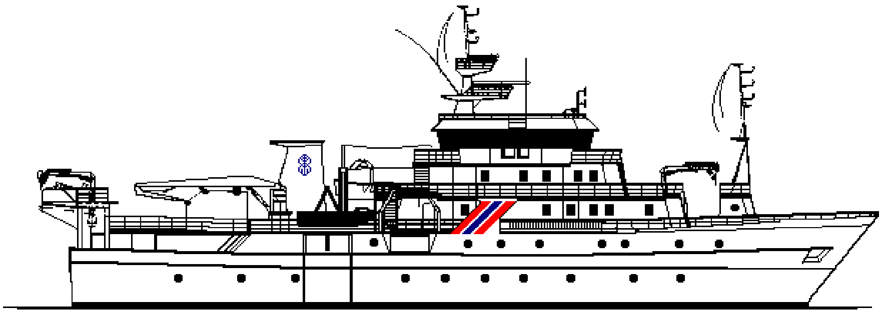

MESOPELAGIC TRANSECT

Walvis Bay – Walvis Ridge, Namibia

30 April - 7 May 2019

Leg 2.3 2019

Institute of Marine Research

Bergen, 2019

CRUISE REPORTS "DR FRIDTJOF NANSEN"

MESOPELAGIC TRANSECT

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30 April - 7 May 2019

Leg 2.3 2019

by

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Institute of Marine Research

Bergen, 2019

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CHAPTER 1. INTRODUCTION

1.1 Survey objectives

The main objective of the survey was to study the biological composition and acoustic properties of the mesopelagic community, monitor vertical movements of scattering layers or their components using a pelagic sampling trawl and a camera system, and to obtain biological samples of mesopelagic organisms. The survey was a repeat of a similar survey conducted with the Dr. Fridtjof Nansen 16-23 November 2017 (Survey no. 2017409), thus offering similar information from the alternate season. The survey also aimed to reach further west than the 2017 survey, thereby providing more information about the oceanic mesopelagic community, including the Walvis Bay Ridge region.

Specific objectives

Mesopelagic community

- Obtain concurrent information on the acoustical properties and biological composition of the mesopelagic community
- Study the acoustic properties of mesopelagic fish and other mesopelagic organisms such as squids, crustaceans, gelatinous organisms and principal zooplankton taxa including their frequency response and target strength
- Obtain biological samples and observations using different sampling gears (trawls, plankton nets and camera systems)
- Collect samples for analysis of C and N stable isotope ratios and fatty acid composition to understand the trophic roles of mesopelagic species

Oceanography

- Map the hydrographic/ environmental conditions in the survey area (temperature, salinity, oxygen, fluorescence, irradiant light, nutrients and pH)
- Measure the principal current dynamics across the shelf, slope and basin
- Estimate the productivity along the inshore-offshore eutrophication gradient

Plankton and jellyfish

- Describe the broad distribution, abundance and taxonomic composition of jellyfish and zooplankton

Seabirds and marine mammals

- Visual observation and counts of seabirds, marine mammals, and litter along the transect

1.2 Participation

National Marine Information and Research Centre (NatMIRC), Namibia:
Justine Kakuuai, Moses Shidalwomunhu Kalola, Larkin Sivula, Hilma Zynap Bundje

University of Namibia (UNAM), Namibia:
Veronica Kapula, Lucia Kavala, Hilma Likius

Department of Agriculture, Forestry and Fisheries (DAFF), South Africa:
Janet Coetzee, Mzwamadoda Phillips, Lennox Loyso Maliza,

University of Western Cape (UWC), South Africa:
Mark Gibbons, Bonga Govusa

BirdLife, South Africa:
Clifford Dorse, Suretha Dorse

Instituto Español de Oceanografía, Spain:
José Francisco González Jiménez

Institute of Marine Research, Norway (IMR) Norway:
Bjørn Erik Axelsen (cruise leader), Inês Dias Bernardes, Stamatina Isari, Anne Christine Utne Palm, Helene Lødemel, Olaf Johan Sørås, Hege Rognaldsen.

1.3 Narrative

Due to problems with issuance of visa for the South African and Spanish participants the departure from Walvis Bay was severely delayed. The vessel departed from Walvis Bay, Namibia, 30th April at 13:00 (UTC), three days after her scheduled departure on 27th May. The transect was started 30th April at 15:30 with CTD station (HD387) and ended at its western boundary near the Walvis Ridge on 5th May at 16:00. Due to the time constraints caused by the delayed departure the sampling and measurements were reduced according to the general provisions set forth in the sailing orders, including measurements with the Simrad WBAT echosounder system. As timely completion of the transect permitted some additional work at the end of the survey, CTD/WBAT profiles were sampled at selected stations on the inbound transit. The vessel docked in Walvis Bay on 7th May 2019 at 06:00 (UTC).

CHAPTER 2. METHODS

2.1 Survey Design

The design of the survey and sampling protocol were based on the sailing orders – *RV Dr Fridtjof Nansen 2019 - Mesopelagic transect – Leg 2.3*, using *Survey Protocols for the R/V Dr. Fritdjof Nansen* as additional reference. Some adaptations were, however, necessary due to time restrictions caused by the delayed start of the survey.

The survey consisted of a East-West transect off Walvis Bay, following the 23° S latitude, which is also a timeseries oceanographic transect for Namibia. Underway acoustic, oceanographic, and weather data were also collected during the westbound return. The transect commenced inshore in the eutrophic zone at 022° 54' 35'' S, 14° 023' 73'' E (48 m bottom depth) on 30 April 2019 at 14:50 (UTC), progressing westwards to the westernmost position at 022° 59' 98'' S, 009° 02' 50'' E in the offshore oligotrophic zone (4504 m bottom depth). Due to the time constraints, the planned 24-hour stations were cancelled. To complete the transect surveying was conducted both during day and night, including twilight periods. Solar time is given in local time (UTC + 2 hours) in Table 2.1.1.

Table 2.1.1 Solar table for Namibia 02.05.2019 in local time (UTC + 2 hours). Solar times drive diel vertical migration in plankton and mesopelagic fish, which in turn impact depth, layer structure and acoustic backscattering properties.

Dawn	**Sunrise**	**Sunset**	**Dusk**
06:59	07:23	18:35	18:58
Morning twilight period: 06:30-08:00		Evening twilight period: 18:00-19:30	
Daytime period: 08:00-18:00		Nighttime period: 19:30-06:30	

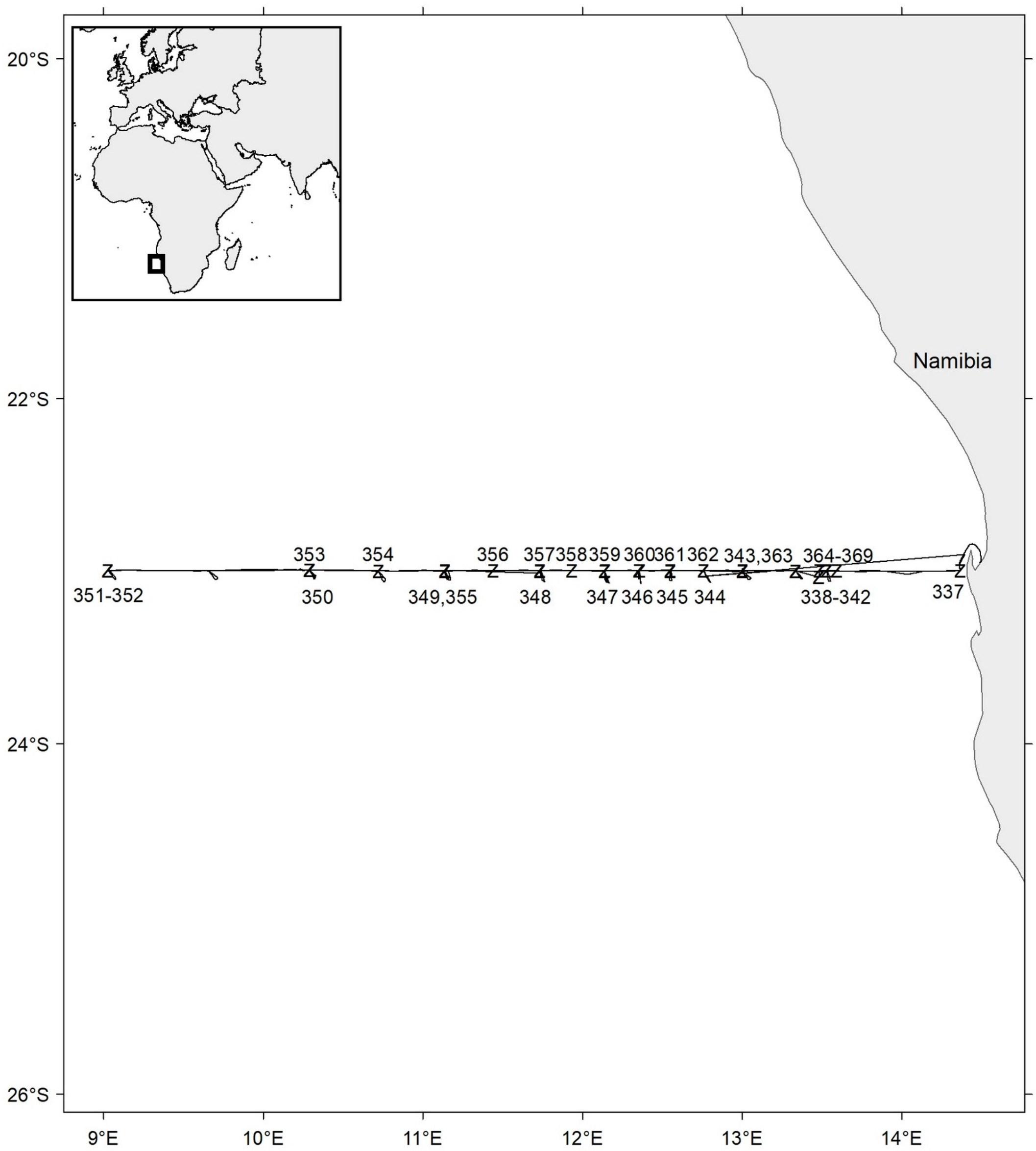
Multifrequency acoustic data were continuously recorded using the Simrad EK80 echosounders. Hydrographic data (CTD) were collected on stations at predefined stations along the transect. Profiled current data were collected underway along the transect using vessel mounted acoustic doppler current profilers (VMADCPs) and at CTD stations using submersed LADCPs. EK80 calibration and operation settings are listed in Annex I.

The Multpelt 624 pelagic sampling trawl was used to sample the mesopelagic nekton community. The plankton community was sampled using the Hydrobios Multinet, WP2 and Bongo plankton nets. The sampling trawls and plankton sampling nets are described in greater detail in Annex II. The Deep Vision stereo camera system was mounted in the Multpelt 624 trawl and was used on all trawl deployments.

The thermosalinograph and weather station were run continuously throughout the survey.

Acoustic transect

The cruise followed a single transect line along the 23° S latitudinal line, commencing in the near-shore eutrophic zone at about 50 m bottom depth (longitude 14° 023’ 73’’ E), extending westwards to 4500 m bottom depth (longitude 009° 02’ 50’’ E). Acoustic data were collected continuously along the transect, with pelagic trawling using the MultPelt 624 pelagic sampling trawl to identify acoustic targets. Comparative tows using the Krill trawl were deployed whenever possible. CTD casts were conducted to measure hydrographic and oceanographic conditions. CTD stations were selected *a priori* to characterize the generic properties of the water masses along the transect line. The sampling intensity was highest over the shelf break, where the largest greatest shifts in water body characteristics and the greatest biological dynamics are normally found. Due to time constraints caused by the delayed departure caused by the visa issues no 24-hour diel cycle station studies were conducted during the survey. The cruise track and sampling events are shown in Figure 2.1.1 through 2.1.3.



Cruise no 2019404 "Dr. Fridtjof Nansen" (Chart I)
27 April–7 May 2019

z CTD st.no 337-369

Figure 2.1.1. CTD stations worked along the transect (n=33). Outbound stations (337-351) included water sampling (180 bottles collected in total), while inbound stations (352-369) did not. Some inbound station (n=15) were combined with WBAT recording of stationary acoustic data (70 and 200 kHz).

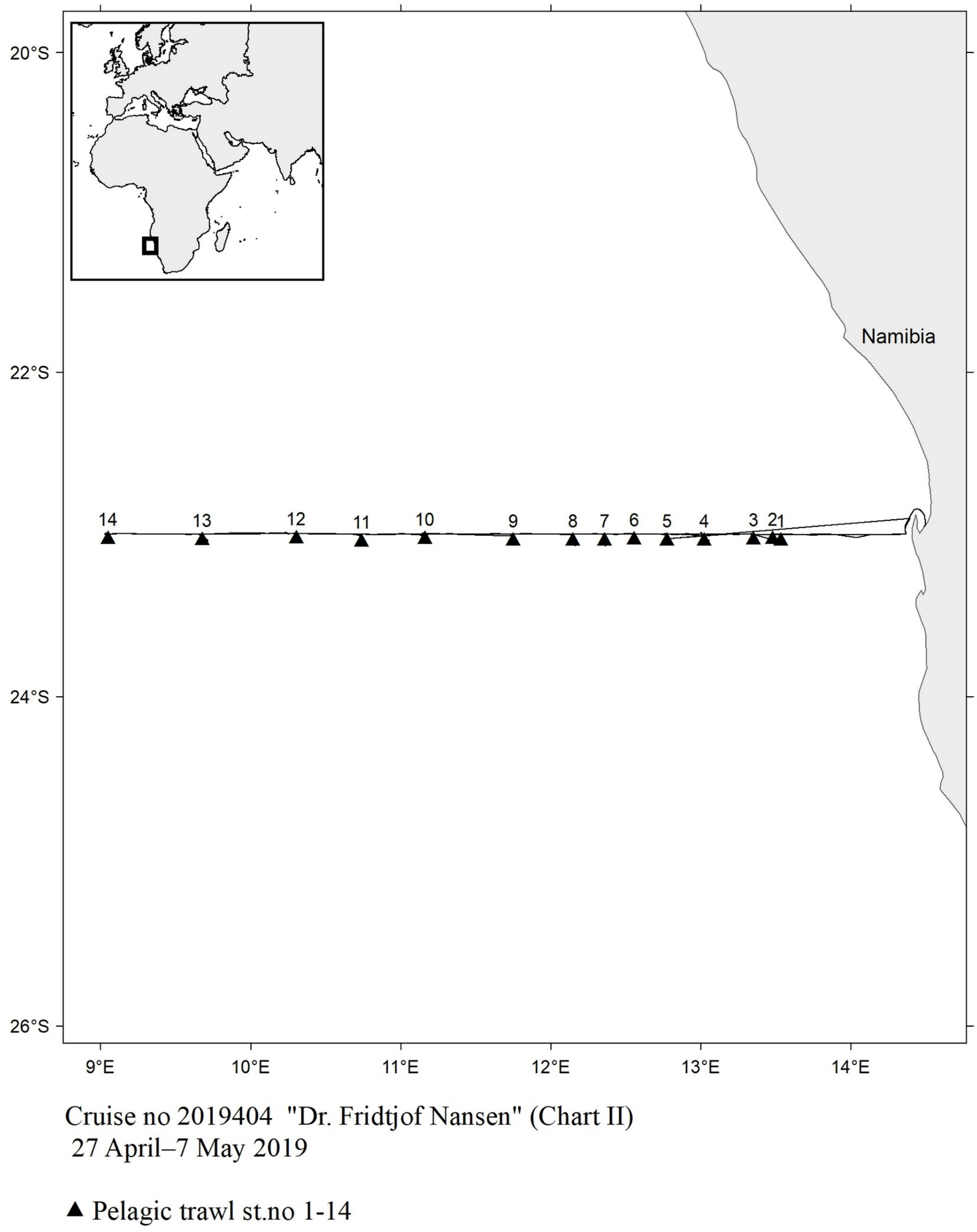


Figure 2.1.2. Pelagic trawl stations worked along the transect using a Multpelt 624 trawl fitted with Deep Vision camera system (n=14).

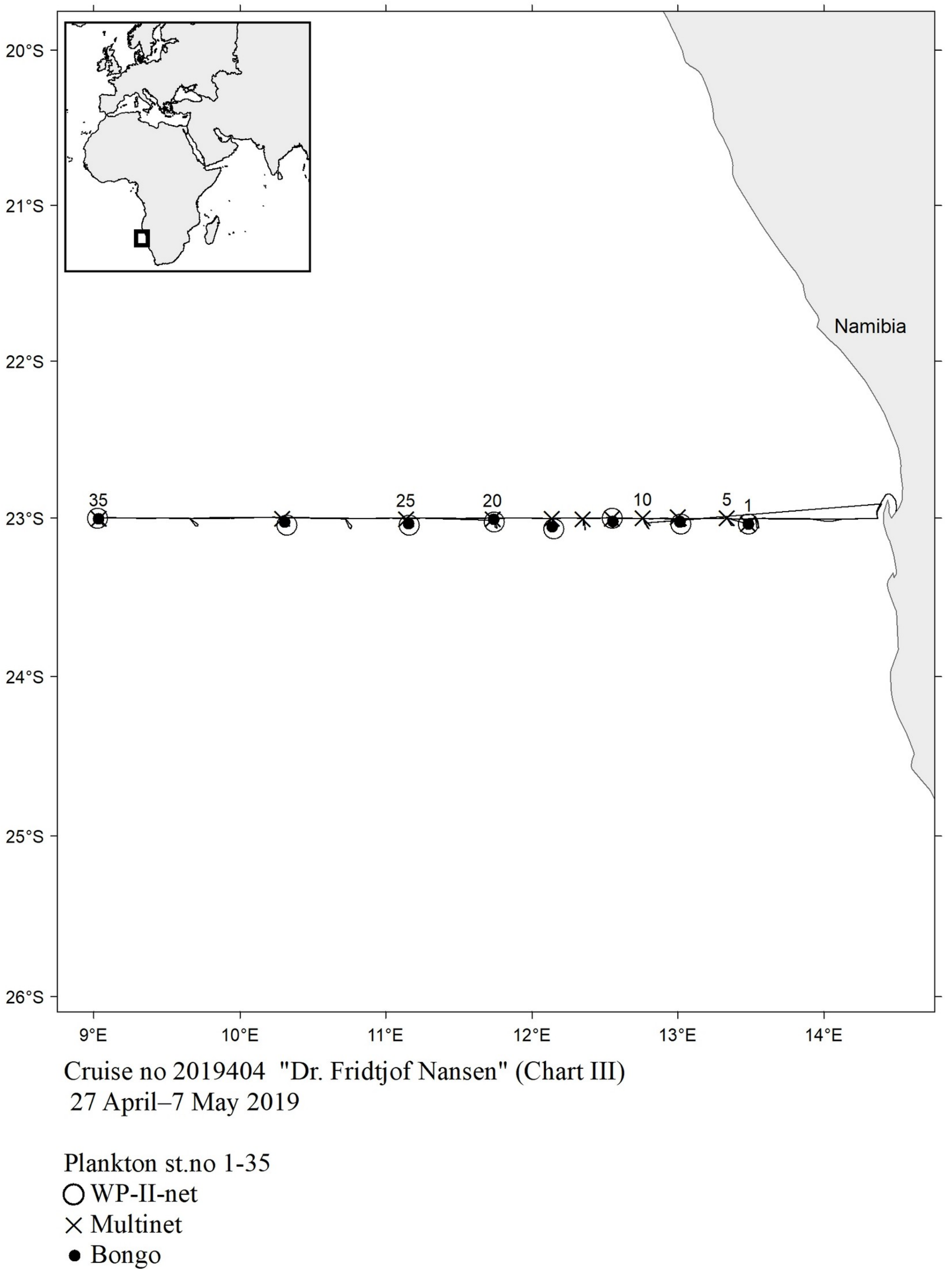


Figure 2.1.3. Plankton net stations worked along the transect (n=27), including Midi multinet (n=11), Bongo (n=8) and WP2 (n=8). Note that Bongo stations are denoted with station numbers for both start and stop of deployments in the figure.

2.2 Environmental observations

Meteorology

Meteorological data logged from the AANDERAA meteorological station included wind direction and speed, air pressure, humidity, and air temperature. All data were recorded from the mast of the ship at about 24 m above sea level every 10 seconds and averaged by unit distance sailed (1 NM).

CTD

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. CTD deployments were only carried out along the transect line. The CTD probe was deployed at 0.5 ms-1 vertical tow speed. Heave compensation (± 0.2 m) was engaged at depths greater than 50 m. The location of the CTD deployments were selected to ensure high sampling density over the shelf break and where hydrographical conditions were expected to be variable. This is to ensure that oceanographic structures such as e.g. thermo-, halo-, oxy- and nutriclines may be identified on a relatively fine scale.

Real time logging and plotting was made using the Seabird Seasave software installed on a PC. Above the shelf and slope, the profiles ranged from the surface to within a few metres above the bottom. The casts were stopped a few meters above the bottom. Offshore, the maximum sampling depth in deep basin near the Walvis Ridge was 4500 m.

Niskin water-bottles (12 units á 10 L) attached to a CTD-mounted rosette were used to collect seawater at predefined depths (sampling depths are listed in section "Nutrient samples" below). The CTD was not stopped in the water column prior to closing the Niskin bottles, so no special effort was made to pinpoint the exact depths of the seawater samples that were used both for salinity and oxygen validation.

For validation of the salinity (conductivity) measurements of the CTD, the salinity of seawater at 12 samples the lower CTD measuring depth were analysed using a Portasal salinometer (mod. 8410A) onboard the vessel. The maximum difference was 0.06, but for all samples taken at 1000 m depth the difference between the CTD and the analyses from the water bottles varied by less than 0.01. In conclusion, the accuracy of the CTD salinity measurements is better than 0.01.

Also attached to the CTD were an uncalibrated Chelsea Mk III Aquatrack fluorometer measuring in situ fluorescence on relative scale and a light sensor measuring photosynthetic active radiation (PAR).

Thermosalinograph

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

Current speed and direction measurements (ADCP)

Vessel Mounted Acoustic Doppler Current Profilers (VMADCPs) from RD Instruments normally operate at 75 and 152 kHz. The operational range of the 75 kHz profiler is 800 m, while the 152 kHz profiler has an operational range of 400 m. The system was run in narrow band mode and data were averaged in 8 m vertical bins at 152 kHz. The 75 kHz transducer was defect when the survey started and could not be used (a report on this was prepared and submitted prior to the survey). Additionally, submersed ADCPs (LADCPs) were attached to the CTD rosette, one oriented upwards and one downwards to measure currents throughout the water column at a finer scale than can be achieved using the vessel mounted systems.

Chlorophyll

Chlorophyll is typically used as an indirect measure of phytoplankton biomass. Seawater samples for analysis of chlorophyll a and phaeopigment concentrations were collected at predefined depths with rosette-mounted Niskin bottles attached to the CTD at the plankton stations. Seawater samples (250 ml) were collected from the standardized depths 5, 25, 50, 75, 100, 200, 300, 400, 500, 600, 800 and 1000 m, with bottom-depth restricting the number of samples collected from a given station. The seawater samples were filtered on Munktell glass-fibre filters (GF/C, 25 mm diameter) using a custom-made filtration system. The filter-samples were stored at -18°C in the dark for subsequent analysis on shore in the IMR laboratory in Norway. The pigments were extracted with 90% acetone in darkness over-night, and the extracts centrifuged and analysed using a Turner Design fluorometer model 10 AU calibrated with pure chlorophyll a (Sigma Inc).

Nutrient samples

Seawater samples (20 ml) for nutrient analyses (nitrate, nitrite, silicate and phosphate) were taken from the Niskin water-bottles. Samples were collected from the standardized depths of 5, 25, 50, 75, 100, 200, 300, 400, 500, 600, 800 and 1000 m, with bottom-depth restricting the number of samples collected from any given station. 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 analyses were made at the Institute of Marine Research (IMR, Bergen, Norway), using a modified Alpkem AutoAnalyzer C (O I Analytical, USA) and following standard procedures (Strickland and Parsons, 1972). Extra standards were added during the analysis to cover the whole measurement range. During the laboratory's quality control of the data, some outlying values that were obviously wrong were excluded. The quality control included evaluation of the ratios between the different nutrients.

2.1 Acoustic measurements

Hull borne echosounder

Hydroacoustic data were collected at 18, 38, 70, 120, 200 and 333 kHz using the Simrad EK80 scientific echosounders running in discrete frequency (CW) mode. Acoustic data were collected throughout the transect. The acoustic data were scrutinized daily. The scrutinization procedure included filtering out acoustic noise from the vessel, bottom detection registered as echoes from the water column, and an initial classification of the backscatter to broad acoustic target groups pelagic fish, mesopelagic fish, plankton, krill (when in distinct layers), other fish and other scatterers. The principal means of identification to acoustical target groups were top-down and bottom-up thresholding, inspection of frequency response at appropriate threshold levels, inspection of in-trawl Deep Vision (DV) imagery and trawl catch data.

Submersed echosounder

The Simrad WBAT (70 and 200 kHz) was deployed concurrent with the CTD probes on some of the deployments on selected study sites inshore targeting monospecific or low diversity aggregations of fish. The WBAT was operated in profiling mode, transmitting horizontally to 100 m range at maximum ping rate. Transceivers were operated in CW mode. Downcast data were recorded using the 70 kHz transducer, while upcast data were recorded using the 200 kHz transducer. The WBAT mission plans were pre-programmed and uploaded to the WBAT prior to each deployment. The deployment of the CTD was timed to correspond to the transmission times set in the mission plans, ensuring that data were collected at the right times and that the WBAT would not transmit whilst out of water. The WBAT settings and deployment log worked are listed in Annex III.

Apart from the ADCP systems described above, no other sonars or bottom profiling echosounders were operated during the survey.

2.2 Biological sampling

Plankton sampling

WP2 (64 µm)

Zooplankton sampling was conducted at 8 stations along an inshore-offshore transect with a WP2 net with 64 µm mesh size (Fig. 2.2.1). Vertical sampling was conducted from 0-200 m, and samples were frozen at -80°C onboard for later analysis. The aim of the sampling was to estimate the stable isotopic composition of the prey of larval fish and investigate the trophic ecology of larval fish. Unfortunately, the samples were not analyzed due to issues with their shipment to Bergen that resulted in the degradation of the samples. For this reason, results from the WP2 sampling are not shown in this report.

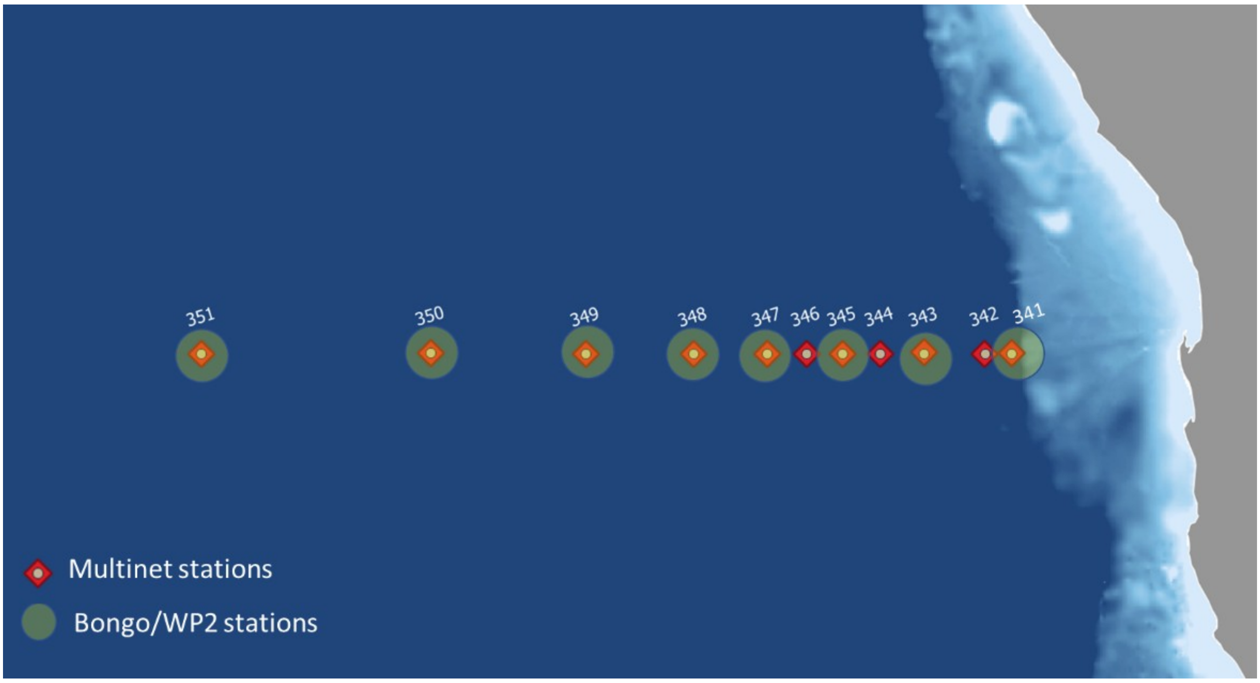


Figure 2.2.1. Multinet and Bongo/WP2 sampling stations worked during the survey.

Bongo (405 µm)

Ichthyoplankton was collected at 8 stations (Fig. 2.2.1) with double oblique tows of a Bongo net (405 µm) from 200 m to the surface. Fish larvae were sorted on board from the samples collected by one of the nets. Samples were preserved in ethanol 96% for later analysis and shipped to Bergen. The samples collected with the second net were frozen at -80℃ with the aim to analyze it together with the WP2 net samples to investigate the trophic ecology of fish larvae using stable isotopes. As with the WP2, samples were degraded before shipping to Bergen, so the analysis was not performed. Only results on the abundance of fish larvae from the first Bongo net will be shown in this report.

Multinet MIDI (180 µm)

Depth stratified mesozooplankton sampling was conducted at 11 stations (Fig. 2.2.1) with a Multinet Midi plankton sampler equipped with five 180 µm mesh nets that were towed at selected depth strata based on the echograms (Fig. 2.2.2). Stations were positioned along the inshore–offshore transect and sampling was conducted one time at each station (either day or night) due to time limitations of the survey. In some stations (i.e., Stations 347, 348, and 349-351) samples were not collected at all selected depth strata due to technical problems with the deployment of the net (Fig. 2.2.2). After their collection, samples from each net were split into two subsamples using a Motoda splitter. One half was used for biomass estimation (size fractionation through 2000 µm, 1000 µm and 180 µm mesh sizes) and dried in the oven (60ºC) in pre-weighted aluminum trays. Samples were transferred to IMR (Bergen) for analysis. The second half was preserved in 4 % borax buffered formaldehyde solution for species identification and enumeration. Samples were shipped to the University of Western Cape (South Africa) for further laboratory analysis.

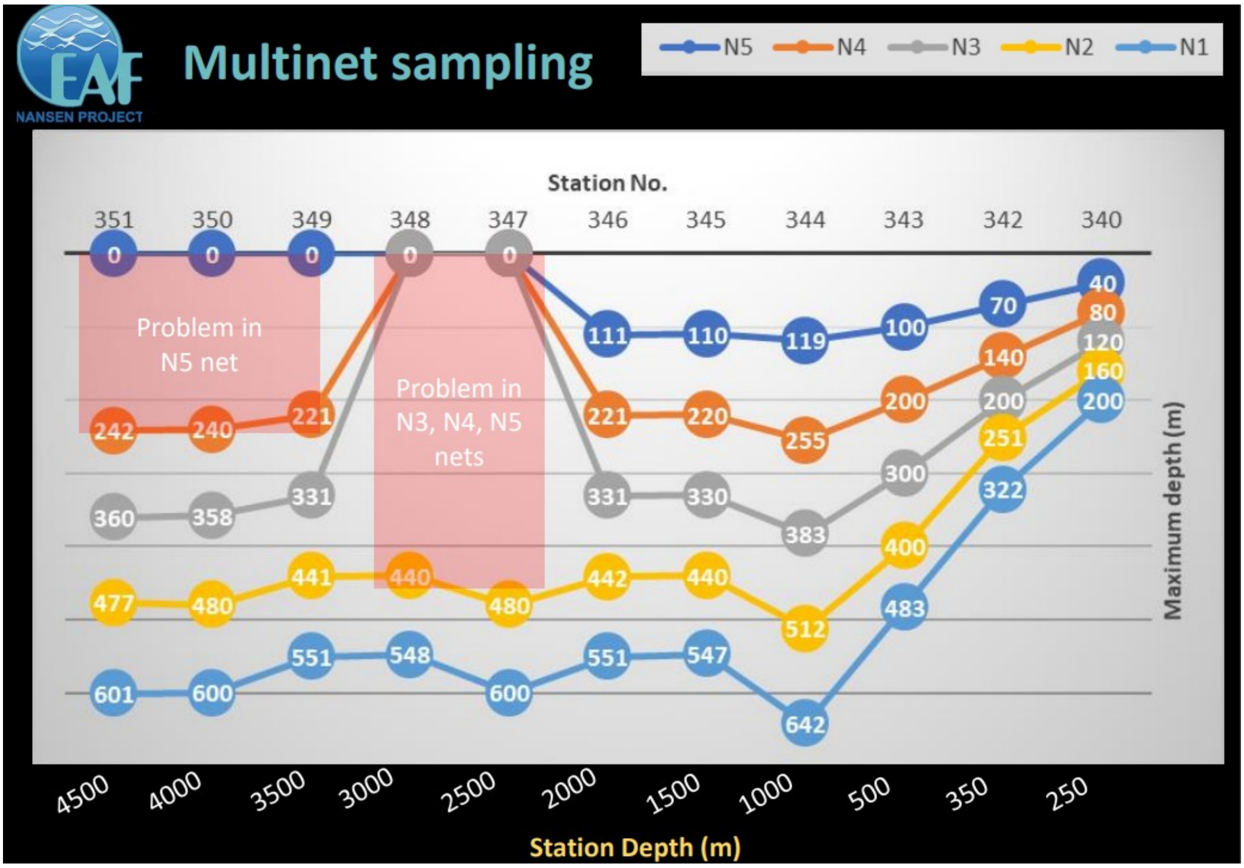


Figure 2.2.2. Multinet sampling schema showing the different nets (N1, N2, N3, N4, N5) and the maximum depths of deployment (numbers inside the circles), station number and depth are also indicated. *Nets not deployed was due to problems with opening.

Sampling trawls and in-trawl video system

The nekton organisms in the pelagic and mesopelagic zones were sampled using the Multpelt 624 pelagic sampling trawl. The Multpelt 624 is a relatively large pelagic trawl designed to catch fast swimming pelagic fish. It has a52 x 12 m mesh (624 m) circumference mouth opening. The codend is lined with an 8 mm mesh inner lining to match the codend selectivity properties of the krill trawl that is often used on mesopelagic surveys (Annex II). The Deep Vision (DV) system was used on all trawl deployments, providing video of the fish and other organisms such as squid, medusae/ gelatinous plankton, and krill and other crustaceans passing through the extension of the trawl before retention in the codend. The DV imagery was subsequently used during postprocessing of the acoustic data. i.e. the “scrutinization”. These data are particularly important to identify where in the water column (depth) the different organisms were caught, but also to verify the presence of fragile organisms such as small medusae and other gelatinous plankton that are often damaged or not retained in the trawl codend.

2.3 Visual observations of marine mammals and seabirds

Seabirds

Data were logged using the protocols developed by the Atlas of Seabirds at Sea (AS@S). AS@S was launched on 16 October 2009, as part of the "Save Our Seabirds Festival" by BirdLife South Africa's Seabird Conservation Programme. (Website: http://seabirds.saeon.ac.za/intro.aspx).

AS@S is a collaboration between BirdLife South Africa and the South African Environmental Observation Network (SAEON). It was created in collaboration with several seabirds-at-sea experts and was initially developed and hosted by the Animal Demography Unit at the University of Cape Town. In 2012 it moved to SAEON and is strongly supported by the South African Department of Environmental Affairs: Oceans and Coasts branch. BirdLasser (the citizen science bird atlas platform: https://www.birdlasser.com/) supports the AS@S function on their smartphone application. The data are collected according to a standard protocol and thereafter uploaded and immediately incorporated into the AS@S database. The database is open-access via the AS@S website and is fast becoming a valuable resource for understanding the abundance, seasonality and distribution of seabirds at sea, and for examining how these have changed through recent decades.

As there were two observers on board, the aim was to collect transect data in all instances where the ship was steaming during daylight hours as there would always be one person on deck conducting the observations.

Effort-based 10-minute transect counts

A 300 m x 300 m block was surveyed in a 180o arc from the bow of the ship (resulting in a 600 m x 300 m survey area). If observation conditions were very poor, for example looking into the rising or setting sun, then the count would only be done on one side of the bow (i.e. a 300 m2 block). Counts were only conducted when the vessel was moving in a constant direction. Ship followers and birds attracted to the ship were not counted. Each bird was recorded as flying or sitting on the water. Ship time was used so that the records could be correlated with the ships positional record and the following environmental parameters: wind speed and direction, sea surface temperature, cloud cover and sea state. Using the AS@SA, each record was logged to species level, number of birds and whether they were in flight or on the water. The counts were divided into 10 minute transects, each with a start and end position (decimal degrees) and time.

Snapshot counts

Occasional snapshot counts of birds following the vessel were conducted. This was done a minimum of three times a day (morning, midday, and afternoon). Time, position, species identification and number present was recorded at each of these counts.

Equipment used

High quality binoculars were used to scan the survey area and identify birds.

Cameras with 100–400 mm zoom lenses were used to get photographs of faraway species and to confirm identification where necessary. Record shots of species encountered were taken whenever possible.

A smartphone was used to log records on the transects. Snapshot counts were recorded in a notebook.

Marine mammals

Effort-based transect counts were conducted in the same manner as the bird observations. However, as there was no software for recording these sightings, they were recorded in a notebook and then transferred to an excel spreadsheet. Species, number of animals and behavior were noted. Cameras were used to get record shots of any of the cryptic groups such as the Ziphiids (Beaked Whales). In addition to those recorded during the transect counts, all additional cetacean sightings were recorded in a separate spreadsheet.

Marine debris

While the bird and mammal observations took precedence, marine litter was also recorded during the survey. The methodology developed by Ryan (2013) was utilized.

This entails selecting a 90^{o} arc from the bow, either on the port or starboard side and recording any visible pollution larger than 1 cm^2. The transect survey area was up to 50 m from the vessel however any large items viewed at greater distances was also recorded. Time, litter type, distance from vessel, buoyancy and presence of encrusting biota was noted for every piece of litter encountered in the survey area while steaming and correlated to the ships positional data. Recorded data was captured in an excel spreadsheet.

Data recording keys: <u>Distance from ship</u>: **0**: 0-10 m; **1**: 11-20 m; **2**: 21-30 m; **3**: 31-40 m; **4**: 41-50 m; **5**: 51-100 m; **6**: >100 m. <u>Size</u>: **a**: <5 cm; **b**: 5-15 cm; **c**: 15-30 cm; **d**: 30-60 cm; **e**: >60 cm. <u>Buoyancy</u>: **-1**: below surface; **0**: at surface; **1**: above surface.

2.4 Summary of survey effort

The total effort in terms of surveyed distance (day/ night), CTD deployments and trawl and plankton net deployments are summarized in table 2.4.1.

Table 2.4.1. Summary of survey effort.

Transect distance			**Plankton net deployments**				**CTD casts**				**Trawls**
Day	Night	Total	Multinet	WP2	Bongo	Total	None	WBAT	LADCP	Total	MultPelt
390	390	781	11	8	8	27	-	10	22	32	14

* 2017402 stations **HD 85–104**

3.1 Oceanography

Winds

The prevailing winds were predominantly from the south during both the two transects (Fig. 1). However, the wind speed was generally larger during the first, outward leg with wind speeds in the range 10-15 m/s (fresh breeze to near gale). The air temperature increased offshore, from 12 degrees near the coast at the end of the cruise to 20 degrees farthest offshore. The temperature decreased slightly from the outward to the inward leg, especially in the eastern part of the section, showing the integrated effect of a prolonged period of upwelling-favourable winds during the cruise (Fig. 3.1.1).

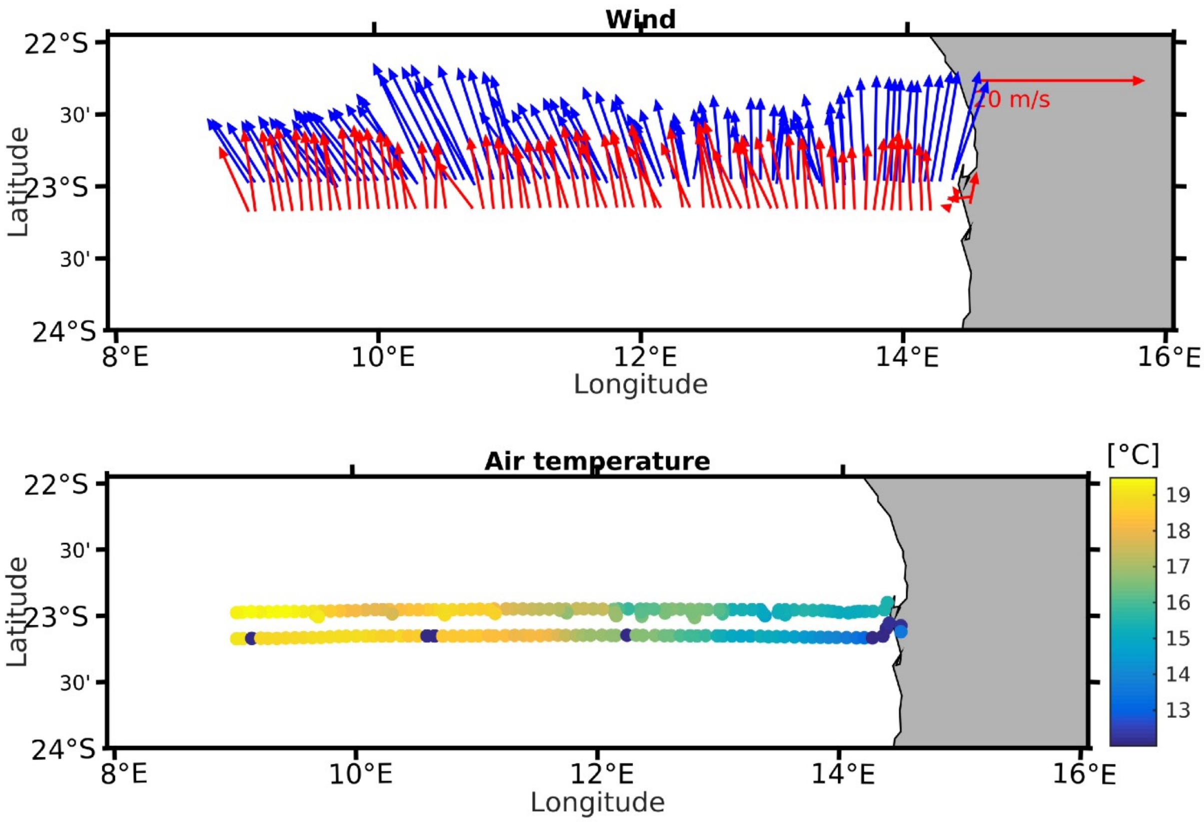


Figure 3.1.1. Top: Wind speed and direction during outward (blue) and inward (red) leg. Bottom: Surface air temperature from the onboard weather station. Note that the data for the inward leg has been moved 0.2 degrees to the south for improved visibility.

The data from the thermosalinograph revealed that the temperature in the surface layer of the ocean displayed a similar pattern as the air temperature with the temperature increasing offshore from 13 degrees C near the coast to 21 degrees C at the westernmost stations (Fig. 3.1.2). Moreover, the temperature was somewhat lower near the coast during the latter, inward leg compared with the outward leg. A similar pattern was also seen in salinity, but with smaller relative differences. Consequently, the density decreased offshore from nearly 1027 kg/m3 near the coast to around 1025 kg m^{-3} at the westernmost stations. Thus, the temperature was the dominating factor with respect to density. Here, we have used data binned at 8 km distance and using processing level L3. Temperature is from the deep-keel water intake at 6 m depth.

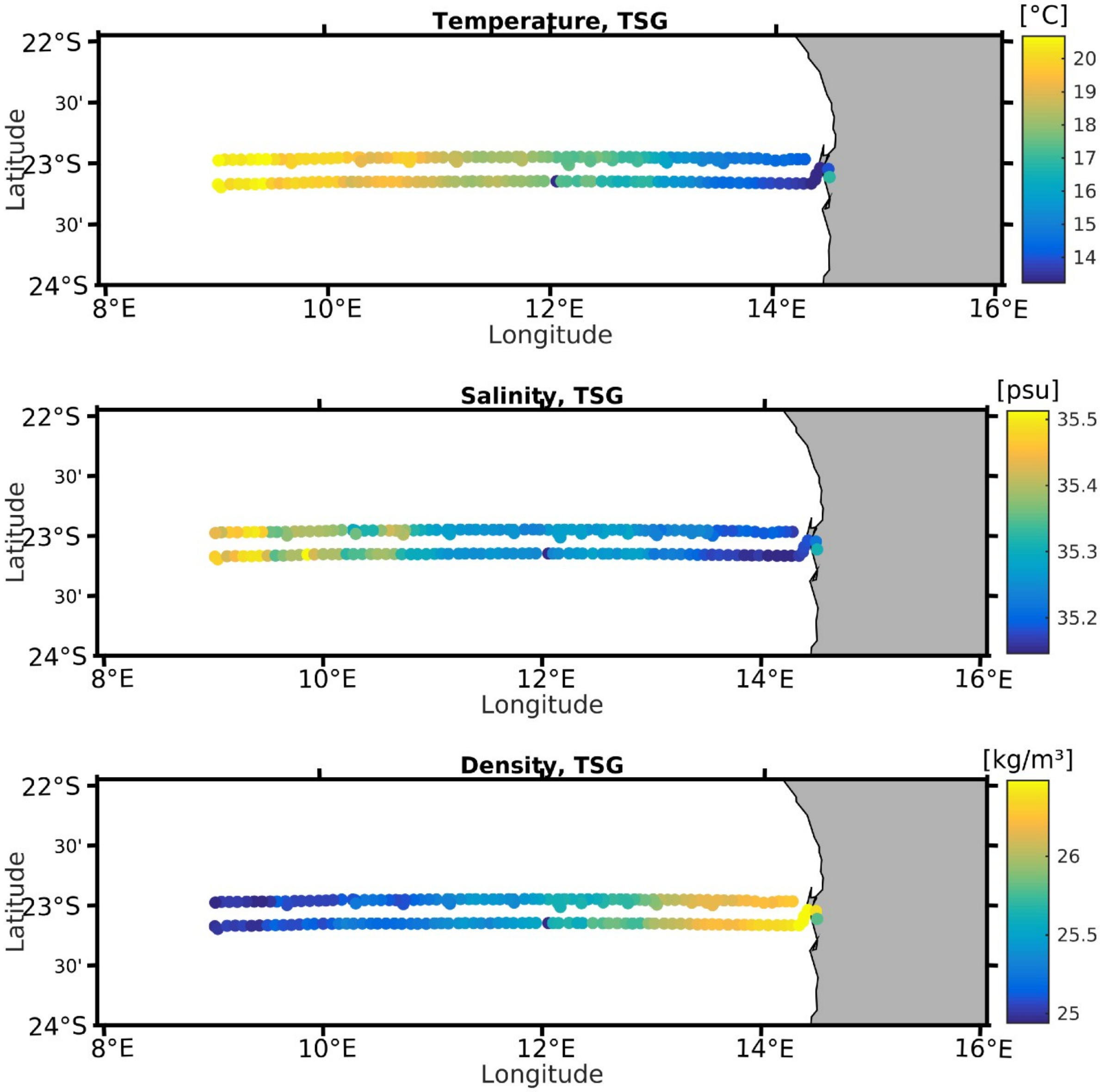


Figure 3.1.2. Top: Temperature (in degrees Celsius) at 6 m depth from the thermosalinograph. Middle: Salinity (in practical salinity units) from the thermosalinograph. Bottom: Density (σ_T; kg m^{-3} – 1000) derived from T and S from the thermosalinograph. Note that the data for the inward leg has been moved 0.2 degrees to the south for improved visibility.

Measurements with the vessel mounted Acoustic Doppler Current Profiler (ADCP) showed a diverse pattern (Fig. 3.1.3). The current field was dominated by eddies with the currents shifting between northward and southward along the section. Moreover, in some parts of the section the currents changed substantially in speed and/or direction between the two legs, i.e., with a few days' interval. Moreover, the currents showed some vertical structure and shear (Figures 3.1.3 and 3.1.4), indicating some baroclinicity (e.g., around 12°E) and Ekman dynamics related to the upper mixed layer (e.g. between 10°E and 12°E).

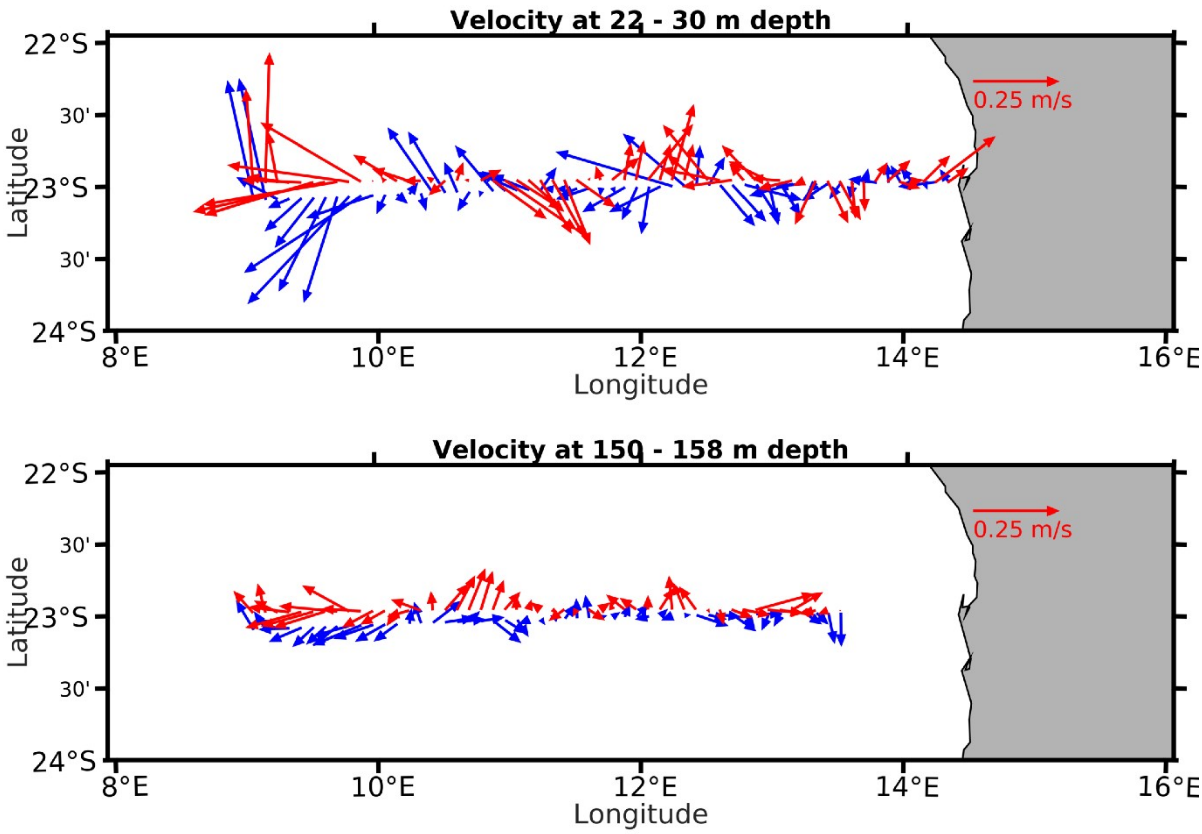


Figure 3.1.3. Current velocity measured by the vessel mounted ADCP during the outward (blue) and inward (red) legs. Top: Velocity in the 22-30 m depth bin. Bottom: Velocity in the 150-158 m depth bin.

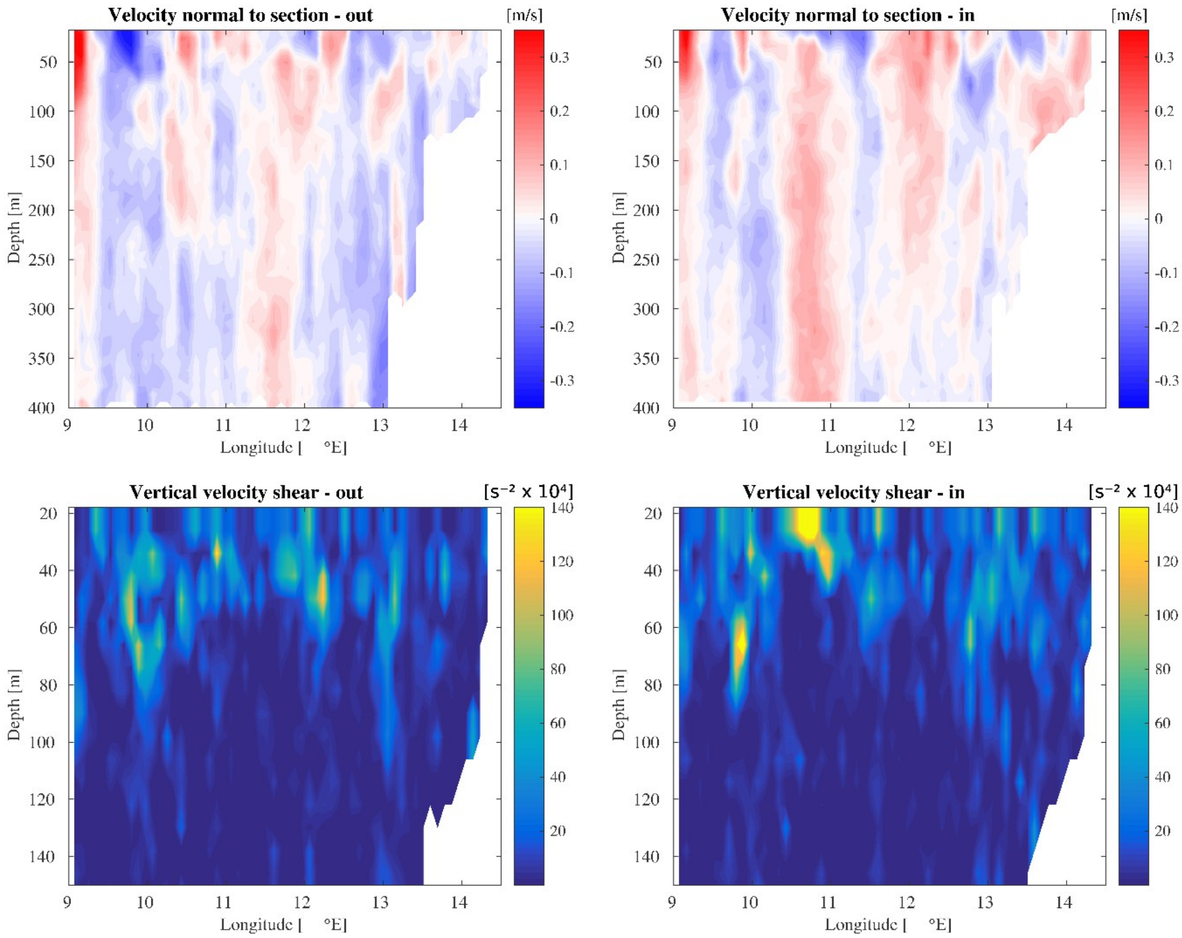


Figure 3.1.4. Top: Velocity normal to section (N-S) during outward leg (left) and inward leg (right). Bottom: Vertical velocity shear during outward leg (left) and inward leg (right).

As also seen from the thermosalinograph data, both the temperature and the salinity increased offshore (Fig. 3.1.5). The temperature data from the CTD indicate a thermocline located between 50 and 100 m depth. The salinity data also show a halocline at around 50 m depth, but in the outer part of the section the salinity increased below a rather homogeneous salinity in the upper 50 m to a subsurface maximum between 50 and 100 m depth, below which the salinity was decreasing. Moreover, both the temperature and the salinity show an indication of a general upwelling towards the coast, although there is also a narrow band of downwelling inshore of 13°E.

The oxygen content was very low near the bottom below 50 m bottom depth and especially between 100 and 300 m bottom depth. Except from that, the oxygen content tended to be higher at depth in the eastern half of the section compared with the western, more offshore half. A distinct increase in oxygen content at 150-300 m depth is seen near 12°E, possible related to eddy activity as indicated by the ADCP measurements (Figures 3.1.3 and 3.1.4).

Fluorescence showed a distinct peak in the upper 50 m between 12°E and 13°E and was relatively low elsewhere, except for relatively high values also close to the coast in the upper 20 m.

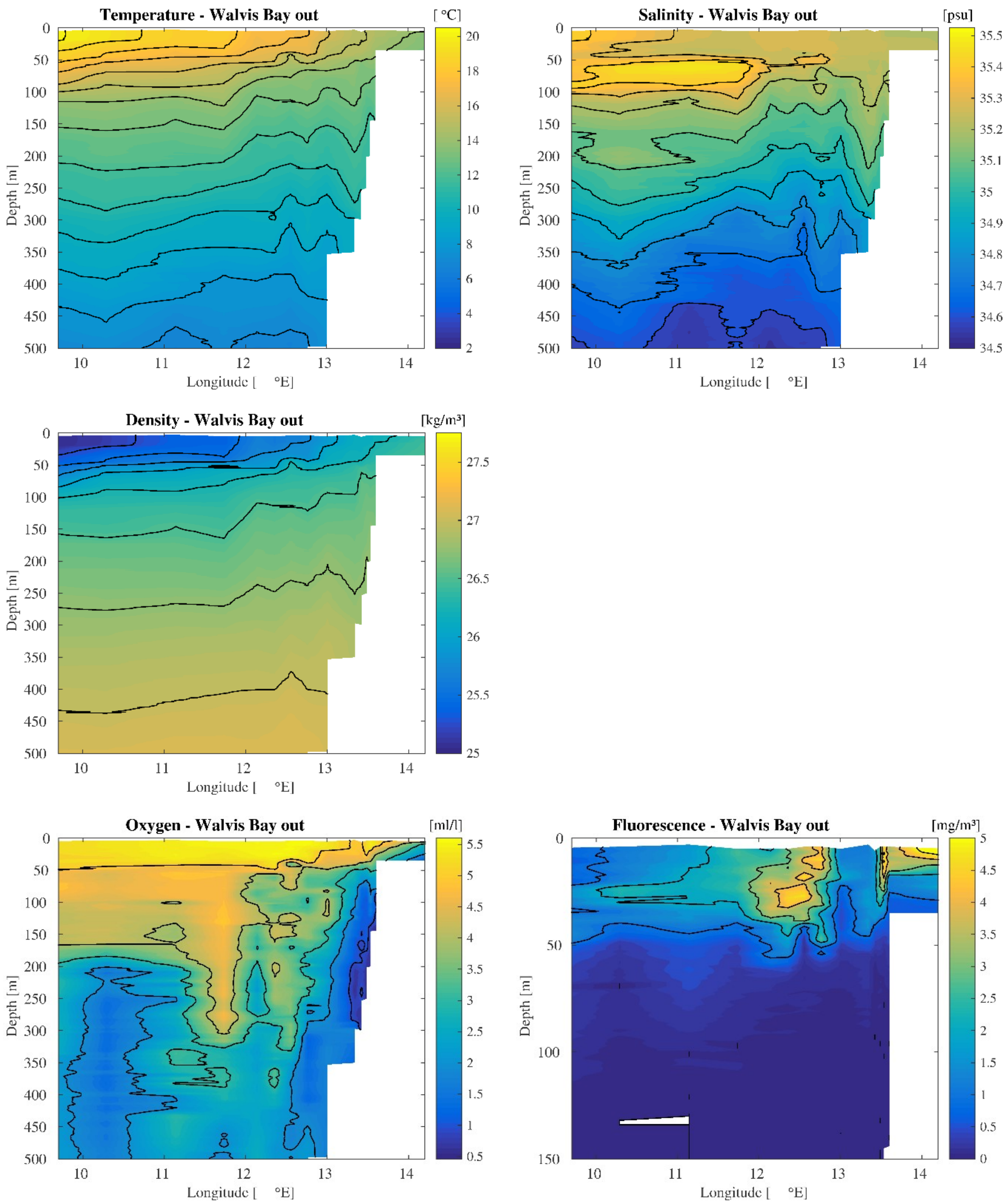


Figure 3.1.5. Vertical sections showing CTD data from the first, outward leg. Top: Temperature (degrees Celsius; left) and salinity (practical salinity units; right), Middle: Density (kg m^{-3} - 1000), Bottom: Oxygen (ml/l; left) and fluorescence (mg m^{-3}; right). Note the different vertical extent in the fluorescence plot (0-150 m) compared with sections for other parameters (0-500 m).

The hydrographic properties seen from the CTD stations including all depths are shown in a *T-S* diagram in Figure 3.1.6. The data clearly reveals surface- or upper-ocean related water masses (with density approximately below 26.5 with variable salinities but temperature generally decreasing with depth. Below the surface layers an intermediate water mass is seen with both the temperature and salinity decreasing and the density steadily increasing with depth. In the deep, two distinct water masses are seen: deep water where the temperature is rather stable while the salinity is increasing above a layer of bottom water where again both the temperature and salinity is decreasing but with rather constant density.

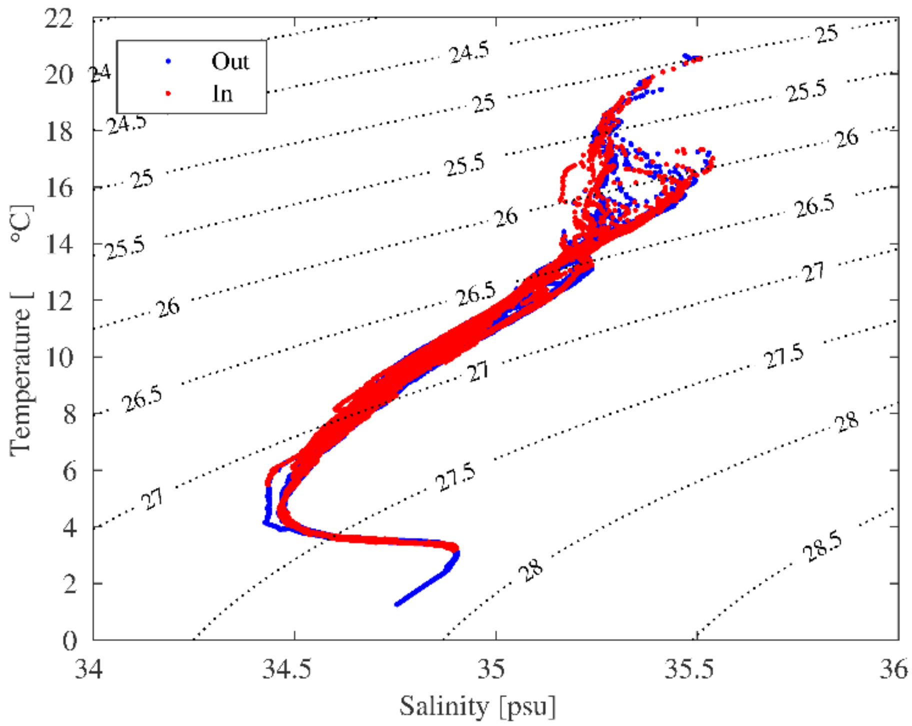


Figure 3.1.6. T-S diagram from all CTD stations from the outward leg (blue) and inward leg (red). All depths are included.

3.2 Zooplankton

Summary of samples collected

A summary of the number of plankton stations and type of samples collected is presented in Table 3.2.1.

Table 3.2.1. Overview of plankton stations and samples collected during the survey. *Samples from the Bongo and WP2 net were not analyzed due to issues with shipment that resulted in their degradation.

Sampling device	№ of stations	Samples collected
Multinet MIDI (180 µm)	11	52
BONGO (405 µm)	8	16
WP2 (64 µm)	8	8

Bongo net (405 µm)

The recorded number of fish larvae in the Bongo collections was generally very low, particularly at the stations positioned in first half of the transect (until station 346). Figure 3.2.1 presents the estimated number of fish larvae per square meter. At Stations 342, 344 and 346 no fish larvae were recorded in the samples during the sorting procedure. This can be likely associated with the high presence of phytoplankton (mainly diatoms), gelatinous zooplankton and euphausiids at these stations. The abundance of fish larvae was found generally higher at stations located in deeper waters, and this was likely associated with a shift in the zooplankton community structure i.e. decrease of euphausiid abundance and increase of the abundance of large calanoid copepods (Fig. 3.2.2).

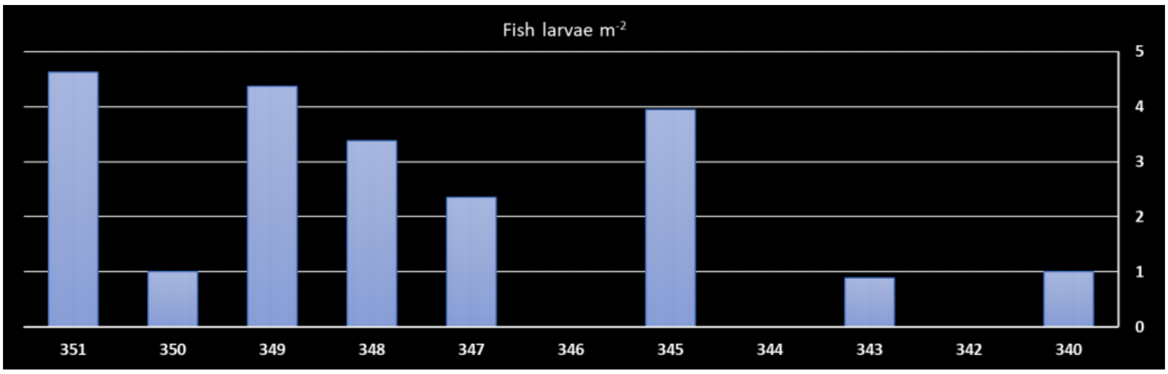


Figure 3.2.1. Fish larvae abundance (ind m^{-2}) from one of the Bongo nets. A total of 66 larvae were sorted from the 8 stations where the Bongo net was deployed.

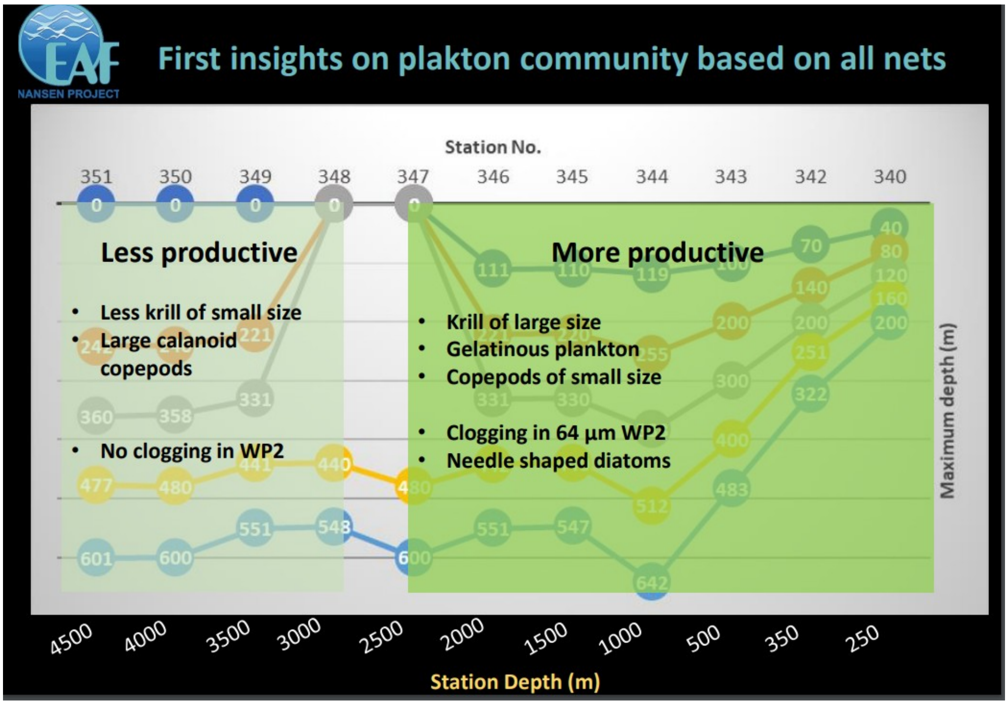


Figure 3.2.2. Schematic representation of the productivity of the ecosystem based in all samplings. The number of stations and their depth are shown.

Multinet MIDI (180 µm)

Total zooplankton biomass

A total of 156 aluminum trays for zooplankton dry weight estimation were produced during the survey and transferred to IMR for zooplankton biomass estimation. Mesozooplankton biomass of samples collected ranged between 2.11 10^{-4} to 0.040 g m^{-3} in the several depths for each station sampled. The distribution of zooplankton biomass in the water column did not follow a clear vertical pattern, zooplankton was distributed along the whole water column (Fig. 3.2.3).

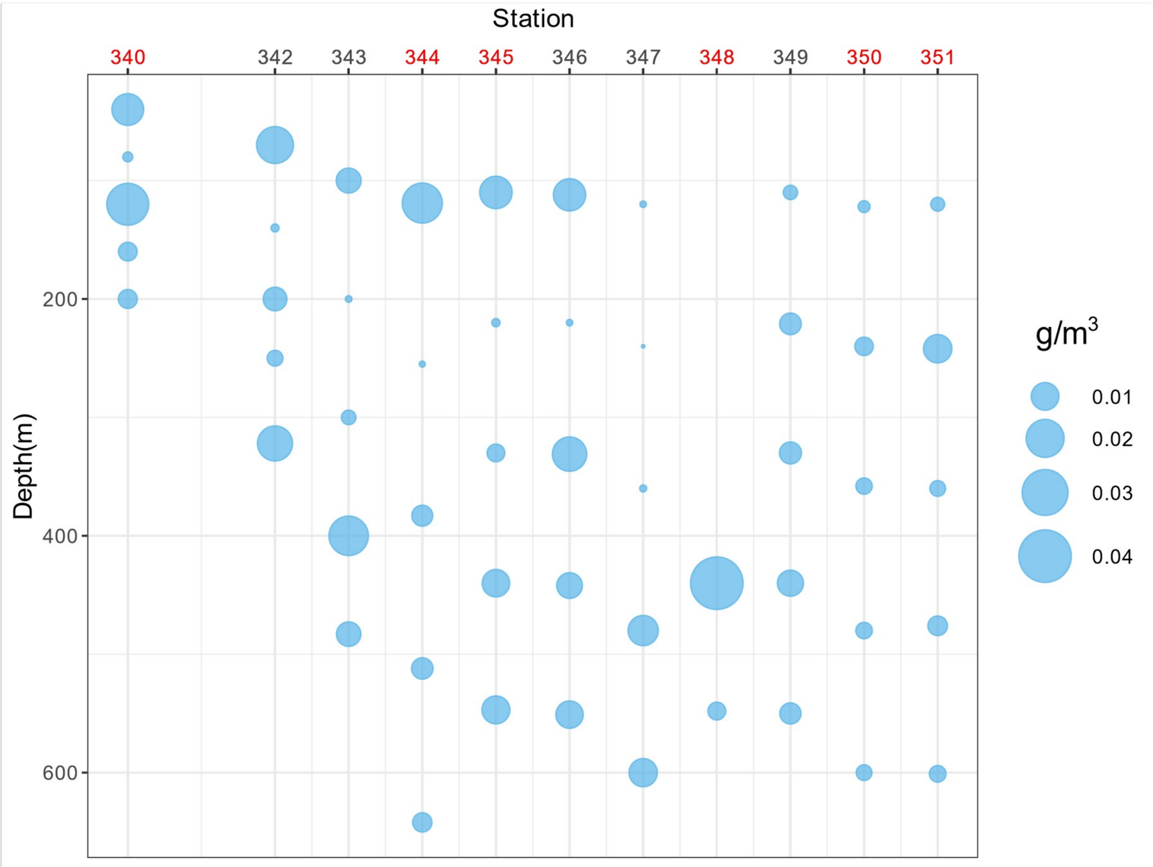
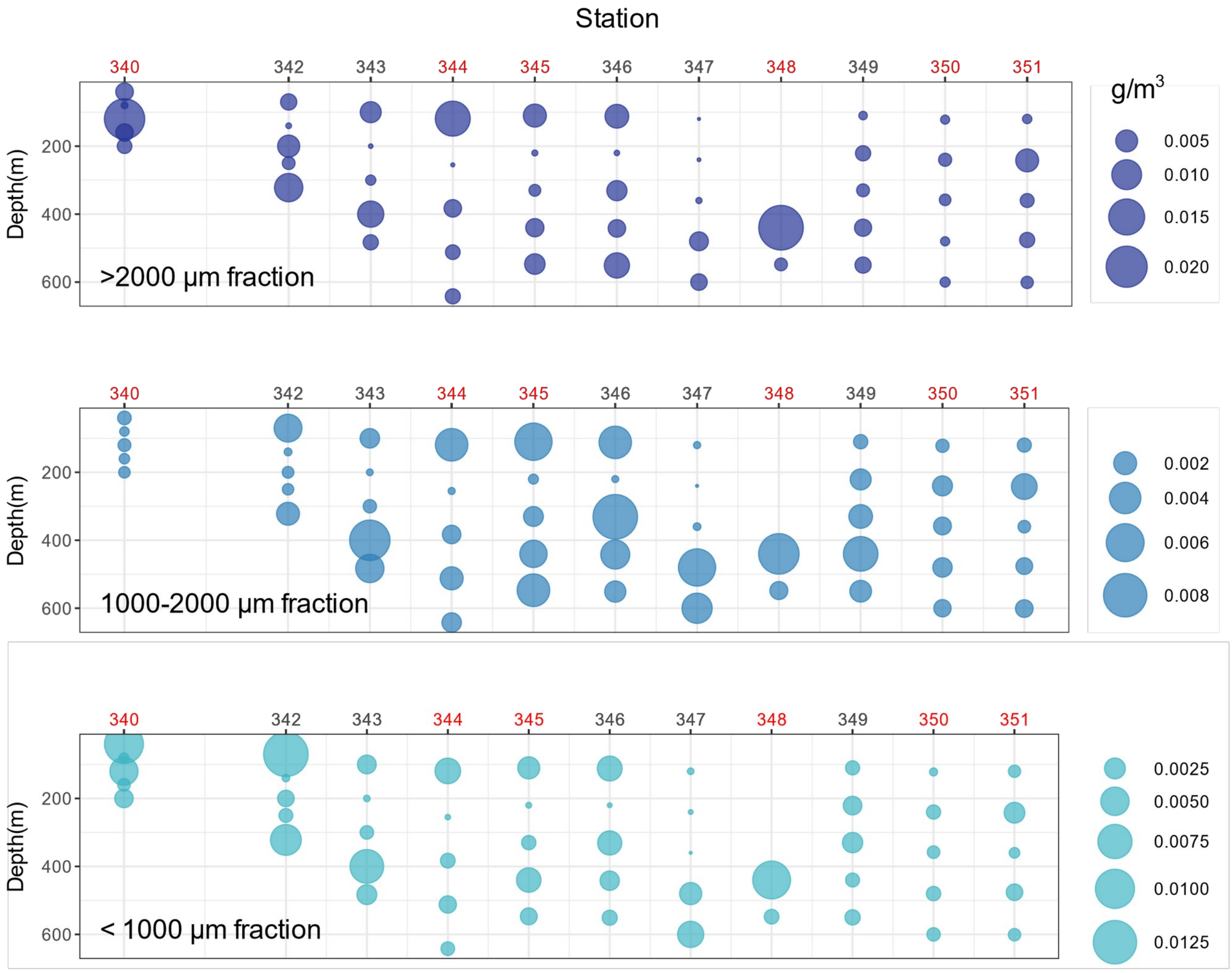


Figure 3.2.3. Vertical distribution of the mesozooplankton biomass (g m^{-3}) based on Multinet MIDI samplings. *Black and red station numbers indicate day- and night time sampling, respectively.

Size fractionated zooplankton biomass

The biomass of organisms larger than 2 mm and smaller than 1 mm was overall concentrated above the 400 m, and for organisms comprising the 1-2 mm size, a large part of the zooplankton biomass was found in the 300-600 m depth layer (Fig. 3.2.4). As an exception, for Stations 343 and 346 the bulk of all zooplankton size fractions was mainly concentrated below 300 m (Fig. 3.2.4).



* Biomass scale differs among size fractions

** Black and red station numbers indicate day- and nighttime sampling, respectively.

Figure 3.2.4. Vertical distribution of size fractionated zooplankton biomass (g m^{-3}) from Multinet MIDI samples.

3.3 Acoustic observations

Acoustic transect

Acoustic data were collected throughout the survey (day and night), a total distance sailed of 781 nm while steaming along the transect. The transect line was covered twice, outbound (westerly direction) and inbound (easterly direction). The sampling (ADCP, LADCP, CTD, trawling and plankton net sampling) was carried out on the westbound coverage, which was considered the primary coverage and that was scrutinized. However, acoustic data are also available for the inbound coverage.

Figure 3.3.1 shows echograms at 38 kHz composing the full length of the transect. The transect continued day and night, consequently diel vertical migrations with scattering layers moving closer to the surface at night can be seen. There were scattered aggregations of pelagic fish visible in the echograms on the inner shelf and, as anticipated, the onset of the mesopelagic layer was detected on the break of the continental shelf, at about 250 m bottom depth. The descent of the mesopelagic layer is readily identifiable in the echograms (Figu. 3.3.1., Panel A). Further offshore, complex multi-layer structures can be seen. The survey was running on a 24-hour basis and includes day/night as well dusk/dawn periods. Consequently, the echogram features are characterized by (rapid) vertical migration/movements of plankton and nekton. Several features of the scattering layers are prominent as the transect progresses from the shelf and slope off Walvis Bay and into the deep ocean basin near Walvis Ridge (4500 m bottom depth):

1. The mesopelagic aggregation near the shelf break (approximately 2750 m bottom depth) was located relatively shallow (25-100 m depth) when first encountered at night time, and can be seen to undertake a vertical migration to deeper waters near the bottom (150-250 m) as daylight commenced.

2. The offshore aggregation had three readily identifiable deep acoustic scattering layers that appeared fairly consistently throughout the transect (although undertaking diel vertical migration). It is clear, however, that the taxonomical composition and diversity of the scattering layers changed markedly while progressing offshore.

3. The acoustic densities were highest inshore and decreased gradually progressing offshore.

These are general features of mesopelagic aggregations that are in line with expected overall patterns. Very similar findings have been reported from the other mesopelagic surveys (e.g. in Namibia (2017), Morocco (2017 and 2019), and in the Bay of Bengal (2018)). Preliminary acoustic data scrutinization was carried out during the survey. Detailed scrutinization will be carried out once all the types of samples (trawl and plankton) have been analysed in detail, as they are both necessary to get a thorough overview of the mesopelagic organisms present in the water column (and in which densities and located at which depth) at the time of the survey. Further scrutinizing and post-processing will be carried out in accordance with the protocol established for mesopelagic that is being developed under Theme 3.

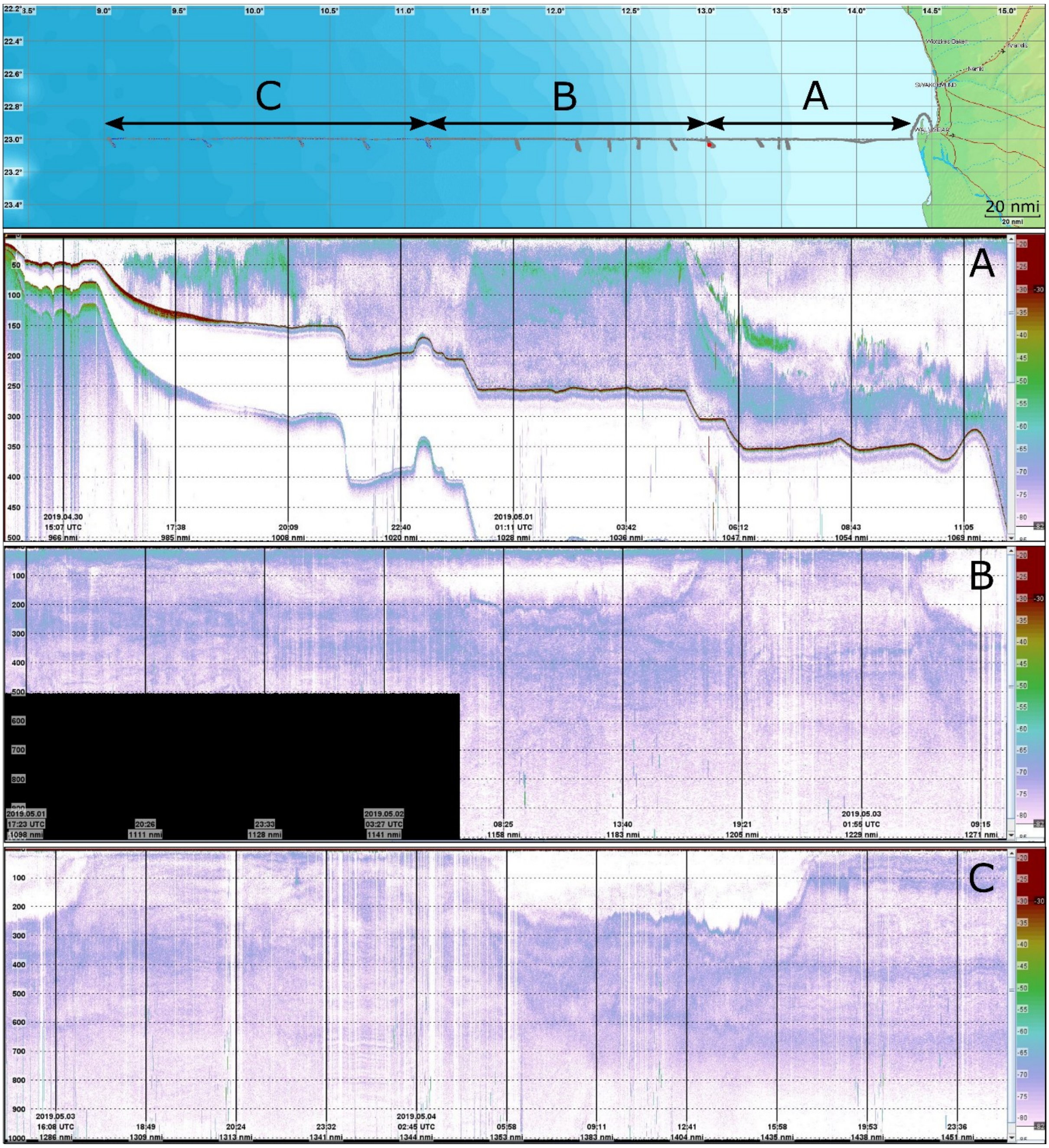


Fig. 3.3.1. Composite echogram from Walvis Bay westwards towards Walvis Ridge (4500 m bottom depth) at 38 kHz. Upper panel: map of the study area showing the transect line and the corresponding echograms sections (panels A-C). X-axis: distance sailed (NM); y-axis: depth (Panel A: 0-500 m; Panels B-C: 0-1000 m). The colour scale represents volume backscattering strength (S_V, dB re $1m^{-1}$), with upper and lower threshold levels at -30 dB and -82 dB, respectively.

3.4 Summary of trawl samples

In accordance with the sailing orders and the standardized sampling scheme for the mesopelagic transect survey, there should ideally be carried out several intensive 24-hour sampling stations along the transect to characterize the biological composition and vertical movements of the layers and to relate this to light and other environmental factors. As part of the 24-hour sampling, comparative trawl haul experiments using the Multpelt and the Macrozooplankton trawl (“Krill trawl”) were also to be conducted. However, due to the time restrictions of the survey this part of the sampling had to be cancelled. To make most use of the time the transect was run 24-hours, and extended further westwards (to near Walvis Ridge, passing the deepest point of the basin at 4500 m bottom depth) than otherwise would be possible. This, however, enabled us to sample the transect at consistent intervals moving from inshore to offshore. Altogether 14 tows (trawl deployments) were conducted along the transect using the MultPelt trawl (Fig 2.1.1). Standardized catch rates (kg h^{-1}, no. h^{-1}) are listed in Annex IV. The trawling intensity was highest over the continental shelf break, where the greatest changes in abundance and composition are found. Further offshore, distance between tows were standardized according bottom depth (intervals). For all tows, the trawl was first set as rapidly as possible to a depth corresponding to slightly (approximately 50 m) underneath the deepest extension of the deep acoustic scattering layers (Fig. 3.3.1), and then towed obliquely throughout the layer, or to the surface. A summary of the trawl hauls using the Multpelt trawl (targeted) is provided in Table 3.4.1.

Table 3.4.1 List of accepted trawl hauls (no-catch hauls [PT1] were excluded) showing the type of trawl, bottom depth, tow duration, catch rates and their relative ratio, and the number of taxa caught. NM: nautical miles, [n]: number of individuals, MT: metric tonnes. Number in parenthesis in the Fish families column indicates the number of distinct taxa not identified to the family level. T: Targeted.

					Catch rates					
Station (PT)		Trawl type	Bottom depth (m)	Tow duration (min)	(kg / NM)	(MT / NM^3)	($\log_{10}$([n] / NM))	($\log_{10}$([n] / NM^3))	Taxa present	Fish families
2	Transect	Multpelt (T)	255	23.0	58.70	767.12	26.57	469.68	10	4 (1)
3	Transect	Multpelt (T)	347	27.9	88.37	507.85	36.96	310.94	16	7 (0)
4	Transect	Multpelt (T)	486	34.4	130.36	387.27	53.25	237.11	24	10 (0)
5	Transect	Multpelt (T)	988	56.6	165.85	64.81	50.18	39.68	36	14 (0)
6	Transect	Multpelt (T)	1516	48.4	228.41	57.54	70.97	35.23	49	18 (1)
9	Transect	Multpelt (T)	3010	47.2	216.12	48.34	68.32	29.60	46	14 (0)
10	Transect	Multpelt (T)	3540	92.0	85.94	8.57	18.46	5.25	21	8 (0)
11	Transect	Multpelt (T)	3800	44.1	245.38	82.51	71.88	50.52	54	21 (0)
12	Transect	Multpelt (T)	4027	55.6	240.31	49.36	60.38	30.22	56	21 (0)
13	Transect	Multpelt (T)	4319	57.8	115.19	17.14	34.86	10.49	25	8 (0)
14	Transect	Multpelt (T)	4502	45.1	284.94	33.50	69.67	20.51	67	23 (1)

Table 3.4.2 summarizes the number of teleost fish families caught in each trawl deployment.

Table 3.4.2 Number of distinct families of teleost fishes caught in all the hauls per trawl type at each station. Numbers in parenthesis indicate the number of distinct taxa not identified to the family level.

Station type:		Transect Station										
Trawl Type	**Haul Type**	**01**	**02**	**03**	**04**	**05**	**08**	**09**	**10**	**11**	**12**	**13**
Multpelt	Target	4 (1)	7 (0)	10 (0)	14 (0)	18 (2)	14 (0)	8	21 (0)	21 (0)	8 (0)	23 (1)

3.5 Deep Vision in-trawl video observations

The Deep Vision (DV) imagery was used actively to inspect visually the composition of the acoustic scattering layers during scrutinization. The relatively new LSSS feature that allows studying video or still frames on the echogram during scrutinization was very useful in that regard. Generally, the layers, although appearing separate, often considered of many of the same organisms, and often in similar densities. However, for some groups/ species the DV data could verify that layers consisted of only one (monospecific) species or group such as e.g. krill (Eupaucidae) or pearlside (*Maurolicus mülleri*). The DV data were also useful to determine vertical minimum or maximum depth of distribution for different groups or species. For a full quantification of all information that can be extracted from the DV data there will, however, be a need for a far more detailed, possibly automated post processing. Due to the small organism sizes, the number of different taxons present together and the often relatively poor light conditions/ visibility it does not seem feasible to obtain absolute counts or measures of animal densities from the DV data.

3.6 Marine mammals, seabirds, and litter visual observations

Marine mammals

Altogether 14 species of marine mammals were observed during the survey, including a blue whale observation (Table 3.6.1). The observation log (1-hour transects) is listed in Annex V.

Table 3.6.1 Visual observations of marine mammals during the survey

Species		Total	30.apr	01.mai	02.mai	03.mai	04.mai	05.mai	06.mai
Southern Right Whale	Eubalaena australis								
Blue Whale	Balaenoptera musculus	1							1
Fin Whale	Balaenoptera physalus								
Minke Whale	Balaenoptera acutorostrata								
Humphack Whale	Megaptera novaeangliae								
Sperm Whale	Physeter catodon								
Long-finned Pilot Whale	Globicephala melas	1			1				
Risso's Dolphin	Grampus griseus								
Dusky Dolphin	Lagenorhynchus obscurus								
Common Bottle-nose Dolphin	Tursiops truncatus								
Southern Right Whale Dolphin	Lissodelphis peronii								
Heaviside's Dolphin	Cephalorhynchus heavisidii								
Cape Fur Seal	Arctocephalus pusillus	1		1				1	
Unidentified 'blackfish'	Globicephalinae speies	1							1
	Total:	3	0	1	1	0	0	1	3

Seabirds

Altogether 45 species of seabirds were observed during the survey (Table 3.6.2).

Table 3.6.2. Visual observations of seabirds during the survey

Birds	Species		Total	30.ap	01.ma	02.ma	03.ma	04.ma	05.ma	06.ma
Wandering Albatross	*Diomedea*	*exulans*	1			1	1			
Tristan Albatross	*Diomedea*	*dabbenena*								
Black-browed Albatross	*Thalassarche*	*melanophris*	1		1	1	1			1
Shy Albatross	*Thalassarche*	*cauta*	1		1	1	1	1		1
Atlantic Yellow-nosed Albatross	*Thalassarche*	*chlororhynchos*	1		1	1	1	1	1	1
Indian Yellow-nosed Albatross	*Thalassarche*	*carteri*	1		1					
Southern Giant Petrel	*Macronectes*	*giganteus*								
Northern Giant Petrel	*Macronectes*	*halli*								
Pintado Petrel	*Daption*	*capense*								
Great-winged Petrel	*Pterodroma*	*macroptera*								
Soft-plumaged Petrel	*Pterodroma*	*mollis*								
White-chinned Petrel	*Procellaria*	*aequinoctialis*	1		1	1	1	1	1	1
Spectacled Petrel	*Procellaria*	*conspicillata*	1		1	1	1	1	1	1
Cory's Shearwater	*Calonectris*	*borealis*	1		1	1	1	1	1	1
Scopoli's Shearwater	*Calonectris*	*diomedea*								
Manx Shearwater	*Puffinus*	*puffinus*								
Sooty Shearwater	*Puffinus*	*griseus*	1		1	1		1	1	1
Great Shearwater	*Puffinus*	*gravis*	1		1	1			1	1
Wilson's Storm Petrel	*Oceanites*	*oceanicus*	1		1	1				1
White-faced Storm Petrel	*Pelagodroma*	*marina*	1					1	1	
Black-bellied Storm Petrel	*Fregetta*	*tropica*								
European Storm Petrel	*Hydrobates*	*pelagicus*	1			1				
Leach's Storm Petrel	*Oceanodroma*	*leucorhoa*	1				1	1	1	1
Cape Gannet	*Morus*	*capensis*	1		1	1	1	1	1	1
Crowned Cormorant	*Microcarbo*	*coronatus*								
Bank Cormorant	*Phalacrocorax*	*neglectus*								
White-breasted Cormorant	*Phalacrocorax*	*lucidus*								
Cape Cormorant	*Phalacrocorax*	*capensis*	1	1						
Sabine's Gull	*Xema*	*sabini*								
Grey-headed Gull	*Chroicocephalus*	*cirrocephalus*	1							
Hartlaub's Gull	*Chroicocephalus*	*hartlaubii*	1							
Kelp Gull	*Larus*	*dominicanus*	1							

Caspian Tern	*Hydroprogne*	*caspia*								
Swift Tern	*Thalasseus*	*bergii*	1	1						
Sandwich Tern	*Thalasseus*	*sandvicensis*								
Common Tern	*Sterna*	*hirundo*								
Arctic Tern	*Sterna*	*paradisaea*	1			1	1	1	1	1
Antarctic Tern	*Sterna*	*vittata*								
South Polar Skua	*Stercorarius*	*maccormicki*								
Subantarctic Skua	*Stercorarius*	*antarcticus*	1	1	1	1	1	1	1	1
Pomarine Skua	*Stercorarius*	*pomarinus*	1				1			
Parasitic Jaeger	*Stercorarius*	*parasiticus*								
Long-tailed Jaeger	*Stercorarius*	*longicaudus*	1						1	
Greater Flamingo	*Phoenicopterus*	*roseus*	1	1						
Great White Pelican	*Pelecanus*	*onocrotalus*	1	1						
		Total:	26	5	12	14	12	11	12	13

Snapshot events of marine bird observations made during sampling events are listed in table 3.6.3.

Table 3.6.3 Visual observations of seabirds during the survey

Date:	01.mai			02.mai			03.mai		04.mai			05.mai			06.mai			
Possition:	23 0.02			22 59.901	23 0.002	23 0.05	23 0.022		23 1.924	23 0.500	22 59.952	22 59.64.6	22 59.88	22 59.975	23 0.011	23 0.034	23 0.016	23 0.086
Time:	14 17.56			12 33.017	12 21.274	12 8.415	11 8.407		10 19.038	9 39.856	9 1.541	9 51.50	10 39.94	11 8.304	12 33.610	12 45.657	13 0.304	13 20.251
Count:	07h28	10h00	16h30			16h30	10h05	15h25	7h40	12h17	18h30	7h45	13h25	18h00	8h50	10h30	12h43	14h55
Observation type	Trawl	Trawl	Trawl	Trawl	Trawl	Trawl	Trawl	Trawl	BONGO	Trawl	CTD	Stern	Stern	CTD	CTD	CTD	CTD	CTD
Wandering Albatross				6	1													
Black-browed Albatross	50	150	350	10	2	2	1	1								2	3	20
Atlantic-Yellownosed Albatross	80	200	500	200	60	30	15	20	1					2	25	12	3	10
Indian-Yellownosed Albatross	0	1	0															
Shy Albatross	15	50	80	1	2	1				1								10
White-chinned Petrel	1000	2000	200	100	50	20	10	3	2	4					10	6	10	80
Spectacled Petrel	1	0	0	1	1	1	1				1				3	1		
Wilson's Storm Petrel	50	30	15															5
Sooty Shearwater	50	500	150														1	1
Great Shearwater	2	25	10															1
Cory's Shearwater				80	100	2	30							30	30		1	
Brown Skua	20	30	30	2		2	4	9	3	1				1	3	2		5
Cape Gannet	20	80	15	2				1										2
Arctic Tern							6											

Marine litter and kelp

The observation log for marine litter and kelp (by transect) is listed in Annex VI. Incidental observations in conjunction with sampling are listed in table 3.6.4.

Table 3.6.4 Incidental visual observations litter and kelp during the survey.

Date:	Time:	Item:	Size:	Distance:	Bouyancy:	Notes: Bio-fowling:
01.mai.19	17h25	Kelp 2m long (old and worn)	e	25 m	1	Old, degraded
02.mai.19	15h50	Unknown material	e	4 m	-1	photographed
03.mai.19	11h05	Kelp (1 m long)	e		1	
04.mai.19	09h24	Kelp (2 m long)	e	10 m	1	photographed
06.mai.19	12h56	Large metal oil drum, red with writing	e	3 m	1	photographed

CHAPTER 4. CONCLUDING REMARKS

The Namibian upwelling is not merely a response to the wind blowing alongshore but a complex pattern if oceanographic process. We observed a classical upwelling season scenario, with wind events that commonly are taking place on a temporal scale of week(s), before being abrupted by calmer periods. In peak upwelling events, more nutrients are pumped into the upper layers than in calmer periods. Interestingly, this general pattern is largely conforming with conditions on the preceding mesopelagic transect survey in this region in 2017 (survey no. 2017409), despite being conducted almost two years earlier and in the opposite season.

However, it is during those calm periods that the stratification sets in and the ocean starts blooming, and it is indeed this pattern of exchanging strong and weak wind periods that drives the productivity of the Benguela upwelling system. Coastal productivity is high in the Benguela system, and nutrients are largely absorbed inside the coastal upwelling zone. Thus, the state of upwelling is not likely greatly influencing the mesopelagic community, which is located offshore of the upwelling zone. This is indicated by the starch oxygen contrasts between the east and west part of the section (Figure 3.1.5). Interestingly, the dip of the oxygen-rich water down to 300 m shifts slightly westward when comparing the CTD stations between the western and eastern (return) sections, suggesting an impact of the reduced wind stress and decreased nearshore temperatures on the inbound transect compared to the outbound - possibly modulated by the diverse current conditions and formation of near-surface eddies.

Despite not conducting diel cycle observations on this survey, diel vertical migration was indeed evident throughout the transect from the echograms (Figure 3.2.1.). On the onset of the mesopelagic layer on the shelf break the majority of scatterers were present in the upper 50-100 m of the water column at night descended to approximately 200-250 m at dawn, as was reported for the 2017409 mesopelagic transect survey. Further offshore the scattering layers were deeper, as expected. Generally, three distinct scattering layers were distinguishable, although undertaking considerable diel vertical migrations and largely being composed by similar functional groups and fish species/ groups (families). Catch rates were rather variable as for preceding surveys. Further analyses are certainly required to elucidate trends in abundance and diversity, as well as catch rates, and how horizontal and vertical distributiond may be modulated by the everchanging oceanographical conditions.

The DV system was a powerful tool for determining the vertical distribution of species or species groups, especially as for this survey in the absence of multiple trawl hauls targeting separate scattering layers. The poor lighting conditions precludes, however, our ability to positively identify individuals to lower taxonomical levels as well as to calculate volume densities.

CHAPTER 5. NOTES ON DATA ERRORS

- The EK 80 echosounders were first calibrated in Bergen, Norway in March 2017. However, no successful calibrations have been carried out since, neither in the region of this survey, in waters with similar temperature/ salinity (sound speed) conditions to the survey, or within a reasonable period of time (drift), potentially seriously impairing the quality of the raw acoustic data. Arrangements were made for a calibration to be performed near Walvis Bay (Henties Bay) shortly after this survey, but if successful, acoustci data recorded on this survey will in either case need to be re-processed using correct calibration coefficients.
- It should also be checked whether the operation settings (power, pulse length, bandwith, etc) reported here in fact correspond to setting used (if not, scrutinized data should be re-exported using correct settings)
- Scales onboard had poor accuracy and precision and were unable to measure the weight of small individual specimens, limiting biological sampling to mass by sub-sample (average weight).
- Many species caught in the trawls were not identified due to absence of mesopelagic taxonomical expertise onboard. This caused major challenges as samples had to be labelled and frozen for subsequent taxonomical identification and the output re-entered into the database. This caused considerable challenges and represents a major risk of impaired catch data quality.
- Still, several species caught were not defined the NANSIS trawl database software onboard and could consequently not be entered into the database.

CHAPTER 6. REFERENCES

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CHAPTER 7. ANNEX

ANNEX I ACOUSTIC INSTRUMENTS

NB! THE COLLECTED RAW ACOUSTIC DATA NEED TO BE CORRECTED FOR UPDTED CALIBRATION SETTINGS AND CHECKED FOR ACTUAL OPERATION SETTINGS USED WHEN COLLECTING THE DATA

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. Standard sphere calibrations were most recently carried out 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 m (drop keel in) 8 m (drop keel out)
Absorption coeff.	8.3 dB/km
Pulse duration	medium (1.024 ms)
Bandwidth	2.43 kHz
Max power	2000 Watt
2way beam angle	20.6 dB
gain	26.95 dB
SA correction	0.03 dB
Angle sensitivity	21.9
3 dB beamwidth	6.22 º along ship
	6.28 º athwart ship
Alongship offset	0.10 º
Athwardship offset	0.06 º

Bottom detection menu	Minimum level 50 dB

ANNEX II SAMPLING TRAWL AND PLANKTON NET DIMENSION

Biological sampling gear (trawls and plankton nets)

Mesopelagic organisms were sampled using a Multpelt 624 (Figure AII.1), which was new and first put in use on the Dr. Fridtjof Nansen III new in 2017. The Multpelt 624 trawl has approximately 35 m high and 60 m wide opening, with a nominal mouth opening of 2100 m^2. The codend of the Multpelt trawl is 33 m in length, with 40 mm meshes in the fore section (16 m in length) and 22 mm meshes in the aft section (17 m). The aft 22 m of the codend is lined with an 8 mm inner liner mesh to ensure similar retention to that of the Krill trawl used on other mesopelagic surveys with Dr. Fridtjof Nansen III, including the previous mesopelagic survey off Walvis Bay in 2017 (survey no 2017402).

The 'Thyborøn type 7 combi' (7.41 m^2, 1720 kg), which is the standard trawl doors for the Dr. Fridtjof Nansen survey (Axelsen et al., 2014) were used in all trawl hauls. Neither restraining rope nor tickler chains were used on any of the trawl hauls.

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 the ship is based on acoustic transmission. The doors are fitted with sensors to provide information on door spread and angle. A trawl eye and depth sensor attached to the headrope provide information about the trawl's depth, opening and clearance (if any) between the footrope and seabed.

A horizontally towed HYDRO-BIOS Multinet and vertically towed WP2 vertical plankton net were used to sample plankton (Figure AII.2). Both nets have 0.25 m^2 opening and were fitted with 180 µm mesh nets.

Double oblique tows were towed at 8 stations using a Bongo net (405µm) from 200 m to the surface for sampling of ichtyoplankton, fish larvae and makrozooplankton. An illustration of the Bongo net is provided in Fig. AII.3.

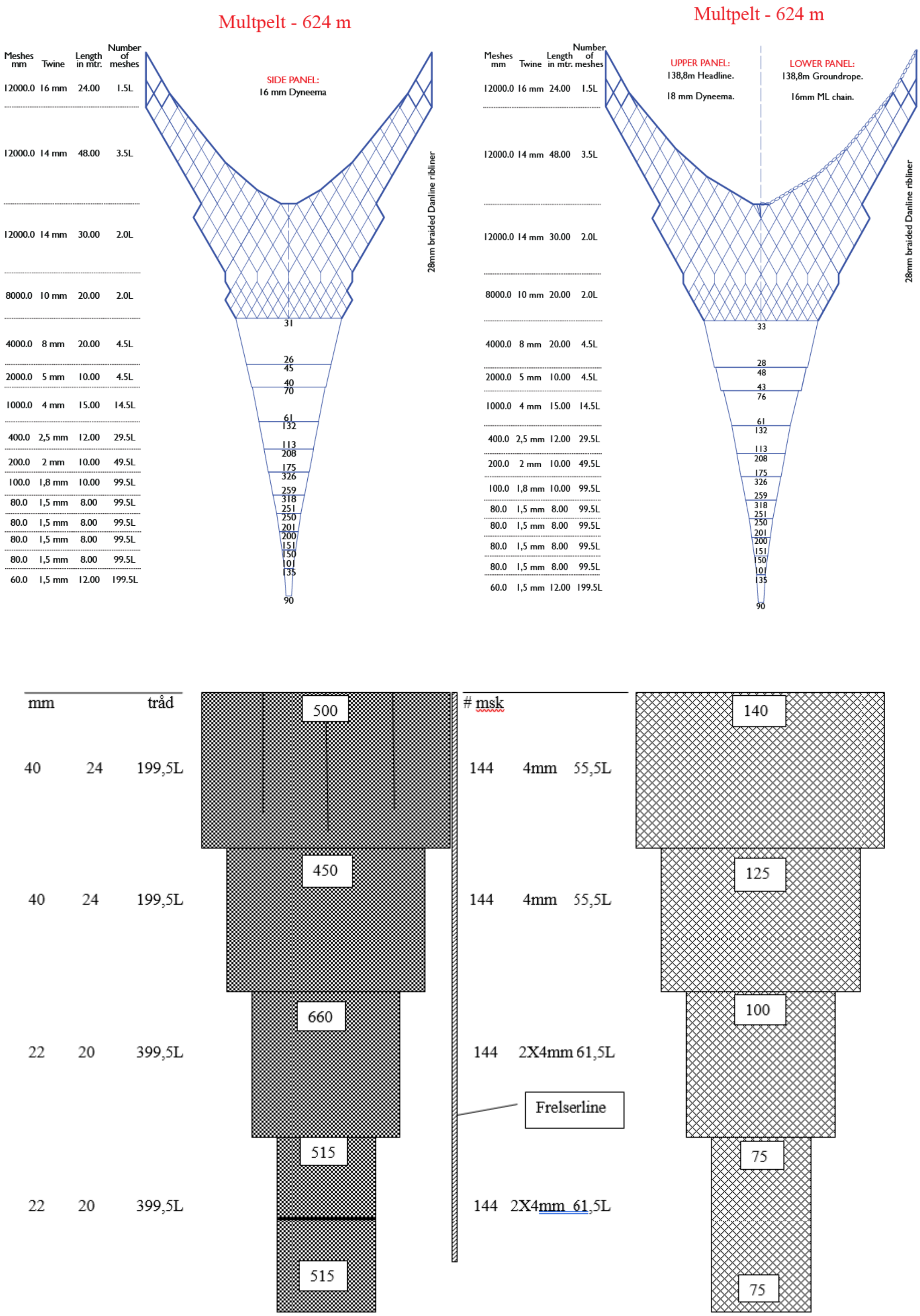

Figure AII.1. Multpelt 624 (top) and codend (bottom). The aft 22 m of the codend are lined with 8 mm knotless meshes (not shown).

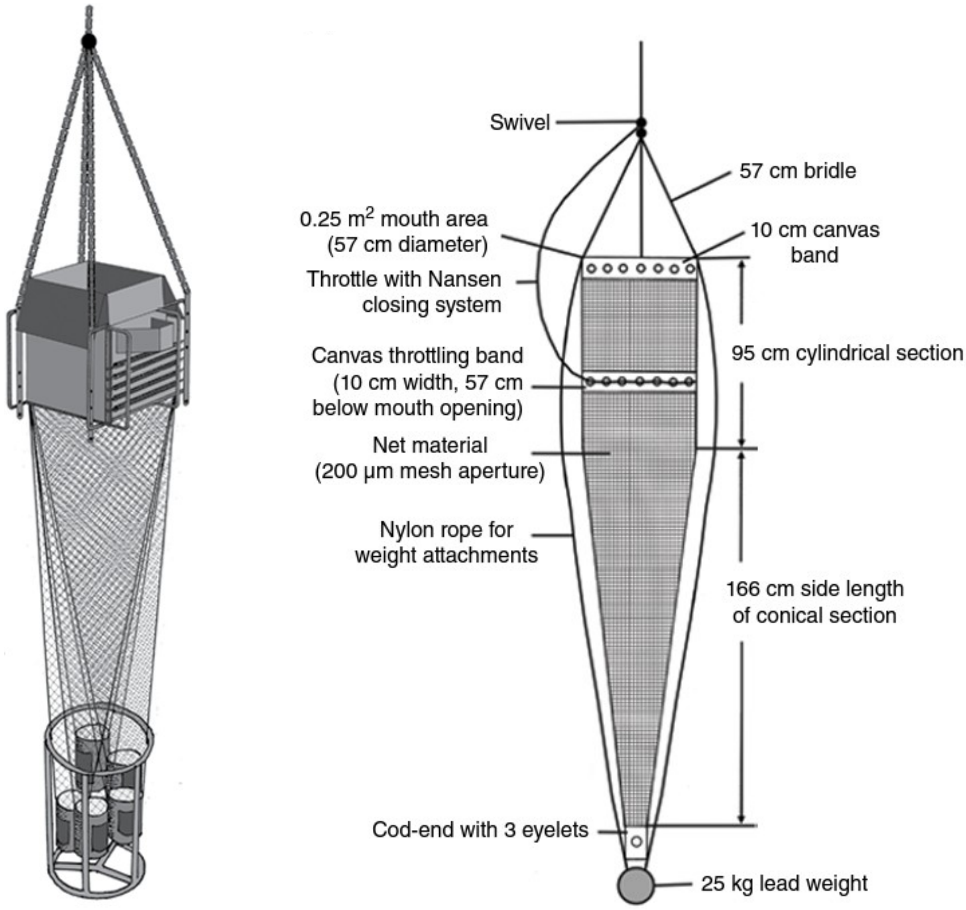

Figure AII.2. HYDRO-BIOS Multinet (left) and WP2 net (right) used to sample plankton Both have $0.25m^2$ opening and 180 µm mesh. Illustrations by R. Jakobsen.

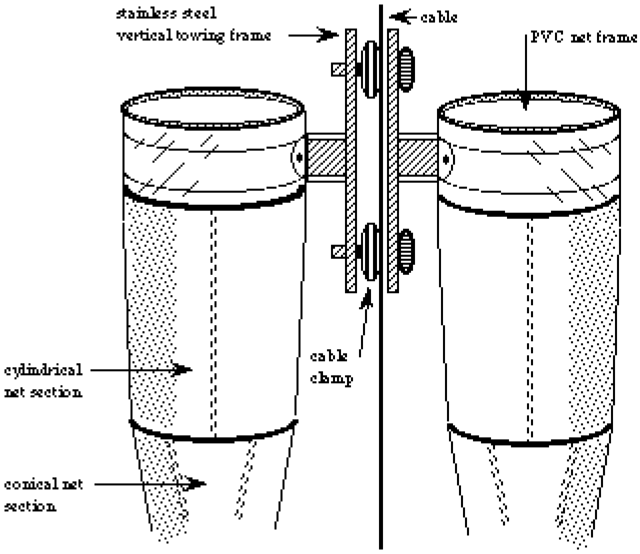

Fig. AII.3. Schematic illustration of Bongo net (405µm) deployed from 200 m to the surface for sampling of ichtyoplankton, fish larvae and makrozooplankton.

ANNEX III WBAT sampling log

2019404 WBAT LOG SHEET – NB! UTC time only

Bottom depth	4500	4000	3500	3000	2500	2000	1500	1000	500	350	350	350	200	150	50
Profile depth	600	600	600	600	600	600	600	600	450	300	275	200	150	100	X
HD station no	352	353	355	357	359	360	361	362	363	364	365	366			X
CTD @ 5 m	00:23	08:44	15:44:26	21:30	02:02:20	04:11:53	06:03:39	08:10:20			14:40:13	15:47:15			X
CTD start down	00:26:00	08:51	15:50:07	21:36	02:06:09	04:17:44	06:15:40	08:16:02			14:42:56	15:51:16			X
CTD @ 50 m	00:27:10				02:06:57						*	**			X
CTD Continue	00:27:35				02:07:23										X
CTD stop down	00:37:50	09:01:48	16:00:32	21:46:45	02:16:52	04:28:19	06:26:10	08:26:33			14:48:11	15:54:42			X
															X
CTD start up	00:43:10	09:07:06	16:06:28	21:52	02:21:00	04:33:14	06:31:15	08:31:56			15:15:07	16:11:00			X
CTD @ 50 m	00:53:05				02:30:44						15:19:15				X
CTD Continue	00:53:30				02:31:48						15:19:37				X
CTD @ 5 m	00:54:23	09:17:50	16:16:54	00:02	02:32:57	04:43:41	06:41:42	08:42:25			15:20:14	16:14:27			X
CTD on deck	00:58	09:24:46	16:23:45	00:08	02:37:57	04:48:53	06:48:53	08:46:37				16:17:17			

Yellow boxes: Winch driven manually and did not stop

*: Profile depth 275 m, cameras w/IR lights attached

**: Profile depth 200 m, cameras w/IR lights attached

600 m profile depth: 1300 ping

ANNEX IV Summary of trawl catch rates (h^{-1}) by numbers and mass

R/V Dr. Fridtjof Nansen SURVEY:2019404 STATION: 1
DATE :30/04/19 GEAR TYPE: PT NO: 8 POSITION:Lat S 23°2.05
start stop duration Lon E 13°32.19
TIME :22:16:27 22:41:09 24.7 (min) Purpose : 1
LOG : 1018.65 1019.96 1.3 Region : 5000
FDEPTH: 120 25 Gear cond.: 0
BDEPTH: 199 194 Validity : 5
Towing dir: 0° Wire out : 350 m Speed : 3.2 kn
Sorted : 0 Total catch: 0.00 Catch/hour: 0.00

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

R/V Dr. Fridtjof Nansen SURVEY:2019404 STATION: 2
DATE :01/05/19 GEAR TYPE: PT NO: 8 POSITION:Lat S 23°1.35
start stop duration Lon E 13°29.04
TIME :01:31:57 01:54:58 23.0 (min) Purpose : 1
LOG : 1028.94 1029.68 0.7 Region : 5000
FDEPTH: 150 15 Gear cond.: 1
BDEPTH: 255 254 Validity : 3
Towing dir: 0° Wire out : 400 m Speed : 1.9 kn
Sorted : 0 Total catch: 349.63 Catch/hour: 911.29

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Lampanyctodes hectoris	739.97	587098	81.20	
Krill	90.83	529053	9.97	
Maurolicus sp.	50.07	96594	5.49	22
Symbolophorus boops	9.86	975	1.08	20
Merluccius paradoxus	5.68	39	0.62	19
Brama brama	4.35	3	0.48	
Todarodes angolensis	3.68	13	0.40	
Pasipheaid	0.89	3102	0.10	
Solenocera sp.	0.41	21	0.05	
Leptocephalus	0.17	104	0.02	
Total	905.90		99.41	

R/V Dr. Fridtjof Nansen SURVEY:2019404 STATION: 3
DATE :01/05/19 GEAR TYPE: PT NO: 8 POSITION:Lat S 23°3.00
start stop duration Lon E 13°48.00
TIME :07:39:04 08:06:55 27.9 (min) Purpose : 1
LOG : 1049.67 1050.84 1.2 Region : 5000
FDEPTH: 300 0 Gear cond.: 0
BDEPTH: 347 343 Validity : 3
Towing dir: 0° Wire out : 800 m Speed : 3.0 kn
Sorted : 2 Total catch: 363.80 Catch/hour: 783.77

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Symbolophorus boops	388.32	45135	49.55	3
Lampanyctodes hectoris	197.62	130524	25.21	4
Brama brama	60.41	47	7.71	31
Maurolicus sp.	33.75	42289	4.31	2
C E P H A L O P O D A	31.07	153	3.96	1
Krill	28.46	169967	3.63	
Merluccius capensis	15.94	41	2.03	29
Centrolophus niger	9.18	2	1.17	
Pasiphae sp.	5.69	13827	0.73	
Trigla lyra	3.27	2	0.42	
SALPS	3.25	814	0.42	
Merluccius paradoxus	2.91	6	0.37	30
Diaphus sp.	2.03	1222	0.26	6
Metelectrona ventralis	1.22	407	0.16	5
Sergestes sp.	0.41	5287	0.05	
Beryx splendens	0.24	2	0.03	
Total	783.77		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2019404 STATION: 4
DATE :01/05/19 GEAR TYPE: PT NO: 8 POSITION:Lat S 23°1.97
start stop duration Lon E 13°1.52
TIME :13:32:23 14:06:47 34.4 (min) Purpose : 1
LOG : 1081.68 1082.99 1.3 Region : 5000
FDEPTH: 425 0 Gear cond.: 0
BDEPTH: 486 473 Validity : 0
Towing dir: 0° Wire out : 880 m Speed : 2.3 kn
Sorted : 6 Total catch: 381.83 Catch/hour: 665.79

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Brama brama	154.37	120	23.19	34
Lampanyctus sp.	138.22	21955	20.76	40
Symbolophorus boops	136.01	16188	20.43	33
Krill	124.18	0	18.65	
Tetragonurus cuvieri	36.20	117	5.44	36
OMMASTREPHIDAE	23.05	126	3.46	32
Merluccius paradoxus	17.68	23	2.66	35
Diaphus hudsoni	7.39	2145	1.11	7
Small squids unident.	6.33	963	0.95	
Lampadena pontifex	3.77	370	0.57	37
Astronesthes sp.	3.47	223	0.52	16
Metelectrona ventralis	3.10	814	0.47	39
Diaphus ostenfeldi	2.73	370	0.41	8
Phosichthys argenteus	1.48	296	0.22	10
Lampanyctus sp.	1.26	1405	0.19	18
Stomias boa boa	1.26	370	0.19	13
Small shrimps	1.06	888	0.16	
Astronesthes sp.	0.96	75	0.14	9
Paradiplospinus gracilis	0.74	75	0.11	12
Scopelosaurus meadi	0.67	296	0.10	11
Chauliodus sloani	0.59	148	0.09	14
Bathylagichthys problematicus	0.52	75	0.08	15
Lampanyctodes hectoris	0.44	593	0.07	17
Maurolicus sp.	0.20	296	0.03	38
PASIPHAEIDAE	0.11	223	0.02	
Total	665.79		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2019404 STATION: 5
DATE :01/05/19 GEAR TYPE: PT NO: 8 POSITION:Lat S 23°2.03
start stop duration Lon E 12°46.65
TIME :19:59:43 20:56:20 56.6 (min) Purpose : 1
LOG : 1109.75 1111.85 2.1 Region : 5000
FDEPTH: 600 0 Gear cond.: 0

BDEPTH: 988 961 Validity : 0
Towing dir: 0° Wire out : 1100 m Speed : 2.2 kn
Sorted : 12 Total catch: 82.93 Catch/hour: 87.89

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Krill	27.47	358	31.25	
Lampanyctus sp.	14.84	3982	16.89	
Tetragonurus cuvieri	6.60	28	7.51	
Brama brama	3.99	3	4.53	
Lyconus brachycolus	3.81	35	4.34	
Paradiplospinus gracilis	2.91	35	3.31	
Symbolophorus boops	2.77	313	3.16	
Howella sherborni	2.64	375	3.00	23
Metelectrona ventralis	2.57	604	2.92	25
Lolliguncula sp.	2.50	291	2.84	
Diaphus hudsoni	2.29	826	2.60	24
Shrimps unidentified	1.94	916	2.21	
BATHYLAGIDAE	1.66	84	1.89	
J E L L Y F I S H	1.60	229	1.82	0
Phosichthys argenteus	1.60	160	1.82	
Centrophorus granulosus	1.51	1	1.71	
Bathylagichthys sp.	1.04	70	1.18	
S H R I M P S	1.04	139	1.18	
Lampadena pontifex	0.90	132	1.03	
Diaphus sp.	0.61	599	0.70	
J E L L Y F I S H	0.60	15	0.68	
Chauliodus sp.	0.55	132	0.63	
Diaphus effulgens	0.49	84	0.55	
Astronesthes sp	0.49	35	0.55	
Myctophid sp. A	0.35	534	0.39	
Symbolophorus barnardi	0.35	70	0.39	
Myctophid sp. B	0.28	430	0.32	
Paradiplospinus gracilis	0.25	3	0.29	0
BATHYLAGIDAE	0.14	139	0.16	0
Nansenia sp.	0.04	4	0.04	
Lestrolepis intermedia	0.04	1	0.04	
Poromitra sp.	0.02	1	0.02	
Stomias boa boa	0.02	21	0.02	
Melanocetus johnsonii	0.01	2	0.01	
Scopelogadus mizolepis mizolepis	0.01	1	0.01	
Sternoptyx pseudobscura	0.00	7	0.00	
Total	87.90		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2019404 STATION: 6
DATE :02/05/19 GEAR TYPE: PT NO: 8 POSITION:Lat S 23°1.51
start stop duration Lon E 12°33.49
TIME :01:52:03 02:40:26 48.4 (min) Purpose : 1
LOG : 1135.53 1137.37 1.8 Region : 5000
FDEPTH: 500 0 Gear cond.: 0
BDEPTH: 1516 1526 Validity : 0
Towing dir: 0° Wire out : 1100 m Speed : 2.3 kn
Sorted : 6 Total catch: 65.36 Catch/hour: 81.06

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Diaphus sp.	9.05	3572	11.17	64
Lampanyctus sp.	8.09	1563	9.98	
Krill	7.70	9177	9.50	
Phosichthys argenteus	6.28	930	7.74	63
Benthodesmus sp.	6.01	74	7.42	0
BATHYLAGIDAE	4.02	198	4.96	
Metelectrona ventralis	3.97	1290	4.90	69
BATHYLAGIDAE	3.78	446	4.67	73
UNIDENTIFIED FISH	2.75	1	3.40	
Lampadena pontifex	2.24	260	2.77	65
Tetragonurus cuvieri	2.18	7	2.69	71
Funchalia sp	2.15	223	2.65	
Diaphus effulgens	1.80	260	2.22	67
Small squids unident., juvenile	1.79	384	2.20	
Diaphus sp.	1.64	2505	2.02	0
Lyconus sp.	1.60	12	1.97	
Chauliodus sloani	1.51	260	1.87	
Howella sp.	1.50	136	1.85	66
Unidentified	1.19	0	1.47	
Melamphaes sp.	1.19	335	1.47	68
Bathylagichthys sp.	1.18	50	1.45	
MELANOSTOMIATIDAE	1.10	62	1.36	
Sergia sp.	0.89	310	1.10	
Oplophorus	0.89	322	1.10	
Small squids unident.	0.82	12	1.01	0
Paradiplospinus gracilis	0.74	37	0.92	
OMMASTREPHIDAE	0.71	6	0.87	
C E P H A L O P O D A	0.66	4	0.81	
Symbolophorus sp.	0.50	112	0.61	
Astronesthes sp.	0.40	37	0.49	0
Unidentified	0.37	12	0.46	0
Nansenia sp.	0.37	25	0.46	
Histioteuthis reversa	0.35	4	0.43	72
Symbolophorus boops	0.30	37	0.37	
Electrona risso	0.21	136	0.26	
Malacosteus sp.	0.17	25	0.21	
C E P H A L O P O D A	0.17	12	0.21	0
Gonostoma sp.	0.14	12	0.17	0
Scopelosaurus meadi	0.11	136	0.14	
Kali sp.	0.10	12	0.12	
Bathylagichthys sp.	0.09	25	0.11	0
Astronesthes sp.	0.07	12	0.09	
ANGUILLIFORMES	0.07	12	0.09	
Poromitra	0.06	12	0.08	
Sternoptyx pseudobscura	0.06	50	0.08	
Gonostoma sp.	0.04	25	0.05	
PARALEPIDIDAE	0.02	25	0.03	
SERGESTIDAE	0.01	149	0.02	
Melanocetus johnsonii	0.00	1	0.00	
Mola mola	0.00	1	0.00	
Total	81.06		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2019404 STATION: 7
DATE :02/05/19 GEAR TYPE: PT NO: 8 POSITION:Lat S 23°1.95
start stop duration Lon E 12°21.72
TIME :08:43:26 09:22:08 38.7 (min) Purpose : 1
LOG : 1158.66 1160.24 1.6 Region : 5000
FDEPTH: 500 0 Gear cond.: 0
BDEPTH: 2004 1994 Validity : 5
Towing dir: 0° Wire out : 950 m Speed : 2.5 kn
Sorted : 3 Total catch: 23.00 Catch/hour: 35.66

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Unidentified squid	3.16	19	8.87	28
Schedophilus huttoni	2.73	2	7.65	
Diaphus sp.	2.65	2203	7.43	26
Krill	2.54	53395	7.13	
Lampanyctus sp.	2.42	288	6.78	27
Funchalia sp	2.12	271	5.96	

Phosichthys argenteus	2.08	313	5.83	
Astronesthes sp.	1.04	81	2.91	
Metelectrona ventralis	0.93	254	2.61	
Small squids unident.	0.70	231	1.96	
Chauliodus sp.	0.65	85	1.83	
Argyropelecus gigas	0.56	11	1.57	
Tetragonurus cuvieri	0.47	2	1.30	
Paradiplospinus gracilis	0.36	14	1.00	
Lampadena pontifex	0.34	23	0.96	
Diaphus ostenfeldi	0.16	23	0.43	
Nansenia sp.	0.12	11	0.32	
Maurolicus sp.	0.08	127	0.22	
Borostomias antarcticus	0.06	2	0.17	
Electrona risso	0.06	34	0.17	
Luciosudis normani	0.06	11	0.16	
Sternoptyx pseudobscura	0.05	3	0.14	
Melanostomias sp.	0.04	2	0.11	
Lepidopus dubius	0.03	2	0.09	
Howella sherborni	0.02	2	0.06	
Stomias sp.	0.02	5	0.04	
Argyropelecus affinis	0.00	2	0.00	
Total	23.43		65.71	

R/V Dr. Fridtjof Nansen SURVEY:2019404 STATION: 8
DATE :02/05/19 GEAR TYPE: PT NO: 8 POSITION:Lat S 23°2.06
start stop duration Lon E 12°9.04
TIME :14:37:13 15:30:07 52.9 (min) Purpose : 1
LOG : 1184.65 1186.45 1.8 Region : 5000
FDEPTH: 600 0 Gear cond.: 0
BDEPTH: 2497 2452 Validity : 5
Towing dir: 0° Wire out : 1200 m Speed : 2.0 kn
Sorted : 0 Total catch: 57.44 Catch/hour: 65.13

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctus sp.	10.52	483	16.16	78
Diaphus hudsoni	8.51	890	13.06	81
Krill	6.76	103889	10.37	
Phosichthys argenteus	5.49	129	8.43	82
Waste General	4.93	0	7.57	
C E P H A L O P O D A	3.07	170	4.72	0
Diaphus sp.	2.86	1500	4.39	80
Funchalia sp	2.79	285	4.28	
Chauliodus sp.	2.76	116	4.23	79
Metelectrona ventralis	2.66	204	4.09	
C E P H A L O P O D A	1.68	7	2.58	
Atolla sp	1.62	96	2.49	
Acanthephyra sp.	1.62	327	2.49	
Paracaristius nemorosus	1.58	5	2.42	
Howella sp.	1.54	41	2.37	83
BATHYLAGIDAE	1.21	20	1.86	84
Sigmops elongatus	0.68	2	1.04	
Heterophotus ophistoma	0.50	1	0.77	
Diaphus ostenfeldi	0.43	14	0.66	
Maurolicus sp.	0.42	837	0.65	
Paradiplospinus gracilis	0.42	16	0.64	
Sergia sp.	0.30	98	0.46	
Tetragonurus cuvieri	0.29	1	0.44	
Platyberyx opalescens	0.28	1	0.44	
Lyconus brachycolus	0.23	2	0.35	
Electrona risso	0.23	27	0.35	
Notostomus sp.	0.18	42	0.28	
Bathylagichthys sp.	0.16	11	0.24	
Periphylla sp	0.14	7	0.21	
Bathophilus sp.	0.13	6	0.19	
Chiasmodon sp.	0.12	1	0.19	
Astronesthes sp.	0.11	17	0.18	
Nansenia sp.	0.11	9	0.17	
Anoplogaster cornuta	0.10	2	0.16	
Lampanyctus sp.	0.09	7	0.14	0
Vinciguerria sp.	0.09	95	0.14	
Scopelogadus mizolepis mizolepis	0.09	34	0.13	
Melanocetus johnsonii	0.08	1	0.12	
Symbolophorus barnardi	0.08	7	0.12	
Diretmus argenteus	0.07	3	0.11	
Cryptopsaras couesii	0.06	1	0.10	
Oplophorus	0.06	49	0.10	
Argyropelecus gigas	0.06	10	0.10	
Poromitra sp.	0.06	20	0.09	
Histioteuthis sp.	0.06	1	0.09	
PLATYTROCTIDAE	0.05	7	0.08	
UNIDENTIFIED FISH	0.05	2	0.07	
Normichthys yahganorum	0.04	7	0.05	
Sternoptyx pseudodiaphana	0.03	7	0.05	
Sternoptyx sp.	0.03	7	0.05	
Stomias lampropeltis	0.02	1	0.03	
Derichthys serpentinus	0.02	2	0.03	
Sagamichthys schnakenbecki	0.02	2	0.02	
Lampadena pontifex	0.01	1	0.02	
Leptostomias sp.	0.01	2	0.02	
Total	65.51		100.57	

R/V Dr. Fridtjof Nansen SURVEY:2019404 STATION: 9
DATE :03/05/19 GEAR TYPE: PT NO: 8 POSITION:Lat S 23°1.93
start stop duration Lon E 11°45.17
TIME :00:24:27 01:11:41 47.2 (min) Purpose : 1
LOG : 1224.31 1226.09 1.8 Region : 5000
FDEPTH: 510 0 Gear cond.: 0
BDEPTH: 3010 2995 Validity : 0
Towing dir: 0° Wire out : 1100 m Speed : 2.3 kn
Sorted : 6 Total catch: 51.66 Catch/hour: 65.63

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Funchalia sp	10.98	934	16.73	
Lampanyctus sp.	8.84	1888	13.47	43
Diaphus sp.	5.62	362	8.56	48
Paradiplospinus gracilis	5.32	20	8.10	
Diaphus hudsoni	5.20	3473	7.92	42
Phosichthys argenteus	4.07	563	6.20	41
ARCHITEUTIDAE	2.27	422	3.46	
Scopelogadus mizolepis mizolepis	2.01	311	3.06	0
Scopelogadus mizolepis mizolepis	2.01	311	3.06	
BATHYLAGIDAE	1.92	61	2.93	45
BATHYLAGIDAE	1.91	172	2.91	0
Metelectrona ventralis	1.81	483	2.75	46
Maurolicus sp.	1.51	241	2.29	
C E P H A L O P O D A	1.32	6	2.01	
Chauliodus sp.	1.18	91	1.80	
Atolla sp	1.05	81	1.60	
Acanthephyra sp.	0.93	192	1.41	
Astronesthes sp	0.77	51	1.17	0
Howella sherborni**	0.74	61	1.12	
Lampadena pontifex	0.65	51	0.99	47
MYCTOPHIDAE	0.65	57	0.99	0
Sergia sp.	0.64	201	0.98	

Symbolophorus barnardi	0.57	51	0.87	
Scopelopsis multipunctatus	0.57	252	0.86	0
Lampichthys procerus	0.54	81	0.82	
Melamphaes sp.	0.43	51	0.66	
Bathylagichthys sp.	0.40	91	0.61	
Diaphus ostenfeldi	0.39	41	0.60	
Anoplogaster cornuta	0.35	10	0.53	
Tetragonurus cuvieri	0.28	1	0.43	
Notostomus sp.	0.23	41	0.35	
Nansenia sp.	0.21	10	0.32	
Poromitra megalops	0.20	51	0.31	
Astronesthes sp	0.20	30	0.31	
Poromitra sp.	0.10	41	0.15	
Luciosudis normani	0.08	10	0.12	
Eustomias sp.	0.07	10	0.11	
Derichthys serpentinus	0.06	10	0.10	
Electrona risso	0.06	30	0.09	
Sergestes sp.	0.05	121	0.07	
Diaphus sp.	0.04	61	0.06	0
Avocettina sp.	0.03	20	0.04	
Argyropelecus gigas	0.02	10	0.03	
Sternoptyx pseudobscura	0.02	10	0.03	
Scopelosaurus meadi	0.01	30	0.02	
Total	66.28		101.00	

R/V Dr. Fridtjof Nansen SURVEY:2019404 STATION: 10
DATE :03/05/19 GEAR TYPE: PT NO: 8 POSITION:Lat S 23°1.32
start stop duration Lon E 11°9.95
TIME :12:16:13 13:05:10 92.0 (min) Purpose : 3
LOG : 1272.94 1278.90 6.0 Region : 5000
FDEPTH: 510 0 Gear cond.: 0
BDEPTH: 3540 3545 Validity : 0
Towing dir: 0° Wire out : 1100 m Speed : 3.9 kn
Sorted : 5 Total catch: 31.28 Catch/hour: 20.41

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Small squid	12.25	2450	59.99	
Diaphus hudsoni	3.63	1815	17.78	
C E P H A L O P O D A	0.85	3	4.16	
Phosichthys argenteus	0.74	127	3.64	49
Metelectrona ventralis	0.70	158	3.43	51
Pterycombus petersii	0.39	1	1.92	
Krill	0.35	1225	1.71	
Lampanyctus sp.	0.32	172	1.57	
Diaphus ostenfeldi	0.26	31	1.29	53
Diaphus sp.	0.22	197	1.07	54
Nansenia sp.	0.17	9	0.86	
Symbolophorus barnardi	0.17	40	0.86	52
Lampadena pontifex	0.09	14	0.43	
Diretmus argenteus	0.08	5	0.38	
Trichiurus sp.	0.05	1	0.22	
Electrona risso	0.04	14	0.21	
Argyropelecus gigas	0.04	14	0.21	
Aphanopus sp.	0.03	5	0.13	
Argyropelecus affinis	0.01	5	0.06	
Maurolicus sp.	0.01	110	0.04	
Winteria telescopa	0.00	5	0.02	
Total	20.41		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2019404 STATION: 11
DATE :03/05/19 GEAR TYPE: PT NO: 8 POSITION:Lat S 23°2.48
start stop duration Lon E 10°44.42
TIME :19:25:41 20:09:44 44.1 (min) Purpose : 1
LOG : 1310.52 1312.09 1.6 Region : 5000
FDEPTH: 600 0 Gear cond.: 0
BDEPTH: 3784 3784 Validity : 0
Towing dir: 0° Wire out : 1170 m Speed : 2.1 kn
Sorted : 3 Total catch: 78.63 Catch/hour: 107.08

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Lampanyctus intricarius	15.82	1960	14.78	74
Lampichthys procerus	13.74	3731	12.83	
BATHYLAGIDAE	10.45	1431	9.76	77
Funchalia sp	8.55	622	7.98	
C E P H A L O P O D A	8.01	5	7.48	
Diaphus hudsoni	7.62	3763	7.11	76
BATHYLAGIDAE	7.24	281	6.77	
Small squid	5.81	1245	5.43	
Atolla sp	3.42	373	3.19	
Howella sherborni**	3.33	312	3.11	
Scopelogadus mizolepis mizolepis	2.98	498	2.79	
Acanthephyra sp.	2.15	530	2.00	
Symbolophorus boops	1.99	249	1.86	
Nansenia sp.	1.65	1524	1.54	
Bathylagichthys sp.	1.55	63	1.45	
Phosichthys argenteus	1.27	187	1.19	
Melamphaes sp.	1.06	94	0.99	
Sergia sp.	0.93	373	0.87	
Holtbyrnia macrops	0.78	94	0.73	
Pterycombus petersii	0.71	1	0.66	
Paradiplospinus gracilis	0.65	10	0.61	
Diaphus sp.	0.65	591	0.61	
Metelectrona ventralis	0.65	157	0.61	
Chauliodus sloani	0.62	63	0.58	
Lampadena pontifex	0.62	63	0.58	
Diaphus ostenfeldi	0.56	63	0.52	
Astronesthes sp.	0.50	33	0.47	
HISTIOTEUTHIDAE	0.39	1	0.37	
Anoplogaster cornuta	0.38	10	0.36	
Odontomacrurus murrayi	0.34	4	0.32	
Melamphaes sp.	0.31	157	0.29	0
Poromitra megalops	0.31	157	0.29	
Tetragonurus cuvieri	0.29	1	0.27	
Paracaristius nemorosus	0.25	3	0.23	
Melanocetus johnsonii	0.25	14	0.23	
Periphylla sp	0.19	31	0.17	
Tetragonurus atlanticus	0.16	1	0.15	
Normichthys yahganorum	0.12	31	0.12	
Sternoptyx pseudodiaphana	0.12	31	0.12	
Oplophorus	0.09	94	0.09	
Maurolicus sp.	0.09	94	0.09	
Nessorhamphus ingolfianus	0.09	4	0.09	
Melanostomias sp.	0.09	3	0.09	
Diretmus sp.	0.04	1	0.04	
Falgellostomias bourei	0.04	1	0.04	
Sergestes sp.	0.03	63	0.03	
Melanonus gracilis	0.03	31	0.03	
Notostomus sp.	0.03	31	0.03	
Vinciguerria sp.	0.03	31	0.03	
Luciosudis normani	0.02	3	0.02	
Sigmops elongatus	0.02	1	0.02	
Opostomias micripnus	0.01	1	0.01	
Centrophorus squamosus	0.00	1	0.00	

Total	107.08		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2019404 STATION: 12
DATE :04/05/19 GEAR TYPE: PT NO: 8 POSITION:Lat S 23°1.08
start stop duration Lon E 10°18.37
TIME :02:22:18 03:17:54 55.6 (min) Purpose : 1
LOG : 1342.89 1344.90 2.0 Region : 5000
FDEPTH: 610 0 Gear cond.: 0
BDEPTH: 4027 4028 Validity : 0
Towing dir: 0° Wire out : 1300 m Speed : 2.2 kn
Sorted : 5 Total catch: 65.02 Catch/hour: 70.15

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
OMMASTREPHIDAE	10.81	4	15.41	
Lampanyctus sp.	8.90	1167	12.69	
Acanthephyra sp.	8.41	2162	11.99	
Small squid	6.99	1536	9.96	
Waste General	4.96	0	7.06	
Atolla sp	4.51	187	6.43	
Phosichthys argenteus	2.30	269	3.28	87
BATHYLAGIDAE	1.96	87	2.80	88
Lampichthys procerus	1.93	433	2.75	
Psenes pellucidus	1.76	1	2.50	
Diaphus hudsoni	1.72	891	2.45	86
BATHYLAGIDAE	1.69	329	2.42	89
Scopelogadus sp.	1.60	243	2.28	
Chauliodus sloani**	1.51	227	2.15	
IDIOSEPIIDAE	1.20	67	1.71	
Funchalia sp	1.19	147	1.69	
Lampadena pontifex	0.97	105	1.38	91
Stomias boa boa	0.86	10	1.22	
Howella sherborni**	0.77	87	1.10	92
Paracaristius nemorosus	0.69	3	0.99	
Bathylagichthys sp.	0.69	18	0.99	
Diaphus sp.	0.48	736	0.68	
Symbolophorus barnardi	0.35	61	0.51	
Poromitra sp.	0.34	79	0.48	
Lampanyctus sp.	0.34	113	0.48	85
Sergia sp.	0.34	182	0.48	
Melamphaes sp.	0.31	79	0.44	
Metelectrona ventralis	0.27	44	0.38	
Diaphus ostenfeldi	0.25	36	0.36	
Regalecus glesne	0.23	2	0.33	
Caristius litinovi	0.22	10	0.31	
Melanonus gracilis	0.17	10	0.25	
Normichthys yahganorum	0.15	36	0.21	
Electrona risso	0.15	53	0.21	
Anoplogaster cornuta	0.14	3	0.20	
Astronesthes sp	0.14	5	0.20	
Periphylla sp	0.13	40	0.18	
Notostomus sp.	0.12	10	0.17	
Paradiplospinus gracilis	0.11	2	0.15	
Aphanopus mikhailini	0.10	1	0.14	
Derichthys serpentinus	0.08	18	0.11	
Odontomacrurus murrayi	0.07	1	0.10	
Maurolicus muelleri	0.05	44	0.07	
Melanocetus johnsonii	0.03	2	0.04	
Diretmus argenteus	0.02	1	0.04	
Melanostomias sp.	0.02	1	0.04	
Melanonus zugmayeri	0.02	1	0.03	
Platyberyx opalescens	0.02	1	0.03	
Sternoptyx pseudodiaphana	0.02	4	0.03	
Avocettina sp.	0.02	10	0.02	
Argyropelecus gigas	0.01	2	0.02	
Scopelosaurus meadi	0.01	10	0.01	90
Solenocera sp.	0.01	10	0.01	
Sergestes sp.	0.01	27	0.01	
Oplophorus	0.01	10	0.01	
Vinciguerria nimbaria	0.00	10	0.01	
Total	70.15		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2019404 STATION: 13
DATE :04/05/19 GEAR TYPE: PT NO: 8 POSITION:Lat S 23°1.68
start stop duration Lon E 9°40.81
TIME :10:45:21 11:43:09 57.8 (min) Purpose : 1
LOG : 1393.80 1396.13 2.3 Region : 5000
FDEPTH: 620 0 Gear cond.: 0
BDEPTH: 4319 4302 Validity : 0
Towing dir: 0° Wire out : 1270 m Speed : 2.4 kn
Sorted : 5 Total catch: 40.74 Catch/hour: 42.30

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Unidentified	17.32	0	40.95	
Diaphus hudsoni	4.55	2147	10.77	
C E P H A L O P O D A	3.68	4	8.69	
Small squids	2.20	358	5.19	
Funchalia sp	2.11	244	5.00	
Lampanyctus sp.	1.63	74	3.85	
Chauliodus sloani**	1.46	74	3.46	
Phosichthys argenteus	1.30	114	3.08	
Metelectrona ventralis	1.30	277	3.08	
Lampichthys procerus	0.89	188	2.12	
Derichthys serpentinus	0.78	8	1.85	
Electrona risso	0.73	106	1.73	
Oplophorus	0.65	488	1.54	
Argyropelecus gigas	0.57	57	1.35	
Sternoptyx pseudobscura	0.52	8	1.23	
Howella sp.**	0.49	33	1.15	
Sergia sp.	0.41	49	0.96	
Diaphus sp.	0.41	131	0.96	
Scopelopsis multipunctatus	0.29	90	0.69	
Symbolophorus barnardi	0.24	25	0.58	
Maurolicus sp.	0.24	42	0.56	
Melanostomias sp.**	0.19	8	0.44	
Lampadena pontifex	0.15	33	0.37	
Melamphaes sp.	0.09	8	0.21	
Serrivomer sp.	0.09	25	0.21	
Total	42.30		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2019404 STATION: 14
DATE :04/05/19 GEAR TYPE: PT NO: 8 POSITION:Lat S 23°1.38
start stop duration Lon E 9°2.99
TIME :19:51:43 20:36:47 45.1 (min) Purpose : 3
LOG : 1438.02 1439.52 1.5 Region : 5000
FDEPTH: 600 0 Gear cond.: 0
BDEPTH: 4502 4500 Validity : 0
Towing dir: 0° Wire out : 1150 m Speed : 2.0 kn
Sorted : 3 Total catch: 34.52 Catch/hour: 45.96

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lampanyctus sp.	4.19	682	9.11	0
Plastic	4.06	0	8.83	

Scopelogadus mizolepis mizolepis	3.51	314	7.63	
Diaphus hudsoni	3.43	4631	7.46	62
Argyropelecus gigas	3.15	393	6.86	
Melanonus gracilis	2.90	13	6.32	
Lampadena pontifex	2.68	40	5.84	
Lampichthys procerus	1.72	379	3.75	
Lampadena dea	1.64	433	3.56	
BATHYLAGIDAE	1.37	79	2.99	57
Chauliodus sp.	1.36	132	2.96	59
Small squid	1.28	511	2.79	
Metelectrona ventralis	1.19	302	2.59	
Diaphus sp.	1.14	982	2.49	0
Histioteuthis sp. *	1.05	67	2.28	
Lampanyctus sp.	0.98	314	2.14	58
Electrona risso	0.97	327	2.11	
Bathylagichthys sp.	0.88	40	1.91	55
Funchalia sp	0.73	79	1.59	
Unidentified	0.63	3	1.37	0
Lampadena speculigera	0.53	27	1.15	
Phosichthys argenteus	0.52	105	1.14	60
Paracaristius nemorosus	0.52	5	1.12	
IDIOSEPIIDAE	0.47	13	1.02	
Scopelopsis multipunctatus	0.47	145	1.02	
Astronesthes sp	0.38	27	0.83	56
Ceratoscopelus warmingii	0.38	92	0.83	
UNIDENTIFIED FISH	0.34	8	0.74	
Unidentified	0.33	4	0.72	
Melamphaes sp.	0.27	27	0.60	
Lampadena chavesi	0.27	40	0.60	
Howella sp.**	0.26	27	0.57	
Periphylla sp	0.26	27	0.57	
Poromitra megalops	0.26	53	0.57	
Diretmus argenteus	0.26	11	0.56	
Lyconus brachycolus	0.20	1	0.43	
Myctophum phengodes	0.13	27	0.28	
Nansenia sp.	0.13	79	0.28	
Atolla sp	0.12	40	0.26	
ONEIRODIDAE	0.07	1	0.15	
Chauliodus sloani**	0.07	3	0.15	
Evermannella balbo	0.07	13	0.14	
Odontostomops normalops	0.06	4	0.13	
Nessorhamphus ingolfianus	0.05	3	0.12	
Diplophos taenia	0.05	5	0.12	
Kali sp.	0.04	1	0.09	
Leptostomias sp.	0.04	1	0.09	
Serrivomer sp.	0.04	4	0.09	0
Holtbyrnia macrops	0.04	1	0.09	
Sternoptyx sp.	0.04	13	0.09	
Photonectes sp.	0.04	1	0.08	
Derichthys serpentinus	0.04	1	0.08	
Astronesthes sp.	0.04	3	0.08	
Nealotus tripes	0.03	1	0.07	
Sergestes sp.	0.03	105	0.07	
Oplophorus	0.03	210	0.07	
Sigmops elongatus	0.02	1	0.05	
Idiacanthus atlanticus**	0.02	1	0.05	
Lestidiops sp.	0.02	1	0.04	
Acanthephyra sp.	0.02	13	0.04	
Melanocetus johnsonii	0.02	1	0.04	
Sergia sp.	0.02	132	0.04	
Falgellostomias bourei	0.02	1	0.03	
Diaphus ostenfeldi	0.01	13	0.03	
Serrivomer sp.	0.01	13	0.03	
Diplophos sp.	0.01	13	0.03	
Scopelosaurus meadi	0.01	27	0.03	
Luciosudis normani	0.01	3	0.03	
Scopelosaurus meadi	0.00	3	0.01	0
Total	45.96		100.01	

ANNEX V Marine mammals observation logs

Transect 1 (one hour)

Date:	30.apr.19	
Start time:	18:02	
End time:	18:55	
Start Position:	23 00.270	14 22.249
End Possitions		

Species		**Time**	**Position**	
			Latitude	**Longitude**
Cape Fur seal		8h54	23 0.1606	14 12.627

Transect 1

Date:	01.mai.19	
Start time:	7h58	
End time:	8h40	
Start Position:	22 56.03	13 22.525
End Possitions	22 57.545	13 20.75

Species		**Time**	**Position**	
			Latitude	**Longitude**
Cape Fur Seal		8h15		

Transect 2

Date:	01.mai.19	
Start time:	10h50	
End time:	12h05	
Start Position:	21 59.157	13 21.837
End Possitions	23 0.011	1320.345

Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

Transect 3

Date:	01.mai.19	
Start time:	12h20	
End time:	13h20	
Start Position:	23 0.0	13 0.283
End Possitions	23 7.257	12 55.354

Species		**Time**	**Position**	
			Latitude	**Longitude**
Cape Fur Seal		13h10		

Transect 4

Date:	01.mai.19				
Start time:	13h20				
End time:	14h02				
Start Position:	23 7.257	12 55.354			
End Possitions	23 0.012	13 0.0208			
Species		**Time**	**Position**		
			Latitude	**Longitude**	
Cape Fur Seal	x1	13h24			killed something
Cape Fur Seal	x3	13h35			sleeping on water
Cape Fur Seal	x2	14h00			swimming

Transect 5

Date:	01.mai.19			
Start time:	15h11			
End time:				
Start Position:	23 1.057	13 0.967		
End Possitions	23 3.0025	13 2.544		
Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

Transect 6

Date:	01.mai.19			
Start time:	14h42			
End time:				
Start Position:	23 1.695	13 2.33		
End Possitions	22 59.48	13 0.21		
Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

Transect 7

Date:	01.mai.19			
Start time:	17h12			
End time:	18h25			
Start Position:	22 59.47	13 0.155		
End Possitions	23 2.129	13 1.63		
Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

02.mai

Transect 8

Date:	02.mai.19			
Start time:	8h00			
End time:	9h05			
Start Position:	22 59.766	12 32.848		
End Possitions	22 59.991	12 21.309		
Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

Transect 9

Date:	02.mai.19			
Start time:	10h07			
End time:	11h45			
Start Position:	23 0.181	12 21.333		
End Possitions	23 4.237	12 21.80		
Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

Transect 10

Date:	02.mai.19			
Start time:	11h55			
End time:	12h19			
Start Position:	23 3.93	12 21.86		
End Possitions	23 0.08	12 21.18		
Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

Transect 11

Date:	02.mai.19			
Start time:	12h30			
End time:	13h28			
Start Position:	23 0.08	12 21.18		
End Possitions	23 2.69	12 21.15		
Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

Transect 12

Date:	02.mai.19			
Start time:	13h46			
End time:	14h50			
Start Position:	23 0.04	12 20.50		
End Possitions	23 0.04	12 8.44		
Species		**Time**	**Position**	
			Latitude	**Longitude**

Cape Fur Seal carcass		14h04		

Transect 13

Date:	02.mai.19			
Start time:	16h00			
End time:	17h30			
Start Position:	23 0.23	12 8.44		
End Possitions	23 3.79	12 9.523		
Species		**Time**	**Position**	
			Latitude	**Longitude**
Long-finned Pilot Whales	approx 15	16h37		

Depth: 2 482 m

Transect 14

Date:	02.mai.19			
Start time:	17h55			
End time:	18h20			
Start Position:	23 4.00	12 9.95		
End Possitions	23 0.04	12 8.38		
Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

03.mai

Transect 15

Date:	03.mai.19			
Start time:	07h35			
End time:	09h55			
Start Position:	22 59.97	11 34.51		
End Possitions	23 0.022	12 8.441		
Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

Transect 16

Date:	03.mai.19			
Start time:	13h35			
End time:	15h10			
Start Position:	22 59.73	11 9.127		
End Possitions	23 3.159	11 10.218		
Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

Transect 17

Date:	03.mai.19
Start time:	15h30

End time:	15h50	
Start Position:	23 3.02	11 9.07
End Possitions	23 0.011	11 8.28

Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

Transect 18

Date:	03.mai.19	
Start time:	18h00	
End time:	18h41	
Start Position:	23 0.437	11 8.100
End Possitions	22 59.846	07.620

Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

04.mai.19

Transect 19

Date:	04.mai.19	
Start time:	8h25	
End time:	8h44	
Start Position:	23 2.415	10 19.341
End Possitions	22 59.725	10 17.000

Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

Transect 19

Date:	04.mai.19	
Start time:	8h44	
End time:	12h05	
Start Position:	22 59.725	10 17.000
End Possitions	23 0.019	9 39.42

Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

Transect 20

Date:	04.mai.19	
Start time:	12h22	
End time:	13h42	
Start Position:	23 0.500	9 39.856
End Possitions	23 2.831	9 42.542

Species		**Time**	**Position**	
			Latitude	**Longitude**

None				

Transect 21

Date:	04.mai.19			
Start time:	12h24			
End time:	18h00			
Start Position:	23 0.046	9 39.104		
End Possitions	22 59.952	9 1.541		
Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

05.mai.19

Transect 22

Date:	05.mai.19			
Start time:	7h45			
End time:	9h40			
Start Position:	22 59.646	9 51.50		
End Possitions	22 59.723	10 12.641		
Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

Transect 23

Date:	05.mai.19			
Start time:	11h40			
End time:	13h50			
Start Position:	22 59.747	10 19.41		
End Possitions	22 59.98	10 43.29		
Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

Transect 24

Date:	05.mai.19				
Start time:	15h24				
End time:	17h37				
Start Position:	22 59.93	10 43.71			
End Possitions	22 59.97	11 08.31			
Species		**Time**	**Position**		
			Latitude	**Longitude**	
unidentified blackfish	17h30				50 m from ship on port

06.mai.19

Transect 25

Date:	06.mai.19			
Start time:	07h30			
End time:	07h58			
Start Position:	22 59.87	12 29.24		
End Possitions	23 0.038	12 33.193		
Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

Transect 26

Date:	06.mai.19			
Start time:	08h50			
End time:	10h00			
Start Position:	23 0.04	12 33.302		
End Possitions	23 0.002	12 45.63		
Species		**Time**	**Position**	
			Latitude	**Longitude**
Blue Whale		09h40		

Transect 27

Date:	06.mai.19			
Start time:	10:50			
End time:	12:17			
Start Position:	23 0.01	12 45.73		
End Possitions	23 0.012	13 0.29		
Species		**Time**	**Position**	
			Latitude	**Longitude**
None				

Transect 28

Date:	06.mai.19			
Start time:	12h58			
End time:	14h47			
Start Position:	23 0.040	13 0.565		
End Possitions	23 0.01	13 20.24		
Species		**Time**	**Position**	
			Latitude	**Longitude**
Cape Fur Seal		14h27		

ANNEX VI Marine litter and kelp observation logs

Effort:

Total distance		
Total time	15:09	

Transect 1 (30 April)

Date:	30.apr.19				
Start time:	18:02				
End time:	18:55	00:53			
Start Position:	23 00.270	14 22.249			
End Possitions					
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
None					

Transect 1

Date:	01.mai.19				
Start time:	07:58:00				
End time:	08:40:00	00:42			
Start Position:	22 56.03	13 22.525			
End Possitions	22 57.545	13 20.75			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
None					

Transect 2

Date:	01.mai.19				
Start time:	10:50				
End time:	12:05	01:15			
Start Position:	21 59.157	13 21.837			
End Possitions	23 0.011	1320.345			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
None					

Transect 3

Date:	01.mai.19				
Start time:	12:20				
End time:	13:20	01:00			
Start Position:	23 0.0	13 0.283			
End Possitions	23 7.257	12 55.354			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
None					

Transect 4

Date:	01.mai.19
Start time:	13:20

End time:	14:02	00:42			
Start Position:	23 7.257	12 55.354			
End Possitions	23 0.012	13 0.0208			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
None					

Transect 5

Date:	01.mai.19				
Start time:	15:11				
End time:					
Start Position:	23 1.057	13 0.967			
End Possitions	23 3.0025	13 2.544			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
None					

Transect 6

Date:	01.mai.19				
Start time:	14:42				
End time:					
Start Position:	23 1.695	13 2.33			
End Possitions	22 59.48	13 0.21			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
None					

Transect 7

Date:	01.mai.19				
Start time:	17:12				
End time:	18:25	01:13			
Start Position:	22 59.47	13 0.155			
End Possitions	23 2.129	13 1.63			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
17h25	Kelp 2m long	e	25m	1	Old and degraded

02.mai

Transect 8

Date:	02.mai.19				
Start time:	08:00				
End time:	09:05	01:05			
Start Position:	22 59.766	12 32.848			
End Possitions	22 59.991	12 21.309			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
None					

None					

Transect 14

Date:	02.mai.19				
Start time:	17:55				
End time:	18:20	00:25			
Start Position:	23 4.00	12 9.95			
End Possitions	23 0.04	12 8.38			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
None					

03.mai

Transect 15

Date:	03.mai.19				
Start time:	07:35				
End time:	09:55	02:20			
Start Position:	22 59.97	11 34.51			
End Possitions	23 0.022	12 8.441			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
None					

Transect 16

Date:	03.mai.19				
Start time:	13:35				
End time:	15:10	01:35			
Start Position:	22 59.73	11 9.127			
End Possitions	23 3.159	11 10.218			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
14h20	Kelp	e	0	0	None visible

Transect 17

Date:	03.mai.19				
Start time:	15:30				
End time:	15:50	00:20			
Start Position:	23 3.02	11 9.07			
End Possitions	23 0.011	11 8.28			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
None					

Transect 18

Date:	03.mai.19

Start time:	18:00				
End time:	18:41	00:41			
Start Position:	23 0.437	11 8.100			
End Possitions	22 59.846	07.620			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
None					

04.mai.19

Transect 19

Date:	04.mai.19				
Start time:	08:25				
End time:	08:44	00:19			
Start Position:	23 2.415	10 19.341			
End Possitions	22 59.725	10 17.000			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
None					

Transect 19

Date:	04.mai.19				
Start time:	08:44				
End time:	12:05	03:21			
Start Position:	22 59.725	10 17.000			
End Possitions	23 0.019	9 39.42			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
09h24	Kelp	e	0	1	none visible
10h09	Kelp	e	5	1	none visible
12h00	kelp	e	5	1	none visible

Transect 20

Date:	04.mai.19				
Start time:	12:22				
End time:	13:42	01:20			
Start Position:	23 0.500	9 39.856			
End Possitions	23 2.831	9 42.542			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
None					

Transect 21

Date:	04.mai.19	
Start time:	12:24	
End time:	18:00	05:36
Start Position:	23 0.046	9 39.104
End Possitions	22 59.952	9 1.541

Time:	Item:	Size:	Distance:	Bouancy:	Notes: Biofowling:
14h49	Kelp	e	5	1	none visible
15h25	Fishing Bouy	c	4	1	none visible
16h30	kelp	e	1	1	none visible
17h13	Kelp	e	3	1	none visible

05.mai.19

Transect 22

Date:	05.mai.19	
Start time:	07:45	
End time:	09:40	01:55
Start Position:	22 59.646	9 51.50
End Possitions	22 59.723	10 12.641

Time:	Item:	Size:	Distance:	Bouancy:	Notes: Biofowling:
None					

Transect 23

Date:	05.mai.19	
Start time:	11:40	
End time:	13:50	02:10
Start Position:	22 59.747	10 19.41
End Possitions	22 59.98	10 43.29

Time:	Item:	Size:	Distance:	Bouancy:	Notes: Biofowling:
13h16	Kelp	e	4	1	none visible

Transect 24

Date:	05.mai.19	
Start time:	15:24	
End time:	17:37	02:13
Start Position:	22 59.93	10 43.71
End Possitions	22 59.97	11 08.31

Time:	Item:	Size:	Distance:	Bouancy:	Notes: Biofowling:
14h30	Kelp 1.5 m	e	2	0	none visible
14h30	Kelp 1.5 m	e	1	0	none visible
16h34	Kelp 2 x2 m	e	5	0	none visible
16h50	Kelp 2 x 1m	e	4	0	none visible
16h54	Kelp 2.5 m	e	2	0	none visible
17h02	Kelp 2m	e	1	0	none visible
17h35	Polystyrene	c	45	0	none visible

06.mai.19

Transect 25

Date:	06.mai.19

Start time:	07:30				
End time:	07:58	00:28			
Start Position:	22 59.87	12 29.24			
End Possitions	23 0.038	12 33.193			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
None					

Transect 26

Date:	06.mai.19				
Start time:	08:50				
End time:	10:00	01:10			
Start Position:	23 0.04	12 33.302			
End Possitions	23 0.002	12 45.63			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
09h37	Kelp	e	5	1	none visible

Transect 27

Date:	06.mai.19				
Start time:	10:50				
End time:	12:17	01:27			
Start Position:	23 0.01	12 45.73			
End Possitions	23 0.012	13 0.29			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
12h10	Kelp 1m	e	4	1	none visible
12h15	Kelp 2m	e	0	1	none visible

Transect 28

Date:	06.mai.19				
Start time:	12:58				
End time:	14:47	01:49			
Start Position:	23 0.040	13 0.565			
End Possitions	23 0.01	13 20.24			
Time:	**Item:**	**Size:**	**Distance:**	**Bouancy:**	**Notes: Biofowling:**
13h14	Kelp 1.3m	e	2	0	none visible
13h32	Kelp 1m	e	2	1	none visible