NORAD-FAO PROGRAMME
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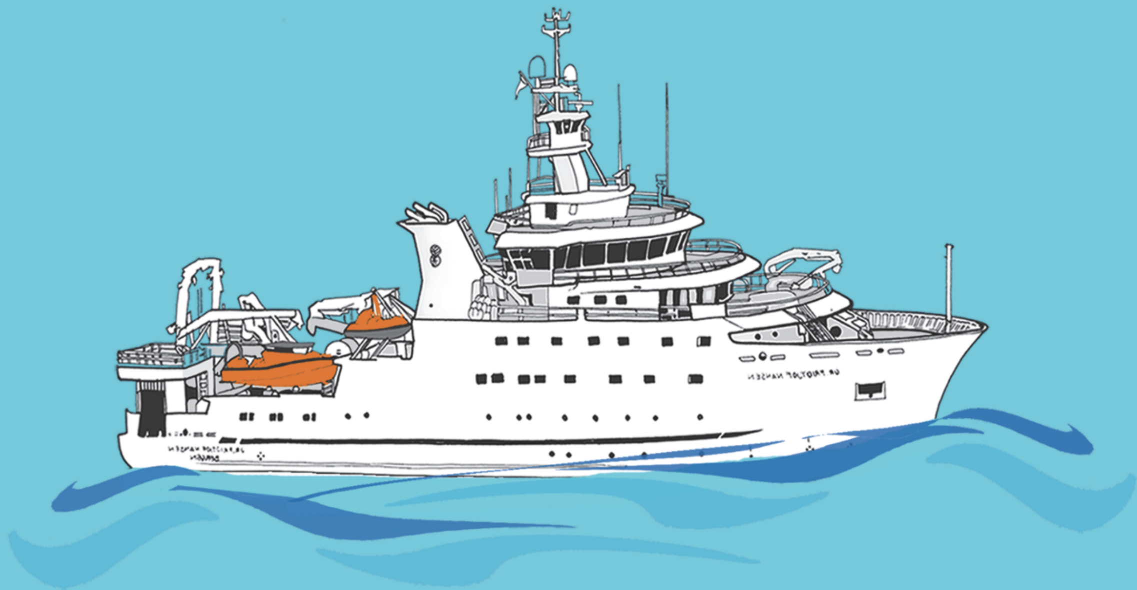
CRUISE REPORTS *DR FRIDTJOF NANSEN*
EAF-Nansen/CR/2019/13-14



SURVEY OF THE PELAGIC FISH STOCKS AND ECOSYSTEM OFF NORTHWEST AFRICA

Cap Blanc–Tanger

30 October–1 December 2019

Institut Mauritanien de Recherches Océanographiques et des Pêches, Mauritania
Institut National de Recherche Halieutique, Casablanca, Morocco
Centre de Recherches Océanographiques de Dakar-Thiaroye, Dakar, Senegal

Institute of Marine Research
Bergen, Norway

THE EAF-NANSEN PROGRAMME (2017–2021)

The EAF-Nansen Programme "Supporting the Application of the Ecosystem Approach to Fisheries Management considering Climate and Pollution Impacts" supports partner countries and regional organizations in Africa and the Bay of Bengal improving their capacity for the sustainable management of their fisheries and other uses of marine and coastal resources through the implementation of the Ecosystem Approach to Fisheries (EAF), taking into consideration the impacts of the climate and pollution.

The Programme is executed by the Food and Agriculture Organization of the United Nations (FAO) in close collaboration with the Institute of Marine Research (IMR) of Bergen, Norway, and funded by the Norwegian Agency for Development Cooperation (Norad). This Programme is the current phase (2017–2021) of the Nansen Programme which started in 1975.

The aim of the Programme is that sustainable fisheries improve food and nutrition security for people in partner countries. It builds on three pillars, Science, Fisheries Management, and Capacity Development, and supports partner countries to produce relevant and timely evidence-based advice for management, to manage fisheries according to the EAF principles and to further develop their human and organizational capacity to manage fisheries sustainably. In line with the EAF principles, the Programme adopts a broad scope, taking into consideration a wide range of impacts of human activities and natural processes on marine resources and ecosystems including fisheries, pollution, climate variability and change.

A new state of the art research vessel, the *Dr Fridtjof Nansen*, is an integral part of the Programme. A comprehensive science plan, covering a broad selection of research areas, and directed at producing knowledge for informing policy and management decisions, guides the Programme's scientific work.

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

LE PROGRAMME EAF-NANSEN (2017-2021)

Le programme EAF-Nansen « Soutenir l'application de l'approche écosystémique pour la gestion des pêches compte tenu des impacts du climat et de la pollution » appui les pays partenaires et les organisations régionales en Afrique et dans le golfe du Bengale pour améliorer leur capacité de gestion durable de leurs pêcheries et d'autres usages de la mer ainsi que les ressources côtières, grâce à la mise en œuvre de l'Approche écosystémique des pêches (AEP), en tenant compte des impacts du climat et de la pollution.

Le programme est exécuté par l'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO) en étroite collaboration avec l'Institut de recherche marine (IMR) de Bergen, en Norvège, et financé par l'Agence norvégienne de coopération au développement (Norad). Ce programme est la phase actuelle (2017-2021) du programme Nansen qui a débuté en 1975.

L'objectif du programme est que la pêche durable améliore la sécurité alimentaire et nutritionnelle des populations des pays partenaires. Il s'appuie sur trois piliers, la science, la gestion des pêches et le développement des capacités, et aide les pays partenaires à produire des avis pertinents et opportuns fondés sur des données factuelles pour la gestion, à gérer les pêcheries conformément aux principes de l'AEP et à développer davantage leur capacité humaine et organisationnelle à gérer durablement les pêches. Conformément aux principes de l'AEP, le programme adopte une large vision, prenant en considération un large éventail d'impacts des activités humaines et des processus naturels sur les ressources et les écosystèmes marins, y compris la pêche, la pollution, la variabilité et le changement climatique.

Un nouveau navire de recherche de pointe, le *Dr Fridtjof Nansen*, fait partie intégrante du programme. Un plan scientifique complet, couvrant un large éventail de domaines de recherche et visant à produire des connaissances pour éclairer les décisions de politique et de gestion, guide les travaux scientifiques du programme.

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

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CRUISE REPORTS *DR FRIDTJOF NANSEN*

SURVEY OF THE PELAGIC FISH STOCKS AND ECOSYSTEM OFF NORTHWEST AFRICA

Cap Blanc–Tanger

30 October–1 December 2019

by

Reidar Toresen, Diana Zaera, Tor Magne Ensrud, Marek Ostrowski, Jan Frode Wilhelmsen, Hege Rognaldsen, Erling Kåre Stenevik, Magne Olsen, Margot Nyeggen, Sarah Ann Bruck, David Cervantes, Lucilla Giulietti, Hector Pena, Olaf Johan Sørås, Geir Landa[1]

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Institute of Marine Research
Bergen, 2021

CONTENTS

ABBREVIATIONS

AGC	Automatic gain control
BT	Bottom trawl
CTD	Conductivity, temperature and depth
FAO	Food and Agriculture Organization of the United Nations
IMR	Institure of Marine Research (Havforskningsinstituttet), Norway
IWC	International Whaling Commission
LSSS	Large Scale Survey System
L.pel	Large pelagic trawl
MLD	Mixed layer depth
NIFES	Nasjonalt institutt for ernærings- og sjømatforskning (now part of IMR)
NORAD	Nowegian Agency for Development Cooperation
RCG	Reverberation controlled gain
R/V	Research vessel
s_A	Acoustic backscattering area
SD	Standard deviation
S.pel	Small pelagic trawl
sV	Acoustic backscattering volume
TS	Target strength
VMADCP	Vertical mounted acoustic Doppler current profiler

EXECUTIVE SUMMARY

This survey is part of a synoptic coverage of the pelagic resources and ecosystem off West Africa, from South Africa to Morocco, undertaken by R/V *Dr Fridtjof Nansen* in 2019. These surveys, covering the continental shelf and upper slope from approximatively 20 m to 500 m depth, had multiple objectives and were hence multidisciplinary. The physical and chemical oceanography were intensively sampled both underway and with a series of fixed stations along transects perpendicular to the coast. Plankton and chemical samples were taken along a series of transects perpendicular to the coast, along with samples of microplastics. Simultaneously, the pelagic stocks were assessed using acoustics complimented by trawling. All surveys used standardised methods to ensure comparability.

This report presents the results from Leg 4.3 and Leg 4.4, i.e. off the coast between Cap Blanc and Tanger from 30 October 2019 to 1 December 2019.

An east-west acoustic sampling grid, with a transect spacing of 10–15 NM, covered the shelf from 20 m and slope to the 500 m bottom depth contour. Biological sampling of the fish was carried out using pelagic and bottom trawls. Standard hydrographic sections were sampled along the acoustic transects. Phytoplankton, zooplankton, ichthyoplankton and micro-plastics were also sampled.

With the expanding scope of the research to be carried out in the context of the EAF-Nansen Programme, the survey objectives and related sampling strategy support research on life cycle, stock identity and trophic relationships of pelagic fish. Therefore, special effort was made to sample several biological parameters for post-survey age and growth, stock structure, population biology and trophic interaction studies.

Altogether 69 trawl hauls were carried out to identify acoustic targets during the survey. A total of 82 CTD casts were made to describe the hydrography of the survey area, 48 plankton stations were also sampled.

The information presented below is a summary of the results of the data analysed during the surveys. Some samples and data have been transported to research institutes in the region, and also farther afield (notably IMR in Bergen, Norway). Samples will be analysed in close cooperation with partner institutions and the resulting datasets will support research as part of the EAF-Nansen Science Plan.

Fish abundance and distribution

Pelagic fish were present over large parts of the region, with greater densities towards the north. The main densities of pelagic fish were found inshore of 50 m bottom depth, sometimes extending inshore of the survey area.

The estimated biomasses of the main pelagic species are summarised in the following table (thousand tonnes).

2019	Cap Blanc - Cap Bojador	Cap Bojador – Cap Cantin	Cap Cantin Tanger	Total
S. pilchardus	3 452	567	235	4 254
E.encrasicolus	3	215	5	223
S.colias	512	106	110	728
T.trecae	4			4
T.trachurus	384	210	26	620
	4 355	1 098	376	5 829

The conditions were rough during parts of the survey (south of Cap Cantin), - else favourable during the survey. The different species were not well mixed in most of the area, and the dominating species, *S. pilchardus* occurred inshore in relatively high densities. In the northernmost area, however, the species were distributed in mixed schools, particularly inshore where all four target-species tended to occur together.

RÉSUMÉ

Cette campagne s'inscrit dans le cadre de l'étude synoptique des ressources et de l'écosystème au large de l'Afrique de l'Ouest, de l'Afrique du Sud au Maroc, entreprise par le N/R *Dr Fridtjof Nansen* en 2019. Cette campagne qui a couvert le plateau continental et la partie supérieure du talus d'environ 20 m à 500 m de fond, avait des objectifs multiples et a donc été réalisée dans un cadre multidisciplinaire. L'océanographie physique et chimique a fait l'objet d'un échantillonnage intensif à la fois lors de la navigation et par le biais d'une série de stations fixes le long de transects perpendiculaires à la côte. Des échantillons de plancton et chimiques ont été prélevés le long d'une série de transects perpendiculaires à la côte, ainsi que des échantillons de microplastiques. Les stocks pélagiques ont également été évalués par acoustique et chalutage. Les scientifiques ont utilisé des méthodes standardisées afin d'assurer la comparabilité des résultats obtenus.

Ce rapport présente les résultats des tronçons 4.3 et 4.4 de la campagne réalisée au large de la côte entre Cap Blanc et Tanger du 30 octobre 2019 au 1er décembre 2019.

Une grille d'échantillonnage acoustique est-ouest, avec un espacement des transects de 10 à 15 NM, a couvert le plateau à une profondeur de 20 m et le talus jusqu'à la profondeur de 500 m.

L'échantillonnage biologique des poissons a été réalisé à l'aide de chaluts pélagiques et de fond. Des sections hydrographiques standard ont été échantillonnées le long des transects acoustiques. Des échantillonnages de phytoplancton, zooplancton, ichtyoplancton et micro-plastiques ont également été réalisés.

Avec l'élargissement du champ d'application des recherches à mener dans le cadre du Programme EAF -Nansen, les objectifs de la campagne et la stratégie d'échantillonnage connexe ont permis de recueillir des données sur les cycles biologiques, l'identité des stocks et les relations trophiques des poissons pélagiques. Par conséquent, un effort particulier a été fait pour échantillonner plusieurs paramètres biologiques pour les études qui feront suite à la campagne sur l'âge et la croissance, la structure des stocks, la biologie des populations et les interactions trophiques.

Au total, 69 traits de chalut ont été effectués pour identifier les cibles acoustiques durant la campagne. Un total de 82 profils CTP ont été effectués pour décrire l'hydrographie de la zone d'étude et 48 stations de plancton ont également été échantillonnées.

Les informations présentées ci-dessous synthétisent les résultats des données analysées durant cette campagne. Certains échantillons et données ont été envoyés à des instituts de recherche de la région ou plus lointains (notamment l'IMR à Bergen, Norvège). Les échantillons seront analysés en étroite collaboration avec les institutions partenaires et les séries de données viendront enrichir les recherches entreprises dans le cadre du Plan scientifique EAF-Nansen.

Abondance et répartition des poissons

La présence de poissons pélagiques a été observée dans une grande partie de la région, les densités enregistrées étant plus importantes au nord de la zone étudiée. Les principales densités de poissons pélagiques ont été observées au large à des profondeurs de 50 m, s'étendant parfois au large de la zone d'étude.

Une estimation des biomasses des principales espèces pélagiques est présentée succinctement dans le tableau suivant (en milliers de tonnes):

2019	Cap Blanc-Cap Boujador	Cap Boujador-Cap Cantin	Cap Cantin Tanger	Total
S. pilchardus	3 452	567	235	4 254
E. encrasicolus	3	215	5	223
S. colias	512	106	110	728
T. trecae	4			4
T. trachurus	380	196	26	602
	4 351	1 084	376	5 811

Bien que les conditions aient été favorables à la réalisation de la campagne, certaines recherches (au sud du Cap Cantin) ont été difficiles. Dans la majeure partie de la zone, la répartition des espèces n'était pas évidente. L'espèce dominante, *S. pilchardus*, était présente dans les zones côtières à des densités relativement élevées. Dans la zone la plus septentrionale, cependant, une répartition des espèces en bancs mixtes a pu être observée, en particulier dans la zone côtière où les quatre espèces cibles étaient plutôt regroupées.

CHAPTER 1. INTRODUCTION

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

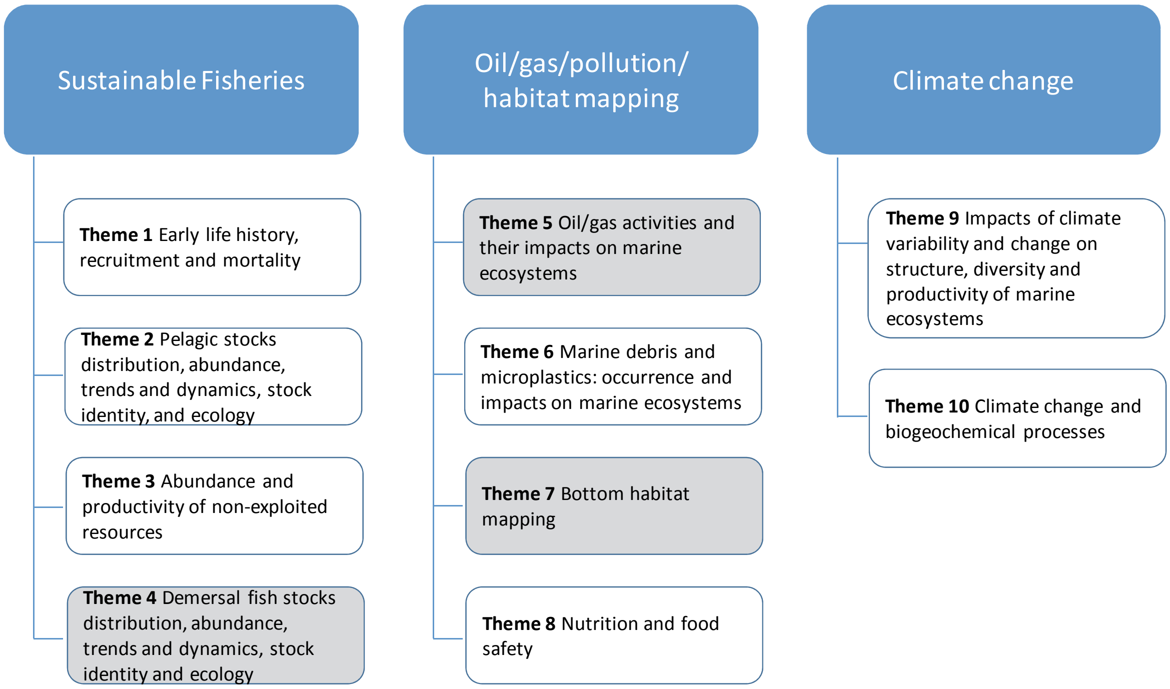


Figure 1. Science themes under the EAF-Nansen Science Plan

This survey has been designed to collect data towards addressing most of the research themes of the science plan (Figure 1, white background).

1.1 Survey objectives

Hydrography:

- To map the hydrographic and environmental conditions in the survey area (temperature, salinity, dissolved oxygen, chlorophyll-a, nutrients, total alkalinity, pH and ocean currents)
- To obtain information on the dissolved oxygen concentrations, ocean acidification state, and calcium carbonate saturation state relevant for calcifying organisms.

Phytoplankton, zooplankton and ichthyoplankton:

- To describe the primary productivity of the region
- To describe the abundance and biomass patterns of meso-zooplankton community, as well as its species composition.

- To provide information on the abundance patterns of ichthyoplankton community (fish eggs and larvae), at the lowest possible taxonomic level.
- To collect samples of jellyfish for a) morphological identification and taxonomic studies, b) genetic studies for the purposes of confirming identity, determining population structure and establishing regional and global connectivity, and c) histological examination of reproductive maturity to determine reproductive synchronicity and semelparity within populations and individuals.

Pelagic stocks:

- To obtain information on abundance, distribution (also by size) of *Sardinella aurita, Sardinella maderensis, Engraulis encrasicolus, Trachurus trecae*, *Trachurus trachurus, Scomber colias* and *Sardina pilchardus* using acoustic methods and a systematic grid survey strategy.
- To collect samples for genetic analysis and for morphometric studies and genetic analysis (for stock identification of *S. aurita* and *S. maderensis).*
- To obtain information on maturity stages, and to collect stomach samples for analysis of contents and otoliths of *S. aurita, S. maderensis, S. pilchardus*, *S. colias* and *E. encrasicolus.*
- To carry out studies on bias in pelagic fish acoustic estimates due to fish behaviour (e.g. vessel avoidance or occurrence in the blind zone) using sonar recordings.

Top predators:

- To record occurrence of top predators.

Marine debris and microplastics:

- To record occurrence of marine debris and sargassum weed (surface).
- To map occurrence of microplastics and describe associated neuston communities.

1.2 The survey area

This survey was part of a regional coverage of the pelagic resources and ecosystems off Northwest Africa, from the southern border of Senegal to Tangier (Morocco). **Errore. L'origine riferimento non è stata trovata.**It covered the region from Cap Blanc (Mauritania) to Tangier (Morocco).

1.3 Participation

Leg 4.3 Cap Blanc to Cap Cantin:

Institute of Marine Research (IMR), Norway

Reidar Toresen, Diana Zaera, Tor Magne Ensrud, Marek Ostrowski, Jan Frode

Wilhelmsen, Hege Rognaldsen

University of Oslo (UiO), Norway
Rita Amundsen

Centre de Recherches Océanographiques de Dakar-Thiaroye (CRODT), Senegal
Oumar Diene

Institut Mauritanien de Recherches Océanographiques et des Pêches (IMROP), Mauritania
Mamadou Lamba Ba, Sidi Mohamed Mohamed Moctar, Beyih Semette, Dede Chemra, Alioun Niang, Mohamed Yahya Ahmed Chaabane, Mohamed Brahim Boubacar M´barek

Institut National de Recherche Halieutique (INRH), Morocco
El Ouehabi Zineb, Amouri Oussama, Hinde Abdelouhab, Yassine Goliat, Mustapha Idrissi, Abdallah Moutiq, Mhamed El Orch, Lahcen Abouabdellah, Mohamed Amezian, Ismail Bessa, Abdelmouhssine Elgarni

Leg 4.4 Cap Cantin to Tanger:

Institute of Marine Research (IMR), Norway
Erling Kåre Stenevik, Magne Olsen, Margot Nyeggen, Sarah Ann Bruck, David Cervantes, Lucilla Giulietti, Hector Pena, Olaf Johan Sørås, Geir Landa

Centre de Recherches Océanographiques de Dakar-Thiaroye (CRODT), Senegal
Ibrahima Camara

Institut Mauritanien de Recherches Océanographiques et des Pêches (IMROP), Mauritania
Alioun Niang, Khalid Limam Malick, Cheikhna Gandega, Dedech Moileck, Yahya Elewa

Institut National de Recherche Halieutique (INRH), Morocco
Karim El Mghouchi, Mohammed Idrissi, Said Charib, Mohamed-Reda Benallal, Said Ait Taleb, Mustapha Yousra, Mohamed Amezian, Abdelaziz Agouzouk, Hassan Oubbamoh, El Kettani Hadili

Department of Environment, Forestry and Fishery (DEAF), South Africa
Fannie Shabangu

1.4 Narrative

The vessel departed from Las Palmas at 18h00 on 30 October 2019 and started the sampling work at Cap Blanc 1 November 2019 at 17h00.

The sampling continued northwards along parallel transects perpendicular to the coast. Figure 2 to Figure 4 show the cruise track and the stations worked during the survey.

The surveyed area was divided in three main parts; Cap Blanc to Cap Bojador, Cap Bojador to Cap Cantin and Cap Cantin to Tangier.

Cap Bojador was reached on 8 November 2019 and Cap Cantin on 17 November 2019. Thereafter the vessel sailed to Casablanca for a change of staff, arriving at 08h00 on 19 November 2019.

The weather was mostly favourable during the early part of the survey, ranging from calm wind to short periods of about 20 m/s. North of Cap Juby the seas became rough and affected the survey for four days.

The vessel made a call in Casablanca for a change of crew and scientific staff on 19 November 2019.

The vessel departed from Casablanca at 12h00 on 21 November 2019 and started the sampling work at Cap Cantin 21 November 2019 at 23h30.

The last transect south of Tanger was reached on 29 November 2019. Thereafter the vessel sailed to Casablanca for a change of scientific team, arriving at 10h00 on 1 December 2019. On the way south to Casablanca a mini survey was conducted with zig-zag transects covering an area where high concentrations of fish had been observed on the way north, to investigate difference in acoustic registrations of pelagic fish between the echo sounder, the SU90 sonar and the MS70 sonar. No trawling was conducted during the mini survey.

The weather was favourable during the coverage north of Cap Cantin.

1.5 Survey effort

Altogether 69 trawl hauls were carried out to identify acoustic targets during the survey. 82 CTD casts were made to describe the water properties in the survey area. 48 plankton stations were also sampled. Table 1 and Table 2 show the survey effort during the survey, in terms of transects and samples, respectively. Figure 2 to Figure 4 show the specific course tracks with sampling stations for hydrography, plankton and fish, respectively. Annex III gives the full record of the trawl stations.

Table 1. Survey sampling effort during the survey. Number of transects

	Acoustic	**Plankton & hydrographic**
Total	87	17

Table 2. Survey sampling effort during the survey. Number of samples. Phyto for phytoplankton net, WP-2 – zooplankton net, Bongo for eggs and larvae, Manta trawl net for plastic particles in the surface, BT - bottom trawl, PT- Pelagic trawl

CTD	**WP2**	**Bongo**	**Manta**	**BT**	**PT**
82	48	43	34	14	55

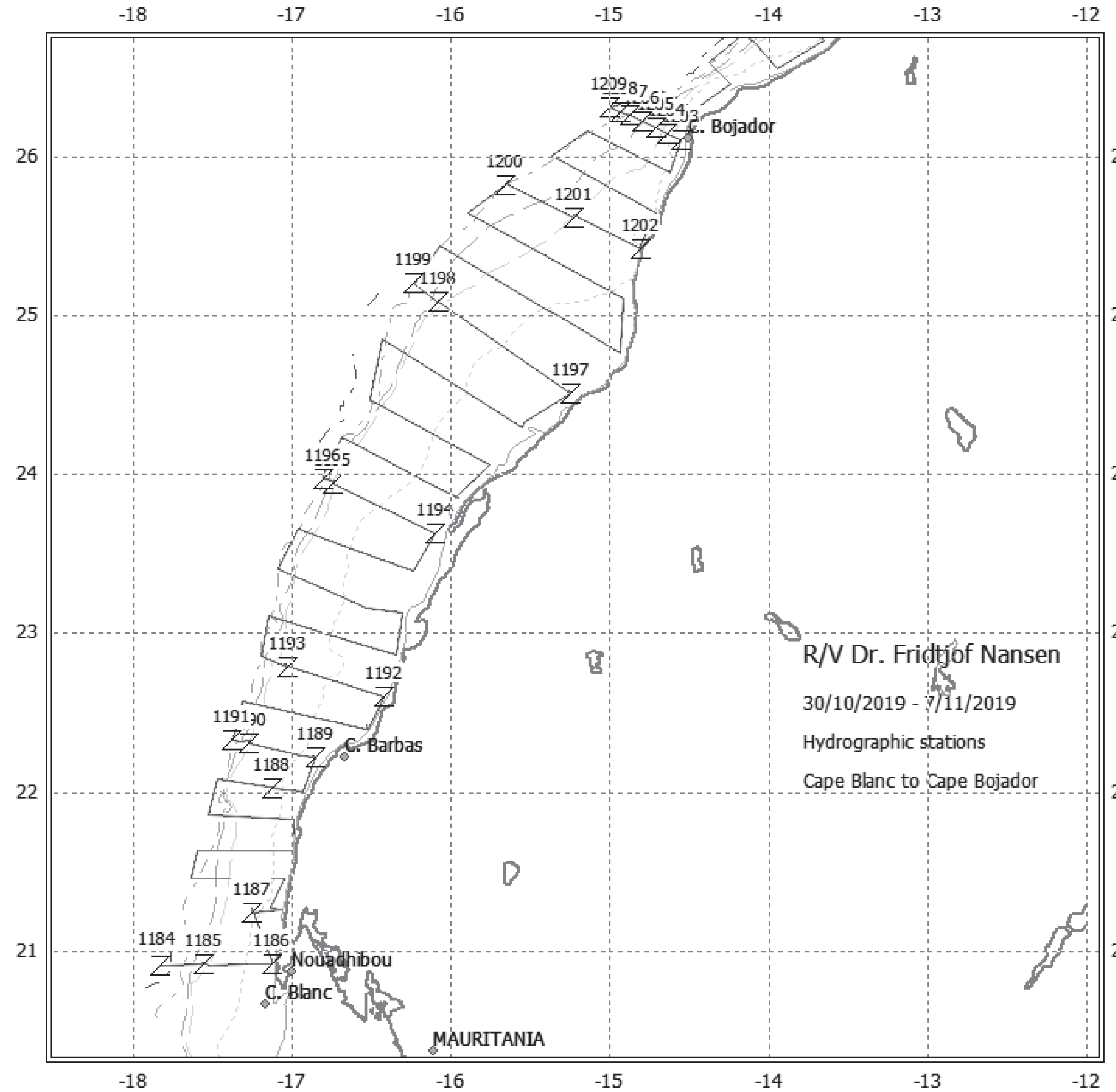


Figure 2A. Course track with hydrographic stations. Cap Blanc to Cap Bojador. Depth contours at 20 m, 100 m, 200 m and 500 m

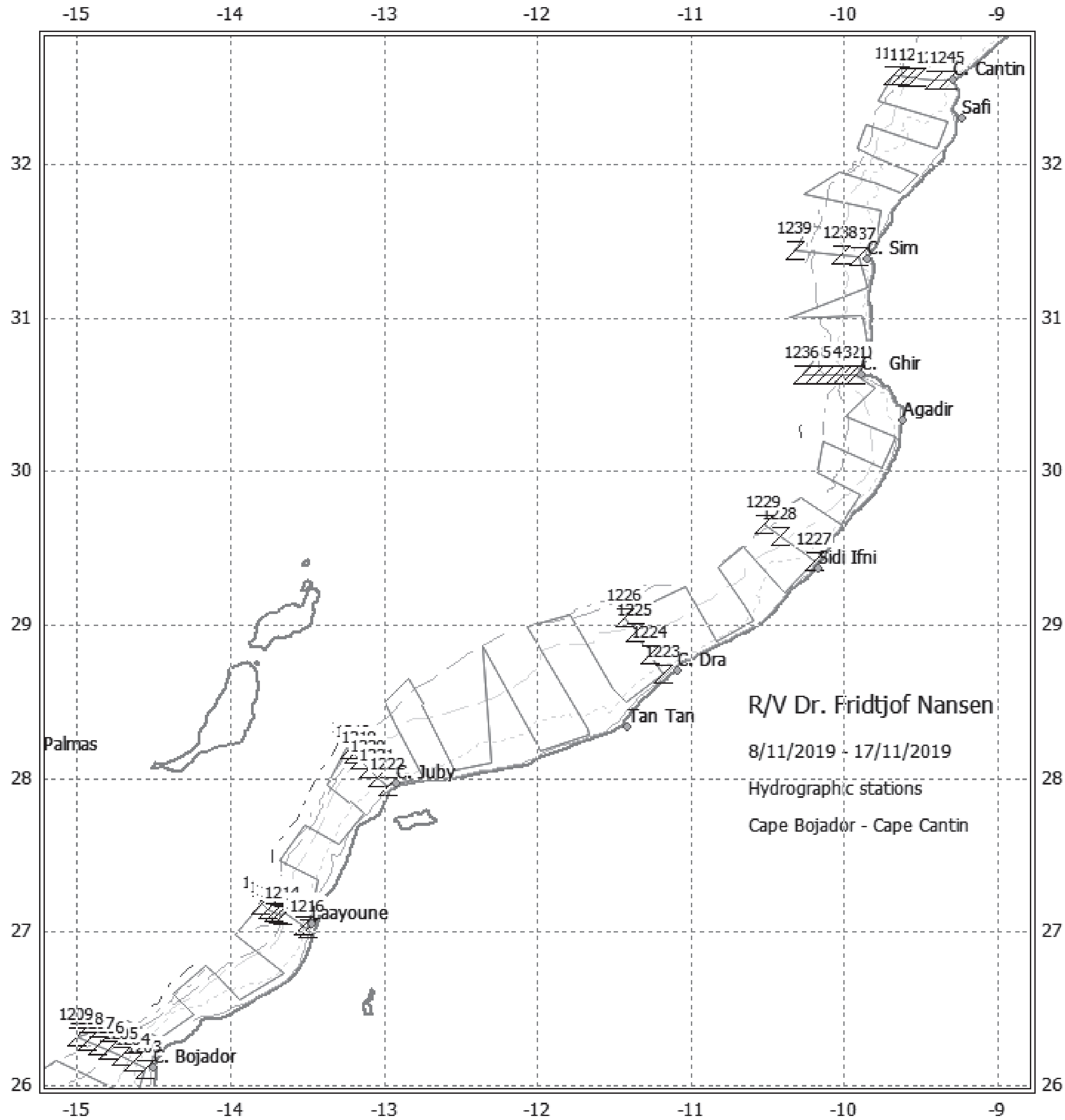


Figure 2B. Course track with hydrographic stations. Cap Bojador to Cap Cantin. Depth contours at 20 m, 100 m, 200 m and 500 m

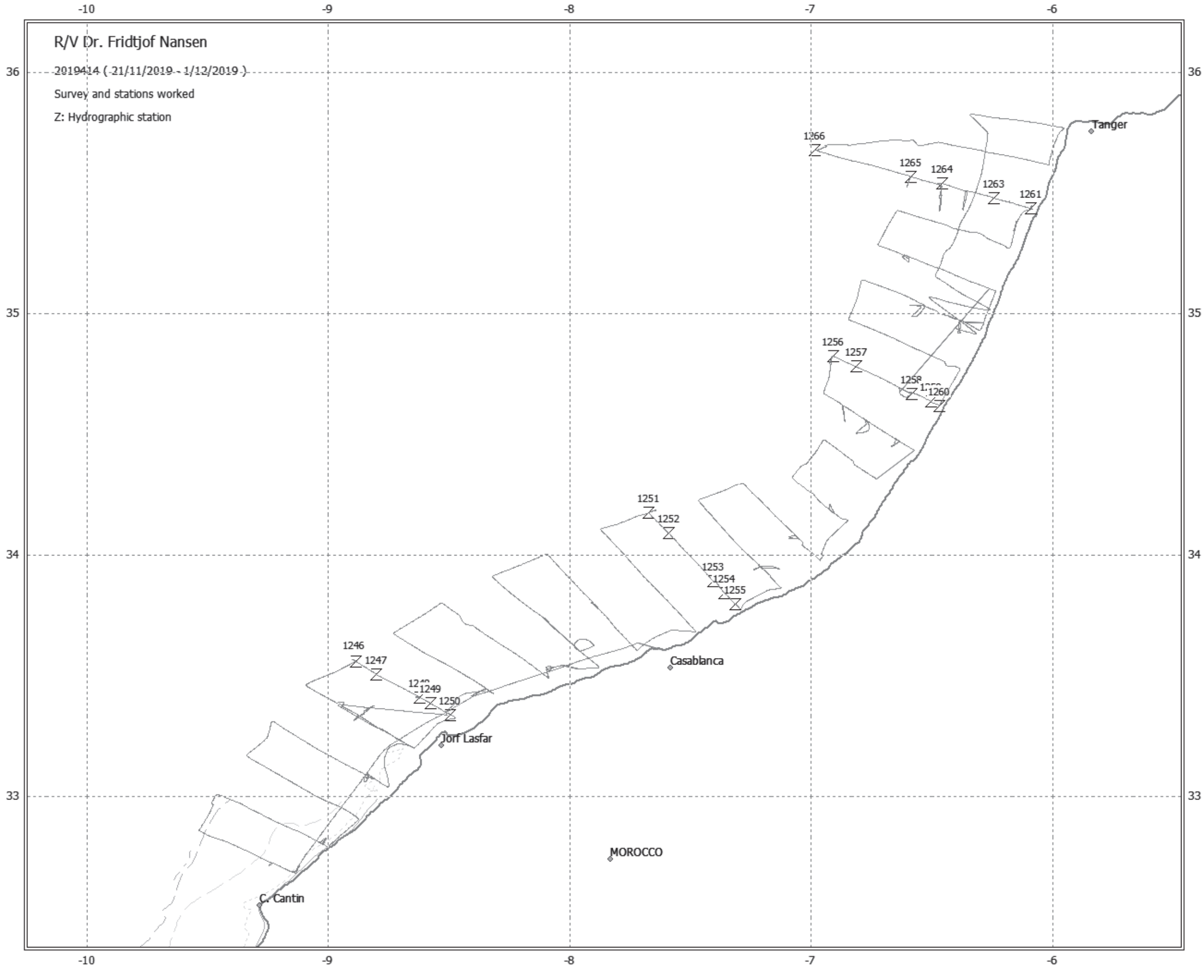


Figure 2C. Course track with hydrographic stations. Cap Cantin to Tanger

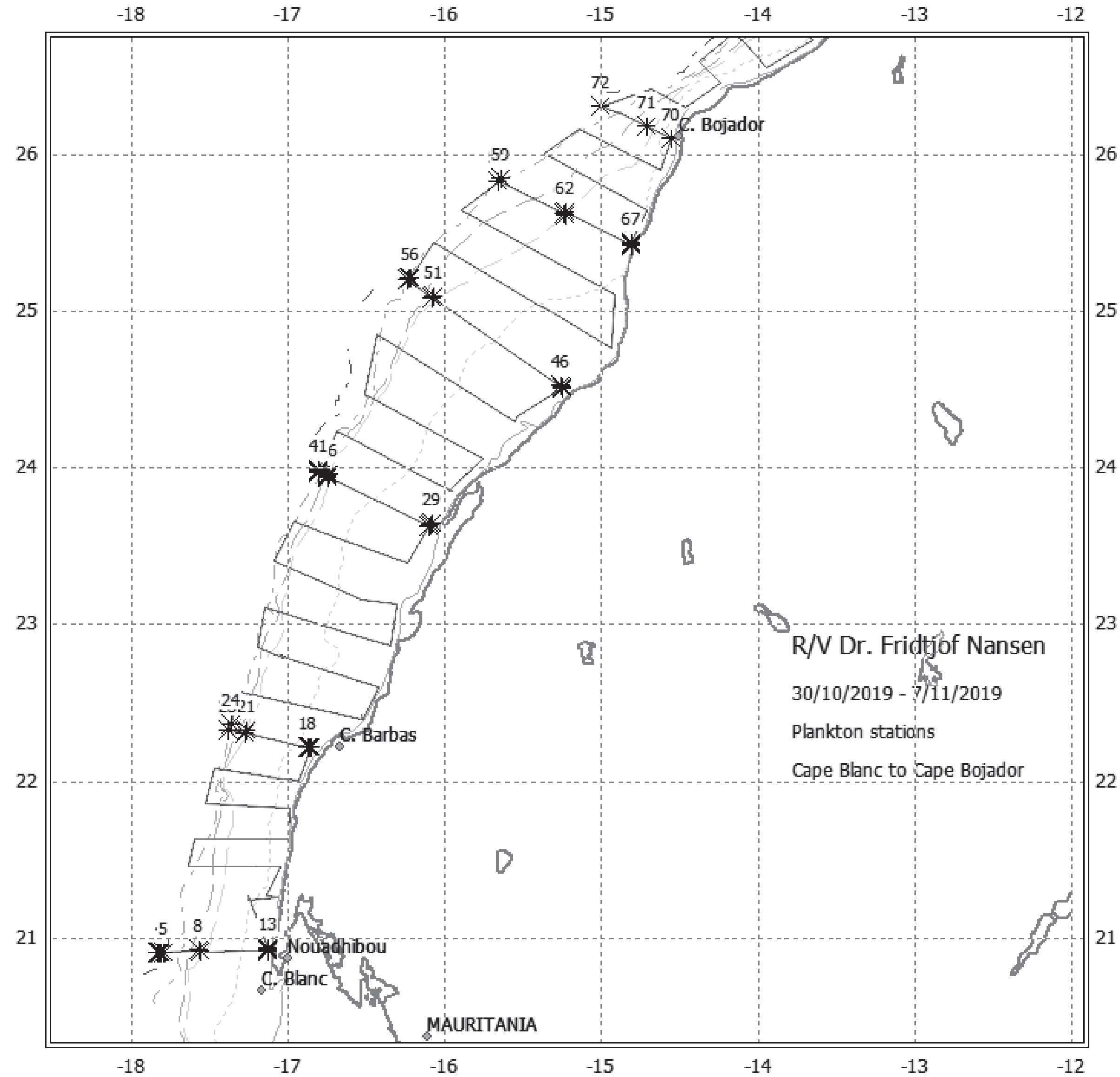


Figure 3A. Course track with plankton stations. Cap Blanc to Cap Bojador. Depth contours at 20 m, 100 m, 200 m and 500 m

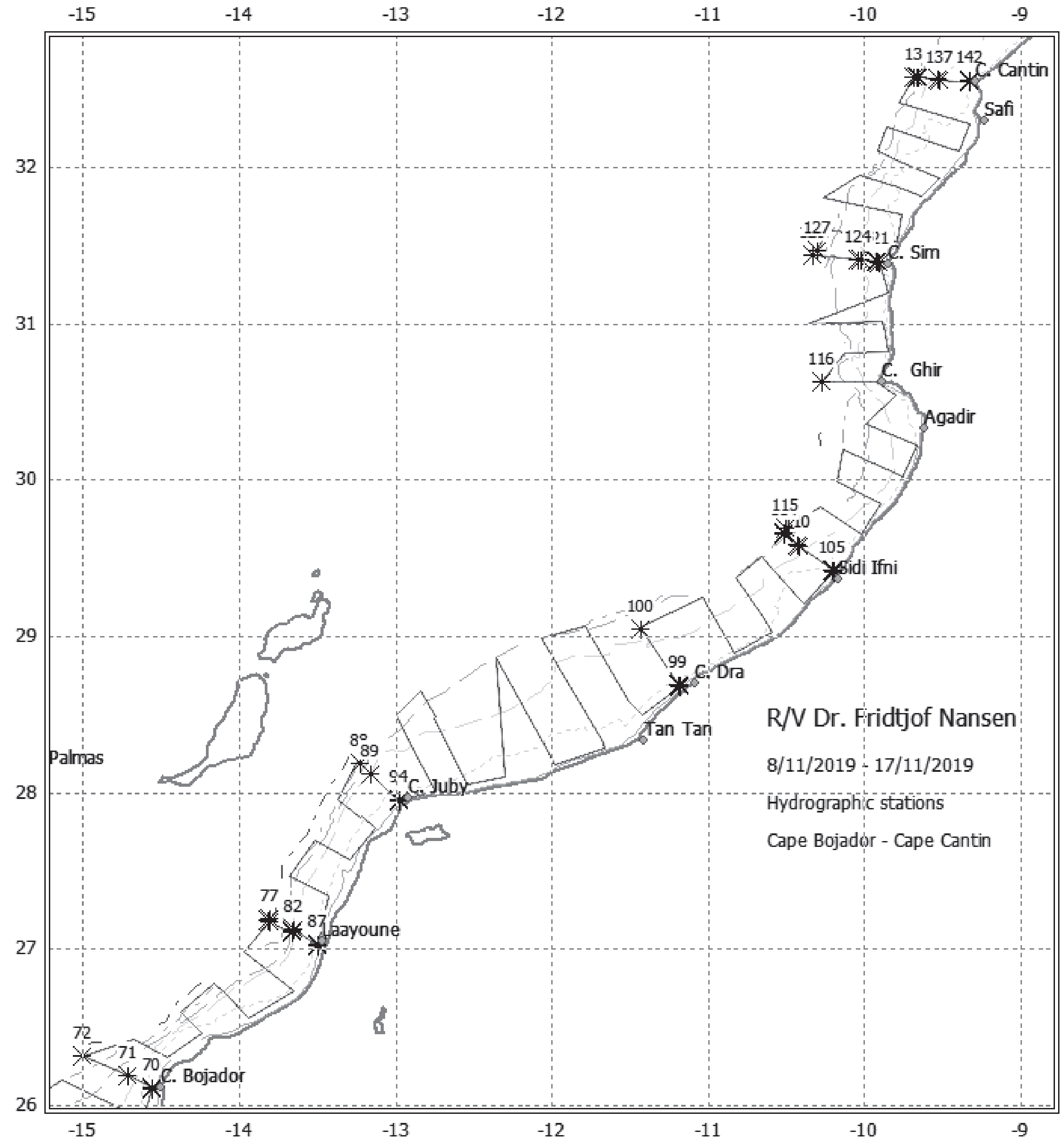


Figure 3B. Course track with plankton stations. Cap Bojador to Cap Cantin. Depth contours at 20 m, 100 m, 200 m and 500 m

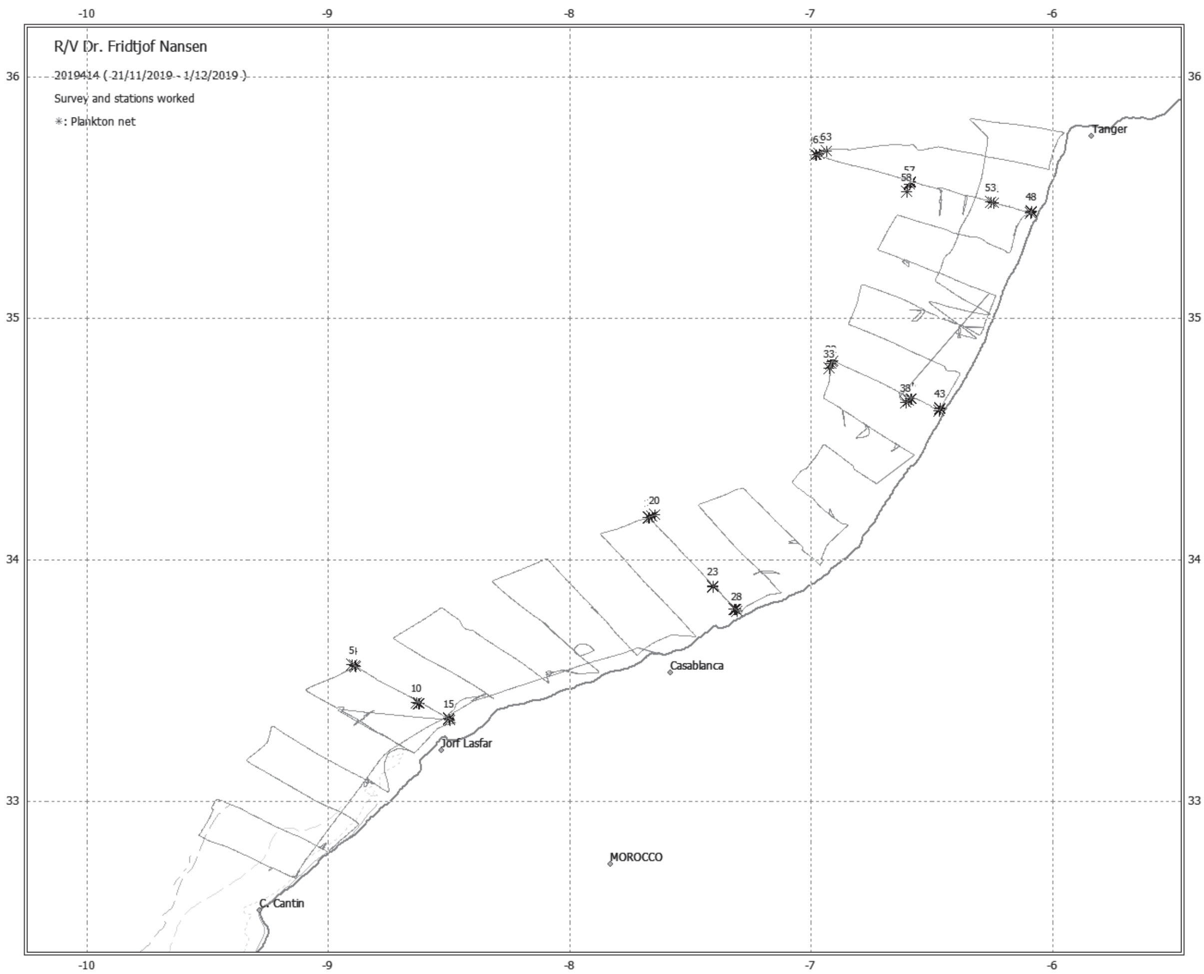


Figure 3C. Course track with plankton stations. Cap Cantin to Tanger

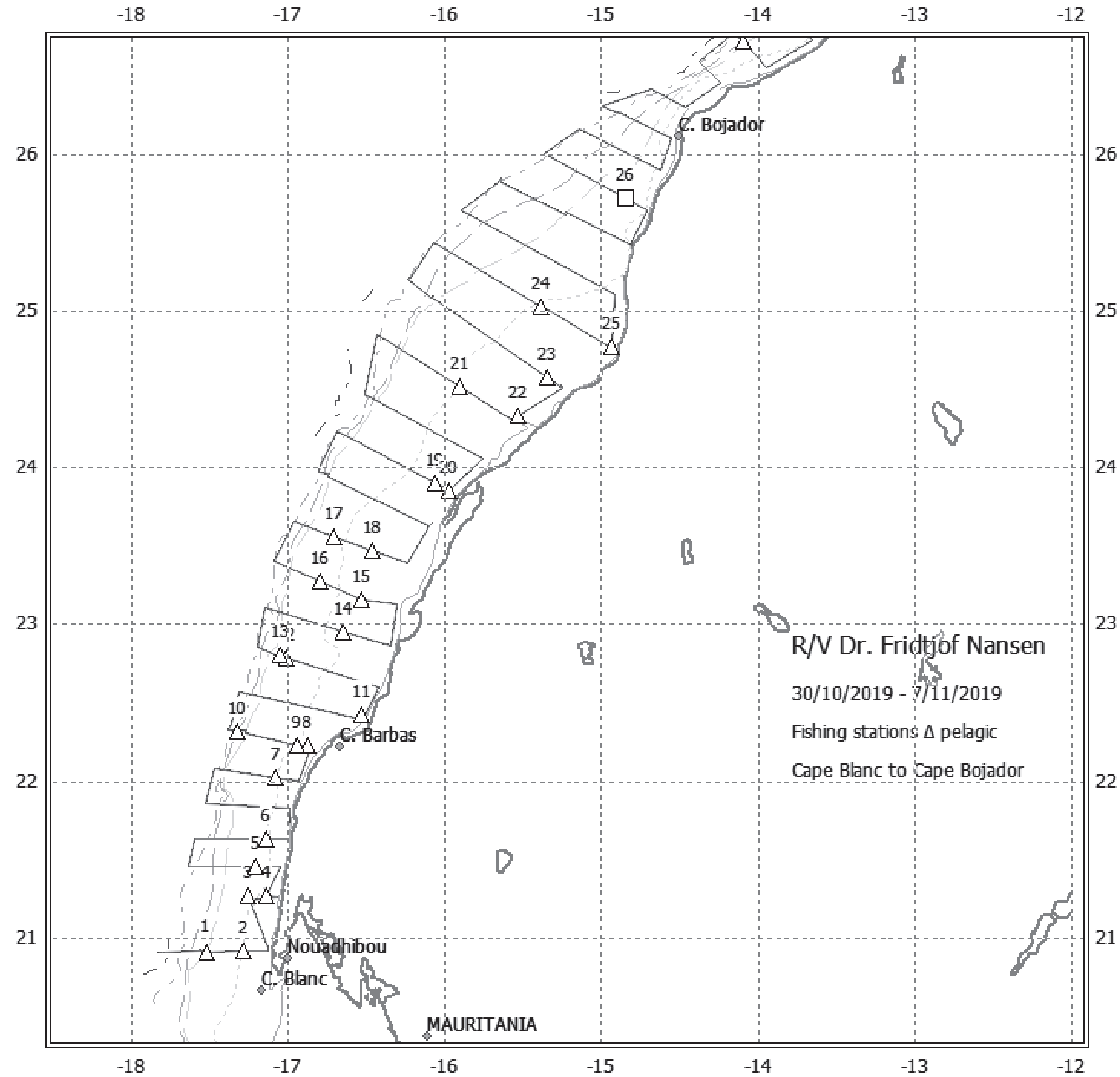


Figure 4A. Course track with trawl-stations. Cap Blanc to Cap Bojador. Depth contours as in Figure 2

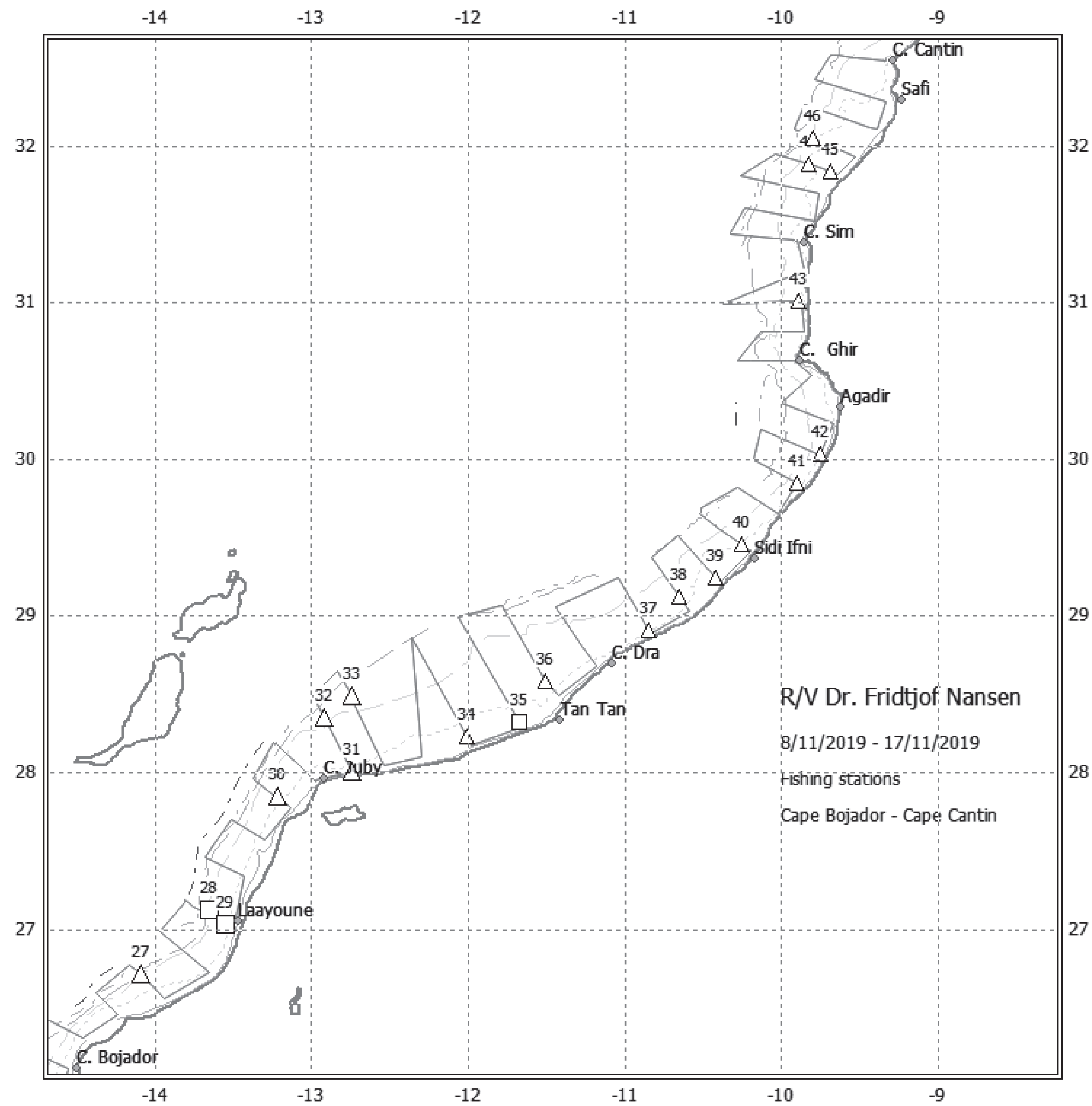


Figure 4B. Course track with trawl stations. Cap Bojador to Cap Cantin. Depth contours as in Figure 2

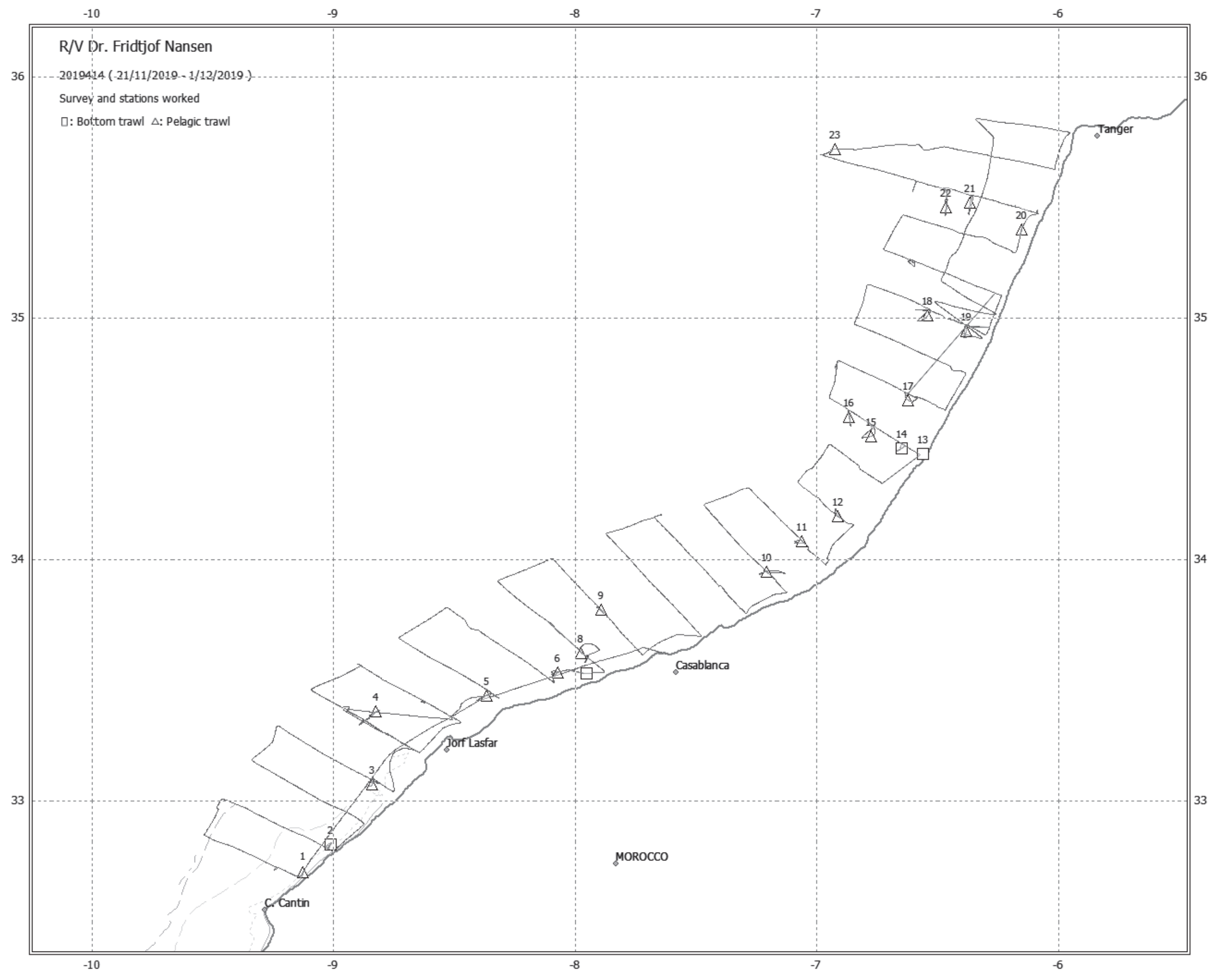


Figure 4C. Course track with trawl stations. Cap Cantin to Tanger

CHAPTER 2. METHODS

2.1 Continuous underway meteorological and hydrographic sampling

2.1.1 Meteorological data

Meteorological data were logged continuously from the Aanderaa Smartguard meteorological station; data included wind direction and speed, air pressure, relative humidity, air temperature and solar radiation. All data were averaged every 60 sec and logged to the Nansis tracklog system. The wind speed and direction data exhibited gaps in the record lasting from a few minutes to several hours. For the use in this report, the short gaps in the wind record were fixed by linear interpolation, those longer than 30 min were flagged as missing data. Meteorological data will only be presented for Leg 4.3 as Leg 4.4 was not equipped with experienced personnel for the on-survey processing. However, the raw data is available for later collaborative processing.

2.1.2 Thermosalinograph

Dr Fridtjof Nansen has two SBE 21 SeaCAT Thermosalinographs (TSG), obtaining samples from 6 m and 4 m depths, respectively. The 6 m intake TSG was used for Leg 4.3 and the 4 m intake TSG was used for Leg 4.4. For their respective surveys, each TSG ran continuously during its survey to measure seawater salinity and temperature every 10 seconds. The 6 m intake is located near the drop keel, whereas the 4 m intake measures water from the intake for the engine cooling water. The 4-m intake is also equipped with a Turner Designs Clyclops-7 submersible fluorometer with turbidity detection capability. However, this sensor proved to be malfunctioning during Leg 4.4 and did not produce usable data.

The results of TSG-derived salinity have been cross-validated against the CTD probe sensors in the following way: (1) the clocks of the data logging computers of the two instruments were synchronised prior to the survey, (2) the continuous TSG data were subsampled at time instances when the CTD probe crossed the depth of 6 m, (3) a histogram of the salinity difference at the sub-sampled points was compared against the normal distribution fit to identify the mean difference and the spread of values between the two sensors. The results are presented in Figure 5. The TSG appears to record salinities about 0.1 PSU higher compared to the CTD and the spread of values between the two instruments is in the order of 0.05 PSU.

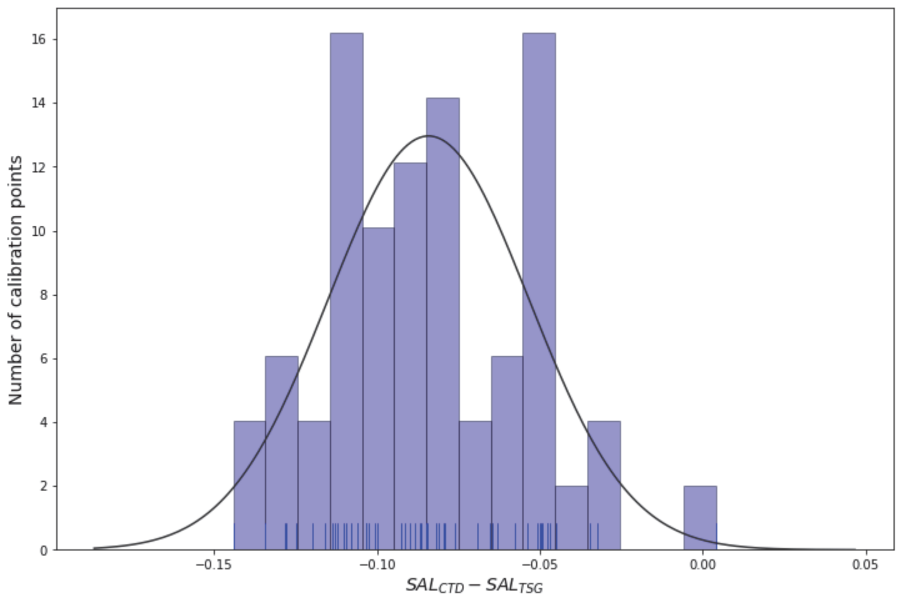


Figure 5. Leg 4.3 histogram of the salinity difference between the CTD probe and TSG unit at the times when the CTD probe was crossing the TSG water intake depth, located at 6 meters

2.1.3 Current speed and direction measurements (ADCP)

The ocean current data were collected continuously throughout the survey with a Teledyne RDI Ocean Surveyor ADCP OS150, operating at the frequency of 150 kHz. The 75 kHz ADCP, which is also fitted onboard, was not operational during this survey. RDI's VmDAS data logging software was used to control its operation and acquire data. The narrowband pinging mode was used, and the manufacturer's recommended bin size of 8 m was applied throughout the survey. Heading, pitch, roll and positional data were acquired by a Kongsberg Marine SEAPATH unit. The VmDAS software used these data to convert the ADCP's along beam velocities into the earth coordinates.

Screening of raw ADCP data to identify and eliminate spurious data sections and eliminate bottom interference was carried out throughout the survey from Cap Blanc to Cap Cantin. In the final processing step, the edited data were binned into even 5 NM distance segments along the survey's transect lines. Current data will only be presented for Leg 4.3 as Leg 4.4 was not equipped with experienced personnel for the on-survey processing. However, the raw data is available for later collaborative processing.

2.2 Fixed hydrographic and plankton sampling

A series of fixed environmental transects are sampled approximately every 60 NM overlapping with the acoustic transects. These environmental transects contain "super-stations" where additional hydrographical and biological sampling occur, such as: CTD deployments, rosette water sampling, and the sampling of zooplankton, fish larvae, fish eggs and microplastics. Super-stations occur at 30 m, 100 m, and 500 m bottom depths with pre-defined water bottle depths (Figure 6). Additional CTD deployments restricted to physical oceanographic parameters occur at intermediate stations at approximately 75 m and 200 m bottom depth. These stations are referred to as "dry stations". If CTD deployments are more than about 15 NM apart, still additional CTD deployments are performed to maintain high hydrographic resolution.

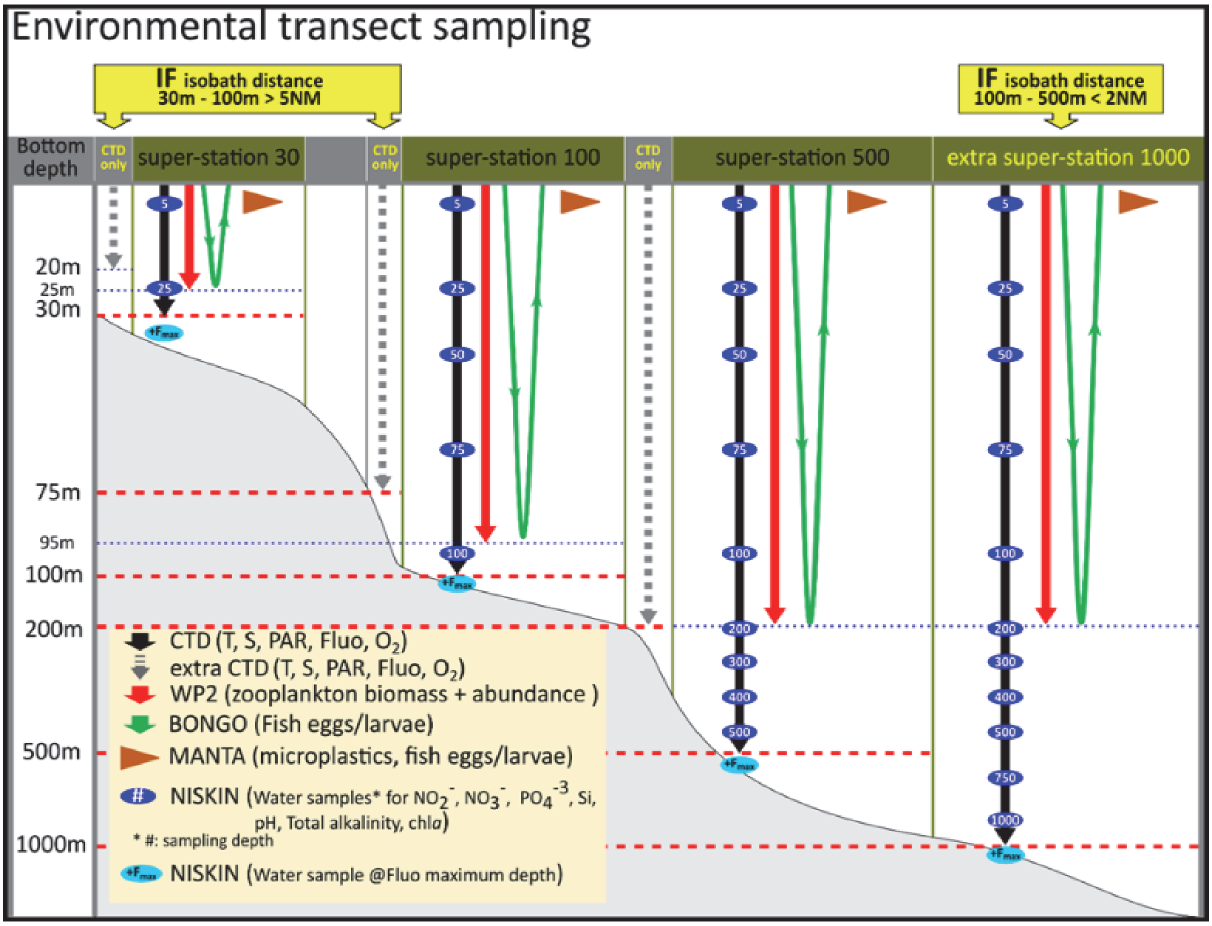


Figure 6. Environmental transect sampling description with identified station distances, sampling depths and equipment used

2.2.1 CTD Sensors

A Sea-Bird 911plus CTD containing two SBE 3plus temperature sensors, two SBE 4C conductivity sensors, a Digiquarts pressure sensor, a SBE 43 dissolved oxygen sensor, a WET Labs ECO-AFL fluorometer and a Satlantic Photosynthetically Active Radiation LOG ICSW sensor is mounted to a 12-bottle rosette for every CTD deployment. Sensor data is collected at 1 m intervals on the downcast and at each bottle closure occurrence during water sampling. All sensor logging and profiling is performed using Sea-Bird's Seasave software.

2.2.1.1 Dissolved Oxygen and Salinity Validation

The purpose of collecting the dissolved oxygen samples is to validate the performance of the CTD probe-mounted oxygen sensor. During Legs 4.3 and 4.4, the sensor SBE 43 serial number 3525 was in use. To validate the sensor performance for Leg 4.3, a histogram of the differences between the sensor readings and titrated samples was constructed. Of the total of oxygen samples titrated, only the 36 where the deviation from the sensor reading was less than 0.5 ml/l were used in the comparison. The remaining samples were considered as outliers, biased in the process of sample collection and titration. The resulting histogram is presented in Figure 7. The distribution appears to slightly skew towards the negative differences. The median is -0.021 ml/l, suggestive of higher sensor-derived oxygen concentrations compared to the samples. However, the precision of this determination, as marked by the spread of of values on the histogram is rather low. Measurements are performed using a Metrohm 916 Ti-Touch potentiometric titrator performing Winkler titrations (Grasshoff et al. 1983) (validation results for Leg 4.4 can be found in Annex V). The Guildline Portasal Salinometer 8410A was being repaired during Leg 4 and therefore onboard validation of the CTD derived salinity values could not be performed.

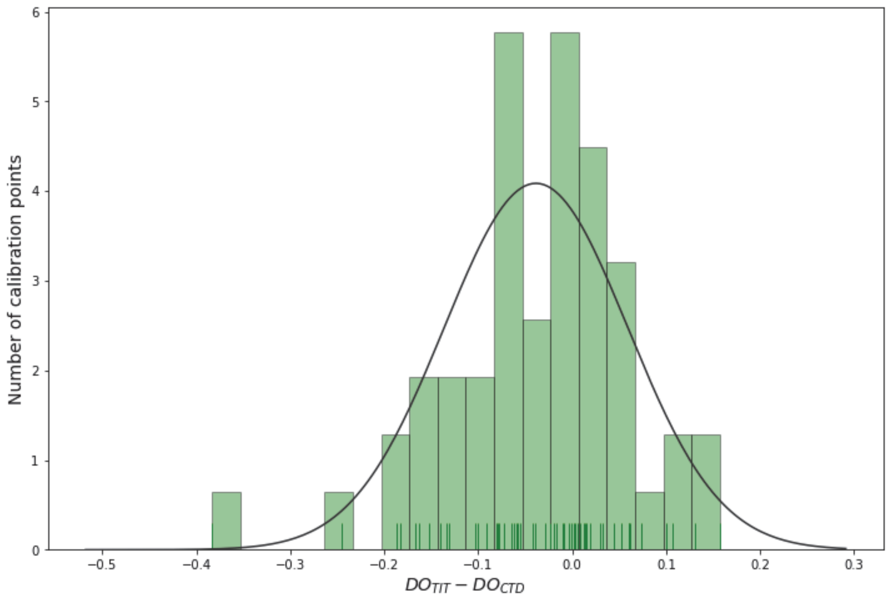


Figure 7. Leg 4.3 histogram of differences between the titrated and CTD-derived dissolved oxygen. The horizontal axis scaled in ml/l

2.2.1.2 Density

The density of seawater is a function of salinity and temperature, and density gradients determine the stability of the water column. The upper part of the water column is usually well mixed, and at the bottom of the mixed layer is a density gradient denoting the pycnocline, which acts as a barrier to vertical mixing. The depth of the pycnocline is defined here as the maximum of δσt/δz where σt is density and z is depth, and was estimated from profiles of water density collected by the CTD. This procedure ensures a correct estimation of the depth of the pycnocline in waters with a large range of salinities, such as were present along parts of the coast investigated.

2.2.2 Discrete Water Sampling

At each super-station deployment, Niskin bottles mounted on the 12-bottle rosette collected water at predefined depths during the up cast to obtain vertical profiles of pH, total alkalinity, nutrients, and chlorophyll α. The CTD stops at each predefined depth for 20–30 seconds to allow the bottles to equilibrate with the surrounding water before closing.

2.2.2.1 *Ocean acidification parameters - pH and alkalinity*

Water samples for pH and total alkalinity analyses were collected in the same 250 ml borosilicate glass bottle using silicone tubing. Since no preservative was used, it was necessary to keep the samples in the dark while waiting to stabilise at 25°C (with a water bath) for analysis. pH was determined using an Agilent Cary 8454 UV-Vis Diode Array spectrophotometer and a 2-mM m-cresol purple indicator dye solution. The indicator dye was measured every 24 hours during analyses to determine the correction factor appropriate for sample measurements (Clayton and Byrne, 1993; Chierici *et al.*, 1999). All pH spectrophotometric measurements were performed in triplicates on board. Total alkalinity was measured via an open-cell potentiometric titration using a 0.05M HCl solution with a sodium chloride background as the titrant (Dickson *et al.*, 2007). A Metrohm 888 Titrando equipped with an Aquatrode plus pH electrode with Pt1000 temperature sensor was used in combination with the Metrohm tiamo software to measure the change in pH and perform the total alkalinity titrations. Certified Reference Material of known total alkalinity from Scripps Institution of Oceanography was measured every 24 hours during analyses to determine the correction factor appropriate for sample measurements. All total alkalinity titrations were performed in triplicates on board. Quality assurance results can be found in Annex VI. Ocean acidification data will only be presented for Leg 4.4 as Leg 4.3 was not equipped with experienced personnel for the on-survey processing. However, the raw data is available for later collaborative processing.

2.2.2.2 *Nutrients*

Seawater samples for nutrient analyses (nitrite, nitrate, silicate and phosphate) were collected at standard depths (one sample at each depth) at each super-station in 20 ml polyethylene vials. Samples were preserved with 0.2 ml chloroform and kept refrigerated and dark (Hagebø and Rey, 1984) until being sent to the Institute of Marine Research for analysis. Analyses will be performed using a Skalar San++ Continuous Flow Analyser while following standard procedures (Grasshoff *et al.*, 1999). Storage and transport may introduce loss of accuracy of the results.

2.2.3 Plankton – primary productivity, zoo- and ichthyoplankton

2.2.3.1 *Chlorophyll-a and Phaeopigments: Primary productivity*

Seawater from the surface to 200 m depth for chlorophyll *a* determination was collected in 260 ml polyethylene flasks and filtered on 0.7 µm filters (Munktell glass-fibre filters Grade: MGF, vacuum 200 mm Hg). The filters were stored at -20°C for 20-24 hours before chlorophyll *a* was extracted in 10 ml of 90% acetone at 4°C. Samples were then centrifuged and transferred to cuvettes for measurement on a Turner Designs 10AU Fluorometer, per Welshmeyer (1994) and Jeffrey and Humphrey (1975). Samples were first measured without acid for chlorophyll *a* determination and after with two drops of 5% HCl for phaeopigment determination. Chlorophyll *a* data is only presented for Leg 4.4 as Leg 4.3 was not equipped with experienced personnel for the on-survey processing. However, the raw data is available for later collaborative processing.

2.2.3.2 *Zooplankton*

Zooplankton samples were taken along every environmental transect (every 60 nm) at "super stations", located over the isobaths of 30 m, 100 m and 500 m. Samples were collected with a WP2-net. The WP2-net (56 cm diameter, mesh size 180 µm) (Fraser, 1966, Anonymous, 1968) was hauled vertically at a speed of ~0.5 m s^{-1} at each station. The net was towed within 5 m from the bottom to the surface, or from 200 m depth to the surface at deep stations.

An additional WP2 net was towed in the 0-30 m depth strata at those stations with bottom depths of 100 m and 500 m. The purpose of these additional samples was to enable a direct comparison of the zooplankton composition and abundance in the upper 30 m layer of the water column along the bottom depth gradient.

Each zooplankton sample was divided into two equal parts using a Motoda plankton splitter (Motoda, 1959). The first part of the sample was size fractioned by using a series of sieves of decreasing mesh sizes (2 000 µm, 1 000 µm and 180 µm). The zooplankton retained on each sieve were dried on aluminium trays at ~60ºC for 24 h. Samples were transferred to IMR (Bergen) for estimation of zooplankton biomass of the different size groups. The second part of the sample was preserved in 4% formaldehyde buffered with borax for species identification and quantification, also at IMR.

2.2.3.3 *Ichthyoplankton*

Ichthyoplankton was collected with double oblique tows of a Bongo (405 µm) 5 m above the bottom, or a maximum depth of 200 m to the surface at deep stations. In all cases, once the Bongo was on board the samples were treated as follows:

a) The sample of the left net (V) was sieved on 180 µm mesh and preserved in 4% borax buffered formaldehyde solution.

b) The sample of the right net (H) was examined under the microscope and all fish larvae (and eggs if possible) sorted. After sorting, the bulk sample was used for estimation of the Zooplankton Displacement Volume (details in the Nansen Plankton Guidelines), and preserved in 4% borax buffered formaldehyde. The sorted ichthyoplankton were photographed and preserved in 96% ethanol for genetics in small labelled scintillation vials or Eppendorf tubes. The biggest fish larvae were removed from the sample, photographed, transferred to vials and preserved in 4% formaldehyde buffered with borax. The rest of the sample was preserved in 96% ethanol for reference purposes and further laboratory analysis. After the cruise, fish eggs will be sorted, and the sorted larvae will be taxonomically analysed at the IMR.

2.2.4 Microplastics

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

The samples collected were washed in filtered seawater over a sieve with a mesh of 180 µm. Microplastic particles were sorted from the sample under a stereomicroscope, and the sorted sample was then checked once more to identify the smallest plastic particles. All potential plastic items were then placed on a gridded petri dish for examination under the stereomicroscope, photographed and, if possible, also measured and described (e.g. length, shape, type and colour). The sorted microplastics were washed with distilled water and dried in pre-weighed aluminium trays in a drying cabinet at 30ºC. The trays were packed in aluminium foil and stored at room temperature until transport to IMR, where they will be studied in more detail. Fish larvae and eggs were also sorted from the Manta trawl samples, photographed, and preserved in 96% ethanol in small scintillation vials. After sorting, the remaining fraction of the Manta samples was preserved in ethanol 96% for studies of neuston at the University of the Western Cape, South Africa (UWC) after the cruise.

2.3 Top predator observations

Two observers scanned for cetaceans and seabirds during most of the daylight hours throughout the survey. Leica 10 x 42 binoculars were used. The total time spent scanning, the nominal effort, was recorded each day. The observation platform, which is at 24.6 m above sea level, was used throughout the survey.

All cetaceans sighted were counted and, where possible, identified. The time of sighting was recorded; this was later matched with the vessel's course track to provide position. A separate form was used for observer effort information, with indications of sea state, swell and ship's activity.

A maximum amount of effort was concentrated on and near the track-line so as not to miss any sightings there. During low-speed or stationary sampling activities the platform was treated as a quasi-fixed vantage point and 360° were scanned, considering that the probability that cetaceans may approach from behind the vessel was significantly increased.

Species were identified in a strictly conservative way, i.e. only when diagnostic features were confirmed, the sighting was assigned to the family or genus level.

As a high priority, but depending on distance, it was attempted to take photographs with a Canon reflex camera with a 70-300 mm zoom lens.

Seabirds were identified, where possible, and counted in 'passing mode', counting being restricted to a line 90° to the port and 90° to starboard. Counts were made periodically throughout the day, each count taking several minutes to complete. During stations for trawling, CTDs and plankton-net hauls counting ceased. It was recognised that detection rates decline significantly with distance and therefore counting was limited to birds passing within about 300 m of the vessel, i.e. a swathe of 600 m within which it was assume that all birds were detected.

2.4 Biological sampling of fish

Biological sampling of the fish was carried out using pelagic and bottom trawls. A complete record of fishing stations and catches is shown in Annex III. In shallow water (<30 m) or at night when pelagic fish was close to the surface, the small pelagic trawl (Åkrahamn trawl) with floats or Super Gisund bottom trawl with floats was used for sampling. In deeper waters, the MultPelt, a much larger trawl, was used. This gear has a much larger opening and can be trawled at faster speeds (up to 5 knots) and therefore has been found to be much more successful at catching fast swimming- pelagic species, especially adult sardinella, sardines and horse mackerel.

All catches were sampled for composition by weight and numbers. Species identification was based on the FAO Species Guides. Length frequency distributions of the target species (by total fish length to the nearest cm below, were taken from all stations where they were present. Other common pelagic fish were also measured. These length measurements were used to estimate the length-weight relationship used in the biomass calculations. Individual biological information on sex and maturity was recorded for 40 fish per trawl (when present) of all target species. The maturity stages were determined following the 5 points gonad maturity scale for partial spawners (Holden & Raitt, 1974) (Annex II). Further descriptions can be found in Annex II.

With the expanding scope of the research being carried out in the EAF -Nansen Programme, the survey objectives and related sampling strategy have been expanded to support research on life cycles, stock identities, and trophic relationships of pelagic fish. For these, special effort was made to record biological parameters as sex and maturity stages. For *S. pilchardus* otoliths were removed and stored for posterior readings. Additionally, samples of whole fish of *S. colias* were frozen for later morphometric analysis and removal-reading of otoliths.

A full list of biological samples per species and trawl station is given in Annex IX.

2.5 Acoustic sampling

2.5.1 Bottom mapping echo sounder

The EM302 multibeam echo sounder is a high-resolution seabed mapping system. Data acquisition starts approximately 10 m below the transducers, while the maximum acquisition depth is limited in practice to 2 000-2 500 m on R/V *Dr Fridtjof Nansen*. Across track coverage (swathe width) is up to 5.5 times water depth and may be limited by the operator either in angle or in swathe width without reducing the number of beams. The operating frequencies is 30 kHz. There are 128 beams with dynamic focusing employed in the near field. The transmitting fan is divided into three sectors to maximize range capability and to suppress interference from multiples of strong bottom echoes. The sectors are transmitted sequentially within each ping and use distinct frequencies or waveforms. The along-track beam width is 1 degree. Ping rate is set according to depth. The receiving beam width is 2 degrees. Sound profiles were set manually in the system according to the area of operation. The data were logged to the on-board Olex plotting system.

2.5.2 Sonar data

A calibrated omni directional fisheries sonar Simrad SU90 was operated continuously during the survey with the following configuration:

- Sampling range horizontal and vertical beams: 450 m
- Horizontal tilt angle: 3 deg
- Frequency: 26 kHz
- Transmit pulse: FM normal
- Vertical beam width horizontal fan: normal

With this configuration, the mean depth of the horizontal beam was about 30 m at 450 m range. To avoid acoustic interference, the sonar was set as slave and the echo sounder as a master. The ping repetition rate obtained was about 1 ping every 2 seconds. The vertical beams were orientated across the vessel track in 90 deg. Data was stored in an external hard drive and transferred routinely to the vessel server.

During trawling for species identification, sonar settings were changed to optimize the observation of the target fish aggregations and returned to the standard settings when resuming surveying.

Twice a day the sonar data was scrutinized, loading effectively the files from the vessel server, without the need for local storing. The module PROFOS (Processing system for omni directional fisheries sonar) which is part of the LSSS system, was used to replay and scrutinize the sonar data.

Sonar data from first schools detected along the survey was used to evaluate the parameters for automatic school segmentation. The parameters used for the automatic processing were as shown in Table 3 below.

Table 3. Parameters used for automatic school segmentation used to detect schools with the sonar equipment

Grow parameters

Omni grow parameters

Parameter	Value	Unit	Description
UseAdaptiveThreshold	✔		
AdaptiveThreshold	12	[dB]	Min value for growing = range dependent trend + AdaptiveThreshold
MinValue	-45	[dB]	Min value for growing
MaxValue	-20	[dB]	Max value for growing
MaxPingFromSeed	10	[#]	Max pings from seed
MaxMissingPings	2	[#]	Max number of consecutive pings where school can be missing
MinMaxDeltaSv	2	[dB]	Regions are rejected if for all samples Sv < min value for growing + MinMaxDeltaSv
MinArea	100	[m²]	Regions are rejected if area < MinArea
MaxArea	30000	[m²]	Regions are rejected if area > MaxArea
MaxAspectRatio	10	[–]	Regions are rejected if sizeAlongRing / sizeAlongBeam > MaxAspectRatio
MinPingCount	10	[#]	Schools are rejected if they span less than MinPingCount number of pings
DiskRadius	100	[m]	Radius used when creating school disk

OK Cancel

A quality control was done on the schools generated from the automatic segmentation, which consisted in deleting wrong segmented schools (i.e. from surface or bottom scatters and dense plankton) and merging schools that were segmented separated.

The results from the sonar data were combined with echo sounder results (ListUserFile 11) and the Stox survey project to generate a sonar NASC (nautical area scattering coefficient, m^2 nmi^{-2}) at each echo sounder sailing distance by transect. Sonar NASC was multiplied by a factor of 2.5 (4 dB) to compensate for the lower side aspect target strength compared with the dorsal target strength used for computing echo sounder NASC. With these results was possible to visualize spatial distribution and depth distribution of main pelagic species from sonar and echo sounder.

2.5.3 Sampling by echo sounder

Acoustic data were recorded using a Simrad EK80 Scientific Split Beam Echo Sounder equipped with keel-mounted transducers at nominal operating frequencies of 18, 38, 70, 120, 200 and 333 kHz. A successful calibration of the echo sounders was conducted in Walvis Bay on 11-12 May 2019 and the echo sounder gains from this calibration were used (Annex I).

Raw echosounder data was continuously recorded together with time and position information and processed using the software LSSS 2.6 (Korneliussen & Ona, 2002). This included pre-processing with the KORONA module for error correction and automatic bottom detection, as well as manual removal of recordings between transects and at stations. The acoustic backscatter values were scrutinized daily as 5 NM integrals of acoustic backscattering coefficients s_A (m^2/NM^2) at 38 kHz, using other frequencies for additional information.

In cases where the integrated echo contained more than one category of fish (see Table 4 below), the mean s_A-value allocated to each category was in the same ratio as their contribution to the total catch of all trawls in that area.

Table 4. Acoustic categories and the taxonomic groups and species assigned to them. Note that only example species are shown for Pelagic species 1 and 2 and Demersal species, i.e. the species lists are not exclusive

Categories	Taxon	Species
Sardinella	Sardinella	*S. aurita* *S. maderensis*
Horse mackerel	Trachurus	*T. trecae* *T. trachurus*
Sardine	Sardina	*Sardina pilchardus*
Anchovy	Engraulis	*Engraulis encrasicolus*
Mackerel	Scombridae	*Scomber colias*
Pelagic species 1	Clupeiformes	*Ilisha africana*
Pelagic species 2	Carangidae	*Selene dorsalis* *Chloroscombrus chrysurus* *Decapterus rhonchus* *Seriola carpenteri*
	Scombridae	*Auxis thazard* *Sarda sarda*
	Sphyraenidae	*Sphyraena guachancho*
Demersal species	Trichiuridae	*Trichiurus lepturus* *Lepidopus caudatus*
	Merlucciidae	*Merluccius* spp.
	Sparidae	*Dentex* spp. *Sparus* spp. *Pagellus bellottii*
	Other taxa	*Saurida brasiliensis* *Ariomma bondi* *Pomadasys incisus*
Other		*Brachydeuterus auritus*
Plankton		Plankton, mesopelagic fish

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

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

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

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

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

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

where

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

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

The target groups are based on groupings used during previous *Nansen* surveys, but recently undated such that all groups are standardised throughout western Africa. Note that the group "plankton" included a range of dispersed weak scatterers including jellyfish, mesopelagic fish and, of course, zooplankton (and colloquially referred to as "*Nansen plankton*").

The catch composition of some of the trawls was adjusted to account for the difference in the catch compared to the acoustically insonified targets being identified. This was particularly for bottom trawls, and several pelagic trawls towed very close to the seabed, where large amounts of benthic and demersal fish were caught, mixed with the targeted pelagic fish. The bottom fish were removed from the calculations of composition.

Biomass estimates were conducted for species identified as priority species by local scientists; *Sardinella aurita*, *S. maderensis*, *Trachurus trecae, T. trachurus, Sardina pilchardus*, *Engraulis encrasicolus* and *Scomber colias* (see Survey Objectives).

The acoustic backscatter was scrutinized daily and allocated to the various target groups.

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

If the targeted fish was a mixture of more than one species and they could not be separated during scrutinization representative distributions all the species, within the stratum, as reflected in the trawl catches, was used. Length distributions of each species, for each catch, was calculated and normalized to a unit number (usually 100). Very small catches (less than about 20 fish) were not included.

When the size classes (of e.g. young fish and older fish) were well mixed, the various length distributions were pooled together, the length frequency sampled in each trawl being weighted equally. Otherwise, when the size classes were segregated, the total distribution area was post-stratified according to the length distributions, and separate estimates were made for each stratum.

The length-weight relationship, which is used to convert numbers to biomass, is normally calculated for each species or group, based on all fish sampled within each country. The small scale in the fish lab was not working during this survey and the accuracy of the larger scale was questionable for smaller fish. A length-weight relationship obtained from the 2002 Mauritanian survey was therefore used.

The biomass estimation process used the following procedure:

- Divide the s_A-value between groups of fish and/or species through scrutinization of the acoustic data and information from the trawl catches.
- Define strata based on the occurrence of a species, or group of species, in an area based on the distribution of s_A-values.
- Calculate the average s_A-value (per nm) of each species/group in each stratum
- The length-frequency samples of the species for the stratum were respectively pooled together with equal importance (as described above).
- The mean back scattering strength (ρ/s_A) of each length class of the target group/species was calculated. The total backscattering for all length classes was then summed. This was automatically done in the Excel spreadsheet made available for acoustic abundance estimation on board R/V *Dr Fridtjof Nanse*n.
- The pooled length distribution was used, together with the mean s_A-value, to calculate the density (numbers per NM^2) by length groups and species, using the above formula. The total number by length group in the area was obtained by multiplying each number/NM^2 by the area.
- The numbers were then converted to biomass using the estimated weight at length.

CHAPTER 3. RESULTS

3.1 Oceanography

As mentioned in the Methods section, Legs 4.3 and 4.4 were not staffed with the same oceanographic experience for processing and analysis. Leg 4.3 personnel had increased competence with physical oceanography, whereas Leg 4.4 had greater competence with chemical oceanography. Therefore, the Cap Blanc to Cap Cantin region of Leg 4 will provide a description of the region using satellite imagery, wind conditions, ADCP-derived currents, and underway CTD deployments. In turn, the Cap Cantin to Tanger region will provide a description of the region concerning ocean acidification and the chlorophyll a concentration distribution. Both regions will have descriptions of the underway subsurface temperature and salinity observations in addition to the CTD deployments along the hydrographic transects. For additional reporting of the regional descriptions not presented here, the raw data is available for later collaborative processing.

3.1.1 Regional scale observations using satellite imagery

Cap Blanc to Cap Cantin Region

According to the climatology of the Moroccan coast, October and November are expected to be relatively calm months, characterized by relatively weak winds and upwelling relaxation. It was not the case observed during this survey. Strong winds and intense upwelling dominated the area between Cap Blanc and Cap Cantin.

Figure 8 shows composite satellite imagery using daily images averaged over the survey period. In the presented images, the band of upwelled water colder than 20ºC extends along the entire length of the Moroccan coastline. Primary productivity in coastal waters, as characterized by ocean colour-derived chlorophyll concentrations, reaches the seldom observed peak values (> 30 mg m-3). The thermal front that separates tropical from upwelled waters, which is expected at this time of the year to be at the boundary between Senegal and Mauritania is clearly located at the southernmost end of the survey area, just south of Cape Blanc. In the northern part of surveyed region, the Cap Ghir Filament that stretches far westward from the Moroccan coast, typically expected during to peak during summer, is well manifested in the presented October-November satellite imagery. In summary, the impression from the presented imagery is that the survey encountered anomalously strong upwelling conditions along the Moroccan coast. The observed distribution of upwelling and major fronts was characteristic more to climatological summer that to the observational period. The anomalous environmental patters could have an effect on distributions of the observed small pelagic fish stocks.

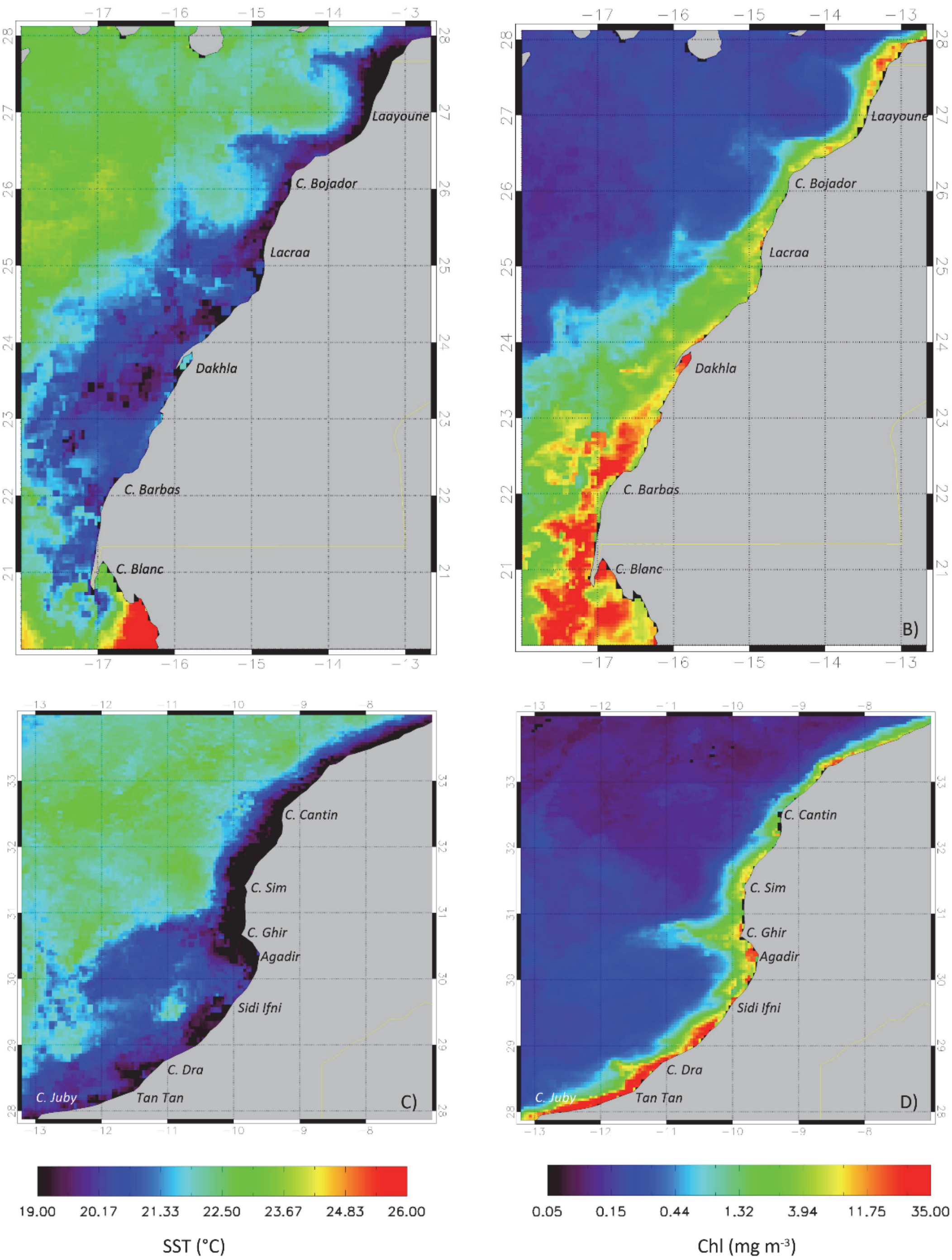


Figure 8. Satellite distribution of sea surface A) temperature (°C) from Cap Blanc to Laayoune, B) chlorophyll (mg/m3) from Cap Blanc to Laayoune, C) temperature (°C) from Cap Juby to Cap Sim and D) chlorophyll (mg/m3) from Cap Juby to Cap Sim during the period of 29 October-10 November 2019

3.1.2 Wind conditions

Cap Blanc to Cap Cantin Region

Figure 9 shows a time-evolution plot of the wind velocity recorded with the vessel-mounted weather station. The average wind speed was 11.5 m s-1. The 20 percent of the hourly observations could be classified as gale (wind speed > 14 m s-1). Moderate to strong wind condition (mean speed ~10 m s-1) dominated the first part of the survey, 10 Oct-11 Nov. Gale to storm conditions prevailed between Nov 8 and 13, followed by a brief hiatus on Nov 14-15. After that, wind speed picked up again to reach the magnitude of 10-12 m s-1.

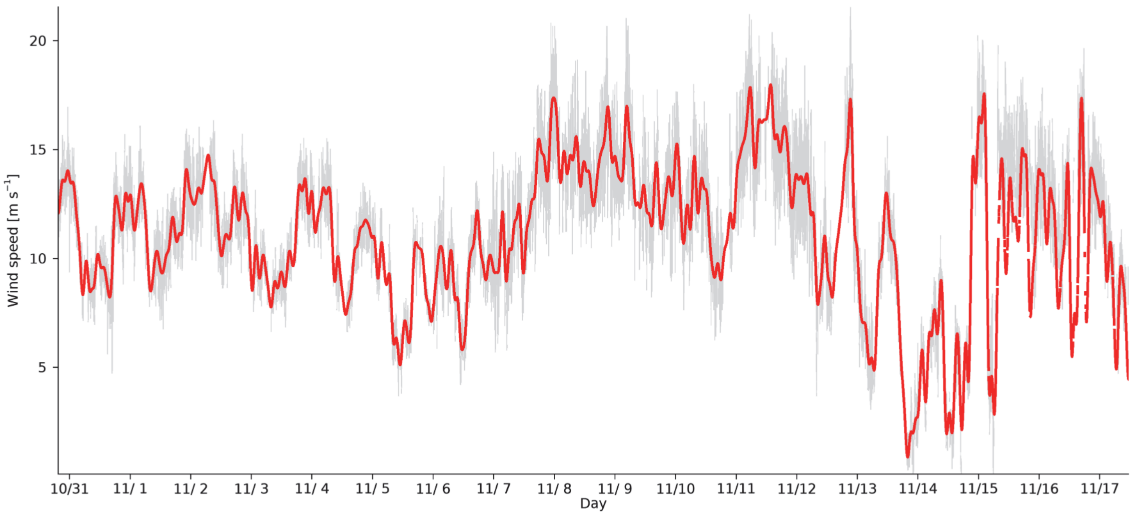


Figure 9. Wind speed Time series (m/s) for the period of 31 October to 17 November

Maps presenting the aerial view of the recorded winds are shown in Figure 10. The northeasterly trade wind dominated the observations throughout the survey domain. The observed wind direction was aligned with the coastline in most of the survey area, implying the active coastal upwelling in the respective coastal regions. The exception was the coastline stretch between Cap Juby to Tan-Tan. Because of its zonal orientation, the coastal waters experienced onshore winds. When wind blows from the onshore direction, it becomes more favourable to development of storm surges rather than to upwelling. The two spells of a calmer weather identified in the preceding figure can be clearly located in the maps as the local minima in the vector distributions, the first recorded off Dakhla, the other off Agadir.

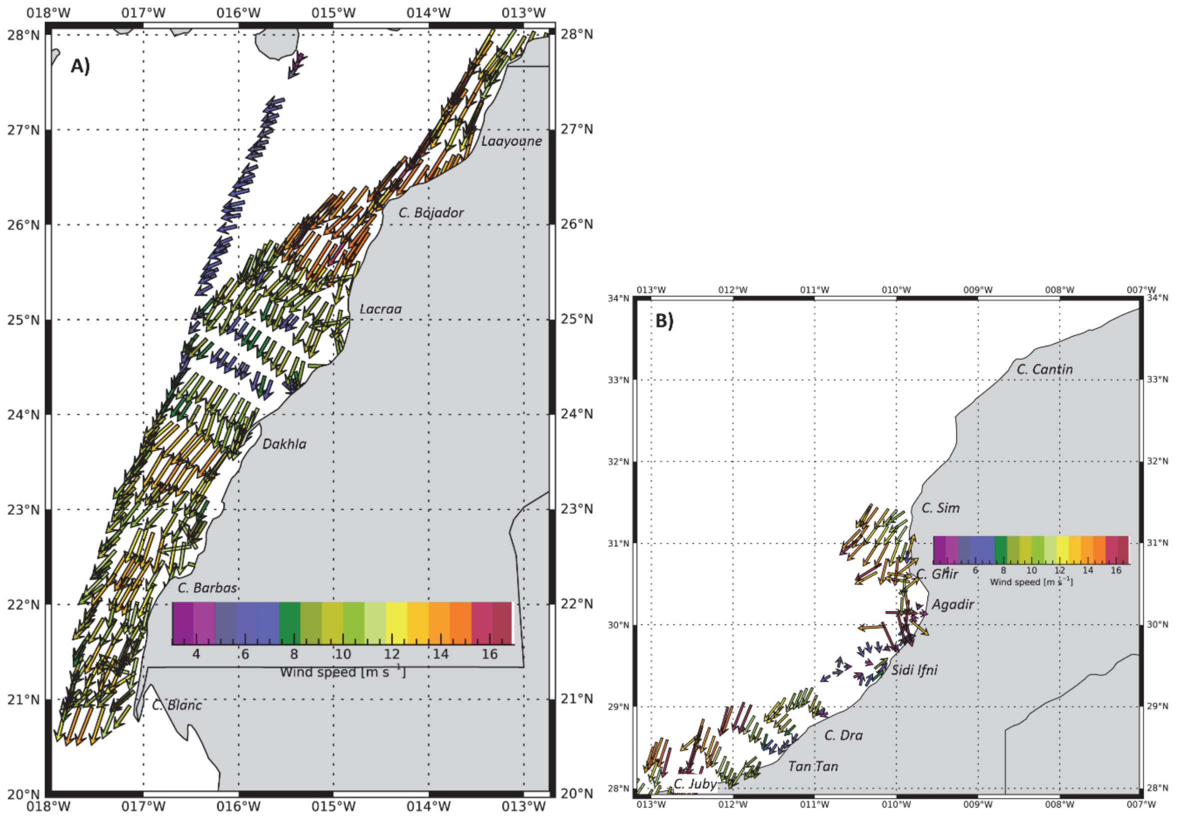


Figure 10. Wind speed and direction A) from Cap Blanc to Laayoune, and B) from Cap Juby to Cap Sim, measured from the wind sensor in the vessel from 31 October to 17 November 2019

3.1.3 Underway observations of temperature and salinity

Cap Blanc to Cap Cantin Region

The objectively interpolated maps of temperature and salinity at 6 m depth on the coastal strip covered by the survey are presented in Figure 11. The large-scale temperature distributions, corroborate the general patterns observed in the satellite-derived SST maps (Figure 8). Notwithstanding, the underway collected add an additional level of detail to this picture, by resolving locations of the upwelling centres not resolvable from the satellite imagery. The major upwelling in the southern region (marked by the temperature drop below 18ºC, Figure 11) are located just north of Cap Blanc, off Lacraa and to the north of Laayuone. Noteworthily, the plume of colder water observed off Dakhla appears to be connected to the Lacraa upwelling cell in the north. Just north of Lacraa, temperature exhibit a sharp zonal gradient, rising from cold to warm temperatures (19º to 21ºC) in the space of a short distance from the coast, manifesting a presence of an anticyclonic (clockwise) eddy.

The underway temperature observed near the coast in the northern region (Figure 11) is on average lower compared to the southern region, which must be attributed more to the decreasing latitude and less so to a stronger upwelling. The two coastal pools with temperature lower than 17ºC, suggesting upwelling centres, can be identified in the north, just of Cap Dra and between Cap Ghir and Cap Sim. The features of the Cap Ghir filament observed in the satellite imagery (Figure 8) are not captured in the presented data due to the narrow, coastal character of the survey design.

Beginning from Cap Barbas (latitude 22ºN) salinity of the upwelled waters observed underway (Figure 11) decreases steadily from the south towards the north. This is the normal pattern, stemming from the fact that upwelled in the north are sourced from Atlantic Central Water (NACW) characterised by lower salinities, compared to the southern regions where upwelled water originates from South Atlantic Central Water (SACW) higher in salinity.

However, underway the salinity also drops to the south of Cap Barbas in Figure 11, which cannot be explained by the change in the characteristic of source water causing the upwelling. As the same drop in salinity appeared in the measurements obtained with alternative instrument (the CTD and Rapid Cast probes) we are confident the observation is correct. At the time of this writing, the cause for the lower surface salinity of upwelled water at Cap Blanc compared to the more northerly regions is not yet understood.

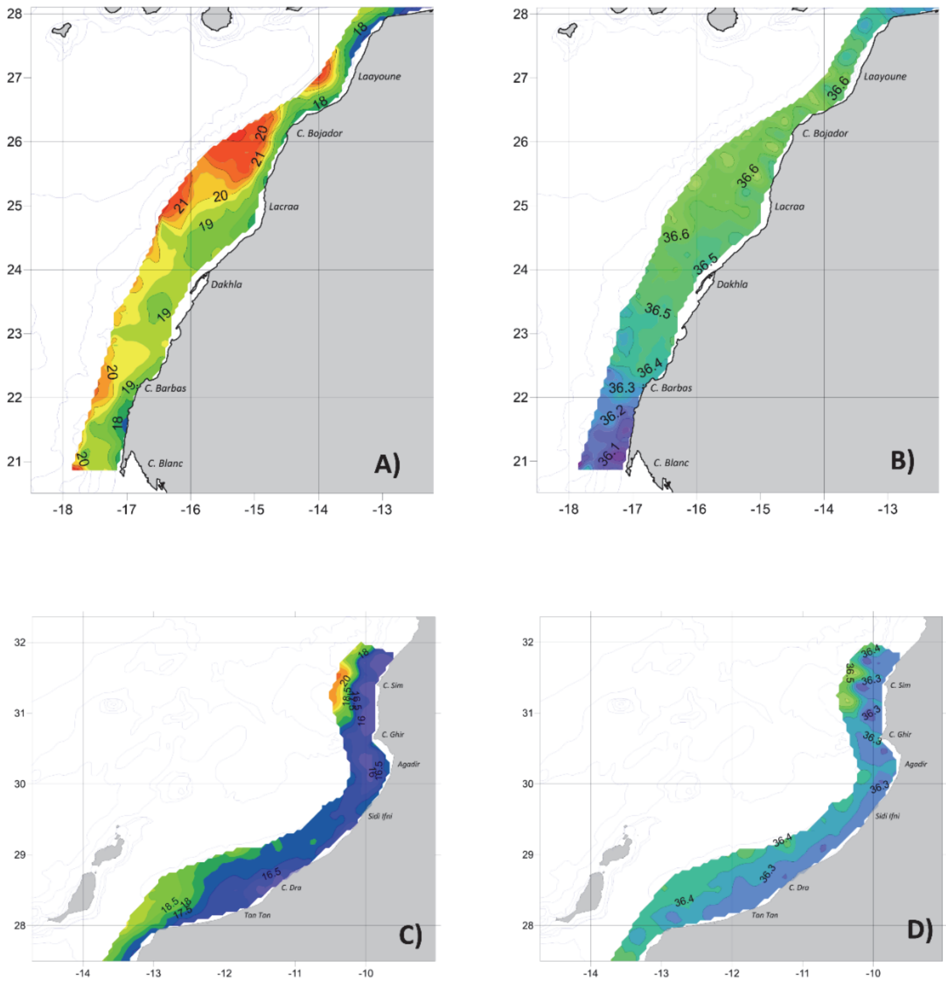


Figure 11. Surface distributions of A) temperature (°C) from Cap Blanc to Laayoune, B) salinity (PSU) from Cap Blanc to Laayoune, C) temperature (°C) from Cap Juby to Cap Sim and D) salinity (PSU) from Cap Juby to Cap Sim measured from the TSG of the vessel during the period of 31 October to 17 November 2019

Cap Cantin to Tanger Region

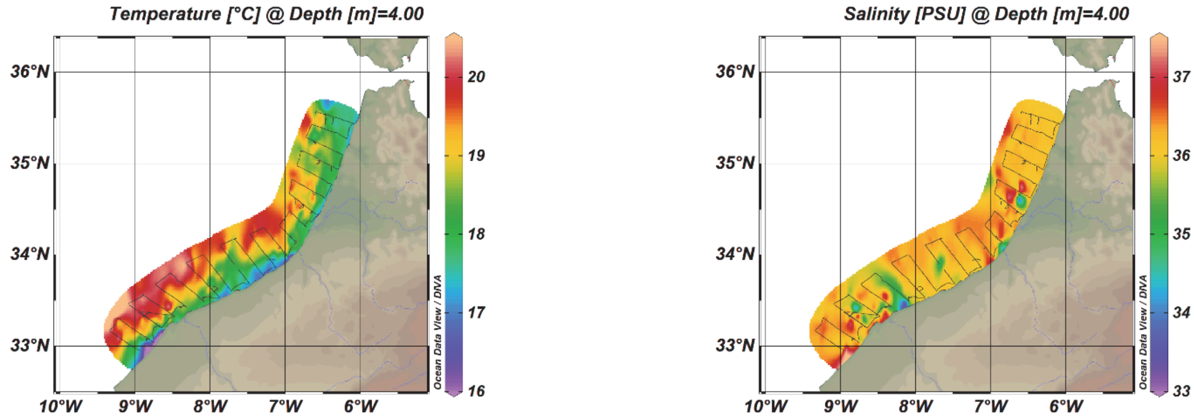


Figure 12. Horizontal distribution of temperature and salinity via the 4 m intake thermosalinograph between Cap Cantin and Tanger

Coastal subsurface waters displayed cooler temperatures ranging from 16°C to 18°C along the northern part of the Moroccan coast, Figure 12. Although the coastal water warmed up as the vessel moved north, the warmest offshore waters were observed in the southern 66% of the survey with levels approaching 21°C. Salinity remained relatively consistent near 36.5 PSU throughout the survey. However, small patches of salinity values approaching 35 PSU and even 34 PSU was observed (particularly in the southern region). Interestingly, these lower values are not immediately outside one of the Moroccan river outlets. Unfortunately, the low salinity areas did not line with the four environmental transects performed on the survey for comparison.

3.1.4 ADCP-derived ocean currents

Cap Blanc to Cap Cantin Region

Figure 13 presents the distribution of current vectors measured with the ADCP at the two selected depth levels, 18-26 m representing the mixed layer (the top level measured with this instrument), and 66-74 m representing the sub-thermocline currents. Several types of currents were observed.

Given the prevailing winds, the dominant currents in the mixed layer may be classified as the upwelling coastal jet current. This type of current flows always equatorward. According to the classical interpretation, it represents a geostrophic flow driven by the cross-shelf temperature gradient set up between cold upwelling plume and warm waters pushed offshore by Ekman transport.

The shallows off south of Cap Barbas to Cap Blanc and Tan-Tan, exhibit the generally the weakest observed currents from the entire survey region (Figure 13). In these very shallow regions, the energy from strong wind that is transferred to the water column dissipates instantly into turbulence owing to the bottom friction. The net offshore current has little chance to develop there. This type of conditions, characterized by strong turbulence but weak current, are retentive to the entrained biota. Noteworthily, the high-density sardine aggregations encountered during this survey were mainly associated with this type of current environment.

An isolated case of strong onshore flow can be identified in Figure 13A, in the region of Dakhla. The interpretation of this pattern requires a further data quality control. The 150 kHz ADCP mounted on the Nansen has a depth range limitation; it is known to perform poorly at depths less then 45-50 m because of the bottom induced signal interference. The presented case of strong onshore flow may be a measurement artefact.

The vectors of the mixed-layer current observed along the offshore rim from Cap Blanc and Dakhla point northwest ward. These indicate the action Slope Current flowing along the shelf edge opposite to the upwelling jet. The Slope Current strengthens in the sub-thermocline layer (Figure 13B). The vectors on the inshore side of this flow deflect towards the coast, suggesting that water mass transported with this current is the source of the upwelled water.

The strongest equatorward flow, in excess 50 cm s-1, is found between Cap Bojador and Dakhla (Figure 13A). The current acceleration at this specific location has an apparent geostrophic origin connected to the topographically trapped eddy located just offshore. The eastern rim of this eddy and the associated thermal front is captured in the underway temperature data (Figure 11A). The same front, at the same fixed location can be found in all historical CTD from the Nansen surveys since 1994. Although the Nansen ADCP observations are relatively recent, the permanence of this front in the historical CTD data implies that the strong equatorward coastal current observed in ADCP data during this survey is a permanent feature of the local hydrography, occurring at the same place regardless of local wind conditions. The bottom flow related to this current can be tracked all the way to the northern boundary of the Sahara Bight, which is located just north of Lacraa (Figure 13B). Observations from elsewhere in the global coastal ocean suggest that the hydrographic and current setting as observed off Lacraa is connected to a current-driven upwelling. The presence of such upwelling cell at the northern boundary needs to be further evidenced. If confirmed, it can be a key environmental factor securing the survival of large sardine population of the Sahara Bight during extreme warm events when the regular wind-driven upwelling collapses.

The alongshore, equatorward direction of the current prevails also in the northern region, including the areas between Cap Juby and Tan-Tan where the wind blows onshore. The current appears to respond to a change in wind conditions on short timescales. Off Agadir, where the survey encountered the hiatus in wind conditions (Figure 10B), the observed currents were also relatively low. Between the Gap Ghir and Cap Sim the current speed increases to over 60 cm s-1, which may be connected to the Gap Ghir Filament circulation. However, our survey data are coastal, not suitable for resolving the pattern connected large scale, Cap Ghir Filament related circulation.

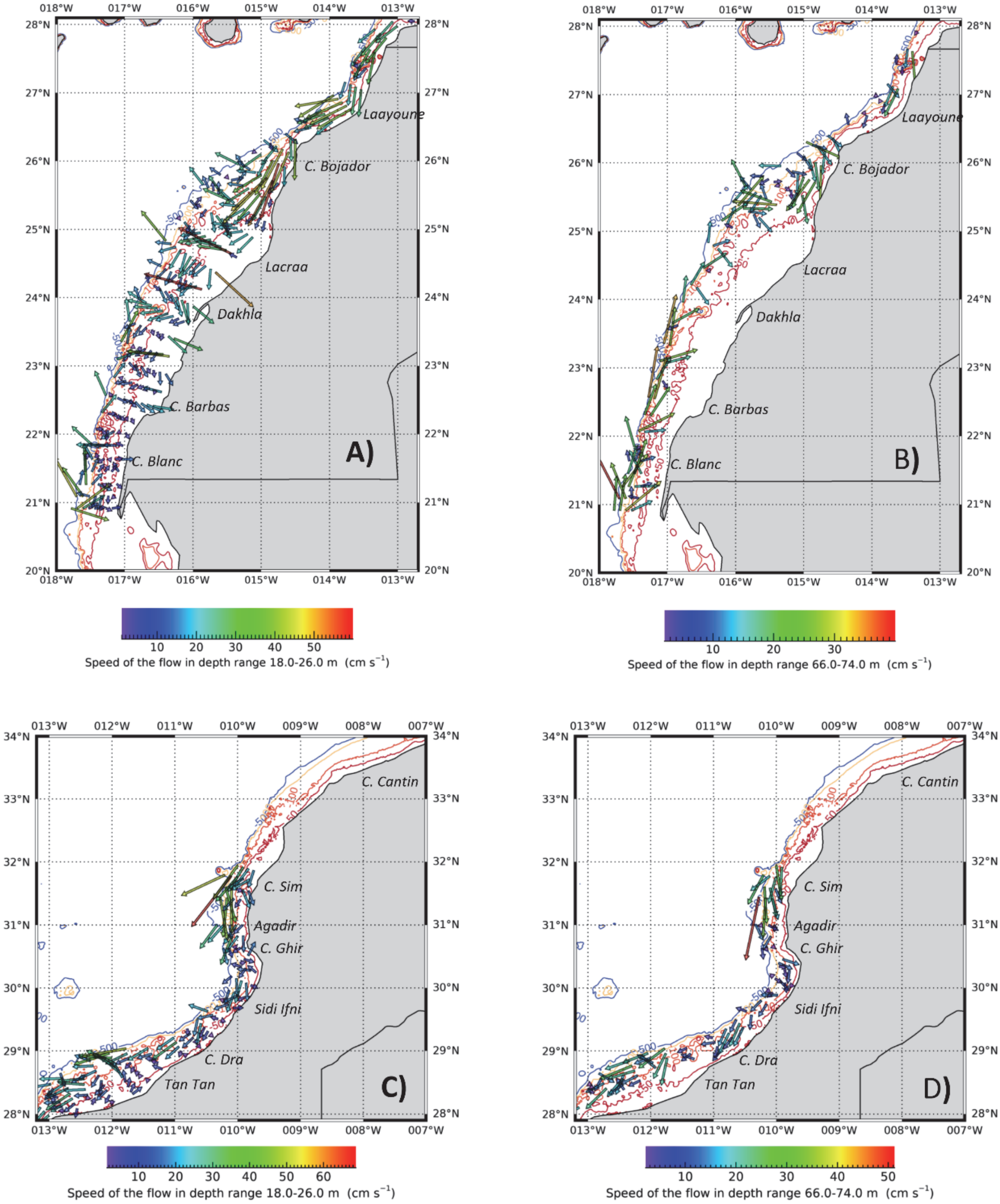


Figure 13. Velocity horizontal distributions (cm/s) A) depth range of 18 m to 26 m from Cap Blanc to Laayoune, B) depth range of 66 m to 74 m from Cap Blanc to Laayoune, C) depth range of 18 m to 26 m from Cap Juby to Cap Sim and D) depth range of 66 m to 74 m from Cap Juby to Cap Sim measured from the ADCP of the vessel during the period of 31 October to 17 November 2019

3.1.5 High-resolution hydrography at the Cap Blanc upwelling cell and over the Sahara Bight.

The Rapid Cast profiling was preformed between Cap Blanc and Dakhla. The results resolve the high-resolution features of the northwest African upwelling, arguably for the first time ever. A total of 922 tows extending from the sea surface to the depth of 150 m or 15 m above the bottom in the shallower waters has been carried out. The results for salinity are presented in Figure 14 and those for potential temperature are shown in the Annex VII, Figure VII.1.

The results indicate a highly dynamic character of upwelling. The nutrient-rich source of the upwelled water (marked in Figure 14 by the salinity less than 36 psu) appear to advance and retract from the shallow waters on diurnal timescale. The stage of upwelling plume advancing towards the coast is captured off Cap Blanc and on T05 section. In contrast, the state plume retracted to the shelf edge is recorded at T02 and T06 sections. The frontal mechanism that drives the diurnal variability appears to be tidally driven by internal solitary waves (ISW) that propagate in the main thermocline toward the coast. In the wake of an ISW advancing wave, the thermocline appears to rise, increasing the volume of upwelling source water in the shallow areas. The opposite phase occurs following the ISW collapse; the thermocline depresses decreasing the volume of the upwelling source water near the coast. Note that our observations are very preliminary. Further studies are planned with the use of the Rapid Cast collected data. Noteworthily, the most abundant sardine aggregations were observed inshore of the ISW activity where the water column was well mixed.

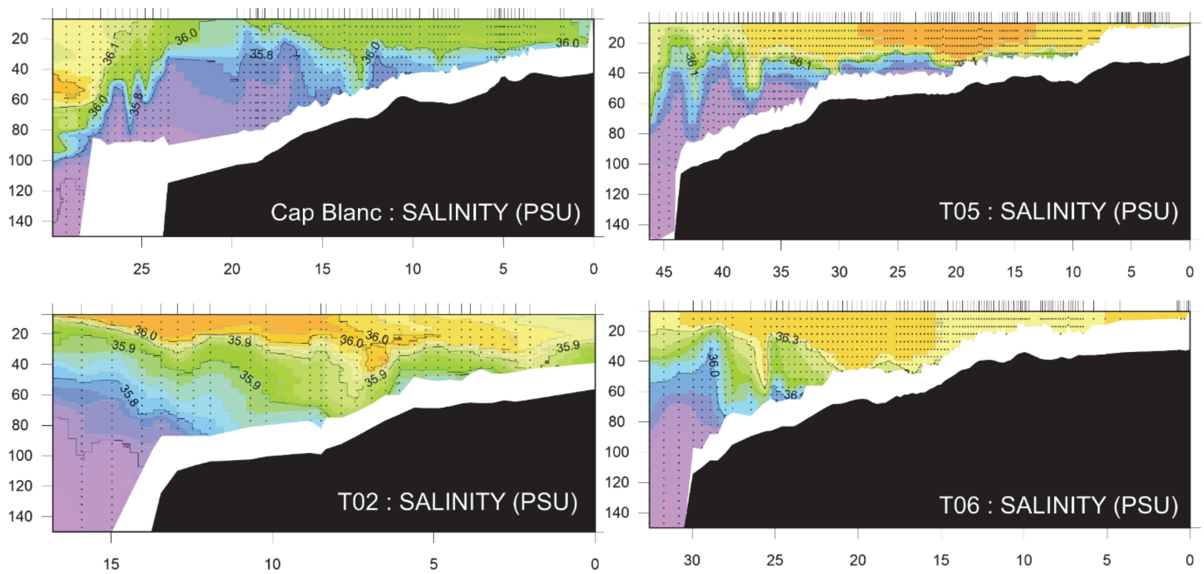


Figure 14. UCTD salinity vertical distributions Cap Blanc in 30/10/2019, T02 in 31/10/2019, T05 in 02/11/2019, and 03/11/2019

3.1.6 Hydrographic sections

Cap Blanc to Cap Cantin Region

In addition to the Rapid Cast measurements, the survey occupied additional oceanographic sections using the standard CTD probe. These sections, located between Cap Blanc and Cap Cantin, extend the existing time series carried out with the Nansen since 1995 that provides data used for regional climate-fish studies. The distributions of potential temperature, salinity, dissolved oxygen and fluorescence along each of the sections from this region are presented in Annex VII.

Cap Cantin to Tanger Region

Four environmental transects were occupied along the leg in the northern part of Morocco where water was collected for chemical analyses in addition to the normal CTD sensor measurements.

Temperature did not vary much as the survey progressed up the coast of northern Morocco (Figure 15). High surface temperatures approached 21°C mostly offshore, whereas lower temperatures approaching 16°C were observed along the coast during transects 2-4. The thermocline was observed between 100 and 200 m with temperatures dropping to 14°C-12°C. Although salinity values follow this same trend of normal high values (36.7 PSU) offshore and lower values along the coast, the salinity does not drop much (36.2 PSU), which is quite surprising considering the river outlets into the area (and directly outside the second transect).

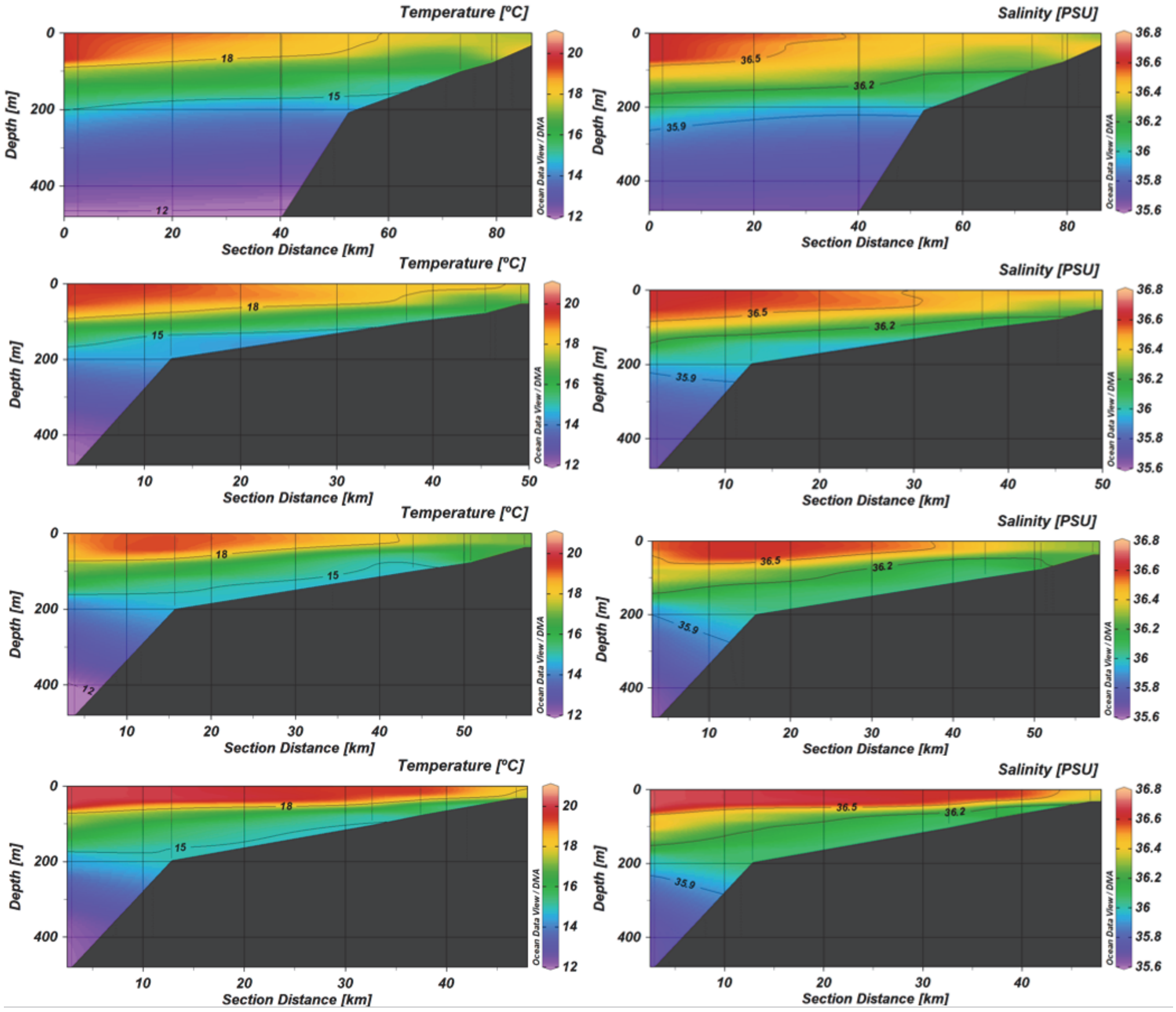


Figure 15. Temperature and salinity values along the four Moroccan transects. The transects are positioned northward from the bottom (33.34°N, 08.53°W) to the top (35.40°N, 06.59°W) along the Moroccan coast

Dissolved oxygen levels also remained relatively stable (and high) throughout the northern Moroccan coast with values ranging from 4.25 ml/l to just about 5.25 ml/l with the highest temperatures at the surface and a consistent oxycline near 100 m (Figure 16). Fluorescence measurements depicted elevated levels ranging from 1.25 µg/l to above 1.5 µg/l against the coast as the vessel moved north. Although that is a small increase, the higher fluorescence levels stretched out 20 km from the coast during the second and third transects but remained fairly concentrated against the coast for the first and fourth transects. The consistent trend of elevated fluorescence against the coast coupled with drops in temperature provide an indication for upwelling in the region and the eventual nutrient data can help test this theory.

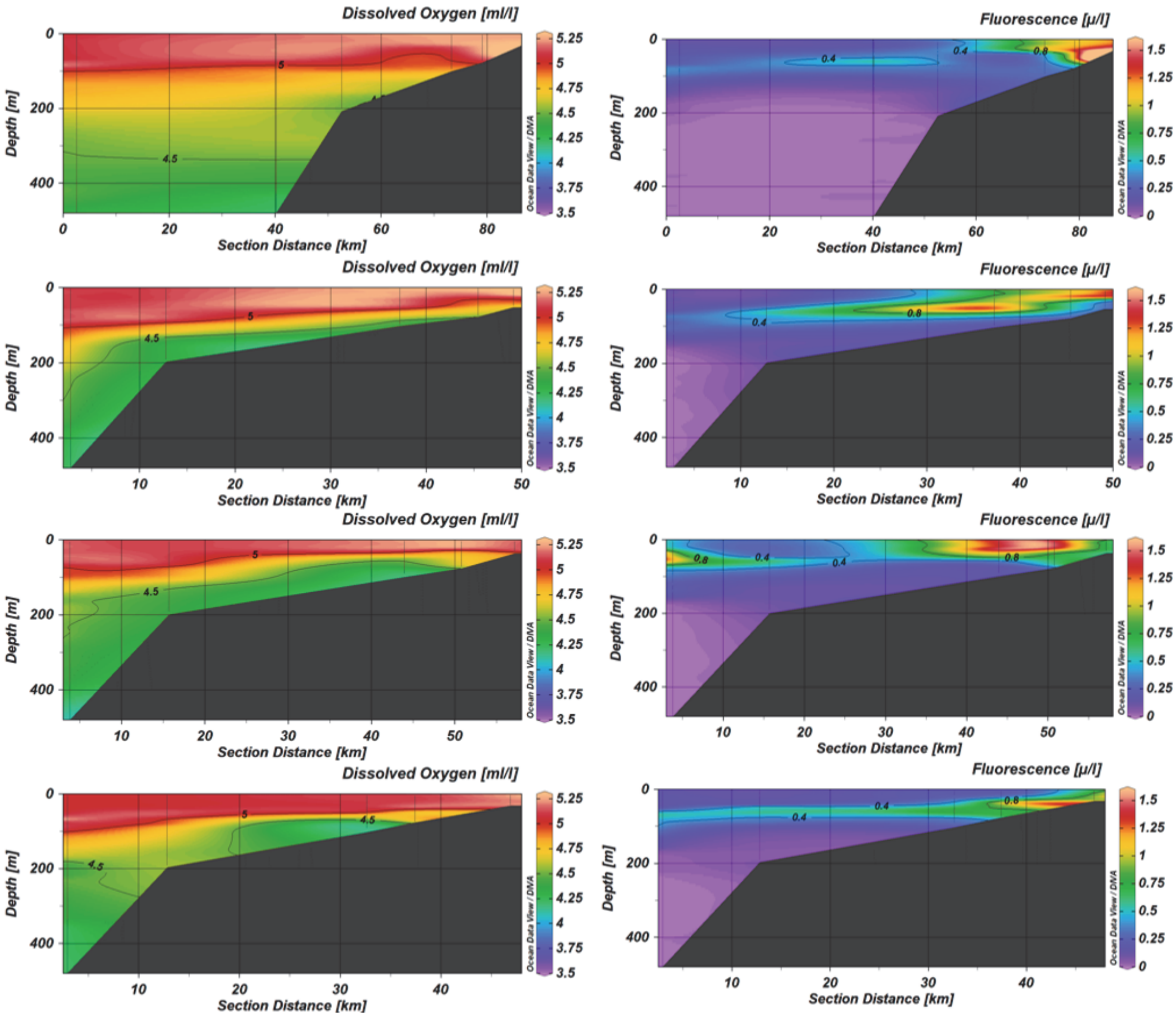


Figure 16. Dissolved oxygen and fluorescence values along the four Moroccan transects. The transects are positioned northward from the bottom (33.34°N, 08.53°W) to the top (35.40°N, 06.59°W) along the Moroccan coast

3.1.7 Water Chemistry

Cape Cantin to Tanger

3.1.7.1 Ocean Acidification

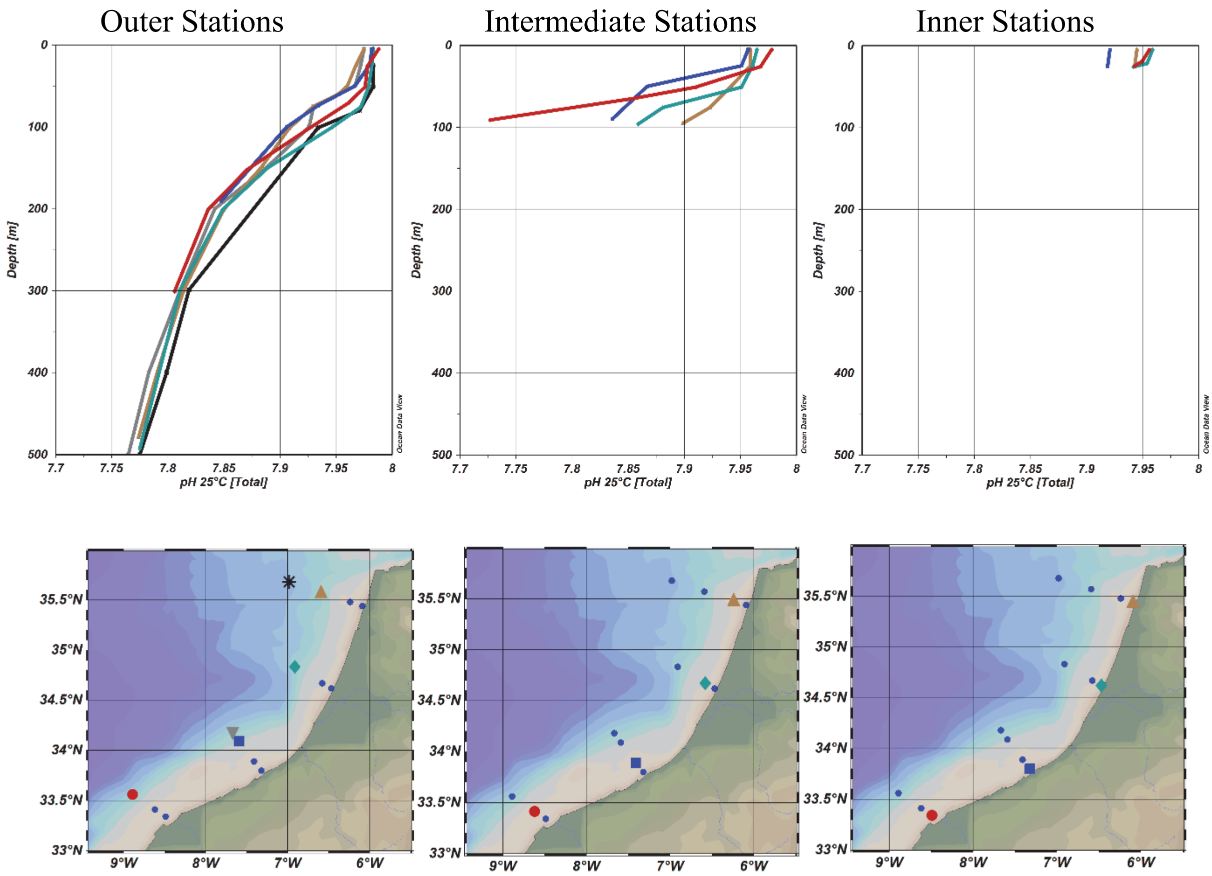


Figure 17. pH profiles for all four environmental transects displayed in groups of outer, intermediate and inner stations

pH profiles along the coast of northern coast of Morocco are divided into outer, intermediate and inner stations, which also correspond to the bottom depth (except for the black symbolled station that went to 1 000 m), Figure 17. Correlating with increased CO_2 at lower depths, the deep outer stations displayed the lowest observed pH values of 7.76-7.77. These offshore outer stations also displayed the highest observed pH values near the surface approaching 7.98-7.99. As the vessel approached the intermediate stations, pH values began to decrease which could be the first indication of upwelling as the seawater is cooler at this intermediate 100 m depth stations. Finally, at the ~25 m deep inner stations, pH values of 7.96 to almost 7.92 (second transect) were observed. The low pH values and lower temperatures further support upwelling as cold water and CO_2 is typically taken from deep waters and pushed along the upward sloping ocean floor as it moves towards the ocean surface against the coast.

After nutrient analyses have been performed at the Institute of Marine Research, phosphate and silicate concentrations combined with the onboard measurements of pH and total alkalinity can be used to calculate the area's inorganic carbon components along with the aragonite saturation state to update the ocean acidification status of the region.

3.1.7.2 Nutrients

Nutrient samples for nitrite, nitrate, phosphate and silicate determination were sent to the Institute of Marine Research for analysis. Data is available upon request.

3.1.7.3 Chlorophyll a

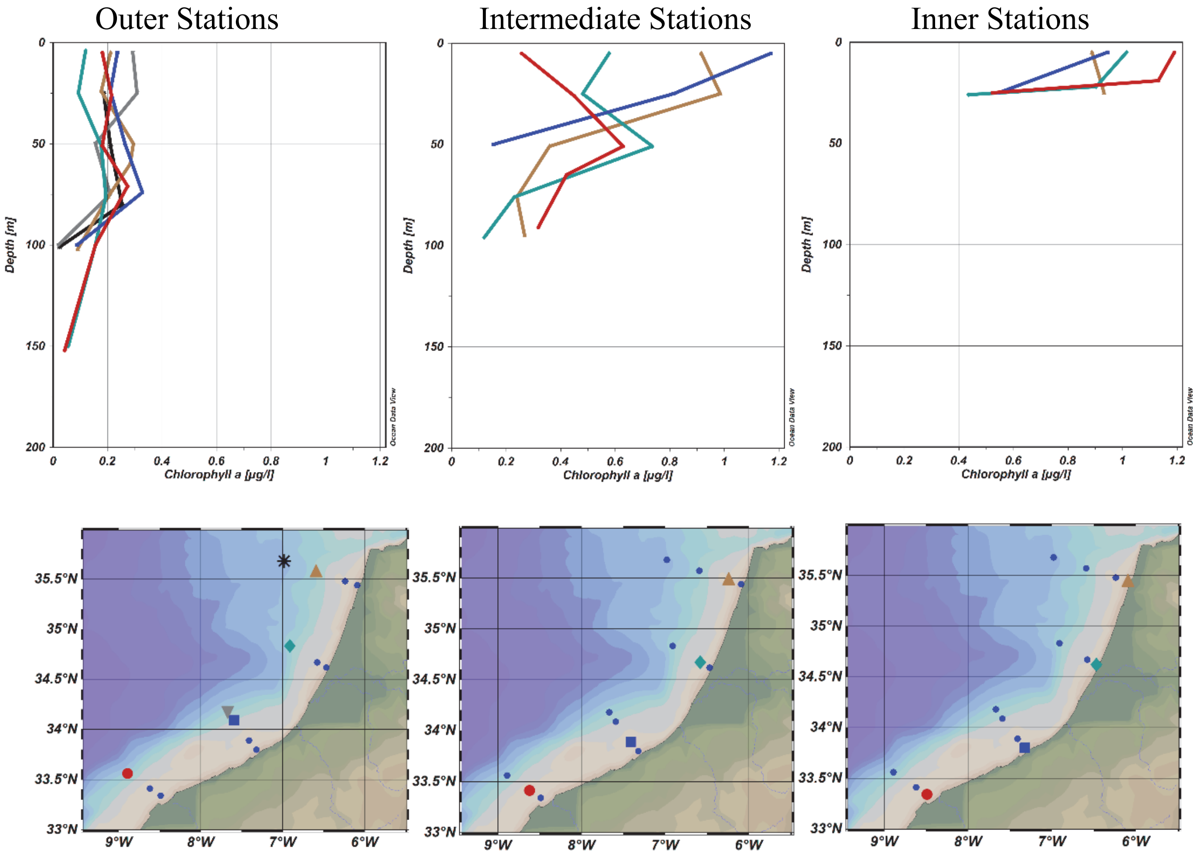


Figure 18. Chlorophyll a profiles as determined by onboard fluorometric analysis for all four environmental transects displayed in groups of outer, intermediate and inner stations

As previously indicated by temperature, fluorescence and pH, upwelling has been speculated against the Moroccan coast and onboard chlorophyll a measurements fit this trend, Figure 18. The deep outer stations all have values below 0.4 µg/l with little variation and low maxima, whereas intermediate stations began to increase with maxima observed near 50 m (0.6-0.7 µg/l) and 30 m and 5 m (0.9-1.19 µg/l). However, chlorophyll a values did begin to drop, approaching the 100 m ocean floor. At the 25 m inner stations, chlorophyll a values ranged from >0.4 µg/l to ~1.2 µg/l but all recorded values at the surface were above 0.89 µg/l.

3.2 Plankton and microplastics

3.2.1 Cap Blanc to Cap Cantin

The environmental sampling grid from Cap Blanc to Cap Cantin consisted of 38 super stations located over the isobaths of 30 m, 100 m and 500 m (Station 1184 to Station 1245). Due to adverse weather conditions the deployment of all sampling devices was not possible at every station. The total number of stations sampled, the sampling device used, and stations not sampled are summarized in Table 5.

Table 5. Overview of the stations sampled from Cap Blanc to Cap Cantin

Sampling device	Number of sampled stations	Not sampled stations
WP2 (180 µm)	35	St 1230, St 1232
Manta trawl (335 µm)	21	St1185, St 1190, St 1191, St1200, St 1201, St 1203, St1205, St1209, St1210, St 1217, St1219, St1226, St1230, St1232, St 1236, St1238, St 1239
Bongo net (405 µm)	30	St1205, St1209, St1217, St1219, St1226, St 1230, St 1232, St 1236

3.2.1.1 Zooplankton

A total of 89 aluminum trays were collected for zooplankton biomass estimation at IMR. A total of 35 WP2 samples (4% borax buffered formaldehyde) were collected for future zooplankton taxonomic identification at INRH. The results of total zooplankton biomass estimation are shown in Figure 19. Total zooplankton biomass ranged between 0.1-10.2 g m^{-2}, with no clear pattern in distribution. Some of the stations with highest zooplankton biomass were located near the shelf break, and some of the lowest values were found in the stations closest to the coast (Figure 19). Size-fractionated samples revealed that organisms smaller than 1 mm in size comprised most of the zooplankton biomass, although for certain stations, particularly in the deepest area of the survey, the contribution of organisms larger than 2 mm was also important (Figure 20).

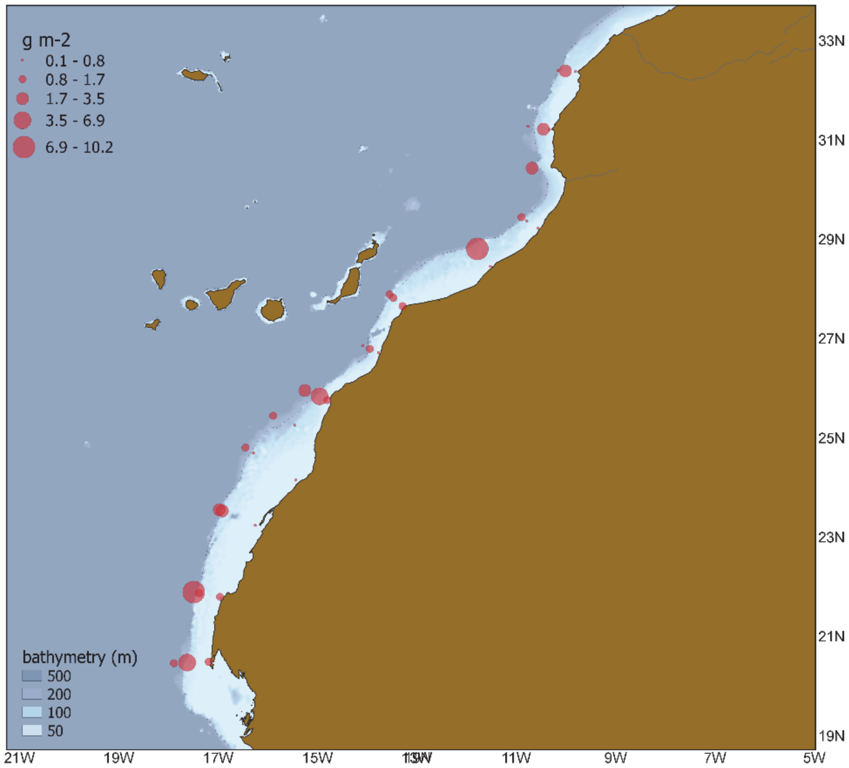


Figure 19. Total zooplankton biomass (g m-2) in the Cap Blanc-Cap Cantin transect

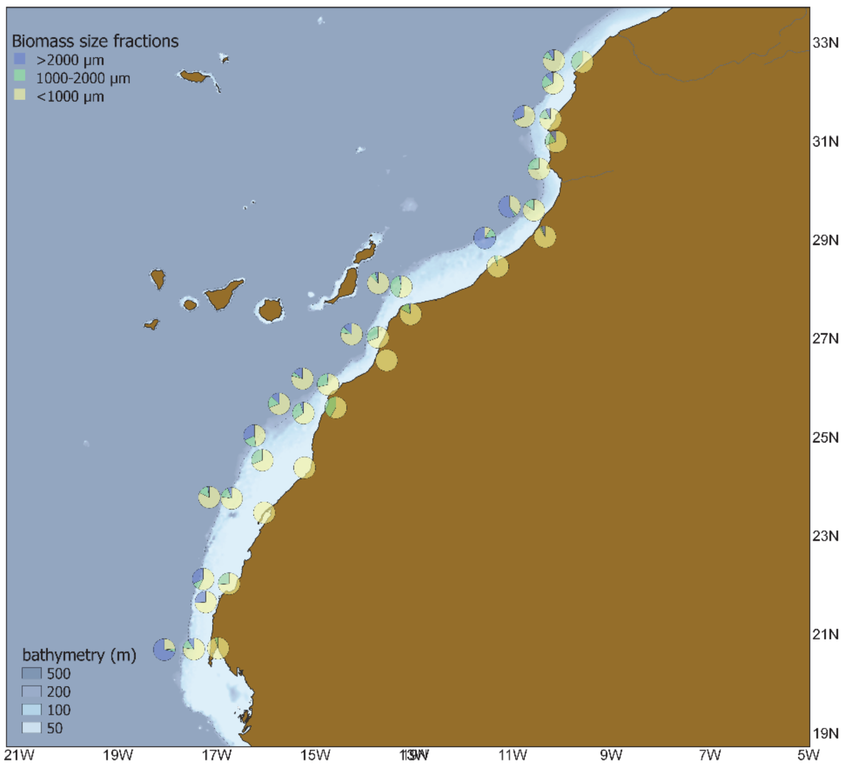


Figure 20. Contribution of different size fractions (< 2 000 µm, 1 000-2 000 µm, and > 1 000 µm) to the total zooplankton biomass in the Cap Blanc-Cap Cantin transect

3.2.1.2 *Ichthyoplankton*

A total of 15 pairs of Bongo net samples were collected. Many eggs and larvae were also collected in the Manta trawl, of which 15 were also taken at the same stations. Ichthyoplankton was sorted from 21 out of the total Bongo net stations. A total of 30 jars with bulk plankton and 21 scintillations vials with fish larvae and eggs (all preserved in 4% formaldehyde solution) were collected for further analysis at INRH (Morocco) for estimation of ichthyoplankton abundance and taxonomic identification, respectively.

3.2.1.3 *Microplastics*

From the area between Cap Blanc and Cap Cantin, a total of 21 Manta trawl net hauls were successfully taken. A total of 6 aluminum trays with microplastics were transferred to IMR for further processing. A total of 14 scintillation vials with sorted larvae and eggs preserved in 96% ethanol were transferred to IMR for taxonomic identification. A total of 21 bulk Manta trawl samples preserved in 96% ethanol were transferred to University of the Western Cape, South Africa for future analysis.

3.2.2 Cap Cantin to Tanger

The plankton sampling from Cap Cantin to Tanger consisted of 13 superstations located over the isobaths of 30 m, 100 m and 500 m, and one over 1000 m depth (Station 1146 to Station 1266). All stations were sampled, and the total number of stations and sampling devices used are summarized in Table 6.

Table 6. Overview of plankton stations sampled from Cap Cantin to Tanger

Sampling device	**Number of sampled stations**
WP2 (180 µm)	13
Manta trawl (335 µm)	13
Bongo (405 µm)	13

3.2.2.1 *Zooplankton*

A total of 37 aluminum trays for zooplankton dry weight estimation were collected during the survey for zooplankton biomass estimation at IMR. The results of total zooplankton biomass estimation are shown in Figure 21. Total zooplankton biomass ranged between 0.6-2.1 g m^{-2}, with no clear pattern of biomass distribution. Size-fractionated samples revealed that organisms smaller than 1 mm in size comprised most of the zooplankton biomass, especially in the central area of the survey. For certain stations in the north and south of the area, the contribution of organisms larger than 1 mm was also important (Figure 22).

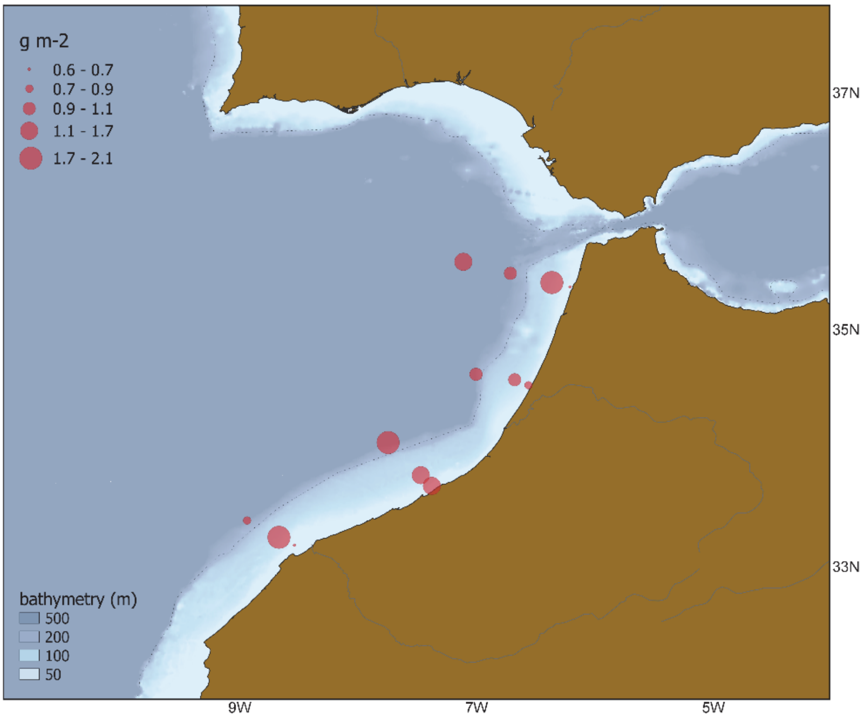


Figure 21. Total zooplankton biomass (g m^{-2}) in the Cap Cantin-Tanger transect

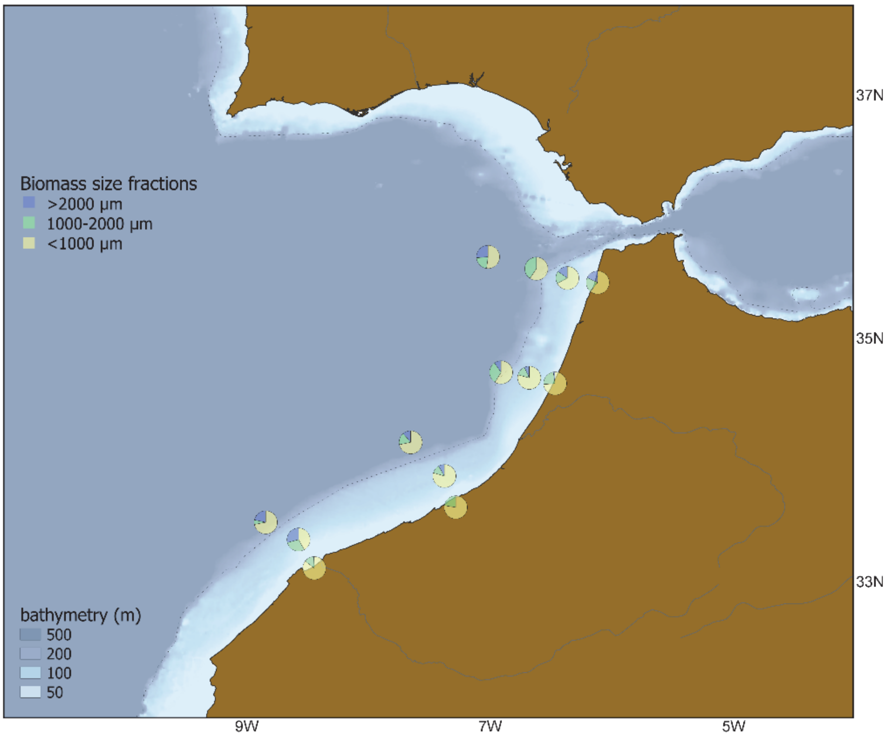


Figure 22. Contribution of different size fractions (< 2 000 µm, 1 000-2 000 µm, and > 1 000 µm) to the total zooplankton biomass in the Cap Cantin-Tanger transect

3.2.2.2 Ichthyoplankton

Bongo net & Manta trawl net

All Bongo-V and Manta trawl samples collected during the survey were processed under a stereomicroscope onboard. The number of fish larvae and eggs found varied between stations, and the highest number were usually found in the stations located closest to the coast (i.e. 30 m and 100 m depth).

The number of sorted fish larvae and eggs from both nets and per station is presented in Table 7. Very few eggs were sorted out from the 13 Bongo samples, while larvae were found in high numbers (< 100 larvae) at most stations. Some pictures of the sorted specimens are provided in Figure23. The Manta collections were examined for sorting fish larvae, but also post larval and juvenile stages. Fish larvae and eggs were found in low numbers, except at the two of the 100 m -depth stations for the larvae (st. 1253 and st. 1266) and at two of the 30 m-depth stations for the eggs (st. 1250 and st. 1261) (Table 7).

Table 7. Numbers of fish larvae and eggs sorted from the Bongo and Manta samples for each station

		Bongo net		**Manta net**	
Station	Station depth (m)	Larvae	Eggs	Larvae/ Post larvae-juveniles	Eggs
1246	498	12	0	1/2	0
1248	106	39	1	1/0	0
1250	33	19	0	2/22	117
1251	518	256	0	48/22	0
1253	100	356	0	374/13	0
1255	34	15	0	5/17	0
1256	496	170	0	3/2	2
1258	103	236	14	2/11	0
1260	50	77	0	7/3	0
1261	32	612	2	47/0	483
1263	101	219	0	246/29	0
1265	489	117	0	6/0	3
1266	1062	209	0	0/10	0
TOTAL		**2 337**	**17**	**742/131**	**605**

All sorted specimens (13 scintillation vials) from the Bongo collections, bulk samples after sorting (13 Bongo V samples in 4 % formaldehyde) and unsorted samples (13 Bongo H samples in 96% ethanol), will be processed at INRH, for taxonomic identification of specimens and further analysis. All sorted specimens from the Manta collections (13 scintillation vials) were transferred to IMR for detailed taxonomic identification. The bulk plankton samples from the Manta net after sorting (11 samples) were transferred to University of the Western Cape, South Africa for further analysis. Unsorted samples with high presence of microplastics from st. 1255 and st. 1260 were transferred to IMR for further analysis.

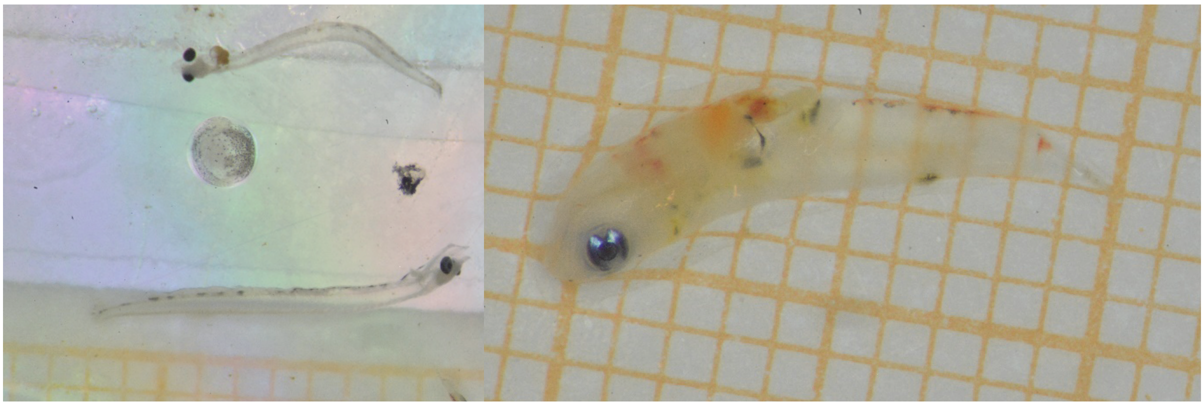


Figure 23. Fish larvae and egg found in a Bongo V sample from station 1248

3.2.2.3 Microplastics

Items resembling microplastics were found at all Manta samples, and a total of 281 items were sorted from the samples. The highest abundance of microplastics was found at the stations closest to the shore in all transects (Figure 24). Figure 25 shows some of the microplastics found (left picture), as well as the sample from station 1255 which was not processed due to the unusually high concentration of micro litter (right picture). A total of 11 aluminium trays with dried microplastics were transferred to IMR for future analysis.

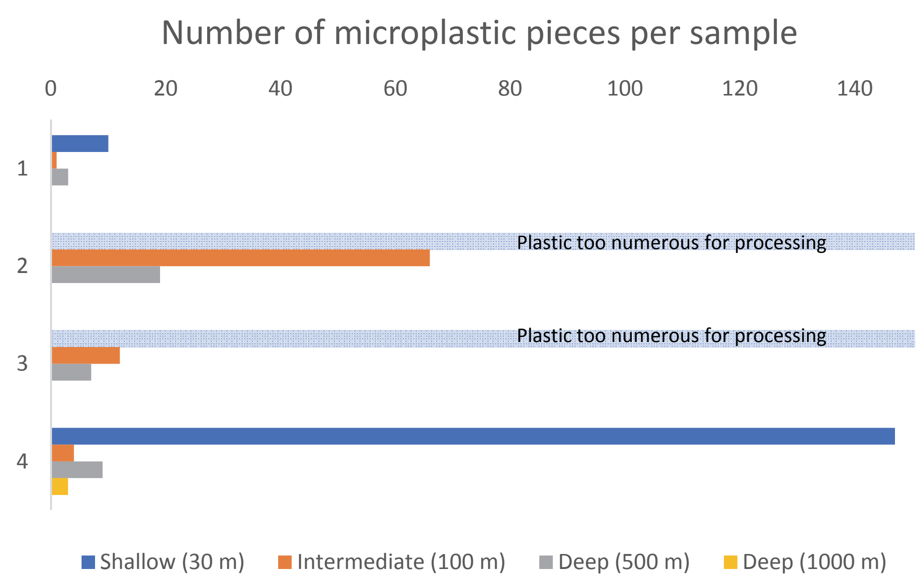


Figure 24. Number of microplastics pieces found in the 4 sampling transects (from Cap Cantin to Tanger) at different depths. The light blue bars indicate the two shallow stations where microplastics were too numerous to process

Figure 25. Microplastics found in the Manta net (left picture), and a sample with high concentration of microplastics (right picture)

3.3 Top predator observations

Tables 8 and Table 10 summarise the daily sightings of seabirds from Cap Blanc to -Cap Cantin and Cap Cantin to -Tanger, respectively, whilst Table 9 and Table 11 summarise the counts of cetaceans for the same respective areas.

Some additional observations are listed below:

- 4 November 2019: we observed two groups of dolphins: the first group consisted of a mixed group of short-beaked common dolphins (10) and striped dolphins (70); the second group consisted of short-beaked common dolphins (15).
- 13 November 2019: a group of small dolphins were observed from the dining room in early morning.
- 14 November 2019: two different groups of small dolphins were observed from the bridge.
- 16 November 2019: small group of unidentified small dolphins (either short-beaked common dolphins or striped dolphins).
- 17 November 2019: two groups of short-beaked common dolphins, one at mid-day (30) and one in late afternoon (20). One group of humpback whales.

Table 8. Total number of seabirds observed Cap Blanc – Cap Cantin

O: October, N: November

English name	**Scientific name**	**31 O**	**1 N**	**2 N**	**3 N**	**4 N**	**5 N**	**6 N**	**7 N**	**8 N**	**9 N**	**10 N**	**11 N**	**12 N**	**13 N**	**14 N**	**15 N**	**16 N**	**17 N**
Wilson's Storm Petrel	*Oceanites oceanicus*		2			2		6											
European Storm Petrel	*Hydrobates pelagicus*			1	4														
Storm Petrel (prob. Leach's Storm-petrel)	*Oceanodroma sp.* (c.f. *O. leucorhoa*)					6													
Scopoli's Shearwater	*Calonectris diomedea*	1		27	17														
Cory's Shearwater	*Calonectris borealis*	334	394	268	121	439	446	110	239	30	9	2					2	3	
Unidentified Shearwater	*Calonectris sp.*		5																
Sooty Shearwater	*Ardenna grisea*					2		3											
Northern Gannet	*Morus bassanus*	406	1 007	517	299	172	825	213	485	21	82	41	6	134	99	188	410	202	271
Red Phalarope	*Phalaropus fulicarius*	5																	
Sabine's Gull	*Xema sabini*	1	5	1															
Audouin's Gull	*Ichthyaetus audouini*		65	63			2					6	2	18	9	6	13		
Lesser black-backed Gull	*Larus fuscus*	7	1	3	19	1	13	73	36	120	1 739	142	28	316	78	222	105	125	612
Yellow-legged Gull	*Larus michahellis*															6			2
Sandwich Tern	*Thalasseus sandvicensis*	2	3	4	11				3								5	1	
Common Tern	*Sterna hirundo*	6										3							
Black Tern	*Chlidonias niger*	10										2							
Great Skua	*Stercorarius skua*	6	7	2	2	2	1	1	2			2				3	1		2
Pomarine Skua	*Stercorarius pomarinus*	17	9	27	1	6	10	1	10			5				1			1
Total		**795**	**1 498**	**913**	**474**	**630**	**1 297**	**407**	**775**	**171**	**1 830**	**203**	**36**	**468**	**186**	**426**	**536**	**331**	**888**

Table 9. Total number of marine mammals observed, Cap Blanc – Cap Cantin

English name	**Nom français**	**Scientific name**	**31 Oct**	**04 Nov**	**13 Nov**	**14 Nov**	**16 Nov**	**17 Nov**	**Total**
Short-beaked common dolphin	Dauphin commun à bec court	*Delphinus delphis*		25		80		50	**155**
Striped dolphin	Dauphin rayé	*Stenella coeruleoalba*		70					**70**
Unidentified dolphin	Dauphin non identifié	*Delphinus/Stenella*			20		10		**30**
Atlantic bottlenose dolphin	Grand dauphin	*Tursiops truncatus*				20			**20**
Sperm whale	Grand cachalot	*Physeter macrocephalus*	4						**4**
Humpback whale	Baleine à bosse	*Megaptera novaeangliae*						3	**3**
Total			**4**	**95**	**20**	**100**	**10**	**53**	**282**

Table 10. Total number of seabirds observed, Cap Cantin – Tanger

English name	Nom français	Scientific name	22-nov.	23-nov.	24-nov.	25-nov.	26-nov.	27-nov.	28-nov.	29-nov.	Total
Wilson's Storm Petrel	Océanite de Wilson	*Oceanites oceanicus*		3							**3**
Leach's Storm Petrel	Océanite culblanc	*Oceanodroma leucorhoa*			1						**1**
Cory's Shearwater	Puffin cendré	*Calonectris borealis*	11	2							**13**
Sooty Shearwater	Puffin fuligineux	*Ardenna grisea*	1								**1**
Great Shearwater	Puffin majeur	*Ardenna gravis*			1						**1**
Northern Gannet	Fou de Bassan	*Morus bassanus*	24	52	428	172	38	5	3	31	**753**
Red Phalarope	Phalarope à bec large	*Phalaropus fulicarius*			2						**2**
Audouin's Gull	Goéland d'Audouin	*Ichthyaetus audouini*	2								**2**
Lesser black-backed Gull	Goéland brun	*Larus fuscus*	58	11	531	50	93	146	8	41	**938**
Yellow-legged Gull	Goéland leucophée	*Larus michahellis*	8		30						**38**
Sandwich Tern	Sterne caugek	*Thalasseus sandvicensis*			1	1					**2**
Great Skua	Grand Labbe	*Stercorarius skua*	2	1	1	1	1	1	2		**9**
Pomarine Skua	Labbe pomarin	*Stercorarius pomarinus*			1		3	1	1		**6**
Total			**106**	**69**	**996**	**224**	**135**	**153**	**14**	**72**	**1 769**

Table 11. Total number of marine mammals observed, Cap Cantin – Tanger

English name	Nom français	Scientific name	24-nov.
Striped dolphin	Dauphin rayé (D. bleu et blanc)	*Stenella coeruleoalba*	250

3.4 Distribution and abundance of pelagic fish

Estimates of the target pelagic species, in numbers and biomass per length group, in the three regions, Cap Blanc to Cap Bojador and Cap Bojador to Cap Cantin, and Cap Cantin to Tanger is presented in Annex IV.

Cap Blanc to Cap Bojador

Sardine, *Sardina pilchardus*

Sardine were found continuously inshore in this area (Figure 26). The densities were high with dense schools at depths shallower than 40 m. The sardine was sometimes mixed with other pelagic species (P2), but trawl stations showed that the sardine very often occurred in clean concentrations, not mixed with other species. Some 30 NM south of Dakhla, the sardine also occurred somewhat offshore, but in low concentrations. The length distribution (Figure 42) showed that the sardine occurred in two main size groups, probably different cohorts. The modal length of these size groups were 16 cm and 23 cm. The estimated biomass of sardine in this area was 3.4 million tonnes (Annex IV).

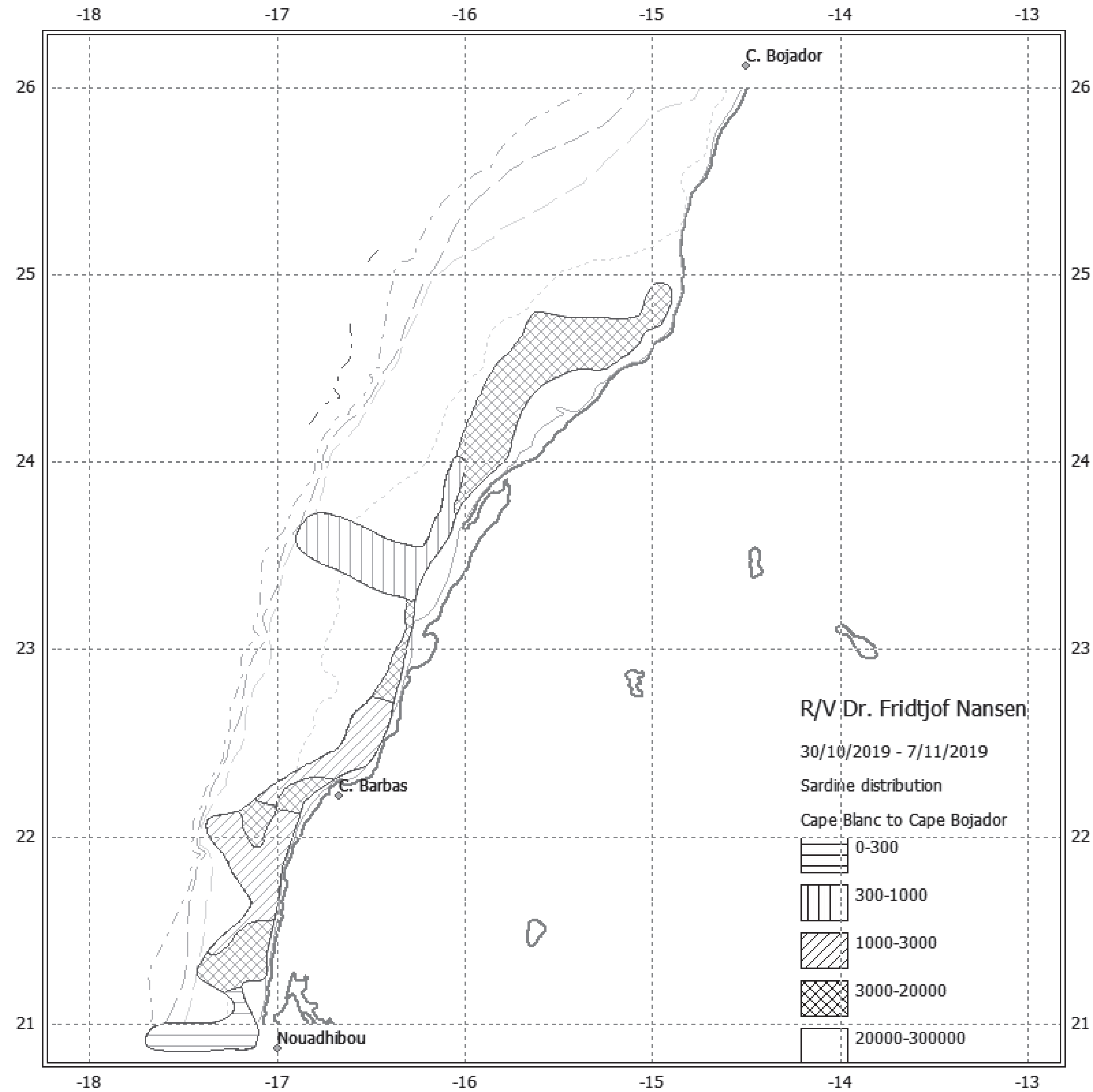


Figure 26. Distribution (density, m^2/NM^2) of sardine, *Sardina pilchardus* in the area between Cap Blanc and Cap Bojador

Mackerel, *Scomber colias*

Mackerel were found in two main aggregations (Figure 27). One some 30 NM north of Cap Barbas and the other one north of Dakhla. The southernmost off Cap Barbas was by far the densest one. The mackerel occurred more offshore than the sardine. The total length -distribution (Figure 42) of the estimated number of fish per length group indicates one modal length of 20 cm. The estimated biomass of mackerel in this area was 512 000 tonnes (Annex IV).

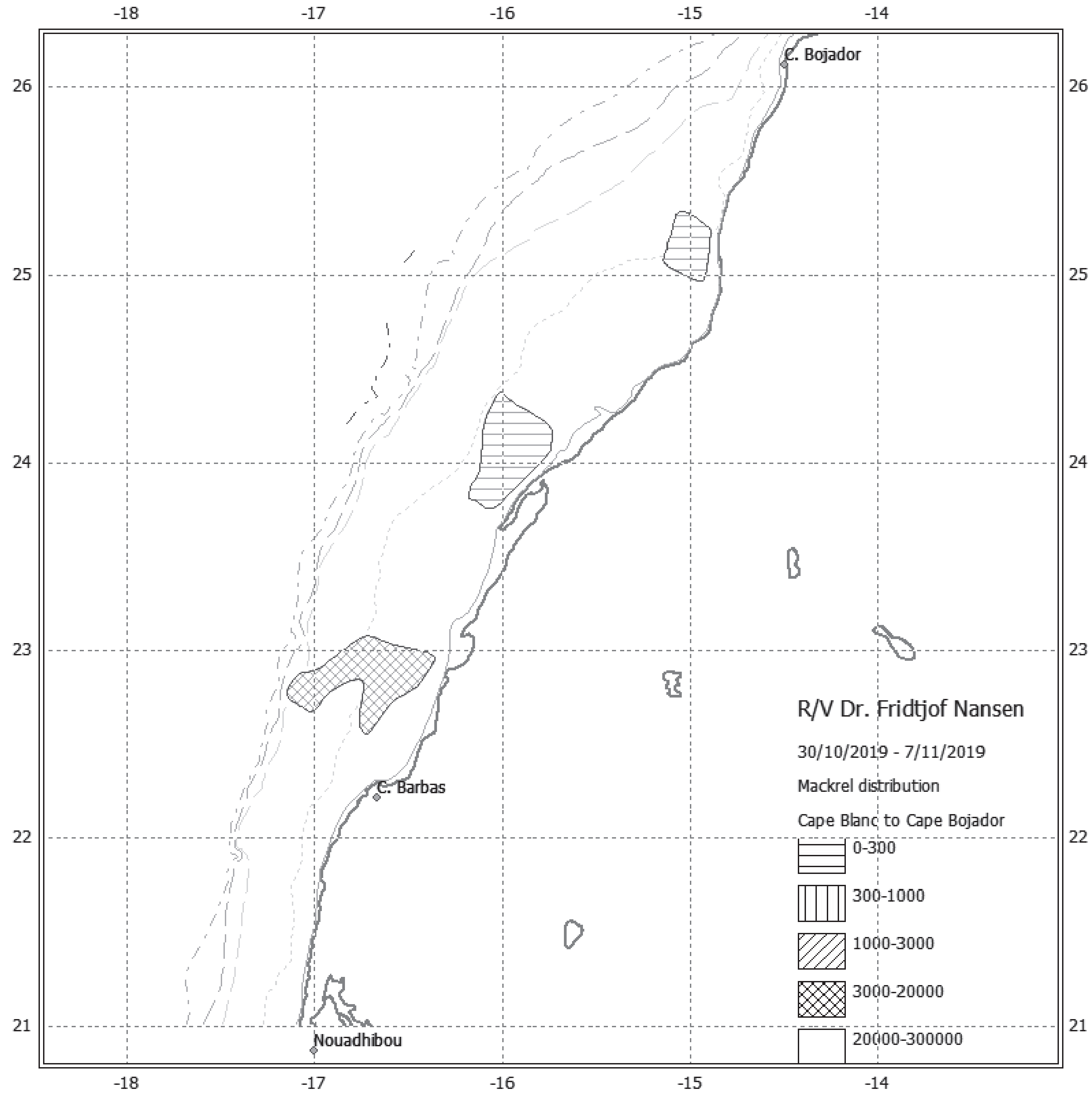


Figure 27. Distribution (density, m^2/NM^2) of mackerel, *Scomber colias*, in the area between Cap Blanc and Cap Bojador

Horse mackerels, *Trachurus trachurus* and *Trachurus trecae*

Horse mackerel were found in several smaller aggregations spread along the shelf (Figure 28). The densities were moderate to high. Typically, the horse mackerel tended to stay close to the bottom during daytime which changed to a more pelagic behaviour during night. *Trachurus trecae* was only observed in the area off Cap Blanc. The other aggregations consisted of *Trachurus trachurus*. The length distribution showed that the horse mackerel had modal length of 13 cm (Figure 42). The estimated biomass of horse mackerel in this region was 388 000 tonnes (Annex IV), of this only 4 000 tonnes was *Trachurus trecae*.

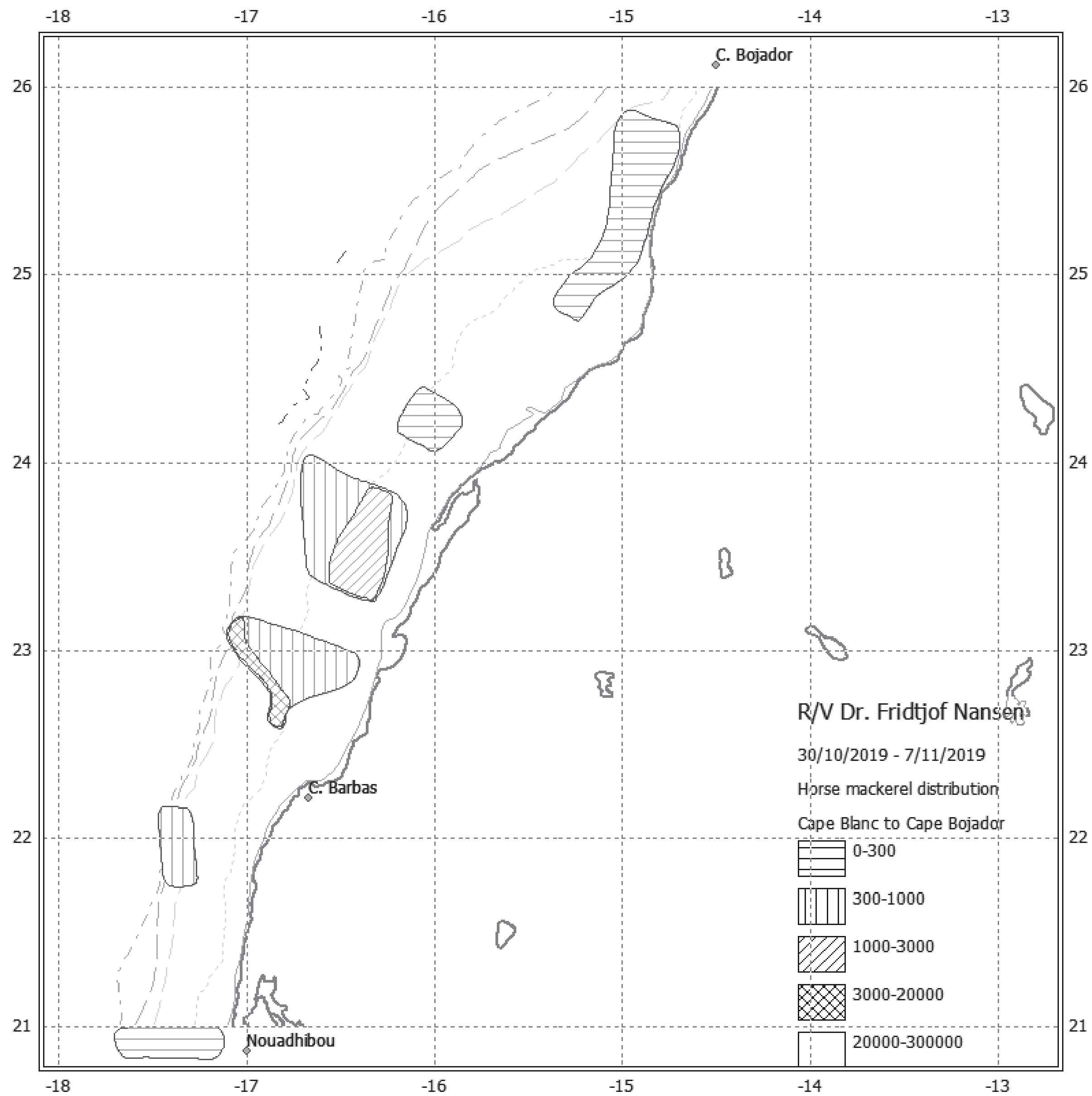


Figure 28. Distribution (density, m^2/NM^2) of horse mackerels, *Trachurus trecae* and *Trachurus trachurus*, in the area between Cap Blanc and Cap Bojador

Anchovy, *Engraulis encrasicolus*

Anchovy was distributed in two low density areas, one off Cap Blanc and the other north of Cap Barbas (Figure 29). The anchovy was mixed with Sardine and other pelagic fish. The length distribution showed a modal length of 10 cm (Figure 42). The estimated biomass of anchovy in this region was 3 900 tonnes (Annex IV).

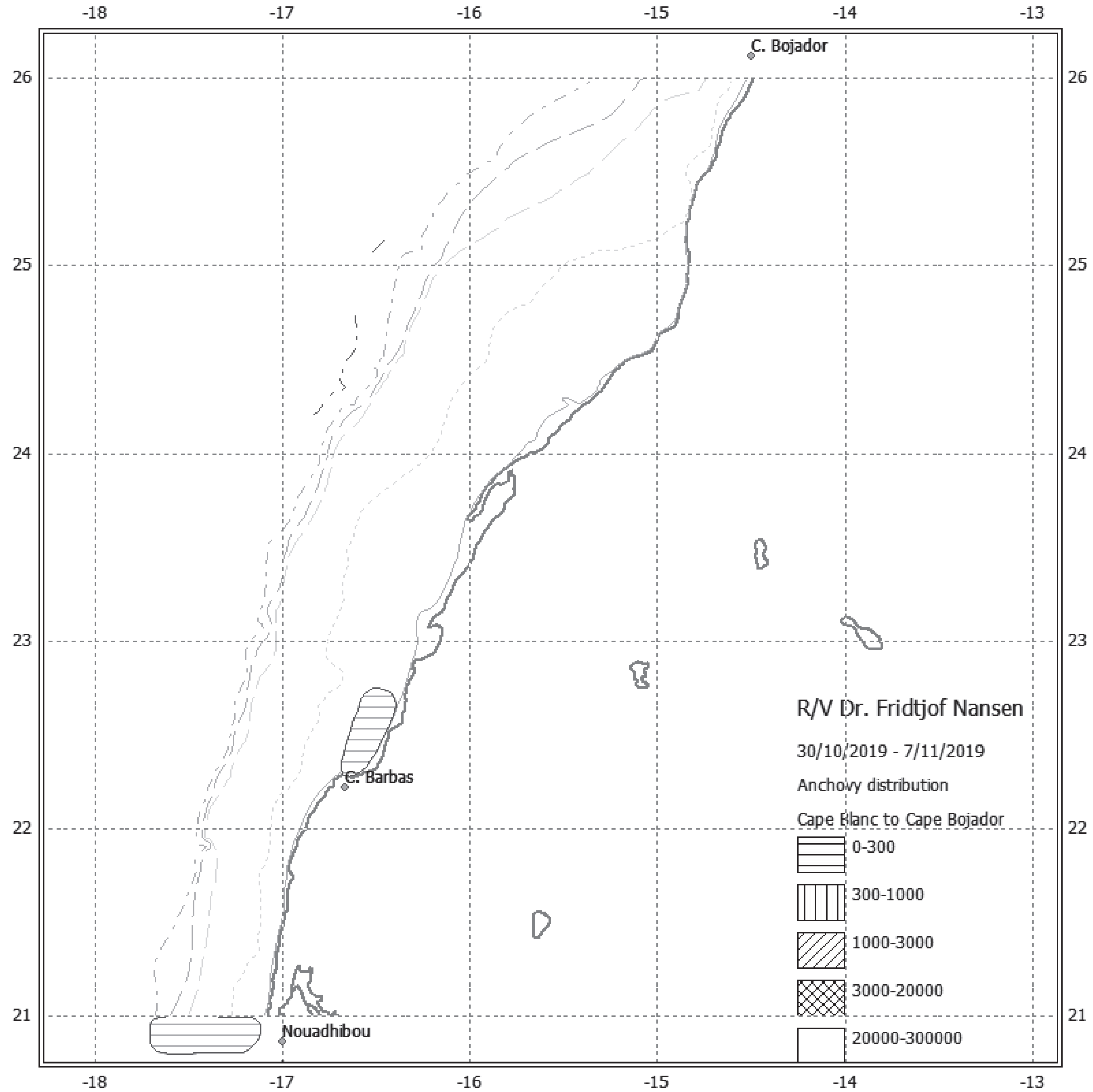


Figure 29. Distribution (density, m^2/NM^2) of Anchovy, *Engraulis encrasicolus*, in the area between Cap Blanc and Cap Bojador

Other pelagic fish, P2

The distribution of other pelagic fish, carangids and associated species is presented in Figure 30, and the biomass estimate was 347 000 tonnes (Annex IV).

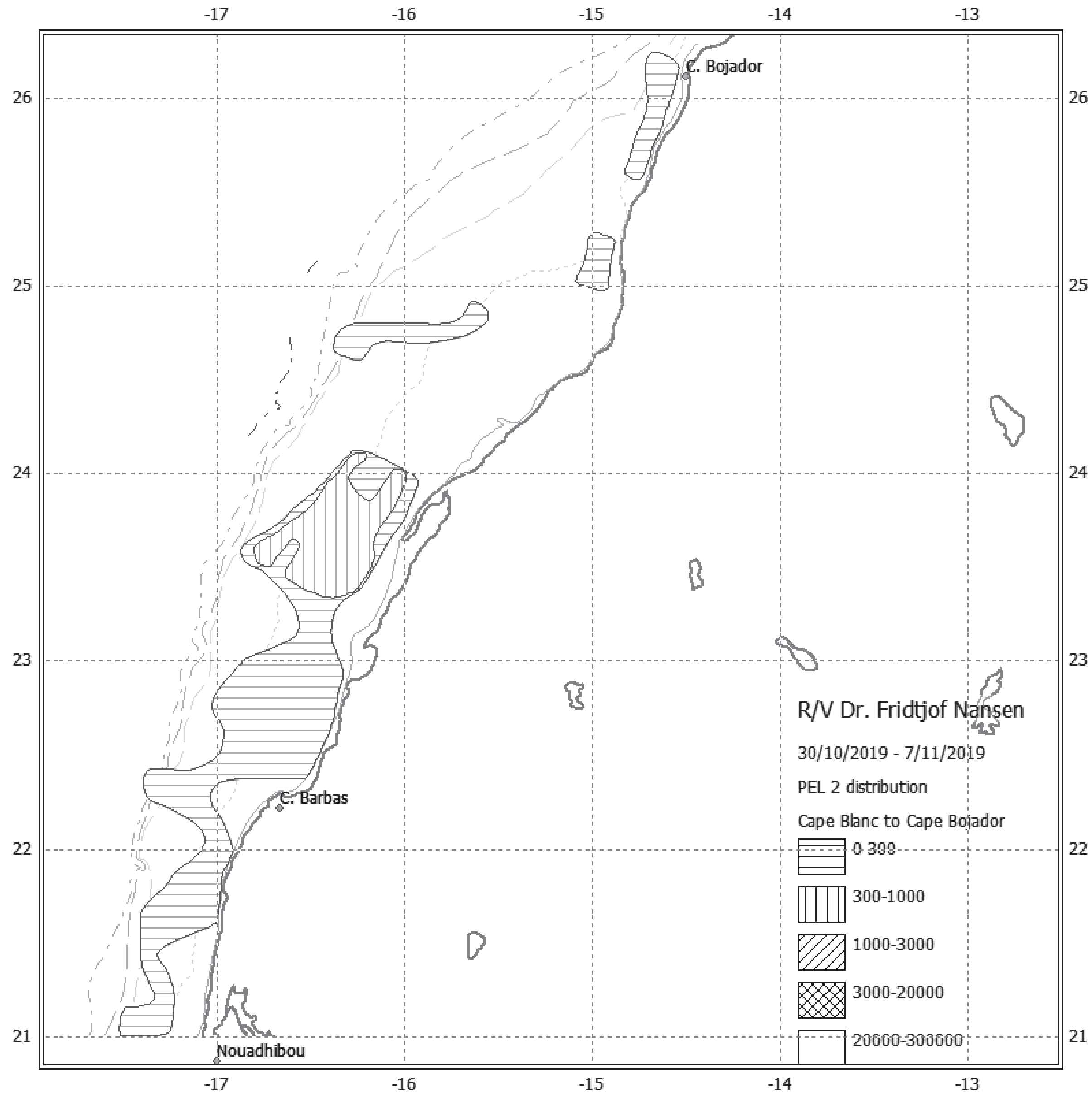


Figure 30. Distribution (density, m^2/NM^2) of P2 (other pelagic fish, carangids and other species), in the area between Cap Blanc and Cap Bojador

Cap Bojador to Cap Cantin

Sardine, *Sardina pilcardus*

Sardine were distributed mostly inshore, mainly as two continuous belts, one from Cap Jubi to Tan Tan, and the other one from Sidi Ifni to Cap Cantin (Figure 31). Trawl stations confirmed that the sardine was present often in very low densities. The modal length of the sardine in this region was 14 cm (Figure 42). The biomass was estimated to 567 000 tonnes (Annex IV).

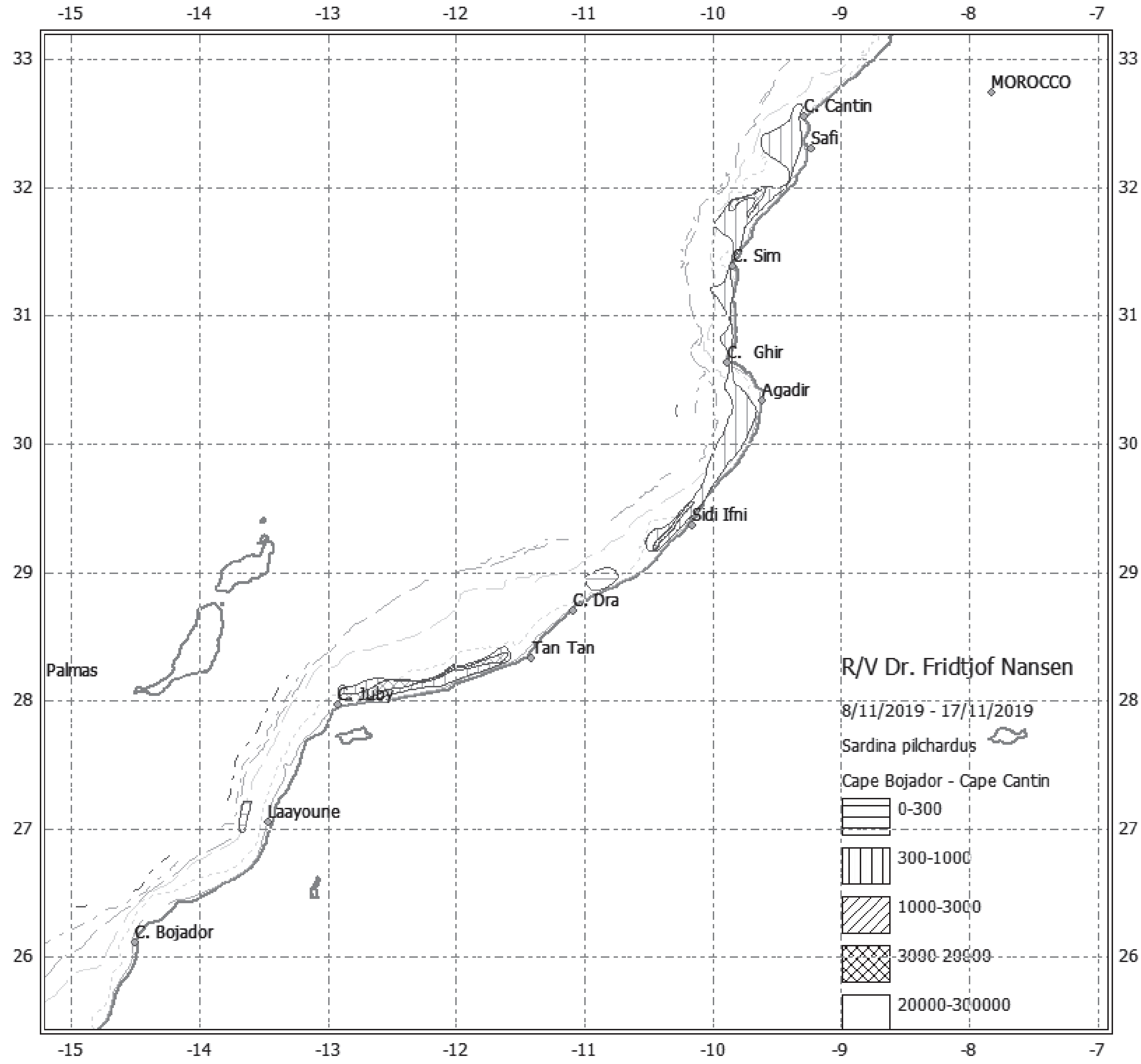


Figure 31. Distribution (density, m^2/NM^2) of Sardine, *Sardina pilchardus* in the area between Cap Bojador and Cap Cantin

Mackerel, *Scomber colias*

Mackerel was found in several smaller concentrations along the coast (Figure 32). The modal length of mackerel was 18 cm, and the biomass was estimated at 106 000 tonnes (Annex IV).

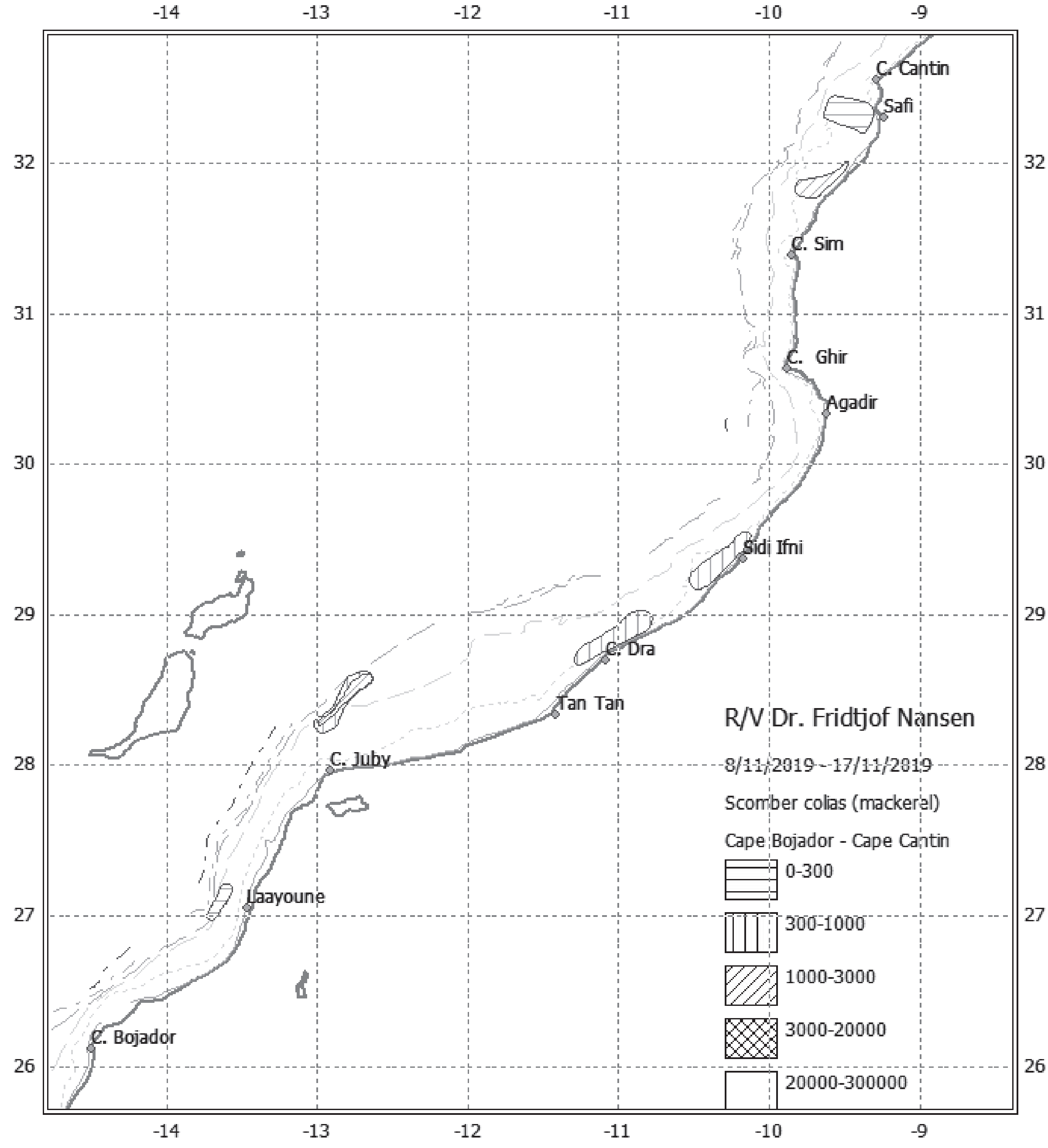


Figure 32. Distribution (density, m^2/NM^2) of mackerel, *Scomber colias*, in the area between Cap Bojador and Cap Cantin

Horse mackerels, *Trachurus trachurus* and *Trachurus trecae*

Horse mackerels was found in several smaller concentrations along the shelf (Figure 33). The modal length indicated two cohorts, one at 14 cm and the other one at 28 cm (Figure 42). The estimated biomass was 196 000 tonnes (Annex IV). No *Trachurus trecae* was observed in this area.

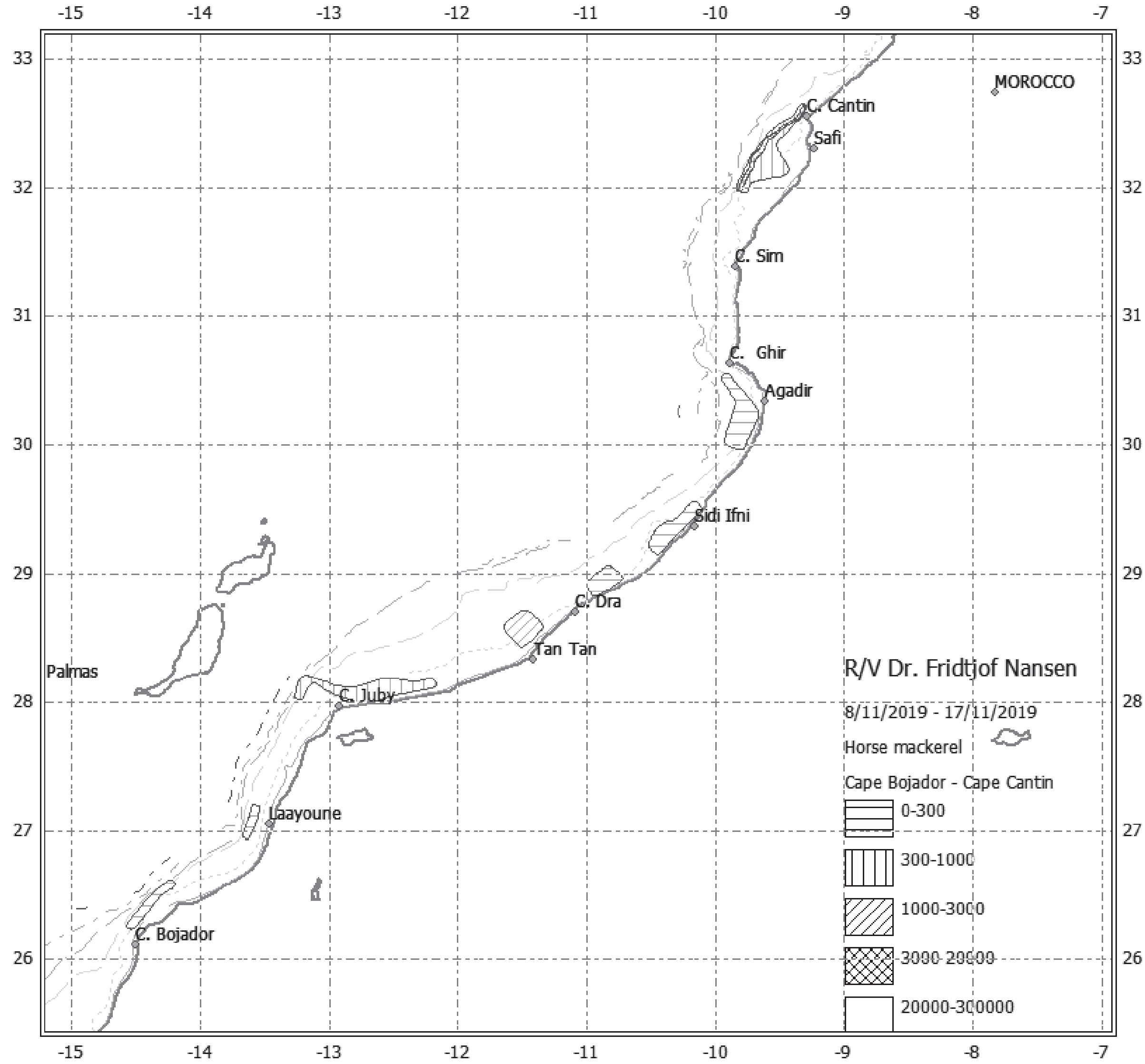


Figure 33. Distribution (density, m^2/NM^2) of horse mackerels, *Trachurus trecae* and *Trachurus trachurus*, in the area between Cap Bojador and Cap Cantin

Anchovy, *Engraulis encrasicolus*

Anchovy was found in several small aggregations along the coast, mainly at the inner parts of the shelf, at depths shallower than 40 m (Figure 34). In one area, between Layounne and Cap Jubi, a very large concentration was found. The modal length indicated two cohorts, one at 6 cm and the other at 11 cm. The biomass was estimated at 215 000 tonnes (Annex IV).

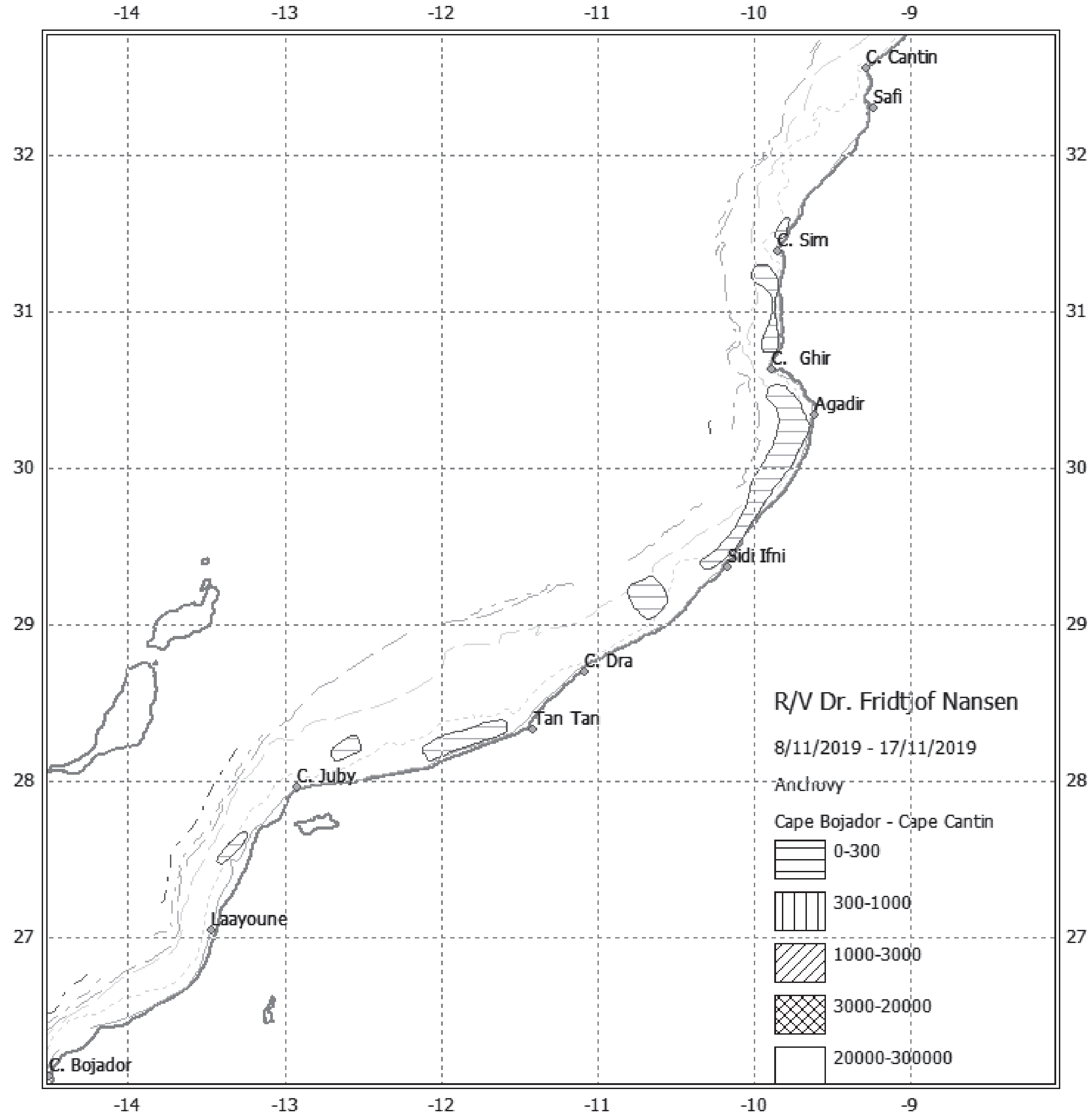


Figure 34. Distribution of anchovy, *Engraulis encrasicolus*, in the area between Cap Bojador to Cap Cantin

Pel 2, carangids and associated species

Pel 2, or other pelagic fish (see Table 4 for examples of fish species included in this group) was also distributed in several smaller areas along the shelf, mainly shallower than 50 m depths (Figure 35). The biomass was estimated at 48 000 tonnes. The P2 consisted often of *Decapterus* sp and *Trachinotus ovatus*.

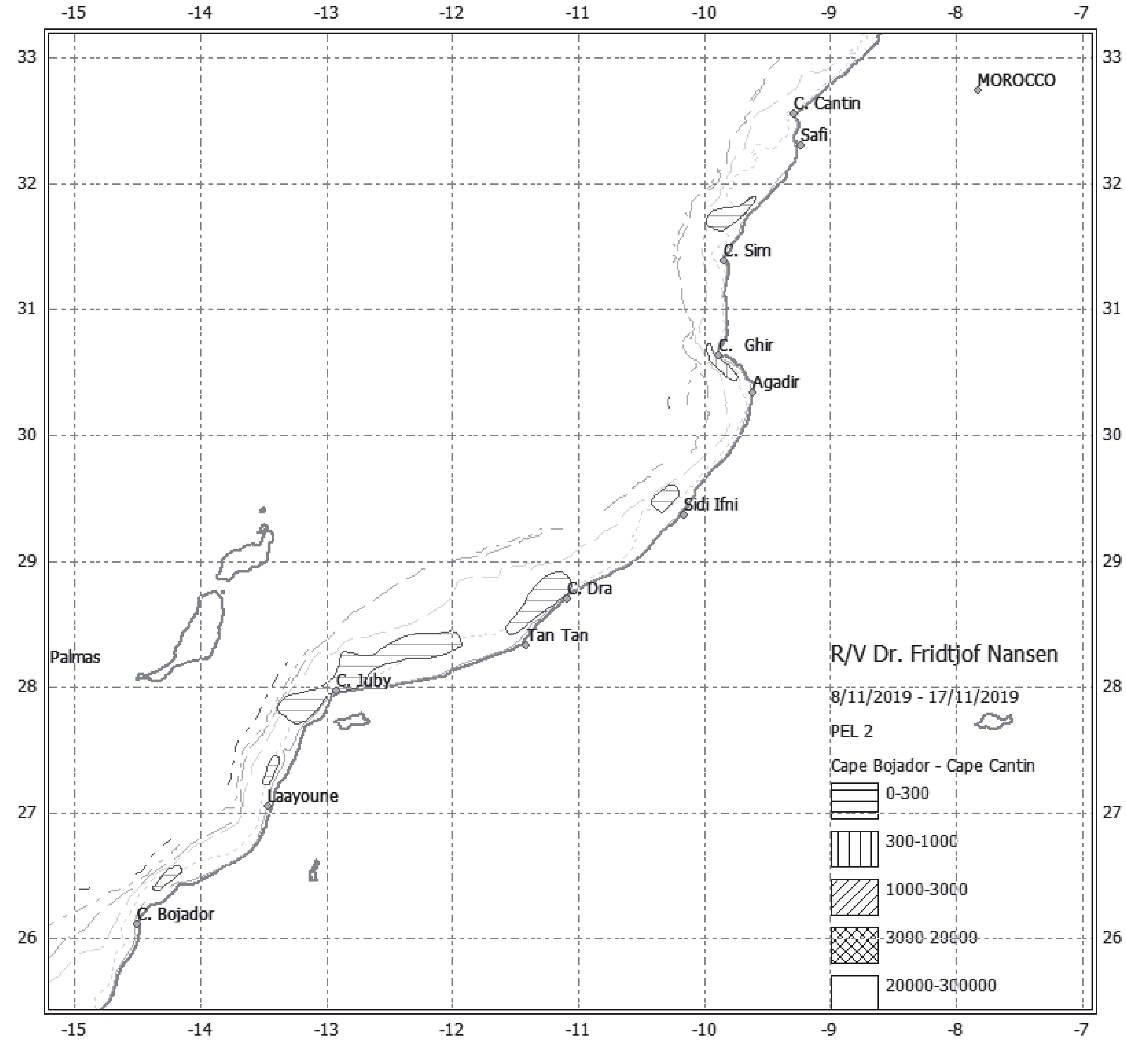


Figure 35. Distribution (density, m^2/NM^2) of P2, carangids and associated species, in the area between Cap Bojador to Cap Cantin

Cap Cantin – Tanger

Typically, pelagic fish in the northern region was distributed in mixed schools, particularly inshore where all four target-species tended to occur together.

Sardine, *Sardina pilchardus*

Sardine were found close inshore in relatively large aggregations of low to medium concentrations throughout the survey area (Figure 36). The highest densities were found in the southernmost and in the northernmost regions. The length distribution from trawl catches showed that sardine in the area was relatively small, mostly between 13 cm and 19 cm. The estimated biomass of sardine in this area was 234 700 tonnes.

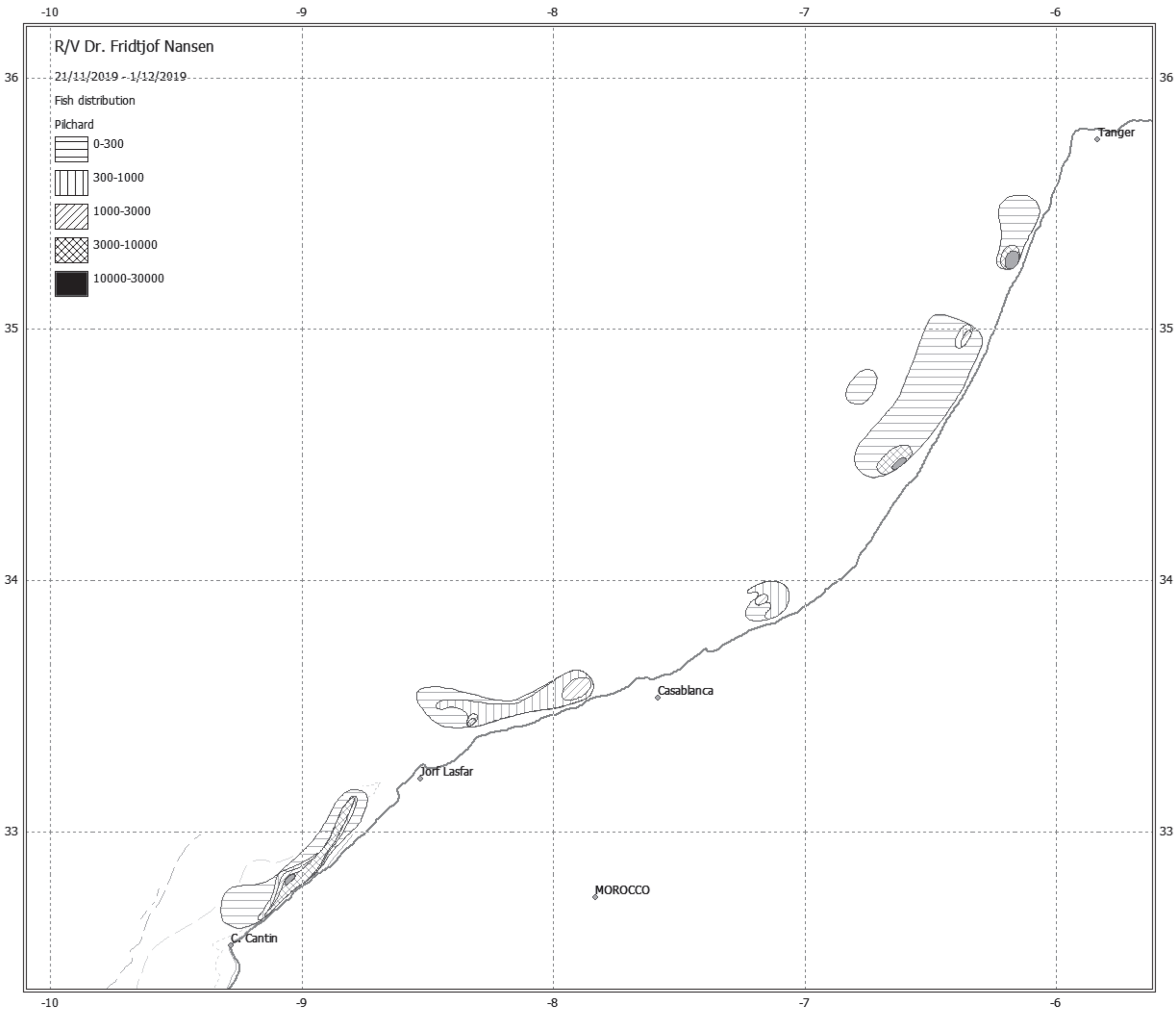


Figure 36. Distribution (density, m^2/NM^2) of sardine, *Sardina pilchardus* in the area between Cap Cantin and Tanger

Mackerel, *Scomber colias*

Mackerel was found in small, low to moderate density aggregations along the coast, with the highest densities observed in the southernmost region, just north of Cap Cantin (Figure 37). In the northernmost region the aggregations extended offshore while in the remaining part of the region aggregations were found closer to the coast. The length distribution from trawl catches showed that mackerel in the area were relatively small, mostly between 17 cm and 23 cm. The estimated biomass of mackerel in the survey area was 110 300 tonnes.

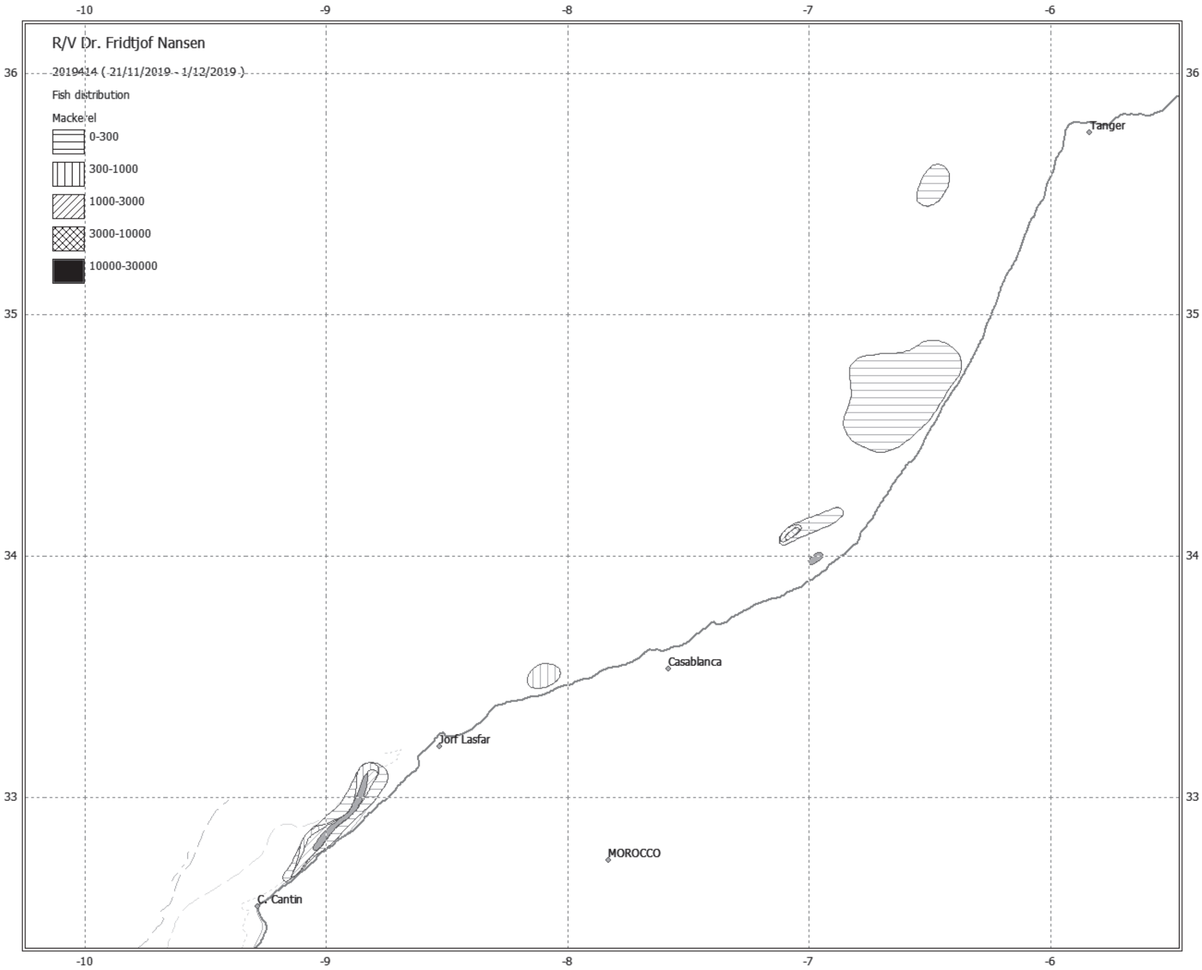


Figure 37. Distribution (density, m^2/NM^2) of mackerel, *Scomber colias*, in the area between Cap Cantin and Tanger

Horse mackerel

Four species of horse mackerel were found in the survey area. *Trachurus trachurus* was dominating, but *T. Trecae*, *T. picturatus* and *T. mediterraneus* were also recorded in trawl catches. Here, the results are presented with all four pooled species together (*Trachurus* spp.). Small aggregations of low-density patches were found along the coast (Figure 38). Most of the horse mackerel were small (15-19 cm), but some larger specimens were also found in the trawl catches (35-43 cm). The estimated biomass of horse mackerel in the survey area was 25 500 tonnes.

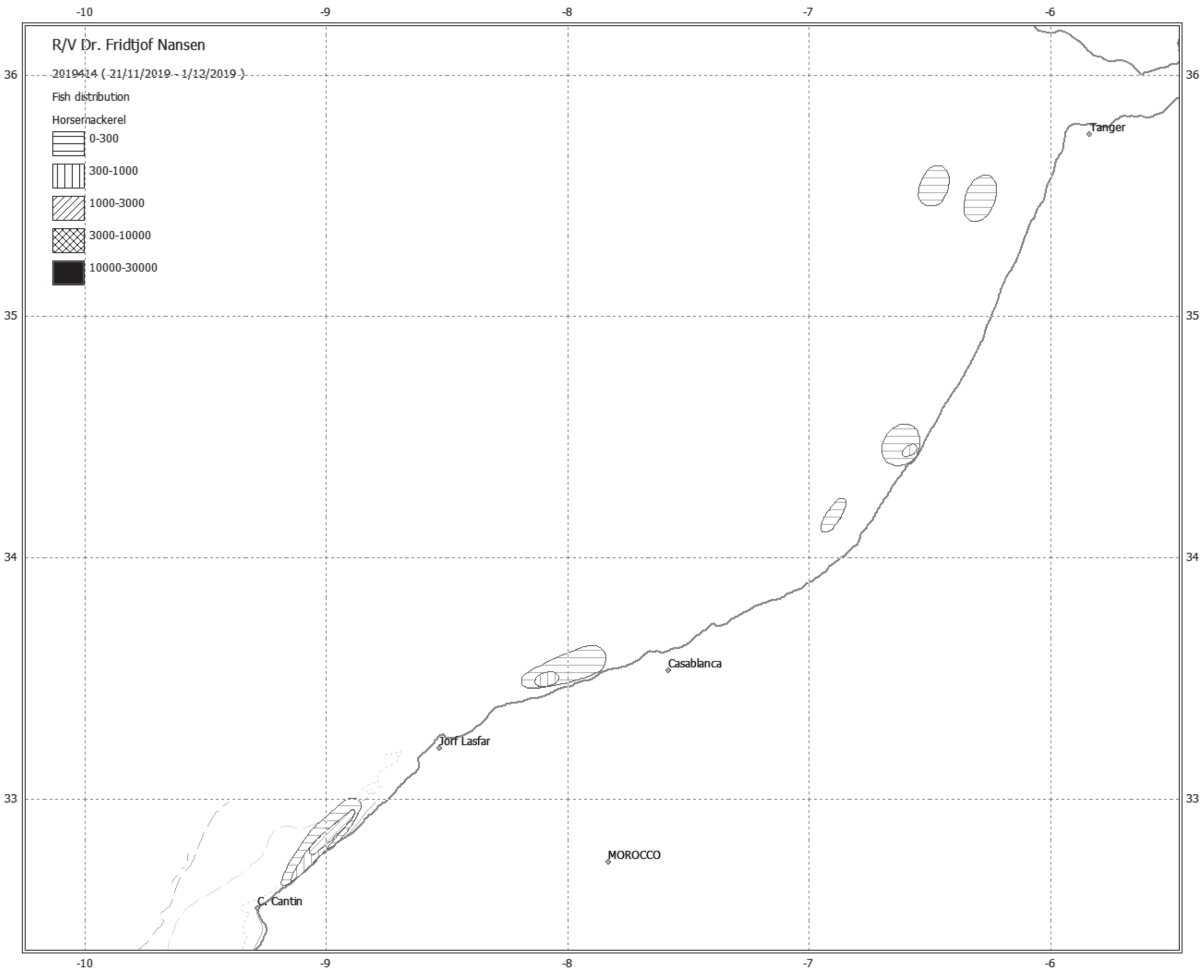


Figure 38. Distribution (density, m^2/NM^2) of horse mackerel species in the area between Cap Blanc and Cap Bojador

Anchovy, *Engraulis encrasicolus*

Anchovies were found in low density aggregations, mostly in the northern part of the survey area (Figure 39). Anchovy ranged from 7 cm to 17 cm in length and the estimated biomass for anchovy was 5 000 tonnes.

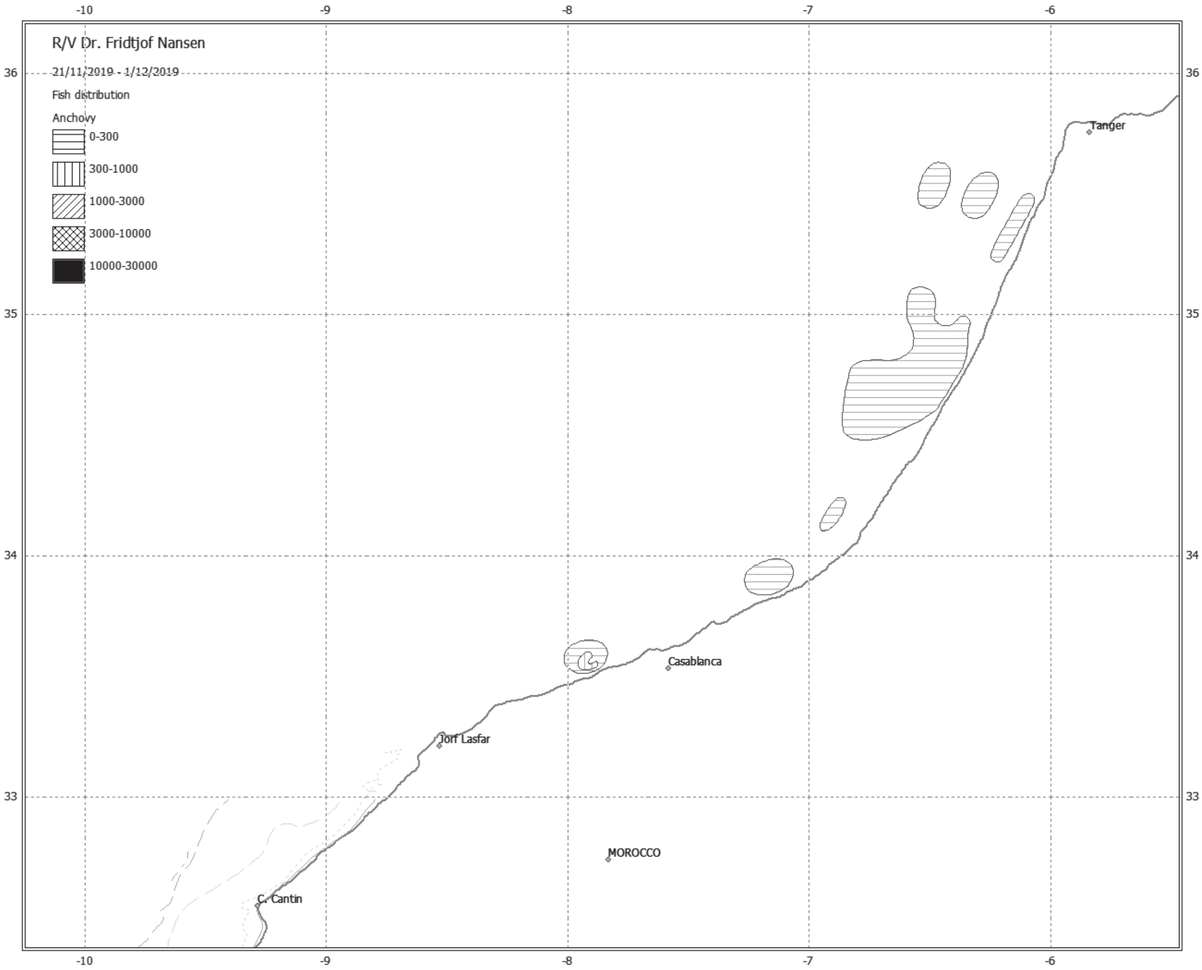
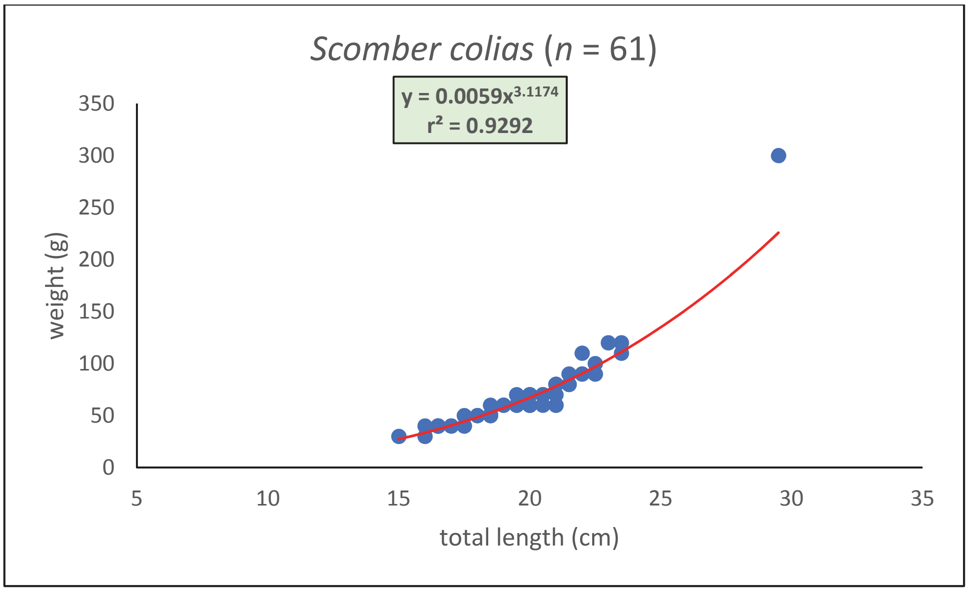


Figure 39. Distribution (density, m^2/NM^2) of Anchovy, *Engraulis encrasicolus*, in the area between Cap Cantin and Tanger

3.5 Biology of target pelagic fish species

Cape Blanc to Cape Bojador

Length-weight relationship as well as condition factor were calculated for *S. colias* and *S. pilchardus,* which were the only two species with sufficient data. These parameters are of great importance in fishery assessment studies since they provide valuable information about the growth of the fish, as well as its general wellbeing and fitness in a marine habitat. Figure 40 shows the length-weight relationship for both sexes combined.



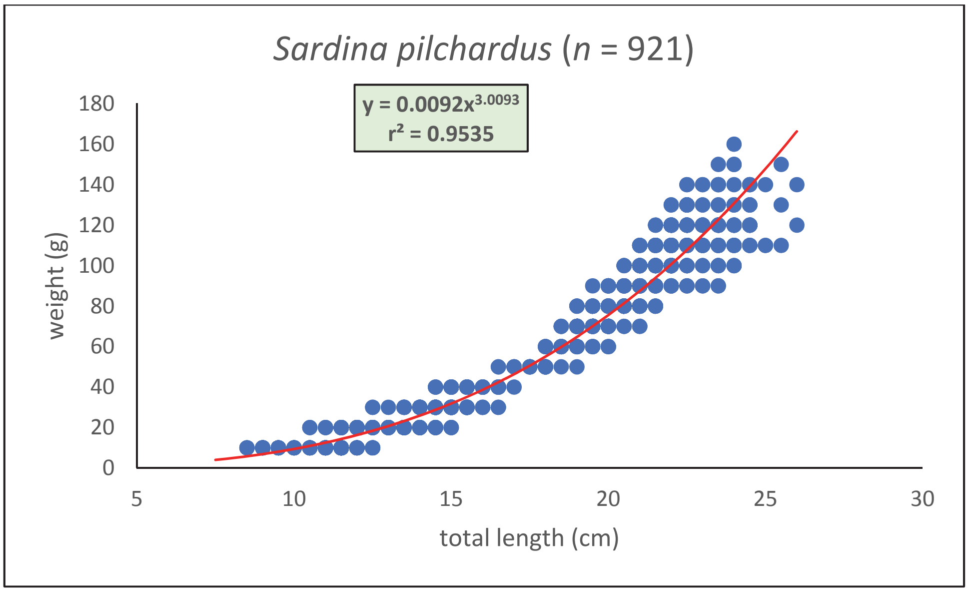


Figure 40. Length-weight relationships for *S. colias* and *S. pilchardus*. Both sexes combined. Cape Blanc to Cape Bojador

Values of b (slope) were within the expected range and show a positive allometric pattern growth for *S. colias* and isometric growth for *S. pilchardus*.

Figure 41 shows the sex ratio for the different target species. For all the species, females predominate significantly.

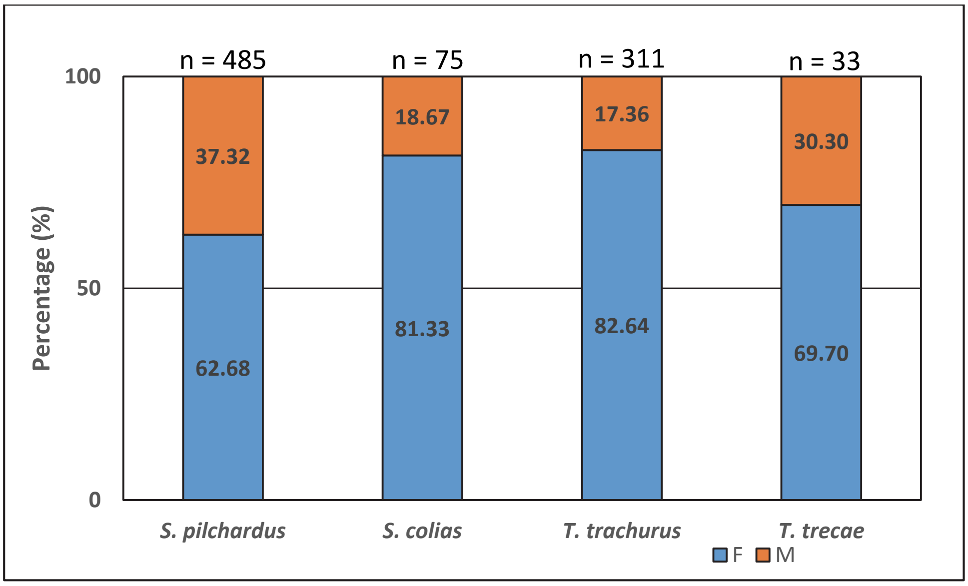


Figure 41. Sex ratio for the different target species: *S. pilchardus*, *S. colias*, *T. trachurus* and *T. trecae*. Cape Blanc to Cape Bojador

For all the species the majority of the individuals was in maturity stages I (immature) and II (mature virgin and recovering spent), with the exception of *S. pilchardus* which had representation of individuals in all stages, and with a less clear pattern, Table 12). Since the percentage of individuals in the other stages was low, it seems reasonable to assume that most of those in stage II were mature virgin.

Table 12. Sexual maturity stages of target species (in percentage): *S. pilchardus*, *S. colias*, *T. trachurus* and *T. trecae*. Cape Blanc to Cape Bojador

Maturity stages	***T. trachurus***	***% T. trachurus***	***T. trecae***	***% T. trecae***	***S. pilchardus***	***% S. pilchardus***	***S.colias***	***% S.colias***
1	93	**34.83**	32	**41.56**	106	**21.86**	37	**49.33**
2	152	**56.93**	28	**36.36**	141	**29.07**	28	**37.33**
3	13	**4.87**	4	**5.19**	49	**10.10**	9	**12.00**
4	8	**3.00**	6	**7.79**	131	**27.01**	1	**1.33**
5	1	**0.37**	7	**9.09**	58	**11.96**		
Total	267		77		485		75	

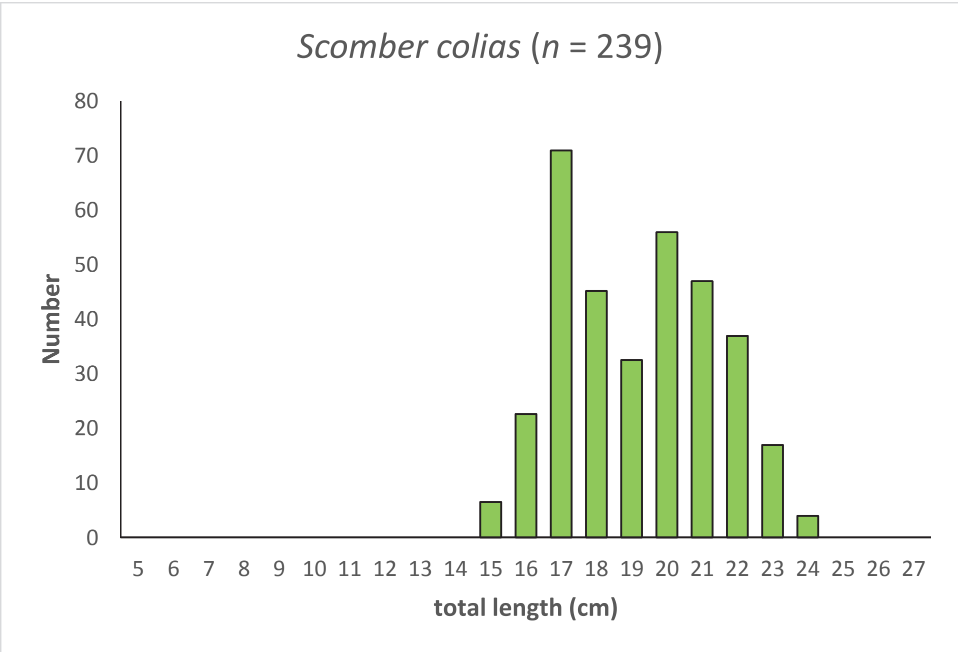
Size distributions for the target species are shown in Figure 42. *S. colias* ranged in size between 15 cm and 24 cm total length (TL) with distributional modes at 15-19 cm TL with a peak around 17 cm TL and another between 17-23 cm TL with a peak at around 20 cm TL. No fish < 15cm TL were captured.

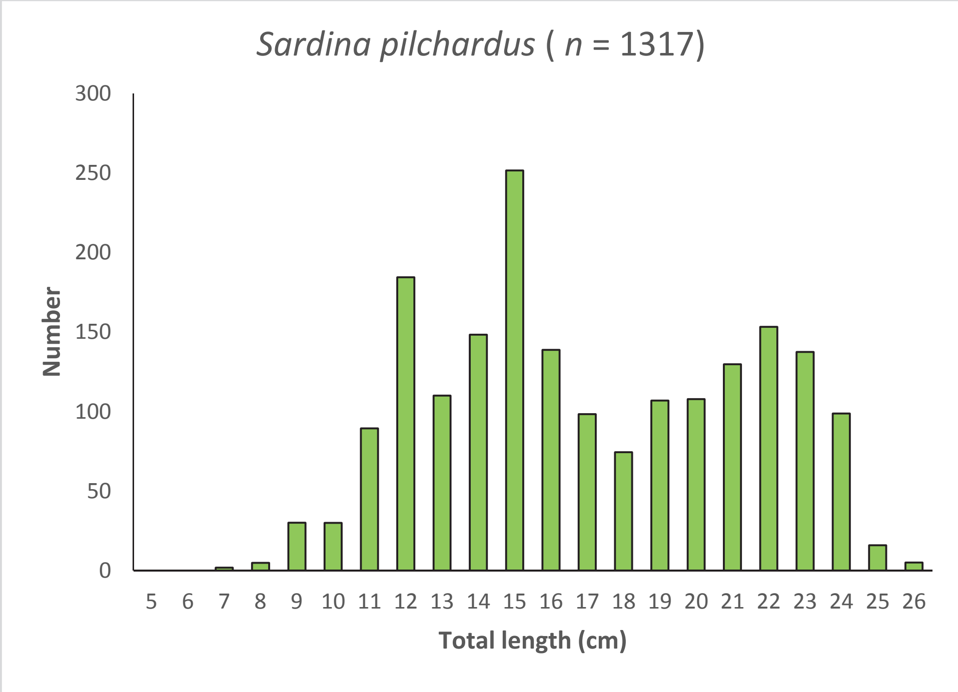
For *S. pilchardus* the length range was between 7 cm and 26 cm TL. With at least three modes at around 12 cm TL (9 cm to 14 cm TL), a second one, at around 15 cm TL (12 cm and 18 cm TL), and a third one at around 22 cm TL (19 and 26 cm TL).

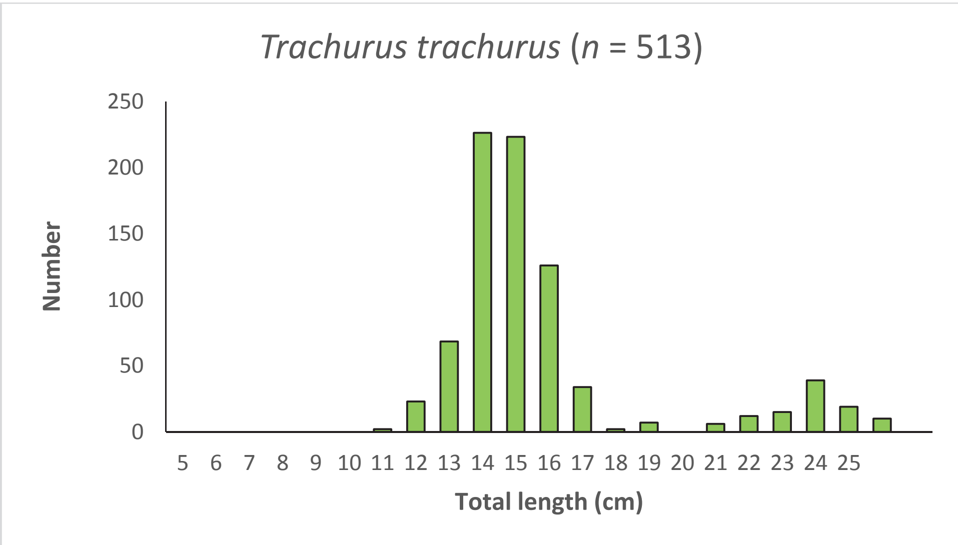
Sizes of *T. trachurus* ranged between 11 and 26 cm TL, but intermediate sizes (18 < TL < 23) were underrepresented. The distribution shows two modal distributions, one between 12 cm and 17 cm TL with a modal peak at around 14 cm TL, and another one between 21 cm and 26 cm TL, with a peak around 24 cm TL.

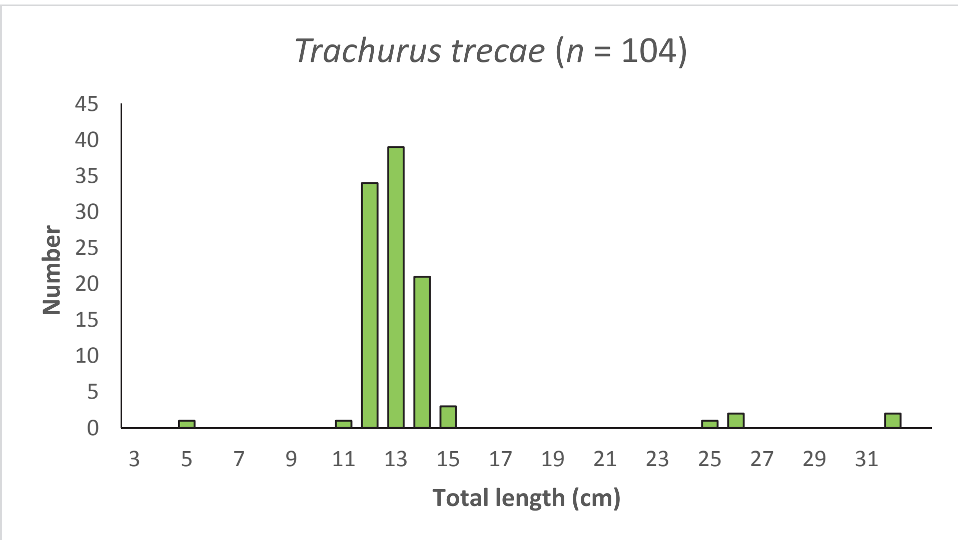
For *T. trecae* the only mode found was at about 13 cm TL (11 cm and 15 cm TL).

E. encrasicolus ranged between 5 cm and 14 cm TL with two probable modal peaks, one at around 7 cm TL and the other at 10 cm or 11 cm TL.




Sardina pilchardus (n = 1317)
Number
300
250
200
150
100
50
0
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Total length (cm)


Trachurus trachurus (n = 513)
Number
250
200
150
100
50
0
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Total length (cm)


Trachurus trecae (n = 104)
Number
45
40
35
30
25
20
15
10
5
0
3 5 7 9 11 13 15 17 19 21 23 25 27 29 31
Total length (cm)

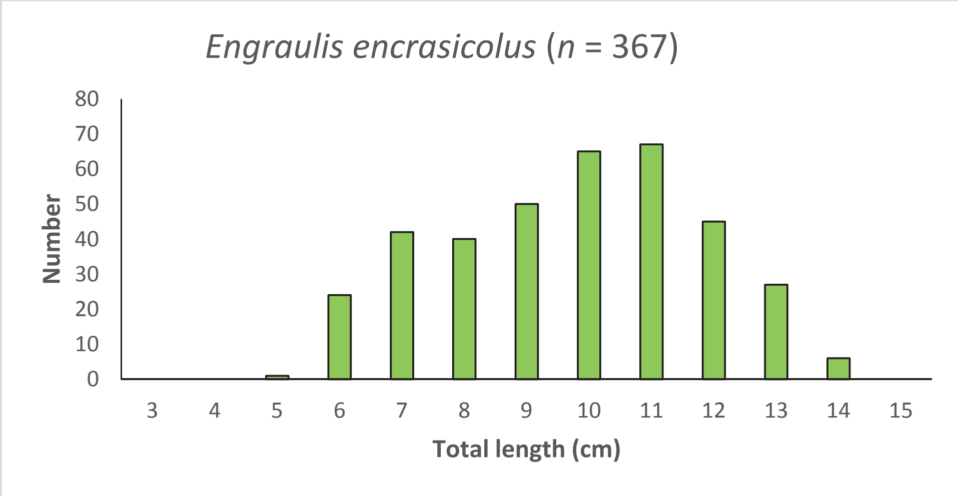


Figure 42. Length frequency distribution for the different target species: *S. pilchardus, S. colias, T. trachurus, T. trecae* and *E. encrasicolus*. Cape Blanc to Cape Bojador

Cape Bojador to Cape Cantin

The sex ratio for *E. encrasicolus, S. pilchardus*, *S. colias*, and *T. trachurus* is shown in Figure 43.

The length-weight relationships for this part of the survey could not be calculated due to malfunctioning of the scales. The length was still recorded, and the results for the target species are presented in Figure 44.

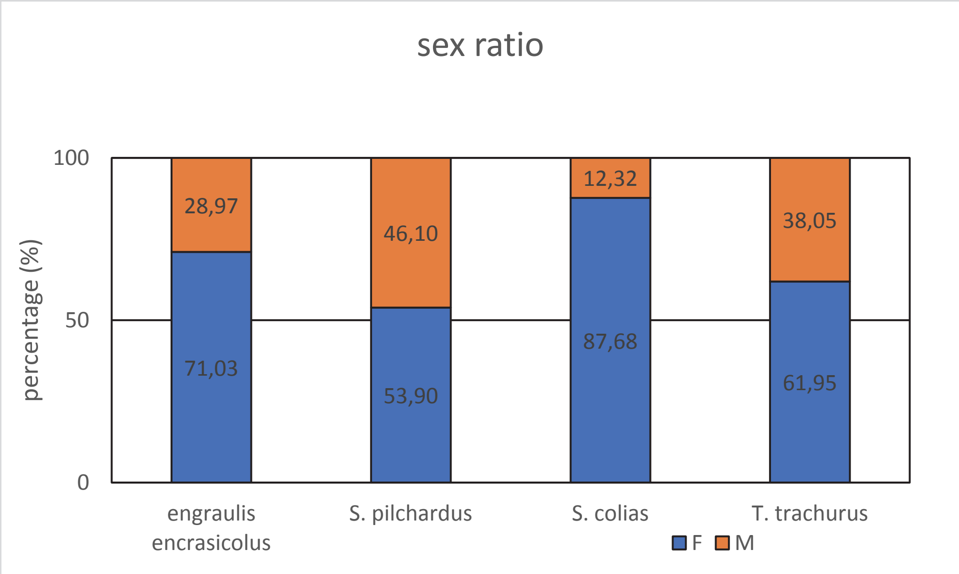
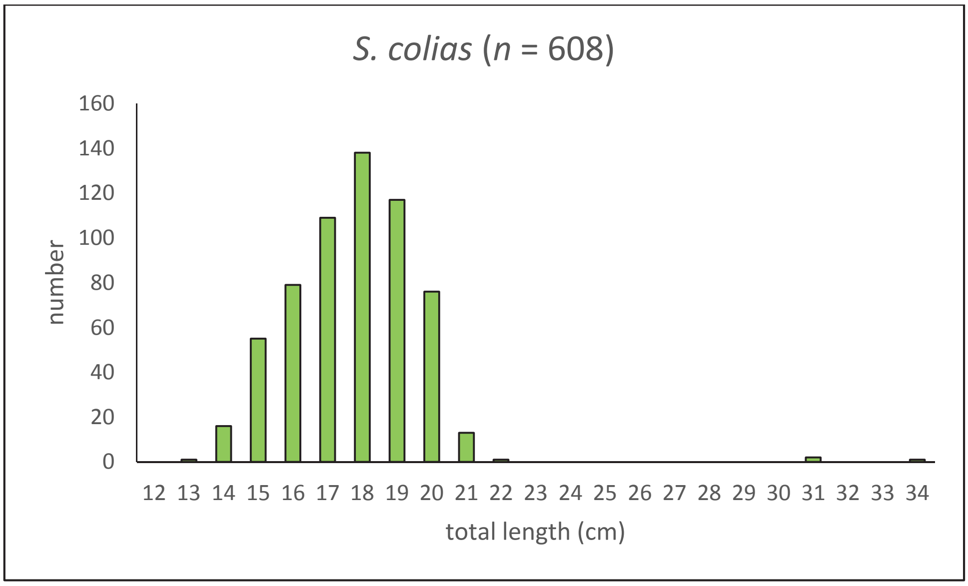
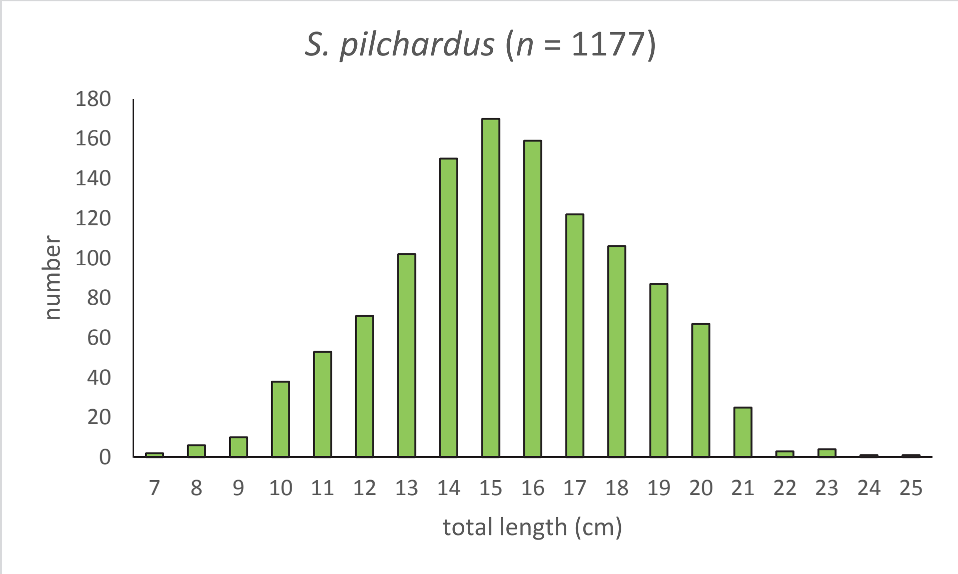
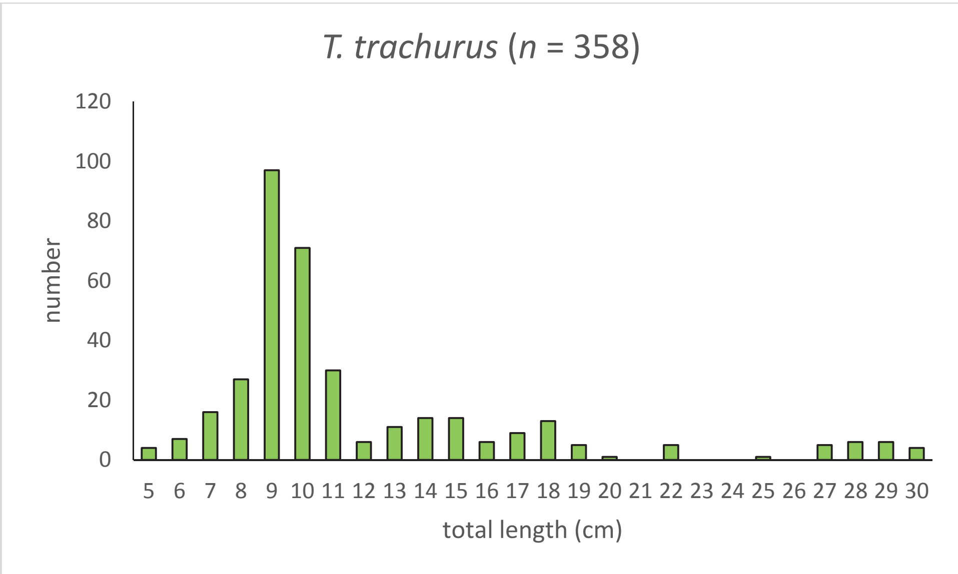


Figure 43. Sex ratio for the different target species*:* *E. encrasicolus, S. pilchardus*, *S. colias*, and *T. trachuruse*. Cape Bojador to Cap Cantin




S. pilchardus (n = 1177)
number
180
160
140
120
100
80
60
40
20
0
7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
total length (cm)


T. trachurus (n = 358)
number
120
100
80
60
40
20
0
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
total length (cm)

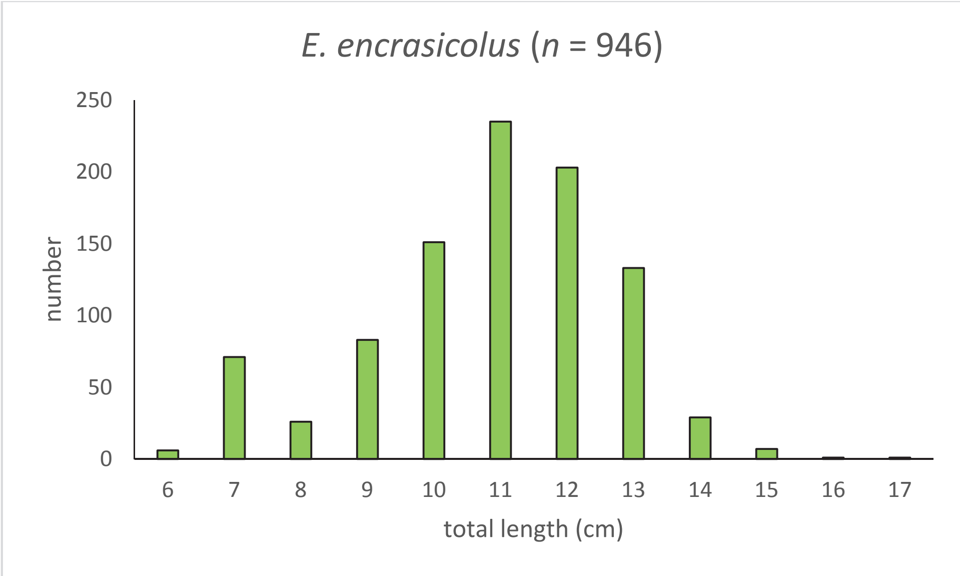
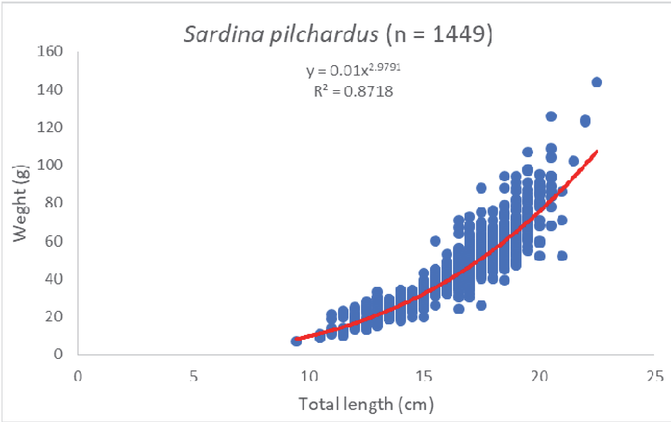
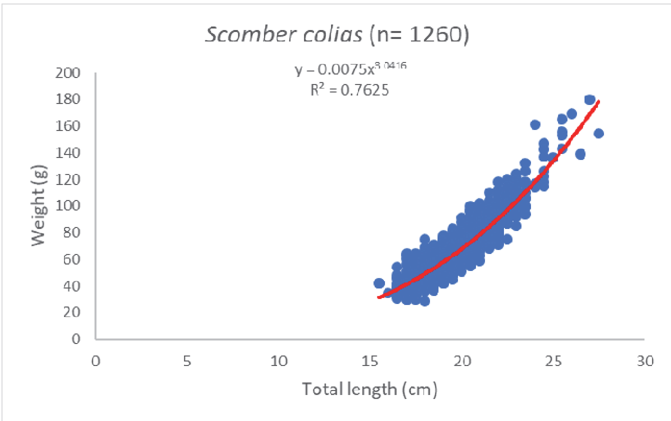


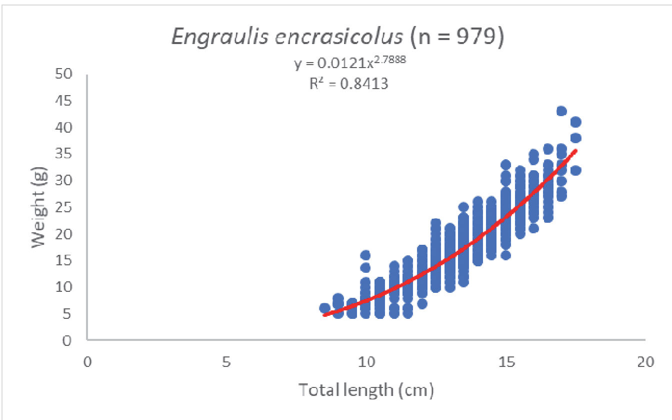
Figure 44. Length frequency distribution for the different target species: *S. pilchardus, S. colias, T. trachurus, T. trecae* and *E. encrasicolu*s. Cape Bojador to Cap Cantin

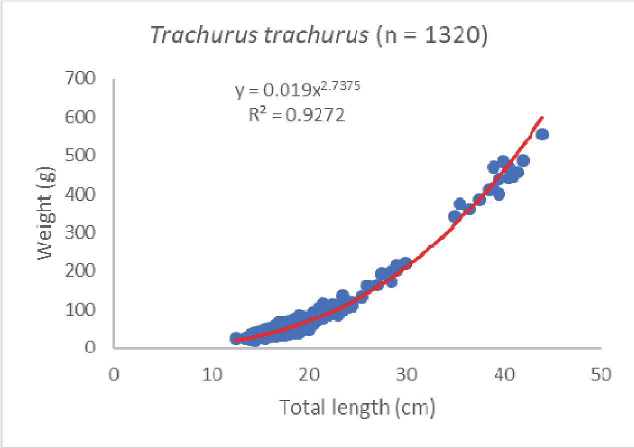
Cap Cantin to Tanger

Length-weight relationship as well as condition factor were calculated for *S. pilchardus, S. colias, E. encrasicolus* and *Trachurus* spp. Figure 45 this relationship for both sexes combined.









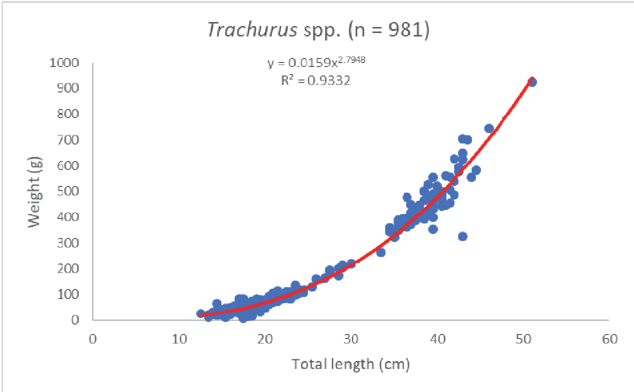


Figure 45. Length-weight relationships for *S. pilchardus, S. colias, E. encrasicolus and Trachurus* spp. Both sexes combined

Figure 46 shows, with the exception of *S. pilchardus,* females dominated among the samples.

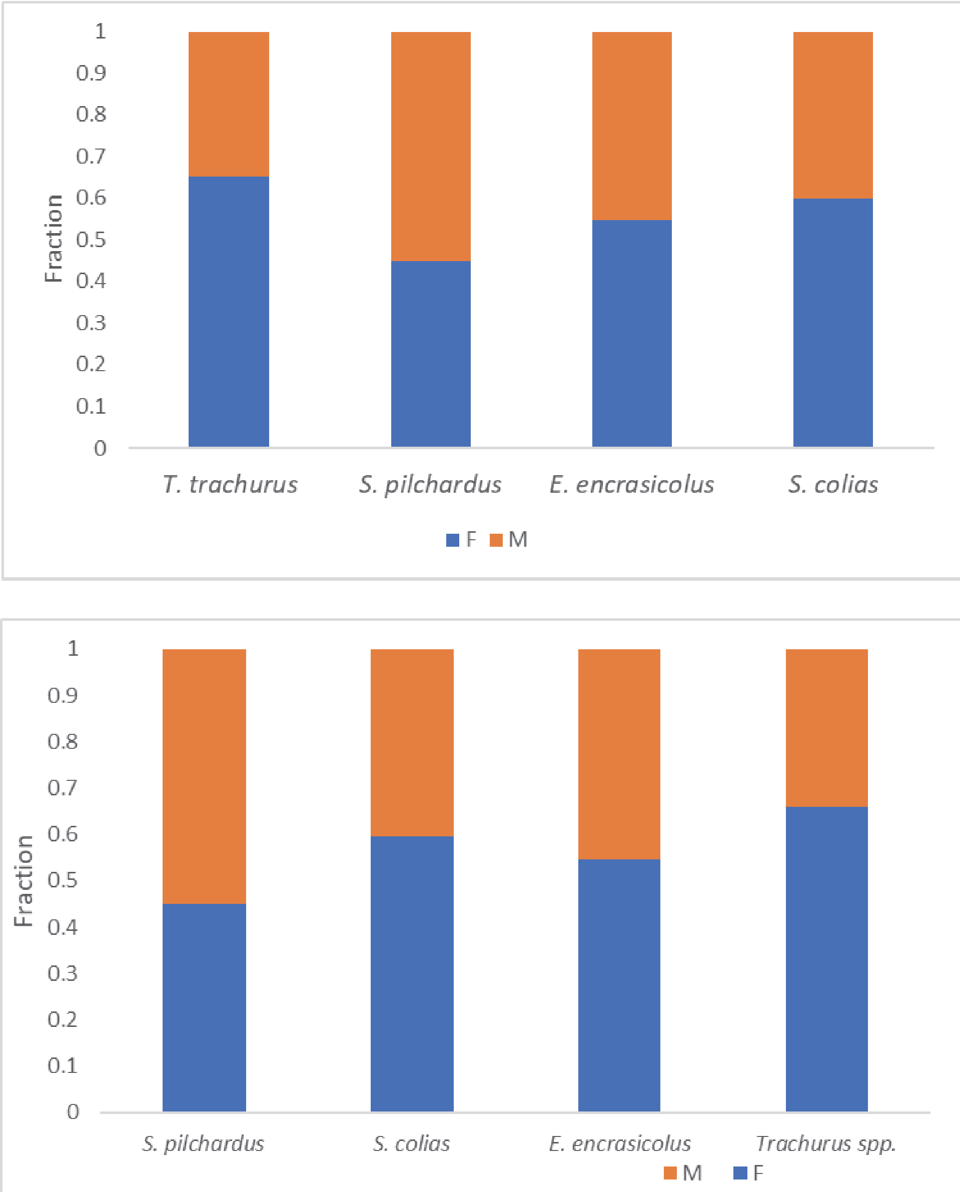


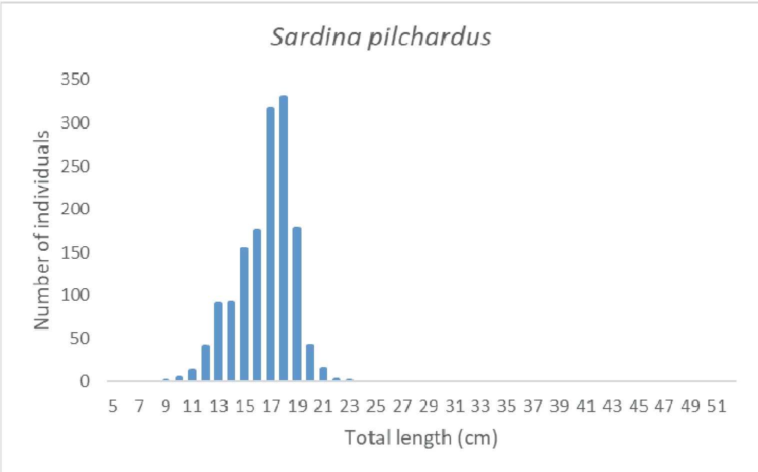
Figure 46. Sex ratio for the different target species: *S. pilchardus*, *S. colias*, *E. encrasicolus* and T. *trachurus*.

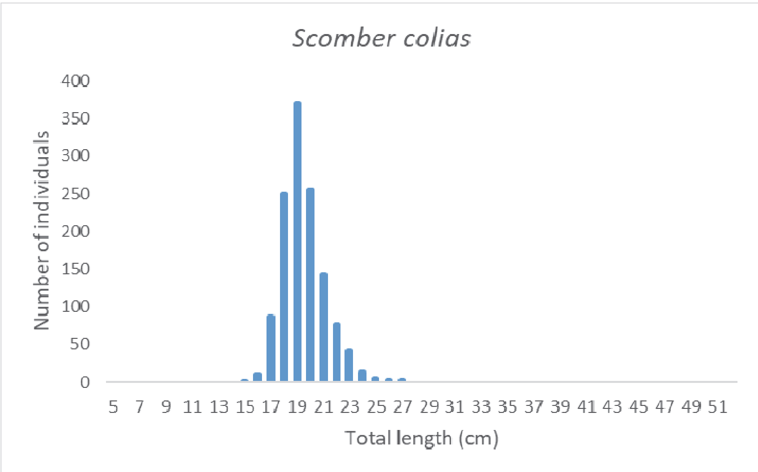
The recorded maturity stages for the different species are shown in Table 13.

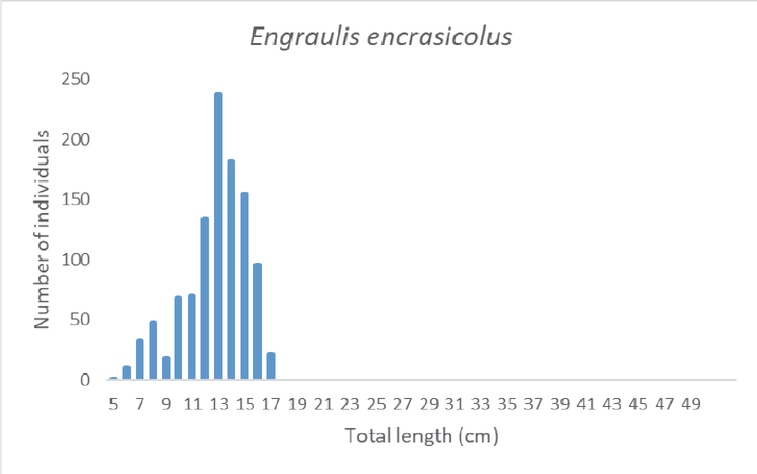
Table 13. Sexual maturity stages of target species, *S. pilchardus*, *S. colias*, *E. encrasicolus* and *T. trachurus* in the trawl catches. The data shown in the table does not include individuals for which sex could not be determined (the majority of individuals for all species)

Maturity stages	*S. pilchardus*	*% S. pilchardus*	*S. colias*	*% S. colias*	*E. encrasicolus*	*% E. encrasicolus*	*T. Trachuru.*	*% T. Trachurus*
1	2	0.1	74	6	10	0.77	63	12.12
2	82	3.91	356	28.85	140	10.84	286	55
3	123	5.86	414	33.55	192	14.87	42	8.08
4	716	34.13	280	22.69	264	20.45	24	4.62
5	1 175	56.01	110	8.91	685	53.06	105	20.19

Size distributions for the target species are shown in Figure 47.







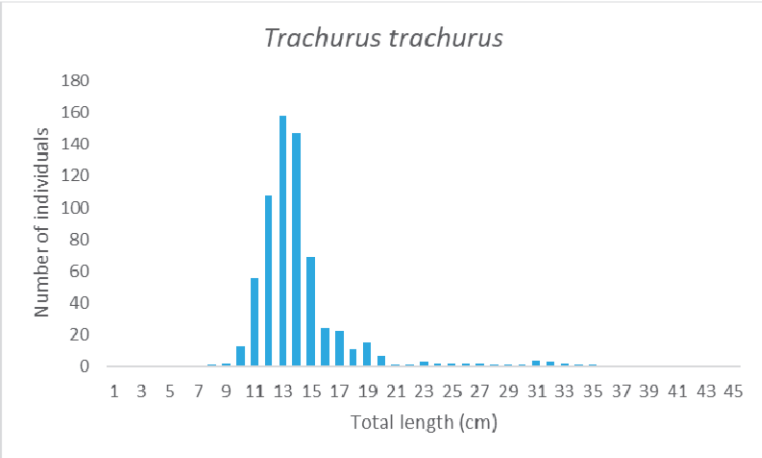


Figure 47. Length frequency distribution for the different target species*: S. pilchardus*, *S. colias*, *E. encrasicolus* and *T. trachurus*

3.6 Sonar investigations

The sea conditions for sonar operation were optimal for most of the survey, with no wind and flat sea surface. These conditions implied absence of surface scatters originated by waves and surface reflection, resulting in a clear sonar image and an easy school detection when present.

The sonar operated stable and continuously with no interruptions during the survey.

The scrutinizing process took about 2 to 3 hours to process the data collected in previous 24 hours, duration depending on the number of schools present and the removal of false schools.

The three main pelagic species (Sardine, mackerel and anchovy) present in the survey area were clearly observed in the sonar, when were aggregated as schools, mostly during daytime. Strong fish echoes and low background noise made the school segmentation easy. However, mackerel during the night was found in more loose aggregations, and in some occasions, was difficult to separate from dense plankton that also was measured by the sonar. The simultaneous display of the echo sounder data during the sonar scrutinizing helped to identify mackerel, in these occasions.

An example of medium size Sardine school at bottom depths of ca. 100 m is show in Figure 48. In the horizontal sonar beams, schools are displayed as colored (yellow to red) polygons and when segmented have a white overlay in all its extension and red dots represent the center of mass of each school detection. Also, it can be observed a school simultaneously sampled with the horizontal and vertical beams, at 250 m port side of the vessel in the center of the image. In the upper panel is possible to observe one schools also measured by the echosounder (at 15:43 UTC), extending from the surface up to 25 m.

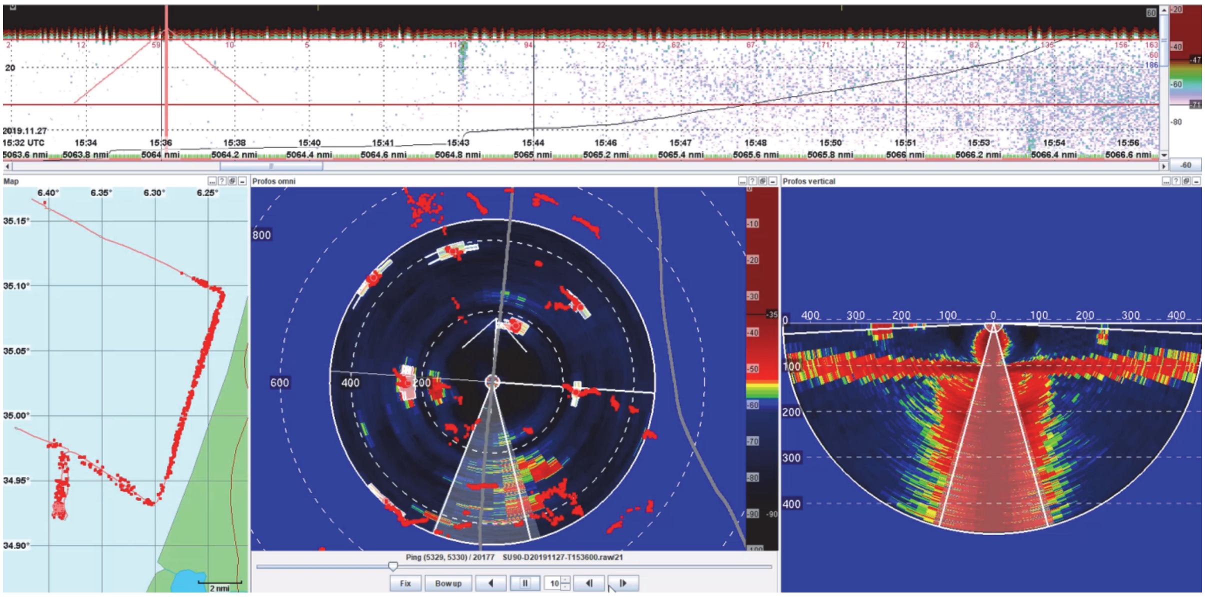


Figure 48. Image from LSSS system showing echo sounder data at 38 kHz (upper panel), survey track in map (left bottom panel), sonar from horizontal beams (center bottom panel) and sonar from vertical beams (right bottom panel)

In some areas at depths shallower than 50 m were found abundant small sardine schools, as showed in Figure 49. These small schools were very clearly observed in the echo sounder from the surface up to the shallow bottom. An idea of the numerous schools found can be observed in the map left panel, where each red dot represents the center of gravity of the schools detected along the track by the sonar.

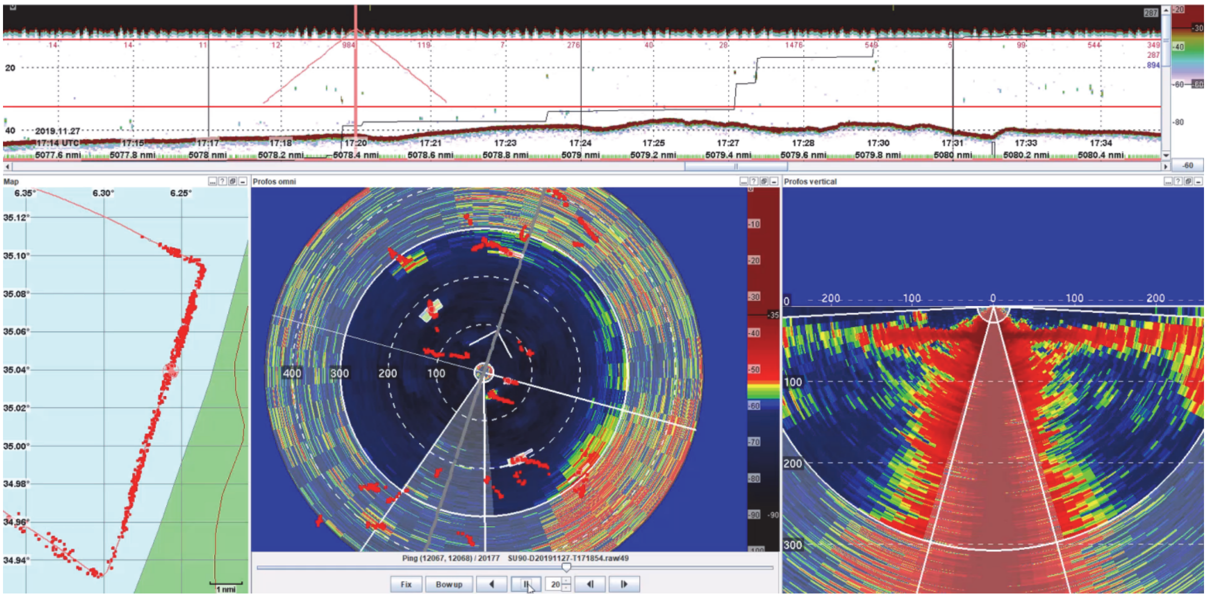
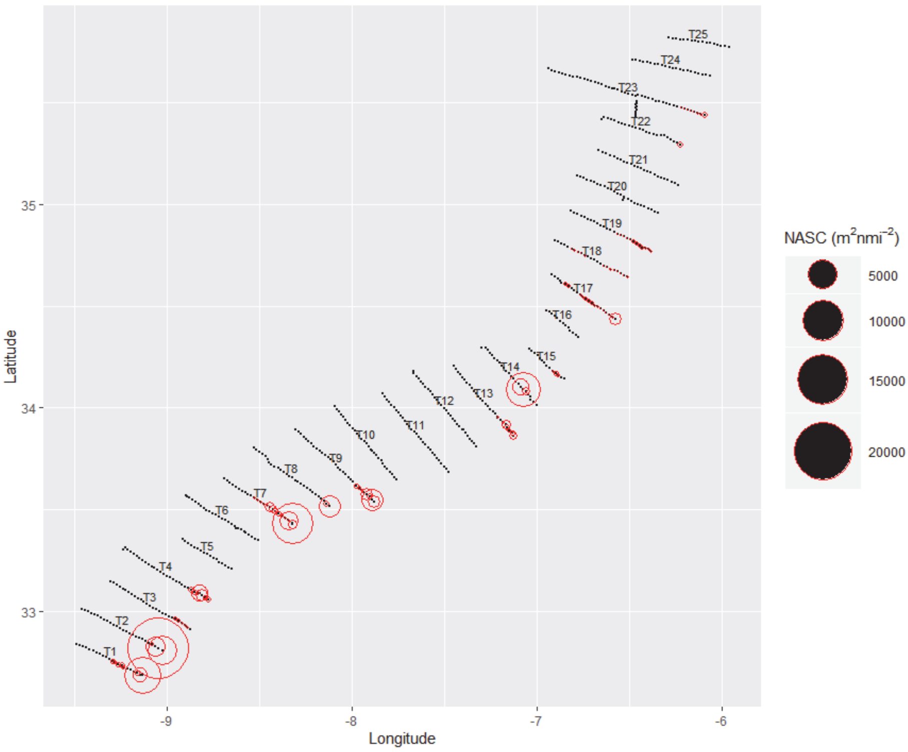


Figure 49. Image from LSSS system showing echo sounder data at 38 kHz (upper panel), survey track in map (left bottom panel), sonar from horizontal beams (center bottom panel) and sonar from vertical beams (right bottom panel)

The combined NASC for the three dominant pelagic species measured with the sonar and echo sounder in the upper 30 m showed a general similar trend, with higher values in the central part of the survey around 34° N and the two southernmost transects (Figure 50).



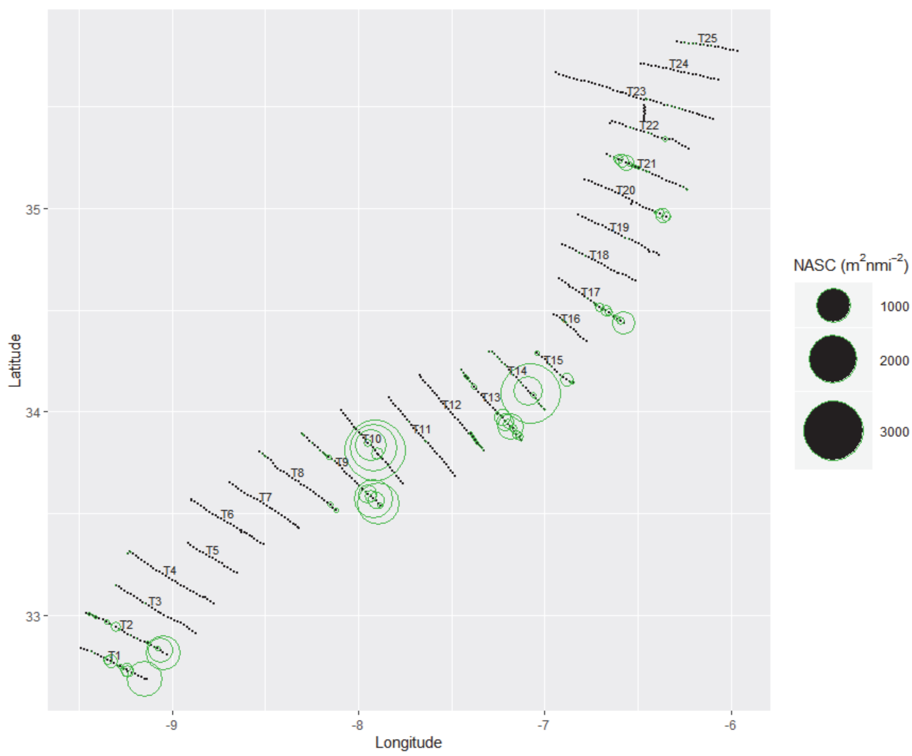


Figure 50. NASC (m^2 nmi^{-2}) from echo sounder (top) and sonar (bottom) observations of pelagic species (mackerel, Sardine and anchovy) from surface up to 30 m depth

Because of the uncertainty in the factor used for the side aspect target strength, absolute sonar NASC values must be taken with caution. Instead, trends of NASC by depth between sonar and echo sounder can inform about possible bias in echo sounder measurements. Higher registrations from echo sounder were observed when pelagic species were distributed in layers rather in schools. In most cases, these layers were not measured by the sonar. Higher sonar NASC values indicate presence of schools not detected by the echo sounder.

Transects with higher NASC values in the sonar were used to compare the vertical distribution of pelagic species between sonar and echo sounder in the depth range sampled by the sonar. The first transects analyzed (T1, T2 and T9) showed a similar trend with no presence of fish in the upper 10 m, and with a moderate increase between 10-15 m clearer observed in the sonar measurements (Figure 51).

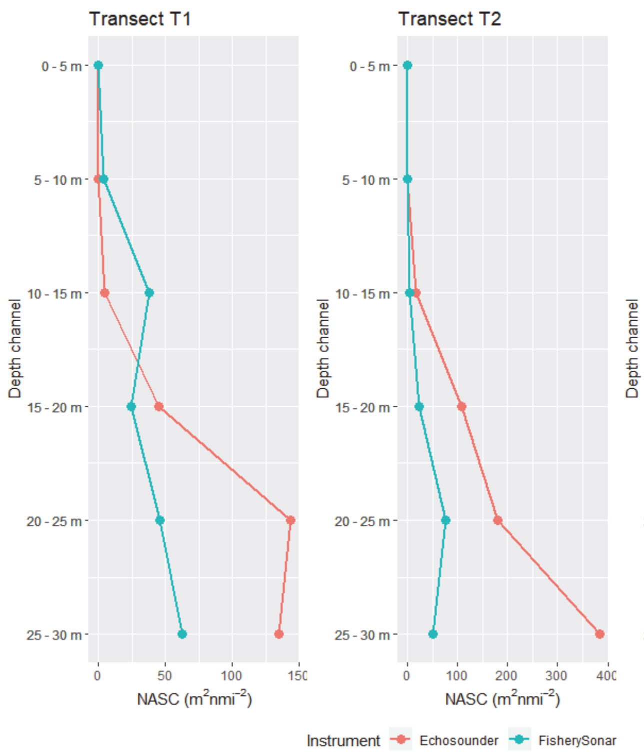


Figure 51. Vertical distribution of NASC (m^2 nmi^{-2}) from sonar and echo sounder for transects T1, T2 and T9 from surface to 30 m

An important difference was found in transect T10, with no acoustic scatters allocated to pelagic species in the echo sounder. A revision of the echo sounder scrutiny reveals these scatters allocated to plankton and not to pelagic fish. In last two transects analyzed (T13 and T14), and like three previous transects, no fish present in the surface to 10 m layer. Also, a higher trend was observed in the sonar registration in the 10 m to 15 m layer, in comparison with the echo sounder measurements, Figure 52.

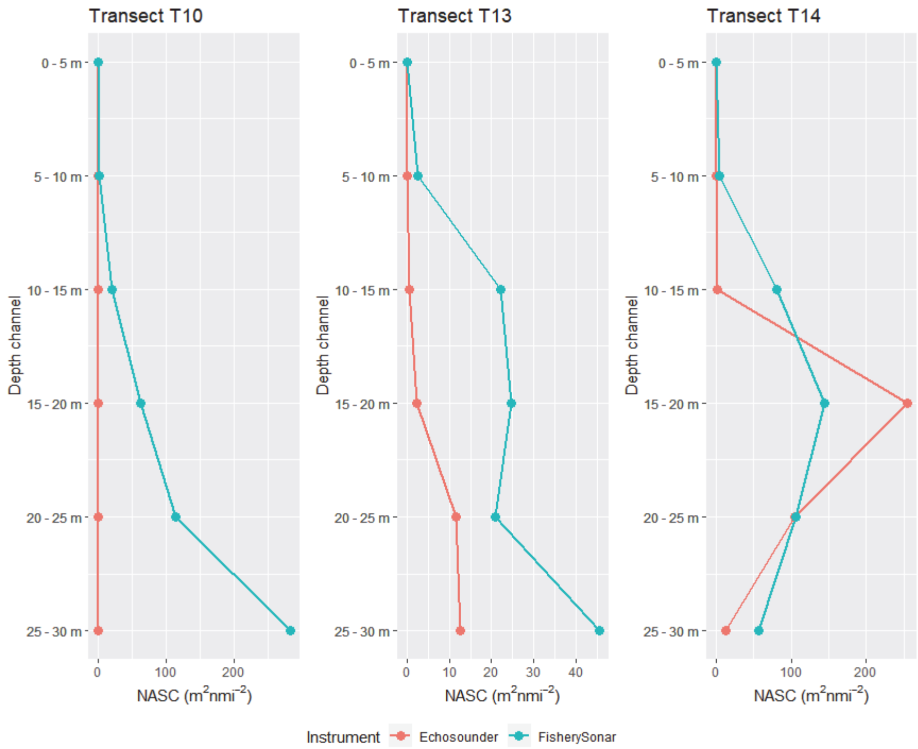


Figure 52. Vertical distribution of NASC (m^2 nmi^{-2}) from sonar and echo sounder for transects T10, T13 and T14 from surface to 30 m.

Final remarks on sonar investigations

Results showed the feasibility of collecting and processing sonar data in a routine daily basis during an acoustic-trawl survey for abundance estimation of pelagic species. The sonar operation was stable and with the synchronization, noise free and adequate ping rate data was obtained. Sonar was set to measure the fish in the upper 30 m, in the echo sounder blind zone. Target species were observed schooling during daytime, in the coastal region on the continental shelf at bottom depth from 150 m to 30 m. In the transects with higher sonar NASC values, the vertical distribution of the sonar showed in general no presence of pelagic species in the surface to 10 m layer. In the layer between 10 m to 15 m the sonar presented a trend with higher values than observed with the echo sounder. These preliminary results indicate no bias in the measurements of the echo sounder blind zone.

CHAPTER 4. CONCLUDING REMARKS

Legs 4.3 and 4.4 had multiple objectives, almost all of which were successfully achieved.

The information presented in this report summarises the results of the data analysed during the survey. Some samples and data have been transported to research institutes in the region, and also farther afield (notably IMR in Bergen, Norway). These samples will be analysed and reported on later as part of the activities under the EAF-Nansen Science Plan.

The survey also collected scientific data to assess one of the possible biases in acoustic biomass estimation due pelagic fish behaviour and their possible presence in the blind zone close to the surface. This data will also be used as part of a collaborative project between IMR and partners from Northwest and Southwest Africa (Theme 2 of the Science Plan).

CHAPTER 5. REGIONAL OVERVIEW

The R/V *Dr Fridtjof Nansen* series of surveys of the pelagic resources in Northwest Africa (Leg 4 of the western Africa coverage for 2019) encompassed Morocco to Senegal. These surveys commenced in the south and progressed northwards and were conducted during September to November. Note that the previous Nansen surveys in 2017 progressed from northern Morocco southwards and took place in a different season, i.e. May–July.

The first leg (4.1) was from the southern border of Senegal to the north, including The Gambia, and took place from 26 September to 07 October 2019. The second leg (4.2) was off the coast of Mauritania from 9 to 20 October 2019. After completing the survey in Mauritania, the vessels steamed to Las Palmas for some routine maintenance, returning for legs 4.3 and 4.4, starting at Cap Blanc on 1 November 2019 and arriving off Tanger on 29 November 2019.

A common survey design was adopted throughout the entire region with parallel transects perpendicular to the coastline, 10 nm apart, and acoustic measurements of pelagic fish obtained on the shelf from 20 m to 500 m bottom depth. At each degree of latitude, a hydrographical transect was carried out, often to a depth of 1 000 m. Meteorological and hydrographic measurements were recorded routinely on these transects in addition to samples on ocean acidification parameters (pH and total alkalinity), nutrients, chlorophyll a, zooplankton, fish eggs and larvae and microplastics. Weather conditions were generally good for surveying apart in northern Morocco, where strong winds made surveying more challenging.

5.1 Oceanographic Conditions

Northwest Africa is characterised by four water masses: Eastern North Atlantic Central Water (ENACW), South Atlantic Central Water (SACW), Mediterranean Intermediate Water (MIW) and Eastern Atlantic Subarctic Intermediate Water (EASIW). Per normal protocol, most CTD deployments are conducted in waters down to 500 m.

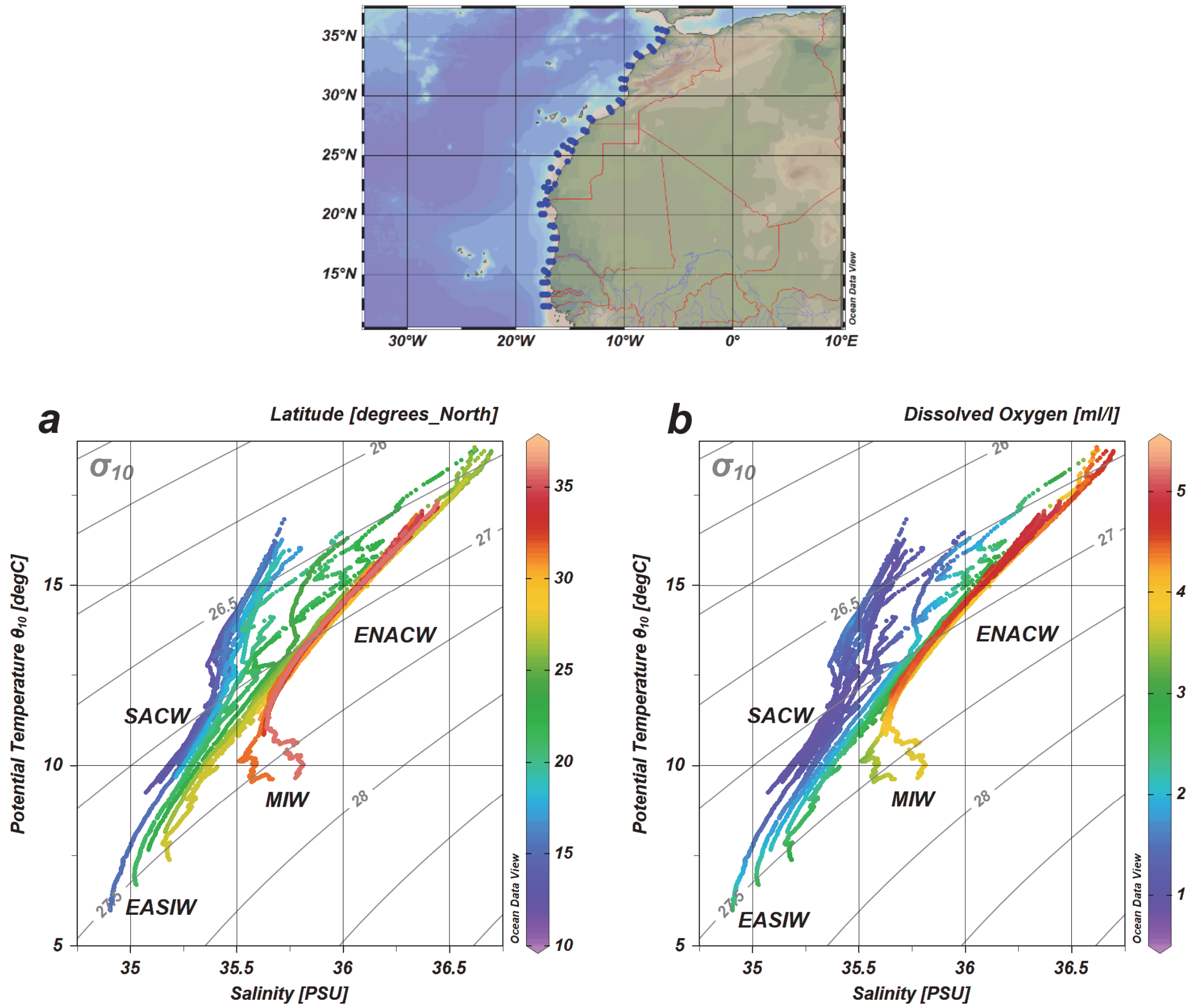


Figure 53. R/V *Dr Fridtjof Nansen* 2019 Northwest Africa CTD distribution map (83 total CTD stations) followed by two T-S diagrams with a dissolved oxygen overlay (a) and a latitudinal overlay (b) for data point region identification.

Approximately 80% of the data points collected during Leg 4 are from 100 m to 500 m depths with the other 20% going down just below 1 000 m. In the upper waters off the Gambia and Senegal, the less-saline, oxygen-deficient SACW with DO values near 0.8 ml/l is observed until it begins mixing with the more oxygenated and saline NACW (~35.5-36.7 PSU and ~5 ml/l respectively) in Mauritania near 20°N (Emery, 2001). As we go into intermediate waters, the less-saline EASIW (< 35.3 PSU) can be observed throughout the Gambia, Senegal, Mauritania and northwards into Morocco. However, in northern Morocco at approximately 32°N, the more saline (35.0-35.8 PSU) and slightly more oxygenated MIW from the Strait of Gibraltar can be observed dominating that region (Figure 54).

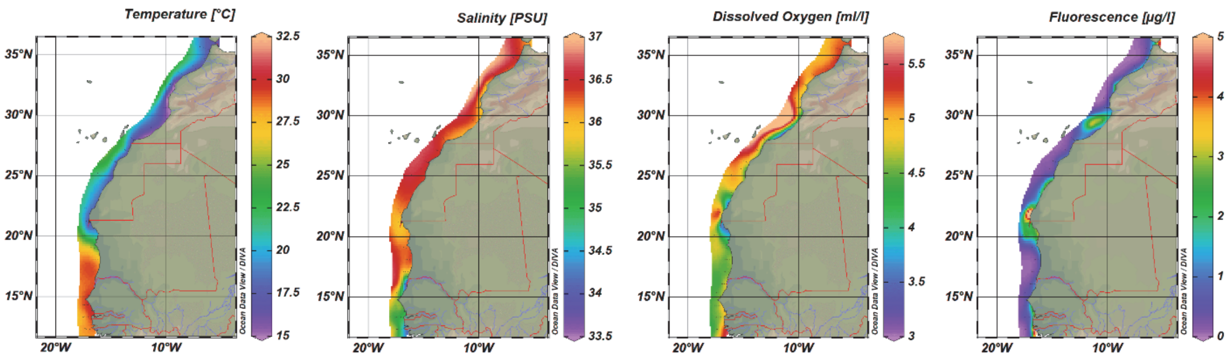


Figure 54. R/V *Dr Fridtjof Nansen* 2019 Northwest Africa horizontal distribution of temperature, salinity, dissolved oxygen and fluorescence at 5 m depth as recorded by the CTD

During this autumn season, the southern region of the survey from the Gambia to Senegal and Mauritania exhibited the warmest subsurface waters reaching 30°C. From northern Mauritania and northwards, subsurface waters cool to 23°C offshore and 17.5° inshore with a minimum at approximately 16°C near 29°N. From northern Morocco to southern Mauritania, subsurface salinity remains relatively high from 36-36.75 PSU. This high salinity is also observed offshore of Senegal but decreases down to 35-34.5 PSU inshore along the coasts of the Gambia and Senegal, especially near the Casamance River outlet. The region's subsurface water is relatively well ventilated with dissolved oxygen levels ranging from 4-6 ml/l with most of Morocco and southern Senegal falling into that higher-level category. Most of Mauritania, northern Senegal and the Gambia averaged approximately 4.5 ml/l. Oxygen levels do drop below 4 ml/l in the tight coastal areas of northern Mauritania, and again near 29°N. However, just offshore at 29°N, oxygen levels are the highest recorded in the region. The qualitative fluorescence data depicts three areas of increased fluorescence: just below the Casamance River in Senegal, near 22°N and near 29°N. Again, 29°N is also the same latitude of lowest subsurface temperature and oxygen maxima (Figure 54).

5.2 Fish distribution and abundance

This series of surveys was carried out in the same way as the previous R/V *Dr Fridtjof Nansen* (1994-2017) regarding both survey design, acoustic scrutinizing and biomass estimation methodology. However, possible limitations in the standardization of specific methodologies and parameters used have been identified and require further detailed investigation. Direct comparison of biomass estimates from the present survey (Table 14) with historic surveys (Table 15) should therefore be done with utmost caution.

A re-evaluation of the biomass estimates over time and across regions to establish a consistent time-series (see Table 15) is recognised as important and is planned within Theme 2 of the EAF-Nansen Programme. Within this project a number of aspects are of direct relevance to the current survey.

As during all the historic surveys, the same target strength was used for all species. For species with low target strength, such as Atlantic chub mackerel (*Scomber colias*), the biomass will be underestimated due to this.

A further bias recognized as potentially important for some regions, both within the northwest African region and elsewhere, is that large embayments and shallow waters of less than 20 m depth are known to contain significant amounts of some of the target species such as sardinellas, as these areas are often favoured by artisanal fishers. This may bias biomass indices, as changes in stock biomass become indistinguishable from distribution shifts when coverage of the distribution is incomplete.

For the present surveys, the length-weight ratio applied in the estimate is based on data collected in the respective areas of the survey. Historically this has to some extent varied between surveys. A study to identify the effect of this in the assessments may be undertaken in the future, also within the framework of Theme 2. This project will also be investigating the effect of using different vessels for the time-series.

Sardine (*Sardina pilchardus*)

The biomass estimate of sardine was similar to the estimates from previous surveys (Table 14), and apart from some 20 000 t found in northern Mauritania, the entire stock being distributed mainly between Cap Blanc and Cape Bojador (Figure 55).

Sardinella *(Sardinella aurita and S. maderensis)*

There are indications that sardinella stocks have declined throughout the Canary Current LME during the past 5 to 10 years. Around 400 000 tonnes were estimated during this series of surveys which is close to the average biomass estimated in surveys since 2015 (see Table 15). However, during the period from 1994 to 2005 the average sardinella biomass estimate was close to 3 million tonnes, and the large difference together with anecdotal information suggests a significant decline.

No sardinella from the CCLME stocks were recorded in Moroccan waters during the survey (Figure 56), the sardinella stock having disappeared completely in Morocco from around 2 million tonnes estimated a decade ago.

Some *Sardinella* spp were found in the northern part of the survey area, close to Tanger. These are believed to be part of the Mediterranean stock.

Less than 50 000 tonnes of sardinella were recorded in Mauritanian waters. This contrasts with the fishery statistics that recorded catches of sardinella as 300 000 tonnes in 2019, and 500 000 tonnes in 2018. This anomaly between the catches and survey estimates requires further investigation, and a project within framework of Theme 2 of the EAF-Nansen Programme has been proposed. In particular, the seasonality of catches should be compared to the survey estimates in that region.

An environmental anomaly was noted in 2019; this being the coldest year in Mauritania on record. This may suggest that the sardinella had migrated out of Mauritanian waters, but this is not supported by increases in the abundance of sardinella in other parts of the CC system.

A significant proportion of the total sardinella biomass was found in Senegalese and The Gambian waters; around 350 000 tonnes. While catch statistics for sardinella are not available for this region, the availability of sardinella in local markets has been reduced as reflected by indications of increasing prices. This suggests that the sardinella stock in this region may have also declined, as elsewhere in Northwest Africa.

It is currently assumed that each of the sardinella species form a single stock in the Northwest African region. An analysis of genetic and morphometric characteristics is currently being conducted within Theme 2 of the EAF-Nansen Programme to reassess the stock status.

Anchovies (*Engraulis encrasicolus*)

The anchovy biomass estimate was the highest recorded in the 25-year time-series of surveys. However, anchovy remains a relatively minor part of the pelagic fish community. Anchovy were found throughout Mauritania and Morocco, the main part of the stock between Cape Cantin and Cape Bojador (Figure 57).

Atlantic chub mackerel (*S. colias*)

The overall biomass estimate of chub mackerel was similar to the past 5-year mean, but this represents around double the long-term biomass estimated earlier this century (Table 15). While *S. colias* was found throughout the region, by far the largest part of the biomass was in Moroccan waters, mainly between Cap Blanc and Cape Bojador (Figure 58).

As with several other small pelagic species in this region, it is assumed that chub mackerel constitute a single stock. Along with the sardinellas, the *S. colias* stock status is being assessed within Theme 2 of the EAF-Nansen Programme through an analysis of genetic and morphometric characteristics.

Horse mackerels (*Trachurus trachurus* and *T. trecae*)

The combined horse mackerel biomass was one of the highest estimates in the 25-year time-series (Table 15).

T. trecae were found throughout Senegal, The Gambia and Mauritania, while *T. trachurus* mainly was found north of Cap Blanc (Figure 59). Very high densities of *T. trecae* were registered in northern Senegal, suggesting a possible increase in stock size in this region.

Other species

More than one million tonnes of snipe fish (*Macroramphosus* sp) were found off northern Morocco.

Other pelagic species were widespread throughout the region (Figure 60).

Table 14. Regional biomass estimates from 2019 R/V *Dr Fridtjof Nansen* surveys (‘000 tonnes)

	Cap Cantin to Tanger	Cape Cantin to Cape Bojador	Cape Bojador to Cap Blanc	Cap Blanc to Cap Timiris	Cap Timiris to St Louis	Northern Senegal	Petite Côte	The Gambia	Casamance	TOTAL
Sardina pilchardus	235	567	3 452	20						**4 274**
Sardinella aurita				25	16	3	25	36	83	**190**
S. maderensis				2	2	5	34	49	113	**202**
E. encrasicolus	5	215	4	30	16					**269**
Trachurus trecae			4	26	217	134	36	4	14	**479**
T. trachurus	25	210	384	1						**603**
Scomber colias	110	106	512	2	1	2	16	17	0	**766**
	376	**1 084**	**4 351**	**146**	**254**	**145**	**112**	**105**	**210**	**6 783**

	Tanger - Cap Cantin	Cap Cantin - Cap Bojador	Cap Bojador - Cap Blanc	Cap Blanc - Cap Timiris	Cap Timiris - St Louis	St Louis - Cap Vert	Cap Vert - The Gambia	The Gambia	Casamance	TOTAL
Sardina pilchardus	235	567	3452	20	0	0	0	0	0	**4 274**
Sardinella aurita	0	0	0	25	16	2	20	29	66	**158**
Sardinella maderensis	0	0	0	2	2	4	37	53	123	**221**
Engraulis encrasicolus	5	215	4	30	16	0	0	0	0	**270**
Trachurus trachurus	25	210	384	1	0	0	0	0	0	**620**
Trachurus tracae	0	0	4	26	217	118	37	4	13	**419**
Scomber colias	110	106	512	2	1	2	2	14	16	**765**
	375	**1 098**	**4 356**	**106**	**252**	**126**	**96**	**100**	**218**	**6 727**

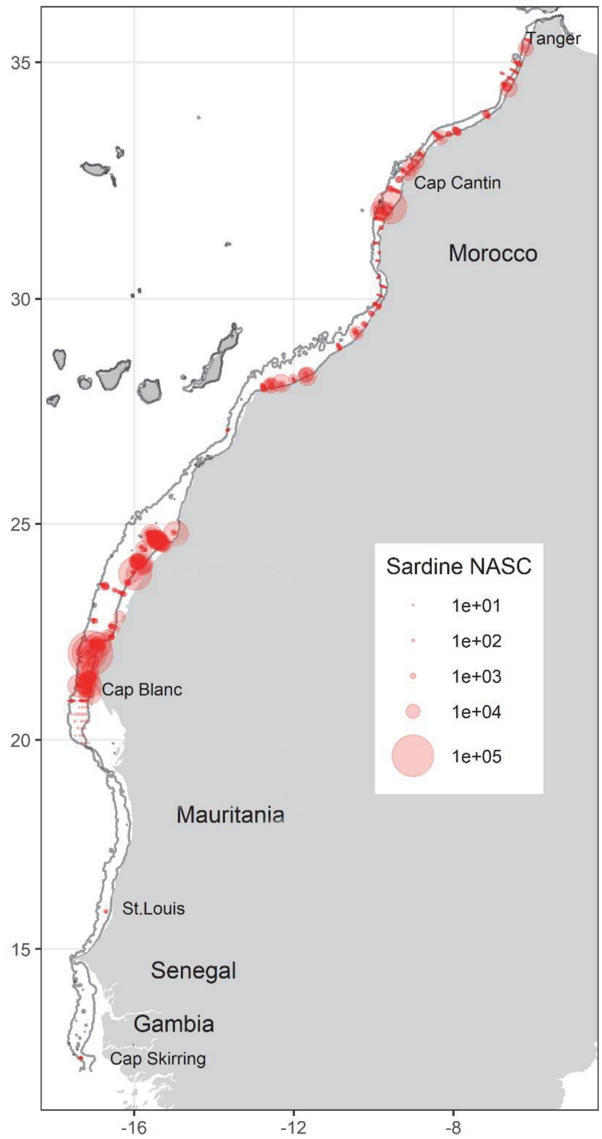


Figure 55. Distribution of sardine (*Sardina pilchardus*), (NASC=nautical area scattering coefficient). 20 m and 100 m depth contours are indicated with grey lines. The countries involved in the surveys and start/end points of each survey segment are named

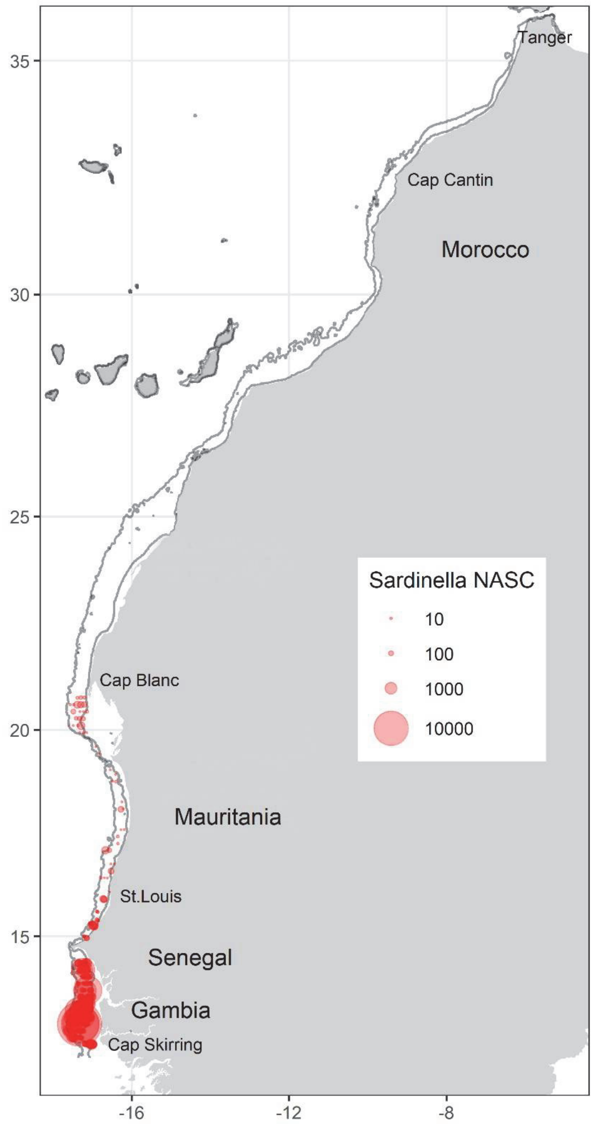


Figure 56. Distribution of sardinellas (*Sardinella aurita* and *S. maderensis* combined), (NASC=nautical area scattering coefficient. 20 m and 100 m depth contours are indicated with grey lines. The countries involved in the surveys and start/end points of each survey segment are named

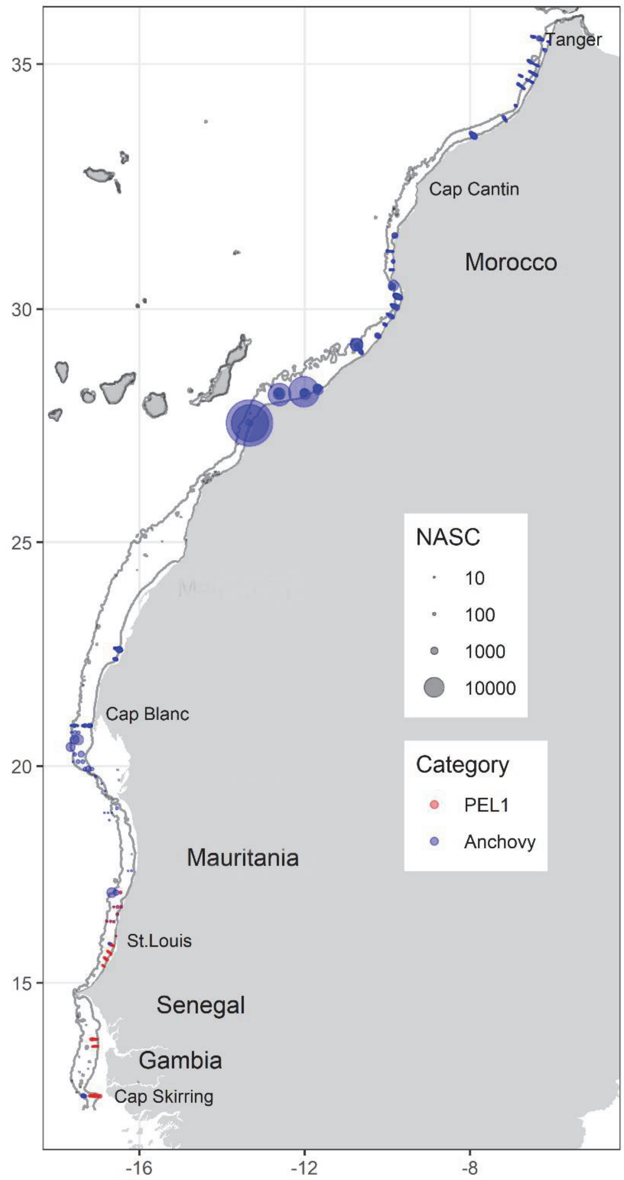


Figure 57. Distribution of anchovy (*Engraulis encrasicolus*, blue) and other clupeids (Pel 1, mainly *Ilisha africana*, red) (NASC=nautical area scattering coefficient). 20 m and 100 m depth contours are indicated with grey lines. The countries involved in the surveys and start/end points of each survey segment are named

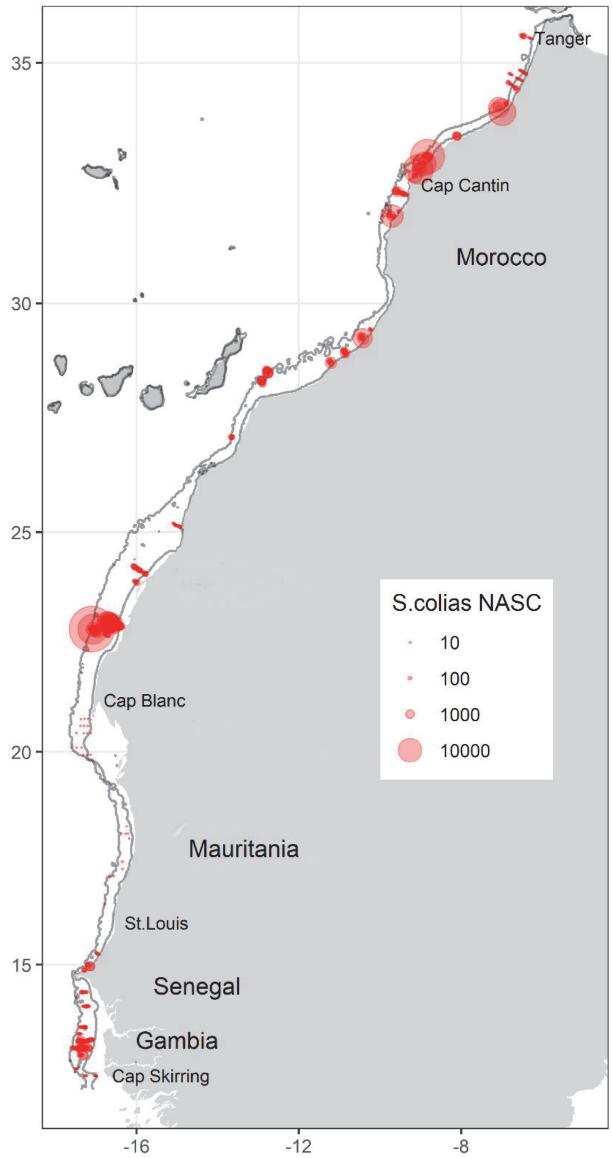


Figure 58. Distribution of Atlantic chub mackerel (*Scomber colias*) (NASC=nautical area scattering coefficient). 20 m and 100 m depth contours are indicated with grey lines. The countries involved in the surveys and start/end points of each survey segment are named

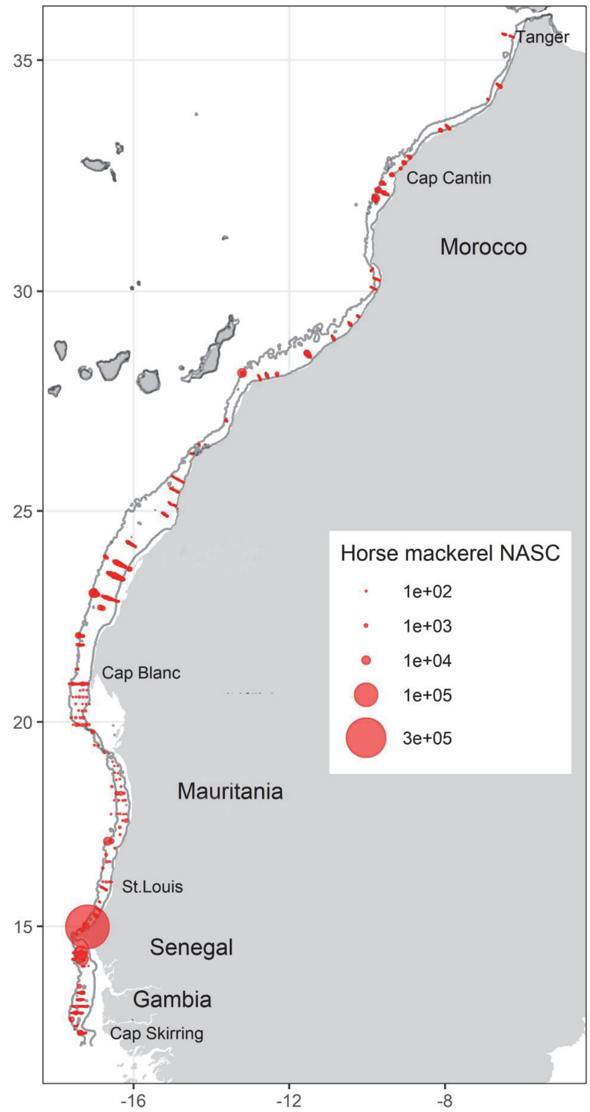


Figure 59. Distribution of horse mackerels (*Trachurus trachurus* and *T. trecae* combined) (NASC=nautical area scattering coefficient). 20 m and 100 m depth contours are indicated with grey lines. The countries involved in the surveys and start/end points of each survey segment are named

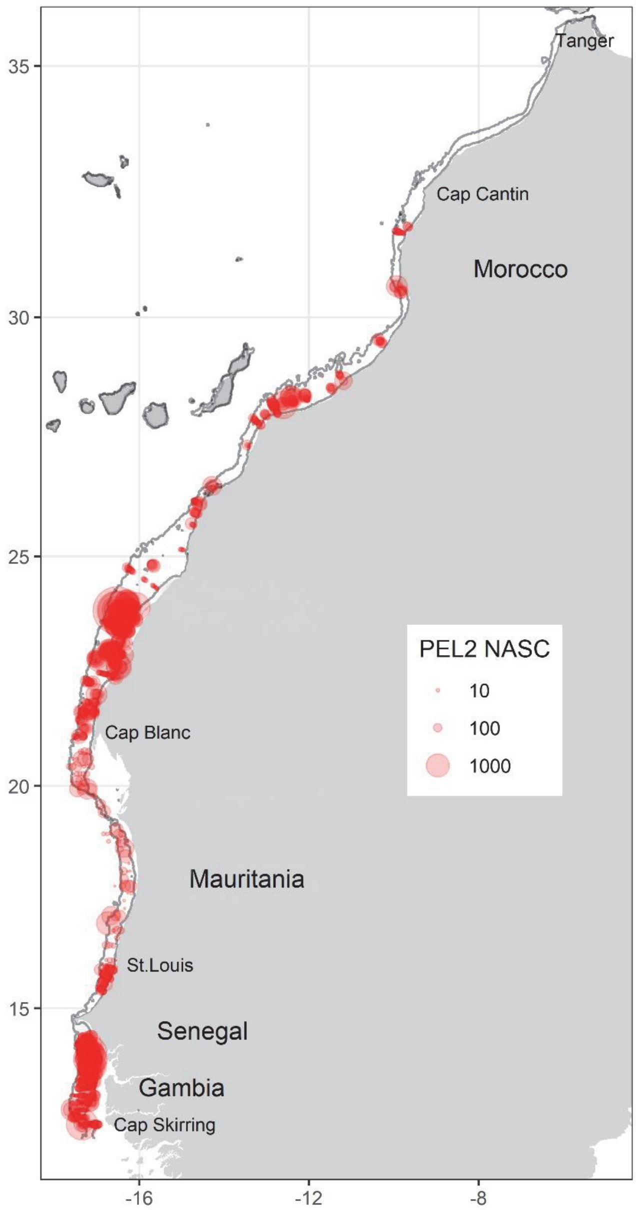


Figure 60. Distribution for Pel 2 (Carangidae, Scombridae, Sphyraenidae and Trichiuridae) (NASC=nautical area scattering coefficient (20 m and 100 m depth contours are indicated with grey lines. The countries involved in the surveys and start/end points of each survey segment are named

Table 15. Acoustic biomass data (million tonnes) from the R/V *Dr Fridtjof Nansen* (in bold) and other vessels for the main species. *Values are not directly comparable among year*

YEAR	***S. pilchardus***	***S. aurita***	***S. maderensis***	***T. trachurus***	***T. trecae***	***S. colias***	***E. encrasicolus***	***Total (excl. sardine)***	**Total**
1995	**3.75**	**1.62**	**1.88**	**0.26**	**0.18**			**3.94**	**7.69**
1996	**5.56**	**1.63**	**1.53**	**0.45**	**0.66**			**4.27**	**9.83**
1997	**1.13**	**0.82**	**1.00**	**0.54**	**0.66**			**3.02**	**4.15**
1998	**1.63**	**0.82**	**1.00**	**0.18**	**0.80**			**2.80**	**4.43**
1999	**2.67**	**2.13**	**1.48**	**0.10**	**0.65**	**0.27**		**4.64**	**7.30**
2000	**3.65**	**1.91**	**0.79**	**0.28**	**1.76**	**0.10**	**0.24**	**5.08**	**8.73**
2001	**4.75**	**1.80**	**1.43**	**0.12**	**0.36**	**0.31**	**0.02**	**4.04**	**8.79**
2002	**6.30**	**1.43**	**0.99**	**0.28**	**0.58**	**0.29**	**0.04**	**3.61**	**9.91**
2003	**5.70**	**1.26**	**1.77**	**0.32**	**0.39**	**0.55**	**0.03**	**4.31**	**10.01**
2004	**7.41**	**1.59**	**2.45**	**0.18**	**0.73**	**0.51**	**0.08**	**5.54**	**12.95**
2005	**8.01**	**0.81**	**1.33**	**0.14**	**1.21**	**0.24**	**0.11**	**3.85**	**11.86**
2006	3.62	1.13	2.05	0.04	0.40	0.44	0.08	4.14	7.76
2007	5.88	0.99	1.19	0.45	0.99	0.61	0.19	4.41	10.29
2008	4.42	2.00	0.55	0.33	0.70	0.63	0.12	4.32	8.74
2009	5.04	2.86	1.67	0.13	0.87	0.76	0.05	6.35	11.39
2010	2.60					0.28			
2011	1.95					0.38			
2012	2.07					0.45			
2013	3.77					0.65			
2014	4.10					1.08			
2015	**4.50**	**0.62**	**0.87**	**0.41**	**0.54**	**0.72**	**0.16**	**3.31**	**7.81**
2016	2.96	0.04	0.05	0.23	0.05	1.06	0.08		
2017	**5.05**	**0.26**	**0.21**	**0.10**	**0.13**	**0.44**	**0.14**	**2.12**	
2019	**4.22**	**0.19**	**0.20**	**1.00**		**0.83**	**0.27**	**2.58**	**6.80**
2019	4.27	0.16	0.22	0.62		0.42	0.76	0.27	2.45
Av 1995-2004	4.60	1.44	1.42	0.98		0.32	0.09	4.10	8.70
Av 2015-2019	4.18	0.28	0.33	0.63		0.76	0.16	2.67	7.31

Years 1995-2006, 2015, 2017 and 2019: Data from the R/V *Dr Fridtjof Nansen.*

Years 2007-2008: Data are *Nansen* equivalents of local vessels using agreed conversion factors.

Year 2009: All data from the Mauritanian R/V *Al Awan* and the Moroccan R/V *Al Amir*, and data for Senegal and the Gambia were estimated by the Working Group.

Year 2010: No estimates for the Mauritanian R/V *Al Awan*, the Moroccan R/V *Al Amir*, Senegal, and the Gambia.

Year 2011: Some estimates for the CCLME (from the R/V *Dr Fridtjof Nansen*) were presented by the CCLME project coordinator.

Year 2012: Data from Mauritanian R/V *Al Amir* were presented to the Working Group for North of Cape Blanc, and results from a survey by the Russian R/V *Atlantida* in Mauritania and Senegal.

Years 2013 and 2014: Survey data from Morocco, Mauritania, and the Russian R/V *Atlantida*.

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ANNEX I. DESCRIPTION OF INSTRUMENTS AND FISHING GEAR

Acoustic instruments

The Simrad EK80/18, 38, 70, 120, 200 and 333 kHz scientific sounder was run throughout the survey. Scrutinizing was done in LSSS using data from the 38-kHz transducer. The last standard sphere calibrations were checked on the 23.01.2017 in Sandviksflaket, Bergen, Norway using a Cu64 sphere 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 used during the survey for the 38-kHz echo sounder were as follows:

Transceiver 2 menu (38 kHz)		
Transducer depth		5.8 m
Absorption coeff.		-8.4 dB/km
Pulse duration		Medium (1,024 ms)
Bandwidth		2.43 kHz
Max power		2000 Watt
Equivalent beam angle		-20,7 dB
Gain		26,62 dB
$_S$A correction		0.03 dB
3 dB beamwidth:		
	alongship	6.25°
	athwartship	6.38°
Alongship offset		0.01º
Athwartship offset		0.06º
Bottom detection menu		Minimum level 50 Db
Angle sensitivity:		
	alongship	18.0°
	athwartship	18.0°

Fishing gear

The vessel has one small four-panel 'Åkrahamn' pelagic trawl, one MultPelt 624 trawl (Figure I.1, new in 2017) and one 'Gisund super bottom trawl'. All trawls were used during the survey.

The smallest pelagic trawl has 8 to 12 m vertical opening under normal operation, whereas the MultPelt 624 trawl has 25 to 35 m opening. The bottom trawl has a 31 m headline and a 47 m footrope fitted with a 12" rubber bobbins gear. The codend has 20 mm meshes, plus an inner net with 10 mm mesh size. The vertical opening is about 5.5 m. The distance between the wing tips is about 18 m during towing. The sweeps are 40 m long. The trawl doors are 8 m^2 'Thyborøen' combi and weigh 2 000 kg. Trawling was conducted for species identification only and no restraining rope was used during the survey.

The SCANMAR system was used during all trawl hauls. This equipment consists of sensors, a hydrophone, a receiver, a display unit and a battery charger. Communication between sensors and ship is based on acoustic transmission. The doors are fitted with sensors to provide information on their interdistance and angle, while a height sensor is fitted on the bottom trawl to measure the trawl opening and provide information on clearance and bottom contact. The all trawls are equipped with a trawl eye that provides information about the trawl opening and the distance of the footrope to the bottom. A pressure sensor is used to show the depth on the headline.

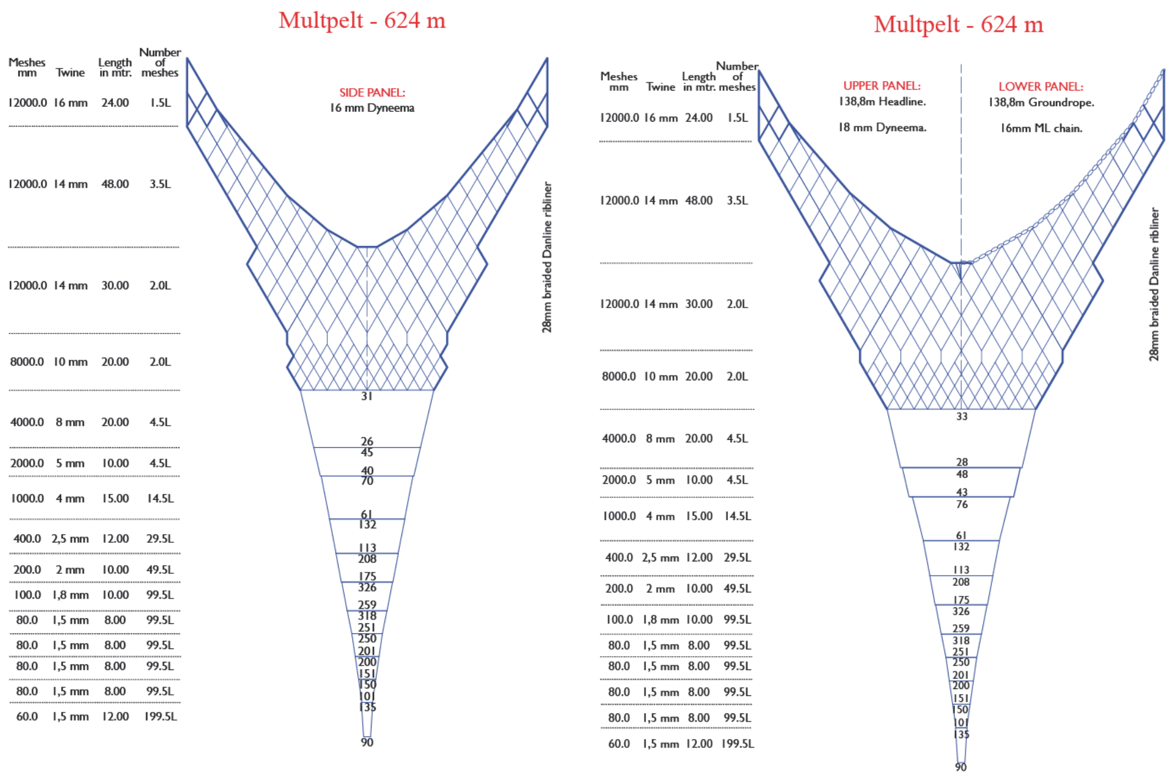

Figure I.1. Schematic drawing of the MultPelt 624 trawl

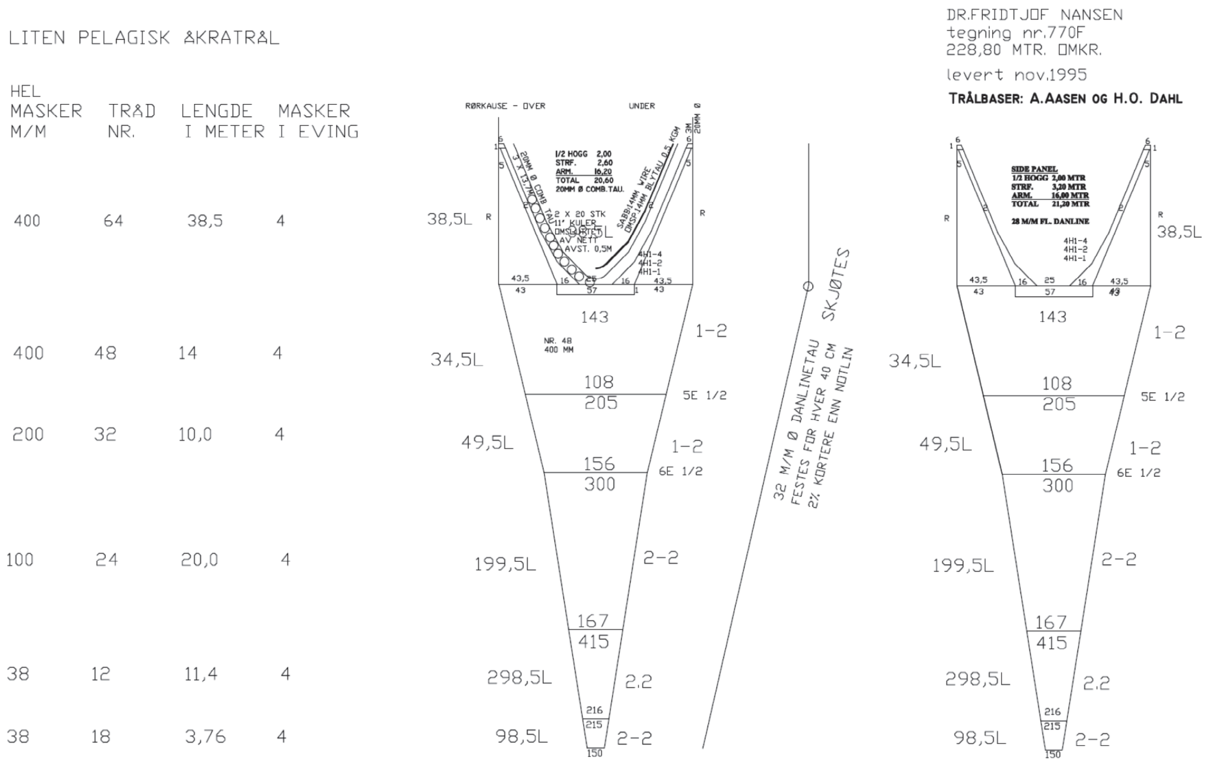

Figure II.2. Schematic drawing of the small pelagic Åkratrawl trawl

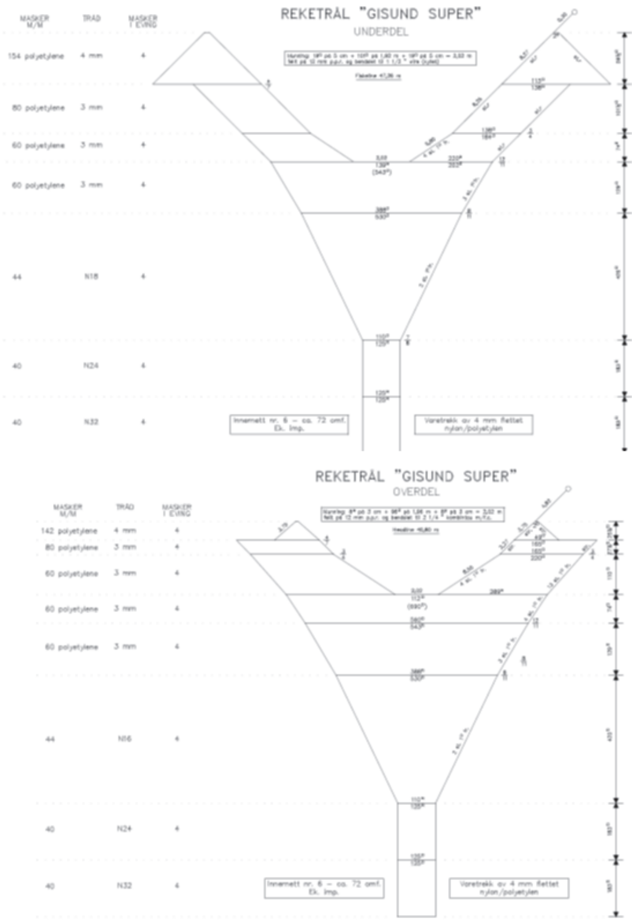

Figure II.3. Schematic drawing of the Super Gisund bottom trawl

ANNEX II. FISH BIOLOGICAL STATES

Sexual maturity

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

Stomach contents

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

ANNEX III. RECORDS OF FISHING STATIONS

2019413

```
R/V Dr. Fridtjof Nansen        SURVEY:2019413        STATION:    1
DATE  :31/10/19             GEAR TYPE: PT NO:  4  POSITION:Lat   N 20°54.69
         start    stop    duration                         Lon   W 17°31.23
TIME  :00:07:04 00:37:32  30.5 (min)          Purpose   : 3
LOG   :  797.30   798.73   1.4                Region    : 1100
FDEPTH:       5        5                      Gear cond.: 0
BDEPTH:      94      102                      Validity  : 0
Towing dir:   0°     Wire out    : 130  m     Speed     : 2.8 kn
Sorted    : 101      Total catch: 101.38      Catch/hour: 199.63
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Trachurus trachurus	83.59	3881	41.87	1
Trachurus trecae	68.13	3353	34.13	3
Sardina pilchardus	22.84	880	11.44	4
MYCTOPHIDAE	15.00	4151	7.52	
Engraulis encrasicolus	5.67	526	2.84	2
Todarodes sagittatus	1.20	2	0.60	
Sarda sarda	1.18	2	0.59	
Auxis thazard	1.10	2	0.55	
Belone belone gracilis	0.79	10	0.39	
Loligo vulgaris	0.12	2	0.06	
Total	199.63		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019413        STATION:    2
DATE  :31/10/19             GEAR TYPE: PT NO:  1  POSITION:Lat   N 20°55.04
         start    stop    duration                         Lon   W 17°17.12
TIME  :02:58:09 03:28:04  29.9 (min)          Purpose   : 3
LOG   :  815.79   817.48   1.7                Region    : 1100
FDEPTH:      15       25                      Gear cond.: 0
BDEPTH:      48       56                      Validity  : 0
Towing dir:   0°     Wire out    : 110  m     Speed     : 3.4 kn
Sorted    :   1      Total catch: 0.87        Catch/hour: 1.75
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Loligo vulgaris	0.60	44	34.48	
Sepia officinalis	0.50	2	28.74	
Spondyliosoma cantharus	0.36	2	20.69	
Sepia orbignyana	0.08	8	4.60	
Boops boops	0.06	2	3.45	
Pagellus bellottii	0.04	70	2.30	
Engraulis encrasicolus	0.03	8	1.72	
Selene dorsalis	0.02	4	1.15	
J E L L Y F I S H	0.02	4	1.15	
MYCTOPHIDAE	0.02	4	1.15	
Illex coindetii	0.01	2	0.57	
GOBIIDAE	0.00	8	0.00	
CARANGIDAE	0.00	2	0.00	
Lagocephalus sp.	0.00	2	0.00	
Total	1.75		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019413        STATION:    3
DATE  :31/10/19             GEAR TYPE: PT NO:  8  POSITION:Lat   N 21°16.22
         start    stop    duration                         Lon   W 17°15.15
TIME  :15:23:09 16:12:55  49.8 (min)          Purpose   : 3
LOG   :  917.84   920.96   3.1                Region    : 1100
FDEPTH:       0        0                      Gear cond.: 0
BDEPTH:      57       56                      Validity  : 0
Towing dir:   0°     Wire out    : 200  m     Speed     : 3.8 kn
Sorted    :  69      Total catch: 68.88       Catch/hour: 83.04
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sarda sarda	71.25	35	85.80	5
Prionace glauca	5.83	1	7.03	
Auxis thazard	2.92	5	3.51	7
Trachinotus ovatus	2.31	6	2.79	6
J E L L Y F I S H	0.63	2	0.75	
Sepia officinalis	0.10	5	0.12	
Total	83.04		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019413        STATION:    4
DATE  :31/10/19             GEAR TYPE: PT NO:  4  POSITION:Lat   N 21°15.98
         start    stop    duration                         Lon   W 17°8.44
TIME  :18:59:58 19:12:48  12.8 (min)          Purpose   : 3
LOG   :  937.58   938.33   0.8                Region    : 1100
FDEPTH:      10       10                      Gear cond.: 0
BDEPTH:      45       45                      Validity  : 0
Towing dir:   0°     Wire out    : 160  m     Speed     : 3.5 kn
Sorted    : 127      Total catch: 2457.76     Catch/hour: 11493.83
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardina pilchardus	11320.90	121328	98.50	8
Spondyliosoma cantharus	141.66	645	1.23	
Sardina pilchardus, juvenile	18.40	1562	0.16	
Loligo vulgaris	12.87	276	0.11	
Total	11493.83		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019413        STATION:    5
DATE  :31/10/19             GEAR TYPE: PT NO:  1  POSITION:Lat   N 21°27.21
         start    stop    duration                         Lon   W 17°12.18
TIME  :22:43:32 22:52:39  9.1  (min)          Purpose   : 3
LOG   :  964.57   965.04   0.5                Region    : 1100
FDEPTH:      10       10                      Gear cond.: 0
BDEPTH:      61       61                      Validity  : 0
Towing dir:   0°     Wire out    : 140  m     Speed     : 3.1 kn
Sorted    :  99      Total catch: 900.00      Catch/hour: 5921.05
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardina pilchardus	5735.59	179243	96.87	9
Trachurus trachurus	45.92	1770	0.78	10
Sarda sarda	44.87	39	0.76	13
Loligo vulgaris	34.12	1118	0.58	
Trachurus trecae	27.56	197	0.47	12
Engraulis encrasicolus	14.43	2164	0.24	11
Campogramma glaycos	12.76	26	0.22	14
Trachinotus ovatus	5.79	20	0.10	16
Total	5921.05		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019413        STATION:    6
DATE  :01/11/19             GEAR TYPE: PT NO:  4  POSITION:Lat   N 21°37.95
         start    stop    duration                         Lon   W 17°8.31
TIME  :06:19:26 06:48:33  29.1 (min)          Purpose   : 3
LOG   : 1028.51  1030.18   1.7                Region    : 1100
FDEPTH:      10       10                      Gear cond.: 0
BDEPTH:      54       46                      Validity  : 0
Towing dir:   0°     Wire out    : 160  m     Speed     : 3.4 kn
Sorted    :  44      Total catch: 44.32       Catch/hour: 91.32
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardina pilchardus	42.61	2598	46.66	17
J E L L Y F I S H	17.51	4	19.18	
Sarda sarda	13.27	4	14.53	
Loligo vulgaris	11.79	3124	12.91	
Trachurus trachurus	3.21	105	3.52	18
Engraulis encrasicolus	2.23	696	2.44	19
Sepia orbignyana	0.58	6	0.63	
Sardinella aurita	0.08	6	0.09	21
Sepia officinalis	0.04	2	0.05	
Trachinotus ovatus	0.00	8	0.00	
Selene dorsalis	0.00	4	0.00	
Total	91.32		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019413        STATION:    7
DATE  :01/11/19             GEAR TYPE: PT NO:  8  POSITION:Lat   N 22°1.50
         start    stop    duration                         Lon   W 17°5.03
TIME  :16:03:51 16:19:27  15.6 (min)          Purpose   : 3
LOG   : 1116.56  1117.74   1.2                Region    : 1100
FDEPTH:       0        0                      Gear cond.: 0
BDEPTH:      54       58                      Validity  : 0
Towing dir:   0°     Wire out    : 180  m     Speed     : 4.6 kn
Sorted    :  73      Total catch: 15000.00    Catch/hour: 57655.35
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardina pilchardus	57513.13	2478823	99.75	22
Engraulis encrasicolus	139.80	13399	0.24	23
Sarda sarda	2.61	4	0.00	24
Total	57655.54		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019413        STATION:    8
DATE  :01/11/19             GEAR TYPE: PT NO:  1  POSITION:Lat   N 22°13.71
         start    stop    duration                         Lon   W 16°52.16
TIME  :21:01:16 21:05:58  4.7  (min)          Purpose   : 3
LOG   : 1146.35  1146.62   0.3                Region    : 1100
FDEPTH:       5        5                      Gear cond.: 0
BDEPTH:      42       42                      Validity  : 0
Towing dir:   0°     Wire out    : 150  m     Speed     : 3.5 kn
Sorted    :   0      Total catch: 858.51      Catch/hour: 10959.70
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardina pilchardus	10624.47	681064	96.94	27
Campogramma glaycos	195.06	421	1.78	28
Dasyatis pastinaca	63.83	13	0.58	26
Gymnura altavela	38.30	13	0.35	25
Loligo vulgaris	14.68	102	0.13	
Sepia officinalis	12.64	204	0.12	
Trichiurus lepturus	6.64	13	0.06	35
Belone belone gracilis	4.09	13	0.04	34
Total	10959.70		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019413        STATION:    9
DATE  :01/11/19             GEAR TYPE: PT NO:  1  POSITION:Lat   N 22°13.95
         start    stop    duration                         Lon   W 16°56.48
TIME  :22:32:28 22:43:38  11.2 (min)          Purpose   : 3
LOG   : 1155.32  1155.84   0.5                Region    : 1100
FDEPTH:      10       10                      Gear cond.: 0
BDEPTH:      50       48                      Validity  : 0
Towing dir:   0°     Wire out    : 140  m     Speed     : 2.8 kn
Sorted    :  32      Total catch: 499.96      Catch/hour: 2685.55
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardina pilchardus	2650.31	90145	98.69	33
Engraulis encrasicolus	20.14	1848	0.75	30
Belone belone gracilis	13.43	86	0.50	32
Trachurus trachurus	1.67	86	0.06	31
Total	2685.55		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019413        STATION:   10
DATE  :02/11/19             GEAR TYPE: PT NO:  4  POSITION:Lat   N 22°19.18
         start    stop    duration                         Lon   W 17°19.53
TIME  :03:03:07 03:07:53  4.8  (min)          Purpose   : 3
LOG   : 1184.36  1184.65   0.3                Region    : 1100
FDEPTH:      10       10                      Gear cond.: 0
BDEPTH:     138      116                      Validity  : 0
Towing dir:   0°     Wire out    : 80   m     Speed     : 3.7 kn
Sorted    :  50      Total catch: 49.89       Catch/hour: 628.87
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Brama brama	529.66	1071	84.23	
MYCTOPHIDAE	91.26	76046	14.51	
SALPS	5.04	25	0.80	
JELLYFISH	1.51	13	0.24	
Nealotus tripes	0.88	25	0.14	
Loligo vulgaris	0.50	13	0.08	
Total	628.87		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019413        STATION:   11
DATE  :02/11/19             GEAR TYPE: PT NO:  7  POSITION:Lat   N 22°25.51
         start    stop    duration                         Lon   W 16°31.84
TIME  :12:45:03 12:59:34  14.5 (min)          Purpose   : 3
LOG   : 1252.32  1253.21   0.9                Region    : 1100
FDEPTH:      15       20                      Gear cond.: 0
BDEPTH:      27       27                      Validity  : 0
Towing dir:   0°     Wire out    : 105  m     Speed     : 3.7 kn
Sorted    :  89      Total catch: 89.12       Catch/hour: 368.01
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardina pilchardus	211.01	7127	57.34	37
Campogramma glaycos	98.03	306	26.64	
Engraulis encrasicolus	32.54	5612	8.84	39
Sepia officinalis	7.68	54	2.09	
Sarda sarda	3.96	4	1.08	40
Diplodus bellottii	3.88	347	1.05	
Pomadasys incisus	2.64	120	0.72	
Argyrosomus regius	2.64	25	0.72	41
Loligo vulgaris	1.57	277	0.43	
Pagellus bellottii	1.40	4	0.38	
Merluccius senegalensis	1.07	8	0.29	43
Scomber colias	0.66	8	0.18	42
Belone belone gracilis	0.41	4	0.11	38
Trachurus trachurus	0.25	17	0.07	
Symphodus bailloni	0.17	4	0.04	
Alloteuthis africana	0.04	4	0.01	
Sardinella aurita	0.04	4	0.01	36
Fishing gears	0.00	8	0.00	
Total	368.01		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019413        STATION:   12
DATE  :02/11/19             GEAR TYPE: PT NO:  8  POSITION:Lat   N 22°47.49
         start    stop    duration                         Lon   W 17°0.57
TIME  :19:08:14 19:36:47  28.5 (min)          Purpose   : 3
LOG   : 1305.69  1307.74   2.1                Region    : 1100
FDEPTH:       0        0                      Gear cond.: 0
BDEPTH:      79       72                      Validity  : 0
Towing dir:   0°     Wire out    : 180  m     Speed     : 4.3 kn
Sorted    : 137      Total catch: 136.58      Catch/hour: 287.13
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Scomber colias	182.06	3065	63.41	44
Sarda sarda	36.08	32	12.56	45
Sardina pilchardus	32.21	580	11.22	47
Katsuwonus pelamis	12.78	4	4.45	50
Prionace glauca	11.90	4	4.14	
Loligo vulgaris	6.85	27	2.39	
Trachurus trachurus	5.13	177	1.79	48
Leptostomias sp.	0.13	17	0.04	51
Total	287.13		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   13
DATE  :02/11/19             GEAR TYPE: PT NO:  7  POSITION:Lat   N 22°48.36
         start    stop    duration                         Lon   W 17°3.27
TIME  :21:04:39 21:24:19  19.7 (min)          Purpose   : 3
LOG   : 1316.43  1317.45   1.0                Region    : 1100
FDEPTH:       60       60                     Gear cond.: 0
BDEPTH:       87       83                     Validity  : 0
Towing dir:    0°     Wire out   : 180  m     Speed     : 3.1 kn
Sorted    :    3      Total catch: 2.85       Catch/hour: 8.69

   SPECIES                                   CATCH/HOUR    % OF TOT. C   SAMP
                                           weight   numbers
   Sardina pilchardus                         6.22       128       71.58       52
   Scomber colias                             1.77        27       20.35       53
   Macrorhamphosus gracilis                   0.55        70        6.32
   Loligo vulgaris                            0.12         3        1.40
   J E L L Y F I S H                          0.03         3        0.35
                                          __________            ________
   Total                                      8.69                100.00
```

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   14
DATE  :03/11/19             GEAR TYPE: PT NO:  4  POSITION:Lat   N 22°57.31
         start    stop    duration                         Lon   W 16°38.87
TIME  :04:11:35 04:21:36  10.0 (min)          Purpose   : 3
LOG   : 1373.54  1374.05   0.5                Region    : 1100
FDEPTH:       10       10                     Gear cond.: 0
BDEPTH:       43       42                     Validity  : 0
Towing dir:    0°     Wire out   : 125  m     Speed     : 3.0 kn
Sorted    :   38      Total catch: 38.20      Catch/hour: 228.74

   SPECIES                                   CATCH/HOUR    % OF TOT. C   SAMP
                                           weight   numbers
   Scomber colias                           172.46      2419       75.39       54
   Trachurus trachurus                       24.19       677       10.58       55
   Sarda sarda                               21.56        18        9.42       56
   Loligo vulgaris                            5.63       659        2.46
   Pagellus bellottii                         2.99        48        1.31
   Sardina pilchardus                         1.92        24        0.84       57
                                          __________            ________
   Total                                    228.74                100.00
```

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   15
DATE  :03/11/19             GEAR TYPE: PT NO:  7  POSITION:Lat   N 23°9.89
         start    stop    duration                         Lon   W 16°31.98
TIME  :10:07:32 10:37:34  30.0 (min)          Purpose   : 3
LOG   : 1424.83  1426.35   1.5                Region    : 1100
FDEPTH:       20       20                     Gear cond.: 0
BDEPTH:       28       30                     Validity  : 0
Towing dir:    0°     Wire out   : 90   m     Speed     : 3.0 kn
Sorted    :   17      Total catch: 16.59      Catch/hour: 33.14

   SPECIES                                   CATCH/HOUR    % OF TOT. C   SAMP
                                           weight   numbers
   Loligo vulgaris                           14.99       823       45.22
   J E L L Y F I S H                         12.11         2       36.53
   Auxis rochei                               6.03         8       18.21       59
   Trachurus trachurus                        0.01         8        0.03       60
   Trachurus trecae                           0.00         2        0.01       61
                                          __________            ________
   Total                                     33.14                100.00
```

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   16
DATE  :03/11/19             GEAR TYPE: PT NO:  8  POSITION:Lat   N 23°16.80
         start    stop    duration                         Lon   W 16°47.89
TIME  :12:56:57 13:19:22  22.4 (min)          Purpose   : 3
LOG   : 1445.01  1446.62   1.6                Region    : 1100
FDEPTH:       20       10                     Gear cond.: 0
BDEPTH:       63       61                     Validity  : 0
Towing dir:    0°     Wire out   : 200  m     Speed     : 4.3 kn
Sorted    :   31      Total catch: 8000.00    Catch/hour: 21409.46

   SPECIES                                   CATCH/HOUR    % OF TOT. C   SAMP
                                           weight   numbers
   Macrorhamphosus gracilis                21409.46  2327114      100.00       62
                                          __________            ________
   Total                                  21409.46                100.00
```

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   17
DATE  :03/11/19             GEAR TYPE: PT NO:  1  POSITION:Lat   N 23°34.00
         start    stop    duration                         Lon   W 16°42.18
TIME  :20:11:47 20:19:17  7.5  (min)          Purpose   : 3
LOG   : 1505.02  1505.48   0.5                Region    : 1100
FDEPTH:       10       10                     Gear cond.: 0
BDEPTH:       68       67                     Validity  : 0
Towing dir:    0°     Wire out   : 160  m     Speed     : 3.7 kn
Sorted    :   69      Total catch: 344.25     Catch/hour: 2750.33

   SPECIES                                   CATCH/HOUR    % OF TOT. C   SAMP
                                           weight   numbers
   Sardina pilchardus                      2734.35     60695       99.42       64
   Scomber colias                            15.18       320        0.55       63
   Engraulis encrasicolus                     0.80        40        0.03       65
                                          __________            ________
   Total                                   2750.33                100.00
```

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   18
DATE  :03/11/19             GEAR TYPE: PT NO:  7  POSITION:Lat   N 23°28.47
         start    stop    duration                         Lon   W 16°27.93
TIME  :22:54:24 23:02:26  8.0  (min)          Purpose   : 3
LOG   : 1523.97  1524.39   0.4                Region    : 1100
FDEPTH:       30       30                     Gear cond.: 0
BDEPTH:       35       33                     Validity  : 0
Towing dir:    0°     Wire out   : 110  m     Speed     : 3.2 kn
Sorted    :    3      Total catch: 2.94       Catch/hour: 21.97

   SPECIES                                   CATCH/HOUR    % OF TOT. C   SAMP
                                           weight   numbers
   Trachurus trachurus                        8.07       194       36.73       66
   Loligo vulgaris                            3.14        60       14.29
   Belone belone gracilis                     2.99        30       13.61       70
   Aspitrigla obscura                         2.54        37       11.56
   Scomber colias                             2.39        30       10.88       67
   Pagellus bellottii                         1.79        15        8.16
   Spondyliosoma cantharus                    0.75        15        3.40
   Trachinus araneus                          0.15         7        0.68       68
   Sardina pilchardus                         0.15         7        0.68       69
                                          __________            ________
   Total                                     21.97                100.00
```

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   19
DATE  :04/11/19             GEAR TYPE: PT NO:  7  POSITION:Lat   N 23°54.51
         start    stop    duration                         Lon   W 16°3.64
TIME  :18:08:05 18:35:41  27.6 (min)          Purpose   : 3
LOG   : 1667.34  1668.92   1.6                Region    : 1100
FDEPTH:       30       30                     Gear cond.: 0
BDEPTH:       31       35                     Validity  : 0
Towing dir:    0°     Wire out   : 120  m     Speed     : 3.5 kn
Sorted    :    2      Total catch: 1.90       Catch/hour: 4.13

   SPECIES                                   CATCH/HOUR    % OF TOT. C   SAMP
                                           weight   numbers
   Scomber colias                             1.52        39       36.84       73
   Loligo vulgaris                            1.17         4       28.42
   Sardina pilchardus                         1.00        13       24.21       72
   Trachurus trachurus                        0.43         9       10.53       71
                                          __________            ________
   Total                                      4.13                100.00
```

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   20
DATE  :04/11/19             GEAR TYPE: PT NO:  1  POSITION:Lat   N 23°51.43
         start    stop    duration                         Lon   W 15°58.27
TIME  :20:01:54 20:11:11  9.3  (min)          Purpose   : 3
LOG   : 1678.82  1679.39   0.6                Region    : 1100
FDEPTH:        5        5                     Gear cond.: 0
BDEPTH:       26       28                     Validity  : 0
Towing dir:    0°     Wire out   : 120  m     Speed     : 3.7 kn
Sorted    : 100       Total catch: 2001.66    Catch/hour: 12927.84

   SPECIES                                   CATCH/HOUR    % OF TOT. C   SAMP
                                           weight   numbers
   Sardina pilchardus                      12782.13   116835       98.87       76
   Scomber colias                           121.81       517        0.94       74
   Sardinella aurita                         12.92       129        0.10       75
   Loligo vulgaris                           10.98        39        0.08
                                          __________            ________
   Total                                  12927.84                100.00
```

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   21
DATE  :05/11/19             GEAR TYPE: PT NO:  7  POSITION:Lat   N 24°31.16
         start    stop    duration                         Lon   W 15°54.30
TIME  :10:30:31 10:54:52  24.4 (min)          Purpose   : 3
LOG   : 1807.10  1808.43   1.3                Region    : 1100
FDEPTH:       40       40                     Gear cond.: 0
BDEPTH:       48       52                     Validity  : 0
Towing dir:    0°     Wire out   : 145  m     Speed     : 3.3 kn
Sorted    :    0      Total catch: 0.00       Catch/hour: 0.00

   SPECIES                                   CATCH/HOUR    % OF TOT. C   SAMP
                                           weight   numbers
   NOCATCH                                    0.00         0        0.00
                                          __________            ________
```

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   22
DATE  :05/11/19             GEAR TYPE: PT NO:  7  POSITION:Lat   N 24°20.04
         start    stop    duration                         Lon   W 15°31.77
TIME  :14:20:50 14:25:46  4.9  (min)          Purpose   : 3
LOG   : 1836.77  1836.99   0.2                Region    : 1100
FDEPTH:       10       10                     Gear cond.: 0
BDEPTH:       22       22                     Validity  : 0
Towing dir:    0°     Wire out   : 100  m     Speed     : 2.7 kn
Sorted    :   63      Total catch: 1500.95    Catch/hour: 18304.24

   SPECIES                                   CATCH/HOUR    % OF TOT. C   SAMP
                                           weight   numbers
   Sardina pilchardus                      18292.68   195012       99.94       77
   Chelidonichthys obscurus                   5.78       293        0.03
   Diplodus bellottii                         2.89       293        0.02
   Loligo vulgaris                            2.89       293        0.02
                                          __________            ________
   Total                                  18304.24                100.00
```

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   23
DATE  :05/11/19             GEAR TYPE: PT NO:  7  POSITION:Lat   N 24°34.82
         start    stop    duration                         Lon   W 15°20.87
TIME  :18:52:34 18:58:43  6.2  (min)          Purpose   : 3
LOG   : 1866.81  1867.14   0.3                Region    : 1100
FDEPTH:       10       10                     Gear cond.: 0
BDEPTH:       28       28                     Validity  : 0
Towing dir:    0°     Wire out   : 140  m     Speed     : 3.2 kn
Sorted    :   68      Total catch: 203.25     Catch/hour: 1982.93

   SPECIES                                   CATCH/HOUR    % OF TOT. C   SAMP
                                           weight   numbers
   Sardina pilchardus                      1982.93     19746      100.00       78
                                          __________            ________
   Total                                   1982.93                100.00
```

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   24
DATE  :06/11/19             GEAR TYPE: PT NO:  8  POSITION:Lat   N 25°1.95
         start    stop    duration                         Lon   W 15°22.99
TIME  :11:17:05 12:17:32  60.5 (min)          Purpose   : 3
LOG   : 1997.66  2002.62   5.0                Region    : 1100
FDEPTH:        0        0                     Gear cond.: 0
BDEPTH:       44       53                     Validity  : 0
Towing dir:    0°     Wire out   : 190  m     Speed     : 4.9 kn
Sorted    :   34      Total catch: 5014.12    Catch/hour: 4976.79

   SPECIES                                   CATCH/HOUR    % OF TOT. C   SAMP
                                           weight   numbers
   Trachinus draco                         4962.78     69479       99.72
   Prionace glauca                            7.90         2        0.16
   Pagellus bellottii                         2.54        11        0.05
   Sarda sarda                                1.65         1        0.03
   Spondyliosoma cantharus                    1.37         8        0.03
   Auxis rochei                               0.56         1        0.01
                                          __________            ________
   Total                                   4976.79                100.00
```

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   25
DATE  :06/11/19             GEAR TYPE: PT NO:  7  POSITION:Lat   N 24°46.74
         start    stop    duration                         Lon   W 14°56.15
TIME  :16:40:52 16:52:03  11.2 (min)          Purpose   : 3
LOG   : 2039.40  2040.15   0.8                Region    : 1100
FDEPTH:       22       22                     Gear cond.: 0
BDEPTH:       28       29                     Validity  : 0
Towing dir:    0°     Wire out   : 140  m     Speed     : 4.0 kn
Sorted    : 137       Total catch: 1749.94    Catch/hour: 9383.08

   SPECIES                                   CATCH/HOUR    % OF TOT. C   SAMP
                                           weight   numbers
   Sardina pilchardus                      8800.72     78231       93.79       79
   Diplodus bellottii                       193.21      3013        2.06       82
   Scomber colias                           105.51      1373        1.12       80
   Boops boops                               76.73      1303        0.82       84
   Trachurus trachurus                       73.99      1576        0.79       81
   Pomadasys incisus                         71.25       477        0.76       86
   Loligo vulgaris                           38.37       273        0.41
   Diplodus vulgaris                         12.33        70        0.13       85
   Mullus surmuletus                         10.96       139        0.12       83
                                          __________            ________
   Total                                   9383.08                100.00
```

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   26
DATE  :07/11/19             GEAR TYPE: BT NO:  1  POSITION:Lat   N 25°43.56
         start    stop    duration                         Lon   W 14°50.94
TIME  :16:04:52 16:33:40  28.8 (min)          Purpose   : 3
LOG   : 2224.85  2226.62   1.8                Region    : 1100
FDEPTH:       90       83                     Gear cond.: 0
BDEPTH:       90       83                     Validity  : 0
Towing dir:    0°     Wire out   : 300  m     Speed     : 3.7 kn
Sorted    :   76      Total catch: 76.24      Catch/hour: 158.78

   SPECIES                                   CATCH/HOUR    % OF TOT. C   SAMP
                                           weight   numbers
   Pomadasys incisus                         99.97       500       62.96
   Trachurus trachurus                       30.61       235       19.28       87
   Dentex maroccanus                          9.21       104        5.80
   Pagellus acarne                            3.75        21        2.36
   Zeus faber                                 2.42         2        1.52
   Diplodus vulgaris                          2.37        10        1.50
   Mullus barbatus                            1.87         8        1.18
   Campogramma glaycos                        1.83         2        1.15
   Sphoeroides pachygaster                    1.33         2        0.84
   Sarpa salpa                                1.29         2        0.81
   Dentex canariensis                         1.29         4        0.81
   Trachurus trecae                           1.25         4        0.79       88
   Pagellus bellottii                         0.96         4        0.60
   Aspitrigla obscura                         0.37         6        0.24
   Pagellus erythrinus                        0.25         2        0.16
                                          __________            ________
   Total                                    158.78                100.00
```

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   27
DATE  :08/11/19             GEAR TYPE: PT NO:  1  POSITION:Lat   N 26°43.20
         start    stop    duration                         Lon   W 14°5.71
TIME  :21:45:46 22:10:55  25.1 (min)          Purpose   : 3
LOG   : 2433.62  2435.07   1.4                Region    : 1100
FDEPTH:       30       30                     Gear cond.: 0
BDEPTH:      106      197                     Validity  : 0
Towing dir:    0°     Wire out   : 140  m     Speed     : 3.5 kn
Sorted    :    0      Total catch: 0.00       Catch/hour: 0.00

   SPECIES                                   CATCH/HOUR    % OF TOT. C   SAMP
                                           weight   numbers
   NOCATCH                                    0.00         0        0.00
                                          __________            ________
```

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   28
DATE  :09/11/19             GEAR TYPE: BT NO:  1  POSITION:Lat   N 27°7.57
         start    stop    duration                         Lon   W 13°39.05
TIME  :14:14:03 14:25:36  11.6 (min)          Purpose   : 3
LOG   : 2525.89  2526.53   0.6                Region    : 1100
FDEPTH:      100      101                     Gear cond.: 0
BDEPTH:      100      101                     Validity  : 0
Towing dir:    0°     Wire out   : 280  m     Speed     : 3.3 kn
Sorted    :   94      Total catch: 3500.00    Catch/hour: 18181.82

   SPECIES                                   CATCH/HOUR    % OF TOT. C   SAMP
                                           weight   numbers
   Scomber colias                          6992.99    230379       38.46       90
   Macrorhamphosus gracilis                6410.23    862473       35.26
   Sardina pilchardus                      4555.17     58275       25.05       89
   Macrorhamphosus scolopax                 108.78     13403        0.60
   Lepidopus caudatus                        77.71      2135        0.43
   Loligo vulgaris                           34.96       192        0.19
   Trachurus trachurus                        1.94       390        0.01
                                          __________            ________
   Total                                  18181.79                100.00
```

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   29
DATE  :09/11/19             GEAR TYPE: BT NO:  1  POSITION:Lat   N 27°2.12
        start    stop    duration                        Lon   W 13°32.94
TIME  :16:07:38 16:18:54  11.3 (min)          Purpose   : 3
LOG   : 2537.61  2538.17   0.6                Region    : 1100
FDEPTH:      65       60                      Gear cond.: 0
BDEPTH:      65       60                      Validity  : 0
Towing dir:   0°     Wire out   : 200  m      Speed     : 3.0 kn
Sorted    :  23      Total catch: 10000.00    Catch/hour: 53333.33
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Macrorhamphosus gracilis	50422.08	7311200	94.54	
Macrorhamphosus scolopax	2608.43	363291	4.89	
Trachurus trachurus	163.09	4656	0.31	
Belone belone gracilis	139.73	2331	0.26	
Total	53333.33		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   30
DATE  :10/11/19             GEAR TYPE: PT NO:  1  POSITION:Lat   N 27°51.05
        start    stop    duration                        Lon   W 13°13.24
TIME  :05:11:22 05:52:13  40.9 (min)          Purpose   : 3
LOG   : 2631.76  2634.32   2.6                Region    : 1100
FDEPTH:      25       35                      Gear cond.: 0
BDEPTH:      61       53                      Validity  : 0
Towing dir:   0°     Wire out   : 130  m      Speed     : 3.8 kn
Sorted    :  22      Total catch: 45.11       Catch/hour: 66.26
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Engraulis encrasicolus	35.25	2961	53.20	96
Pagellus erythrinus	19.09	66	28.82	92
Spondyliosoma cantharus	3.67	16	5.54	94
Diplodus vulgaris	3.38	18	5.10	91
Pagellus acarne	3.23	15	4.88	93
Sardina pilchardus	0.73	38	1.11	95
Pomadasys incisus	0.38	3	0.58	
Trachinus draco	0.37	4	0.55	
Diplodus bellottii	0.15	3	0.22	
Lepidotrigla carolae	0.00	3	0.00	
Total	66.26		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   31
DATE  :10/11/19             GEAR TYPE: PT NO:  7  POSITION:Lat   N 28°0.47
        start    stop    duration                        Lon   W 12°44.76
TIME  :18:00:41 18:19:40  19.0 (min)          Purpose   : 3
LOG   : 2703.28  2704.55   1.3                Region    : 1100
FDEPTH:      20        5                      Gear cond.: 0
BDEPTH:      31       35                      Validity  : 0
Towing dir:   0°     Wire out   : 110  m      Speed     : 4.0 kn
Sorted    : 104      Total catch: 240.98      Catch/hour: 761.79
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardina pilchardus	684.40	26226	89.84	99
Diplodus bellottii	37.81	648	4.96	101
Trachurus trachurus	17.20	310	2.26	100
Mixed debries	7.37	0	0.97	
Engraulis encrasicolus	3.38	1252	0.44	97
Chelon ramada	3.10	6	0.41	
Merluccius senegalensis	2.94	16	0.39	
Campogramma glaycos	2.50	16	0.33	
Scomber colias	1.17	16	0.15	98
Pomadasys incisus	0.89	16	0.12	
Penaeus kerathurus	0.54	6	0.07	
Loligo vulgaris	0.28	51	0.04	
S H R I M P S	0.16	117	0.02	
Sepia officinalis	0.06	13	0.01	
Total	761.79		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   32
DATE  :10/11/19             GEAR TYPE: PT NO:  1  POSITION:Lat   N 28°21.38
        start    stop    duration                        Lon   W 12°55.44
TIME  :21:46:19 22:16:57  30.6 (min)          Purpose   : 3
LOG   : 2732.87  2734.91   2.0                Region    : 1100
FDEPTH:      25        5                      Gear cond.: 0
BDEPTH:     107       99                      Validity  : 0
Towing dir:   0°     Wire out   : 180  m      Speed     : 4.0 kn
Sorted    :  24      Total catch: 24.46       Catch/hour: 47.91
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Scomber colias	36.24	1224	75.63	102
JELLYFISH	9.29	323	19.38	
Sardina pilchardus	0.82	24	1.72	103
Mixed debries	0.71	0	1.47	
Todarodes sagittatus	0.59	2	1.23	
Spondyliosoma cantharus	0.27	2	0.57	
Metal waste	0.00	2	0.00	
Total	47.91		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   33
DATE  :11/11/19             GEAR TYPE: PT NO:  8  POSITION:Lat   N 28°29.41
        start    stop    duration                        Lon   W 12°44.59
TIME  :03:10:49 03:50:17  39.5 (min)          Purpose   : 3
LOG   : 2772.69  2775.32   2.6                Region    : 1100
FDEPTH:      30       60                      Gear cond.: 0
BDEPTH:     107      111                      Validity  : 0
Towing dir:   0°     Wire out   : 350  m      Speed     : 4.0 kn
Sorted    :  32      Total catch: 6000.00     Catch/hour: 9123.16
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Scomber colias	9123.16	222515	100.00	104
Total	9123.16		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   34
DATE  :12/11/19             GEAR TYPE: PT NO:  7  POSITION:Lat   N 28°13.97
        start    stop    duration                        Lon   W 12°0.62
TIME  :08:40:28 09:05:51  25.4 (min)          Purpose   : 3
LOG   : 2914.03  2915.31   1.3                Region    : 1100
FDEPTH:      35       35                      Gear cond.: 0
BDEPTH:      43       43                      Validity  : 0
Towing dir:   0°     Wire out   : 110  m      Speed     : 3.0 kn
Sorted    :  71      Total catch: 354.36      Catch/hour: 837.73
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Engraulis encrasicolus	725.53	99397	86.61	105
Sardina pilchardus	103.55	7300	12.36	106
Pagellus acarne	3.59	12	0.43	
Diplodus puntazzo	3.50	2	0.42	111
Merluccius merluccius	0.57	5	0.07	107
Chelidonichthys sp.	0.52	2	0.06	
Diplodus bellottii	0.28	5	0.03	
Scomber colias	0.14	5	0.02	109
Trachurus trachurus	0.02	2	0.00	110
Citharus linguatula	0.02	2	0.00	
Total	837.73		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   35
DATE  :12/11/19             GEAR TYPE: BT NO:  1  POSITION:Lat   N 28°19.34
        start    stop    duration                        Lon   W 11°40.46
TIME  :13:12:26 13:22:10  9.7  (min)          Purpose   : 3
LOG   : 2943.49  2944.07   0.6                Region    : 1100
FDEPTH:      42       41                      Gear cond.: 0
BDEPTH:      42       41                      Validity  : 0
Towing dir:   0°     Wire out   : 135  m      Speed     : 3.6 kn
Sorted    :  37      Total catch: 1014.54     Catch/hour: 6262.59
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardina pilchardus	4874.14	153278	77.83	112
Engraulis encrasicolus	1235.56	118802	19.73	113
Argyrosomus regius	75.93	6	1.21	
Trachurus trachurus	46.23	457	0.74	114
Scomber colias	13.21	333	0.21	
Diplodus bellottii	6.30	74	0.10	
Diplodus vulgaris	5.31	12	0.08	
GOBIIDAE	3.27	167	0.05	
Pomadasys incisus	1.11	6	0.02	
Pagellus bellottii	1.05	6	0.02	
Cepola sp.	0.49	6	0.01	
Total	6262.59		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   36
DATE  :13/11/19             GEAR TYPE: PT NO:  4  POSITION:Lat   N 28°34.91
        start    stop    duration                        Lon   W 11°30.42
TIME  :02:41:33 02:55:02  13.5 (min)          Purpose   : 3
LOG   : 3041.80  3042.59   0.8                Region    : 1100
FDEPTH:      10       10                      Gear cond.: 0
BDEPTH:      63       63                      Validity  : 0
Towing dir:   0°     Wire out   : 130  m      Speed     : 3.5 kn
Sorted    :   0      Total catch: 0.13        Catch/hour: 0.58
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
JELLYFISH	0.53	22	92.31	
Trachurus trachurus	0.04	13	7.69	
Total	0.58		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   37
DATE  :13/11/19             GEAR TYPE: PT NO:  8  POSITION:Lat   N 28°54.81
        start    stop    duration                        Lon   W 10°50.67
TIME  :17:31:38 17:53:44  22.1 (min)          Purpose   : 3
LOG   : 3142.92  3144.56   1.6                Region    : 1100
FDEPTH:       0        0                      Gear cond.: 0
BDEPTH:      53       62                      Validity  : 0
Towing dir:   0°     Wire out   : 180  m      Speed     : 4.5 kn
Sorted    :  68      Total catch: 7501.48     Catch/hour: 20375.23
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Scomber colias	12725.53	176844	62.46	116
Sardina pilchardus	7350.09	179772	36.07	115
Trachurus trachurus	188.93	6858	0.93	117
Mixed debries	54.86	0	0.27	
Engraulis encrasicolus	48.76	2385	0.24	118
Campogramma glaycos	4.02	3	0.02	125
JELLYFISH	3.05	299	0.01	
Total	20375.24		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   38
DATE  :13/11/19             GEAR TYPE: PT NO:  1  POSITION:Lat   N 29°7.36
        start    stop    duration                        Lon   W 10°38.92
TIME  :22:20:10 22:38:00  17.8 (min)          Purpose   : 3
LOG   : 3175.74  3176.78   1.0                Region    : 1100
FDEPTH:      10       10                      Gear cond.: 0
BDEPTH:      63       60                      Validity  : 0
Towing dir:   0°     Wire out   : 150  m      Speed     : 3.5 kn
Sorted    :  25      Total catch: 24.50       Catch/hour: 82.40
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Engraulis encrasicolus	78.23	6861	94.94	119
Mixed debries	1.21	0	1.47	
Sardina pilchardus	1.14	64	1.39	121
Loligo vulgaris	1.08	198	1.31	
Trachurus trachurus	0.40	40	0.49	120
J E L L Y F I S H	0.34	17	0.41	
Total	82.40		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   39
DATE  :14/11/19             GEAR TYPE: PT NO:  1  POSITION:Lat   N 29°14.60
        start    stop    duration                        Lon   W 10°25.14
TIME  :04:55:08 05:15:34  20.4 (min)          Purpose   : 3
LOG   : 3231.01  3232.34   1.3                Region    : 1100
FDEPTH:      15       10                      Gear cond.: 0
BDEPTH:      42       41                      Validity  : 0
Towing dir:   0°     Wire out   : 100  m      Speed     : 3.9 kn
Sorted    :  41      Total catch: 41.48       Catch/hour: 121.76
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardina pilchardus	61.29	1236	50.34	123
Scomber colias	47.20	778	38.77	122
Mixed debries	7.57	0	6.22	
Octopus vulgaris	2.94	3	2.41	
Trachurus trachurus	1.64	123	1.35	124
Pagellus acarne	0.59	3	0.48	
Belone belone gracilis	0.35	3	0.29	
Loligo vulgaris	0.18	53	0.14	
Sepiola sp.	0.01	3	0.00	
Solenocera africana	0.00	9	0.00	
Total	121.77		100.01	

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   40
DATE  :14/11/19             GEAR TYPE: PT NO:  7  POSITION:Lat   N 29°27.71
        start    stop    duration                        Lon   W 10°15.33
TIME  :08:59:03 09:16:45  17.7 (min)          Purpose   : 3
LOG   : 3258.40  3259.40   1.0                Region    : 1100
FDEPTH:      40       35                      Gear cond.: 0
BDEPTH:      48       45                      Validity  : 0
Towing dir:   0°     Wire out   : 150  m      Speed     : 3.4 kn
Sorted    :  66      Total catch: 81.10       Catch/hour: 275.07
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardina pilchardus	165.59	4182	60.20	127
Engraulis encrasicolus	67.00	4718	24.36	126
Trachurus trachurus	30.30	3029	11.01	128
Mixed debries	9.11	0	3.31	
Scomber colias	2.08	34	0.76	129
Loligo vulgaris	0.83	170	0.30	
Aspitrigla obscura	0.17	3	0.06	
Total	275.07		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   41
DATE  :14/11/19             GEAR TYPE: PT NO:  1  POSITION:Lat   N 29°50.83
        start    stop    duration                        Lon   W 9°53.68
TIME  :19:34:13 20:05:48  31.6 (min)          Purpose   : 3
LOG   : 3329.20  3330.84   1.6                Region    : 1100
FDEPTH:       5        5                      Gear cond.: 0
BDEPTH:      63       80                      Validity  : 0
Towing dir:   0°     Wire out   : 170  m      Speed     : 3.1 kn
Sorted    :  70      Total catch: 286.50      Catch/hour: 544.16
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardina pilchardus	462.15	116682	84.93	130
Engraulis encrasicolus	63.82	5597	11.73	132
Mola mola	9.88	2	1.82	
Pomatomus saltatrix	2.60	2	0.48	134
Trachurus trachurus	1.82	258	0.34	133
Sarpa salpa	1.29	2	0.24	
Trachurus trecae	0.99	2	0.18	135
Trachinotus ovatus	0.91	4	0.17	
Scomber colias	0.46	8	0.08	131
J E L L Y F I S H	0.15	15	0.03	
Loligo vulgaris	0.08	23	0.01	
Merluccius merluccius	0.02	2	0.00	
Total	544.16		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   42
DATE  :15/11/19             GEAR TYPE: PT NO:  4  POSITION:Lat   N 30°2.15
        start    stop    duration                        Lon   W 9°45.16
TIME  :04:10:06 04:18:22  8.3  (min)          Purpose   : 3
LOG   : 3384.90  3385.45   0.5                Region    : 1100
FDEPTH:      10       10                      Gear cond.: 0
BDEPTH:      59       69                      Validity  : 0
Towing dir:   0°     Wire out   : 140  m      Speed     : 3.9 kn
Sorted    :  38      Total catch: 1028.94     Catch/hour: 7465.14
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Engraulis encrasicolus	6776.23	584155	90.77	137
Sardina pilchardus	366.53	14699	4.91	138
Mola mola	210.69	44	2.82	136
Trachurus trachurus	106.92	16034	1.43	139
JELLYFISH	3.82	189	0.05	
Alloteuthis subulata	0.96	385	0.01	
Total	7465.14		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   43
DATE  :15/11/19             GEAR TYPE: PT NO:  1  POSITION:Lat   N 31°0.83
         start    stop    duration                         Lon   W 9°53.44
TIME  :21:35:13 22:12:34  37.3 (min)          Purpose   : 3
LOG   : 3503.18  3505.26   2.1                Region    : 1100
FDEPTH:      10       10                      Gear cond.: 0
BDEPTH:      63       47                      Validity  : 0
Towing dir:   0°     Wire out   : 150  m      Speed     : 3.3 kn
Sorted    :   9      Total catch: 8.96        Catch/hour: 14.40
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Engraulis encrasicolus	4.02	358	27.90	142
Merluccius merluccius	3.25	51	22.54	143
Mixed debries	3.15	0	21.87	
Sardina pilchardus	2.67	72	18.53	140
Loligo vulgaris	0.48	157	3.35	
Diplodus vulgaris	0.39	2	2.68	
Trachurus trachurus	0.29	32	2.01	141
Alloteuthis africana	0.10	16	0.67	
Sepiola sp.	0.03	11	0.22	
Solenocera africana	0.03	10	0.22	
Total	14.40		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   44
DATE  :17/11/19             GEAR TYPE: PT NO:  1  POSITION:Lat   N 31°53.20
         start    stop    duration                         Lon   W 9°49.31
TIME  :02:03:27 03:01:54  58.5 (min)          Purpose   : 3
LOG   : 3713.52  3716.93   3.4                Region    : 1100
FDEPTH:      10       24                      Gear cond.: 0
BDEPTH:      49       52                      Validity  : 0
Towing dir:   0°     Wire out   : 130  m      Speed     : 3.5 kn
Sorted    :  54      Total catch: 53.60       Catch/hour: 55.02
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardina pilchardus	46.27	732	84.09	144
Diplodus vulgaris	4.33	17	7.87	
Mixed debries	2.76	0	5.02	
Alloteuthis subulata	0.66	287	1.19	
Trachurus trachurus	0.29	2	0.52	
Spondyliosoma cantharus	0.21	1	0.37	
Engraulis encrasicolus	0.16	9	0.30	146
Belone belone gracilis	0.14	2	0.26	
Pagellus acarne	0.11	1	0.21	
Scomber colias	0.08	2	0.15	
Total	55.01		99.98	

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   45
DATE  :17/11/19             GEAR TYPE: PT NO:  7  POSITION:Lat   N 31°50.42
         start    stop    duration                         Lon   W 9°41.22
TIME  :04:31:00 04:50:51  19.9 (min)          Purpose   : 3
LOG   : 3726.99  3728.30   1.3                Region    : 1100
FDEPTH:      25       30                      Gear cond.: 0
BDEPTH:      40       42                      Validity  : 0
Towing dir:   0°     Wire out   : 130  m      Speed     : 3.9 kn
Sorted    :  38      Total catch: 80.53       Catch/hour: 243.42
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardina pilchardus	123.20	2225	50.61	149
Scomber colias	105.31	1916	43.26	148
Merluccius merluccius	4.11	12	1.69	152
Pagellus acarne	3.45	12	1.42	151
Pomadasys incisus	1.99	9	0.82	
Diplodus bellottii	1.69	21	0.70	153
Caranx rhonchus	1.39	21	0.57	150
Mixed debries	1.21	0	0.50	
Diplodus vulgaris	0.54	3	0.22	
Loligo vulgaris	0.21	3	0.09	
Belone belone gracilis	0.18	3	0.07	
Scorpaena notata	0.12	3	0.05	
GOBIIDAE	0.00	18	0.00	
Engraulis encrasicolus	0.00	3	0.00	
Total	243.42		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2019413        STATION:   46
DATE  :17/11/19             GEAR TYPE: PT NO:  8  POSITION:Lat   N 32°3.08
         start    stop    duration                         Lon   W 9°47.96
TIME  :08:54:32 09:17:30  23.0 (min)          Purpose   : 3
LOG   : 3760.66  3762.02   1.4                Region    : 1100
FDEPTH:       0        0                      Gear cond.: 0
BDEPTH:      89       45                      Validity  : 0
Towing dir:   0°     Wire out   : 150  m      Speed     : 3.6 kn
Sorted    :   8      Total catch: 8.26        Catch/hour: 21.59
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Trachurus trachurus	11.03	57	51.09	154
Mixed debries	8.00	0	37.05	
Scomber colias	2.56	8	11.86	155
Total	21.59		100.00	

2019414

```
R/V Dr. Fridtjof Nansen        SURVEY:2019414         STATION:    1
DATE  :21/11/19              GEAR TYPE: PT NO:  4  POSITION:Lat   N 32°42.47
        start    stop    duration                            Lon   W 9°7.55
TIME  :23:42:44 23:50:06  7.4  (min)        Purpose   : 3
LOG   : 4111.25  4111.63   0.4              Region    : 1100
FDEPTH:       0        0                    Gear cond.: 0
BDEPTH:      51       50                    Validity  : 0
Towing dir:    0°      Wire out   : 110  m  Speed     : 3.1 kn
Sorted    : 106        Total catch: 106.22  Catch/hour: 864.79
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardina pilchardus	623.28	9151	72.07	3
Scomber colias	197.83	3745	22.88	2
Trachurus trachurus	40.38	830	4.67	1
Belone belone gracilis	2.77	16	0.32	
Alloteuthis subulata	0.41	81	0.05	
Sepia officinalis	0.08	8	0.01	
Plastic	0.04	8	0.00	
Total	864.79		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019414         STATION:    2
DATE  :22/11/19              GEAR TYPE: BT NO:  1  POSITION:Lat   N 32°49.33
        start    stop    duration                            Lon   W 9°0.78
TIME  :07:33:44 07:40:19  6.6  (min)        Purpose   : 3
LOG   : 4176.65  4176.97   0.3              Region    : 1100
FDEPTH:      57       56                    Gear cond.: 0
BDEPTH:      57       56                    Validity  : 0
Towing dir:    0°      Wire out   : 180  m  Speed     : 2.9 kn
Sorted    :   0        Total catch: 208.23  Catch/hour: 1901.61
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Scomber colias	805.48	18767	42.36	5
Sardina pilchardus	723.29	12192	38.04	4
Trachurus trachurus	98.63	1836	5.19	6
Diplodus vulgaris	82.56	320	4.34	
Psetta maxima	60.27	9	3.17	
Pagellus acarne	59.18	237	3.11	
Trisopterus luscus	40.18	548	2.11	
Trachinus draco	10.41	146	0.55	
Merluccius merluccius	5.84	237	0.31	
Umbrina canariensis	3.11	27	0.16	
Callionymus lyra	2.19	37	0.12	
Sepia officinalis	1.64	18	0.09	
Scorpaena stephanica	1.46	27	0.08	
Zeus faber	1.28	9	0.07	
Palaemon serratus	1.19	210	0.06	
Symphodus bailloni	1.19	9	0.06	
Arnoglossus imperialis	1.00	37	0.05	
Diplodus bellottii	0.77	27	0.04	
Mullus surmuletus	0.55	18	0.03	
Solenocera membranacea	0.55	237	0.03	
Alloteuthis subulata	0.55	18	0.03	
Microchirus variegatus	0.18	9	0.01	
Dicologoglossa cuneata	0.09	9	0.00	
Cepola macrophthalma	0.02	9	0.00	
Total	1901.61		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019414         STATION:    3
DATE  :22/11/19              GEAR TYPE: PT NO:  8  POSITION:Lat   N 33°4.20
        start    stop    duration                            Lon   W 8°50.43
TIME  :16:40:30 16:48:49  8.3  (min)        Purpose   : 3
LOG   : 4255.47  4255.98   0.5              Region    : 1100
FDEPTH:       0        0                    Gear cond.: 0
BDEPTH:      85       83                    Validity  : 0
Towing dir:    0°      Wire out   : 280  m  Speed     : 3.7 kn
Sorted    :   0        Total catch: 3500.00 Catch/hour: 25240.38
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Scomber colias	20811.06	353885	82.45	8
Sardina pilchardus	4406.25	72346	17.46	7
Trachurus trachurus	23.00	188	0.09	9
Total	25240.31		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019414         STATION:    4
DATE  :23/11/19              GEAR TYPE: PT NO:  4  POSITION:Lat   N 33°22.24
        start    stop    duration                            Lon   W 8°49.50
TIME  :01:31:32 02:01:32  30.0 (min)        Purpose   : 3
LOG   : 4304.30  4305.84   1.5              Region    : 1100
FDEPTH:       0        0                    Gear cond.: 0
BDEPTH:     133      135                    Validity  : 0
Towing dir:    0°      Wire out   : 120  m  Speed     : 3.1 kn
Sorted    :   0        Total catch: 0.04    Catch/hour: 0.08
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Scomber colias	0.08	2	100.00	
Total	0.08		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019414         STATION:    5
DATE  :23/11/19              GEAR TYPE: PT NO:  4  POSITION:Lat   N 33°26.32
        start    stop    duration                            Lon   W 8°21.97
TIME  :21:37:39 22:09:25  31.8 (min)        Purpose   : 3
LOG   : 4436.66  4438.59   1.9              Region    : 1100
FDEPTH:       0       12                    Gear cond.: 0
BDEPTH:      36       54                    Validity  : 0
Towing dir:    0°      Wire out   : 110  m  Speed     : 3.6 kn
Sorted    :   0        Total catch: 89.20   Catch/hour: 168.51
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardina pilchardus	151.38	2979	89.83	12
Belone belone gracilis	11.05	159	6.56	
Balistes capriscus	2.78	2	1.65	
Sarpa salpa	1.26	4	0.75	
Scomber colias	0.98	15	0.58	11
Engraulis encrasicolus	0.50	38	0.30	10
Loligo vulgaris	0.48	9	0.28	
Alloteuthis subulata	0.05	15	0.03	
Boops boops	0.03	2	0.02	
Total	168.51		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019414         STATION:    6
DATE  :24/11/19              GEAR TYPE: PT NO:  4  POSITION:Lat   N 33°32.06
        start    stop    duration                            Lon   W 8°4.37
TIME  :06:47:28 07:16:43  29.3 (min)        Purpose   : 3
LOG   : 4513.55  4514.99   1.4              Region    : 1100
FDEPTH:       0       14                    Gear cond.: 0
BDEPTH:      45       41                    Validity  : 0
Towing dir:    0°      Wire out   : 130  m  Speed     : 2.9 kn
Sorted    :  34        Total catch: 34.45   Catch/hour: 70.67
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Trachurus trachurus	23.02	281	32.57	13
Scomber colias	22.97	265	32.51	14
Sardina pilchardus	19.98	392	28.27	15
Boops boops	3.75	25	5.31	
Loligo vulgaris	0.94	4	1.34	
Total	70.67		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019414         STATION:    7
DATE  :24/11/19              GEAR TYPE: BT NO:  1  POSITION:Lat   N 33°31.77
        start    stop    duration                            Lon   W 7°57.25
TIME  :08:41:09 08:53:38  12.5 (min)        Purpose   : 3
LOG   : 4523.13  4523.87   0.7              Region    : 1100
FDEPTH:      35       33                    Gear cond.: 0
BDEPTH:      35       33                    Validity  : 0
Towing dir:    0°      Wire out   : 120  m  Speed     : 3.5 kn
Sorted    :   0        Total catch: 39.60   Catch/hour: 190.40
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Diplodus vulgaris	70.38	423	36.97	
Trachurus trachurus	21.01	447	11.03	17
Diplodus bellottii	17.16	255	9.01	
Sardina pilchardus	14.33	298	7.52	16
Umbrina canariensis	11.30	125	5.93	
Mugil cephalus	11.01	34	5.78	
Trisopterus luscus	9.18	192	4.82	
PORIFERA (Sponges)	6.15	0	3.23	
Pagellus acarne	4.76	14	2.50	
Boops boops	4.04	67	2.12	
Alloteuthis subulata	3.32	630	1.74	
Sepia officinalis	2.74	10	1.44	
Argentina sphyraena	2.64	236	1.39	
Merluccius merluccius	1.73	19	0.91	
Cymbium sp.	1.59	10	0.83	
Pegusa lascaris	1.39	5	0.73	
Palaemon serratus	1.20	341	0.63	
Engraulis encrasicolus	1.15	437	0.61	18
Scomber colias	1.06	14	0.56	
Mullus surmuletus	0.96	14	0.51	
Pomadasys incisus	0.96	10	0.51	
Rossia macrosomia	0.34	72	0.18	
Unid. juvenile fishes	0.29	433	0.15	
Penaeus kerathurus	0.29	5	0.15	
Conger conger	0.29	5	0.15	
Symphodus bailloni	0.19	5	0.10	
Dicologoglossa cuneata	0.19	5	0.10	
Liocarcinus puber	0.19	5	0.10	
Chelidonichthys lucerna	0.18	5	0.10	
Scorpaena notata	0.10	5	0.05	
Squilla mantis	0.10	5	0.05	
PORTUNIDAE	0.07	10	0.04	
Plastic	0.05	5	0.03	
Starfish	0.05	14	0.03	
BYTIIDAE	0.00	5	0.00	
Total	190.40		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019414         STATION:    8
DATE  :24/11/19              GEAR TYPE: PT NO:  8  POSITION:Lat   N 33°36.83
        start    stop    duration                            Lon   W 7°58.49
TIME  :10:48:23 11:58:02  69.7 (min)        Purpose   : 3
LOG   : 4533.80  4539.11   5.3              Region    : 1100
FDEPTH:       0        0                    Gear cond.: 0
BDEPTH:      71       73                    Validity  : 0
Towing dir:    0°      Wire out   : 370  m  Speed     : 4.6 kn
Sorted    :  68        Total catch: 200.00  Catch/hour: 172.29
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardina pilchardus	107.58	3638	62.44	22
Engraulis encrasicolus	28.91	1796	16.78	21
Trachurus trecae	18.35	39	10.65	19
Scomber colias	8.64	98	5.01	20
Alloteuthis subulata	2.29	447	1.33	
Mola mola	2.02	1	1.17	
Brama brama	2.00	2	1.16	
Merluccius merluccius	1.45	16	0.84	
Trachinotus ovatus	0.89	3	0.52	
Spondyliosoma cantharus	0.21	1	0.12	
Trachinus draco	0.04	1	0.03	
Total	172.37		100.05	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019414         STATION:    9
DATE  :24/11/19              GEAR TYPE: PT NO:  4  POSITION:Lat   N 33°47.50
        start    stop    duration                            Lon   W 7°53.54
TIME  :18:34:38 18:44:59  10.4 (min)        Purpose   : 3
LOG   : 4600.05  4600.55   0.5              Region    : 1100
FDEPTH:      10       22                    Gear cond.: 0
BDEPTH:     119      120                    Validity  : 0
Towing dir:    0°      Wire out   : 130  m  Speed     : 2.9 kn
Sorted    :  60        Total catch: 460.00  Catch/hour: 2664.09
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Scomber colias	2577.86	38624	96.76	23
Engraulis encrasicolus	47.78	1442	1.79	25
Trachurus picturatus	23.63	654	0.89	24
Sardina pilchardus	11.41	1488	0.43	26
Total	2660.68		99.87	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019414         STATION:   10
DATE  :25/11/19              GEAR TYPE: PT NO:  8  POSITION:Lat   N 33°57.03
        start    stop    duration                            Lon   W 7°12.42
TIME  :12:39:25 13:16:31  37.1 (min)        Purpose   : 3
LOG   : 4730.63  4733.76   3.1              Region    : 1100
FDEPTH:       0        0                    Gear cond.: 0
BDEPTH:     103       86                    Validity  : 0
Towing dir:    0°      Wire out   : 400  m  Speed     : 5.1 kn
Sorted    :  61        Total catch: 360.00  Catch/hour: 582.21
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Sardina pilchardus	519.67	10011	89.26	27
Mola mola	24.45	8	4.20	
Engraulis encrasicolus	23.81	1208	4.09	28
Trachurus mediterraneus	10.06	23	1.73	29
Alloteuthis subulata	2.49	826	0.43	
Liza aurata	1.73	3	0.30	
Total	582.21		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019414         STATION:   11
DATE  :25/11/19              GEAR TYPE: PT NO:  4  POSITION:Lat   N 34°4.58
        start    stop    duration                            Lon   W 7°3.60
TIME  :19:35:35 19:51:30  15.9 (min)        Purpose   : 3
LOG   : 4788.74  4789.67   0.9              Region    : 1100
FDEPTH:      10       22                    Gear cond.: 0
BDEPTH:     125      126                    Validity  : 0
Towing dir:    0°      Wire out   : 130  m  Speed     : 3.5 kn
Sorted    :  95        Total catch: 1450.00 Catch/hour: 5468.26
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Scomber colias	4871.84	79079	89.09	33
Trachurus picturatus	510.70	12882	9.34	30
Sardina pilchardus	63.84	1207	1.17	32
Engraulis encrasicolus	21.85	1150	0.40	31
Total	5468.23		100.00	

```
R/V Dr. Fridtjof Nansen        SURVEY:2019414         STATION:   12
DATE  :26/11/19              GEAR TYPE: PT NO:  4  POSITION:Lat   N 34°10.66
        start    stop    duration                            Lon   W 6°54.74
TIME  :00:49:54 01:19:41  29.8 (min)        Purpose   : 3
LOG   : 4816.86  4818.49   1.6              Region    : 1100
FDEPTH:       0        0                    Gear cond.: 0
BDEPTH:     131      129                    Validity  : 0
Towing dir:    0°      Wire out   : 120  m  Speed     : 3.3 kn
Sorted    :  74        Total catch: 184.56  Catch/hour: 371.85
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Scomber colias	162.91	2770	43.81	36
Engraulis encrasicolus	107.04	5819	28.79	34
Trachurus trachurus	60.12	1654	16.17	35
Sardina pilchardus	19.48	635	5.24	37
Trachinotus ovatus	11.40	60	3.07	
Merluccius merluccius	6.10	310	1.64	
Alloteuthis subulata	4.07	1165	1.09	
Rossia macrosomia	0.48	242	0.13	
Belone belone gracilis	0.20	2	0.05	
Total	371.83		99.99	

R/V Dr. Fridtjof Nansen SURVEY:2019414 STATION: 13
DATE :26/11/19 GEAR TYPE: BT NO: 1 POSITION:Lat N 34°26.38
start stop duration Lon W 6°33.74
TIME :08:21:25 08:57:48 36.4 (min) Purpose : 3
LOG : 4876.39 4878.71 2.3 Region : 1100
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 22 28 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 0.0 kn
Sorted : 97 Total catch: 570.00 Catch/hour: 939.82

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Loligo vulgaris	220.58	1499	23.47	
Trachurus trachurus	147.96	2735	15.74	39
Diplodus bellottii	69.50	925	7.39	
Atherina boyeri	52.76	6214	5.61	
Pomadasys incisus	40.20	322	4.28	
Alloteuthis subulata	26.86	7067	2.86	
Sepia officinalis	23.56	49	2.51	
Trachurus mediterraneus	22.29	457	2.37	40
Boops boops	10.32	155	1.10	
Sparus aurata	8.38	49	0.89	
Psetta maxima	7.40	10	0.79	
Pagellus acarne	6.13	419	0.65	
Scomber colias	2.34	30	0.25	
Liza aurata	1.95	10	0.21	
Lithognathus mormyrus	1.75	10	0.19	
Merluccius merluccius	1.07	20	0.11	
Mullus surmuletus	0.30	10	0.03	
Penaeus japonicus	0.20	10	0.02	
Trisopterus luscus	0.20	10	0.02	
PORTUNIDAE	0.20	20	0.02	
Total	643.94		68.52	

R/V Dr. Fridtjof Nansen SURVEY:2019414 STATION: 14
DATE :26/11/19 GEAR TYPE: BT NO: 1 POSITION:Lat N 34°27.71
start stop duration Lon W 6°38.92
TIME :10:36:53 10:46:39 9.8 (min) Purpose : 3
LOG : 4889.04 4889.61 0.6 Region : 1100
FDEPTH: 62 62 Gear cond.: 0
BDEPTH: 62 62 Validity : 0
Towing dir: 0° Wire out : 180 m Speed : 3.5 kn
Sorted : 70 Total catch: 1100.00 Catch/hour: 6755.37

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardina pilchardus	6283.79	171193	93.02	41
Scomber colias	230.97	3851	3.42	42
Trachurus trachurus	156.85	2499	2.32	43
Trachurus picturatus	38.51	964	0.57	44
Raja asterias	9.58	6	0.14	
Squilla mantis	6.63	190	0.10	
Merluccius merluccius	5.59	25	0.08	
Engraulis encrasicolus	4.36	964	0.06	
Chelidonichthys lucerna	4.05	31	0.06	
Liocarcinus sp	3.93	289	0.06	
Alloteuthis subulata	3.68	98	0.05	
Liocarcinus puber	1.47	98	0.02	
Sepia elegans	1.35	98	0.02	
Conger conger	1.29	6	0.02	
Parapenaeus longirostris	1.23	98	0.02	
Diplodus vulgaris	1.17	6	0.02	
Loligo vulgaris	0.92	6	0.01	
Solenocera membranacea	0.12	98	0.00	
Total	6755.50		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2019414 STATION: 15
DATE :26/11/19 GEAR TYPE: PT NO: 8 POSITION:Lat N 34°30.69
start stop duration Lon W 6°46.51
TIME :13:11:53 13:59:02 47.1 (min) Purpose : 3
LOG : 4905.56 4908.42 2.9 Region : 1100
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 112 121 Validity : 0
Towing dir: 0° Wire out : 520 m Speed : 3.6 kn
Sorted : 73 Total catch: 750.00 Catch/hour: 954.81

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardina pilchardus	682.30	17017	71.46	45
Alopias vulpinus	190.96	1	20.00	
Mola mola	59.96	22	6.28	
Engraulis encrasicolus	10.38	960	1.09	46
Scomber colias	9.22	163	0.97	47
Merluccius merluccius	0.87	57	0.09	
Trachurus picturatus	0.65	1	0.07	
Alloteuthis subulata	0.38	125	0.04	
Cepola macrophthalma	0.10	10	0.01	
Total	954.82		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2019414 STATION: 16
DATE :26/11/19 GEAR TYPE: PT NO: 8 POSITION:Lat N 34°35.48
start stop duration Lon W 6°51.96
TIME :16:03:15 16:26:37 23.4 (min) Purpose : 3
LOG : 4919.30 4920.60 1.3 Region : 1100
FDEPTH: 130 150 Gear cond.: 0
BDEPTH: 187 176 Validity : 0
Towing dir: 0° Wire out : 550 m Speed : 3.3 kn
Sorted : 60 Total catch: 320.00 Catch/hour: 821.57

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Scomber colias	516.84	6136	62.91	49
Engraulis encrasicolus	276.10	10665	33.61	48
Mola mola	28.24	8	3.44	
Trachurus picturatus	0.39	13	0.05	
Total	821.57		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2019414 STATION: 17
DATE :27/11/19 GEAR TYPE: PT NO: 4 POSITION:Lat N 34°39.71
start stop duration Lon W 6°37.30
TIME :00:38:03 01:07:55 29.9 (min) Purpose : 3
LOG : 4965.61 4967.15 1.6 Region : 1100
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 109 115 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.1 kn
Sorted : 4 Total catch: 4.27 Catch/hour: 8.58

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Scomber colias	3.76	54	43.79	52
Engraulis encrasicolus	3.07	295	35.83	51
Sardina pilchardus	1.75	54	20.37	50
Total	8.58		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2019414 STATION: 18
DATE :27/11/19 GEAR TYPE: PT NO: 8 POSITION:Lat N 35°0.73
start stop duration Lon W 6°32.48
TIME :10:41:15 11:12:42 31.4 (min) Purpose : 3
LOG : 5040.64 5042.41 1.8 Region : 1100
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 148 153 Validity : 0
Towing dir: 0° Wire out : 420 m Speed : 3.4 kn
Sorted : 0 Total catch: 76.46 Catch/hour: 145.87

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Engraulis encrasicolus	116.38	6290	79.78	54
Maurolicus muelleri	18.89	26982	12.95	
Scomber colias	3.51	86	2.41	53
Brama brama	3.00	4	2.05	
Merluccius merluccius	1.66	21	1.14	
Alloteuthis subulata	1.37	174	0.94	
Trachurus picturatus	0.59	11	0.41	
Trachurus trachurus	0.42	4	0.29	
Sardina pilchardus	0.04	2	0.03	
Illex coindetii	0.02	2	0.01	
Total	145.87		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2019414 STATION: 19
DATE :27/11/19 GEAR TYPE: PT NO: 8 POSITION:Lat N 34°56.85
start stop duration Lon W 6°22.92
TIME :14:48:34 14:56:27 7.9 (min) Purpose : 3
LOG : 5061.65 5062.26 0.6 Region : 1100
FDEPTH: 70 100 Gear cond.: 0
BDEPTH: 215 215 Validity : 0
Towing dir: 0° Wire out : 400 m Speed : 4.6 kn
Sorted : 68 Total catch: 1800.00 Catch/hour: 13705.58

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardina pilchardus	13659.67	282213	99.67	55
Scomber colias	44.09	1797	0.32	56
Engraulis encrasicolus	1.83	198	0.01	57
Total	13705.58		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2019414 STATION: 20
DATE :28/11/19 GEAR TYPE: PT NO: 1 POSITION:Lat N 35°22.08
start stop duration Lon W 6°9.15
TIME :03:09:58 03:27:26 17.5 (min) Purpose : 3
LOG : 5155.84 5156.87 1.0 Region : 1100
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 48 50 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.5 kn
Sorted : 20 Total catch: 20.48 Catch/hour: 70.37

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardina pilchardus	67.53	1797	95.95	58
Belone belone gracilis	1.62	14	2.30	
Engraulis encrasicolus	0.52	405	0.73	
Alloteuthis subulata	0.41	186	0.59	
Scomber colias	0.14	3	0.20	
Trachurus trachurus	0.07	3	0.10	
ISOPODS	0.05	124	0.07	
Boops boops	0.03	3	0.04	
Rossia macrosomia	0.02	21	0.02	
Plastic	0.00	3	0.00	
Total	70.37		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2019414 STATION: 21
DATE :28/11/19 GEAR TYPE: PT NO: 8 POSITION:Lat N 35°28.69
start stop duration Lon W 6°21.95
TIME :08:48:12 09:12:52 24.7 (min) Purpose : 3
LOG : 5182.94 5184.78 1.9 Region : 1100
FDEPTH: 100 120 Gear cond.: 0
BDEPTH: 122 121 Validity : 0
Towing dir: 0° Wire out : 600 m Speed : 4.5 kn
Sorted : 62 Total catch: 61.91 Catch/hour: 150.63

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Engraulis encrasicolus	94.89	6635	62.99	59
Trachurus trachurus	24.94	158	16.56	61
Mola mola	22.14	7	14.70	
Scomber colias	6.08	114	4.04	60
Merluccius merluccius	2.34	39	1.55	
Boops boops	0.15	2	0.10	
Alloteuthis subulata	0.05	10	0.03	
Lepidopus caudatus	0.05	2	0.03	
Total	150.63		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2019414 STATION: 22
DATE :28/11/19 GEAR TYPE: PT NO: 8 POSITION:Lat N 35°27.49
start stop duration Lon W 6°28.01
TIME :13:35:36 14:36:07 60.5 (min) Purpose : 3
LOG : 5206.18 5209.74 3.6 Region : 1100
FDEPTH: 170 200 Gear cond.: 0
BDEPTH: 235 204 Validity : 0
Towing dir: 0° Wire out : 600 m Speed : 3.5 kn
Sorted : 0 Total catch: 128.05 Catch/hour: 126.97

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Ceratoscopelatus cf maderensis	60.98	12587	48.03	
Maurolicus muelleri	29.51	61159	23.24	
Scomber colias	24.00	337	18.90	62
Trachurus picturatus	6.25	133	4.92	64
Engraulis encrasicolus	4.34	1730	3.42	63
Merluccius merluccius	0.69	11	0.55	
Trachurus trachurus	0.68	12	0.54	65
Trachurus trachurus	0.36	1	0.28	
Lepidopus caudatus	0.12	4	0.09	
Lestidiops sp.	0.04	4	0.03	
Total	126.97		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2019414 STATION: 23
DATE :28/11/19 GEAR TYPE: PT NO: 8 POSITION:Lat N 35°41.98
start stop duration Lon W 6°55.38
TIME :23:18:13 00:19:06 60.9 (min) Purpose : 3
LOG : 5247.53 5251.02 3.5 Region : 1100
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 968 837 Validity : 0
Towing dir: 0° Wire out : 180 m Speed : 3.4 kn
Sorted : 1 Total catch: 30.02 Catch/hour: 29.59

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
SALPS	14.92	0	50.43	
Diaphus sp.	9.09	17993	30.71	
Notoscopelus sp.	0.95	179	3.21	
Lampanyctus sp.	0.95	3029	3.21	
MYCTOPHIDAE	0.95	2284	3.21	
Lampadena sp.	0.77	1129	2.60	
Krill	0.51	5134	1.74	
Ceratoscopelus sp.	0.39	385	1.30	
Illex coindetii	0.16	12	0.53	
Cranchia scabra	0.16	9	0.53	
Leptocephalus	0.15	282	0.52	
Maurolicus muelleri	0.13	360	0.43	
Leptostomias sp.	0.10	26	0.35	
PARALEPIDIDAE	0.10	16	0.33	
PANDALIDAE	0.08	102	0.26	
CRANCHIIDAE	0.06	14	0.20	
PASIPHAEIDAE	0.05	26	0.17	0
STOMIIDAE	0.05	26	0.17	
Gnathophausia sp.	0.03	26	0.09	
Total	29.59		100.00	

ANNEX IV. ABUNDANCE ESTIMATES OF TARGET FISH SPECIES

Cap Blanc to Cap Cantin

	Sardina pilchardus					
	N (thousands)			Biomass (tonnes)		
Length cm	Cap Blanc - Cap Bojador	Cap Bojador - Cap Cantin	TOTAL	Cap Blanc - Cap Bojador	Cap Bojador - Cap Cantin	TOTAL
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	55 108	55 108	0	191	191
8	336 720	165 325	502 045	1 696	833	2 528
9	1 950 163	275 542	2 225 704	13 711	1 937	15 648
10	2 146 567	1 019 505	3 166 072	20 376	9 678	30 054
11	3 465 307	1 311 526	4 776 833	43 216	16 356	59 573
12	5 448 302	1 346 666	6 794 969	87 258	21 568	108 826
13	5 864 576	1 682 152	7 546 728	118 318	33 938	152 256
14	9 877 571	1 764 979	11 642 550	246 927	44 122	291 049
15	15 519 047	1 951 550	17 470 597	473 886	59 592	533 478
16	5 349 005	2 384 151	7 733 156	197 033	87 821	284 854
17	1 737 639	1 704 408	3 442 047	76 364	74 903	151 267
18	675 253	1 421 849	2 097 102	35 059	73 821	108 880
19	1 044 146	915 203	1 959 349	63 486	55 646	119 132
20	3 383 619	825 465	4 209 084	239 032	58 314	297 347
21	4 647 825	292 867	4 940 691	378 773	23 867	402 640
22	4 528 782	43 232	4 572 014	423 002	4 038	427 040
23	4 300 901	462	4 301 363	457 696	49	457 745
24	4 084 357	115	4 084 472	492 534	14	492 547
25	361 162	115	361 278	49 106	16	49 122
26	226 748	0	226 748	34 601	0	34 601
27	0	0	0	0	0	0
28	0	0	0	0	0	0
29	0	0	0	0	0	0
30	0	0	0	0	0	0
31	0	0	0	0	0	0
32	0	0	0	0	0	0
33	0	0	0	0	0	0
34	0	0	0	0	0	0
35	0	0	0	0	0	0
38	0	0	0	0	0	0
39	0	0	0	0	0	0
40	0	0	0	0	0	0
TOTAL	74 947 688	17 160 222	92 107 909	3 452 074	566 704	4 018 778

	Scomber colias					
	N (thousands)			Biomass (tonnes)		
Length cm	Cap Blanc - Cap Bojador	Cap Bojador - Cap Cantin	TOTAL	Cap Blanc - Cap Bojador	Cap Bojador - Cap Cantin	TOTAL
10	0	0	0	0	0	0
11	0	3 514	3 514	0	42	42
12	0	28 114	28 114	0	439	439
13	0	63 427	63 427	0	1 258	1 258
14	0	241 359	241 359	0	5 984	5 984
15	16 239	217 056	233 295	496	6 626	7 122
16	184 184	281 828	466 011	6 834	10 456	17 290
17	891 215	392 485	1 283 701	39 730	17 497	57 226
18	1 284 150	413 334	1 697 484	68 084	21 914	89 998
19	896 767	311 301	1 208 068	56 032	19 451	75 483
20	1 422 391	241 429	1 663 820	103 883	17 632	121 515
21	474 130	53 560	527 690	40 175	4 538	44 714
22	1 083 727	0	1 083 727	105 823	0	105 823
23	812 795	0	812 795	90 900	0	90 900
24	0	0	0	0	0	0
25	0	0	0	0	0	0
26	0	0	0	0	0	0
27	0	0	0	0	0	0
28	0	67	67	0	14	14
29	0	582	582	0	132	132
30	0	962	962	0	243	243
31	0	537	537	0	150	150
32	0	90	90	0	28	28
33	0	0	0	0	0	0
TOTAL	7 065 599	2 249 555	9 315 154	511 956	106 377	618 333

	Trachurus trachurus					
	N (thousands)			Biomass (tonnes)		
Length cm	Cap Blanc - Cap Bojador	Cap Bojador - Cap Cantin	TOTAL	Cap Blanc - Cap Bojador	Cap Bojador - Cap Cantin	TOTAL
4	0	0	0	0	0	0
5	0	7 975	0	0	13	0
6	0	14 202	0	0	37	0
7	0	31 138	0	0	126	0
8	0	47 162	0	0	278	0
9	0	216 920	0	0	1 785	0
10	0	139 747	0	0	1 553	1 553
11	294 206	72 842	0	4 296	1 064	5 359
12	2 365 908	118 372	0	44 361	2 219	46 580
13	3 322 357	284 311	0	78 473	6 715	85 188
14	1 996 993	455 567	2 452 560	58 446	13 333	71 779
15	1 947 726	399 951	2 347 677	69 630	14 298	83 928
16	1 558 244	128 401	1 686 646	67 198	5 537	72 736
17	300 910	231 122	532 033	15 482	11 891	27 373
18	26 481	308 163	334 644	1 610	18 731	20 341
19	614 824	128 401	743 225	43 765	9 140	52 905
20	0	25 680	25 680	0	2 124	2 124
21	11 966	0	11 966	1 142	0	1 142
22	0	128 401	128 401	0	14 041	14 041
23	0	0	0	0	0	0
24	0	0	0	0	0	0
25	0	21 111	0	0	3 361	3 361
26	0	0	0	0	0	0
27	0	105 557	0	0	21 075	0
28	0	126 669	0	0	28 150	0
29	0	126 669	0	0	31 218	0
30	0	84 446	0	0	23 001	0
31	0	0	0	0	0	0
32	0	0	0	0	0	0
33	0	0	0	0	0	0
TOTAL	12 439 615	3 202 809	15 642 424	384 401	209 690	594 091

	Trachurus trecae					
	N (thousands)			Biomass (tonnes)		
Length cm	Cap Blanc - Cap Bojador	Cap Bojador - Cap Cantin	TOTAL	Cap Blanc - Cap Bojador	Cap Bojador – Cap Cantin	TOTAL
10	0	0	0	0	0	0
11	1 558	0	1 558	23	0	23
12	52 974	0	52 974	993	0	993
13	60 764	0	60 764	1 435	0	1 435
14	32 719	0	32 719	958	0	958
15	4 674	0	4 674	167	0	167
16	0	0	0	0	0	0
17	0	0	0	0	0	0
18	0	0	0	0	0	0
19	0	0	0	0	0	0
20	0	0	0	0	0	0
21	0	0	0	0	0	0
22	0	0	0	0	0	0
23	0	0	0	0	0	0
24	0	0	0	0	0	0
25	0	0	0	0	0	0
26	0	0	0	0	0	0
TOTAL	6 457 144	2 270 139	8 262 831	384 401	195 899	488 408

	Engraulis encrasicolus					
	N (thousands)			Biomass (tonnes)		
Length cm	Cap Blanc - Cap Bojador	Cap Bojador - Cap Cantin	TOTAL	Cap Blanc - Cap Bojador	Cap Bojador - Cap Cantin	TOTAL
5	0	0	0	0	0	0
6	4 997	302 931	307 928	7	449	457
7	24 985	3 584 683	3 609 668	57	8 166	8 223
8	121 249	1 129 466	1 250 715	402	3 746	4 148
9	123 895	1 405 389	1 529 285	574	6 507	7 080
10	140 505	3 921 199	4 061 703	878	24 512	25 390
11	121 700	5 530 450	5 652 150	999	45 420	46 420
12	51 012	7 072 197	7 123 209	538	74 590	75 128
13	29 110	3 739 240	3 768 349	387	49 680	50 066
14	6 616	91 101	97 716	109	1 500	1 609
15	0	18 498	18 498	0	372	372
TOTAL	51 012	7 072 197	7 123 209	538	74 590	75 128

Cap Cantin to Tanger

Number of fish in millions

	N(millions)			
Length cm	*S. pilchardus*	*S. colias*	*E. encrasicolus*	*T. trachurus*
5				
6				
7				
8				
9			2	
10			11	
11	4		20	
12	41		33	
13	184		73	1
14	278		50	5
15	406	5	43	11
16	563	26	23	34
17	1 049	204	5	84
18	1 071	538		72
19	644	611		36
20	168	265		13
21	71	90		8
22	10	29		4
23	5	12		3
24		5		3
25		2		0
26		0		0
27		3		1
28				1
29				1
30				0
31				
32				
33				0
34				1
35				1
36				1
37				4
38				3
39				3
40				2
41				1
42				2
43				2
44				0
45				0
TOTAL	**4 493**	**1 790**	**261**	**299**

Biomass in 1 000 tons

	Biomass (1000 tons)			
Length cm	*S. pilchardus*	*S. colias*	*E. encrasicolus*	*T. trachurus*
5				
6				
7				
8				
9			0.0	
10			0.1	
11	0.1		0.2	
12	0.8		0.5	
13	4.3		1.2	0.0
14	8.0		1.1	0.2
15	14.3	0.2	1.1	0.4
16	23.9	1.0	0.7	1.4
17	52.9	9.2	0.2	4.0
18	63.8	28.9		4.0
19	44.9	38.4		2.4
20	13.6	19.4		1.0
21	6.6	7.6		0.7
22	1.1	2.8		0.4
23	0.6	1.3		0.3
24		0.6		0.3
25		0.3		0.1
26		0.0		0.0
27		0.5		0.1
28				0.2
29				0.2
30				0.1
31				
32				
33				0.1
34				0.3
35				0.4
36				0.5
37				1.5
38				1.2
39				1.2
40				1.0
41				0.6
42				1.1
43				1.4
44				0.0
45				0.3
TOTAL	**234.7**	**110.3**	**5.0**	**25.5**

ANNEX V. HYDROGRAPHIC SENSORS

CTD Sensors

Type	Serial Number	Model	Calibration Date
Deck unit	11-1082	SBE 11plus	
Pressure sensor	127957	DigiQuartz	22.07.2013
Underwater unit	09P75372-1160	SBE 9plus 6800m	20.10.2018
Water sampler	32-0972	SBE 32 6800m	
Conductivity sensor	42037	SBE 4C 6800m	04.12.2018
Conductivity sensor	43080	SBE 4C 6800m	04.12.2018
Oxygen sensor	43-3525	SBE 43 7000m	02.02.2019
Submersible pump	52147	SBE 5T	2014
Submersible pump	054196	SBE 5T	
Temperature sensor	31602	SBE 3plus 6800m	18.12.2018
Temperature sensor	03P4537	SBE 3plus 6800m	18.12.2018
Fluorometer	4892	WET Labs ECO-AFL fluorometer	08.11.2017
Sonar Altimeter	1186	Benthos PSA-916	2005
Par sensor	1123	PAR-LOG ICSW	12.10.2017

Thermosalinograph Sensors – 6 m water intake

Type	Serial Number	Model	Calibration Date	Usage Start Date
Thermosalinograph	21-3419	SBE21	06.04.2016	04.04.2019
Conductivity sensor	3419	SBE21	06.04.2016	04.04.2019
Temperature sensor (Int)	3419	SBE21	06.04.2016	04.04.2019
Temperature sensor (Ext)	0878	SBE38	31.03.2016	04.04.2019

Thermosalinograph Sensors – 4 m water intake

Type	Serial Number	Model	Calibration Date	Usage Start Date
Thermosalinograph	21-3418	SBE21	06.04.2016	15.04.2017
Conductivity sensor	3418	SBE21	06.04.2016	15.04.2017
Temperature sensor (Int)	3418	SBE21	06.04.2016	15.04.2017
Temperature sensor (Ext)	0880	SBE38	23.03.2016	15.04.2017
Fluorometer	2300402	Turner Designs C3	06.2019	21.11.2019

ANNEX VI. WATER CHEMISTRY QUALITY ASSURANCE

The quality assurance data provided here will only be presented for Leg 4.4 as Leg 4.3 was not equipped with experienced personnel for the on-survey processing. However, the raw data is available for later collaborative processing.

pH and total alkalinity samples were measured in triplicates.

Parameter	Sample count	Average Triplicate* Standard Deviation
pH	84	0.003
Total alkalinity	84	1.74

*Erroneous values removed

Fluorometric standard measurements were performed to quality assure chlorophyll a and phaeopigment measurements

Parameter	Low Standard	High Standard
Standard Average	500	4277
Standard Deviation	6	64
Average Drift	-10	-20

CTD dissolved oxygen and salinity value validity statistics

Parameter	Sample Count	Offset from factory calibration
Dissolved Oxygen	10	4.0%
Salinity	0	N/A

The Portasal salinometer was being repaired during Leg 4 and therefore it was not possible to validate CTD-derived salinity values with discrete water samples from the rosette.

ANNEX VII. ADDITIONAL HYDROGRAPHIC TRANSECT DESCRIPTIONS

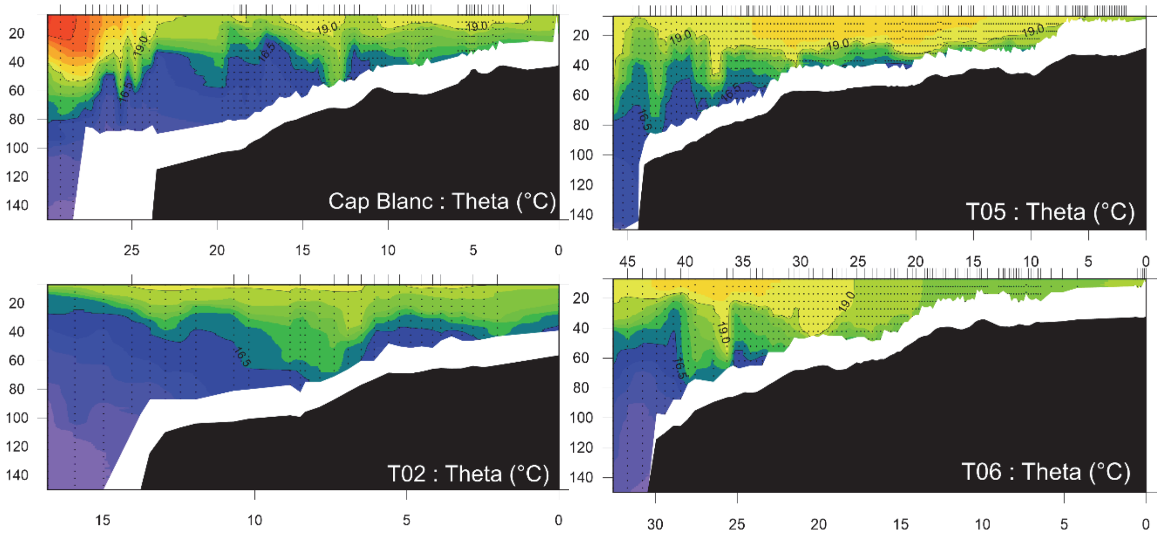

Figure VII.1. UCTD temperature (°C) vertical distributions Cap Blanc in 30/10/2019, T02 in 31/10/2019, T05 in 02/11/2019, and 03/11/2019. Y-axis: Pressure (dbar); X-axis: Distance (NM)

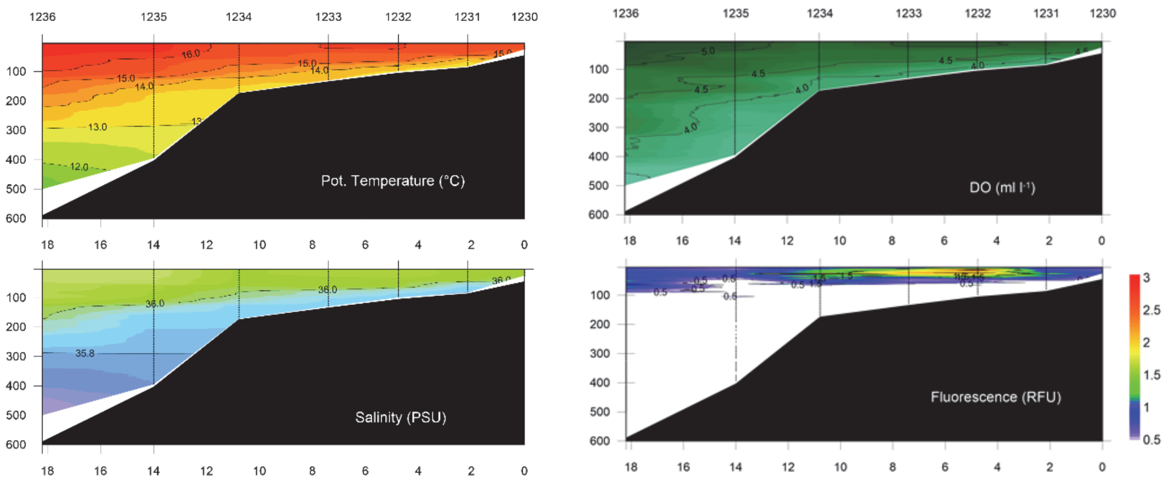

Figure VII.2. Vertical distributions of temperature, salinity, dissolved oxygen and fluorescence in Cap Ghir. Y-axis: Pressure (dbar); X-axis: Distance (NM)

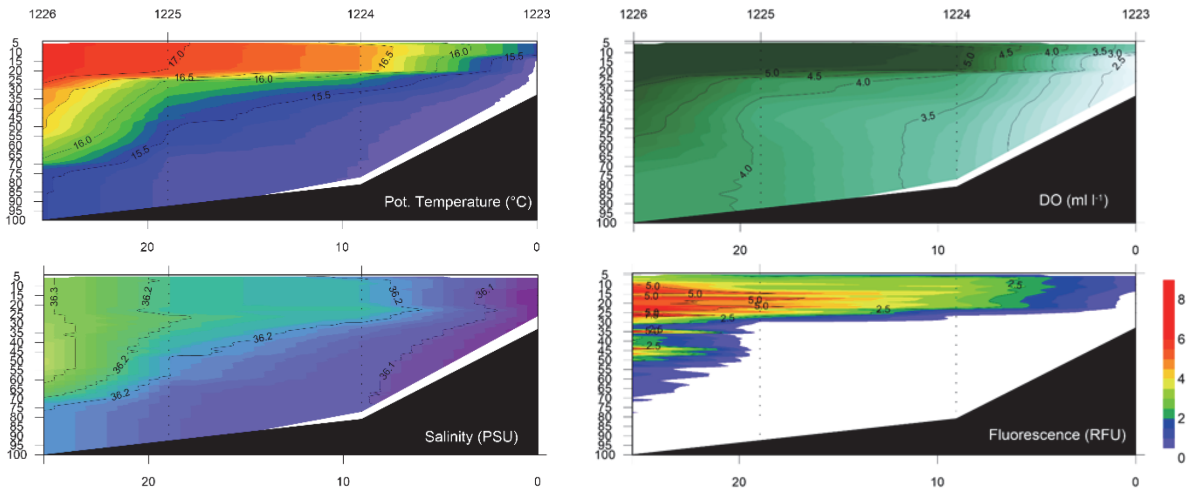

Figure VII.3. Vertical distributions of temperature, salinity, dissolved oxygen and fluorescence in Cap Draa. Y-axis: Pressure (dbar); X-axis: Distance (NM)

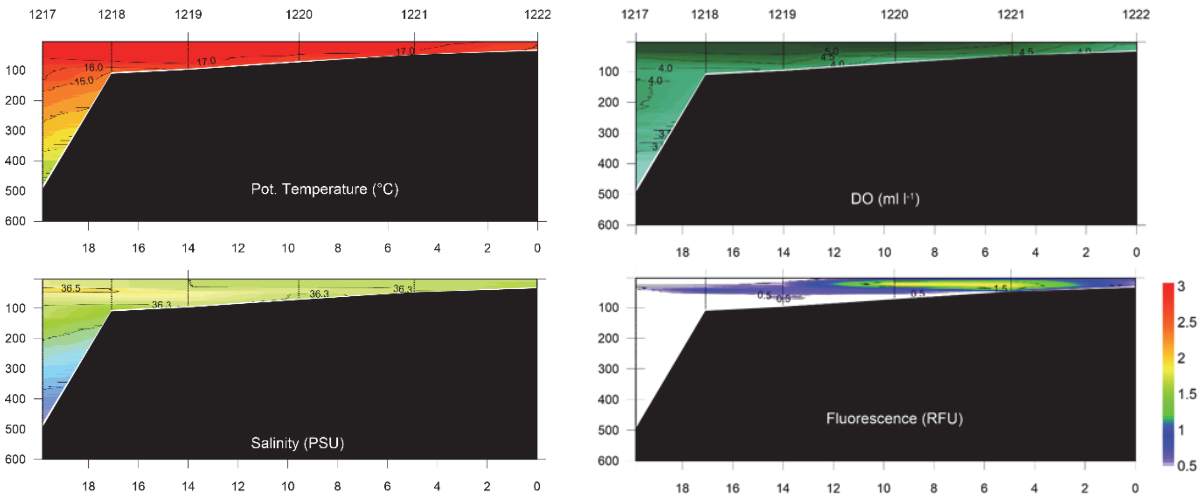

Figure VII.4. Vertical distributions of temperature, salinity, dissolved oxygen and fluorescence in Cap Juby. Y-axis: Pressure (dbar); X-axis: Distance (NM)

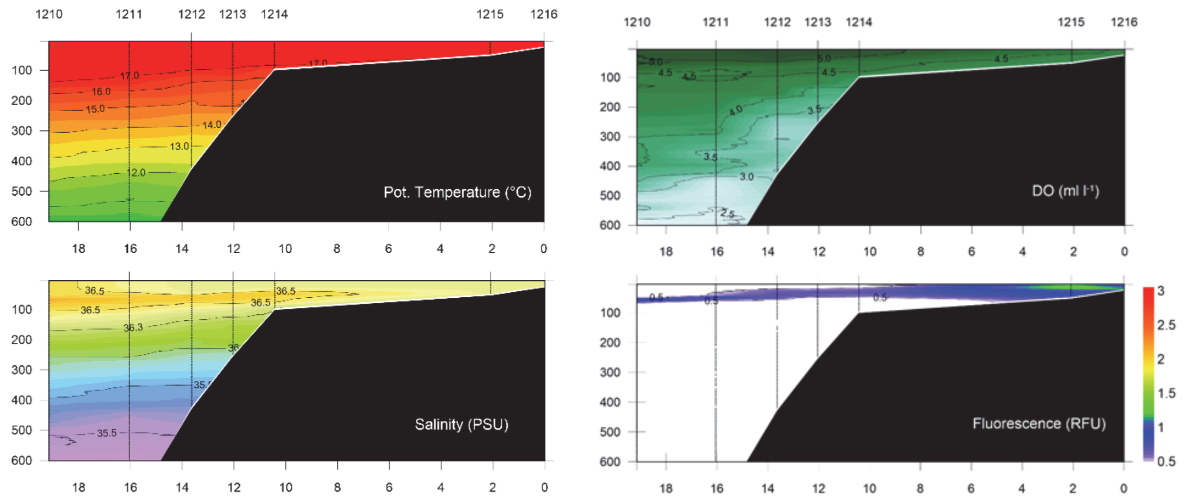

Figure VII.5. Vertical distributions of temperature, salinity, dissolved oxygen and fluorescence in Laayoune. Y-axis: Pressure (dbar); X-axis: Distance (NM)

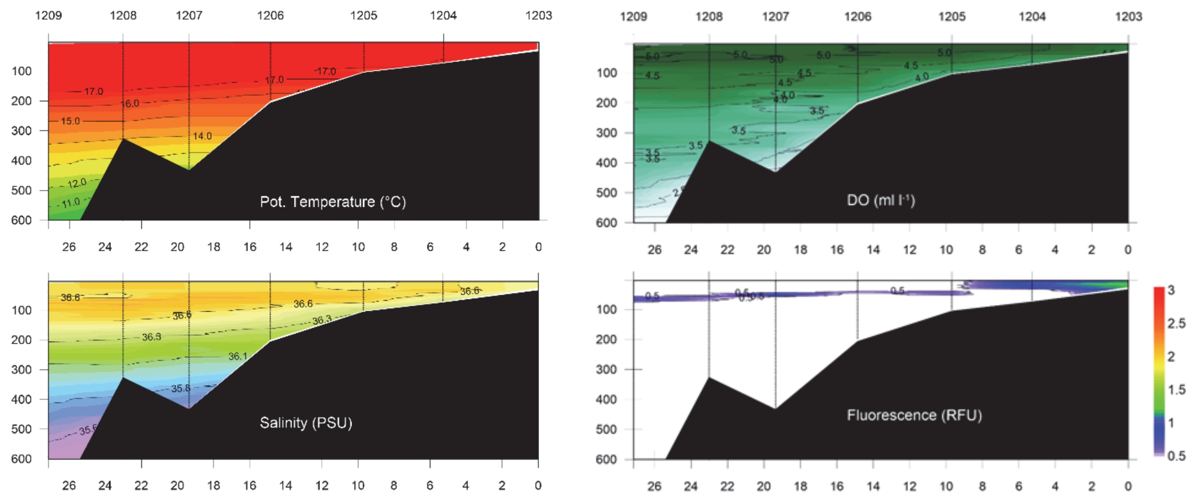

Figure VII.6. Vertical distributions of temperature, salinity, dissolved oxygen and fluorescence in Bojador. Y-axis: Pressure (dbar); X-axis: Distance (NM)

ANNEX VIII. SAMPLES COLLECTED, PRESERVATION AND STATUS

Survey	Station	Species name	length	length/weight	Biology (sex, maturity)	otoliths collected	individuals frozen	individuals formalin	Comment
2019413	1	*Sardina pilchardus*		40	40	40			
2019413	1	*Trachurus trachurus*	120	30	30				
2019413	1	*Engraulis encrasicolus*	102	30	30				
2019413	1	*Trachurus trecae*	118	30	30				
2019413	1	*Sardina pilchardus*					8		ecotoxicology & food safety
2019413	3	*Sarda sarda*		29					
2019413	3	*Trachinotus ovatus*		5					
2019413	3	*Auxis thazard*		4					
2019413	4	*Sardina pilchardus*				31			
2019413	4	*Sardina pilchardus*	117	30					ecotoxicology & food safety
2019413	4	*Sardina pilchardus*					20		
2019413	5	*Sardina pilchardus*							
2019413	5	*Sardina pilchardus*				40			
2019413	5	*Campogramma glaycos*		4					
2019413	5	*Trachinotus ovatus*		2					
2019413	5	*Trachurus trachurus*		28					
2019413	5	*Trachurus trecae*		3					
2019413	5	*Sardina pilchardus*	79	30	30				
2019413	5	*Engraulis encrasicolus*	33	10	10				
2019413	5	*Sardina pilchardus*					20		ecotoxicology & food safety
2019413	6	*Sardina pilchardus*					20		ecotoxicology & food safety
2019413	6	*Trachurus trachurus*					20		ecotoxicology & food safety
2019413	6	*Sardina pilchardus*		70	30	30			
2019413	6	*Engraulis encrasicolus*	100						
2019413	6	*Sardinalla aurita*		3					
2019413	6	*Trachurus trachurus*		21	30				
2019413	7	*Sardina pilchardus*	100	40	40	39			
2019413	7	*Engraulis encrasicolus*		16	16				

Survey	Station	Species name	length	length/weight	Biology (sex, maturity)	otoliths collected	individuals frozen	individuals formalin	Comment
2019413	7	*Sarda sarda*		1					
2019413	7	*Sardina pilchardus*					20		ecotoxicology & food safety
2019413	8	*Sardina pilchardus*					20		ecotoxicology & food safety
2019413	8	*Sardina pilchardus*	100	30	30	40			
2019413	8	*Campogramma glaycos*		6					
2019413	8	*Belone belone gracilis*		1					
2019413	8	*Trichiurus lepturus*		1					
2019413	8	*Gymnura altavela*		1					
2019413	8	*Dasyatis pastinaca*		1					
2019413	9	*Engraulis encrasicolus*		23	23				
2019413	9	*Trachurus trachurus*		1	1				
2019413	9	*Belone belone gracilis*		1					
2019413	9	*Sardina pilchardus*	70	30	30	30			
2019413	9	*Sardina pilchardus*					20		ecotoxicology & food safety
2019413	11	*Sardina pilchardus*					20		ecotoxicology & food safety
2019413	11	*Sardinalla aurita*		1			1		morphometrics **22 degrees**
2019413	11	*Scomber colias*		2			2		morphometrics **22 degrees**
2019413	11	*Sarda sarda*		1					
2019413	11	*Argyrosomus regius*		6					
2019413	11	*Merluccius senegalensis*		2					
2019413	11	*Engraulis encrasicolus*	72	29	29				
2019413	11	*Sardina pilchardus*	70	30	30				
2019413	11	*Belone belone gracilis*		1					
2019413	12	*Scomber colias*					40		morphometrics **22 degrees**
2019413	12	*Scomber colias*							
2019413	12	*Sardina pilchardus*				30			
2019413	12	*Trachurus trachurus*					22		ecotoxicology & food safety
2019413	12	*Scomber colias*					22		ecotoxicology & food safety
2019413	12	*Sardina pilchardus*					22		ecotoxicology & food safety
2019413	12	*Sardina pilchardus*		69	31				

Survey	Station	Species name	length	length/weight	Biology (sex, maturity)	otoliths collected	individuals frozen	individuals formalin	Comment
2019413	12	*Trachurs trachurus*		84					
2019413	12	*Scomber colias*		100					
2019413	12	*Sarda sarda*		15					
2019413	12	*Katsuwonus pelamis*		2					
2019413	12	*Lepostomias sp*		4					
2019413	13	*Sardina pilchardus*					20		ecotoxicology & food safety
2019413	14	*Scomber colias*		100	30		20		
2019413	14	*Trachurus trachurus*		100	30		20		
2019413	14	*Sarda sarda*							
2019413	14	*Sardina pilchardus*		4	4	4			
2019413	15	*Trachurus trachurus*	4						
2019413	15	*Trachurus trecae*	1						
2019413	15	*Auxis rochei*		4					
2019413	16	*Macroramphus gracilis*	50						
2019413	17	*Sardina pilchardus*					22		ecotoxicology & food safety
2019413	17	*Sardina pilchardus*	99	30		30			
2019413	17	*Scomber colias*		8			8		morphometrics **23 degrees**
2019413	17	*Engraulis encrasicolus*	1						
2019413	18	*Trachurus trachurus*		25	25				
2019413	18	*Scomber colias*		4	4				
2019413	18	*Trachinus araneus*		1					
2019413	18	*Sardina pilchardus*		1		30			
2019413	18	*Belone belone gracilis*		4					
2019413	19	*Sardina pilchardus*		6	6	6			
2019413	19	*Scomber colias*		18	18				
2019413	19	*Trachurus trachurus*		5	5				
2019413	20	*Sardinalla aurita*		1	1	1			
2019413	20	*Sardina pilchardus*		30	30	30			
2019413	20	*Sardina pilchardus*					20		ecotoxicology & food safety
2019413	22	*Sardina pilchardus*					40		ecotoxicology & food safety

Survey	Station	Species name	length	length/weight	Biology (sex, maturity)	otoliths collected	individuals frozen	individuals formalin	Comment
2019413	22	*Sardina pilchardus*		99	30	30	14		
2019413	23	*Sardina pilchardus*				30			
2019413	23	*Sardina pilchardus*					20		ecotoxicology & food safety
2019413	23	*Sardina pilchardus*		100	30				
2019413	25	*Sardina pilchardus*	100	30		30			
2019413	25	*Sardina pilchardus*					15		ecotoxicology & food safety
2019413	25	*Scomber colias*		19	19		15		ecotoxicology & food safety
2019413	25	*Trachurus trachurus*		23	23				
2019413	25	*Pomadasys incisus*		7					
2019413	25	*Mullus barbatus*		2					
2019413	25	*Boopd boops*		18					
2019413	25	*Diplophus bellottii*		43					
2019413	25	*Diplophus vulgaris*		1					
2019413	26	*Trachurus trachurus*					15		ecotoxicology & food safety
2019413	26	*Trachurus trachurus*		100	30				
2019413	26	*Trachurus trecae*		2					
2019413	28	*Scomber colias*					20		ecotoxicology & food safety
2019413	28	*Scomber colias*					20		morphometrics **27 degrees**
2019413	28	*Scomber colias*		100	30				
2019413	28	*Sardina pilchardus*		100	30	30	15		ecotoxicology & food safety
2019413	30	*Sardina pilchardus*			12	12			
2019413	30	*Engraulis encrasicolus*		100	30				
2019413	30	*Diplodus vulgaris*		6					
2019413	30	*Pagellus acarne*		5					
2019413	30	*Pagellus erythrinus*		22					
2019413	30	*Spondylosoma cantharus*		6					
2019413	31	*Diplodus bellottii*		88					
2019413	31	*Scomber colias*			2				
2019413	31	*Engraulis encrasicolus*	100						
2019413	31	*Sardina pilchardus*		105	30	30			

Survey	Station	Species name	length	length/weight	Biology (sex, maturity)	otoliths collected	individuals frozen	individuals formalin	Comment
2019413	31	*Sardina pilchardus*					20		ecotoxicology & food safety
2019413	31	*Trachurus thachurus*		39	30		20		ecotoxicology & food safety
2019413	32	*Scomber colias*					20		ecotoxicology & food safety
2019413	32	*Scomber colias*					40		morphometrics **38 degrees**
2019413	32	*Scomber colias*		93	30				
2019413	32	*Sardina pilchardus*		12	12	12			
2019413	33	*Scomber colias*		100	30	30			
2019413	34	*Sardina pilchardus*		110	30	30			
2019413	34	*Sardina pilchardus*					20		ecotoxicology & food safety
2019413	34	*Diplodus puntazzo*		1					
2019413	34	*Engraulis encrasicolus*		137	30				
2019413	34	*Scomber colias*		2	2				
2019413	34	*Trachurus trachurus*		1					
2019413	34	*Merluccius merluccius*		2					
2019413	35	*Sardina pilchardus*		100	30	30			
2019413	35	*Engraulis encrasicolus*		99	30				
2019413	35	*Trachurus trachurus*		11	10				
2019413	37	*Scomber colias*		100	30		20		ecotoxicology & food safety
2019413	37	*Sardina pilchardus*		100	30		20		ecotoxicology & food safety
2019413	37	*Campogramma glaycos*		1					
2019413	37	*Trachurus trachurus*		23	22				
2019413	37	*Sardina pilchardus*					20		ecotoxicology & food safety
2019413	37	*Scomber colias*					20		ecotoxicology & food safety
2019413	38	*Engraulis encrasicolus*		100	30				
2019413	38	*Sardina pilchardus*		18	18	18			
2019413	38	*Trachurus trachurus*		12					
2019413	39	*Sardina pilchardus*		98	30	30			
2019413	39	*Sardina pilchardus*					20		ecotoxicology & food safety
2019413	39	*Scomber colias*					20		ecotoxicology & food safety
2019413	39	*Trachurus trachurus*		42	16				

Survey	Station	Species name	length	length/weight	Biology (sex, maturity)	otoliths collected	individuals frozen	individuals formalin	Comment
2019413	39	*Scomber colias*		100	30				
2019413	40	*Sardina pilchardus*					20		ecotoxicology & food safety
2019413	40	*Sardina pilchardus*		100	30	30			
2019413	40	*Engraulis encrasicolus*		100	30				
2019413	40	*Trachurus trachurus*		100	13				
2019413	40	*Scomber colias*		8	8				
2019413	41	*Sardine pilchardus*		100	30	30			
2019413	41	*Sardine pilchardus*					20		ecotoxicology & food safety
2019413	41	*Engraulis encrasicolus*		100	30				
2019413	41	*Trachurus trecae*		1			1		for identification check
2019413	41	*Scomber colias*							
2019413	41	*Pomatomus saltatrix*		1					
2019413	41	*Trachurus trachurus*		100	30				
2019413	42	*Mola mola*		6					
2019413	42	*Engraulis encrasicolus*		101					
2019413	42	*Sardine pilchardus*		77	30	30			
2019413	42	*Trachurus trachurus*		53					
2019413	42	*Engraulis encrasicolus*		101	30		20		ecotoxicology & food safety
2019413	43	*Sardina pilchardus*		45	30	30			
2019413	43	*Trachurus trachurus*		20	2				
2019413	43	*Engraulis encrasicolus*		100	30				
2019413	43	*Merluccius merluccius*			32				
2019413	43	*Sardine pilchardus*					15		ecotoxicology & food safety
2019413	43	*Engraulis encrasicolus*					20		ecotoxicology & food safety
2019413	44	*Sardina pilchardus*		100	30				
2019413	45	*Sardina pilchardus*		100	30	30			
2019413	45	*Sardine pilchardus*					20		ecotoxicology & food safety
2019413	45	*Scomber colias*		100	30		20		ecotoxicology & food safety
2019414	1	*Sardina pilchardus*							
2019414	1	*Scomber colias*							

Survey	Station	Species name	length	length/weight	Biology (sex, maturity)	otoliths collected	individuals frozen	individuals formalin	Comment
2019414	1	Nansis		300	90				
2019414	2	*Sardina pilchardus*							
2019414	2	*Scomber colias*							
2019414	2	Nansis		263	90				
2019414	3	Nansis		201	61				
2019414	5	*Sardina pilchardus*							
2019414	5	Nansis		128	58				
2019414	6	*Sardina pilchardus*							
2019414	7	*Sardina pilchardus*							
2019414	8	*Sardina pilchardus*							
2019414	9	*Sardina pilchardus*							
2019414	7	Nansis		246	60				
2019414	8	Nansis		290	120				
2019414	9	Nansis		187	90				
2019414	11	*Sardina pilchardus*							
2019414	11	*Scomber colias*							
2019414	10	Nansis		212	30				
2019414	11	Nansis		241	71				
2019414	12	Nansis		400	120				
2019414	12	*Sardina pilchardus*							
2019414	13	*Sardina pilchardus*							
2019414	14	*Sardina pilchardus*							
2019414	13	Nansis		246	90				
2019414	14	Nansis		176	96				
2019414	15	Nansis		275	90				
2019414	16	Nansis		200	60				
2019414	17	Nansis		154	84				
2019414	17	*Sardina pilchardus*							
2019414	18	*Scomber colias*							
2019414	20	*Sardina pilchardus*							

Survey	Station	Species name	length	length/weight	Biology (sex, maturity)	otoliths collected	individuals frozen	individuals formalin	Comment
2019414	20	Nansis		100	30				
2019414	21	Nansis		215	90				
2019414	22	*Ceratoscopelecus maderensis*				200			
2019414	22	*Maurolicus muelleri*				200			
2019414	22	Nansis		312	102				
2019414	23	Stomiidae				1			
2019414	23	Leptistomias				1			
2019414	23	Notoscopelus				1			
2019414	23	Diaphus				2			
2019414	23	Diaphus				10			
2019414	23	Diaphus				10			
2019414	23	Lampanyctus				2			
2019414	23	Ceratoscopelus				5			
2019414	23	Myctophidae				4			