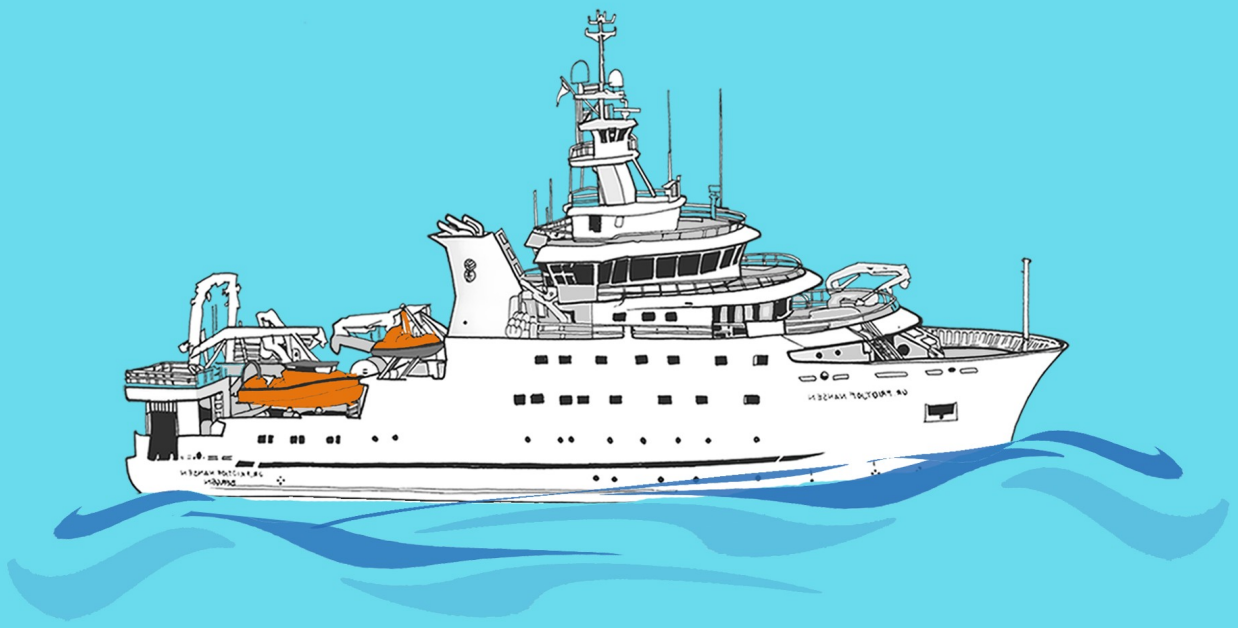
NORAD-FAO PROGRAMME
GCP/GLO/690/NOR

CRUISE REPORTS *DR FRIDTJOF NANSEN*
EAF-Nansen/CR/2017/4



SURVEY OF THE PELAGIC FISH RESOURCES AND ECOSYSTEM OFF WEST AFRICA

Senegal and The Gambia

9 July - 18 July 2017

Centre de Recherches Océanographiques
de Dakar-Thiaroye
Dakar, Senegal

Institute of Marine Research
Bergen, Norway

Department of Fisheries
Banjul, The Gambia

The EAF-Nansen Programme

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

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

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

Le Programme EAF-Nansen

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

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

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

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CRUISE REPORTS "DR FRIDTJOF NANSEN"

SURVEY OF THE PELAGIC FISH RESOURCES AND ECOSYSTEM OFF WEST AFRICA

Senegal and The Gambia
9 July - 18 July 2017

By

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Contents

EXECUTIVE SUMMARY

The R/V Dr Fridtjof Nansen surveyed along the coast of Senegal and The Gambia, from St. Louis to the Casamance.

A common survey design was adopted with parallel transects perpendicular to the coastline, 10 NM apart, and acoustic measurements of pelagic fish obtained on the shelf from the 20 m to the 500 m bottom depth. At each degree of latitude, a hydrographic transect was carried out to a depth of 1000 m. Meteorological and hydrographic measurements were recorded routinely on these transects in addition to samples on ocean acidification parameters (pH and alkalinity), nutrients, phytoplankton, zooplankton, fish eggs and larvae and microplastics on some stations.

The survey was carried out with a scientific personnel of 30, coming from eight different countries.

Data collection along the coasts of Senegal and The Gambia was extensive, covering a wide range of scientific fields related to marine biology and ecology: hydrography, meteorology, microplastic, phytoplankton, zooplankton, jellyfish, eggs and larvae, fish biology, genetics, fish abundance, and food safety. A large part of the samples and of the data collected has not been analysed and this will be done in the context of the Science Plan. Hence, this survey report only gives an account of what was done during the survey and presents some preliminary results.

The hydrographic conditions were quite similar along the coasts of Senegal and The Gambia. The surface layer had typical characteristics of tropical water masses with high temperatures and high salinities.

Fluorescence measurements indicated low algal concentrations throughout the area. pH values were highest in the surface and decreased with depth. There were no clear geographical patterns in the biomass of zooplankton along the coast of Senegal and The Gambia.

Microplastics were found at 15 of the 18 sampling stations, and the highest concentrations were found at a station relatively close to Dakar.

With respect to main groups of pelagic fish encountered during the survey of Senegal and The Gambia, sardinellas were mainly distributed between Cap Vert and The Gambia, with approximately the same biomass of *S. aurita* and *S. maderensis*. The highest abundance of *T. trecae* was found north of Cap Vert. The biomass of *S. colias* was low throughout the sampling area. Carangids and associated species were found in all areas, with the highest abundance on the shelf of The Gambia. Among the non-target species, *Boops boops* constituted the highest biomass in the trawl catches, followed by *Brachydeuterus auritus*.

With regard to biomass estimates of sardinellas and carangids and associated species (including *T. trecae*) for Senegal and The Gambia, the results show that in 2017, the biomass had decreased to almost half of that in 2015 and was just below the long-term mean, noting that the 2015 estimate was one of the highest on records. The biomass of sardinella was well below the long-term mean already in 2015, and in 2017, it had dropped to the second lowest on records.

RÉSUMÉ

Le N/R Dr Fridtjof Nansen a conduit une campagne le long des côtes du Sénégal et de la Gambie, de Saint-Louis au Casamance.

Un plan d'échantillonnage a été adopté avec des transects parallèles perpendiculaires à la côte, espacés de 10 MN, et des mesures acoustiques de poissons pélagiques obtenues sur le plateau de 20 m à 500 m de profondeur. À chaque degré de latitude, un transect hydrographique a été effectué jusqu'à une profondeur de 1000 m. Des mesures météorologiques et hydrographiques ont été enregistrées régulièrement au cours de la campagne. En plus, des échantillons sur les paramètres d'acidification des océans (pH et alcalinité), les nutriments, le phytoplancton, le zooplancton, les œufs de poissons, les larves et les microplastiques ont aussi été recueillies

La campagne a été réalisée avec un personnel scientifique composé de 30 personnes provenant de huit pays différents.

La collecte des données au cours de cette campagne le long des côtes du Sénégal et de la Gambie a été intense, couvrant un large éventail de domaines scientifiques liés à la biologie marine et à l'écologie : l'hydrographie, la météorologie, les microplastiques, le phytoplancton, le zooplancton, les méduses, la biologie de la pêche, y compris les œufs et les larves, la génétique et l'abondance de poisson. Beaucoup de données n'ont pas encore été analysées. Par conséquent, ce rapport donne seulement un aperçu de ce qui a été fait pendant la campagne et présente quelques résultats.

Les conditions hydrographiques étaient assez similaires le long des côtes du Sénégal et de la Gambie. La couche superficielle avait des caractéristiques typiques des masses d'eau tropicales avec des températures et salinités élevées.

Les niveaux de fluorescence ont montré une présence faible de phytoplancton. On pas trouvé de schéma géographique de la biomasse du zooplancton le long des côtes du Sénégal et de la Gambie.

Des microplastiques ont été trouvés dans 15 des 18 stations d'échantillonnage, et les concentrations les plus élevées ont été trouvées dans une station relativement proche à Dakar.

En ce qui concerne les principaux groupes de poissons pélagiques rencontrés lors de l'enquête du Sénégal et de la Gambie, les sardinelles étaient principalement réparties entre le Cap Vert et la Gambie, avec approximativement la même biomasse de *S. aurita* et *S. maderensis*. L'abondance la plus élevée de *T. trecae* a été observée au nord du Cap Vert. La biomasse de *S. colias* était faible dans toute la zone d'échantillonnage. Des carangidés et des espèces associées ont été trouvés dans toutes les régions, l'abondance la plus élevée se trouvant sur le plateau de la Gambie. Parmi les espèces non ciblées, les *Boops boops* constituaient la biomasse la plus élevée dans les captures au chalut, suivies par le *Brachydeuterus auritus*.

En ce qui concerne les estimations de la biomasse de sardinelles et de carangidés et des espèces associées (y compris *T. trecae*) pour le Sénégal et la Gambie, les résultats montrent qu'en 2017, la biomasse avait été réduite de près de la moitié de celle de 2015 et qu'elle était juste en dessous du niveau à long terme, notant que l'estimation de 2015 était l'une des plus élevées jamais enregistrées. La biomasse de sardinelles était déjà bien inférieure à la moyenne à long terme en 2015 et, en 2017, elle était tombée au deuxième niveau le plus bas jamais enregistré.

CHAPTER 1. INTRODUCTION

1.1 Survey objectives

This survey was planned as part of a synoptic coverage of West Africa's pelagic resources and ecosystems conducted from Morocco to South Africa, from May to December 2017 as part of the EAF-Nansen Programme (2017-2021).

In connection with this phase of the Programme, a Science Plan has been developed that addresses 11 different themes within three main lines of research related to resources, impacts of oil/mining activities and pollution on resources and ecosystems and climate change. Therefore, in addition to providing key information on abundance and distribution of main pelagic stocks, the survey programme was designed to also support the research projects under the science plan.

The specific objectives include:

Hydrography:

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

Phytoplankton, zooplankton, ichthyoplankton and jellyfish:

- To establish as far as possible, the distribution, abundance and composition of phyto- and zooplankton, and fish eggs and larvae;
- To contribute to increase the understanding of taxonomy, biology and ecological role of jellyfish.

Pelagic stocks abundance, distribution and biology:

- To obtain information on abundance, distribution (also by size) of *Sardina pilchardus*, *Sardinella aurita, Sardinella maderensis, Trachurus trachurus, Trachurus trecae*, *Scomber colias, and Engraulis encrasicolus* using acoustic methods and a systematic grid survey strategy.
- To collect samples for genetic and morphometric analysis (for stock identification of *S. aurita*, *S. pilchardus* and *Scomber colias*).
- To obtain information on maturity stages of *S. aurita*, *S. pilchardus* and *Scomber colias.*
- To collect stomach samples for analysis of contents for selected species.
- To collect otoliths, *S. aurita*, *S. pilchardus* and *Scomber colias* for stock identification.

Food safety:

- To collect samples for levels of environmental contaminants, nutrients, parasites and microorganisms with regards to food safety and pollution.

Microplastics:

- To collect samples of microplastic particles in surface waters.

1.2 Participation

Institute of Marine Research, Norway (IMR), Norway:
Oddgeir Berg Alvheim, Geir Landa, Jostein Andre Solhaug, Elisabeth Lundsør, Tore Johannessen (Cruise leader), Tor Magne Ensrud and Thomas James Williams,

National Institute of Nutrition and Seafood Research (NIFES), Norway:
Edel Erdal

Centro de Investigação Pesqueira Aplicada, Guinea Bissau:
Duarte Bucal (team leader Guinea Bissau), Martinho Joaquim Gomes, Abrigo Menda and Amadeu Mendes De Almeida.

Centre de Recherches Océanographiques de Dakar-Thiaroye, Senegal,
Oumar Sadio (team leader Senegal), Tamsir Ousmane Sow, Saliou Faye, Limale Deme, Aboubacar Gueye, Naby Souleymane Faye and Ndague Diougoul.

Marine Nationale Sénégalaise, Senegal
Mamadou Diene (Navy observer)

Instituto Español de Oceanografía, Spain:
Begoña Maria Sotillo De Olano.

The University of the Western Cape, South Africa:
Yasmeen Parker.

Institut Mauritanien de Recherches Océanographiques et des Pêches (IMROP), Mauritania :
Alioune Niang, Cheikhna Gandega and Ahmed Diagne.

Department of Fisheries (FD), The Gambia:
Momodou S Jallow (Gambian team leader), Salifu Ceesay, Momodou Sidibeh.

Instituto Nacional de Desenvolvimento das Pescas, Cap Verde:
Ivanice Oliveira Monteiro and Nuno Roberto Dias Brito Vieira.

1.3 Narrative

The R/V *Dr. Fridtjof Nansen* departed from Dakar, Senegal, on 6 July 2017 to finish the last part of the survey off Mauritania. On 9 July, at 16 00 GMT, the vessel entered northern

Senegalese waters and thus the present survey along the coast of Senegal and The Gambia could start. Gambian waters were entered on 13 July at 03 00 GMT, and reached the southern border on 14 July at 12 00 GMT. The border between Senegal and Guinea-Bissau was reached on 17 July at 04 00 GMT, which concluded the survey. The R/V *Dr Fridtjof Nansen* then returned to Dakar on 18 July at 12 00 GMT. The weather conditions were good during the entire survey.

1.4 Survey effort

During all surveys along the west coast of Africa, a common survey design was adopted. The survey was run along parallel transects, 10 NM (nautical miles) apart. The transects were laid approximately perpendicular to the coastline, and acoustic measurements of pelagic fish were obtained on the shelf from the 20 m to the 500 m isobath. Trawling was done either to identify echo registrations or to check 'blindly' if fish were mixed with the plankton in the upper layers of the water column. Pelagic trawl with floats was occasionally used to catch fish close to the surface. A smaller pelagic trawl or the bottom trawl with floats were used for sampling pelagic fish in shallow waters (depth less than 30 m). Figure 1.1 shows the course track and trawl stations.

At each degree of latitude, a hydrographic transect was carried out to a depth of 1 000 m. These transects included CTD casts and sampling of phytoplankton, zooplankton, fish eggs and larvae, and plastics. To obtain hydrographic measurements from Gambian waters, an additional hydrographic transect was carried out between 13 and 14 °N. Figure 1.2 shows the position of hydrographic stations, and Table 1 shows effort during the survey in terms of number of trawl stations, CTD casts and samples of plastic (Manta trawl), phytoplankton, zooplankton (WP2) and fish eggs and larvae (Multi net).

Fish were also sampled for analyses of food safety. No. of samples for this purpose are given in Table 2.

Overview of samples for biological purposes is provided in Annex II.

Table 1. Survey effort. Phyto: phytoplankton net, WP-2: zooplankton net; Multi: multinet for eggs and larvae; Manta: manta trawl for plastic particles in the surface; BT: Bottom trawl; PT: Pelagic trawl. Samples from a hydrographic transect that was carried out on the border between The Gambia and Casamance, Senegal, was allocated to Casamance. An extra hydrographic transect was conducted in the middle of the Gambian EEZ (13.33°N, east- west). Three additional Manta hauls sampling plastic were carried out, near St. Louis, Dakar and Banjul.

	NM sailed	CTD	Phyto	WP-2	Multi	Manta	BT	PT
St Louis - Cap Vert	257	6	3	5	3	4	2	5
Cap Vert - The Gambia	321	9	3	5	3	5	2	7
The Gambia	209	11	3	5	3	4	1	4
Casamance	248	16	6	10	6	6	2	3
Total	1035	42	14	25	15	19	7	19

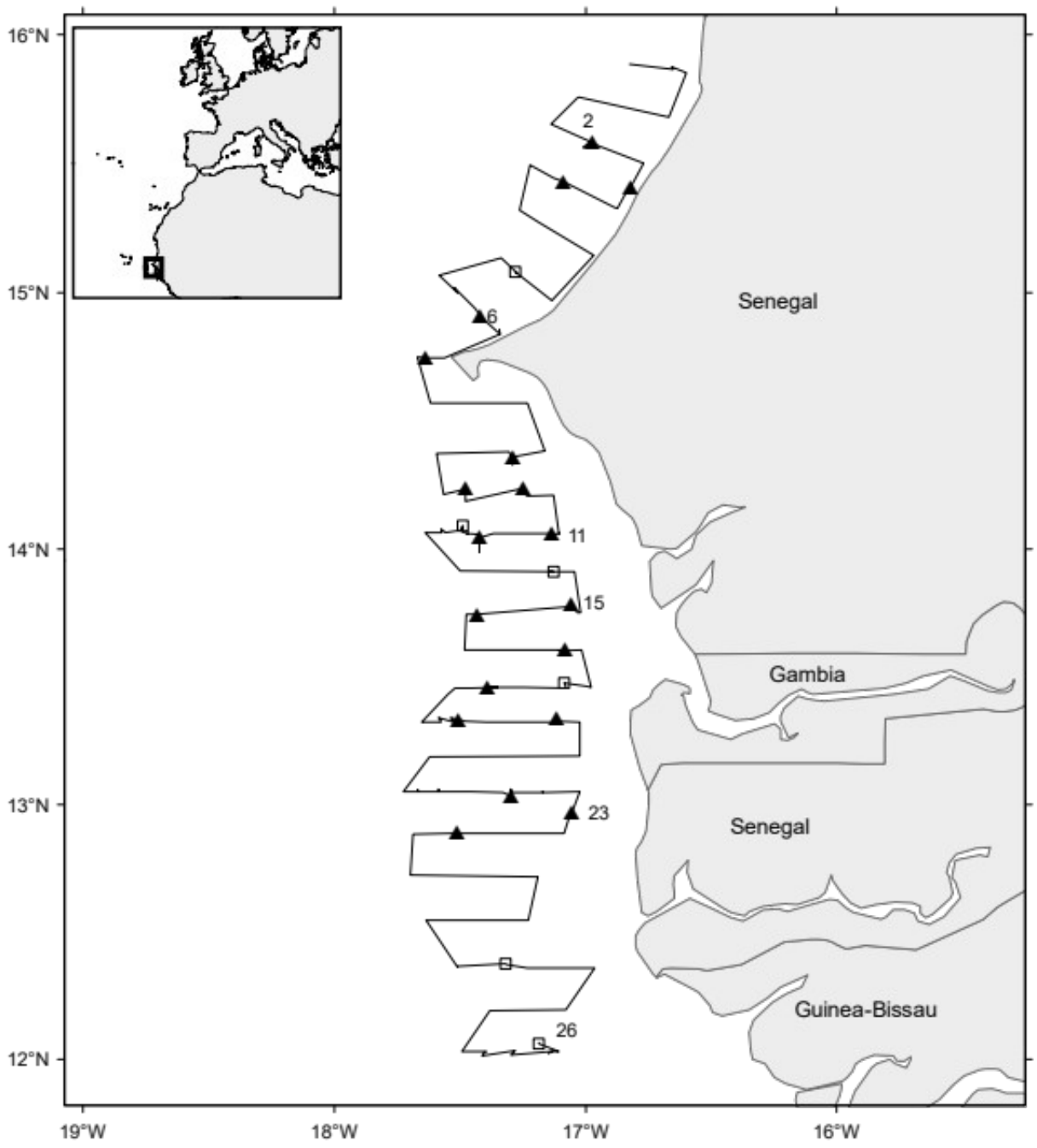


Figure 1.1. Course tracks with trawl stations along Senegal and The Gambia – squares indicate bottom trawl and triangles pelagic trawl. Symbols:▲: pelagic trawl; □ : bottom trawl

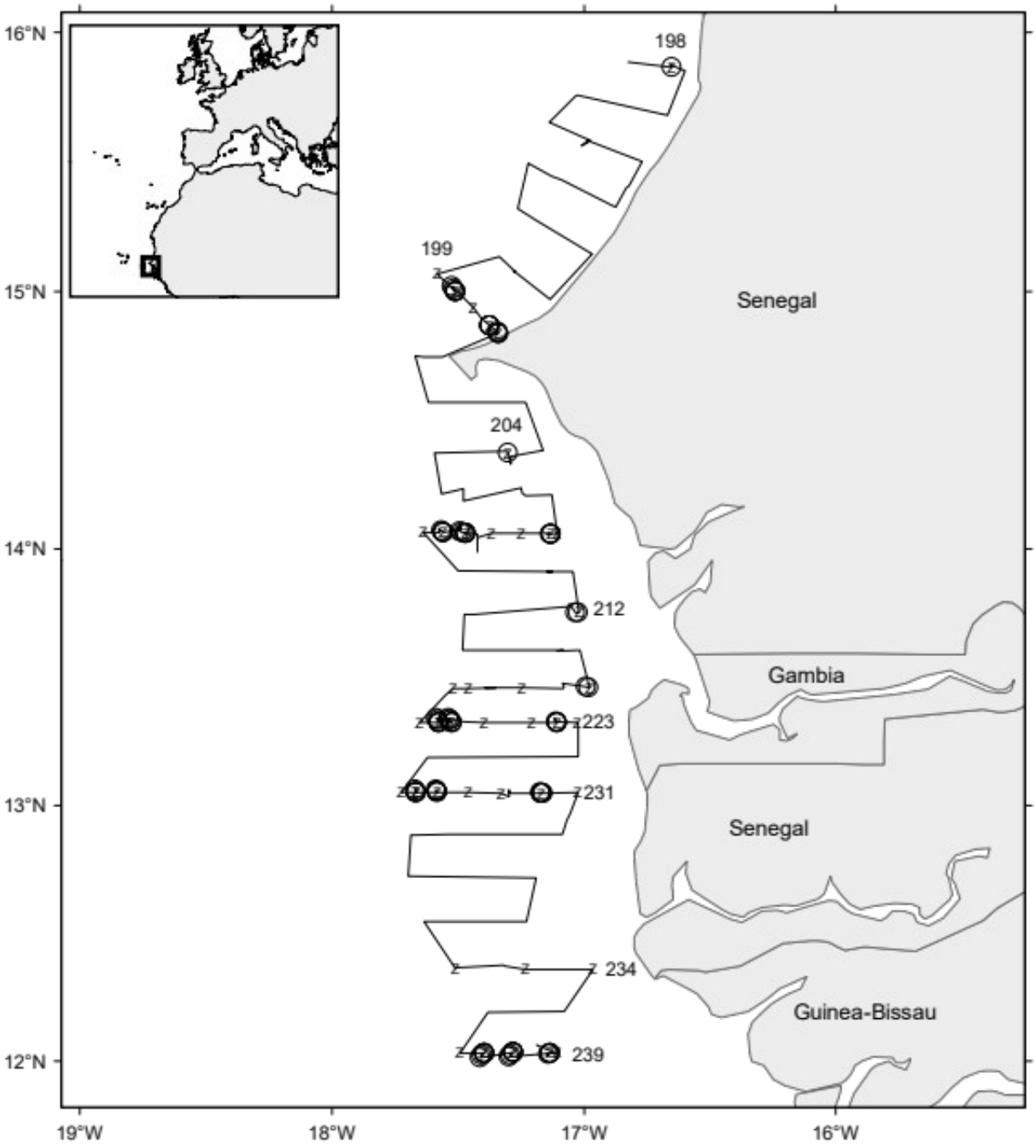


Figure 1.2. Course track with hydrographic and plankton stations – Z indicates CTD; O indicates CTD, plankton, Multi net for eggs and larvae, Manta net for plastic and chemical seawater analyses.

Table 2. No of fish samples collected for food safety analyses per species.

Species	No. of samples	No of positions	Tissue	Nutr.	Cont.	Other
Auxis thazard	18	18	Fillet Liver samples	X	X	
Sardinella maderensis	25	25	Fillet Liver samples	X	X	
Sardinella aurita	25	25	Fillet Liver samples	X	X	
Galeoides decadactylus	19	19	Fillet Liver samples	X	X	

Nutrition: Energy, water content, total fat, proteins, ash, fatty acids, cholesterol, amino acids, tryptophan, vitamins (D, A, E, K, C, thiamine, riboflavin, B6, B12, folate, niacin, pantothene, biotin), iodine, selenium and other minerals.
Contaminants: Heavy metals, Inorganic arsenic, PAH, PBDE, PCB, dioxins, furans, PFAS, pesticides, HBCD,
TBBP-A.
TBARS = Thiobarbituric acid reactive substances
PAH = Polycyclic Aromatic Hydrocarbons
PBDE = Polybrominated diphenyl ethers
PCB= Polychlorinated biphenyls
PFAS = Polyfluoroalkyl substances
HBCD = Hexa Bromo CycloDodecane
TBBPA = Tetrabromobisphenol A

CHAPTER 2. METHODS

2.1 Meteorological data recording

Meteorological data were logged continuously from the AANDERAA Smartguard meteorological station, including wind direction and speed, air pressure, humidity, air temperature and solar radiation. All data were logged to the Nansis tracklog system averaged by unit distance sailed (1 NM).

2.2 Oceanography

Thermosalinograph

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

CTD

Sampling along transects

Vertical temperature and salinity profiles were obtained by a Seabird 911 CTD, while *in situ* concentrations of dissolved oxygen were measured using a CTD-mounted SBE 43 oxygen sensor. Real time logging and plotting was performed using the Seabird Seasave software installed on a PC. Attached to the CTD was also an uncalibrated Chelsea Mk III Aquatracka fluorometer, which measures *in situ* fluorescence on relative scale. The CTD was stopped at the designated depths for 15 seconds before closing the Niskin bottles. CTD casts were conducted at, or close to every degree of latitude, from the coast and offshore to approximately 1 000 m bottom depth. An additional hydrographic transect was carried out in the middle of the Gambian EEZ (13.33 °N, east- west). 12 Niskin bottles (10 l), attached to a CTD-mounted rosette, were used to collect water at standard sampling depths: 5, 25, 50, 75, 100, 150, 200, 250, 300, 400, 500, 750, and 1 000 m. At stations with bottom depth of 1000 m, the sample from 250 m was not collected due to the limitation to 12 Niskin bottles.

Superstations

At bottom depths of 30 m, 100 m and 500 m, the following type of samples/data were collected (so-called “Superstations”): salinity, temperature, dissolved oxygen and fluorescence measured by the CTD with additional sensors, seawater samples, phytoplankton, zooplankton, fish larvae and eggs, and microplastics.

Ocean acidification parameters (pH and alkalinity)

Seawater samples (250 ml) from the CTD-mounted Niskin bottles were collected in borosilicate glass bottles using silicone tubing to reduce air exchange. Both pH and alkalinity

were analysed on board the vessel. pH was determined spectrophotometrically using a diode array spectrophotometer and a pH sensitive indicator, m-cresol purple in 2 mM solution, as described by Clayton and Byrne (1993) and Chierici et al. (1999). Alkalinity was measured by titration with acid (0.05M HCl) and changes in pH were measured with an electrode (potential in mV) using tiamo software. Further processing of the data will be done as part of the science plan Theme 10: Climate change and biogeochemical processes, expected to provide more information on the marine carbonate system and parameters for ocean acidification.

Nutrients

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

2.3 Plankton

Phytoplankton biomass

Chlorophyll-*a* was sampled as an indicator of phytoplankton biomass. For chlorophyll-*a* and phaeopigment measurements, seawater was collected from the CTD at the standard depths (not below 200 meters). The water was filtered using a 0.7µm filtration system (Munktell fiberglass filters Grade: MGF, vacuum 400 mm Hg) and stored at 20°C until analysis on shore by the Institute of Marine Research. The assay is performed by extraction with 90% acetone followed by centrifugation, and the measurements are taken with a fluorometer (model 10 AU, Turner Designs Inc., Sunnyvale, Ca., USA), according to Welshmeyer (1994) and Jeffrey and Humphrey (1975).

In the southern part of the survey-area (stations 105 to 163), 3 parallels were filtered from each depth and stored at -20°C. After 3 weeks, all batches were transferred to -80 ºC. One of the batches was then freeze-dried and thereafter stored at -80 °C. For chlorophyll-a and phaeopigment measurements, water is collected (263 ml) at the standardized depths. The water is filtered using a 0.7µm filtration system (Munktell fiberglass filters Grade: MGF, vacuum 400 mm Hg).

Two batches (one freeze-dried and one only frozen at -80 C) were transported to Norway (Bergen) for subsequent analyses. The last batch in the -80 C freezer was left on the ship for later analyses on board. The analyses in Norway will be done by the Institute of Marine Research which is an accredited laboratory. The assay is performed by extraction with 90% acetone followed by centrifugation, and analysed with a fluorometer (model 10 AU, Turner Designs Inc., Sunnyvale, Ca., USA), according to Welshmeyer (1994) and Jeffrey and Humphrey (1975). The same assay (but not accredited) will be implemented on board the R/V *Dr. Fridtjof Nansen* during fall 2017.

Phytoplankton identification

Phytoplankton was collected along the hydrographic transects at stations positioned at bottom depths of approximately 30 m, 100 m and 500 m. At each plankton-station, qualitative phytoplankton samples were collected with a net (35 cm in diameter and mesh size of 10 µm), hauled vertically at a speed of 0.1 ms^{-1} from the depth of 30 m to the surface (from ca. 5 m above bottom at the 30 m stations). The samples were preserved with 2 ml of 20 % formalin buffered with hexamine in 100 ml bottles (i.e. a final solution of ca. 0.4% formaldehyde). These samples are not quantitative but used to establish the taxonomic composition of the phytoplakton community.

Zooplankton

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

Furthermore, a second collection with the WP2-net was performed for the depth-stratum of 30-0 m at the stations with bottom depths of 100 m and 500 m. The purpose of these additional samplings was to enable a direct comparison of the zooplankton composition and concentrations in the uppermost layer of the water-column along the bottom depth gradient. Each zooplankton-sample was divided into two equally large parts using a Motoda plankton splitter (Motoda 1959). The first part of the sample was size-fractioned by using a series of sieves with the decreasing mesh-sizes of 2000 µm, 1000 µm and 180 µm, and the zooplankton retained on each sieve were thereafter dried on aluminium-trays at ~60 ºC for 24 h. These samples will be dried once more and weighed on shore after the cruise for estimation of biomasses for the different size-groups. The second part of the sample was preserved in seawater with a final solution of 4% formaldehyde buffered with borax for subsequent species identification and quantification on land.

Ichthyoplankton

Fish eggs and larvae were collected using a Hydro-Bios Multinet with 405 µm meshes. Samples were obtained along the hydrographic transects at approximately 30, 100 and 500 m depth. The net was towed obliquely from the bottom or a maximum depth of 100 m to the surface with a towing speed of 1.5 ms^{-1}. All fish larvae visible to "the naked eye" were removed from the total sample, transferred to vials and preserved in 4% borax buffered formaldehyde. After removing visible fish larvae, the Multinet sample was fractionated using a Motoda plankton splitter for enumeration of eggs under a stereomicroscope (Motoda 1959). The principle of this procedure is to split a homogenised sample into two "equal" parts, which

again can be split further depending on the sample size. Small fish larvae overlooked by the "naked eye" scan were collected under the stereomicroscope and preserved in a separate vial noting the splitting factor. The remaining fish eggs were preserved in 4% borax buffered formaldehyde in vials noting the splitting factor. The rest of the sample was fixed for reference purpose and for possible later checks of overlooked egg and larvae.

Microplastics

Microplastics were collected along the hydrographic transects at bottom depths of approximately 30 m, 100 m and 500 m. At each station, the surface layer was sampled with a Manta-trawl with a rectangular opening of 19 cm × 61 cm (HxW), mesh size of 335 µm and two wings to keep it in balance and at the surface during the tow. Trawls were hauled horizontally at a speed of ~1.5 ms^{-1} for 15 minutes. Trawling was performed some meters away from of the right-hand side, about mid-ship, attempting to avoid the wake of the vessel. Geographical start and stop positions were recorded in the bridge-log. In addition, the counts of a flowmeter attached below the trawl opening were recorded at start and stop of each trawl event.

The Manta-trawl samples were washed in filtered seawater over a sieve with mesh size of 180 µm. Plastic particles will be picked with the aid of a dissecting stereomicroscope. Plastic particles were picked from the sample under a stereomicroscope. This repeated twice to ensure detection of the smallest plastic particles. All assumed plastic items were then placed on a gridded petri dish for examination under the stereo-microscope, photographed and, to the extent possible, also measured and described (e.g. length, shape, type and colour). The sorted microplastics were washed with distilled water and dried in pre-weighed aluminium-trays in a drying cabinet at 30 ºC. The trays were packed in aluminium foil and stored at room temperature until transport to the laboratory at IMR, where they will be studied in more detail. After removing the plastics, the remaining part of the samples - mainly biological material - was preserved for studies of neuston that will be carried out after the cruise.

2.4 Trawl sampling

Species composition and size distribution of pelagic fish were estimated based on samples obtained from pelagic and bottom trawl hauls. This information is essential for estimating the biomass of the various species from the acoustic measurements. Annex III gives a description of the instruments and the fishing gear used. In shallow water (< 30 m) or at night when pelagic fish was close to the surface, a small pelagic trawl with floats or a bottom trawl with floats were used for sampling. All catches were sorted, and subsamples taken to measure number and weight by species. Species identification was based on the FAO Species Guides. Individual fish were measured by total length (nearest cm below) and weight. For target species, 30 individuals were investigated with respect to sex, maturity and stomach fullness. In addition, for target species, the following biological samples were collected for later use: otoliths for aging, fin clips for genetic analyses, stomachs for diet studies and liver for condition studies. Based on obtained measurements, length-weight relationships were established for acoustically estimates of the biomass of target species.

The target species during this survey can be found below, while the complete records of fishing stations and catches are shown in Annex I. A full list of biological samples per species and trawl station is given in Annex II.

2.5 Sampling for food safety

Whole fish, fillet and different organs from various fish and octopus were sampled during this survey. All the samples will be analysed for a wide variety of nutrients and contaminants at IMR. Tissue samples from mackerel will be analysed for the parasite *Kudoa*.

Some of the samples will also be analysed for correspondence between the microbiota and the metal content of the gut. One pelagic fish sample will be analysed for the content of microplastic particles. This work will be carried out in close cooperation with partners in the region.

2.6 Acoustic sampling

Current speed and direction measurements

Two hull-mounted Acoustic Doppler Current Profiler (ADCP) from RD Instruments ran during the survey. The frequency of the ADCP are 75 and 150 kHz. The system is run in narrow band mode and data were averaged in 16 and 4 m vertical bins at 75 and 150 kHz respectively and stored on files for post survey processing. The 150 kHz was run continuously while the 75 kHz was turned off during the last part of the survey due to interference with the ping rate of the EK80 echosounder.

Sonar data

A Simrad SH90 Sonar was recording data continuously during the survey and stored for post processing after the survey. The sonar was set to a frequency of 26 kHz, in FM Normal mode. The sonar was operated using bow up/180 degrees operation mode with the bearing of the vertical beams perpendicular to the vessel direction, and a horizontal range of 450 m and tilt angle of 3 degrees. The filters built in the sonar software to improve the school representation (i.e. AGC, RCG) and ping to ping was set to default values, except for the noise filter, which was turned off. The settings, including range and tilt, were kept the same throughout the survey, except during trawling operations when the sonar in some instances was used to target fish schools.

Bottom mapping echo sounder

The EM 710 multibeam echo sounder is a high to very high-resolution seabed mapping system. Acquisition depth is approximately 3 m below the transducers and the maximum acquisition depth is limited in practice to 1000 - 1500 m on R/V *Dr. Fridtjof Nansen*. Across track coverage (swath width) is up to 5.5 times water depth and may be limited by the operator either in angle or in swath width without reducing the number of beams. The

operating frequencies are between 70 to 100 kHz. There are 128 beams with dynamic focusing employed in the near field. The transmitting fan is divided into three sectors to maximize range capability and to suppress interference from multiples of strong bottom echoes. The sectors are transmitted sequentially within each ping and use distinct frequencies or waveforms. The along track beam width is 1 degree. Ping rate is set according to depth. The receiving beam width is 2 degrees. Sound profiles were set manually in the system according to the area of operation. The data was logged to the on-board Olex plotting system.

Acoustic estimates of fish biomass

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

Acoustic data were logged and post-processed using the latest acoustic data post-processing software, the Large-Scale Survey System (LSSS) Version 2.0. The technical specifications and operational settings of the echo sounder used during the survey are given in Annex III.
In cases where the target category of fish contains more than one species (e.g. sardinellas and *Trachurus trecae*), the mean s_A-value allocated to the category is divided between the species in the same ratio as their contribution to the mean backscattering strength in the catches (relative amount by number at length in the catches). The following target strength (TS) function was applied to convert s_A-values (mean integrator value for a given species or group of species in a specified area) to number of fish:

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

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

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

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

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

where

ρ_i = density of fish in length group i
s_A = mean integrator value
p_i = proportion of fish in length group i

$\sum_{i=1}^{n} \frac{p_i}{C_{Fi}}$ = the relative backscattering cross section (m^2) of the length frequency sample of the target species, and

C_{fi} = reciprocal backscattering cross section (σ_{bs}^{-1}) of a fish in length group *i.*

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

The following target species/groups were used:

1) Sardinellas, round sardinella, *Sardinella aurita*, and flat sardinella, *S. maderensis*.
2) Cunene horse mackerel, *Trachurus trecae*
3) Atlantic chub mackerel, *Scomber colias*
4) Other pelagic species, i.e. carangids and associated species
5) Other demersal species.

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

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

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

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

If the targeted fish is a mixture of more than one species, for example sardinellas, a representative distribution of the two, within the region, as shown in the trawl catches, are used. A length distribution representing the number of the two species for each catch must be calculated. Thereafter, these distributions must be normalized to a unit number (usually 100) so they are equally weighted (independent of sample size).

A systematic approach to a) divide the s_A-value between species in a category of fish (e.g. *S. aurita* and *S. maderensis*) and b) produce pooled length distributions of a target species for

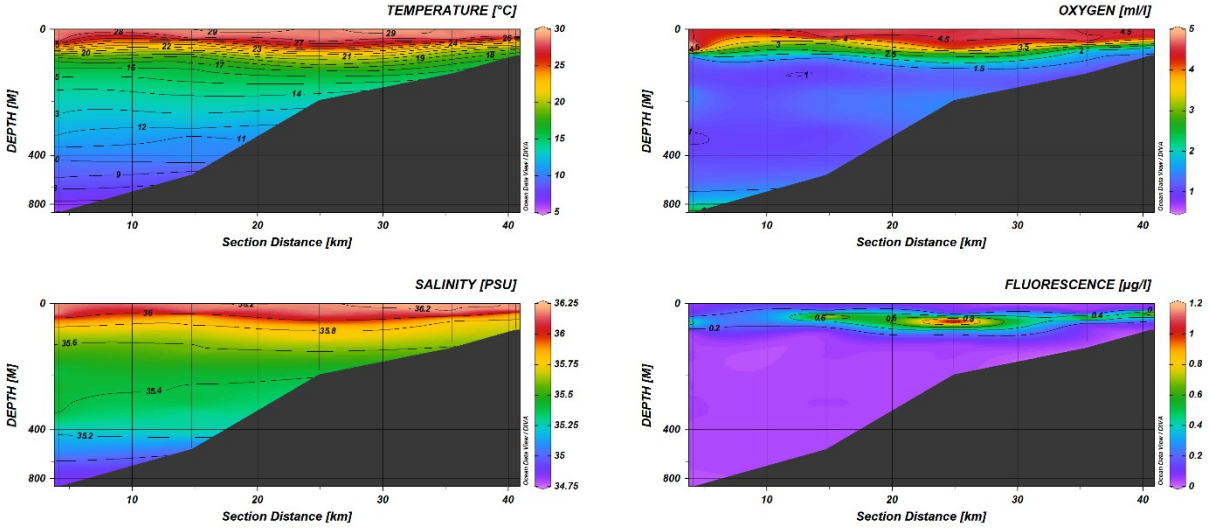
use in the above equation and c) calculate the biomass estimates for a region, is obtained through the following procedure:

- The samples of the species in the category (e.g. sardinellas) are respectively pooled together with equal importance (normalized).
- The mean backscattering strength (ρ/s_A) of each length frequency distribution of the target species is calculated and summed. This is automatically done in the Excel Spreadsheet made available for acoustic abundance estimation on board the R/V *Dr. Fridtjof Nansen*, provided the data are punched in this sheet.
- The mean s_A-value allocated to the category of fish in the region is divided between the species in the same ratio as their relative contribution to the mean backscattering strength of the length groups in the sample representing the region.
- The pooled length distribution is used, together with the mean s_A-value, to calculate the density (numbers per square NM) by length groups and species, using the above formula. The total number by length group in the area is obtained by multiplying each number by the area.
- The numbers are then converted to biomass using the estimated weight at length.

3.1 Hydrographic conditions

Cross shelf hydrographic profiles

Cross shelf hydrographic profiles of temperature, salinity, oxygen and fluorescence are presented in Figure 3.1 to 3.5. Notice the non-linear y axes, and different colour scales on the various panels. The hydrographic conditions were quite similar at all five transects. The surface layer had typical characteristics of tropical water masses with high temperatures and high salinities. The thermocline was present at around 50 m depth. Above the thermoclines, the water masses were well oxygenated with concentrations of 3-5 ml l^{-1}. At deeper waters, oxygen concentrations were low, varying between 1 and 2 ml l^{-1}, in line with previous measurements in these waters. At some of transects there was indication of subsurface maxima of Chl *a* (fluorescence). However, is should be noted that the maximum values of the scale ranges are low. Hence, the overall picture of Chl *a* along the coasts of Senegal and The Gambia is generally one of low concentrations.



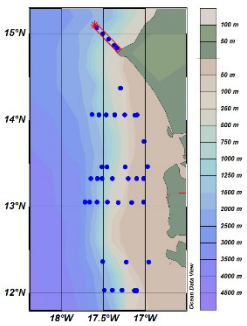


Figure 3.1. 15 ° N, Cap Vert

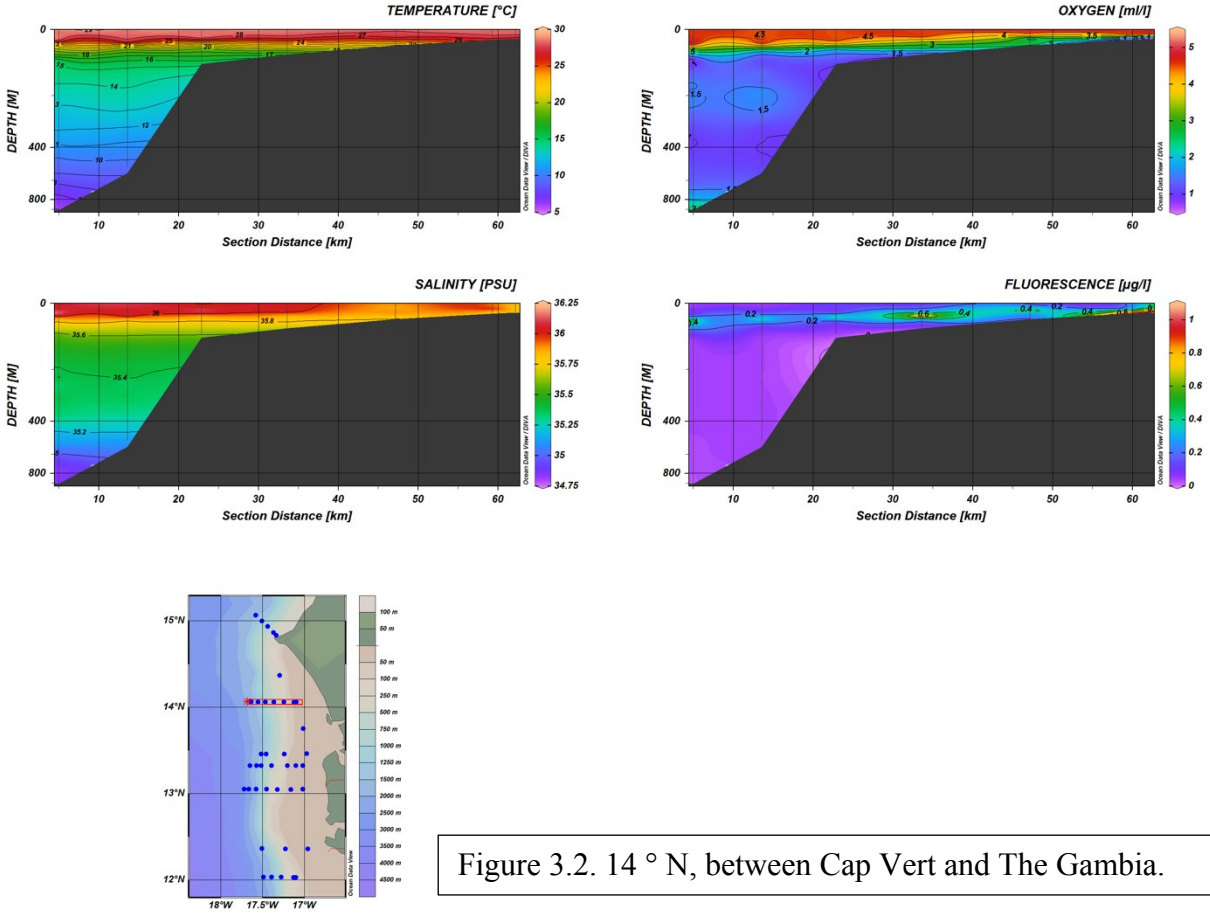


Figure 3.2. 14 ° N, between Cap Vert and The Gambia.

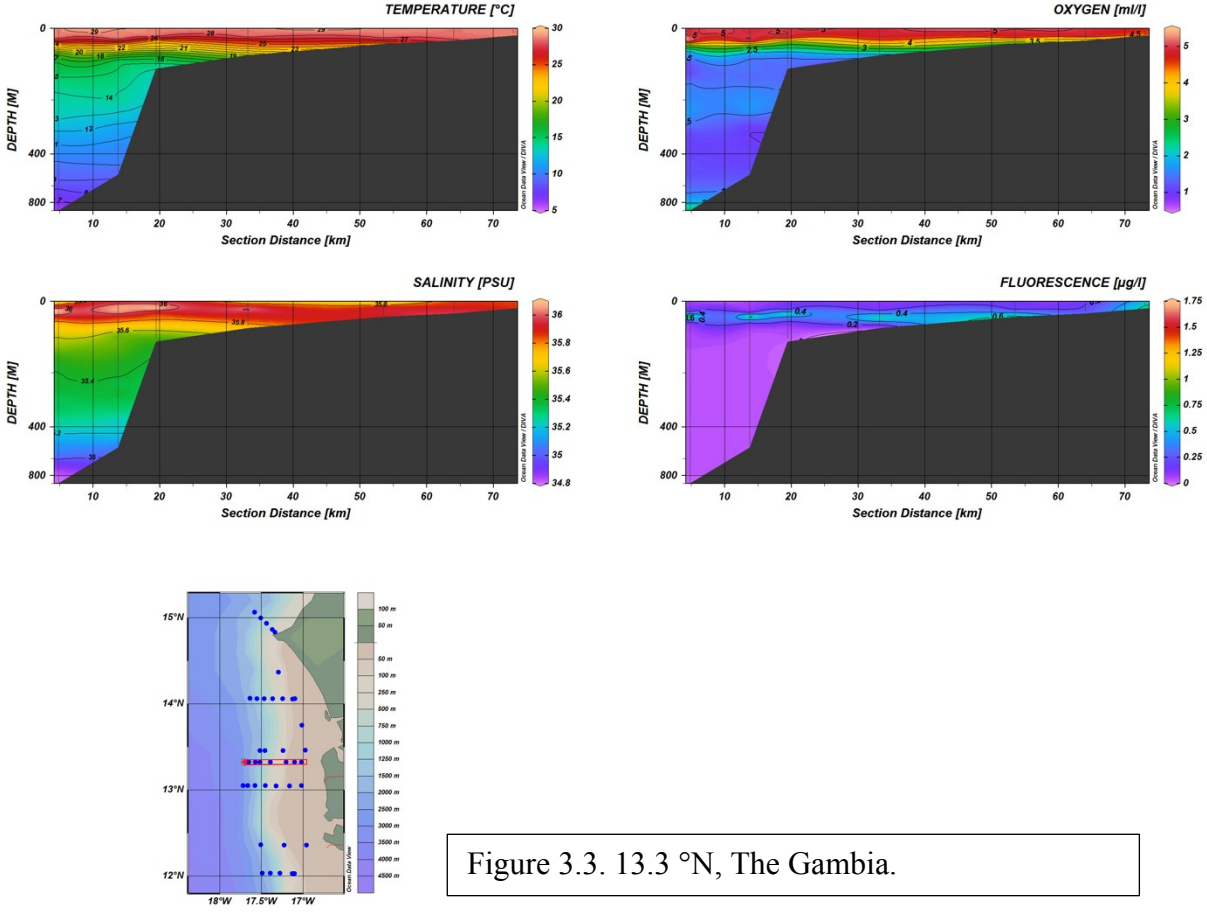
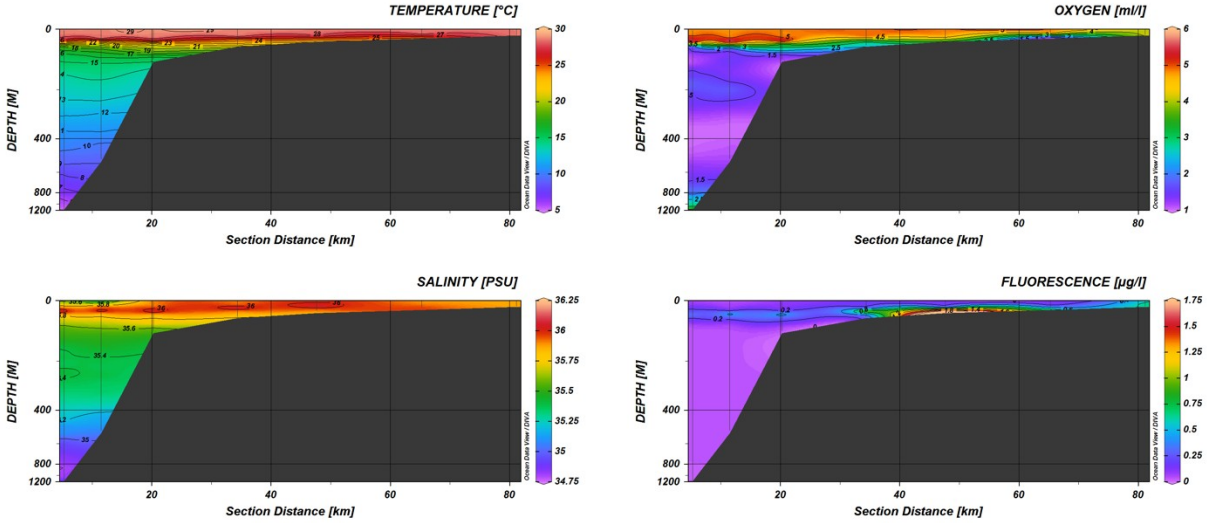


Figure 3.3. 13.3 °N, The Gambia.



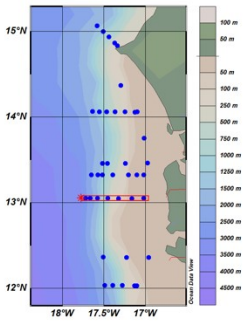
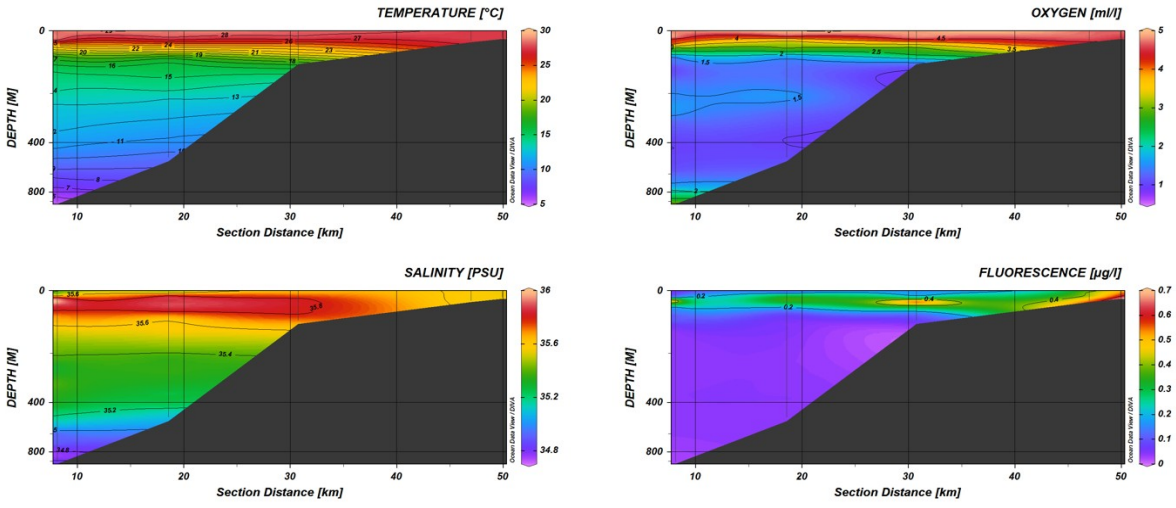


Figure 3.4. 13 °N, border between the Gambia and Casamance, Senegal.



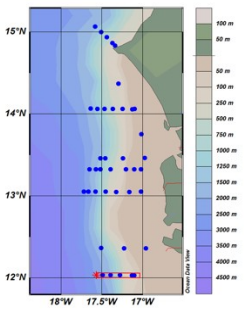


Figure 3.5. 12 °N, border between Senegal (Casamance) and Guinea Bissau.

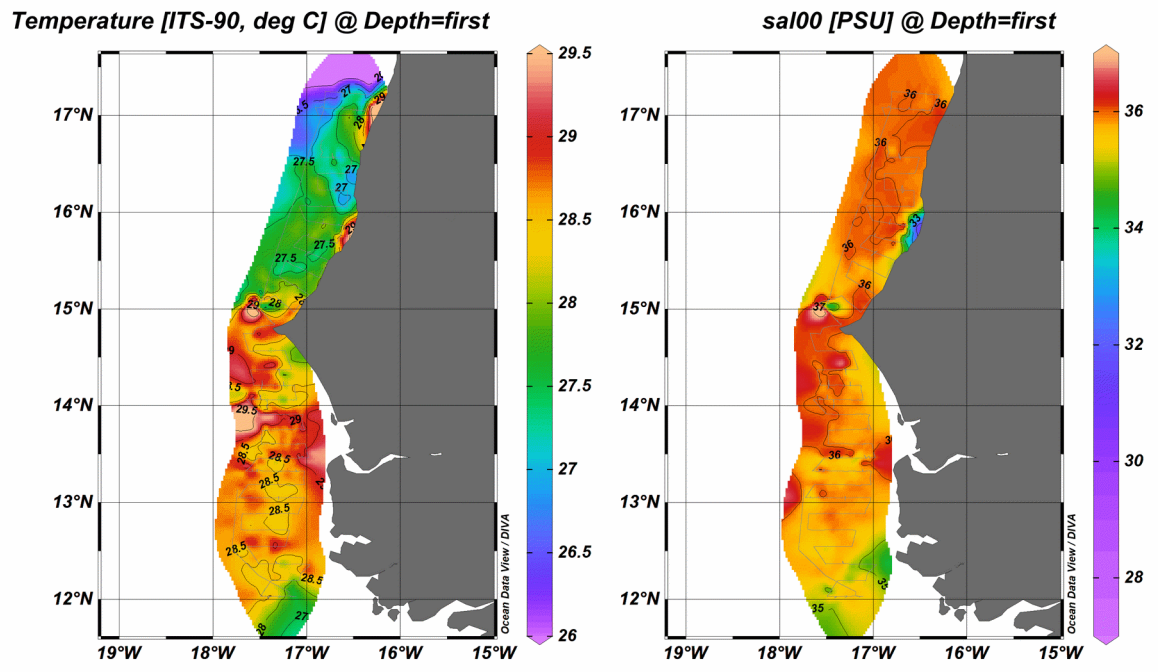
Figure 3.1 - 3.5. Cross-shelf distribution of temperature, salinity, oxygen and fluorescence (Chl *a*) from five hydrographic transects between 12 and 15 °N, presented from north to south.

Sea surface distribution of temperature, salinity and fluorescence

Figure 3.6 shows sea surface temperature, salinity and Chl *a* along the coasts of Senegal and The Gambia (~12 to 16 °N). Notice that the range of the colour scales are relatively narrow, which may leave a visual impression of higher variability than what was observed. North of Cap Vert (15 °N) the surface temperature was relatively homogeneous around 27.5 °C, except near the mouth of Senegal River (St. Louis, 16 °N) where the temperature reached almost 30 °C. The same pattern was observed in salinity, with generally high, homogeneous salinities around 36 PSU, but with lower salinities near the mouth of River Senegal.

South of Cap Vert the sea surface temperature varied between 28.5 and 29.5 °C, except for slightly lower temperatures south of Dakar and near the southern border of Casamance (12 °N). The salinity south of Cap Vert varied between 35 and 36.5 PSU, except near the southern border of Casamance where salinity dropped below, probably as a result of influence from rivers.

The Chl *a* was low throughout the sampling area, with concentrations generally <0.2 µg l^{-1}.



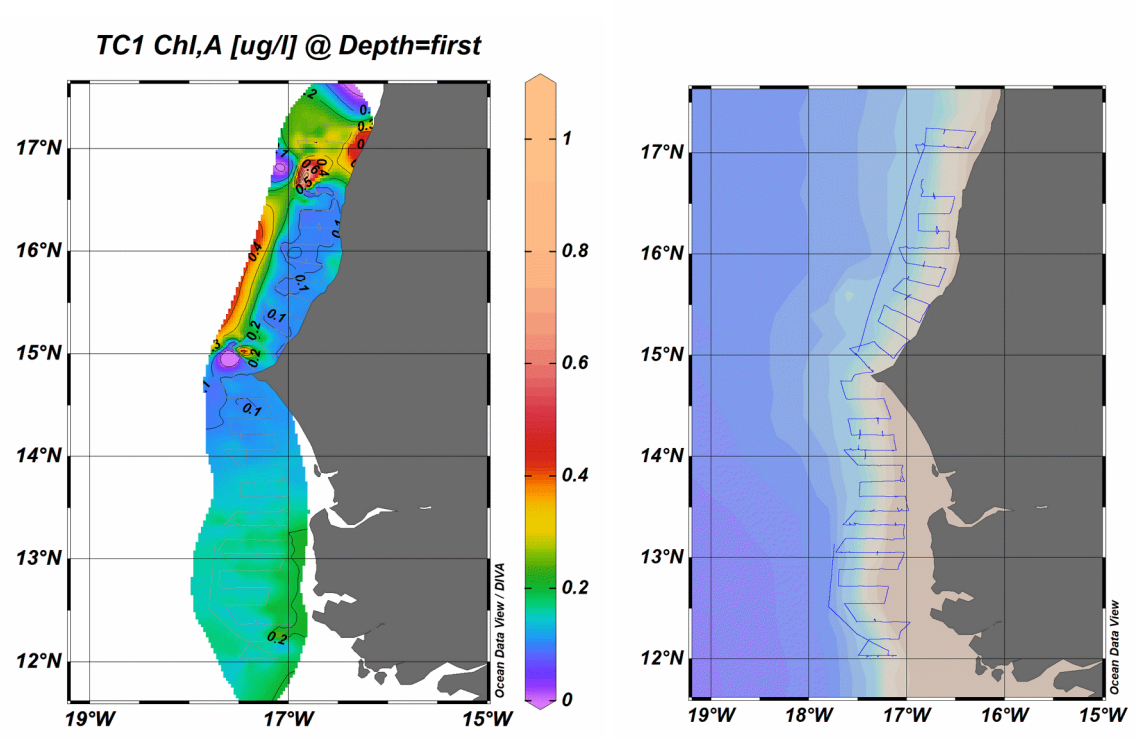
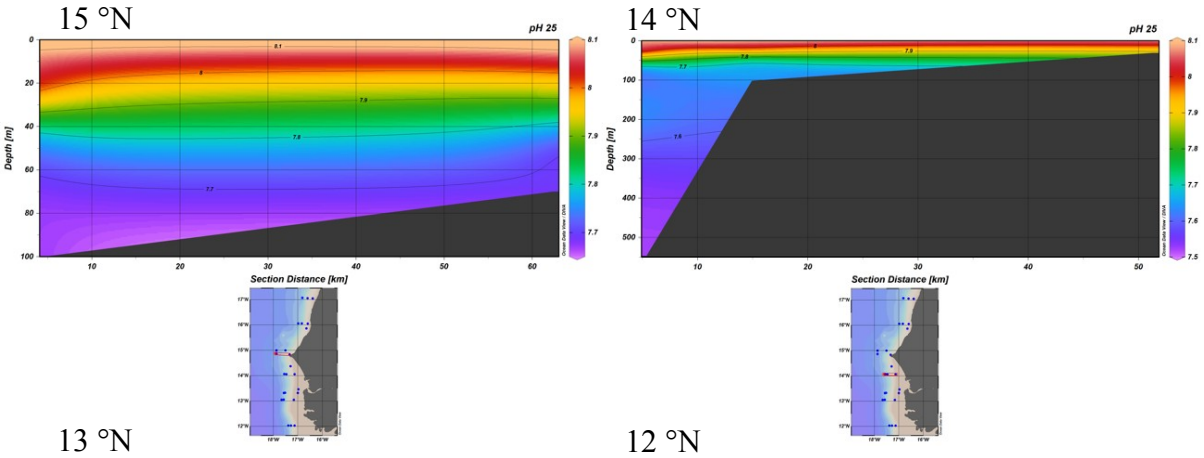


Figure 3.6 Sea surface temperature, salinity and Chl *a* (fluorescence); Senegal and The Gambia (~between 12 and 16 °N).

Cross shelf distribution of pH

Cross shelf distributions of pH are presented in Figure 3.7. Notice different and nonlinear scales on y axes. pH showed the same pattern at all transects, with highest values near the surface and gradually decreasing values with depth.



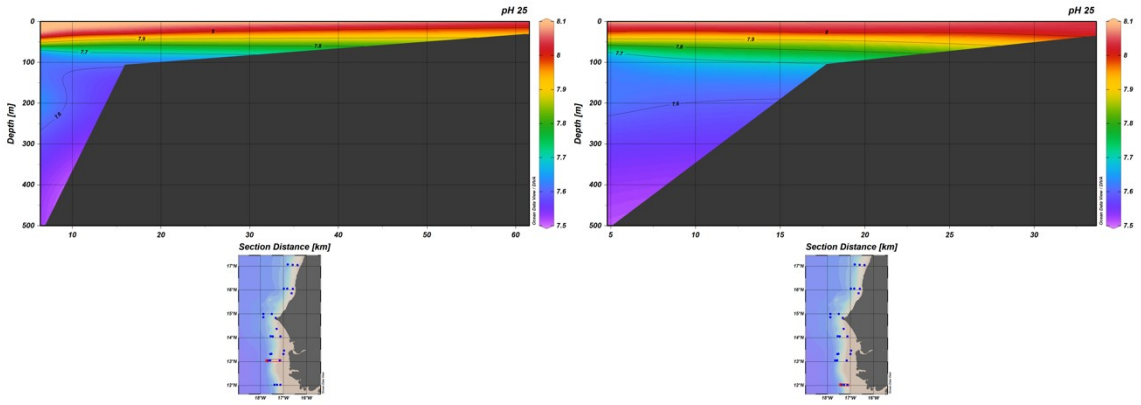


Figure 3.7. Cross shelf distribution of pH along the coasts of Senegal and The Gambia.

Nutrients

Nutrient samples will be analysed in the IMR laboratory in Norway, and data distributed once these analyses have been completed.

3.2 Plankton

Phytoplankton

Phytoplankton was not analysed prior to the completion of this report.

Chlorophyll *a*

This material will be analysed by IMR in Norway, and the data distributed once these analyses have been completed.

Zooplankton

Zooplankton biomass distributions for the coastal area of Senegal and The Gambia are given in Figures 3.8 and 3.9. When considering a subset of data representing the whole water-column for stations with bottom depths of ~100 m or less and restricted to the uppermost 200 m for stations with bottom depths of ~ 500 m, the average zooplankton biomass was 4.9 g dry-weight m^{-2}. "Repeated samples" for the uppermost 30 m were here excluded. The standard deviation was 2.8 g m^{-2} dry-weight, and the number of observations was 14, with the biomasses ranging between 1.5 and 10.6 gm^{-2}. For comparison, when only considering the uppermost ~ 30 m of the water column (Figure 3.9), regardless of bottom depth, the average biomass for the whole study area was 1.5 dry-weight m^{-2} (standard deviation of 0.9 g dry-weight m^{-2}, and 14 observations). These biomasses ranged between 1.5 and 4.8 g m^{-2}, and included both day and night samples.

Considering the total zooplankton biomass for the whole study area (Figures 3.8 and 3.9), no clear geographical patterns emerged.

Notice that a direct comparison of the biomasses along each transect in Figure 3.8, that ran perpendicular to the coast-line, would not make much sense as the lower sampling depths and hence sampling volumes increased with increasing bottom depth.

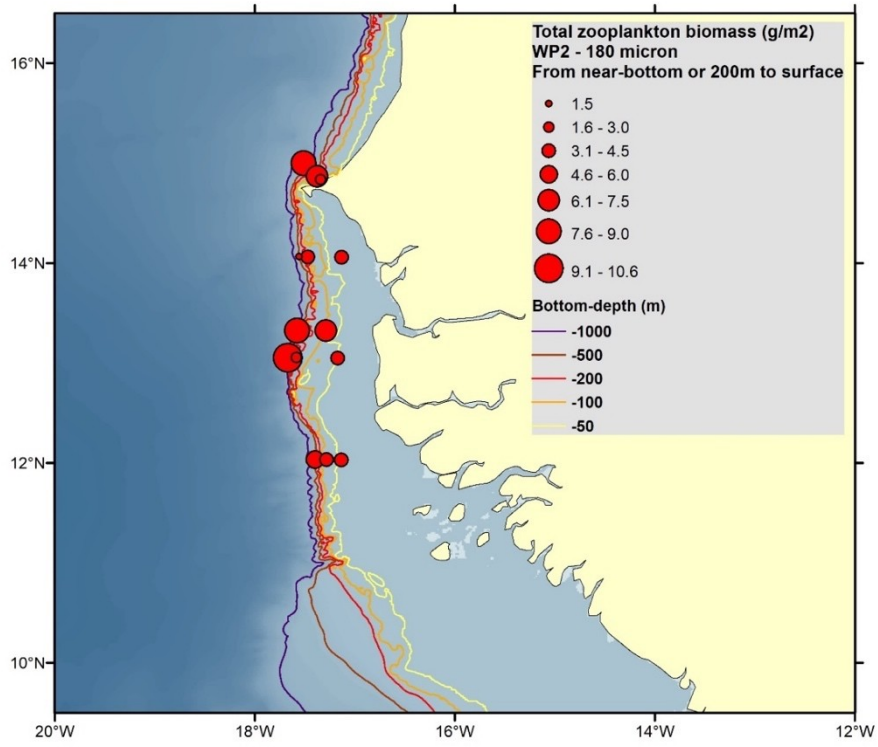


Figure 3.8. Total zooplankton biomasses (dry weight, g/m^2) for sampling-strata of ~ 25-0 m at bottom depth of 30 m, ~ 90-0 m at bottom depth of 100 m, and ~ 200-0 m at bottom depth of 500 m (c.f. bottom depth contours in the figure). Hence, the samples here shown for different bottom depths are not directly inter-comparable but rather indicate the zooplankton biomasses from the bottom (or 200 m) to the surface. Both day and night samples are included.

However, in Figure 3.9 we also present results for samples collected only from the uppermost ~ 30 m, regardless of bottom depth. Figure 3.9 includes both day and night samples, and we have here not accounted for diel vertical migrations of the plankton which might represent some bias when comparing the biomasses. Neither in this case was any clear geographical pattern observed when considering the whole study area.

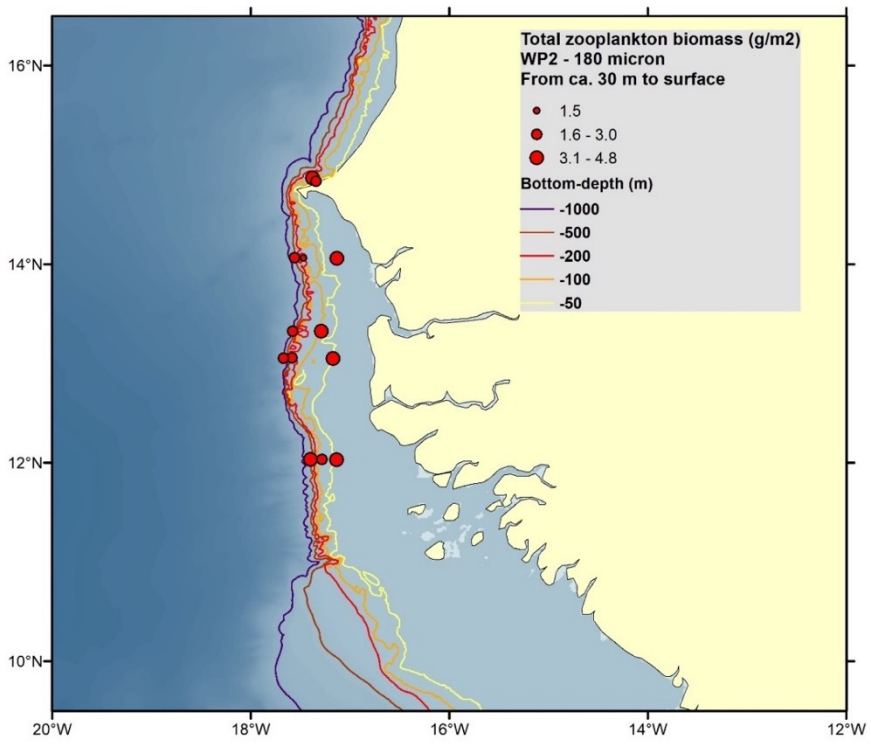


Figure 3.9. Total zooplankton biomasses (dry weight, g/m^2) for the uppermost ~ 30 m. Both day and night samples are included.

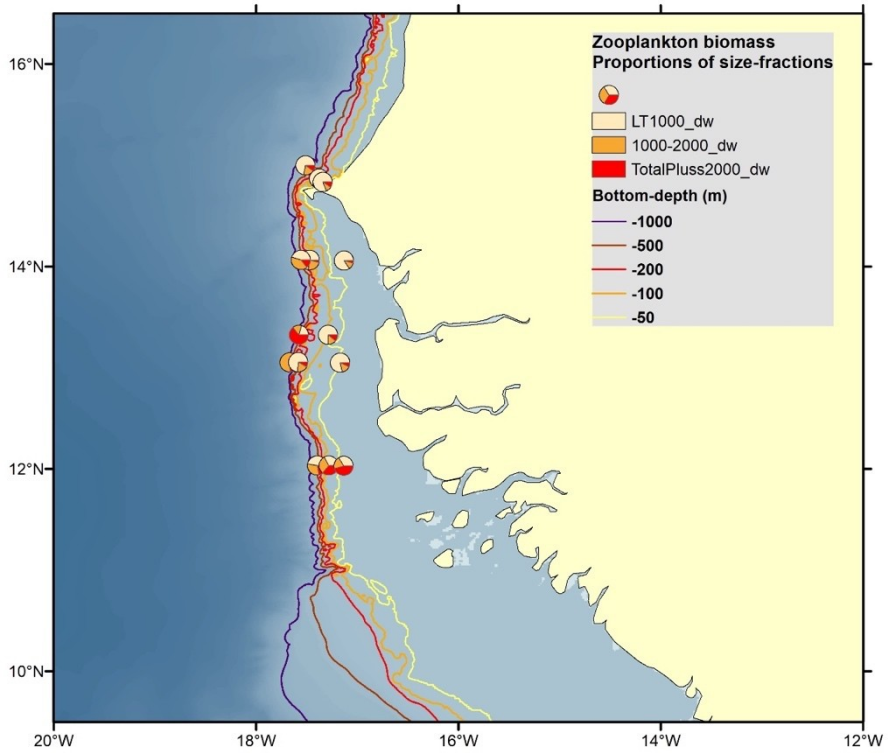


Figure 3.10. Weight proportions of three zooplankton size groups (180-1 000 µm in yellow, 1 000-2 000 µm in orange, and > 2 000 µm in red). The results presented here represent the sampling strata of ~ 25-0 m at bottom depth of 30 m, ~ 90-0 ~m at bottom depth of 100 m, and ~ 200-0 m at bottom depth of 500 m. Hence, the samples here shown for different bottom depths within the same transect

are not directly inter-comparable but rather indicate the zooplankton size composition in the water column above the bottom or depth of 200 m.

Considering the whole region, the weight-proportions of the sampled zooplankton tended to be dominated by the smallest (180-1000 μm) and intermediate (180-1000 μm) size-fractions of the biomass – though with a few exceptions (Figure 3.10). This tendency was indicated also when only considering the uppermost 30 m of the water column (not shown).

Ichtyoplankton

Samples of fish eggs and fish larvae have not yet been analysed, and will be presented separately from this report.

Microplastics

Preliminary results from sampling of microplastics along the coasts of Senegal and The Gambia are presented in Table 3 and Figure 3.11. Apart from a sample containing very high presence of microplastics (station 113 – plastics not yet counted, nor described), a total of 217 objects were collected from the rest of the stations. Plastic particles were found at 15 out of 18 stations. The highest numbers were found at station 204, which is situated south of Dakar.

Table 3. Number of plastic particles per stations and length group along the coasts of Senegal and The Gambia.

	Length groups				
Station	**<1mm**	**1-2.5mm**	**2.5-5mm**	**5-10mm**	**>10mm**
198	0	1	1	1	1
200	2	5	0	1	2
202	0	0	2	0	3
203	0	2	0	0	0
204	0	28	23	19	8
206	1	0	5	0	1
209	0	0	0	4	32
210	0	0	0	0	0
213	3	4	2	4	5
218	0	0	0	0	0
219	0	0	0	1	0
222	1	2	0	0	0
225	0	0	0	0	0
227	0	0	0	0	0
230	2	3	1	0	1
236	2	2	4	0	0
237	1	1	1	0	0
238	8	6	0	0	0

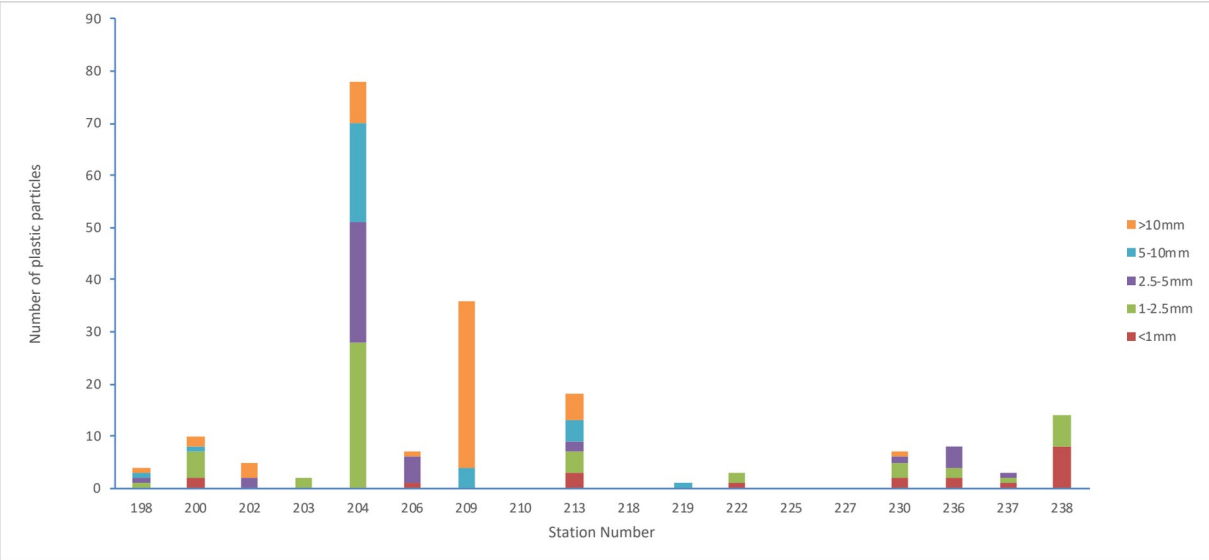


Figure 3.11. Number of plastic particles per station along the coasts of Senegal and The Gambia.

3.3 Distribution and abundance of pelagic fish

Catches per trawl haul are presented in Annex I, overview of biological sampling of fish in Annex II, length distribution of target species in Annex IV and estimated numbers and biomass by length group in Annex V. The main groups of pelagic fish encountered during the survey of Senegal and The Gambia are illustrated with contoured acoustic densities in Figures 3.12 to 3.15.

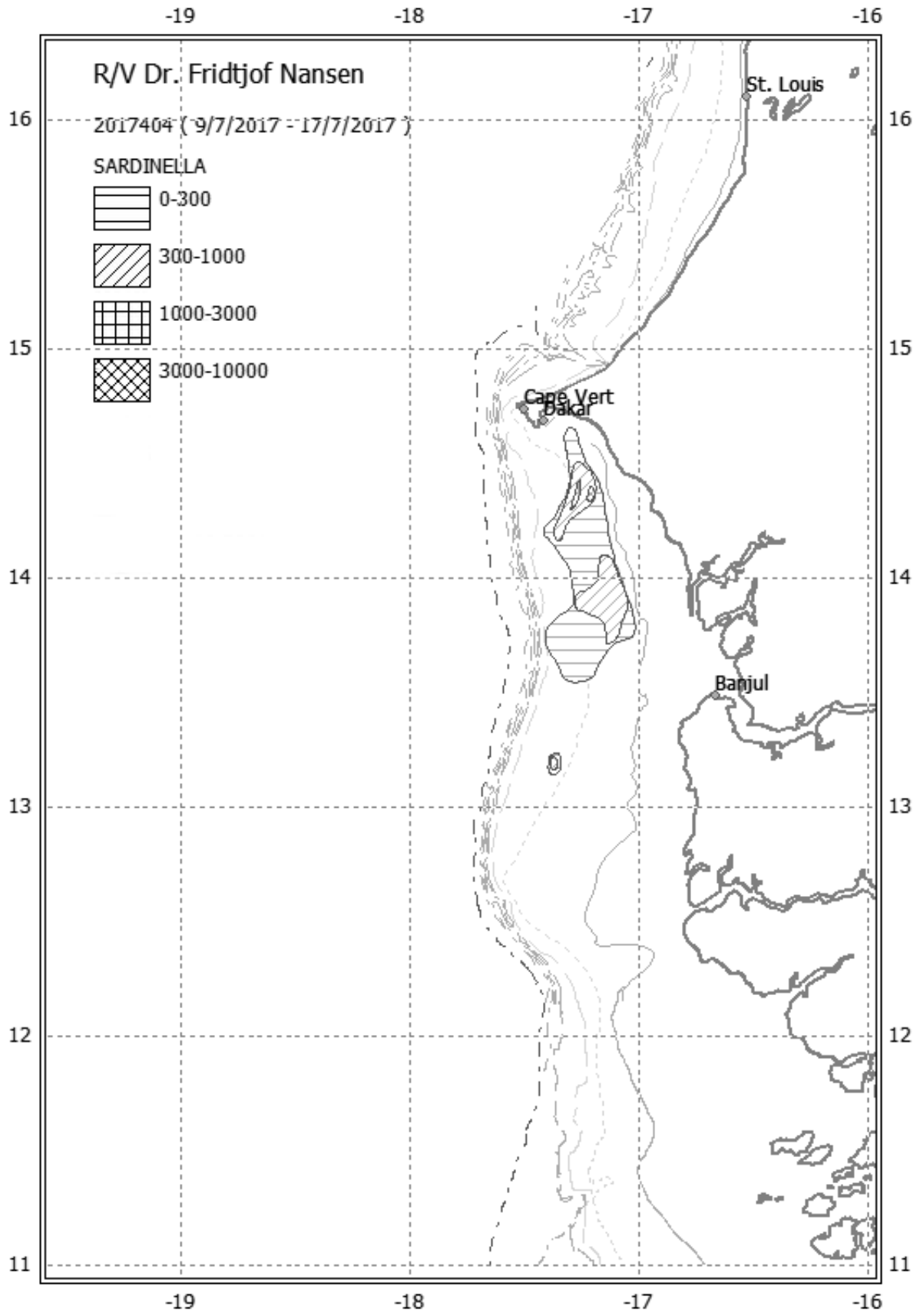


Figure 3.12. Distribution of sardinellas, St. Louis to Casamance.

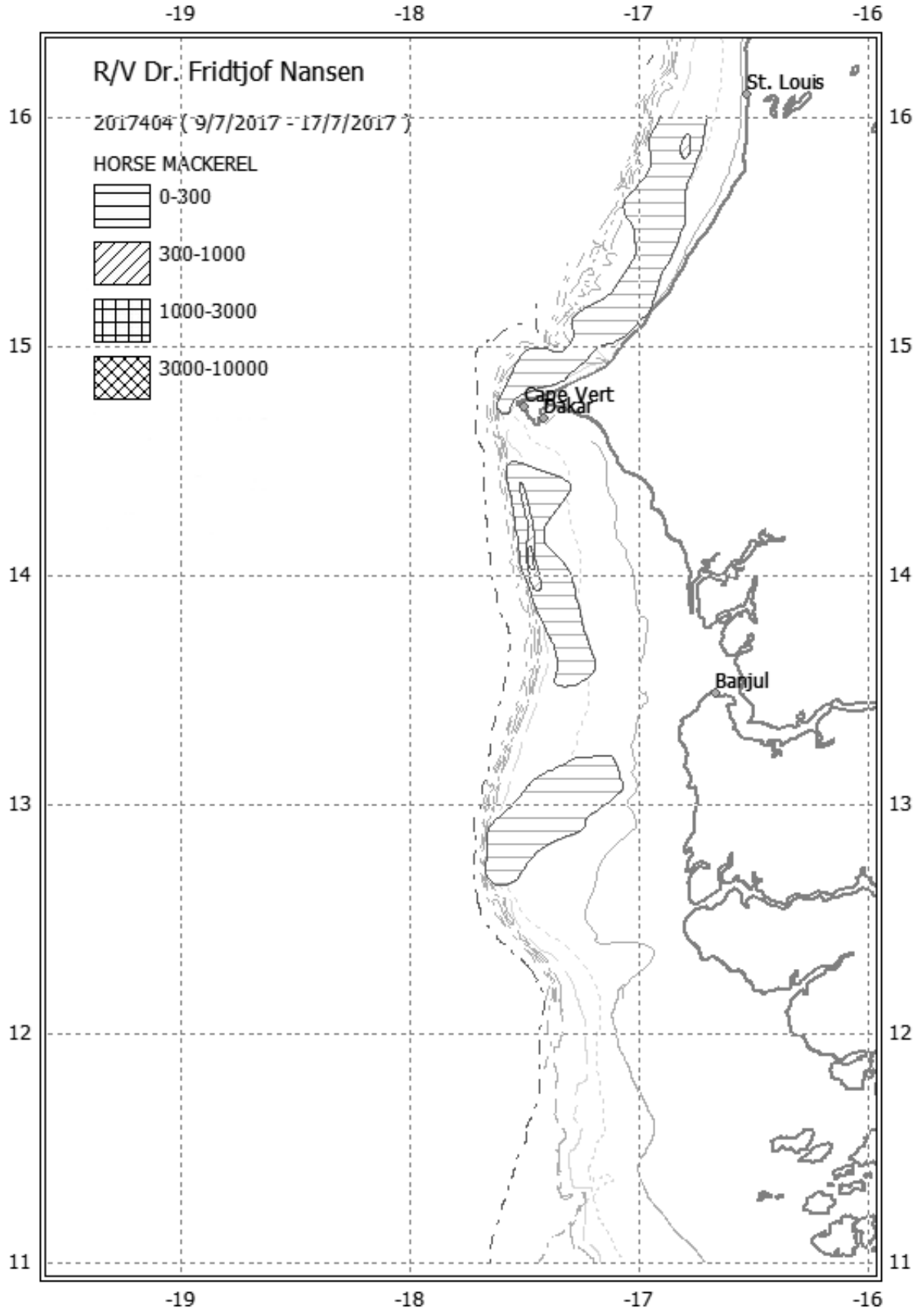


Figure 3.13. Distribution of *Trachurus trecae*, St. Louis to Casamance.

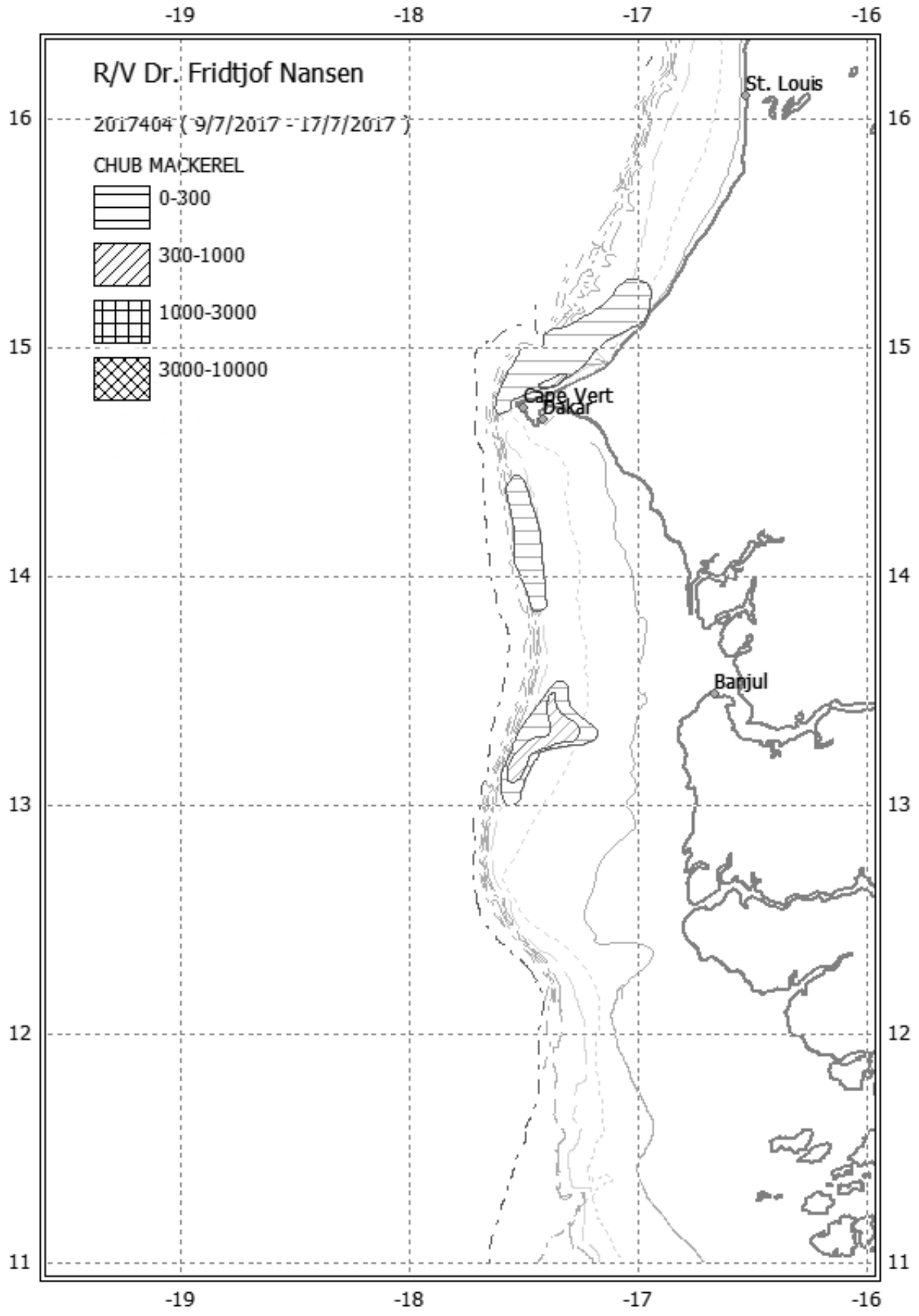


Figure 3.14. Distribution of Chub mackerel, St. Louis to Casamance.

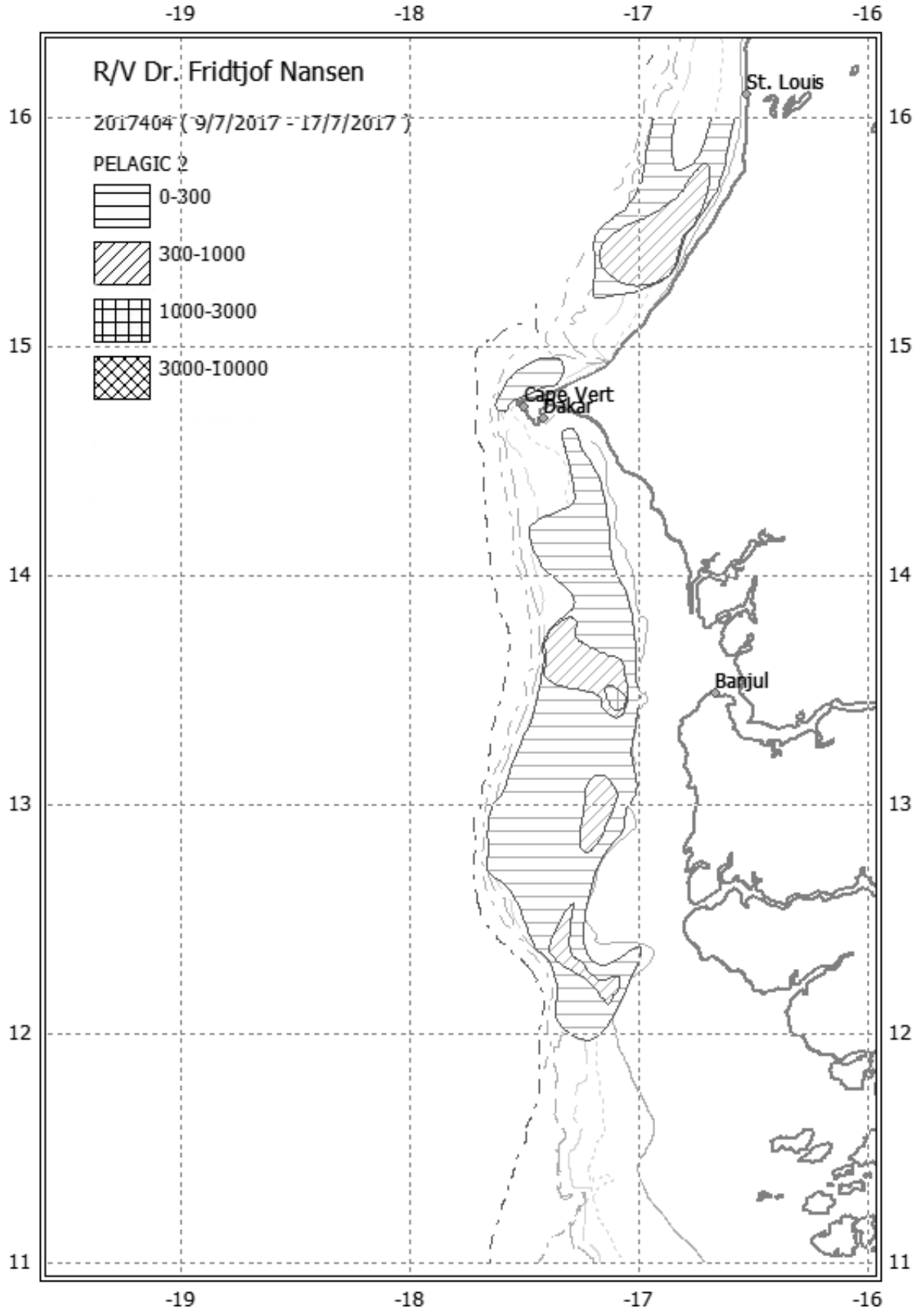


Figure 3.15. Carangids and associated species, St. Louis to Casamance.

St. Louis – Cap Vert

No sardinellas were observed in the area. *T. trecae* were found in a continuous belt between St. Louis and Cap Vert. The biomass was estimated to 48.2 thousand tonnes, and the length distribution showed three modal peaks, at 10, 19 and 27 cm (see Annex V). *S. colias* were found in low concentrations just north of Cap Vert. Carangids and associated species were found in two separate distributions, with the highest concentrations south close to the Mauritanian border.

The estimated biomasses of the main groups of pelagic fish between Cap Vert and St. Louis are presented in Table 4.

Table 4. St. Louis – Cap Vert. Biomass estimates of pelagic fish, thousand tonnes.

Region	*S. maderensis*	*S. aurita*	*T. trecae*	*S. colias*	Carangids etc.
St. Louis - Cap Vert	0,0	0,0	48,2	7,7	63,4

Cap Vert – The Gambian border

Sardinellas were distributed from south of Dakar to the Gambian border. The estimated biomass of *S. aurita* and *S. maderensis* were the same, about 86 thousand tonnes each. Both species showed one modal peak, at 25 cm. *T. trecae* was observed in low concentration in the same area as the sardinellas, but slightly more offshore. The biomass was estimated to 13.6 thousand tonnes, and the length distribution showed one modal peak at 18 cm. *S. colias* was only found in very low abundances, and carangids and associated species were found in a continuous band from Dakar to the Gambian border.

Table 5 below shows biomass estimates.

Table 5. Cap Vert – The Gambian border. Biomass estimates of pelagic fish, thousand tonnes.

Region	*S. maderensis*	*S. aurita*	*T. trecae*	*S. colias*	Carangids etc.
Cap Vert - The Gambia	86,4	85,9	13,6	1,5	43,4

The Gambian shelf

In Gambian waters, an estimated biomass of 9.8 thousand tonnes of *S. maderensis* were found in one small area (Figure 3.12 and Table 6). The length distribution showed one modal peak of ~25 cm. Both *S. aurita* and *T. trecae* were practically absent. *S. colias* was found at some distance from the coast in one distribution. The biomass was estimated to 18.3 thousand tonnes, and the length distribution showed one modal peak at 20 cm. The biomass of carangids and associated species was estimated to 95.9 thousand tonnes. The distribution was wide and a continuation from that further north.

Table 6. The Gambia. Biomass estimates of pelagic fish, thousand tonnes.

Region	*S. maderensis*	*S. aurita*	*T. trecae*	*S. colias*	Carangids etc.
The Gambia	9,8	0,2	1,5	18,3	95,9

The Casamance shelf

Only carangids and associate species were found in noticeable concentration on the Casamance shelf. The biomass was estimated to 53.9 thousand tonnes, and distribution was connected with the distribution further north.

Table 7. The Casamance shelf. Biomass estimates of pelagic fish, thousand tonnes.

Region	*S. maderensis*	*S. aurita*	*T. trecae*	*S. colias*	Carangids etc.
Casamance	0,0	0,0	2,7	0,0	53,9

3.4 Summary of biomass estimates

Table 8 below provides an overview of the biomass estimates of the main pelagic species.

Table 8. Summary of biomass estimates of pelagic fish, Senegal and The Gambia.

Region	*S. maderensis*	*S. aurita*	*T. trecae*	*S. colias*
St. Louis - Cap Vert	0,0	0,0	48,2	7,7
Cap Vert - The Gambia	86,4	85,9	13,6	1,5
Casamance	0,0	0,0	2,7	0,0
Total	*86,4*	*85,9*	*64,5*	*9,2*
The Gambia	9,8	0,2	1,5	18,3

CHAPTER 4. REGIONAL SUMMARY

The R/V *Dr Fridtjof Nansen* survey of the pelagic resources in Northwest Africa (Leg 1.1 of the western Africa coverage for 2017) encompassed Morocco to Cape Blanc. The second leg (Leg 1.2), conducted an experimental survey of the mesopelagic resources of the region, and the third and fourth legs (1.3 and 1.4) conducted pelagic surveys for Mauritania and Senegal, respectively.

The first leg of the survey covered the region between Tangier and Cape Blanc from 7-27 May 2017 (Leg1.1). This was temporarily postponed so the vessel could conduct a survey on mesopelagic resources for West Africa from 26 May to 11 June (Leg 1.2), and for an unscheduled maintenance period of the vessel. The third leg for pelagic resources took place for Mauritania from 27 June – 9 July, and for Senegal and the Gambia from 9-18 July (there was a break in service from 3-6 July to allow for a crew change on the vessel). After completing the survey in Mauritania, the vessels continued surveying Senegal and Gambia from 9-18 July 2017 (Leg1.4). A common survey design was adopted in the entire region with parallel transects perpendicular to the coastline, 10 nm apart, and acoustic measurements of pelagic fish obtained on the shelf from 20-500 m bottom depth. At each degree latitude, a hydrographical transect was carried out 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 alkalinity), nutrients, phytoplankton, zooplankton, fish eggs and larvae and microplastics. Weather conditions were good for surveying during the entire period.

Oceanographic Conditions

Between Tangier and Cape Blanc, the oceanographic conditions showed a gradual increase in surface temperatures and lowering of the thermocline from the north to the south, and a corresponding decrease in oxygen in the upper 50 m (as observed at the 100 m CTD stations). The region north of 32° show the most stable water masses and the least upwelling. Close inshore, at the 30 m CTD stations, a clear separation in conditions is observed around 25°N, where water masses close to the coast are more fully mixed south of this latitude. Salinity in the upper 200 m are generally high across the entire region (> 36), and highest salinity is found at 24°N where salinity close to the coast is above 36.3 across the water column corresponding with lower fluorescence values. The areas of highest Chlorophyll *a* concentrations typically a4 3correspond with areas of lower salinity and indicates upwelling. These areas are roughly between 32°N- 30°N, around 27°N extending to both sides, and especially from 23°N and southwards where Chlorophyll *a* values increase > 4 µg/l. A clear frontal Zone was visible in the region around Cape Blanc.

At Cape Blanc, a clear separation of water masses from the northern and southern Canary Current system with strong increase in temperature from around 20°C (of Cape Blanc) to 28°C south of Cape Timiris can be observed. There is an indication of southward protruding

water masses inshore in this region while offshore northwards moving water masses affect the outer shelf in the surface. Upwelling affects especially the northern border region of Mauritania and primary production (fluorescence) and oxygen is high inshore. A similar situation can also be observed in the far southern part of Mauritania close to the coast. These two regions are separated by a central region with low primary production and strongly stratified water masses. At 19°N and 18°N, water masses are becoming increasingly more stratified, especially offshore with warm saline tropical water masses observed in the surface layers. Primary production is low across the shelf. Low oxygen waters < 1 ml/l can be observed close to the bottom on the central outer shelf.

The hydrographical conditions in Senegal and the Gambia were relatively uniform considering the geographical spread of stations. The surface layer had typical characteristics of tropical water masses with high temperatures and high salinities. Thermoclines were present around 50 m depths. Above the thermoclines, the water masses were well oxygenated, while in deeper waters, oxygen concentrations were low, varying between 1 and 2 ml l-1. This agrees with recent measurements in these waters. Some transects had indications of subsurface maximum Chlorophyll *a*.

Fish distribution and abundance

Surveys with the previous R/V *Dr Fridtjof Nansen* (1994-2016) were carried out in the same way as the present survey (2017-present) with regard to both survey design, acoustic scrutinizing and biomass estimation methodology. The methodology followed the recommendations of the Northwest Africa acoustic survey planning group. This allows for direct comparison of biomass estimates from the present survey with historic surveys. Still, the 2017 survey was carried out in May-July while most of the historic surveys that are part of the time series were carried out between October-December. This will affect the distribution of the fish, and potentially also their availability in the survey area. Table 9 presents the biomass estimates by main species and sub-region while Table 10 shows the trends over time based on the surveys with Dr. Fridtjof Nansen.

A strong separation between the stocks in northern and southern part of the CCLME region is observed. The total biomass north of Cape Blanc is high while the southern part of the region is struggling with declining stock sizes for several species.

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. In addition, large shallow water areas with bottom depth < 20 m were not covered by the surveys and there are known seasonal variations in the abundance of pelagic fish in shallow waters, especially *Sardinella maderensis.* For the present survey, 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 assessment may be undertaken in the future.

Sardine (*Sardina pilchardus*). Sardine were found with variable densities in the northern CCLME region between Cap Spartel in the north and Cap Blanc, with generally very high density almost without interruption between Cape Blanc and Cape Juby. The highest densities were found between Cape Barbas and Cape Bojador. The main distribution was found inshore of 40 m bottom depth and the fish was strongly aggregated in most of the area, only occasionally extending much beyond 50 m isobath. The total biomass registered in Morocco is around 5 million tonnes, representing 98% of the total biomass in the region. South of Cape Blanc, the biomass was estimated to 61 thousand tonnes, and it was found in one area on the outer shelf north of Cape Timiris. This was the furthest south the sardine was found during this survey and no sardine was found in the warm tropical water masses further south.

Sardinella (*Sardinella aurita* and *S. maderensis*). The sardinella, *S. aurita,* was found north to Dakhla, and only a few fish were found further north close to Cape Bojador. *S. aurita* were found in relatively patchy low to medium density aggregation. The total biomass registered north of Cape Blanc was around 140 thousand tonnes, representing 54% of the total biomass in the region. In Mauritanian waters, both species were found. A very low biomass was found from Cape Blanc - Cape Timiris with only 7 thousand tonnes of *S. maderensis* while a total of 109 thousand tonnes of *S. maderensis* and 34 thousand tonnes of *S. aurita* was found from Cape Timiris to St Louis. In Senegal, no sardinella was found north of Dakar. Sardinella were distributed only in Petite Cote, from Cap Vert to Banjul and the total biomass is estimated to 86 thousand tonnes for *S. aurita* (33% of the total biomass in the region) and 96 thousand tonnes for *S. maderensis* (45% of the total biomass in the region). Generally, the biomass of both species of sardinella was low.

Anchovies (*Engraulis encrasicolus*). Anchovies were found only in the northern most part of the region between Cape Bojador and Cape Spartel, and in the southern part of this region between Cape Barbas and Cape Blanc. Between these areas no anchovy were found. The fish were confined inshore in water depths < 50 m, and the density was medium. The total biomass north of Cap Blanc is around 65 thousand tonnes, representing 45% of the total biomass in the region. In Mauritania, 34 thousand tonnes were found in the northern region, on the shelf south of Cape Blanc. The fish were mixed with sardine of the same size within the distribution area. South of Cape Timiris, around 44 thousand tonnes of anchovy were found in two separate areas along the shelf. No anchovy were found in Senegal.

In the northern part of the survey area, north of Cap Blanc, **Horse mackerels** (*Trachurus trachurus* and *T. trecae*) were found patchily and in generally low density over the outer shelf in most of the area between Cape Blanc and Cape Spartel. *Trachurus trachurus* was the main species while *T. trecae* was found only between Cap Blanc and Cape Barbas. The total biomass registered in Morocco for *Trachurus trachurus* is 95 thousand tonnes (98% of the total biomass in the region) and 31 thousand tonnes for *Trachurus trecae* (24% of the total biomass in the region). Only 9 thousand tonnes of horse mackerel were found in Mauritania from Cape Blanc to Cape Timiris. This was the southernmost distribution of *Trachurus trachurus,* with a biomass of 2 thousand tonnes while 7 thousand tonnes was *T.*

trecae. Between Cap Timiris and St. Louis a total of 25 thousand tonnes of *T. trecae* was found, the distribution continued southwards into Senegal all along the shelf from St. Louis to Casamance with total biomass estimated to 66 thousand tonnes (51% of the total biomass in the region)

Atlantic chub mackerel (*S. colias*) were recorded almost continuously covering most of the shelf in the northern CCLME region between 150-20 m depth from Cape Blanc to Cape Spartel, with the highest densities on the mid and outer shelf. Concentrations were highest off Dakhla and between Laayoune and Cape Bojador. The total biomass registered north of Cap Blanc is 388 thousand tonnes, representing 88% of the total biomass in the region (total 441 thousand tonnes). In Mauritania, a total of 20 thousand tonnes of chub mackerel was observed between Cape Blanc and Cape Timiris. In this region also, Chub mackerel was found in deeper waters than most of the other species, but with a dominance on the shelf and over the shelf break. The densities were generally low. In the southern region, from Cape Timiris to St Louis, around 5 thousand tonnes of Chub mackerel were found. Small patches of fish were found between Cape Timiris and Nouakchott while further south, the distribution was more continues from 17°N to St. Louis. In Senegal, the chub mackerel was distributed from Kayar to Casamance with main concentrations off Sine Saloum. The total biomass was estimated to 28 thousand tonnes (6% of the total biomass in the region).

Table 9: Regional biomass estimates from 2017 R/V *Dr Fridtjof Nansen* survey.

	Biomass ('000 tonnes)									
	Tanger **Cap Cantin**	**Cap Cantin** **Cap Juby**	**Cap Juby** **Cap Blanc**	**Cap Blanc** **Cap Timiris**	**Cap Timiris** **St Louis**	**St Louis** **Cap Vert**	**Cap Vert** **The Gambia**	**The Gambia**	**The Gambia** **Casamance**	**TOTAL**
Sardina pilchardus	19	502	4 471	61	0	0	0	0	0	**5 053**
Sardinella aurita	0	0	140	0	34	0	86	0	0	**260**
Sardinella maderensis	0	0	0	7	109	0	86	10	0	**212**
Engraulis encrasicolus	10	15	40	34	44	0	0	0	0	**143**
Trachurus trachurus	28	52	15	2	0	0	0	0	0	**97**
Trachurus tracae	0	0	31	7	25	48	14	1	3	**129**
Scomber colias	98	171	119	20	5	8	2	18	0	**441**

Table 10: Regional acoustic biomass data (million tonnes) from R/V *Dr Fridtjof Nansen* surveys 1995-2017 for the main species.

YEAR	*S. pilchardus*	*S. aurita*	*S. maderensis*	*T. trachurus*	*T. trecae*	*S. colias*	*E. encrasicolus*	*Total (without 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	0.621	0.867	0.405	0.542	0.72	0.158	3.31	7.81
2016	**2.964**	**0.036**	**0.052**	**0.225**	**0.048**	**1.056**	**0.079**		
2017	5.05	0.26	0.212	0.097	0.129	0.44	0.14	2.12	

Years 1995-2006, 2015 and 2017: data from the R/V *Dr Fridtjof Nansen*.
Years 2007-2008: data are *Nansen* equivalents of local vessels using agreed conversion factors.
Year 2009: all data from the Mauritanian R/V *Al Awan* and the Moroccan R/V *Al Amir*, and data for Senegal and the Gambia were estimated by the Working Group.
Year 2010: No estimates for the Mauritanian R/V *Al Awan*, the Moroccan R/V *Al Amir*, Senegal, and the Gambia.
Year 2011: Some estimates for the CCLME (from the R/V *Dr Fridtjof Nansen*) were presented by the CCLME project coordinator.
Year 2012: Data from Mauritanian R/V *Al Amir* were presented to the Working Group for North of Cape Blanc, and results from a survey by the Russian R/V *Atlantida* in Mauritania and Senegal.
Years 2013 and 2014: Survey data from Morocco, Mauritania, and the Russian R/V *Atlantida*.

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ANNEX I RECORDS OF FISHING STATIONS

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 1
DATE :09/07/17 GEAR TYPE: BT NO: 1 POSITION:Lat N
15°54.20
start stop duration Lon W
16°49.28
TIME :13:32:47 13:56:32 23.8 (min) Purpose : 1
LOG : 392.42 393.81 1.4 Region : 1300
FDEPTH: 84 83 Gear cond.: 0
BDEPTH: 84 83 Validity : 0
Towing dir: 0° Wire out : 240 m Speed : 3.5 kn
Sorted : 58 Total catch: 58.30 Catch/hour: 147.28

C	SAMP SPECIES	CATCH/HOUR weight	numbers	% OF TOT.
	Trachurus trecae	65.28	452	44.32
1				
	Boops boops	13.74	278	9.33
2				
	Illex coindetii	12.18	192	8.27
	Mustelus mustelus	9.55	3	6.48
	Trichiurus lepturus	7.68	18	5.21
	Brachydeuterus auritus	7.53	33	5.11
	Zeus faber	6.37	18	4.32
	SALPS	4.55	455	3.09
	Priacanthus arenatus	3.94	8	2.68
	Dentex angolensis	3.69	28	2.50
3				
	Selene dorsalis	3.33	3	2.26
	Alloteuthis africana	2.93	480	1.99
	Sphyraena guachancho	2.83	8	1.92
	Raja miraletus	2.07	3	1.41
	Lepidotrigla carolae	0.35	8	0.24
	Scorpaena stephanica	0.30	3	0.21
	Pagellus bellottii	0.30	5	0.21
	Octopus vulgaris	0.30	3	0.21
	LEUCOSIIDAE	0.13	3	0.09
	Unidentified crab	0.13	58	0.09
	Syacium micrurum	0.10	3	0.07
	Total	147.28		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 2
DATE :09/07/17 GEAR TYPE: BT NO: 1 POSITION:Lat N
15°35.05
start stop duration Lon W
16°58.52
TIME :13:32:47 13:56:32 23.8 (min) Purpose : 1
LOG : 392.42 393.81 1.4 Region : 1300
FDEPTH: 84 83 Gear cond.: 0
BDEPTH: 84 83 Validity : 0
Towing dir: 0° Wire out : 240 m Speed : 3.5 kn
Sorted : 160 Total catch: 935.08 Catch/hour: 2362.31

C	SAMP SPECIES	CATCH/HOUR weight	numbers	% OF TOT.
	Trichiurus lepturus	848.84	1698	35.93
	Brachydeuterus auritus	480.15	2089	20.33
6				
	Priacanthus arenatus	443.87	1683	18.79
7				
	Trachurus trecae	324.83	12788	13.75
4				
	J E L L Y F I S H	80.24	20	3.40
	Caranx rhonchus	76.40	268	3.23
	Trachinotus ovatus	29.99	114	1.27
	Alectis alexandrinus	25.47	99	1.08
	Sardinella maderensis	19.76	109	0.84
5				
	Euthynnus alletteratus	18.39	43	0.78
	Sarda sarda	4.75	5	0.20
	Sphyraena guachancho	4.52	15	0.19
	Scomber colias	3.69	28	0.16
	Illex coindetii	1.41	43	0.06
	Total	2362.31		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 3
DATE :10/07/17 GEAR TYPE: PT NO: 7 POSITION:Lat N
15°24.51
start stop duration Lon W
16°49.30
TIME :02:40:09 02:54:50 14.7 (min) Purpose : 1
LOG : 494.78 495.53 0.8 Region : 1300
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 23 25 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.1 kn
Sorted : 55 Total catch: 55.38 Catch/hour: 226.35

C	SAMP SPECIES	CATCH/HOUR weight	numbers	% OF TOT.
	Chloroscombrus chrysurus	77.33	752	34.16
11				
	Brachydeuterus auritus	55.59	1847	24.56
9				
	Ilisha africana	39.81	789	17.59
8				
	Selene dorsalis	14.31	270	6.32
10				
	Sardinella maderensis	13.08	74	5.78
	Trichiurus lepturus	6.46	98	2.85
	Eucinostomus melanopterus	5.64	41	2.49
	Alectis alexandrinus	5.07	8	2.24
	Caranx senegallus	4.99	20	2.20
	Caranx rhonchus	2.86	16	1.26
	Trachinotus ovatus	0.65	4	0.29
	Engraulis encrasicolus	0.33	168	0.14
	Trachurus trecae	0.16	8	0.07
	Sepia officinalis	0.08	16	0.04
	Total	226.35		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 4
DATE :10/07/17 GEAR TYPE: PT NO: 8 POSITION:Lat N
15°25.83
start stop duration Lon W
17°5.31
TIME :05:37:04 06:11:32 34.5 (min) Purpose : 1
LOG : 515.04 517.45 2.4 Region : 1300
FDEPTH: 5 5 Gear cond.: 0
BDEPTH: 151 211 Validity : 0
Towing dir: 0° Wire out : 210 m Speed : 4.2 kn
Sorted : 114 Total catch: 319.82 Catch/hour: 556.69

C	SAMP SPECIES	CATCH/HOUR weight	numbers	% OF TOT.
	Trachinotus ovatus	244.18	938	43.86
	MYCTOPHIDAE	176.69	65443	31.74
	Abraliopsis sp.	92.69	28089	16.65
	Synagrops microlepis	20.99	50	3.77
	Euthynnus alletteratus	12.64	19	2.27
	Lestidiops sp.	3.26	345	0.58
0				
	Lestidiops sp.	2.35	289	0.42
	Lagocephalus laevigatus	1.08	73	0.19
	Brachydeuterus auritus	1.04	5	0.19
	OMMASTREPHIDAE	0.91	17	0.16
0				
	Not found	0.66	2	0.12
	Saurida waniesco	0.17	17	0.03
	Total	556.66		99.99

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 5
DATE :10/07/17 GEAR TYPE: BT NO: 2 POSITION:Lat N
15°4.90
start stop duration Lon W
17°16.82
TIME :14:08:06 14:20:29 12.4 (min) Purpose : 1
LOG : 584.54 585.21 0.7 Region : 1300
FDEPTH: 137 128 Gear cond.: 0
BDEPTH: 137 128 Validity : 0
Towing dir: 0° Wire out : 350 m Speed : 3.2 kn
Sorted : 72 Total catch: 292.28 Catch/hour: 1416.54

C	SAMP SPECIES	CATCH/HOUR weight	numbers	% OF TOT.
	Scomber colias	904.56	23554	63.86
12				
	Trachurus trecae	464.49	6344	32.79
13				
	Capros aper	12.41	155	0.88
	Zenopsis conchifer	12.31	5	0.87
	Ariomma bondi	10.47	155	0.74
	Pontinus kuhlii	5.04	78	0.36
	Sphoeroides pachgaster	2.33	19	0.16
	Aulopus filamentosus	1.74	10	0.12
	Todarodes pacificus	1.45	34	0.10
	Antigonia capros	1.36	58	0.10
	Munida sp.	0.39	58	0.03
	Total	1416.54		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 6
DATE :10/07/17 GEAR TYPE: PT NO: 8 POSITION:Lat N
14°54.65
start stop duration Lon W
17°25.12
TIME :21:49:40 22:03:10 13.5 (min) Purpose : 1
LOG : 623.33 624.33 1.0 Region : 1300
FDEPTH: 0 10 Gear cond.: 0
BDEPTH: 143 132 Validity : 0
Towing dir: 0° Wire out : 210 m Speed : 4.4 kn
Sorted : 35 Total catch: 365.89 Catch/hour: 1626.18

C	SAMP SPECIES	CATCH/HOUR weight	numbers	% OF TOT.
	Trachurus trecae	1035.56	87760	63.68
15				
	Scomber colias	512.00	20644	31.48
14				
	Auxis thazard	28.89	80	1.78
	Euthynnus alletteratus	27.73	22	1.71
	Engraulis encrasicolus	12.44	933	0.77
18				
	Caranx crysos	8.44	13	0.52
0				
	Sphyraena sphyraena	0.98	4	0.06
	Saurida waniesco	0.13	89	0.01
	Total	1626.18		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 7
DATE :11/07/17 GEAR TYPE: PT NO: 4 POSITION:Lat N
14°44.66
start stop duration Lon W
17°38.28
TIME :04:11:35 04:38:23 26.8 (min) Purpose : 1
LOG : 654.59 656.12 1.5 Region : 1300
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 336 478 Validity : 0
Towing dir: 0° Wire out : 145 m Speed : 3.4 kn
Sorted : 2 Total catch: 2.27 Catch/hour: 5.07

C	SAMP SPECIES	CATCH/HOUR weight	numbers	% OF TOT.
	Not found	4.16	2	82.12
	Diaphus effulgens	0.49	488	9.71
	Alloteuthis africana	0.18	40	3.53
	SALPS	0.11	2	2.21
	Ascidiacea	0.11	4	2.21
	Phyllosoma	0.00	2	0.04

Balistes capriscus, juvenile	0.00	2	0.04
CARANGIDAE, juvenile	0.00	2	0.04
Acanthurus monroviae, juvenile	0.00	2	0.04
SOLEIDAE, juvenile	0.00	2	0.04
Total	5.07		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 8
DATE :11/07/17 GEAR TYPE: PT NO: 1 POSITION:Lat N
14°21.62
start stop duration Lon W
17°17.49
TIME :11:43:08 12:13:09 30.0 (min) Purpose : 1
LOG : 712.74 714.52 1.8 Region : 1300
FDEPTH: 10 23 Gear cond.: 0
BDEPTH: 45 45 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 3.6 kn
Sorted : 0 Total catch: 0.00 Catch/hour: 0.00

SPECIES	CATCH/HOUR		% OF TOT.
C SAMP			
	weight	numbers	
Plastic	0.00	2	0.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 9
DATE :11/07/17 GEAR TYPE: PT NO: 8 POSITION:Lat N
14°13.98
start stop duration Lon W
17°28.62
TIME :17:54:05 18:29:27 35.4 (min) Purpose : 1
LOG : 756.04 758.82 2.8 Region : 1300
FDEPTH: 50 65 Gear cond.: 0
BDEPTH: 104 100 Validity : 0
Towing dir: 0° Wire out : 550 m Speed : 4.7 kn
Sorted : 4 Total catch: 3.88 Catch/hour: 6.59

SPECIES	CATCH/HOUR		% OF TOT.
C SAMP			
	weight	numbers	
Ascidiacea	6.17	409	93.77
Trachurus trecae	0.15	2	2.32
Todaropsis eblanae	0.10	2	1.55
Todaropsis eblanae	0.10	2	1.55
0			
SALPS	0.05	2	0.77
Acanthurus monroviae, juvenile	0.00	3	0.03
Sphoeroides sp., juvenile	0.00	3	0.03
Total	6.59		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 10
DATE :11/07/17 GEAR TYPE: PT NO: 1 POSITION:Lat N
14°14.22
start stop duration Lon W
17°14.85
TIME :22:26:48 22:47:25 20.6 (min) Purpose : 1
LOG : 784.29 785.50 1.2 Region : 1300
FDEPTH: 17 19 Gear cond.: 0
BDEPTH: 40 41 Validity : 0
Towing dir: 0° Wire out : 90 m Speed : 3.5 kn
Sorted : 60 Total catch: 60.38 Catch/hour: 175.69

SPECIES	CATCH/HOUR		% OF TOT.
C SAMP			
	weight	numbers	
Chloroscombrus chrysurus	119.30	1219	67.90
Sardinella aurita	35.79	274	20.37
19			
Sardinella maderensis	11.17	0	6.36
22			
Trachurus trecae	2.33	15	1.32
21			
Dactylopterus volitans	2.10	3	1.19
Alectis alexandrinus	1.75	3	0.99
Sphyraena guachancho	0.81	3	0.46
Brachydeuterus auritus	0.76	6	0.43
Selene dorsalis	0.47	3	0.26
Caranx rhonchus	0.41	3	0.23
Pomadasys incisus	0.41	3	0.23
Scomber colias	0.12	3	0.07
Total	175.40		99.83

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 11
DATE :12/07/17 GEAR TYPE: PT NO: 7 POSITION:Lat N
14°3.60
start stop duration Lon W
17°8.16
TIME :02:33:12 02:52:32 19.3 (min) Purpose : 1
LOG : 806.87 808.01 1.1 Region : 1300
FDEPTH: 20 25 Gear cond.: 0
BDEPTH: 31 33 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 3.5 kn
Sorted : 105 Total catch: 288.29 Catch/hour: 894.86

SPECIES	CATCH/HOUR		% OF TOT.
C SAMP			
	weight	numbers	
Sardinella maderensis	759.86	4730	84.91
23			
Sardinella aurita	40.07	214	4.48
24			
Chloroscombrus chrysurus	30.45	174	3.40
25			
Brachydeuterus auritus	25.33	258	2.83
Pagellus bellottii	14.46	99	1.62
Pomadasys incisus	6.46	65	0.72
Pagrus caeruleostictus	6.33	31	0.71
Caranx rhonchus	4.97	50	0.55
Eucinostomus melanopterus	1.99	25	0.22
Selene dorsalis	1.12	9	0.12
Not found	0.74	3	0.08
Pomadasys rogeri	0.74	3	0.08
Trichiurus lepturus	0.56	3	0.06
Plectorhinchus mediterraneus	0.50	3	0.06
Dactylopterus volitans	0.37	3	0.04
Galeoides decadactylus	0.31	3	0.03
Echeneis naucrates	0.31	3	0.03
Diplodus bellottii	0.25	3	0.03
Parapenaeus longirostris	0.04	6	0.00
Total	894.86		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 12
DATE :12/07/17 GEAR TYPE: PT NO: 8 POSITION:Lat N
14°2.62
start stop duration Lon W
17°25.42
TIME :05:49:17 06:28:51 39.6 (min) Purpose : 1
LOG : 824.99 828.20 3.2 Region : 1300
FDEPTH: 5 5 Gear cond.: 0
BDEPTH: 89 88 Validity : 0
Towing dir: 0° Wire out : 160 m Speed : 4.9 kn
Sorted : 25 Total catch: 24.90 Catch/hour: 37.76

SPECIES	CATCH/HOUR		% OF TOT.
C SAMP			
	weight	numbers	
Auxis thazard	15.38	71	40.72
Ascidiacea	10.49	2187	27.79
Euthynnus alletteratus	6.22	9	16.47
Scomber colias	3.43	56	9.08
26			
Sarda sarda	2.24	5	5.94
Total	37.76		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 13
DATE :12/07/17 GEAR TYPE: BT NO: 2 POSITION:Lat N
14°5.56
start stop duration Lon W
17°29.41
TIME :10:02:40 10:09:19 6.7 (min) Purpose : 1
LOG : 842.79 843.15 0.4 Region : 1300
FDEPTH: 109 110 Gear cond.: 0
BDEPTH: 109 110 Validity : 0
Towing dir: 0° Wire out : 300 m Speed : 3.2 kn
Sorted : 65 Total catch: 1502.48 Catch/hour: 13556.21

SPECIES	CATCH/HOUR		% OF TOT.
C SAMP			
	weight	numbers	
Boops boops	9600.00	236373	70.82
Trachurus trecae	3148.87	52177	23.23
27			
Scomber colias	532.33	18090	3.93
28			
Dentex macrophthalmus	144.36	830	1.06
Ascidiacea	63.16	4159	0.47
Sphoeroides pachgaster	36.09	208	0.27
Scyliorhinus cervigoni	14.26	9	0.11
Scorpaena angolensis	10.47	9	0.08
Raja miraletus	6.68	9	0.05
Total	13556.21		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 14
DATE :12/07/17 GEAR TYPE: BT NO: 2 POSITION:Lat N
13°54.74
start stop duration Lon W
17°7.57
TIME :18:09:13 18:29:58 20.8 (min) Purpose : 1
LOG : 889.36 890.51 1.1 Region : 1300
FDEPTH: 33 35 Gear cond.: 0
BDEPTH: 33 35 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 3.3 kn
Sorted : 4 Total catch: 4.20 Catch/hour: 12.14

SPECIES	CATCH/HOUR		% OF TOT.
C SAMP			
	weight	numbers	
Pagrus caeruleostictus	3.35	46	27.62
Pseudupeneus prayensis	2.20	26	18.10
Pagellus bellottii	1.79	17	14.76
Sarda sarda	1.73	3	14.29
Ascidiacea	1.39	353	11.43
Brachydeuterus auritus	0.69	6	5.71
Scarus hoefleri	0.29	3	2.38
Eucinostomus melanopterus	0.23	3	1.90
Diplodus bellottii	0.23	3	1.90
Fistularia tabacaria	0.12	3	0.95
PAGUROIDEA	0.06	14	0.48
Alloteuthis africana	0.06	52	0.48
Total	12.14		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 15
DATE :12/07/17 GEAR TYPE: PT NO: 7 POSITION:Lat N
13°47.19
start stop duration Lon W
17°3.57
TIME :21:59:32 22:11:58 12.4 (min) Purpose : 1
LOG : 913.21 913.80 0.6 Region : 1300
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 29 29 Validity : 0
Towing dir: 0° Wire out : 190 m Speed : 2.9 kn
Sorted : 103 Total catch: 103.27 Catch/hour: 498.50

C	SPECIES SAMP	CATCH/HOUR weight	numbers	% OF TOT.
	Brachydeuterus auritus	229.57	2076	46.05
	Chloroscombrus chrysurus	94.32	1023	18.92
31				
	Sardinella aurita	74.34	415	14.91
29				
	Sardinella maderensis	37.75	232	7.57
30				
	Caranx rhonchus	17.96	87	3.60
	Not found	10.72	53	2.15
	Octopus vulgaris	9.36	10	1.88
	Sphyraena guachancho	5.21	10	1.05
	Alectis alexandrinus	5.12	10	1.03
	Eucinostomus melanopterus	2.90	24	0.58
	Pomadasys jubelini	2.70	10	0.54
	Galeoides decadactylus	1.93	14	0.39
	Trachinotus ovatus	1.74	10	0.35
	Trichiurus lepturus	1.35	10	0.27
	Sphoeroides pachgaster	1.06	5	0.21
	Pomadasys incisus	1.04	5	0.21
	Penaeus kerathurus	0.54	19	0.11
	Scomber colias	0.39	5	0.08
	J E L L Y F I S H	0.32	5	0.06
	Fistularia tabacaria	0.17	5	0.03
	Total	498.50		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 16
DATE :13/07/17 GEAR TYPE: PT NO: 4 POSITION:Lat N
13°44.83
start stop duration Lon W
17°25.93
TIME :01:08:56 01:40:04 31.1 (min) Purpose : 1
LOG : 936.27 937.83 1.6 Region : 1300
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 122 385 Validity : 0
Towing dir: 0° Wire out : 145 m Speed : 3.0 kn
Sorted : 1 Total catch: 9.38 Catch/hour: 18.08

C	SPECIES SAMP	CATCH/HOUR weight	numbers	% OF TOT.
	Todaropsis eblanae	6.05	18	33.47
	Ariomma bondi	5.67	108	31.34
	MYCTOPHIDAE	3.32	2066	18.33
	Ascidiacea	1.93	100	10.66
	SALPS	0.73	25	4.05
	Scomber colias	0.35	12	1.92
32				
	Lestidiops sp.	0.04	2	0.21
	Acanthurus monroviae, juvenile	0.00	2	0.01
	Plastic	0.00	2	0.00
	Total	18.08		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 17
DATE :13/07/17 GEAR TYPE: PT NO: 7 POSITION:Lat N
13°36.34
start stop duration Lon W
17°5.04
TIME :05:52:03 06:13:30 21.4 (min) Purpose : 1
LOG : 971.20 972.44 1.2 Region : 1400
FDEPTH: 15 20 Gear cond.: 0
BDEPTH: 30 33 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 3.5 kn
Sorted : 108 Total catch: 107.82 Catch/hour: 301.59

C	SPECIES SAMP	CATCH/HOUR weight	numbers	% OF TOT.
	Chloroscombrus chrysurus	136.45	2643	45.24
33				
	Caranx rhonchus	105.85	445	35.10
34				
	Brachydeuterus auritus	15.50	134	5.14
	Pagellus bellottii	7.27	42	2.41
	Pagrus caeruleostictus	6.71	25	2.23
	Alectis alexandrinus	5.15	11	1.71
	Not found	4.81	22	1.60
	Sphyraena guachancho	4.08	11	1.35
	Eucinostomus melanopterus	3.08	22	1.02
	Selene dorsalis	2.97	17	0.98
	Not found	2.18	3	0.72
	Sardinella maderensis	1.51	8	0.50
	Trachinotus goreensis	1.34	3	0.45
0				
	Galeoides decadactylus	1.23	3	0.41
	Trachinotus ovatus	1.12	6	0.37
	Sphyraena barracuda	0.67	3	0.22
	Pomadasys incisus	0.62	3	0.20
	Pseudupeneus prayensis	0.56	6	0.19
	Fistularia tabacaria	0.22	3	0.07
	Halobatrachus didactylus	0.17	3	0.06
	Penaeus kerathurus	0.11	3	0.04
	J E L L Y F I S H	0.00	3	0.00
	Total	301.59		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 18
DATE :13/07/17 GEAR TYPE: BT NO: 2 POSITION:Lat N
13°28.56
start stop duration Lon W
17°5.18
TIME :10:03:17 10:19:05 15.8 (min) Purpose : 1
LOG : 998.80 999.67 0.9 Region : 1300
FDEPTH: 31 31 Gear cond.: 0
BDEPTH: 31 31 Validity : 0
Towing dir: 0° Wire out : 110 m Speed : 3.3 kn
Sorted : 67 Total catch: 353.12 Catch/hour: 1340.97

C	SPECIES SAMP	CATCH/HOUR weight	numbers	% OF TOT.
	Not found	562.03	2343	41.91
	Brachydeuterus auritus	412.03	4075	30.73
	Pomadasys jubelini	266.20	1082	19.85
	Caranx rhonchus	28.66	110	2.14
36				
	Trichiurus lepturus	18.53	65	1.38
	Galeoides decadactylus	15.57	38	1.16
	Sphyraena guachancho	15.19	38	1.13
	Trachinotus goreensis	9.11	23	0.68
	Chloroscombrus chrysurus	7.59	133	0.57
35				
	Drepane africana	4.56	4	0.34
	Chrysaora sp.	1.51	42	0.11
	Total	1340.97		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 19
DATE :13/07/17 GEAR TYPE: PT NO: 8 POSITION:Lat N
13°27.55
start stop duration Lon W
17°23.43
TIME :13:32:28 14:12:54 40.4 (min) Purpose : 1
LOG : 1020.85 1023.39 2.5 Region : 1400
FDEPTH: 15 35 Gear cond.: 0
BDEPTH: 83 71 Validity : 0
Towing dir: 0° Wire out : 250 m Speed : 3.8 kn
Sorted : 9 Total catch: 8.74 Catch/hour: 12.97

C	SPECIES SAMP	CATCH/HOUR weight	numbers	% OF TOT.
	Euthynnus alletteratus	5.11	15	39.36
	Caranx crysos	3.71	7	28.60
	Trachinotus ovatus	2.34	10	18.08
	Sardinella maderensis	1.81	9	13.96
37				
	Total	12.97		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 20
DATE :13/07/17 GEAR TYPE: PT NO: 8 POSITION:Lat N
13°20.10
start stop duration Lon W
17°30.27
TIME :23:45:55 00:08:09 22.2 (min) Purpose : 1
LOG : 1061.64 1063.24 1.6 Region : 1400
FDEPTH: 0 30 Gear cond.: 0
BDEPTH: 107 99 Validity : 0
Towing dir: 0° Wire out : 250 m Speed : 4.3 kn
Sorted : 35 Total catch: 190.62 Catch/hour: 514.50

C	SPECIES SAMP	CATCH/HOUR weight	numbers	% OF TOT.
	Scomber colias	215.11	3166	41.81
39				
	Abraliopsis sp.	125.91	34340	24.47
	MYCTOPHIDAE	80.16	41225	15.58
	Brachydeuterus auritus	39.68	283	7.71
	Caranx crysos	34.22	0	6.65
38				
	Ascidiacea	6.21	486	1.21
	Echeneis naucrates	3.01	3	0.59
	Sphyraena guachancho	2.94	11	0.57
	Saurida waniesco	2.16	513	0.42
	Sarda sarda	1.29	3	0.25
	Trachurus trecae	1.08	216	0.21
	Euthynnus alletteratus	0.99	3	0.19
	Dactylopterus volitans	0.65	3	0.13
	Trachinotus ovatus	0.59	3	0.12
	Paralepidae	0.50	40	0.10
	Total	514.50		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 21
DATE :14/07/17 GEAR TYPE: PT NO: 7 POSITION:Lat N
13°20.56
start stop duration Lon W
17°7.02
TIME :04:51:56 05:06:05 14.2 (min) Purpose : 1
LOG : 1087.45 1088.28 0.8 Region : 1400
FDEPTH: 20 20 Gear cond.: 0
BDEPTH: 34 33 Validity : 0
Towing dir: 0° Wire out : 110 m Speed : 3.5 kn
Sorted : 25 Total catch: 166.10 Catch/hour: 704.30

C	SPECIES SAMP	CATCH/HOUR weight	numbers	% OF TOT.
	Brachydeuterus auritus	490.56	5813	69.65
	Chloroscombrus chrysurus	153.16	1573	21.75
41				
	Sardinella maderensis	19.55	127	2.78
40				
	Pagellus bellottii	16.54	81	2.35
	Sphyraena afra	5.51	8	0.78
	Caranx rhonchus	5.51	81	0.78
42				
	Pomadasys incisus	4.79	25	0.68
	Eucinostomus melanopterus	3.56	34	0.51
	Not found	2.79	13	0.40
	Selene dorsalis	1.38	17	0.20
	Trachinotus ovatus	0.75	4	0.11
	Alloteuthis africana	0.19	127	0.03
	Total	704.29		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 22
DATE :14/07/17 GEAR TYPE: PT NO: 1 POSITION:Lat N
13°2.12
start stop duration Lon W
17°17.93
TIME :20:52:46 21:25:06 32.3 (min) Purpose : 1
LOG : 1178.82 1180.47 1.7 Region : 1300
FDEPTH: 20 20 Gear cond.: 0
BDEPTH: 41 43 Validity : 0
Towing dir: 0° Wire out : 90 m Speed : 3.1 kn
Sorted : 77 Total catch: 76.86 Catch/hour: 142.64

C	SPECIES SAMP	CATCH/HOUR weight	numbers	% OF TOT.
	Chloroscombrus chrysurus	119.85	1193	84.03
46				
	Trachurus trecae	6.60	32	4.63
44				
	Caranx rhonchus	4.59	28	3.22
43				
	Selene dorsalis	4.25	46	2.98
45				
	Brachydeuterus auritus	2.64	20	1.85
	Pagellus bellottii	1.78	9	1.25
	Pomadasys incisus	0.93	6	0.65
	Sardinella maderensis	0.82	6	0.57
	Trachinotus ovatus	0.37	2	0.26
	Pseudupeneus prayensis	0.37	7	0.26
	Hemicaranx bicolor	0.30	2	0.21
	Eucinostomus melanopterus	0.14	2	0.10
	Total	142.64		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 23
DATE :15/07/17 GEAR TYPE: PT NO: 7 POSITION:Lat N
12°58.14
start stop duration Lon W
17°3.34
TIME :01:25:35 01:58:38 33.0 (min) Purpose : 1
LOG : 1203.08 1204.81 1.7 Region : 1300
FDEPTH: 5 5 Gear cond.: 0
BDEPTH: 21 22 Validity : 0
Towing dir: 0° Wire out : 125 m Speed : 3.1 kn
Sorted : 64 Total catch: 64.38 Catch/hour: 116.87

C	SPECIES SAMP	CATCH/HOUR weight	numbers	% OF TOT.
	Chloroscombrus chrysurus	90.81	762	77.70
48				
	Brachydeuterus auritus	12.24	109	10.47
	Sardinella maderensis	4.32	36	3.70
47				
	Caranx senegallus	2.63	16	2.25
51				
	Ilisha africana	2.43	33	2.08
49				
	Trachinotus ovatus	1.52	9	1.30
	Caranx rhonchus	1.28	7	1.10
50				
	Alectis alexandrinus	0.58	2	0.50
	Caranx crysos	0.36	2	0.31
	Trachurus trecae	0.33	2	0.28
	Caranx rhonchus, juvenile	0.22	24	0.19
	Selene dorsalis	0.15	2	0.12
	Alloteuthis africana	0.01	5	0.01
	Brachydeuterus auritus, juvenile	0.01	5	0.00
	Total	116.87		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 24
DATE :15/07/17 GEAR TYPE: PT NO: 1 POSITION:Lat N
12°53.36
start stop duration Lon W
17°30.82
TIME :05:30:38 05:50:19 19.7 (min) Purpose : 1
LOG : 1233.62 1234.69 1.1 Region : 1300
FDEPTH: 25 35 Gear cond.: 0
BDEPTH: 52 54 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.3 kn
Sorted : 61 Total catch: 253.93 Catch/hour: 774.18

C	SPECIES SAMP	CATCH/HOUR weight	numbers	% OF TOT.
	Brachydeuterus auritus	643.17	6381	83.08
	Caranx rhonchus	53.90	268	6.96
53				
	Chloroscombrus chrysurus	27.56	232	3.56
52				
	Sphyraena guachancho	16.24	55	2.10
56				
	Selene dorsalis	15.37	134	1.98
58				
	Sardinella maderensis	5.84	34	0.75
55				
	Trachurus trecae	3.65	30	0.47
57				
	Trichiurus lepturus	2.20	3	0.28
	Galeoides decadactylus	1.77	9	0.23
	Dactylopterus volitans	1.52	9	0.20
	Scomber colias	1.40	12	0.18
	Trachinotus ovatus	0.67	3	0.09
	Pomadasys incisus	0.58	3	0.08
	Eucinostomus melanopterus	0.30	3	0.04
	Total	774.18		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 25
DATE :16/07/17 GEAR TYPE: BT NO: 2 POSITION:Lat N
12°22.60
start stop duration Lon W
17°19.14
TIME :10:22:25 10:33:18 10.9 (min) Purpose : 1
LOG : 1343.74 1344.29 0.6 Region : 1300
FDEPTH: 46 46 Gear cond.: 0
BDEPTH: 46 46 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.0 kn
Sorted : 59 Total catch: 58.68 Catch/hour: 323.90

C	SPECIES SAMP	CATCH/HOUR weight	numbers	% OF TOT.
	Galeoides decadactylus	78.55	237	24.25
	Ilisha africana	75.84	1292	23.42
	Cymbium cymbium	28.92	6	8.93
	Selene dorsalis	25.17	121	7.77
60				
	Rhizoprionodon acutus	13.80	11	4.26
	Pseudotolithus senegalensis	11.50	17	3.55
	Trichiurus lepturus	10.44	39	3.22
	Sphyraena guachancho	8.40	33	2.59
61				
	Octopus vulgaris	7.56	11	2.33
	Elops senegalensis	7.13	17	2.20
	Trichiurus lepturus, juvenile	7.11	1352	2.19
	Chloroscombrus chrysurus	6.30	50	1.94
59				
	Brachydeuterus auritus, juvenile	5.01	2136	1.55
	Galeoides decadactylus, juvenile	4.16	1115	1.28
	Sepia bertheloti	3.89	11	1.20
	Ilisha africana, juvenile	3.44	1093	1.06
	Penaeus notialis	3.29	397	1.02
	Brachydeuterus auritus	3.15	50	0.97
	Alectis alexandrinus	3.06	6	0.94
	Thorogobius angolensis	2.94	1606	0.91
	Caranx rhonchus	2.19	6	0.67
	Pisodonophis semicinctus	2.11	6	0.65
	Not found	1.66	11	0.51
	Serranus accraensis	1.38	6	0.43
	Syacium micrurum	1.27	11	0.39
	Sardinella maderensis	1.02	6	0.32
	Not found	0.95	6	0.29
	Brotula barbata	0.94	6	0.29
	Lagocephalus laevigatus	0.92	22	0.28
	Grammoplites gruveli	0.47	22	0.14
	Not found	0.47	204	0.14
	Pseudupeneus prayensis	0.34	6	0.11
	Alloteuthis africana	0.20	132	0.06
	Scyllarides herklotsii	0.11	17	0.03
	Cynoponticus ferox, juvenile	0.06	6	0.02
	Saurida waniesco, juvenile	0.06	55	0.02
	Sea urchin	0.04	6	0.01
	Stenorhynchus lanceolatus	0.03	6	0.01
	Sepia bertheloti, juvenile	0.03	6	0.01
	Selene dorsalis, juvenile	0.00	6	0.00
	Engraulis encrasicolus	0.00	6	0.00
	Total	323.89		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017404 STATION: 26
DATE :17/07/17 GEAR TYPE: BT NO: 2 POSITION:Lat N
12°3.67
start stop duration Lon W
17°11.23
TIME :03:29:56 03:35:36 5.7 (min) Purpose : 1
LOG : 1446.18 1446.44 0.3 Region : 1300
0
FDEPTH: 59 57 Gear cond.: 0
BDEPTH: 59 57 Validity : 0
Towing dir: 0° Wire out : 160 m Speed : 2.7 kn
Sorted : 0 Total catch: 103.66 Catch/hour: 1096.96

C	SPECIES SAMP	CATCH/HOUR weight	numbers	% OF TOT.
	Pseudotolithus senegalensis	229.21	317	20.89
	Galeoides decadactylus	209.31	624	19.08
	Pentheroscion mbizi	147.94	1630	13.49
	Albula vulpes	120.00	159	10.94
	Pegusa lascaris	60.53	455	5.52
	Pomadasys perotaei	54.78	85	4.99
	Pisodonophis semicinctus	49.31	159	4.50
	Not found	49.21	74	4.49
	Brachydeuterus auritus	24.22	381	2.21
	Trichiurus lepturus	22.68	74	2.07
	Not found	16.53	116	1.51
	Pteroscion peli	15.10	116	1.38
	PAGUROIDEA	13.97	529	1.27
	Ophiotrix sp.	11.01	0	1.00
	Epinephelus aeneus	10.05	21	0.92
	G A S T R O P O D S	8.73	698	0.80
	Pseudupeneus prayensis	8.05	53	0.73
	Elops senegalensis	5.72	11	0.52
	Mystriophis rostellatus	5.49	53	0.50
	Thorogobius angolensis	4.87	2963	0.44
	Sardinella maderensis	4.65	21	0.42
	Bembrops greyi	4.53	53	0.41
	Scyllarides herklotsii	4.34	2963	0.40
	Scorpaena angolensis	3.77	53	0.34
	Cynoponticus ferox	3.49	32	0.32
	Sphyraena guachancho	2.06	11	0.19
	B I V A L V E S	1.93	4709	0.18
	Thorogobius angolensis	1.56	138	0.14
	Brotula barbata	1.39	32	0.13
	Not found	0.85	169	0.08
	Not found	0.74	169	0.07
	DROMIIDAE	0.53	169	0.05
	Parapenaeus longirostris	0.22	32	0.02
	LEUCOSIIDAE	0.21	201	0.02
	Plastic	0.00	11	0.00
	Total	1096.96		100.00

ANNEX II OVERVIEW OF BIOLOGICAL SAMPLES

Table II.1- Number of individuals sampled including length measurement per species for Senegal and The Gambia

Species name	Length	liver	stomach	otoliths	fin clip
Trachurus trecae	408	125	1	155	
Sardinella aurita	209	60	86	60	60
Sardinella maderensis	255	181	174	181	181
Engraulis encrasicolus	21	21	21	21	21
Scomber colias	368	150	149	150	150
Caranx crysos	18				
Caranx senegallus	9				
Caranx rhonchus	220				
Chloroscombrus chrysurus	632				
Selene dorsalis	122				
Brachydeuterus auritus	185				
Ilisha africana	117				
Boops boops	100				
Dentex angolensis	11				
Sphyraena guachancho	25				
Total number of individuals	2700	537	431	567	412

Table II. 2. Number of individuals sampled per species and station for Senegal and The Gambia, excluding length measurements.

Station	Species name	liver	stomach	otoliths	fin clip
1	*Trachurus trecae*	30	30		
2	*Trachurus trecae*	30	30	1	
2	*Sardinella maderensis*	30	30	23	30
5	*Trachurus trecae*	30	30		
5	*Scomber colias*	30	30	30	30
6	*Trachurus trecae*	30			
6	*Engraulis encrasicolus*	21	21	21	21
6	*Scomber colias*	30	30	30	30
10	*Trachurus trecae*	5	5		
10	*Sardinella aurita*	30	30	29	30
10	*Sardinella maderensis*	24	24	24	24
11	*Sardinella aurita*	27	27	27	27
11	*Sardinella maderensis*	30	30	30	30
12	*Scomber colias*	30	30	30	30
13	*Trachurus trecae*	30	30		
13	*Scomber colias*	30	30	29	30
15	*Sardinella aurita*	3	3	30	3
15	*Sardinella maderensis*	30	30	30	30
19	*Sardinella maderensis*	6	6	6	6
20	*Scomber colias*	30	30	30	30
21	*Sardinella maderensis*	30	30	30	30
23	*Sardinella maderensis*	20	20	20	20
24	*Sardinella maderensis*	11	11	11	11
Total number of individuals		567	537	431	412

ANNEX III 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 was checked on the 23.01.2017 in Sandviksflaket, Bergen, Norway using Cu-64 for the 18 kHz, Cu-60 for the 38 kHz, WC-38.1 for the 70, 120 and 200 kHz, and the WC-22 for the 333 kHz. The details of the settings for the 38 kHz echo sounder were as follows:

Transceiver-2 menu (38 kHz)	
Transducer depth	5 - 8 m
Absorbtion coeff.	8.3 dB/km
Pulse duration	medium (1,024ms)
Bandwidth	2.43 kHz
Max power	2000 Watt
2-way beam angle	-20,6dB
gain	26,95 dB
S_A 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 1) and one ‘Gisund super bottom trawl’. All trawls were used during the survey. The smallest pelagic trawl has 10-12 m vertical opening under normal operation, whereas the MultPelt 624 trawl has 30-40 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 inter-distance 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 pelagic trawls are equipped with a trawl eye that provides information about the trawl opening and the distance of the footrope to the bottom. A pressure sensor is used to show the depth on the headline.

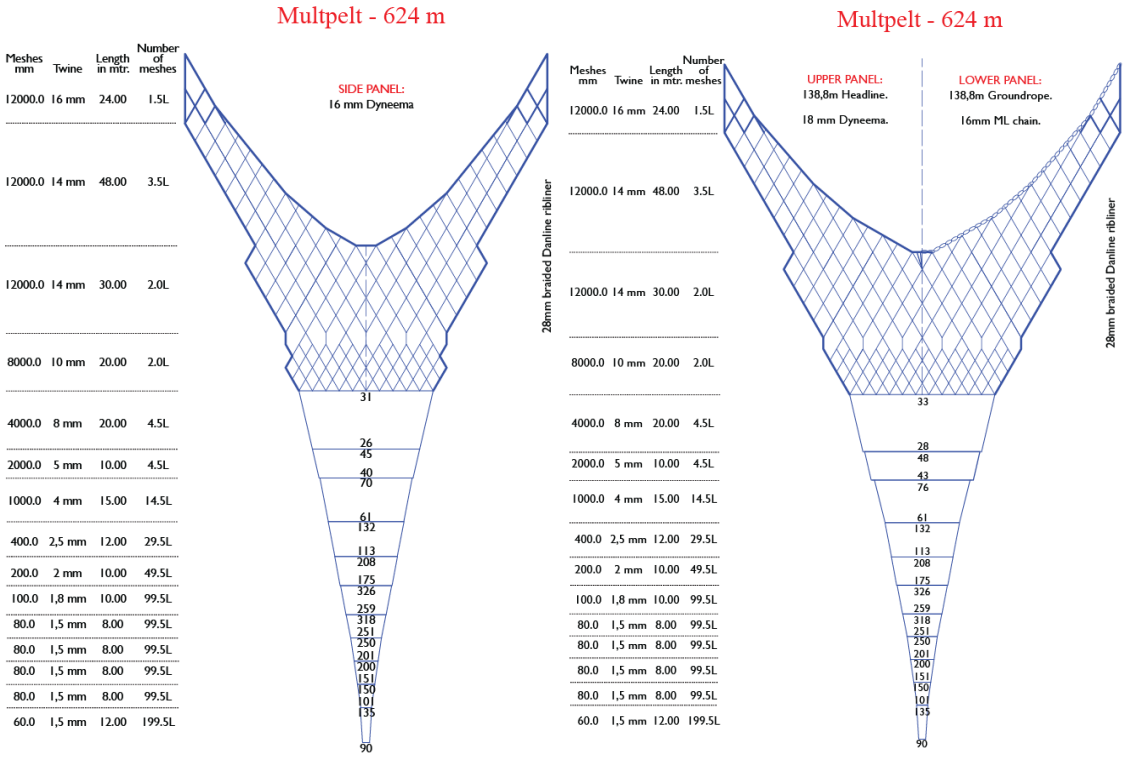
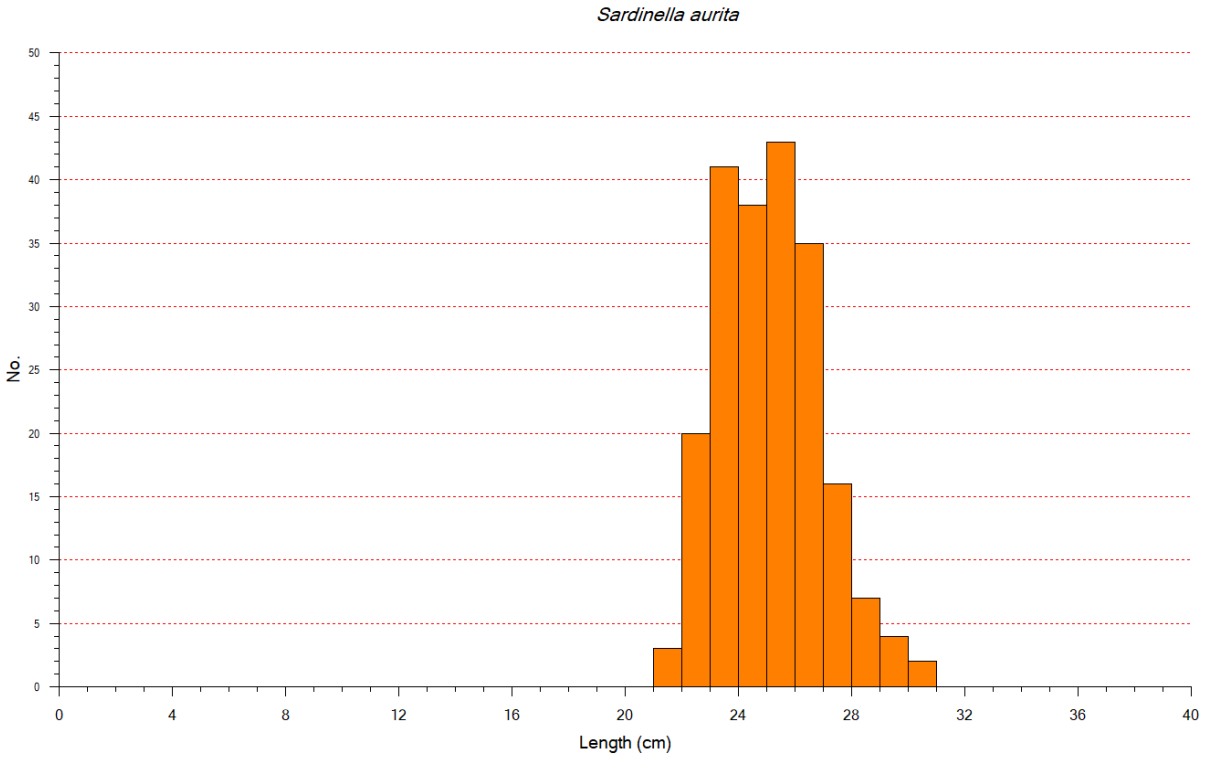


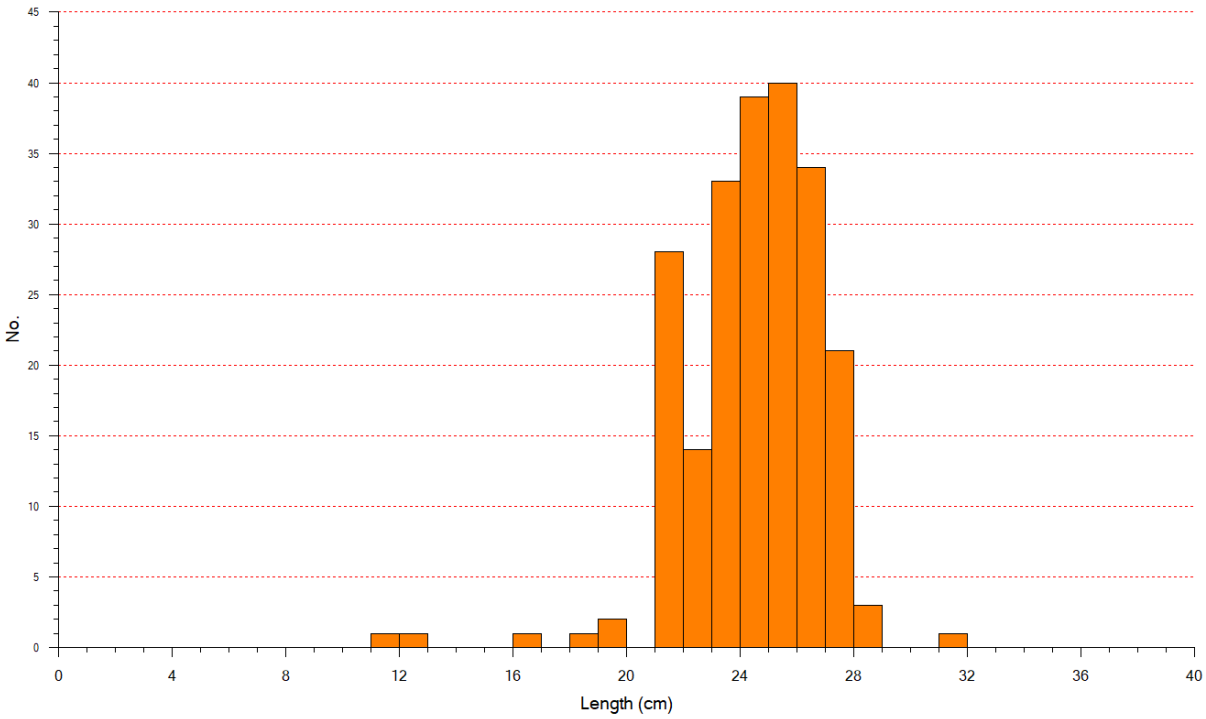
Figure 1. Schematic drawing of the MultPelt 624.

ANNEX IV LENGTH DISTRIBUTION BY SPECIES AND REGION

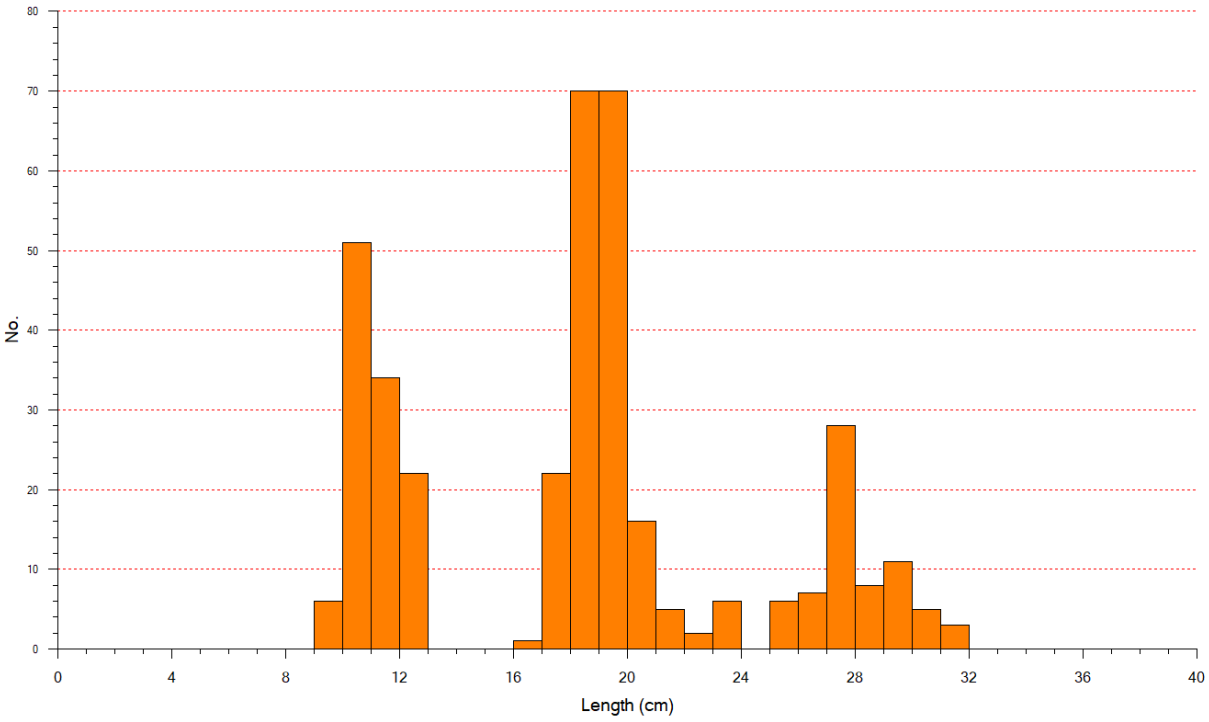
Senegal



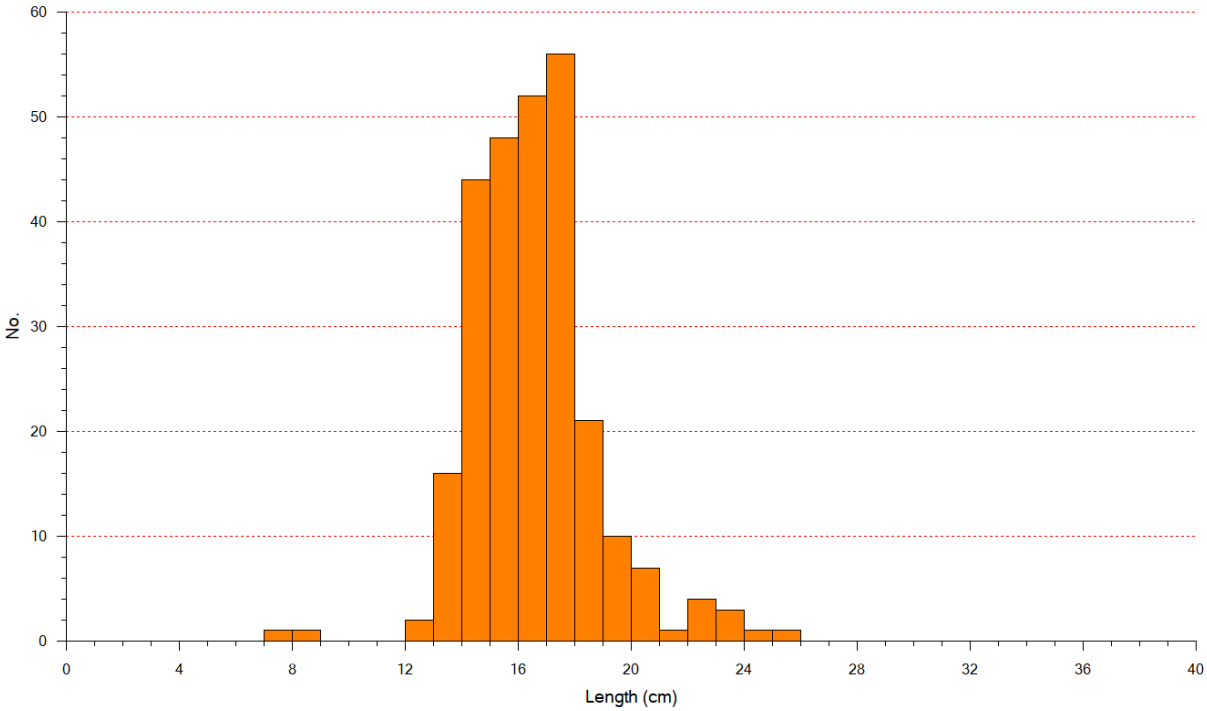
Sardinella maderensis



Trachurus trecae

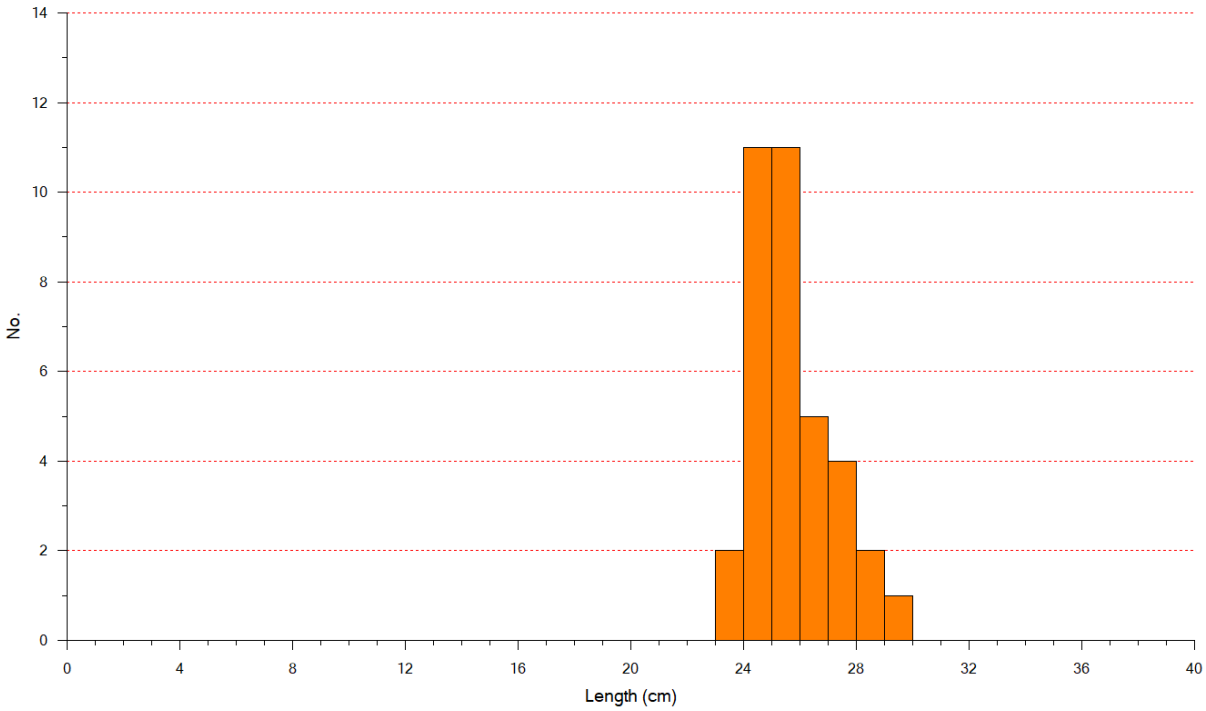


Scomber colias

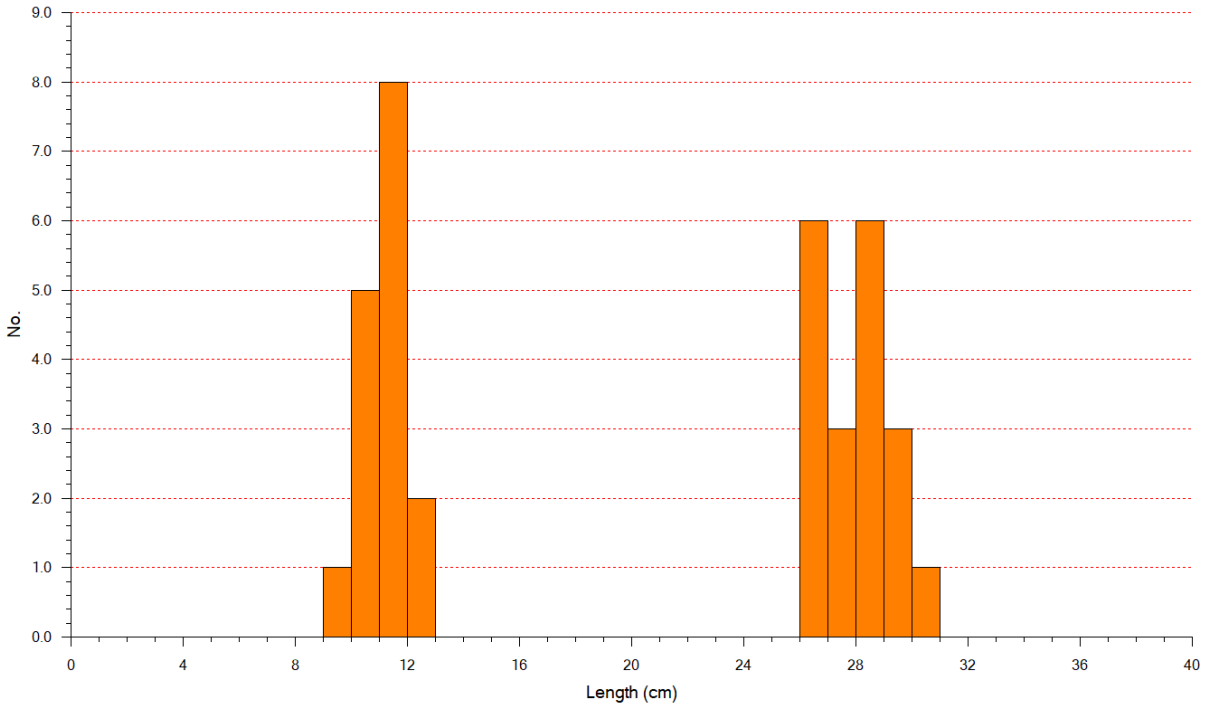

60
50
40
30
20
10
0
No.
0
4
8
12
16
20
24
28
32
36
40
Length (cm)

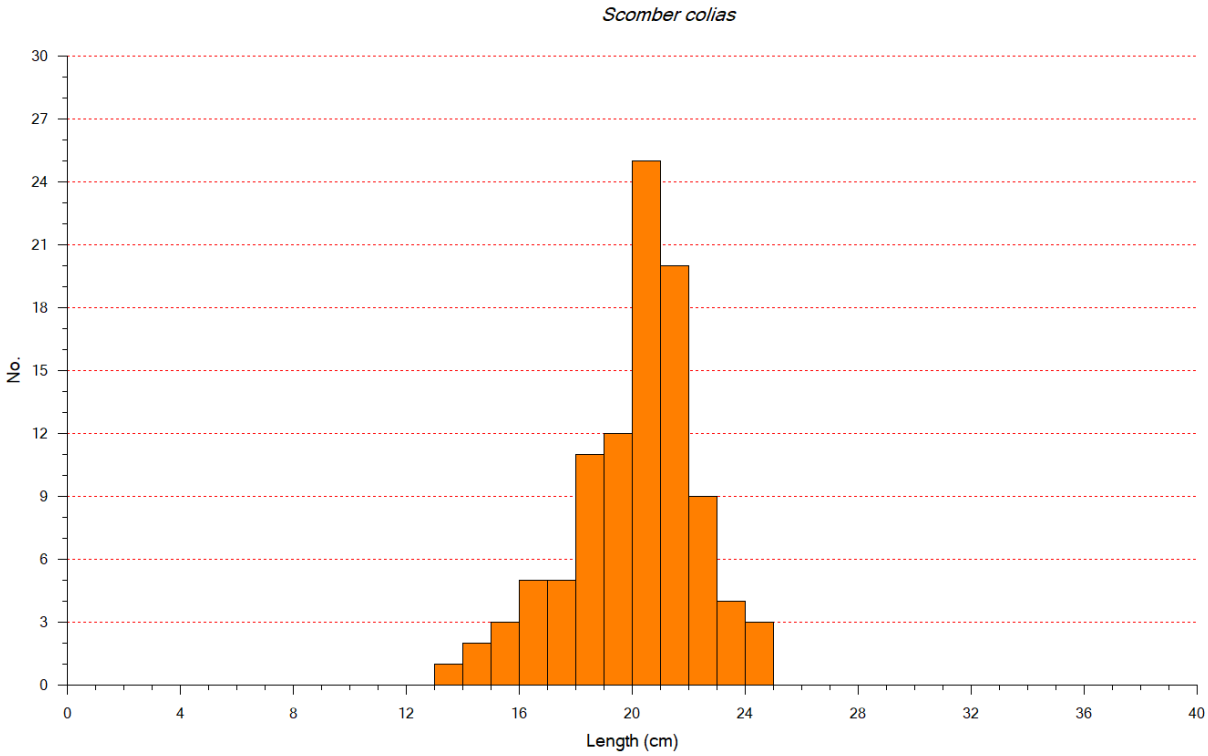
The Gambia

Sardinella maderensis



Trachurus trecae




Scomber colias
No.
Length (cm)
0
3
6
9
12
15
18
21
24
27
30
0
4
8
12
16
20
24
28
32
36
40

ANNEX V ESTIMATED NUMBERS AND BIOMASS BY LENGTH-GROUP AND SUB-REGION

Round sardinella *(Sardinella aurita)*

Numbers in millions					
Length (cm)	St. Louis-C. Vert	C. Vert - Gambia	The Gambia	Casamance	**Total**
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21		10			**10**
22		42			**43**
23		92			**92**
24		87			**88**
25		108			**109**
26		97			**97**
27		60			**60**
28		23			**23**
29		8			**8**
30		4			**4**
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
Total		**532**	**1**		**533**

Biomass in 1 000 tonnes					
Length (cm)	St. Louis-C. Vert	C. Vert - Gambia	The Gambia	Casamance	**Total**
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21		1			**1**
22		5			**5**
23		12			**12**
24		13			**13**
25		18			**18**
26		18			**18**
27		12			**12**
28		5			**5**
29		2			**2**
30		1			**1**
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
Total		**86**			**86**

Flat sardinella *(Sardinella maderensis)*

Numbers in millions						Biomass in 1 000 tonnes					
Length (cm)	St. Louis-C. Vert	C. Vert - Gambia	The Gambia	Casamance	**Total**	Length (cm)	St. Louis-C. Vert	C. Vert - Gambia	The Gambia	Casamance	**Total**
5						5					
6						6					
7						7					
8						8					
9						9					
10						10					
11			1		**1**	11					
12			1		**1**	12					
13						13					
14						14					
15						15					
16			1		**1**	16					
17						17					
18		2			**2**	18					
19		2	1		**3**	19					
20						20					
21		48	1		**49**	21		5			**5**
22		23	2		**25**	22		3			**3**
23		52	6		**58**	23		7	1		**8**
24		106	13		**119**	24		16	2		**18**
25		161	12		**174**	25		28	2		**30**
26		108	13		**121**	26		21	2		**23**
27		29	8		**37**	27		6	2		**8**
28			1		**1**	28					
29						29					
30						30					
31						31					
32						32					
33						33					
34						34					
35						35					
36						36					
37						37					
38						38					
39						39					
40						40					
Total		**532**	**60**		**592**	**Total**		**86**	**10**		**96**

Cunene horse mackerel *(Trachurus trecae)*

Numbers in millions					
Length (cm)	St. Louis-C. Vert	C. Vert - Gambia	The Gambia	Casamance	**Total**
5					
6					
7					
8					
9	8			1	**9**
10	93		1	3	**97**
11	56	2	2	4	**65**
12	29		1	1	**31**
13					
14					
15					
16	4				**4**
17	18	29			**48**
18	46	116	1		**163**
19	94	68	1		**162**
20	41	9			**50**
21	9	2	1	2	**14**
22			1	2	**2**
23			2	4	**6**
24					
25	11				**11**
26	13		1	3	**17**
27	55		1	1	**57**
28	17		1	3	**21**
29	23		1	1	**25**
30	11				**11**
31	4			1	**5**
32					
33					
34					
35					
36					
37					
38					
39					
40					
Total	**533**	**226**	**14**	**24**	**798**

Biomass in 1 000 tonnes					
Length (cm)	St. Louis-C. Vert	C. Vert - Gambia	The Gambia	Casamance	**Total**
5					
6					
7					
8					
9					
10	1				**1**
11	1				**1**
12	1				**1**
13					
14					
15					
16					
17	1	1			**2**
18	3	7			**10**
19	7	5			**12**
20	4	1			**4**
21	1				**1**
22					
23					**1**
24					
25	2				**2**
26	2				**3**
27	12				**12**
28	4			1	**5**
29	6				**7**
30	3				**3**
31	1				**2**
32					
33					
34					
35					
36					
37					
38					
39					
40					
Total	**48**	**14**	**1**	**3**	**66**

Chub mackerel *(Scomber colias)*

Numbers in millions						Biomass in 1 000 tonnes					
Length (cm)	St. Louis-C. Vert	C. Vert - Gambia	The Gambia	Casamance	**Total**	Length (cm)	St. Louis-C. Vert	C. Vert - Gambia	The Gambia	Casamance	**Total**
5						5					
6						6					
7						7					
8						8					
9						9					
10						10					
11						11					
12	2				**2**	12					
13	21		3		**24**	13					
14	54	1	6		**60**	14					
15	42	4	8		**54**	15	1				**1**
16	59	5	14		**78**	16	1				**1**
17	52	6	14		**72**	17	2				**3**
18	14	6	31		**50**	18	2		1		**3**
19	1	3	33		**38**	19	1		1		**2**
20	1	2	69		**73**	20			2		**2**
21			56		**56**	21			5		**5**
22		2	25		**27**	22			4		**4**
23		1	11		**12**	23			2		**2**
24			8		**9**	24			1		**1**
25						25			1		**1**
26						26					
27						27					
28						28					
29						29					
30						30					
31						31					
32						32					
33						33					
34						34					
35						35					
36						36					
37						37					
38						38					
39						39					
40						40					
Total	**246**	**31**	**278**		**554**	**Total**	**8**	**2**	**18**		**28**

ANNEX VI BIOLOGICAL SCALES- MATURITY, STOMACK FULLNESS AND FAT RESERVES

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, more or less symmetrical. Ova not visible to naked eye.
III	Ripening	Ovary and testis is about 2/3rds length of body cavity. Ovary pinkish yellow color 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 color 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 FULLNES:

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.

FAT RESERVES:

SCALE	DESIGNATION	DESCRIPTION
0	No fat	Complete absence of fat in body cavity.
1	Very little fat	A small line of fat along the intestine.
2	Moderate fat	Moderate fat deposits around the intestine, stomach, the kidney, swimbladder and vertebrae.
3	Excessive fat	Excessive fat deposits around the intestine and stomach. The abdominal cavity is completely covered by fat.