* (the lightfish), it was possible to estimate the biomass of these three species. Although several other lanternfish species were caught during some of the trawls, their abundance was not sufficiently high to warrant biomass estimation. Table 6 gives the biomass estimates derived per stratum and for the entire survey area.

Table 6. Estimates of mean density ($\overline{\rho}$), Biomass (B) and coefficient of variation (CV) derived for each stratum and for the total survey area for *Lampanyctodes hectoris*, *Maurolicus muelleri* and *Symbolophorous boops*. Stratum A (W.Bay to Easter Point), Stratum B (Easter Point to Orange River), Stratum C (Orange River to Hondeklip Bay), Stratum D (Hondeklip Bay to Doring Bay) and Stratum E (Doring Bay to Cape Town).

	Lampanyctodes hectoris			*Maurolicus muelleri*			*Symbolophorous boops*		
	$\overline{\rho}$ ($g.m^{-2}$)	B (tons)	CV (%)	$\overline{\rho}$ ($g.m^{-2}$)	B (tons)	CV (%)	$\overline{\rho}$ ($g.m^{-2}$)	B (tons)	CV (%)
Stratum A	8.71	260528	0.18	1.83	54739	0.37	7.50	224354	0.51
Stratum B	6.52	297613	0.25	1.06	48251	0.50	0.66	29906	0.41
Stratum C	0.70	24652	0.95	3.66	129057	0.70	0.05	1842	0.95
Stratum D	1.20	36447	0.97	11.19	340858	0.38	0.19	5839	0.98
Stratum E	2.42	84039	0.46	2.42	171091	0.21	0.65	22601	0.94
Total up to Orange River		563954	0.16		102990	0.31		254260	0.44
Total for Survey		709094	0.15		745071	0.22		284543	0.41

The total biomass of mesopelagic fish species recorded during the survey is around 1.7 million tones with approximately equal quantities of lanternfish and lightfish. The contribution of other myctophids (dominated by *Symbolophorous boops*) was around 16 % of the total. In the area between Walvis Bay and the Orange River, the biomass was dominated by lanternfish while the dominance of lightfish in the area south of the Orange River was evident. The biomass of commercially exploited pelagic fish incidentally encountered during the survey was also calculated and is given in Table 7. It must be cautioned, however, that survey effort was not high

enough to ensure unbiased sampling of the biomass of small pelagics such as sardine. These fish have a very patchy distribution and the biomass is developed over small spatial scales. The biomass is therefore dependent on the hit or miss of high density areas. Furthermore, these pelagic fish species frequently occur very close inshore and therefore their entire distribution would not have been covered during this survey. The only significant biomass of commercially exploited fish measured was that of round herring at around 300 thousand tons. This biomass was divided almost equally between the northern area and the southern area of the survey.

Table 7. Estimates of Biomass (B) and coefficient of variation (CV) derived for each stratum and for the total survey area for commercial pelagic fish incidentally encountered during the survey. Stratum A (W.Bay to Easter Point), Stratum B (Easter Point to Orange River), Stratum C (Orange River to Hondeklip Bay), Stratum D (Hondeklip Bay to Doring Bay) and Stratum E (Doring Bay to Cape Town).

	Sardine		*Anchovy*		*Round herring*		Horse mackerel	
	B (tons)	CV (%)	B (tons)	CV (%)	B (tons)	CV (%)	B	CV (%)
Stratum A	0	0.00	0	0.00	45	1.05	3029	0.96
Stratum B	0	0.00	0	0.00	170276	0.83	10	1.02
Stratum C	4534	0.95	0	0.00	95965	0.07	882	1.05
Stratum D	0	0.00	135	0.98	32573	0.98	3761	0.99
Stratum E	0	0.00	107	1.15	59859	0.44	2836	0.50
Total up to Orange River								
	0	0.00	0	0.00	170321	0.83	3039	0.96
Total for Survey								
	4534	0.62	242	0.95	358651	0.41	10521	0.47

The distribution and relative abundance of *Lampanyctodes hectoris, Maurolicus muelleri,* Sy*mbolophorous boops* and *Etrumeus whiteheadi* is shown in Figures 10 and 11. The distribution of *Lampanyctodes hectoris*, the lanternfish was continuous from Walvis Bay to just north of Hondeklip bay. In this area, the highest densities occurred in the midshelf area with a few high-density areas occurring north of the Orange River. In the southern part of the survey, lanternfish densities were much lower and limited to the offshore regions mostly, with another high-density spot off Cape Town.

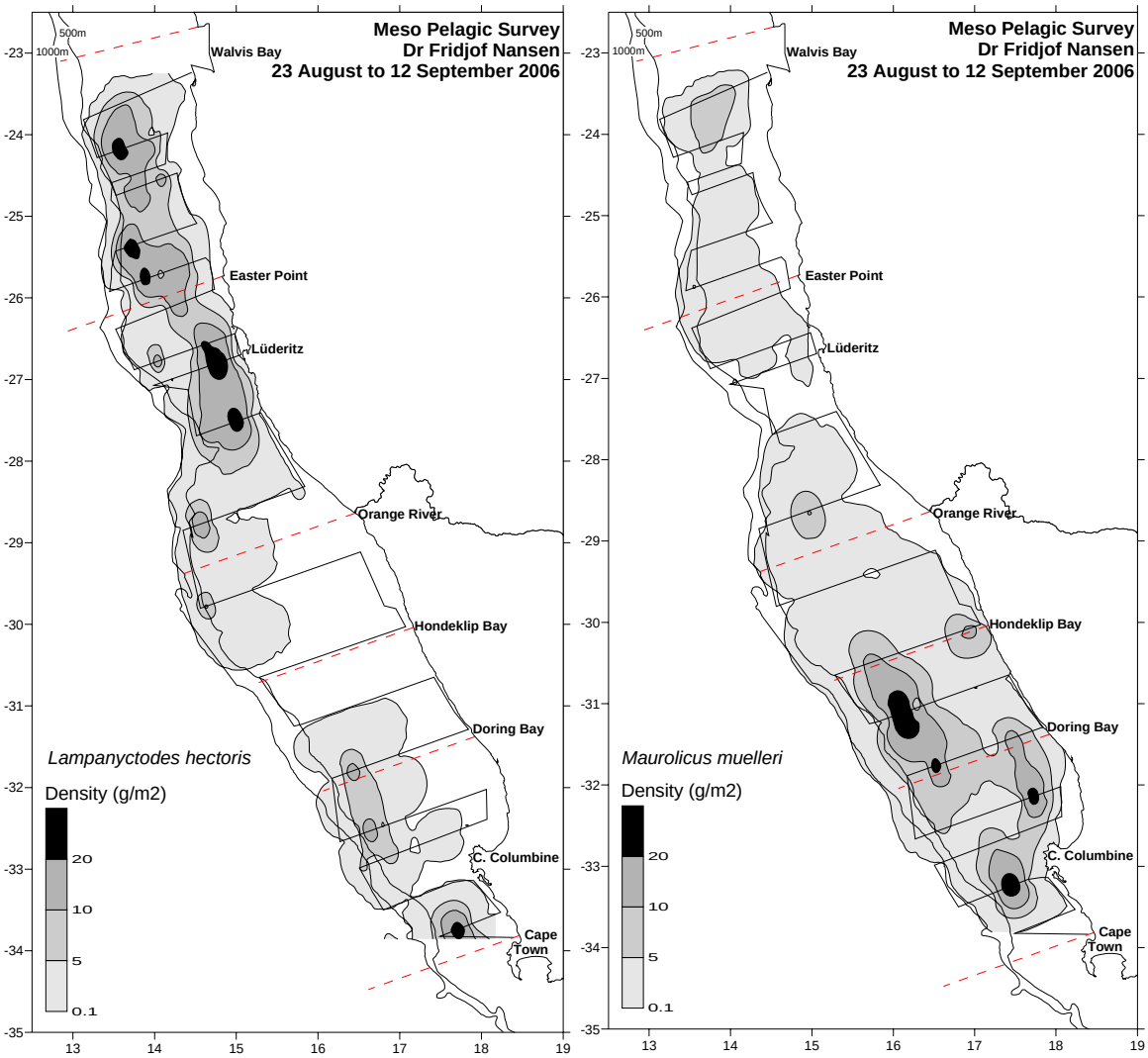


Figure 10. Distribution and relative abundance of lanternfish (left) and lightfish (right).

The distribution of lightfish expanded across the shelf in most areas, with the abundance increasing towards the south where several high-density areas were recorded in the midshelf area south of Hondeklip Bay.

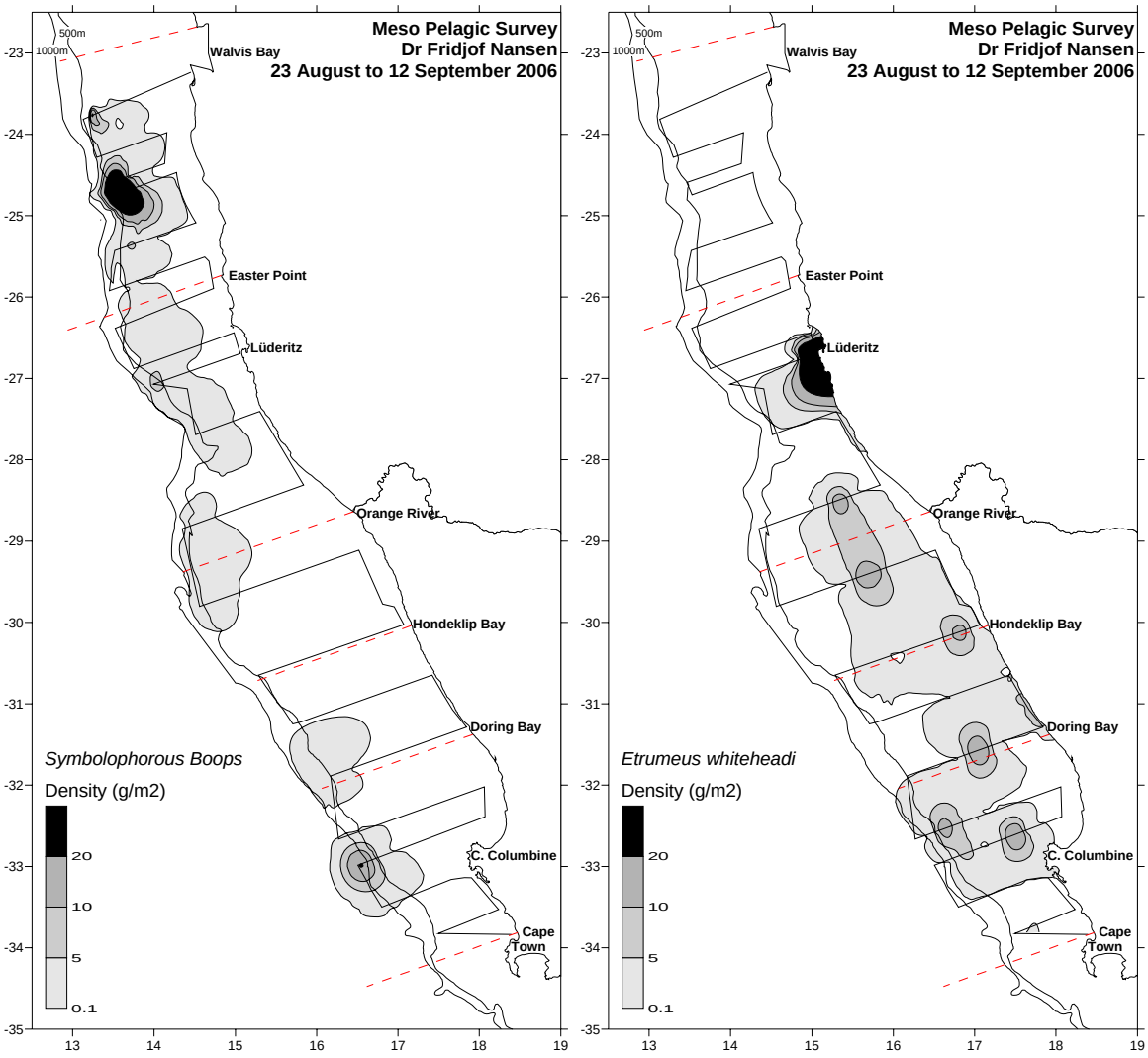


Figure 11. Distribution and relative abundance of *symbolophorous boops* (left) and round herring (right).

The distribution of *Symbolophorous boops* was mainly limited to the outer shelf areas, with a very high-density area between Walvis Bay and Easter point. Although the distribution extended as far south as Cape Columbine, the densities in the southern area were much lower. A very high-density area of round herring was found close inshore just south of Lüderitz. Further south the densities remained constant over the mid to inner shelf between the Orange River and Cape Columbine.

The population length frequency distribution derived from acoustically weighted trawl length frequencies for each of the 3 target species, for each stratum and for the survey as a whole is given in Figure 12, 13 and 14.

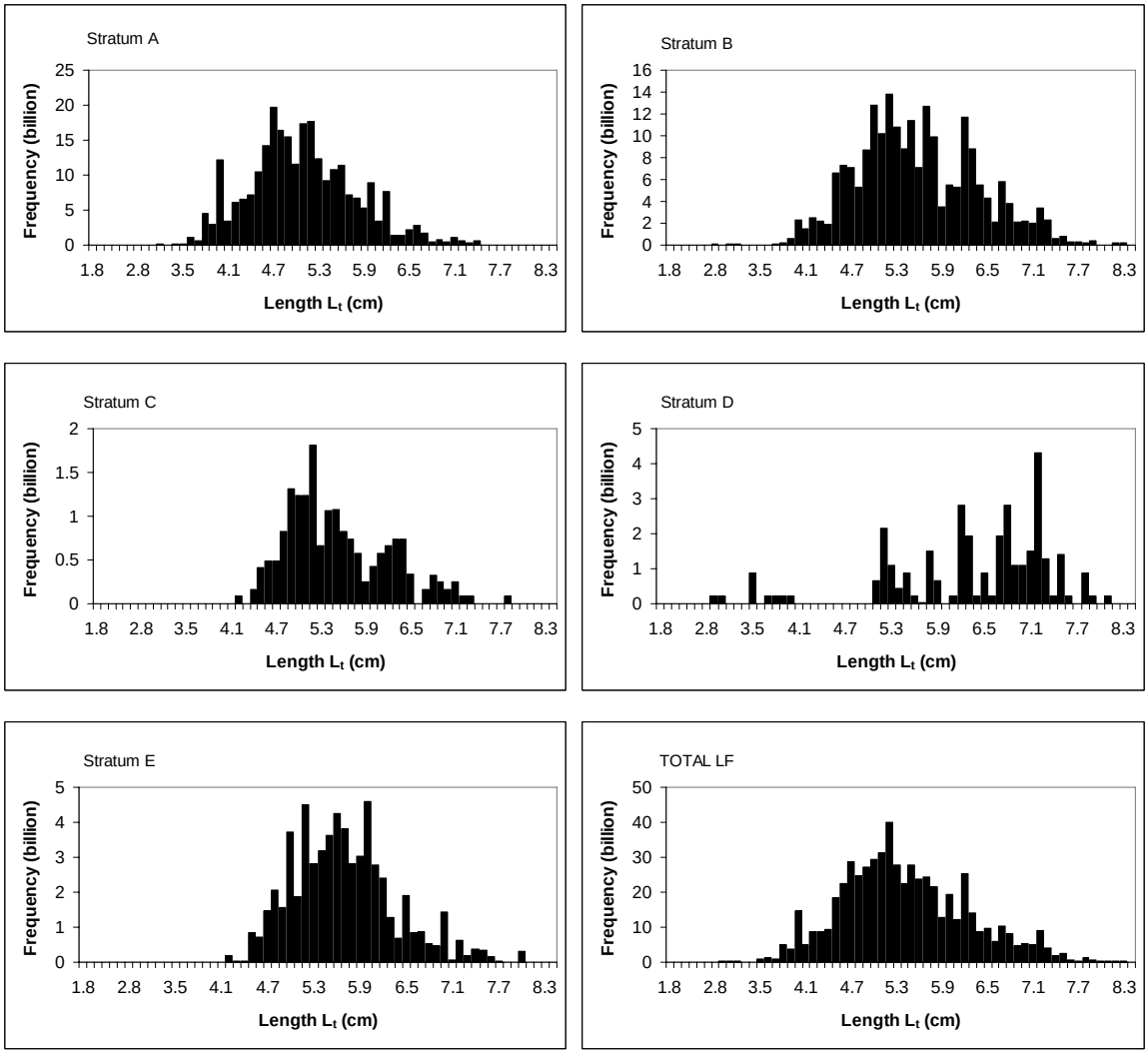


Figure 12. Acoustically weighted length frequency for each stratum and the entire population – Lanternfish (*Lampanyctodes hectoris*)

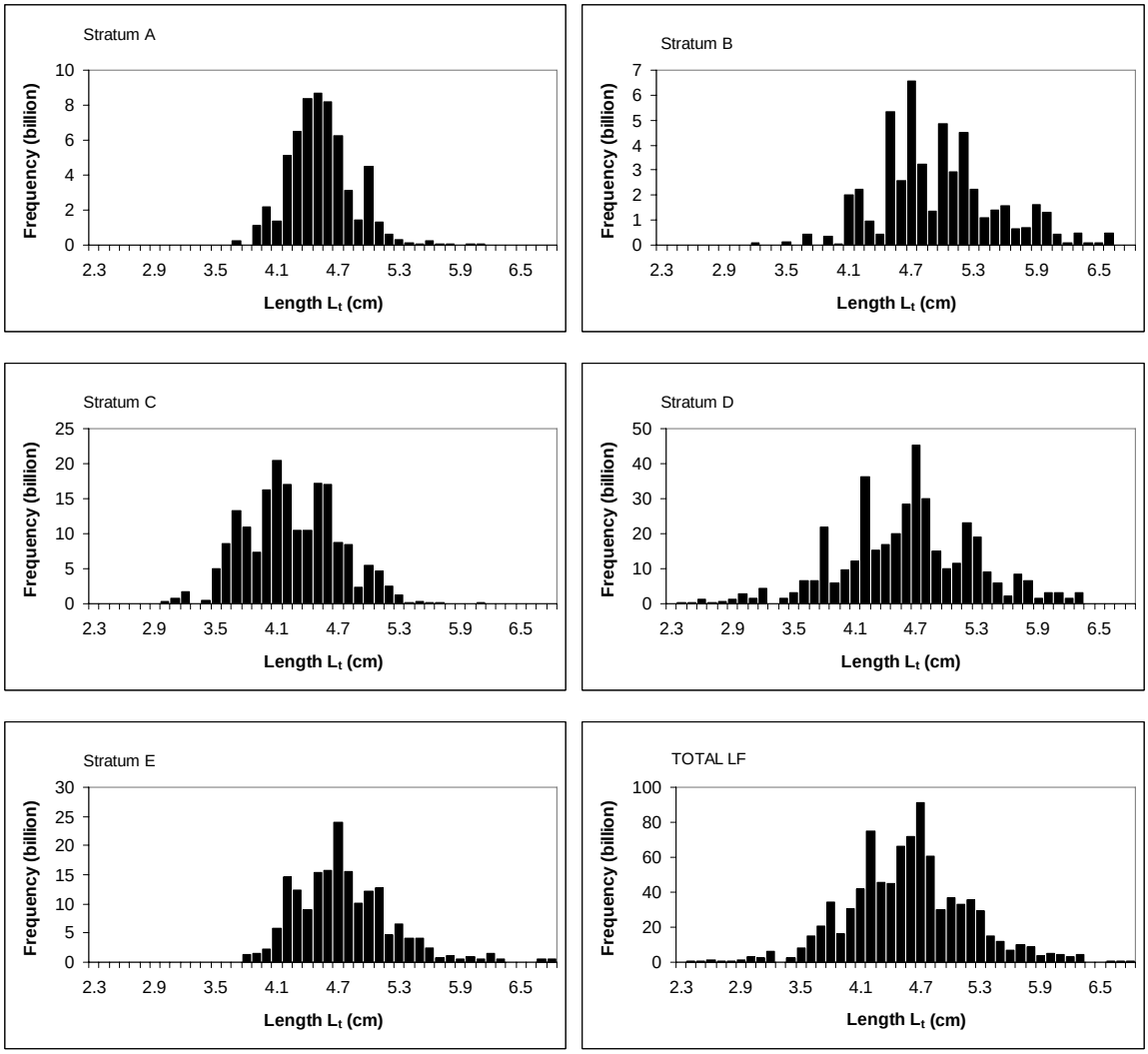


Figure 13. Acoustically weighted length frequency for each stratum and the entire population – Lightfish (*Maurolicus muelleri*).

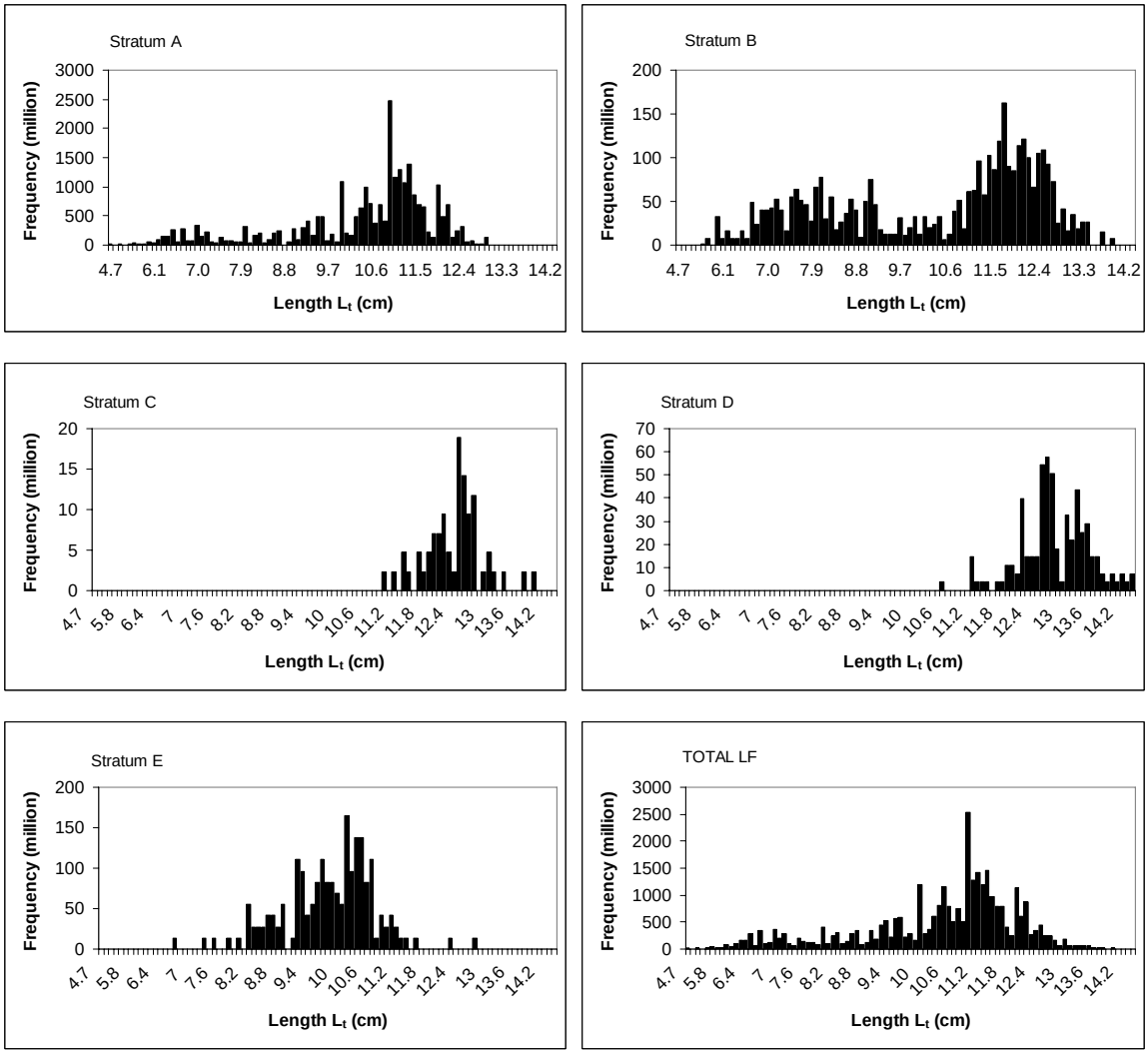


Figure 14. Acoustically weighted length frequency for each stratum and the entire population – myctophid (*Symbolophorous boops*).

3.4. DISTRIBUTION AND ABUNDANCE OF EGG AND LARVAE

Data on egg and larvae distribution was collected with the Hydrobios Multinet and the CUFES. Egg and larvae of both lightfish and lanternfish were distributed in the whole survey area. The Hydrobios Multinet collected depth discrete samples of egg and larvae from standard depths of 0 – 50 m, 50 – 100 m, 100 – 150 m, 150 – 200 m and 200 – 250 m as described in the method chapter. Typically eggs were found in high concentrations further offshore than the larvae, and lightfish deeper than lanternfish.

Lightfish

The horizontal distribution of egg and larvae of the lightfish are described in Figure 15 and 16. The data from each station was merged to show the total concentration per surface area. Both egg and larvae of the lightfish were found in large quantities in the three upper nets, between 0 - 150 m depth. Highest concentrations were found between 50 - 100 m depth.

Lightfish eggs were the most frequently found eggs in the Multinet. The distribution was continues from the first survey line off Walvis Bay to the survey was terminated outside Cape Town. The lowest concentrations were found off Panther Head where the shelf is at its most narrow. High concentrations were found on each side of this with particularly high concentrations on the shelf edge around the 200 m isobath. The concentrations decreased inshore and disappeared between 100 m – 50 m depth.

The lightfish larvae were patchier distributed than the eggs. One concentration area was found offshore at the shelf edge off Conception Bay. Another concentration was found on the diel station south of Lüderitz around 200 m depth, extending southwards in lower concentrations to the next environmental line. The third and largest concentration area was found on the South African shelf immediately south of the Orange River border to Namibia. This concentration area extended from approximately 100 m depth and offshore out off the survey area with the highest concentrations were found offshore on the line off Hondeklip. The distribution extended south of the survey area off Cape Town.

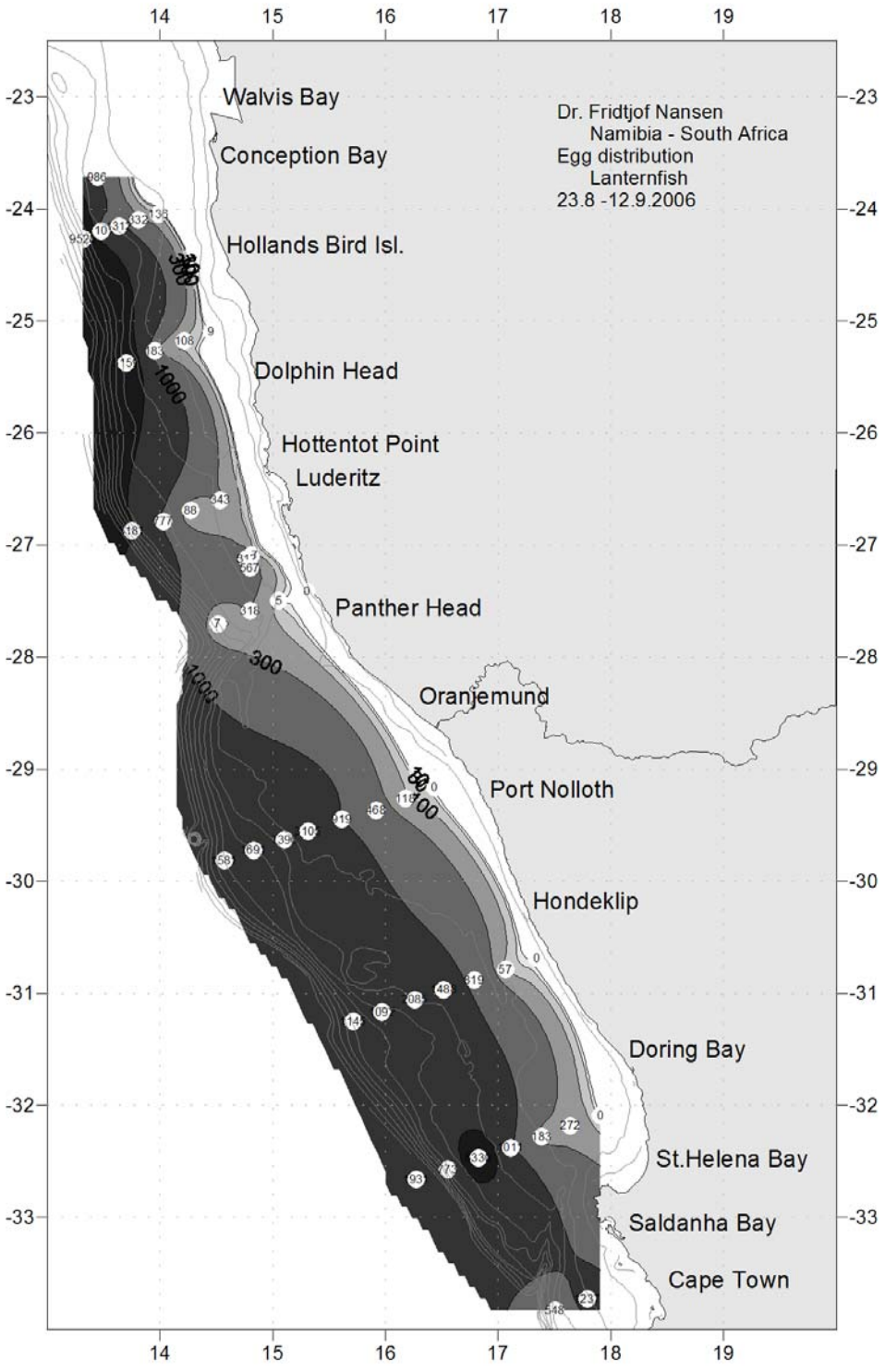


Figure 15. Horizontal distribution of eggs from the lightfish, *Maurolicus muelleri* in the survey area. Data collected with the Hydrobios Multinet

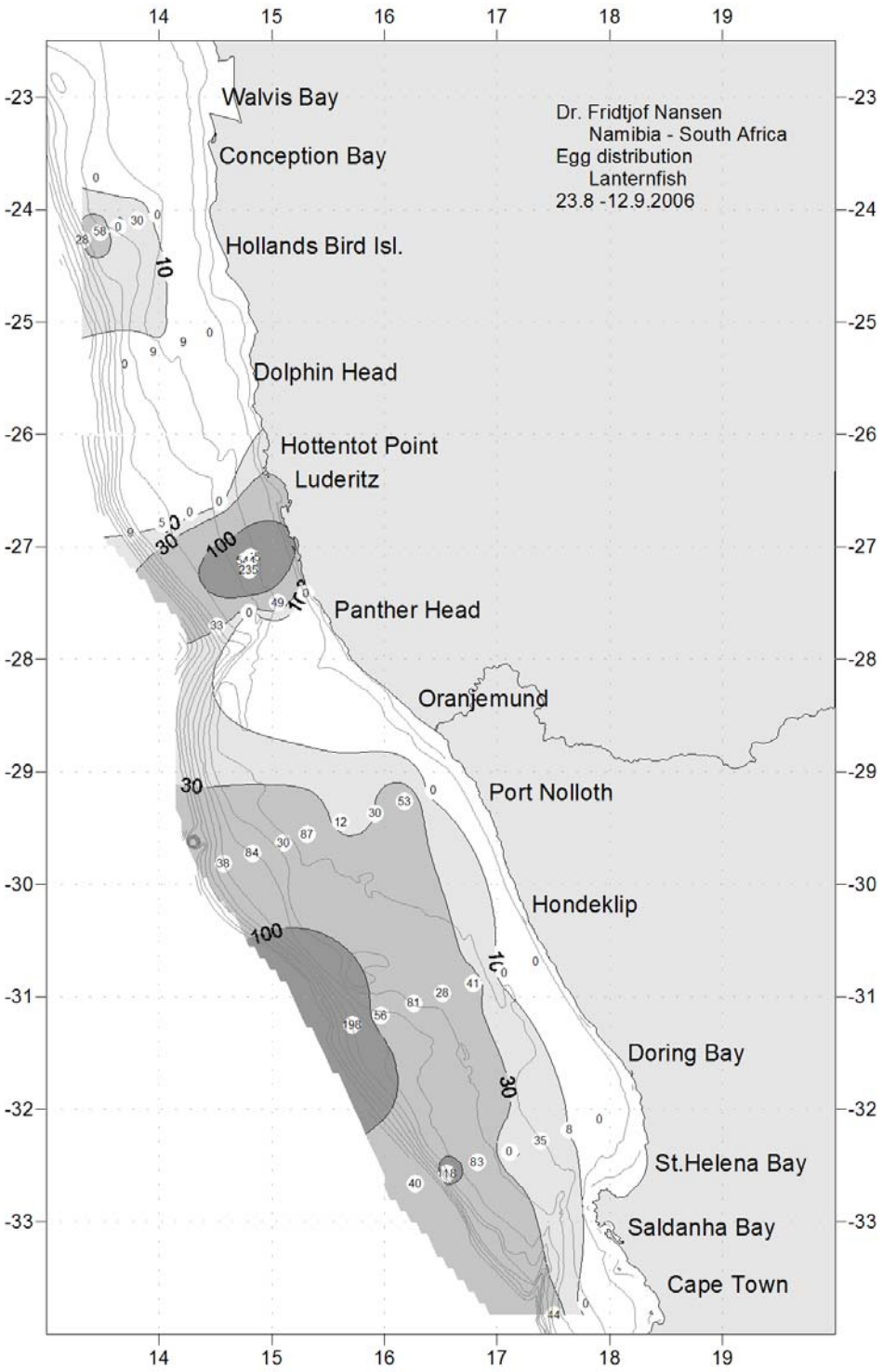


Figure 16. Horizontal distribution of larvae from the lightfish, *Maurolicus muelleri* in the survey area. Data collected with the Hydrobios Multinet

Lanternfish

Egg and larvae of the lanternfish, Figure 17 and 18, were typically found closer to the surface

than lightfish, gradually decreasing to low concentrations in the deepest net between 200 -250 depth. The highest abundance of eggs was found offshore on the shelf edge between Walvis Bay and Lüderitz with eggs distributed across the whole shelf towards Lüderitz. A gap in the distribution was experienced south of Lüderitz were the shelf edge is most narrow. Another concentration area was found on the South African shelf edge, south of the Orange River to approximately 32°30' S, with the inshore part of the abundance typically following the 100 m isobath. Highest concentrations were found between the 200 m and the 500 m isobath.

The distribution of larvae of lanternfish was more extensive than the eggs, with a distribution across the whole survey region. Very few lanternfish larvae was found inshore of the 100 m isobath between Hollands Bird Island and Panther Head, corresponding with the most intense part of the Lüderitz upwelling cell observed during the survey. The highest concentrations of lanternfish eggs were distributed offshore in the northern part of the survey area, and extended outside of the surveyed area. In the southern part of the survey area, on the other hand, main concentrations were found on the shelf between 100 m and 200 m depth. The distribution extended offshore and southwards outside of the surveyed area.

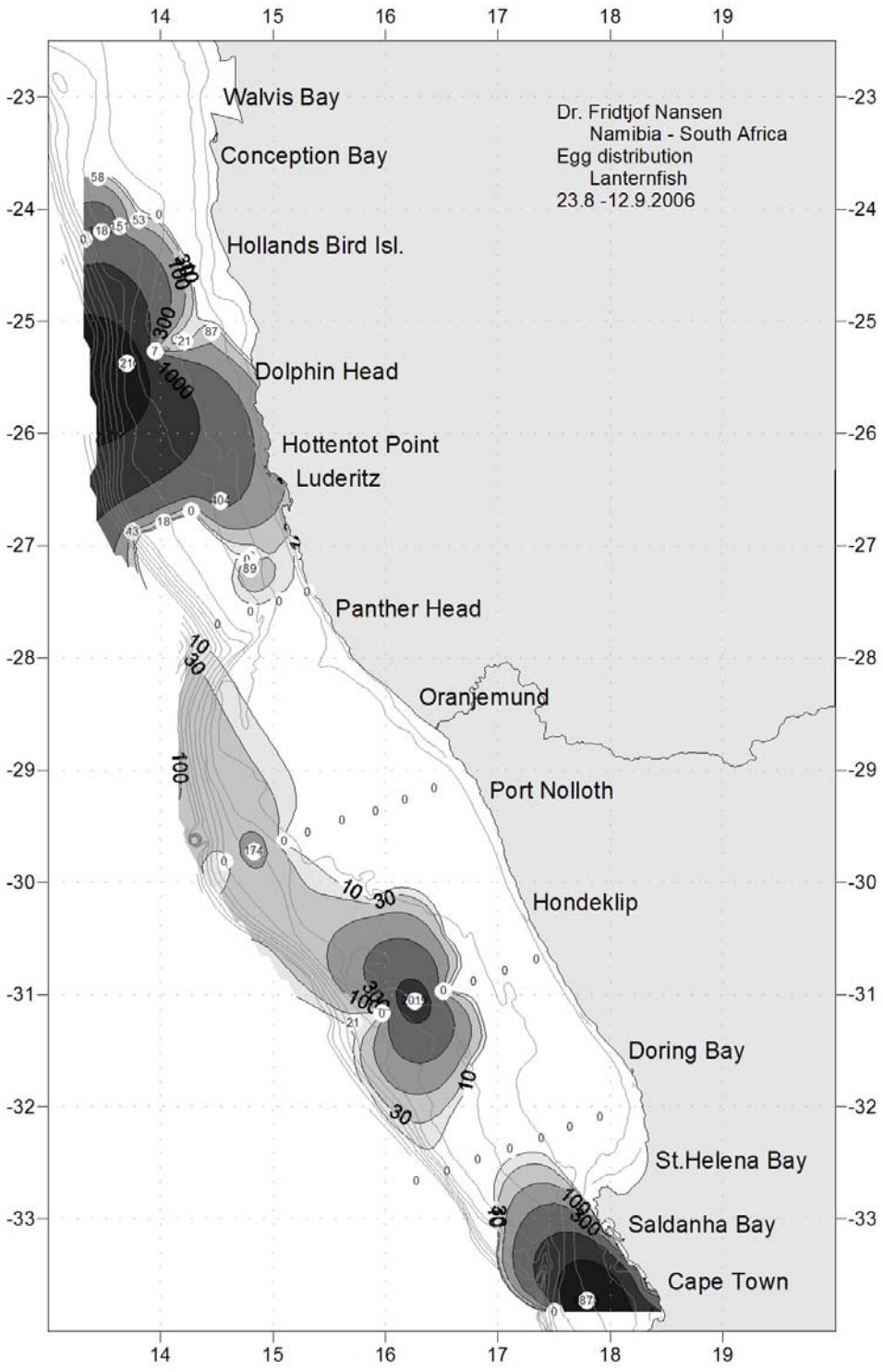


Figure 17. Horizontal distribution of eggs from lanternfish, *Lampanyctus hectoris* and *Symbolophorus boops* in the survey area. Data collected with the Hydrobios Multinet

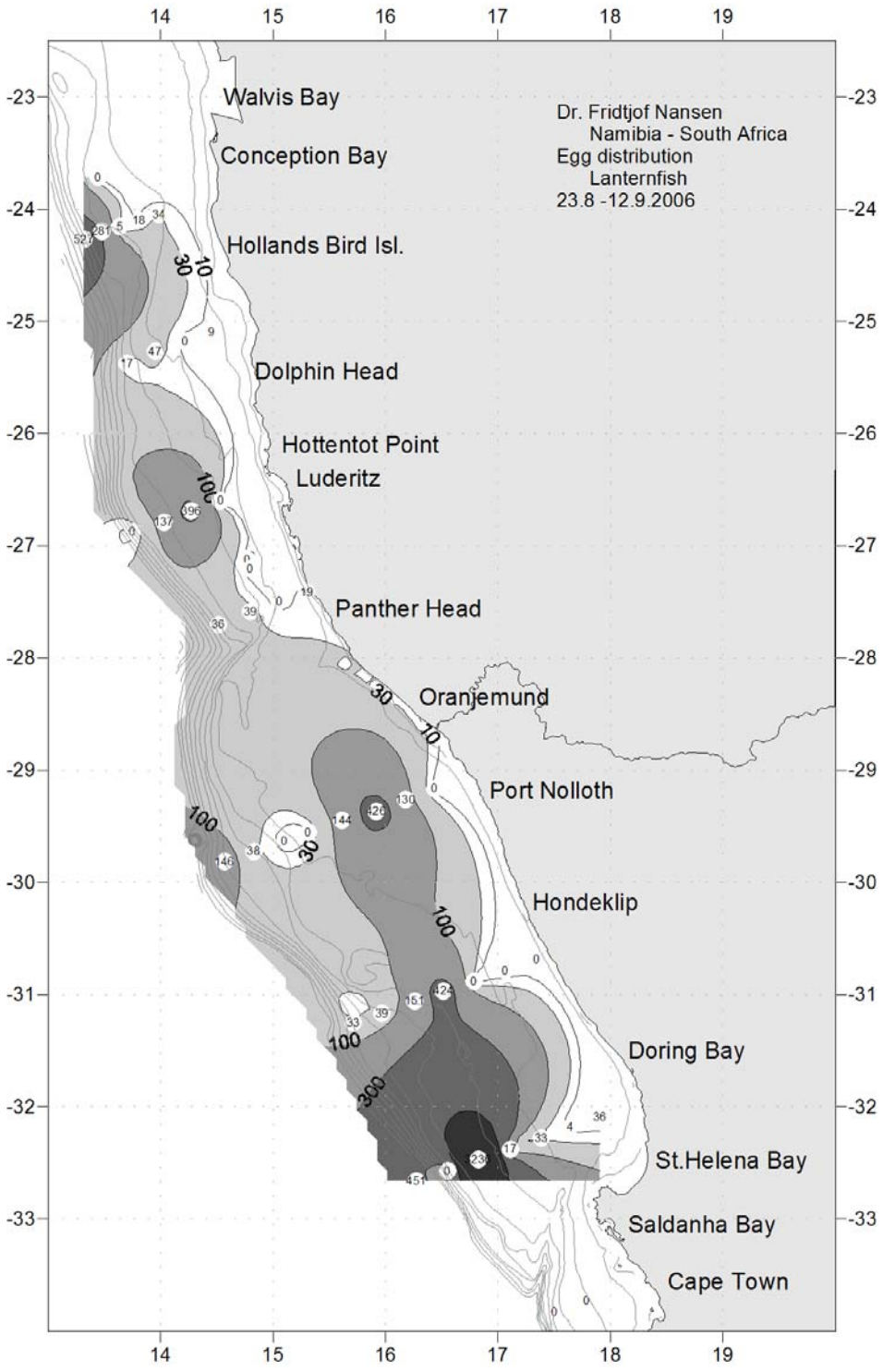


Figure 18. Horizontal distribution of larvae from lanternfish, *Lampanyctus hectoris* and *Symbolophorus boops* in the survey area. Data collected with the Hydrobios Multinet

3.5. EGG BUOYANCY MEASUREMENTS

Only wild caught eggs were used for buoyancy measurements during this survey. On Multinet station 11 and 12, a number of good quality lightfish eggs were found and about 30 eggs were inserted into density gradient column II. The eggs were in different stages and some of the eggs started to hatch shortly after. However, a number of eggs were in early stages and measurements on these eggs were conducted for four days until hatching and also newly hatched larvae were measured (Figure 19). The mean salinity of neutral buoyancy was 32.83 during the first measurements and the eggs got heavier towards hatching. After hatching, the newly hatched larvae had a salinity of mean neutral buoyancy of between 32.5 and 33. The measurements of the larvae were conducted shortly after hatching while larval movement was still low. After a while the larvae swimming activity increased. They were very actively swimming upward followed by a quiet period while sinking. The impression is that they were more active than other larvae we have measured before such as sardine and anchovy. Typically they would sink for about one minute for then to swim up to 8 cm up the column. A second experiment on lightfish eggs were conducted towards the end of the survey (eggs collected from stations 39-41). These eggs were heavier than the eggs from the first experiment and had a salinity of mean neutral buoyancy of 35.27 during the first measurement.

On one of the last stations, a high number of good quality lanternfish eggs were found and about 20 of these were inserted in column II. They were only measured two times before the survey ended and the salinity of mean neutral buoyancy was 33.44 during the first measurement and 34.04 during the second measurement.

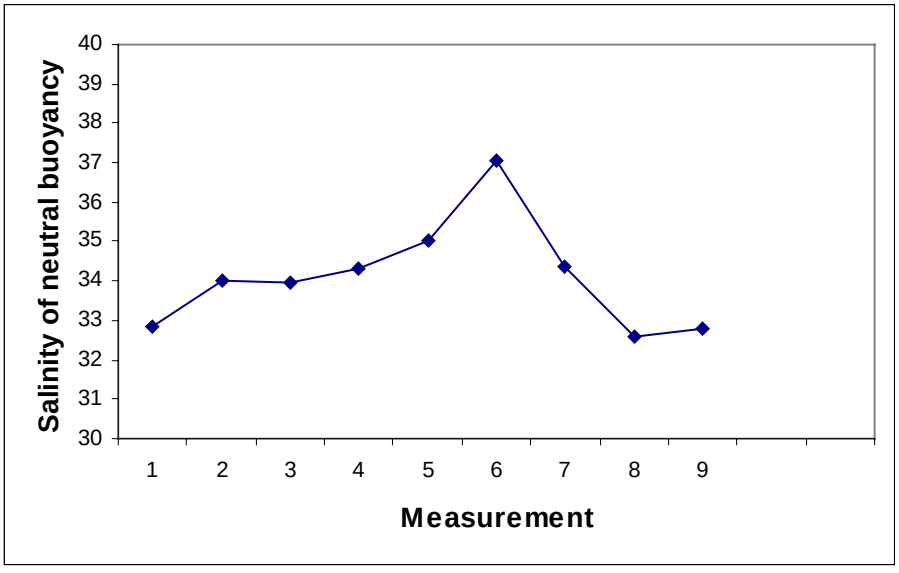


Figure 19. Buoyancy of lightfish eggs/larvae during development from newly fertilized until after hatching. The three last measurements are larvae.

3.6. DIEL CYCLE

3.6.1. Environmental conditions

Five CTD's were taken during the diel experiments, Figure 20. The results show that the water masses were relatively stable during the period. Temperatures ranged from >14.5°C in the surface to <9.5°C in the bottom waters. Salinity ranged from 35.0 PSU in the surface to 34.7 PSU in the bottom waters. The water column was well oxygenated with values ranging from 6 ml/l in the surface to <3.5 in the bottom layer.

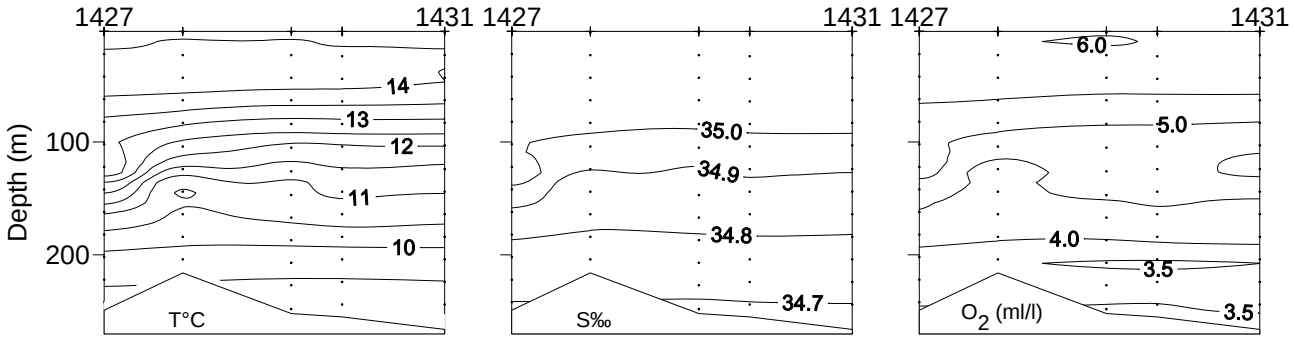


Figure 20. Vertical sections of temperature, salinity and oxygen during the diel experiment period. Scale on x-axis is time in hours from first station.

3.6.2. Acoustic observations

The vertical migration of a mesopelagic fish layer, composed primarily of *L. hectoris*, was observed during two dawn decent (Figure 21) and one dusk ascent (Figure 22) period. The acoustic observations were groundtruthed by several bottom and pelagic trawls. In addition, stomach contents data and zooplankton caught in depth stratified Multinet hauls will be analysed at a later stage to shed more light on the vertical distribution and feeding behaviour of *L. hectoris.*

The scattered surface layer (between 20-40 m deep) was observed starting to descent at 05h20 in a dense stream until it had reached the sea floor (250 m) at 06h25 (Figure 21). The start of the migration commenced long before sunrise, which was at 06h13. The average decent rate of the observed layer was calculated at 5.9 cm/sec, which was slightly quicker than the ascent rate of 4.8 cm/sec. Catch data from trawl stations performed before and after the dawn period showed that in this case *L. hectoris* proportions in the upper 60 m were comparatively high (98%) before the descent started (Table 8). In addition, deeper (>100 m) towed multisampler trawls also done shortly before the descent showed higher proportions of cape hake (55-60%) and lower percentages of *L. hectoris*. After the decent was 'completed', the dense layer hard on the bottom was composed of a mixture of cape hake (74%) and *L. hectoris* (18%), while a tow about 10 m above the bottom contained a high percentage of *L. hectoris* (97%), (Table 8). Very few *L.*

hectoris remained higher up in the water column during daytime, although proportions were still high in a multisampler trawl at 30 and 80 m respectively.

The dense layer on and close to the bottom started ascending at app. 17h00 (Figure 22), well before sunset at 17h48. The average ascent rate was 4.8 cm/sec, and by app. 18h20 the layer had reached a depth of 20 m beneath the surface, where it scattered and spread out over a depth range of 20-40 m. In 1.2 hrs this layer had thus migrated 230 m off the bottom. The ascent was slightly slower compared to the descent, which took just over an hour. The dense layer observed on the sea bottom before the ascent started consisted mainly of cape hake and some *L. hectoris* (Table 9; Tow 1773). The amounts of *L. hectoris* at 160 and 60 m were very small and zero respectively (Table 9), indicating that this species was practically absent at these depths during daytime. Multisampler trawls performed after the layers had stabilized indicated that the top 60m consisted of 98% *L. hectoris* (see above under descent). Catch rates of nighttime pelagic (shallower than 60 m) *L. hectoris* were similarly high as daytime demersal *L. hectoris*. Pelagic catch rates ranged from 34-128 kg/hr, while daytime demersal catch rates varied between 53-250 kg/hr., indicating that the largest proportion of the myctophids take part in this vertical migration. This is further substantiated by the observation that night time deep trawls and daytime shallow trawls contained very little or no *L. hectoris*.

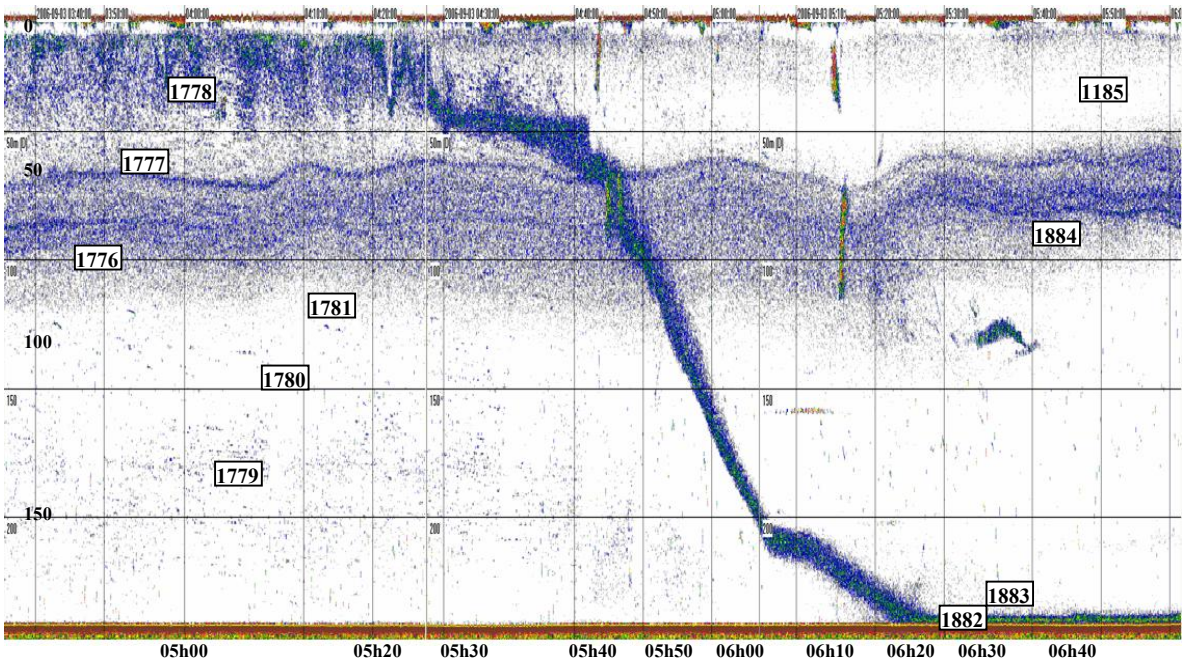


Figure 21. Vertical descent at dawn of *L. hectoris* to 250m bottom depth. Numbers indicate trawl stations performed at various depths and are summarized in Table 8.

Table 8. Summary of trawl stations done before and after the dusk descent on the 02/09/06. The station numbers are shown in Figure 20.

Station #	Time	Depth (m)	Total catch (kg)	% *L. hectoris*
1776	22:45	95	4.2	73
1777	23:10	60	32.4	98
1778	23:30	30	6.8	99
1779	01:10	180	10.1	1
1780	01:40	140	1.7	9
1781	02:10	115	1.4	20
1882	08:35	240	362	18
1883	10:05	235	64.1	98
1884	10:30	80	0.6	95
1885	10:56	30	0.1	87

Table 9. Summary of trawl stations done before the dawn ascent on 02/09/06. Trawl station numbers are shown in Figure 21.

Station #	Time	Depth (m)	Total catch (kg)	% *L. hectoris*
1772	11:00	213	172	8
1773	14:08	225	1	21
1774	14:38	160	0.01	50
1775	15:10	60	0.05	0

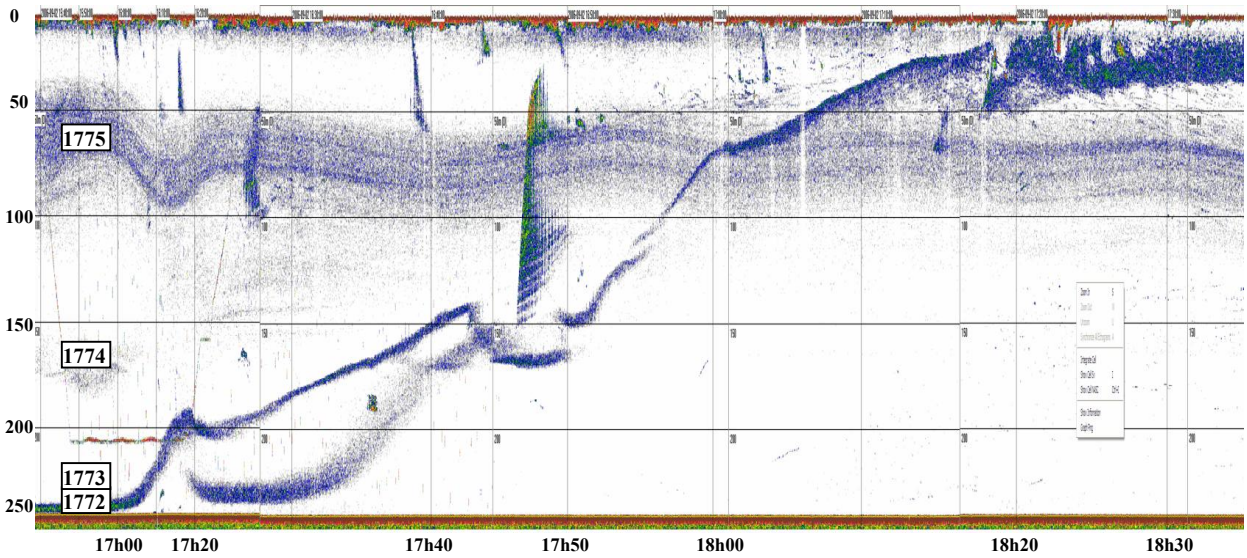


Figure 22. Vertical ascent at dusk of *L. hectoris* from 250m to 20-30m depth. Numbers indicate trawl stations performed at various depths and are summarized in Table 9.

ANNEX I RECORDS OF FISHING STATIONS

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1733
DATE:24/ 8/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2336
start stop duration Long E 1339
TIME :07:53:53 08:03:52 10 (min) Purpose code: 1
LOG :1962.27 1962.80 0.51 Area code : 1
FDEPTH: 190 190 GearCond.code:
BDEPTH: 202 201 Validity code:
Towing dir: 190ø Wire out: 500 m Speed: 34 kn*10

Sorted: Kg Total catch: 3.19 CATCH/HOUR: 19.14

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	15.24	9150	79.62	8341
Maurolicus muelleri	3.06	4140	15.99	8342
Lepidopus caudatus	0.84	30	4.39	
Total	19.14		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1734
DATE:24/ 8/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2335
start stop duration Long E 1340
TIME :08:13:36 08:24:11 11 (min) Purpose code: 1
LOG :1963.27 1963.83 0.57 Area code : 1
FDEPTH: 160 160 GearCond.code:
BDEPTH: 198 196 Validity code:
Towing dir: 65ø Wire out: 450 m Speed: 32 kn*10

Sorted: Kg Total catch: 0.22 CATCH/HOUR: 1.20

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Todaropsis eblanae	0.55	11	45.83	8346
Lampanyctodes hectoris	0.27	164	22.50	8343
Todarodes sagittatus	0.16	5	13.33	8345
Maurolicus muelleri	0.16	136	13.33	8344
S H R I M P S	0.05	196	4.17	
Total	1.19		99.16	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1735
DATE:24/ 8/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2335
start stop duration Long E 1342
TIME :08:43:16 08:53:17 10 (min) Purpose code: 1
LOG :1964.70 1965.40 0.57 Area code : 1
FDEPTH: 60 60 GearCond.code:
BDEPTH: 192 190 Validity code:
Towing dir: 65ø Wire out: 200 m Speed: 34 kn*10

Sorted: Kg Total catch: 0.04 CATCH/HOUR: 0.24

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Todarodes sagittatus	0.12	12	50.00	8349
Lampanyctodes hectoris	0.06	48	25.00	8347
Maurolicus muelleri	0.06	60	25.00	8348
Total	0.24		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1736
DATE:24/ 8/06 GEAR TYPE: BT No: 1 POSITION:Lat S 2342
start stop duration Long E 1324
TIME :13:19:21 13:45:29 26 (min) Purpose code: 1
LOG :1992.76 1994.93 1.59 Area code : 2
FDEPTH: 280 270 GearCond.code:
BDEPTH: 280 270 Validity code:
Towing dir: 75ø Wire out: 800 m Speed: 34 kn*10

Sorted: 24 Kg Total catch: 93.80 CATCH/HOUR: 216.46

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	146.86	114102	67.85	8355
Merluccius capensis	35.77	166	16.52	8350
Symbolophorus boops	19.96	5589	9.22	8354
Coelorinchus coelorhinc. polli	8.65	62	4.00	8352
Chlorophthalmus sp.	2.08	76	0.96	8353
Helicolenus dactylopterus	1.13	48	0.52	8351
Lepidopus caudatus	1.04	2	0.48	
SQUOM50	0.67	9	0.31	8356
Squilla sp.	0.28	16	0.13	
Total	216.44		99.99	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1737
DATE:24/ 8/06 GEAR TYPE: PT No: 4 POSITION:Lat S 2348
start stop duration Long E 1310
TIME :18:56:25 19:11:07 15 (min) Purpose code: 1
LOG :2019.14 2019.99 0.84 Area code : 2
FDEPTH: 10 10 GearCond.code:
BDEPTH: 439 413 Validity code:
Towing dir: 61ø Wire out: 130 m Speed: 35 kn*10

Sorted: Kg Total catch: 57.00 CATCH/HOUR: 228.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Symbolophorus boops	224.80	22776	98.60	8357
Argonauta sp.	2.16	8	0.95	
Lycoteuthis diadema	1.92	640	0.84	
Todarodes sagittatus	0.68	20	0.30	
SQUEN11	0.32	92	0.14	
Bathynectes piperitus	0.08	4	0.04	
Total	229.96		100.87	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1738
DATE:25/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2412
start stop duration Long E 1331
TIME :03:50:04 04:19:21 29 (min) Purpose code: 1
LOG :2077.26 2079.06 1.78 Area code : 2
FDEPTH: 120 105 GearCond.code:
BDEPTH: 311 313 Validity code:
Towing dir: 252ø Wire out: 380 m Speed: 35 kn*10

Sorted: 7 Kg Total catch: 34.80 CATCH/HOUR: 72.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	62.77	43426	87.18	8358
Symbolophorus boops	8.36	1206	11.61	8359
ARGENTINIDAE	0.37	52	0.51	8360
Dosidicus sp.	0.25	68	0.35	
Lycoteuthis diadema	0.12	21	0.17	
Electrona risso	0.10	43	0.14	8361
Maurolicus muelleri	0.02	29	0.03	8362
Total	71.99		99.99	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1739
DATE:25/ 8/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2405
start stop duration Long E 1351
TIME :11:00:36 11:10:57 10 (min) Purpose code: 1
LOG :2113.30 2113.90 0.59 Area code : 2
FDEPTH: 240 240 GearCond.code:
BDEPTH: 254 256 Validity code:
Towing dir: 245ø Wire out: 650 m Speed: 35 kn*10

Sorted: 3 Kg Total catch: 13.70 CATCH/HOUR: 82.20

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	65.28	59304	79.42	8365
Maurolicus muelleri	10.50	11592	12.77	8363
Symbolophorus boops	6.36	2790	7.74	8364
Dosidicus sp.	0.06	30	0.07	
Total	82.20		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1740
DATE:25/ 8/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2406
start stop duration Long E 1349
TIME :11:28:42 11:38:53 10 (min) Purpose code: 1
LOG :2114.86 2115.44 0.57 Area code : 2
FDEPTH: 225 225 GearCond.code:
BDEPTH: 259 262 Validity code:
Towing dir: 250ø Wire out: 550 m Speed: 35 kn*10

Sorted: 2 Kg Total catch: 1.58 CATCH/HOUR: 9.48

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	7.80	9054	82.28	8367
Todaropsis eblanae	1.08	18	11.39	
Todarodes angolensis	0.42	6	4.43	
Lampanyctodes hectoris	0.18	264	1.90	8366
Total	9.48		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1741
DATE:25/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2423
start stop duration Long E 1403
TIME :51:40:44 51:41:56 15 (min) Purpose code: 1
LOG :2170.22 2171.19 0.96 Area code : 2
FDEPTH: 25 25 GearCond.code: 1
BDEPTH: 159 157 Validity code: 1
Towing dir: 70ø Wire out: 130 m Speed: 40 kn*10

Sorted: 11 Kg Total catch: 11.00 CATCH/HOUR: 44.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	43.64	40976	99.18	8368
Merluccius capensis, juveniles	0.20	4	0.45	
Todarodes angolensis	0.04	8	0.09	
Dosidicus sp.	0.04	16	0.09	
Total	43.92		99.81	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1742
DATE:25/ 8/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2430
start stop duration Long E 1346
TIME :21:40:55 21:41:05 10 (min) Purpose code: 1
LOG :2195.08 2195.67 0.57 Area code : 2
FDEPTH: 100 100 GearCond.code:
BDEPTH: 328 325 Validity code:
Towing dir: 55ø Wire out: 250 m Speed: 40 kn*10

Sorted: 2 Kg Total catch: 12.35 CATCH/HOUR: 74.10

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	58.08	41910	78.38	8370
Symbolophorus boops	14.94	3024	20.16	8369
Maurolicus muelleri	0.84	1044	1.13	8371
Lycoteuthis diadema	0.18	24	0.24	
Total	74.04		99.91	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1743
DATE:25/ 8/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2429
start stop duration Long E 1348
TIME :21:41:16 23:20:07 12 (min) Purpose code: 1
LOG :2196.61 2197.41 0.80 Area code : 2
FDEPTH: 300 30 GearCond.code:
BDEPTH: 318 312 Validity code:
Towing dir: 70ø Wire out: 120 m Speed: 38 kn*10

Sorted: 3 Kg Total catch: 16.50 CATCH/HOUR: 82.50

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	43.90	50470	53.21	8373
Symbolophorus boops	38.45	3630	46.61	8372
Lycoteuthis diadema	0.05	20	0.06	
Todarodes angolensis	0.05	20	0.06	
Total	82.45		99.94	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1744
DATE:26/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2435
start stop duration Long E 1328
TIME :02:24:44 02:53:57 29 (min) Purpose code: 1
LOG :2221.35 2222.99 1.63 Area code : 2
FDEPTH: 45 45 GearCond.code:
BDEPTH: 478 424 Validity code:
Towing dir: 70ø Wire out: 150 m Speed: 33 kn*10

Sorted: 4 Kg Total catch: 20.65 CATCH/HOUR: 42.72

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Symbolophorus boops	37.20	3844	87.08	8376
Electrona risso	2.86	1066	6.69	8375
Gymnoscopelus sp.	1.49	281	3.49	8374
Lampanyctodes hectoris	0.52	478	1.22	8377
Dosidicus sp.	0.52	161	1.22	
Lycoteuthis diadema	0.12	10	0.28	
Stomias boa boa	0.02	21	0.05	
Total	42.73		100.03	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1745
DATE:26/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2432
start stop duration Long E 1406
TIME :08:21:12 08:30:28 9 (min) Purpose code: 1
LOG :2273.06 2273.60 0.53 Area code : 2
FDEPTH: 140 140 GearCond.code:
BDEPTH: 154 153 Validity code:
Towing dir: 246ø Wire out: 360 m Speed: 40 kn*10

Sorted: 14 Kg Total catch: 14.13 CATCH/HOUR: 94.20

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	67.33	65427	71.48	8378
Thyrsites atun	22.67	7	24.07	
Dosidicus sp.	1.67	507	1.77	
Todarodes angolensis	1.33	20	1.41	
Lampanyctodes hectoris	1.00	533	1.06	8379
Etrumeus whiteheadi	0.20	7	0.21	
Total	94.20		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1746
DATE:26/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2429
start stop duration Long E 1415
TIME :10:17:27 10:39:56 22 (min) Purpose code: 1
LOG :2287.09 2288.35 1.24 Area code : 2
FDEPTH: 120 120 GearCond.code:
BDEPTH: 131 135 Validity code:
Towing dir: 249ø Wire out: 300 m Speed: 35 kn*10

Sorted: 15 Kg Total catch: 15.76 CATCH/HOUR: 42.98

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	30.00	17776	69.80	8380
Thyrsites atun	11.18	3	26.01	
Etrumeus whiteheadi	1.06	22	2.47	8381
SQUEN11	0.46	169	1.07	
Lolligoncula mercatoris	0.16	93	0.37	
Todarodes angolensis	0.08	3	0.19	
Total	42.94		99.91	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1747
DATE:26/ 8/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2507
start stop duration Long E 1426
TIME :16:53:23 17:03:11 10 (min) Purpose code: 1
LOG :2340.61 2341.18 0.56 Area code : 2
FDEPTH: 130 130 GearCond.code:
BDEPTH: 133 132 Validity code:
Towing dir: 72ø Wire out: 320 m Speed: 40 kn*10

Sorted: 6 Kg Total catch: 6.40 CATCH/HOUR: 38.40

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Chelidonichthys capensis	20.22	72	52.66	
Merluccius capensis, juveniles	10.44	180	27.19	
Lampanyctodes hectoris	6.48	5622	16.88	8382
Lepidopus caudatus	0.60	96	1.56	
Sufflogobius bibarbatus	0.42	264	1.09	
Todaropsis eblanae	0.12	6	0.31	
Todarodes angolensis	0.06	12	0.16	
Lolligoncula mercatoris	0.06	18	0.16	
Total	38.40		100.01	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1748
DATE:26/ 8/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2506
start stop duration Long E 1428
TIME :17:19:01 17:29:20 10 (min) Purpose code: 1
LOG :2342.12 2342.82 4.87 Area code : 2
FDEPTH: 30 30 GearCond.code: 1
BDEPTH: 128 126 Validity code:
Towing dir: 72ø Wire out: 130 m Speed: 40 kn*10

Sorted: 6 Kg Total catch: 6.25 CATCH/HOUR: 37.50

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	36.00	26346	96.00	8383
Merluccius capensis, juveniles	0.84	18	2.24	
Lolligoncula mercatoris	0.42	198	1.12	
Todaropsis eblanae	0.12	18	0.32	
Todarodes angolensis	0.06	12	0.16	
Sufflogobius bibarbatus	0.06	18	0.16	
Total	37.50		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1749
DATE:26/ 8/06 GEAR TYPE: PT No: 4 POSITION:Lat S 2512
start stop duration Long E 1410
TIME :21:25:05 21:39:41 15 (min) Purpose code: 1
LOG :2367.47 2368.26 0.79 Area code : 2
FDEPTH: 10 10 GearCond.code:
BDEPTH: 191 190 Validity code:
Towing dir: 70ø Wire out: 130 m Speed: 40 kn*10

Sorted: 15 Kg Total catch: 15.10 CATCH/HOUR: 60.40

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	35.40	74000	58.61	8384
Thyrsites atun	12.80	4	21.19	
Todarodes angolensis	7.36	896	12.19	
Merluccius capensis	2.80	4	4.64	
Krill	1.80	9060	2.98	
Argonauta sp.	0.12	4	0.20	
Abriliopsis gilchristi	0.08	36	0.13	
Elops sp.	0.04	4	0.07	
Lolligoncula mercatoris	0.04	4	0.07	
Total	60.44		100.08	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1750
DATE:27/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2524
start stop duration Long E 1342
TIME :03:13:52 03:43:10 29 (min) Purpose code: 1
LOG :2403.55 2405.40 1.83 Area code : 2
FDEPTH: 40 45 GearCond.code:
BDEPTH: 367 394 Validity code:
Towing dir: 208ø Wire out: 130 m Speed: 36 kn*10

Sorted: 7 Kg Total catch: 73.05 CATCH/HOUR: 151.14

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	116.67	78902	77.19	8386
Symbolophorus boops	24.99	2249	16.53	8385
Thyrsites atun	7.03	2	4.65	
Maurolicus muelleri	1.59	163	1.05	8388
Lycoteuthis diadema	0.52	62	0.34	
Abriliopsis gilchristi	0.25	103	0.17	
Electrona risso	0.06	21	0.04	8387
Total	151.11		99.97	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1751
DATE:27/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2536
start stop duration Long E 1329
TIME :07:20:50 07:32:40 12 (min) Purpose code: 1
LOG :2436.52 2437.20 0.67 Area code : 1
FDEPTH: 150 150 GearCond.code:
BDEPTH: 754 744 Validity code:
Towing dir: 29ø Wire out: 400 m Speed: 40 kn*10

Sorted: 32 Kg Total catch: 32.00 CATCH/HOUR: 160.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	159.80	154920	99.88	8389
Abriliopsis gilchristi	0.15	55	0.09	
Emmelichthys nitidus	0.05	5	0.03	
Total	160.00		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1752
DATE:27/ 8/06 GEAR TYPE: BT No:19 POSITION:Lat S 2549
start stop duration Long E 1353
TIME :15:48:01 16:07:25 19 (min) Purpose code: 1
LOG :2494.59 2495.65 1.04 Area code : 1
FDEPTH: 341 341 GearCond.code:
BDEPTH: 341 341 Validity code:
Towing dir: 148ø Wire out:1020 m Speed: 32 kn*10

Sorted: 392 Kg Total catch: 392.39 CATCH/HOUR: 1239.13

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Merluccius capensis	549.47	1326	44.34	8391
Merluccius paradoxus	495.79	2207	40.01	8390
Helicolenus dactylopterus	142.11	553	11.47	8392
Lampanyctodes hectoris	25.26		2.04	
Caelorinchus simorhynchus	8.84	92	0.71	
Nezumia sp.	5.37	129	0.43	
Squalus megalops	4.42	9	0.36	
Trachurus capensis	3.63	16	0.29	
Lycoteuthis diadema	2.12	101	0.17	
Galeus polli	1.74	13	0.14	
Epigonus sp.	0.35	82	0.03	
Chlorophthalmus sp.	0.03	3		
Total	1239.13		99.99	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1753
DATE:27/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2542
start stop duration Long E 1408
TIME :18:50:12 19:05:39 15 (min) Purpose code: 1
LOG :2516.74 2517.81 1.07 Area code : 1
FDEPTH: 25 25 GearCond.code:
BDEPTH: 240 246 Validity code:
Towing dir: 242ø Wire out: 130 m Speed: 40 kn*10

Sorted: 18 Kg Total catch: 18.65 CATCH/HOUR: 74.60

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	65.28	79560	87.51	8394
Maurolicus muelleri	9.32	10884	12.49	8393
Total	74.60		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1754
DATE:27/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2535
start stop duration Long E 1426
TIME :22:18:55 22:33:28 15 (min) Purpose code: 1
LOG :2541.37 2542.33 0.96 Area code : 1
FDEPTH: 25 25 GearCond.code:
BDEPTH: 158 156 Validity code:
Towing dir: 90ø Wire out: 130 m Speed: 40 kn*10

Sorted: 5 Kg Total catch: 5.00 CATCH/HOUR: 20.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	20.00	22060	100.00	8395
Total	20.00		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1755
DATE:28/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2603
start stop duration Long E 1420
TIME :05:51:02 06:04:23 13 (min) Purpose code: 1
LOG :2605.47 2606.35 0.88 Area code : 1
FDEPTH: 60 60 GearCond.code:
BDEPTH: 206 206 Validity code:
Towing dir: 15ø Wire out: 190 m Speed: 40 kn*10

Sorted: 21 Kg Total catch: 21.40 CATCH/HOUR: 98.77

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	76.15	75378	77.10	8396
Thyrsites atun	18.00	5	18.22	
Maurolicus muelleri	4.52	4791	4.58	8397
Lycoteuthis diadema	0.05	5	0.05	
Todarodes angolensis	0.05	5	0.05	
Total	98.77		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1756
DATE:28/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2612
start stop duration Long E 1400
TIME :09:36:20 09:58:01 22 (min) Purpose code: 1
LOG :2631.81 2633.09 1.26 Area code : 1
FDEPTH: 150 150 GearCond.code:
BDEPTH: 346 342 Validity code:
Towing dir: 32ø Wire out: 330 m Speed: 40 kn*10

Sorted: Kg Total catch: CATCH/HOUR:

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

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1757
DATE:28/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2609
start stop duration Long E 1401
TIME :10:49:51 11:10:14 20 (min) Purpose code: 1
LOG :2636.57 2637.71 1.14 Area code : 1
FDEPTH: 290 295 GearCond.code:
BDEPTH: 336 331 Validity code:
Towing dir: 55ø Wire out: 700 m Speed: 33 kn*10

Sorted: 2 Kg Total catch: 111.70 CATCH/HOUR: 335.10

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Todarodes angolensis	100.38	969	29.96	
Lampanyctodes hectoris	71.01	46650	21.19	8396
Symbolophorus boops	66.81	14457	19.94	8397
J E L L Y F I S H	59.19	1944	17.66	
Lycoteuthis diadema	31.53	2166	9.41	
Electrona risso	3.63	1437	1.08	8400
Maurolicus muelleri	2.13	2622	0.64	8398
ARGENTINIDAE	0.42	84	0.13	8399
Total	335.10		100.01	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1758
DATE:28/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2620
start stop duration Long E 1339
TIME :14:41:06 14:49:49 9 (min) Purpose code: 1
LOG :2663.76 2664.27 0.51 Area code : 1
FDEPTH: 160 150 GearCond.code:
BDEPTH: 529 554 Validity code:
Towing dir: 249ø Wire out: 500 m Speed: 34 kn*10

Sorted: 16 Kg Total catch: 16.20 CATCH/HOUR: 108.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	107.47	103673	99.51	8401
Lycoteuthis diadema	0.47	20	0.44	
Emmelichthys nitidus	0.07	20	0.06	
Total	108.01		100.01	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1759
DATE:29/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2646
start stop duration Long E 1403
TIME :02:42:18 02:55:33 13 (min) Purpose code: 1
LOG :2733.55 2734.32 0.77 Area code : 1
FDEPTH: 80 80 GearCond.code:
BDEPTH: 408 410 Validity code:
Towing dir: 250ø Wire out: 240 m Speed: 35 kn*10

Sorted: Kg Total catch: 11.34 CATCH/HOUR: 52.34

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	42.92	25389	82.00	8402
Symbolophorus boops	9.42	822	18.00	8403
Abriliopsis gilchristi	0.05	9	0.10	
Emmelichthys nitidus	0.05	5	0.10	
Total	52.44		100.20	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1760
DATE:29/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2639
start stop duration Long E 1422
TIME :06:40:08 06:41:00 16 (min) Purpose code: 1
LOG :2759.79 2761.07 1.28 Area code : 1
FDEPTH: 25 25 GearCond.code:
BDEPTH: 337 341 Validity code:
Towing dir: 290ø Wire out: 130 m Speed: 40 kn*10

Sorted: Kg Total catch: 0.02 CATCH/HOUR: 0.08

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Brama brama	0.04	8	50.00	
Maurolicus muelleri	0.04	8	50.00	8404
Emmelichthys nitidus	0.04	4	50.00	
Abriliopsis gilchristi	0.04	11	50.00	
Total	0.16		200.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1761
DATE:29/ 8/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2635
start stop duration Long E 1439
TIME :10:01:35 11:41:35 18 (min) Purpose code: 1
LOG :2782.47 2783.32 0.81 Area code : 1
FDEPTH: 75 75 GearCond.code:
BDEPTH: 223 218 Validity code:
Towing dir: 137ø Wire out: 230 m Speed: 30 kn*10

Sorted: Kg Total catch: 37.00 CATCH/HOUR: 123.33

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	122.30	91043	99.16	8405
Todarodes angolensis	0.57	47	0.46	
Symbolophorus boops	0.30	67	0.24	8407
Lycoteuthis diadema	0.13	20	0.11	
Maurolicus muelleri	0.07	63	0.06	8406
Abriliopsis gilchristi	0.03	3	0.02	
Total	123.40		100.05	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1762
DATE: 1/ 9/06 GEAR TYPE: BT No:19 POSITION:Lat S 2647
start stop duration Long E 1449
TIME :03:20:51 08:20:04 28 (min) Purpose code: 1
LOG :2867.26 2868.85 1.60 Area code : 1
FDEPTH: 179 173 GearCond.code:
BDEPTH: 179 173 Validity code:
Towing dir: ø Wire out: 540 m Speed: 32 kn*10

Sorted: 2 Kg Total catch: 403.05 CATCH/HOUR: 863.68

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Merluccius capensis	362.14	5070	41.93	8409
Thyrsites atun	325.71	88	37.71	8412
Lampanyctodes hectoris	109.29	89184	12.65	8410
Chelidonichthys capensis	17.68	56	2.05	8411
Callorhinchus capensis	15.00	9	1.74	
Todarodes angolensis	13.52	171	1.57	
Sufflogobius bibarbatus	6.56	1153	0.76	8414
Trachurus capensis	5.08	86	0.59	
Sepia australis	4.39	171	0.51	
Maurolicus muelleri	3.54	3446	0.41	8413
Lepidopus caudatus	0.51	9	0.06	
Helicolenus dactylopterus	0.26	86	0.03	
Total	863.68		100.01	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1763
DATE: 1/ 9/06 GEAR TYPE: BT No:19 POSITION:Lat S 2655
start stop duration Long E 1430
TIME :13:20:33 13:20:45 20 (min) Purpose code: 1
LOG :2894.10 2895.06 0.96 Area code : 1
FDEPTH: 314 314 GearCond.code:
BDEPTH: 314 314 Validity code:
Towing dir: 355ø Wire out: 900 m Speed: 30 kn*10

Sorted: 373 Kg Total catch: 373.29 CATCH/HOUR: 1119.87

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Merluccius paradoxus, juvenile	397.80	555	35.52	8419
Merluccius paradoxus	276.00	621	24.65	8418
Lampanyctodes hectoris	183.42	115068	16.38	8417
Coelorinchus coelorhinc. polli	100.50	2052	8.97	
Merluccius capensis	90.00	159	8.04	
Symbolophorus boops	21.75	4287	1.94	8416
Helicolenus dactylopterus	19.80	186	1.77	
Todarodes angolensis	9.78	21	0.87	
Genypterus capensis	8.40	9	0.75	
Lepidopus caudatus	6.00	6	0.54	
Thyrsites atun	3.90	3	0.35	
Lycoteuthis diadema	0.57	36	0.05	
Galeus polli	0.51	3	0.05	
Maurolicus muelleri	0.39	315	0.03	8415
Squilla sp.	0.27	21	0.02	
Bathynectes piperitus	0.27	12	0.02	
Abriliopsis gilchristi	0.24	81	0.02	
Emmelichthys nitidus	0.12	21	0.01	
Epigonus sp.	0.09	21	0.01	
GOBIIDAE	0.06	24	0.01	
Physiculus capensis	0.03	3		
Total	1119.90		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1764
DATE: 1/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2701
start stop duration Long E 1409
TIME :17:34:41 17:50:48 16 (min) Purpose code: 1
LOG :2920.65 2921.61 0.95 Area code : 1
FDEPTH: 300 310 GearCond.code:
BDEPTH: 410 406 Validity code:
Towing dir: 69ø Wire out: 900 m Speed: 37 kn*10

Sorted: 4 Kg Total catch: 4.19 CATCH/HOUR: 15.71

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Diaphus sp.	8.29	623	52.77	8421
Lycoteuthis diadema	2.96	188	18.84	
Photichthys argenteus	2.21	353	14.07	
Symbolophorus boops	1.58	124	10.06	8420
Todarodes angolensis	0.23	4	1.46	
Gymnoscopelus sp.	0.23	30	1.46	
Epigonus sp.	0.11	30	0.70	
Maurolicus muelleri	0.04	15	0.25	
Funchalia woodwardi	0.04	4	0.25	
Electrona risso	0.04	23	0.25	
Total	15.73		100.11	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1765
DATE: 1/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2704
start stop duration Long E 1402
TIME :18:20:21 20:00:45 12 (min) Purpose code:
LOG :2934.39 2935.13 0.73 Area code : 1
FDEPTH: 100 100 GearCond.code: 1
BDEPTH: 460 451 Validity code:
Towing dir: 70ø Wire out: 320 m Speed: 38 kn*10

Sorted: 2 Kg Total catch: 1.55 CATCH/HOUR: 7.75

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Funchalia woodwardi	6.95	550	89.68	
Gymnoscopelus sp.	0.45	90	5.81	8425
Maurolicus muelleri	0.20	185	2.58	8428
Electrona risso	0.15	35	1.94	8426
Lampanyctodes hectoris	0.05	50	0.65	8427
Total	7.80		100.66	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1766
DATE: 1/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2703
start stop duration Long E 1404
TIME :20:00:00 20:00:01 12 (min) Purpose code: 1
LOG :2936.26 2937.02 0.75 Area code : 1
FDEPTH: 70 70 GearCond.code:
BDEPTH: 441 436 Validity code:
Towing dir: 70ø Wire out: 270 m Speed: 37 kn*10

Sorted: 1 Kg Total catch: 0.86 CATCH/HOUR: 4.30

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	1.95	310	45.35	8432
Funchalia woodwardi	0.80	60	18.60	
Gymnoscopelus sp.	0.40	75	9.30	8430
Symbolophorus boops	0.40	30	9.30	8429
Electrona risso	0.35	95	8.14	8431
Lycoteuthis diadema	0.30	40	6.98	
Lepidopus caudatus	0.05	15	1.16	
Emmelichthys nitidus	0.05	35	1.16	
Total	4.30		99.99	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1767
DATE: 1/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2703
start stop duration Long E 1406
TIME :20:51:28 21:08:31 17 (min) Purpose code: 1
LOG :2938.13 2939.34 1.18 Area code : 1
FDEPTH: 30 30 GearCond.code:
BDEPTH: 429 422 Validity code:
Towing dir: 70ø Wire out: 170 m Speed: 38 kn*10

Sorted: 2 Kg Total catch: 1.52 CATCH/HOUR: 5.36

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Symbolophorus boops	3.92	395	73.13	8432
Lycoteuthis diadema	0.64	74	11.94	
Funchalia woodwardi	0.28	28	5.22	
Electrona risso	0.25	74	4.66	8436
Lampanyctodes hectoris	0.18	367	3.36	8434
Abriliopsis gilchristi	0.04	7	0.75	
Gymnoscopelus sp.	0.04	7	0.75	8433
Total	5.35		99.81	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1768
DATE: 2/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2707
start stop duration Long E 1445
TIME :01:08:55 01:37:42 29 (min) Purpose code: 1
LOG :2973.58 2975.31 1.74 Area code : 1
FDEPTH: 55 55 GearCond.code:
BDEPTH: 257 247 Validity code:
Towing dir: 90ø Wire out: 180 m Speed: 30 kn*10

Sorted: 23 Kg Total catch: 22.70 CATCH/HOUR: 46.97

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	39.29	22037	83.65	8438
Merluccius paradoxus, juvenile	4.63	106	9.86	8439
Lepidopus caudatus	2.21	74	4.71	
Maurolicus muelleri	0.43	370	0.92	8437
Todarodes angolensis	0.33	120	0.70	
Scopelosaurus meadi	0.02	2	0.04	
Emmelichthys nitidus	0.02	4	0.04	
Elops sp.	0.02	6	0.04	
Epigonus sp.	0.02	2	0.04	
Total	46.97		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1769
DATE: 2/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2706
start stop duration Long E 1448
TIME :08:14:47 08:26:45 12 (min) Purpose code: 1
LOG :2983.28 2984.05 0.75 Area code : 1
FDEPTH: 230 220 GearCond.code:
BDEPTH: 235 228 Validity code:
Towing dir: 75ø Wire out: 730 m Speed: 39 kn*10

Sorted: 27 Kg Total catch: 27.26 CATCH/HOUR: 136.30

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	128.55	74990	94.31	8441
Lepidopus caudatus	7.00	110	5.14	
Maurolicus muelleri	0.45	390	0.33	8440
Etrumeus whiteheadi	0.25	5	0.18	
Symbolophorus boops	0.05	5	0.04	
Total	136.30		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1770
DATE: 2/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2705
start stop duration Long E 1450
TIME :08:00:31 08:00:42 12 (min) Purpose code: 1
LOG :2984.65 2985.40 0.73 Area code : 1
FDEPTH: 60 60 GearCond.code:
BDEPTH: 221 214 Validity code:
Towing dir: 75ø Wire out: 200 m Speed: 39 kn*10

Sorted: 1 Kg Total catch: 0.17 CATCH/HOUR: 0.85

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	0.35	175	41.18	8442
Lycoteuthis diadema	0.05	5	5.88	
Gymnoscopelus sp.	0.05	5	5.88	
Symbolophorus boops	0.05	5	5.88	
Total	0.50		58.82	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1771
DATE: 2/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2705
start stop duration Long E 1451
TIME :08:00:47 09:01:05 14 (min) Purpose code: 1
LOG :2985.92 2986.85 0.93 Area code : 1
FDEPTH: 30 30 GearCond.code:
BDEPTH: 211 206 Validity code:
Towing dir: 75ø Wire out: 120 m Speed: 39 kn*10

Sorted: 1 Kg Total catch: 1.31 CATCH/HOUR: 5.61

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Todarodes angolensis	5.49	1611	97.86	
Lampanyctodes hectoris	0.13	69	2.32	8443
Maurolicus muelleri	0.04	9	0.71	8444
Total	5.66		100.89	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1772
DATE: 2/ 9/06 GEAR TYPE: BT No:19 POSITION:Lat S 2704
start stop duration Long E 1451
TIME :09:01:08 10:00:09 16 (min) Purpose code: 1
LOG :2989.28 2990.16 0.86 Area code : 1
FDEPTH: 210 213 GearCond.code:
BDEPTH: 210 213 Validity code:
Towing dir: 190ø Wire out: 570 m Speed: 33 kn*10

Sorted: 172 Kg Total catch: 172.06 CATCH/HOUR: 645.23

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Merluccius capensis, juveniles	534.98	8854	82.91	8446
Lampanyctodes hectoris	53.25	19061	8.25	8445
Merluccius paradoxus, juvenile	33.53	559	5.20	8447
Merluccius capensis	18.75	64	2.91	8448
Chelidonichthys capensis	2.63	4	0.41	
Trachurus capensis	2.29	4	0.35	
Sufflogobius bibarbatus	1.05	255	0.16	8449
Maurolicus muelleri	0.34	259	0.05	8450
Sepia australis	0.30	26	0.05	
Lolliguncula sp.	0.08	38	0.01	
Todarodes angolensis	0.04	11	0.01	
Abriliopsis gilchristi	0.04	8	0.01	
Emmelichthys nitidus	0.04	4	0.01	
Argonauta sp.	0.04	4	0.01	
Lepidopus caudatus	0.04	4	0.01	
Total	647.40		100.35	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1773
DATE: 2/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2706
start stop duration Long E 1448
TIME :13:08:14 13:23:36 15 (min) Purpose code: 1
LOG : 297.62 2998.49 0.87 Area code : 1
FDEPTH: 225 225 GearCond.code:
BDEPTH: 236 230 Validity code:
Towing dir: 60ø Wire out: 580 m Speed: 35 kn*10

Sorted: 1 Kg Total catch: 0.99 CATCH/HOUR: 3.96

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lepidopus caudatus	1.28	32	32.32	
Etrumeus whiteheadi	0.96	16	24.24	8453
Lampanyctodes hectoris	0.84	424	21.21	8451
Maurolicus muelleri	0.76	756	19.19	8452
Lycoteuthis diadema	0.08	4	2.02	
Lolliguncula mercatoris	0.04	4	1.01	
Total	3.96		99.99	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1774
DATE: 2/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2705
start stop duration Long E 1450
TIME :13:38:00 13:53:08 15 (min) Purpose code: 1
LOG :2999.40 0.31 0.90 Area code : 1
FDEPTH: 160 160 GearCond.code:
BDEPTH: 220 212 Validity code:
Towing dir: 60ø Wire out: 550 m Speed: 38 kn*10

Sorted: 1 Kg Total catch: 0.02 CATCH/HOUR: 0.08

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	0.04	16	50.00	8455
Maurolicus muelleri	0.04	8	50.00	8454
Total	0.08		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1775
DATE: 2/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2705
start stop duration Long E 1451
TIME :14:09:01 14:24:24 15 (min) Purpose code: 1
LOG :3001.03 3001.94 0.89 Area code : 1
FDEPTH: 60 60 GearCond.code:
BDEPTH: 207 199 Validity code:
Towing dir: 60ø Wire out: 180 m Speed: 40 kn*10

Sorted: Kg Total catch: 0.06 CATCH/HOUR: 0.24

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
SQUEN11	0.16	8	66.67	
Maurolicus muelleri	0.04	4	16.67	8456
Todarodes angolensis	0.04	12	16.67	
Total	0.24		100.01	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1776
DATE: 2/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2706
start stop duration Long E 1447
TIME :21:46:25 21:58:31 12 (min) Purpose code: 1
LOG :3014.06 3014.78 0.71 Area code : 1
FDEPTH: 95 95 GearCond.code:
BDEPTH: 239 234 Validity code:
Towing dir: 50ø Wire out: 300 m Speed: 39 kn*10

Sorted: 4 Kg Total catch: 4.20 CATCH/HOUR: 21.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	15.50	8065	73.81	8457
Merluccius paradoxus, juvenile	2.00	75	9.52	8458
Maurolicus muelleri	1.85	1810	8.81	8459
Lepidopus caudatus	1.50	35	7.14	
Sepia australis	0.10	5	0.48	
Inioteuthis capensis	0.05	30	0.24	
Total	21.00		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1777
DATE: 2/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2705
start stop duration Long E 1448
TIME :22:10:02 22:22:03 12 (min) Purpose code: 1
LOG :3015.42 3016.15 0.73 Area code : 1
FDEPTH: 60 60 GearCond.code:
BDEPTH: 231 225 Validity code:
Towing dir: 50ø Wire out: 200 m Speed: 39 kn*10

Sorted: 1 Kg Total catch: 32.40 CATCH/HOUR: 162.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	158.90	99050	98.09	8461
Lepidopus caudatus	2.45	135	1.51	
Maurolicus muelleri	0.65	670	0.40	8460
Total	162.00		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1778
DATE: 2/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2704
start stop duration Long E 1449
TIME :22:33:08 22:44:52 12 (min) Purpose code: 1
LOG :3016.82 3017.57 0.73 Area code : 1
FDEPTH: 30 30 GearCond.code:
BDEPTH: 221 216 Validity code:
Towing dir: 40ø Wire out: 115 m Speed: 39 kn*10

Sorted: 7 Kg Total catch: 6.80 CATCH/HOUR: 34.00

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	33.50	18670	98.53	8462
Todarodes angolensis	0.40	65	1.18	
Abriliopsis gilchristi	0.05	15	0.15	
Argonauta sp.	0.05	5	0.15	
Total	34.00		100.01	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1779
DATE: 3/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2705
start stop duration Long E 1448
TIME :00:10:05 00:25:08 15 (min) Purpose code: 1
LOG :3020.93 3021.77 0.84 Area code : 1
FDEPTH: 180 180 GearCond.code:
BDEPTH: 228 234 Validity code:
Towing dir: 200ø Wire out: 550 m Speed: 40 kn*10

Sorted: 10 Kg Total catch: 10.14 CATCH/HOUR: 40.56

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Merluccius capensis	24.40	304	60.16	8463
Callorhinchus capensis	9.80	4	24.16	
Merluccius paradoxus, juvenile	3.20	64	7.89	8464
Maurolicus muelleri	2.12	1940	5.23	8465
Lampanyctodes hectoris	0.44	268	1.08	8467
Sufflogobius bibarbatus	0.32	272	0.79	8466
Sepia australis	0.28	16	0.69	
Total	40.56		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1780
DATE: 3/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2706
start stop duration Long E 1447
TIME :00:40:03 00:55:29 15 (min) Purpose code: 1
LOG :3022.56 3023.38 0.82 Area code : 5
FDEPTH: 140 140 GearCond.code:
BDEPTH: 238 243 Validity code:
Towing dir: 200ø Wire out: 440 m Speed: 40 kn*10

Sorted: 1 Kg Total catch: 1.68 CATCH/HOUR: 6.72

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Merluccius paradoxus, juvenile	3.72	72	55.36	8471
Merluccius capensis	1.60	20	23.81	8468
Lampanyctodes hectoris	0.60	428	8.93	8470
Maurolicus muelleri	0.52	460	7.74	8469
Lepidopus caudatus	0.20	4	2.98	
Inioteuthis capensis	0.04	8	0.60	
Sufflogobius bibarbatus	0.04	8	0.60	8472
Total	6.72		100.02	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1781
DATE: 3/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2707
start stop duration Long E 1447
TIME :01:08:08 01:24:53 17 (min) Purpose code: 1
LOG :3024.03 3024.95 0.91 Area code : 1
FDEPTH: 115 115 GearCond.code:
BDEPTH: 248 255 Validity code:
Towing dir: 200ø Wire out: 330 m Speed: 37 kn*10

Sorted: 1 Kg Total catch: 1.35 CATCH/HOUR: 4.76

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Merluccius paradoxus, juvenile	1.62	35	34.03	8474
Merluccius capensis	1.41	32	29.62	8473
Lampanyctodes hectoris	0.95	399	19.96	8476
Funchalia woodwardi	0.32	579	6.72	
Maurolicus muelleri	0.28	265	5.88	8475
Lepidopus caudatus	0.18	4	3.78	
Total	4.76		99.99	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1782
DATE: 3/ 9/06 GEAR TYPE: BT No:19 POSITION:Lat S 2706
start stop duration Long E 1446
TIME :07:35:56 07:56:35 21 (min) Purpose code: 1
LOG :3031.57 3032.68 1.09 Area code : 1
FDEPTH: 241 243 GearCond.code:
BDEPTH: 241 243 Validity code:
Towing dir: 155ø Wire out: 640 m Speed: 34 kn*10

Sorted: 362 Kg Total catch: 362.16 CATCH/HOUR: 1034.74

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Merluccius capensis, juveniles	767.97	9543	74.22	8479
Lampanyctodes hectoris	188.51	145009	18.22	8477
Callorhinchus capensis	37.14	20	3.59	
Merluccius capensis	8.57	17	0.83	
Raja straeleni	8.57	3	0.83	
Merluccius paradoxus, juvenile	8.57	191	0.83	8480
Thyrsites atun	8.57	3	0.83	
Chelidonichthys capensis	2.86	6	0.28	
Maurolicus muelleri	1.69	1506	0.16	8478
Todarodes angolensis	1.63	86	0.16	
Caelorinchus simorhynchus	0.40		0.04	
Lepidopus caudatus	0.23	3	0.02	
Sufflogobius bibarbatus	0.03	17		
Total	1034.74		100.01	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1783
DATE: 3/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2709
start stop duration Long E 1447
TIME :09:03:29 09:18:00 15 (min) Purpose code: 1
LOG :3035.46 3036.22 0.75 Area code : 1
FDEPTH: 235 235 GearCond.code:
BDEPTH: 256 260 Validity code:
Towing dir: 170ø Wire out: 570 m Speed: 32 kn*10

Sorted: 64 Kg Total catch: 64.05 CATCH/HOUR: 256.20

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	250.32	157404	97.70	8481
Lepidopus caudatus	3.24	68	1.26	
Etrumeus whiteheadi	1.48	24	0.58	8483
Maurolicus muelleri	1.16	1032	0.45	8482
Total	256.20		99.99	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1784
DATE: 3/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2711
start stop duration Long E 1447
TIME :09:30:07 09:44:03 14 (min) Purpose code: 1
LOG :3036.69 3037.36 0.66 Area code : 1
FDEPTH: 80 80 GearCond.code:
BDEPTH: 259 260 Validity code:
Towing dir: 170ø Wire out: 260 m Speed: 39 kn*10

Sorted: 1 Kg Total catch: 0.63 CATCH/HOUR: 2.70

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	2.53	1671	93.70	8484
Maurolicus muelleri	0.17	133	6.30	8485
Total	2.70		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1785
DATE: 3/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2712
start stop duration Long E 1448
TIME :09:56:26 10:08:33 12 (min) Purpose code: 1
LOG :3038.02 3038.75 0.72 Area code : 1
FDEPTH: 30 30 GearCond.code:
BDEPTH: 263 266 Validity code:
Towing dir: 150ø Wire out: 90 m Speed: 39 kn*10

Sorted: Kg Total catch: 0.07 CATCH/HOUR: 0.35

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	0.35	230	100.00	8486
Maurolicus muelleri	0.00	5		8487
Total	0.35		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1786
DATE: 4/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2823
start stop duration Long E 1543
TIME :07:38:42 07:50:30 12 (min) Purpose code: 1
LOG :3197.78 3198.48 0.70 Area code : 1
FDEPTH: 115 115 GearCond.code:
BDEPTH: 129 127 Validity code:
Towing dir: 60ø Wire out: 300 m Speed: 38 kn*10

Sorted: 4 Kg Total catch: 4.89 CATCH/HOUR: 24.45

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Krill	9.65	23885	39.47	
Lolligoncula mercatoris	5.85	2400	23.93	
Sepia australis	4.05	180	16.56	
Merluccius capensis, juveniles	2.70	35	11.04	8488
Lepidopus caudatus	1.60	160	6.54	
Todaropsis eblanae	0.60	10	2.45	
Lampanyctodes hectoris	0.05	5	0.20	8489
Total	24.50		100.19	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1787
DATE: 4/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2822
start stop duration Long E 1544
TIME :07:59:34 08:11:53 12 (min) Purpose code: 1
LOG :3198.94 3199.66 0.72 Area code : 1
FDEPTH: 50 50 GearCond.code:
BDEPTH: 124 122 Validity code:
Towing dir: 40ø Wire out: 150 m Speed: 38 kn*10

Sorted: Kg Total catch: 0.04 CATCH/HOUR: 0.20

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Lolligoncula mercatoris	0.10	35	50.00	
Maurolicus muelleri	0.05	90	25.00	8490
Krill	0.05	150	25.00	
Lepidopus caudatus	0.00	5		
Total	0.20		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1788
DATE: 4/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2830
start stop duration Long E 1521
TIME :11:17:41 11:42:20 25 (min) Purpose code: 1
LOG :3225.70 3227.19 1.48 Area code : 1
FDEPTH: 100 100 GearCond.code:
BDEPTH: 180 176 Validity code:
Towing dir: 74ø Wire out: 270 m Speed: 40 kn*10

Sorted: 147 Kg Total catch: 147.15 CATCH/HOUR: 353.16

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Etrumeus whiteheadi	352.22	8638	99.73	8491
Sardinops ocellatus	0.94	22	0.27	8492
Total	353.16		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1789
DATE: 4/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2841
start stop duration Long E 1452
TIME :16:08:01 16:19:59 12 (min) Purpose code: 1
LOG :3262.27 3262.95 0.67 Area code : 1
FDEPTH: 165 165 GearCond.code:
BDEPTH: 189 188 Validity code:
Towing dir: 70ø Wire out: 500 m Speed: 36 kn*10

Sorted: Kg Total catch: 0.60 CATCH/HOUR: 3.00

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Maurolicus muelleri	2.90	2910	96.67	8493
Inioteuthis capensis	0.05	40	1.67	
Emmelichthys nitidus	0.05	10	1.67	
Total	3.00		100.01	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1790
DATE: 4/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2841
start stop duration Long E 1453
TIME :16:25:58 16:38:02 12 (min) Purpose code: 1
LOG :3263.26 3263.98 0.72 Area code : 1
FDEPTH: 110 110 GearCond.code:
BDEPTH: 186 185 Validity code:
Towing dir: 70ø Wire out: 340 m Speed: 38 kn*10

Sorted: Kg Total catch: 10.00 CATCH/HOUR: 50.00

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Maurolicus muelleri	50.00	41995	100.00	8494
Total	50.00		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1791
DATE: 4/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2840
start stop duration Long E 1454
TIME :16:44:33 16:56:31 12 (min) Purpose code: 1
LOG :3264.28 3264.96 0.67 Area code : 1
FDEPTH: 46 46 GearCond.code:
BDEPTH: 184 183 Validity code:
Towing dir: 70ø Wire out: 135 m Speed: 37 kn*10

Sorted: Kg Total catch: 0.02 CATCH/HOUR: 0.10

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Maurolicus muelleri	0.10	65	100.00	8495
Total	0.10		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1792
DATE: 4/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2849
start stop duration Long E 1428
TIME :20:19:42 20:22:47 3 (min) Purpose code: 1
LOG :3294.45 3294.78 0.33 Area code : 1
FDEPTH: 10 10 GearCond.code:
BDEPTH: 290 304 Validity code:
Towing dir: 70ø Wire out: 150 m Speed: 39 kn*10

Sorted: Kg Total catch: 11.18 CATCH/HOUR: 223.60

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	208.00	153040	93.02	8496
Symbolophorus boops	15.60	1060	6.98	8497
Total	223.60		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1793
DATE: 5/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2938
start stop duration Long E 1504
TIME :09:43:09 09:58:21 15 (min) Purpose code: 1
LOG :3399.10 3399.98 0.86 Area code : 5
FDEPTH: 250 250 GearCond.code:
BDEPTH: 281 288 Validity code:
Towing dir: 243ø Wire out: 690 m Speed: 36 kn*10

Sorted: 80 Kg Total catch: 80.10 CATCH/HOUR: 320.40

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Brama brama	247.80	328	77.34	8493
Maurolicus muelleri	72.60	97148	22.66	8494
Total	320.40		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1795
DATE: 5/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 2940
start stop duration Long E 1527
TIME :16:15:00 16:26:59 12 (min) Purpose code: 1
LOG :3434.44 3435.14 0.72 Area code : 5
FDEPTH: 40 40 GearCond.code:
BDEPTH: 195 198 Validity code:
Towing dir: 250ø Wire out: 140 m Speed: 38 kn*10

Sorted: 126 Kg Total catch: 126.35 CATCH/HOUR: 631.75

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Etrumeus whiteheadi	580.75	11500	91.93	8497
Sardinops ocellatus	51.00	665	8.07	8496
Total	631.75		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1796
DATE: 6/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2916
start stop duration Long E 1610
TIME :00:42:27 01:02:10 20 (min) Purpose code: 1
LOG :3489.46 3490.73 1.27 Area code : 5
FDEPTH: 45 45 GearCond.code:
BDEPTH: 168 169 Validity code:
Towing dir: 330ø Wire out: 160 m Speed: 40 kn*10

Sorted: 4 Kg Total catch: 4.75 CATCH/HOUR: 14.25

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sepia australis	8.85	903	62.11	
Maurolicus muelleri	3.30	5391	23.16	8498
Etrumeus whiteheadi	1.83	45	12.84	8500
Merluccius capensis, juveniles	0.15	24	1.05	8501
Lampanyctodes hectoris	0.09	42	0.63	8499
Lolligoncula mercatoris	0.03	12	0.21	
Todarodes angolensis	0.03	3	0.21	
Inioteuthis capensis	0.00	3		
Total	14.28		100.21	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1797
DATE: 6/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 2946
start stop duration Long E 1649
TIME :08:45:29 09:02:37 17 (min) Purpose code: 1
LOG :3558.58 3559.65 1.05 Area code : 5
FDEPTH: 85 85 GearCond.code:
BDEPTH: 129 128 Validity code:
Towing dir: 340ø Wire out: 260 m Speed: 37 kn*10

Sorted: 13 Kg Total catch: 12.51 CATCH/HOUR: 44.15

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Maurolicus muelleri	40.66	58496	92.10	8503
Etrumeus whiteheadi	3.42	145	7.75	8502
Funchalia woodwardi	0.04	95	0.09	
Trachurus capensis, juvenile	0.04	7	0.09	8504
Total	44.16		100.03	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1798
DATE: 6/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 3011
start stop duration Long E 1639
TIME :14:41:31 15:01:09 20 (min) Purpose code: 1
LOG :3610.63 3611.91 1.27 Area code : 1
FDEPTH: 65 50 GearCond.code:
BDEPTH: 187 185 Validity code:
Towing dir: 65ø Wire out: 250 m Speed: 40 kn*10

Sorted: Kg Total catch: 12.07 CATCH/HOUR: 36.21

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Etrumeus whiteheadi	20.40	366	56.34	8506
Maurolicus muelleri	15.60	17601	43.08	8505
Trachurus capensis, juvenile	0.21	108	0.58	8507
Total	36.21		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1799
DATE: 6/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 3023
start stop duration Long E 1604
TIME :19:07:58 19:20:05 12 (min) Purpose code: 1
LOG :3649.86 3650.59 0.72 Area code : 5
FDEPTH: 120 120 GearCond.code:
BDEPTH: 235 234 Validity code:
Towing dir: 67ø Wire out: 340 m Speed: 37 kn*10

Sorted: Kg Total catch: 0.28 CATCH/HOUR: 1.40

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	1.05	1885	75.00	
Merluccius paradoxus, juvenile	0.25	75	17.86	
Todaropsis eblanae	0.05	5	3.57	
Sepia australis	0.05	20	3.57	
Inioteuthis capensis	0.00	5		
Total	1.40		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1800
DATE: 6/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 3023
start stop duration Long E 1605
TIME :19:30:28 19:42:29 12 (min) Purpose code: 1
LOG :3651.14 3651.86 0.72 Area code : 5
FDEPTH: 60 60 GearCond.code:
BDEPTH: 234 232 Validity code:
Towing dir: 67ø Wire out: 165 m Speed: 37 kn*10

Sorted: Kg Total catch: 0.61 CATCH/HOUR: 3.05

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	3.05	5555	100.00	8508
Total	3.05		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1801
DATE: 6/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 3022
start stop duration Long E 1607
TIME :19:54:34 20:06:40 12 (min) Purpose code: 1
LOG :3652.57 3653.32 0.74 Area code : 5
FDEPTH: 30 30 GearCond.code:
BDEPTH: 230 229 Validity code:
Towing dir: 67ø Wire out: 90 m Speed: 37 kn*10

Sorted: Kg Total catch: 0.18 CATCH/HOUR: 0.90

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	0.40	560	44.44	8509
Etrumeus whiteheadi	0.30	5	33.33	8510
Todarodes sagittatus	0.05	5	5.56	
Todaropsis eblanae	0.05	5	5.56	
Lolligoncula mercatoris	0.05	5	5.56	
Trachurus capensis	0.05	5	5.56	8511
Total	0.90		100.01	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1802
DATE: 7/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 3035
start stop duration Long E 1528
TIME :00:31:41 00:46:51 15 (min) Purpose code: 1
LOG :3693.07 3693.95 0.88 Area code : 5
FDEPTH: 100 100 GearCond.code:
BDEPTH: 308 308 Validity code:
Towing dir: 65ø Wire out: 300 m Speed: 40 kn*10

Sorted: 11 Kg Total catch: 11.45 CATCH/HOUR: 45.80

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	36.60	59616	79.91	8512
Brama brama	9.20	8	20.09	
Total	45.80		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1803
DATE: 7/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 3034
start stop duration Long E 1530
TIME :00:52:49 01:07:22 15 (min) Purpose code: 1
LOG :3694.19 3695.11 0.92 Area code : 5
FDEPTH: 20 20 GearCond.code:
BDEPTH: 309 303 Validity code:
Towing dir: 65ø Wire out: 130 m Speed: 40 kn*10

Sorted: Kg Total catch: 6.65 CATCH/HOUR: 26.60

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	26.60	34292	100.00	8513
Total	26.60		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1804
DATE: 7/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 3112
start stop duration Long E 1540
TIME :07:19:28 07:31:53 12 (min) Purpose code: 1
LOG :3751.01 3751.75 0.72 Area code : 1
FDEPTH: 195 195 GearCond.code:
BDEPTH: 603 600 Validity code:
Towing dir: 332ø Wire out: 635 m Speed: 38 kn*10

Sorted: Kg Total catch: 16.98 CATCH/HOUR: 84.90

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	81.50	71135	96.00	8514
Brama brama	3.40	5	4.00	
Total	84.90		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1805
DATE: 7/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 3111
start stop duration Long E 1540
TIME :07:43:43 07:55:47 12 (min) Purpose code: 1
LOG :3752.25 3752.99 0.73 Area code : 5
FDEPTH: 28 26 GearCond.code:
BDEPTH: 598 608 Validity code:
Towing dir: 332ø Wire out: 90 m Speed: 39 kn*10

Sorted: Kg Total catch: 0.01 CATCH/HOUR: 0.05

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Loligo reynaudi	0.05	25	100.00	
Total	0.05		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1806
DATE: 7/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 3106
start stop duration Long E 1611
TIME :14:34:38 14:54:17 20 (min) Purpose code: 1
LOG :3793.45 3794.60 1.15 Area code : 5
FDEPTH: 300 300 GearCond.code:
BDEPTH: 330 340 Validity code:
Towing dir: 245ø Wire out: 900 m Speed: 40 kn*10

Sorted: Kg Total catch: 23.15 CATCH/HOUR: 69.45

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	54.15	57561	77.97	8515
Brama brama	15.30	6	22.03	
Total	69.45		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1807
DATE: 7/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 3057
start stop duration Long E 1634
TIME :20:36:37 20:48:39 12 (min) Purpose code: 1
LOG :3825.83 3826.56 0.72 Area code : 5
FDEPTH: 80 80 GearCond.code:
BDEPTH: 258 262 Validity code:
Towing dir: 254ø Wire out: 260 m Speed: 38 kn*10

Sorted: Kg Total catch: 5.22 CATCH/HOUR: 26.10

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	25.25	42080	96.74	8516
Etrumeus whiteheadi	0.65	10	2.49	8517
Todarodes angolensis	0.15	10	0.57	
Todaropsis eblanae	0.05	5	0.19	
Elops sp.	0.05	10	0.19	
Total	26.15		100.18	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1808
DATE: 7/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 3058
start stop duration Long E 1633
TIME :21:01:44 21:13:43 12 (min) Purpose code: 1
LOG :3827.32 3828.08 0.75 Area code : 5
FDEPTH: 30 30 GearCond.code:
BDEPTH: 262 262 Validity code:
Towing dir: 254ø Wire out: 90 m Speed: 39 kn*10

Sorted: Kg Total catch: 0.06 CATCH/HOUR: 0.30

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	0.15	130	50.00	8519
C E P H A L O P O D A	0.05	5	16.67	
Inioteuthis capensis	0.05	5	16.67	
Trachurus capensis	0.05	10	16.67	8518
Total	0.30		100.01	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1809
DATE: 8/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 3042
start stop duration Long E 1716
TIME :03:42:14 03:57:15 15 (min) Purpose code: 1
LOG :3875.80 3876.74 0.94 Area code : 1
FDEPTH: 25 25 GearCond.code:
BDEPTH: 141 144 Validity code:
Towing dir: 250ø Wire out: 130 m Speed: 40 kn*10

Sorted: Kg Total catch: 15.66 CATCH/HOUR: 62.64

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Krill	34.48	76620	55.04	
Thyrsites atun	9.68	8	15.45	
Lolliguncula sp.	9.44	3484	15.07	
Maurolicus muelleri	3.64	4948	5.81	8520
Sepia australis	3.60	144	5.75	
Etrumeus whiteheadi	1.36	24	2.17	8522
Lampanyctodes hectoris	0.36	180	0.57	8521
Lepidopus caudatus	0.04	68	0.06	
Merluccius capensis, juveniles	0.04	4	0.06	
Total	62.64		99.98	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1810
DATE: 8/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 3059
start stop duration Long E 1737
TIME :08:38:09 08:51:08 13 (min) Purpose code: 1
LOG :3913.11 3913.88 0.76 Area code : 5
FDEPTH: 40 45 GearCond.code:
BDEPTH: 59 68 Validity code:
Towing dir: 320ø Wire out: 120 m Speed: 38 kn*10

Sorted: 18 Kg Total catch: 49.49 CATCH/HOUR: 228.42

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Etrumeus whiteheadi	167.63	53442	73.39	8524
Engraulis capensis	30.32	6738	13.27	8523
Thyrsites atun	18.92	9	8.28	
Lolligoncula mercatoris	6.74	3697	2.95	
Trachipterus trachypterus	4.80	2008	2.10	8525
Total	228.41		99.99	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1811
DATE: 8/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 3125
start stop duration Long E 1730
TIME :13:56:35 14:13:36 17 (min) Purpose code: 1
LOG :3959.56 3960.54 0.97 Area code : 5
FDEPTH: 100 100 GearCond.code:
BDEPTH: 157 152 Validity code:
Towing dir: 68ø Wire out: 330 m Speed: 40 kn*10

Sorted: Kg Total catch: 4.56 CATCH/HOUR: 16.09

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	16.09	20442	100.00	8526
Total	16.09		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1812
DATE: 8/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 3134
start stop duration Long E 1703
TIME :17:51:00 18:05:35 15 (min) Purpose code: 1
LOG :3990.39 3991.26 0.85 Area code : 5
FDEPTH: 10 10 GearCond.code:
BDEPTH: 270 265 Validity code:
Towing dir: 65ø Wire out: 120 m Speed: 37 kn*10

Sorted: Kg Total catch: 5.82 CATCH/HOUR: 23.28

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Etrumeus whiteheadi	22.52	384	96.74	8527
Maurolicus muelleri	0.56	564	2.41	8528
Lepidopus caudatus	0.04	8	0.17	
Todarodes angolensis	0.04	4	0.17	
Lampanyctodes hectoris	0.04	12	0.17	8530
Merluccius paradoxus, juvenile	0.04	4	0.17	
Trachurus capensis	0.04	44	0.17	8529
Total	23.28		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1813
DATE: 8/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 3146
start stop duration Long E 1631
TIME :22:00:42 22:15:43 15 (min) Purpose code: 1
LOG :4025.92 4026.86 0.94 Area code : 5
FDEPTH: 100 100 GearCond.code:
BDEPTH: 346 341 Validity code:
Towing dir: 62ø Wire out: 300 m Speed: 40 kn*10

Sorted: Kg Total catch: 6.10 CATCH/HOUR: 24.40

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	21.20	43156	86.89	8529
Merluccius paradoxus, juvenile	2.84	468	11.64	8528
Lampanyctodes hectoris	0.36	160	1.48	8530
Diaphus sp.	0.04	4	0.16	
Total	24.44		100.17	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1814
DATE: 8/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 3146
start stop duration Long E 1632
TIME :22:24:28 22:39:14 15 (min) Purpose code: 1
LOG :4027.35 4028.34 0.99 Area code : 5
FDEPTH: 50 50 GearCond.code:
BDEPTH: 340 334 Validity code:
Towing dir: 246ø Wire out: 180 m Speed: 40 kn*10

Sorted: 2 Kg Total catch: 13.32 CATCH/HOUR: 53.28

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	44.28	24820	83.11	8533
Maurolicus muelleri	5.96	8204	11.19	8532
Brama brama	2.80	4	5.26	8531
Lycoteuthis diadema	0.24	80	0.45	
Total	53.28		100.01	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1815
DATE: 8/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 3145
start stop duration Long E 1634
TIME :22:47:58 23:03:32 16 (min) Purpose code: 1
LOG :4028.88 4030.05 1.16 Area code : 5
FDEPTH: 20 20 GearCond.code:
BDEPTH: 330 325 Validity code:
Towing dir: 64ø Wire out: 100 m Speed: 40 kn*10

Sorted: Kg Total catch: 38.48 CATCH/HOUR: 144.30

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Brama brama	122.25	113	84.72	8536
Maurolicus muelleri	19.80	31984	13.72	8535
Lampanyctodes hectoris	2.10	960	1.46	8534
Todarodes angolensis	0.08	8	0.06	
Lycoteuthis diadema	0.04	8	0.03	
Todaropsis eblanae	0.04	8	0.03	
Total	144.31		100.02	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1816
DATE: 9/ 9/06 GEAR TYPE: PT No: 4 POSITION:Lat S 3155
start stop duration Long E 1610
TIME :01:56:26 02:26:04 30 (min) Purpose code: 1
LOG :4055.42 4057.17 1.72 Area code : 1
FDEPTH: 5 5 GearCond.code:
BDEPTH: 516 534 Validity code:
Towing dir: 174ø Wire out: 130 m Speed: 40 kn*10

Sorted: Kg Total catch: 44.16 CATCH/HOUR: 88.32

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Symbolophorus boops	61.00	5770	69.07	8537
Brama brama	17.80	16	20.15	8538
Lycoteuthis diadema	8.10	426	9.17	8539
Cubiceps caerulus	0.50	4	0.57	
Todarodes angolensis	0.48	64	0.54	
Maurolicus muelleri	0.40	416	0.45	8540
Trachurus capensis	0.02	4	0.02	8541
Abriliopsis gilchristi	0.02	4	0.02	
Total	88.32		99.99	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1817
DATE: 9/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 3238
start stop duration Long E 1619
TIME :09:13:10 09:46:21 33 (min) Purpose code: 1
LOG :4109.64 4111.25 1.61 Area code : 5
FDEPTH: 300 315 GearCond.code:
BDEPTH: 1451 1636 Validity code:
Towing dir: 250ø Wire out: 850 m Speed: 35 kn*10

Sorted: Kg Total catch: 14.84 CATCH/HOUR: 26.98

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	26.69	29849	98.93	8542
STERNOPTYCHIDAE	0.13	4	0.48	
Abriliopsis gilchristi	0.04	7	0.15	
Cranchia scabra	0.02	2	0.07	
Todarodes angolensis	0.02	2	0.07	
Lepidopus caudatus	0.02	2	0.07	
MYCTOPHIDAE	0.02	5	0.07	8544
Elops sp.	0.02	2	0.07	
Emmelichthys nitidus	0.02	4	0.07	
Lampanyctodes hectoris	0.02	85	0.07	8543
Total	27.00		100.05	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1818
DATE: 9/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 3224
start stop duration Long E 1653
TIME :15:58:13 16:10:32 12 (min) Purpose code: 1
LOG :4151.24 4152.10 0.85 Area code : 1
FDEPTH: 250 250 GearCond.code:
BDEPTH: 318 319 Validity code:
Towing dir: 330ø Wire out: 800 m Speed: 37 kn*10

Sorted: Kg Total catch: 30.40 CATCH/HOUR: 152.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	74.70	42730	49.14	8545
Etrumeus whiteheadi	74.00	915	48.68	8546
Maurolicus muelleri	3.30	2340	2.17	8547
Total	152.00		99.99	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1819
DATE: 9/ 9/06 GEAR TYPE: PT No: 2 POSITION:Lat S 3223
start stop duration Long E 1652
TIME :16:25:31 16:37:27 12 (min) Purpose code: 1
LOG :4152.94 4153.85 0.91 Area code : 1

FDEPTH: 60 50 GearCond.code:
BDEPTH: 320 320 Validity code:
Towing dir: 330ø Wire out: 176 m Speed: 38 kn*10

Sorted: Kg Total catch: 1.44 CATCH/HOUR: 7.20

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Allothunnus fallai	7.00	5	97.22	
Maurolicus muelleri	0.10	60	1.39	8548
Todarodes angolensis	0.10	35	1.39	
Total	7.20		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1820
DATE: 9/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 3217
start stop duration Long E 1723
TIME :22:42:09 23:08:57 27 (min) Purpose code: 1
LOG :4192.39 4193.93 1.52 Area code : 5
FDEPTH: 50 50 GearCond.code:
BDEPTH: 202 206 Validity code:
Towing dir: 270ø Wire out: 175 m Speed: 35 kn*10

Sorted: Kg Total catch: 0.29 CATCH/HOUR: 0.64

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Todarodes angolensis	0.27	40	42.19	
Merluccius paradoxus, juvenile	0.20	31	31.25	8545
Abriliopsis gilchristi	0.07	11	10.94	
Champsodon capensis	0.02	2	3.13	
Maurolicus muelleri	0.02	11	3.13	8547
Lepidopus caudatus	0.02	4	3.13	
Elops sp.	0.02	4	3.13	
Trachurus capensis	0.02	29	3.13	8546
Total	0.64		100.03	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1821
DATE:10/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 3207
start stop duration Long E 1747
TIME :02:57:21 03:12:01 15 (min) Purpose code: 1
LOG :4222.53 4223.44 0.91 Area code : 1
FDEPTH: 20 20 GearCond.code:
BDEPTH: 139 142 Validity code:
Towing dir: 240ø Wire out: 125 m Speed: 40 kn*10

Sorted: Kg Total catch: 24.02 CATCH/HOUR: 96.08

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	95.00	114004	98.88	8548
Lolliguncula mercatoris	0.32	132	0.33	
Todarodes angolensis	0.12	72	0.12	
Sepia australis	0.12	28	0.12	
Trachurus capensis	0.04	16	0.04	8549
Total	95.60		99.49	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1822
DATE:10/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 3229
start stop duration Long E 1749
TIME :10:11:17 10:30:11 19 (min) Purpose code: 1
LOG :4280.87 4282.00 1.13 Area code : 5
FDEPTH: 115 115 GearCond.code:
BDEPTH: 144 142 Validity code:
Towing dir: 25ø Wire out: 330 m Speed: 40 kn*10

Sorted: 1 Kg Total catch: 20.56 CATCH/HOUR: 64.93

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	48.88	56488	75.28	8550
Brama brama	14.21	6	21.89	
Etrumeus whiteheadi	1.07	44	1.65	8552
Lampanyctodes hectoris	0.76	420	1.17	8551
Total	64.92		99.99	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1823
DATE:10/ 9/06 GEAR TYPE: BT No:19 POSITION:Lat S 3240
start stop duration Long E 1727
TIME :14:42:21 15:02:35 20 (min) Purpose code: 1
LOG :4310.48 4311.47 1.00 Area code : 5
FDEPTH: 251 252 GearCond.code:
BDEPTH: 251 252 Validity code:
Towing dir: 360ø Wire out: 800 m Speed: 30 kn*10

Sorted: Kg Total catch: 71.67 CATCH/HOUR: 215.01

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Etrumeus whiteheadi	72.90	1212	33.91	8555
Merluccius capensis	37.50	123	17.44	8554
Merluccius paradoxus	22.80	330	10.60	8556
Maurolicus muelleri	14.16	16221	6.59	8558
Paracallionymus costatus	14.07	201	6.54	
Chelidonichthys capensis	13.83	33	6.43	
Brama brama	11.04	6	5.13	
Lampanyctodes hectoris	8.34	5793	3.88	8557
Todaropsis sp.	4.53	87	2.11	
Trachurus capensis	3.60	12	1.67	8559
Helicolenus dactylopterus	3.00	132	1.40	8553
Lepidopus caudatus	2.52	45	1.17	
Raja straeleni	1.83	3	0.85	
Lophius vomerinus	1.44	3	0.67	
ZEIDAE	1.29	6	0.60	
Holohalaelurus regani	0.93	3	0.43	
Genypterus capensis	0.54	3	0.25	
Coelorinchus coelorhinc. polli	0.33	6	0.15	
Malacocephalus laevis	0.18	3	0.08	
Emmelichthys nitidus	0.15	3	0.07	
Total	214.98		99.97	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1824
DATE:10/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 3246
start stop duration Long E 1659
TIME :18:54:23 19:09:52 15 (min) Purpose code: 1
LOG :4339.22 4340.15 0.93 Area code : 1
FDEPTH: 105 10 GearCond.code:
BDEPTH: 343 338 Validity code:
Towing dir: 10ø Wire out: 140 m Speed: 37 kn*10

Sorted: Kg Total catch: 0.21 CATCH/HOUR: 0.84

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	0.80	852	95.24	8559
Elops sp.	0.04	8	4.76	
Total	0.84		100.00	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1825
DATE:10/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 3258
start stop duration Long E 1636
TIME :23:06:31 23:25:31 19 (min) Purpose code: 1
LOG :4366.59 4367.77 1.16 Area code : 5
FDEPTH: 60 60 GearCond.code:
BDEPTH: 1340 1438 Validity code:
Towing dir: 200ø Wire out: 180 m Speed: 40 kn*10

Sorted: Kg Total catch: 4.69 CATCH/HOUR: 14.81

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Symbolophorus boops	5.05	486	34.10	8560
Funchalia woodwardi	2.91	714	19.65	
Symbolophorus boops	2.84	439	19.18	8563
MYCTOPHIDAE	1.93	1513	13.03	8562
Lampanyctodes hectoris	1.48	1048	9.99	8564
Gymnoscopelus sp.	0.16	95	1.08	8565
Abriliopsis gilchristi	0.13	16	0.88	
Lycoteuthis diadema	0.06	13	0.41	
Diplophos sp.	0.03	3	0.20	
Cranchia scabra	0.03	13	0.20	
Diaphus sp.	0.03	35	0.20	8561
Elops sp.	0.03	25	0.20	
Todarodes angolensis	0.03	3	0.20	
Lepidopus caudatus	0.03	28	0.20	
Scomberesox saurus	0.03	3	0.20	
Thyrsites atun	0.03	6	0.20	
Total	14.80		99.92	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1826
DATE:11/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 3316
start stop duration Long E 1724
TIME :08:31:59 09:01:52 30 (min) Purpose code: 1
LOG :4446.28 4447.81 1.51 Area code : 5
FDEPTH: 220 250 GearCond.code:
BDEPTH: 495 445 Validity code:
Towing dir: 223ø Wire out: 600 m Speed: 37 kn*10

Sorted: Kg Total catch: 6.44 CATCH/HOUR: 12.88

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Maurolicus muelleri	12.02	12144	93.32	8567
Diaphus sp.	0.40	186	3.11	8569
Abriliopsis gilchristi	0.38	78	2.95	
Todarodes sp.	0.02	6	0.16	
Lestidiops sp.	0.02	6	0.16	
Elops sp.	0.02	6	0.16	
Trachurus capensis	0.02	2	0.16	8570
Jasus lalandii	0.02	10	0.16	
Cranchia scabra	0.02	4	0.16	
Lampanyctodes hectoris	0.02	4	0.16	8568
Total	12.94		100.50	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1827
DATE:11/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 3319
start stop duration Long E 1803
TIME :14:08:12 14:33:02 25 (min) Purpose code: 1
LOG :4493.22 4495.11 1.86 Area code : 5
FDEPTH: 20 20 GearCond.code:
BDEPTH: 65 78 Validity code:
Towing dir: 330ø Wire out: 120 m Speed: 40 kn*10

Sorted: Kg Total catch: 0.13 CATCH/HOUR: 0.31

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis	0.26	158	83.87	8571
Lolligoncula mercatoris	0.02	7	6.45	
Elops sp.	0.02	2	6.45	
Engraulis encrasicolus	0.02	7	6.45	8572
Total	0.32		103.22	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:1828
DATE:11/ 9/06 GEAR TYPE: PT No: 1 POSITION:Lat S 3346
start stop duration Long E 1737
TIME :21:23:12 21:38:25 15 (min) Purpose code: 1
LOG :4551.95 4552.84 0.88 Area code : 5
FDEPTH: 45 28 GearCond.code:
BDEPTH: 264 270 Validity code:
Towing dir: 244ø Wire out: 120 m Speed: 38 kn*10

Sorted: Kg Total catch: 22.12 CATCH/HOUR: 88.48

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	73.20	64100	82.73	8573
Thyrsites atun	13.20	4	14.92	
Merluccius paradoxus, juvenile	1.52	224	1.72	8574
Etrumeus whiteheadi	0.40	8	0.45	8575
Champsodon capensis	0.16	32	0.18	
Jasus lalandii	0.04	4	0.05	
Maurolicus muelleri	0.04	4	0.05	8576
Scomberesox saurus	0.04	4	0.05	
Total	88.60		100.15	

DR. FRIDTJOF NANSEN PROJECT:BE PROJECT STATION:9999
DATE: 1/ 1/01 GEAR TYPE: No: POSITION:Lat S
start stop duration Long W
TIME :00:00:00 00:00:00 (min) Purpose code:
LOG : Area code :
FDEPTH: 0 0 GearCond.code:
BDEPTH: Validity code:
Towing dir: ø Wire out: m Speed: kn*10

Sorted: Kg Total catch: CATCH/HOUR:

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
search reached end of file Line # 63				
Total				

ANNEX II CALIBRATION WITH REFERENCE SPHERE

Vessel: "Dr. Fridtjof Nansen"		Date: 08.08.2006	
Echo sounder: EK500-1		Locality: Baia dos Elefantes, Angola	
Transducer: ES18-B	Sphere: CU64	Bottom depth: 30 m	
Sound vel: 1517 m/s (measured in situ)	r_{sphere}:20.2 m	$T_{sph-dep.}$:17.772 °C, $S_{sph-dep.}$:35,741 ‰	TS_{sphere}: -34.3 dB (correct for sound vel. or t, s)

TX/RX no: 3	Frequency: 18 kHz	Date previous calibration: 11/1-2006

Settings in sound velocity menu during calibration:

Mean sound velocity between 0 m and sphere depth: 1517 m/s (settings to be optimised according the present conditions)

Setting parameters in transmitter/receiver menu:	Previous values:	Values appeared at this calibration	Values set after calibration
Transducer depth (m) during (has to be 0,0 m during calibration)	0,0	0,0	5,5
Absorption coefficient (dB/km)	3	3	3
Pulse duration (ms)	Short	Short	Short
Band width (kHz)	Wide	Wide	Wide
TX effect ref. transducer terminals (W)	2000	2000	2000
Equivalent beam angle (10 log ψ) (dB)	-17,2	-17,2	-17,2
S_V transducer sensitivity (dB)	23,90	23,85	23,85
TS transducer sensitivity (dB)	23,86	23,80	23,80
Angle sensitivity along ship	13,9	13,9	13,9
Angle sensitivity athwart ship	13,9	13,9	13,9
3 dB beam width along ship (deg)	10,9	10,95	11.0
3 dB beam width athwart ship (deg)	10,9	10,67	10,7
Along ship deviation from centre (deg)	-0,18	0.01	0.01
Athwart ship deviation from centre (deg)	-0,05	0.11	0.11

Measured values before any adjustments: (measured with sphere in acoustic axis)

Read TS_{sphere}: -34.3 dB	Read S_A: 1998 m^2/nmi^2

Theoretical S_A in existing sphere depth (m^2/nmi^2)	2049

$$S_A = \frac{\sigma}{r^2 \psi} 1852^2 \qquad \sigma = 4\pi 10^{0.1TS}$$

Read S_A after control/adjustment of S_V transducer sensitivity (m^2/nmi^2)	2035

Remarks: *lowering keel:* *out* *in*

File name: 2006408.018

Weather conditions: ☒very good ☐good ☐bad (tick) Wind speed: 3.5 m/s

In cases where a variance of the transducer sensitivity is > 0,3 dB there has to be searched for possible causes. If no faults can be proven, a new calibration has to be made after relatively short time.

Vessel: "Dr. Fridtjof Nansen"		Date: 2006.08.08	
Echo sounder: EK500-1		Locality: Baia dos Elefantes, Angola	
Transducer: ES38-B	Sphere: WC38	Bottom depth: 30 m	
Sound vel: 1517 m/s (measured in situ)	r_{sphere}:20,1 m	$T_{sph-dep.}$:17.772 °C, $S_{sph-dep.}$:35.741 ‰	TS_{sphere}: -42,4 dB (correct for sound vel. or t, s)

TX/RX no: 1	Frequency: 38 kHz	Date previous calibration: 5/8-2005

Settings in sound velocity menu during calibration:

Mean sound velocity between 0 m and sphere depth: 1517 m/s (settings to be optimised according the present conditions)

Setting parameters in transmitter/receiver menu:	Previous values:	Values appeared at this calibration	Values set after calibration
Transducer depth (m) during (has to be 0,0 m during calibration)	0,0	0,0	5,5
Absorption coefficient (dB/km)	10	10	10
Pulse duration (ms)	Medium	Medium	Medium
Band width (kHz)	Wide	Wide	Wide
TX effect ref. transducer terminals (W)	2000	2000	2000
Equivalent beam angle (10 log ψ) (dB)	-21,0	-21,0	-21,0
S_V transducer sensitivity (dB)	26,96	26,86	26,86
TS transducer sensitivity (dB)	27,07	26.99	26.99
Angle sensitivity along ship	21,9	21,9	21,9
Angle sensitivity athwart ship	21,9	21,9	21,9
3 dB beam width along ship (deg)	6.9	6,95	7.0
3 dB beam width athwart ship (deg)	6,9	6,83	6,8
Along ship deviation from centre (deg)	-0,07	0,02	0,02
Athwart ship deviation from centre (deg)	0,08	0,02	0,02

Measured values before any adjustments: (measured with sphere in acoustic axis)

Read TS_{sphere}: 42,4 dB	Read S_A: 738 m^2/nmi^2

Theoretical S_A in existing sphere depth (m^2/nmi^2)	769

$$S_A = \frac{\sigma}{r^2 \psi} 1852^2 \qquad \sigma = 4\pi 10^{0.1TS}$$

Read S_A after control/adjustment of S_V transducer sensitivity (m^2/nmi^2)	766

Remarks: *lowering keel: out* *<u>in</u>*

File name: 2006408.038

Weather conditions: ☒very good ☐good ☐bad (tick) Wind speed: 3.5 m/s

In cases where a variance of the transducer sensitivity is > 0,3 dB there has to be searched for possible causes. If no faults can be proven, a new calibration has to be made after relatively short time.

Vessel: "Dr. Fridtjof Nansen"		Date: 2006.08.08	
Echo sounder: EK500-1		Locality: Baia dos Elefantes, Angola	
Transducer: ES120-7	Sphere: WC38	Bottom depth: 30 m	
Sound vel: 1517 m/s (measured in situ)	r_{sphere}:20.2 m	$T_{sph-dep.}$:17.772 °C, $S_{sph-dep.}$:35.741 ‰	TS_{sphere}: -39,6 dB (correct for sound vel. or t, s)

TX/RX no: 2	Frequency: 120 kHz	Date previous calibration: 11/01-2006

Settings in sound velocity menu during calibration:

Mean sound velocity between 0 m and sphere depth: 1517 m/s (settings to be optimised according the present conditions)

Setting parameters in transmitter/receiver menu:	Previous values:	Values appeared at this calibration	Values set after calibration
Transducer depth (m) during (has to be 0,0 m during calibration)	0,0	0,0	5,5
Absorption coefficient (dB/km)	38	38	38
Pulse duration (ms)	Long	Long	Long
Band width (kHz)	Narrow	Narrow	Narrow
TX effect ref. transducer terminals (W)	1000	1000	1000
Equivalent beam angle (10 log ψ) (dB)	-20,6	-20,6	-20,6
S_V transducer sensitivity (dB)	26.23	26.22	26.22
TS transducer sensitivity (dB)	26.38	26.20	26.20
Angle sensitivity along ship	21,0	21,0	21,0
Angle sensitivity athwart ship	21,0	21,0	21,0
3 dB beam width along ship (deg)	7.3	7.11	7.1
3 dB beam width athwart ship (deg)	7.2	6.91	6.9
Along ship deviation from centre (deg)	-0.18	0.3	0.3
Athwart ship deviation from centre (deg)	-0.08	0.14	0.14

Measured values before any adjustments: (measured with sphere in acoustic axis)

Read TS_{sphere}: -39,6 dB	Read S_A: 1315 m^2/nmi^2

Theoretical S_A in existing sphere depth (m^2/nmi^2)	1323

$$S_A = \frac{\sigma}{r^2 \psi} 1852^2 \qquad \sigma = 4\pi 10^{0.1TS}$$

Read S_A after control/adjustment of S_V transducer sensitivity (m^2/nmi^2)	1324

Remarks: *lowering keel:* *out* *in*

File name: 2006408.120

Weather conditions: ☒very good ☐good ☐bad (tick) Wind speed: 3.5 m/s

In cases where a variance of the transducer sensitivity is > 0,3 dB there has to be searched for possible causes. If no faults can be proven, a new calibration has to be made after relatively short time.

Vessel:	"Dr. Fridtjof Nansen"		Date:	08.08.2006	
Echo sounder:	EK500-2		Locality:	Baia dos Elefantes, Angola	
Transducer:	200-7F	Sphere:	WC38	Bottom depth:	30 m
Sound vel: 1517 m/s (measured in situ)	r_{sphere}:20.0 m	$T_{sph-dep.}$:17.772 °C, $S_{sph-dep.}$:35.741 ‰		TS_{sphere}:	-38,9 dB (correct for sound vel. or t, s)

TX/RX no: 1	Frequency: 200 kHz	Date previous calibration: 11.01.2006

Settings in sound velocity menu during calibration:

Mean sound velocity between 0 m and sphere depth: 1524 m/s (settings to be optimised according the present conditions)

Setting parameters in transmitter/receiver menu:	Previous values:	Values appeared at this calibration	Values set after calibration
Transducer depth (m) during (has to be 0,0 m during calibration)	0,0	0,0	5,5
Absorption coefficient (dB/km)	53	53	53
Pulse duration (ms)	Long	Long	Long
Band width (kHz)	Narrow	Narrow	Narrow
TX effect ref. transducer terminals (W)	1000	1000	1000
Equivalent beam angle (10 log ψ) (dB)	-20,5	-20,5	-20,5
S_V transducer sensitivity (dB)	23.82	23.50	23.50
TS transducer sensitivity (dB)	24,80	23.50	23.50
Angle sensitivity along ship			
Angle sensitivity athwart ship			
3 dB beam width along ship (deg)			
3 dB beam width athwart ship (deg)			
Along ship deviation from centre (deg)			
Athwart ship deviation from centre (deg)			

Measured values before any adjustments: (measured with sphere in acoustic axis)

Read TS_{sphere}: -38.9 dB	Read S_A: 1960 m^2/nmi^2

Theoretical S_A in existing sphere depth (m^2/nmi^2)	1558

$$S_A = \frac{\sigma}{r^2 \psi} 1852^2 \qquad \sigma = 4\pi 10^{0.1TS}$$

Read S_A after control/adjustment of S_V transducer sensitivity (m^2/nmi^2)	1540

Remarks: *lowering keel: out* *in*

Weather conditions: ☒very good ☐good ☐bad (tick) Wind speed: 3.5 m/s

In cases where a variance of the transducer sensitivity is > 0,3 dB there has to be searched for possible causes. If no faults can be proven, a new calibration has to be made after relatively short time.

Calibration carried out by: Jan Frode Wilhelmsen, Tore Mørk

ANNEX III SAMPLES COLLECTED FOR THE HAKE GENETIC PROJECT

Merluccius capensis			Merluccius paradoxus		
Trawl	Date	Number	Trawl	Date	Number
1736	24/08/2006	30	1752	27/08/2006	30
1747	26/08/2006	30	1763	01/09/2006	40
1762	01/09/2006	30	1782	03/09/2006	30
1823	01/09/2006	42	1799	06/09/2006	15
			1823	10/09/2006	75
Total Number		132	Total Number		190

Details of genetic samples collected for the hake genetic project