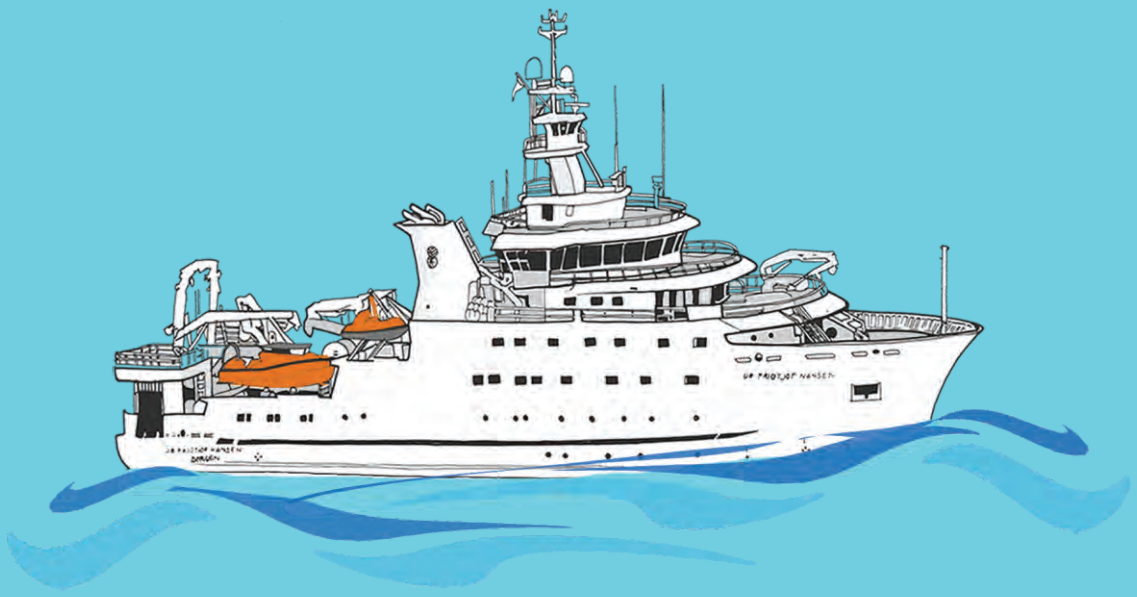
NORAD-FAO PROGRAMME
GCP/GLO/690/NOR

CRUISE REPORTS *DR FRIDTJOF NANSEN*
EAF-Nansen/CR/2017/8



# SURVEY OF THE PELAGIC FISH RESOURCES AND ECOSYSTEM OFF WEST AFRICA

## Angola

**01 October – 30 October 2017**

**Instituto Nacional de Investigação**
**Pesqueira, Angola**

**Institute of Marine Research**
**Bergen, Norway**

## The EAF-Nansen Programme

The EAF-Nansen Programme "Supporting the application of the Ecosystem Approach to Fisheries Management considering climate and pollution impacts" (GCP/GLO/690/NOR) aims to further strengthen the knowledge base and the overall institutional capacity for the implementation of the Ecosystem Approach to Fisheries (EAF) in developing countries, with additional attention to the impact of climate variability and change, pollution and other anthropogenic stressors.

The programme, that started implementation in May 2017, builds on earlier phases, and is governed by an agreement between the Food and Agriculture Organization of the United Nations (FAO), the Institute of Marine Research (IMR), Norway and the Norwegian Agency for Development Cooperation (Norad). The three pillars of the new programme are: Science, Fisheries management, and Capacity development. A new state of the art research vessel, *Dr Fridtjof Nansen* is an integral part of the programme. A science plan, covering 11 research themes, guides the programme scientific work.

The programme works in partnership with countries, regional organizations, other UN agencies as well as other partner projects and institutions.

## Le Programme EAF-Nansen

Le Programme EAF-Nansen "Appuyer la mise en œuvre de l'approche écosystémique de la gestion des pêches en tenant compte des impacts du climat et de la pollution" (GCP/GLO/690/NOR), vise à renforcer la base de connaissances et les capacités institutionnelles pour la mise en œuvre de l'approche écosystémique des pêches (AEP) dans les pays en développement, en accordant une attention particulière aux effets de la variabilité et du changement climatique, de la pollution et d'autres facteurs de stress anthropiques.

Le programme, qui a débuté en mai 2017, s'appuie sur les phases précédentes et est régi par un protocole d'accord entre l'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO), l'Institut de recherche marine (IMR) de Norvège et l'Agence norvégienne de Coopération au développement (Norad). Les trois piliers du nouveau programme sont : la science, l'aménagement des pêches et le développement des capacités. Un navire de recherche à la pointe de la technologie, le nouveau *Dr Fridtjof Nansen*, fait partie intégrante du programme. Un plan scientifique, couvrant 11 thèmes de recherche, guide les travaux scientifiques du programme.

Le programme travaille en partenariat avec les pays, les organisations régionales, d'autres agences des Nations Unies ainsi que d'autres projets et institutions partenaires.

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**CRUISE REPORTS *DR FRIDTJOF NANSEN***

# SURVEY OF THE PELAGIC FISH RESOURCES AND ECOSYSTEM OFF WEST AFRICA

**Angola**

**01 October – 30 October 2017**

**by**

**Kathrine Michalsen[1], Filomena vaz Velho[2], Ines Dias Bernades[1], Øystein Skageset[1], Jens-Otto Krakstad[1], Tor Ensrud[1], Marek Ostrowski[1], António Barradas[2]**

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**Institute of Marine Research**
**Bergen, 2020**

# CONTENTS

## EXECUTIVE SUMMARY

The survey of the pelagic resources and ecosystems in Angola took place from 1 to 30 October 2017, as part of a synoptic coverage of the west coast of Africa (Morocco to South Africa) from May to December 2017. The research activities were guided by the EAF-Nansen Programme Science Plan that addresses a number of key research questions related to fishery biology, pollution and climate. Pelagic fish distribution and biomass were the main objectives of this survey. Determination of key biological parameters of selected pelagic species and samples for determination of stock identity for those that have transboundary distributions were also important objectives. In addition, parameters relevant to physical, chemical and biological oceanography were recorded and samples of plankton, microplastics, and food safety collected for future analysis. These samples will be processed and the data analysed as part of the activities planned under the EAF-Nansen Programme Science Plan.

The oceanographic observations made during this survey evinced a prevalence of downwelling conditions in the northern and central regions, but with some relatively strong wind-driven upwelling events in the Central Region. Of particular interest was the identification of anticyclonic eddies in the northern and central regions that ensure coastal retention. These eddies are generated by the southward flowing Angola Current.

Biomass estimates can be summarised as follows:

- Sardinella stocks seem to be in relatively good condition, with a total biomass of about 780 000 tonnes of wich about 67% was *Sardinella maderensis* (526 000 tonnes) while 254 000 tonnes, or 33% of the total, was *Sardinella aurita*. This is at the same level as the surveys done in the winter of 2007 (725 000 tonnes) and the summer of 2012 (739 000 tonnes). 36% of the biomass estimated for *S. aurita* included fish with length less than 21 cm TL.
- The total biomass of Cunene horse mackerel was estimated at 229 000 tonnes. This estimation was slightly less than during the 2015 winter survey (300 000 tonnes), although higher than the long-term mean (2006-2015) of 178 000 tonnes. Fish <21 cm TL made up 38% of the total biomass of Cunene horse mackerel.
- The biomass of Cape horse mackerel was estimated at 43 000 tonnes. The biomass estimated this year was 68% less than in the 2015 winter survey (133 000 tonnes). However, these changes may be due to seasonal fluctuations in distribution. For both species, the juvenile cohorts were the most dominating. Other biological references clearly indicate that the Cunene horse mackerel stock is still under considerable pressure. Since the start of the time series with the R/V *Dr Fridtjof Nansen* (2) in 1996 the length distributions have been shifting towards smaller fish, indicating high fishing pressure on the adult stock.

Given the transboundary nature of the pelagic resources, the results of these surveys should be evaluated in a regional context.

# INTRODUCTION

## Survey objectives

The research activities under the EAF-Nansen program are guided by the EAF-Nansen Programme Science Plan. The science plan is intended to ensure good scientific use of the wealth of data generated by the R/V *Dr Fridtjof Nansen* and other related data, addressing key research questions in support of tactical and strategic fisheries management.

The science plan covers 11 research themes, presented in Figure 1.

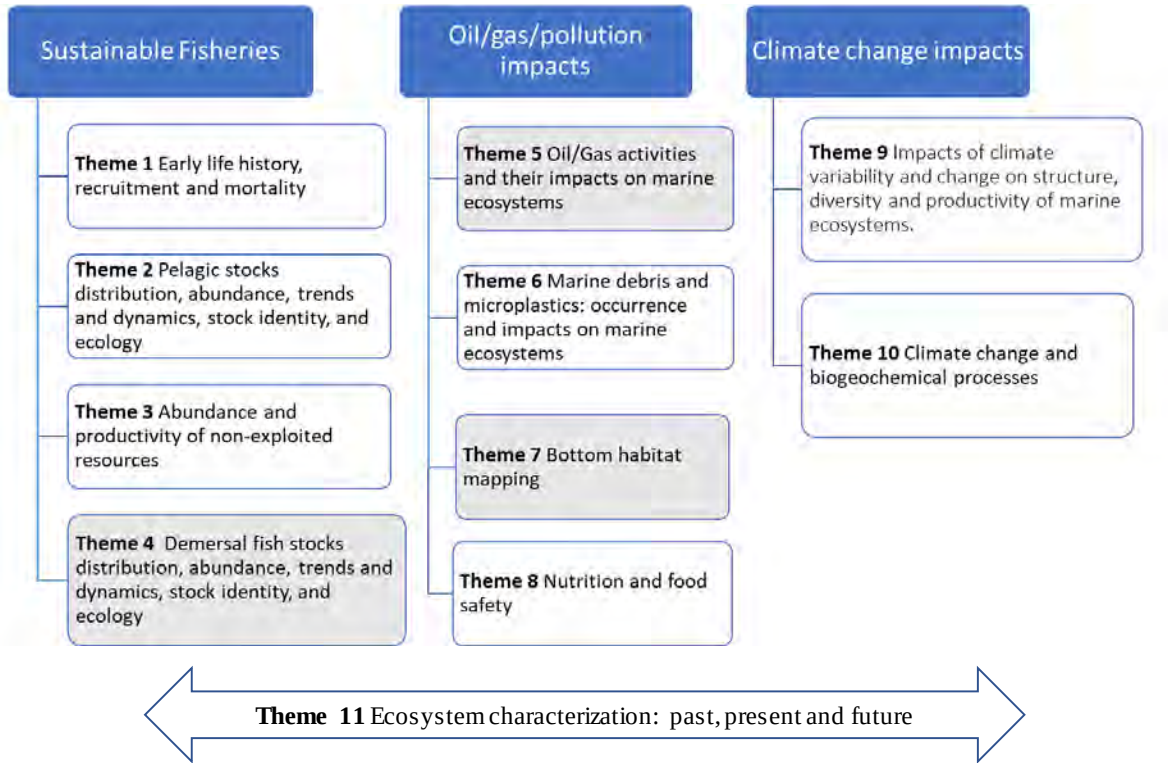


Figure 1. Research themes of the EAF-Nansen science plan.

A special focus of Theme 2 is to provide knowledge on shared resources and contribute to understanding stock structure of pelagic fish along the West African coast, their biology and the environment where they occur. More specific objectives included:

Hydrography:

- To map the hydrographic/environmental conditions in the survey area (temperature, salinity, oxygen, chlorophyll, nutrients and pH values-acidity).

Phytoplankton, zooplankton and ichthyoplankton and jellyfish:

- To establish as far as possible, the distribution, abundance and composition of phyto- and zooplankton, and species composition of fish eggs and larvae (data to be used, in part, to understand acoustic backscatter from zooplankton that can be used to refine the target strength for fish and jellyfish targets).

Pelagic stocks:

- To obtain information on abundance, distribution (also by size) of *Sardinella aurita, Sardinella maderensis, Engraulis encrasicolus, Trachurus trecae and T. capensis, Scomber colias, Ethmalosa fimbriata* and *Decapterus rhonchus* using acoustic methods and a systematic grid survey strategy;
- To collect samples for genetic analysis and for morphometric studies, both for stock identification of *S. aurita, S. maderensis, E. encrasicolus, T. trecae, T. capensis, S. colias* and *E. fimbriata;*
- To obtain information on maturity stages, and to collect stomach samples for analysis of contents and otoliths of *S. aurita, S. maderensis, E. encrasicolus, T. trecae, T. capensis, S. colias* and *E. fimbriata.*

Mesopelagic fish:

- To identify the main species and collect samples for identification and isotope analysis.

Marine debris and pollution:

- To record occurrence of marine debris (surface);
- To collect samples for analysis of levels of nutrients and contaminants including microplastics;
- To map occurrence of microplastics and describe associated neuston communities.

Contaminants:

- To collect samples of fish species consumed locally for analysis of contaminant levels and nutrient values.

## Participation

Institute of Marine Research, Bergen, Norway:

Leg 3.1: Kathrine Michalsen, Ines Dias Bernades, Øystein Skageset, Ingrid Sværen, Tommy Paulsen, Jan Frode Wilhelmsen and Jan Arne Vågenes.

Leg 3.2: Jens Otto Krakstad, Tor Magne Ensrud, Frøydis Bogetveit, Bernardine Everett, Marek. Ostrowski, Geir Landa and Olaf Sørås.

National Institute of Nutrition and Seafood Research, Bergen, Norway:

Leg 3.1: Per-Olav Rasmussen and Sofie Myhre Christiansen

Leg 3.2: Vidar Fauskanger

Ministère de l'agriculture, de l'élevage, de la pêche et de l'alimentation (MAEPA), Gabon:

Leg 3.1: Davy Angueko, Marie Francoise Nzang-Ovono épse Eva-Essangone, Jean De Dieu Lewembe and Jean-Bernard Mougoussi

Ministère de l'Agriculture, de l'Elevage et de la Pêche, Congo:

Leg 3.1: Tite Romuald Akenze, Blaise Richard Ntse, Ahmed Stanislas Belvere Nakavoua and Rychie Jucelle Léticia Ntelamanou

Ministère de Pêche et Elevage, Democratic Repuplic of Congo:

Leg 3.1: Casimir Mulumba N'Kelenda Koffi and Jean Marie Kambale Mangaya

Instituto Nacional de Investigação Pesqueira, Angola:

Leg 3.1: Filomena Vaz Velho, Miguel André António, Djamila Fernanda dos S. Pedro Mauricio, Geraldina de Assunção Salvador José, António Buco, William Carlos João Augusto, Suzana João da Conceicão Nicolau, Sónia Cristina Pedro da Silva and Amaro José Francisco

Leg 3.2: António Joaquim da Costa Barradas, Domingas Nsaku, Eusébio dos Santos, Joana de Sousa Pinheiro, Pedro Panzo, Sténia Esmeraldina Kamundongo Isaías da Costa, Marcelina André, Eridson dos Santos, Emanuel Mahongo Kahilo and Ndongala Mbiyavanga Miguel

National Marine Information and Research Centre, Namibia:

Leg 3.2: Latoya Shivute, Theopolina Iita, Justine Kakuuai, Chibo Chikwililwa, Bartholomeus Tjandja, Blessing Kamwi, Josephine Edward, Sharon Kahunda, Selma Nuuyoma and Richard Horaeb

University of the Western Cape, South Africa:

Leg 3.2: Aseeqah Davids

## Narrative

The survey area has, as in previous years, been divided into three regions:

Congo River - North of Pta. das Palmeirinhas (6°-9°S): ANGOLA NORTH

The region between 9°S and 13°S: ANGOLA CENTRAL

The region between 13°S and Cunene River (17°15'S): ANGOLA SOUTH

The design of the survey and the sampling followed the agreed design described in the sailing order for Leg 3. This implied a systematic survey track consisting of pseudo-parallel acoustic transect lines perpendicular to the coast line with equally spaced transect lines (10 nautical miles, NM, apart). The Cabinda region was not included in this survey. Stricter enforcement of regulations are in place in this region, as requested by the oil companies that operate in the

area. The oil exploitation in the northern region has been rapidly expanding in the last years affecting both the length and track of some of the original acoustic lines.

The survey off Angola was divided in two different legs. The first leg was a continuation of survey 2017407 in Congo and Gabon which started 21 September. The border to Angola at Congo River (the Cabinda area was not surveyed) was crossed on the 1st of October. The first leg covered the Northern region of Angola including the Environmental transect at Pta. das Palmerinhas and arrived in Luanda at 11:00 the 11th of October. A reception was held on the 12 October, with the Norwegian embassy in Angola hosting. A crew change took place on the 13 October and the vessel departed on 14 October at 15:30 local time. The second leg started with a first transect of the central region during the same evening. The coverage of the central region was compleded by 22 October in the morning and the coverage of the southern region started. A calibration of the echosounders was attempted on 23 October at Baia Dos Elefantes but due to the presence of high abundance of *Lagocephalus laevigatus* in the area it was not possible to carry out the calibration sucsessfully. The vessel therefore continued in the afternoon. The Southern region of Angola was completed in the early morning of 30 October. The vessel then continued the survey into Namibian waters. The results for the Namibia part are presented in a separate cruise report.

Table 1. The coast of Angola was surveyed during two legs, on the following dates.

| Country/region | Total days | Start | Complete |
|---|---|---|---|
| Leg 3.1 Northern Angola | 12 | 01/10/2017 | 11/10/2017 |
| Leg 3.2 Central and Southern Angola | 17 | 14/10/2017 | 30/10/2017 |

The weather was generally favourable, and no days were lost due to bad weather or other problems.

## Survey effort

Figures 2, 3 and 4 show the cruise tracks with fishing, plankton and hydrographic stations for the northern, central and southern regions of Angola, respectively. The sampling trawls, including the small (10 m vertical opening) pelagic trawl and the demersal trawl (5 m opening), were used during the survey. Table 2 summarises the survey effort by regions.

Table 2. Survey effort during the survey. Distance - distance surveyed (log, NM), CTD, Phyto - phytoplankton net, WP-2 – zooplankton net, Multi – net for eggs and larvae, Manta – net for plastic particles in the surface, BT - bottom trawl, PT - pelagic trawl.

| **Region** | **Distance** | **CTD** | **Phyto** | **WP-2** | **Multi** | **Manta** | **BT** | **PT** |
|---|---|---|---|---|---|---|---|---|
| Congo River - Pta. Palmerinhas | 1049.897 | 62 | 12 | 12 | 24 | 16 | 11 | 14 |
| Pta. Palmerinhas – Benguela | 1040.746 | 58 | 15 | 15 | 23 | 15 | 10 | 18 |
| Benguela - Cunene River | 851.041 | 68 | 19 | 21 | 21 | 21 | 5 | 16 |
| Total | 4319.681 | 228 | 46 | 34 | 68 | 52 | 40 | 59 |

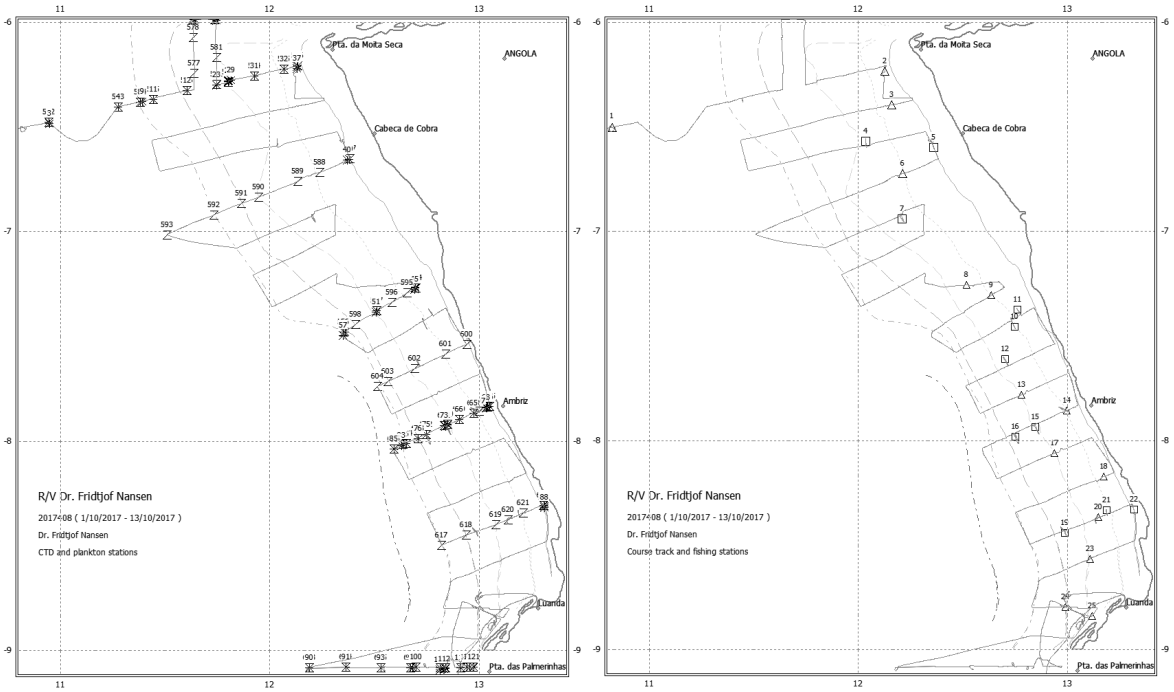


Figure 2. Course track with hydrographic and multinet stations (left panel) and trawl stations (right panel), Congo River - Pta. das Palmerinhas. Depth contours at 20, 50, 100, 200, and 500 m.

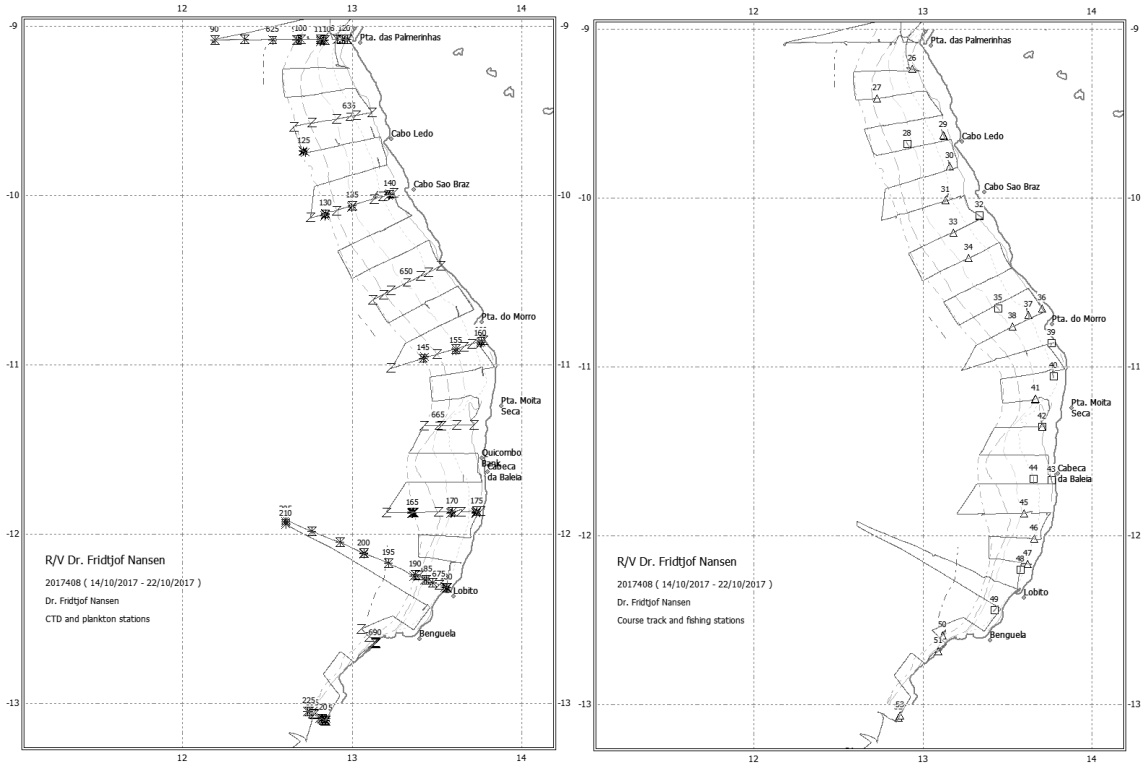


Figure 3. Course track with hydrographic and multinet stations (left panel) and trawl stations (right panel), Pta. das Palmerinhas - Benguela. Depth contours at 20, 50, 100, 200, and 500 m.

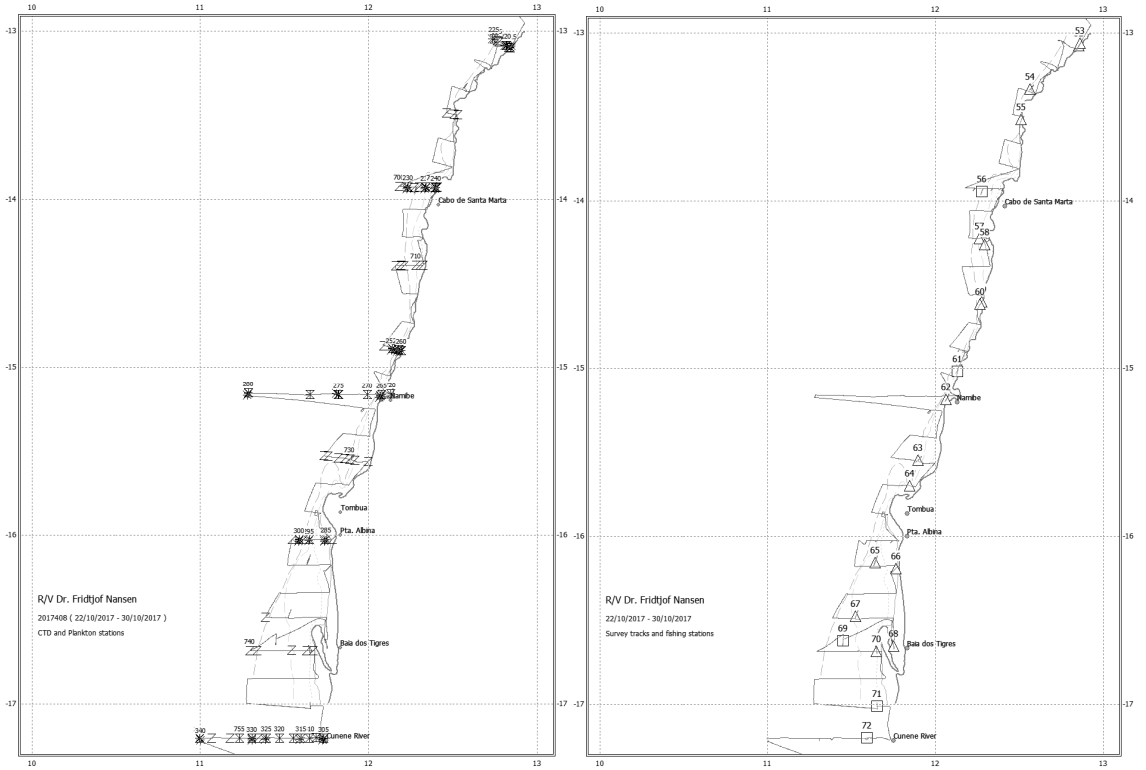


Figure 4. Course track with hydrographic and multinet stations (left panel) and trawl stations (right panel), Benguela-Cunene River. Depth contours at 20, 50, 100, 200, and 500 m.

# METHODS

## Underway sampling

### 1.1.1 Meteorological data recording

Meteorological data were logged continuously from the AANDERAA Smartguard meteorological station and included wind direction and speed, air pressure, relative humidity, air temperature and solar radiation. All data were logged to the Nansis tracklog system averaged every 60 sec. The logging of the wind channel was not functioning as expected. The data logged before 20th October were not usable due to a software error in the logging system. The software problem was eventually fixed, but the corrected software revealed gaps in the wind record lasting from a few minutes to several hours. The issue was traced to the wind sensor malfunctioning. The instrument manufacturer (Aanderaa) was notified of the problem. The wind data presented in this report cover the period after the software error was fixed and were manually edited to remove the spurious values generated during periods when the sensor was not operational.

### 1.1.2 Thermosalinograph

The SBE 21 Seacat thermosalinograph ran continuously during the survey, obtaining samples of sea surface (at 4 m depth) recording salinity and relative temperature every 10 seconds. An attached in-line C3 Turner Design Submersible Fluorometer measured turbidity and chlorophyll-*a* levels.

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

Two vessel-mounted Acoustic Doppler Current Profiler (VMADCP), the Ocean Surveyor (OS) units by RDI Instruments operating at 75 and 150 kHz, ran continuously during the survey. Both systems were set to narrowband pinging mode. The ping transmissions were multiplexed to eliminate the interference with other acoustic instruments operating at the same time. The resulting pinging rate was variable, ranging from 2 to 4 seconds, on average throughout the survey. ADCPs carry out the current estimation based on the movement of planktonic backscatter. The estimation is carried out in the depth bins of whose size is frequency dependent. In the case of the 75 kHz OS unit, the manufacturer's recommended bin size of 16 m was used throughout the survey. In the case of the 150 kHz unit, the survey started with the depth bin size of 4 m to better resolve the current vertical structure. However, a closer examination of the recorded data during the following days revealed no gain in the vertical resolution but increased noise levels. For this reason, from 20th October the OS 150 kHz depth bin size was switched to 8 m, which is the manufacturer recommended value.

The raw recorded data consisted of the sum of the current and ship's velocity. During the first post-processing phase, the GPS-derived ship velocity was substrated from the record to obtain the ping-based current estimates. Those estimates were characterized by high noise levels and could not be used directly to describe the current. During the second

post-processing phase, the noise levels were reduced by ensemble averaging of the ping-based current profiles to 120-second time-based ensembles. In the process, the pings under the 25 per cent of good (PG - the RDI data quality indicator) were masked, and so were the pings with identified GPS errors. In the third post-processing step, the continuous record of the time-based ensembles covering the whole survey track was separated into straight line segments, each covering one cross-shelf section of the survey track. As the trawl hauls and fixed stations occurred on most of these sections, the time-based sampling produced clusters in space, with more samples per distance unit at locations of fixed stations and trawl hauls compared to regions covered by the vessel in transit. To obtain the spatially even coverage, in the final-postprocessing stage, the data collected along each cross-shelf section were regularised to equal distance units projected onto a straight line fitted across the geographical positions of the time-based ensambles sampled along the respective section.

## Bottom mapping echo sounder

The EM 710 multibeam echo sounder is a high to very high-resolution seabed mapping system. Data acquisition depth starts approximately 3 m below the transducers and the maximum acquisition depth is limited in practice to 1000 - 1500 m on the R/V *Dr Fridtjof Nansen*. Across track coverage (swath width) is up to 5.5 times water depth and may be limited by the operator either in angle or in swath width without reducing the number of beams. The operating frequencies are between 70 to 100 kHz. There are 128 beams with dynamic focusing employed in the near field. The transmitting fan is divided into three sectors to maximize range capability and to suppress interference from multiples of strong bottom echoes. The sectors are transmitted sequentially within each ping and use distinct frequencies or waveforms. The along track beam width is 1 degree. Ping rate is set according to depth. The receiving beam width is 2 degrees. Sound profiles were set manually in the system according to the area of operation. The data was logged to the on-board Olex plotting system.

## Fixed hydrographic sampling

A series of biological and oceanographic sampling was undertaken every 60 NM, i.e. along every $6^{th}$ acoustic transect (Transects 6, 12, 18 and so on). Samples were taken at the inshore end of the acoustic transects, usually at a water depth of between 25 and 30 m, usually at the 100 m isobath and at the outer end of the transects, i.e. at 500 m bottom depth. These stations were referred to as “super-stations”. Additional CTD stations were added at 60-70 m and 200 m depth. The samples collected on every second hydrographic transects are shown in Figure 5.

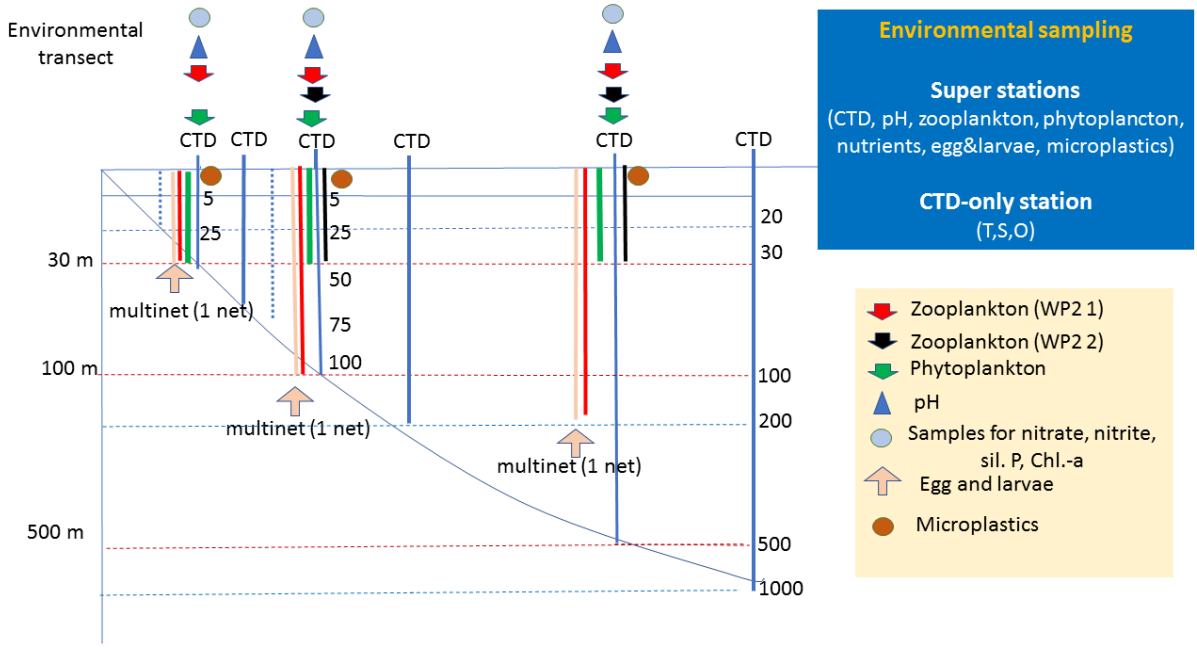


Figure 5. Overview of sampling conducted at environmental transects.

In addition, further lines of CTD stations were sampled along the intermediary transects between the "super-stations", that is 30 NM after a line of super-stations (i.e. Transects 3, 9, 15 and so on).

### 1.1.4 CTD sensors – temperature, salinity, oxygen

Vertical temperature and salinity profiles were obtained by a Seabird 911 CTD, while *in situ* concentrations of dissolved oxygen were measured using a CTD-mounted SBE 43 oxygen sensor. Real time logging and plotting was performed using the Seabird Seasave software installed on a PC. Attached to the CTD was also an uncalibrated Chelsea Mk III Aquatracka fluorimeter, which measures *in situ* fluorescence on relative scale.

The salinity sensor was validated during the first survey in 2017 using a Portasal salinometer from Osil (mod. 8410A, so was the oxygen sensor using the Winkler titration (Grasshoff *et al*. 1983). Additionally, the performance of the temperature and conductivity sensors was validated by comparing the readings of the dual set of sensors mounted on the CTD. A failure of the secondary conductivity sensor was detected on 9 October leading to the replacement of that sensor. The conductivity (salinity) data collected by the secondary sensor are therefore not usable before October 10. However, the secondary sensors are used only for the data validations; therefore the described sensor failure did not affect the survey result.

Except for the above issue, no deviations from the factory calibrations were detected for any of the other sensors by the adopted validation procedures. The detailed account of the validation procedures is provided in Annex VI.

### 2.3.2 Ocean acidification parameters - pH and alkalinity

The Nansen is currently equipped with a CTD rosette holding up to 12 ten-litre Niskin bottles that are used to collect water samples from pre-defined depths. The standard sampling depths were set to: 500, 400, 300, 200, 100, 75, 50, 25, and 5 m and the standard transects were sampled at 30, 100 and 500 meters' depth. These samples were used to determine pH, alkalinity and for nutrient analysis (nitrate, nitrite, silicate and phosphate) as described below.

Seawater samples (250 ml) from the CTD-mounted Niskin-bottles were collected in borosilicate glass bottles using silicone tubing to reduce air exchange. Both pH and alkalinity were analysed on board the vessel. pH was determined spectrophotometrically using a diode array spectrophotometer and a pH sensitive indicator, m-cresol purple in 2 mM solution, as described by Clayton and Byrne, 1993; Chierici *et al.*, 1999. Alkalinity was measured by titration with acid (0.05M HCl) and changes in pH were measured with an electrode (potential in mV) using tiamo software. Further processing of the data will be done on land at IMR and will provide more information on the marine carbonate system and parameters for ocean acidification.

### 2.3.3 Nutrients

Seawater samples (20 ml) for nutrient analysis (nitrate, nitrite, silicate and phosphate) were collected from the Niskin water-bottles. The seawater samples were stored in 20 ml polyethylene vials, conserved with 0.2 ml chloroform, and kept cool and dark in a refrigerator (Hagebø and Rey, 1984). The analysis of the samples will be done on shore by IMR, using a modified Alpkem AutoAnalyzer C (O I Analytical, USA) and following standard procedures (Strickland and Parsons, 1972).

## Phytoplankton sampling

### 2.4.1 Phytoplankton biomass

Chlorophyll-*a* was sampled as an indicator of phytoplankton biomass. For chlorophyll-*a* and phaeopigment measurements, seawater was collected from the CTD at the standard depths (not below 200 meters). The water was filtered using a 0.7µm filtration system (Munktell glass-fibre filters Grade: MGF, vacuum 200 mm Hg). In the southern part of the survey-area (stations 105 to 163), 3 parallels were filtered from each depth and stored at -20°C. The assay is performed by extraction with 90% acetone followed by centrifugation, and analysed with a fluorometer (model 10 AU, Turner Designs Inc., Sunnyvale, Ca., USA), according to Welshmeyer (1994) and Jeffrey and Humphrey (1975).

### 2.4.2 Phytoplankton identification

Phytoplankton was collected at super-stations as described above. At each super-station, qualitative phytoplankton samples were collected with a net (35 cm in diameter and mesh-size of 10 µm), hauled vertically at a speed of 0.1 $ms^{-1}$ from the depth of 30 m to the

surface (from ca. 5 m above bottom at the 30 m stations). These samples are not quantitative, but used to establish the taxonomic composition of the phytoplankton community.

## Zooplankton sampling

Mesozooplankton was collected with a WP2-net along the hydrographic transects at stations positioned at bottom-depths of approximately 30 m, 100 m and 500 m. The WP2-net (56 cm diameter, mesh size 180 µm) (Fraser 1966, Anonymous 1968) was hauled vertically at a speed of ~0.5 $ms^{-1}$ at each station. At the shallowest and intermediately deep stations (bottom-depths of 30 m and 100 m, respectively) the sampling strata were from near-bottom to the surface (deepest sampling depths of ~25 and 90 m, respectively). At the stations with bottom-depth of ~500 m or greater, the sampling stratum was from the depth of 200 m to the surface.

Furthermore, a second sample with the WP2 net was collected from the upper 30 m at the stations with bottom depths of 100 m and 500 m. The purpose of these additional samples was to enable a direct comparison of the zooplankton composition and concentrations in the uppermost layer of the water-column along the bottom-depth gradient. Each zooplankton sample was divided into two equal parts using a Motoda plankton splitter (Motoda 1959). The first part of the sample was size-fractioned by using a series of sieves with the decreasing mesh-sizes of 2000 µm, 1000 µm and 180 µm, and the zooplankton retained on each sieve were dried on aluminium trays at ~60 ºC for 24 h. These samples will be dried once more and weighed on shore after the cruise at the IMR for estimation of biomasses for the different size-groups. The second part of the sample was preserved in seawater with a final solution of 4% formaldehyde buffered with borax for subsequent species identification and quantification, also at the IMR.

## Fish-eggs and larvae

Sampling for fish eggs and larvae was done at the super-stations with a Hydro-Bios Multinet with mesh-size 405 µm. The Multinet was towed obliquely from 10 m above the bottom or from a maximum depth of 200 m in deeper stations. At 26 of the stations only one net, net #1 (405 µm) was used. During the national Angolan monitoring transects, a total of 13 stations were sampled using up to five nets (25-0 m; 50-25 m; 75-50 m; 100-75 m; 200-100 m). The upper four nets were fittet with 180 µm mesh-sized cod-ends while the lower net was fittet with a net with a mesh-size of 405 µm.

Fish larvae visible to "the naked eye" were removed from the total sample, photographed and transferred to vials. The fish larvae were then preserved in 4% formaldehyde buffered with borax. When all visible fish larvae had been removed from the Multinet sample, the rest of the sample was preserved for reference purposes and to check for any overlooked larvae.

The fish-eggs will be sorted and the larvae identified on shore after the cruise at the IMR.

## Microplastics

Microplastics are normally defined as small pieces of plastic marine debris smaller than 5 mm. Microplastics were collected along the hydrographic transects at all super-stations At each station, the surface layer was sampled with a Manta-trawl, with a rectangular opening of 19 cm × 61 cm (HxW), mesh-size 335 µm and two wings to keep it balanced and at the surface during the tow. Trawls were hauled horizontally at a speed of ~1.5 $ms^{-1}$ for 15 minutes. The counts of a manual flowmeter attached in the lower part of the trawl opening were recorded at the start and end of each trawl. Trawling was performed some meters away from of the starboard side, about mid-ship, attempting to avoid the wake of the vessel.

Once the Manta-trawl was retrieved, the samples were washed in filtered sea-water over a sieve with a mesh-size 180 µm. Microplastic particles were sorted from the sample under a stereo-microscope, and the sorted sample was then checked once more to reduce the risk of overlooking the smallest plastic particles. All assumed plastic items were then placed on a gridded petri dish for examination under the stereo-microscope, photographed and, to the extent possible, measured and described (e.g. length, shape, type and colour). The plastic material from each sample was then washed with deionized water and dried in pre-weighed aluminum-trays. The trays were packed in aluminium foil and stored in the freezer until transport to the IMR laboratory, where they will be studied in more detail. After removing the plastics, the remaining part of the samples - mainly biological material - was preserved in formalin for studies of neuston at the IMR after the cruise.

## Food safety

Whole fish, fillet and different organs from various fish that are regularly consumed in the countries included in the survey area were sampled and preserved. All the samples will be analysed for a wide variety of nutrients and contaminants at IMR, Bergen (see section 3.6) as part of Theme 8. Tissue samples of mackerel will be analysed for the parasite Kudoa.Some of the samples will also be analysed for correspondence between the microbiota and the metal content of the gut. One pelagic fish sample and two mesopelagic fish samples will be analysed for the content of microplastic particles.

## Jellyfish collection and preservation

Jellyfish were sampled from pelagic and bottom trawl hauls. When the total catch was considered too big, the entire catch (fish, jellyfish, etc.) was sub-sampled. Thereafter, all jellyfish specimens caught, or representative random samples thereof, were identified to the lowest possible taxon. The jellyfish collected were then measured across the bell, and weighed.

Jellyfish specimens that were in a good condition were photographed (top and bottom sections). Tissue samples were collected for genetic studies, aimed at determining the species and the population structure, and establishing regional and global connectivity. For these genetic studies, a small piece of the oral arm tissue was removed and preserved in 96%

ethanol (EtOH) and stored at -20°C. After 24 hours, the 96% EtOH was drained from each sample and then replaced with new 96% EtOH. The sample was then stored at -20°C until analysis.

The rest of the specimen was preserved in 10% formalin and placed in a cooler on board for long-term storage. These samples formed part of a greater morphological identification and taxonomic study. In addition to this, jellyfish specimens of a variety of sizes that were in good condition were rinsed with freshwater, individually oven dried at 40°C, and then frozen at -20°C for stable isotope and fatty acid analysis. These specimens were collected to determine the trophic position and ecological role of jellyfish within their ecosystem.

Due to limited space and storage material, only five to ten of the best representatives of *Rhizostoma* and *Chrysaora* species (species of interest) caught in each trawl were stored as explained above. Whenever non-interest species were caught, samples were treated as explained above, but only when the species was caught for the first time. This specimen then served as a type specimen, and, only presence was noted for subsequent occurrences.

## Top predators observations

Observations of mammals (whales, dolphins etc) and birds were not done on Leg 3.2.

## Biological trawl sampling

Biological sampling of the fish was carried out using pelagic and bottom trawls. In shallow water (<30 m) or at night when pelagic fish was close to the surface, the pelagic trawl with floats or bottom trawl with floats was used for sampling. The MultPelt trawl could not be used due to winch problems, which meant that pelagic trawling was only possible with the small pelagic Harstad trawl. In several instances, especially when the acoustic target was fairly small and isolated, this made it more difficult to obtain sufficient catches to describe identified acoustic targets. A more detailed description of instruments and fishing gear is given Annex I.

All catches were sampled for composition by weight and numbers of each species caught. Species identification was based on the FAO Species Guides. For the selected target species length (total length to the nearest cm), weight (to the nearest 0.5 g), sex, gonad maturity stage (according to table in Annex III), and stomach fullness (according to table in Annex III) were recorded. When the size distribution of the target species in the catch was seemingly narrow (similarly sized individuals), a total of 50 individuals were length measured. Length and weight measurements were used to estimate the length-weight relationship and together with length frequency distributions applied in biomass calculations. In addition, the following biological samples of selected species were taken: otoliths (in paper envelopes), pectoral finclips (max in 96% ethanol) for genetic analysis, stomach and liver samples (frozen in plastic bags), and frozen samples for morphometric analysis (25-30 fish). Instead of attempting to remove otoliths, stomach and liver from small individuals (<10cm, and in most

instances all anchovy and sardinella), whole fish were frozen down, as it seemed less cumbersome and time consuming to do this on land in well equipped labs.

The target groups used for this survey can be found in Table 3, while the complete records of fishing stations and catches are shown in Annex II. A full list of biological samples per species and trawl station is given in Annex IV.

## Acoustic sampling

2.12.1 Sonar data

A Simrad SH90 Sonar recorded data continuously during the survey for post processing after the survey. The sonar was set to a frequency of 26 kHz, in FM Normal mode. The sonar was operated using bow up/180 deg operation mode with the bearing of the vertical beams 90 deg, perpendicular to the vessel direction with a range of 450 m and with the horizontal beams set to 450 m with a tilt angle of 3 deg. The filters built into the sonar software to improve the school representation (i.e. AGC, RCG and ping to ping) were set to default values except for the Noise filter, which was turned off.

The settings including range and tilt was kept the same during all the surveying except during trawling operations where the sonar was at times used actively to focus in on targets.

No other sonars were used during the survey.

2.12.2 Echo sounder

Acoustic data were recorded using a Simrad EK80 Scientific Split Beam Echo Sounder equipped with keel-mounted transducers at nominal operating frequencies of 18, 38, 70, 120, 200 and 333 kHz. The survey was started without an *a priori* calibration, although the sounders were calibrated in Bergen on the 23rd January, 2017. Annex I gives the details of the acoustic settings used during the survey.

2.12.3 Estimation of biomass

Acoustic data were logged and post-processed on board using the latest acoustic data post-processing software, the Large-Scale Survey System (LSSS) Version 2.0.

In cases where the integrated echo contained more than one category of fish, i.e sardinella and horse mackerel (see Table 3 below), the mean $s_A$-value allocated to each category was in the same ratio as their contribution to the abundance in trawls in that area.

The following target strength (TS) function was applied to convert $s_A$-values (mean integrator value for a given species or group of species in a specified area) to number of fish:

$$TS = 20 \log L - 72 \text{ dB}$$

which can be converted (see Toresen *et al*. 1998 for details) to the area form (scattering cross sections of acoustic targets):

$$C_{Fi} = 1.26\ 10^{6}\ L^{-2}$$

where L is total length in 1 cm length group *i* and $C_{Fi}$ ($m^{-2}$) is the reciprocal back scattering strength, or so-called fish conversion function. To split and convert the allocated $s_A$-values ($m^2/NM^2$) to fish densities (numbers per length group per $NM^2$), the following formula was used:

$$\rho_i = s_A \cdot \frac{p_i}{\sum_{i=1}^{n} \frac{p_i}{C_{F_i}}}$$

where

$\rho_i$ = density of fish in length group *i*
$s_A$ = mean integrator value
$p_i$ = proportion of fish in length group *i*
$\sum_{i=1}^{n} \frac{p_i}{C_{Fi}}$ = the relative back scattering cross section ($m^2$) of the length frequency sample of the target species, and
$C_{fi}$ = reciprocal back scattering cross section ($\sigma_{bs}^{-1}$) of a fish in length group *i.*

The integrator outputs were split into the fish groups listed below using a combination of behaviour pattern as deduced from echo diagrams, the LSSS analysis and catch composition.

Table 3 lists the target groups used. These are adapted from previous groupings owing to the importance of providing biomass estimates for not only the sardinellas, but also *Decapterus* sp., *Scomber colias*, *Trachurus trecae* and *T. capensis*, *Engraulis encrasicolus* and *Ethmalosa fimbriata.* Note that no estimates were made of the latter two the due to insufficient quantities to warrant biomass estimates.

Table 3. Allocation of acoustic densities to species groups.

| **Group** | **Taxon** | **Species** |
|---|---|---|
| Sardinella | *Sardinella* sp. | *S. aurita*<br>*S. maderensis* |
| Horse mackerel | *Trachurus* sp. | *T. trecae*<br>*T. capensis* |
| Pilchard | *Sardinops* | *S. ocellatus* |
| Big-eye grunt | *Brachydeuterus* | *B. auritus* |
| Pelagic species 1 | Clupeiformes | *Ilisha africana*<br>*Etrumeus whiteheadi*<br>*Engraulis encrasicolus* |
| Pelagic species 2 | Carangidae | *Selene dorsalis*<br>*Chloroscombrus chrysurus*<br>*Decapterus rhonchus*<br>*Decapterus punctatus* |

| Group | Taxon | Species |
|---|---|---|
| | Scombridae | *Seriola carpenteri*<br>*Auxis thazard* |
| | Sphyraenidae<br>Others | *Sarda sarda*<br>*Scomber japonicus (*changed name to *S. colias)*<br>*Sphyraena guachancho*<br>*Trichiurus lepturus*<br>*Lepidopus caudatus* |
| Demersal species | Sparidae<br>Other taxa | *Dentex angolensis*<br>*D. macrophthalmus*<br>*D. congoensis*<br>*D. canariensis*<br>*D. barnardi*<br>*Pagellus bellottii*<br>*Sparus caeruleostictus*<br>*S. pagrus africanus*<br>*Saurida brasiliensis*<br>*Ariomma bondi*<br>*Pomadasys incisus*<br>*Galeoides decadactylus* |
| Mesopelagic species | Myctophidae<br>Other mesopelagic fish | Diaphus dumerili |
| Plankton | Calanoidae<br>Euphausiidae<br>Other plankton | *Calanus* sp**.**<br>*Meganyctiphanes* sp. |

The acoustic backscatter was scrutinized daily and allocated to the various target groups. The sV threshold used when sardinellas occurred to filter out other species and plankton was -45 dB, or in regions where the plankton layer was extremely dense an even lower threshold had to be used. For Pelagic I, Pelagic II and "other pelagic species" -50 dB was used. To identify mesopelagic layers a threshold of -60 dB was used.

The above equations show that the conversion from $s_A$-values to number of fish is dependent on the length composition of the fish. It was therefore important to get representative length distributions from the key species groups in the whole distribution area.

When the size classes (of e.g. young fish and older fish) were well mixed, the various length distributions were pooled together with equal importance. Otherwise, when the size classes were segregated, the total distribution area was post-stratified, according to length distributions, and separate estimates were made for the strata containing fish with equal size.

For a stratum representing a distribution of a target group, the following basic data are needed for the estimation of abundance:

1) The average $s_A$-value for the region,
2) The surface area (usually square nautical miles, $NM^2$), and
3) A representative length distribution of the fish in the region.

If the targeted fish was a mixture of more than one species, for example sardinellas, representative distributions of all the species, within the stratum, as shown in the trawl catches, were used. Length distributions representing the various species for each catch was calculated and normalized to a unit number (usually 100). These were then averaged without weighting. Very small catches (normally less than about 20 fish) were not included. The total catch of each species from all the trawls in a stratum was used as a proxy for estimating the proportion of the total biomass of each species present. While it is recognised that catch is a poor indicator of relative abundance, especially for pelagic fish, no other method is easily available from the data available.

The process followed was therefore to

a) divide the $s_A$-value between groups of fish and/or species,
b) produce pooled length distributions of a target species/category for use in the above equation and
c) calculate the biomass estimates for a region,

using the following procedure:

- The length-frequency samples of the species in the category were respectively normalised (raised to 100) together with equal importance.
- The mean back scattering strength ($\rho/s_A$) of each length frequency distribution of the target group/ species was calculated and summed. This was automatically done in the Excel spread-sheet made available for acoustic abundance estimation on board R/V *Dr Fridtjof Nansen.*
- The pooled length distribution was used, together with the mean $s_A$-value, to calculate the density (numbers per square NM) by length groups and species, using the above formula. The total number by length group in the area was obtained by multiplying each number by the area.
- The numbers were then converted to biomass using the estimated weight at length.

# RESULTS - OCEANOGRAPHY

## Introduction

The recent analysis of the historic ADCP data (Tchipalanga *et al*., 2018), and the monitoring of the currents during this survey, have brought improved understanding on the seasonality of the Angola Current. Satellite observations and compilations of historic data suggested that the Angola Current exhibits a semi-annual periodicity, with two periods of southward flow acceleration, in February-March and in October-November in association with forcing at the equator seasonal downwelling periods. This survey, for the first time, mapped the entire drift route of the Angola Current from its origins in the Congo to the to its termination at the Angola- Benguela Frontal Zone (ABFZ).

Seasonal oceanographic regimes over the Angolan continental shelf are controlled by the four main factors, (1) atmosphere-ocean feedback between the solar radiation and SST affecting the coastal cloudiness and rain rates, (2) dynamics of the far-field of the Congo River discharge responsible for the formation of low salinity plume, (3) local wind conditions that control upwelling and the northward current near the coast and (4) equatorial forcing controlling the seasonal and interannual variability of the Angola Current (AC) and thermocline depth over the shelf. During this October-November survey, we observed all of the above factors acting in concert, resulting in sea surface warming and intrusion of low salinity water in the north, in a few upwelling-favorable events near the coast and in an intensified southward advection towards the shelf break.

The oceanographic observations made during this survey evinced a prevalence of downwelling conditions in the northern and central shelves. However, this is the first survey carried out during the October-November conditions. Compared to the historic surveys in other seasons, this survey observed some relatively strong wind-driven upwelling events over the Central Region. Sadly, due to an onboard wind recording system failure, no wind observations were recorded until October 20$^{th}$.

*Coastal upwelling index*

The high productivity of Namibian waters is owing to a strong upwelling. Towards Angola the coastal wind weakens, implying a weaker upwelling. However, a comparably strong upwelling may still be maintained at the lower latitudes despite the lower wind speed. It occurs because of the decreasing effect of the Earth rotation at low latitudes intensifies offshore transport producing large mass deficit inshore at lower wind speeds. To compare the strength of upwelling between the Angolan sector and the 'classical' Namibian upwelling, Figure 6 shows the distribution of the wind-stress derived coastal upwelling index (CUI, Copper *et al*., 2014) in the function of latitude along the vessel's path covering both, southern Angola and northern Namibia. The rise in the CUI upon crossing the 16°S and further south towards Namibian waters (south of 17°15'S) is evident. Another obvious feature of is the presence of a large number of separate upwelling events rather than of a continuous upwelling. Outstanding from these patterns, a relatively strong upwelling event

(peak CUI ~ 300 $m^3$ s-3 100 $m^{-1}$) was recorded off Benguela (12° - 13°S). The geographical location of this upwelling event coincides with the development of algal blooming near the coast, shown in Figure 13. Another outstanding feature in Figure 6 occurs in the southernmost extremity of the distribution, in Namibian waters (21°S), where the CUI turns negative, caused by an onshore wind event encountered by the vessel during the transit over that area.

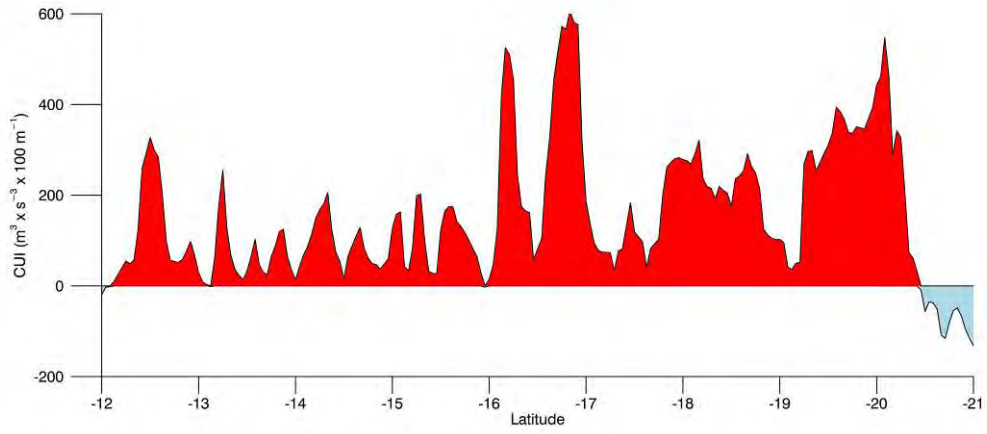


Figure 6. Evolution of Coastal Upwelling Index (CUI) in the function of latitude along the survey path of the vessel, between 12° and 21°S.

## Hydrography

### 1.1.5 The Northern Region

The distribution of temperature and salinity recorded underway at 4 m depth is shown in Figure 7. In the far north, despite the proximity of the Congo River, the recorded surface salinity was relatively high, above 34 psu (Figure 7A). As the survey track terminated a few miles south of the Congo River Canyon, the acquired data does not indicate the presence of the river plume. The Congo River discharges water to the northwest and its fast-flowing plume does not mix with the shelf waters to the south of the river mouth. After leaving the continental shelf, the plume slows down and diffuses into the open ocean. The drop in salinity below 25 psu observed in Figure 7A indicates that the vessel crossed into the region where the plume diffuses in the far end of the survey region. Not included in the map are the underway salinity data collected during the northward inclusion of the vessel into the Congo River Canyon. This took place in the region where the speed of the river plume was too high to be measured reliably with the vessel's underway system.

Elsewhere across the northern region, the surface salinity distribution exhibited salinities increasing slightly towards inshore waters. This pattern signals the onset of the seasonal freshening of the surface layer over the Angolan shelf. Even though the salinity contrast between the inshore and offshore waters data was small at the time of the observation (35.5 inshore vs. 34.9 offshore), comparing Figure 7 and 8 suggests the advection of reduced salinity water on the offshore side by the southward flowing Angola Current. As it is

recognized that the Angola Current accelerates during October-November, the observed inshore-offshore salinity contrast is expected to increase as the season progresses.

The pattern of salinity increasing towards inshore is reversed in the temperature distribution (Figure 7B), showing colder waters inshore and warmer offshore. The upwelling cells at Ambriz can be clearly identified in the figures by the salinity > 35.2 and temperature < 25.0°.

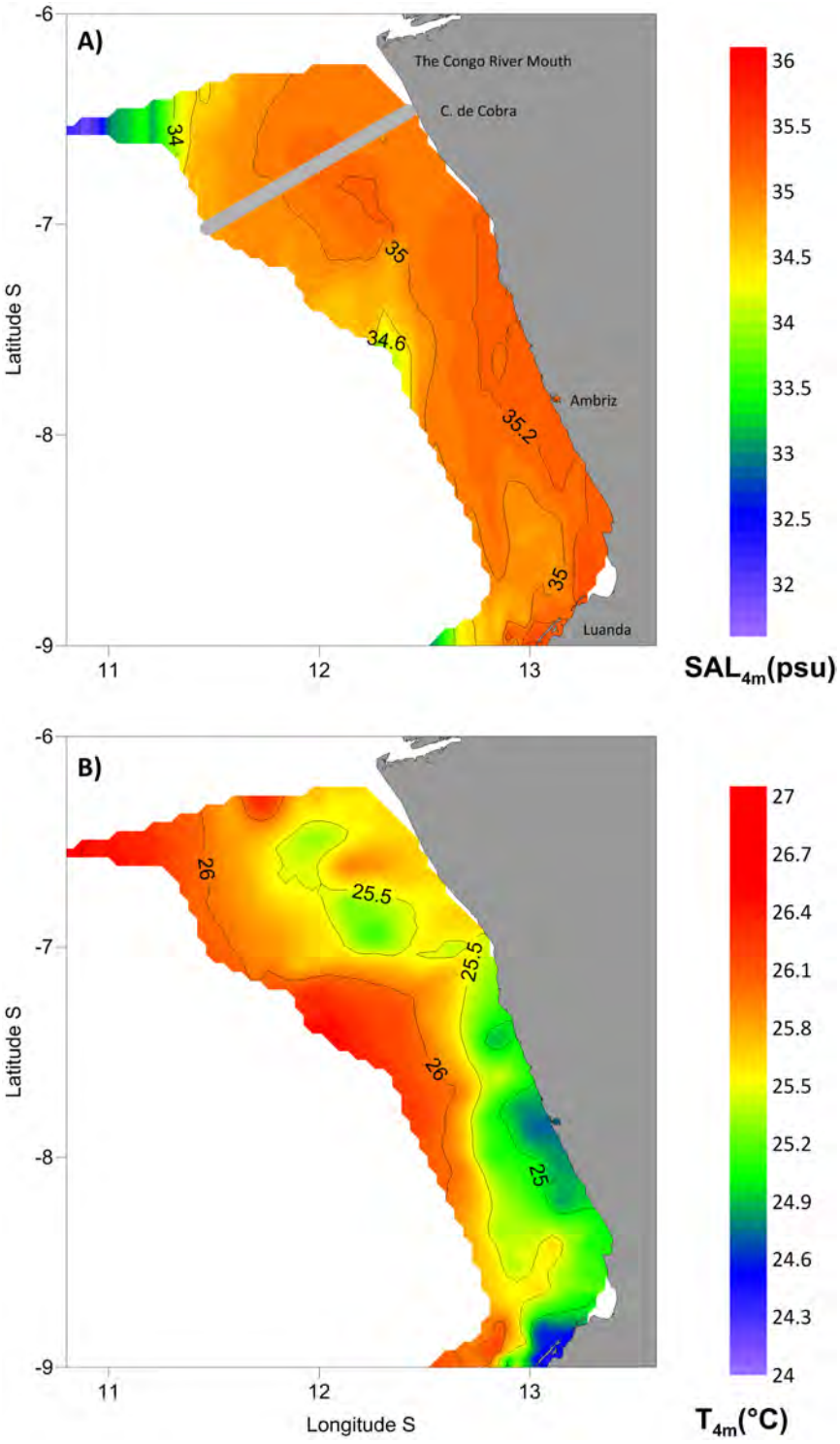


Figure 7. Distribution of salinity (A) and temperature (B) at the 4 m depth over the Northern shelf, 1-10 October 2017.

No wind data are available for that survey period; therefore the role of coastal wind in forcing this upwelling cannot be evaluated. However, this upwelling could also be sustained by an interaction of the Angola Current and coastal bathymetry.

The ADCP-derived distribution of the current at 20 m depth (Figure 8) manifests an anticyclonic eddy. Its perimeter extends shoreward to reach the Ambriz upwelling cell. Anticyclonic eddies are characterized by downwelling at their centers of rotation and by upwelling towards the outer edges. It is thus possible that the pool of water cooler from its surroundings observed off Ambriz (Figure 7B) manifests an eddy induced upwelling enhanced by the shape of the local topographic configuration.

The suggestion of a topographically arrested eddy off Ambriz is further strengthened by examining the surface temperature distribution (Figure 7B). It exhibits the local temperature maximum (an indicative of downwelling) at the same location where the ADCP-derived current vectors congest to mark the eddy center (Figure 8).

Figure 9 presents the vertical sections of potential temperature (A), salinity (B), dissolved oxygen (C) and the alongshore component of the current (D) across the Cabeça da Cobra section at 6°38’ S. (See Figure 7A for the location of this section). The downwelling conditions are manifested off the shelf break by the downsloping contours of temperature (Figure 9A), salinity (Figure 9B), and dissolved oxygen (Figure 9C). The surface-intensified Angola Current advects these water masses southwards (Figure 9D). The maximum velocity of the current is 30 cm $s^{-1}$, and is found at 20 m depth, which is the base of the surface low salinity layer. Below 50 m depth, there is a northward-flowing Slope Current. The description of the Slope Current is provided elsewhere in this report (see Section 3.2.4). Over the inner shelf, the prevailing current direction is northward. The maximum velocity of this coastal current is in the range of 20 cm $s^{-1}$.

The average depth of the 19°C isotherm derived for the northern shelf (based on 38 stations) is 68.1 m, which matches the values representing the average downwelling conditions observed during the historic February-March surveys with the R/V *Dr Fridtjof Nansen*.

### 1.1.6 The Central Region

The boundary between the Northern and Central regions is located just south of Luanda, at 9°S. At this latitude, the coastline and continental shelf bend sharply westwards forming the Luanda Bay. Under the sea surface, the southern boundary of the Lunada Bay extends into a northward facing underwater cliff running for about 50 km to the west from the coast. The southward-flowing Angola Current becomes topographically steered at this bathymetric threshold, being typically stronger at this location than elsewhere in the Northern and Central regions. The tendency to form closed circulation cells downstream of headlands and shallow bathymetric protrusions exposed to a steady incident current. As the eddy affected region in Figure 10A coincides with the location of the major recruitment area for sardinella off the Central region (Ostrowski and Barradas, 2018), we suggest that the topographically induced eddy retention may be the principal physical mechanism supporting the larval retention in this particular region.

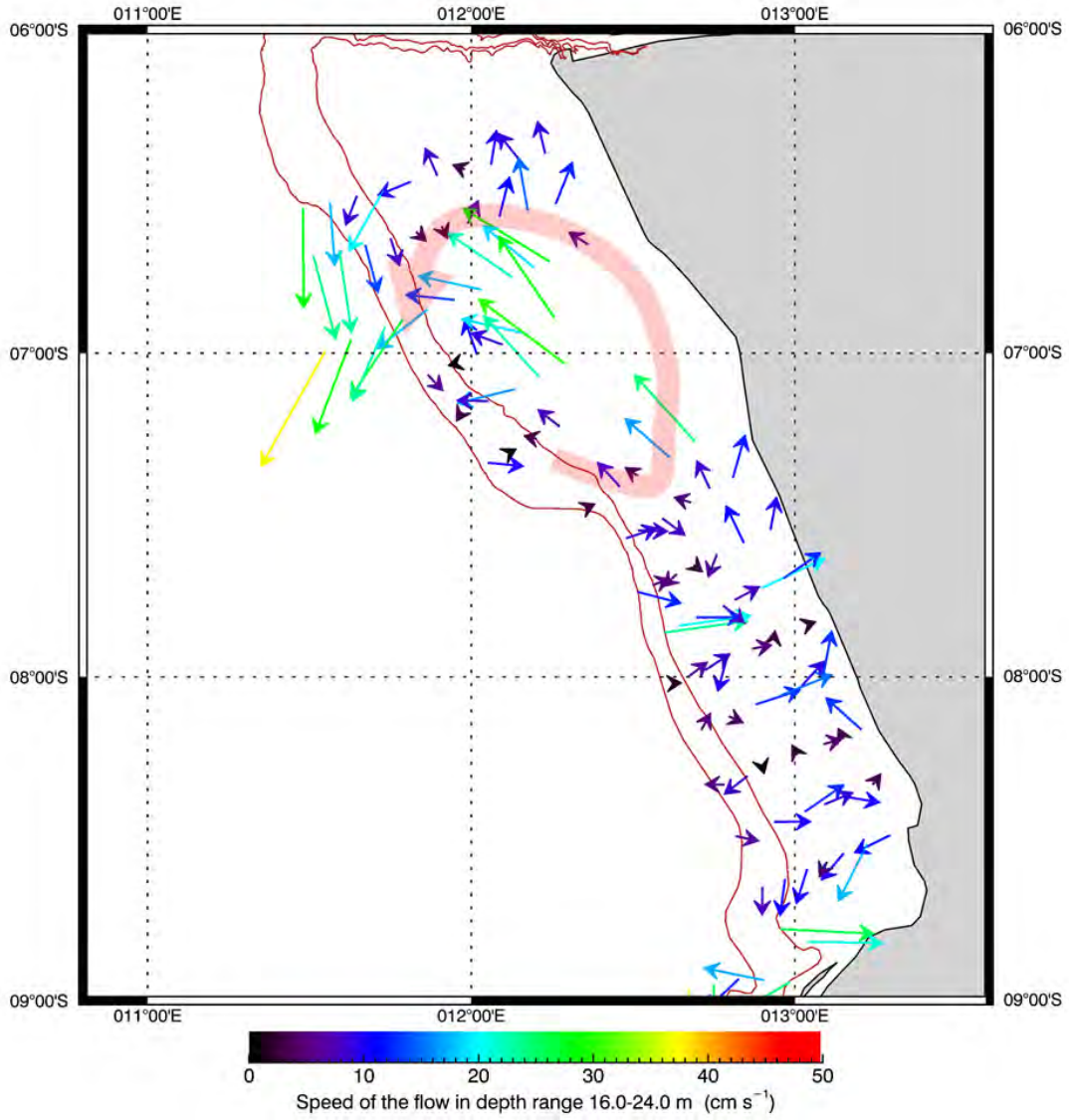


Figure 8. Distribution of the mean current between the 16 and 24 m depth derived with 150 kHz ADCP unit. The current arrows are color-coded per the velocity scale shown below the figure. The thick semi-transparent arrow in the figure center is a conceptual schema of the presumed warm eddy inducing the upwelling at Ambriz.

Figure 10A captures the topographically accelerated Angola Current just south of Luanda at the seaward side of the surveyed region. At 10°S, the signature of the strong current vanishes as the survey enters the shadow zone in the lee of the Luanda bathymetric threshold. The current vectors become smaller and veer eastward suggesting a closed eddy pattern. The ridge-like shapes of the isotherms peaking at T > 26.5°C in the same region (Figure 11B), confirm the warm eddy feature.

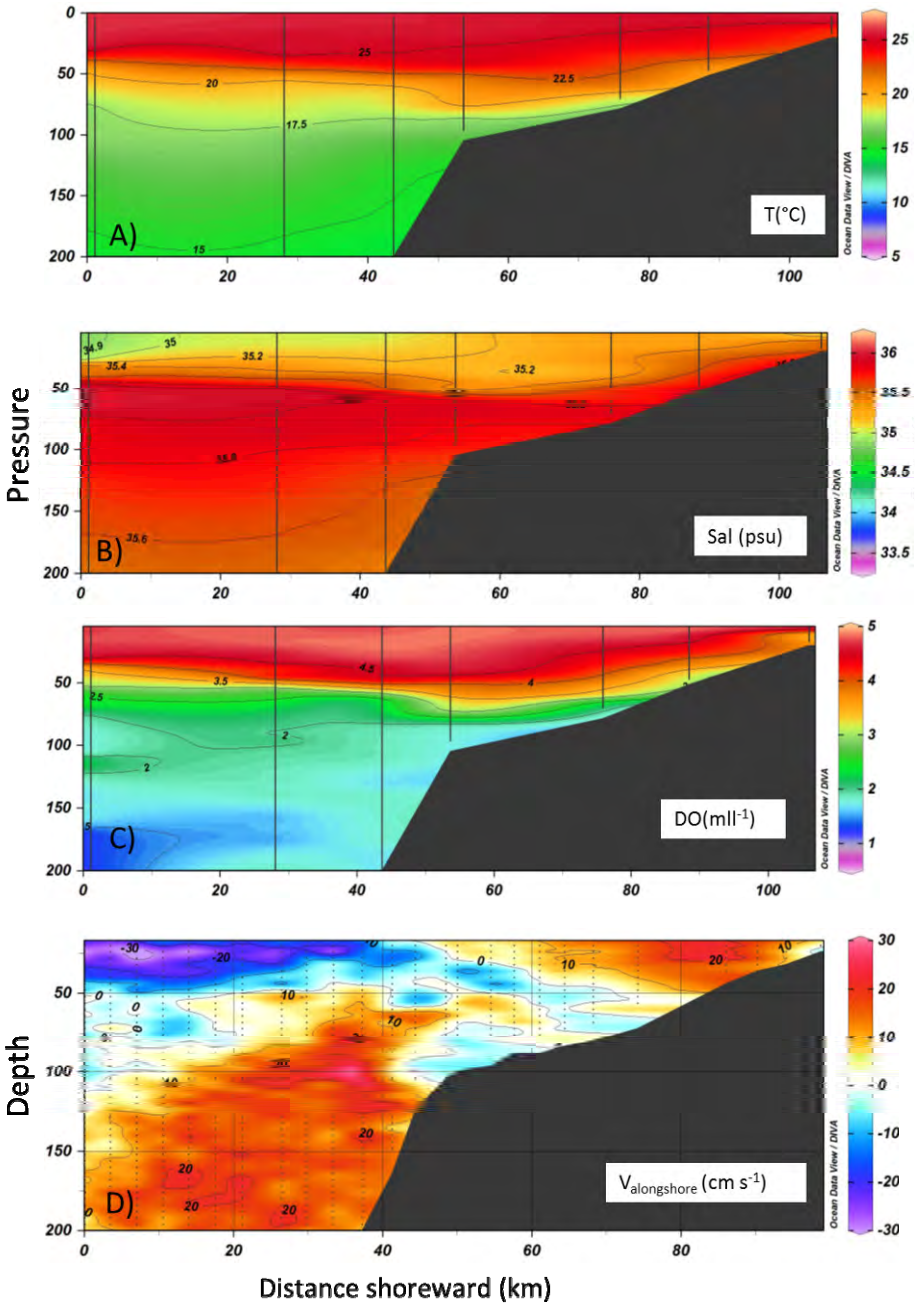


Figure 9. Distributions of potential temperature (A), salinity (B), dissolved oxygen (C) and alongshore component of the current (D) across the Cabeca de Cobra section, 6°38', 3-4 October 2017. See Figure 2 for the location of this section. The rotation of the coast used to present the current data in figure 3D was set to 28°T, according to the local orientation of the shelf break.

Figure 10B indicates the presence of a similar anticyclonic eddy at 12°S, in the lee of the shallow Quicombo Bight. In this case, the incident current on the upstream side of the bight is in the range of 30 cm s-1, which is weaker than that observed off Luanda.

The Angola Current, which is the driving force responsible for the formation of the observed eddies varies seasonally, being stronger during the austral summer than during astral winter

(Tchipalanga *et al*. 2018). It implies stronger coastal retention by the eddies during the warm compared to cold seasons.

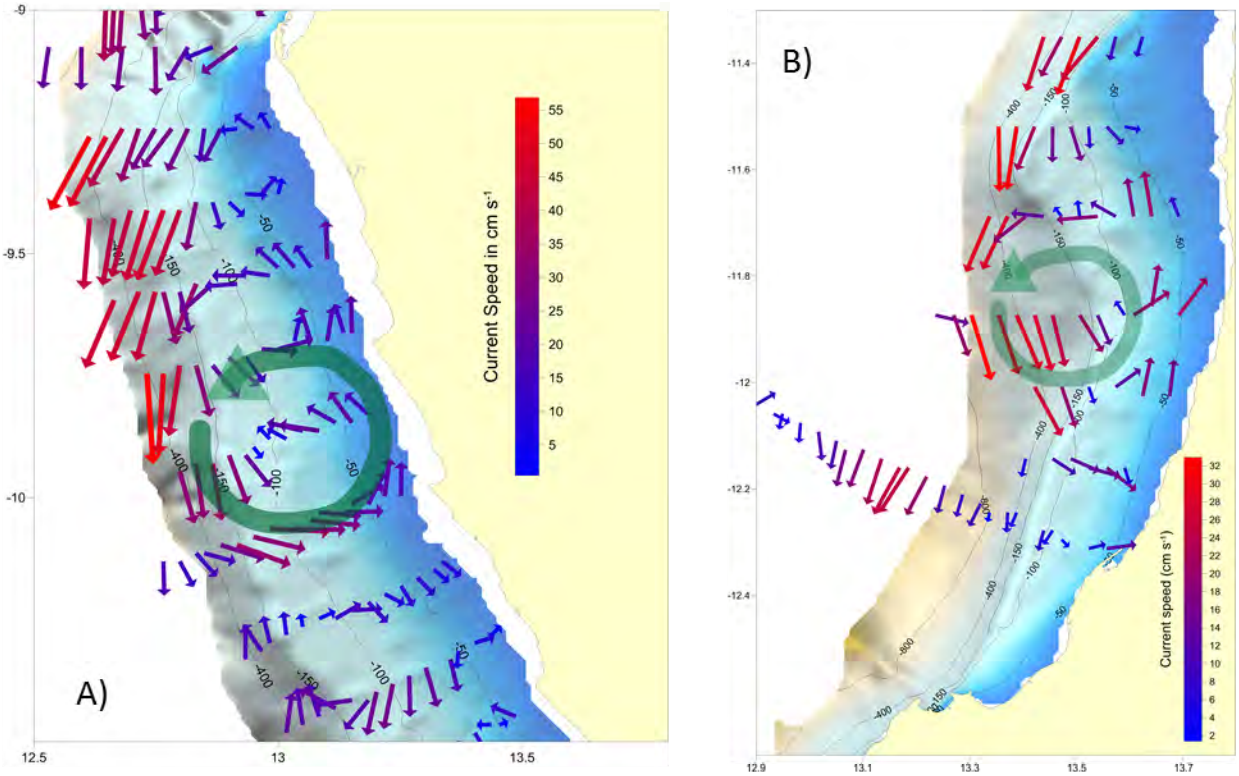


Figure 10. The topographically arrested antycyclonic eddies suggested by the ADCP observations along the Central Region, the Cabo Saõ Braz eddy, (A) and the Quicombo Eddy (B). The current vectors represent the mean flow from the 43-47 m depth range. The local bathymetry shown in the background is derived from the collected with the R/V *Dr Fridtjof Nansen* during 1994-2005.

The upwelling over the Angolan shelf is characterized by a strong seasonal cycle. October-November is ascribed as the downwelling period, implying low biological productivity. Figure 12 depicts hydrographic conditions observed along the exemplary Rio Longa section during the survey. (See Figure 11 for the section location). Below the 20 m depth, the isotherms and isohalines tend to slope down towards the coast, indicating downwelling. The seasonal downwelling is a large scale feature associated to the El-Niño-like phenomenon that dominates the seasonal hydrography of Angola, termed the Coastally Trapped (CTW) or Kelvin waves. The depressed isotherms and isohalines in Figure 12 manifest the arrival of the seasonal downwelling Kelvin wave. The surface intensified southward current (Figure 10) is another signature of the same type of wave.

During the survey, two algal bloom episodes were recorded off Rio Longa, and off Benguela (Figure 12). The FRU maxima (Fluorescence Relative Units, scaled to µl l-1) were observed in the subsurface (Figure 12, bottom). The subsurface maxima were considerably higher than the surface chlorophyll values recorded underway.

The observed algal bloom events shown in Figure 12 coincided with strong wind episodes. At the same time, the intrusion of warm waters from the north was intensifying, suggesting that

upwelling occurred due to a combination of wind and eddy-driven forcing. Concurrently, low salinity layer was spreading onto the shelf. Under these conditions, the maximum primary productivity appeared to develop in the subsurface. However, this is a very preliminary conclusion, as at the time of this writing we cannot confirm whether the CTD-mounted and underway fluorimeter data are directly compatible.

The upwelling productivity pattern observed during this survey is distinct from the conditions observed from the surveys carried out during the main upwelling season (May-August) when the coastal wind is typically much calmer, and the flow in the Angola Current is weaker. The fluorescence data does, however, indicate a similar intensity of phytoplankton blooms.

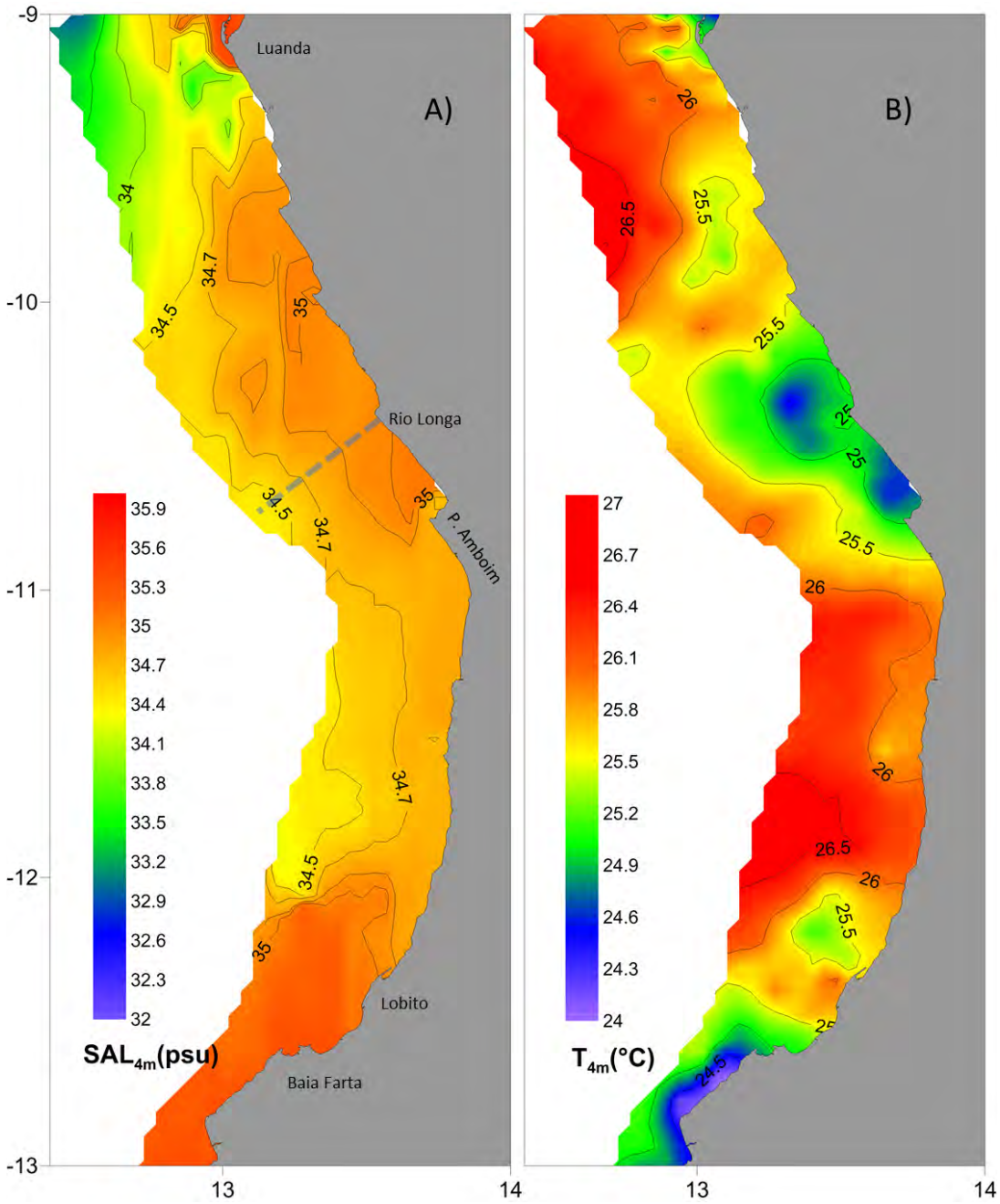


Figure 11. Distribution of salinity (A) and temperature (B) over the Central Shelf. The location of the Rio Longa section marked with the broken line.

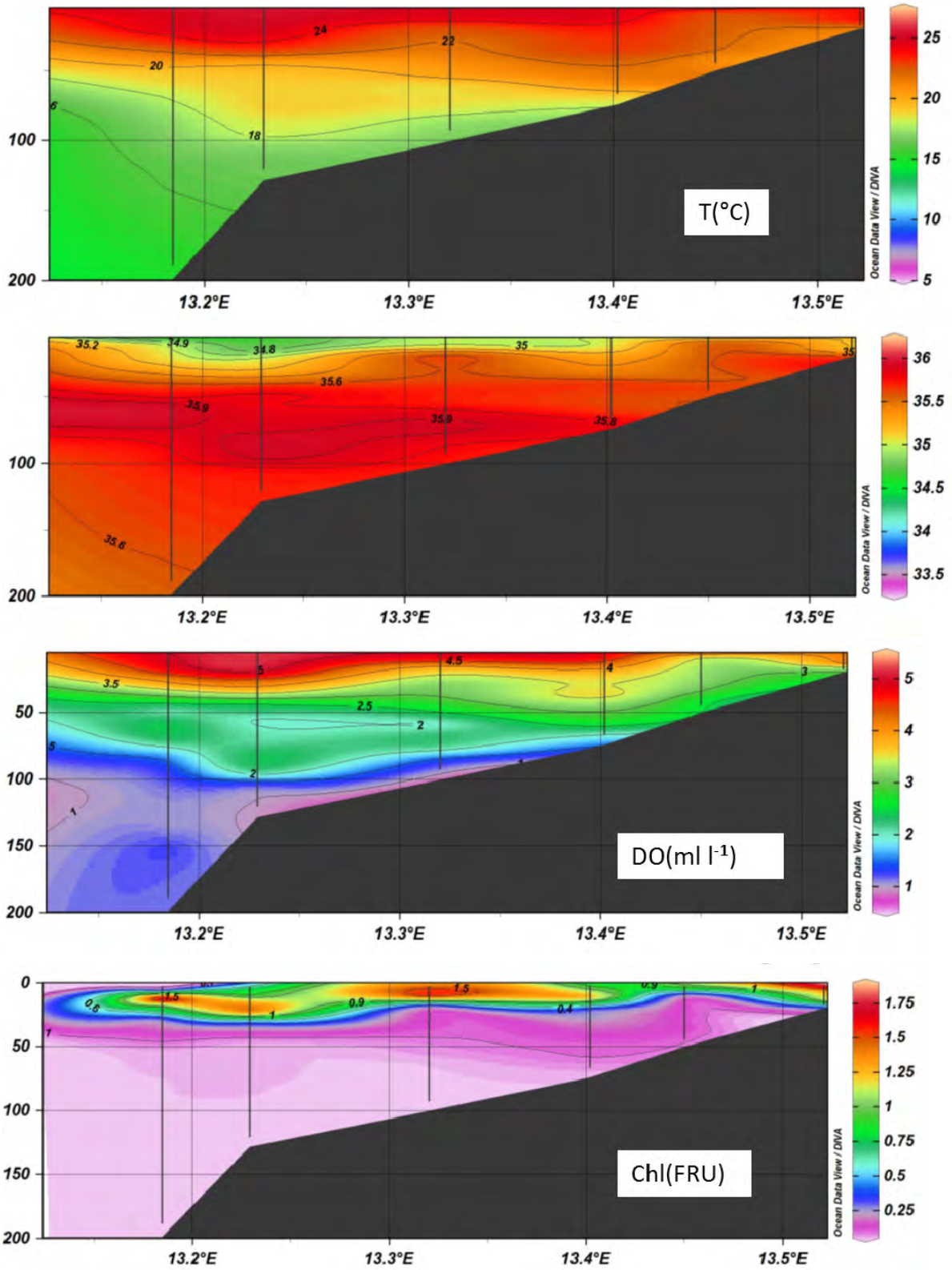


Figure 12. The vertical distributions (from top to bottom) of potential temperature, salinity, dissolved oxygen and fluorescence along the Rio Longa section, 17 October 2017.

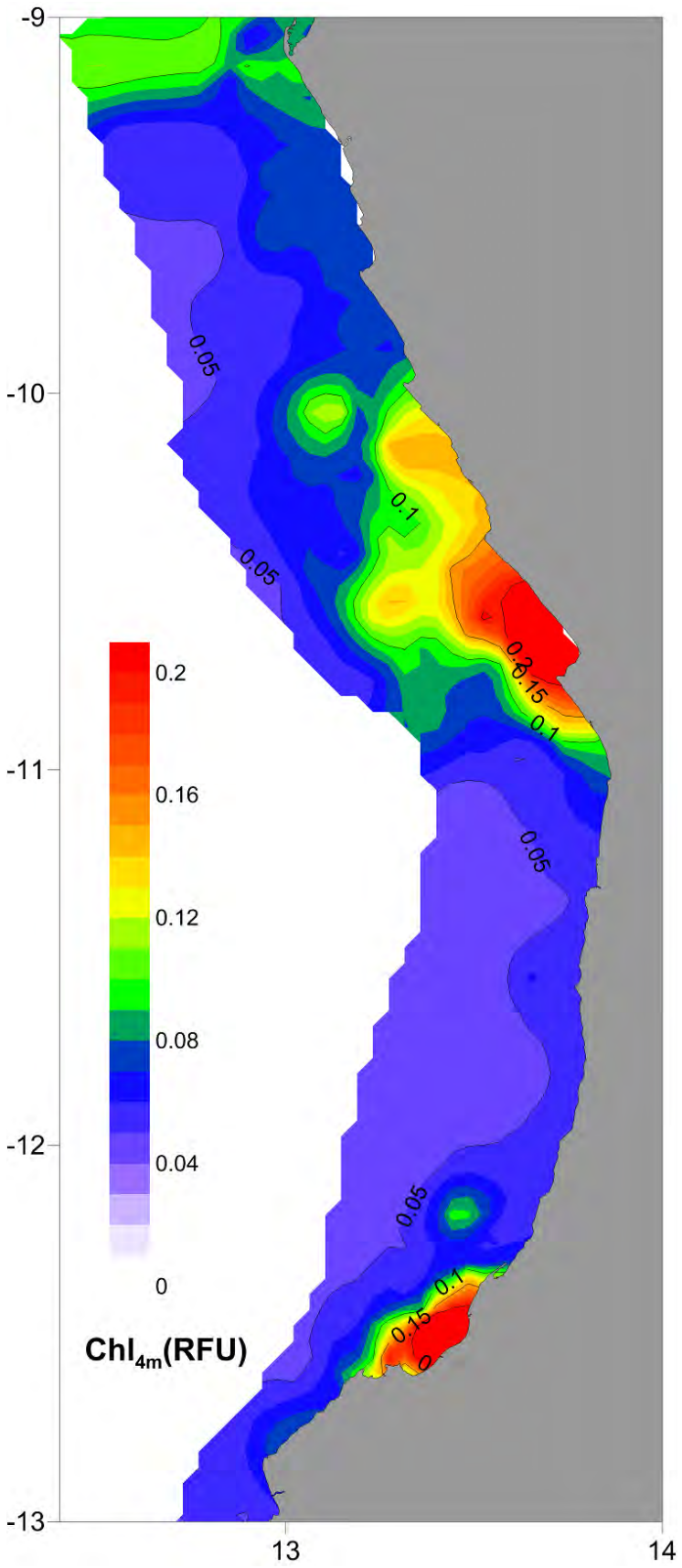


Figure 13. Distribution of the fluorescence-derived chlorophyll at the 4 m depth recorded underway in the Central region.

### 1.1.7 The Southern Region

*Wind conditions*

Wind conditions were monitored south of 12°S in the southern region. Due to a data login system error (cf. Section 2.1.1), there are no wind records from the Northern and Central regions. Qualitatively, coastal wind in these regions appeared somewhat stronger than during the most recent previous surveys with R/V *Dr Fridtjof Nansen*. This is probably related to the seasonal intensifications of coastal wind conditions observed in satellite-observed data.

Figure 14 presents the distribution of average wind vectors along the survey track over southern Angola's coast.The first correct wind vectors appear at the Lobito section. The wind patterns presented to the north of this section are incorrect and should be disregarded. The wind direction generally agrees with the direction of the coastline, suggesting favourable upwelling conditions. Onshore winds dominated over the survey area only once, during the calibration stopover in the Elephant Bay. The wind speed was generally moderate ($< 5$ m $s^{-1}$) over the survey segment covering the narrow continental shelf section (12°-16°S), but increased significantly once the vessel crossed the Pta.

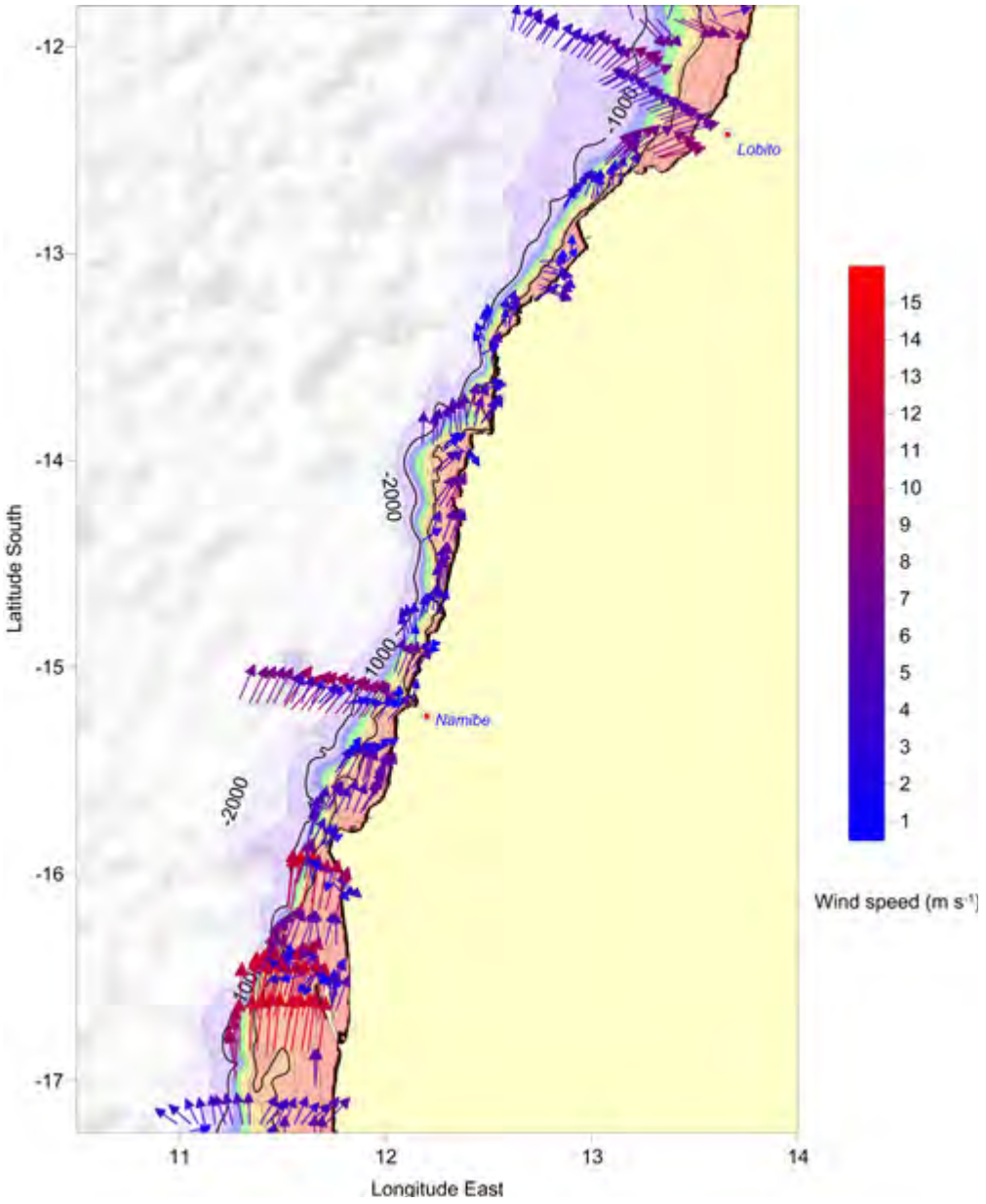


Figure 14. Distribution of wind along the survey track of the R/V *Dr Fridtjof Nansen* in the southern sector of the Angolan shelf, 20-29 October 2017. The wind vectors are colour coded according to wind speed.

The coastal bathymetry influences the oceanographic conditions along the Southern Angolan coast. The main bathymetric divide occurs at 16°S, near the port of Tombwa, with the very narrow continental shelf in the north and the wide continental shelf, extension of the northern Benguela shelf, in the south.

The subsurface distributions of temperature and salinity, shown in Figure 15 exhibit a sharp division at about the same latitude. Warm and relatively saline surface waters, T > 22° C, S > 35.7 psu, advected with the Angola Current (AC) dominate to the north of 16°S. Cold and lower salinity waters originated from the upwelling plume dominate south of 17°S. Between 16° and 17°S, the isotherms and isohalines assume a direction perpendicular to the coast, indicating a front. This is the expression of the Angola-Benguela Frontal Zone (ABFZ)

separating the tropical ecosystem of Angola from the Benguela upwelling region. In the presented observations, the ABFZ was centred at 17°S, just north of the Angola-Namibia marine boundary, as indicated by the convergence of the isotherms and isohalines in Figure 15.

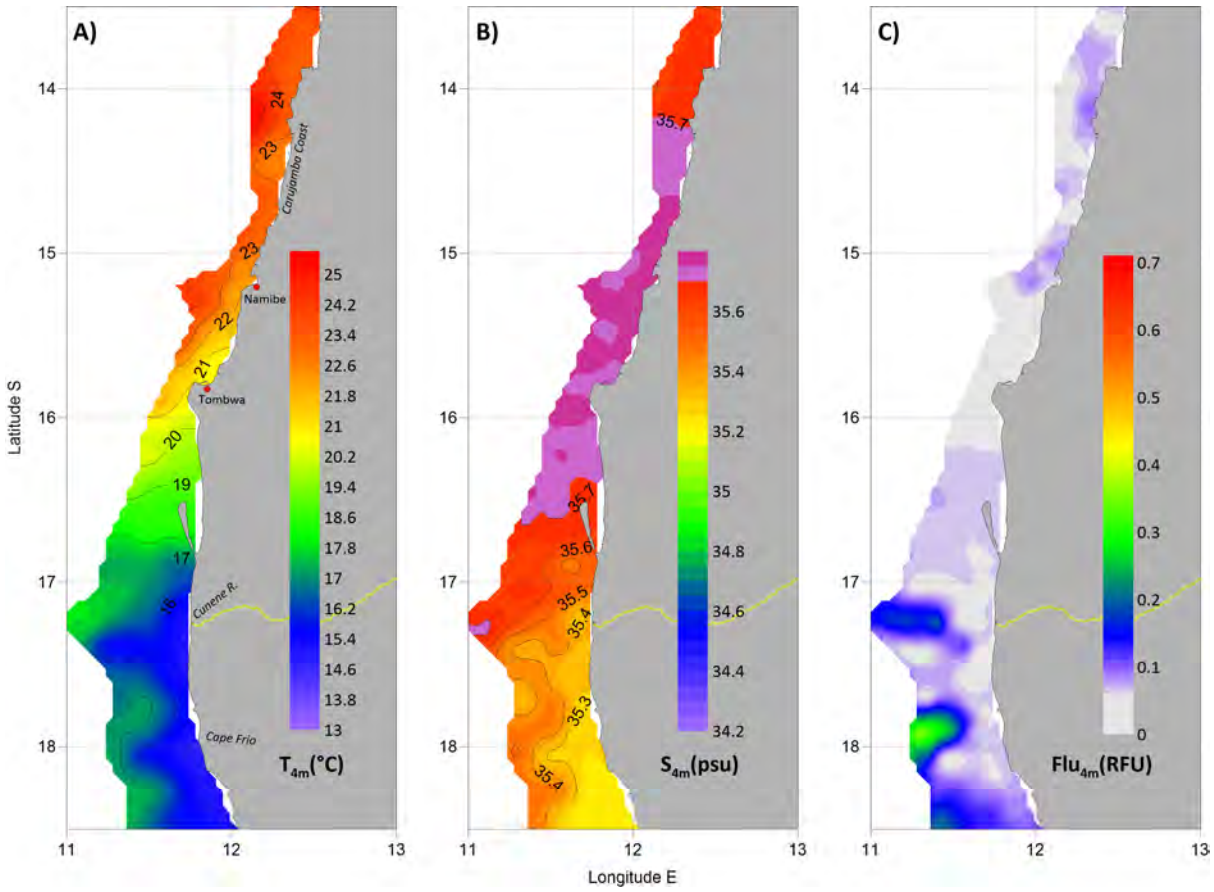


Figure 15. Horizontal distributions of temperature (A), salinity (B) and fluorescence in the southern region derived from underway collected thermosalinograph (TSG) data.

Figure 16 shows the distribution of the current in the depth range of 18-26 m. Presented is the topmost layer resolved by the 150 kHz ADCP. The presented flow patterns represent the top mixed layer. To better resolve detail, the northern and the southern side of the bathymetric and oceanographic divide are presented on separate panels.

The Angola Current forms a persistent southward flow along the African continent. Such a flow is generally not resolved in Figure 16A. The probable reason for this is the very short length of cross-shelf sections surveyed in this particular region, not reaching the core of the AC, located at some distance from the coast. Along the Namibe section, which covered over 40 nautical miles offshore, the core of the AC was detected at about 30 nautical miles offshore. The maximum current velocity was in the order of 40 cm $s^{-1}$. The same core is resolved on the offshore ends of the subsequent surveyed sections along the Tombwa-Namibe Coast (Figure 16B).

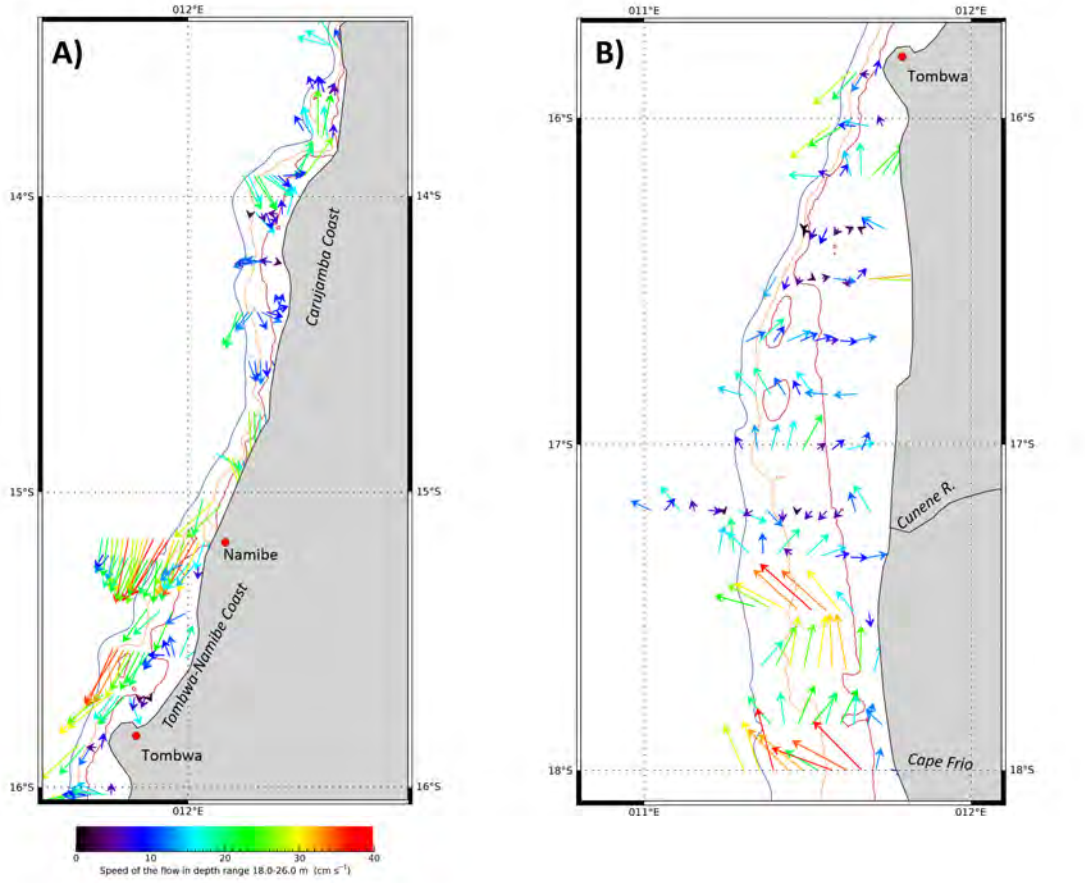


Figure 16. Distribution of ADCP-derived currents in the Southern Region; depth range: 18-26m. A: Elephant Bay to Tombwa; B: Tombwa to Cape Frio. Observations with OS 150 kHz ADCP. Cross-section currents only shown. The vectors are color coded. The color scale below the A panel.

Given the poor cross-shelf extent of the coverage, it is difficult to assess the fate of the AC core after crossing the 16° parallel. The low velocity of the current over the shelf between 16° and 17° (Figure 16B) suggest that the AC departed offshore at that location and did impact strongly the circulation over the ABFZ shelf sector. In contrast, the ABFZ sector was exposed to a strong northward current at its southern flank. The northward current, $V > 40$ cm $s^{-1}$, was connected with strong offshore transport. To the north of the presumed ABFZ location (cf. Figure 15A and B) the observed current velocities were reduced significantly. Comparing Figure 16B with the temperature and salinity distribution (Figure 15A and B) shows that the observed offshore flow was coincident with the region of the upwelling plume development.

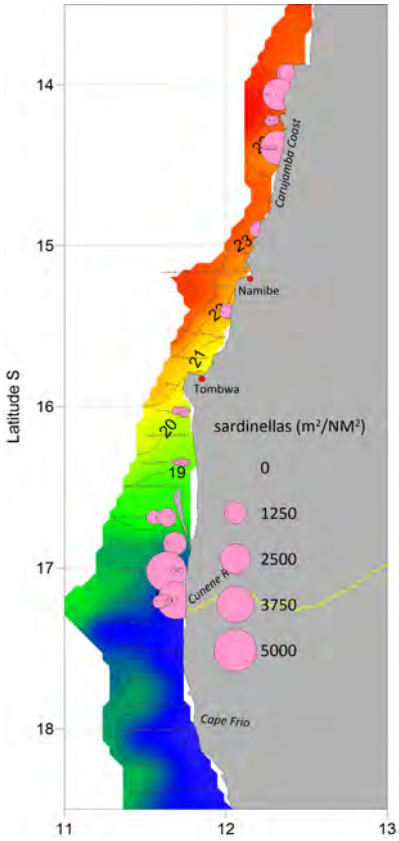


Figure 17. Acoustic density allocated to *Sardinella* spp. in the southern region. The area of the circle proportional to the acoustic density (SA-values) within a 5 NM elementary distance unit (EDSU). Underlying the acoustically-derived fish distribution, is the distribution of temperature, the same as shown in Figure 15A.

Figure 17 demonstrates the pattern of correspondence between oceanographic boundaries distribution of sardinella in the Southern Region. The densest aggregations of sardinella were found in the region of the strongest surface temperature gradient associated with the ABFZ. Fish was still present when the temperature dropped below 16°C. However, the nearshore habitat where the most of fish were found was characterized by low currents (cf. Figure 15B), suggesting retention favourable conditions nearshore.

### 1.1.8 Observations of the Slope Current and Lower Slope Angola Current

The availability of the new mid-range ADCP instrument, the RDI's OS75 made it possible to obtain a detailed registration of the flows along the Angola's continental slope. To our knowledge, this report is the first indication on the existence of steady flowing, opposite direction currents flowing along the Angolan continental slope.

Figure 18 depicts sections of the alongshore component of the flow observed along the Lobito section at the southern extremity of the Central Region, along the Palmerinhas section located just south of Luanda and at the Moita Seca section located just south of the Congo River Canyon. The regions of the equatorward and poleward flows are marked with the red and blue colors, respectively.

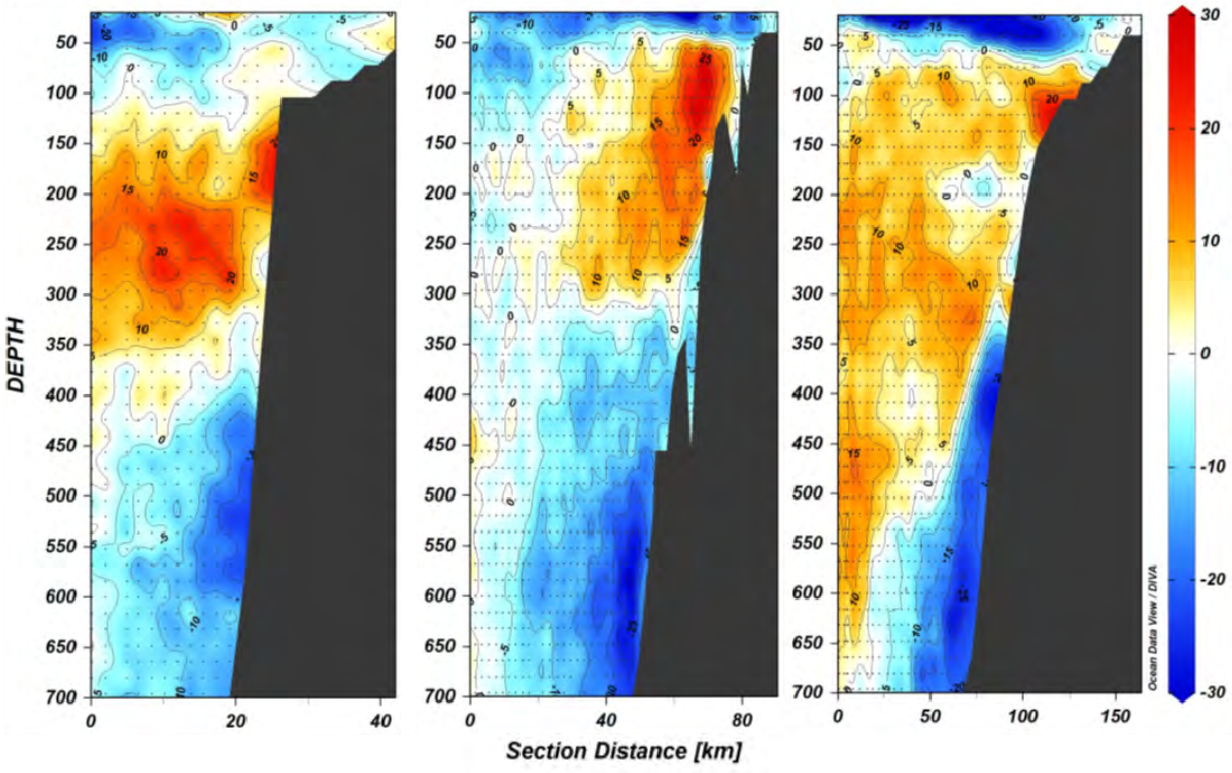


Figure 18. The vertical cross sections across the alongshore component of the current observed at Lobito on Oct. 20 (left), at Palmerinhas just south of Luanda on Oct 8 (Center) and at Moita Seca in the southern near-field of the Congo River outflow on Oct 2(right).

All three sections exhibit the oppositely flowing currents across the water column. The subsurface poleward flow occupies the top 50 m. At Moita Seca it is spread across the shelf, at Palmerinhas, it intensifies on the outer shelf and is weak inshore, and at Lobito it is observed sewards of the shelf break. Note however the time lags between the observations at these three section. Some differences in the flow patterns, particularly in the top layer are likely to arise from different synoptic conditions between the observations. Note that the top observational depth shown is located at the depth of 20 meters; ADCPs do not detect currents at the shallower depths.

The top-layer seen in Figure 18 is known as the **Angola Current** (AC). Historic observations indicate that during October-November this current tends to accelerate poleward, forced by remote processes in the equatorial region. The maximum velocity seen in Figure 18 reaches 30 cm $s^{-1}$ at the northern section at Moita Seca. At the remaining two sections shown in Figure 18 the top poleward current speed is in the range 20-25 cm $s^{-1}$.

Underneath the Angolan Current flow, just below the thermocline, Figure 18 indicates the presence of the equatorward flowing current, termed here as the **Slope Current** (SC). The observed pattern, of the surface and slope currents flowing in the opposite directions is frequently encountered in the wind-driven upwelling regions. In those cases, the SC develops as a compensation to the equatorward flowing, upwelling-induced coastal jets. For instance, the poleward flowing SC in the opposition to the coastal jet has been frequently observed with the R/V *Dr Fridtjof Nansen* over the Orange Banks and Namaqua coast of South Africa during the Benefit/BCC survey program 2003-2013. However, in Figure 11 it is the surface current (AC) that flows poleward and it is the subsurface current (SC) that flows equatorward. Thus, the direction of both flows is exactly opposite to the typical vertical flow patterns known from upwelling regions.

This reversed vertical flow pattern may have some subtle consequences to the biota dwelling in the outer shelf region, notably to the diel vertical migrants (DVM). Given the opposite currents, DVMs maintain their position along the coast through migration between the surface layer at night and the deep water, typically in depth range of 200-400 m, during daytime. As it is obvious from the flow patterns shown in Figure 19, off Angola the DVMs are carried south during the day and to north during the night. This is exactly the opposite day-night transport pattern to that which DVMs experience in an upwelling region. It will be interesting to confront this observation with the forthcoming mesopelagic experiment in Namibia.

The SC at Lobito and Palmerinhas flows as a midwater core surrounded by relatively stagnant waters. At Lobito, the AC layer occupies the depth range between 150 and 350 exhibiting the two velocity cores, the main core at about 10 kilometers from the shelf break and another close to the bottom in the depth range 150-200 m. This second core appears to be a synoptic-scale feature; as it has not reappeared in the results from the second crossing of the Lobito section made about 12 hours later (not shown). At Palmerinhas (Figure 18 center), the width of the SC core is very narrow and follows the abrupt topography just south of Luanda.

The flow across the Moita Seca at midwater depth range is broad and diffuse (Figure 18, right). On the seaward side of the section, the current is equatorward at 10 cm $s^{-1}$. It dominates almost entire water column, except of the top 30 meters. A rapid change in the flow direction occurs close to the bottom below 350 m depth. The flow reverses abruptly to attain the speed of -15 cm $s^{-1}$ (to the south) within the first 10 kilometers from the sloping bottom. As we are not aware of any established reference of this flow, we refer to it hereafter as the **Lower Slope Angola Current** (LSAC). The same current is identifiable at the Palmerinhas and Lobito sections below the depth of 400 m and within the first kilometers

from the continental slope (Figure 15, left and center). At those sections, however, the LSAC flows clearly under the SL rather than on its side.

Returning to the equatorward flowing Slope Current, Figure 19 presents the horizontal distribution of this current at the depth of 200 meters across the length of the entire Angolan Tropical Upwelling Region. Clearly, at that depth the SL does not represent the continuous northward flow. The current is northward between the southmost point shown on the map and the Quicombo-Novo Redondo and again from Luanda to the Congo River. The data collected between 11° and 9°30'S indicate the absence of the SL and the LSAC the outer shelf. This may be due to the fact that this region is located in the shade of the main core of the Angola Current, as described in Section 3.1.3, and therefore exhibit a reduced activity of the compensation currents flowing underneath.

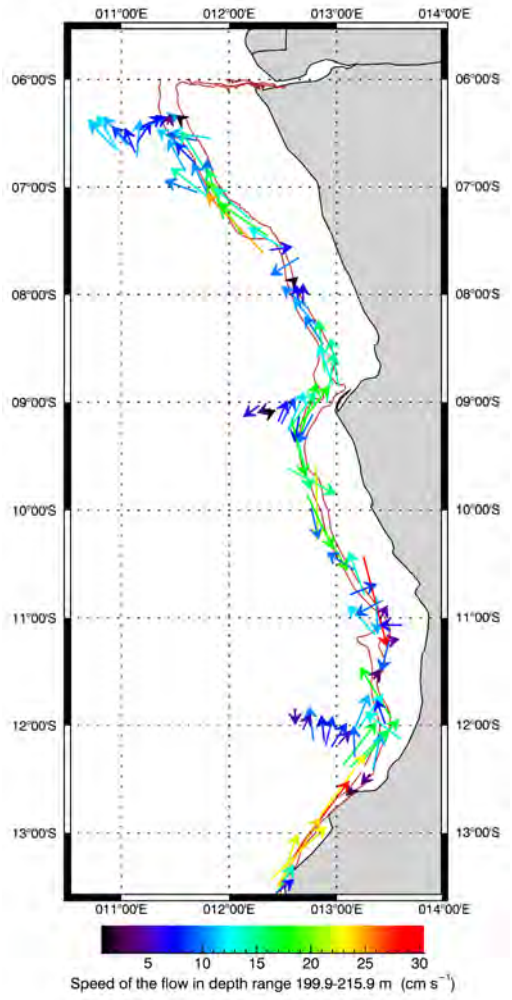


Figure 19. Current at 200 m collected with the OS 75 kHz ADCP unit during Survey 2017408. The speed of the current color-coded. The depth contours of 200 and 500 m indicated by the thin brown lines.

Hydrographic variables were measured in sections normal to the coastline about every 30 nm, except in the southern region where it was measured every 40 nm. The CTD sampled

continuous profiles of pressure, temperature, salinity, oxygen, fluorescence, oxygen and Photosyntetically Active Radiation (PAR). In addition, water samples nutrient, chlorophyll, salinity and oxygen were collected from surface to bottom at selected depths. An overview of the data collected is given in Table 4.

Table 4. Overview of the number of samples collected on water chemistry in the 3 different regions of Angola.

| **Region** | **No. of sampling stations** | **No. of nutrients samples** | **No. of pH/ Alk samples** | **No. of Chl.A samples** | **No. of Oxygen samples** | **No. of salinity samples** |
|---|---|---|---|---|---|---|
| Angola North | 47 | 139 | 163 | 20 | 24 | 105 |
| Angola Central | 18 | 107 | 81 | 25 | 25 | 117 |
| Angola South | 20 | 137 | 107 | 49 | 40 | 137 |
| Total | 85 | 383 | 351 | 94 | 89 | 359 |

## Phyto and zooplankton samples

Samples containing phytoplankton and zooplankton were collected from the phytoplankton vertical haul net and the WP2 net (also vertical haul). These samples will be analysed later and the results reported separately.

A total of 84 zooplankton samples for taxonomic analysis were collected on the Angolan shelf from Central to Southern Angola. Enroute to the southern Angola stations, the zooplankton samples were increasingly dominated by the copepod, *Calanoides carintaus.* Around the Cunene River area, about 17°S, a dense phytoplankton bloom was encountered, with a subsequent partial clogging of the cod-end. The blooms were dominated by the concentric diatom *Coscinodiscus* species, although the identity still needs confirmation. When blooms were present, very few zooplankton were observed. An overview of the number of samples of phyto- and zooplankton is given in Table 5.

Table 5. Number of samples of phyto- and zooplankton collected.

| **Region** | **Phytoplankton** | **Zooplankton from 200 m** | | **Zooplankton from 25 m** | |
|---|---|---|---|---|---|
| | Formalin | Formalin | Dried | Formalin | Dried |
| **Angola North** | 12 | 12 | 52 | 12 | 24 |
| **Angola Central** | 15 | 15 | 56 | 18 | 61 |
| **Angola South** | 19 | 21 | 79 | 28 | 85 |
| **Total** | **34** | **36** | **135** | **46** | **146** |

## Fish eggs and fish larvae

The preliminary results show that an estimated 1209 fish larvae were sampled. Species identified included Myctophids, *Vinciguerria, Sardinella*, *Engraulis encrasicolus* (Figure 20), Soleidae and *Trachurus.* Due to time constraints, we were not able to fully identify all the fish eggs and fish larvae to species level. The samples were therefore preserved in formalin for further investigation onshore. From the preliminary results it is evident that more fish larvae were sampled in the inshore and shallow stations.

To increase the number of fish eggs collected, water sampling from the water intake at 2 m (CUFES intake) were used. Nine 1-hour stations were sampled in Angola in which six stations had fish eggs and fish larvae present. The remaining 3 stations had no fish eggs or fish larvae. These were all offshore stations. 14 eggs and 7 fish larvae (Figure 21) were sampled from the surface water pump. Most of the ichthyoplankton remains unidentified.

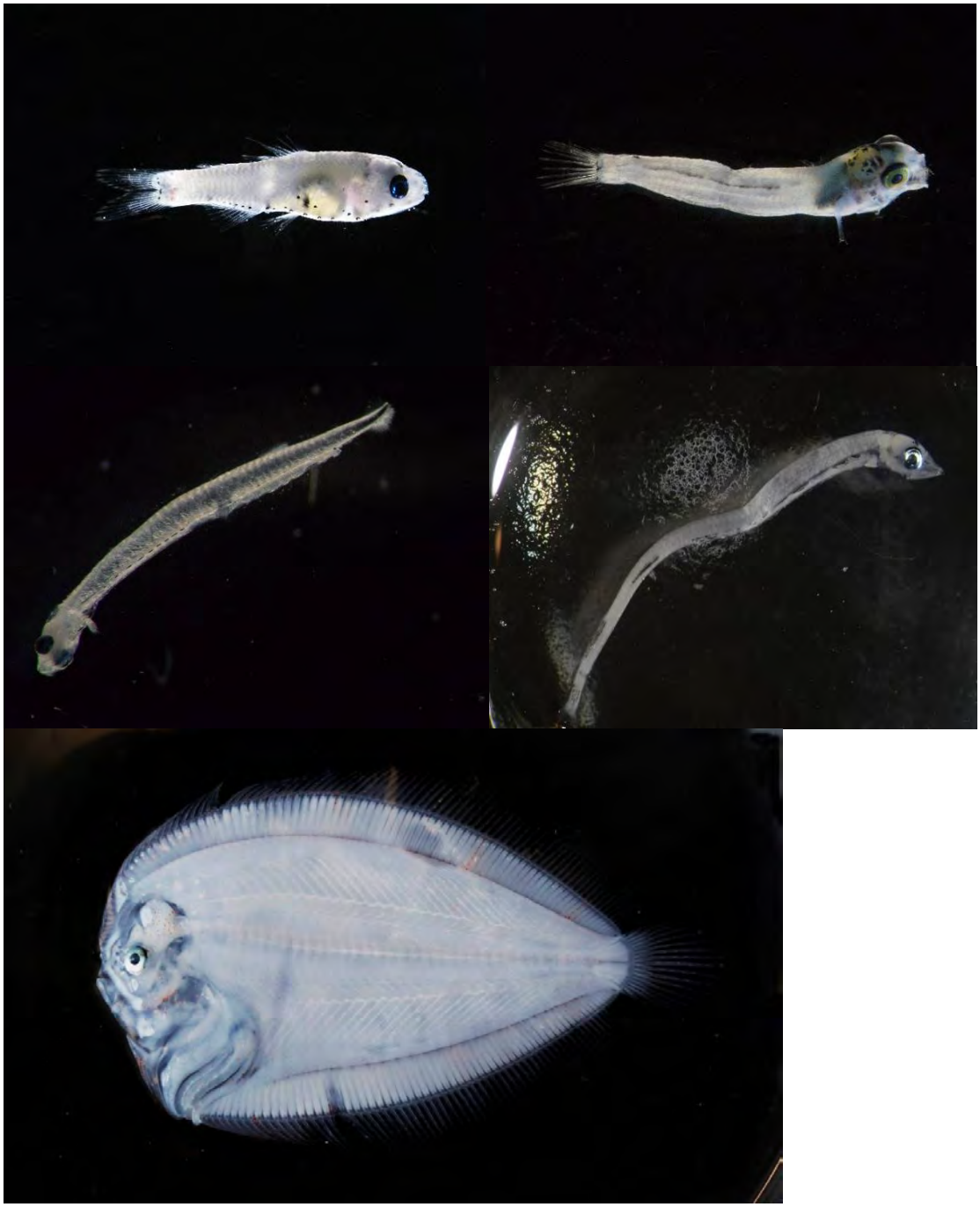

Figure 20. Showing fish larvae found in the Multinet samples. Upper-left; *Myctophid* larvae, Upper-right; *Unidentified* larvae, Central-left; *Sardine* larvae, Cental-right; *Vinciguerria nimbaria* larvae, Bottom; likely *Heteromycteris capensis*.

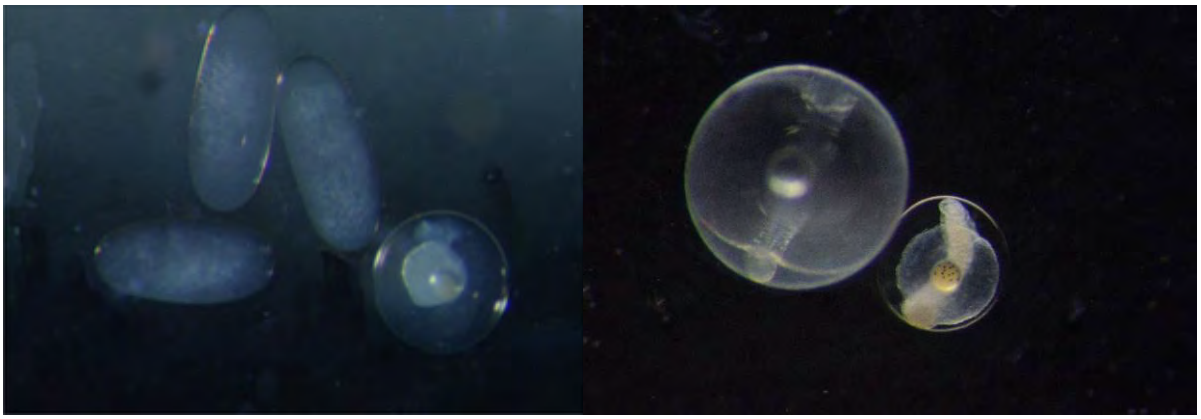

Figure 21. Anchovy egg and unidentified fish eggs from the termosalinograph water samples.

At station ST_751 a Coscinodiscus algae bloom reduced the abundance of fish eggs, and no fish larvae was present in the sample. A high abundance of krill was caught in the 200 - 100 meter strata.

## Microplastics

Microplastics were sampled at the surface in 36 stations with a Manta Trawl Net. Red and yellow paint particles, most likely originating from the sampling gear, are included in the data. An overview of the sampling stations are presented in Table 6.

Out of the 36 stations surveyed, microplastic particles were recorded in samples from 12 of the stations (Figures 22 and 23). The results indicate that stations closer to shore had a higher abundance of microplastics than offshore stations. The stations with the highest concentration of microplastics were ST_642 and ST_645 (Capo São Braz) which are in a retention area, and ST_745 just off the Cunene River.

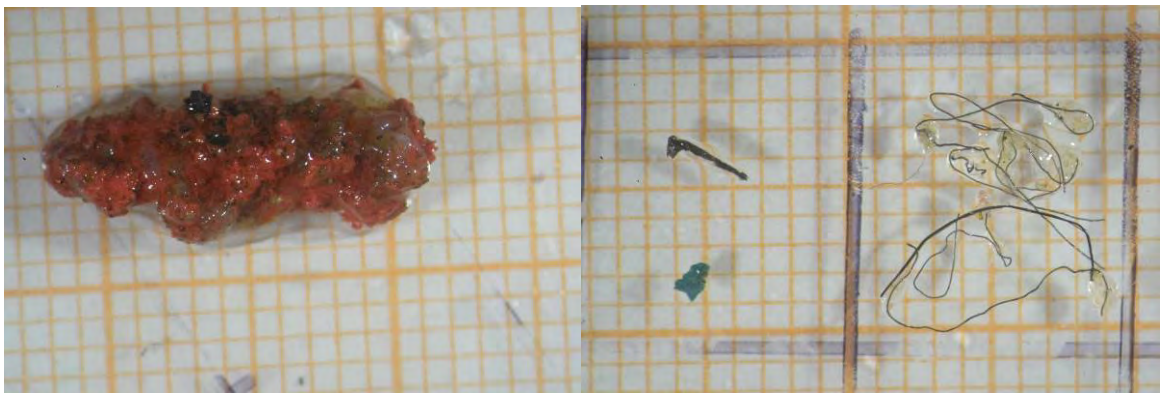

Figure 22. Some examples of microplastics caught in the mata trawl (station 715).

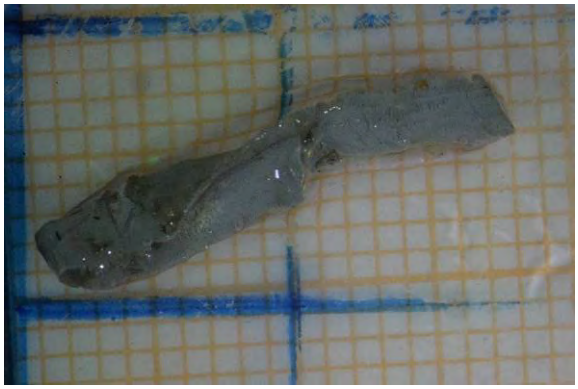

Figure 23. An example of microplastics caught in the mata trawl (station 743).

Table 6. Summary of microplastics sampling stations.

| **Country** | **No. of sampling stations** | **No. of samples with visible microplastics** | **Total no. of plastic objects** | **No. of samples preserved in formaldehyde** | **No. of samples preserved by freezing** |
|---|---|---|---|---|---|
| Angola North | 16 | 16 | 42 | 0 | 0 |
| Angola Central | 15 | 8 | 30 | 0 | 8 |
| Angola South | 21 | 8 | 18 | 0 | 8 |
| Total | 52 | 32 | 90 | 0 | 16 |

## Food safety

Sampling for food safety was conducted to study both the nutrition value of various fish species and to test for any traces of contaminants in commercial fish species. For nutrition the following parameters will be analysed; Total energy, water content, total fat, proteins, ash, fatty acids, cholesterol, amino acids, tryptophan, vitamins (D, A, E, K, C, thiamine, riboflavin, B6, B12, folate, niacin, pantotene, biotin), iodine, selenium and other minerals. For contaminants the following parameters will be analysed; heavy metals, inorganic arsenic, PAH, PBDE, PCB, dioxins, furans, PFAS, pesticides, HBCD, TBBPA, TBARS (Thiobarbituric acid reactive substance). Table 7 shows the number of samples collected for the different kinds of analysis of fish for food safety. The sample analysis will be carried out at the IMR.

Table 7. The sampling done for analytical work for each species.

| | | | AREA 4040 and 4050 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | SMALL FISH GROUP | | | | | | | | | |
| Date | Species | Number of Fish | | Journal | B-sample? | Tissue | # freecedryed | Survey | Station No. | Posisjon | Country |
| | | Large Fish | Small fish | number | | | samples | | | | |
| 14.10.2017 | Sarinella maderensis | | 150 | 2017-1358 | Ja | 75 Whole fish / 75 Filet | 12 | 2017408 | 26 | S 9.236 E 12.937 | Angola |
| 15.10.2017 | Sardinella aurita | | 150 | 2017-1360 | Ja | 75 Whole fish / 75 Filet | 12 | 2017408 | 29 | S 9.63 E 13.12 | Angola |
| 16.10.2017 | Brachydeuterus auritus | | 150 | 2017-1365 | Ja | 75 Whole fish / 75 Filet | 12 | 2017408 | 32 | S 10.10 E 13.335 | Angola |
| 16.10.2017 | Trachurus trecae | | 150 | 2017-1361 | Ja, 75 % | 75 Whole fish / 75 Filet | 9 | 2017408 | 33 | S 10.21 E 13.18 | Angola |
| 17.10.2017 | Ilisha africana | | 150 | 2017-1362 | Ja | 75 Whole fish / 75 Filet | 12 | 2017408 | 36 | S 10.653 E 13.705 | Angola |
| 20.10.2017 | Saurida brasiliensis | | 150 | 2017-1363 | Ja, 75 % | 75 Whole fish / 75 Filet | 9 | 2017408 | 46 | S 12.018 E 13.66 | Angola |
| 20.10.2017 | Trachurus trecae | | 150 | 2017-1366 | Ja, 75 % | 75 Whole fish / 75 Filet | 9 | 2017408 | 46 | S 12.018 E 13.660 | Angola |
| 27.10.2017 | Engraulis encrasicolus | | 150 | 2017-1583 | Ja | 75 Whole fish / 75 Filet | 12 | 2017408 | 64 | S 15.70 E11.85 | Angola |
| 27.10.2017 | Trachurus trecae | | 108 | 2017-1584 | Ja | 75 Whole fish / 75 Filet | 12 | 2017408 | 65 | S 16.16 E 11.64 | Angola |
| 28.10.2017 | Sardinella aurita | | 150 | 2017-1585 | Ja | 75 Whole fish / 75 Filet | 12 | 2017408 | 70 | S 16.68 E 11.65 | Angola |
| 29.10.2017 | Engraulis encrasicolus | | 150 | 2017-1586 | Ja | 75 Whole fish / 75 Filet | 12 | 2017408 | 71 | S 17.01 E 11.65 | Angola |
| | | | # 1608 | | | | | | | | |
| | | | | | | | | | | | |
| | LARGE FISH GROUP | | | | | | | | | | |
| 15.10.2017 | Sphyraena guachancho | 25 | | 2017-1072 | Nei | Muscel, 15 liver, 15 feces + mix (1-5, 6-10, 11-15) | 28 | 2017408 | 29/30 | S 9.815 E 13.158 | Angola |
| 17.10.2017 | Stromateus fiatola | 23 | | 2017-1073 | Nei | Muscel, 15 liver, 15 feces+ mix (1-5, 6-10, 11-15) | 26 | 2017408 | 35 | S 10.655 E 13.447 | Angola |
| 18.10.2017 | Pseudotolithus senegalensis | 25 | | 2017-1339 | Nei | Muscel, 15 liver, 15 feces + mix (1-5, 6-10, 11-15) | 28 | 2017408 | 39 | S 10.86 E 13.76 | Angola |
| 21.10.2017 | Stromateus fiatola | 25 | | 2017-1341 | Yes | Muscel, 15 liver, 15 feces + mix (1-5, 6-10, 11-15) | 53 | 2017408 | 49 | S 12.44 E 13.42 | Angola |
| 21.10.2017 | Auxis thazard | 5 | | 2017-1340 | Nei | Muscel, 5 liver, 5 feces + mix (1-5) | 6 | 2017408 | 51 | S 12.68 E 13.090 | Angola |
| 24.10.2017 | Sardinella maderensis | 25 | | 2017-1342 | Nei | Muscel, 15 liver, 15 feces + mix (1-5, 6-10, 11-15) | 28 | 2017408 | 57 | S 14.22 E 12.26 | Angola |
| 25.10.2017 | Auxis thazard | 10 | | 2017-1343 | Nei | Muscel, 10 liver, 10 feces + mix (1-5, 6-10) | 12 | 2017408 | 60 | S 14.62 E 12.267 | Angola |

## Jellyfish sampling

Jellyfish were caught in six out of 72 trawls in Angola (Table 8). Five different species of jellyfish were caught, of which *Chysaora* spp. was the most frequently caught genera (Table 8). The predefined species of interest, *Rhizastoma spp*., *Chrysaora Africana*, and *Chrysaora fulgida* were caught in four of the trawls. *Chirodropus gorilla* was the only other species caught.

Table 8. Jellyfish species trawled at various stations between Luanda, Angola and the Namibian Border.

| **Station** | **Species** |
|---|---|
| PT 26 | *Rhizostoma spp.* |
| | *Chrysaora spp.* |
| BT 32 | *Rhizostoma spp.* |
| BT 61 | *Chrysaora africana* |
| PT 68 | *Chirodropus gorilla* |
| PT 70 | *Chirodropus gorilla* |
| BT 72 | *Chrysaora africana* |
| | *Chrysaora fulgida* |

# RESULTS - PELAGIC FISH BIOLOGY

## Biology of target species

With the expanding scope of the research to be carried out in the context of the EAF-Nansen Programme, the survey objectives and related sampling strategy have been expanded to supporter research on life cycles, stock identity, and trophic relationships of pelagic fish.

For this scope, special effort was carried out to collect biological parameters of eight target species: *Trachurus trecae, Trachurus capensis, Sardinella aurita, Sardinella maderensis, Sardinops sagax, Scomber japonicus, Engraulis encrasicolus,* and *Etrumeus whiteheadi*. The biological sampling included: length, weight, otoliths, fin clips, stomachs, livers and gonad maturity stages (Table 9). These biological parameters will be used for post-survey age and growth, stock structure, population biology and trophic interaction studies.

Table 9. Total number of individuals for each target species analyzed for biological parameters.

| Species | Length/Weight | Sex | Maturity | Stomach | Liver | Fin clips | Otoliths |
|---|---|---|---|---|---|---|---|
| *Trachurus trecae* | 2723 | 724 | 370 | 462 | 462 | 462 | 127 |
| *Trachurus capensis* | 272 | 60 | 2 | 60 | 60 | 60 | 10 |
| *Sardinella aurita* | 1842 | 757 | 337 | 440 | 440 | 440 | 91 |
| *Sardinella maderensis* | 1592 | 599 | 541 | 300 | 300 | 300 | 74 |
| *Sardinops sagax* | 21 | 21 | 3 | 21 | 21 | 21 | 12 |
| *Scomber colias* | 721 | 100 | 21 | 74 | 74 | 74 | 14 |
| *Engraulis encrasicolus* | 953 | 98 | | | | | |
| *Etrumeus whiteheadi* | 106 | | | | | | |
| *Selene dorsalis* | 269 | | | | | | |
| *Ilisha africana* | 365 | | | | | | |
| *Chloroscombrus chrysurus* | 505 | | | | | | |
| Total | 9369 | 2359 | 1274 | 1357 | 1357 | 1357 | 328 |

The analysis of the biological parameters in this section are based on the lengths, weights, maturities, and stomach fullness of five of the eight target species: *Trachurus trecae, Trachurus capensis, Sardinella aurita, Sardinella maderensis, Sardinops sagax and Scomber japonicus*. Very few biological samples were taken for *Engraulis encrasicolus* and *T. capensis* so these were not included in the analysis.

Each subsection below discusses the overall results for Angola as well as the characteristics of three areas of Angola: North (Congo River – Pta. Palmeirinhas), Central (Pta. Palmeirinhas – Benguela) and South (Benguela - Cunene River).

## Sex ratio and gonad development

*Sex-ratio*

From Congo River to Cunene River-Angola, a total of 2359 fish were analysed. From these, 45.1% were juvenile, 30.9% were female, and 24% were male (Figure 24). The majority of the individuals of the four target species were juveniles, except from in *S.maderensis* where the majority were females.

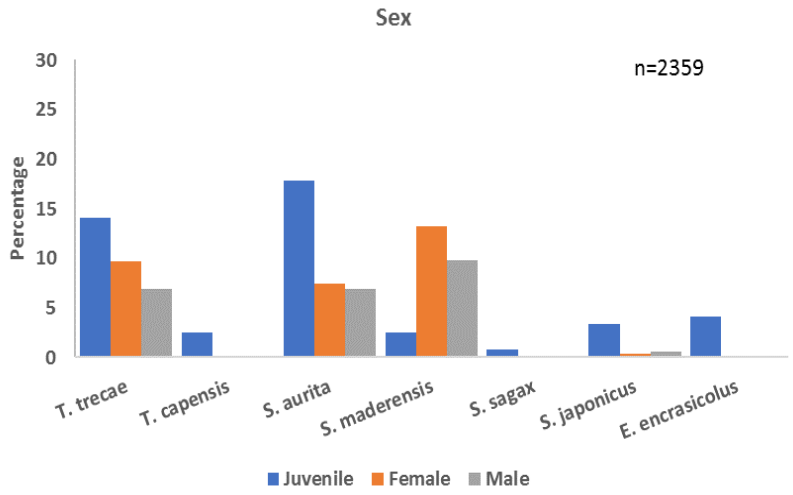


Figure 24. Sex distribution of selected species sampled off Angola.

Congo River – Pta. Palmeirinhas

The results of the analysis from Congo River – Pta. Palmeirinhas showed an occurrence of juveniles for all the species. *S. aurita* had the highest occurrence of juveniles (31.6%), whilst in the *E. encrasicolus* and *S. colias (japonicus)* sampled there were only juvenile fish. It should be noted that the number of samples for this species are not representative of the population (n = 128 individuals). For the remaining species, the sex-ratios showed similar percentages with a slight dominance of females, with the exception of *S. maderensis* which displayed a strong dominance of females (Figure 25).

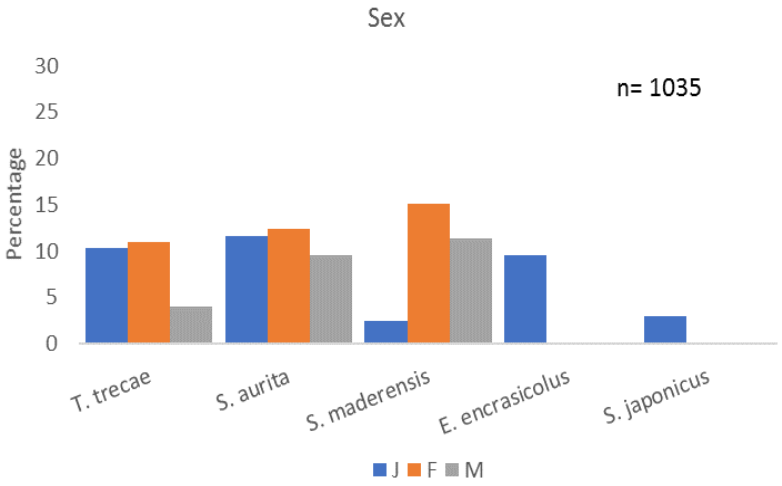


Figure 25. Sex distribution of selected species, northern Angola.

Pta. Palmeirinhas – Benguela

The results of the analysis from Pta. Palmeirinhas – Benguela showed a high occurrence of juveniles for all the species, with an exception of *S. maderensis*. All *E. encrasicolus* in the sample were juvenile. For the remaining species, the sex-ratios showed similar percentages with a slight dominance of males, with an exception of *S. maderensis* which displayed a slight dominance of females (Figure 26).

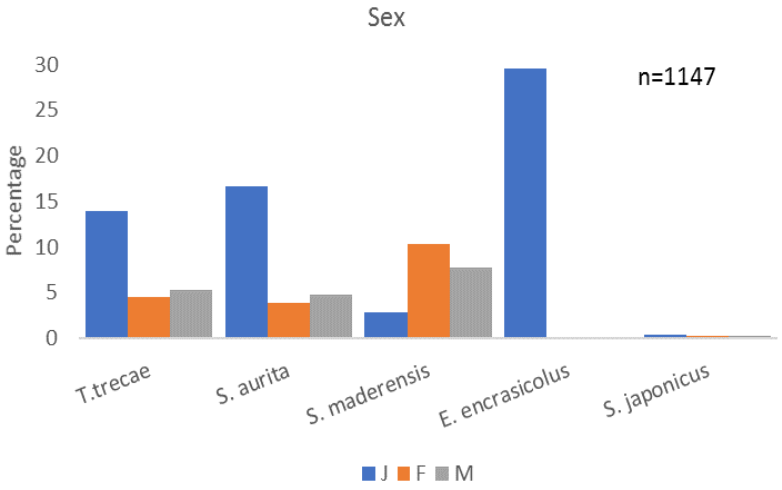


Figure 26. Sex distribution of selected species sampled in central Angola.

Benguela - Cunene River

Similar to the northern and central regions of Angola, the results of the analysis from Benguela - Cunene River showed a high occurrence of juveniles for all the species. *S. maderensis* had no

juveniles in this region. *E. whiteheadi* and *E. encrasicolus* were comprised of juveniles only. No males were encountered in *T. capensis* and *S. sagax* (Figure 27).

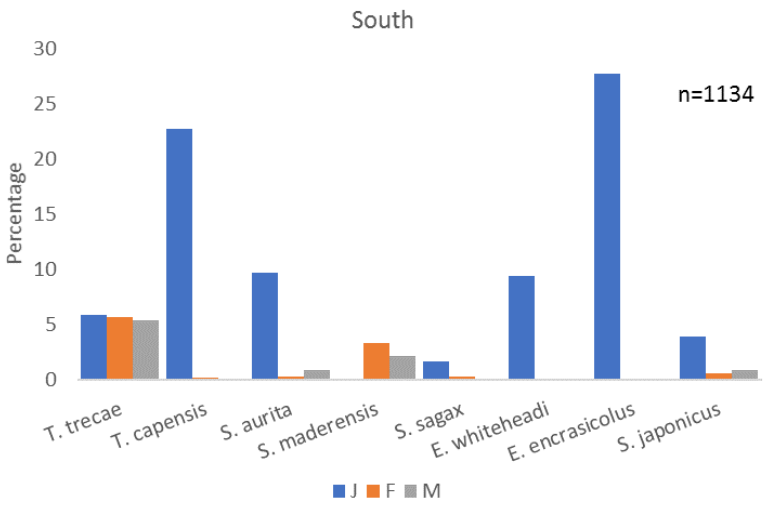


Figure 27. Sex distribution of selected species sampled in south Angola.

*Gonad development*

Mature individuals comprised 27% of the sampled catch, and they were mainly in stage 2 (maturing virgins or recovering spent). The remaining 73% percent of the sampled catch were immature individuals that included mainly juvenile fish. *S. maderensis*, *S. aurita* and *T.trecae* displayed a high number of immature and ripening individuals. *S. sagax* and *T. capensis* had no occurrence of juvenile individuals whilst *S. colias* only had immature individuals and none in the ripening stage. The sampling of these three species was however very limited.

*Trachurus trecae*

Between Congo River – Pta. Palmeirinhas the analysis showed a high percentage of maturing individuals with 31,7%, at lengths ranging from 15-23 cm. The percentage of mature individuals (stages 3, 4 and 5) were 9,6%, 18,3% and 30,8 %, respectively. Stages 4 and 5 were comprised of individuals whith lengths between 22 and 28 cm, while stage 3 individuals ranged from 19-25 cm. In the central region, a high percentage of maturing individuals was observed (74.5%, at lengths ranging from 14-30 cm). The percentage of mature individuals (stages 3 and 4) were 5,9% and 11,8% respectively. Stages 3 and 4 comprised of individuals with lengths between 24-30 cm. In the central region, no individuals were found to be in stage 5. In the southern region of Angola showed a high percentage of ripe individuals (32,8%, with lengths between 16-33 cm). The percentage of maturing individuals in stage 2 were 31,3%. Only 3,1% of individuals were found to be in stage 5, and these had lengths of 20-21 cm.

*Sardinella aurita*

From Congo River to Pta. Palmeirinhas a high percentage of maturing individuals was observed (57%, with lengths ranging from 15-29 cm). The percentage of mature individuals (stages 3, 4 and 5) was 9,4%, 0,8% and 32 %, respectively. Further south, between Pta. Palmeirinhas- Benguela, a high percentage of maturing individuals were recorded (61.4% with lengths ranging from 19-21cm). In this region, there were no ripe individuals. In the southern part of Angola, only one female fish was analysed. It had a length of 17 cm and was in stage 4 ripeness.

*Sardinella maderensis*

The results of the analysis from Congo River – Pta. Palmeirinhas showed a high percentage of maturing females, stage 2 (19.9 %), with lengths ranging from 17-27cm. The percentage of mature individuals (stages 3, 4 and 5) were 14.7%, 42.9% and 21.2%, respectively. Further south in the central region a high percentage of maturing individuals were recorded (42.3%, with lengths ranging between 16-29 cm). The percentage of mature individuals (stages 3 and 4) was 9.3% and 22.9%, respectively. Stages 3 and 4 were comprised of individuals of 20-32 cm lengths. There were only 15.2% individuals in stage 5. Results of the analysis from the southern region of Angola showed a high percentage of ripening and ripe individuals with 59,5% and 24.3%, respectively with lengths ranging from 26-31cm. The percentage of maturing individuals in stage 2 were 13.5%.

*Stomach fullness*

The stomach analysis of the target species reveal that most of the individuals had empty or very little stomach content. *T. trecae* showed the highest incidence of empty stomachs and *S. aurita* showed the highest incidence of very little stomach content (Figure 28).

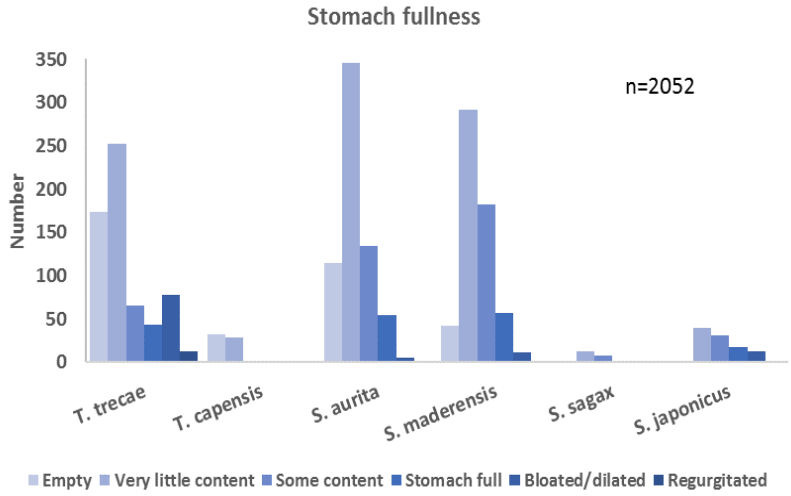


Figure 28. Stomach fullness of selected species off Angola.

# RESULTS - DISTRIBUTION SIZE COMPOSITION AND BIOMASS ESTIMATES

## Congo River - Pta. Palmerinhas

### 1.1.9 Sardinella

Sardinella was distributed in three areas between Congo River and Pta. Palmerinhas. (Figure 29). The northernmost area was located between Pta. da Moita Seca and south of Cabeça da Cobra. The fish were distributed from the inshore limit of the survey area near the coast to about 100 m depth. The second distribution patch was found near N'Zeto while the third area of distribution extended from north of Ambriz to north of Luanda. In this area, the fish was found slightly more inshore than in the northernmost area, and the fish were mainly distributed inside of the 50 m bottom depth. The highest densities in the northern region were observed in two small areas near Cabeça da Cobra, N'Zeto and north of Luanda. In these areas densities ranged between $1001<s_A<10\ 000\ m^2/NM^2$.

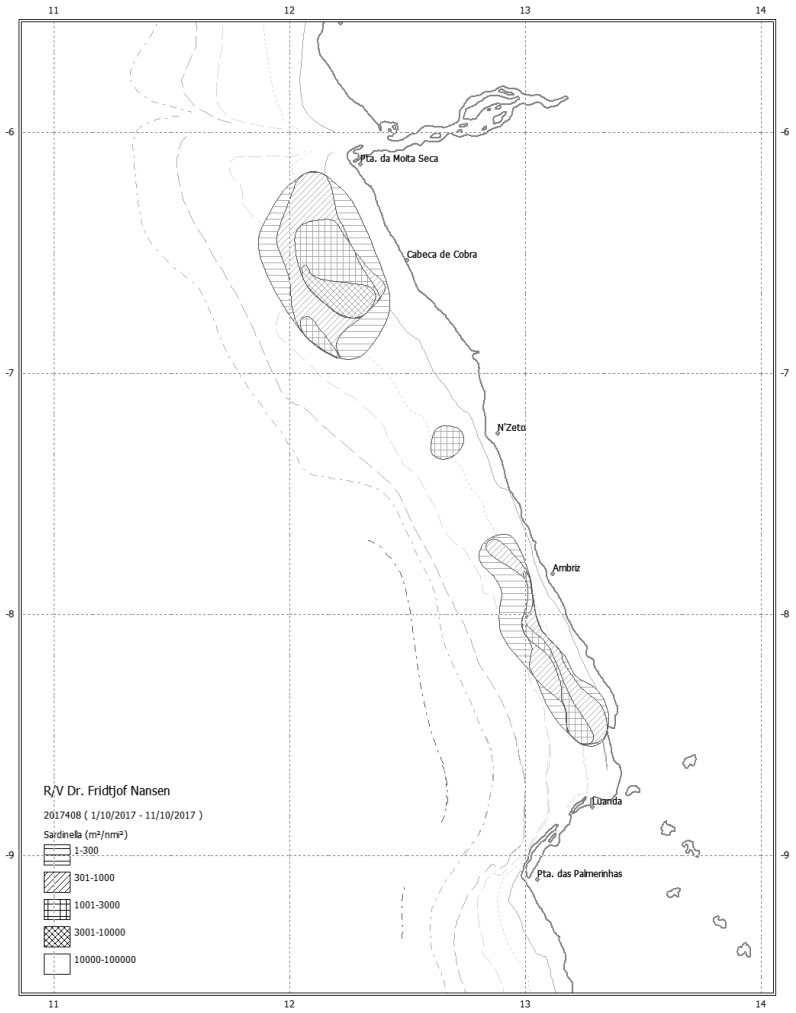


Figure 29. Distribution of *Sardinella maderensis* and *Sardinella aurita*. Congo River-Pta. das Palmerinhas. Depth contours at 20, 50, 100, 200, and 500m.

Figure 30 shows the length distribution of both sardinella species in the northern region. *S. maderensis* showed one modal peak around 27 cm total length (TL), mostly between 22 and 30 cm TL. *S. aurita* showed three modal peaks, around 14, 18 and 29 cm TL. About half (59%) of the total biomass contained fish from 9-22 cm TL.

The estimated biomass for this region was 392 931 tonnes, *Sardinella maderensis* was 309 286 tonnes and *Sarinella aurita* was 83 645 tonnes. The total biomass was higher than what recorded in 2015 (131 419 tonnes). However, the abundance of *S. maderensis* has decreased, whilst the biomass of *S. aurita* increased compared to the 2015 values. This year, *S. maderensis* represented about 79% and *S. aurita* 21% of the biomass in the northern area.

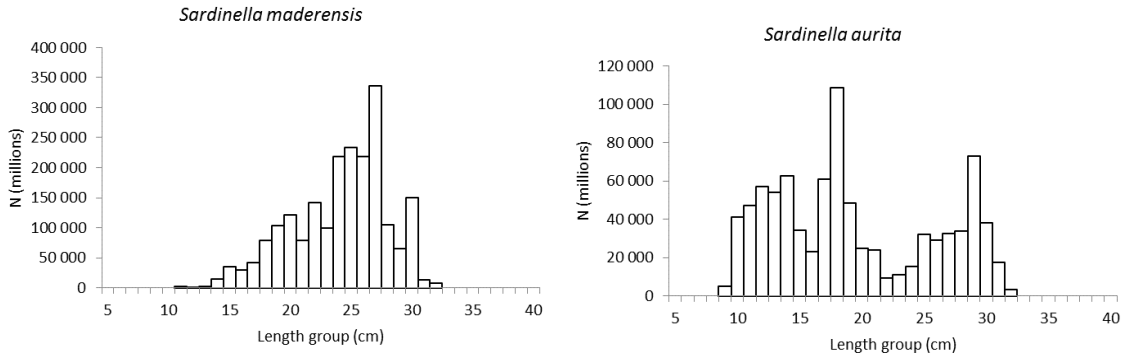


Figure 30. Total length distribution of *Sardinella maderensis* and *Sardinella aurita*, Congo River-Pta. das Palmerinhas.

### 1.1.10 Horse mackerel

Cunene horse mackerel, *T. trecae*, was recorded in two areas; south of Cabeça da Cobra and in a continuos area along the coast from N'Zeto to Luanda (Figure 31). Low densities were recorded in most of this area ($0<s_A<300$ $m^2/NM^2$), with some medium densities in small areas ($301<s_A<1000$ $m^2/NM^2$). During this survey, most fish were captured between 30-100 m depth. The horse mackerel was generally caught with bottom trawl during the day and pelagic trawl during the night, and mixed with unusually large individuals of *Trichiurus lepturus*.

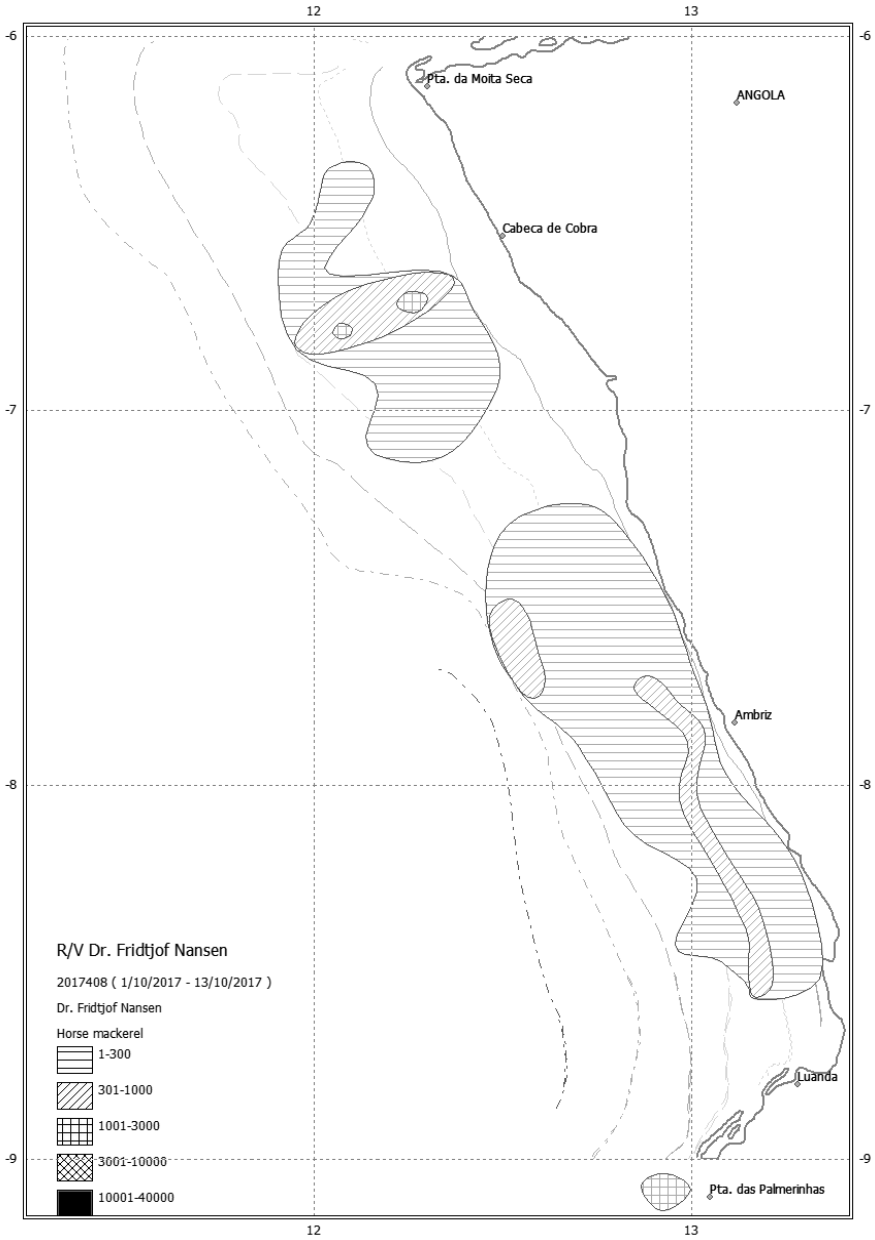


Figure 31. Distribution of Cunene horse mackerel (*Trachurus trecae*), Congo River-Pta. das Palmerinhas. Depth contours at 20, 50, 100, 200, and 500 m.

The length frequency of Cunene horse mackerel showed two modal peaks, around 9 and 23 cm TL (Figure 32).

The biomass of Cunene horse mackerel was estimated to 156 043 tonnes, corresponding to approximately 3.4 million fish. 19% of the biomass belonged to juvenile fish of 5 - 20 cm length, while adult fish between 21 - 50 cm contributed to 81% of the biomass. The observed biomass in the northern area was much higher during this survay compared to the last thirteen years.

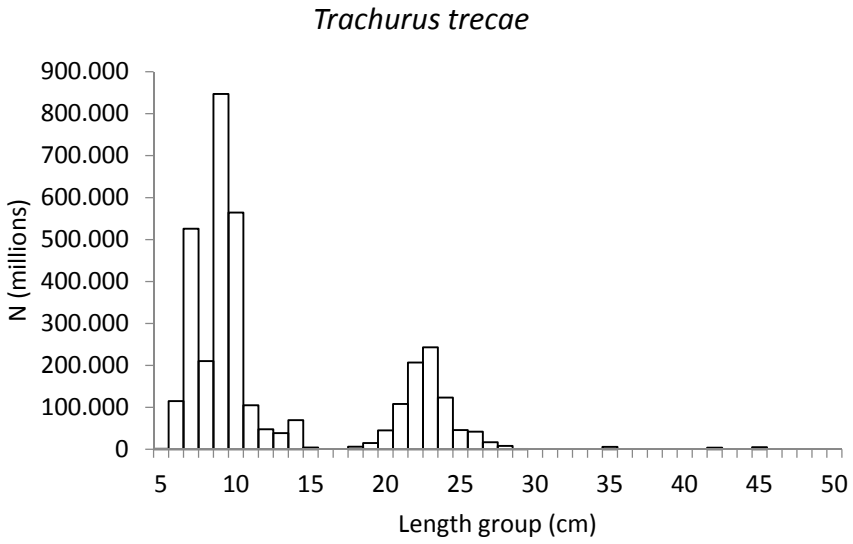


Figure 32. Total length frequency distribution of Cunene horse mackerel, Congo River - Pta. das Palmerinhas.

Of the 897 biological samples of *Trachurus trecae* from the north area, 36% of the fish were found to be mature, 64% were immature. Most of the fish were found in stage I and II for both stages. Most of the fish in stages III, IV and V were females. The length at 50% maturity of *Trachurus trecae* from this region was 18 cm (Figure 33).

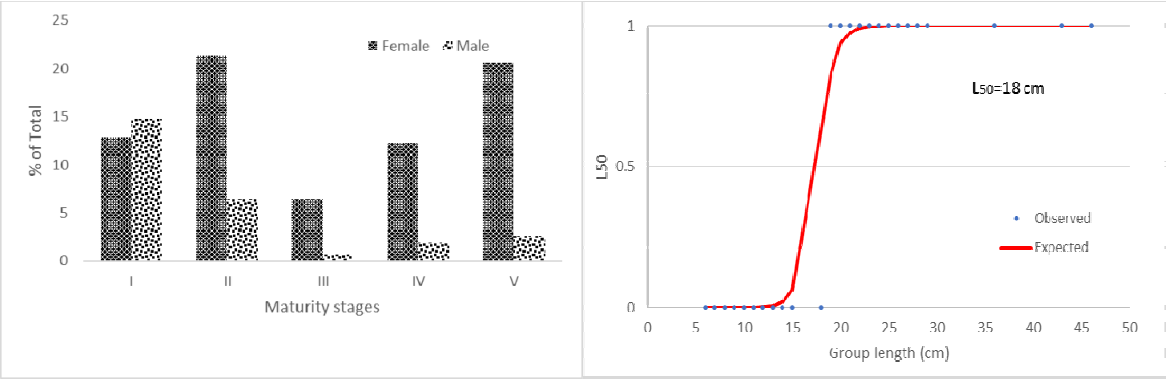


Figure 33. Maturity stages by sex (left) and first length at maturity of *Trachurus trecae* in the Northern region (right).

### 1.1.11 Pelagic species Group 1

During the survey, two species, *Ilisha africana* and *Eugraulis encrasicolus* belonging to the Pel1 acoustic group was found in the northern region. However, only biomass of *Ilisha africana* was calculated because the other species was only caught in small densities at two stations. The pelagic species group 1 were distributed in two areas, near to Pta. da Moita Seca in low densities ($0<s_A<300$ $m^2/NM^2$) and medium densities ($301<s_A<1000$ $m^2/NM^2$), and north to Luanda in a small area with low densities (Figure 34).

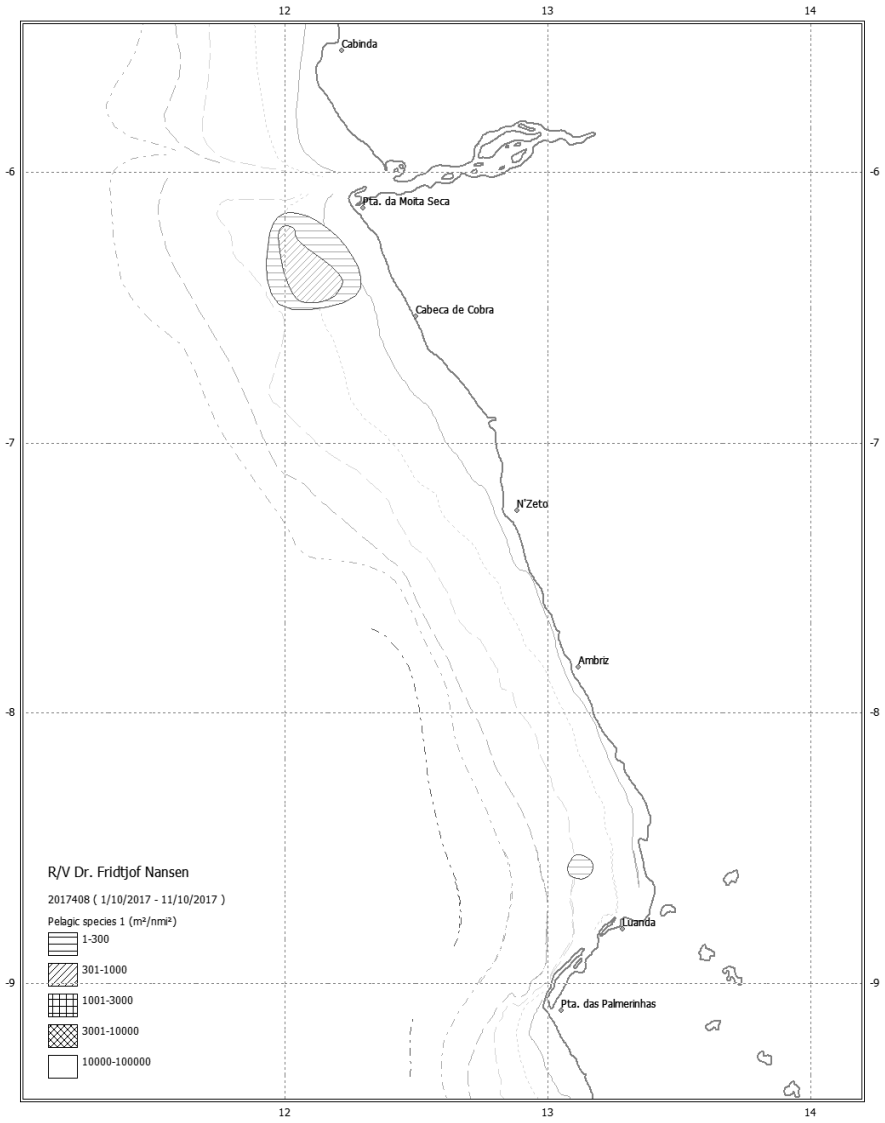


Figure 34. Distribution of Pelagic 1, Congo River-Pta. das Palmerinhas. Depth contours at 20, 50, 100, 200 and 500m.

Figure 35 shows the length distribution of the *Ilisha africana* found in the northern region, displaying one modal peak around 20 cm TL. Most of the abundance contained fish from 12-24 cm length. The biomass of *Ilisha africana* was estimated to 16 867 tonnes.

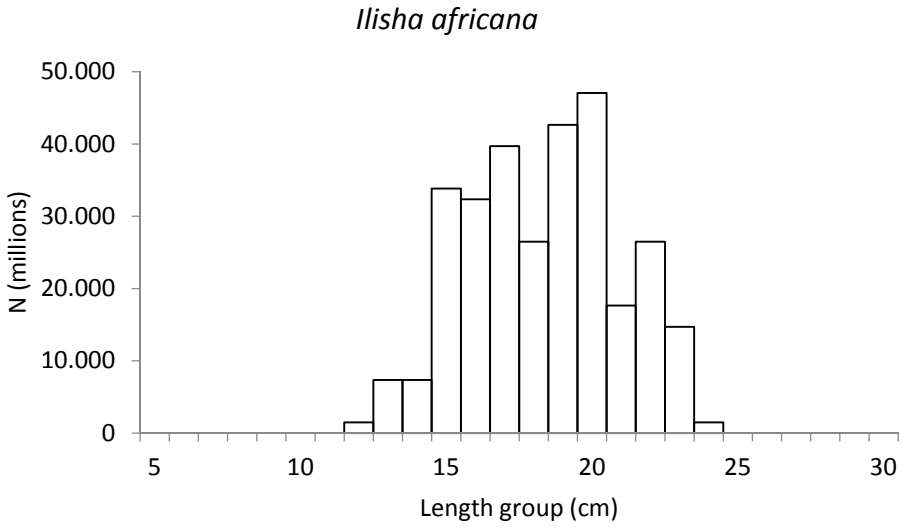


Figure 35. Total length frequency distribution of *Ilisha africana*, Congo River - Pta. das Palmerinhas.

### 1.1.12 Pelagic species Group 2

The dominant species observed in this category was *Trichiurus lepturus*. The Carangidae, *Chloroscombrus chrysurus* and *Selene dorsalis* were also found at many of the trawl stations. Near Cabeça da Cobra this group was found in two small areas, with medium ($301<S_A<1\ 000\ m^2/NM^2$) to high densities ($1\ 001<S_A<3\ 000\ m^2/NM^2$) (Figure 36). The size of the distribution area was quite large compared to 2015.

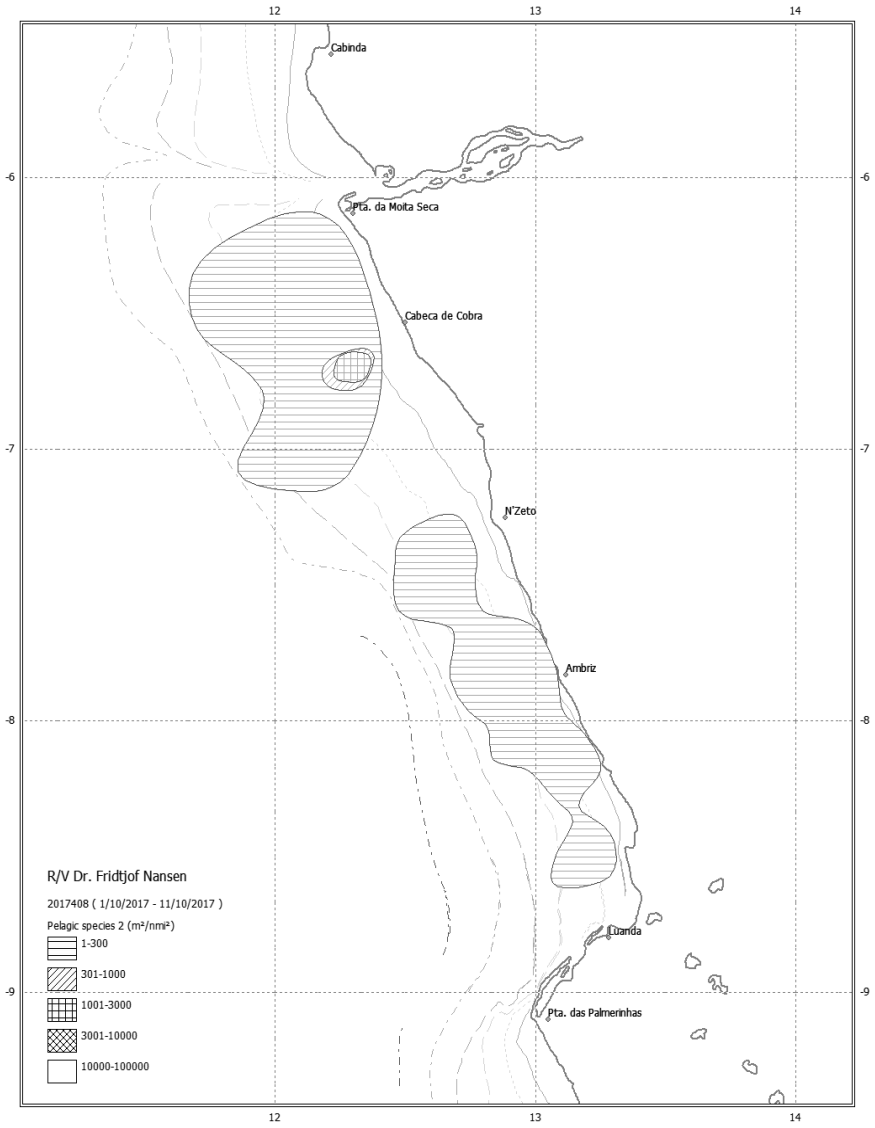


Figure 36. Distribution of Pelagic 2, Congo River-Pta. das Palmerinhas. Depth contours at 20, 50, 100, 200 and 500m.

The biomass calculation was based on an assumed average fish size of 30 cm and average condition factor of 1.0, and was estimated to be 126 228 tonnes, in line with what estimated in earlier surveys.

Table 10 shows the summary of the estimated abundance of main commercial species or species groups in the northern region.

Table 10. Estimated biomass of pelagic fish (tonnes), Congo River – Pta. das Palmerinhas.

| ***Sardinella maderensis*** | ***Sardinella aurita*** | ***Trachurus trecae*** | **Pelagic 1** | **Pelagic 2** |
|---|---|---|---|---|
| 309 286 | 83 645 | 156 043 | 16 867 | 126 228 |

## Pta. das Palmerinhas - Benguela

### 1.1.13 Sardinella

In the central area Sardinella was distributed continuously along the coast. Over most of the area, low ($1<s_A<300$ $m^2/NM^2$), medium ($301<s_A<1\,000$ $m^2/NM^2$) and several small areas with high ($1\,001<s_A<3\,000$ $m^2/NM^2$) densities of Sardinella were observed. Additionally, from south of Ponta do Morro to Cabeça da Baleia, very high ($3\,001<s_A<10\,000$ $m^2/NM^2$) densities of sardinella were observed (Figure 37). Mostly large individuals (>21 cm length) of both species were caught in the trawls. *S. aurita* was only occationally caught, and then in small numbers.

Sardinella was observed in the upper layer of the water column, schooling near the surface during the daytime. However, it proved difficult to sample sardinella schools during the day due to trawl avoidance. This was to some extent limiting the ability to observe size composition, especially in the areas with the shortest transects.

The length distribution of *S. maderensis* showed one modal peak at 23 cm total length, while *S. aurita* showed two peaks around 10 cm and 25 cm total length (Figure 38). Juvenile *S. aurita* was caught mostly inshore in the central region, in a few stations with low number of fish.

The total biomass for both species of sardinella was estimated to 327 056 tonnes. Of these, 134 981 tonnes was allocated to *S. aurita* and 192 075 tonnes to *S. maderensis*. Compared to 2015 (428 873 tonnes) a 24% a decrease of the total biomass estimated in this region was observed. About 59% of the total sardinella biomass was allocated to *S. maderensis.*

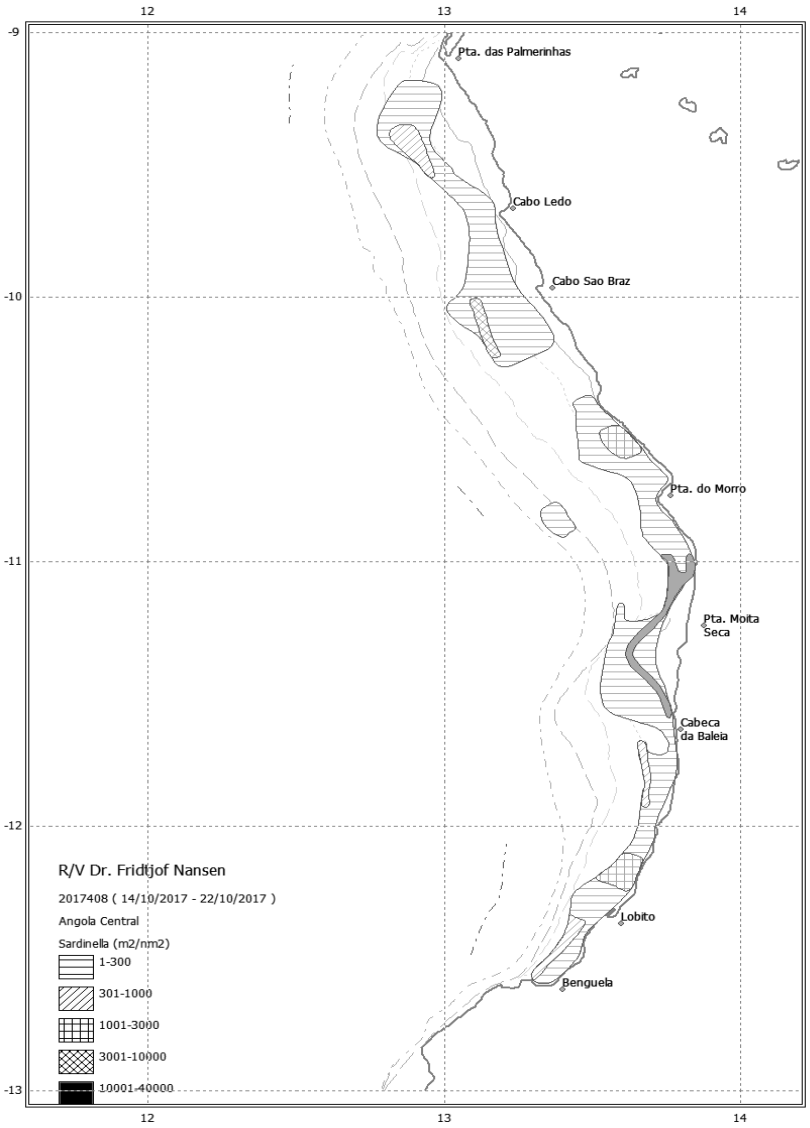


Figure 37. Distribution of *Sardinella aurita and S. maderensis.* Pta. das Palmerinhas- Benguela. Depth contours at 20, 50, 100 and 200 m.

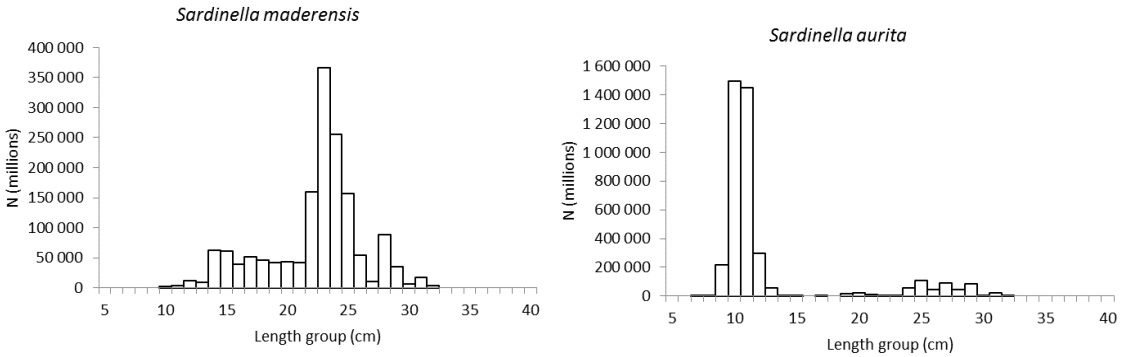


Figure 38. Total length distribution of S. *maderensis* and *S. aurita*. Pta. das Palmerinhas - Benguela.

### 1.1.14 Horse mackerel

In the central region (Figure 39) Cunene horse mackerel (*Trachurus trecae*) were found in patches distributed with low density ($0<s_A<300$ $m^2/NM^2$) off Cabo Ledo offshore, from Cabo São Braz (offshore) to Ponta do Morro (inshore), around Cabeça da Baleia, from north of Lobito to south of Benguela, and south of Baia Farta. Higher density was observed in a small area inshore of Ponta das Palmeirinhas ($1\ 001<s_A<3\ 000$ $m^2/NM^2$).

The biomass of Cunene horse mackerel in this region was estimated at 16 446 tonnes. This is a very low estimate compared to 2015 (149 131 tonnes).

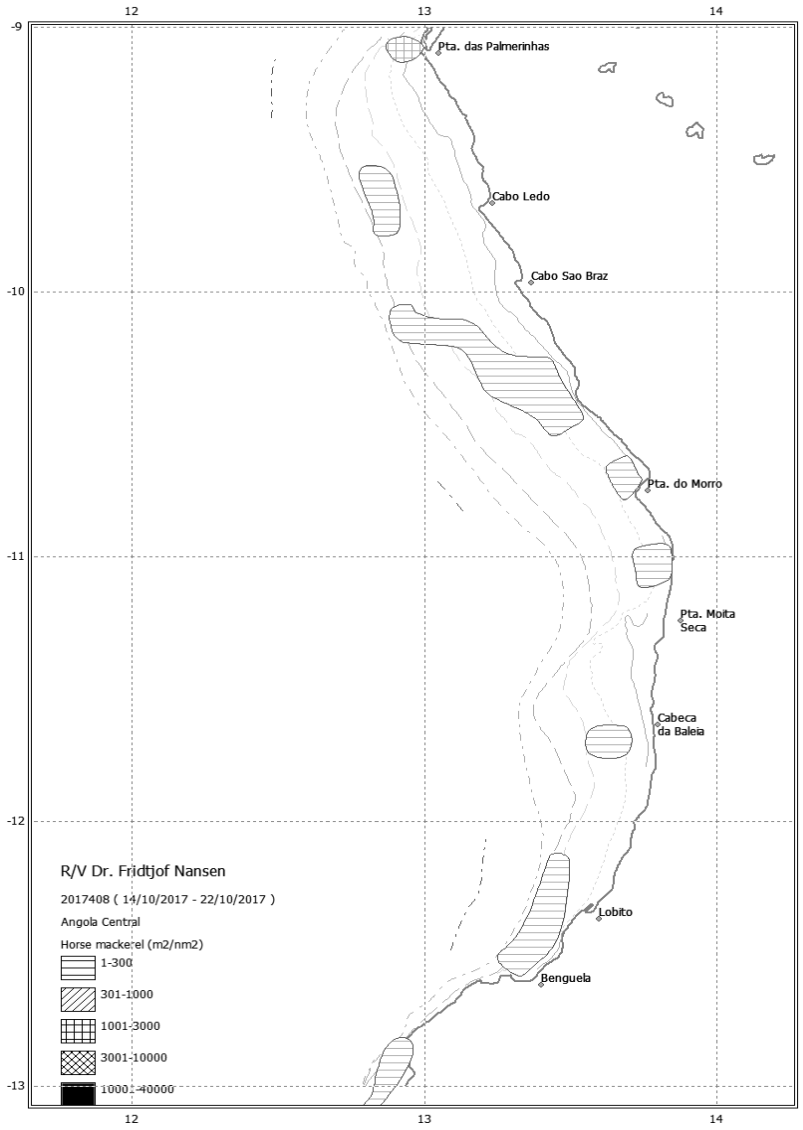


Figure 39. Distribution of horse mackerel (*Trachurus trecae*). Pta. das Palmerinhas- Benguela. Depth contours at 20, 50, 100, 200 and 500 m.

The length frequency distribution is shown in Figure 40. The length frequency ranged between 5 and 33 cm with two well-defined peaks at 9 cm and 28 cm. 79% of the biomass

estimated comprised of fish > 20 cm length, whilst juvenile fish represented about 21% of the total biomass estimated in the central region.

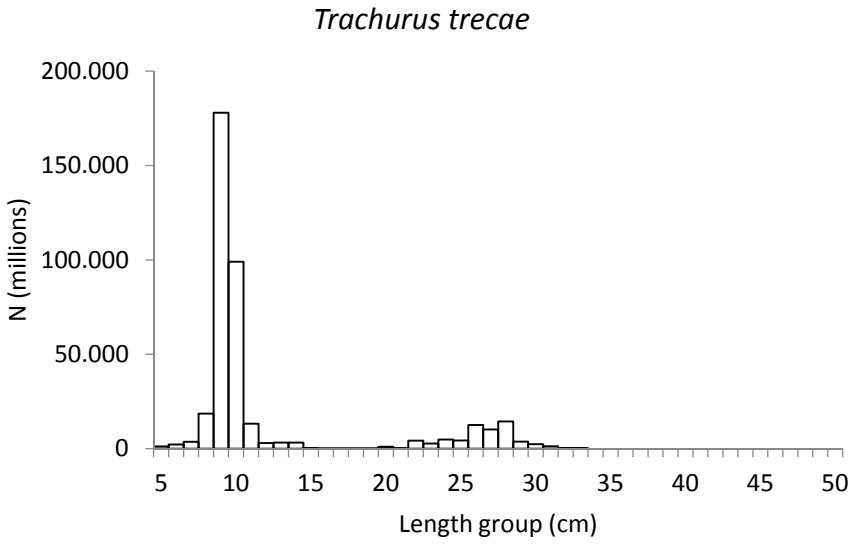


Figure 40. Total length distribution of horse mackerel (*Trachurus trecae*), Pta. das Palmerinhas-Benguela.

In the central region, biological sampling was conducted on a total of 1 171 fishes. From these, 91% were immature. Most of the fish were found in stage II, both for females and males. Stage V was not found in this region (Figure 41). The length at 50% maturity was 20 cm.

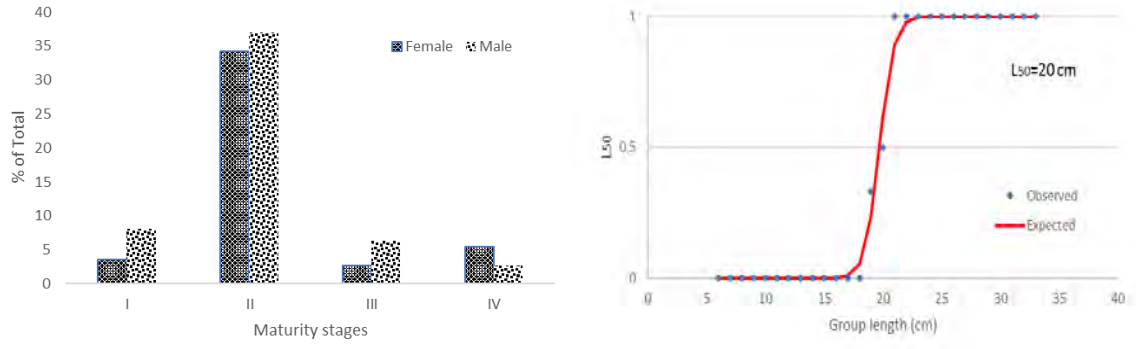


Figure 41. Maturity stages by sex and first length at maturity for *Trachurus trecae* in the Central region.

### 1.1.15 Pelagic species Group 1

Pelagic species Group 1 was found in patches distributed with low densities ($0<s_A<300$ m$^2$/NM$^2$) south of Cabo São Braz and near Cabeça da Baleia (Figure 42). *Ilisha africana* and *Engraulis encrasicolus* were found in the region during the survey. In 2015 this

group of fish were not recorded neither acustically nor in any catches in the central region. The biomass estimated in 2017 was 4 369 tonnes.

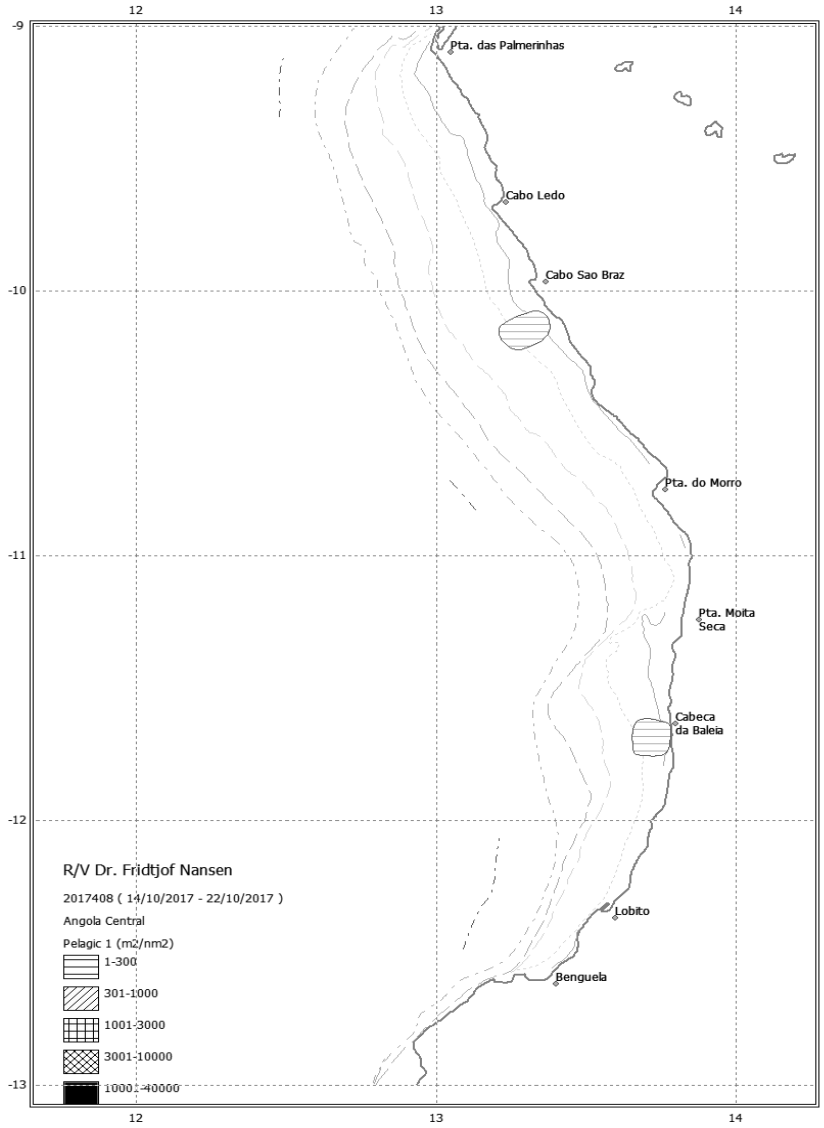


Figure 42. Distribution of Pelagic 1, Pta. das Palmerinhas-Benguela. Depth contours at 20, 50, 100, 200 and 500m.

The length frequency distribution is shown in Figure 43. *I. africana* ranged between 12 and 25 cm with one peak at 19 cm, and *E. encrasicolus* ranged between 6 and 13 cm total length with one well-defined peak at 10 cm.

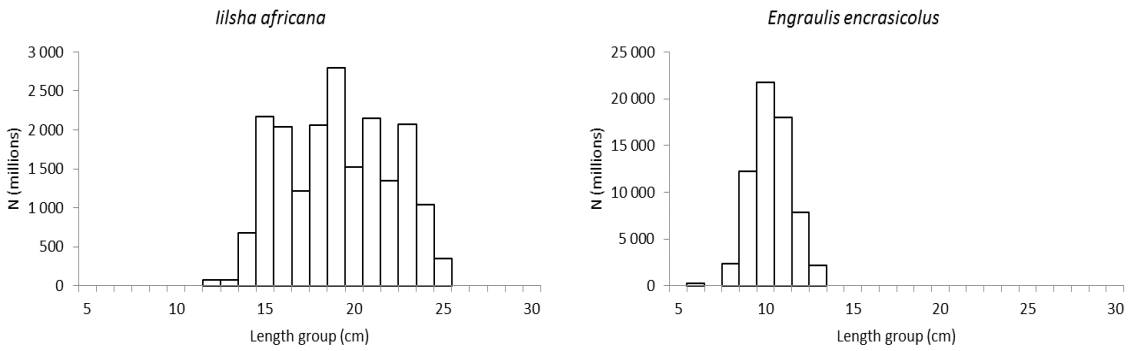


Figure 43. Total length frequency distribution of Pelagic Species Group 1, Pta. das Palmerinhas-Benguela.

### 1.1.16 Pelagic species Group 2

This group was found in low densities ($0<s_A<300$ $m^2/NM^2$) along the entire coast (Figure 44). The most common species caught in the trawl from this group were the Carangids *Selene dorsalis, Caranx rhoncus,* and *Trachinotus ovatus*. Other species observed were *Chloroscombrus chrysurus, Scomber japonicus, Sphyraena sp* and *Trichiurus lepturus*.

The biomass estimated was 92 046 tonnes, based on an average length of 30 cm. This biomass in this region was 5.1 times higher compared to 2015 (18 100 tonnes).

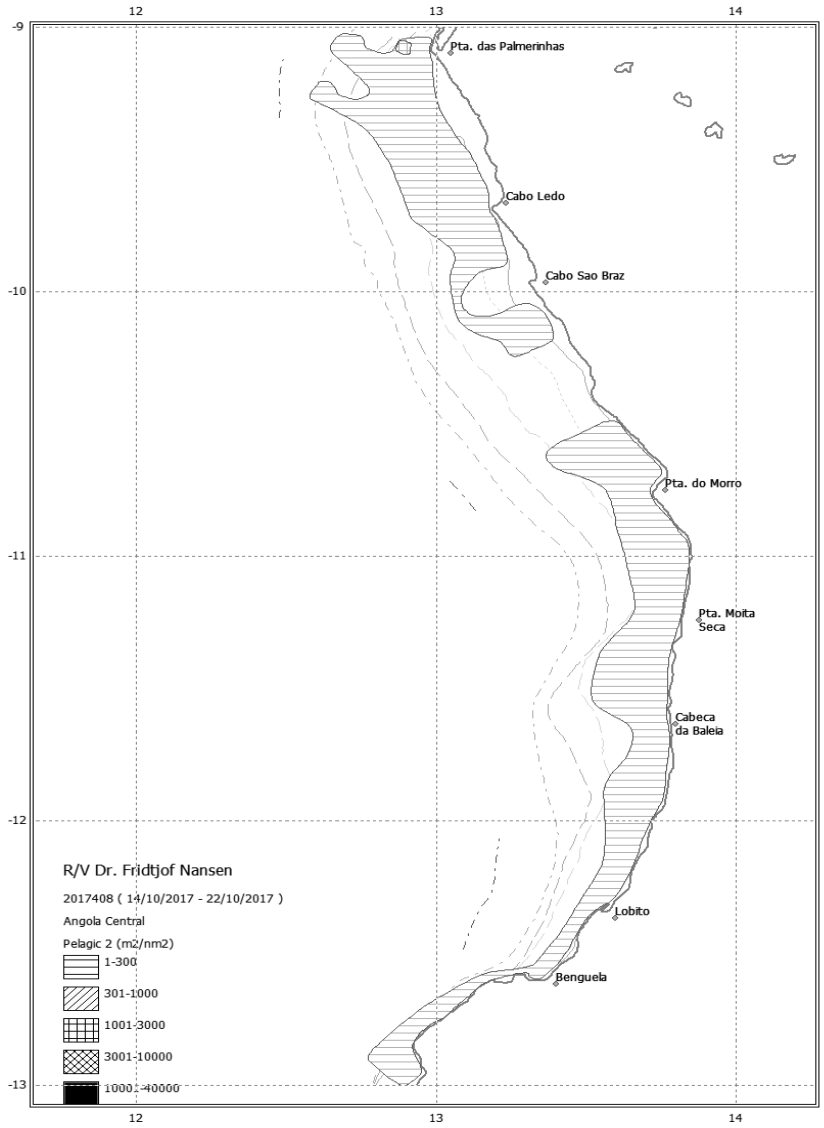


Figure 44. Distribution of pelagic species, group 2. Pta. das Palmerinhas- Benguela. Depth contours at 20, 50, 100, 200 and 500 m.

Table11 shows the summary of the abundance estimated of main commercial species in central region.

Table 11. Estimated abundance of pelagic fish (tonnes), Pta. das Palmeirinhas-Benguela.

| ***Sardinella maderensis*** | ***Sardinella aurita*** | ***Trachurus trecae*** | **Pelagic 1** | **Pelagic 2** |
|---|---|---|---|---|
| 192 075 | 134 981 | 16 446 | 4 369 | 92 46 |

## Benguela – Cunene

### 1.1.17 Sardinella

Both species of Sardinella (*S. aurita* and *S. maderensis*) were found in the southern region of Angola. The fish was generally patchily distributed. Low densities ($0<s_A<300$ $m^2/NM^2$) were observed between Ponta Albina to the Cunene River, while two areas with medium densities ($301<s_A<1\,000$ $m^2/NM^2$) was recorded inshore, near Cabo Santa Marta and between Namibe and Tômbwa. High densities ($1\,001<s_A<3\,000$ $m^2/NM^2$) of sardinella were found in several small areas near Cabo Santa Marta and between Baía dos Tigres to the Cunene River (Figure 45). The last recordings of *S. maderensis* were observed in Ponta Albina in small numbers while *S. aurita* extended the distribution slightly south of the border with Namibia.

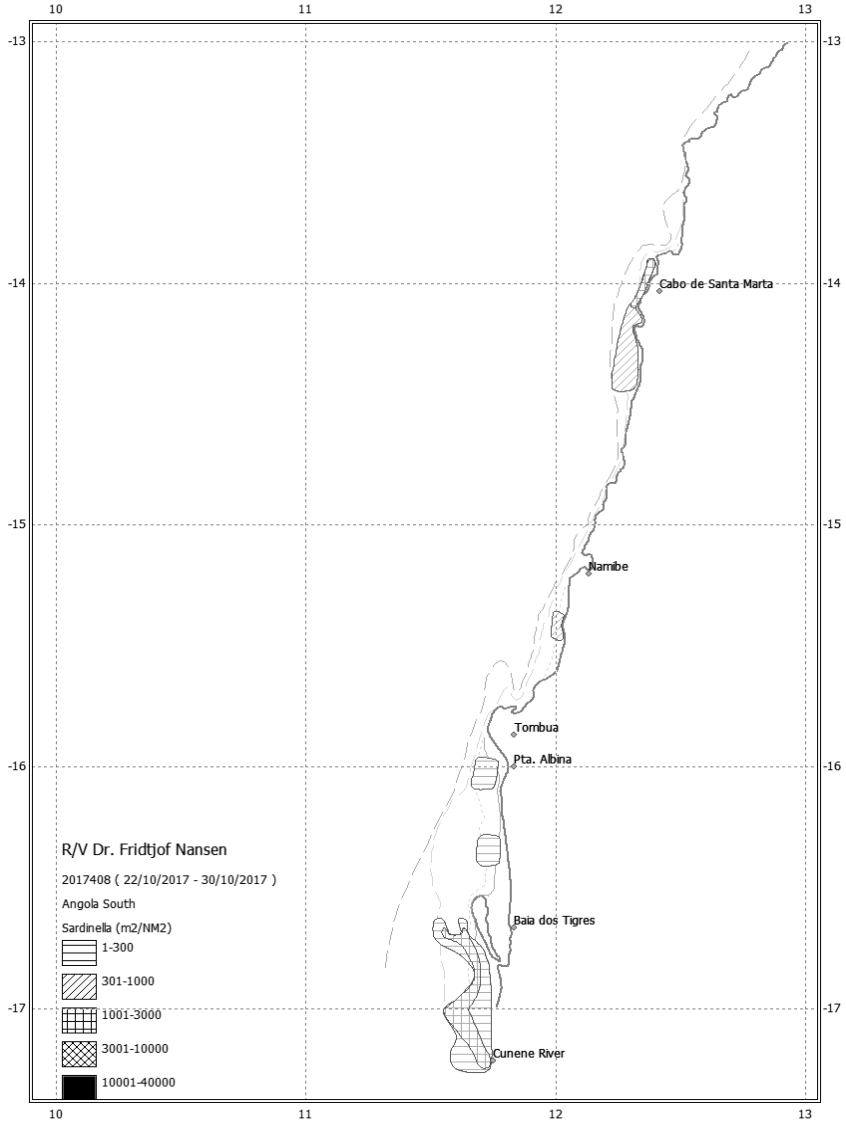


Figure 45. Distribution of *Sardinella* spp. Benguela-Cunene river. Depth contours at 20, 50, 100 and 200 m.

Figure 46 shows the length distribution of sardinellas in the southern region. *S. maderensis* showed one modal peak around 29 cm TL. Most fish were from 24 to 32 cm TL. *S. aurita* showed one modal peak, around 11 cm TL, and 99% of the total biomass estimated for this species in this region was composed of juvenile fish from 8 to 14 cm TL.

The estimated biomass for this region was 60 123 tonnes, of which 24 633 tonnes were *S. maderensis* and 35 490 tonnes *S. aurita*, or about 41% and 59% respectively. In the 2015 August and September survey sardinella was not recorded in this region.

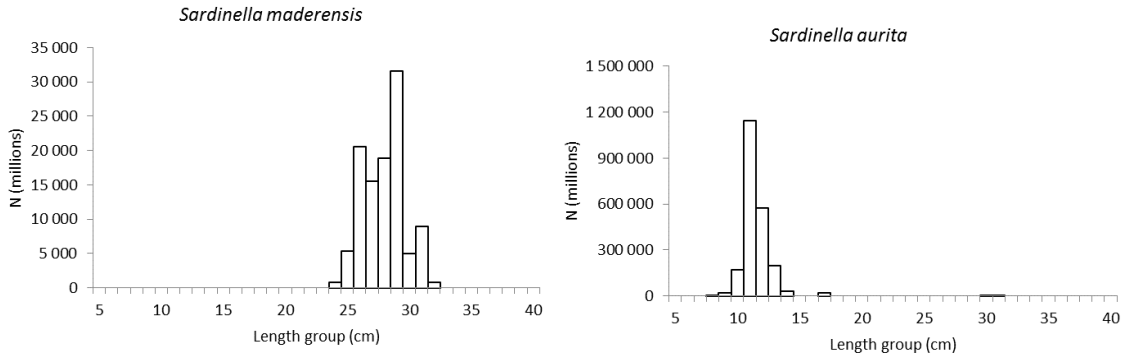


Figure 46. Total length distribution of *Sardinella maderensis* and *S. aurita*. Benguela- Cunene river.

### 1.1.18 Horse mackerel

The southern region was as usual dominated by *T. trecae*, with the northernmost recordings of *T. capensis* found at 16°37'S in trawl no. 69. *T. trecae* were recorded continuously in a low-density area ($0< s_A <300$ m$^2$/NM$^2$) from north of Namibe to the Cunene river (Figure 47). *T. trecae* were also found in a small area of medium density ($301<s_A<1\,000$ m$^2$/NM$^2$) offshore south of Namibe, while both species were found mixed between Baía dos Tigres and Cunene River in the low-density distribution area ($0<s_A<300$ m$^2$/NM$^2$), at medium densities ($301<s_A<1\,000$ m$^2$/NM$^2$) and high densities ($1\,001< s_A<3\,000$ m$^2$/NM$^2$).

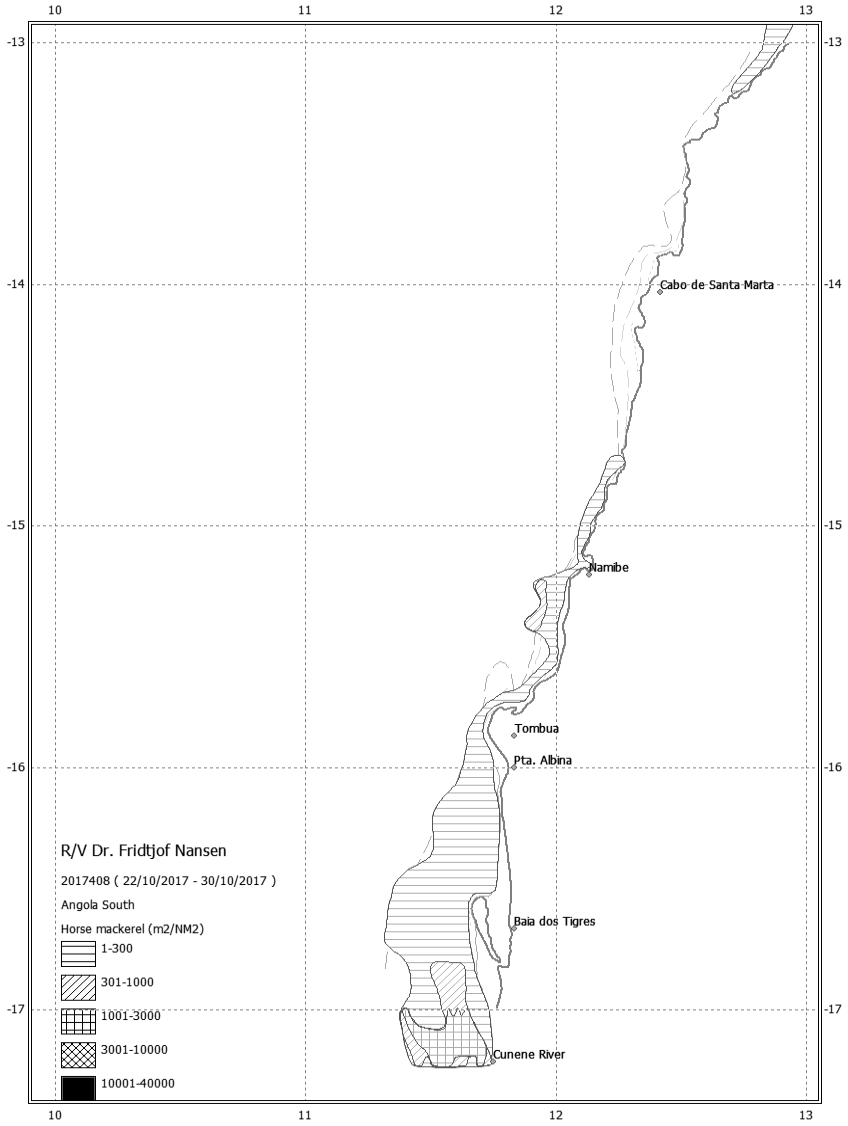


Figure 47. Distribution of *Trachurus trecae* and *T. capensis*. Benguela–Cunene. Depth contours at 20, 50, 100 and 200 m.

Figure 48 shows the length frequency distributions of the Cunene and Cape horse mackerels, respectively. Cunene horse mackerel showed a dominating modal peak around 8 cm and indications of a second peak at 20 cm TL. Cape horse mackerel also showed two modes, a dominating peak at around 12 and indications of a second peak at 19 cm TL.

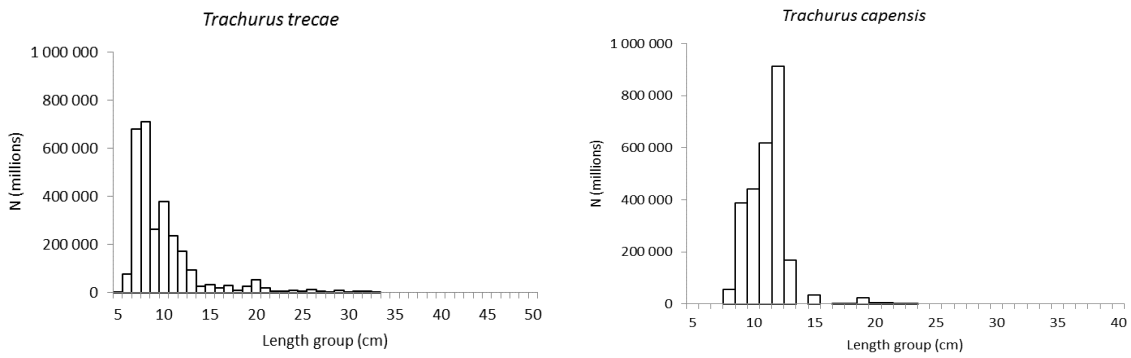


Figure 48. Total length distributions of *Trachurus trecae* (left) and *T. capensis* (right) Benguela-Cunene.

The biomass estimated for both the horse mackerel species in the region was 99 400 tonnes, which is 109 556 tonnes less than 2015 and thus a considerable reduction. Of this, 57 % was Cunene horse mackerel while 43% was Cape horse mackerel. Juveniles fish dominated the estimate in numbers for both species in this region. 72 % of the Cunene horse mackerel biomass was fish <20cm TL while 99 % of the biomass of cape horse mackerel was <20% TL.

Of the 191 biological samples from the southern area, 33.5 % were female, 32 % were male, and 34.5 % were indetermined. 33.5 % of the fish were found to be mature, and 66.5 % were immature. The same proportion (female and male) were found to be in stage II. In stages I and III most of the fish were male, and in stage IV most were female. In stage V only females were found in small proportions. The length at 50% maturity for *T. trecae* in this region was 20 cm TL (Figure 49).

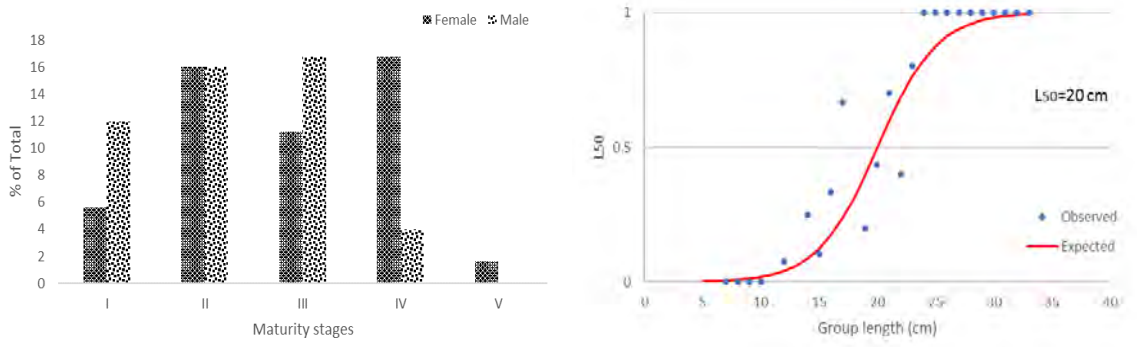


Figure 49. Maturity stages by sex and first length at maturity for *Trachurus trecae* in the southern region.

### 1.1.19 Pelagic species Group 1

The dominant species in this group (Pelagic 1) in the southern region of Angola was anchovy (*Engraulis encrasicolus*) and round herring (*Etrumeus whiteheadi*). *Ilisha africana* was not found. The two species were found in low proportion in two trawls between Baía dos Tigres and Cunene river, and acoustic densities were recorded with low ($0<s_A<300$ $m^2/NM^2$) and medium densities ($301<s_A<1\,000$ $m^2/NM^2$) near Baía dos Tigres and Cunene river, and with high densities ($1\,001< s_A<3\,000$ $m^2/NM^2$) in a smaller area south of Baía dos Tigres (Figure 50).

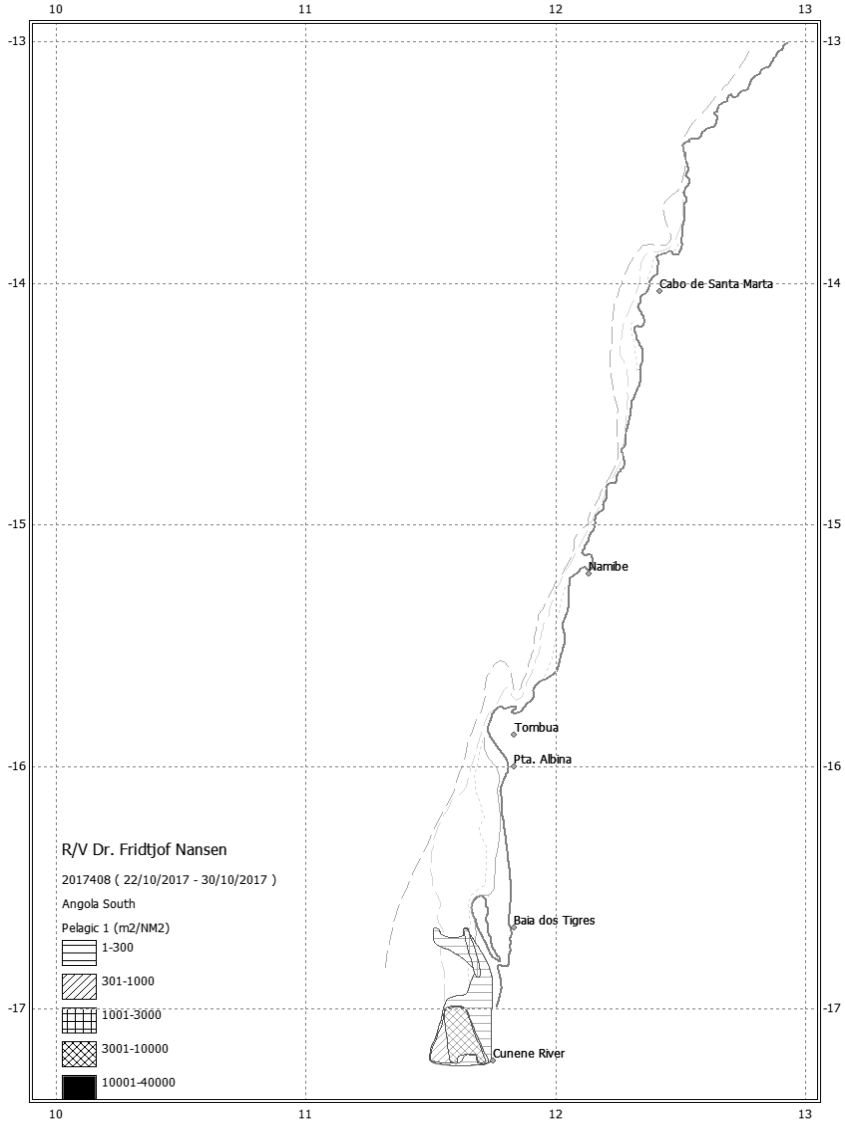


Figure 50. Distribution of Pelagic 1. Benguela–Cunene. Depth contours at 10, 20, 50, 100, 200 and 500 meters.

The biomass for this group was estimated to be 44 558 tonnes and consisted of mostly *E. encrasicolus* (about 97%). The length distribution for *E. encrasicolus* showed one mode at around 11 cm TL, while *E. whiteheadi* showed a mode at around 21 cm TL (Figure 51). The

length-weight relationship for the central and southern region was used together to estimate the biomass due to the low number of biological samples taken in the south.

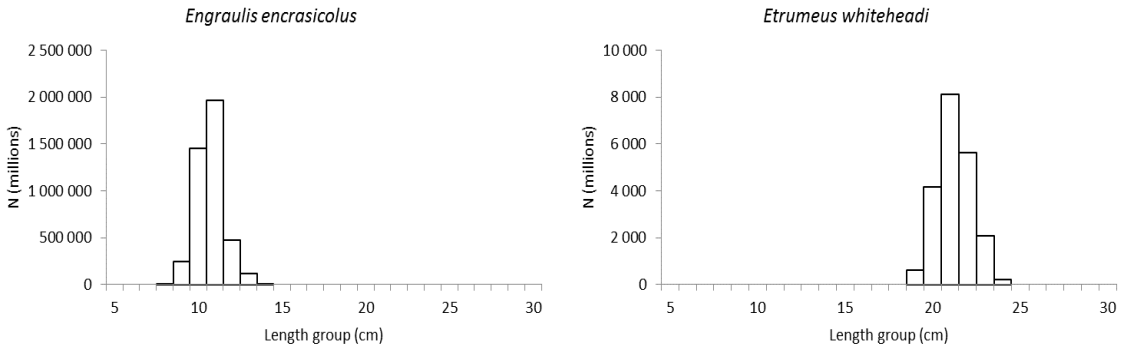


Figure 51. Total length distribution of *Engraulis encrasicolus* and *Etrumeus whiteheadi*, Benguela-Cunene.

### 1.1.20 Pelagic species Group 2

This group was found along of the southern region in patches distributed with low densities ($0<s_A<300$ $m^2/NM^2$) and one small area with medium densities ($301<s_A<1\,000$ $m^2/NM^2$) off Tômbwa (Figure 52). The group was dominated by carangids, as well as *Scomber colias*, *Sphyraena* sp and *Trichiurus lepturus*. The biomass estimated was 29 778 tonnes, based on a standard average length of 30 cm TL.

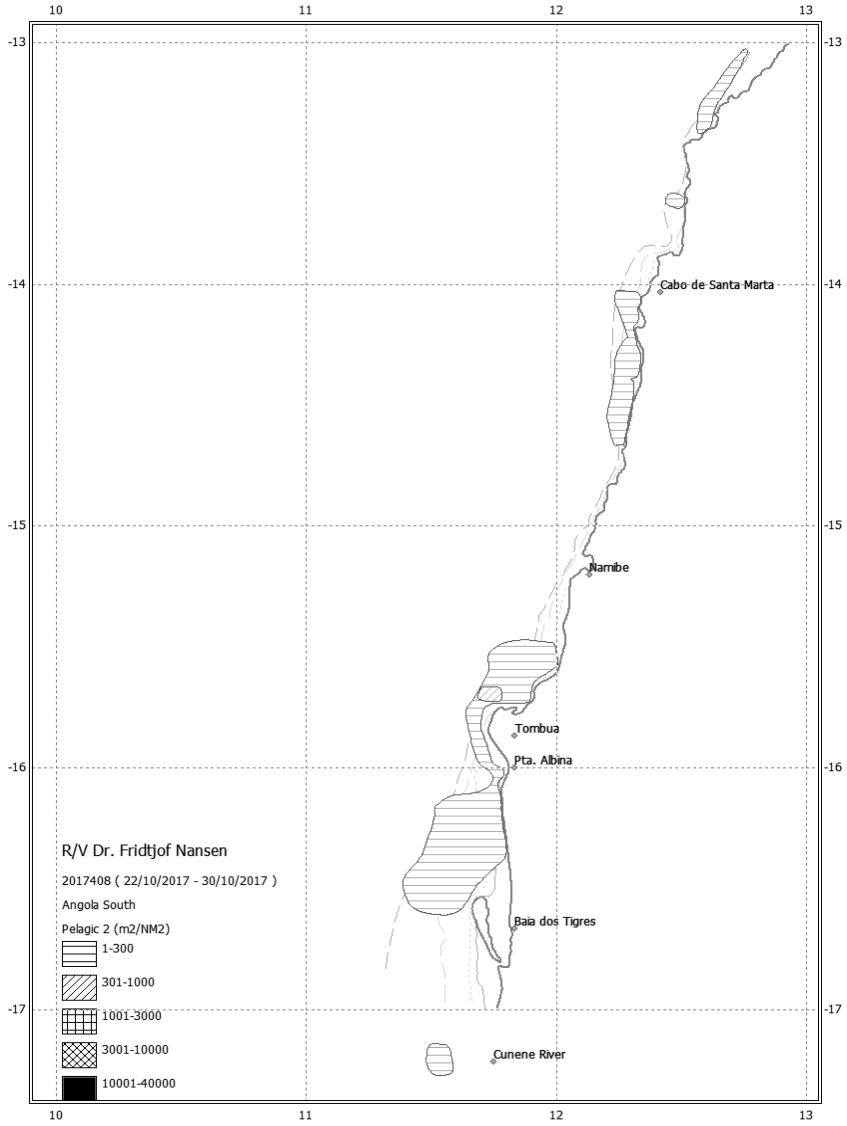


Figure 52. Distribution of Pelagic 2. Benguela–Cunene. Depth contours at 10, 20, 50, 100, 200 and 500 meters.

Table 12 shows the summary of the abundance estimates of main commercial species in the southern region.

Table 12. Estimated abundance of pelagic fish (tonnes), Benguela-Cunene.

| **Sardinella maderensis** | **Sardinella aurita** | **Trachurus trecae** | **Trachurus capensis** | **Pelagic 1** | **Pelagic 2** |
|---|---|---|---|---|---|
| 24 633 | 35 490 | 56 500 | 42 900 | 44 558 | 29 778 |

## Sardinella

The estimated biomass of sardinella shows a fluctuating pattern throughout the time series (Figure 53). This is commonly found in pelagic species, usually reflecting actual changes in abundance but also variation in the availability of the surveyed populations, often caused by changes in the environmental conditions. Overall, the Sardinella stocks presently seem to be in relatively good condition. The total biomass estimated for sardinellas was 780 110 tonnes. *Sardinella maderensis* contributed about 67% (525 994 tonnes) to the total, while 254 116 tonnes of *Sardinella aurita* was found in the survey area contributing about 33% to the total estimate. This is at the same level as the surveys done in the winter 2007 (725 000 tonnes) and the summer 2012 (739 000 tonnes). It is however considerably less than the exceptionally high biomass estimated during the 2012 winter survey (1 119 000 tonnes).

The length compostion for *S. aurita* show the highest abundance (in numbers) of size groups between 7-14 cm. 36% of the biomass estimated for *S. aurita* was comprised of fish at a length less than 21 cm TL registered across the Angola coast.

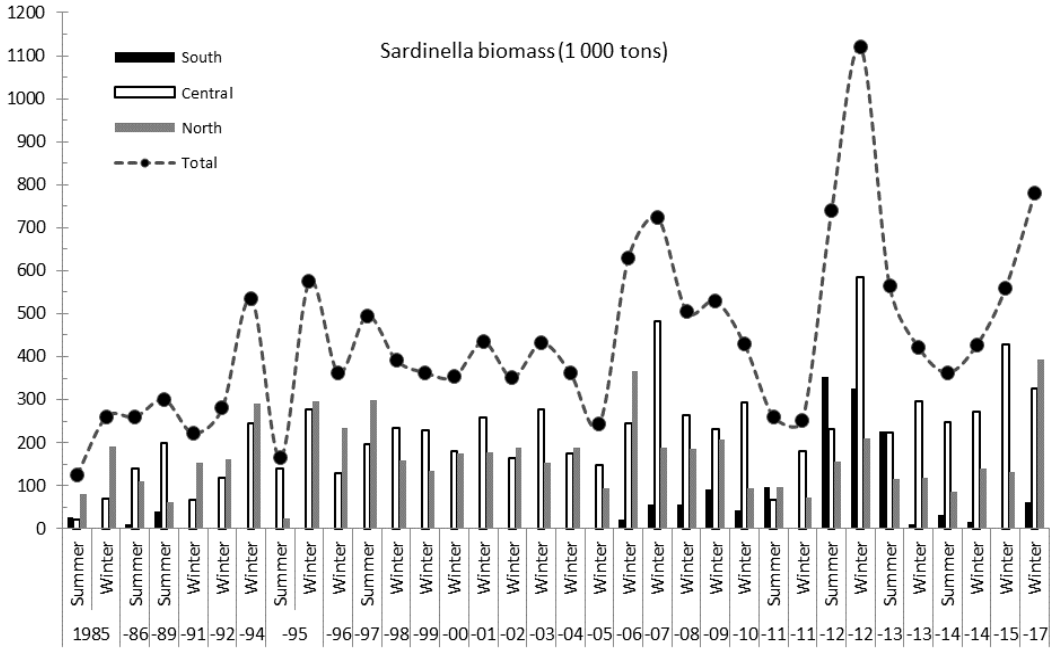


Figure 53. Biomass estimates of Sardinella by regions and surveys (1000 tonnes).

The overall length frequency distributions of the two Sardinella species show the juvenile and adult cohorts (Figure 54). The distribution of *S. aurita* shows well-defined cohorts with modal peaks around 11, 18 and 29 cm total length. For *S. madrensis*, the distribution shows a modal peak at 22 cm TL. It is of interest to notice the high registrations of juvenile *S. aurita* along most of the Angolan coast. This may to some extent be attributed to seasonality. This

survey was carried out later in the year than the usual winter surveys, and it is therefore not directly comparable. It should be noted that the main spawning season for *S. aurita* is during the "long cold season" from June to September.

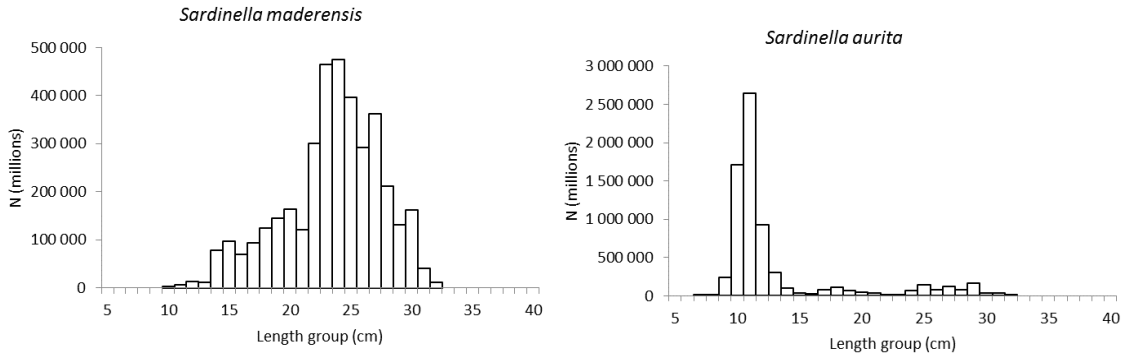


Figure 54. Overall total length distribution of S. *maderensis* and *S. aurita*.

## Horse mackerel

The total biomass of Cunene horse mackerel was estimated to 229 000 tonnes (Figure 55). This estimation was slightly less than during the 2015 winter survey (300 000 tonnes), although higher than the long-term mean (2006-2015) of 178 000 tonnes. Fish <21 cm TL comprised 38% of the total biomass of Cunene horse mackerel.

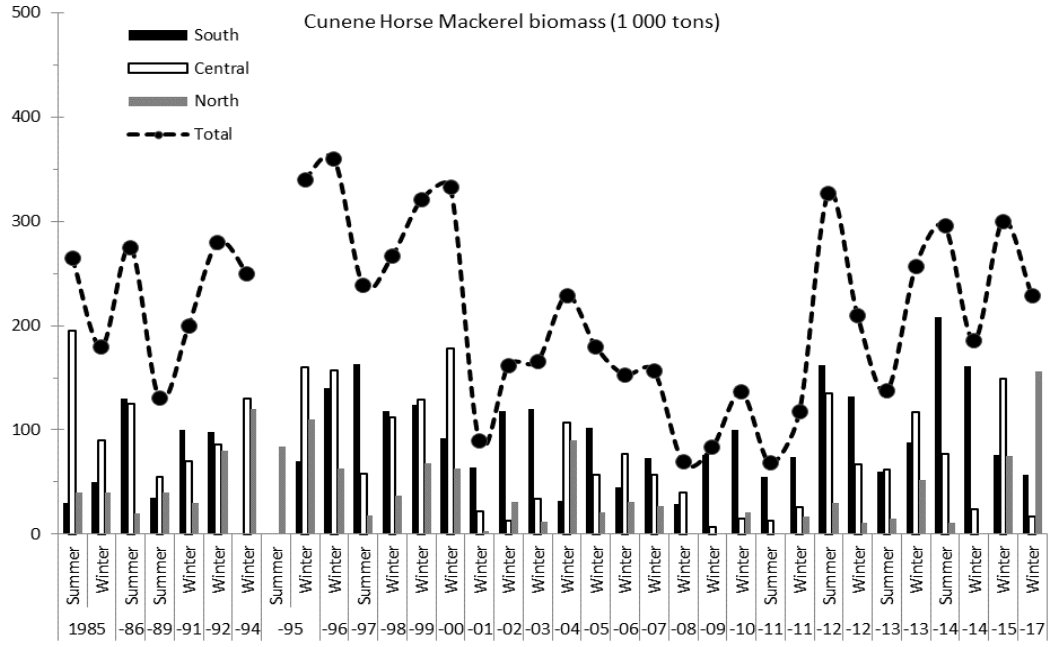


Figure 55. Biomass estimates of Cunene horse mackerel by regions and surveys (1 000 tonnes).

The biomass of Cape horse mackerel in Angola was estimated to 43 000 tonnes. The biomass estimated this year was 68% less than in the 2015 winter survey (133 000 tonnes). However, most of the biomass of Cape horse mackerel was found on the Namibian side of the border. These changes in biomass for *T. capensis* in Angola may thus just be a reflection of seasonal and interannual fluctuations in distribution, and must be seen in conjunction with the biomass of Cape horse mackerel in Namibia.

Figure 56 shows the size distribution of the two horse mackerel species found in Angolan waters. For both species, the juvenile cohorts are the most dominating. *T. trecae* showed well-defined cohorts with modal peaks around 9 and 23 cm TL. For *T. capensis*, the distribution showed a modal peak at 12 cm and a tendency of a peak at 19 cm TL.

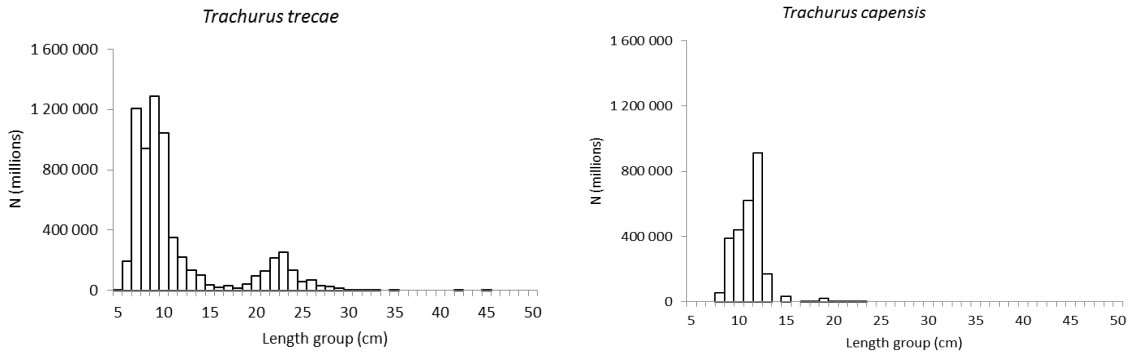


Figure 56. Overall total length distribution of *T. trecae* and *T. capensis.*

Other biological references also clearly indicate that the Cunene horse mackerel stock is still under considerable pressure. From the reference year 1996, the length distributions have been shifting towards smaller fish, indicating high fishing pressure on the adult stock (Figure 55).

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

## Biomass estimation of Pelagic group 1 and Pelagic Group 2

Estimates of species groups (pelagic 1 and pelagic 2) are based on less detailed sampling than sardinellas and horse mackerels.

This year the pelagic 1 group was dominated by a single species in the northern and central regions (*Ilisha Africana)*, and by two species (*Engralis encrasicolus* and *Etrumeus whiteheadi)* in the southern region), and separate estimates were calculated for each species. Pelagic 1 species are usually found very close to the surface and the proportion of the biomass found above the acoustic range may therefore be considerable. This is a known source of bias and it is not known whether this bias varies between seasons or years.

Pelagic 2 species are estimated assuming a fixed length of 30 cm for a mixed group of species and a mean condition factor. Conversion of echo abundance to number of fish depends on the average of squared lengths and this will change between years. This is a source of bias in the estimation of numbers of fish. Different length distributions may produce the same average squared length, but the corresponding biomass will be different.

## REGIONAL OVERVIEW

Most pelagic species have a transboundary distribution and trends in biomass are most meaningful if done at population level especially when there is evidence of migration across national boundaries, as it is the case for most pelagic species found in Angola. The EAF-Nansen Programme aims at supporting collaborative work by coastal countries to assess if and to what extent resources may be shared and the results from these surveys will be further analysed at the regional level.

Table 13 provides an overiew of the biomass estimates of the main pelagic species in the region Gabon to southern Namibia. The categories Pelagic Fish 1 and Pelagic fish 2 are not included as the species composition is rather different at different latitudes and a regional overview is therefore less meaningful.

Table 13. Regional biomass estimates of main species of pelagic species (1000 tonnes), Gabon-Namibia.

| **Species** | **Congo-Gabon** | **Angola** | | | **Namíbia** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Total** | **North** | **Central** | **South** | **North** | **Central** | **South** | **Total** |
| *Trachurus trecae* | 14.8 | 156.0 | 16.5 | 56.5 | - | - | - | 244 |
| *Trachurus capensis* | - | - | - | 42.9 | 1 219 | 173 | - | 1435 |
| *Sardinella aurita* | 4.8 | 83.6 | 134.9 | 35.5 | - | - | - | 259 |
| *Sardinella maderensis* | 37.7 | 309.3 | 192.1 | 24.6 | - | - | - | 564 |
| *Sardinops sagax* | | - | - | - | 142 | 3 | - | 145 |

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# ANNEX I. DESCRIPTION OF INSTRUMENTS AND FISHING GEAR

**Acoustic instruments**

The Simrad EK80/18, 38, 70,120, 200 and 333 kHz scientific sounder was run during the survey. Scrutinizing was done in LSSS using the data from the 38-kHz transducer. Last standard sphere calibrations were checked on the 23.01.2017 in Sandviksflaket, Bergen, Norway using Cu64 for the 18 kHz, Cu60 for the 38 kHz, WC38.1 for the 70, 120 and 200 kHz, and the WC22 for the 333 kHz. The details of the settings for the 38-kHz echo sounder were as follows:

| | |
|---|---|
| Transceiver2 menu (38 kHz) | |
| Transducer depth | 5 8 m |
| Absorption coeff. | 8.3 dB/km |
| Pulse duration | medium (1,024ms) |
| Bandwidth | 2.43 kHz |
| Max power | 2000 Watt |
| 2way beam angle | 20,6dB |
| gain | 26,95 dB |
| SA correction | 0.03 dB |
| Angle sensitivity | 21.9 |
| 3 dB beamwidth | 6.22º along ship |
| | 6.28 athwart ship |
| Alongship offset | 0.10º |
| Athwardship offset | 0.06º |
| | |
| Bottom detection menu | Minimum level 50 Db |

The echosounder was tried re-calibrated in Baia dos Elefantes, Angola. However this exercise was not successful due to a high number of fish (*Lagocephalus laevigatus*) in the water column. These repeatedly bit off the line the calibration sphere was held in and made it impossible to get the sphere in the water.

**Fishing gear**

The vessel has one small four-panel Åkrahamn pelagic trawl, one MultPelt 624 trawl (Figure I.1, new in 2017) and one ‘Gisund super bottom trawl’. The multpelt trawl was not used during the survey due to a problem on the winch system. The smallest pelagic trawl has a 8 to 12 m vertical opening under normal operation, whereas the MultPelt 624 trawl has a 25 to 35 m opening.

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' combi, 8 $m^2$ with a weigh of 2 000 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.

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 interdistance and angle, while a height sensor is fitted on the bottom trawl to measure the trawl opening and provide information on clearance and bottom contact.

All 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.

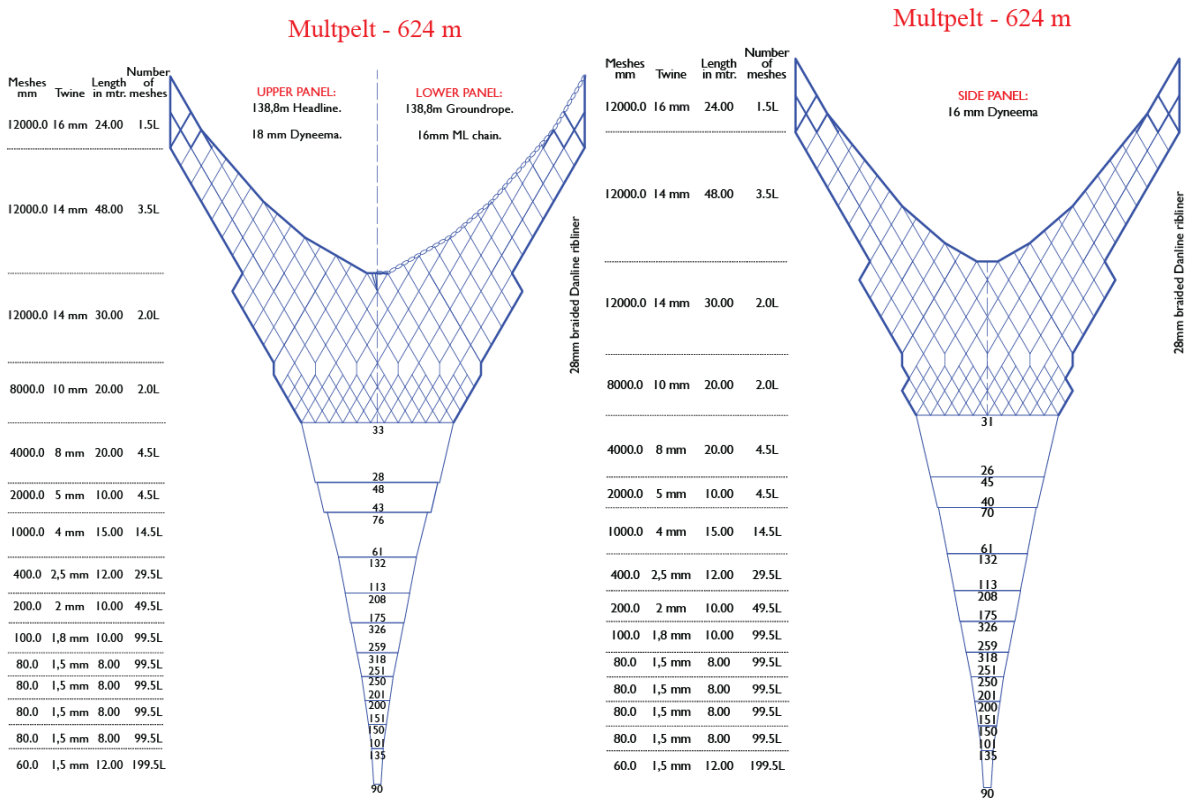


Figure I.1. Schematic drawing of the MultPelt 624.

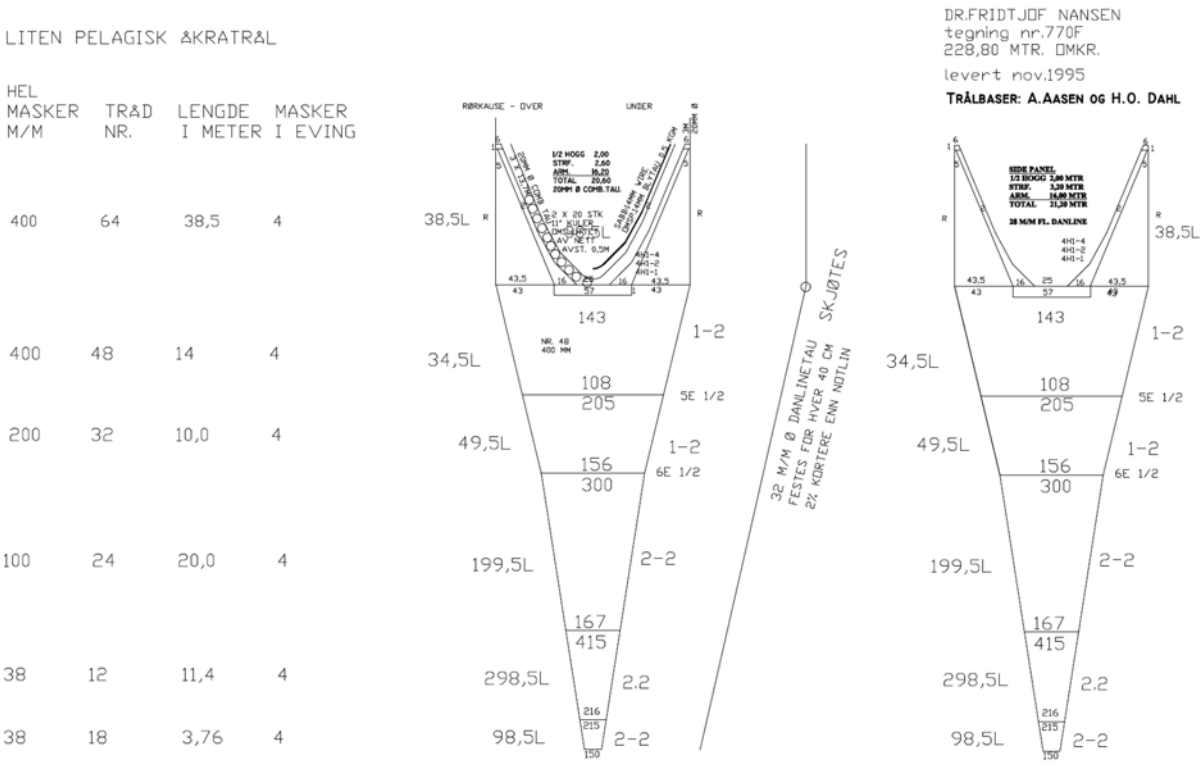


Figure I.2. Schematic drawing of the small pelagic Åkratraw.

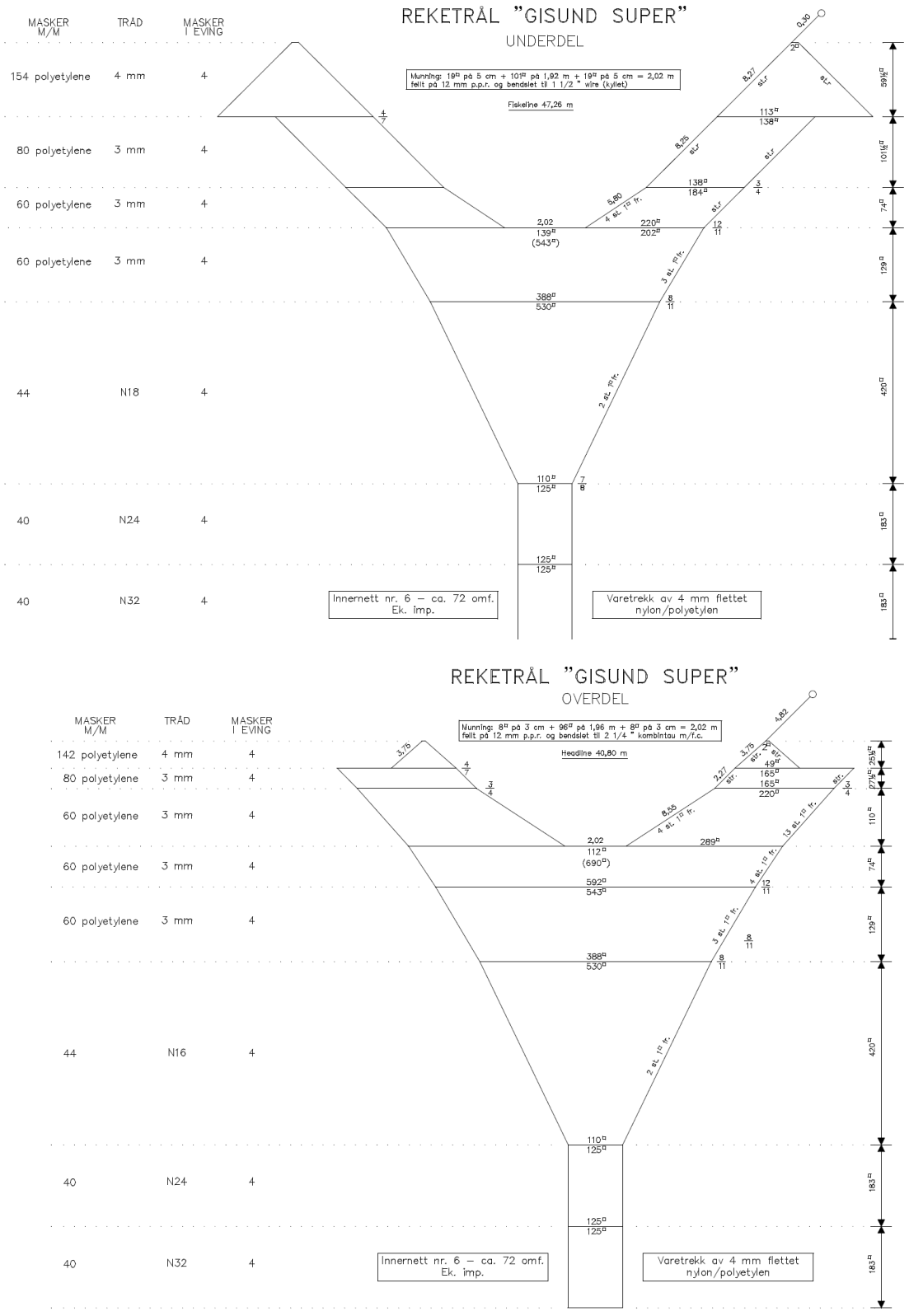


Figure I.3. Schematic drawing of the Super Gisund bottom trawl.

# ANNEX II. RECORDS OF FISHING STATIONS

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 1
DATE :01/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 6°30.20
start stop duration Lon E 10°49.37
TIME :18:18:08 18:48:31 30.4 (min) Purpose : 1
LOG : 1937.79 1939.42 1.6 Region : 4054
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 1829 1891 Validity : 0
Towing dir: 0° Wire out : 130 m Speed : 3.2 kn
Sorted : 52 Total catch: 51.52 Catch/hour: 101.75

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| MYCTOPHIDAE | 56.31 | 51284 | 55.34 | |
| Cubiceps baxteri | 9.36 | 332 | 9.20 | |
| Ommastrephes sp. | 7.82 | 16 | 7.69 | |
| Trichiurus lepturus | 6.87 | 3304 | 6.75 | |
| Small squids | 5.63 | 16 | 5.53 | |
| Squid unidentified | 4.70 | 164 | 4.62 | |
| Promethichthys prometheus | 2.49 | 164 | 2.45 | |
| Gempylus serpens | 2.33 | 18 | 2.29 | |
| Unidentified | 2.29 | 18 | 2.25 | |
| Brama brama | 1.90 | 12 | 1.86 | |
| Lestrolepis intermedia | 0.85 | 344 | 0.83 | |
| Selene dorsalis | 0.77 | 687 | 0.76 | |
| Invertebrate | 0.39 | 43 | 0.39 | |
| Psenes cyanophrys | 0.06 | 2 | 0.05 | |
| Total | 101.77 | | 100.02 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 2
DATE :02/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 6°14.17
start stop duration Lon E 12°7.58
TIME :21:00:48 21:30:56 30.1 (min) Purpose : 1
LOG : 2071.40 2073.03 1.6 Region : 4054
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 36 40 Validity : 0
Towing dir: 0° Wire out : 130 m Speed : 3.2 kn
Sorted : 77 Total catch: 77.23 Catch/hour: 153.79

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Sardinella aurita | 73.72 | 5759 | 47.94 | 1 |
| Hemicaranx bicolor | 19.36 | 72 | 12.59 | 6 |
| Engraulis encrasicolus | 16.13 | 5377 | 10.49 | 3 |
| Sphyraena sphyraena | 16.05 | 129 | 10.44 | |
| Scomberomorus tritor | 8.96 | 12 | 5.83 | 5 |
| Sarda sarda | 6.45 | 16 | 4.20 | 11 |
| Sardinella maderensis | 5.62 | 52 | 3.65 | 2 |
| JELLYFISH | 3.62 | 10 | 2.36 | |
| Alloteuthis africana | 1.83 | 516 | 1.19 | |
| Euthynnus alletteratus | 0.96 | 2 | 0.62 | |
| Trachurus trecae | 0.76 | 181 | 0.49 | 4 |
| Brachydeuterus auritus | 0.24 | 2 | 0.16 | |
| Saurida brasiliensis | 0.08 | 14 | 0.05 | |
| Trichiurus lepturus | 0.02 | 2 | 0.01 | |
| Total | 153.79 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 3
DATE :03/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 6°23.75
start stop duration Lon E 12°9.64
TIME :00:17:13 00:46:39 29.4 (min) Purpose : 1
LOG : 2094.68 2096.16 1.5 Region : 4054
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 39 43 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.0 kn
Sorted : 160 Total catch: 160.20 Catch/hour: 326.61

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Chloroscombrus chrysurus | 185.52 | 2642 | 56.80 | 10 |
| Sardinella maderensis | 74.86 | 964 | 22.92 | 8 |
| Sardinella aurita | 31.40 | 495 | 9.61 | 7 |
| Sphyraena sphyraena | 16.64 | 37 | 5.09 | 9 |
| JELLYFISH | 8.77 | 16 | 2.68 | |
| Lagocephalus laevigatus | 3.10 | 12 | 0.95 | |
| Ilisha africana *** | 2.81 | 49 | 0.86 | |
| Scomberomorus tritor | 1.71 | 2 | 0.52 | |
| Selene dorsalis | 0.98 | 12 | 0.30 | |
| Decapterus punctatus | 0.29 | 6 | 0.09 | |
| Alloteuthis africana | 0.29 | 73 | 0.09 | |
| Trichiurus lepturus | 0.24 | 2 | 0.07 | |
| Total | 326.61 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 4
DATE :03/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 6°34.13
start stop duration Lon E 12°2.18
TIME :10:23:08 10:47:55 24.8 (min) Purpose : 1
LOG : 2184.99 2186.22 1.2 Region : 4054
FDEPTH: 86 84 Gear cond.: 0
BDEPTH: 86 84 Validity : 0
Towing dir: 0° Wire out : 260 m Speed : 3.0 kn
Sorted : 171 Total catch: 171.16 Catch/hour: 414.43

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Pagellus bellottii | 130.41 | 2959 | 31.47 | |
| Dentex angolensis | 56.95 | 1695 | 13.74 | |
| Dentex congoensis | 48.43 | 2421 | 11.68 | |
| Trachurus trecae | 44.12 | 5380 | 10.65 | 13 |
| Boops boops | 41.07 | 1656 | 9.91 | |
| Lagocephalus laevigatus | 21.55 | 36 | 5.20 | |
| JELLYFISH | 12.40 | 31 | 2.99 | |
| Trachurus trecae | 10.51 | 116 | 2.54 | 12 |
| Paragaleus pectoralis | 10.07 | 5 | 2.43 | |
| Fistularia petimba | 7.17 | 15 | 1.73 | |
| Pseudupeneus prayensis | 7.02 | 94 | 1.69 | |
| Zeus faber | 6.15 | 10 | 1.48 | |
| Trichiurus lepturus | 4.36 | 7 | 1.05 | |
| Selene dorsalis | 3.97 | 12 | 0.96 | |
| Illex coindetii | 2.32 | 24 | 0.56 | |
| Brotula barbata | 2.13 | 2 | 0.51 | |
| Branchiostegus semifasciatus *** | 1.69 | 2 | 0.41 | |
| Raja miraletus | 1.36 | 5 | 0.33 | |
| Brachydeuterus auritus | 0.63 | 5 | 0.15 | |
| Chaetodon hoefleri | 0.48 | 2 | 0.12 | |
| Trigla lyra | 0.44 | 7 | 0.11 | |
| Sardinella aurita | 0.39 | 2 | 0.09 | |
| Scomber japonicus | 0.29 | 10 | 0.07 | |
| Dentex gibbosus | 0.29 | 2 | 0.07 | |
| Alloteuthis africana | 0.10 | 46 | 0.02 | |
| Saurida brasiliensis | 0.05 | 2 | 0.01 | |
| Citharus linguatula | 0.05 | 2 | 0.01 | |
| Lophius vaillanti | 0.05 | 2 | 0.01 | |
| Total | 414.43 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 5
DATE :03/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 6°36.00
start stop duration Lon E 12°21.59
TIME :15:24:04 15:52:40 28.6 (min) Purpose : 1
LOG : 2212.98 2214.71 1.7 Region : 4054
FDEPTH: 23 23 Gear cond.: 0
BDEPTH: 23 23 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.6 kn
Sorted : 0 Total catch: 256.97 Catch/hour: 539.10

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Chloroscombrus chrysurus | 373.38 | 4076 | 69.26 | 16 |
| Sardinella maderensis | 67.80 | 837 | 12.58 | 15 |
| JELLYFISH | 33.69 | 21 | 6.25 | |
| Caranx rhonchus | 17.12 | 71 | 3.18 | 17 |
| Lagocephalus laevigatus | 10.70 | 34 | 1.98 | |
| Sphyraena sphyraena | 8.69 | 13 | 1.61 | |
| Sardinella aurita | 8.39 | 80 | 1.56 | 14 |
| Pagellus bellottii | 3.15 | 31 | 0.58 | |
| Pseudupeneus prayensis | 3.02 | 34 | 0.56 | |
| Sepia orbignyana | 2.94 | 4 | 0.54 | |
| Scomberomorus tritor | 2.90 | 2 | 0.54 | |
| Balistes capriscus | 2.56 | 4 | 0.47 | |
| Hemicaranx bicolor | 2.18 | 2 | 0.40 | |
| Selene dorsalis | 1.72 | 17 | 0.32 | |
| Caranx crysos | 0.42 | 2 | 0.08 | |
| Alloteuthis africana | 0.29 | 42 | 0.05 | |
| Pagrus caeruleostictus | 0.15 | 4 | 0.03 | |
| Total | 539.10 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 6
DATE :03/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 6°43.43
start stop duration Lon E 12°12.76
TIME :18:43:46 19:13:54 30.1 (min) Purpose : 1
LOG : 2231.98 2233.65 1.7 Region : 4054
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 61 64 Validity : 0
Towing dir: 0° Wire out : 130 m Speed : 3.3 kn
Sorted : 0 Total catch: 38.97 Catch/hour: 77.60

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Sardinella maderensis | 26.60 | 153 | 34.28 | 18 |
| Trachinotus ovatus | 18.04 | 42 | 23.25 | 19 |
| Caranx crysos | 10.55 | 8 | 13.60 | 20 |
| Lagocephalus laevigatus | 8.24 | 10 | 10.62 | |
| Alloteuthis africana | 4.06 | 0 | 5.23 | |
| JELLYFISH | 2.87 | 8 | 3.70 | |
| Alectis alexandrinus | 1.95 | 2 | 2.51 | |
| Hirundichthys speculiger | 1.55 | 4 | 2.00 | |
| Trichiurus lepturus | 1.51 | 2 | 1.95 | |
| Hemicaranx bicolor | 0.76 | 2 | 0.98 | |
| Scomber japonicus | 0.52 | 16 | 0.67 | 21 |
| Chloroscombrus chrysurus | 0.52 | 2 | 0.67 | |
| Sardinella aurita | 0.40 | 4 | 0.51 | |
| Trachurus trecae | 0.02 | 4 | 0.03 | |
| Total | 77.60 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 7
DATE :04/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 6°56.51
start stop duration Lon E 12°12.47
TIME :07:37:27 08:17:42 40.3 (min) Purpose : 1
LOG : 2325.26 2327.42 2.2 Region : 4054
FDEPTH: 82 79 Gear cond.: 0
BDEPTH: 82 79 Validity : 0
Towing dir: 0° Wire out : 220 m Speed : 3.2 kn
Sorted : 0 Total catch: 222.90 Catch/hour: 332.27

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Dentex angolensis | 85.00 | 402 | 25.58 | 22 |
| Pomadasys incisus | 56.44 | 274 | 16.99 | |
| Umbrina canariensis | 24.98 | 66 | 7.52 | |
| Dentex congoensis | 24.03 | 167 | 7.23 | 23 |
| Dentex barnardi | 19.80 | 52 | 5.96 | |
| Trachurus trecae | 17.20 | 119 | 5.18 | 25 |
| Pagellus bellottii | 17.14 | 0 | 5.16 | |
| Trichiurus lepturus | 15.92 | 18 | 4.79 | |
| Lagocephalus laevigatus | 13.12 | 31 | 3.95 | |
| Seriola carpenteri | 12.13 | 9 | 3.65 | |
| Fistularia petimba | 7.60 | 19 | 2.29 | |
| Alloteuthis africana | 7.54 | 3394 | 2.27 | |
| Zeus faber | 7.45 | 15 | 2.24 | |
| Paragaleus pectoralis | 4.65 | 3 | 1.40 | |
| JELLYFISH | 4.17 | 6 | 1.26 | |
| Chaetodon hoefleri | 2.80 | 16 | 0.84 | |
| Pagrus caeruleostictus | 2.68 | 4 | 0.81 | |
| Pseudupeneus prayensis | 2.12 | 12 | 0.64 | |
| Sphyraena sphyraena | 2.09 | 1 | 0.63 | |
| Raja miraletus | 1.97 | 3 | 0.59 | |
| Brachydeuterus auritus | 1.31 | 10 | 0.39 | |
| Illex coindetii | 0.57 | 6 | 0.17 | |
| Caranx rhonchus | 0.42 | 1 | 0.13 | |
| Cynoglossus canariensis | 0.33 | 1 | 0.10 | |
| Scomber japonicus | 0.30 | 6 | 0.09 | 26 |
| Sepia officinalis | 0.24 | 3 | 0.07 | |
| Chelidonichthys gabonensis | 0.18 | 1 | 0.05 | |
| Citharus linguatula | 0.12 | 3 | 0.04 | |
| Total | 332.30 | | 100.01 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 8
DATE :04/10/17 GEAR TYPE: PT NO: 1 POSITION:Lat S 7°15.39
start stop duration Lon E 12°31.00
TIME :18:44:44 19:15:42 31.0 (min) Purpose : 1
LOG : 2415.22 2417.13 1.9 Region : 4054
FDEPTH: 40 45 Gear cond.: 0
BDEPTH: 72 64 Validity : 0
Towing dir: 0° Wire out : 160 m Speed : 3.7 kn
Sorted : 8 Total catch: 7.86 Catch/hour: 15.23

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Lagocephalus laevigatus | 5.54 | 8 | 36.39 | |
| Trachurus trecae | 3.45 | 283 | 22.65 | 28 |
| Trichiurus lepturus | 2.48 | 4 | 16.28 | |
| Sardinella maderensis | 1.32 | 6 | 8.65 | 27 |
| Saurida brasiliensis | 1.05 | 930 | 6.87 | |
| Alloteuthis africana | 0.81 | 387 | 5.34 | |
| Selar crumenophthalmus | 0.39 | 2 | 2.54 | |
| Scomber japonicus | 0.08 | 2 | 0.51 | |
| Invertebrate | 0.08 | 2 | 0.51 | |
| Boops boops | 0.04 | 2 | 0.25 | |
| Total | 15.23 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 9
DATE :04/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 7°18.25
start stop duration Lon E 12°38.26
TIME :22:13:21 22:44:41 31.3 (min) Purpose : 1
LOG : 2431.24 2432.94 1.7 Region : 4054
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 54 65 Validity : 0
Towing dir: 0° Wire out : 140 m Speed : 3.3 kn
Sorted : 3 Total catch: 2.98 Catch/hour: 5.71

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Lagocephalus laevigatus | 2.18 | 4 | 38.26 | |
| Trachinotus ovatus | 1.88 | 6 | 32.89 | 29 |
| Decapterus punctatus | 1.03 | 13 | 18.12 | 30 |
| Sardinella maderensis | 0.31 | 2 | 5.37 | |
| Alloteuthis africana | 0.27 | 134 | 4.70 | |
| Saurida brasiliensis | 0.04 | 80 | 0.67 | |
| Total | 5.71 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 10
DATE :05/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 7°27.44
start stop duration Lon E 12°44.81
TIME :07:40:49 08:15:34 34.8 (min) Purpose : 1
LOG : 2482.71 2484.70 2.0 Region : 4054
FDEPTH: 60 58 Gear cond.: 0
BDEPTH: 60 58 Validity : 0
Towing dir: 0° Wire out : 180 m Speed : 3.4 kn
Sorted : 316 Total catch: 316.48 Catch/hour: 546.44

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Lagocephalus laevigatus | 483.32 | 970 | 88.45 | |
| Alectis alexandrinus | 11.95 | 19 | 2.19 | |
| Chloroscombrus chrysurus | 9.22 | 76 | 1.69 | 31 |
| Sphyraena guachancho | 8.39 | 10 | 1.54 | 33 |
| Selar crumenophthalmus | 8.18 | 21 | 1.50 | |
| Scomberomorus tritor | 5.70 | 2 | 1.04 | |
| Decapterus rhonchus** | 4.87 | 16 | 0.89 | 35 |
| Pagrus caeruleostictus | 4.25 | 14 | 0.78 | |
| Fistularia petimba | 2.90 | 7 | 0.53 | |
| Pagellus bellottii | 1.86 | 12 | 0.34 | 34 |
| Illex coindetii | 1.62 | 473 | 0.30 | |
| Seriola carpenteri | 1.14 | 2 | 0.21 | |
| Raja miraletus | 0.90 | 2 | 0.16 | |
| Selene dorsalis | 0.64 | 7 | 0.12 | |
| Scomber japonicus | 0.41 | 12 | 0.08 | 32 |
| Chelidonichthys gabonensis | 0.35 | 2 | 0.06 | |
| Citharus linguatula | 0.31 | 2 | 0.06 | |
| Chaetodon hoefleri | 0.28 | 2 | 0.05 | |
| Grammoplites gruveli | 0.10 | 2 | 0.02 | |
| Trachurus trecae | 0.04 | 10 | 0.01 | 56 |
| Sardinella aurita | 0.02 | 2 | 0.00 | |
| Total | 546.44 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 11
DATE :05/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 7°22.48
start stop duration Lon E 12°45.72
TIME :09:28:27 10:02:39 34.2 (min) Purpose : 1
LOG : 2491.76 2493.61 1.9 Region : 4054
FDEPTH: 31 42 Gear cond.: 0
BDEPTH: 31 42 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.3 kn
Sorted : 0 Total catch: 54.46 Catch/hour: 95.54

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Balistes capriscus | 22.81 | 58 | 23.87 | |
| Pseudupeneus prayensis | 12.25 | 107 | 12.82 | |
| Sphyraena guachancho | 11.68 | 16 | 12.23 | |
| Sepia orbignyana | 8.42 | 11 | 8.81 | |
| Pagrus caeruleostictus | 6.63 | 26 | 6.94 | |
| Epinephelus aeneus | 5.60 | 5 | 5.86 | |
| Lagocephalus laevigatus | 5.19 | 11 | 5.44 | |
| Chilomycterus reticulatus | 3.23 | 2 | 3.38 | |
| Illex coindetii | 2.98 | 839 | 3.12 | |
| Raja miraletus | 2.77 | 5 | 2.90 | |
| Pagellus bellottii | 1.91 | 14 | 2.00 | |
| Pomadasys perotaei | 1.86 | 2 | 1.95 | |
| Chilomycterus spinosus mauretanicus | 1.82 | 4 | 1.91 | |
| Zeus faber | 1.79 | 2 | 1.87 | |
| Dasyatis margarita | 1.19 | 5 | 1.25 | |
| Chelidonichthys gabonensis | 1.09 | 7 | 1.14 | |
| Dentex barnardi | 0.88 | 4 | 0.92 | |
| Seriola carpenteri | 0.88 | 2 | 0.92 | |
| Chloroscombrus chrysurus | 0.49 | 4 | 0.51 | |
| Sarda sarda | 0.49 | 2 | 0.51 | |
| Citharus linguatula | 0.49 | 4 | 0.51 | |
| Brachydeuterus auritus | 0.39 | 4 | 0.40 | |
| Aluterus heudelotii | 0.39 | 2 | 0.40 | |
| Chaetodon hoefleri | 0.18 | 2 | 0.18 | |
| Fistularia petimba | 0.07 | 2 | 0.07 | |
| Sardinella maderensis | 0.04 | 2 | 0.04 | |
| Scomber scombrus | 0.04 | 2 | 0.04 | |
| Total | 95.54 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 12
DATE :05/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 7°36.58
start stop duration Lon E 12°42.02
TIME :15:01:56 15:37:52 35.9 (min) Purpose : 1
LOG : 2528.33 2530.17 1.8 Region : 4054
FDEPTH: 96 96 Gear cond.: 0
BDEPTH: 96 96 Validity : 0
Towing dir: 0° Wire out : 260 m Speed : 3.1 kn
Sorted : 84 Total catch: 83.90 Catch/hour: 140.11

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Dentex angolensis | 27.42 | 7411 | 19.57 | 36 |
| Boops boops | 23.88 | 508 | 17.04 | |
| Trichiurus lepturus | 18.77 | 30 | 13.40 | |
| Dentex congoensis | 16.60 | 439 | 11.85 | |
| Brotula barbata | 8.82 | 0 | 6.29 | |
| Trigla lyra | 8.72 | 55 | 6.22 | 38 |
| Lagocephalus laevigatus | 6.61 | 17 | 4.72 | |
| Zeus faber | 5.44 | 12 | 3.89 | |
| Pagellus bellottii | 5.31 | 110 | 3.79 | |
| Selene dorsalis | 3.31 | 7 | 2.36 | |
| Octopus macropus | 3.17 | 5 | 2.26 | |
| Trachurus trecae | 2.24 | 167 | 1.60 | 37 |
| Brachydeuterus auritus | 2.17 | 18 | 1.55 | |
| Illex coindetii | 1.40 | 17 | 1.00 | |
| Raja miraletus | 1.30 | 2 | 0.93 | |
| Dentex barnardi | 1.27 | 3 | 0.91 | |
| Uranoscopus cadenati | 1.10 | 2 | 0.79 | |
| Saurida brasiliensis | 0.90 | 53 | 0.64 | |
| Chaetodon hoefleri | 0.77 | 3 | 0.55 | |
| Balistes capriscus | 0.40 | 2 | 0.29 | |
| Citharus linguatula | 0.23 | 5 | 0.17 | |
| Scomber japonicus | 0.23 | 7 | 0.17 | |
| Microchirus frechkopi | 0.03 | 2 | 0.02 | |
| Total | 140.10 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 13
DATE :05/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 7°46.88
start stop duration Lon E 12°46.78
TIME :21:35:21 22:05:26 30.1 (min) Purpose : 1
LOG : 2566.15 2567.77 1.6 Region : 4054
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 98 92 Validity : 0
Towing dir: 0° Wire out : 130 m Speed : 3.2 kn
Sorted : 94 Total catch: 93.74 Catch/hour: 186.98

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Trachurus trecae | 73.01 | 407 | 39.04 | 41 |
| Sardinella maderensis | 58.84 | 337 | 31.47 | 40 |
| Lagocephalus laevigatus | 16.60 | 34 | 8.88 | |
| Selene dorsalis | 15.44 | 6 | 8.26 | 43 |
| Scomberomorus tritor | 7.18 | 6 | 3.84 | 42 |
| Euthynnus alletteratus | 7.10 | 6 | 3.80 | 44 |
| Trachinotus ovatus | 4.51 | 12 | 2.41 | 45 |
| Sardinella aurita | 2.19 | 12 | 1.17 | 39 |
| Trichiurus lepturus | 1.72 | 2 | 0.92 | |
| Illex coindetii | 0.40 | 4 | 0.21 | |
| Total | 186.98 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 14
DATE :06/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 7°51.45
start stop duration Lon E 12°59.87
TIME :02:31:17 03:01:06 29.8 (min) Purpose : 1
LOG : 2594.66 2596.27 1.6 Region : 4054
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 52 56 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.2 kn
Sorted : 44 Total catch: 111.08 Catch/hour: 223.50

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Sardinella aurita | 85.79 | 477 | 38.39 | 47 |
| Sardinella maderensis | 75.25 | 628 | 33.67 | 46 |
| Ilisha africana *** | 27.24 | 419 | 12.19 | 49 |
| Chloroscombrus chrysurus | 14.53 | 181 | 6.50 | 48 |
| Selene dorsalis | 12.60 | 125 | 5.64 | 51 |
| Sphyraena guachancho | 3.26 | 20 | 1.46 | |
| Echeneis naucrates | 1.09 | 6 | 0.49 | |
| Sarda sarda | 0.97 | 2 | 0.43 | |
| Brachydeuterus auritus | 0.76 | 14 | 0.34 | |
| Trachurus trecae | 0.76 | 80 | 0.34 | 50 |
| Decapterus punctatus | 0.48 | 6 | 0.22 | |
| Trichiurus lepturus | 0.32 | 4 | 0.14 | |
| Alloteuthis africana | 0.28 | 93 | 0.13 | |
| Scomber japonicus | 0.16 | 2 | 0.07 | |
| Total | 223.50 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 15
DATE :06/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 7°56.23
start stop duration Lon E 12°50.85
TIME :07:50:23 08:18:46 28.4 (min) Purpose : 1
LOG : 2612.07 2613.56 1.5 Region : 4054
FDEPTH: 103 104 Gear cond.: 0
BDEPTH: 103 104 Validity : 0
Towing dir: 0° Wire out : 280 m Speed : 3.2 kn
Sorted : 0 Total catch: 145.89 Catch/hour: 308.44

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Trichiurus lepturus | 109.39 | 258 | 35.47 | |
| Lagocephalus laevigatus | 43.32 | 82 | 14.04 | |
| Dentex angolensis | 41.78 | 258 | 13.54 | 54 |
| Cynoponticus ferox | 34.08 | 2 | 11.05 | |
| Dentex congoensis | 13.83 | 307 | 4.48 | 53 |
| JELLYFISH | 10.87 | 55 | 3.52 | |
| Brachydeuterus auritus | 7.78 | 51 | 2.52 | |
| Trachurus trecae | 6.72 | 38 | 2.18 | 52 |
| Pagellus bellottii | 6.43 | 72 | 2.08 | 55 |
| Uranoscopus cadenati | 5.84 | 2 | 1.89 | |
| Illex coindetii | 5.20 | 57 | 1.69 | |
| Antennarius sp. | 3.81 | 25 | 1.23 | |
| Merluccius polli | 3.21 | 387 | 1.04 | |
| Zeus faber | 2.79 | 25 | 0.90 | |
| Pontinus accraensis | 2.62 | 13 | 0.85 | |
| Brotula barbata | 2.07 | 2 | 0.67 | |
| Umbrina canariensis | 1.78 | 8 | 0.58 | |
| Sepia orbignyana | 1.78 | 6 | 0.58 | |
| Citharus linguatula | 1.48 | 27 | 0.48 | |
| Selene dorsalis | 1.27 | 2 | 0.41 | |
| Octopus vulgaris | 0.97 | 2 | 0.32 | |
| Saurida brasiliensis | 0.42 | 42 | 0.14 | |
| Chaetodon hoefleri | 0.42 | 2 | 0.14 | |
| Microchirus frechkopi | 0.38 | 6 | 0.12 | |
| Parapristipoma humile | 0.21 | 2 | 0.07 | |
| Metal waste | 0.00 | 6 | 0.00 | |
| Total | 308.44 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 16
DATE :06/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 7°58.97
start stop duration Lon E 12°45.03
TIME :10:07:05 10:35:39 28.6 (min) Purpose : 1
LOG : 2624.78 2626.32 1.6 Region : 4054
FDEPTH: 124 124 Gear cond.: 0
BDEPTH: 124 124 Validity : 0
Towing dir: 0° Wire out : 340 m Speed : 3.3 kn
Sorted : 122 Total catch: 121.95 Catch/hour: 256.11

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Dentex angolensis | 69.62 | 288 | 27.18 | 58 |
| Dentex congoensis | 42.59 | 296 | 16.63 | 59 |
| Spicara alta | 41.33 | 806 | 16.14 | 61 |
| Erythrocles monodi | 24.11 | 269 | 9.41 | |
| Ariomma bondi | 16.59 | 368 | 6.48 | |
| Octopus macropus | 14.70 | 17 | 5.74 | |
| Trigla lyra | 10.88 | 132 | 4.25 | |
| Boops boops | 7.48 | 181 | 2.92 | |
| Zenopsis conchifer | 6.51 | 4 | 2.54 | |
| Umbrina canariensis | 4.62 | 13 | 1.80 | |
| Trachurus trecae | 3.65 | 25 | 1.43 | 57 |
| Zeus faber | 2.65 | 11 | 1.03 | |
| Dentex barnardi | 2.56 | 6 | 1.00 | |
| Branchiostegus semifasciatus | 2.52 | 4 | 0.98 | |
| Scomber japonicus | 1.30 | 27 | 0.51 | 60 |
| Sepia orbignyana | 1.22 | 8 | 0.48 | |
| Lagocephalus laevigatus | 1.18 | 2 | 0.46 | |
| Illex coindetii | 0.80 | 11 | 0.31 | |
| Brachydeuterus auritus | 0.59 | 4 | 0.23 | |
| Pagellus bellottii | 0.59 | 11 | 0.23 | |
| Trichiurus lepturus | 0.34 | 4 | 0.13 | |
| Uranoscopus cadenati | 0.13 | 4 | 0.05 | |
| Alloteuthis africana | 0.08 | 15 | 0.03 | |
| Citharus linguatula | 0.08 | 6 | 0.03 | |
| Total | 256.11 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 17
DATE :06/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 8°3.57
start stop duration Lon E 12°56.38
TIME :20:41:49 21:11:52 30.1 (min) Purpose : 1
LOG : 2670.26 2671.95 1.7 Region : 4054
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 98 89 Validity : 0
Towing dir: 0° Wire out : 130 m Speed : 3.4 kn
Sorted : 0 Total catch: 17.31 Catch/hour: 34.56

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Sardinella aurita | 11.26 | 54 | 32.58 | 62 |
| Sardinella maderensis | 10.50 | 62 | 30.39 | 63 |
| Lagocephalus laevigatus | 7.69 | 20 | 22.24 | |
| Illex coindetii | 1.80 | 18 | 5.20 | |
| Trachinotus ovatus | 1.60 | 4 | 4.62 | 64 |
| Euthynnus alletteratus | 1.32 | 2 | 3.81 | |
| JELLYFISH | 0.40 | 2 | 1.16 | |
| Total | 34.56 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 18
DATE :07/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 8°10.30
start stop duration Lon E 13°10.48
TIME :00:31:07 01:01:14 30.1 (min) Purpose : 1
LOG : 2697.24 2698.83 1.6 Region : 4054
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 42 50 Validity : 0
Towing dir: 0° Wire out : 145 m Speed : 3.2 kn
Sorted : 52 Total catch: 52.17 Catch/hour: 103.93

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Brachydeuterus auritus | 41.59 | 1434 | 40.02 | |
| Sardinella maderensis | 21.59 | 263 | 20.78 | 66 |
| Sardinella aurita | 11.91 | 201 | 11.46 | 65 |
| Ilisha africana *** | 8.53 | 205 | 8.20 | 68 |
| Chloroscombrus chrysurus | 8.25 | 82 | 7.93 | 67 |
| Selene dorsalis | 5.38 | 137 | 5.17 | 71 |
| Sarda sarda | 3.55 | 8 | 3.41 | |
| Trichiurus lepturus | 0.80 | 125 | 0.77 | |
| Trachurus trecae | 0.48 | 28 | 0.46 | 69 |
| Sphyraena guachancho | 0.48 | 2 | 0.46 | |
| Alloteuthis africana | 0.34 | 181 | 0.33 | |
| Scomber japonicus | 0.32 | 28 | 0.31 | |
| Sepia officinalis | 0.26 | 12 | 0.25 | |
| Eucinostomus melanopterus | 0.18 | 2 | 0.17 | |
| Galeoides decadactylus | 0.11 | 2 | 0.11 | |
| Echeneis naucrates | 0.11 | 2 | 0.10 | |
| Parapenaeus longirostris | 0.07 | 4 | 0.06 | |
| Total | 103.93 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 19
DATE :07/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 8°26.39
start stop duration Lon E 12°59.24
TIME :08:20:40 08:45:40 25.0 (min) Purpose : 1
LOG : 2748.47 2749.80 1.3 Region : 4054
FDEPTH: 123 125 Gear cond.: 0
BDEPTH: 123 125 Validity : 0
Towing dir: 0° Wire out : 310 m Speed : 3.2 kn
Sorted : 86 Total catch: 86.36 Catch/hour: 207.26

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Dentex angolensis | 49.54 | 221 | 23.90 | 73 |
| Dentex congoensis | 46.94 | 300 | 22.65 | 75 |
| Spicara alta | 45.36 | 336 | 21.89 | 72 |
| Ariomma bondi | 42.72 | 787 | 20.61 | 76 |
| Sphoeroides pachygaster | 7.10 | 7 | 3.43 | |
| Erythrocles monodi | 3.41 | 34 | 1.64 | |
| Umbrina canariensis | 3.07 | 10 | 1.48 | |
| Octopus vulgaris | 2.54 | 2 | 1.23 | |
| Pagellus bellottii | 1.44 | 10 | 0.69 | 74 |
| Illex coindetii | 1.34 | 22 | 0.65 | |
| Boops boops | 0.91 | 10 | 0.44 | |
| Zeus faber | 0.67 | 2 | 0.32 | |
| Chelidonichthys capensis | 0.67 | 5 | 0.32 | |
| Sepia officinalis | 0.58 | 2 | 0.28 | |
| Scomber japonicus | 0.43 | 10 | 0.21 | 77 |
| Chaetodon hoefleri | 0.38 | 2 | 0.19 | |
| Lophiodes kempi | 0.14 | 2 | 0.07 | |
| Total | 207.26 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 20
DATE :07/10/17 GEAR TYPE: PT NO: 1 POSITION:Lat S 8°21.90
start stop duration Lon E 13°8.92
TIME :11:19:17 12:05:39 46.4 (min) Purpose : 1
LOG : 2763.83 2766.28 2.5 Region : 4054
FDEPTH: 35 55 Gear cond.: 0
BDEPTH: 72 79 Validity : 0
Towing dir: 0° Wire out : 140 m Speed : 3.2 kn
Sorted : 0 Total catch: 1.10 Catch/hour: 1.42

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Lagocephalus laevigatus | 1.04 | 3 | 72.73 | |
| Sardinella maderensis | 0.39 | 3 | 27.27 | |
| Total | 1.42 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 21
DATE :07/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 8°20.07
start stop duration Lon E 13°11.19
TIME :13:00:42 13:19:58 19.3 (min) Purpose : 1
LOG : 2772.83 2773.86 1.0 Region : 4054
FDEPTH: 58 59 Gear cond.: 0
BDEPTH: 58 59 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.2 kn
Sorted : 308 Total catch: 898.39 Catch/hour: 2797.27

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Brachydeuterus auritus | 2178.19 | 49784 | 77.87 | |
| Trachurus trecae | 220.08 | 2176 | 7.87 | 80 |
| Sphyraena guachancho | 93.32 | 202 | 3.34 | |
| Trichiurus lepturus | 50.15 | 872 | 1.79 | |
| Pagellus bellottii | 49.60 | 495 | 1.77 | |
| Sardinella aurita | 46.11 | 330 | 1.65 | 78 |
| Galeoides decadactylus | 40.60 | 156 | 1.45 | |
| Selene dorsalis | 39.50 | 461 | 1.41 | 81 |
| Chloroscombrus chrysurus | 39.13 | 377 | 1.40 | |
| Sardinella maderensis | 17.08 | 165 | 0.61 | 79 |
| Pomadasys incisus | 8.82 | 56 | 0.32 | |
| Octopus macropus | 5.33 | 9 | 0.19 | |
| Lagocephalus laevigatus | 4.78 | 9 | 0.17 | |
| Dentex angolensis | 2.57 | 9 | 0.09 | |
| Pseudupeneus prayensis | 0.73 | 9 | 0.03 | |
| Dentex barnardi | 0.73 | 9 | 0.03 | |
| Sepia orbignyana | 0.55 | 9 | 0.02 | |
| Total | 2797.28 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 22
DATE :07/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 8°19.81
start stop duration Lon E 13°19.08
TIME :15:24:28 15:45:11 20.7 (min) Purpose : 1
LOG : 2783.99 2785.10 1.1 Region : 4054
FDEPTH: 22 23 Gear cond.: 0
BDEPTH: 22 23 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.2 kn
Sorted : 250 Total catch: 499.16 Catch/hour: 1445.46

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Brachydeuterus auritus | 751.27 | 26004 | 51.97 | |
| Sphyraena guachancho | 168.42 | 724 | 11.65 | 84 |
| Ilisha africana *** | 116.87 | 4002 | 8.09 | |
| Galeoides decadactylus | 89.88 | 689 | 6.22 | |
| Carlarius parkii | 71.12 | 139 | 4.92 | |
| Rhinoptera marginata *** | 50.04 | 23 | 3.46 | |
| Pseudotolithus senegalensis | 44.94 | 237 | 3.11 | |
| Sardinella aurita | 23.86 | 817 | 1.65 | 82 |
| Rhinobatos albomaculatus | 23.05 | 6 | 1.59 | |
| Chloroscombrus chrysurus | 19.58 | 411 | 1.35 | |
| Eucinostomus melanopterus | 15.29 | 272 | 1.06 | |
| Pteroscion peli | 14.71 | 440 | 1.02 | |
| Trichiurus lepturus | 7.64 | 272 | 0.53 | |
| Drepane africana | 6.37 | 35 | 0.44 | |
| Sardinella maderensis | 6.02 | 214 | 0.42 | 83 |
| Sepia orbignyana | 5.68 | 6 | 0.39 | |
| Pseudupeneus prayensis | 5.44 | 64 | 0.38 | |
| Pomadasys incisus | 5.33 | 69 | 0.37 | |
| Panulirus regius | 3.36 | 12 | 0.23 | |
| Pomadasys jubelini | 3.24 | 23 | 0.22 | |
| Ephippion guttifer | 2.20 | 6 | 0.15 | |
| Pentanemus quinquarius | 1.97 | 52 | 0.14 | |
| Lagocephalus laevigatus | 1.74 | 12 | 0.12 | |
| Selene dorsalis | 1.74 | 98 | 0.12 | |
| Penaeus notialis | 1.62 | 139 | 0.11 | |
| Unidentified | 1.51 | 6 | 0.10 | |
| Ethmalosa fimbriata | 0.81 | 6 | 0.06 | |
| Pisodonophis semicinctus | 0.79 | 6 | 0.05 | |
| Sepia officinalis | 0.35 | 12 | 0.02 | |
| Cynoglossus senegalensis | 0.35 | 6 | 0.02 | |
| Dicologoglossa cuneata | 0.23 | 6 | 0.02 | |
| Trachurus trecae | 0.03 | 6 | 0.00 | |
| Total | 1445.46 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 23
DATE :07/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 8°33.90
start stop duration Lon E 13°6.51
TIME :18:59:28 19:30:07 30.6 (min) Purpose : 1
LOG : 2806.72 2808.31 1.6 Region : 4054
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 99 108 Validity : 0
Towing dir: 0° Wire out : 130 m Speed : 3.1 kn
Sorted : 57 Total catch: 56.58 Catch/hour: 110.76

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Lagocephalus laevigatus | 29.13 | 78 | 26.30 | |
| Trachurus trecae | 25.72 | 3674 | 23.22 | 89 |
| Engraulis encrasicolus | 20.63 | 2580 | 18.63 | 90 |
| Sardinella maderensis | 15.31 | 80 | 13.82 | 86 |
| Scomber japonicus | 5.87 | 217 | 5.30 | 87 |
| Sardinella aurita | 4.27 | 23 | 3.85 | 85 |
| Euthynnus alletteratus | 2.70 | 4 | 2.44 | 88 |
| Synagrops microlepis | 2.27 | 1623 | 2.05 | |
| Bregmaceros mcclellandi | 1.92 | 1319 | 1.73 | |
| Auxis thazard | 1.10 | 2 | 0.99 | |
| Saurida brasiliensis | 0.78 | 364 | 0.71 | |
| Hemiramphus balao | 0.47 | 4 | 0.42 | |
| Illex coindetii | 0.47 | 12 | 0.42 | |
| Selene dorsalis | 0.12 | 76 | 0.11 | |
| Total | 110.76 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 24
DATE :07/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 8°47.82
start stop duration Lon E 12°59.41
TIME :23:39:23 00:14:32 35.1 (min) Purpose : 1
LOG : 2840.48 2841.96 1.5 Region : 4054
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 207 237 Validity : 0
Towing dir: 0° Wire out : 145 m Speed : 2.5 kn
Sorted : 0 Total catch: 25.42 Catch/hour: 43.39

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Caranx crysos | 18.16 | 12 | 41.86 | 93 |
| Sardinella aurita | 11.47 | 46 | 26.44 | 91 |
| Trichiurus lepturus | 7.34 | 46 | 16.92 | |
| Sardinella maderensis | 4.47 | 19 | 10.31 | 92 |
| Trachinotus ovatus | 1.23 | 3 | 2.83 | 94 |
| SALPS | 0.72 | 0 | 1.65 | |
| Total | 43.39 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 25
DATE :08/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 8°50.23
start stop duration Lon E 13°7.13
TIME :02:25:20 02:47:13 21.9 (min) Purpose : 1
LOG : 2856.95 2858.34 1.4 Region : 4054
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 96 105 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.8 kn
Sorted : 95 Total catch: 95.28 Catch/hour: 261.29

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Sardinella maderensis | 81.83 | 614 | 31.32 | 96 |
| Trachurus trecae | 59.56 | 8627 | 22.80 | 97 |
| Isurus oxyrinchus | 48.81 | 3 | 18.68 | |
| Lagocephalus laevigatus | 36.25 | 74 | 13.87 | |
| Scomber japonicus | 8.72 | 0 | 3.34 | 99 |
| Engraulis encrasicolus | 8.28 | 1478 | 3.17 | 98 |
| Sardinella aurita | 6.36 | 134 | 2.43 | 95 |
| Sphyraena guachancho | 6.14 | 19 | 2.35 | 101 |
| Sarda sarda | 3.73 | 11 | 1.43 | 100 |
| Chloroscombrus chrysurus | 1.10 | 8 | 0.42 | |
| Illex coindetii | 0.27 | 3 | 0.10 | |
| Saurida brasiliensis | 0.19 | 30 | 0.07 | |
| Small squids | 0.04 | 11 | 0.01 | |
| Total | 261.29 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 26
DATE :14/10/17 GEAR TYPE: PT NO: 7 POSITION:Lat S 9°14.16
start stop duration Lon E 12°56.23
TIME :22:14:11 22:23:15 9.1 (min) Purpose : 1
LOG : 3118.03 3118.50 0.5 Region : 4040
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 21 23 Validity : 0
Towing dir: 0° Wire out : 175 m Speed : 3.1 kn
Sorted : 0 Total catch: 129.32 Catch/hour: 855.46

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Sardinella maderensis | 342.67 | 7244 | 40.06 | 103 |
| Chloroscombrus chrysurus | 117.35 | 569 | 13.72 | 106 |
| Selene dorsalis | 94.73 | 1316 | 11.07 | 104 |
| Brachydeuterus auritus | 88.64 | 1528 | 10.36 | 105 |
| Sphyraena guachancho | 69.99 | 218 | 8.18 | 108 |
| JELLYFISH | 57.55 | 33 | 6.73 | |
| Ilisha africana *** | 38.37 | 331 | 4.49 | 107 |
| Caranx crysos | 36.25 | 26 | 4.24 | 110 |
| Galeoides decadactylus | 7.94 | 93 | 0.93 | 109 |
| Sardinella aurita | 1.72 | 79 | 0.20 | 102 |
| Trachurus trecae | 0.13 | 7 | 0.02 | 111 |
| Bregmaceros atlanticus | 0.07 | 40 | 0.01 | |
| Sardinella aurita | 0.05 | 7 | 0.01 | 112 |
| Total | 855.46 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 27
DATE :15/10/17 GEAR TYPE: PT NO: 1 POSITION:Lat S 9°24.77
start stop duration Lon E 12°43.75
TIME :04:08:09 04:29:24 21.3 (min) Purpose : 1
LOG : 3165.97 3167.05 1.1 Region : 4040
FDEPTH: 15 30 Gear cond.: 0
BDEPTH: 156 139 Validity : 0
Towing dir: 0° Wire out : 110 m Speed : 3.0 kn
Sorted : 0 Total catch: 0.00 Catch/hour: 0.00

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

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 28
DATE :15/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 9°40.72
start stop duration Lon E 12°54.44
TIME :16:42:52 17:01:54 19.0 (min) Purpose : 1
LOG : 3248.20 3249.19 1.0 Region : 4040
FDEPTH: 113 111 Gear cond.: 0
BDEPTH: 113 111 Validity : 0
Towing dir: 0° Wire out : 280 m Speed : 3.1 kn
Sorted : 192 Total catch: 327.60 Catch/hour: 1032.90

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Synagrops microlepis | 772.28 | 159162 | 74.77 | |
| Trichiurus lepturus | 50.76 | 66 | 4.91 | |
| Cynoponticus ferox | 29.64 | 6 | 2.87 | |
| Trachurus trecae | 29.07 | 123 | 2.81 | 113 |
| Lagocephalus laevigatus | 25.54 | 47 | 2.47 | |
| Brotula barbata | 18.29 | 9 | 1.77 | |
| Dentex angolensis | 16.08 | 91 | 1.56 | |
| Scorpaena normani | 14.38 | 114 | 1.39 | |
| Umbrina canariensis | 11.85 | 47 | 1.15 | |
| Zeus faber | 10.09 | 16 | 0.98 | |
| Illex coindetii | 8.64 | 205 | 0.84 | |
| Uranoscopus polli | 7.31 | 25 | 0.71 | |
| Branchiostegus semifasciatus | 7.00 | 6 | 0.68 | |
| Trigla lyra | 5.04 | 44 | 0.49 | |
| Ariomma bondi | 4.73 | 54 | 0.46 | |
| Octopus magnificus | 4.60 | 3 | 0.45 | |
| Saurida brasiliensis | 4.54 | 438 | 0.44 | |
| Boops boops | 4.10 | 117 | 0.40 | |
| Citharus linguatula | 2.65 | 60 | 0.26 | |
| Pterothrissus belloci | 1.64 | 13 | 0.16 | |
| Merluccius polli | 1.45 | 76 | 0.14 | |
| Sepia orbignyana | 1.01 | 6 | 0.10 | |
| Sphyraena guachancho | 0.88 | 3 | 0.09 | |
| Lophiodes kempi | 0.76 | 6 | 0.07 | |
| Scomber japonicus | 0.57 | 13 | 0.05 | 114 |
| Total | 1032.90 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 29
DATE :15/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 9°37.73
start stop duration Lon E 13°7.32
TIME :19:29:59 19:49:40 19.7 (min) Purpose : 1
LOG : 3266.01 3267.25 1.3 Region : 4040
FDEPTH: 5 5 Gear cond.: 0
BDEPTH: 34 34 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 3.8 kn
Sorted : 26 Total catch: 25.68 Catch/hour: 78.29

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Sardinella aurita | 38.23 | 1625 | 48.83 | 115 |
| Sardinella maderensis | 23.17 | 320 | 29.60 | 116 |
| Pomadasys peroteti** | 8.41 | 9 | 10.75 | |
| Sphyraena guachancho | 3.05 | 12 | 3.89 | |
| Chloroscombrus chrysurus | 1.83 | 15 | 2.34 | |
| Caranx rhonchus | 1.65 | 6 | 2.10 | |
| Sarda sarda | 1.52 | 3 | 1.95 | |
| Scomber japonicus | 0.24 | 3 | 0.31 | |
| Alloteuthis africana | 0.18 | 58 | 0.23 | |
| Total | 78.29 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 30
DATE :15/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 9°48.92
start stop duration Lon E 13°9.48
TIME :22:59:06 23:21:37 22.5 (min) Purpose : 1
LOG : 3288.63 3289.99 1.4 Region : 4040
FDEPTH: 5 5 Gear cond.: 0
BDEPTH: 40 41 Validity : 0
Towing dir: 0° Wire out : 130 m Speed : 3.6 kn
Sorted : 0 Total catch: 261.04 Catch/hour: 695.49

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Chloroscombrus chrysurus | 323.55 | 2683 | 46.52 | |
| Sardinella aurita | 172.54 | 2955 | 24.81 | 117 |
| Sardinella maderensis | 100.39 | 12805 | 14.43 | 118 |
| Caranx rhonchus | 25.79 | 133 | 3.71 | |
| Sphyraena guachancho | 21.79 | 101 | 3.13 | |
| Sarda sarda | 17.48 | 48 | 2.51 | |
| Lagocephalus laevigatus | 16.63 | 35 | 2.39 | |
| Alectis alexandrinus | 5.28 | 8 | 0.76 | |
| Arius parkii ** | 5.28 | 3 | 0.76 | |
| Selene dorsalis | 3.09 | 27 | 0.44 | |
| Selar crumenophthalmus | 1.12 | 5 | 0.16 | |
| Trachinotus goreensis | 0.91 | 3 | 0.13 | |
| Scomber japonicus | 0.80 | 11 | 0.11 | 119 |
| Alloteuthis africana | 0.43 | 144 | 0.06 | |
| Decapterus punctatus | 0.37 | 3 | 0.05 | |
| Synagrops microlepis | 0.05 | 8 | 0.01 | |
| Total | 695.49 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 31
DATE :16/10/17 GEAR TYPE: PT NO: 1 POSITION:Lat S 10°0.83
start stop duration Lon E 13°7.97
TIME :12:39:31 13:08:53 29.4 (min) Purpose : 1
LOG : 3356.63 3358.51 1.9 Region : 4040
FDEPTH: 30 30 Gear cond.: 0
BDEPTH: 75 64 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 3.8 kn
Sorted : 0 Total catch: 0.00 Catch/hour: 0.00

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

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 32
DATE :16/10/17 GEAR TYPE: PT NO: 2 POSITION:Lat S 10°6.31
start stop duration Lon E 13°20.12
TIME :18:09:42 18:27:45 18.1 (min) Purpose : 1
LOG : 3384.37 3385.29 0.9 Region : 4040
FDEPTH: 20 21 Gear cond.: 0
BDEPTH: 20 21 Validity : 0
Towing dir: 0° Wire out : 90 m Speed : 3.0 kn
Sorted : 75 Total catch: 75.02 Catch/hour: 249.37

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Brachydeuterus auritus | 125.12 | 4803 | 50.17 | |
| Ilisha africana *** | 40.29 | 898 | 16.16 | |
| Sardinella maderensis | 32.84 | 798 | 13.17 | 121 |
| Sphyraena guachancho | 14.16 | 50 | 5.68 | |
| Ephippion guttifer | 9.64 | 3 | 3.87 | |
| Selene dorsalis | 7.98 | 166 | 3.20 | |
| Sardinella aurita | 7.25 | 63 | 2.91 | 120 |
| Jellyfish | 6.45 | 3 | 2.59 | |
| Scomberomorus tritor | 2.13 | 3 | 0.85 | |
| Chloroscombrus chrysurus | 1.73 | 30 | 0.69 | |
| Trachinotus ovatus | 0.53 | 3 | 0.21 | |
| Remora remora | 0.47 | 3 | 0.19 | |
| Pomadasys incisus | 0.40 | 3 | 0.16 | |
| Galeoides decadactylus | 0.40 | 3 | 0.16 | |
| Total | 249.37 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 33
DATE :16/10/17 GEAR TYPE: PT NO: 1 POSITION:Lat S 10°12.41
start stop duration Lon E 13°10.91
TIME :21:43:06 21:59:30 16.4 (min) Purpose : 1
LOG : 3405.06 3405.85 0.8 Region : 4040
FDEPTH: 35 25 Gear cond.: 0
BDEPTH: 88 91 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 2.9 kn
Sorted : 28 Total catch: 27.89 Catch/hour: 102.04

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Trachurus trecae | 60.00 | 6684 | 58.80 | 125 |
| Brachydeuterus auritus | 16.02 | 252 | 15.70 | |
| Sardinella aurita | 8.27 | 391 | 8.10 | 122 |
| Lagocephalus laevigatus | 6.73 | 22 | 6.60 | |
| Saurida brasiliensis | 3.66 | 768 | 3.59 | |
| Sardinella maderensis | 3.33 | 18 | 3.26 | 124 |
| Bregmaceros atlanticus | 3.07 | 1482 | 3.01 | |
| Engraulis encrasicolus | 0.44 | 40 | 0.43 | |
| Scomber japonicus | 0.30 | 4 | 0.29 | 123 |
| Loligo vulgaris | 0.15 | 51 | 0.14 | |
| Synagrops microlepis | 0.07 | 70 | 0.07 | |
| Total | 102.04 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 34
DATE :17/10/17 GEAR TYPE: PT NO: 1 POSITION:Lat S 10°21.43
start stop duration Lon E 13°16.23
TIME :03:33:50 04:03:20 29.5 (min) Purpose : 1
LOG : 3451.29 3452.89 1.6 Region : 4040
FDEPTH: 10 25 Gear cond.: 0
BDEPTH: 90 82 Validity : 0
Towing dir: 0° Wire out : 90 m Speed : 3.3 kn
Sorted : 3 Total catch: 3.12 Catch/hour: 6.35

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Trachurus trecae | 2.52 | 283 | 39.74 | 126 |
| Lagocephalus laevigatus | 2.48 | 8 | 39.10 | |
| Saurida brasiliensis | 0.53 | 104 | 8.33 | |
| Sardinella aurita | 0.33 | 31 | 5.13 | 127 |
| Alloteuthis africana | 0.33 | 122 | 5.13 | |
| Synagrops microlepis | 0.16 | 59 | 2.56 | |
| Total | 6.35 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 35
DATE :17/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 10°39.34
start stop duration Lon E 13°26.83
TIME :14:36:29 15:03:31 27.0 (min) Purpose : 1
LOG : 3526.95 3528.35 1.4 Region : 4040
FDEPTH: 97 97 Gear cond.: 0
BDEPTH: 97 97 Validity : 0
Towing dir: 0° Wire out : 270 m Speed : 3.1 kn
Sorted : 598 Total catch: 597.54 Catch/hour: 1326.39

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Synagrops microlepis | 1051.50 | 301880 | 79.28 | |
| Lagocephalus laevigatus | 100.95 | 280 | 7.61 | |
| Trichiurus lepturus | 66.28 | 222 | 5.00 | |
| Stromateus fiatola | 56.78 | 73 | 4.28 | |
| Zeus faber | 17.54 | 42 | 1.32 | |
| Squatina oculata | 13.01 | 4 | 0.98 | |
| Uranoscopus polli | 3.95 | 9 | 0.30 | |
| Citharus linguatula | 2.71 | 38 | 0.20 | |
| Brotula barbata | 2.40 | 2 | 0.18 | |
| Raja miraletus | 2.22 | 2 | 0.17 | |
| Scorpaena normani | 2.13 | 29 | 0.16 | |
| Illex coindetii | 2.09 | 18 | 0.16 | |
| Umbrina canariensis | 1.07 | 2 | 0.08 | |
| Torpedo torpedo | 0.93 | 4 | 0.07 | |
| Chelidonichthys gabonensis | 0.80 | 4 | 0.06 | |
| Brachydeuterus auritus | 0.53 | 2 | 0.04 | |
| Dentex angolensis | 0.40 | 7 | 0.03 | |
| Pontinus accraensis | 0.36 | 2 | 0.03 | |
| Dicologoglossa hexophthalma | 0.27 | 4 | 0.02 | |
| Pterothrissus belloci | 0.27 | 2 | 0.02 | |
| Sepia orbignyana | 0.22 | 2 | 0.02 | |
| Total | 1326.39 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 36
DATE :17/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 10°39.23
start stop duration Lon E 13°42.29
TIME :18:12:09 18:36:07 24.0 (min) Purpose : 1
LOG : 3553.21 3554.49 1.3 Region : 4040
FDEPTH: 5 5 Gear cond.: 0
BDEPTH: 24 24 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.2 kn
Sorted : 131 Total catch: 131.38 Catch/hour: 328.86

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Chloroscombrus chrysurus | 129.06 | 2606 | 39.24 | 131 |
| Lagocephalus laevigatus | 83.15 | 198 | 25.29 | |
| Sardinella maderensis | 76.30 | 783 | 23.20 | 129 |
| Ilisha africana *** | 21.08 | 476 | 6.41 | 130 |
| Sardinella aurita | 7.21 | 45 | 2.19 | 128 |
| Brachydeuterus auritus | 5.56 | 223 | 1.69 | |
| Trichiurus lepturus | 2.00 | 15 | 0.61 | |
| Sphyraena guachancho | 1.45 | 8 | 0.44 | |
| Galeoides decadactylus | 1.25 | 23 | 0.38 | |
| Trachinotus ovatus | 1.10 | 20 | 0.33 | |
| Selene dorsalis | 0.55 | 20 | 0.17 | |
| Eucinostomus melanopterus | 0.15 | 3 | 0.05 | |
| Total | 328.86 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 37
DATE :17/10/17 GEAR TYPE: PT NO: 1 POSITION:Lat S 10°41.52
start stop duration Lon E 13°37.63
TIME :20:22:08 20:51:51 29.7 (min) Purpose : 1
LOG : 3566.10 3567.89 1.8 Region : 4040
FDEPTH: 25 35 Gear cond.: 0
BDEPTH: 52 50 Validity : 0
Towing dir: 0° Wire out : 110 m Speed : 3.6 kn
Sorted : 216 Total catch: 215.54 Catch/hour: 435.14

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Brachydeuterus auritus | 361.70 | 5396 | 83.12 | |
| Trachurus trecae | 38.92 | 2301 | 8.94 | 132 |
| Sardinella maderensis | 12.88 | 99 | 2.96 | 133 |
| Sepia orbignyana | 3.88 | 121 | 0.89 | |
| Sardinella aurita | 3.67 | 73 | 0.84 | 134 |
| Lagocephalus laevigatus | 2.95 | 4 | 0.68 | |
| Chloroscombrus chrysurus | 2.91 | 18 | 0.67 | |
| Stromateus fiatola | 2.34 | 6 | 0.54 | |
| Pagellus bellottii | 1.94 | 77 | 0.45 | |
| Boops boops | 1.17 | 67 | 0.27 | |
| Ilisha africana *** | 0.69 | 6 | 0.16 | |
| MYCTOPHIDAE | 0.52 | 404 | 0.12 | |
| Sphyraena guachancho | 0.48 | 2 | 0.11 | |
| Pomadasys incisus | 0.36 | 2 | 0.08 | |
| Trichiurus lepturus | 0.28 | 2 | 0.06 | |
| Bregmaceros atlanticus | 0.20 | 151 | 0.05 | |
| Alloteuthis africana | 0.12 | 22 | 0.03 | |
| Saurida brasiliensis | 0.08 | 20 | 0.02 | |
| Penaeus notialis | 0.04 | 2 | 0.01 | |
| Total | 435.14 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 38
DATE :17/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 10°45.74
start stop duration Lon E 13°31.77
TIME :22:39:38 23:10:07 30.5 (min) Purpose : 1
LOG : 3579.16 3580.73 1.6 Region : 4040
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 98 109 Validity : 0
Towing dir: 0° Wire out : 165 m Speed : 3.1 kn
Sorted : 85 Total catch: 526.36 Catch/hour: 1036.14

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Trichiurus lepturus | 1001.46 | 3366 | 96.65 | |
| Lagocephalus laevigatus | 26.97 | 81 | 2.60 | |
| Trachinotus ovatus | 3.86 | 18 | 0.37 | |
| Euthynnus alletteratus | 3.23 | 2 | 0.31 | |
| Sardinella maderensis | 0.63 | 4 | 0.06 | 135 |
| Total | 1036.14 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 39
DATE :18/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 10°51.61
start stop duration Lon E 13°45.75
TIME :11:55:26 12:19:16 23.8 (min) Purpose : 1
LOG : 3643.31 3644.56 1.3 Region : 4040
FDEPTH: 32 40 Gear cond.: 0
BDEPTH: 32 40 Validity : 0
Towing dir: 0° Wire out : 135 m Speed : 3.1 kn
Sorted : 163 Total catch: 403.96 Catch/hour: 1017.10

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Brachydeuterus auritus | 331.15 | 7825 | 32.56 | |
| Pseudotolithus senegallus | 136.72 | 463 | 13.44 | |
| Pteroscion peli | 124.18 | 2055 | 12.21 | |
| Raja miraletus | 118.04 | 40 | 11.61 | |
| Trichiurus lepturus | 112.90 | 770 | 11.10 | |
| Caretta caretta | 101.97 | 3 | 10.03 | |
| Galeoides decadactylus | 39.68 | 217 | 3.90 | |
| Dicologoglossa cuneata | 9.67 | 237 | 0.95 | |
| Pomadasys perotaei | 8.96 | 30 | 0.88 | |
| Rhinobatos ocellatus | 6.85 | 5 | 0.67 | |
| Ephippion guttifer | 6.34 | 5 | 0.62 | |
| Chloroscombrus chrysurus | 3.22 | 30 | 0.32 | |
| Grammoplites gruveli | 3.22 | 55 | 0.32 | |
| Trachurus trecae | 2.17 | 23 | 0.21 | 136 |
| Chilomycterus spinosus mauretanicus | 2.01 | 5 | 0.20 | |
| Umbrina canariensis | 1.71 | 35 | 0.17 | |
| Ilisha africana *** | 1.51 | 25 | 0.15 | |
| Echeneis naucrates | 1.31 | 5 | 0.13 | |
| Sphyraena guachancho | 1.31 | 10 | 0.13 | |
| Selene dorsalis | 1.11 | 15 | 0.11 | |
| Eucinostomus melanopterus | 0.70 | 5 | 0.07 | |
| Scomber japonicus | 0.50 | 5 | 0.05 | 137 |
| Sardinella maderensis | 0.50 | 5 | 0.05 | 138 |
| Sepia orbignyana | 0.50 | 50 | 0.05 | |
| Penaeus notialis | 0.40 | 15 | 0.04 | |
| Torpedo marmorata | 0.30 | 5 | 0.03 | |
| Alloteuthis africana | 0.10 | 101 | 0.01 | |
| Gobioides sp. | 0.05 | 55 | 0.00 | |
| Total | 1017.10 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 40
DATE :18/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 11°3.23
start stop duration Lon E 13°46.35
TIME :14:44:20 15:17:10 32.8 (min) Purpose : 1
LOG : 3662.92 3664.69 1.8 Region : 4040
FDEPTH: 56 54 Gear cond.: 0
BDEPTH: 56 54 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.2 kn
Sorted : 130 Total catch: 686.34 Catch/hour: 1254.36

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Brachydeuterus auritus | 389.78 | 5307 | 31.07 | |
| Trachurus trecae | 265.81 | 3699 | 21.19 | 139 |
| Raja miraletus | 175.71 | 269 | 14.01 | |
| Caretta caretta | 81.33 | 2 | 6.48 | |
| Pomadasys jubelini | 75.35 | 60 | 6.01 | |
| Argyrosomus hololepidotus | 68.67 | 148 | 5.47 | |
| Trichiurus lepturus | 45.84 | 183 | 3.65 | |
| Galeoides decadactylus | 25.52 | 79 | 2.03 | |
| Lagocephalus laevigatus | 15.80 | 35 | 1.26 | |
| Pomadasys incisus** | 15.80 | 60 | 1.26 | |
| Sardinella aurita | 15.45 | 521 | 1.23 | 140 |
| Rhinobatos annulatus | 12.06 | 4 | 0.96 | |
| Torpedo torpedo | 11.46 | 18 | 0.91 | |
| Pagellus bellottii | 10.42 | 113 | 0.83 | |
| Sepia orbignyana | 8.51 | 9 | 0.68 | |
| Pomatomus saltatrix | 7.47 | 9 | 0.60 | |
| Dentex barnardi | 7.47 | 26 | 0.60 | |
| Pseudotolithus senegalensis | 7.29 | 9 | 0.58 | |
| Selene dorsalis | 4.51 | 51 | 0.36 | |
| Octopus vulgaris | 2.08 | 9 | 0.17 | |
| Umbrina canariensis | 1.91 | 9 | 0.15 | |
| Pseudupeneus prayensis | 1.74 | 9 | 0.14 | |
| Sphyraena guachancho | 1.39 | 9 | 0.11 | |
| Chelidonichthys gabonensis | 1.22 | 9 | 0.10 | |
| Grammoplites gruveli | 0.69 | 26 | 0.06 | |
| Dicologoglossa cuneata | 0.52 | 9 | 0.04 | |
| Scomber japonicus | 0.22 | 4 | 0.02 | 141 |
| Gobioides sp. | 0.17 | 5 | 0.01 | |
| Citharus linguatula | 0.17 | 9 | 0.01 | |
| Total | 1254.36 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 41
DATE :18/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 11°11.37
start stop duration Lon E 13°39.97
TIME :20:18:36 20:18:51 0.3 (min) Purpose : 1
LOG : 3704.24 3704.25 0.0 Region : 4040
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 105 105 Validity : 0
Towing dir: 0° Wire out : 140 m Speed : 2.2 kn
Sorted : 74 Total catch: 73.62 Catch/hour: 17668.80

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Trichiurus lepturus | 16358.40 | 58560 | 92.58 | |
| Lagocephalus laevigatus | 1022.40 | 2160 | 5.79 | |
| Synagrops microlepis | 168.00 | 87840 | 0.95 | |
| MYCTOPHIDAE | 33.60 | 9360 | 0.19 | |
| Engraulis encrasicolus | 33.60 | 3840 | 0.19 | |
| Brachydeuterus auritus | 28.80 | 240 | 0.16 | |
| Scomber japonicus | 19.20 | 240 | 0.11 | |
| Saurida brasiliensis | 4.80 | 240 | 0.03 | |
| Total | 17668.80 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 42
DATE :18/10/17 GEAR TYPE: PT NO: 7 POSITION:Lat S 11°21.19
start stop duration Lon E 13°42.37
TIME :23:34:18 23:52:53 18.6 (min) Purpose : 1
LOG : 3723.86 3724.76 0.9 Region : 4040
FDEPTH: 5 5 Gear cond.: 0
BDEPTH: 26 29 Validity : 0
Towing dir: 0° Wire out : 155 m Speed : 2.9 kn
Sorted : 15 Total catch: 15.04 Catch/hour: 48.57

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Chloroscombrus chrysurus | 10.79 | 81 | 22.21 | |
| Lagocephalus laevigatus | 9.69 | 19 | 19.95 | |
| Pomadasys jubelini | 7.30 | 19 | 15.03 | |
| Sardinella maderensis | 5.68 | 48 | 11.70 | 143 |
| Sphyraena guachancho | 5.49 | 19 | 11.30 | |
| Sardinella aurita | 2.71 | 58 | 5.59 | 142 |
| Raja miraletus | 2.39 | 3 | 4.92 | |
| Pomadasys rogeri | 2.20 | 10 | 4.52 | |
| Sepia orbignyana | 0.78 | 388 | 1.60 | |
| Brachydeuterus auritus | 0.65 | 6 | 1.33 | |
| Eucinostomus melanopterus | 0.45 | 3 | 0.93 | |
| Alloteuthis africana | 0.19 | 45 | 0.40 | |
| Citharus linguatula | 0.19 | 3 | 0.40 | |
| Gobioides sp. | 0.06 | 16 | 0.13 | |
| Total | 48.57 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 43
DATE :19/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 11°40.27
start stop duration Lon E 13°45.64
TIME :08:11:29 08:35:02 23.6 (min) Purpose : 1
LOG : 3786.86 3788.19 1.3 Region : 4040
FDEPTH: 27 27 Gear cond.: 0
BDEPTH: 27 27 Validity : 0
Towing dir: 0° Wire out : 85 m Speed : 3.4 kn
Sorted : 126 Total catch: 858.50 Catch/hour: 2187.27

| SPECIES | CATCH/HOUR weight | % OF TOT. C numbers | SAMP |
|---|---|---|---|
| Brachydeuterus auritus | 1092.74 | 1496 49.96 | |
| Rhinobatos albomaculatus | 224.66 | 135 10.27 | |
| Galeoides decadactylus | 146.60 | 1340 6.70 | |
| Pseudotolithus senegalensis | 136.76 | 171 6.25 | |
| Lithognathus mormyrus | 127.94 | 390 5.85 | |
| Umbrina canariensis | 51.24 | 408 2.34 | |
| Argyrosomus hololepidotus | 49.71 | 51 2.27 | |
| Pagellus bellottii | 48.53 | 153 2.22 | |
| Atractoscion aequidens | 43.78 | 18 2.00 | |
| Pomadasys incisus | 40.04 | 33 1.83 | |
| Pomadasys peroteti** | 36.31 | 51 1.66 | |
| Pseudupeneus prayensis | 31.90 | 171 1.46 | |
| Selene dorsalis | 24.05 | 132 1.10 | 147 |
| Gymnura micrura | 20.77 | 18 0.95 | |
| Engraulis encrasicolus | 15.95 | 1832 0.73 | 148 |
| Torpedo torpedo | 13.57 | 18 0.62 | |
| Sphyraena guachancho | 12.89 | 33 0.59 | |
| Chloroscombrus chrysurus | 12.03 | 61 0.55 | |
| Alectis alexandrinus | 10.18 | 18 0.47 | |
| Ilisha africana *** | 10.09 | 89 0.46 | 149 |
| Lagocephalus laevigatus | 7.46 | 18 0.34 | |
| Selar crumenophthalmus | 7.46 | 33 0.34 | |
| Epinephelus aeneus | 5.77 | 18 0.26 | |
| Sardinella aurita | 4.69 | 145 0.21 | 144 |
| Mugil curema | 4.07 | 33 0.19 | |
| Penaeus notialis | 2.37 | 51 0.11 | |
| Trachurus trecae | 1.76 | 99 0.08 | 146 |
| Boops boops | 1.70 | 34 0.08 | |
| Sardinella maderensis | 1.22 | 8 0.06 | 145 |
| Dicologoglossa cuneata | 1.02 | 33 0.05 | |
| Total | 2187.27 | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 44
DATE :19/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 11°39.77
start stop duration Lon E 13°39.32
TIME :10:37:30 10:51:18 13.8 (min) Purpose : 1
LOG : 3802.03 3802.73 0.7 Region : 4040
FDEPTH: 59 61 Gear cond.: 0
BDEPTH: 59 61 Validity : 0
Towing dir: 0° Wire out : 175 m Speed : 3.0 kn
Sorted : 147 Total catch: 147.23 Catch/hour: 640.13

| SPECIES | CATCH/HOUR weight | % OF TOT. C numbers | SAMP |
|---|---|---|---|
| Trichiurus lepturus | 220.70 | 339 34.48 | |
| Lagocephalus laevigatus | 114.35 | 322 17.86 | |
| Trachurus trecae | 102.52 | 12565 16.02 | 150 |
| Manta birostris | 93.91 | 4 14.67 | |
| Brachydeuterus auritus | 40.70 | 287 6.36 | |
| Engraulis encrasicolus | 19.48 | 2122 3.04 | 152 |
| Sardinella aurita | 11.48 | 1026 1.79 | 151 |
| Alloteuthis africana | 6.26 | 2009 0.98 | |
| Auxis thazard | 5.22 | 9 0.82 | |
| Dentex barnardi | 4.70 | 26 0.73 | |
| Euthynnus alletteratus | 4.35 | 4 0.68 | |
| Atractoscion aequidens | 3.96 | 4 0.62 | |
| Umbrina canariensis | 3.22 | 13 0.50 | |
| Dentex angolensis | 2.52 | 70 0.39 | |
| Selene dorsalis | 2.17 | 9 0.34 | |
| Sphyraena guachancho | 1.30 | 4 0.20 | |
| Fistularia petimba | 1.22 | 4 0.19 | |
| Chaetodon marcellae **' | 0.70 | 4 0.11 | |
| Scorpaena stephanica | 0.61 | 4 0.10 | |
| Pseudupeneus prayensis | 0.35 | 4 0.05 | |
| Prognathodes marcellae | 0.35 | 4 0.05 | |
| Saurida brasiliensis | 0.09 | 9 0.01 | |
| Total | 640.13 | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 45
DATE :19/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 11°51.98
start stop duration Lon E 13°36.00
TIME :22:04:24 22:34:20 29.9 (min) Purpose : 1
LOG : 3863.61 3865.41 1.8 Region : 4040
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 96 83 Validity : 0
Towing dir: 0° Wire out : 145 m Speed : 3.6 kn
Sorted : 15 Total catch: 15.32 Catch/hour: 30.71

| SPECIES | CATCH/HOUR weight | % OF TOT. C numbers | SAMP |
|---|---|---|---|
| Euthynnus alletteratus | 7.10 | 4 23.11 | |
| Auxis thazard | 6.98 | 20 22.72 | |
| Trachinotus ovatus | 4.73 | 16 15.41 | |
| Sarda sarda | 4.33 | 12 14.10 | |
| Pomatomus saltatrix | 2.73 | 4 8.88 | |
| Saurida brasiliensis | 1.48 | 142 4.83 | |
| Scomber japonicus | 1.38 | 22 4.48 | |
| Hemiramphus balao | 0.72 | 4 2.35 | |
| Synagrops microlepis | 0.60 | 688 1.96 | |
| MYCTOPHIDAE | 0.48 | 130 1.57 | |
| Trachurus trecae | 0.10 | 10 0.34 | 153 |
| Leptocephalus | 0.04 | 0 0.13 | |
| Illex coindetii | 0.02 | 8 0.07 | |
| Bregmaceros atlanticus | 0.02 | 10 0.06 | |
| Total | 30.71 | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 46
DATE :20/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 12°1.09
start stop duration Lon E 13°39.61
TIME :02:51:58 03:22:06 30.1 (min) Purpose : 1
LOG : 3887.84 3889.37 1.5 Region : 4040
FDEPTH: 5 5 Gear cond.: 0
BDEPTH: 53 66 Validity : 0
Towing dir: 0° Wire out : 110 m Speed : 3.0 kn
Sorted : 119 Total catch: 118.64 Catch/hour: 236.26

| SPECIES | CATCH/HOUR weight | % OF TOT. C numbers | SAMP |
|---|---|---|---|
| Caretta caretta | 89.61 | 2 37.93 | |
| Lagocephalus laevigatus | 71.45 | 153 30.24 | |
| Sardinella maderensis | 25.01 | 115 10.59 | 154 |
| Trachurus trecae | 21.19 | 2147 8.97 | 156 |
| Pomatomus saltatrix | 9.52 | 12 4.03 | |
| Trichiurus lepturus | 5.30 | 10 2.24 | |
| Trachinotus ovatus | 4.26 | 18 1.80 | |
| Saurida brasiliensis | 3.19 | 482 1.35 | |
| Engraulis encrasicolus | 2.63 | 279 1.11 | 158 |
| Sphyraena guachancho | 1.99 | 2 0.84 | |
| Alloteuthis africana | 0.92 | 797 0.39 | |
| Sardinella aurita | 0.76 | 84 0.32 | 155 |
| Scomber japonicus | 0.36 | 6 0.15 | 157 |
| Bregmaceros sp. | 0.08 | 30 0.03 | |
| DIODONTIDAE | 0.00 | 4 0.00 | |
| Total | 236.26 | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 47
DATE :20/10/17 GEAR TYPE: PT NO: 1 POSITION:Lat S 12°9.94
start stop duration Lon E 13°37.36
TIME :07:55:16 08:21:00 25.7 (min) Purpose : 1
LOG : 3927.46 3928.91 1.4 Region : 4040
FDEPTH: 15 20 Gear cond.: 0
BDEPTH: 41 59 Validity : 0
Towing dir: 0° Wire out : 90 m Speed : 3.4 kn
Sorted : 74 Total catch: 74.12 Catch/hour: 172.84

| SPECIES | CATCH/HOUR weight | % OF TOT. C numbers | SAMP |
|---|---|---|---|
| Caretta caretta | 109.60 | 2 63.41 | |
| Trachinotus ovatus | 29.52 | 131 17.08 | |
| Lagocephalus laevigatus | 18.75 | 37 10.85 | |
| Sphyraena guachancho | 4.20 | 14 2.43 | |
| Sarda sarda | 4.10 | 9 2.37 | 160 |
| Sardinella maderensis | 3.40 | 23 1.97 | 159 |
| Chloroscombrus chrysurus | 2.15 | 12 1.24 | 161 |
| Remora remora | 1.12 | 2 0.65 | |
| Total | 172.84 | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 48
DATE :20/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 12°11.98
start stop duration Lon E 13°34.68
TIME :09:16:59 09:38:35 21.6 (min) Purpose : 1
LOG : 3933.64 3934.75 1.1 Region : 4040
FDEPTH: 65 69 Gear cond.: 0
BDEPTH: 65 69 Validity : 0
Towing dir: 0° Wire out : 175 m Speed : 3.1 kn
Sorted : 211 Total catch: 211.16 Catch/hour: 586.56

| SPECIES | CATCH/HOUR weight | % OF TOT. C numbers | SAMP |
|---|---|---|---|
| Trachurus trecae | 259.50 | 4117 44.24 | 162 |
| Pomadasys incisus | 91.67 | 656 15.63 | |
| Boops boops | 87.67 | 2092 14.95 | |
| Atractoscion aequidens | 55.06 | 28 9.39 | |
| Lagocephalus laevigatus | 18.28 | 56 3.12 | |
| Fistularia petimba | 15.56 | 50 2.65 | |
| Dentex angolensis | 9.22 | 44 1.57 | |
| Dentex barnardi | 7.78 | 31 1.33 | |
| Trichiurus lepturus | 6.94 | 14 1.18 | |
| Brachydeuterus auritus | 5.89 | 33 1.00 | |
| Octopus vulgaris | 4.83 | 3 0.82 | |
| Zeus faber | 3.83 | 6 0.65 | |
| Auxis thazard | 3.56 | 6 0.61 | |
| Trachinotus ovatus | 3.44 | 14 0.59 | 165 |
| Stromateus fiatola | 3.00 | 6 0.51 | |
| Sphyraena guachancho | 2.56 | 8 0.44 | |
| Branchiostegus semifasciatus | 2.06 | 3 0.35 | |
| Scomber japonicus | 1.39 | 19 0.24 | 163 |
| Engraulis encrasicolus | 1.22 | 103 0.21 | 164 |
| Chaetodon hoefleri | 1.11 | 6 0.19 | |
| Umbrina canariensis | 0.78 | 3 0.13 | |
| Sardinella maderensis | 0.72 | 3 0.12 | |
| Chelidonichthys gabonensis | 0.33 | 3 0.06 | |
| Citharus linguatula | 0.17 | 3 0.03 | |
| Total | 586.56 | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 49
DATE :21/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 12°26.24
start stop duration Lon E 13°25.39
TIME :13:35:01 13:56:22 21.4 (min) Purpose : 1
LOG : 4067.35 4068.56 1.2 Region : 4040
FDEPTH: 72 72 Gear cond.: 0
BDEPTH: 72 72 Validity : 0
Towing dir: 0° Wire out : 200 m Speed : 3.4 kn
Sorted : 0 Total catch: 338.94 Catch/hour: 952.52

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Synagrops microlepis | 486.18 | 202797 | 51.04 | |
| Trachurus trecae | 188.01 | 812 | 19.74 | 166 |
| Trichiurus lepturus | 145.24 | 365 | 15.25 | |
| Stromateus fiatola | 94.37 | 101 | 9.91 | |
| Sphyraena sphyraena | 7.64 | 22 | 0.80 | |
| Boops boops | 6.35 | 11 | 0.67 | |
| Torpedo torpedo | 5.40 | 17 | 0.57 | |
| Fistularia petimba | 3.20 | 8 | 0.34 | |
| Zeus faber | 3.09 | 6 | 0.32 | |
| Raja miraletus | 2.81 | 3 | 0.30 | |
| Dentex macrophthalmus | 2.36 | 20 | 0.25 | |
| Pomatomus saltatrix | 2.02 | 3 | 0.21 | |
| Lagocephalus laevigatus | 1.18 | 3 | 0.12 | |
| Dentex barnardi | 1.18 | 3 | 0.12 | |
| Sardinella aurita | 0.87 | 3 | 0.09 | |
| Chelidonichthys gabonensis | 0.84 | 6 | 0.09 | |
| Citharus linguatula | 0.79 | 14 | 0.08 | |
| Sepia orbignyana | 0.34 | 3 | 0.04 | |
| Scorpaena normani | 0.31 | 3 | 0.03 | |
| Serranus cabrilla | 0.28 | 3 | 0.03 | |
| Saurida brasiliensis | 0.06 | 3 | 0.01 | |
| Total | 952.52 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 50
DATE :21/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 12°35.26
start stop duration Lon E 13°6.92
TIME :19:57:45 20:23:45 26.0 (min) Purpose : 1
LOG : 4106.36 4107.87 1.5 Region : 4040
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 540 606 Validity : 0
Towing dir: 0° Wire out : 160 m Speed : 3.5 kn
Sorted : 20 Total catch: 20.22 Catch/hour: 46.66

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Ommastrephes pteropus | 22.02 | 81 | 47.18 | |
| MYCTOPHIDAE | 13.68 | 9097 | 29.33 | |
| Auxis thazard | 4.52 | 16 | 9.69 | 167 |
| Nealotus tripes | 2.40 | 97 | 5.14 | |
| S H R I M P S | 1.37 | 14705 | 2.93 | |
| Gempylus serpens | 1.11 | 7 | 2.37 | |
| Ariomma bondi | 1.06 | 25 | 2.27 | |
| Scopelosaurus herwigi | 0.32 | 2 | 0.69 | |
| Lestrolepis intermedia | 0.09 | 30 | 0.20 | |
| FISH LARVAE | 0.09 | 48 | 0.20 | |
| Total | 46.67 | | 100.01 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 51
DATE :21/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 12°40.85
start stop duration Lon E 13°5.38
TIME :23:24:52 23:55:07 30.3 (min) Purpose : 1
LOG : 4121.31 4123.03 1.7 Region : 4040
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 103 103 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.4 kn
Sorted : 53 Total catch: 333.85 Catch/hour: 662.18

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Trichiurus lepturus | 626.22 | 4011 | 94.57 | |
| Auxis thazard | 9.56 | 12 | 1.44 | |
| Trachinotus ovatus | 9.48 | 30 | 1.43 | |
| Lagocephalus laevigatus | 7.95 | 18 | 1.20 | |
| Balistes capriscus | 3.69 | 4 | 0.56 | |
| Sarda sarda | 1.98 | 4 | 0.30 | |
| MYCTOPHIDAE | 1.90 | 1428 | 0.29 | |
| Illex coindetii | 0.91 | 4 | 0.14 | |
| Lepidopus caudatus | 0.48 | 4 | 0.07 | |
| Total | 662.18 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 52
DATE :22/10/17 GEAR TYPE: PT NO: 1 POSITION:Lat S 13°4.45
start stop duration Lon E 12°51.36
TIME :05:32:03 05:38:03 6.0 (min) Purpose : 1
LOG : 4169.40 4169.74 0.3 Region : 4050
FDEPTH: 15 15 Gear cond.: 0
BDEPTH: 87 88 Validity : 0
Towing dir: 0° Wire out : 90 m Speed : 3.4 kn
Sorted : 0 Total catch: 0.00 Catch/hour: 0.00

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

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 53
DATE :22/10/17 GEAR TYPE: PT NO: 1 POSITION:Lat S 13°3.61
start stop duration Lon E 12°51.86
TIME :05:48:48 06:07:37 18.8 (min) Purpose : 1
LOG : 4170.35 4171.44 1.1 Region : 4050
FDEPTH: 15 52 Gear cond.: 0
BDEPTH: 88 85 Validity : 0
Towing dir: 0° Wire out : 145 m Speed : 3.5 kn
Sorted : 1 Total catch: 0.92 Catch/hour: 2.93

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Lagocephalus laevigatus | 1.91 | 6 | 65.22 | |
| Trachinotus ovatus | 1.02 | 3 | 34.78 | |
| Total | 2.93 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 54
DATE :23/10/17 GEAR TYPE: PT NO: 1 POSITION:Lat S 13°20.03
start stop duration Lon E 12°33.98
TIME :17:56:09 18:14:51 18.7 (min) Purpose : 1
LOG : 4224.83 4225.96 1.1 Region : 4050
FDEPTH: 25 30 Gear cond.: 0
BDEPTH: 115 120 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.6 kn
Sorted : 51 Total catch: 50.88 Catch/hour: 163.25

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Erythrocles monodi | 72.39 | 616 | 44.34 | |
| Synagrops microlepis | 53.65 | 8 | 32.86 | |
| MYCTOPHIDAE | 33.45 | 23743 | 20.49 | |
| Scomber japonicus | 1.28 | 16 | 0.79 | 168 |
| Ariomma bondi | 0.96 | 55 | 0.59 | |
| S H R I M P S | 0.81 | 3019 | 0.50 | |
| Loligo vulgaris | 0.71 | 93 | 0.43 | |
| Total | 163.25 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 55
DATE :23/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 13°30.87
start stop duration Lon E 12°30.77
TIME :23:18:51 23:59:05 40.2 (min) Purpose : 1
LOG : 4251.11 4252.97 1.9 Region : 4050
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 350 39 Validity : 0
Towing dir: 0° Wire out : 140 m Speed : 2.8 kn
Sorted : 111 Total catch: 3218.15 Catch/hour: 4799.62

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Scomber japonicus | 4467.65 | 97936 | 93.08 | 169 |
| Loligo vulgaris | 168.05 | 768 | 3.50 | |
| Mola ramsayi | 66.67 | 1 | 1.39 | 172 |
| Auxis thazard | 56.30 | 257 | 1.17 | 171 |
| Sarda sarda | 33.27 | 85 | 0.69 | 170 |
| Remora sp. | 5.12 | 43 | 0.11 | |
| Ariomma bondi | 2.56 | 43 | 0.05 | |
| Total | 4799.62 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 56
DATE :24/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 13°56.68
start stop duration Lon E 12°16.65
TIME :10:33:17 10:42:58 9.7 (min) Purpose : 1
LOG : 4314.72 4315.19 0.5 Region : 4050
FDEPTH: 151 153 Gear cond.: 0
BDEPTH: 151 153 Validity : 0
Towing dir: 0° Wire out : 390 m Speed : 2.9 kn
Sorted : 99 Total catch: 362.04 Catch/hour: 2244.04

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Dentex macrophthalmus | 1815.74 | 18986 | 80.91 | |
| Illex coindetii | 308.53 | 3992 | 13.75 | |
| Dentex angolensis | 58.98 | 161 | 2.63 | |
| Sphoeroides pachygaster | 29.49 | 43 | 1.31 | |
| Synagrops microlepis | 21.76 | 2950 | 0.97 | |
| Pagellus bellottii | 4.54 | 43 | 0.20 | |
| Trigla lyra | 2.73 | 43 | 0.12 | |
| Scorpaena normani | 2.27 | 25 | 0.10 | |
| Total | 2244.04 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 57
DATE :24/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 14°13.38
start stop duration Lon E 12°15.88
TIME :18:28:30 18:58:24 29.9 (min) Purpose : 1
LOG : 4359.06 4360.71 1.6 Region : 4050
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 87 53 Validity : 0
Towing dir: 0° Wire out : 130 m Speed : 3.3 kn
Sorted : 147 Total catch: 147.21 Catch/hour: 295.40

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Sardinella maderensis | 124.98 | 536 | 42.31 | 173 |
| Trachinotus ovatus | 66.34 | 243 | 22.46 | |
| MYCTOPHIDAE | 29.73 | 15652 | 10.06 | |
| Lagocephalus laevigatus | 22.35 | 68 | 7.57 | |
| Euthynnus alletteratus | 17.14 | 24 | 5.80 | 177 |
| Scomber japonicus | 14.23 | 46 | 4.82 | 175 |
| Sarda sarda | 6.74 | 4 | 2.28 | 176 |
| Pomatomus saltatrix | 5.10 | 6 | 1.73 | |
| Synagrops microlepis | 2.70 | 855 | 0.91 | |
| Sardinella aurita | 2.69 | 177 | 0.91 | 174 |
| Loligo vulgaris | 1.80 | 518 | 0.61 | |
| Argyrosomus hololepidotus | 1.61 | 2 | 0.54 | |
| Total | 295.40 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 58
DATE :24/10/17 GEAR TYPE: PT NO: 1 POSITION:Lat S 14°15.53
start stop duration Lon E 12°17.79
TIME :19:56:50 20:32:41 35.9 (min) Purpose : 1
LOG : 4365.70 4367.56 1.9 Region : 4050
FDEPTH: 30 15 Gear cond.: 0
BDEPTH: 52 53 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 3.1 kn
Sorted : 30 Total catch: 29.72 Catch/hour: 49.74

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Sardinella maderensis | 25.31 | 100 | 50.87 | 178 |
| Lagocephalus laevigatus | 4.89 | 15 | 9.83 | |
| Argyrosomus hololepidotus | 4.57 | 5 | 9.19 | |
| Pagellus bellottii | 3.65 | 102 | 7.34 | |
| Pomatomus saltatrix | 3.21 | 7 | 6.46 | |
| Trachinotus ovatus | 2.34 | 12 | 4.71 | |
| Trachurus trecae | 1.61 | 147 | 3.23 | 180 |
| Sardinella aurita | 1.21 | 156 | 2.42 | 179 |
| Trichiurus lepturus | 0.74 | 2 | 1.48 | |
| Alloteuthis africana | 0.64 | 117 | 1.28 | |
| Chelidonichthys gabonensis | 0.47 | 102 | 0.94 | |
| Boops boops | 0.40 | 10 | 0.81 | |
| Scomber japonicus | 0.30 | 3 | 0.61 | 181 |
| Selene dorsalis | 0.27 | 2 | 0.54 | 182 |
| Sepia orbignyana | 0.07 | 2 | 0.13 | |
| Saurida brasiliensis | 0.05 | 3 | 0.10 | |
| Engraulis encrasicolus | 0.03 | 2 | 0.07 | |
| Total | 49.74 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 59
DATE :25/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 14°36.00
start stop duration Lon E 12°16.68
TIME :03:25:21 03:37:36 12.3 (min) Purpose : 1
LOG : 4401.44 4402.05 0.6 Region : 4050
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 106 107 Validity : 0
Towing dir: 0° Wire out : 140 m Speed : 3.0 kn
Sorted : 0 Total catch: 0.00 Catch/hour: 0.00

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

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 60
DATE :25/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 14°37.00
start stop duration Lon E 12°16.04
TIME :03:50:48 04:10:24 19.6 (min) Purpose : 1
LOG : 4402.61 4403.63 1.0 Region : 4050
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 115 120 Validity : 0
Towing dir: 0° Wire out : 140 m Speed : 3.1 kn
Sorted : 151 Total catch: 151.27 Catch/hour: 463.07

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Scomber japonicus | 416.91 | 1231 | 90.03 | 183 |
| Sarda sarda | 15.80 | 40 | 3.41 | 185 |
| Lagocephalus laevigatus | 14.20 | 43 | 3.07 | |
| Auxis thazard | 11.39 | 40 | 2.46 | 184 |
| Trachinotus ovatus | 4.35 | 12 | 0.94 | |
| Illex coindetii | 0.43 | 3 | 0.09 | |
| Total | 463.07 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 61
DATE :25/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 15°0.89
start stop duration Lon E 12°7.81
TIME :16:06:55 16:25:22 18.4 (min) Purpose : 1
LOG : 4445.37 4446.33 1.0 Region : 4050
FDEPTH: 97 95 Gear cond.: 0
BDEPTH: 97 95 Validity : 0
Towing dir: 0° Wire out : 255 m Speed : 3.1 kn
Sorted : 563 Total catch: 563.10 Catch/hour: 1831.22

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Dentex macrophthalmus | 1443.90 | 11727 | 78.85 | |
| Umbrina canariensis | 131.90 | 624 | 7.20 | |
| Trachurus trecae | 115.12 | 1424 | 6.29 | 186 |
| Dentex angolensis | 29.66 | 234 | 1.62 | |
| Atractoscion aequidens | 26.99 | 20 | 1.47 | |
| Pagellus bellottii | 17.17 | 137 | 0.94 | |
| Zeus faber | 13.40 | 16 | 0.73 | |
| Raja miraletus | 13.27 | 20 | 0.72 | |
| Scomber japonicus | 12.88 | 254 | 0.70 | 187 |
| Boops boops | 9.37 | 78 | 0.51 | |
| Perulibatrachus rossignoli | 7.41 | 20 | 0.40 | |
| Dentex gibbosus | 5.85 | 39 | 0.32 | |
| Dentex barnardi | 4.29 | 20 | 0.23 | |
| Total | 1831.22 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 62
DATE :25/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 15°10.99
start stop duration Lon E 12°3.94
TIME :21:55:39 22:24:08 28.5 (min) Purpose : 1
LOG : 4472.51 4474.00 1.5 Region : 4050
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 85 156 Validity : 0
Towing dir: 0° Wire out : 110 m Speed : 3.1 kn
Sorted : 13 Total catch: 13.47 Catch/hour: 28.38

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Trachurus trecae | 19.09 | 200 | 67.27 | 188 |
| Sarda sarda | 2.49 | 6 | 8.76 | 190 |
| Lagocephalus laevigatus | 2.40 | 8 | 8.46 | |
| Scomber japonicus | 2.11 | 32 | 7.42 | 191 |
| Pomatomus saltatrix | 0.97 | 2 | 3.42 | |
| MYCTOPHIDAE | 0.67 | 238 | 2.38 | |
| Trichiurus lepturus | 0.38 | 6 | 1.34 | |
| S H R I M P S | 0.13 | 655 | 0.45 | |
| Sardinella aurita | 0.08 | 4 | 0.30 | 189 |
| Synagrops microlepis | 0.04 | 19 | 0.15 | |
| JELLYFISH | 0.02 | 2 | 0.07 | |
| Total | 28.38 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 63
DATE :26/10/17 GEAR TYPE: PT NO: 1 POSITION:Lat S 15°32.81
start stop duration Lon E 11°53.75
TIME :22:33:09 22:58:45 25.6 (min) Purpose : 1
LOG : 4610.49 4611.91 1.4 Region : 4050
FDEPTH: 25 35 Gear cond.: 0
BDEPTH: 111 138 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.3 kn
Sorted : 2 Total catch: 1.58 Catch/hour: 3.70

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| MYCTOPHIDAE | 2.39 | 771 | 64.56 | |
| Synagrops microlepis | 0.61 | 63 | 16.46 | |
| Scomber japonicus | 0.47 | 2 | 12.66 | 192 |
| Parapenaeus longirostris | 0.14 | 206 | 3.80 | |
| Trichiurus lepturus | 0.09 | 2 | 2.53 | |
| Total | 3.70 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 64
DATE :27/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 15°41.88
start stop duration Lon E 11°50.86
TIME :02:29:34 02:56:22 26.8 (min) Purpose : 1
LOG : 4633.33 4634.67 1.4 Region : 4050
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 164 94 Validity : 0
Towing dir: 0° Wire out : 140 m Speed : 3.0 kn
Sorted : 76 Total catch: 479.24 Catch/hour: 1072.93

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Engraulis encrasicolus | 981.40 | 85030 | 91.47 | 193 |
| MYCTOPHIDAE | 35.19 | 14561 | 3.28 | |
| Trachurus trecae | 27.40 | 128 | 2.55 | 194 |
| Trichiurus lepturus | 8.60 | 134 | 0.80 | |
| Sarda sarda | 5.78 | 13 | 0.54 | 195 |
| Scomber japonicus | 5.78 | 25 | 0.54 | 196 |
| Pomatomus saltatrix | 4.16 | 7 | 0.39 | |
| Lagocephalus laevigatus | 3.94 | 11 | 0.37 | |
| Synagrops microlepis | 0.54 | 67 | 0.05 | |
| Hoplostethus cadenati | 0.13 | 2 | 0.01 | |
| Total | 1072.93 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 65
DATE :27/10/17 GEAR TYPE: PT NO: 1 POSITION:Lat S 16°9.42
start stop duration Lon E 11°38.47
TIME :18:19:28 18:47:34 28.1 (min) Purpose : 1
LOG : 4711.82 4713.65 1.8 Region : 4050
FDEPTH: 30 40 Gear cond.: 0
BDEPTH: 60 19 Validity : 0
Towing dir: 0° Wire out : 140 m Speed : 3.9 kn
Sorted : 91 Total catch: 90.64 Catch/hour: 193.54

| SPECIES | CATCH/HOUR weight | numbers | % OF TOT. C | SAMP |
|---|---|---|---|---|
| Lagocephalus laevigatus | 92.37 | 273 | 47.73 | |
| Scomber japonicus | 65.59 | 835 | 33.89 | 198 |
| Trachurus trecae | 33.14 | 743 | 17.12 | 197 |
| Pagellus bellottii | 1.20 | 51 | 0.62 | |
| Sarda sarda | 1.02 | 2 | 0.53 | 199 |
| Loligo vulgaris | 0.21 | 2 | 0.11 | |
| Total | 193.54 | | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 66
DATE :27/10/17 GEAR TYPE: PT NO: 4 POSITION:Lat S 16°11.40
start stop duration Lon E 11°45.87
TIME :21:01:30 21:35:35 34.1 (min) Purpose : 1
LOG : 4727.78 4729.45 1.7 Region : 4050
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 36 42 Validity : 0
Towing dir: 0° Wire out : 105 m Speed : 2.9 kn
Sorted : 118 Total catch: 117.96 Catch/hour: 207.68

| SPECIES | CATCH/HOUR weight | % OF TOT. C numbers | SAMP |
|---|---|---|---|
| Trachurus trecae | 119.23 | 5468 57.41 | 200 |
| Scomber japonicus | 45.39 | 606 21.85 | 201 |
| Dasyatis sp. | 17.11 | 2 8.24 | |
| Lagocephalus laevigatus | 9.79 | 30 4.71 | |
| Dasyatis marmorata | 4.15 | 4 2.00 | |
| Sarda sarda | 3.10 | 4 1.49 | 202 |
| Loligo vulgaris | 2.71 | 70 1.31 | |
| Myliobatis aquila | 2.68 | 4 1.29 | |
| Sepia orbignyana | 1.80 | 7 0.86 | |
| Sardinella maderensis | 0.42 | 2 0.20 | 205 |
| Engraulis encrasicolus | 0.35 | 23 0.17 | 206 |
| Sardinops sagax | 0.35 | 5 0.17 | 203 |
| Trachinus armatus | 0.35 | 7 0.17 | |
| Sardinella aurita | 0.25 | 4 0.12 | 204 |
| Total | 207.68 | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 67
DATE :28/10/17 GEAR TYPE: PT NO: 1 POSITION:Lat S 16°28.63
start stop duration Lon E 11°31.55
TIME :04:01:24 04:31:50 30.4 (min) Purpose : 1
LOG : 4773.94 4775.71 1.8 Region : 4050
FDEPTH: 20 20 Gear cond.: 0
BDEPTH: 98 93 Validity : 0
Towing dir: 0° Wire out : 90 m Speed : 3.5 kn
Sorted : 0 Total catch: 0.48 Catch/hour: 0.95

| SPECIES | CATCH/HOUR weight | % OF TOT. C numbers | SAMP |
|---|---|---|---|
| Myliobatis aquila | 0.91 | 2 95.83 | |
| Illex coindetii | 0.04 | 6 4.17 | |
| Total | 0.95 | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 68
DATE :28/10/17 GEAR TYPE: PT NO: 7 POSITION:Lat S 16°39.21
start stop duration Lon E 11°45.13
TIME :09:22:44 09:50:52 28.1 (min) Purpose : 1
LOG : 4808.84 4810.39 1.6 Region : 4050
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 23 25 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.3 kn
Sorted : 0 Total catch: 0.06 Catch/hour: 0.13

| SPECIES | CATCH/HOUR weight | % OF TOT. C numbers | SAMP |
|---|---|---|---|
| JELLYFISH | 0.13 | 2 100.00 | |
| Total | 0.13 | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 69
DATE :28/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 16°37.27
start stop duration Lon E 11°27.06
TIME :13:43:32 14:09:35 26.1 (min) Purpose : 1
LOG : 4840.60 4842.00 1.4 Region : 4050
FDEPTH: 119 117 Gear cond.: 0
BDEPTH: 119 117 Validity : 0
Towing dir: 0° Wire out : 310 m Speed : 3.2 kn
Sorted : 165 Total catch: 388.20 Catch/hour: 894.13

| SPECIES | CATCH/HOUR weight | % OF TOT. C numbers | SAMP |
|---|---|---|---|
| Trachurus trecae | 392.50 | 9321 43.90 | 207 |
| Dentex macrophthalmus | 302.56 | 5641 33.84 | |
| Etrumeus whiteheadi | 75.45 | 1214 8.44 | 208 |
| Loligo vulgaris | 50.33 | 424 5.63 | |
| Trachurus capensis | 25.22 | 424 2.82 | 209 |
| Sphoeroides pachygaster | 14.69 | 28 1.64 | |
| Sepia orbignyana | 8.02 | 7 0.90 | |
| Scomber japonicus | 5.80 | 60 0.65 | 210 |
| Echinus gilchristi ? | 3.96 | 428 0.44 | |
| Trigla lyra | 2.99 | 16 0.33 | |
| Pterothrissus belloci | 2.90 | 32 0.32 | |
| Zeus faber | 2.83 | 16 0.32 | |
| Pagellus bellottii | 1.70 | 16 0.19 | |
| Merluccius capensis | 1.61 | 5 0.18 | |
| Atractoscion aequidens | 1.29 | 5 0.14 | |
| Spondyliosoma cantharus | 0.76 | 5 0.09 | |
| Scorpaena normani | 0.64 | 12 0.07 | |
| Dentex barnardi | 0.64 | 5 0.07 | |
| JELLYFISH | 0.21 | 5 0.02 | |
| Total | 894.13 | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 70
DATE :28/10/17 GEAR TYPE: PT NO: 1 POSITION:Lat S 16°41.04
start stop duration Lon E 11°38.88
TIME :19:59:04 20:20:33 21.5 (min) Purpose : 1
LOG : 4877.18 4878.40 1.2 Region : 4050
FDEPTH: 28 21 Gear cond.: 0
BDEPTH: 56 57 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 3.4 kn
Sorted : 396 Total catch: 396.32 Catch/hour: 1107.03

| SPECIES | CATCH/HOUR weight | % OF TOT. C numbers | SAMP |
|---|---|---|---|
| Engraulis encrasicolus | 608.94 | 52573 55.01 | 212 |
| Sardinella aurita | 488.83 | 21793 44.16 | 211 |
| JELLYFISH | 6.20 | 8 0.56 | |
| Sardinops sagax | 1.54 | 92 0.14 | 214 |
| Trachurus trecae | 1.45 | 145 0.13 | 213 |
| Scomber japonicus | 0.08 | 8 0.01 | |
| Total | 1107.03 | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 71
DATE :29/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 17°0.77
start stop duration Lon E 11°39.22
TIME :05:05:37 05:17:29 11.9 (min) Purpose : 1
LOG : 4949.59 4950.24 0.7 Region : 4050
FDEPTH: 61 59 Gear cond.: 0
BDEPTH: 61 59 Validity : 0
Towing dir: 0° Wire out : 170 m Speed : 3.3 kn
Sorted :1040 Total catch: 1040.35 Catch/hour: 5258.69

| SPECIES | CATCH/HOUR weight | % OF TOT. C numbers | SAMP |
|---|---|---|---|
| Engraulis encrasicolus | 2956.12 | 260062 56.21 | 218 |
| Trachurus capensis | 1069.99 | 98062 20.35 | 217 |
| Sardinella aurita | 511.79 | 25319 9.73 | 215 |
| Thyrsites atun | 303.39 | 91 5.77 | |
| Trachurus trecae | 193.80 | 14467 3.69 | 216 |
| Loligo vulgaris | 83.25 | 6005 1.58 | |
| Chelidonichthys capensis | 51.86 | 273 0.99 | |
| Dasyatis marmorata | 22.75 | 5 0.43 | |
| Mustelus mustelus | 18.90 | 5 0.36 | |
| SALPS | 15.01 | 1026 0.29 | |
| Dentex macrophthalmus | 10.92 | 71 0.21 | |
| Sepia orbignyana | 9.30 | 5 0.18 | |
| Sardinops sagax | 6.82 | 409 0.13 | 219 |
| Scomber japonicus | 4.09 | 71 0.08 | |
| Pterothrissus belloci | 0.68 | 71 0.01 | |
| Total | 5258.69 | 100.00 | |

R/V Dr. Fridtjof Nansen SURVEY:2017408 STATION: 72
DATE :29/10/17 GEAR TYPE: BT NO: 2 POSITION:Lat S 17°12.11
start stop duration Lon E 11°35.46
TIME :11:27:18 11:49:20 22.0 (min) Purpose : 1
LOG : 4978.98 4980.13 1.1 Region : 4050
FDEPTH: 105 97 Gear cond.: 0
BDEPTH: 105 97 Validity : 0
Towing dir: 0° Wire out : 290 m Speed : 3.1 kn
Sorted : 76 Total catch: 1221.44 Catch/hour: 3326.66

| SPECIES | CATCH/HOUR weight | % OF TOT. C numbers | SAMP |
|---|---|---|---|
| Trachurus capensis | 2311.32 | 169340 69.48 | 220 |
| JELLYFISH | 345.13 | 915 10.37 | |
| Dentex macrophthalmus | 183.89 | 8715 5.53 | |
| Raja miraletus | 82.80 | 131 2.49 | |
| Synagrops microlepis | 79.31 | 26887 2.38 | |
| Coelorinchus caelorhincus | 68.85 | 44 2.07 | |
| Mustelus mustelus | 54.91 | 44 1.65 | |
| Sepia officinalis | 37.48 | 44 1.13 | |
| Merluccius capensis | 31.38 | 479 0.94 | |
| Chelidonichthys capensis | 26.15 | 131 0.79 | |
| Sepia orbignyana | 26.15 | 44 0.79 | |
| Arius heudelotii ** | 22.66 | 44 0.68 | |
| Scomber japonicus | 17.43 | 392 0.52 | 222 |
| Etrumeus whiteheadi | 13.07 | 305 0.39 | 221 |
| Trachurus trecae | 9.59 | 523 0.29 | 223 |
| Chelidonichthys queketti | 4.36 | 44 0.13 | |
| GOBIIDAE | 4.36 | 1089 0.13 | |
| Pterothrissus belloci | 3.49 | 349 0.10 | |
| Dicologoglossa cuneata | 1.74 | 174 0.05 | |
| Loligo vulgaris | 1.74 | 44 0.05 | |
| Callinectes sp. | 0.87 | 87 0.03 | |
| Total | 3326.66 | 100.00 | |

# ANNEX III. BIOLOGY SCALES

### Sexual maturity

| Stage | State | Description |
|---|---|---|
| **I** | Immature | Ovary and testis about 1/3rd length of body cavity. Ovaries pinkish, translucent, testis whitish. Ova not visible to naked eye. |
| **II** | Maturing virgin and recovering spent | Ovary and testis about ½ length of body cavity. Ovary pinkish, translucent, testis whitish, symmetrical. Ova not visible to naked eye. |
| **III** | Ripening | Ovary and testis is about 2/3rds length of body cavity. Ovary pinkish yellow colour with granular appearance, testis whitish to creamy. No transparent or translucent ova visible. |
| **IV** | Ripe | Ovary and testis from 2/3rds to full length of body cavity. Ovary orange-pink in colour with conspicuous superficial blood vessels. Large transparent, ripe ova visible. Testis whitish-creamy, soft. |
| **V** | Spent | Ovary and testis shrunken to about ½ length of body cavity. Walls loose. Ovary may contain remnants of disintegrating opaque and ripe Ova, darkened or translucent. Testis bloodshot and flabby |

### Stomach content

| Scale | Designation | Description |
|---|---|---|
| **0** | Empty | Stomach empty except for water. |
| **1** | Very little content | Stomach is almost empty. Only traces of small organisms can be found. |
| **2** | Some content | Stomach not completely full and not dilated. |
| **3** | Stomach full | Stomach full, but not bloated/dilated. |
| **4** | Bloated/dilated | The stomach is visibly expanded and tight. Content can be observed from the outside. |

# ANNEX IV. LIST OF BIOLOGICAL SAMPLES COLLECTED FOR FUTURE ANALYSIS

| Cruise # Station | 2017408 Area | Date (sampling) | Nutr Vails | Chl. A filter | Phytopl. | wp2 btl. Formol | wp2 alu trays | Multinet Bottles | Manta plastic trays | Manta bottle | Manta E+L Vails | Manta eggs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 638 | Angola C | 15.10.2017 | 9 | 6 | 1 | 2 | 6 | 1 | 1 | 1 | | |
| 639 | | 16.10.2017 | | | | | | 0 | 0 | 0 | | |
| 640 | | 16.10.2017 | 9 | | 1 | 2 | 6 | 1 | 1 | 1 | | |
| 642 | | 16.10.2017 | 4 | 5 | 1 | 2 | 7 | 1 | 1 | 1 | | |
| 643 | | 16.10.2017 | 4 | 4 | | | | 0 | 0 | 0 | | |
| 645 | | 16.10.2017 | 2 | 2 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | |
| 646 | | 16.10.2017 | | | | | | 0 | 0 | 0 | | |
| 655 | | 18.10.2017 | 8 | 5 | 1 | 2 | 6 | 1 | 0 | 1 | 1 | |
| 657 | | 18.10.2017 | 4 | 4 | 1 | 2 | 6 | 1 | 0 | 1 | | |
| 660 | | 18.10.2017 | 2 | 2 | 1 | 1 | 3 | 1 | 1 | 1 | | |
| 668 | | 19.10.2017 | 9 | 6 | 1 | 2 | 10 | 1 | 1 | 1 | 1 | |
| 670 | | 19.10.2017 | 5 | 5 | 1 | 2 | 10 | 1 | 1 | 1 | | |
| 672 | | 19.10.2017 | 2 | 2 | 1 | 1 | 3 | 1 | 0 | 1 | | |
| 674 | Lobito | 20.10.2017 | 4 | 4 | 1 | 1 | 3 | 1 | 1 | 1 | | |
| 675 | Lobito | 20.10.2017 | | | | | | 0 | 0 | 0 | | |
| 677 | Lobito | 20.10.2017 | 6 | 6 | | 1 | 3 | 0 | 0 | 0 | | |
| 678 | Lobito | 20.10.2017 | 6 | 6 | 1 | 2 | 8 | 4 | 0 | 1 | | |
| 680 | Lobito | 20.10.2017 | 10 | 10 | 1 | 2 | 6 | 5 | 0 | 0 | | |
| 681 | Lobito | | | | | 2 | 8 | | | | | |
| 682 | Lobito | 20.10.2017 | 11 | 7 | 1 | 2 | 6 | 5 | 0 | 0 | | |
| 683 | Lobito | | | | | 2 | 11 | | | | | |
| 684 | Lobito | | | | | 2 | 8 | | | | | |
| 685 | Lobito | 21.10.2017 | 12 | 7 | 1 | 2 | 6 | 5 | 0 | 0 | | |
| 691 | Angola S | 22.10.2017 | 2 | 2 | 1 | 1 | 3 | 1 | 0 | 1 | | |
| 693 | | 22.10.2017 | 5 | 5 | 1 | 2 | 6 | 1 | 0 | 1 | | |
| 696 | | 22.10.2017 | 9 | 6 | 1 | 2 | 6 | 5 | 0 | 1 | | |
| 701 | | 24.10.2017 | 7 | 4 | 1 | 2 | 7 | 1 | 0 | 1 | | |
| 704 | | 24.10.2017 | 6 | 6 | | 2 | 6 | 5 | 0 | 1 | | |
| 706 | | 24.10.2017 | 3 | 3 | 1 | 1 | 3 | 1 | 0 | 0 | | |
| 715 | | 25.10.2017 | 7 | 4 | 1 | 2 | 6 | 1 | 1 | 1 | | |
| 717 | | 25.10.2017 | 5 | 5 | 1 | 2 | 6 | 1 | 0 | 1 | | |
| 719 | | 25.10.2017 | 3 | 3 | 1 | 1 | 3 | 1 | 0 | 1 | | |
| 720 | Namibe | | | | | 2 | 8 | | | | | |
| 721 | Namibe | 25.10.2017 | 6 | 6 | 1 | 2 | 6 | 5 | 1 | 1 | | |
| 722 | Namibe | | | | | 2 | 5 | | | | | |
| 723 | Namibe | 26.10.2017 | 12 | 7 | 1 | 2 | 11 | 5 | 1 | 1 | | |
| 724 | Namibe | | | | | 2 | 8 | | | | | |
| 725 | Namibe | 26.10.2017 | 12 | 7 | | 2 | 6 | 5 | 0 | 1 | | |
| 734 | | 27.10.2017 | 2 | 2 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 4 |
| 735 | | 27.10.2017 | 5 | 5 | 1 | 2 | 6 | 1 | 1 | 1 | | |
| 737 | | 27.10.2017 | 10 | 7 | 1 | 2 | 6 | 1 | 1 | 1 | | |
| 745 | Cunene | 29.10.2017 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | | |
| 746 | Cunene | | | | | 1 | 2 | | | | | |
| 747 | Cunene | | | | | 2 | 8 | | | | | |
| 748 | Cunene | 29.10.2017 | 9 | 9 | 1 | 2 | 7 | 4 | 0 | 1 | 1 | 2 |
| 749 | Cunene | | | | | 2 | 8 | | | | | |
| 750 | Cunene | | | | | 2 | 8 | | | | | |
| 751 | Cunene | 29.10.2017 | 10 | 10 | 1 | 2 | 6 | 5 | 0 | 1 | | |
| 754 | Cunene | 29.10.2017 | 12 | 9 | 1 | 2 | 5 | 5 | 0 | 1 | | |
| 755 | Cunene | | | | | 2 | 6 | | | | | |
| 758 | Cunene | 30.10.2017 | 11 | 6 | 1 | 2 | 7 | 5 | 1 | 1 | | |
| | | | | | | | | | | | | |
| | **Angola** | | **244** | **188** | **33** | **83** | **283** | **85** | **16** | **31** | **5** | **6** |

| Country | Area | Survey | Leg | Station | Species | length | length/weight | Biology (sex, maturity & stomach fullness) | liver samples frozen | stomach samples frozen | Gonad weight | Stomach weight | fin clips preserved and frozen | otoliths collected | frozen individuals | Jellyfish genetics | Jellyfish formalin | Mesopelagic sample sp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Angola | North | 2017408 | 1 | 2 | *Sardinella maderensis* | | 26 | 26 | 26 | 26 | 26 | 26 | 15 | 5 | 0 | | | |
| Angola | North | 2017408 | 1 | 2 | *Scomberomorus tritor* | | 6 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 2 | *Trachurus trecae* | | 90 | | | | | | | | 25 | | | |
| Angola | North | 2017408 | 1 | 3 | *Chloroscombrus chrysurus* | | 100 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 3 | *Sardinella aurita* | | 99 | 30 | 30 | 30 | 30 | 30 | 30 | 5 | | | | |
| Angola | North | 2017408 | 1 | 3 | *Sardinella maderensis* | | 100 | 30 | 30 | 30 | 30 | 30 | 15 | 5 | | | | |
| Angola | North | 2017408 | 1 | 3 | *Sphyraena guachancho* | | 18 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 4 | *Trachurus trecae, adults* | | 38 | 35 | 35 | 35 | 35 | 35 | 30 | 5 | | | | |
| Angola | North | 2017408 | 1 | 4 | *Trachurus trecae, juveniles* | | | | | | | | 30 | | 25 | | | |
| Angola | North | 2017408 | 1 | 5 | *Chloroscombrus chrysurus* | | 100 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 5 | *Decapterus rhonchus* | | 34 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 5 | *Jellyfish* | | | | | | | | | | | 5 | 5 | |
| Angola | North | 2017408 | 1 | 5 | *Sardinella aurita* | | 38 | 30 | 30 | 30 | 30 | 30 | 30 | 5 | | | | |
| Angola | North | 2017408 | 1 | 5 | *Sardinella maderensis* | | 100 | 30 | 30 | 30 | 30 | 30 | 30 | 5 | 25 | | | |
| Angola | North | 2017408 | 1 | 6 | *Caranx crysos* | | 4 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 6 | *Sardinella maderensis* | | 77 | 30 | 30 | 30 | 30 | 30 | | 5 | | | | |
| Angola | North | 2017408 | 1 | 6 | *Scomber japonicus* | | 8 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 6 | *Trachinotus ovatus* | | 21 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 7 | *Dentex angolensis* | | 47 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 7 | *Dentex congoensis* | | 35 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 7 | *Pagellus bellotti* | | 47 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 7 | *Scomber japonicus* | | 4 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 7 | *Trachurus trecae* | | 48 | 30 | 30 | 30 | 30 | 30 | 30 | 5 | 0 | 5 | 5 | |
| Angola | North | 2017408 | 1 | 8 | *Sardinella maderensis* | | 3 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 8 | *Trachurus trecae* | | 123 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 9 | *Decapterus punctatus* | | 7 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 9 | *Trachinotus ovatus* | | 3 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 10 | *Chloroscombrus chrysurus* | | 44 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 10 | *Decapterus rhonchus* | | 9 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 10 | *Pagellus bellotti* | | 7 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 10 | *Scomber japonicus* | | 7 | 7 | 7 | 7 | 7 | 7 | | | | | | |
| Angola | North | 2017408 | 1 | 10 | *Sphyraena guachancho* | | 6 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 12 | *Boops boops* | | 33 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 12 | *Selene dorsalis* | | 4 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 12 | *Trachurus trecae* | | 107 | | | | | | 30 | | | | | |
| Angola | North | 2017408 | 1 | 13 | *Euthynnus alletteratus* | | 3 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 13 | *Sardinella aurita* | | 6 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 13 | *Sardinella maderensis* | | 99 | 30 | 30 | 30 | 30 | 30 | 30 | 5 | 25 | | | |
| Angola | North | 2017408 | 1 | 13 | *Scomberomorus tritor* | | 3 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 13 | *Selene dorsalis* | | 43 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 13 | *Trachinotus ovatus* | | 6 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 13 | *Trachurus trecae* | | 100 | 35 | 35 | 35 | 35 | 35 | 35 | 5 | 25 | | | |
| Angola | North | 2017408 | 1 | 14 | *Sardinella aurita* | | 100 | 30 | 30 | 30 | 30 | 30 | 30 | 5 | | | | |
| Angola | North | 2017408 | 1 | 14 | *Sardinella maderensis* | | 100 | 30 | 30 | 30 | 30 | 30 | 30 | 5 | | | | |
| Angola | North | 2017408 | 1 | 15 | *Dentex angolensis* | | 78 | | | | | | | | | | | |

| Country | Area | Survey | Leg | Station | Species | length | length/weight | Biology (sex, maturity & stomach fullness) | liver samples frozen | stomach samples frozen | Gonad weight | Stomach weight | fin clips preserved and frozen | otoliths collected | frozen individuals | Jellyfish genetics | Jellyfish formalin | Mesopelagic sample sp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Angola | North | 2017408 | 1 | 15 | *Dentex congoensi* | | 78 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 15 | *Jellyfish* | | | | | | | | | | | 5 | 5 | |
| Angola | North | 2017408 | 1 | 15 | *Pagellus bellottii* | | 34 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 15 | *Scomber japonicus* | | 13 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 15 | *Spicara alta* | | 84 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 15 | *Trachurus trecae* | | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 5 | | | | |
| Angola | North | 2017408 | 1 | 16 | *Dentex angolensis* | | 31 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 16 | *Dentex congoensis* | | 43 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 16 | *Scomber japonicus* | | 13 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 16 | *Spicara alta* | | 84 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 16 | *Trachinotus goreensis* | | 1 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 16 | *Trachurus trecae* | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 0 | | | | |
| Angola | North | 2017408 | 1 | 17 | *Sardinella aurita* | | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 5 | | | | |
| Angola | North | 2017408 | 1 | 17 | *Sardinella maderensis* | | 31 | 30 | 30 | 30 | 30 | 30 | 30 | 5 | | | | |
| Angola | North | 2017408 | 1 | 17 | *Trachinotus ovatus* | | 2 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 18 | *Chloroscombrus chrysurus* | | 41 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 18 | *Ilisha africana* | | 103 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 18 | *Sardinella aurita* | | 103 | 30 | 30 | 30 | 30 | 30 | | 5 | | | | |
| Angola | North | 2017408 | 1 | 18 | *Sardinella maderensis* | | 48 | 30 | 30 | 30 | 30 | 30 | 30 | 5 | | | | |
| Angola | North | 2017408 | 1 | 18 | *Trachurus trecae* | | 15 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 20 | *Trachurus trecae* | | | | | | | | | | 25 | | | |
| Angola | North | 2017408 | 1 | 21 | *Sardinella aurita* | | 36 | 29 | 29 | 29 | 29 | 29 | 29 | 5 | | | | |
| Angola | North | 2017408 | 1 | 21 | *Sardinella maderensis* | | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 5 | | | | |
| Angola | North | 2017408 | 1 | 21 | *Selene dorsalis* | | 50 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 21 | *Trachurus trecae* | | 87 | 30 | 30 | 30 | 30 | 30 | 30 | 5 | 25 | | | |
| Angola | North | 2017408 | 1 | 22 | *Sardinella aurita* | | 141 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 22 | *Sardinella maderensis* | | 37 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 22 | *Sphyraena guachancho* | | 48 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 23 | *Engraulis encrasicolus* | | 100 | | | | | | | | 25 | | | |
| Angola | North | 2017408 | 1 | 23 | *Euthynnus alletteratus* | | 2 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 23 | *Sardinella aurita* | | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 5 | | | | |
| Angola | North | 2017408 | 1 | 23 | *Sardinella maderensis* | | 39 | 30 | 30 | 30 | 30 | 30 | 30 | 5 | 25 | | | |
| Angola | North | 2017408 | 1 | 23 | *Scomber japonicus* | | 111 | | | | | | | | 25 | | | |
| Angola | North | 2017408 | 1 | 23 | *Trachurus trecae* | | 100 | | | | | | | | 25 | | | |
| Angola | North | 2017408 | 1 | 24 | *Caranx crysos* | | 6 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 24 | *Sardinella aurita* | | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 5 | 25 | | | |
| Angola | North | 2017408 | 1 | 24 | *Sardinella maderensis* | | 11 | | | | | | | | | | | |
| Angola | North | 2017408 | 1 | 25 | *Engraulis encrasicolus* | | 100 | | | | | | 30 | | 25 | | | |
| Angola | North | 2017408 | 1 | 25 | *Sardinella aurita* | | 49 | 30 | 30 | 30 | 30 | 30 | 30 | 5 | 19 | | | |
| Angola | North | 2017408 | 1 | 25 | *Sardinella maderensis* | | 100 | 30 | 30 | 30 | 30 | 30 | 30 | 5 | | | | |
| Angola | North | 2017408 | 1 | 25 | *Scomber japonicus* | | 63 | 30 | 30 | 30 | 30 | 30 | 30 | 0 | | | | |
| Angola | North | 2017408 | 1 | 25 | *Trachurus trecae* | | | | | | | | | | 25 | | | |
| Angola | Central | 2017408 | 2 | 26 | *Brachydeuterus auritus* | | 50 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 26 | *Caranx crysos* | | 4 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 26 | *Chloroscombrus chrysurus* | | 50 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 26 | *Galeoides decadactylus* | | 14 | | | | | | | | | | | |

| Country | Area | Survey | Leg | Station | Species | length | length/weight | Biology (sex, maturity & stomach fullness) | liver samples frozen | stomach samples frozen | Gonad weight | Stomach weight | fin clips preserved and frozen | otoliths collected | frozen individuals | Jellyfish genetics | Jellyfish formalin | Mesopelagic sample sp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Angola | Central | 2017408 | 2 | 26 | *Ilisha africana* | | 50 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 26 | *Sardinella aurita* | | 12 | 12 | 12 | 12 | 1 | 12 | 12 | 0 | | | | |
| Angola | Central | 2017408 | 2 | 26 | *Sardinella maderensis* | | 98 | 30 | 30 | 30 | 12 | 30 | 30 | 0 | | | | |
| Angola | Central | 2017408 | 2 | 26 | *Selene dorsalis* | | 58 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 26 | *Sphyraena guachancho* | | 33 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 28 | *Scomber japonicus* | | 4 | 4 | 4 | 4 | 0 | 4 | 4 | 0 | | | | |
| Angola | Central | 2017408 | 2 | 28 | *Trachurus trecae* | | 18 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | | | | |
| Angola | Central | 2017408 | 2 | 29 | *Sardinella aurita* | | 99 | 30 | 30 | 30 | 29 | 30 | 30 | 24 | | | | |
| Angola | Central | 2017408 | 2 | 29 | *Sardinella maderensis* | | 101 | 30 | 30 | 30 | 23 | 30 | 30 | 10 | | | | |
| Angola | Central | 2017408 | 2 | 30 | *Sardinella aurita* | | 148 | 30 | 30 | 30 | 19 | 30 | 30 | 0 | | | | |
| Angola | Central | 2017408 | 2 | 30 | *Sardinella maderensis* | | 100 | 30 | 30 | 30 | 30 | 30 | 30 | 8 | | | | |
| Angola | Central | 2017408 | 2 | 30 | *Scomber japonicus* | | 4 | 4 | 4 | 4 | 0 | 4 | 4 | 4 | | | | |
| Angola | Central | 2017408 | 2 | 32 | *Sardinella aurita* | | 18 | 19 | 19 | 19 | 14 | 19 | 19 | 10 | | | | |
| Angola | Central | 2017408 | 2 | 32 | *Sardinella maderensis* | | 100 | 30 | 30 | 30 | 23 | 30 | 30 | 10 | | | | |
| Angola | Central | 2017408 | 2 | 33 | *Sardinella aurita* | | 101 | 30 | 30 | 30 | 0 | 30 | 30 | 24 | | | | |
| Angola | Central | 2017408 | 2 | 33 | *Sardinella maderensis* | | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 2 | | | | |
| Angola | Central | 2017408 | 2 | 33 | *Scomber japonicus* | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | |
| Angola | Central | 2017408 | 2 | 33 | *Trachurus trecae* | | 317 | 30 | 30 | 30 | 0 | 30 | 30 | 30 | | | | |
| Angola | Central | 2017408 | 2 | 34 | *Sardinella aurita* | | 15 | 15 | 15 | 15 | 0 | 15 | 15 | 10 | | | | |
| Angola | Central | 2017408 | 2 | 34 | *Trachurus trecae* | | 100 | 30 | 30 | 30 | 0 | 30 | 30 | 10 | | | | |
| Angola | Central | 2017408 | 2 | 36 | *Chloroscombrus chrysurus* | | 76 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 36 | *Ilisha africana* | | 77 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 36 | *Sardinella aurita* | | 17 | 18 | 18 | 18 | 18 | 18 | 18 | 10 | | | | |
| Angola | Central | 2017408 | 2 | 36 | *Sardinella aurita* | | | | | | | | | 10 | | | | |
| Angola | Central | 2017408 | 2 | 36 | *Sardinella maderensis* | | 100 | 30 | 30 | 30 | 30 | 30 | 30 | 10 | | | | |
| Angola | Central | 2017408 | 2 | 37 | *Sardinella aurita* | | 36 | 29 | 29 | 29 | 8 | 29 | 29 | 10 | | | | |
| Angola | Central | 2017408 | 2 | 37 | *Sardinella maderensis* | | 49 | 30 | 30 | 30 | 30 | 30 | 30 | | | | | |
| Angola | Central | 2017408 | 2 | 37 | *Trachurus trecae* | | 100 | 29 | 29 | 29 | 9 | 29 | 29 | 10 | | | | |
| Angola | Central | 2017408 | 2 | 38 | *Sardinella maderensis* | | 2 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 39 | *Sardinella maderensis* | | 1 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 39 | *Scomber japonicus* | | 1 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 39 | *Trachurus trecae* | | 9 | 9 | 9 | 9 | 8 | 9 | 9 | 9 | | | | |
| Angola | Central | 2017408 | 2 | 40 | *Sardinella aurita* | | 57 | 30 | 30 | 30 | 0 | 30 | 30 | 10 | | | | |
| Angola | Central | 2017408 | 2 | 40 | *Scomber japonicus* | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | | | | |
| Angola | Central | 2017408 | 2 | 40 | *Trachurus trecae* | | 159 | 30 | 30 | 30 | 16 | 30 | 30 | 10 | | | | |
| Angola | Central | 2017408 | 2 | 42 | *Sardinella aurita* | | 18 | 18 | 18 | 18 | 4 | 18 | 18 | 10 | | | | |
| Angola | Central | 2017408 | 2 | 42 | *Sardinella maderensis* | | 14 | 15 | 15 | 15 | 14 | 15 | 15 | 10 | | | | |
| Angola | Central | 2017408 | 2 | 43 | *Engraulis encrasicolus* | | 100 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 43 | *Ilisha africana* | | 35 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 43 | *Sardinella aurita* | | 57 | 30 | 30 | 30 | 6 | 30 | 30 | 8 | | | | |
| Angola | Central | 2017408 | 2 | 43 | *Sardinella maderensis* | | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | | | | |
| Angola | Central | 2017408 | 2 | 43 | *Selene dorsalis* | | 50 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 43 | *Trachurus trecae* | | 37 | 30 | 30 | 30 | 1 | 30 | 30 | 10 | | | | |
| Angola | Central | 2017408 | 2 | 44 | *Engraulis encrasicolus* | | 100 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 44 | *Sardinella aurita* | | 100 | 30 | 30 | 30 | 0 | 30 | 30 | 9 | | | | |
| Angola | Central | 2017408 | 2 | 44 | *Trachurus trecae* | | 100 | 30 | 30 | 30 | 0 | 30 | 30 | 10 | | | | |
| Angola | Central | 2017408 | 2 | 45 | *Trachurus trecae* | | 5 | 5 | 5 | 5 | 0 | 5 | 5 | 4 | | | | |

| Country | Area | Survey | Leg | Station | Species | length | length/weight | Biology (sex, maturity & stomach fullness) | liver samples frozen | stomach samples frozen | Gonad weight | Stomach weight | fin clips preserved and frozen | otoliths collected | frozen individuals | Jellyfish genetics | Jellyfish formalin | Mesopelagic sample sp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Angola | Central | 2017408 | 2 | 46 | *Engraulis encrasicolus* | | 100 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 46 | *Sardinella aurita* | | 42 | 30 | 30 | 30 | 1 | 30 | 30 | 10 | | | | |
| Angola | Central | 2017408 | 2 | 46 | *Sardinella maderensis* | | 57 | 30 | 30 | 30 | 30 | 30 | 30 | 10 | | | | |
| Angola | Central | 2017408 | 2 | 46 | *Scomber japonicus* | | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | | |
| Angola | Central | 2017408 | 2 | 46 | *Trachurus trecae* | | 100 | 30 | 30 | 30 | 0 | 30 | 30 | 9 | | | | |
| Angola | Central | 2017408 | 2 | 47 | *Chloroscombrus chrysurus* | | 5 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 47 | *Sarda sarda* | | 3 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 47 | *Sardinella maderensis* | | 10 | 10 | 10 | 10 | 10 | 10 | | 10 | | | | |
| Angola | Central | 2017408 | 2 | 48 | *Engraulis encrasicolus* | | 39 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 48 | *Scomber japonicus* | | 7 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 48 | *Trachinotus ovatus* | | 5 | | | | | | | | | | | |
| Angola | Central | 2017408 | 2 | 48 | *Trachurus trecae* | | 126 | 30 | 30 | 30 | 30 | 30 | 30 | 10 | | | | |
| Angola | Central | 2017408 | 2 | 49 | *Trachurus trecae* | | 100 | 30 | 30 | 30 | 30 | 30 | 30 | 10 | | | | |
| Angola | Central | 2017408 | 2 | 50 | *Auxis thazard* | | 7 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 54 | *Scomber japonicus* | | 5 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 55 | *Auxis thazard* | | 6 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 55 | *Mola ramsayi* | | 1 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 55 | *Sarda sarda* | | 2 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 55 | *Scomber japonicus* | | 100 | 30 | 30 | 30 | 3 | 30 | 30 | | | | | |
| Angola | South | 2017408 | 2 | 57 | *Euthynnus alletteratus* | | 10 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 57 | *Sarda sarda* | | 2 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 57 | *Sardinella aurita* | | 87 | 30 | 30 | 30 | 2 | 30 | 30 | 10 | | | | |
| Angola | South | 2017408 | 2 | 57 | *Sardinella maderensis* | | 100 | 30 | 30 | 30 | 30 | 30 | 30 | 10 | | | | |
| Angola | South | 2017408 | 2 | 57 | *Scomber japonicus* | | 1 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 58 | *Sardinella aurita* | | 91 | 30 | 30 | 30 | 0 | 30 | 30 | | | | | |
| Angola | South | 2017408 | 2 | 58 | *Sardinella maderensis* | | 66 | 30 | 30 | 30 | 30 | 30 | 30 | 8 | | | | |
| Angola | South | 2017408 | 2 | 58 | *Scomber japonicus* | | 1 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 58 | *Selene dorsalis* | | 1 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 58 | *Trachurus trecae* | | 90 | 30 | 30 | 30 | 3 | 30 | 30 | 10 | | | | |
| Angola | South | 2017408 | 2 | 60 | *Auxis thazard* | | 12 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 60 | *Sarda sarda* | | 9 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 60 | *Scomber japonicus* | | 98 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 61 | *Scomber japonicus* | | 13 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 61 | *Trachurus trecae* | | 72 | 30 | 30 | 30 | 30 | 30 | 30 | 10 | | | | |
| Angola | South | 2017408 | 2 | 62 | *Sarda sarda* | | 3 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 62 | *Sardinella aurita* | | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 0 | | | | |
| Angola | South | 2017408 | 2 | 62 | *Scomber japonicus* | | 15 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 62 | *Trachurus trecae* | | 104 | 30 | 30 | 30 | 30 | 30 | 30 | 10 | | | | |
| Angola | South | 2017408 | 2 | 63 | *Scomber japonicus* | | 1 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 64 | *Engraulis encrasicolus* | | 99 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 64 | *Sarda sarda* | | 6 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 64 | *Scomber japonicus* | | 11 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 64 | *Trachurus trecae* | | 56 | 30 | 30 | 30 | 30 | 30 | 30 | 10 | | | | |
| Angola | South | 2017408 | 2 | 65 | *Sarda sarda* | | 1 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 65 | *Scomber japonicus* | | 100 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 65 | *Trachurus trecae* | | 102 | 30 | 30 | 30 | 30 | 30 | 30 | 10 | | | | |
| Angola | South | 2017408 | 2 | 66 | *Engraulis encrasicolus* | | 13 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 66 | *Sarda sarda* | | 2 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 66 | *Sardinella aurita* | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | | | |
| Angola | South | 2017408 | 2 | 66 | *Sardinella maderensis* | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | |
| Angola | South | 2017408 | 2 | 66 | *Sardinops sagax* | | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | |

| Country | Area | Survey | Leg | Station | Species | length | length/weight | Biology (sex, maturity & stomach fullness) | liver samples frozen | stomach samples frozen | Gonad weight | Stomach weight | fin clips preserved and frozen | otoliths collected | frozen individuals | Jellyfish genetics | Jellyfish formalin | Mesopelagic sample sp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Angola | South | 2017408 | 2 | 66 | *Scomber japonicus* | | 100 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 66 | *Trachurus trecae* | | 100 | 30 | 30 | 30 | 12 | 30 | 30 | 10 | | | | |
| Angola | South | 2017408 | 2 | 69 | *Etrumeus whiteheadi* | | 100 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 69 | *Scomber japonicus* | | 11 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 69 | *Trachurus capensis* | | 72 | 30 | 30 | 30 | 30 | 30 | 30 | 10 | | | | |
| Angola | South | 2017408 | 2 | 69 | *Trachurus trecae* | | 100 | 30 | 22 | 22 | 22 | 22 | 30 | 10 | | | | |
| Angola | South | 2017408 | 2 | 70 | *Engraulis encrasicolus* | | 102 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 70 | *Sardinella aurita* | | 102 | 30 | 30 | 30 | 9 | 30 | 30 | 10 | | | | |
| Angola | South | 2017408 | 2 | 70 | *Sardinops sagax* | | 12 | 12 | 12 | 12 | 0 | 12 | 12 | 9 | | | | |
| Angola | South | 2017408 | 2 | 70 | *Trachurus trecae* | | 19 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 71 | *Engraulis encrasicolus* | | 100 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 71 | *Sardinella aurita* | | 100 | 30 | 30 | 30 | 0 | 30 | 30 | 10 | | | | |
| Angola | South | 2017408 | 2 | 71 | *Sardinops sagax* | | 6 | 6 | 6 | 6 | 0 | 6 | 6 | 6 | | | | |
| Angola | South | 2017408 | 2 | 71 | *Trachurus capensis* | | 100 | 30 | 30 | 30 | 0 | 30 | 30 | 10 | | | | |
| Angola | South | 2017408 | 2 | 71 | *Trachurus trecae* | | 100 | 30 | 30 | 30 | 2 | 30 | 30 | 10 | | | | |
| Angola | South | 2017408 | 2 | 72 | *Etrumeus whiteheadi* | | 6 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 72 | *Scomber japonicus* | | 9 | | | | | | | | | | | |
| Angola | South | 2017408 | 2 | 72 | *Trachurus capensis* | | 100 | 30 | 30 | 30 | 2 | 30 | 30 | 10 | | | | |
| Angola | South | 2017408 | 2 | 72 | *Trachurus trecae* | | 12 | 12 | 12 | 12 | 1 | 12 | 12 | 0 | | | | |

# ANNEX V. ABUNDANCE ESTIMATES BY NUMBERS AND BIOMASS

*Trachurus trecae*

| | N (thousands) | | | | Biomass (tonnes) | | | |
|---|---|---|---|---|---|---|---|---|
| Length | Congo River | Pta. das Palmerinhas | Benguela | TOTAL | Congo River | Pta. das Palmerinhas | Benguela | TOTAL |
| cm | Pta. das Palmerinhas | Benguela | Cunene River | | Pta. das Palmerinhas | Benguela | Cunene River | |
| 5 | 1 173 | 1 167 | 511 | 2 851 | 2 | 2 | 1 | 5 |
| 6 | 115 048 | 2 197 | 75 733 | 192 978 | 299 | 6 | 297 | 602 |
| 7 | 525 991 | 3 650 | 679 043 | 1 208 684 | 2 135 | 17 | 3 906 | 6 057 |
| 8 | 210 465 | 18 623 | 709 992 | 939 081 | 1 261 | 122 | 5 714 | 7 098 |
| 9 | 847 206 | 177 997 | 264 705 | 1 289 907 | 7 173 | 1 629 | 2 871 | 11 673 |
| 10 | 564 234 | 99 052 | 378 594 | 1 041 880 | 6 522 | 1 222 | 5 372 | 13 115 |
| 11 | 105 169 | 13 211 | 234 602 | 352 982 | 1 613 | 214 | 4 249 | 6 076 |
| 12 | 47 620 | 2 994 | 172 067 | 222 682 | 947 | 62 | 3 898 | 4 907 |
| 13 | 38 648 | 3 246 | 94 137 | 136 032 | 976 | 85 | 2 622 | 3 683 |
| 14 | 69 443 | 3 233 | 27 546 | 100 221 | 2 191 | 104 | 929 | 3 224 |
| 15 | 4 324 | 305 | 33 002 | 37 631 | 168 | 12 | 1 332 | 1 512 |
| 16 | 0 | 17 | 18 767 | 18 783 | 0 | 1 | 896 | 896 |
| 17 | 0 | 17 | 29 645 | 29 661 | 0 | 1 | 1 657 | 1 658 |
| 18 | 6 209 | 33 | 9 773 | 16 015 | 418 | 2 | 634 | 1 054 |
| 19 | 14 979 | 99 | 26 883 | 41 960 | 1 187 | 8 | 2 009 | 3 204 |
| 20 | 44 958 | 1 001 | 52 103 | 98 062 | 4 164 | 91 | 4 452 | 8 707 |
| 21 | 108 128 | 173 | 20 618 | 128 919 | 11 614 | 18 | 2 002 | 13 634 |
| 22 | 207 031 | 4 264 | 5 855 | 217 149 | 25 615 | 509 | 642 | 26 766 |
| 23 | 243 196 | 2 766 | 5 934 | 251 896 | 34 447 | 376 | 732 | 35 555 |
| 24 | 123 302 | 4 812 | 8 150 | 136 264 | 19 882 | 740 | 1 124 | 21 746 |
| 25 | 45 942 | 4 371 | 6 986 | 57 299 | 8 390 | 758 | 1 072 | 10 220 |
| 26 | 41 991 | 12 549 | 12 281 | 66 822 | 8 643 | 2 439 | 2 090 | 13 172 |
| 27 | 16 862 | 10 185 | 6 460 | 33 508 | 3 895 | 2 211 | 1 214 | 7 319 |
| 28 | 8 157 | 14 432 | 3 493 | 26 081 | 2 105 | 3 484 | 723 | 6 312 |
| 29 | 706 | 3 722 | 8 150 | 12 577 | 203 | 996 | 1 849 | 3 048 |
| 30 | 0 | 2 392 | 3 493 | 5 885 | 0 | 707 | 867 | 1 574 |
| 31 | 0 | 1 329 | 4 657 | 5 986 | 0 | 432 | 1 260 | 1 693 |
| 32 | 0 | 266 | 5 821 | 6 087 | 0 | 95 | 1 713 | 1 808 |
| 33 | 0 | 266 | 1 164 | 1 430 | 0 | 104 | 372 | 476 |
| 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | 5 882 | 0 | 0 | 5 882 | 3 006 | 0 | 0 | 3 006 |
| 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | 3 921 | 0 | 0 | 3 921 | 3 508 | 0 | 0 | 3 508 |
| 43 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 45 | 5 139 | 0 | 0 | 5 139 | 5 684 | 0 | 0 | 5 684 |
| TOTAL | 3 405 725 | 388 368 | 2 900 164 | 6 694 258 | 156 046 | 16 446 | 56 500 | 228 991 |

*Trachurus capensis*

| Length cm | N (thousands) | | | | Biomass (tonnes) | | | |
|---|---|---|---|---|---|---|---|---|
| | Congo River Pta. das Palmerinhas | Pta. das Palmerinhas Benguela | Benguela Cunene River | TOTAL | Congo River Pta. das Palmerinhas | Pta. das Palmerinhas Benguela | Benguela Cunene River | TOTAL |
| 5 | | | 0 | 0 | | | 0 | 0 |
| 6 | | | 0 | 0 | | | 0 | 0 |
| 7 | | | 0 | 0 | | | 0 | 0 |
| 8 | | | 56 792 | 56 792 | | | 401 | 401 |
| 9 | | | 388 076 | 388 076 | | | 3 625 | 3 625 |
| 10 | | | 440 811 | 440 811 | | | 5 302 | 5 302 |
| 11 | | | 618 623 | 618 623 | | | 9 362 | 9 362 |
| 12 | | | 912 723 | 912 723 | | | 17 051 | 17 051 |
| 13 | | | 169 023 | 169 023 | | | 3 835 | 3 835 |
| 14 | | | 0 | 0 | | | 0 | 0 |
| 15 | | | 33 805 | 33 805 | | | 1 087 | 1 087 |
| 16 | | | 0 | 0 | | | 0 | 0 |
| 17 | | | 267 | 267 | | | 12 | 12 |
| 18 | | | 1 336 | 1 336 | | | 67 | 67 |
| 19 | | | 22 782 | 22 782 | | | 1 308 | 1 308 |
| 20 | | | 5 612 | 5 612 | | | 366 | 366 |
| 21 | | | 3 742 | 3 742 | | | 275 | 275 |
| 22 | | | 1 336 | 1 336 | | | 110 | 110 |
| 23 | | | 1 069 | 1 069 | | | 98 | 98 |
| 24 | | | 0 | 0 | | | 0 | 0 |
| 25 | | | 0 | 0 | | | 0 | 0 |
| TOTAL | 0 | 0 | 2 655 996 | 2 655 996 | 0 | 0 | 42 900 | 42 900 |

*Sardinella maderensis*

| Length cm | N (thousands) | | | | Biomass (tonnes) | | | |
|---|---|---|---|---|---|---|---|---|
| | Congo River Pta. das Palmerinhas | Pta. das Palmerinhas Benguela | Benguela Cunene River | TOTAL | Congo River Pta. das Palmerinhas | Pta. das Palmerinhas Benguela | Benguela Cunene River | TOTAL |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | 2 359 | | 2 359 | | 29 | | 29 |
| 11 | 2 544 | 3 413 | | 5 956 | 32 | 54 | | 86 |
| 12 | 1 110 | 12 346 | | 13 456 | 18 | 250 | | 268 |
| 13 | 2 046 | 9 184 | | 11 231 | 43 | 232 | | 274 |
| 14 | 14 590 | 62 787 | | 77 376 | 380 | 1 944 | | 2 324 |
| 15 | 35 410 | 61 217 | | 96 627 | 1 135 | 2 296 | | 3 431 |
| 16 | 29 735 | 39 735 | | 69 470 | 1 158 | 1 783 | | 2 941 |
| 17 | 42 243 | 50 984 | | 93 227 | 1 977 | 2 708 | | 4 685 |
| 18 | 79 284 | 45 466 | | 124 751 | 4 413 | 2 833 | | 7 246 |
| 19 | 103 788 | 41 201 | | 144 989 | 6 809 | 2 986 | | 9 794 |
| 20 | 121 446 | 42 822 | | 164 267 | 9 312 | 3 582 | | 12 894 |
| 21 | 78 624 | 41 357 | | 119 981 | 6 994 | 3 966 | | 10 960 |
| 22 | 141 499 | 159 301 | | 300 800 | 14 506 | 17 405 | | 31 911 |
| 23 | 99 547 | 365 691 | | 465 238 | 11 688 | 45 264 | | 56 952 |
| 24 | 218 301 | 255 969 | 784 | 475 054 | 29 190 | 35 708 | 125 | 65 022 |
| 25 | 233 848 | 156 984 | 5 281 | 396 113 | 35 425 | 24 563 | 925 | 60 913 |
| 26 | 218 001 | 53 949 | 20 571 | 292 521 | 37 235 | 9 426 | 3 953 | 50 614 |
| 27 | 336 848 | 10 028 | 15 516 | 362 392 | 64 582 | 1 949 | 3 260 | 69 790 |
| 28 | 105 089 | 87 857 | 18 902 | 211 848 | 22 523 | 18 915 | 4 328 | 45 767 |
| 29 | 65 742 | 34 520 | 31 565 | 131 827 | 15 691 | 8 205 | 7 854 | 31 749 |
| 30 | 150 409 | 6 761 | 4 992 | 162 162 | 39 832 | 1 768 | 1 346 | 42 947 |
| 31 | 13 533 | 17 514 | 8 911 | 39 958 | 3 963 | 5 025 | 2 597 | 11 585 |
| 32 | 7 367 | 3 775 | 784 | 11 926 | 2 379 | 1 185 | 246 | 3 809 |
| 33 | | | | | | | | |
| 34 | | | | | | | | |
| 35 | | | | | | | | |
| TOTAL | 2 101 005 | 1 565 216 | 107 306 | 3 773 528 | 309 286 | 192 075 | 24 633 | 525 994 |

*Sardinella aurita*

| Length cm | N (thousands) Congo River Pta. das Palmerinhas | Pta. das Palmerinhas Benguela | Benguela Cunene River | TOTAL | Biomass (tonnes) Congo River Pta. das Palmerinhas | Pta. das Palmerinhas Benguela | Benguela Cunene River | TOTAL |
|---|---|---|---|---|---|---|---|---|
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | 881 | | 881 | | 3 | | 3 |
| 8 | | 3 667 | 322 | 3 988 | | 17 | 2 | 19 |
| 9 | 5 215 | 217 604 | 17 940 | 240 759 | 26 | 1 467 | 141 | 1 634 |
| 10 | 41 257 | 1 497 939 | 173 323 | 1 712 519 | 287 | 13 915 | 1 853 | 16 056 |
| 11 | 47 363 | 1 451 628 | 1 144 770 | 2 643 761 | 452 | 18 044 | 16 213 | 34 709 |
| 12 | 57 032 | 295 745 | 576 194 | 928 971 | 727 | 4 801 | 10 557 | 16 085 |
| 13 | 54 066 | 53 432 | 200 157 | 307 656 | 900 | 1 110 | 4 651 | 6 661 |
| 14 | 62 891 | 2 075 | 30 148 | 95 114 | 1 341 | 54 | 874 | 2 269 |
| 15 | 34 262 | 1 038 | | 35 299 | 921 | 34 | | 955 |
| 16 | 23 209 | | | 23 209 | 775 | | | 775 |
| 17 | 60 992 | 3 524 | 19 683 | 84 199 | 2 498 | 168 | 1 020 | 3 685 |
| 18 | 108 693 | | | 108 693 | 5 397 | | | 5 397 |
| 19 | 48 351 | 15 982 | | 64 332 | 2 882 | 1 077 | | 3 959 |
| 20 | 24 886 | 23 822 | | 48 709 | 1 764 | 1 884 | | 3 648 |
| 21 | 23 962 | 11 219 | | 35 181 | 2 004 | 1 034 | | 3 037 |
| 22 | 9 284 | 2 861 | | 12 145 | 909 | 305 | | 1 214 |
| 23 | 10 977 | 6 303 | | 17 280 | 1 250 | 772 | | 2 022 |
| 24 | 15 307 | 54 117 | | 69 424 | 2 014 | 7 574 | | 9 587 |
| 25 | 32 331 | 106 923 | | 139 254 | 4 886 | 17 008 | | 21 894 |
| 26 | 29 176 | 46 623 | | 75 800 | 5 039 | 8 388 | | 13 427 |
| 27 | 32 626 | 88 442 | | 121 067 | 6 407 | 17 915 | | 24 322 |
| 28 | 33 672 | 46 016 | | 79 688 | 7 484 | 10 450 | | 17 934 |
| 29 | 72 908 | 86 862 | | 159 769 | 18 264 | 22 029 | | 40 293 |
| 30 | 38 215 | 307 | 297 | 38 819 | 10 746 | 87 | 86 | 10 919 |
| 31 | 17 583 | 21 812 | 297 | 39 692 | 5 530 | 6 824 | 94 | 12 449 |
| 32 | 3 262 | 61 | | 3 324 | 1 144 | 21 | | 1 165 |
| 33 | | | | | | | | |
| 34 | | | | | | | | |
| 35 | | | | | | | | |
| TOTAL | 887 520 | 4 038 882 | 2 163 132 | 7 089 534 | 83 645 | 134 981 | 35 490 | 254 116 |

***P1***

| Length cm | *Ilisha africana* N (thousands) Congo River Pta. das Palmerinhas | Pta. das Palmerinhas Benguela | *Engraulis* Benguela Cunene River | TOTAL | *Ilisha africana* Biomass (tonnes) Congo River Pta. das Palmerinhas | Pta. das Palmerinhas Benguela | *Engraulis* Benguela Cunene River | TOTAL |
|---|---|---|---|---|---|---|---|---|
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | 208 | 208 | | | 1 | 1 |
| 9 | | | 242 359 | 242 359 | | | 1 701 | 1 701 |
| 10 | | | 1 451 958 | 1 451 958 | | | 12 668 | 12 668 |
| 11 | | | 1 960 451 | 1 960 451 | | | 20 843 | 20 843 |
| 12 | 1 471 | 58 | 473 146 | 474 675 | 25 | 1 | 6 030 | 6 055 |
| 13 | 7 354 | 58 | 119 377 | 126 789 | 154 | 1 | 1 798 | 1 953 |
| 14 | 7 354 | 526 | 3 195 | 11 075 | 188 | 16 | 56 | 261 |
| 15 | 33 828 | 1 694 | | 35 523 | 1 047 | 62 | | 1 108 |
| 16 | 32 357 | 1 346 | | 33 703 | 1 196 | 57 | | 1 253 |
| 17 | 39 711 | 703 | | 40 414 | 1 735 | 35 | | 1 770 |
| 18 | 26 474 | 959 | | 27 433 | 1 355 | 55 | | 1 410 |
| 19 | 42 653 | 1 367 | | 44 020 | 2 536 | 89 | | 2 625 |
| 20 | 47 065 | 1 110 | | 48 175 | 3 226 | 82 | | 3 308 |
| 21 | 17 649 | 1 186 | | 18 836 | 1 385 | 99 | | 1 484 |
| 22 | 26 474 | 966 | | 27 440 | 2 365 | 90 | | 2 455 |
| 23 | 14 708 | 1 374 | | 16 082 | 1 487 | 143 | | 1 630 |
| 24 | 1 471 | 810 | | 2 281 | 167 | 94 | | 261 |
| 25 | | 270 | | 270 | | 35 | | 35 |
| TOTAL | 298 570 | 12 427 | 4 250 694 | 4 561 691 | 16 867 | 859 | 43 097 | 60 823 |

| | *Engraulis* *Etrumeus* | | | | *Engraulis* *Etrumeus* | | | |
|---|---|---|---|---|---|---|---|---|
| | N (thousands) | | | | Biomass (tonnes) | | | |
| Length<br>cm | Congo River Pta. das Palmerinhas | Pta. das Palmerinhas Benguela | Benguela Cunene River | TOTAL | Congo River Pta. das Palmerinhas | Pta. das Palmerinhas Benguela | Benguela Cunene River | TOTAL |
| 5 | | | | | | | | |
| 6 | | 79 | | 79 | | 0 | | 0 |
| 7 | | | | | | | | |
| 8 | | 714 | | 714 | | 2 | | 2 |
| 9 | | 3 716 | | 3 716 | | 15 | | 15 |
| 10 | | 6 812 | | 6 812 | | 31 | | 31 |
| 11 | | 6 382 | | 6 382 | | 26 | | 26 |
| 12 | | 3 791 | | 3 791 | | 6 | | 6 |
| 13 | | 1 222 | | 1 222 | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | 294 | | 294 |
| 17 | | | | | | 294 | | 294 |
| 18 | | | | | | 784 | | 784 |
| 19 | | | 623 | 623 | | 980 | 31 | 1 011 |
| 20 | | | 4 154 | 4 154 | | 98 | 241 | 339 |
| 21 | | | 8 101 | 8 101 | | 588 | 546 | 1 134 |
| 22 | | | 5 608 | 5 608 | | 98 | 436 | 534 |
| 23 | | | 2 077 | 2 077 | | 294 | 185 | 479 |
| 24 | | | 208 | 208 | | | 21 | 21 |
| 25 | | | | | | | | |
| TOTAL | | 22 716 | 20 771 | 43 487 | | 3 510 | 1 461 | 4 970 |

## ANNEX VI. Validation of the oxygen and salinity data

During survey the following CTD sensors were in use:

| Parameter | Function | Model | Serial | Last Factory Cal |
|---|---|---|---|---|
| Temperature | Primary | SBE3 plus 6800m | 03P4537 | 2016-10-28 |
| | Secondary | | 3162 | 2016-10-27 |
| Conductivity | Primary | SBE 4C 6800m | 2037 | 2016-10-25 |
| | Secondary | | 3132 | 2017-04-27 |
| Oxygen | | SBE43 7000m | 43-3525 | 2017-04-08 |

Note that secondary conductivity data before Station 633 are invalid. The sensor 3162 was installed on October 10 in Luanda, replacing the previous sensor, dysfunctional since the beginning of the survey.

The quality of the CTD was validated it two ways, by comparing with results from water bottle samples collected at the same depth levels (oxygen and salinity) and by checking the difference between the readings of the primary and secondary sensors (temperature and conductivity).

Water bottle samples for oxygen and salinity were taken at offshore ends of the four sections: Namibe (sta 725), Cunene (sta 758) , 19°S (sta 770) and 20°S (sta780). Each batch consisted of 10 water bottle samples collected during the CTD probe ascent. The samples were taped immediately after the CTD probe was recovered on deck.

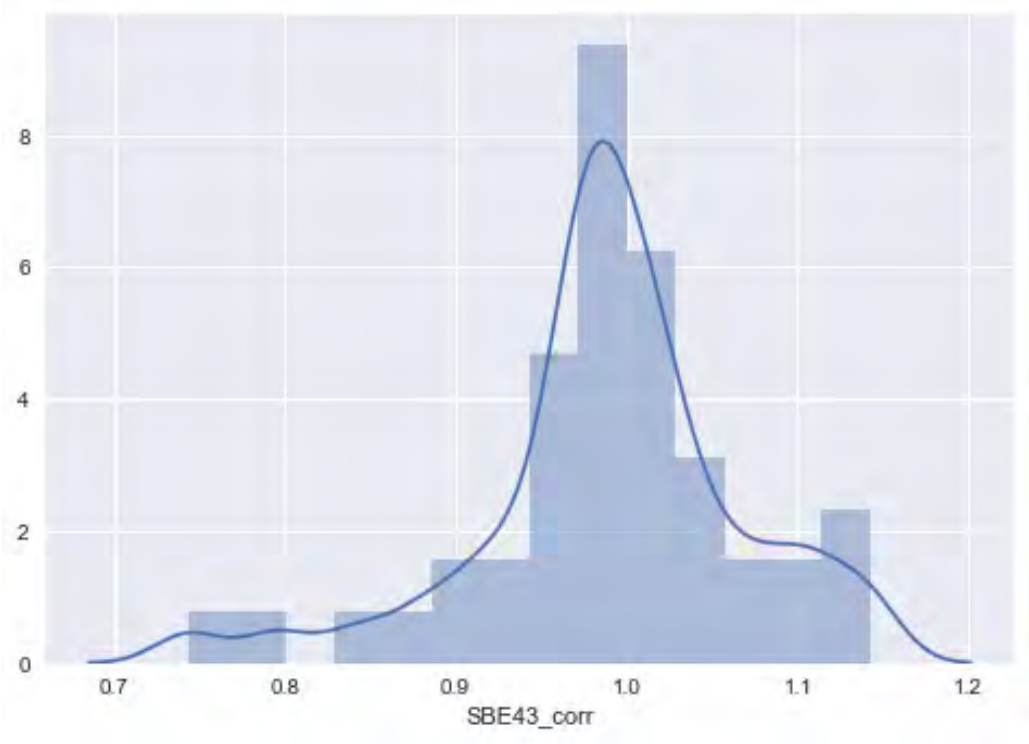


Figure VI.1. Histogram of the correction ratio of the titrated to CTD-sampled oxygen based on all oxygen samples processed during Survey 2017408.

*Oxygen water bottle vs. CTD*

The oxygen samples were treaded with the Winkler method. The range of oxygen concentrations in the samples was 0.47-6.51 ml/l. The comparison against the sensor values was carried out according to the quality check described in the Sea-Bird application note AN 64-2 from SBE 43 Oxygen sensor (http://www.seabird.com/application-notes). The key parameter used in this comparison is the correction ratio of the titrated to sensor measured oxygen value. If this ratio is different from one, then the calibration coefficients used during the data logging should be modified to include this value. The difference between the sensor and titrated oxygen of 10-15% indicates that the sensor must be replaced.

Figure VI.1 shows the histogram of the oxygen correction ratio obtained for water bottle samples collected during this survey. The ratio varied from one processed sample to another. The spread of values is considerable, from 0.7 to 1.1. Notwithstanding, the histogram exhibits a bell-like shape, suggesting the normal distribution. Stemming from this observation, the overall result of the oxygen validation can be presented by means of the following statistical summaries:

- The mean oxygen correction ratio 0.989
- Median oxygen correction ratio 0.989
- Standard deviation 0.08

The presented values suggest the deviation of the titrated to sensor-measured oxygen is in the order of 1 per cent. However, given the limited number of samples processed, uncertainties with the quality of the Winkler titrations preformed on the vessel and the relatively recent factory calibration of the sensor, our conclusion is to use the original factory calibrated sensor data, ignoring the corrections suggested by the above statistics.

*Salinity water bottle vs. CTD*

Salinity samples were evaluated against the standard seawater with the Guildline Portasal salinometer. The laboratory setting to conduct accurate salinity calibrations on the vessel is not perfect. These measurements require maintaining constant temperature for many hours prior to observation, while the CTD lab is located next to the open deck where the CTD probe is operated. The whisker plot in Figure VI.2 presents the difference between the laboratory-measured and CTD-sampled salinity at the four stations.


Figure VI.2. Median and quartiles of the difference between the salinometer and CTD-probe derived at the four stations sampled during survey 2017408. The horizontal axis describes station number, the vertical axis describes the difference between the salinometer and sensor derived variability.

The reproducible results were obtained at Stas 725 and 758. On the two remaining stations, the results varied strongly between the samples and between these stations. The pattern in Figure VI.2 may suggest either a sensor failure after station 758 or a drastic deterioration in the quality of the laboratory salinity evaluations. Given the stability of reading between the independent sensors (see the next section), the latter problem has to be assumed.

Removing the two outstanding stations (Sta 770 and 780) and retaining only the reproducible part of the result (sta 725 and 758) yields the following summary statistics of the difference between the salinometer and CTD derived salinities:

- Mean value: -0.001 psu
- Median: -0.005 psu
- RMS: 0.013

This would have been very good result, had it been characterizing all four stations. Note that maximum accuracy of the salinometer is 0.003 psu.

*Primary vs. secondary sensors.*

The temperature and conductivity sensors on the Nansen CTD system are duplicated. Monitoring of the evolution in the difference between the primary and secondary sensors reading during a survey helps to identify issues not easily identifiable on single sensor system, such as the sensor drift. Figure VI.3 presents a map of differences in salinity as function of the station number and depth during survey 2017408. The map includes all stations beginning with Sta 633 occupied on October 10, after the faulty conductivity sensor was replaced.

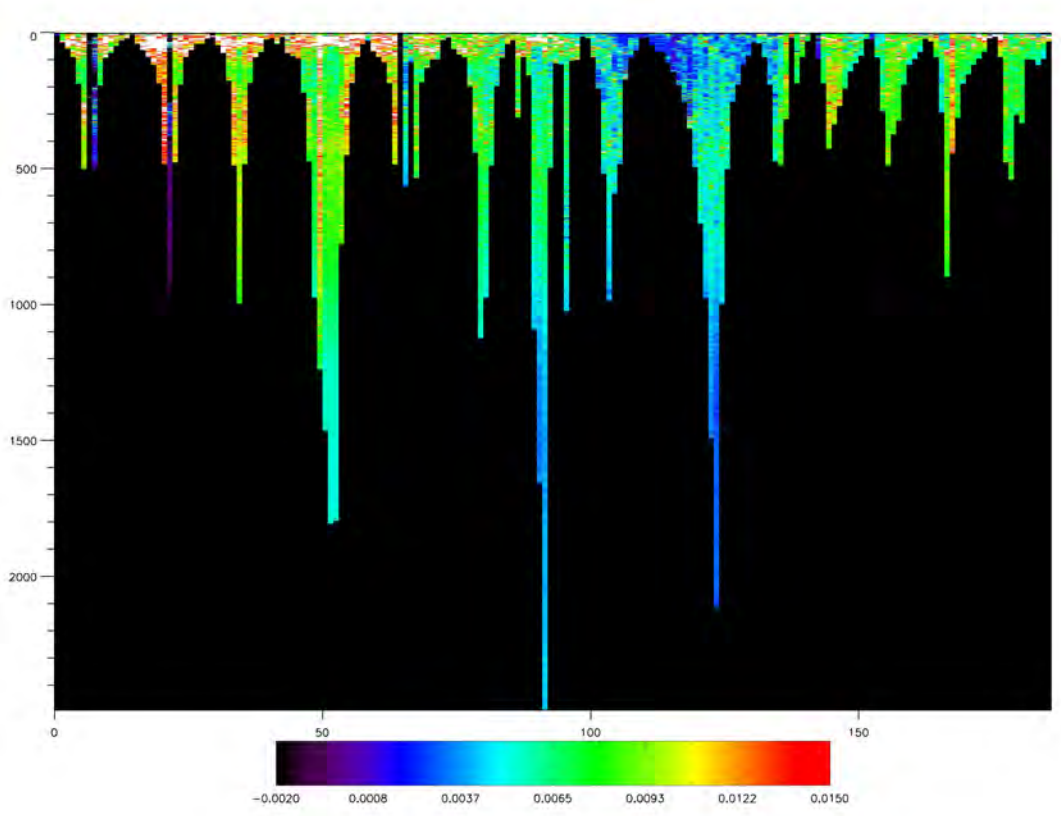


Figure VI.3. The difference in salinity computed using the primary and secondary temperature and salinity sensors in the function of station number (minus 633) and depth. Horizontal axis denotes the reduced station number (Sta – 633); the vertical axis denotes depth.