NORAD-FAO PROGRAMME
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CRUISE REPORTS *DR FRIDTJOF NANSEN*
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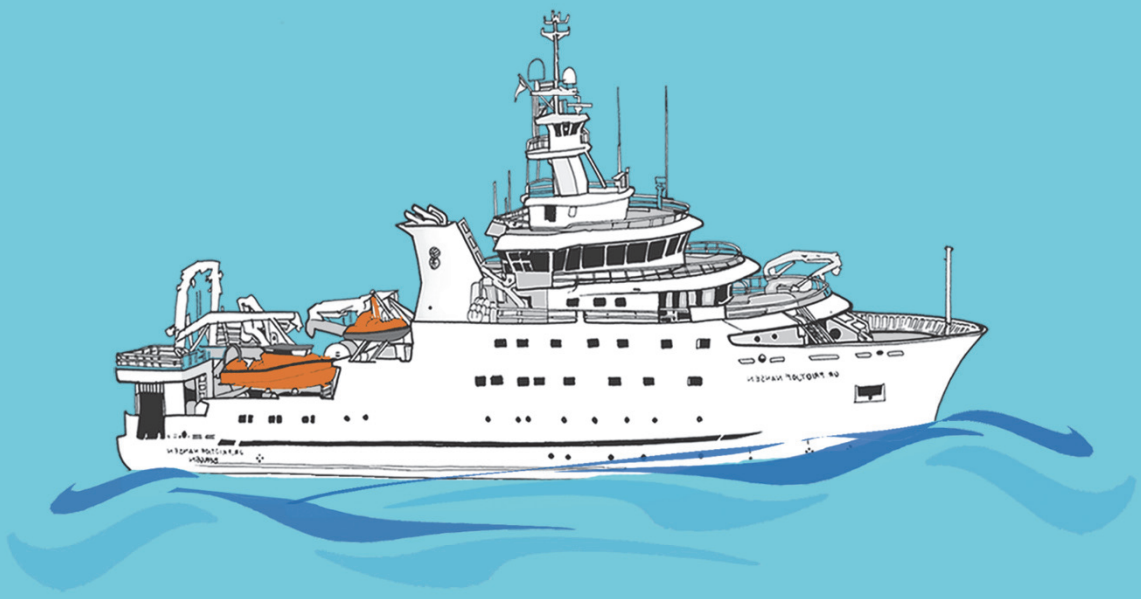

PELAGIC STOCKS AND ECOSYSTEMS SENEGAL-MOROCCO

Senegal and The Gambia

26 September–7 October 2019

Department of Fisheries,
Banjul, The Gambia

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.

Zimmermann, F., Dias Bernardes, I., Hertzberg, A., Bank, M., Odland, E., Cervantes, D., Jallow, M.S., Sarre, A. 2020. Pelagic stocks and ecosystems Senegal-Morocco, 26 September–7 October 2019. NORAD-FAO PROGRAMME GCP/GLO/690/NOR, CRUISE REPORTS *DR FRIDTJOF NANSEN*, EAF-Nansen/CR/2019/11

CRUISE REPORTS *DR FRIDTJOF NANSEN*

PELAGIC STOCKS AND ECOSYSTEMS SENEGAL-MOROCCO

Senegal and The Gambia

26 September–7 October 2019

by

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Institute of Marine Research
Bergen, 2020

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EXECUTIVE SUMMARY

This survey is part of a synoptic coverage of the pelagic resources and ecosystem off West Africa, from Senegal to Morocco. 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 was 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 facilitate comparability.

This report presents the results from Leg 4.1, i.e. off the coast from the southern to the northern border of Senegal, including The Gambia, from 26 September to 7 October 2019.

An east-west acoustic sampling grid, with a transect spacing of 10 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. 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 have been expanded to support research on life cycles, stock identities, and trophic relationships of pelagic fish. Special effort was made to sample several biological parameters for post-survey age and growth, stock structure, population biology and trophic interaction studies. 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.

Pelagic fish were present over the entire survey region but with species-specific differences in occurrence and density. Sardinellas dominated the species composition in the southern areas where an extended, shallow shelf and outflow of large estuaries provide an ideal habitat. Horse mackerel, on the other hand, had a strong presence in north of Senegal, and some very dense schools were observed. A mixture of other pelagic species was found throughout the survey, making the acoustic biomass estimation particularly challenging and contributing to the substantial uncertainty. Small pelagics are short-lived, highly fecund fish that often migrate over large distances. The abundance of small pelagics can therefore change dramatically in a short period of time, hence the observed stock densities are simply a snapshot in time and abundance changes of the various species may change drastically even in absence of fishing.

RÉSUMÉ

Cette campagne s'inscrit dans le cadre de la couverture synoptique des ressources et de l'écosystème pélagiques au large de l'Afrique de l'Ouest, du Sénégal au Maroc. Cette étude du plateau continental et de la partie supérieure du talus (20 m à 500 m de profondeur), avait des objectifs multiples et a donc été multidisciplinaires. L'océanographie physique et chimique a été échantillonnée à la fois en mer et avec une série de stations fixes le long de transects perpendiculaires à la côte. Des échantillons de plancton et des échantillons 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 été évalués simultanément par mesure acoustique et par chalutage. Toutes les campagnes ont utilisé des méthodes standardisées pour faciliter la comparabilité des données.

Ce rapport présente les résultats du tronçon 4.1 de la campagne, réalisée au large de la côte du Sénégal, du sud au nord, Gambie comprise, du 26 septembre au 7 octobre 2019.

Une grille d'échantillonnage acoustique est-ouest, avec un espacement des transects de 10 nm, a couvert le plateau à partir de 20 m et le talus jusqu'à 500 m de profondeur. L'échantillonnage biologique des poissons a été réalisé à l'aide de chaluts pélagiques et du chalut de fond. Des sections hydrographiques standard ont été échantillonnées le long des transects acoustiques. Le zooplancton, l'ichtyoplancton et les microplastiques ont également été échantillonnés.

Avec l'élargissement de la recherche menée dans le cadre du Programme EAF-Nansen, les objectifs de la campagne et la stratégie d'échantillonnage ont été étendus pour soutenir la recherche sur les cycles biologiques, l'identité des stocks et les relations trophiques des poissons pélagiques. Un effort particulier a été fourni pour échantillonner plusieurs paramètres biologiques pour des études post-campagne sur l'âge et la croissance, la structure des stocks, la biologie des populations et les interactions trophiques. Les échantillons seront analysés en étroite collaboration avec les institutions partenaires et les recherches réalisées dans le cadre du plan scientifique EAF-Nansen pourront s'appuyer sur ces séries de données.

Les poissons pélagiques étaient présents dans l'ensemble de la région étudiée, mais avec des différences d'occurrence et de densité selon les espèces. Les sardinelles ont dominé la composition par espèces dans les zones méridionales où un plateau étendu et peu profond et les flux des grands estuaires constituent un habitat idéal. Le chinchard, en revanche, était très présent au nord du Sénégal, et des bancs très denses ont été observés. Plusieurs autres espèces pélagiques ont été observées tout au long de la campagne, rendant l'estimation acoustique de la biomasse particulièrement difficile et contribuant à une incertitude élevée. Les petits pélagiques sont des poissons à courte durée de vie, très féconds, qui migrent souvent sur de grandes distances. L'abondance des petits pélagiques peut donc changer radicalement en un court laps de temps, et les densités de stock observées ne sont qu'un instantané dans le temps, et les changements d'abondance des différentes espèces peuvent évoluer radicalement même en l'absence de pêche.

CHAPTER 1. INTRODUCTION

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

The science plan is a dynamic document that currently covers 11 themes, presented in Figure 1 below:

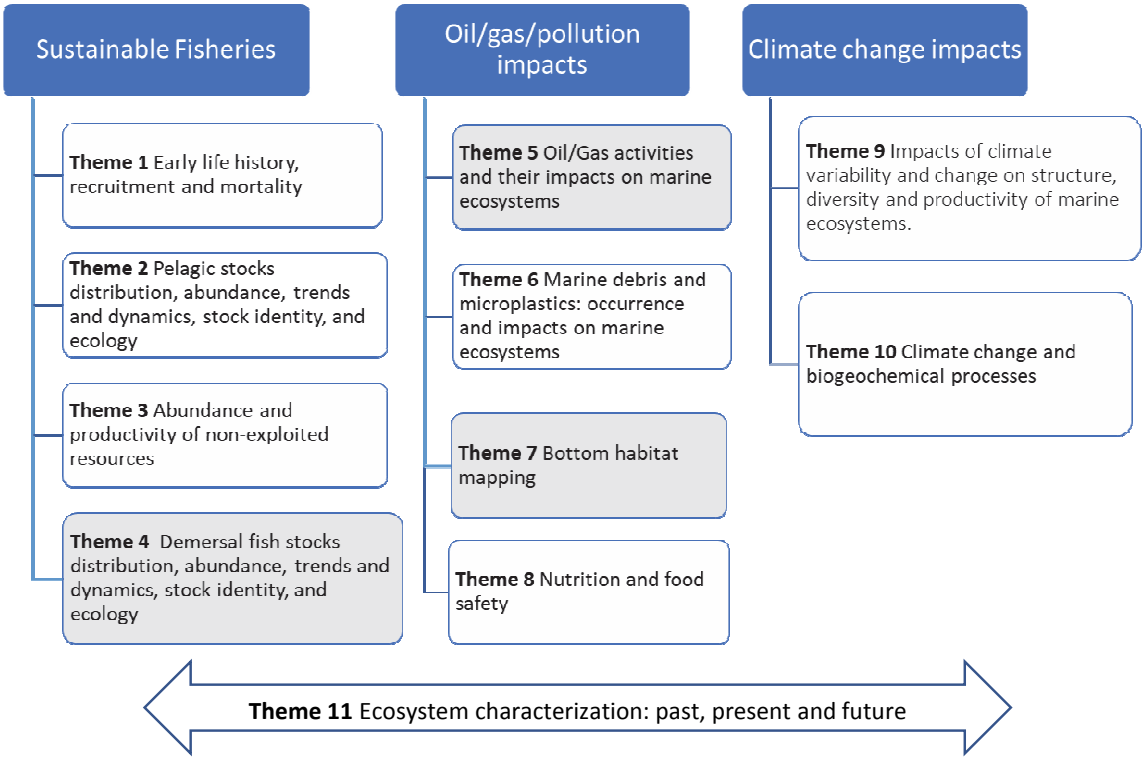


Figure 1. Research themes of the EAF-Nansen science plan

This survey has been designed to collect data towards addressing aspects of most of the research themes of the science plan (those with a white background in the figure above).

1.1 Survey objectives

Pelagic resources:

- To obtain information on abundance, distribution, age and size composition of main pelagic stocks using acoustic methods and a systematic grid survey approach.
- To collect samples for morphometric (whole fish and otholiths) and genetic analysis (for stock identification of *Sardinella aurita* and *Scomber colias*).
- To obtain information on maturity stages of *S. aurita*, *S. maderensis*, *Sardina pilchardus*, *S. colias*, and *Engraulis encrasicolus*.

Food safety and pollution:

- To collect samples for levels of environmental contaminants, nutrients, parasites and microorganisms with regards to food safety and pollution of selected species, specifically *S. aurita* and *S. maderensis*.

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 horizons relevant for calcifying organisms.

Primary productivity, zooplankton, ichthyoplankton and jellyfish:

- To describe the primary productivity and the abundance and biomass of phytoplankton in the region.

- To provide information on the abundance of ichthyoplakton 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, population structure assessment and establishing regional and global connectivity, c) histological examination of reproductive maturity to determine reproductive synchronicity and semelparity within populations and individuals, and d) stable isotope analysis to determine trophic position (nitrogen) and energy sources (carbon).

Marine debris and pollution:

- To map the occurrence of microplastics.

- To record the occurrence of marine debris in surface waters.

- To record the occurrence of floating seaweed aggregations (*Sargassum* sp.) and collect opportunistic samples for genetic studies.

- To obtain information on trace metal concentrations (methylmercury) in seawater.

Top predators:

- To register the occurrence of marine mammals and seabirds.

1.2 The survey area

The area surveyed in 2019 included the continental shelf and upper slope of the West Coast of Africa. Leg 4 covered the area from the Southern border of Senegal to Tangier (Morocco) and was divided into 4 sub-legs. An additional sub-leg was dedicated to mesopelagic fish surveys (Leg 4.5). The overall 2019 survey programme on the Northwest African shelf was focused on off-shore Senegal and The Gambia (Leg 4.1), Mauritania (Leg 4.2) and Morocco (Leg 4.3 and Leg 4.4).

1.3 Participation

A total of 28 researchers and technicians from Senegal, The Gambia, Mauritania, Côte d'Ivoire, and Norway participated in the survey. The full list of the participants and their affiliations is given in Table 1 below.

Table 1. List of participants, their role, affiliation and the period they stayed onboard

Leg	Participant	Role	Affiliation	Period
4.1	Fabian Zimmermann	Cruise leader	IMR	26.09-07.10
4.1	Abdoulaye Sarre	Co-cruise Leader	CRODT	26.09-07.10
4.1	Ines Bernandes	Fish Team Leader	IMR	26.09-07.10
4.1	Eirik Odland	Fish Team Leader	IMR	26.09-07.10
4.1	Tor Ensrud	Plankton Team Leader	IMR	26.09-07.10
4.1	Agnethe Herzberg	Chemical oceanography	IMR	26.09-07.10
4.1	Olaf J. Sørås	Chief Instruments Engineer	IMR	26.09-07.10
4.1	Fredrik E. Otterlei Madsen	Instruments Engineer	IMR	26.09-07.10
4.1	Michael Bank	Food safety	IMR	26.09-07.10
4.1	Limalé Deme	Water Chemistry	CRODT	26.09-07.10
4.1	Tamsir Sow	Plankton biology	CRODT	26.09-07.10
4.1	Aboubacar Gueye	Plankton biology	CRODT	26.09-07.10
4.1	Khalil Bodian	Fish biology	CRODT	26.09-07.10
4.1	Maguette Niang	Fish biology	CRODT	26.09-07.10
4.1	Bor Coulibaly	Fish biology	CRODT	26.09-07.10
4.1	Omar Ndiaye	Fish biology	CRODT	26.09-07.10
4.1	Mama Faye	Whale/seabird observation	CRODT	26.09-07.10
4.1	Bineta Diaby	Food safety	CRODT	26.09-07.10
4.1	Ibrahima Camara	Food safety	CRODT	26.09-07.10
4.1	Lamin Fofana	Plankton biology	DoF	26.09-07.10
4.1	Momodou S. Jallow	Fish biology	DoF	26.09-07.10
4.1	Modou Lamin Conteh	Fish biology	DoF	26.09-07.10

Leg	Participant	Role	Affiliation	Period
4.1	Baboucarr Senghore	Physical Oceanography	DoF	26.09-07.10
4.1	Ebou Mass Mbye	Whale/seabird observation	The Gambia	26.09-07.10
4.1	Mamadou Lamba Ba	Water chemistry	IMROP	26.09-07.10
4.1	Hammoud El Vadhel	Fish biology	IMROP	26.09-07.10
4.1	Wagne Moulaye	Food safety/nutrition	IMROP	26.09-07.10
4.1	Kanga Desire Kouame	Physical oceanography	CRO	26.09-07.10

List of institution abbreviations:

IMR – Institute of Marine Research, Bergen, Norway
CRODT – Centre de Recherches de Dakar-Thiaroye Dakar, Senegal
DoF – Department of Fisheries, Banjul, The Gambia
CRO – Centre De Recherche Océanologique, Côte d'Ivoire
IMROP – Institut Mauritanien de Recherche Océanographique et des Pêches, Mauritania

1.4 Narrative

The vessel departed from Dakar, Senegal, at 13h00 on 27 September 2019, and sampling commenced at the first environmental transect just north of the border between Senegal and Guinea-Bissau on the next day at 08h00. The acoustic coverage for Leg 4.1 was initiated at the same time. The coverage consisted of an acoustic sampling grid that had a transect spacing of approximately 10 NM, covering the shelf and slope from 20 m until the 500 m bottom depth contour. The Casamance section in southern Senegal was completed late on 29 September 2019 when Gambian waters were entered. The vessel crossed back into the Petite Côte region of Senegal on 30 September 2019, initiated the last section north of Dakar on 2 October 2019, and finished the sampling for small pelagic resources on 4 October 2019.

After all sampling was concluded the vessel steamed to the area south of Dakar where the calibration of the echosounder was conducted. The vessel arrived at the port of Dakar at 10h00 on 7 October 2019. Survey dates per survey region are shown in Table 2. The weather was favourable, and no days were lost due to bad weather. In total 1 day was lost during the survey because of a delay in obtaining the Senegalese fishing license.

Table 2. Survey dates for Senegal and The Gambia covered by *Dr Fridtjof Nansen* in 2019

Survey area	Days	Date Start	Date Completion
Senegal: Casamance	1	28/09/2019	29/09/2019
Gambia	1	29/09/2019	30/09/2019
Senegal: Petite Côte	2	30/09/2019	02/10/2019
Senegal: North	2	02/10/2019	04/10/2019
Total	6	28/09/2019	04/10/2019

1.5 Survey effort

The design of the survey and the sampling followed approved protocols described in the sailing order for Leg 4 and was based on past pelagic surveys of the R/V *Dr Fridtjof Nansen* in the area. Pelagic and bottom trawling were conducted in areas of increased echo backscattering as determined from the echosounders and sonars onboard during the day. In the night, pelagic trawling was used to target the scattered fish near the surface. This resulted in a total of 31 trawls over the entire survey area. Most trawling occurred at bottom depths ranging from 20 m to 80 m, as indications of target species in deeper areas were rare.

The survey area and subsequently the stock estimates were divided into four main regions: The Gambia and three regions in Senegal: Casamance (from the southern border of The Gambia to the border of Guinea-Bissau), Petite Côte (from the northern border of The Gambia to Dakar, previously named Cap Vert), and the North of Senegal (from Dakar to the border of Mauritania). These established regions are consistent with those used in previous survey reports from Senegal, but they have been renamed in the present report to reflect an administrative restructuring in Senegal, during which the district name "Cape Vert" was renamed "Dakar".

Hydrographic variables were measured at four transects perpendicular to the coastline placed in a distance of 60 NM. At these "environmental transects", more elaborate sampling was carried out, including CTD with water samples at standard depths for chemical, nutrient and trace metal analyses and zooplankton/ichthyoplankton sampling as well as microplastics.

Table **3**Table 3 summarizes the survey effort categorized by region. The cruise tracks with bottom trawls, CTD stations and zooplankton/ichthyoplankton and microplastics stations are identified in Figure 2.

Table 3. Survey effort in number of sampling stations (total and by region). Number of BT-bottom trawl hauls, PT-pelagic trawl hauls, CTD casts, WP2-zooplankton nets, Bongo-nets for eggs and larvae, Manta-Trawl for surface plastic particles. The distance sailed in each region is also provided

Region	Distance	CTD	WP-2	Bongo	Manta	BT	PT
Senegal: Casmance	183 nmi	6	3	3	3	5	7
The Gambia	61 nmi	7	3	3	3	1	3
Senegal: Petite Côte	191 nmi	7	3	3	3	1	4
Senegal: North	191 nmi	6	3	3	3	5	4
Total	626 nmi	26	12	12	12	12	18

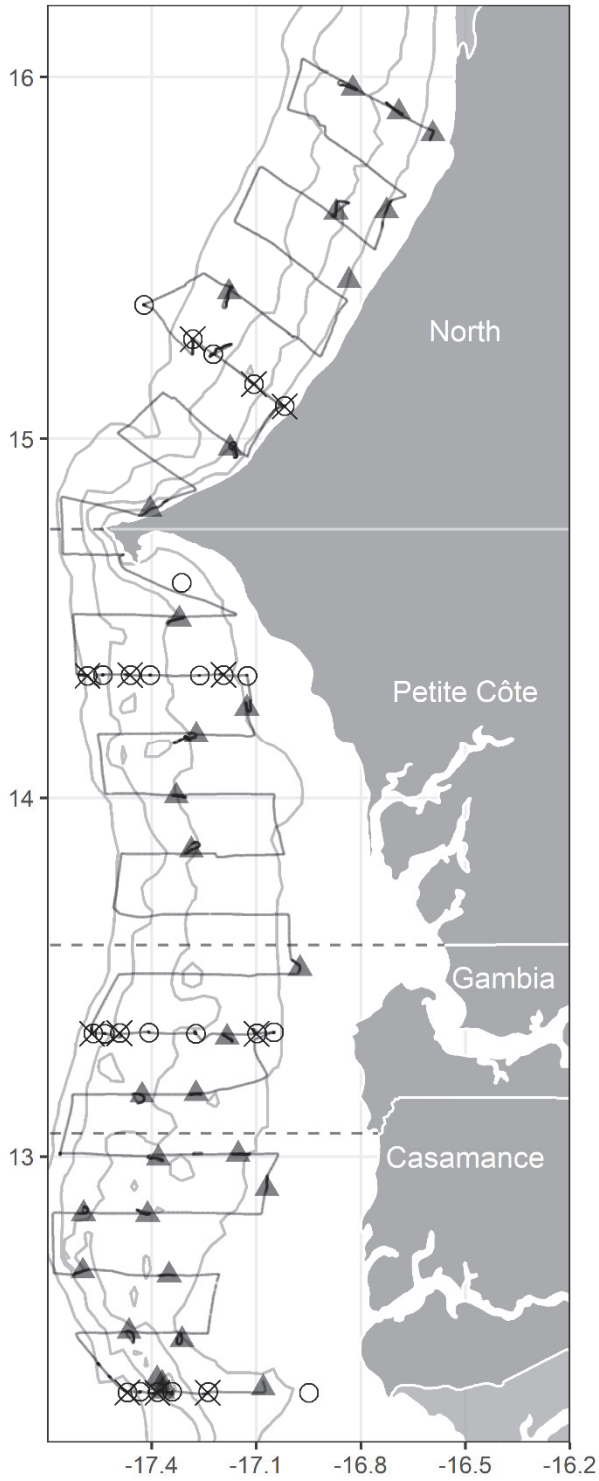


Figure 2. Course track with hydrographic stations (circles), super stations (crosses) and trawl stations (triangles). Depth contours at 20 m, 50 m, 100 m and 500 m as well as The Gambia and the three regions in Senegal (Casamance, Petite Côte and Northern Senegal) are indicated

CHAPTER 2. METHODS

2.1 Underway hydrographic sampling

2.1.1 Meteorological data recording

Meteorological data were logged continuously from the AANDERAA Smartguard meteorological station and included wind direction and speed, air pressure, relative humidity, air temperature and solar radiation. All data were logged to the Nansis tracklog system averaged every 60 seconds.

2.1.2 Thermosalinograph

A SBE 21 SeaCAT Thermosalinograph ran continuously during the survey, obtaining samples at 4 m depth to measure salinity and temperature every 10 seconds. A Sea-Bird WETStar Fluorometer was also attached in-line to measure sub-surface fluorescence levels. The secondary temperature sensor closer to the intake registered sub-surface temperatures.

2.1.3 Current speed and direction measurements (ADCP)

The ocean current data were collected with 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 ran in narrow band mode and averaged data in 8 m vertical bins. 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 earth coordinates.

2.2 Fixed station hydrographic sampling

A series of biological and oceanographic transects were sampled along every 4th acoustic transect. These stations were referred to as "super-stations". The standard Nansen sampling protocol is for super-stations to be conducted at 30 m, 100 m, and 500 m depths. Depending on the width of the continental shelf additional CTD casts were taken at 20 m, 50 m and 200 m bottom depths, and an extra station at 1 000 m depth was added for oxygen calibration purposes. In total, four environmental transects were sampled, with 12 "super-stations" and 14 additional CTD stations. An overview of the number of samples collected is given in Table 3. The samples collected on the environmental transects are shown in Figure 3.

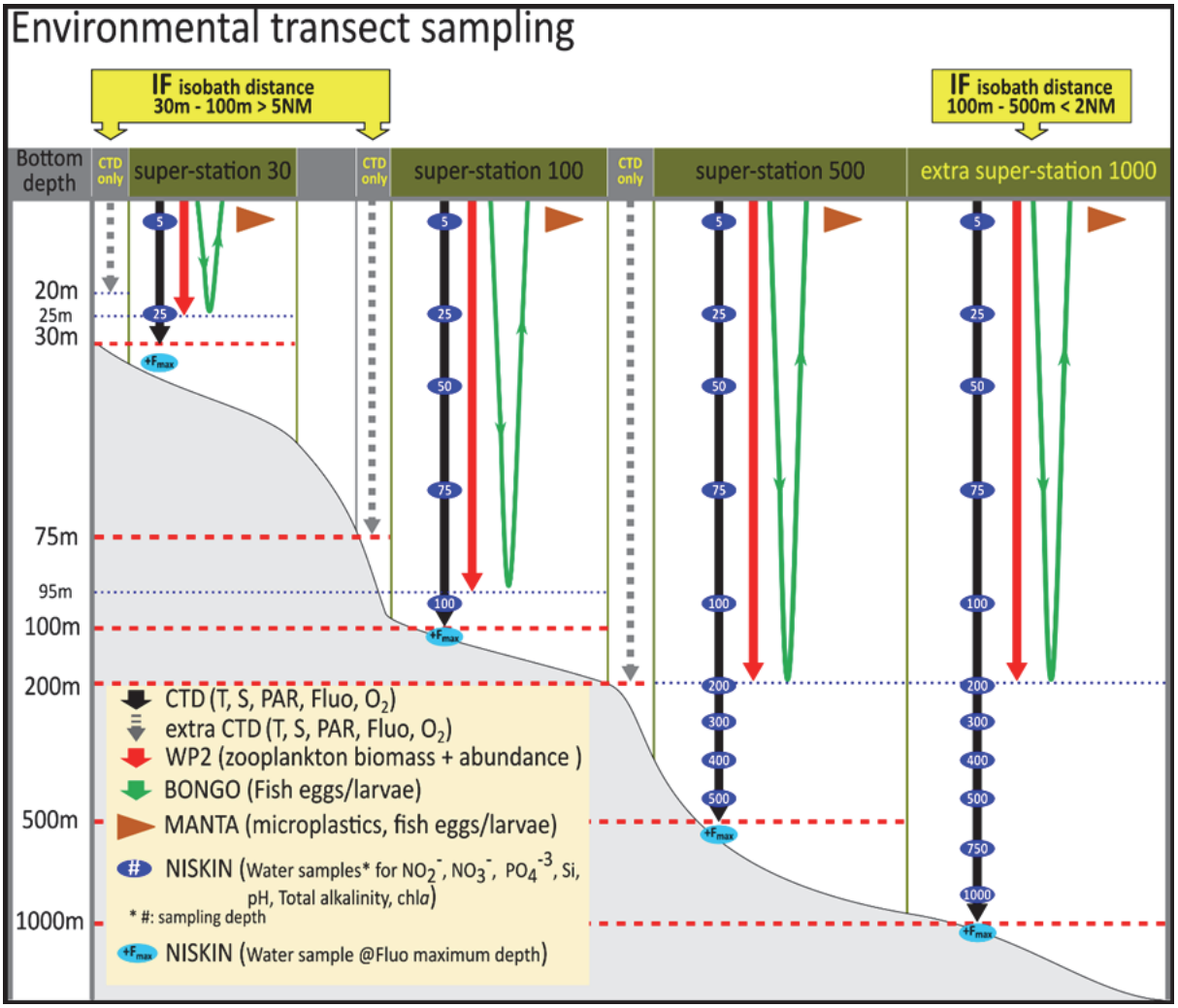


Figure 3. CTD and plankton sampling protocol along environmental transects

At each super-station CTD deployment, Niskin and GoFlo 1080 series bottles mounted on the rosette collected water at predefined depths during the upcast to obtain vertical profiles of pH, total alkalinity, nutrients, chlorophyll-α and methylmercury. The CTD stopped at each predefined depth for at least 20 seconds to allow the bottles to rinse with the surrounding water as it reached equilibrium to best represent the water composition at that depth.

A Sea-Bird 911plus CTD profiler [equipped with 2 x SBE 3Plus Oceanographic Temperature sensors, 2 x SBE 4C Conductivity sensors, a Digiquartz Pressure ('P') sensor, a SBE 43 dissolved oxygen ('DO') sensor, a WET Labs ECO-AFL Fluorometer and a Satlantic Photosynthetically Active Radiation ('PAR') LOG ICSW sensor] was mounted to a 12-Niskin bottle Rosette and used for every CTD deployment. All sensor logging and vertical profiling is performed using Sea-Bird's Seasave software.

Water was collected from low-gradient depths of 300 m and below to perform onboard validations of the dissolved oxygen sensor measurements. The values were validated using a Metrohm 916 Ti-Touch potentiometric titrator performing Winkler (Grasshoff *et al.*, 1983) and Karl Fischer titrations. The thermistor circuitry of the Guildline Portasal Salinometer

8410A was not working (one of two thermistors were out of service), thus no water samples were analysed to validate the sensor salinity values.

Results of sensor validations of the hydrographic sensors and water chemistry quality assurance are shown in Annex II.

2.2.1 Ocean acidification parameters (pH and total alkalinity)

Water samples for pH and total alkalinity analysis 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 & 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.

2.2.2 Nutrient samples

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 & Rey, 1984) until being sent to the Institute of Marine Research for analysis. Analysis was performed using a Skalar San++ Continuous Flow Analyser while following standard procedures (Grasshoff *et al.*, 2009). Storage and transport may have introduced a loss of accuracy for the results.

Phosphate and silicate concentrations combined with the on-board 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.

2.2.3 Primary productivity

Water for chlorophyll-α samples were collected in 1 000 ml polyethylene bottles and transferred into 260 ml bottles for filtration. Two replicates were filtered on depths where sensor data from the bottle files indicate values higher than 0.5 µg/l. In areas with very low chlorophyll concentration (all below 0.5 µg/l) double amount of water (2 x 260 ml) was filtered. On all other depths, one replicate of 260 ml was done. These water samples were collected from 200 m to the surface and filtered using a 0.7 µm filtration system (Munktell

glass-fibre filters Grade: MGF, vacuum 200 mmHg). The filters were stored in a freezer at -80°C until further fluorometric analysis (Welschmeyer, 1994)

2.2.4 Zooplankton and microplastics sampling

Plankton sampling was conducted at 12 super stations (Table 4) positioned in 4 transects running perpendicular to the coast, corresponding each to one of the four regions (Figure 2).

Table 4. Overview of the plankton super stations sampled

Sampling device	Number of stations sampled
Phytoplankton	12
WP2 (180 μm)	12
Bongo (405 μm)	12

Sampling for mesozooplankton and ichthyoplankton was conducted at all stations. Mesozooplankton samples were collected with vertical tows using a WP2 net (180 μm). The net was towed within 5-10 m of the bottom to the surface, or from 200 m depth to the surface at deep stations. Each sample was halved with a Motoda splitter. One half was size fractionated through 2 000 μm, 1 000 and 180 μm mesh sizes, and dried in the oven (60^{o}C) in pre-weighed aluminum trays. The second half was preserved in 4% borax buffered formaldehyde solution.

Ichthyoplankton was collected with double oblique tows of a Bongo (405μm) 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 (Bongo V) was preserved directly in 4% borax buffered formaldehyde solution.

b) The sample of the right net (Bongo H) was preserved in 95% ethanol and was used for sorting larval fish onboard and preliminary taxonomic identification. Larval fish were sorted for most of the samples and identified to family or lower taxonomic level. The sorted larval fish were stored in small vials with ethanol for further analysis.

A Manta Trawl net with a 335 μm mesh size was towed from the wake of the vessel while sailing at 3 knots (1.5 m/s) for 15 min. The sampling processing involved sorting of:

1) Microplastics, which were photographed, washed in fresh water, dried in aluminum trays, individually packed in aluminum foil, and stored frozen.

2) Fish larvae and eggs were sorted and preserved in 95% ethanol for later analysis. After the sorting, the rest of the sample was preserved in 95% ethanol.

2.2.5 Trace metal sampling

Six Niskin water-bottles were replaced by Oceanographic six Go-Flo Bottles (Teflon lined) attached to a CTD-mounted rosette and used to collect water at predefined depths. Samples are collected in parallel and at the same standardized depths, except for 5 m, as for nutrient samples taken from the Niskin water-bottles.

In total, 23 CTD Stations were sampled for methylmercury in seawater. At those, a total of 78 samples were collected from depths ranging from 20 m to 1 000 m. Trace metal clean sampling was followed for seawater sampling.

2.3 Top predator observations

Observations were carried out on all days when the vessel was moving at a regular speed, i.e. on or between acoustic transects but not at CTD stations or while trawling. Sightings were recorded from the observation platform of the vessel, situated 21.5 m above sea level, during daylight hours between 07h00 to 18h00 (with breaks). Marine mammal observations were the main objective with seabirds' observations of secondary importance.

Primary observations were carried out in "passing mode", meaning that the ship did not deviate from its track while sailing between oceanographic and fisheries sampling stations. The search effort changed from primary to secondary during such stations. Both marine mammal and seabird observations covered a forward angle of 180° from port to starboard. Occurrences of marine mammals, sea birds and seaweed were registered according to standard protocol by two observers during daylight hours while the vessel was following a transect with regular speed.

2.4 Seaweed observations and sampling

Sargassum seaweed was observed as part of the top predator observations. An ad-hoc protocol was used, registering observations of sargassum seaweed and three levels of relative density (small patches, large patches, consistent cover over a large area).

2.5 Food safety and nutrition sampling

Three stations were sampled for food safety and nutrition. *Sardinella aurita*, *Sardinella maderensis* and *Engraulis encrasicolus* were sampled individually (n=25) and in composite form. Only one of each species was captured at each individual station. Established protocols were followed. Samples were shipped to Bergen for further analysis.

2.6 Biological sampling and stock estimation

2.6.1 Biological sampling

Pelagic and bottom trawls were used to collect biological samples. Trawling was conducted with the purpose of identifying species composition and size distribution of the target species. In shallow water (<40 m), bottom trawls were used. In deeper waters, a large pelagic trawl (MultPelt) was used during the day and a smaller pelagic trawl during night, when fish aggregate close to the surface. During daytime, pelagic fish disperse and show gear avoidance behaviour, making the MultPelt more suitable to catch a representative sample due to its larger opening and higher maximum speed (up to 5 knots). This is particularly relevant for the pelagic target species that tend to be highly mobile and can be therefore difficult to catch, especially sardinella.

Total weight and abundance of all species were registered for all trawl samples. Species identification followed the FAO Species Guides. Length frequency distributions of the target species were taken from all stations where they were present according to species-specific sampling protocols. Individual length and weight measurements were used to estimate the length-weight relationship necessary for the biomass estimation. Individual biological information on sex and maturity was recorded for up to 30 individuals per trawl for all target species. In addition, up to 30 samples per degree of whole specimens of *S. pilchardus* and *S. colias* were frozen for subsequent biological, morphometric and genetic analysis on land.

Annex III provides a full list of biological samples per species and trawl station.

2.6.2 Biomass estimation

Species biomass was estimated using NASC data obtained from scrutinized acoustic data and length and species composition in trawl samples. The following target strength function was applied to convert the s_A-values to number of fish:

$$TS = 20 \cdot \log(L) - 72,$$

with *TS* as target strength in dB and *L* as length group of fish. This can be converted (see Toresen *et al.*, 1998 for details) to the area form (scattering cross sections of acoustic targets):

$$C_i = 1.26 \cdot 10^6 \cdot {L_i}^{-2},$$

where C_i is the reciprocal back-scattering strength of fish in length group *i*.

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: where i = density of fish in length group i sA = mean integrator value pi = proportion of fish in length group i = the relative back scattering cross section (m2) of the length frequency sample of the target species, and Cfi = reciprocal back scattering cross section (sbs-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 species used are listed in Table 5. These are adapted from previous groupings owing to the importance of providing biomass estimates for not only the sardinellas, but also *Decapterus* sp., *Scomber colias*, *Trachurus trecae*, *Engraulis encrasicolus* and *Ethmalosa fimbriata*. Note that insufficient quantities, the latter two were found to warrant biomass estimates, also that although *Decapterus punctatus* was not listed as a priority species in the objectives, it often occurs with its congener *D. rhonchus* and hence the two species cannot be separated acoustically. *D. punctatus* was therefore included in the Pelagic 2 fish group, Table 5.

The s_V threshold used when sardinellas occurred to filter out other species and plankton was -35 dB, or in regions where the plankton layer was extremely dense and even lower threshold had to be used. For Pelagic I, Pelagic II and "other pelagic species" -45 dB was used. To identify mesopelagic layers a threshold of -60 dB was used. The above equations show that the conversion from s_A-values to number of fish is dependent on the length composition of the fish. It was therefore important to get representative length distributions from the key species groups in the whole distribution area. When the size classes (e.g. of young fish and older fish)

were well mixed, the various length distributions were pooled together with equal importance. Otherwise, when the size classes were segregated, the total distribution area was post-stratified, according to length distributions, and separate estimates were made for the strata containing fish with equal size. If the targeted fish was a mixture of more than one species, for example sardinellas, representative distributions of all the species, within the stratum, as shown in the trawl catches, was used. Length distributions representing the various species for each catch was calculated and normalized to a unit number (usually 100). These were then averaged without weighting. Very small catches (normally less than 20 fish) were not included. The total catch of each species from all the trawls in a stratum was used as a proxy for estimating the proportion of the total biomass of each species present. While it is recognised that catch is a poor indicator of relative abundance, especially for pelagic fish, no other method is easily available. The process followed was therefore to a) divide the s_A-value between groups of fish and/or species, b) produce pooled length distributions of a target species/category for use in the above equation and c) calculate the biomass estimates for a region, using the following procedure: The length-frequency samples of the species in the category were respectively pooled together with equal importance (normalized). The mean back scattering strength (s_A) of each length frequency distribution of the target group/species was calculated and summed. The pooled length distribution was used, together with the mean s_A-value, to calculate the density (numbers per square NM) by length groups and species. The total number by length group in the area was obtained by multiplying each number by the area. The numbers were then converted to biomass using the estimated weight at length.

Input parameters are listed in Annex II.

2.7 Jellyfish collection

Jellyfish were sampled from the trawl hauls. When the total catch was considered too big, the catch (fish, jellyfish, etc.) was sub-sampled. Thereafter, all jellyfish specimens caught, or representative random samples thereof, were identified to the lowest possible taxon.

For every one degree, five jellyfish were preserved for further analysis. A small section of the oral arm tissue was removed and preserved in 96% ethanol (EtOH) and stored at -20°C. The rest of the specimen was stored in formalin.

2.8 Acoustic sampling

2.8.1 Bottom mapping echo sounder

Typically, a EM 710 multibeam echo sounder is used for high-resolution seabed mapping. The EM EM 710 is mounted on the drop keel and the operational depths of the EM 710 are 3 m to 2 000 m. Across track coverage (swath width) is up to 5.5 times water depth and may be limited by the operator either in angle or in swath width without reducing the number of beams. The operating frequencies are between 70 to 100 kHz. There are 128 beams with dynamic focusing employed in the near field. The transmitting fan is divided into three sectors to maximize range capability and to suppress interference from multiples of strong bottom echoes. The sectors are transmitted sequentially within each ping and use distinct frequencies

or waveforms. The along-track beam width is 1 degree. Ping rate is set according to depth. The receiving beam width is 2 degrees. Sound profiles were set manually in the system according to the area of operation. Data from the EM710 was logged to the on-board Olex plotting system and to raw data files.

During the survey, swath coverage and depth range settings were adjusted regularly to optimize the mapping. The measured sound speed profile was also input in the system when CTD measurements were carried out. Tide correction was not done.

2.8.2 Sonar data

Sonar (SH90) was used during all acoustic transects to facilitate school detection and the sonar data was stored for later analysis.

2.8.3 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 hence the echo sounder gains were adjusted at the start of this survey.

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.

Targets were allocated to predefined acoustic categories (listed in Table 5) based on; 1) their contribution to the abundance in available trawl data from the corresponding area, and 2) expert assessment of the observed echogram features, including information on the distribution and schooling behaviour. Low aggregation densities with high species diversity and/or indistinguishable acoustic properties prevent the allocation of many targets on a species-level in many cases. Subsequently, a range of acoustic categories were used that aggregated two or more species. These included the combination of both sardinella and horse mackerel species into one category each as well as several broader categories: clupeid-like species (PEL1), carangid-like species (PEL2), and demersal fish. An additional for other fish was established to account for substantial densities of *Brachydeuterus auritus* in some areas. Remaining backscattering that could not be identified as fish was allocated to plankton.

In terms of their acoustical properties, sardinellas and PEL1 were usually separated, based on their generally stronger acoustical properties at similar packing densities, largely due to the more frequent occurence of gas filled swimbladders among the species in the clupeid species. Inspection of the frequency response patterns in candidate schools/aggregations was therefore often used to assist the scrutinization. Known schooling features, specifically of horse mackerel, were used where schooling was observed.

Acoustic characteristics were compared with the observed species composition in adjacent trawl samples to verify the classification of the acoustic target or clarify acoustically unclear patterns (e.g. low densities), and the relative distribution in the biological sample was always given priority in case of doubt.

Scrutinized data were then stored as mean s_A by acoustic category in 1 (horizontal) times 10 m (vertical) sized bins. The scrutinized echogram was exported into a dataset that contained the acoustic area density values as Nautical Area Scattering Coefficing (NASC), in intervals of 1 nm per acoustic group.

Table 5. 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 sp.	S. aurita S. maderensis
Horse mackerel	Trachurus sp.	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
	Others	Trichiurus lepturus
		Lepidopus caudatus
Demersal species	Merlucciidae	Merluccius spp.
	Sparidae	Dentex spp.
		Sparus spp.
		Pagellus bellottii

Categories	Taxon	Species
	Other taxa	Saurida brasiliensis Ariomma bondi Pomadasys incisus
Other		Brachydeuterus auritus
Plankton		Plankton, mesopelagic fish

CHAPTER 3. RESULTS OF THE SURVEY

3.1 Hydrography

3.1.1 Hydrographic transects

The hyrdrographic monitoring consisted of a deployment of a total of 26 total CTDs, 12 of which were chosen for extra hydrographic sampling along four transects (Table 6, Figure 4). Transects were placed with the aim to summarize each region's coastal characteristics.

Table 6. Quantities of CTD stations, super stations, and hydrographic samples amongst the two participating countries

Sample type	The Gambia	Senegal			Total
		Casamance	Petite Côte	North	
Total CTD stations	7	6	7	6	26
Super stations	3	3	3	3	12
pH	16	19	18	17	70
Total alkalinity	16	19	18	17	70
Chlorophyll a	13	13	15	14	55
Nutrients	16	19	18	17	70

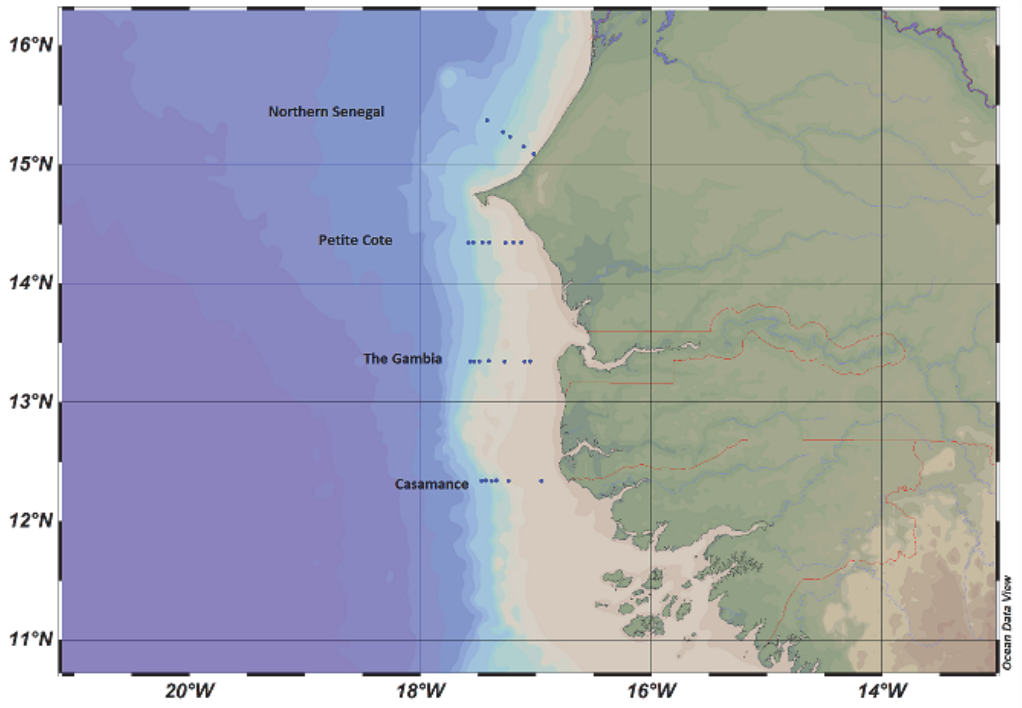


Figure 4. Four hydrographic transects with water collection for chemical analysis in addition to the normal CTD sensor measurements were conducted during this survey: three hydrographic ecosystem transects along the coast of Senegal and one hydrographic ecosystem transect off the coast of The Gambia

3.1.2 Horizontal distribution of oceanographic parameters

Coastal subsurface waters were relatively high in the survey area, with temperatures raising from 28°C to above 30°C (Figure 5). Salinity remained relatively consistent near 35 PSU throughout the survey. However, in the northern area where the shelf is steep high mixing was observed near the surface and salinity values varied. In the south, large parts of the wide shelf were inaccessible due to shallow waters. Therefore, shelf comparability of the region is limited, as the ship could not approach the shore to the same extent.

The fluorescence was stable in the northern region, but lower in concentration compared to the south and increased towards the coast in Gambian waters. For salinity (and all parameters), it would be beneficial to have data closer to the shore for a complete picture.

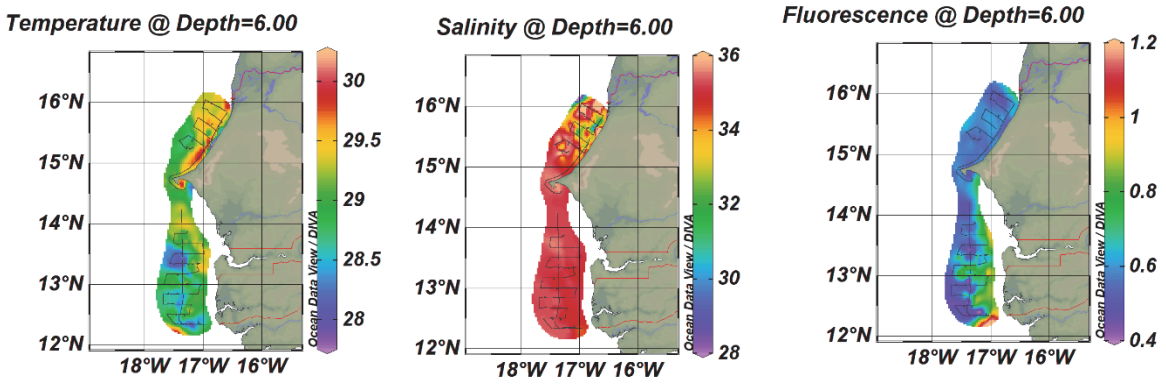


Figure 5. Horizontal distributions of temperature, salinity and fluorescence via the 6 m intake thermosalinograph

3.1.3 Vertical distribution of oceanographic parameters

The high surface temperature, approaching 30°C, did not vary much along the northward survey track. In Casamance the continental shelf has a low slope gradient with high water temperature on the shelf (Figure 6) and a commonly observed thermocline between 30 m and 60 m. The salinity values are higher in Northern Senegal (above 35.7 PSU), while Casamance in the south recorded relatively lower salinity values (34.7-35.3) on the shelf. Low salinity in Casamance and The Gambia may be related to the large freshwater influences from several major estuaries along the coast. The Gambian transect (Figure 7) recorded warming subsurface temperatures near 30°C as the survey progressed northward and salinity increasing to 35.25 PSU, compared to the less saline water farther south.

After the sharp oxycline between 30 m–60 m, dissolved oxygen levels reached 2 ml/l and continued to decline in deep waters (Figure 8) except for a small increase near 200 m or 300 m before reaching a second minimum below 1 ml/l at 400 m. Above the subsurface oxygen for all transects were consistently above 4 ml/l. Fluorescence measurements depict elevated levels ranging from 2 µg/l to above 3 µg/l against the coast at the transects of Casamance and Petite Côte. The concentration in fluorescence was lower, about 0.5-1.5 µg/l, on the Gambian transect.

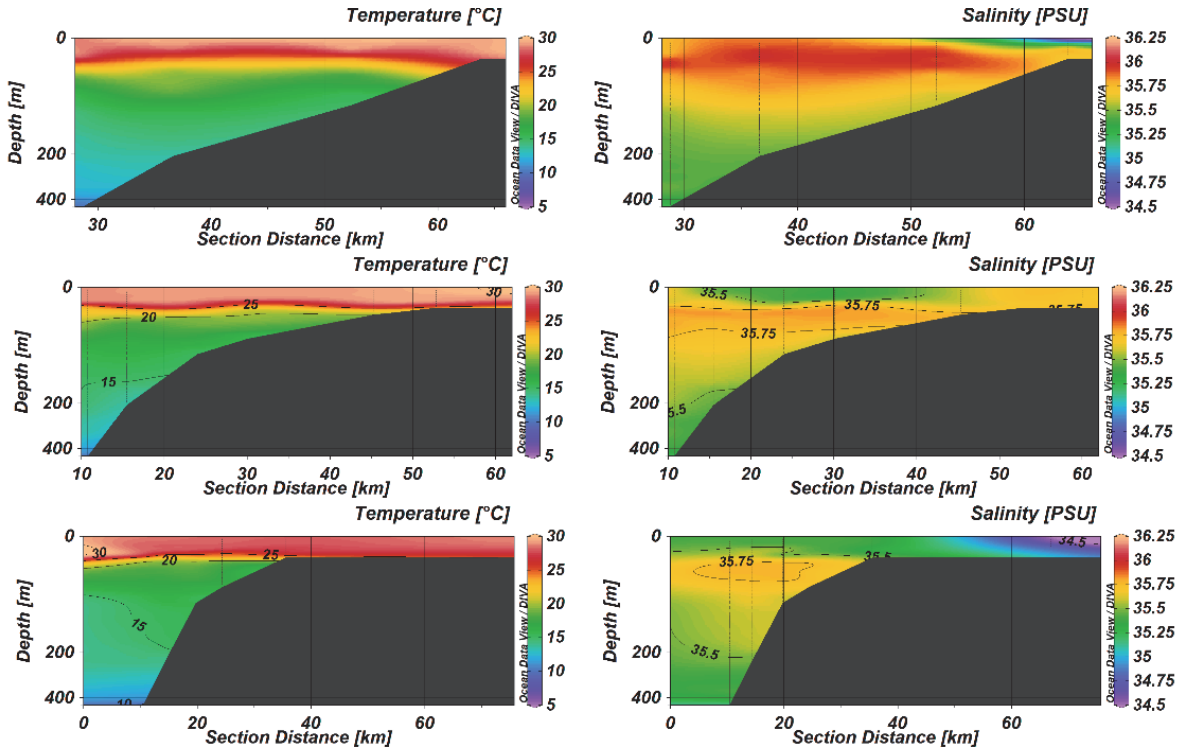


Figure 6. Temperature and salinity values along the Senegalese transects. The transects are shown from north to south along the Senegalese coast, representing Northern Senegal (top), Petite Côte (middle) and Casamance (bottom)

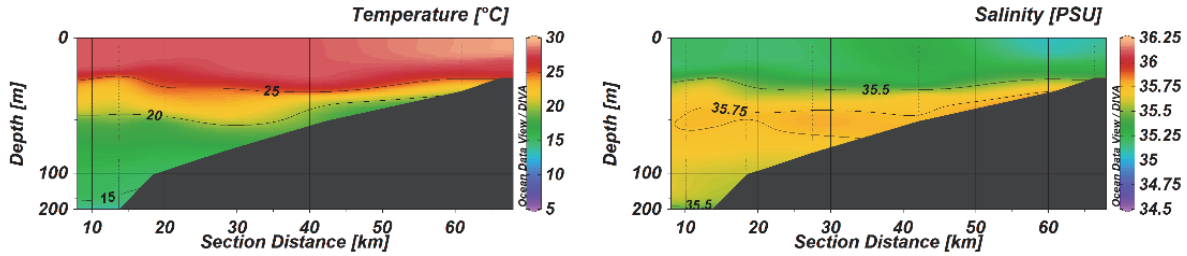


Figure 7. Temperature and salinity values of The Gambia transect

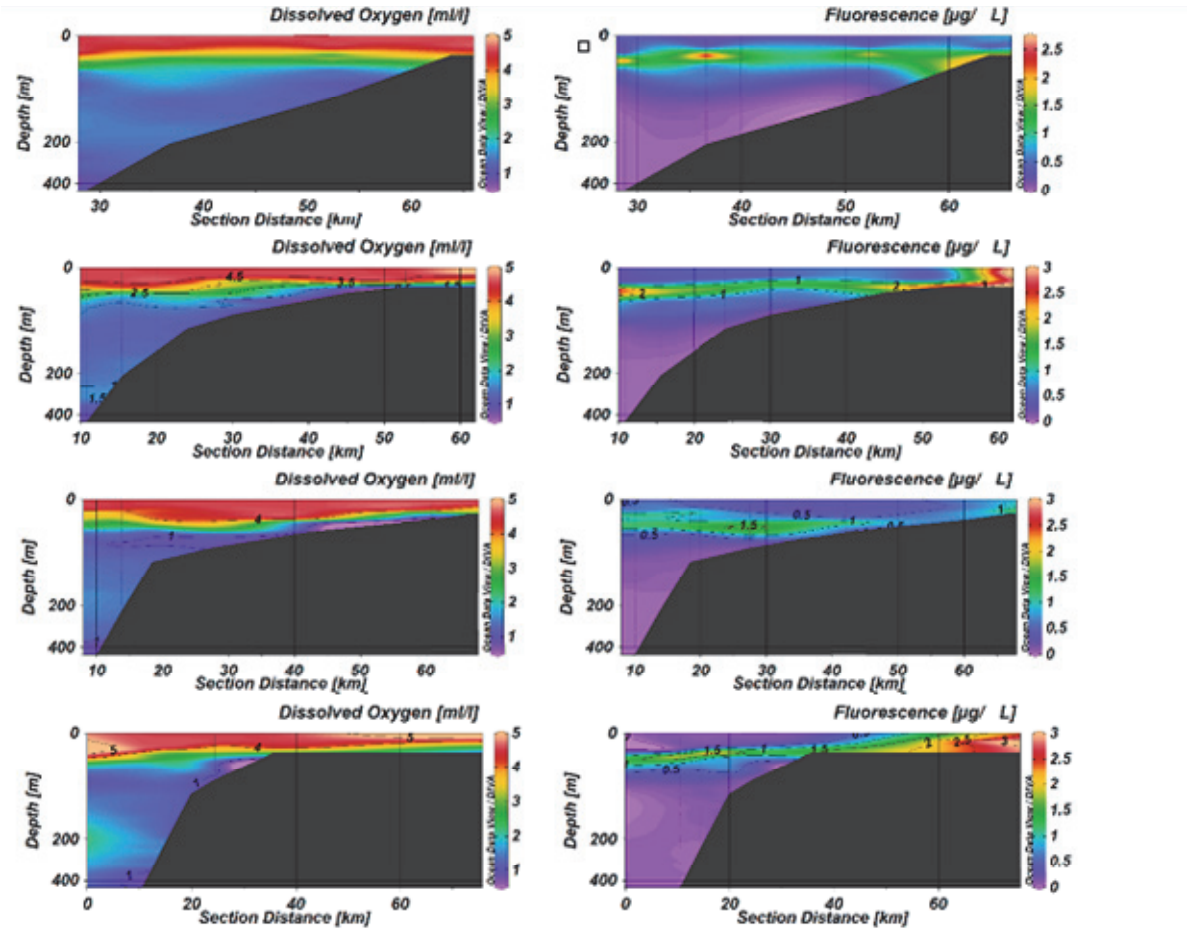


Figure 8. Dissolved oxygen and fluorescence values along the three Senegalese and single Gambian transects. The transects are positioned northward from the bottom, with the Gambian transect depicted second from the bottom

3.1.4 ADCP results

ADCP data was collected and preprocessed on board. The raw data can be used for postprocessing to analyse the horizontal distributions of ocean current direction velocity.

3.1.5 Ocean Acidification

On board analysis of pH and total alkalinity were performed during the survey to observe the oceanic CO_2 characteristics of Senegal and The Gambia. In combination with the nutrient samples that were analysed at IMR, the aragonite saturation state of each country can be determined to observe the effects of ocean acidification.

3.1.6 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 pH and dissolved oxygen relationship

The map below (Figure 9) shows the four transects marked in different colors to correspond with the plots for pH, dissolved oxygen and Chlorophyll a.

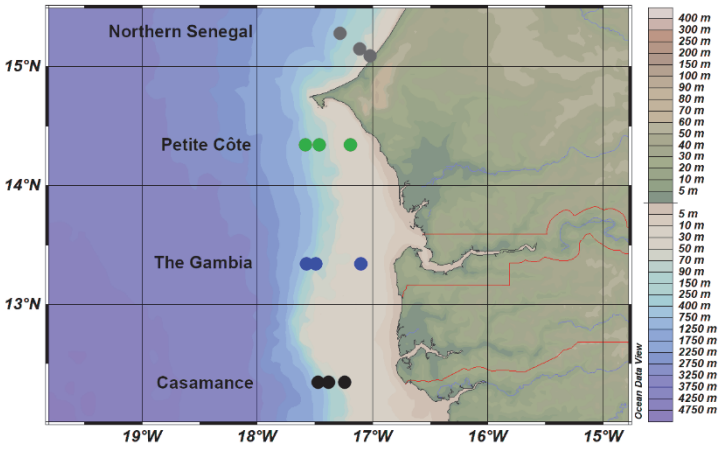


Figure 9. Map of the four ecosystem transects: three in Senegal and one in the Gambia. Transect colors correspond to the profiles in Figure 10 and Figure 11.

pH decreases sharply from 8.1 near the surface to about 7.6-7.65 at 80 m. All deeper stations continue to decrease except for the Casamance transect in the south. In Casamance, the pH rises from 7.62 to 7.65 until 200 m where it begins to decrease again with the other transects toward a pH of 7.5. Dissolved oxygen follows the same pattern as pH as Figure 10, showing a minimum near 80 m between 1-1.4 ml/l before increasing again between 1.4-1.6 until 200 m for all transects except Petite Côte at 300 m. At 400 m, a second dissolved oxygen minimum is observed with all values between 0.75-1 ml/l. Dissolved oxygen values begin to increase again as the bottom is approached but they stay below 1 ml/l. This oxygen minimum zone is observed along the entire coast of the survey as is confirmed in Figure 8.

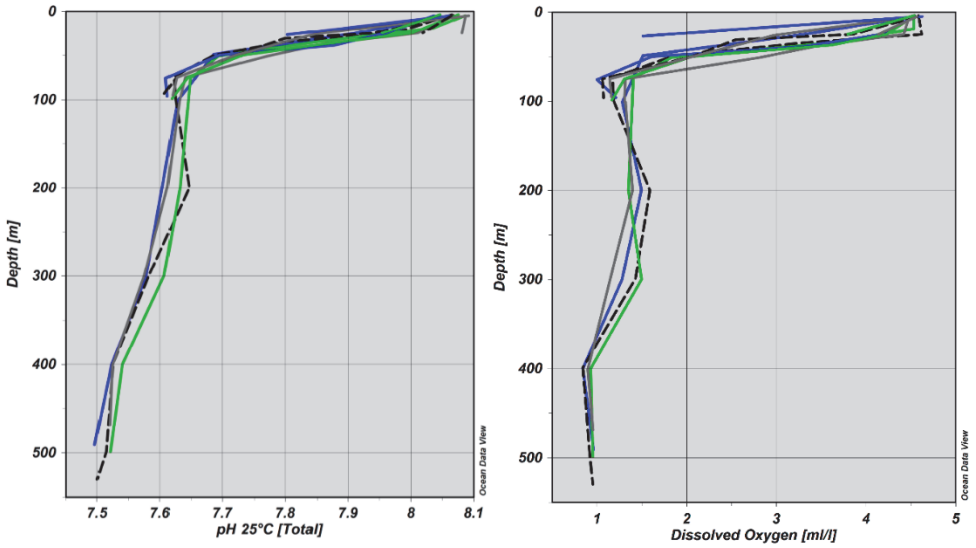


Figure 10. pH and dissolved oxygen profiles at all four ecosystem transects: three in Senegal and one in The Gambia. Transect colors correspond to Figure 9

3.1.8 Chlorophyll a

Since Chlorophyll a is the pigment responsible for photosynthesis and is therefore found in photosynthetic organisms such as phytoplankton, these concentrations can be used as an indicator for phytoplankton biomass estimations. In this survey, the Chlorophyll a maxima approximated at 1.25 µg/l in The Gambia and Senegal, Figure 11. However, there are slightly higher chlorophyll a maxima above 2.0 µg/l at Petite Côte and Casamance (confirmed with duplicate measurements), which support the fluorescence sensor measurements in Figure 8. Although the water temperature is slightly lower here compared to the other transects, it is still above 25°C, so it is difficult to confidently suggest upwelling. Once again, observations closer to the coast would provide necessary valuable informationfor upwelling identification.

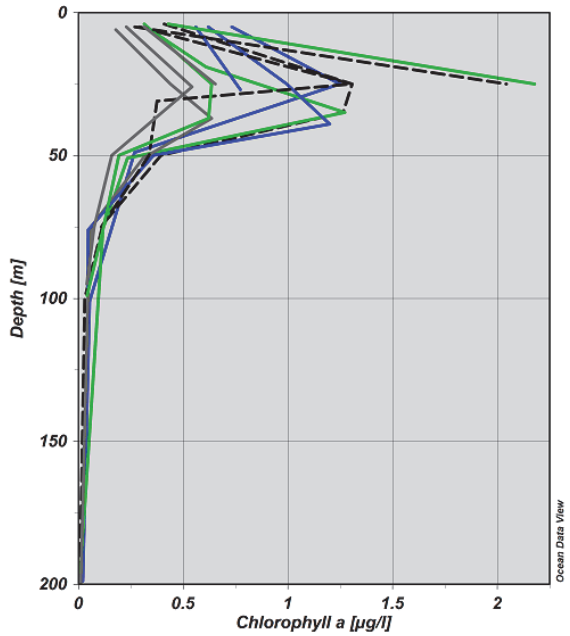


Figure 11. Chlorophyll a concentrations observed at all four ecosystem transects: three in Senegal and one in the Gambia. Transect colors correspond to Figure 9

3.1.9 Trace metals

A total of 78 seawater samples were collected for mercury speciation (inorganic mercury, methylmercury and total mercury). All samples were collected between 20 m and 1 000 m depths in conjunction with CTD sampling. Analyses are ongoing and results will be published separately from this report.

3.2 Zooplankton and microplastics

The plankton sampling grid of the survey consisted of 12 super stations located over the isobaths of 30 m, 100 m and 500 m (Station 1136 to Station 1158, Figure 12). The total number of stations sampled with each sampling device are summarized in Table 4.

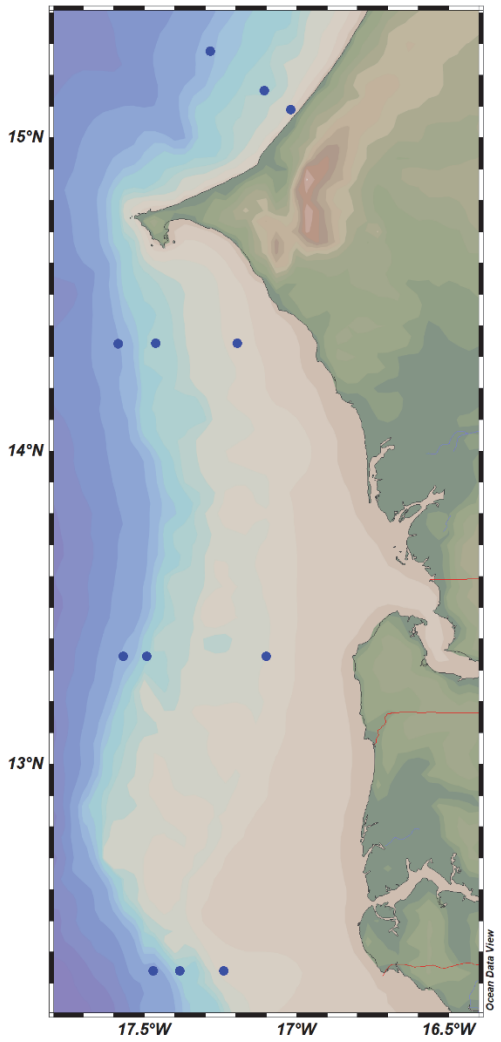


Figure 12. Super stations in the surveyed area

3.2.1 Zooplankton

A total of 36 aluminum trays for zooplankton dry weight estimation were produced during the survey and transferred to IMR for zooplankton biomass estimation. Based on these measurements the mesozooplankton biomass is presented in Figure 13. Total zooplankton biomass (Figure 13a) ranged between 2.15-13.87 g m^{-2}, with most biomass found in a deep station on the third transect.

Size fractionation of samples revealed that organisms smaller than 1 mm in size comprised most of the biomass (Figure 13b), although for some stations in the northern part of the surveyed area the contribution of organisms larger than 2 mm was also important (Figure 13d). A total of 12 samples collected with the WP2 net and preserved in formalin were shipped to INRH (Casablanca) for further analysis. The taxonomic analysis of these samples will provide insight of the zooplankton community.

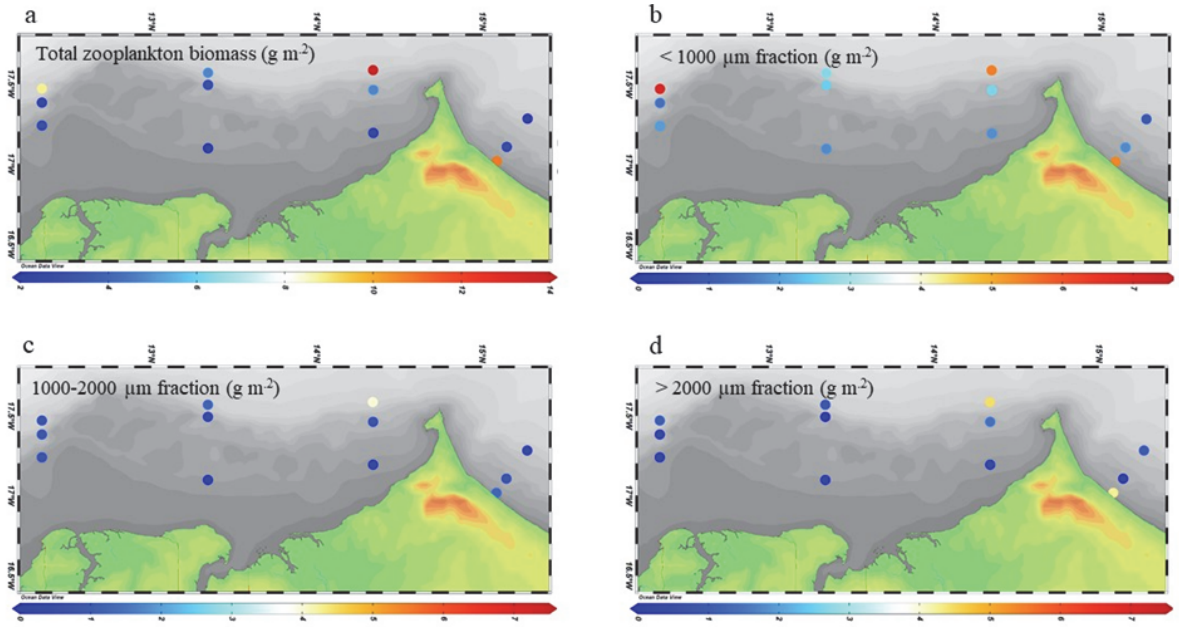


Figure 13. Zooplankton biomass (g m^{-2}, given in the colour scale) at the super stations, (a) Total biomass, (b, c, d) Size fractionated biomass at each station

3.2.2 Ichthyoplankton

All the samples collected with the Mantra trawl and half of the samples collected with the Bongo net during the survey were processed under the stereomicroscope onboard. Table 7 shows the number of sorted eggs and fish larvae collected with each net and per station.

For some of the samples collected with the Bongo net, a fraction was sorted onboard, and a total of 1 242 fish larvae and 1 662 eggs were found from 12 of the samples (Table 7). Pictures of some of the sorted specimens are provided in Figure 5. The sorted specimens from the Bongo net collection and bulk samples from Bongo H (ethanol preserved) and V (formalin preserved) were shipped to INRH, Casablanca, for further analysis and taxonomic identification of specimens.

The Manta trawl samples were sorted for fish larvae, but also post larval and juvenile stages. Fish larvae were found in varying abundance, with two stations (st. 1149 and 1156) having more than 1 000 larvae in the sample. One post larval Myctophidae was sorted from a Manta sample on station 1158. All sorted specimens from the Manta trawl collections were transferred to IMR for taxonomic identification. Bulk plankton samples from the Manta trawl net after sorting (12 samples) were transferred to University of Western Cape, South Africa for future analysis.

Table 7. Number of fish larvae and eggs sorted from the Bongo net and Manta trawl samples

	Bongo net		**Manta net**	
Station	Larvae	Eggs	Larvae/Post larvae-juveniles	Eggs
1136	392*	28*	18	< 100
1138	120*	8*	9	23
1140	80	16	3**	0**
1142	166*	994*	49	0
1145			419	19
1147			82	2
1149	295	84	1 226	20
1152			47	8
1154	189*	532*	53	0
1155			12	8
1156			1 097	117
1158			38/1	24
TOTAL	1 242	1 662	3 053/1	221

* Fraction of sample sorted, given number is estimated number of larvae/eggs in total sample

** Manta on station 1140 was full of phytoplankton, ichthyoplankton picked out from fraction > 1000 μm

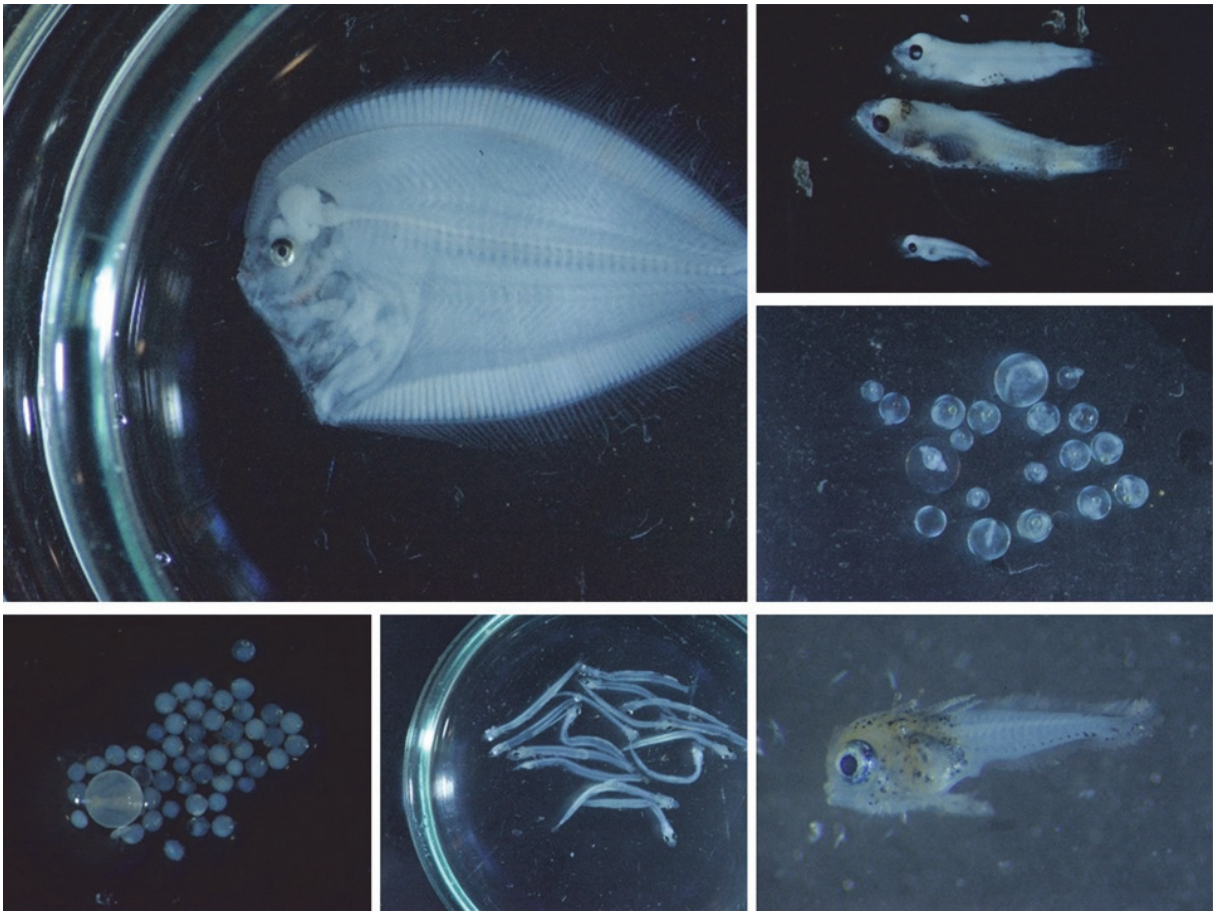


Figure 14. Fish larvae and eggs collected with the Bongo net and Manta trawl during the survey

3.2.3 Microplastics and Debris

Items resembling microplastics were found in five of the 12 Manta trawl samples. A total of 19 items were isolated from the samples and most were identified as plastic rope fibres (Figure 15). No microplastics were found in the deeper stations. Figure 16 shows the number of microplastic pieces within the 4 sampling transects at different station depths (i.e. shallow, intermediate, deep). A total of 5 trays with dried microplastics were transferred to IMR for future analysis.

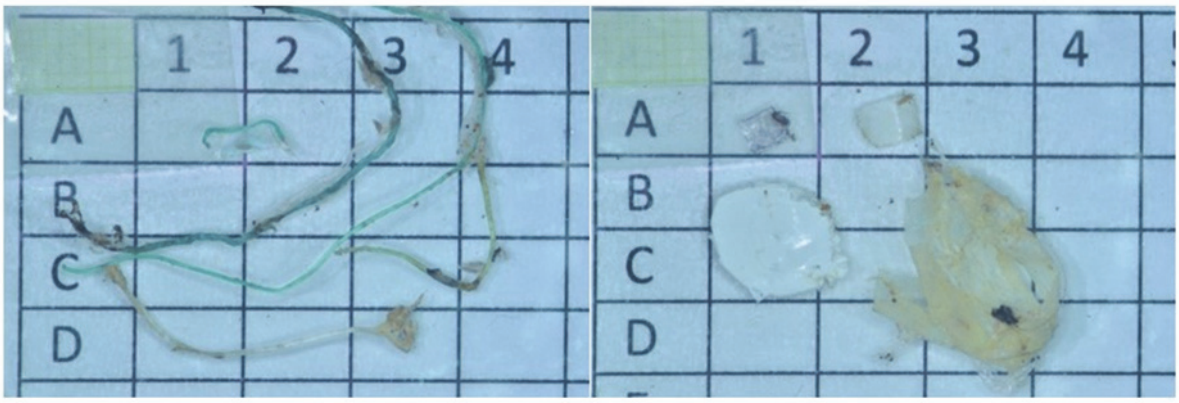


Figure 15. Examples of microplastics found in the Manta trawl net

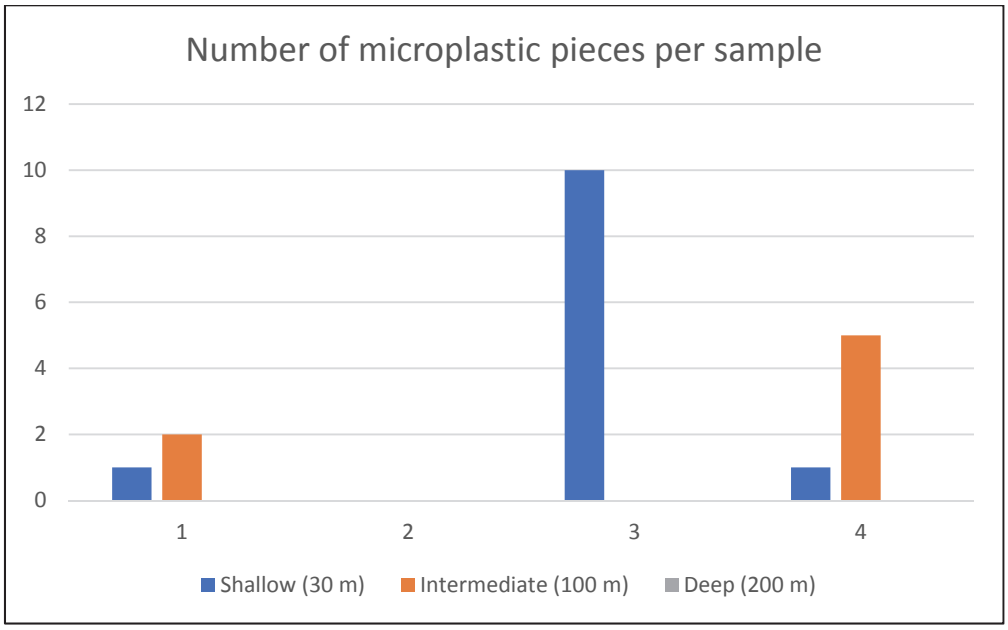


Figure 16. Distribution of microplastics from shallow to deep waters along 4 transects taken in Senegal and The Gambia

3.3 Top predator observations

3.3.1 Seabirds

A total of nine different seabird species were observed throughout the six days cruise survey (Table 8). Four other seabird species could not be identified due to long distances from the ship. The Arctic tern was the most observed seabird species during the survey.

There were no observations of birds of different species flying together in this survey. Pelican birds, likely the great white pelican, were observed on 4 November 2019, all resting on the sea surface. The distance in time between the two observations was approximately one hour, and in both cases the birds were drifting with the current in a north-western direction.

Aside from seabirds, significant numbers of the common bulbul, *Pycnonotus barbatus*, were observed, numbering between 1 and 120 individuals. This species is small, with an estimated size of 15 cm to 18 cm. Senegalese scientists on board stated that the species is abundant in the Saint-Louis region on land. The species sometimes landed on the vessel.

Table 8. Number of observed seabird species listed by region

Species		**The Gambia**	**Senegal**			**Total**
Common name	**Scientific name**		**Casamance**	**Petite Côte**	**North**	
Arctic tern	Sterna paradisaea	4	38	125	15	**182**
Lesser black-backed gull	Larus fuscus		1		3	**4**
Bulwer's petrel	Bulweria bulwerii	1	1	1	110	**113**
Black tern	Chlidonias niger	1	2	2		**5**
Bridled tern	Sterna anaethetus			1		**1**
Scopoli's shearwater	Calonectris diomedea			3		**3**
Pomarine jaeger	Stercorarius pomarinus			1		**1**
Lesser crested tern	Thalasseus bengalensis				2	**2**
Great white pelican	Pelecanus onocrotalus				2	**2**

3.3.2 Marine mammals

The short-beaked common dolphin (*Delphinus delphis*) was the only dolphin species observed, with two sighting on 28 September 2019, at the coast of the Casamance region (Table 9). The first observation of a single dolphin was at N12.33, W017.10, 90° from starboard side of the research vessel, at 09:22. The second observation was a high density school seen from Lat. N12.42, -017.55, between 17:25 – 17:31 (6 minutes) moving NE to NW from a distance of 100.0 m. from the R/V *Dr Fridtjof Nansen*. Another dolphin pod was observed on 2 October 2019.

Table 9. Observations of *Delphinus delphis*

No.	Date	Abundance	Time	Direction	Distance from vessel (m)
1	28/09/19	5	09:22	Starboard	100
2	28/09/19	Large pod	17:25	"	100
3	02/10/19	Large pod	15:01	Portside	150

An estimated 20 short finned pilot whales (*Globicephala macrorhynchus*) were observed at Lat. 15.11, Lon. 17.35, from 14:57 on 2 October 2019, moving towards North-West.

Additionally, one humpback whale (*Megaptera novaeangliae*) was sighted from the bridge outside of routine observations.

3.3.3 Sargassum seaweed

Brown seaweed identified as *Sargassum* was observed floating on high density in the Casamance region on 28 September 2019, at 12:47, at N12.34, W 17.37.

3.3.4 Marine debris

Minimal amounts of debris were observed in Senegalese waters, mostly consisting of single plastic paper and aluminumspraying bottle. None was observed in the Gambian waters.

3.4 Food safety

Samples of three species were collected at three stations (1 species per station) during the survey. Table 10 lists the species names, codes, and station numbers of samples worked on during the Leg 4.1 for nutrition, food safety and, at one station, for microplastics.

Table 10. Species, species code and station number of samples collected for food safety and nutrition. The additional microplastics is indicated with an asterisk

No.	Species name	Species code	Station number
1	Sardinella aurita (large)	CLUSL01	5
2	Sardinella maderensis (large)	CLUSL02	13
3	Engraulis encrasicolus (small)	ENGEN01	29*

3.5 Jellyfish

Samples were collected at three stations during the survey and were transferred to University of Western cape, South Africa for future analysis.

3.6 Pelagic fish assessment

3.6.1 Overview

Acoustic registration on all transects were assigned to the acoustic categories based on target strength, frequency response and species identification from trawl sampling. In total, 31 bottom and pelagic trawl samples were taken (Figure 17). The total catches per trawl sample ranged from 1.2 kg to 35 t with a median of 100 kg, and typically contained a mixture of pelagic fish species. In addition, the bentopelagic species *B. auritus* and a high diversity of demersal fish, shellfish and molluscs were caught, especially in bottom trawls in shallower habitats. The median bottom depth of the trawl stations was 45 m, with a range between 20 m and 320 m. The highest fish densities were consistently observed on the shelf in a depth between approximately 20 m and 70 m, whereas on the outer shelf and the shelf slope registrations were scarce and mostly linked to mesopelagic and deep-sea species. In the three

southern regions, especially Casamance and The Gambia, the shelf stretches out far, resulting in the longest transects of up to 36 NM. Because the survey was restricted to a minimum bottom depth of 20 m, this resulted in some cases in a distance of more than 25 nmi between the transect start and the shore. This resulted probably in a poor coverage of the pelagic species in Casamance and The Gambia, as (high) registrations continued up to the near-shore end of transects. Consequently, it can be assumed that the distributions of pelagic species such as as *S. maderensis* and to a lesser extent *S. aurita* (Sarré *et al.*, 2018) most likely stretched much further inshore and were therefore only partially covered.

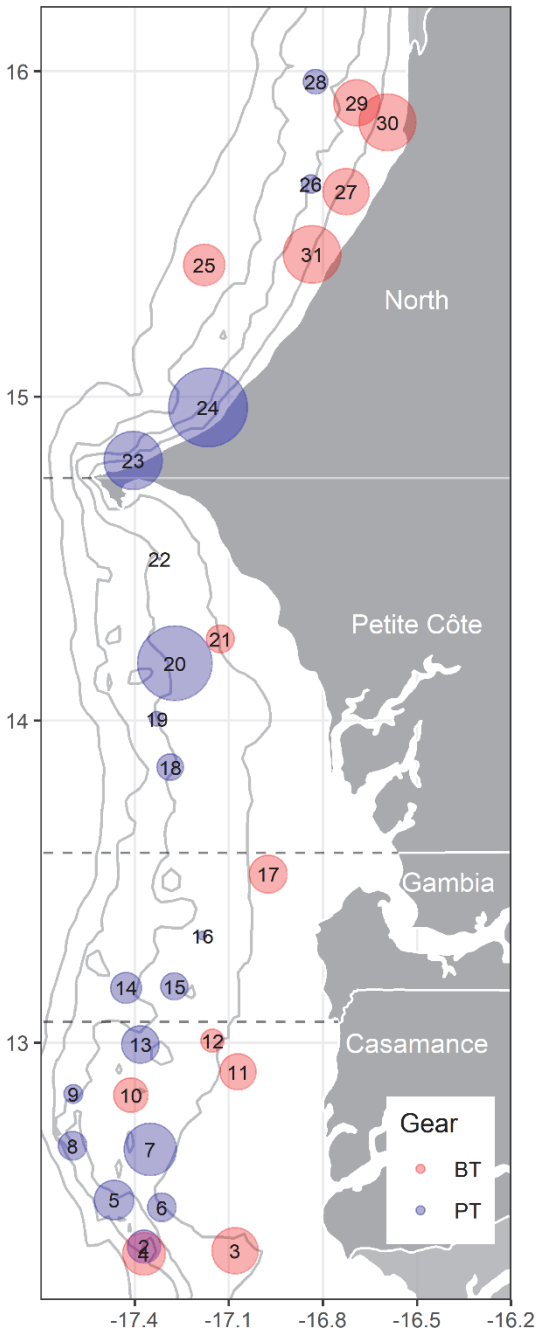


Figure 17. Map of the 31 trawl stations, detailing gear type (BT = bottom trawl, PT = pelagic trawl), location and biomass of catch (log-scaled) in the four surveyed regions

Generally, pelagic species were consistently present throughout the survey area. Typically, registrations were weak to intermediate with small schools or entirely scattered, particularly at night. Occasionally, large densities were observed, especially of horse mackerel in Petite Côte and Northern Senegal. Catches at trawl stations were strongly dominated by horse mackerel in Petite Côte and Northern Senegal, whereas the diversity was higher in Casamance and The Gambia (Figure 18). In Casamance, *B. auratus* consituted a major share of the trawl catches and, thus, potentially of the total biomass. Both sardinella species were detected in all four regions (Figure 19), however with a decreasing trend from south to north. Generally, sardinella was mostly a minor fraction of trawl samples, which can partially be attributed to a strong avoidance behaviour, especially during the day. The largest biomass of both commonly observed sardinella species was found in Casamance, corroborating a preference of these two species for the long, shallow shelf in this area (and underlining the issue of insufficient coverage due to bottom depth). Overall, sardinella biomass was estimated at a similar level as in 2015, clearly above the last estimates in 2017. Horse mackerels *Trachurus trecae* was detected throughout all regions and in patchy, but in some instances very large concentrations (Figure 20). Especially in Petite Côte and Northern Senegal, horse mackerel schools of very large density were observed that suggest a high abundance of the species in these regions.

Other clupeid species were mostly found with comparatively low biomass in shallow areas in all regions, whereas other pelagics (carangids, scombrids, etc.) had a substantial presence, including on the outer shelf area (Figure 21). *Scomber colias*, which was assessed separately, occurred in a patchier distribution, with high densities locally in the different regions while mostly absent elsewhere (Figure 22). Sardine and anchovy are known to occur in Senegambian waters, and especially sardine was detected in substantial numbers on some previous surveys of Nansen or Itaf Deme. However, on this survey sardine and anchovy were mostly absent except for two registrations each: both species were found in the trawl sample of one station along the most southern transect and one along the most northern transect, resulting in very low sample size and an inconclusive picture of their distribution (Figure 23). Consequently, biomasses of sardine and anchovy were not estimated.

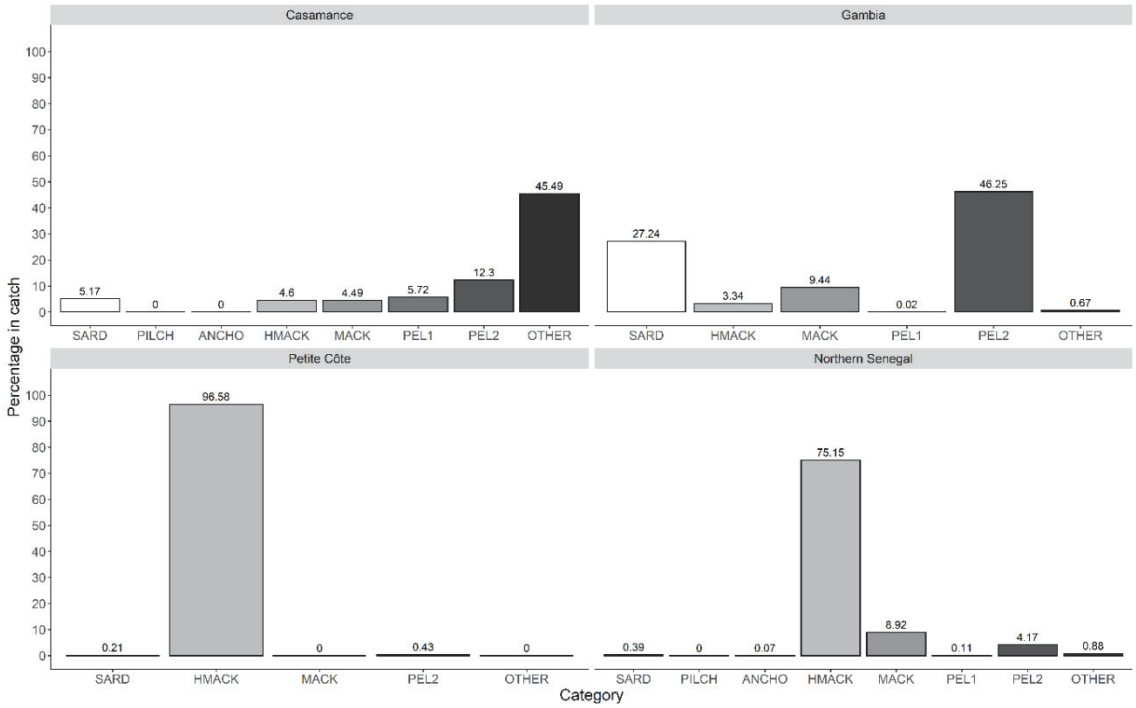


Figure 18. Proportions of pelagic species categories: according to acoustic categories: SARD = Sardinellas, HMACK = *T. trecae*, MACK = *S colias*, PEL1 = Other clupeids, PEL2 = Carangids, other scombrids, etc., OTHER = *B. auritus*; for details see Table 5 in trawl catches by region. Demersal and other species were omitted

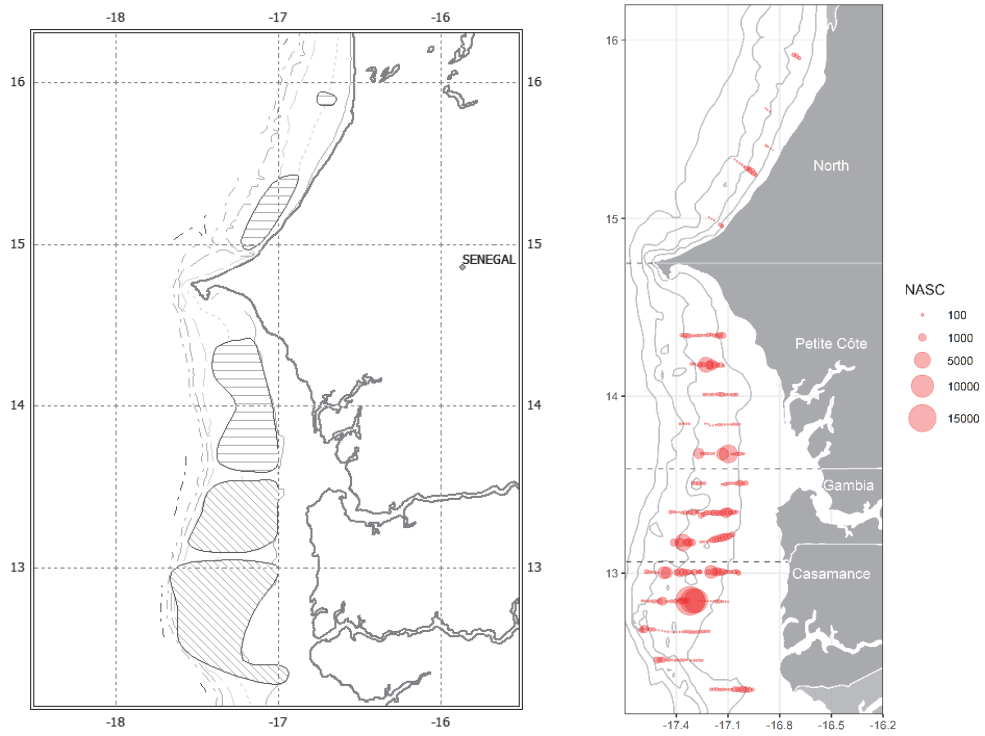


Figure 19. Extent of acoustic registrations of *S. aurita* and *S. Maderensis*: distribution polygon drawn in Nansis (left) and underlying NASC values (right). Polygons in the left figure designate strata for acoustic biomass estimation and do not represent true stock distribution. In the right figure, the borders between the four main regions are indicated with dashed lines, grey solid lines show 20 m, 50 m, 100 m and 500 m depth contours

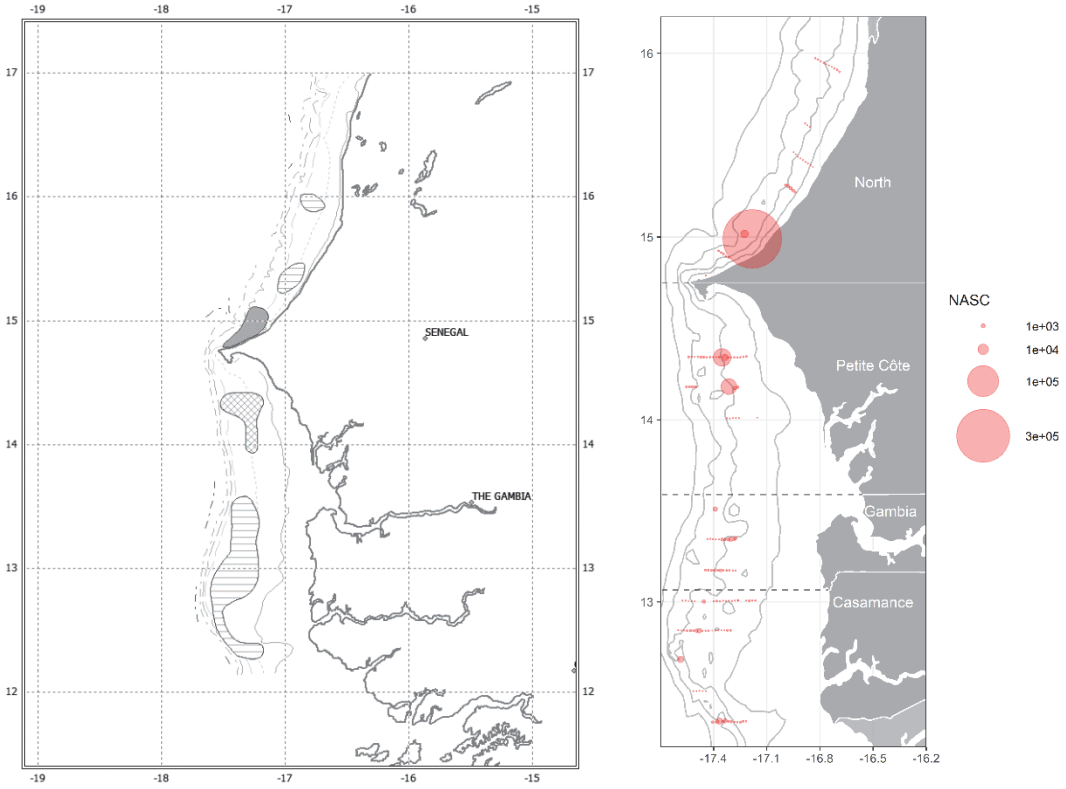


Figure 20. Extent of acoustic registrations of horse mackerel (*T. tracae*): distribution polygon drawn in Nansis (left) and underlying NASC values (right). Polygons in the left figure designate strata for acoustic biomass estimation and do not represent true stock distribution. In the right figure, the borders between the four main regions are indicated with dashed lines, grey solid lines show 20 m, 50 m, 100 m and 500 m depth contours

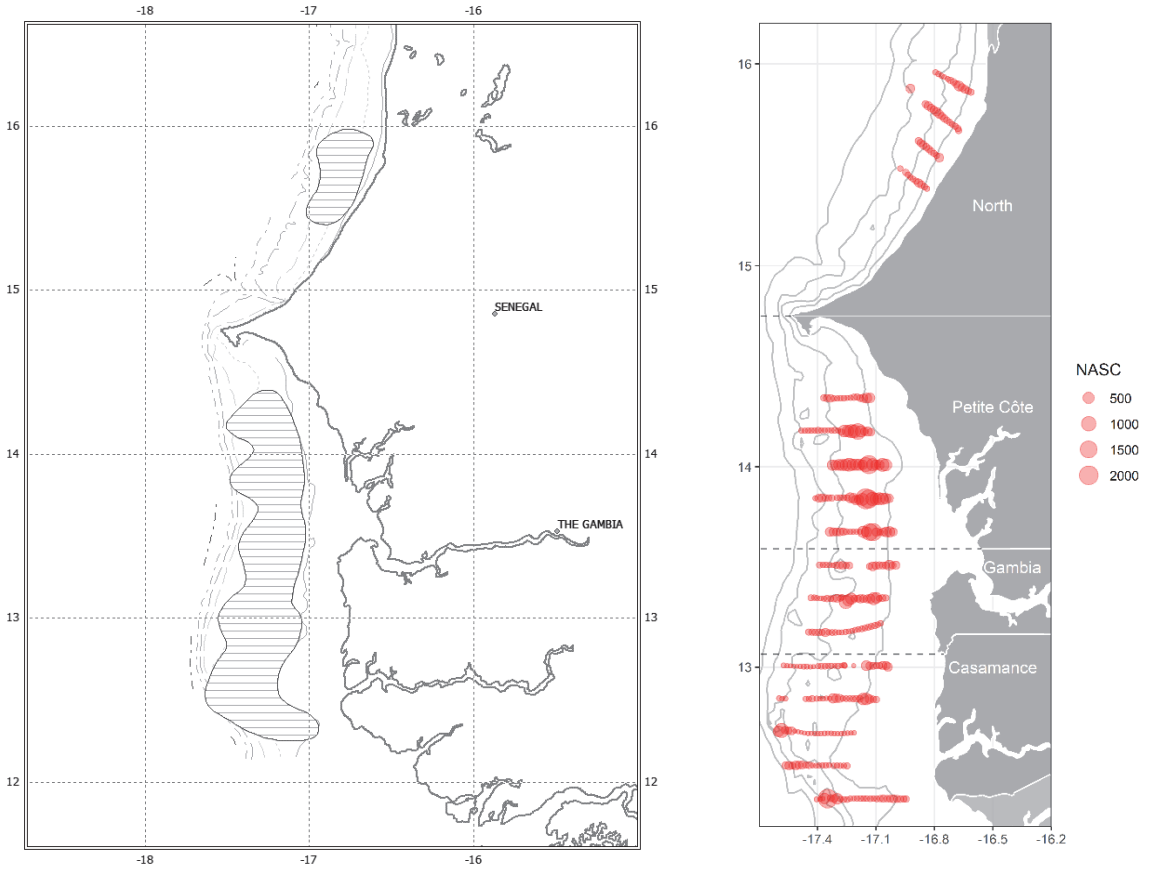


Figure 21. Extent of acoustic registrations of other small pelagics (carangids, scombrids, etc.): distribution polygon drawn in Nansis (left) and underlying NASC values (right). Polygons in the left figure designate strata for acoustic biomass estimation and do not represent true stock distribution. In the right figure, the borders between the four main regions are indicated with dashed lines, grey solid lines show 20 m, 50 m, 100 m and 500 m depth contours

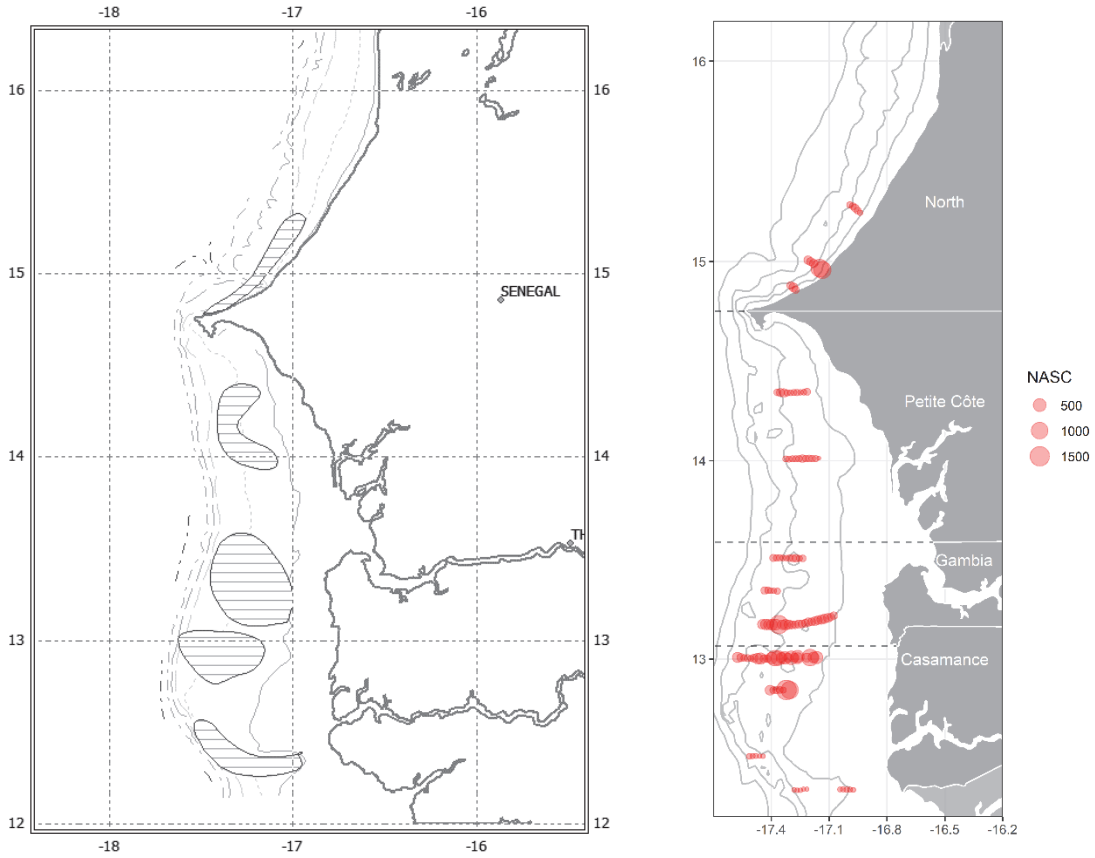


Figure 22. Extent of acoustic registrations of *S. colias*: distribution polygon drawn in Nansis (left) and underlying NASC values (right). Polygons in the left figure designate strata for acoustic biomass estimation and do not represent true stock distribution. In the right figure, the borders between the four main regions are indicated with dashed lines, grey solid lines show 20 m, 50 m, 100 m and 500 m depth contours

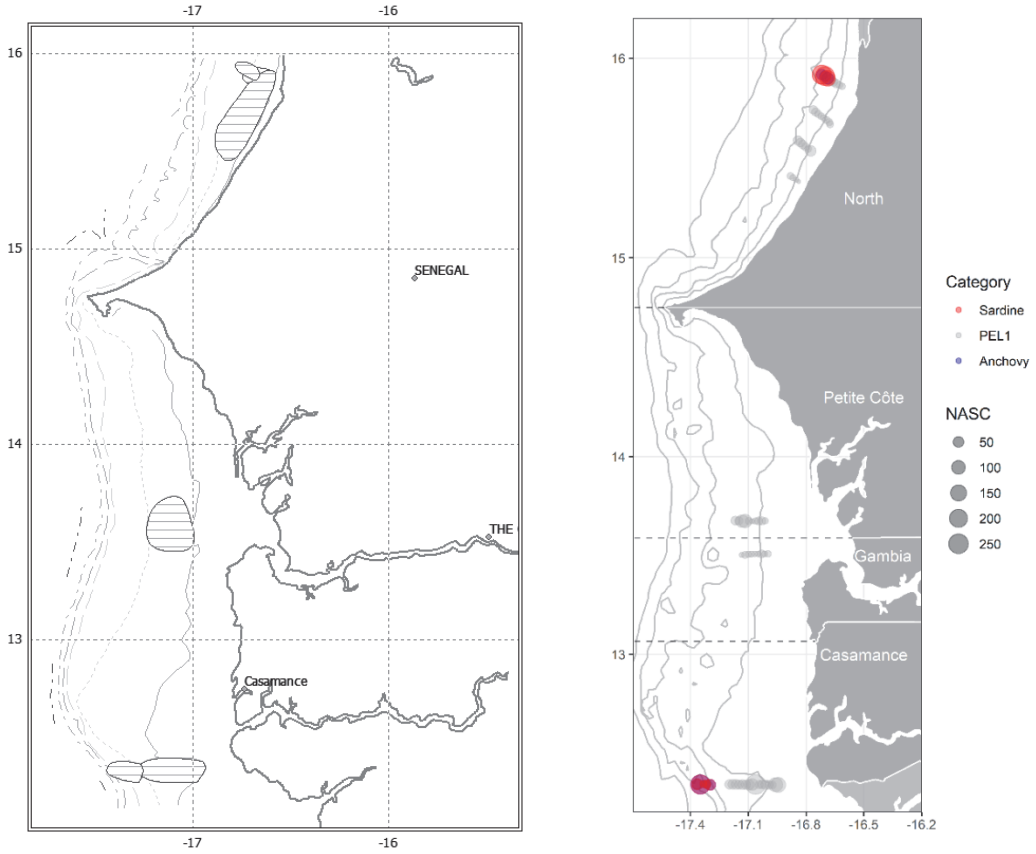


Figure 23. Extent of acoustic registrations of anchovy, sardine and other clupeids: distribution polygon drawn in Nansis (left) and underlying NASC values (right). In the right figure, the borders between the four main regions are indicated with dashed lines, grey solid lines show 20 m, 50 m, 100 m and 500 m depth contours

3.6.2 Stock composition

The stock composition was largely consistent across the entire survey area for all target species. This applied both for the size structure (Figure 24) as well as the sex and maturity composition (Figure 25). Maturity stages are described in Annex IV. Trawl samples showed for all target species except *T. trecae* a relatively homogeneous size structure with only few individuals outside a narrow size range, suggesting little age diversity in the sampled schools. For *T. trecae* we found, on the other hand, two very distinct size clusters: in Casamance and Gambia, there were only small individuals (<15 cm), whereas in Petite Côte the trawl sample consisted mostly of larger fish (>20 cm). The sex ratio was similar in all species with a slight dominance of male individuals. The maturity stages of both sardinella species were mostly spawning or spent, whereas there was a wider range between maturing and spent in similar proportions for the three other species.

However, sex and maturity stage were uncertain or not identified for a significant part of all samples, especially horse mackerel. Subsequently, the presented results are based on relatively few samples and their conclusiveness therefore limited. This applies also to the size composition, as the number of samples was insufficient for a fine-scale regional analysis. Sardinellas in particular are difficult to obtain in sufficient numbers in pelagic trawls due to

their speed and gear avoidance, subsequently it is uncertain how representative the collected data is for the true stock composition.

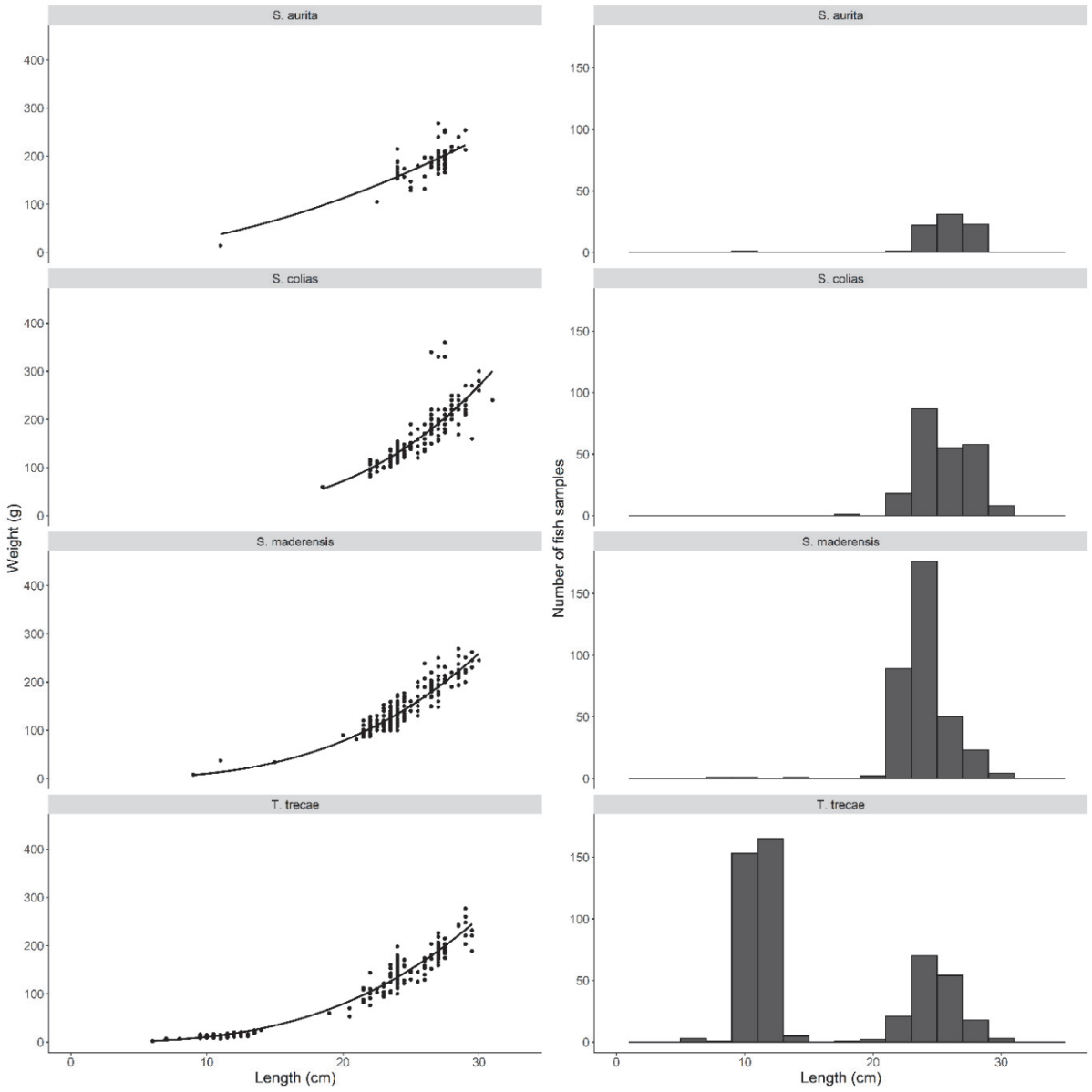


Figure 24. Length-weight relationship (left) and size composition (right) of the 4 target species *S. aurita*, *S. colias*, *S. maderensis*, and *T. trecae* for the entire survey area. Estimated length-weight relationships based on power function are shown as lines. Size composition is given by 2 cm bins

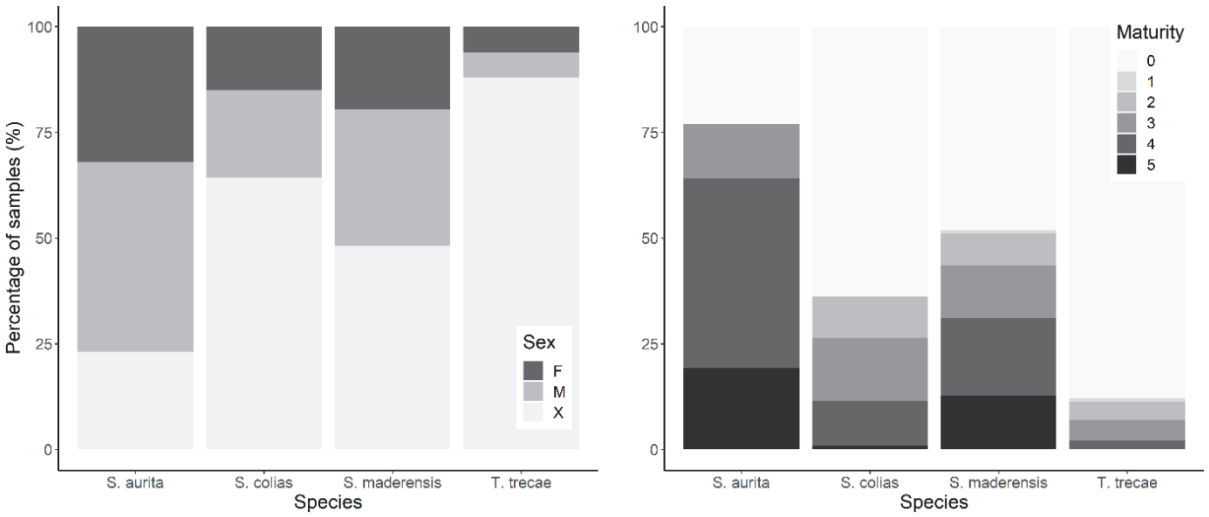


Figure 25. Proportional composition of the sampled target species by sex (left) and maturity stage (right). X and 0 denote samples with unidentified sex and maturity stage, respectively

3.6.3 Casamance

Formative for the Casamance region between Guinea-Bissau and the southern border of The Gambia is an extensive, shallow shelf, with partly more than 20 nmi of distance between the 20 m isobath and the coast. In addition, there is substantial nutrient inflow from the Casamance river system. This results in a large and productive habitat for many of the common pelagic species in Senegal and The Gambia, notably *S. maderensis*.

The findings in this survey confirmed the expectations, detecting a diverse mixture of pelagic fish in substantial densities between 20 m and 50 m bottom depth. There was a strong presence of sardinella, especially *S. maderensis*, but also significant amounts of all other pelagic species, including *T. trecae* and *S. colias*. Their distribution extended beyond the 20 m bottom depth limit of this survey and was therefore not fully covered. Besides sardinella, *B. auritus* was a common species, especially in the depth range of 20–30 m. Biomass estimates underlined the large presence of sardinellas, especially *S. maderensis* (Table 11).

Table 11. Biomass estimates of target species in the Casamance region of Senegal. Horse mackerel is exclusively *T. trecae* in this and all following regions

Region	S. aurita	S. maderensis	T. trecae	S. colias	Clupeids	Other pelagics
Casamance	82 897	112 602	13 940	153	1 648	45 937

3.6.4 Gambia

The Gambian shelf ecosystem is similar to Casamance, with an extended shelf that is linked to a large estuary. The observed species composition was therefore comparable, with sardinellas most common among target species. Distributions of pelagic species in The Gambia are clearly connected with the neighboring regions in Casamance and the southern area of Petite Côte. Biomass estimates reflected the similar species composition as in Casamance (Table 12).

Table 12. Biomass estimates of target species in The Gambia

Region	S. aurita	S. maderensis	T. trecae	S. colias	Clupeids	Other pelagics
Gambia	35 929	48 804	4 011	16 668	391	28 435

3.6.5 Petite Côte

Although the coastline of Petite Côte is substantially larger than Casamance and The Gambia, the distance between the shelf slope and the coast decreases in northward direction. Together with the increasing exposure to the open ocean, this explains the low densities of fish observed in the northern part of Petite Côte, especially close to Dakar. Larger densities of pelagic fish were found in the southern part of Petite Côte close to the Gambian border. Of these, *S. maderensis* was found to be common, underlining the link with the two more southern regions. However, *T. trecae* became more common towards the north, mostly close to the sea floor near the shelf slope in depths between 40 m and 70 m. Very dense registrations of horse mackerel were observed ca. 20 nmi south of Dakar. Overall, the biomass of pelagic species in this region are dominated by horse mackerel and other pelagics (Table 13).

Table 13. Biomass estimates of target species in the Petite Côte region of Senegal

Region	S. aurita	S. maderensis	T. trecae	S. colias	Clupeids	Other pelagics
Petite Côte	25 113	34 111	36 337	16 224	0	121 407

3.6.6 Northern Senegal

The North of Senegal is separated by the peninsula of Dakar and very distinct bathymetry and oceanographic features from the three southern regions, with much more exposure to currents and a narrower shelf. Observations of pelagic as well as demersal fish were therefore largely constrained to a narrow band close to the coast with a bottom depth between 20 m and 40 m. Registrations of pelagics in this area were patchy but very strong, with some of the highest densities observed on the entire survey. This applies especially for the southern part of the area, north of Dakar, where large, dense schools of *T. trecae* were found. In the north towards the border with Mauritania, the presence of pelagic species was lower and two of the most northern trawl stations revealed large numbers of jellyfish. Additionally, dense accumulations of plankton and mesopelagic fish on the shelf slope in ca. 300 m were observed on most transects. A trawl station in one such area resulted in substantial amounts of crustaceans as well as larger demersal fish. Biomass estimates underlined the substantial presence of dense horse mackerel schools, overshadowing all other target species (Table 14).

Table 14. Biomass estimates of target species in Northern Senegal

Region	S. aurita	S. maderensis	T. trecae	S. colias	Clupeids	Other pelagics
North	3 488	4 738	134 410	2 367	879	14 839

3.6.7 Summary of biomass estimates

Biomass estimates show an intermediate total biomass of *S. aurita* and *S. maderensis*, with clearly higher levels for the latter in all regions (Table 15). Sardinella biomass was especially large in the inshore area of Casamance that contributed more than half to the total biomass, despite the incomplete coverage of the area. For horse mackerel an exactly opposite pattern was found, with comparatively low biomass of *T. trecae* observed in Casamance and The Gambia but very high biomass of *T. trachurus* recorded in Northern Senegal despite the small shelf area. *Ilisha africana* as main share of other clupeids was only present in patchy distributions in very shallow areas along the entire shore. Other pelagics, on the other hand, were widely distributed over the regions and bottom depths, with the highest densities in the Petite Côte region.

Table 15. Biomass estimates in metric tonnes by species or category, country and region, as well as grand total for the entire survey area. Horse mackerel consists of *T. trachurus* in the North of Senegal and of *T. trecae* in all other regions. Other clupeids consist primarily of *Ilisha africana* whereas other pelagics include carangids, scombrids (except for *S. colias)* and other pelagics

Country	Region	S. aurita	S. maderensis	T. trecae	S. colias	Clupeids	Other pelagics
The Gambia	Total	35 929	48 804	4 011	16 668	391	28 435
Senegal	Casamance	82 897	112 602	13 940	153	1 648	45 937
	Petite Côte	25 113	34 111	36 337	16 224	0	121 407
	North	3 488	4 738	134 410	2 367	879	14 839
	Total	111 498	151 451	184 688	18 744	2 527	182 183
Total		147 427	200 255	188 699	35 412	2 918	210 618

3.6.8 Limitations and uncertainty

Acoustic biomass estimations are highly sensitive to inputs and, thus, observation errors. General sources of uncertainty include, among others, the observation variance when covering highly mobile pelagic species, potentially insufficient coverage, assumptions about the stock structure, assumptions about the target strength (e.g. same parameters for all species), and the subjectivity when scrutizining acoustic data. Furthermore, there were several survey-specific constraints related to technical or data limitations. The incomplete coverage in the southern regions due to a minimum bottom depth of 20 m to operate the vessel may be especially severe for the biomass estimates, as the distribution of sardinella and other pelagic species extends wide into the large, shallow shelf.

Trawl catches of some species were limited and allowed in most cases not for region-specific size compositions or length-weight relationships. Sardinella were especially difficult to catch in pelagic trawls and the limited observations are likely not representative. This may have substantial implication for the biomass estimates, as they are strongly impacted by the size composition and length-weight relationship used. An additional challenged were species with patchy distributions and high variation in densities. Notably the acoustic registrations for

horse mackerel showed strong variations, with coefficients of variation clearly above 1 for all strata and higher than 2 in some cases despite post-stratification. This includes two very dense registrations from two large schools encountered in the North that have a major impact on the biomass estimates. Post-stratification poses another major source of uncertainty due to its subjectivity.

All acoustic biomass estimates should be interpreted with caution and under consideration of their limitations and uncertainties. The presented estimates represent therefore not absolute biomass values but rather provide a relative index for comparison within the same survey framework (note that comparability may be restricted by incomplete standardization among years).

3.7 Demersal fish and shellfish

Because many of the pelagic target species occur in relatively shallow areas, bottom trawls were used at 12 of 31 trawl stations. Sampling with bottom trawls took place in all regions, however most of the stations were placed in Casamance and Northern Senegal due to the extended shallow shelf and the very narrow shelf, respectively. These bathymetric features resulted in high densities of pelagic species found in area with bottom depth above 50 m, where bottom trawling is the suitable method to catch them. The distribution of bottom trawl stations provided a relatively comprehensive overview of demersal species in the waters off Casamance and Northern Senegal, whereas samples in The Gambia and Petite Côte are based on one bottom trawl each and are therefore not representative.

The use of bottom trawl resulted in regular samples of demersal fish (Figure 26) and shellfish (Figure 27). The single most common species found at these trawl stations was bigeye grunt, *B. auritus*, a commercially important, benthopelagic species that can be found near the bottom during the day and higher up in the water column at night. *B. auritus* was consistently found at most bottom trawl stations and in all regions, however the highest densities occurred in Northern Senegal. A similar pattern was found for other commercially important demersal fish, especially several *Pomadasys* species, which added up to a mean catch weight of 40 kg/NM in Northern Senegal. Common in both Casamance and Northern Senegal was also red pandora, *Pagellus bellottii*. In addition, *Dentex* species contributed a notable share of catches in Casamance.

Several shellfish species relevant for fisheries were found in bottom trawls (Figure 27). This includes the southern pink shrimp, *Penaeus notialis* (or *Farfantepenaeus notialis*), a commercially valuable resource in the surveyed countries. Two other shrimp species were registered, the deep-water rose shrimp (*Parapenaeus longirostris*) and caramote prawn (*Penaeus kerathurus*). In addition, 10.5 and 7kg/NM in average were caught of the Senegale smooth swimcrab, *Sanquerus validus*, in Casamance and Northern Senegal, respectively.

Besides the regular bottom trawl station in shallow areas, which targeted pelagic fish, one bottom trawl in deep water at around 300 m bottom depth was conducted in Northern Senegal. The goal was to determine the species composition of strong acoustic registrations

near the seafloor where the mesopelagic layer met the shelf. The total sample weight was 241 kg, consisting of a diverse range of species. The major contributor with 40% of the total catch was Benguela hake, *Merluccius polli*, followed by silvery john dory, *Zenopsis conchifer*, and *Munida* squat lobster (Figure 28). In addition, thinlip splitfin (*Synagrops microlepis*), Atlantic greeneye (*Chlorophthalmus atlanticus*), largehead hairtail (*Trichiurus lepturus*), Pelican flounder (*Chascanopsetta lugubris*), and deep-water rose shrimp (*P. longirostris*) were all found in densities over 1kg/NM. Although not representative as a single species, these finding indicate a substantial biomass in ca. 300 m along the steep shelf in Northern Senegal that may be of commercial importance.

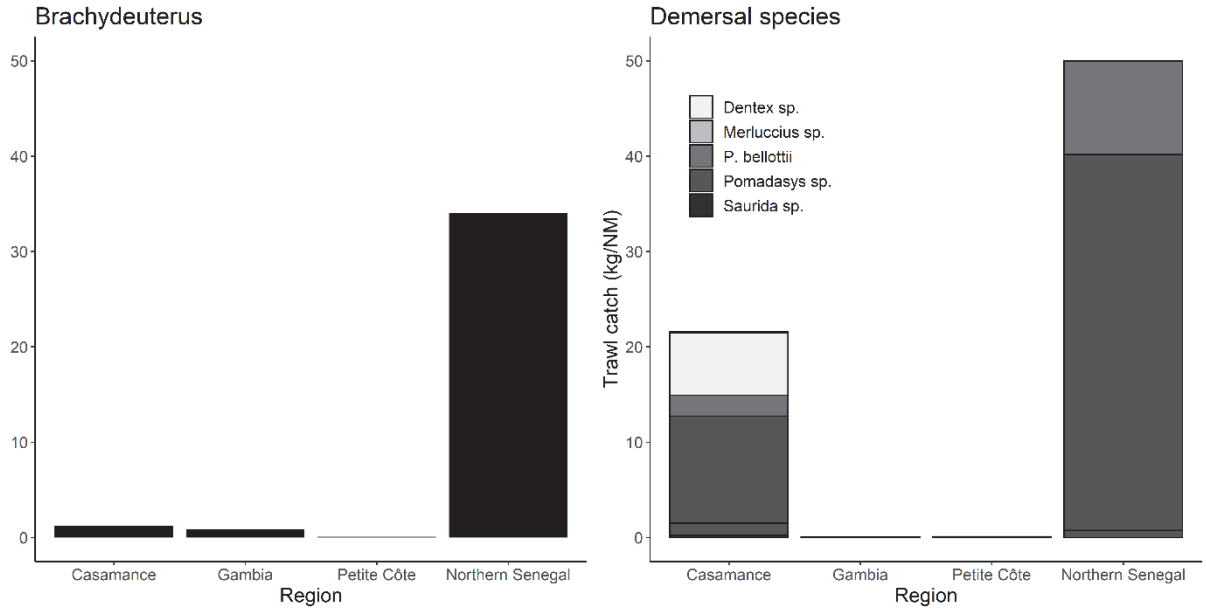


Figure 26. Trawl catches of bigeye grunt (*B. auritus*) (left) and main demersal species (right) at all regular bottom trawl stations (targeting pelagic species). All stations shown were placed in costal areas above 60 m bottom depth

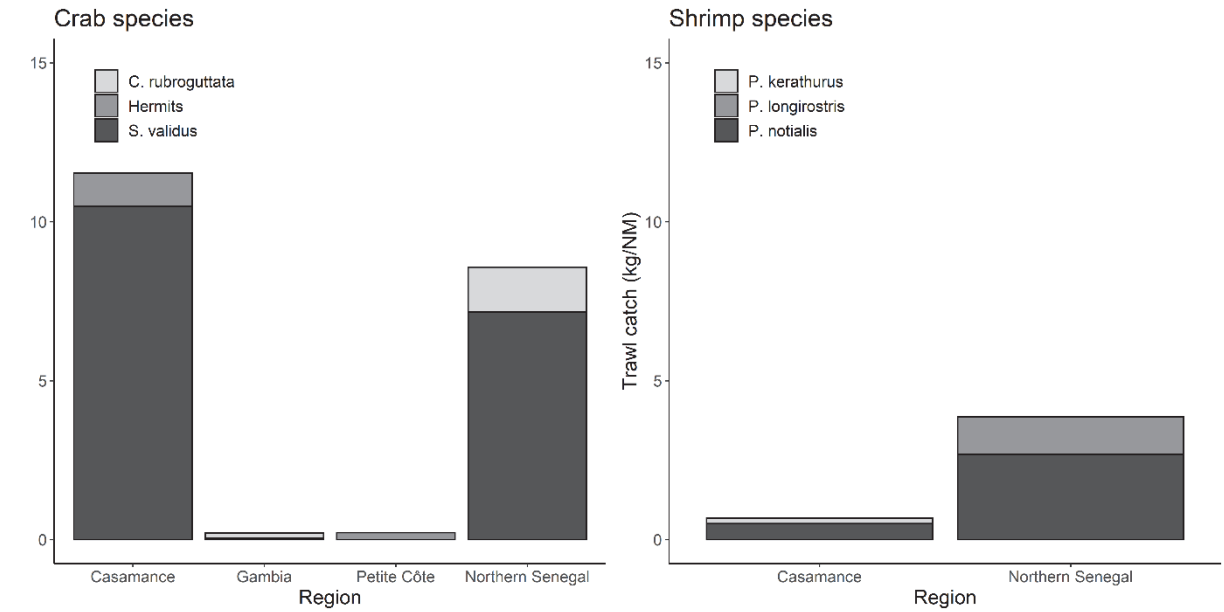


Figure 27. Trawl catches of crabs (left) and shrimps (right) at all regular bottom trawl stations (targeting pelagic species). All stations shown were placed in costal areas above 60 m bottom depth

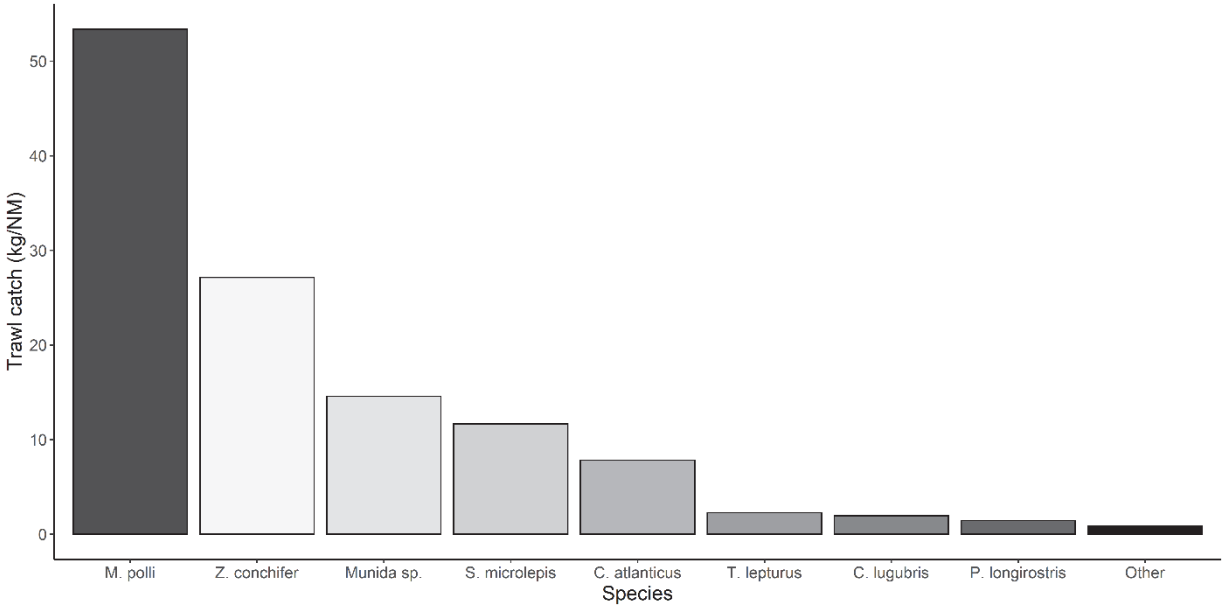


Figure 28. Trawl catches by species at the only deep bottom trawl station during the survey, located in Northern Senegal. Mean bottom depth was registered as 299 m

CHAPTER 4. CONCLUDING REMARKS

The survey covered the continental shelf (20–100 m) and upper slope (100–500m) off The Gambia and Senegal with evenly spaced transects running perpendicular to the coastline. Acoustic registrations were integrated every 1NM and allocated to defined acoustic groups based on pelagic and bottom trawl catches, vertical and depth profiles, target strength and frequency response.

Several of the major pelagic fish species like the sardinellas and horse mackerel species were present over most parts of the Gambian and Senegalese shelf, with species-specific differences in regional distributions. Horse mackerel was present in high density near the coast in Northern Senegal, whereas both sardinellas were present in substantial numbers in Casamance and The Gambia. High densities of horse mackerel could be found up to 80 m bottom depth, whereas sardinellas and *S. colias* were generally limited to shallower waters (< 50 m bottom depth). Anchovy and sardine were largely absent from the area, with only two insignificant registrations. Other pelagics such as carangids, scombrids and barracudas were found throughout the survey area and the shelf area, up to bottom depths of 70–80 m.

Table 16 summarises the estimated biomasses for the sardinellas combined as well as other pelagics from previous surveys in the two countries since 1981. The total estimate for sardinellas is close to the average of previous survey estimates and clearly higher than the last estimate from 2017, whereas other pelagics are estimated below the long-term average. Care should be taken when interpreting results obtained from different surveys especially in relation to time of the year survey has taken place.

No equivalent "time series" is available for horse mackerel, but comparisons with 2015 and 2017 indicate a very high biomass. An especially high uncertainty should be assumed in this case, as the distribution was patchy and estimates are largely determined by few but very large observations. Sensitivity analysis showed that a few strong registrations of very dense schools drive the estimate up several-fold, causing large variation in the estimates.

Most of the surveyed pelagic species are migratory and highly mobile, exhibiting strong spatio-temporal variation. These dynamics remain difficult to assess or even predict, and the results from the current report must be considered together with the results obtained in the other survey legs. To what extent observed variations in biomass can be related to environmental parameters, behavioural patterns or fishing mortality requires further investigation.

Table 16. Biomass estimates (in thousand tonnes) of both sardinellas and other pelagics (Carangids, scombrids, etc.) for the years 1981 to 2019 in the survey area (The Gambia and Senegal)

Year	Period	Sardinellas	Other pelagics*
1981	Apr - May	210	570
1981	Sep	360	-
1982	Feb - Mar	40	90
1986	Nov -Dec	330	170
1992	Feb - Mar	1 530	690
1995	Nov -Dec	760	220
1996	Nov -Dec	230	530
1997	Nov -Dec	300	250
1998	Nov -Dec	390	340
1999	Nov -Dec	1 390	470
2000	Nov -Dec	300	540
2001	Jun - July	410	230
2001	Nov -Dec	430	480
2002	Jun - July	600	430
2002	Nov -Dec	910	260
2003	Jun - July	670	610
2003	Nov -Dec	597	319
2004	Nov -Dec	819	289
2005	Nov -Dec	828	231
2006	Nov -Dec	712	291
2015	Oct	373	592
2017	July	182	257
2019	Sep - Oct	348	211

CHAPTER 5. REGIONAL OVERVIEW

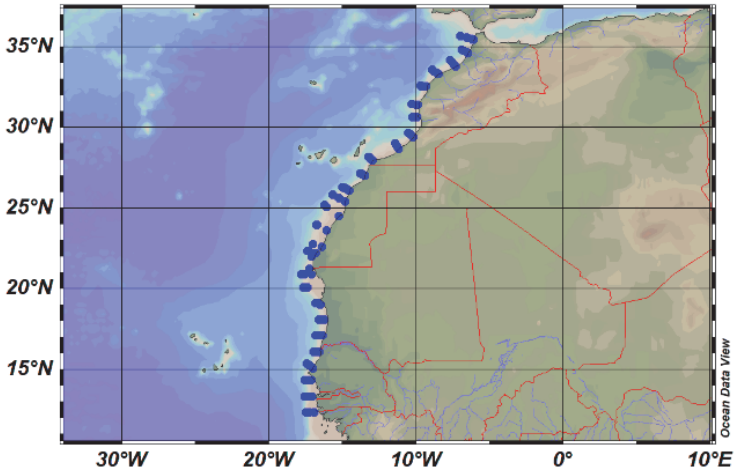
The R/V *Dr Fridtjof Nansen* series of surveys of the pelagic resources in Northwest Africa (Leg 4 of the western Africa coverage for 2019) encompassed Morocco to Senegal. These surveys commenced in the south and progressed northwards and were conducted during September to November. Note that the previous Nansen surveys in 2017 progressed from northern Morocco southwards and took place in a different season; 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 7 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 vessel 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.



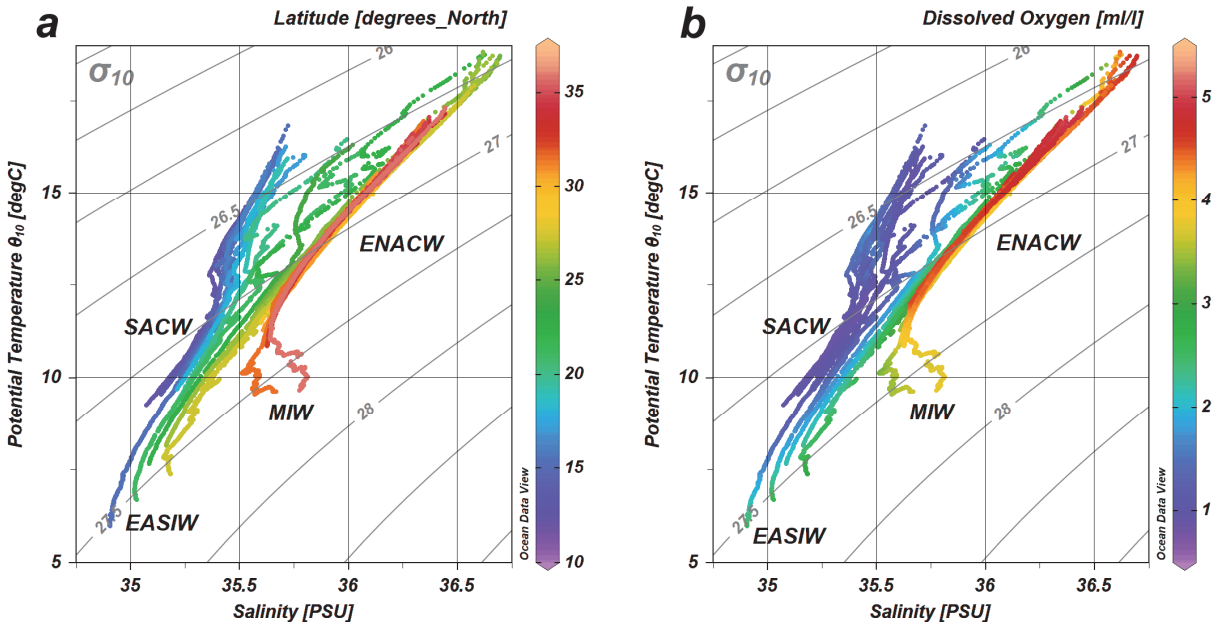


Figure 29. R/V *Dr Fridtjof Nansen* 2019 Northwest Africa CTD distribution map (83 total CTD stations) followed by two T-S diagrams with a dissolved oxygen overlay (a) and a latitudinal overlay (b) for data point region identification

Approximately 80% of the data points collected during Leg 4 are from 100 to 500 m depths with the other 20% going down just below 1000 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 29).

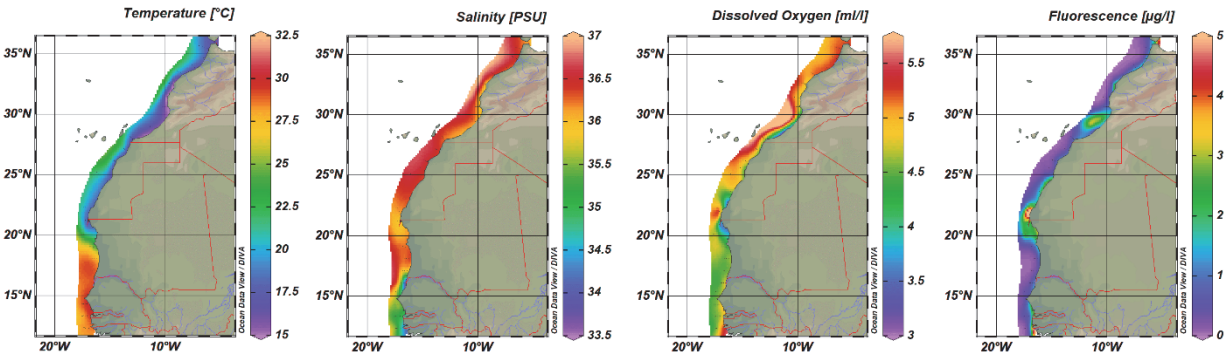


Figure 30. R/V *Dr Fridtjof Nansen* 2019 Northwest Africa horizontal distribution of temperature, salinity, dissolved oxygen and fluorescence at 5 m depth as recorded by the CTD

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 norhwards, 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 30).

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 17) with historic surveys (Table 18) 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 18) 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 17) with, apart from some 20 000 t found in northern Mauritania, the entire stock being distributed mainly between Cap Blanc and Cape Bojador (Figure 31).

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 t were estimated during this series of surveys which is close to the average biomass estimated in surveys since 2015 (see Table 18). 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 32), 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 t of sardinella were recorded in Mauritanian waters. This contrasts with the fishery statistics that recorded catches of sardinella as 300 000 t in 2019, and 500 000 t 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 t. 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 33).

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 18)

T. trecae were found throughout Senegal, The Gambia and Mauritania, while *T. trachurus* was restricted to waters north of Cap Blanc (Figure 34). Very high densities of *T. trecae* were registered in Northern Senegal, suggesting a possible increase in stock size in this region.

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 18). 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 35).

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.

Other species

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

Other clupeids, notably *Ilisha africana,* occurred in southern Mauritania and throughout Morocco (Figure 33).

Other pelagic species were widespread throughout the region (Figure 36).

Table 17. 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	18	3	25	36	83	**190**
S. maderensis				0	2	5	34	49	113	**202**
E. encrasicolus	5	215	3	30	16					**269**
Trachurus trecae			4	69	217	134	36	4	14	**479**
T. trachurus	26	196	380	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**

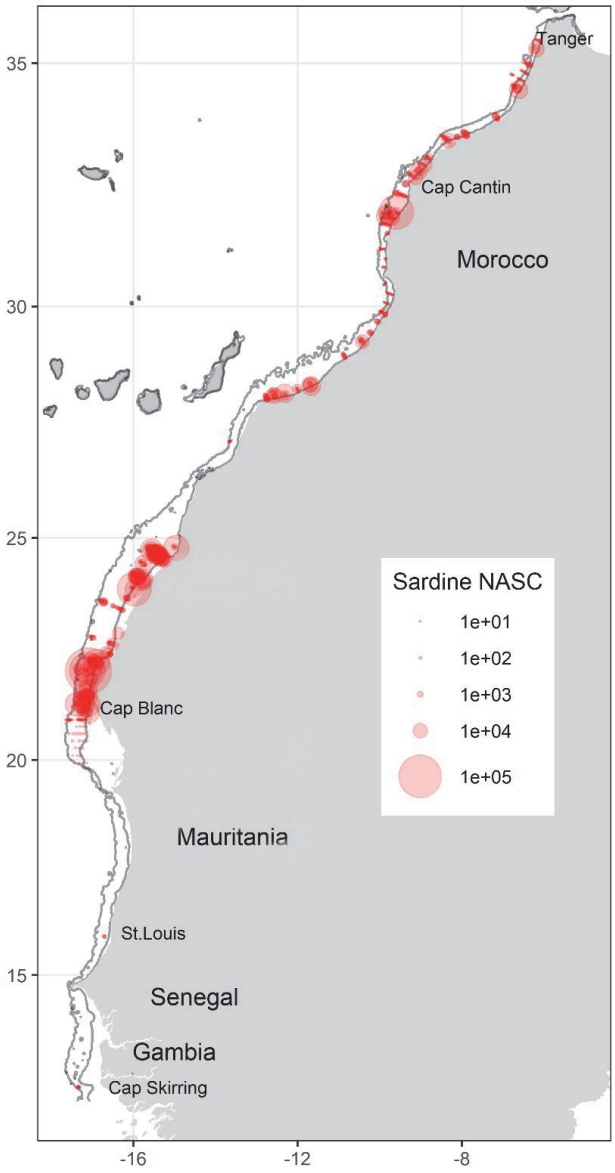


Figure 31. Distribution of sardine (*Sardina pilchardus*), (NASC = nautical area scattering coefficient). 20 m and 100 m depth contours are indicated with grey lines. The countries involved in the surveys and start/end points of each survey segment are named

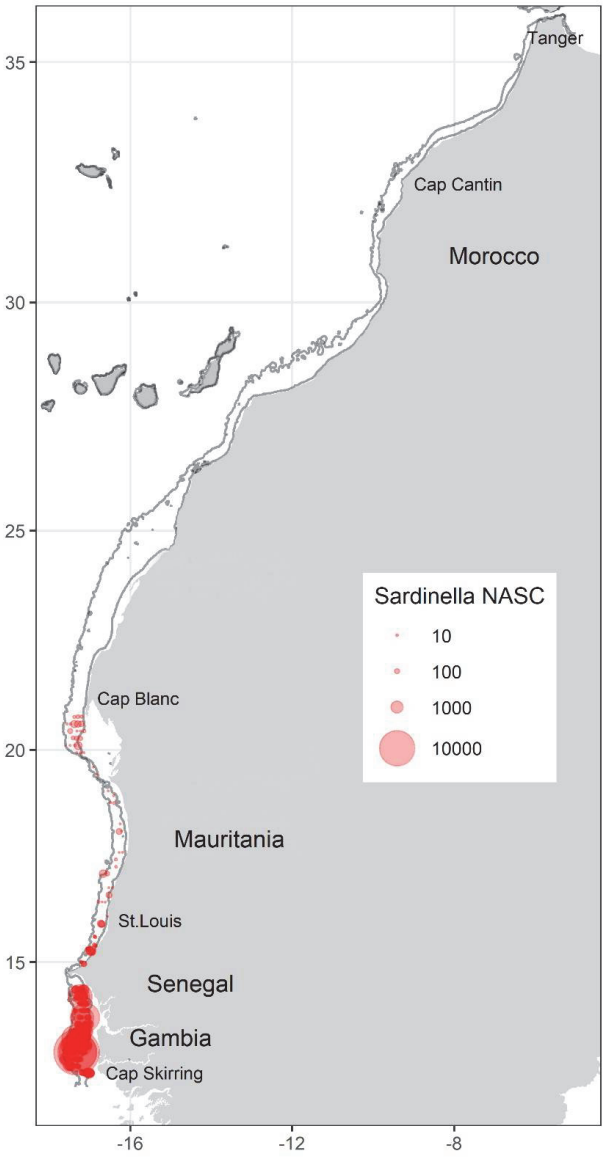


Figure 32. Distribution of sardinella (*Sardinella aurita* and *S. maderensis* combined), (NASC = nautical area scattering coefficient). 20 m and 100 m depth contours are indicated with grey lines. The countries involved in the surveys and start/end points of each survey segment are named

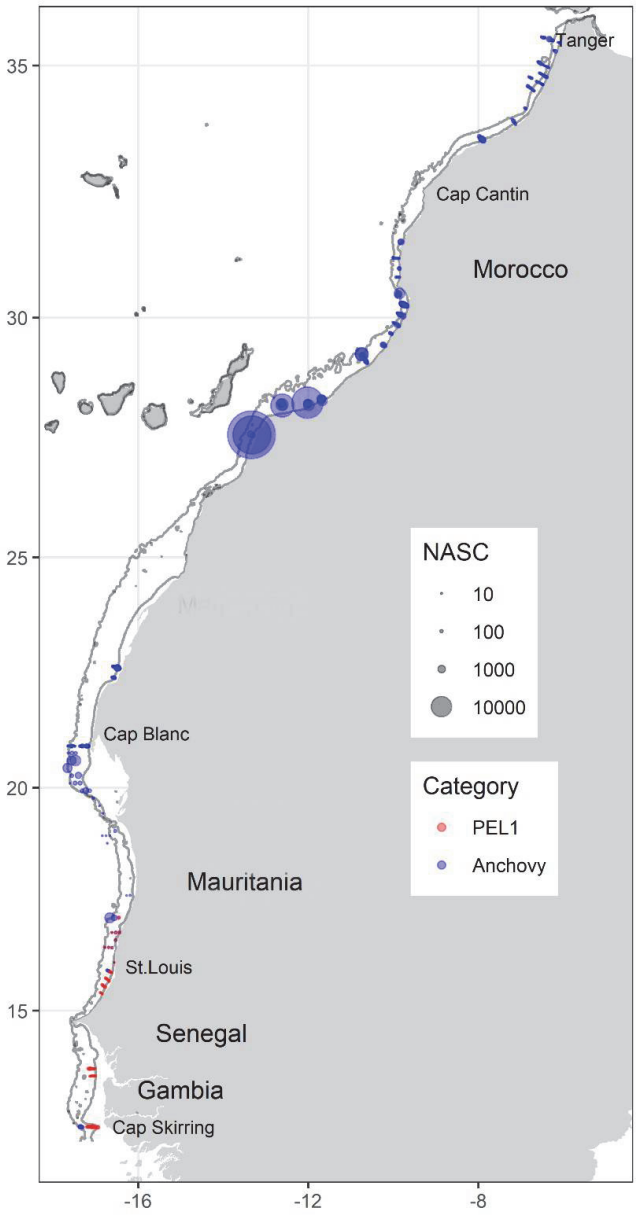


Figure 33. Distribution of anchovy (*Engraulis encrasicolus*, blue) and other clupeids (Pel 1, mainly *Ilisha africana*, red) (NASC = nautical area scattering coefficient). 20 m and 100 m depth contours are indicated with grey lines. The countries involved in the surveys and start/end points of each survey segment are named

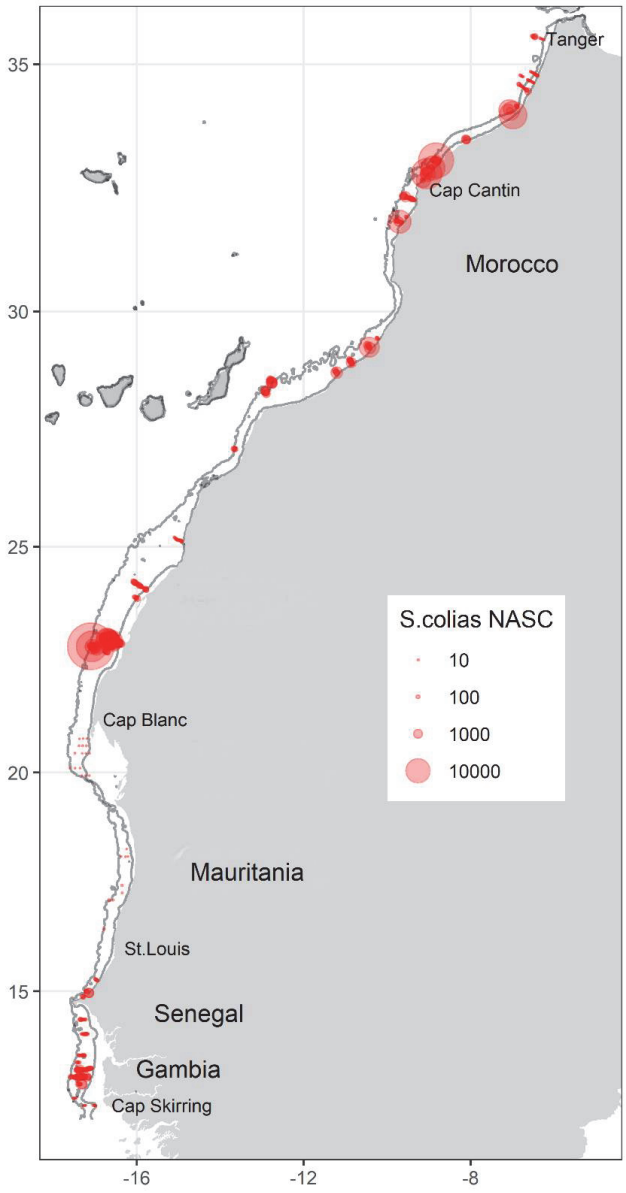


Figure 34. Distribution of Atlantic chub mackerel (*Scomber colias*) (NASC = nautical area scattering coefficient). 20 m and 100 m depth contours are indicated with grey lines. The countries involved in the surveys and start/end points of each survey segment are named

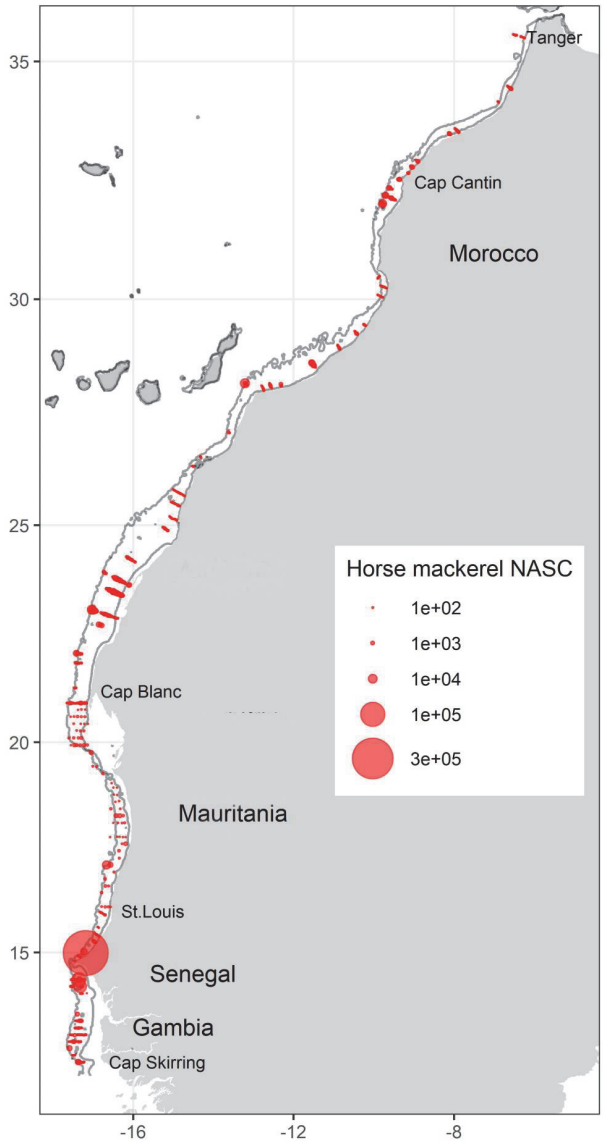


Figure 35. Distribution of horse mackerels (*Trachurus trachurus* and *T. trecae* combined) (NASC = nautical area scattering coefficient). 20 m and 100 m depth contours are indicated with grey lines. The countries involved in the surveys and start/end points of each survey segment are named

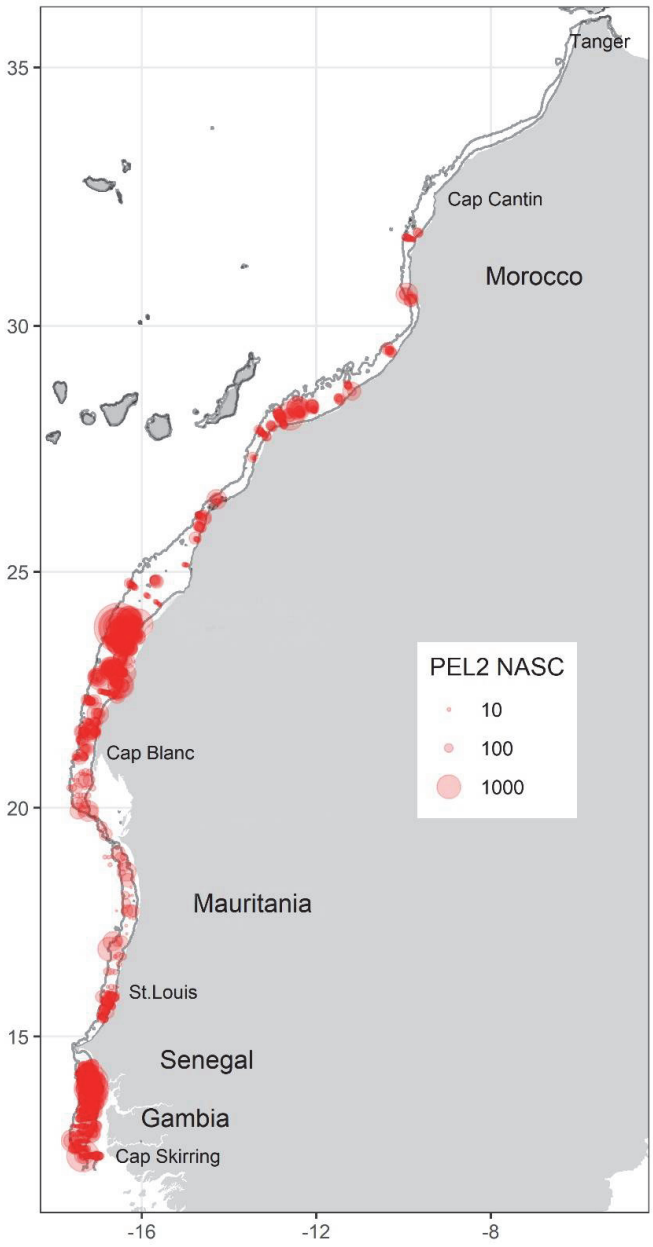


Figure 36. Distribution for Pel 2 (Carangidae, Scombridae, Sphyraenidae and Trichiuridae) (NASC = nautical area scattering coefficient). 20 m and 100 m depth contours are indicated with grey lines. The countries involved in the surveys and start/end points of each survey segment are named

Table 18. 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 years

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**
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*.

REFERENCES

Chierici, M., Fransson, A. & Anderson, L. 1999. Influence of m-cresol purple indicator additions on the pH of seawater samples: Correction factors evaluated from a chemical speciation model. Marine Chemistry - MAR CHEM. 65. 281-290. 10.1016/S0304-4203(99)00020-1.

Clayton, T. & Byrne, R. 1993. Spectrophotometric Seawater pH Measurements: Total Hydrogen Ion Concentration Scale Calibration of m-Cresol Purple and At-Sea Results. Deep-sea Research Part I-oceanographic Research Papers - DEEP-SEA RES PT I-OCEANOG RES. 40. 2115-2129. 10.1016/0967-0637(93)90048-8.

Dickson, A.G., Sabine, C.L. & Christian, J.R. (eds.). 2007. Guide to Best Practices for Ocean CO2 Measurements. PICES Special Publication 3, 191 pp.

Grasshoff, K., Kremling, K. & Ehrhardt, M. 2009. Method of Seawater Analysis. John Wiley & Sons.

Hagebø, M. & Rey, F. 1984. Lagring av sjøvann til analyse av næringssalter.

Korneliussen, R.J. & Ona, E. 2002. An operational system for processing and visualizing multi-frequency acoustic data. ICES J Mar Sci 59:293-313.

Sarré, A., Krakstad, J.O., Brehmer, P., Mbye, E.M. 2018. Spatial distribution of main clupeid species in relation to acoustic assessment surveys in the continental shelves of Senegal and The Gambia. Aquat Living Resour 31:9.

Welschmeyer, N.A. 1994. Fluorometric analysis of chlorophyll a in the presence of chlorophyll b and pheopigments. Limnology and Oceanography 39:1985-1992.

ANNEX I. DESCRIPTION OF INSTRUMENTS AND FISHING GEAR

Acoustic instruments

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

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

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, and has an inner net with 10 mm mesh size. The vertical opening is about 5.5 m. The distance between the wing tips is about 18 m during towing. The sweeps are 40 m long. The trawl doors are 'Thyborøen' combi, 8 m^2 and weigh 2 000 kg. The door spreading is about 45 m when using restraining rope. Trawling was conducted for species identification only and no restraining rope was therefore used during the survey.

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

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.

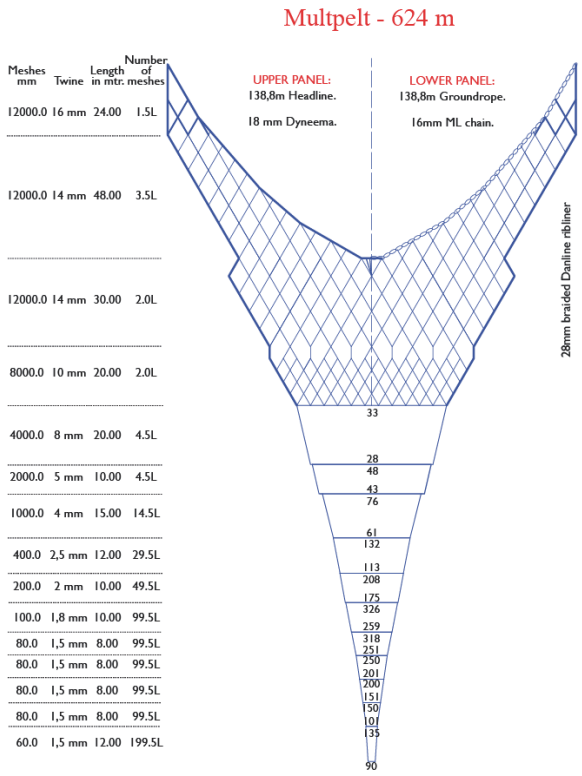


Figure I.1. Schematic drawing of the MultPelt 624

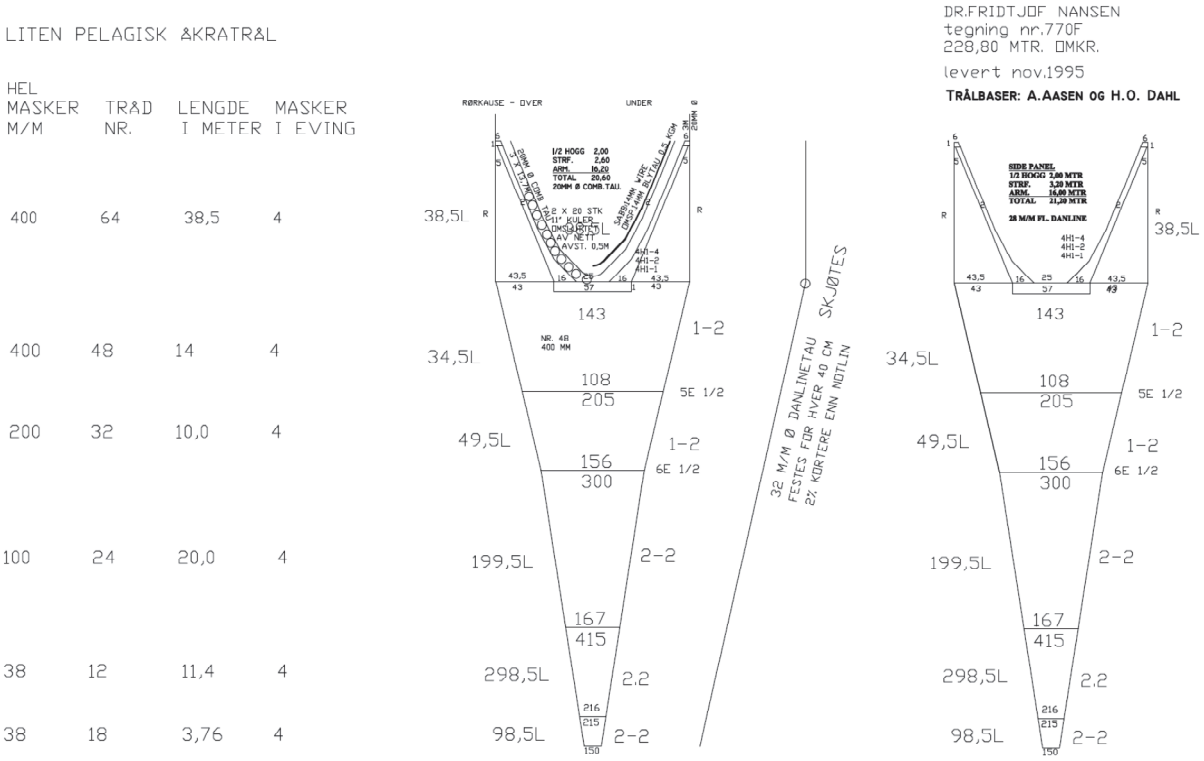


Figure I.2. Schematic drawing of the small pelagic Åkratrawl

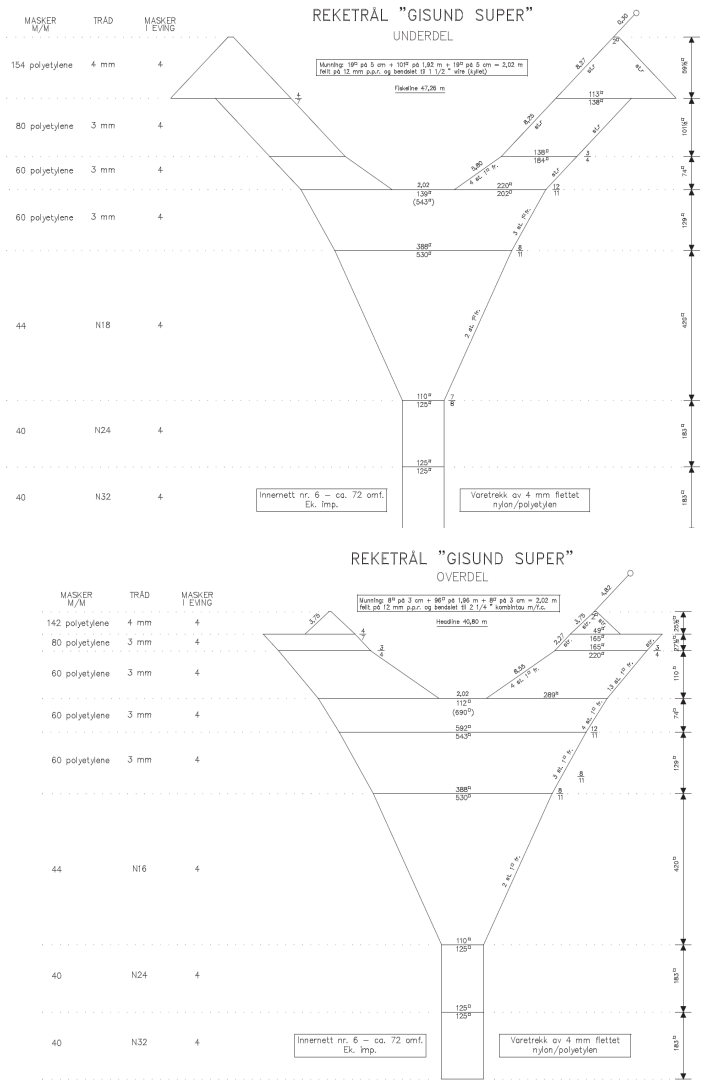


Figure I.3. Schematic drawing of the Super Gisund bottom trawl

ANNEX II. HYDROGRAPHY SENSORS AND WATER CHEMISTRY QUALITY ASSURANCE

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 – 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	257S	9702011 WETStar	20.04.2015	02.01.2019

Water Chemistry Quality Assurance

pH and total alkalinity samples were measured in triplicates.

Parameter	Sample count	Average Triplicate* Standard Deviation
pH	70	0.003
Total alkalinity	70	1.98

*Erroneous values removed

Fluorometric standard measurements were performed to quality control chlorophyll a and phaeopigment measurements:

Parameter	Low Standard	High Standard
Standard Average	483	4 133
Standard Standard Deviation	11	102
Average Drift	-18	-99

CTD dissolved oxygen and salinity value validity statistics

Parameter	Sample Count	Offset from factory calibration
Dissolved Oxygen	5	-0.5 %
Salinity	0	N/A

The Portasal salinometer was being repaired during Leg 4.1. Therefore, it was not possible to perform validation measurements for the salinity values derived from the CTD.

ANNEX III. RECORDS OF FISHING STATIONS

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 1
DATE :28/09/19 GEAR TYPE: PT NO: 4 POSITION:Lat N 12°22.68
start stop duration Lon W 17°23.10
TIME :03:10:31 03:13:03 2.5 (min) Purpose : 1
LOG : 7161.24 7161.37 0.1 Region : 1300
FDEPTH: 0 0 Gear cond.: 5
BDEPTH: 74 74 Validity : 5
Towing dir: 0° Wire out : 120 m Speed : 3.1 kn
Sorted : 0 Total catch: 0.00 Catch/hour: 0.00

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

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 2
DATE :28/09/19 GEAR TYPE: PT NO: 4 POSITION:Lat N 12°21.97
start stop duration Lon W 17°22.20
TIME :03:36:04 03:51:47 15.7 (min) Purpose : 1
LOG : 7162.38 7163.25 0.9 Region : 1300
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 75 76 Validity : 1
Towing dir: 0° Wire out : 120 m Speed : 3.4 kn
Sorted : 0 Total catch: 73.94 Catch/hour: 282.40

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C
Brachydeuterus auritus	180.35	1608	63.86
Selene dorsalis	53.62	336	18.99
6			
Selar crumenophthalmus	16.35	50	5.79
2			
Sardinella maderensis	12.12	107	4.29
1			
Euthynnus alletteratus	10.66	15	3.77
5			
Scomber colias	3.33	23	1.18
3			
Trachinotus ovatus	2.95	8	1.05
Sphyraena guachancho	1.18	4	0.42
Fodiator acutus	0.70	4	0.25
Chloroscombrus chrysurus	0.65	4	0.23
Sardinella aurita	0.49	4	0.17
Engraulis encrasicolus	0.10	27	0.04
4			
Bregmaceros sp.	0.06	397	0.02
Sepia sp	0.03	23	0.01
Saurida brasiliensis	0.02	8	0.01
Ariomma bondi	0.01	4	0.00
Total	282.63		100.08

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 3
DATE :28/09/19 GEAR TYPE: BT NO: 2 POSITION:Lat N 12°21.17
start stop duration Lon W 17°4.81
TIME :08:12:32 08:43:23 30.9 (min) Purpose : 1
LOG : 7196.83 7198.55 1.7 Region : 1300
FDEPTH: 25 20 Gear cond.: 0
BDEPTH: 25 20 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.3 kn
Sorted : 0 Total catch: 431.68 Catch/hour: 839.57

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C
Galeoides decadactylus	214.95	1540	25.60
Ilisha africana, juvenile	204.56	53835	24.37
Carlarius parkii	143.92	1418	17.14
Ilisha africana	61.79	1340	7.36
8			
Trichiurus lepturus	58.54	231	6.97
Sanquerus validus	35.05	89	4.17
Pteroscion peli	25.42	263	3.03
Eucinostomus melanopterus	25.26	247	3.01
Selene dorsalis	11.71	161	1.39
7			
Chloroscombrus chrysurus	11.71	86	1.39
9			
Pseudotolithus senegalensis	6.38	31	0.76
Brachydeuterus auritus	5.23	62	0.62
Scomberomorus tritor	4.98	4	0.59
Pseudupeneus prayensis	4.61	31	0.55
PAGUROIDEA	3.54	16	0.42
Sepia officinalis	3.50	10	0.42
Sphyraena guachancho	3.23	18	0.38
Penaeus notialis	3.07	128	0.37
Ephippion guttifer	2.29	8	0.27
Sardinella maderensis	2.26	12	0.27
10			
Lagocephalus laevigatus	1.69	8	0.20
Sea urchin	1.69	123	0.20
Umbrina canariensis	1.38	16	0.16
Pisodonophis semicinctus	0.78	2	0.09
ASTEROIDEA	0.76	62	0.09
Penaeus kerathurus	0.54	2	0.06
Cynoglossus canariensis	0.43	4	0.05
Epinephelus aeneus	0.29	8	0.03
Total	839.57		100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 4
DATE :28/09/19 GEAR TYPE: BT NO: 2 POSITION:Lat N 12°20.64
start stop duration Lon W 17°22.20
TIME :11:53:13 12:23:17 30.1 (min) Purpose : 1
LOG : 7220.69 7222.37 1.7 Region : 1300
FDEPTH: 84 75 Gear cond.: 0
BDEPTH: 84 75 Validity : 0
Towing dir: 0° Wire out : 270 m Speed : 3.3 kn
Sorted : 81 Total catch: 270.11 Catch/hour: 539.14

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C
Trachurus trecae	183.03	15557	33.95
19			
URCHINS	69.88	8585	12.96
Carlarius parkii	58.32	517	10.82
Selene dorsalis	48.40	279	8.98
Brotula barbata	31.04	142	5.76
Octopus vulgaris	23.27	38	4.32
Dentex angolensis	21.96	22	4.07
Scorpaena stephanica	12.93	48	2.40
Cymbium pepo	10.36	2	1.92
Chelidonichthys gabonensis	8.18	130	1.52
Brachydeuterus auritus	7.37	72	1.37
Pseudupeneus prayensis	7.21	54	1.34
Priacanthus arenatus	7.01	30	1.30
Scorpaena scrofa	6.59	124	1.22
Scomber colias	5.43	34	1.01
18			
Scyliorhinus canicula	4.09	6	0.76
Citharus linguatula	3.97	84	0.74
Trichiurus lepturus	3.73	18	0.69
Loligo vulgaris	3.45	36	0.64
Umbrina canariensis	3.29	10	0.61
Galeoides decadactylus	2.08	12	0.39
Pagellus bellottii	2.02	124	0.37
Pontinus kuhlii	1.66	78	0.31
Pegusa lascaris	1.60	12	0.30
Venus sp.	1.48	60	0.27
Branchiostegus semifasciatus	1.38	6	0.26
Holothuria sp.	0.84	18	0.16
Saurida parri	0.84	118	0.16
Sphoeroides marmoratus	0.78	30	0.14
Cynoponticus ferox	0.72	6	0.13
Microchirus frechkopi	0.72	24	0.13
Zeus faber	0.70	10	0.13
Boops boops	0.66	24	0.12
Pentheroscion mbizi	0.62	4	0.11
Todarodes sagittatus	0.56	6	0.10
Serranus cabrilla	0.50	6	0.09
Arnoglossus imperialis	0.48	54	0.09
Sepia hierredda	0.46	12	0.09
Paraconger notialis	0.36	6	0.07
G A S T R O P O D S	0.36	42	0.07
Chaetodon hoefleri	0.26	2	0.05
Fishing gears	0.24	2	0.04
Serranus africanus	0.12	6	0.02
Sardina pilchardus	0.12	12	0.02
Pteroscion peli	0.10	2	0.02
Total	539.14		100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 5
DATE :28/09/19 GEAR TYPE: PT NO: 4 POSITION:Lat N 12°30.66
start stop duration Lon W 17°27.92
TIME :19:28:16 19:57:25 29.1 (min) Purpose : 1
LOG : 7252.81 7254.37 1.6 Region : 1300
FDEPTH: 10 12 Gear cond.: 0
BDEPTH: 45 46 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.2 kn
Sorted : 0 Total catch: 179.28 Catch/hour: 369.14

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C
Caranx rhonchus	96.77	525	26.22
14			
Sardinella aurita	92.33	332	25.01
11			
Selene dorsalis	75.15	507	20.36
13			
Brachydeuterus auritus	43.49	426	11.78
Sardinella maderensis	38.42	231	10.41
15			
Selar crumenophthalmus	6.55	21	1.77
Chloroscombrus chrysurus	4.45	29	1.20
Carlarius heudelotii	2.51	4	0.68
Trachurus trecae	2.51	4	0.68
Trachinotus ovatus	2.31	10	0.62
Auxis thazard	1.56	8	0.42
Dactylopterus volitans	1.03	2	0.28
Scomber colias	1.03	10	0.28
12			
Sphyraena guachancho	0.82	2	0.22
Loligo vulgaris	0.21	2	0.06
Total	369.14		100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 6
DATE :28/09/19 GEAR TYPE: PT NO: 4 POSITION:Lat N 12°29.27
start stop duration Lon W 17°18.80
TIME :21:49:44 22:19:39 29.9 (min) Purpose : 1
LOG : 7267.65 7269.50 1.9 Region : 1300
FDEPTH: 0 12 Gear cond.: 0
BDEPTH: 25 25 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 3.7 kn
Sorted : 0 Total catch: 40.48 Catch/hour: 81.19

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C
Brachydeuterus auritus	53.90	628	66.39
Eucinostomus melanopterus	10.23	148	12.60
Sardinella maderensis	5.61	28	6.91
16			
Sardinella aurita, juvenile	2.57	178	3.16
Caranx rhonchus, juvenile	1.97	116	2.42
Selene dorsalis	1.89	6	2.32
Euthynnus alletteratus	1.36	2	1.68
Sardinella aurita	1.28	6	1.57
17			
Caranx rhonchus	1.16	4	1.43
Sphyraena barracuda	0.44	2	0.54
Hemiramphus brasiliensis	0.32	2	0.40
Brachydeuterus auritus**, juvenile	0.24	148	0.30
Echeneis naucrates	0.22	2	0.27
Total	81.19		100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 7
DATE :29/09/19 GEAR TYPE: PT NO: 4 POSITION:Lat N 12°40.12
start stop duration Lon W 17°21.00
TIME :01:15:15 01:38:40 23.4 (min) Purpose : 1
LOG : 7294.12 7295.40 1.3 Region : 1300
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 31 34 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.3 kn
Sorted : 73 Total catch: 1004.73 Catch/hour: 2574.03

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C
Brachydeuterus auritus	2524.30	21789	98.07
Sardinella maderensis	17.55	82	0.68
38			
Selene dorsalis	10.68	59	0.42
Sphyraena guachancho	5.15	15	0.20
Pomadasys incisus	3.82	18	0.15
Galeoides decadactylus	2.69	15	0.10
Chloroscombrus chrysurus	2.54	20	0.10
Trichiurus lepturus	2.46	10	0.10
Eucinostomus melanopterus	1.61	8	0.06
Ilisha africana	1.49	20	0.06
Caranx crysos	1.15	3	0.04
Trachinotus ovatus	0.28	3	0.01
Echeneis naucrates	0.15	3	0.01
Sepia hierredda	0.15	3	0.01

Priacanthus arenatus	0.05	3	0.00
Sardinella aurita	0.04	3	0.00
37			
Penaeus notialis	0.03	3	0.00
Total	2574.15		100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 8
DATE :29/09/19 GEAR TYPE: PT NO: 4 POSITION:Lat N 12°40.75
start stop duration Lon W 17°35.84
TIME :03:22:12 03:42:19 20.1 (min) Purpose : 1
LOG : 7308.80 7309.90 1.1 Region : 1300
FDEPTH: 0 120 Gear cond.: 0
BDEPTH: 52 91 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.3 kn
Sorted : 0 Total catch: 39.70 Catch/hour: 118.39

SPECIES	CATCH/HOUR	% OF TOT. C
SAMP	weight	numbers
Trachurus trecae	44.79	3447	37.83
20			
Sardinella maderensis	35.49	262	29.98
23			
Selene dorsalis	26.21	113	22.14
21			
Brachydeuterus auritus	3.91	33	3.30
Trachinotus ovatus	3.58	15	3.02
Sardinella aurita	3.37	21	2.85
22			
Euthynnus alletteratus	0.89	3	0.76
Ariomma bondi	0.15	15	0.13
Total	118.39		100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 9
DATE :29/09/19 GEAR TYPE: PT NO: 4 POSITION:Lat N 12°50.42
start stop duration Lon W 17°35.75
TIME :05:56:34 06:27:18 30.7 (min) Purpose : 1
LOG : 7328.90 7330.52 1.6 Region : 1300
FDEPTH: 5 18 Gear cond.: 0
BDEPTH: 62 62 Validity : 0
Towing dir: 0° Wire out : 130 m Speed : 3.2 kn
Sorted : 0 Total catch: 10.90 Catch/hour: 21.29

SPECIES	CATCH/HOUR	% OF TOT. C
SAMP	weight	numbers
Brachydeuterus auritus	10.82	76	50.80
Lagocephalus lagocephalus	3.63	8	17.06
Sardinella maderensis	2.35	16	11.03
25			
Trachinotus ovatus	2.30	10	10.82
Trachurus trecae	1.55	121	7.28
24			
Sardinella aurita	0.64	4	3.01
26			
Total	21.29		100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 10
DATE :29/09/19 GEAR TYPE: BT NO: 2 POSITION:Lat N 12°50.25
start stop duration Lon W 17°24.71
TIME :08:04:51 08:35:58 31.1 (min) Purpose : 1
LOG : 7343.78 7345.53 1.8 Region : 1300
FDEPTH: 43 45 Gear cond.: 0
BDEPTH: 43 45 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.4 kn
Sorted : 0 Total catch: 87.72 Catch/hour: 169.12

SPECIES	CATCH/HOUR	% OF TOT. C
SAMP	weight	numbers
Pomadasys incisus	75.48	478	44.63
Pseudupeneus prayensis	37.71	357	22.30
Pagellus bellottii	25.53	243	15.09
Dactylopterus volitans	5.40	25	3.19
Mustelus mustelus	4.36	2	2.58
Plectorhinchus mediterraneus	3.24	8	1.92
Acanthurus monroviae	2.54	6	1.50
Trachurus trecae	2.08	13	1.23
Pegusa lascaris	1.62	19	0.96
Pagrus caeruleostictus	1.27	4	0.75
Brotula barbata	1.12	2	0.66
Trachinocephalus myops	1.04	8	0.62
Raja miraletus	1.00	2	0.59
Chaetodon hoefleri	0.89	6	0.52
Sphoeroides spengleri	0.77	27	0.46
Eucinostomus melanopterus	0.77	6	0.46
Scorpaena scrofa	0.69	8	0.41
Chelidonichthys gabonensis	0.58	6	0.34
Chloroscombrus chrysurus	0.58	4	0.34
Sepia bertheloti	0.54	4	0.32
Syacium micrurum	0.50	4	0.30
Penaeus notialis	0.31	8	0.18
Fistularia tabacaria	0.23	4	0.14
Brachydeuterus auritus	0.21	2	0.13
Sardinella aurita, juvenile	0.21	2	0.13
Parapristipoma octolineatum	0.19	2	0.11
Grammoplites gruveli	0.19	6	0.11
Bothus podas	0.04	2	0.02
Arnoglossus imperialis	0.01	4	0.01
Total	169.12		100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 11
DATE :29/09/19 GEAR TYPE: BT NO: 2 POSITION:Lat N 12°54.56
start stop duration Lon W 17°4.20
TIME :11:15:04 11:47:20 32.3 (min) Purpose : 1
LOG : 7371.11 7373.07 2.0 Region : 1300
FDEPTH: 21 22 Gear cond.: 0
BDEPTH: 21 22 Validity : 0
Towing dir: 0° Wire out : 125 m Speed : 3.6 kn
Sorted : 0 Total catch: 112.18 Catch/hour: 208.58

SPECIES	CATCH/HOUR	% OF TOT. C
SAMP	weight	numbers
Chloroscombrus chrysurus	102.43	866	49.11
29			
Caranx rhonchus	21.13	136	10.13
28			
Sepia hierredda	18.96	24	9.09
Pseudupeneus prayensis	16.06	279	7.70
Alectis alexandrinus	10.28	33	4.93
Lagocephalus laevigatus	8.26	33	3.96
Sphyraena guachancho	6.60	4	3.16
Carlarius parkii	5.99	20	2.87
Trachinotus ovatus	4.00	24	1.92
Plectorhinchus mediterraneus	3.24	84	1.55
Pagrus caeruleostictus	1.99	78	0.95
Sardinella maderensis	1.51	9	0.72
27			
Pagellus bellottii	1.49	7	0.71
Stephanolepis hispidus	1.17	6	0.56
Balistes capriscus	1.15	2	0.55
Raja miraletus	1.10	2	0.53
Albula vulpes	0.84	2	0.40
Selene dorsalis	0.58	4	0.28
Dactylopterus volitans	0.54	2	0.26
Pomadasys incisus	0.37	4	0.18
Sardinella aurita	0.35	2	0.17
Dentex canariensis	0.32	4	0.15
Scorpaena scrofa	0.24	4	0.12
Total	208.58		100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 12
DATE :29/09/19 GEAR TYPE: BT NO: 2 POSITION:Lat N 13°0.36
start stop duration Lon W 17°9.14
TIME :13:24:43 13:54:30 29.8 (min) Purpose : 1
LOG : 7386.17 7387.79 1.6 Region : 1300
FDEPTH: 26 24 Gear cond.: 0
BDEPTH: 26 24 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.3 kn
Sorted : 0 Total catch: 19.24 Catch/hour: 38.75

SPECIES	CATCH/HOUR	% OF TOT. C
SAMP	weight	numbers
Sepia hierredda	7.43	16	19.18
Trachinotus ovatus	5.96	40	15.38
Pomadasys jubelini	4.11	6	10.60
Lagocephalus laevigatus	3.12	8	8.06
Carlarius parkii	3.02	8	7.80
Caranx rhonchus	2.88	14	7.43
30			
Chloroscombrus chrysurus	2.40	22	6.19
Pseudupeneus prayensis	2.38	22	6.13
Octopus vulgaris	2.32	2	5.98
Stephanolepis hispidus	1.17	6	3.01
Selene dorsalis	0.95	8	2.44
Alectis alexandrinus	0.81	2	2.08
Citharus linguatula	0.64	4	1.66
Pagellus bellottii	0.60	2	1.56
Fistularia petimba	0.56	4	1.46
Pagrus caeruleostictus	0.40	22	1.04
Total	38.75		100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 13
DATE :29/09/19 GEAR TYPE: PT NO: 8 POSITION:Lat N 12°59.69
start stop duration Lon W 17°22.89
TIME :16:44:33 16:50:28 5.9 (min) Purpose : 1
LOG : 7410.75 7411.18 0.4 Region : 1300
FDEPTH: 0 30 Gear cond.: 0
BDEPTH: 46 45 Validity : 0
Towing dir: 0° Wire out : 220 m Speed : 4.3 kn
Sorted : 135 Total catch: 134.87 Catch/hour: 1366.92

SPECIES	CATCH/HOUR	% OF TOT. C
SAMP	weight	numbers
Scomber colias	1053.55	7571	77.07
31			
Sardinella maderensis	270.10	2068	19.76
33			
Sardinella aurita	24.31	142	1.78
32			
Trachurus trecae	8.61	51	0.63
Sarda sarda	6.79	20	0.50
Trachinotus ovatus	1.82	10	0.13
Echeneis naucrates	1.72	10	0.13
Total	1366.92		100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 14
DATE :29/09/19 GEAR TYPE: PT NO: 4 POSITION:Lat N 13°10.25
start stop duration Lon W 17°25.69
TIME :21:49:28 22:18:54 29.4 (min) Purpose : 1
LOG : 7451.47 7453.04 1.6 Region : 1400
FDEPTH: 10 24 Gear cond.: 0
BDEPTH: 66 65 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.2 kn
Sorted : 0 Total catch: 56.87 Catch/hour: 115.94

SPECIES	CATCH/HOUR	% OF TOT. C
SAMP	weight	numbers
Scomber colias	43.47	338	37.49
34			
Sardinella maderensis	35.88	277	30.95
36			
Sardinella aurita	16.68	90	14.38
35			
Trachurus trecae	16.07	173	13.86
Sarda sarda	1.63	4	1.41
Trachinotus ovatus	1.55	8	1.34
Loligo vulgaris	0.47	10	0.40
Lagocephalus laevigatus	0.20	2	0.18
Total	115.94		100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 15
DATE :30/09/19 GEAR TYPE: PT NO: 4 POSITION:Lat N 13°10.49
start stop duration Lon W 17°16.38
TIME :00:13:13 00:25:55 12.7 (min) Purpose : 1
LOG : 7467.98 7468.53 0.6 Region : 1400
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 45 46 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 2.6 kn
Sorted : 0 Total catch: 33.45 Catch/hour: 157.91

SPECIES	CATCH/HOUR	% OF TOT. C
SAMP	weight	numbers
Sardinella aurita	139.26	680	88.19
39			
Sardinella maderensis	9.87	94	6.25
40			
Dactylopterus volitans	3.78	5	2.39
Scomber colias	3.16	19	2.00
0			
Scomber colias	1.23	14	0.78
Brachydeuterus auritus	0.42	5	0.27
Caranx rhonchus	0.19	9	0.12
Total	157.91		100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 16
DATE :30/09/19 GEAR TYPE: PT NO: 4 POSITION:Lat N 13°19.97
start stop duration Lon W 17°11.05
TIME :05:26:15 05:39:39 13.4 (min) Purpose : 1
LOG : 7504.73 7505.48 0.8 Region : 1400
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 40 39 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.4 kn
Sorted : 0 Total catch: 2.66 Catch/hour: 11.90

SPECIES	CATCH/HOUR	% OF TOT. C
SAMP		

		weight	numbers	
	Sardinella aurita	7.34	36	61.65
41				
	Trachinotus ovatus	2.77	18	23.31
	Sardinella maderensis	1.79	13	15.04
42				
	Total	11.90		100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 17
DATE :30/09/19 GEAR TYPE: BT NO: 2 POSITION:Lat N 13°31.46
start stop duration Lon W 16°58.49
TIME :15:57:48 16:27:48 30.0 (min) Purpose : 3
LOG : 7575.00 7576.81 1.8 Region : 1400
FDEPTH: 20 18 Gear cond.: 0
BDEPTH: 20 18 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.6 kn
Sorted : 0 Total catch: 142.73 Catch/hour: 285.46

SAMP	SPECIES	CATCH/HOUR	% OF TOT. C
		weight numbers	
	Caranx rhonchus	115.00 2142	40.29
45			
	Trichiurus lepturus	87.92 264	30.80
	Pseudupeneus prayensis	23.36 514	8.18
	Pagrus caeruleostictus	19.32 1360	6.77
	Chloroscombrus chrysurus	10.68 174	3.74
	Sardinella maderensis	9.16 68	3.21
44			
	Galeoides decadactylus	7.00 88	2.45
	Brachydeuterus auritus	3.00 62	1.05
	Balistes capriscus	1.76 2	0.62
	Nicholsina usta	1.34 8	0.47
	Ephippion guttifer	1.06 2	0.37
	Stephanolepis hispidus	0.86 4	0.30
	Sepia hierredda	0.78 2	0.27
	Eucinostomus melanopterus	0.74 6	0.26
	Calappa rubroguttata	0.58 2	0.20
	Scorpaena scrofa	0.48 10	0.17
	Gymnothorax afer	0.46 4	0.16
	Sardinella aurita	0.42 2	0.15
43			
	Lagocephalus laevigatus	0.38 2	0.13
	Epinephelus costae	0.26 2	0.09
	Halobatrachus didactylus	0.18 2	0.06
	Torpedo torpedo	0.18 2	0.06
	Pomadasys incisus	0.16 2	0.06
	Sanquerus validus	0.16 4	0.06
	Ilisha africana	0.10 2	0.04
	Serranus cabrilla	0.06 2	0.02
	Plectorhinchus mediterraneus	0.06 2	0.02
	Total	285.46	100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 18
DATE :30/09/19 GEAR TYPE: PT NO: 4 POSITION:Lat N 13°51.27
start stop duration Lon W 17°17.21
TIME :22:46:47 23:39:16 52.5 (min) Purpose : 1
LOG : 7635.52 7638.29 2.8 Region : 1300
FDEPTH: 10 24 Gear cond.: 0
BDEPTH: 53 49 Validity : 0
Towing dir: 0° Wire out : 110 m Speed : 3.2 kn
Sorted : 0 Total catch: 31.03 Catch/hour: 35.48

SAMP	SPECIES	CATCH/HOUR	% OF TOT. C
		weight numbers	
	Selene dorsalis	15.30 71	43.12
49			
	Sphyraena guachancho	6.84 14	19.27
	Sardinella maderensis	6.67 62	18.79
48			
	Jellyfish	3.69 1	10.41
46			
	Sardinella aurita	1.97 10	5.54
47			
	Trachinotus ovatus	0.97 6	2.74
	Caranx rhonchus	0.03 1	0.10
	Priacanthus arenatus	0.01 1	0.03
	Total	35.48	100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 19
DATE :01/10/19 GEAR TYPE: PT NO: 4 POSITION:Lat N 14°0.28
start stop duration Lon W 17°19.77
TIME :04:56:04 05:16:52 20.8 (min) Purpose : 3
LOG : 7685.59 7686.73 1.1 Region : 1300
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 63 60 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.3 kn
Sorted : 0 Total catch: 6.19 Catch/hour: 17.86

SAMP	SPECIES	CATCH/HOUR	% OF TOT. C
		weight numbers	
	Trachinotus ovatus	17.08 81	95.59
50			
	Scomber colias	0.69 9	3.88
	Trachurus trecae	0.04 3	0.23
	Saurida brasiliensis	0.02 3	0.13
	Priacanthus arenatus	0.02 6	0.11
	Selene dorsalis	0.01 3	0.05
	Acanthurus monroviae, juvenile	0.00 6	0.02
	Total	17.86	100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 20
DATE :01/10/19 GEAR TYPE: PT NO: 8 POSITION:Lat N 14°10.61
start stop duration Lon W 17°16.33
TIME :09:52:37 10:11:39 19.0 (min) Purpose : 3
LOG : 7727.49 7729.16 1.7 Region : 1300
FDEPTH: 10 30 Gear cond.: 0
BDEPTH: 48 51 Validity : 0
Towing dir: 0° Wire out : 250 m Speed : 5.3 kn
Sorted : 0 Total catch: 20000.00 Catch/hour: 63058.33

SAMP	SPECIES	CATCH/HOUR	% OF TOT. C
		weight numbers	
	Trachurus trecae	61130.01 436953	96.94
51			
	Pagellus bellottii	492.80 3285	0.78
	Pomadasys incisus	328.53 2298	0.52
	Diplodus vulgaris	144.53 656	0.23
	Plectorhinchus mediterraneus	144.53 328	0.23
	Sphyraena guachancho	137.97 328	0.22
	Sardinella aurita	111.68 656	0.18
	Spondyliosoma cantharus	52.56 328	0.08
	Nicholsina usta	45.97 328	0.07
	Sphoeroides marmoratus	19.71 656	0.03
	Boops boops	13.12 328	0.02
	Bodianus speciosus	5.80 3	0.01
	Fishing gears	0.00 3	0.00
	Total	62627.20	99.32

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 21
DATE :01/10/19 GEAR TYPE: BT NO: 2 POSITION:Lat N 14°15.09
start stop duration Lon W 17°7.62
TIME :15:05:49 15:45:43 39.9 (min) Purpose : 3
LOG : 7752.78 7755.13 2.4 Region : 1300
FDEPTH: 24 22 Gear cond.: 0
BDEPTH: 24 22 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.5 kn
Sorted : 0 Total catch: 37.27 Catch/hour: 56.04

SAMP	SPECIES	CATCH/HOUR	% OF TOT. C
		weight numbers	
	Chloroscombrus chrysurus	16.00 158	28.55
53			
	Plastic	7.31 2	13.04
	Pagrus caeruleostictus	5.74 21	10.25
	Cymbium pepo	4.57 2	8.16
	Alectis alexandrinus	2.90 8	5.18
	Caranx rhonchus	2.85 21	5.09
52			
	Lithognathus mormyrus	2.66 8	4.75
	Lagocephalus laevigatus	2.45 3	4.37
	Sepia hierredda	2.11 9	3.76
	Xyrichtys novacula	1.38 17	2.47
	Scorpaena scrofa	1.23 21	2.20
	Mugil curema	0.96 5	1.72
	Fistularia petimba	0.93 9	1.66
	Hermits, mixed	0.77 2	1.37
	Selene dorsalis	0.77 5	1.37
	Eucinostomus melanopterus	0.68 6	1.21
	Trachinotus ovatus	0.59 3	1.05
	Coris julis	0.44 5	0.78
	Sphyraena guachancho	0.44 2	0.78
	Pagellus bellottii	0.27 2	0.48
	Brachydeuterus auritus	0.27 3	0.48
	Diplodus bellottii	0.21 3	0.38
	Halobatrachus didactylus	0.21 2	0.38
	Serranus accraensis	0.15 2	0.27
	Pomadasys incisus	0.11 2	0.19
	URCHINS	0.05 2	0.08
	Total	56.04	100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 22
DATE :02/10/19 GEAR TYPE: PT NO: 4 POSITION:Lat N 14°29.97
start stop duration Lon W 17°19.27
TIME :02:36:11 03:06:03 29.9 (min) Purpose : 3
LOG : 7821.04 7822.68 1.6 Region : 1300
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 48 57 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.3 kn
Sorted : 0 Total catch: 1.22 Catch/hour: 2.46

SAMP	SPECIES	CATCH/HOUR	% OF TOT. C
		weight numbers	
	Scomber colias	1.14 12	46.16
54			
	Trachurus trecae	0.56 32	22.79
55			
	Euthynnus alletteratus	0.34 2	13.89
	Sardinella maderensis	0.18 2	7.35
	Priacanthus arenatus	0.12 44	4.90
	Fodiator acutus	0.04 2	1.63
	Saurida brasiliensis	0.02 4	0.82
	Loligo vulgaris	0.02 4	0.82
	Sepia officinalis	0.02 4	0.82
	Bregmaceros sp.	0.02 54	0.82
	Total	2.46	100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 23
DATE :02/10/19 GEAR TYPE: PT NO: 8 POSITION:Lat N 14°48.20
start stop duration Lon W 17°24.30
TIME :10:46:31 11:14:43 28.2 (min) Purpose : 1
LOG : 7893.55 7895.98 2.4 Region : 1300
FDEPTH: 10 30 Gear cond.: 0
BDEPTH: 56 60 Validity : 0
Towing dir: 0° Wire out : 250 m Speed : 5.2 kn
Sorted : 0 Total catch: 2219.53 Catch/hour: 4724.08

SAMP	SPECIES	CATCH/HOUR	% OF TOT. C
		weight numbers	
	Sphyraena sphyraena	2023.74 5908	42.84
59			
	Trachurus trachurus	1245.27 9995	26.36
56			
	Sarda sarda	541.21 830	11.46
60			
	Caranx rhonchus	432.30 1594	9.15
58			
	Scomber colias	363.89 2124	7.70
57			
	Pomadasys incisus	73.20 398	1.55
	Sardinella aurita	20.24 166	0.43
	Loligo forbesi	17.26 34	0.37
	Pagellus bellottii	6.96 117	0.15
	Fishing gears	0.00 2	0.00
	Total	4724.08	100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 24
DATE :02/10/19 GEAR TYPE: PT NO: 8 POSITION:Lat N 14°58.00
start stop duration Lon W 17°10.00
TIME :16:42:58 17:40:00 57.0 (min) Purpose : 1
LOG : 7944.33 7949.86 5.5 Region : 1300
FDEPTH: 15 15 Gear cond.: 6
BDEPTH: 25 25 Validity : 0
Towing dir: 0° Wire out : 60 m Speed : 4.8 kn
Sorted : 0 Total catch: 35000.00 Catch/hour: 36822.72

SAMP	SPECIES	CATCH/HOUR	% OF TOT. C
		weight numbers	
	Trachurus trecae	32756.55 181333	88.96
62			
	Scomber colias	3790.34 17875	10.29
63			
	Jellyfish	111.99 215	0.30
61			
	Sardinella aurita	103.37 429	0.28
	Sardinella maderensis	60.30 215	0.16
	Total	36822.55	100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 25
DATE :03/10/19 GEAR TYPE: BT NO: 2 POSITION:Lat N 15°24.33
start stop duration Lon W 17°10.69
TIME :09:18:20 09:55:21 37.0 (min) Purpose : 1
LOG : 8025.56 8027.25 1.7 Region : 1300
FDEPTH: 278 320 Gear cond.: 0
BDEPTH: 278 320 Validity : 0

Towing dir: 0° Wire out : 590 m Speed : 2.7 kn
Sorted : 0 Total catch: 224.18 Catch/hour: 363.34

SPECIES SAMP	CATCH/HOUR weight	numbers	% OF TOT. C
Merluccius polli	146.26	1757	40.25
Zenopsis conchifer	74.36	50	20.47
Munida sp.	39.94	5705	10.99
Synagrops microlepis	31.90	2470	8.78
Chlorophthalmus atlanticus	21.39	1011	5.89
Sphoeroides pachygaster	18.61	28	5.12
Trichiurus lepturus	6.19	3	1.70
Chascanopsetta lugubris	5.38	13	1.48
Octopus vulgaris	4.80	3	1.32
Parapenaeus longirostris	3.95	532	1.09
Pontinus kuhlii	2.14	52	0.59
Paraconger notialis	1.94	13	0.54
MYCTOPHIDAE	1.17	454	0.32
Raja microocellata	1.10	6	0.30
Sepia officinalis	0.84	45	0.23
Ophidion lozanoi	0.78	39	0.21
Malacocephalus occidentalis	0.65	19	0.18
Bembrops heterurus	0.58	13	0.16
Loligo vulgaris, juvenile	0.45	156	0.12
Lophiodes kempi	0.32	6	0.09
Microchirus boscanion	0.26	26	0.07
Parapandalus narval	0.19	58	0.05
Helicolenus dactylopterus ***, juvenile	0.13	32	0.04
Total	363.34		100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 26
DATE :03/10/19 GEAR TYPE: PT NO: 8 POSITION:Lat N 15°39.23
start stop duration Lon W 16°50.34
TIME :19:43:32 20:42:04 59.0 (min) Purpose : 3
LOG : 8113.11 8109.64 3.5 Region : 1300
FDEPTH: 25 35 Gear cond.: 0
BDEPTH: 25 35 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.0 kn
Sorted : 0 Total catch: 10.35 Catch/hour: 10.53

SPECIES SAMP	CATCH/HOUR weight	numbers	% OF TOT. C
Trachinotus ovatus	2.95	15	28.02
Brachydeuterus auritus	2.64	15	25.12
Trichiurus lepturus	1.75	13	16.62
Selene dorsalis	0.71	4	6.76
Caranx rhonchus	0.69	3	6.57
Loligo vulgaris	0.61	8	5.80
Trachurus trecae	0.53	5	5.02
Sphyraena guachancho	0.43	2	4.06
Sardinella aurita	0.18	1	1.74
Loligo vulgaris, juvenile	0.02	35	0.19
Bregmaceros sp.	0.01	44	0.10
Total	10.53		100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 27
DATE :03/10/19 GEAR TYPE: BT NO: 2 POSITION:Lat N 15°37.83
start stop duration Lon W 16°43.57
TIME :23:17:15 23:47:11 29.9 (min) Purpose : 3
LOG : 8132.86 8134.48 1.6 Region : 1300
FDEPTH: 28 28 Gear cond.: 0
BDEPTH: 28 28 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.2 kn
Sorted : 0 Total catch: 433.40 Catch/hour: 868.55

SPECIES SAMP	CATCH/HOUR weight	numbers	% OF TOT. C
Pseudotolithus senegalensis	181.08	2020	20.85
Pentanemus quinquarius	159.68	5327	18.38
Pomadasys perotaei	127.94	565	14.73
Pteroscion peli	108.70	6481	12.51
Carlarius parkii	82.12	601	9.46
Cymbium cymbium	48.74	156	5.61
JELLYFISH	35.35	144	4.07
64			
Trichiurus lepturus	21.18	647	2.44
Gymnura altavela	18.72	2	2.16
Dasyatis marmorata	16.03	8	1.85
Parapenaeus longirostris	10.22	2104	1.18
Drepane africana	8.74	192	1.01
Ilisha africana	8.66	3463	1.00
Pseudotolithus elongatus	5.97	6	0.69
Sanquerus validus	5.29	253	0.61
Alectis alexandrinus	5.01	6	0.58
Brachydeuterus auritus	4.57	36	0.53
Selene dorsalis	4.21	1251	0.48
Pisodonophis semicinctus	3.25	8	0.37
Cynoglossus senegalensis	3.15	4	0.36
Blennius normani	3.13	1780	0.36
Pomadasys jubelini	2.75	2	0.32
Munida sp.	1.68	301	0.19
Penaeus notialis	1.38	86	0.16
Cynoglossus monodi	0.34	36	0.04
Sardinella aurita	0.17	72	0.02
Starfish (pentagon)	0.12	12	0.01
Bregmaceros mcclellandi	0.12	24	0.01
Dicologoglossa cuneata	0.12	12	0.01
Genypterus capensis	0.12	12	0.01
Hemicaranx bicolor	0.01	12	0.00
Chloroscombrus chrysurus	0.01	12	0.00
Total	868.55		100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 28
DATE :04/10/19 GEAR TYPE: PT NO: 4 POSITION:Lat N 15°58.09
start stop duration Lon W 16°49.38
TIME :05:22:59 05:52:08 29.2 (min) Purpose : 3
LOG : 8182.44 8184.11 1.7 Region : 1300
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 89 95 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.4 kn
Sorted : 0 Total catch: 24.18 Catch/hour: 49.76

SPECIES SAMP	CATCH/HOUR weight	numbers	% OF TOT. C
Trachurus trecae	41.71	3056	83.82
65			
J E L L Y F I S H	7.49	45	15.05
Loligo vulgaris	0.45	6	0.91
Plastic	0.10	6	0.21
Acanthurus monroviae, juvenile	0.00	6	0.00
Selene dorsalis, juvenile	0.00	6	0.00
Total	49.76		100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 29
DATE :04/10/19 GEAR TYPE: BT NO: 2 POSITION:Lat N 15°54.20
start stop duration Lon W 16°41.49
TIME :07:47:47 08:26:16 38.5 (min) Purpose : 3
LOG : 8198.50 8200.66 2.2 Region : 1300
FDEPTH: 46 57 Gear cond.: 0
BDEPTH: 46 57 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.4 kn
Sorted : 156 Total catch: 447.54 Catch/hour: 697.65

SPECIES SAMP	CATCH/HOUR weight	numbers	% OF TOT. C
Brachydeuterus auritus	327.61	2324	46.96
Trichiurus lepturus	70.85	931	10.16
Trachurus trecae	64.30	793	9.22
Engraulis encrasicolus	48.01	15001	6.88
66			
Pagellus bellottii	33.09	200	4.74
J E L L Y F I S H	28.93	48	4.15
Pseudupeneus prayensis	21.61	164	3.10
Raja miraletus	17.77	25	2.55
Trachurus trecae, juvenile	16.29	1585	2.33
Octopus vulgaris	16.04	34	2.30
Hexaplex duplex	9.29	14	1.33
CIDARIDAE	6.11	292	0.88
Priacanthus arenatus	5.32	22	0.76
Citharus linguatula	4.88	167	0.70
Brachydeuterus auritus, juvenile	3.41	1313	0.49
Zeus faber	3.20	22	0.46
Pomadasys jubelini	2.24	14	0.32
Pseudotolithus senegalensis	2.10	3	0.30
Penaeus notialis	2.04	145	0.29
Scorpaena scrofa	2.04	41	0.29
Arius parkii **	1.96	14	0.28
Loligo vulgaris	1.56	11	0.22
Merluccius senegalensis	1.45	14	0.21
Pteroscion peli	1.23	8	0.18
Stromateus fiatola	1.03	2	0.15
Boops boops	1.01	84	0.15
Brotula barbata	0.80	11	0.11
Halobatrachus didactylus	0.65	3	0.09
Chilomycterus spinosus mauretanicus	0.58	2	0.08
Sepia bertheloti	0.58	30	0.08
Sardina pilchardus	0.51	3	0.07
Sardinella aurita, juvenile	0.31	14	0.04
Sepia officinalis	0.30	30	0.04
GOBIIDAE	0.30	161	0.04
Parapenaeus longirostris	0.30	69	0.04
Diplodus bellottii	0.19	3	0.03
Pterothrissus belloci	0.14	3	0.02
Total	698.04		100.06

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 30
DATE :04/10/19 GEAR TYPE: BT NO: 2 POSITION:Lat N 15°50.59
start stop duration Lon W 16°35.60
TIME :09:52:57 10:33:49 40.9 (min) Purpose : 1
LOG : 8210.81 8213.10 2.3 Region : 1300
FDEPTH: 20 21 Gear cond.: 0
BDEPTH: 20 21 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.4 kn
Sorted : 0 Total catch: 1884.68 Catch/hour: 2767.52

SPECIES SAMP	CATCH/HOUR weight	numbers	% OF TOT. C
J E L L Y F I S H	929.52	6931	33.59
Drepane africana	444.64	1292	16.07
Pentanemus quinquarius	361.82	9692	13.07
Pseudotolithus senegalensis	266.08	1292	9.61
Trichiurus lepturus	260.79	1380	9.42
Pteroscion peli	208.52	2526	7.53
Cynoglossus monodi	72.83	822	2.63
Brachydeuterus auritus	62.85	558	2.27
Portunus validus	42.88	529	1.55
Pseudotolithus elongatus	41.12	59	1.49
Ilisha africana ***	27.02	294	0.98
Galeoides decadactylus	17.62	1527	0.64
Lagocephalus laevigatus	12.92	264	0.47
Chloroscombrus chrysurus	7.34	29	0.27
Carlarius parkii	5.29	176	0.19
Pisodonophis semicinctus	5.11	13	0.18
Parapenaeus longirostris	1.17	235	0.04
Total	2767.52		100.00

R/V Dr. Fridtjof Nansen SURVEY:2019411 STATION: 31
DATE :04/10/19 GEAR TYPE: BT NO: 2 POSITION:Lat N 15°26.26
start stop duration Lon W 16°50.08
TIME :14:42:47 15:21:28 38.7 (min) Purpose : 1
LOG : 8238.92 8241.08 2.2 Region : 1300
FDEPTH: 32 32 Gear cond.: 0
BDEPTH: 32 32 Validity : 0
Towing dir: 0° Wire out : 130 m Speed : 3.4 kn
Sorted : 0 Total catch: 2061.56 Catch/hour: 3198.70

SPECIES SAMP	CATCH/HOUR weight	numbers	% OF TOT. C
J E L L Y F I S H	1034.76	1356	32.35
67			
Pentanemus quinquarius	798.91	39268	24.98
Pteroscion peli	699.86	46686	21.88
Brachydeuterus auritus	173.93	1651	5.44
Trichiurus lepturus	154.18	4982	4.82
Pseudotolithus senegalensis	121.46	6	3.80
Gymnura altavela	48.72	2	1.52
Ilisha africana	37.44	825	1.17
Penaeus notialis	23.44	690	0.73
Bembrops heterurus	22.11	472	0.69
Octopus vulgaris	18.57	118	0.58
Cymbium cymbium	13.27	177	0.41
Stromateus fiatola	7.94	5	0.25
Eucinostomus melanopterus	7.08	59	0.22
Cynoglossus monodi	6.19	59	0.19
Lesueurigobius sanzi	5.01	236	0.16
Calappa rubroguttata	4.72	88	0.15
Cynoponticus ferox	4.41	2	0.14
Dasyatis centroura	4.34	2	0.14
Antennarius striatus	2.95	17	0.09
Selene dorsalis	2.65	973	0.08
Raja miraletus	2.08	3	0.06
Cynoglossus robustus	1.82	2	0.06
Pseudotolithus elongatus	1.55	2	0.05
Pisodonophis semicinctus	1.30	6	0.04
Total	3198.70		100.00

ANNEX IV. BIOLOGY SCALES AND STAGES

Sexual maturity

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

Stomach content

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

ANNEX V. INPUT VALUES FOR STOCK ESTIMATES

Sardinellas

Species	Stratum	Casmance	Gambia	Petite Cote	N-1	N-2
	Mean Sa	507	375	224	92	114
	Area (nm2)	1216	712	832	245	29
S. aurita	L-W a	0.02	0.02	0.02	0.02	0.02
	L-W b	2.90	2.90	2.90	2.90	2.90
S. maderensis	L-W a	0.13	0.13	0.13	0.13	0.13
	L-W b	2.910	2.91	2.91	2.91	2.91

Horse mackerel

Species	Stratum	Casmance	Gambia	PC-1	PC-2	PC-3	N-1	N-2	N-3	N-4
	Mean Sa	114	69	3087	1403	24	32	61031	174	30
	Area (nm2)	664	399	10	73	4	73	7	37	27
T. tracea	L-W a	0.013	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	L-W b	2.901	2.90	2.90	2.90	2.90	2.90	2.90	2.9	2.9

Scomber colias

Species	Stratum	Casmance	Gambia	PC-1	PC-2	North
	Mean Sa	2	172	84	24	40
	Area (nm2)	260	346	612	280	179
S. colias	L-W a	0.004	0.004	0.004	0.004	0.004
	L-W b	3.265	3.265	3.265	3.265	3.265

Pelagic 1 (clupeids)

Stratum	Casmance	Petite Cote	North
Mean Sa	73	12	21
Area (nm2)	129	179	237
Mean length (cm)	14	14	14
Condition factor	0.01	0.01	0.01

Pelagic 2 (other pelagics)

Stratum	Casmance	Gambia	Petite Cote	North
Mean Sa	80	110	280	59
Area (nm2)	1272	622	1083	650
Mean length (cm)	23	23	23	23
Condition factor	0.01	0.01	0.01	0.01

ANNEX VI. STANDARD PROCESS FOR HANDING OVER DATA TO THE PARTNERS

Survey no 2019408		after the survey	at the post survey meeting	upon request	not collected/stored	analyzed by partner country	analyzed through the Science Plan
Data types	Data						
Acoustic data	EK60 compatible		x				
Acoustic data	EK80			x			
Acoustic data	MS70				x		
Acoustic data	ME70				x		
Acoustic data	SU90				x		
Acoustic data	SH90				x		
Acoustic data	SBP300	-	-		x		
Acoustic data	EM302			x			
Acoustic data	EM710			x	-		
Physics	CTD probe	x					
Physics	CTD Underway				x		
Physics	ADCP 75kHz	-					
Physics	ADCP 150kHz	x					
Physics	LADCP				x		
Physics	Thermosalinograph	x					
Physics	Nutrients		x				
Physics	pH			x			
Physics	Total alkalinity			x			
Physics	PCO2			x			
Physics	Chlorophyll	x	x				
Biology	Trawl catch data	x	x				
Biology	Zooplankton		x				
Biology	Phytoplankton		x				
Pollution	Microplastics						x
Geology	Sediment (trawl)						x
Geology	Grab					x	
Observation platforms	VAMS				x		
Observation platforms	WBAT				x		
Observation platforms	Deep vision				x		

ANNEX VII. SAMPLES COLLECTED, PRESERVATION AND STATUS

Sample type	Analyses	Samples	Preservation	Port of offloading	Type of transportation	Institution address	Contact person	Status
Niskin bottles on CTD	Sea water nutrients	20 ml scintillation vials	0.2 ml chloroform (keep cool)	Dakar	Checked Luggage	IMR	David Cervantes	Processed
WP2 (180 µm) from max 200 m ½ Split	Zooplankton biomass estimation	Aluminium trays	Dried and then frozen	Las Palmas	Boat	IMR	Stamatina Isari	Processed
WP2 (180 µm) from max 200 m ½ Split	Zooplankton community identification	Bottles with ½ of bulk WP2 sample	4% formaldehyde	Las Palmas	Boat	IMR	Stamatina Isari	Processed
Bongo V (left net, 405 µm), double oblique tow from max 200 m	Ichthyoplankton community identification	Bottles with the bulk of the sample after sorting ichthyoplankton	4% formaldehyde	Las Palmas	Boat	IMR	Stamatina Isari	Processed
Bongo H (right net 405 µm), double oblique tow from max 200 m	Ichthyoplankton community identification	Bottles with the bulk of the sample after sorting ichthyoplankton	4% formaldehyde	Las Palmas	Boat	IMR	Stamatina Isari	Processed
	Ichthyoplankton community identification	Scintillation vials with sorted larval fish and eggs from one of right bongo net (H)	96% ethanol	Las Palmas	Boat	IMR	Stamatina Isari	Processed
Manta trawl (335 µm): surface tow for 15 mins	Neuston community identification	Neuston community	96 % ethanol	Las Palmas	Plane	UWC	Mark Gibbons	?

Sample type	Analyses	Samples	Preservation	Port of offloading	Type of transportation	Institution address	Contact person	Status
		identification						
	Species identification, Genetics	Scintillation vials with sorted ichthyoplankton from the bulk manta sample	96% ethanol	Las Palmas	Plane	IMR	Stamatina Isari	?
	Abundance and chemical composition of microplastics	Aluminium trays with sorted microplastics from the bulk manta sample	Photographed, dried and frozen	Las Palmas		IMR	Bjørn Einar Grøsvik,	?
Trawl samples	Species identification	Jellyfish whole individual	Dried + frozen	Las Palmas	Plane	UWC	Mark Gibbons	?
Trawl samples	Genetic analyses?	Jellyfish arm	96% Ethanol + frozen	Las Palmas	Plane	UWC	Mark Gibbons	?
Trawl samples	??	Jellyfish the rest	4% formaldehyde	Las Palmas	Plane	UWC	Mark Gibbons	?
Trawl samples	Taxonomy	Whole fish, for species that cannot be identified	Frozen	Las Palmas		IMR		?
Trawl samples	Otoliths							?
Trawl samples	Stomachs							?
Trawl samples	Fin clips							?
Trawl samples	Frozen samples (morphometrics)							?
Trawl samples	Gonads							?
Trawl samples								?
Trawl samples	Museum collection	Whole specimen	4% formaldehyde	Las Palmas				?

Sample type	Analyses	Samples	Preservation	Port of offloading	Type of transportation	Institution address	Contact person	Status
Trawl samples	chemical composition	Food safety samples	freezed dried / vacum packed	Las Palmas		IMR		?
Trawl samples	chemical composition	Fish liver - food safety	Frozen -80	Las Palmas		IMR		?