NORAD-FAO PROGRAMME
GCP/GLO/690/NOR

CRUISE REPORTS *DR FRIDTJOF NANSEN*
EAF-Nansen/CR/2017/6

SURVEY OF THE PELAGIC FISH RESOURCES AND ECOSYSTEM OFF WEST AFRICA

Côte d'Ivoire and Ghana

22 August – 13 September 2017

Centre de Recherches Océanologiques, Côte d'Ivoire
Fisheries Scientific Survey Division, Ghana

Institute of Marine Research
Bergen, Norway

The EAF-Nansen Programme

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

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

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

Le Programme EAF-Nansen

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

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

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

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CRUISE REPORTS *DR FRIDTJOF NANSEN*

SURVEY OF THE PELAGIC FISH RESOURCES AND ECOSYSTEM OFF WEST AFRICA

Côte d'Ivoire and Ghana

22 August – 13 September 2017

by

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Institute of Marine Research
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CONTENTS

LIST OF ABBREVIATIONS

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

EXECUTIVE SUMMARY

This survey is part of a synoptic coverage of the pelagic resources and ecosystem off West Africa, from Morocco to South Africa, undertaken by R/V *Dr Fridtjof Nansen* in 2017. These surveys, covering the continental shelf and upper slope from approximatively 20 to 500 m depth, while given priority to pelagic resources also had additional objectives and were hence multidisciplinary. The physical and chemical oceanography was intensively sampled both underway and with a series of fixed stations along transects perpendicular to the coast. Plankton and chemical samples were taken along a series of transects perpendicular to the coast, along with samples of microplastics. Simultaneously, the pelagic stocks were assessed using acoustics complimented by trawling. All surveys used standardised methods to ensure data comparability.

This report presents the results from Leg 2.2, i.e. covering Côte d'Ivoire and Ghana from 24th August to 11th September 2017.

The continental shelf of Côte d'Ivoire and Ghana is generally narrow, with the shelf break at 100-120 m between 10-15 NM offshore. The exception is the area east of Cape Three Points where the shelf is upto 50 NM wide and stretches to Cape Coast.

An acoustic sampling grid with a transect spacing of 10 NM, approximately perpendicular to the coast, covered the shelf and slope to the 500 m bottom depth contour. Biological sampling of the fish was carried out using pelagic and bottom trawls. Standard hydrographic sections were sampled along the acoustic transects. Phytoplankton, zooplankton, ichthyoplankton and micro-plastics were also sampled. On two long transects off Cape Three Points (125 NM) and the Volta River estuary (90 NM) hydrographic, plankton and micro-plastic data, as well as samples of the mesopelagic stocks were collected.

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

Altogether 40 trawl hauls were carried out to identify acoustic targets during the survey. A total of 134 CTD casts were made to describe the hydrography of the survey area, and 34 plankton stations were also sampled.

The information presented below is a brief summary of the results of the data analysed during the surveys. The samples collected will be analysed in close cooperation with partner institutions and the resulting datasets will support research as part of the EAF-Nansen Science Plan.

Marine environment

The hydrographic data generally suggested well-stratified water masses, with an indication of upwelling in an area east of Cape Three Points (off Komenda). Dissolved oxygen levels in the

upper 20-50 m were generally high, with values above 3 ml/l in the surface mixed layer. Oxygen levels below 2 ml/l were recorded in the central and eastern parts of Côte d'Ivoire east of Cape Three Points. Temperatures in the surface mixed layer were generally above 22ºC, with higher temperatures (> 25ºC) east of Accra. Salinity in the surface mixed layer varied between 35.7 and 36‰ on the Ghanian shelf and between 34.5 and 35.8‰ along Côte d'Ivoire, with limited regional variation due to freshwater runoff.

Fish abundance and distribution

The distribution of the various pelagic fish groups differed between the two countries surveyed, with high densities, particularly of anchovy, in Ghanaian waters, while the main species in Côte d'Ivoire was horse mackerel. The main densities of pelagic fish were found inshore of 50 m bottom depth and in the case of horse mackerel could extend to 90 m bottom depth, with inshore distributions sometimes extending inshore of the survey area.

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

	Sardinella & anchovy	**Other pelagic fish**
Côte d'Ivoire	1 360	15 850
Ghana	77 140	34 800
Total	**78 500**	**50 650**

Several comparable surveys by the R/V *Dr Fridtjof Nansen* covered Côte d'Ivoire and Ghana between 1981 and 2017 and the results are among the lowest in the time series.

RÉSUMÉ EN FRANCAIS

Cette campagne fait partie d'une couverture synoptique des ressources pélagiques et de l'écosystème au large de l'Afrique de l'Ouest, effectuée en 2017 avec le N/R *Dr Fridtjof Nansen* depuis le Maroc jusqu'en Afrique du Sud. La campagne qui a couvert le plateau continental et la partie supérieure du talus de 20 à 500 m de profondeur. Bien que la priorité ait été donnée aux ressources pélagiques, la campagne avait des objectifs additionels et de ce fait a revêtu un caractére multidisciplinaire. L'océanographie physique et chimique a fait l'objet d'un échantillonnage intensif, le long d'une série de stations fixes situées le long de transects perpendiculaires à la côte. Des échantillons de plancton ainsi que des échantillons de microplastiques ont été prélevés le long d'une série de transects perpendiculaires à la côte. Simultanément, les stocks de poissons pélagiques ont été évalués en utilisant des instruments acoustiques complétés par des chalutages. Des méthodes standardisées on été utilisées pour assurer la comparabilité des données.

Ce rapport présente les résultats de la campagne 2.2, qui a couvert la Côte d'Ivoire et le Ghana du 24 août au 11 septembre 2017.

Le plateau continental de la Côte d'Ivoire et du Ghana est généralement étroit, avec une fracture du plateau située à 100-120 m de profondeur, et localisée entre 10 et 15 MN de la côte. La seule exception est la zone située à l'est du cap des Trois-Pointes, où la largeur du plateau atteint jusqu'à 50 milles marins, et s'étend jusqu'à Cape Coast.

Un reseau d'échantillonnage acoustique avec des transects espacés de 10 NM, approximativement perpendiculaire à la côte, a couvert le plateau et le talus jusqu'à 500 m de profondeur. L'échantillonnage biologique des poissons a été réalisé à l'aide de chaluts pélagiques et de chaluts de fond. Des sections hydrographiques standard ont été échantillonnées le long des transects acoustiques. Le phytoplancton, le zooplancton, l'ichtyoplancton et les microplastiques ont également été échantillonnés. Lors de deux longs transects au large du cap des Trois-Pointes (125 NM) et de l'estuaire du fleuve de la Volta (90 NM), des données hydrographiques, de plancton et de microplastique, ainsi que des échantillons des stocks mésopélagiques ont été collectés.

Avec l'extention de la portée de la recherche du plan scientifique du Programme EAF-Nansen, les objectifs de la campagne ont été élargis pour appuyer la recherche sur les cycles de vie, l'identité des stocks et les relations trophiques des poissons pélagiques. Un effort particulier a été consenti pour échantillonner plusieurs paramètres biologiques pour effectuer par la suite des études sur l'âge et la croissance, la structure du stock, la biologie des populations et les interactions trophiques.

Au total, 40 traits de chaluts ont été effectués pour identifier des cibles acoustiques. Un total de 134 CTD ont été réalisés pour décrire l'hydrographie de la zone d'étude, et 34 stations de plancton ont également été échantillonnées.

Les informations présentées dans ce rapport sont un résumé succint des résultats des données analysées au cours de la campagne. Les échantillons recueillis seront analysés en étroite

coopération avec les institutions partenaires et données résultants soutiendront la recherche dans le cadre du plan scientifique du Programme EAF-Nansen.

Milieu marin

Les données hydrographiques suggéraient généralement des masses d'eau bien stratifiées, avec une indication de remontée des eaux (upwelling) dans une zone située à l'est du cap des Trois-Pointes (au large de Komenda). Les niveaux d'oxygène dissous dans dans la strate supérieure des 20-50 m étaient généralement élevés, avec des valeurs supérieures à 3 ml/l dans la couche mixte de la surface. Des niveaux d'oxygène inférieurs à 2 ml/l ont été enregistrés dans le centre et la partie orientale de la Côte d'Ivoire, à l'est du cap des Trois-Pointes. Les températures dans la couche mixte de la surface étaient généralement supérieures à 22°C, avec des températures plus élevées (> 25°C) à l'est d'Accra. La salinité dans la couche mixte de la surface variait entre 35,7 et 36‰ sur le plateau ghanéen et entre 34,5 et 35,8‰ le long de la Côte d'Ivoire, les variations régionales étant limitées en raison du ruissellement des eaux douces.

Abondance et répartition du poisson

La distribution des divers groupes de poissons pélagiques était différente entre les deux pays étudiés, avec des densités élevées, en particulier les anchois, dans les eaux ghanéennes, tandis que la principale espèce en Côte d'Ivoire était le chinchard. Les principales densités de poissons pélagiques ont été trouvées sur la zone côtière à 50 m de profondeur. Dans le cas du chinchard, elles pouvaient atteindre 90 m de profondeur, les distributions côtières s'étendant parfois du côté côtier de la zone d'étude.

Les biomasses estimées (tonnes) des principaux groupes pélagiques sont résumées dans le tableau suivant.

	Sardinelle et anchois	**Autres poissons pélagiques**
Côte d'Ivoire	1 360	15 850
Ghana	77 140	34 800
Total	**78 500**	**50 650**

Plusieurs études comparables menées avec le N/R *Dr Fridtjof* Nansen ont couvert la Côte d'Ivoire et le Ghana entre 1981 et 2017 et les résultats de cette campagne figurent parmi les plus bas de la série chronologique.

CHAPTER 1. INTRODUCTION

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

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

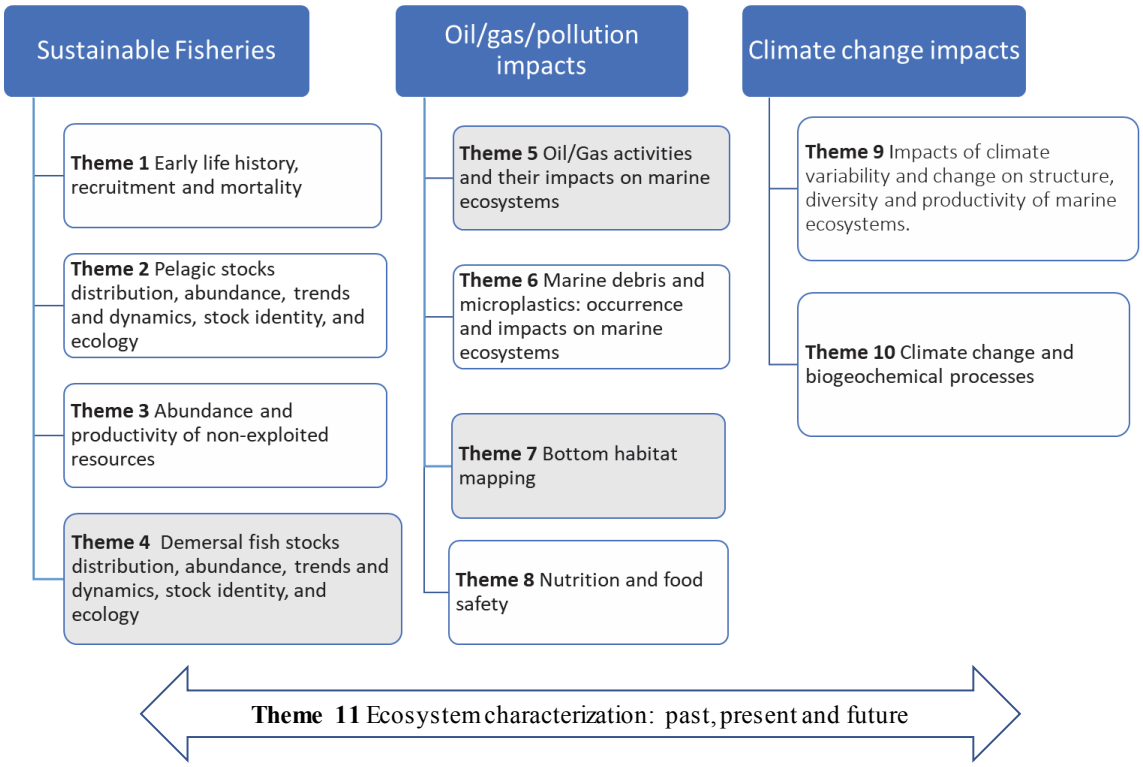

Figure 1. Themes of the Sciene Plan.

This survey has been designed to collect data towards addressing the following themes:

- Sustainable fisheries impacts – Themes 1, 2 and 3,
- Oil/gas/pollution impacts – Themes 6 and 8,
- Climate change impact – Theme 9, and
- the overarching Theme 11 of characterising the present ecosystem.

The specific objectives for this survey are formutated accordingly.

1.1 Survey objectives

Hydrography

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

Phytoplankton, zooplankton and ichthyoplankton and jellyfish

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

Pelagic fish

To obtain information on abundance and distribution of *Sardinella aurita, Sardinella maderensis, Engraulis encrasicolus, Trachurus trecae*, *Scomber colias, Ethmalosa fimbriata* and *Decapterus rhonchus* using acoustic methods and a systematic grid survey strategy.

To collect samples for genetic analysis and for morphometric studies, both for stock identification of *S. aurita, S. maderensis, E. encrasicolus, T. trecae*, *S. colias* and *E. fimbriata.*

To obtain information on gonad maturity, collect stomach samples for diet analysis, and otoliths of *S. aurita, S. maderensis, E. encrasicolus, T. trecae*, *S. colias* and *E. fimbriata.*

Mesopelagic fish

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

Marine debris and pollution

- To record occurrence of marine debris at the surface.
- To map occurrence of microplastics and describe associated neuston communities.

Contaminants

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

1.2 Participation

Institute of Marine Research, Bergen, Norway:
Arved Staby, Magne Olsen, Tor Ensrud, Bjørn Krafft, Geir Landa, Åse Sudman

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

Fisheries Commission (Fisheries Scientific Survey Division – FSSD), Tema, Ghana:
Hawa Bint-Yaqub (local cruise leader), Richmond Quartey, Edmund Nii-Anme, Daniel Lantei Nortey

University of Ghana, Department of Marine and Fisheries Sciences, Accra, Ghana:
Benjamin Osei Botwe

Centre de Recherches Océanologiques (CRO), Abidjan, Côte d'Ivoire:
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Université Nangui Abrogoua, Abidjan, Côte d'Ivoire:
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Nigerian Institute for Oceanography and Marine Research (NIOMR), Lagos, Nigeria:
Dunsin Abimbola Bolaji

Direction des Pêches et de l'Aquaculture (DPA), Lomé, Togo:
Beigue Alfa P'ham

Institut de Recherches Halieutiques et Océanologiques du Bénin (IRHOB), Cotonou, Bénin:
Victor O. Okpeitcha

1.3 Narrative

The vessel departed from Monrovia, Liberia, at 12h00 UTC on 24th August 2017, starting the sampling work at the border of Liberia and Côte d'Ivoire on 25th August at 12h00. Figures 2 - 4 show the cruise track and the stations worked during the survey off Côte d'Ivoire. The survey proceeded with an acoustic sampling grid that had a transect spacing of approximately 10 NM, covering the shelf and slope until the 500-m bottom depth contour. The sampling continued southwards along parallel transects approximately perpendicular to the coast. West and east of Abidjan one transect was skipped respectively, because of oil related activity and high density of fishing boats and other vessels.

The border between Côte d'Ivoire and Ghana was reached on the 30th August at 14h00 UTC.

East of the border in Ghanaian waters is a large area with oil and gas activity. In this area some transects were shortened to avoid the security parimeter of rigs and vessels. Figures 5 - 7 show the cruise track and the stations carried out during the survey off Ghana. A long environmental transect extending 125 NM offshore was conducted on 1st and 2nd September off Cape Three Point. Thereafter the vessel continued surveying towards the Ghanaian - Benin border, where the last transect was finished on 10th September at 07h00 hrs. The vessel continued to do an extended environmental transect (90 NM offshore to 5000 m depth) until 11th September 12h00, and then returned to Tema for a crew change, arriving at 09h00 on 12th September.

The two countries were surveyed on the following dates:

Table 1: Survey dates.

	Total days in country	**Start**	**Complete**
Côte d'Ivoire	6.5	25 August	30 August
Ghana	13.5	30 August	12 September

Standard hydrographical sections were sampled along acoustic transects every 30 NM from 500 m bottom depth to between 20 and 30 m bottom depth close to the coast. Along every second hydrographic section phytoplankton, zooplankton, ichthyoplankton and micro-plastics were sampled additionally at each station. These stations were termed "super-stations".

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

1.4 Survey effort

A total of 40 pelagic and bottom trawl hauls were carried out to identify acoustic targets during the survey. 134 CTD casts were made along hydrographic and deep water transects to describe the water properties in the survey area. Respectively 34 phytoplankton, egg and larvae (multinet), microplastic (Manta trawl), CTD (water samples), and 59 zooplankton (WP2) stations were also sampled. Tables 2 and 3 show the survey effort by country. Annex II gives the full details of the trawl stations.

Table 2. Survey sampling effort during the survey off Côte d'Ivoire and Ghana. Numbers indicate number of transects. Number of stations are shown in parathesis. One deep-water environmental transect was conducted off Cape Three Point and one east of Tema in Ghanaian waters.

	Acoustic	**Hydrographic**	**Plankton & hydrographic**
Côte d'Ivoire	27	5*	4
Ghana	28	4*	5
Total	55	9	10

* Respectively two and four of the hydrographic transects in Côte d'Ivoire and Ghana were extended to 1500 - 2000 m depth.

Table 3. Survey sampling effort during the survey showing number of samples. Phytoplankton (phyto), Zooplankton (WP2), eggs and larvae (Multinet), plastic particles in the surface (Manta), bottom trawl (BT), pelagic trawl (PT). Samples from the deep water environmental transects are included in the Ghana samples.

Region	**CDT**	**Phyto**	**WP-2**	**Multinet**	**Manta**	**BT**	**PT**	**Distance travelled (NM)**
Côte d'Ivoire	50	12	20	12	12	8	9	729
Ghana	84	22	39	22	22	6	17	1000
Deep water environmental transect	22	12	21	12	12	-	5	440
Transit from Monrovia to Côte d'Ivoire border								270

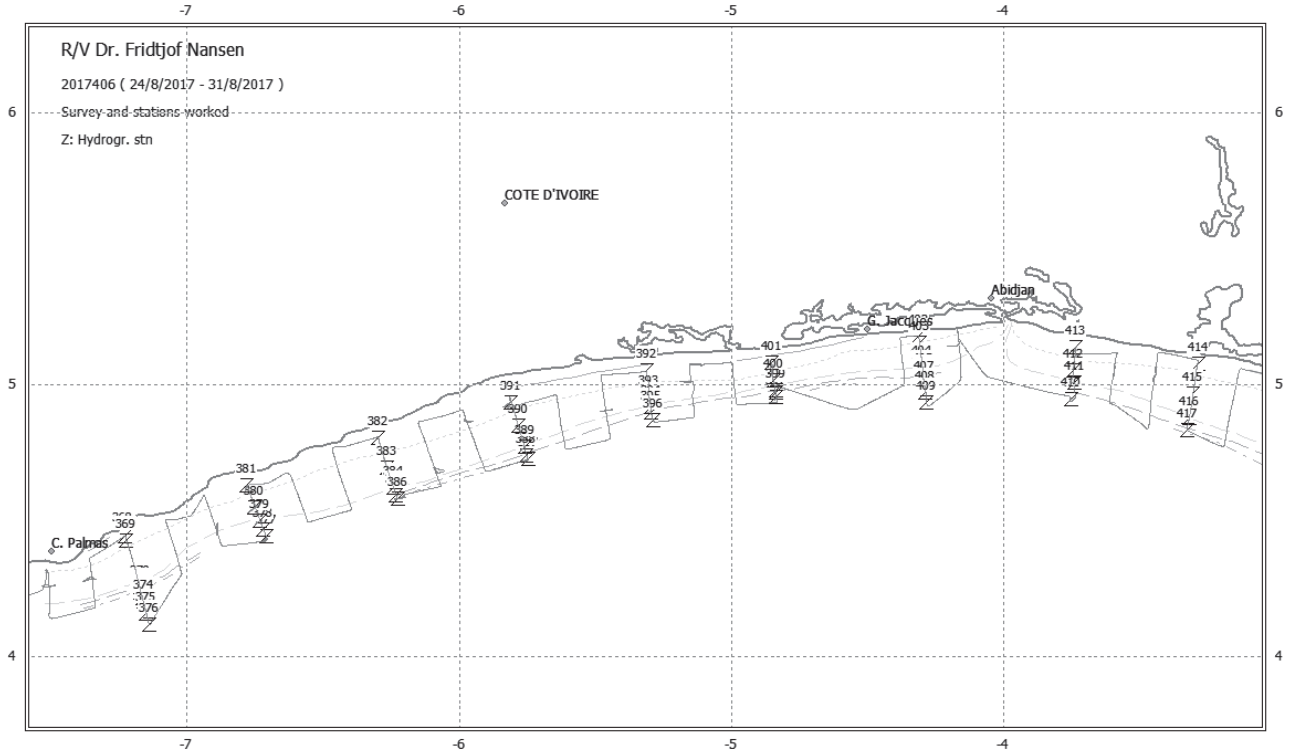

Figure 2. Course track with hydrographic stations, Côte d'Ivoire. Depth contours at 20 m, 50 m, 100 m, 200 m and 500 m are indicated.

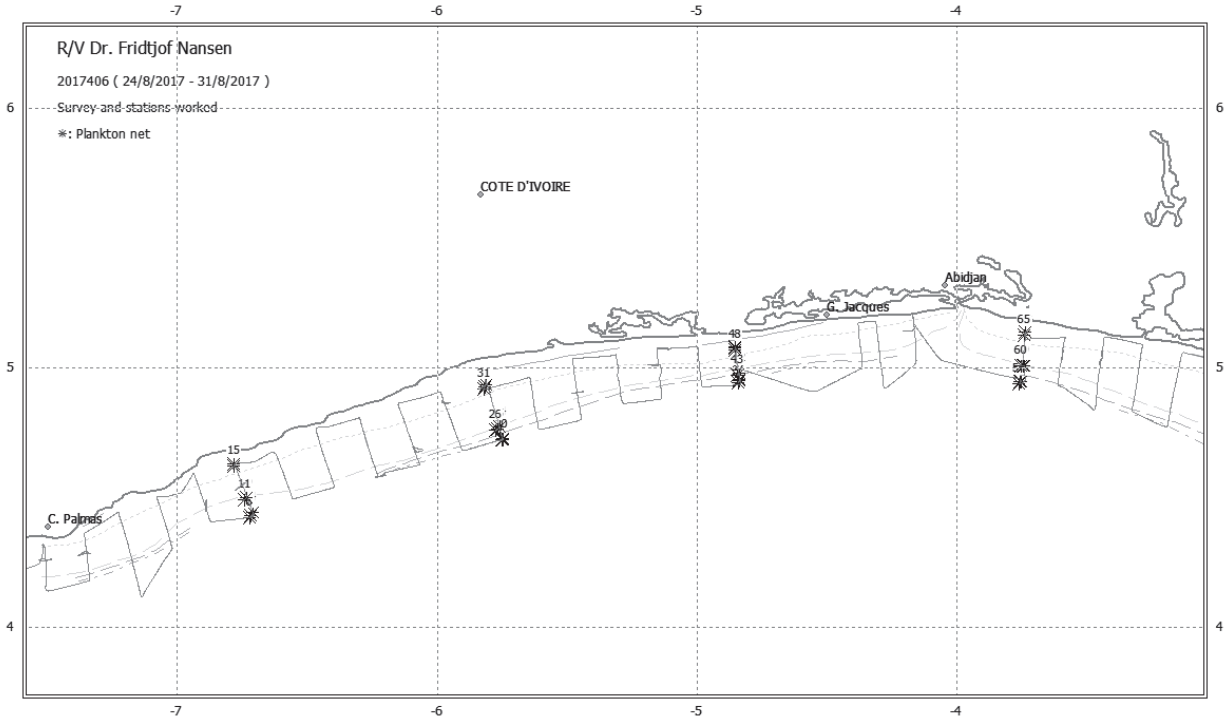

Figure 3. Course track with plankton (phytoplankton, WP2, Manta trawl) stations, Côte d'Ivoire. Depth contours at 20 m, 50 m, 100 m, 200 m and 500 m are indicated.

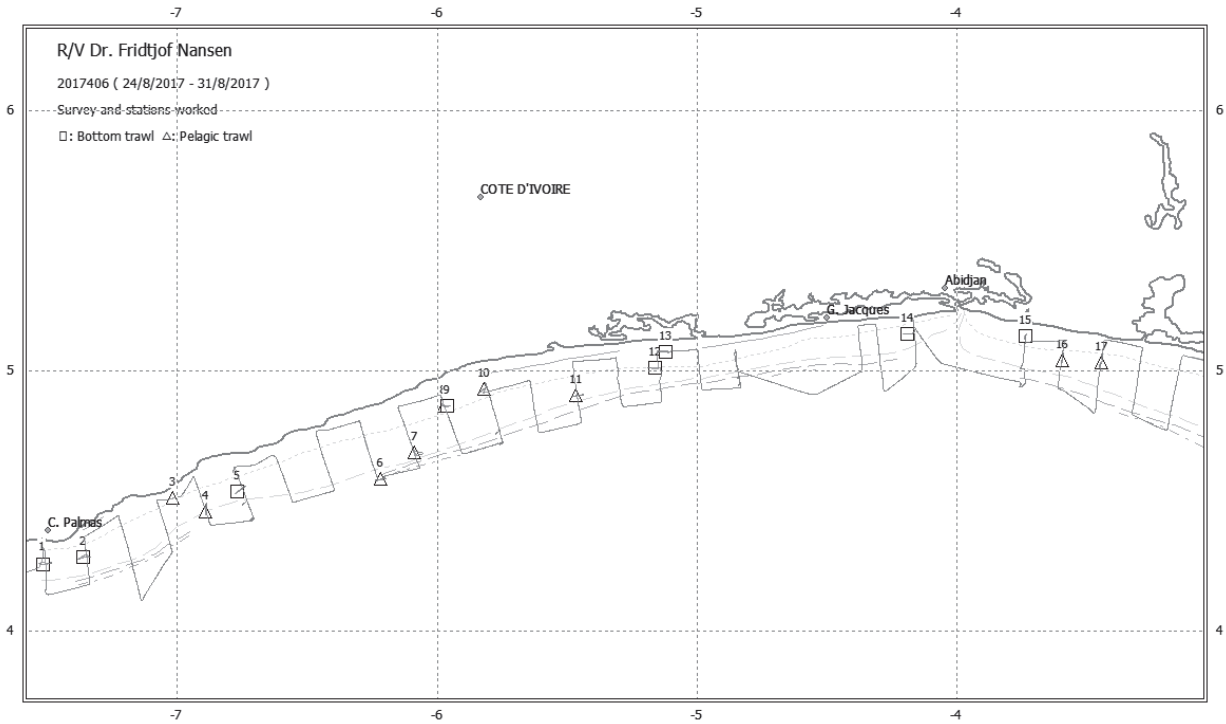

Figure 4. Course track with bottom - and pelagic trawl stations, Côte d'Ivoire. Depth contours at 20 m, 50 m, 100 m, 200 m and 500 m are indicated.

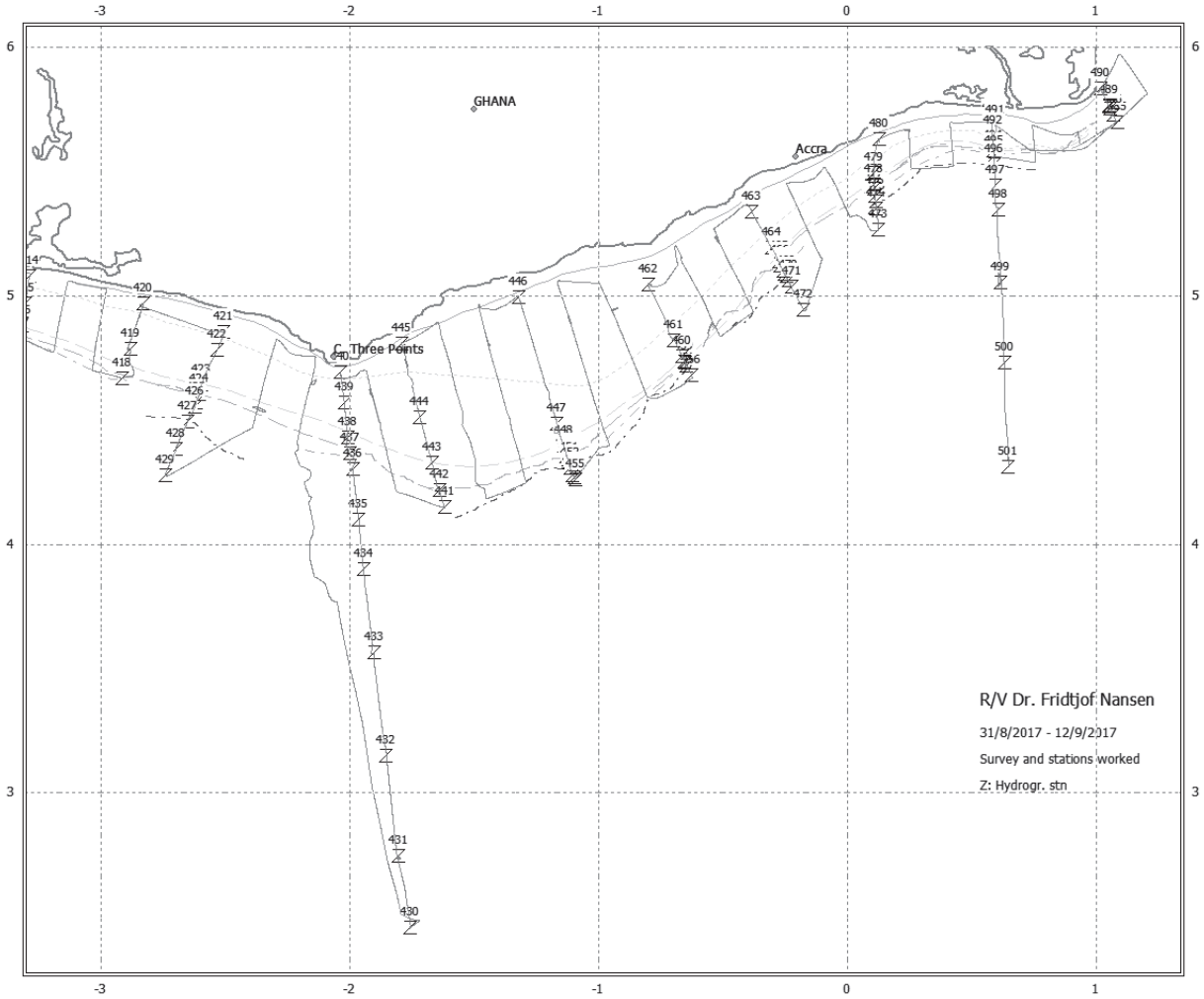

Figure 5. Course track with hydrographic stations, Ghana. Depth contours at 20 m, 50 m, 100 m, 200 m and 500 m are indicated.

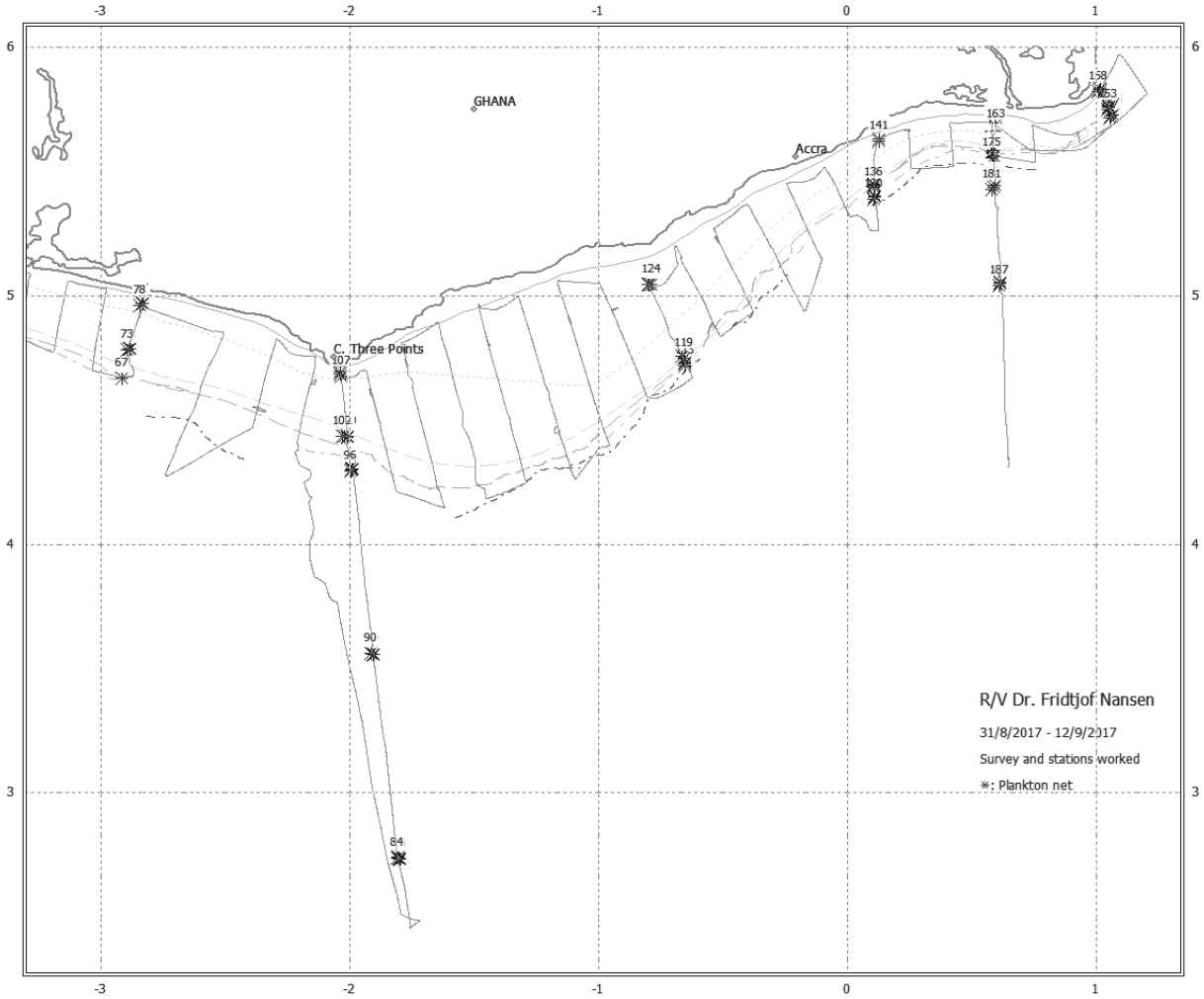

Figure 6. Course track with plankton (phytoplankton, WP2, Manta trawl) stations, Ghana. Depth contours at 20 m, 50 m, 100 m, 200 m and 500 m are indicated.

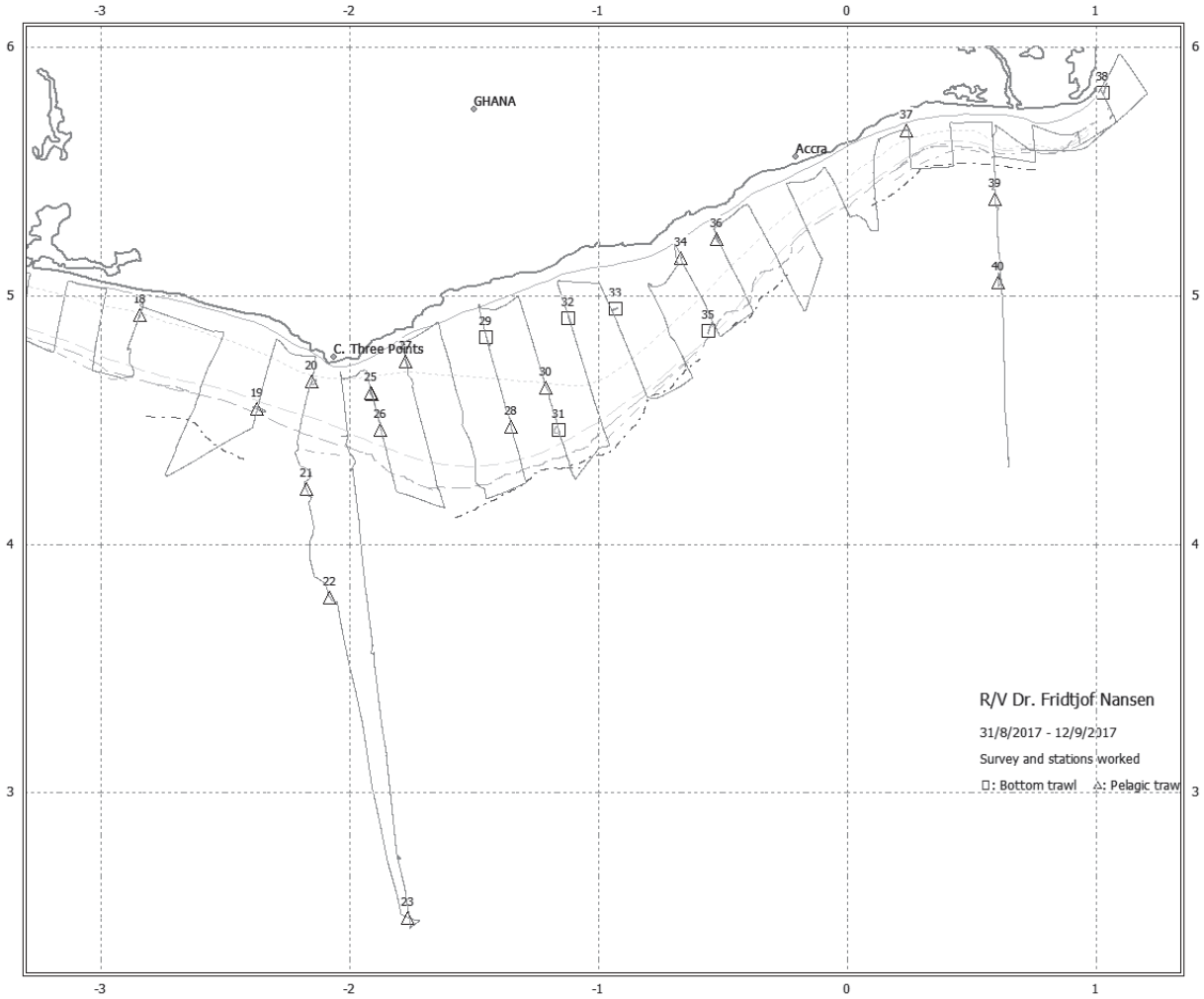

Figure 7. Course track with bottom- and pelagic trawl stations, Ghana. Depth contours at 20 m, 50 m, 100 m, 200 m and 500 m are indicated.

CHAPTER 2. METHODS

2.1 Continuous underway meteorological and hydrographic sampling

2.1.1 Meteorological data recording

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

2.1.2 Thermosalinograph

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

2.1.3 Current speed and direction measurements (ADCP)

Two hull-mounted Acoustic Doppler Current Profiler (VMADCP) from RD Instruments ran during the survey. The frequency of the VMADCP are 75 and 150 kHz. The system was 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.

2.1.4 Bottom mapping echo sounder

The EM 710 multibeam echo sounder is a high to very high-resolution seabed mapping system. Data acquisition depth starts approximately 3 m below the transducers and the maximum acquisition depth is limited in practice to 1000 - 1500 m on. 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.

2.2 Fixed station sampling

A series of biological and oceanographic sampling was undertaken every 60 NM, i.e. along every 6th acoustic transect (Transects 6, 12, 18 and so on). Samples were taken at the inshore end of the acoustic transects, usually at a water depth of between 25 and 30 m, usually at the 100-m isobath and at the outer end of the transects, i.e. at 500 m bottom depth. These stations were referred to as "super-stations". Since time permitted additional CTD stations were added at 60-70 m and 250 m depth in Côte d'Ivoire and Ghana. Off Ghana extra stations were also added at 1000 and 2000 m depth.

CTD casts were deployed at all super-stations. Since most transects off Côte D'Ivoire were comparatively short (10-15 NM), with the shelf gradually sloping to app 100-120 m before steeply falling off to 500 m, additional stations CTD were added based on depth. This meant that extra CTD casts were done at 60-70 m and 250-300 m depth on all transects.

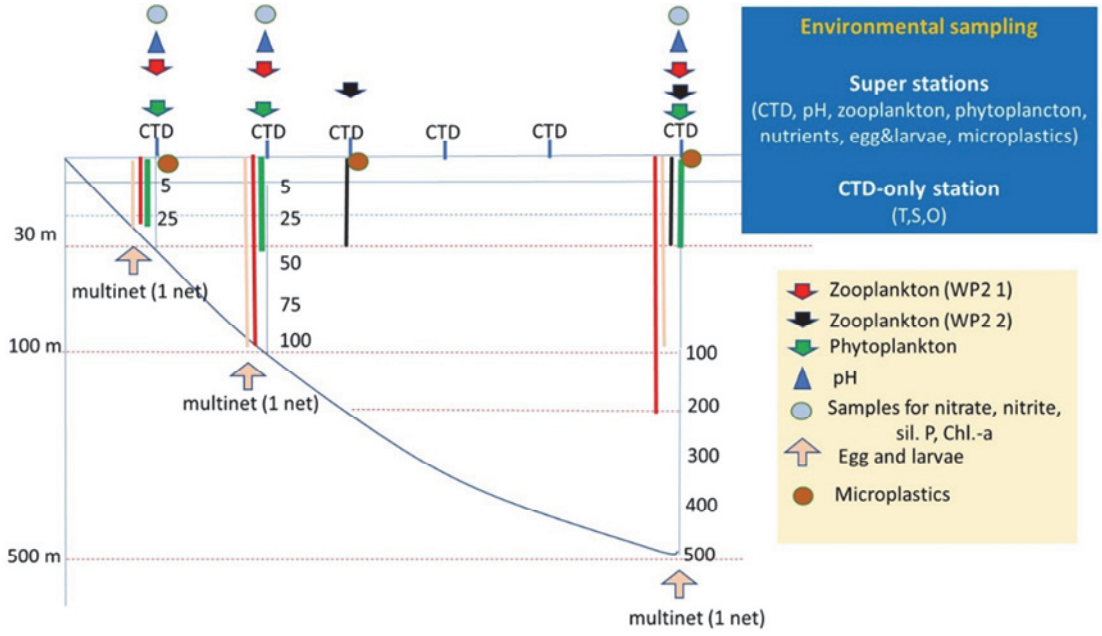

Figure 8. Overview of samples collected on hydrographic (only CTD every 30 NM) and environmental super stations (every 60 NM).

Several of the CTD-only transects were extended to deeper depths. On these so-called 'Marek transects' water samples were collected at 30, 100 and 500m depth. An overview of these transects is given in Table 4.

On the 1st and 2nd September a deep-water transect extending 125 NM off shore off Cape Three Points in Ghanaian waters was performed. The transect had an approximately 180° bearing. The same data as on the super station transects was collected with several additional deep stations (Table 5). A further deep-water transect extending approximately 90 NM offshore off Adafoah was sampled on 9 - 11th September. Stations sampled are summarized in Table 5.

Table 4. Extended CTD transects (Marek transects) with water sampling.

Country	Transect #	Max. depth (m)	Station depth
Côte d'Ivoire	3	2000	40, 50, 110, 340, 560, 800, 1000, 1570
	20	1500	30, 50, 100, 250, 530, 800, 1080
Ghana	29	1900	45, 60, 110, 250, 500, 810, 1020, 1525
	37	3100	25, 60, 100, 380, 600, 840, 1060, 1820, 2690
	40	2070	30, 60, 110, 260, 580, 1100
	43	3100	30, 60, 100, 260, 560, 790, 1040, 2100
	46	2000	30, 65, 100, 230, 500, 740, 1030

Table 5. Sampling along the deep-water environmental transect off Cape Three points on 1 and 2 September., and off Adafoah on 9-11 September. (All CTD casts to bottom, max to 4500m; Water sample depths 30 – 500m: 5, 25, 50, 75, 100, 200, 300, 400, 500; Water sample depths > 4000m: 5, 25, 50, 100, 250, 500, 750, 1000, 1500, 2000, 3000, 4000).

Stn	Approx. bottom depth	Distance from previous station	Distance from 1st station	Sampling – Cape Three Points
a	30	--	--	Super-station, CTD water samples
b	70	8	8	CTD
c	100	8	16	Super-station, CTD water samples
d	300	3	19	CTD
e	500	3	22	Super-station, CTD water samples
f	1500	12	35	CTD
g	4250	12	45	CTD
h	5000	20	65	Super-station, CTD water samples
i	5000	25	90	CTD
j	5000	25	115	Super-station, CTD water samples
k	5000	25	140	CTD water samples
				Sampling - Adafoah
a	30	--	--	Super-station, CTD water samples
b	40	2	2	CTD
c	100	3	5	Super-station, CTD water samples
d	250	1	6	CTD
e	500	1	7	Super-station, CTD water samples
f	1000	3	10	CTD
g	1500	6	16	Super-station, CTD water samples
h	2000	6	22	CTD
i	3000	18	40	Super-station, CTD water samples
J	3500	24	64	CTD
k	4000	25	89	Super-station, CTD water samples

2.2.1 CTD sensors – temperature, salinity, oxygen and fluorescence

Vertical temperature and salinity profiles were obtained with 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. Attached to the CTD was an uncalibrated Chelsea Mk III Aquatracka fluorimeter, which measures *in situ* fluorescence on relative scale.

The output of the salinity sensor was validated during the R/V *Dr. Fridtjof Nansen* survey of Morocco in April 2017 and on this survey using the Portasal salinometer from Osil (mod. 8410A) onboard the vessel (Figure 9). The oxygen sensor was changed in June (Cruise Number 2017403) and validated five times during this cruise using the Winkler titration method (Grasshoff *et al.* 1983; Figure 10).

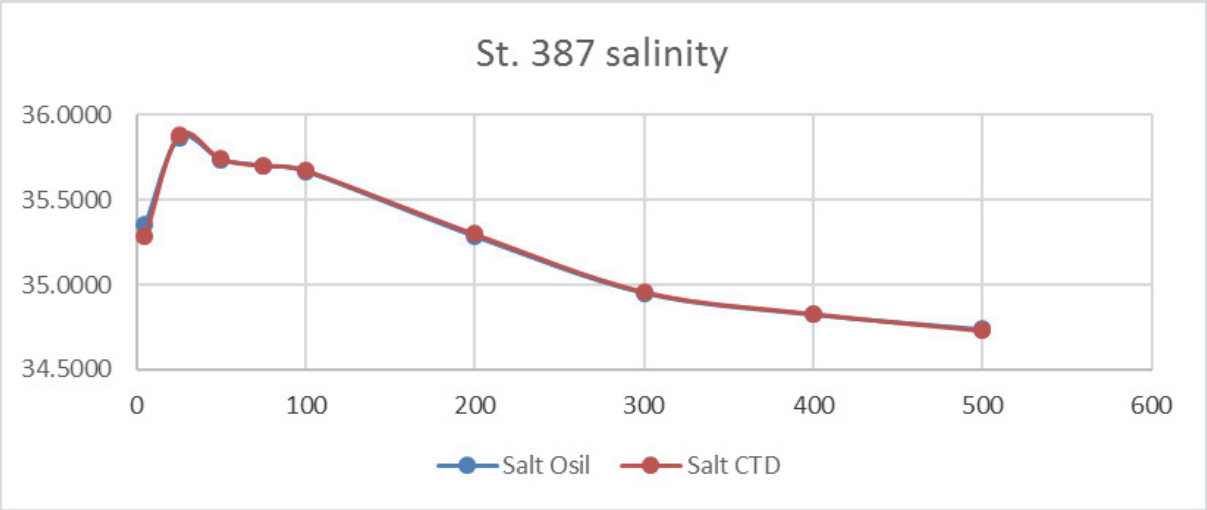

Figure 9. Initial test of the the conductivity sensor output plotted against salinity measured using the Portasal salinometer.

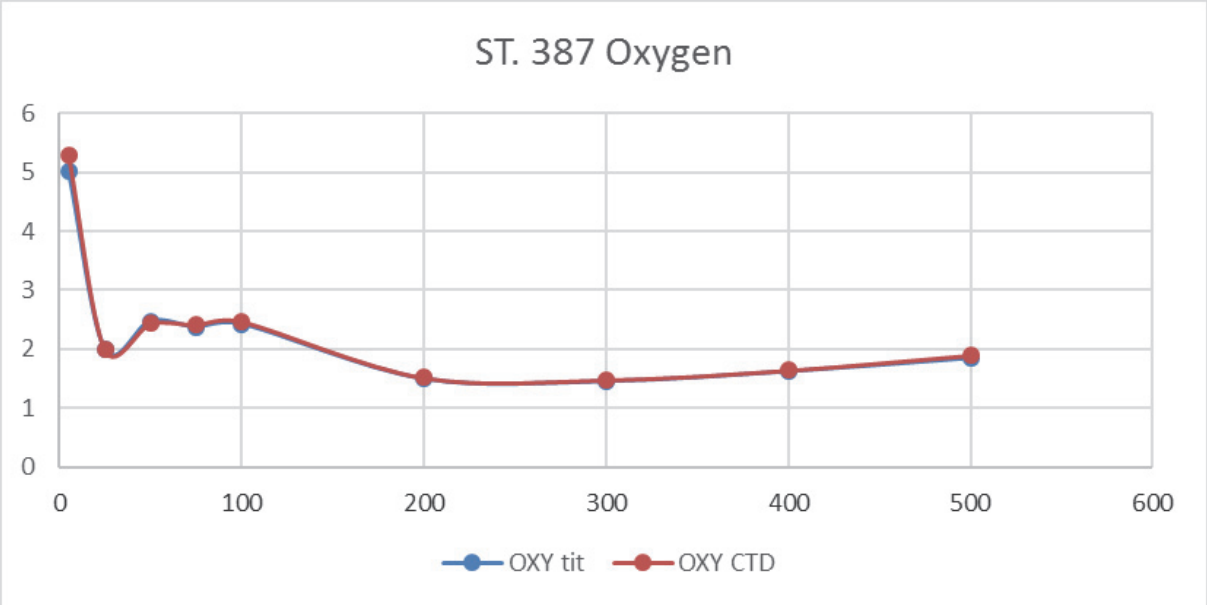

Figure 10. Measured oxygen concentrations (22 samples) plotted against oxygen sensor data.

2.2.2 Ocean acidification parameters - pH and alkalinity

The Nansen is equipped with a CTD rosette holding up to twelve Niskin bottles (10 L) that are used to collect water samples from pre-defined depths. The standard sampling depths were set to: 500, 400, 300, 200, 100, 75, 50, 25, and 5 m and the standard transects were sampled at 30, 100 and 500 meters depth. These samples were used to determine pH, alkalinity and for nutrient analyses (nitrate, nitrite, silicate and phosphate) as described below.

The Marek transects were sampled at the same depths but sampled for nutrients and chlorophyll only. The outer CTD on some of these transects were used for validation of the oxygen and conductivity sensors on the CTD.

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

2.2.3 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 IMR, using a modified Alpkem AutoAnalyzer C (O I Analytical, USA) and following standard procedures (Strickland and Parsons, 1972).

2.3 Plankton – phyto-, zoo- and ichthyoplankton

2.3.1 Phytoplankton biomass

Chlorophyll-*a* was sampled as an indicator of phytoplankton biomass. For chlorophyll-*a* and phaeopigment measurements, seawater collected with the CTD at the standard depths (not below 200 meters) was analysed. The water was filtered using a 0.7µm filtration system (Munktell glass-fibre filters Grade: MGF, vacuum 200 mm Hg). In the southern part of the survey-area (stations 105 to 163), 3 parallels were filtered from each depth and stored at -20 °C. After 3 weeks, all batches were transferred to -80 °C. One of the batches was then freeze-dried and thereafter stored at -80 °C. Two batches (one freeze-dried and one only frozen at -80 °C) will be transported to IMR, which is an accredited laboratory, for subsequent analyses, the last batch will remain in the -80 °C freezer on the ship for later analyses on board. 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 *Dr Fridtjof Nansen* during the fall 2017.

2.3.2 Phytoplankton identification

At each plankton-station, qualitative phytoplankton samples were collected with a Phytoplankton net (35 cm in diameter and mesh-size of 10 µm), hauled vertically at a speed ~0.1 ms^{-1} from ~30 m depth to the surface (5 m above bottom at the 30 m stations). The samples were preserved with 2 ml 4 % formalin and stored in dark 100 ml glass bottles for subsequent taxonomic analyses on shore.

2.3.3 Zooplankton

Zooplankton samples were taken along the hydrographic transects on stations with bottom depths of 30, 100 and 500 m using a WP2 net (56 cm diameter, mesh size 180 µm; Fraser 1966, Anonymous 1968) hauled vertically (shallow zooplankton-station 25 m, medium-deep plankton-station 100 m, and deep plankton-station 200 m) to the surface with a speed of ~0.5 ms^{-1}. A Hydrobios flowmeter was attached to the metal frame in the center of the mouth. From the medium-deep and deep plankton station an additional WP2 was hauled from 30 m depth. Each sample was divided into two equally sized aliquots using a Motoda plankton splitter (Motoda 1959). Half the sample was preserved with borax-buffered formalin resulting in a final formalin concentration of 4% in a 100 ml plastic bottle for subsequent taxonomic analysis on shore. The other half of the sample was sequentially poured through three sieves to obtain the zooplankton biomasses representing the size-fractions >2000 µm, 2000-1000 µm, and 1000-180 µm. The biomass samples were stored on pre-weighed aluminum dishes and dried at ~60°C for a ~24 h period. After drying, the samples were stored in a freezer at -18°C for subsequent weighing of biomass dry weight at the Institute of Marine Research (after a second time of drying).

2.3.4 Fish eggs and larvae

A Hydro-Bios Multinet MIDI system with mouth-opening area of 0.25 m^2 was used for the sampling of eggs and larvae. One net (405 µm) was hauled obliquely with an average net retrieval speed of ~0.5 ms^{-1} and a vessel speed of ~1.8 knots. 4 other nets were attached to the unit but with open codends. At the shallow (30 m) plankton stations, the net was towed in the 25-0 depth-stratum, at the medium-deep (100 m) stations, from 100-0 m and at the deep (500 m) plankton-station from 100-0 m. All samples were inspected visually for eggs and larvae. These were removed from the total sample, counted, photographed and preserved in 4% formaldehyde buffered with borax. When samples contained high densities of other zooplankton or phytoplankton or the making of visual inspections was complicated, the sample was either split or preserved whole for later analysis on shore.

2.3.5 Microplastics

Microplastics are small pieces of plastic marine debris normally less than 5 mm long, but larger marine debreis was also recorded if sampled. Microplastics were collected along the hydrographic transects at all super-stations. At each station, the surface layer was sampled

with a Manta-trawl, with a rectangular opening of 19 cm × 61 cm (HxW), mesh-size 335 µm and two wings to keep it balanced and at the surface during the tow. Trawls were hauled horizontally at a speed of ~1.5 ms^{-1} for 15 minutes. The counts of a manual flowmeter attached in the lower part of the trawl opening were recorded at the start and end of each trawl. Trawling was performed some meters away from of the starboard side, about mid-ship, attempting to avoid the wake of the vessel.

Once the Manta-trawl was back on the ship, the samples were washed in filtered sea-water over a sieve with a mesh-size 180 µm. Microplastic particles were sorted from the sample under a stereo-microscope, and the sorted sample was then checked once more to reduce the risk of overlooking the smallest plastic particles. All assumed plastic items were then placed on a gridded petri dish for examination under the stereo-microscope, photographed and, to the extent possible, 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 in room-temperature until transport to the laboratory of IMR, where they will be studied in more detail. After removing the plastics, the remaining part of the samples - mainly biological material - was preserved in formalin for studies of neuston after the cruise.

2.4 Food safety

Whole fish, fillet and different organs from various fish that are regularly consumed in the two countries were sampled during this survey and preserved. All the samples will be analysed for a wide variety of nutrients and contaminants in IMR, Bergen, as listed below. Tissue samples from mackerel samples will also be analysed for the parasite Kudoa.

Some of the samples will also be analysed for correspondence between the microbiota and the metal content of the gut. One pelagic fish sample and two mesopelagic fish samples will be analysed for the content of microplastic particles.

2.5 Top predator observations

Observations of mammals (whales, dolphins etc) and birds were not done on Leg 2.2.

2.6 Biological sampling of fish

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

All catches were sampled for composition by weight and numbers of each species caught. Species identification was based on the FAO Species Guides. For the selected target species length (total length to the nearest cm), weight (to the nearest 0,5 g), sex, gonad maturity stage (according to the table in Annex III), and stomach fullness (according to the table in Annex III) were recorded. When the size distribution of the target species in the catch was seemingly narrow (similarly sized individuals), a total of 50 individuals were length measured. Length and weight measurements were used to estimate the length-weight relationship and together with length frequency distributions applied in biomass calculations. In addition, the following biological samples of large fish were taken: otoliths (in paper envelopes), pectoral finclips (max in 96% ethanol) for genetic analysis, stomach and liver samples (frozen in plastic bags), and frozen samples for morphometric analysis (25-30 fish). Instead of attempting to remove otoliths, stomach and liver from small individuals (<10cm, and in most instances all anchovy and sardinella), whole fish were frozen down, since it seemed less cumbersome and time consuming to do this onland in well equipped labs.

The target groups used for this survey can be found in Table 6, while the complete records of fishing stations and catches are shown in Annex II. A full list of biological samples per species and trawl station is given in Annex IV.

2.7 Acoustic sampling

2.7.1 Sonar data

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

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

2.7.2 Echo sounder

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

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

In cases where the integrated echo contained more than one category of fish (see Table 6

below), the mean s_A-value allocated to each category was in the same ratio as the mean proportion in trawl catches in that area.

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

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

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

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

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

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

where

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

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

Table 6 lists the target groups used. These are adapted from previous groupings owing to the importance of providing biomass estimates for not only the sardinellas, but also *Decapterus* sp., *Scomber colias, Trachurus trecae*, *Engraulis encrasicolus* and *Ethmalosa fimbriate.* Although *Decapterus punctatus* was not listed as a priority species in the objectives, it often occurs with its congener *D. rhonchus* and hence the two species cannot be separated acoustically. *D. punctatus* was therefore included in the Pelagic I fish group.

Table 6. Allocation of acoustic densities to species groups and sampling.

Group	Taxon	Species	Sampling
Sardinellas	Clupeidae “	*Sardinella aurita* *Sardinella maderensis*	*Full biological*
Horse mackerels	Carangidae	*Trachurus trecae*	*Full biological*
Pelagic species I	Carangidae “ Engraulidae Clupeidae Scombridae	*Decapterus rhonchus* *Decapterus punctatus* *Engraulis encrasicolus* *Ethmalosa fimbriata* *Scomber colias*	*Full biological*
Pelagic species II	Carangidae “ “ “ Trichiuridae Clupeidae	*Chloroscombrus chrysurus* *Caranx rhonchus* *Caranx crysos* *Selene dorsalis* *Trichiurus lepturus* *Illishia africana*	*Length & Weight*
Other pelagic species, incl:	Scombridae Carangidae Sphyraenidae	 *Scomberomorus tritor* *Selar crumenophthalmus* *Sphyraena guachancho*	*Length & Weight*
Demersal species, incl:	Ariommatidae Caproidae Serranidae Polynemidae Sparidae “ Priacanthidae Mullidae	*Ariomma bondi** *Antigonia capros** *Epinephelus aeneus* *Galeoides decadactylus* *Pagellus bellotti** *Pagrus caeruleostictus** *Priacanthus arenatus* *Pseudupeneus prayensis**	*Total mass* **Length & Weight*
Mesopelagic	Myctophidae and other mesopelagic fish		*Total mass*
Plankton	Calanoidae, Euphausiidae and other plankton		

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

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

If the targeted fish was a mixture of more than one species and they could not be separated during scrutinisation, for example sardinellas, representative distributions of all the species within the stratum, as reflected in the trawl catches, was used. Length distributions of each species, for each catch, was calculated and normalized to a unit number (usually 100). These were then averaged without weighting. Very small catches (normally less than about 20 fish)

were not included. *Trichiurus lepturus* was not included in length frequency samples of Pelagic II fish as the shape, and hence length-weight relationship, as this species is very different from all the other priority pelagic fish, *T. lepturus* being an extremely long and thin fish. The proportion (by weight) in the trawl catches was however used to estimate the proportion of this species in the Pelagic II mixture.

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

The total catch of each species from all the trawls in a stratum was used as a proxy for estimating the proportion of the total biomass of each species present. While it is recognised that catch is a poor indicator of relative abundance, especially for pelagic fish, no other method is easily available from the data obtained.

The length-weight relationship, which is used to convert numbers to biomass, was calculated for each species or group, based on all fish sampled within each country. Samples were not broken down into separate strata.

The biomass estimation process used the following procedure:

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

CHAPTER 3. RESULTS

3.1 Hydrography

3.1.1 Côte d'Ivoire

The continental shelf off Côte d'Ivoire is narrow and generally between 10-14 nm wide. Hydrographic variables were measured on transects nearly perpendicular to the coastline, and water samples for pH and total alkalinity, nutrients, chlorophyll, salinity and oxygen were collected from surface to bottom at selected depths along these transects. The sampling effort is shown in Table 3. In addition, the sensors on the Seabird CTD recorded temperature, salinity, oxygen and fluorescence at 1 m intervals throughout the water column.

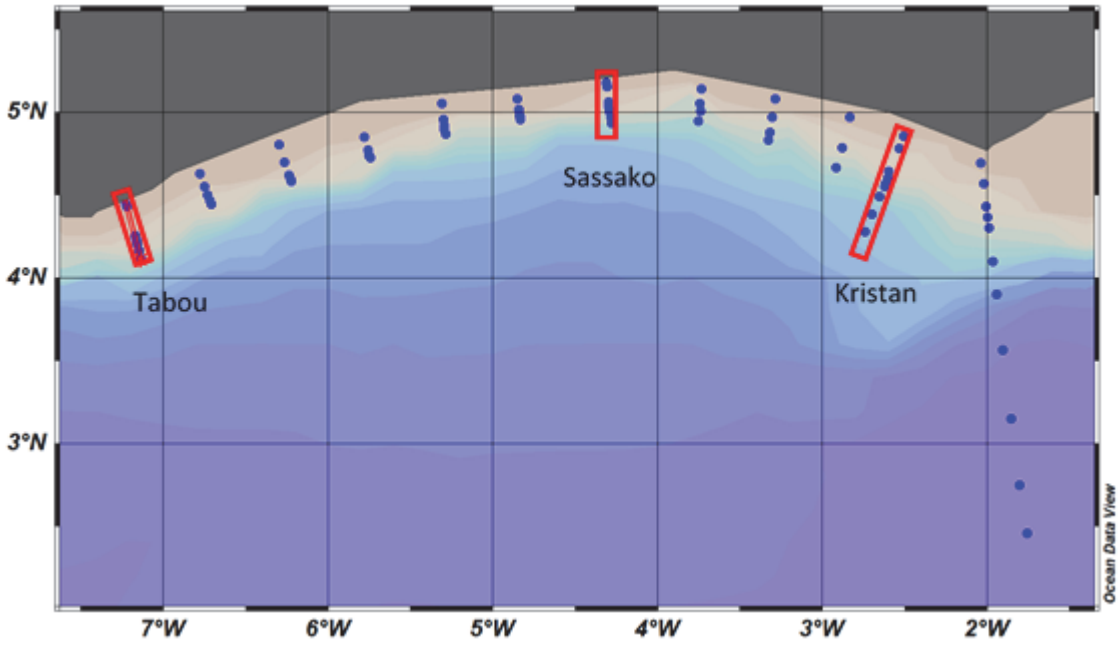

Figure 11. Positions of the CTD stations in waters off Côte d'Ivoire. Red squares indicate hydrographic transects used to produced vertical profiles for oxygen, salinity and temperature. Tabou (7.2°), Sassako (4.3°), Kristan (2.6°).

3.1.1.1 Cross shelf distribution of hydrographic variables

The continental shelf off Côte d'Ivoire is very narrow, and slopes steeply off from approximately 100-120m bottom depth (Figure 11).

Oxygen

Dissolved oxygen was generally higher (> 2.5 ml/l) in the upper 15-20m, where it gradually decreased with depth, regardless of distance to shore (Figure 12). On the transect off Tabou lower oxygen concentrations (>2.5 ml/l) were also observed close inshore, between 15-50m bottom depth. At 25 to 200 m depth oxygen concentrations were about 2.5 ml/l, before

decreasing to 1-1.5 ml/l in a pronounced oxygen minimum zone (OMZ) at 200 to 400 m depth.

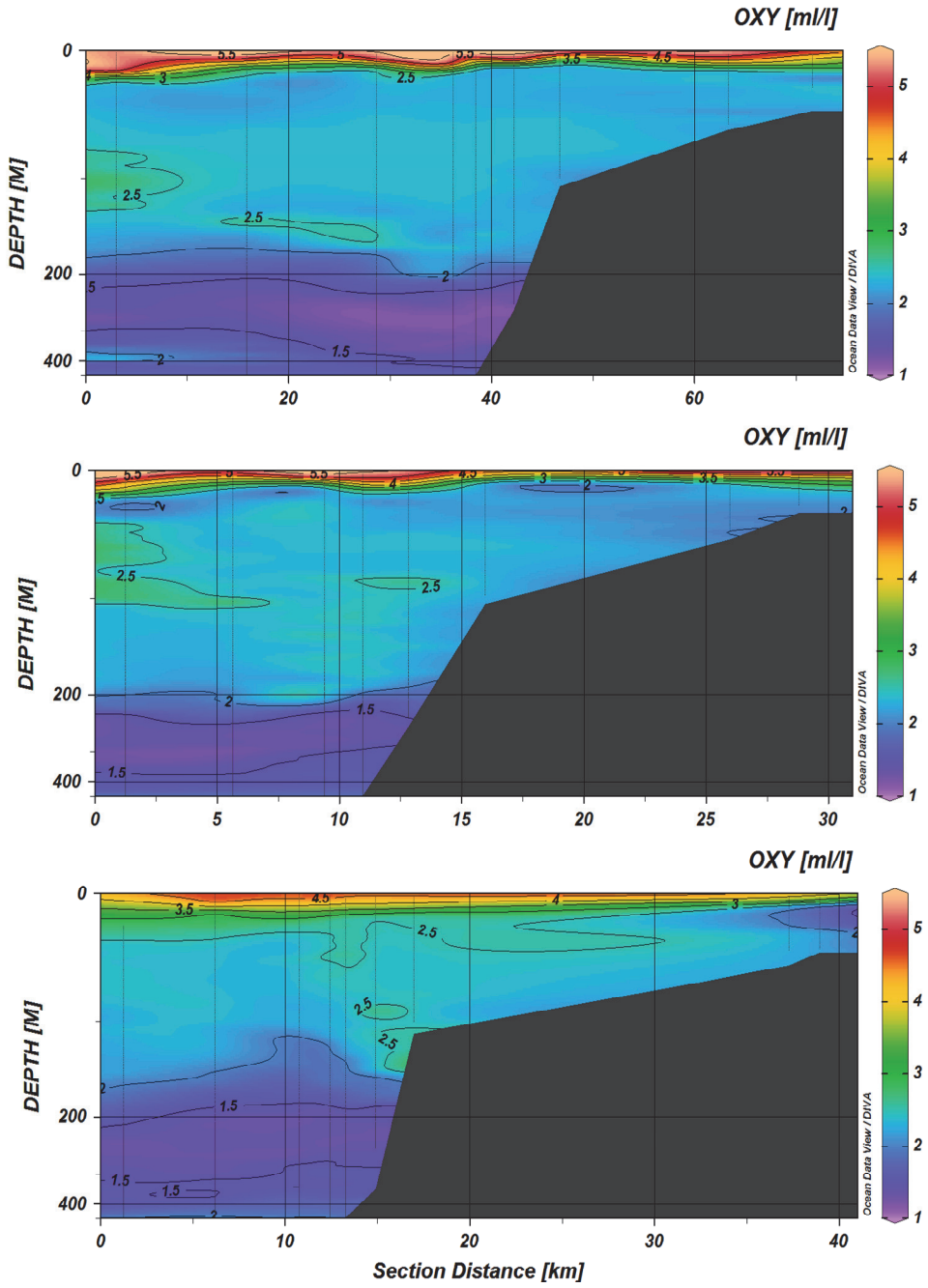

Figure 12. Vertical profiles of dissolved oxygen on three extended transects in waters off Côte d'Ivoire. Top to bottom: Kristan (2.6°), Sassako (4.3°), Tabou (7.2°).

Salinity

Salinity was generally highest (35.8-36) between 15 and 100/150 m depth (Figure 13), and gradually decreased to 34.8-35 below 150 m. Salinity decreased with distance from shore, e.g off Tabou in the west salinity in the surface layer was 34.4 offshore and 34.6-34.8 further inshore.

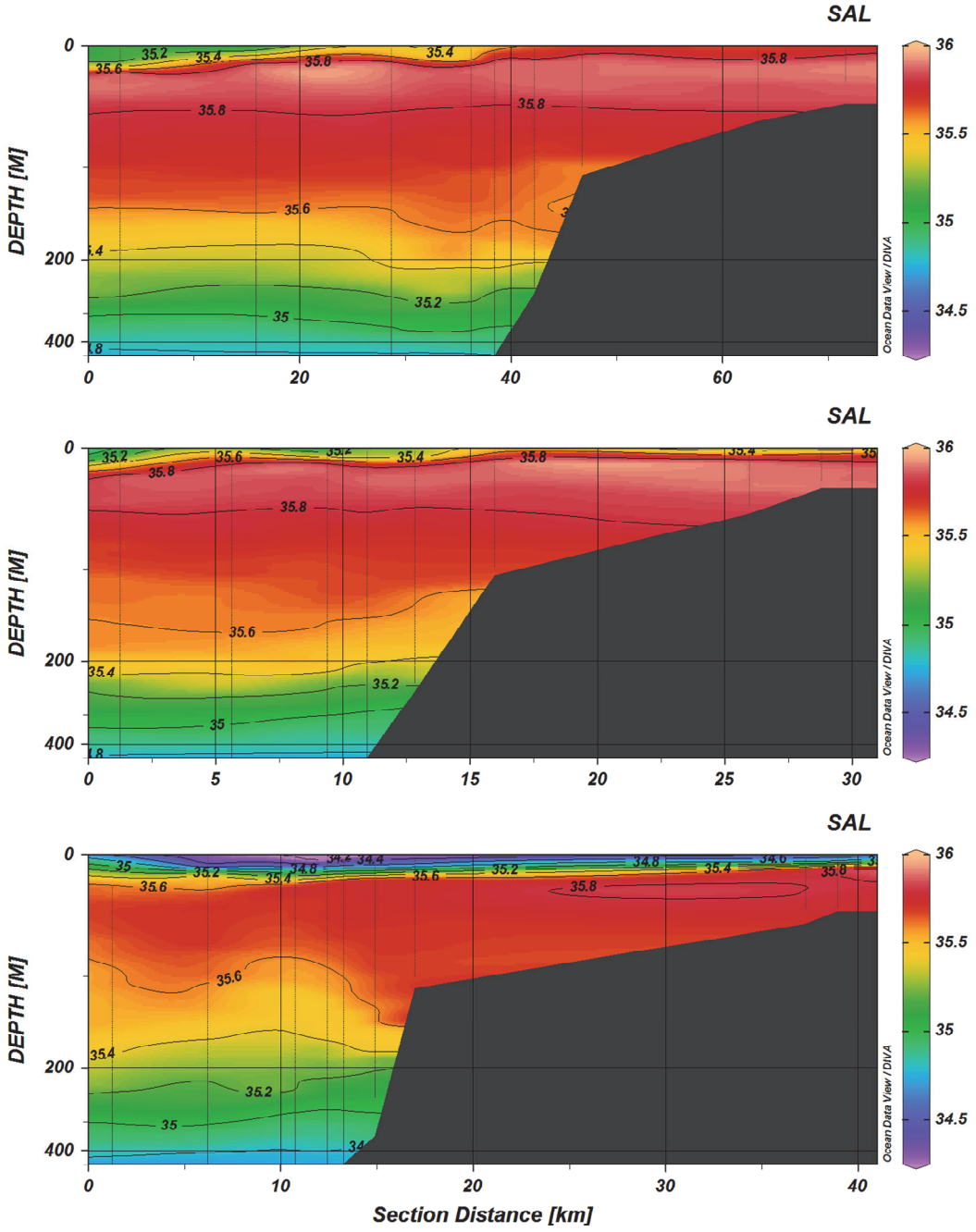

Figure 13. Vertical profiles of salinity on three extended transects in waters off Côte d'Ivoire. Top: Top to bottom: Kristan (2.6°), Sassako (4.3°), Tabou (7.2°).

Temperature

Surface temperature ranged between 22-24°C, although surface water mass with slightly higher temperature (and lower salinity) was observed west of Tabou and offshore on the border with Liberia (Figure 14). The temperature gradient was highest in the upper 50m, decreasing by 5-6°C from the surface. At 50 and 200 m depth temperature was app. 17°C and 14°C respectively.

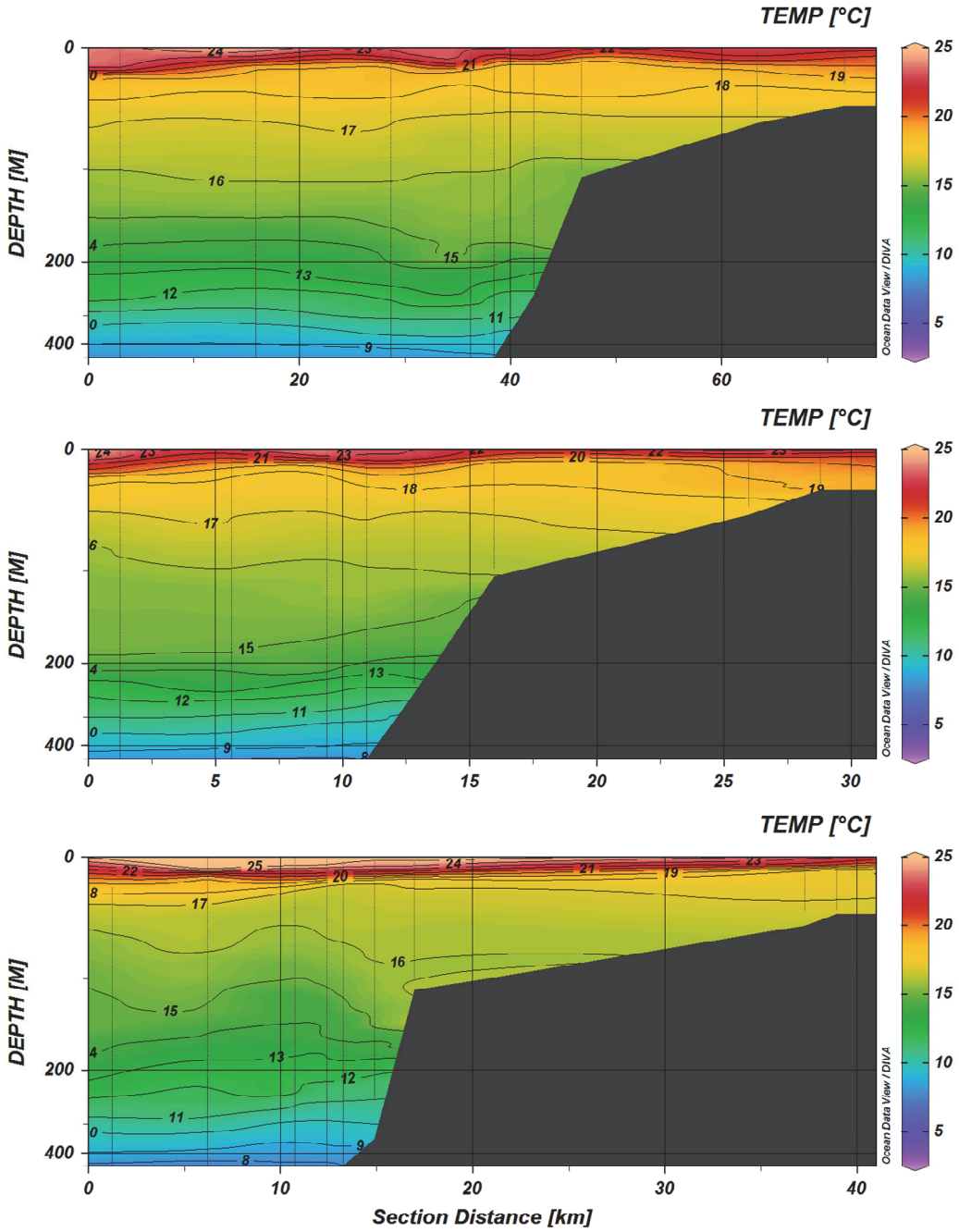

Figure 14. Mixed layer depth (left) and depth of subsurface chlorophyll maxima (m), where such a maxima were present.

Fluorescence

High flurorescence of 0.8-1.6 µg/l was observed in the eastern parts off Kristan between 5-25 m depth (Figure 15). Fluroescence varied with distance from shore but with no clear trend, and decreased to 0.2 at approximately 50 m depth on all transects. Moving westwards fluorescence in the surface layer was generally lower and decreased to 0.4-0.6 µg/l.

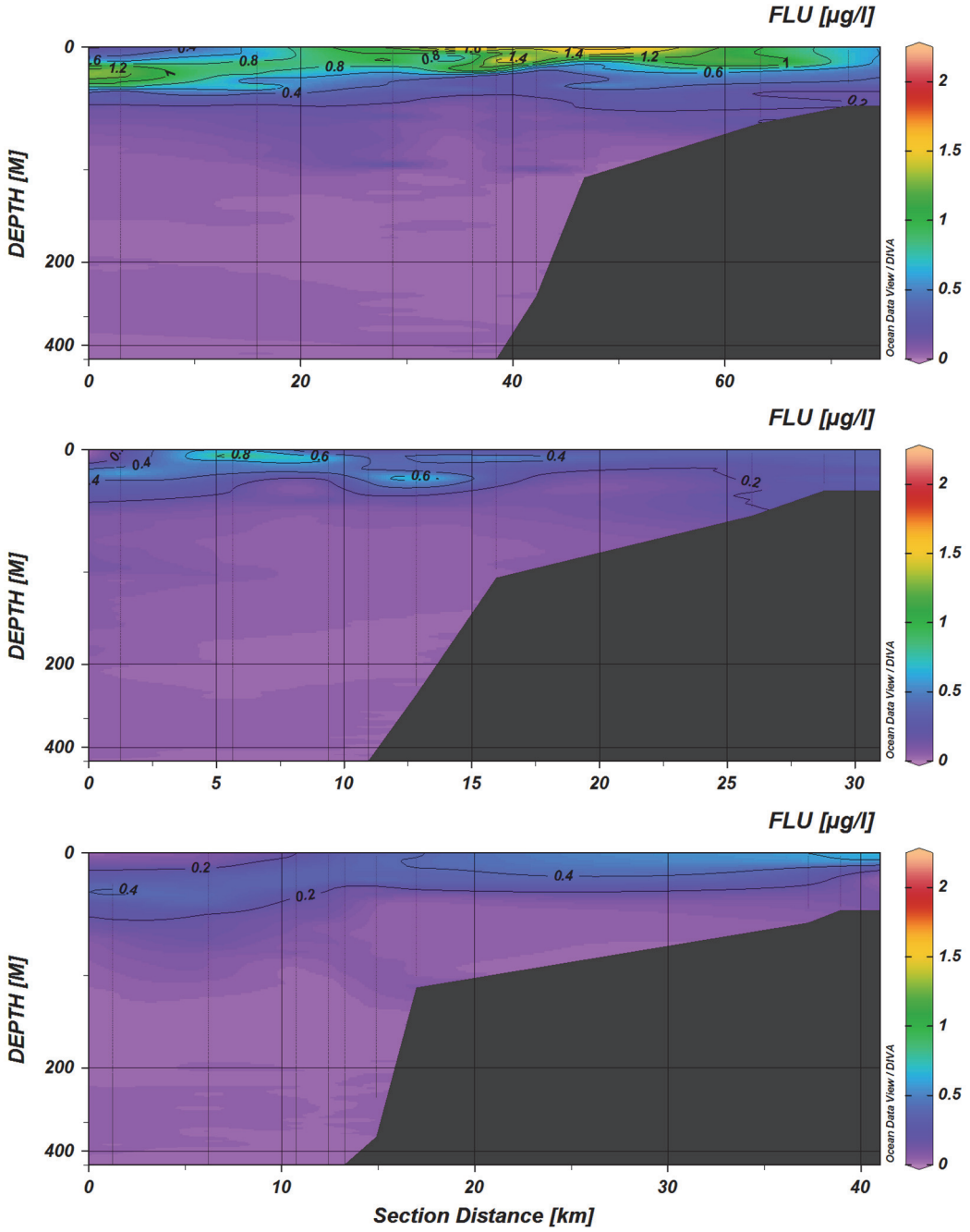

Figure 15. Vertical profiles of flurescence on three extended transects in waters off Côte d'Ivoire. Top: Kristan (2.6°), middle Sassako (4.3°), bottom Tabou (7.2°).

3.1.1.2 Surface horizontal distribution of hydrographic variables

The horizontal distributions of temperature, salinity and oxygen in surface waters (5 m depth) are respectively shown in Figure 16-18. Inshore areas west of 6°W characterized by lower temperatures (< 22°C) corresponded with water masses that had lower salinity and lower dissolved oxygen concentrations (15 m depth). Surface water masses in the area between 4-5°W were characterized by higher temperatures, salinites and partially also higher oxygen recordings.

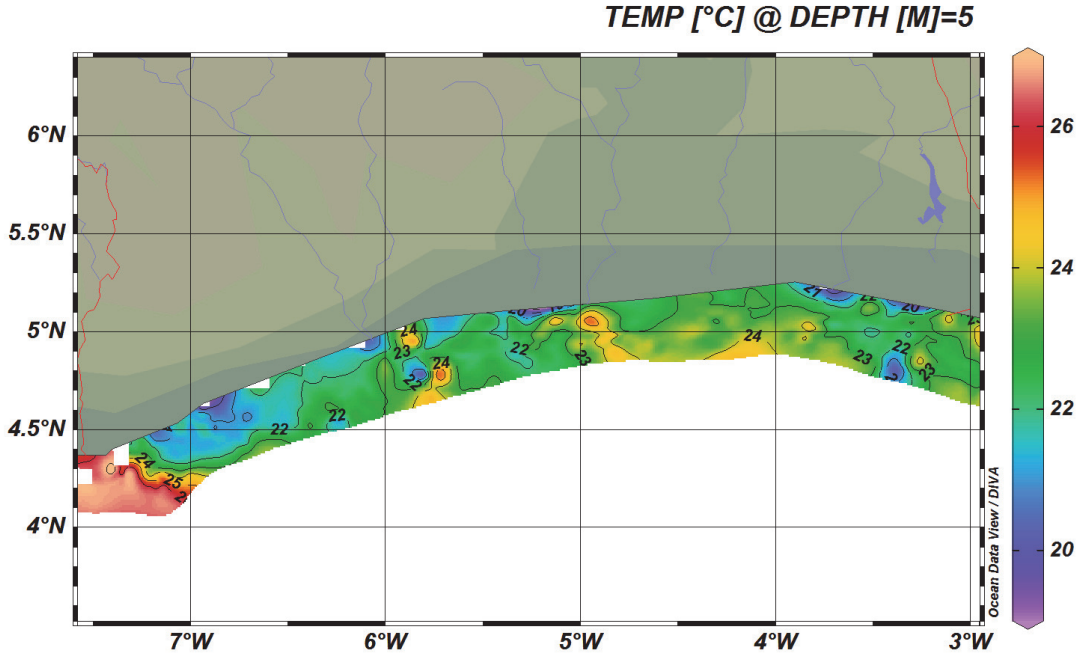

Figure 16. The horizontal distribution of sea surface temperature (ºC) off Côte d'Ivoire at 5 m depth.

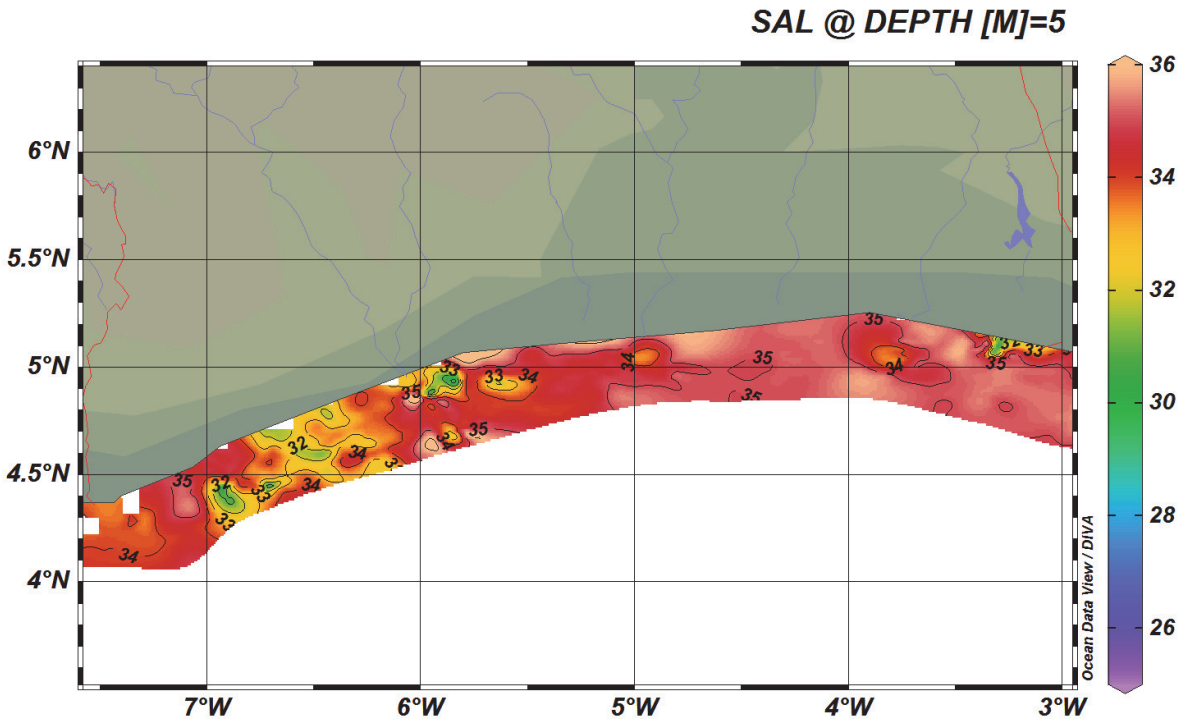

Figure 17. The horizontal distribution of salinity off Côte d'Ivoire at 5 m depth.

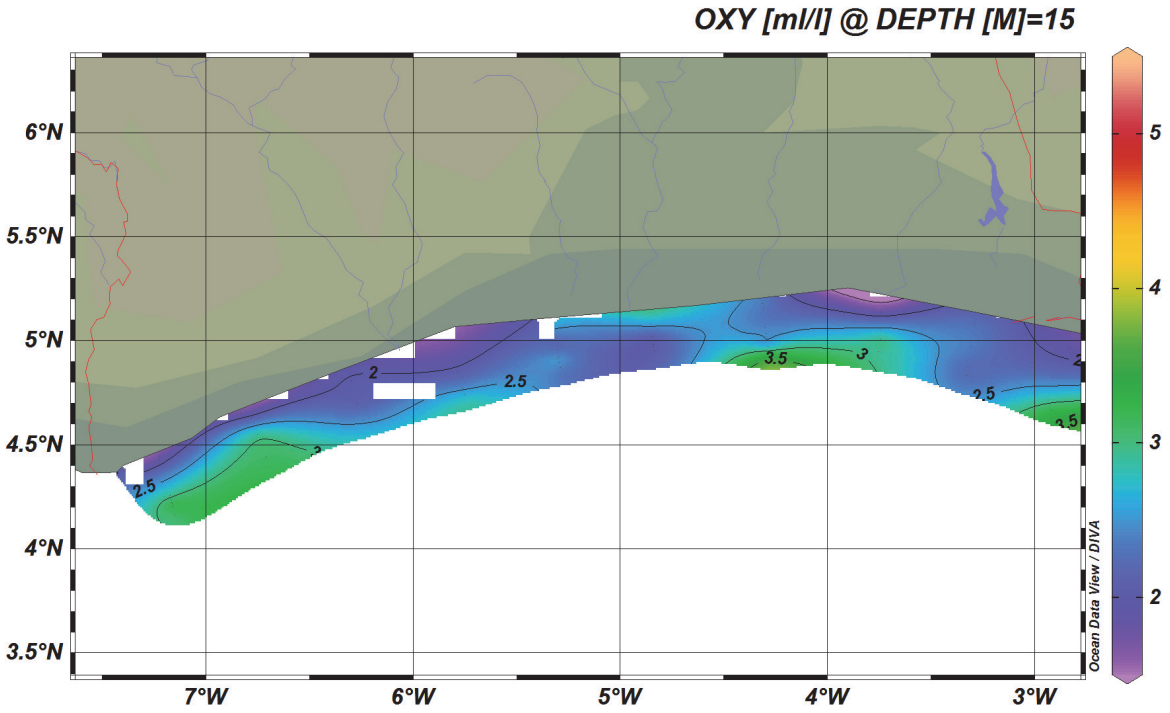

Figure 18. The horizontal distribution of oxygen off Côte d'Ivoire at 15 m depth.

3.1.2 Ghana

In the west off Cape Three Points the shelf broadens to form a plateau (app. 60-70nm wide shelf at Komenda), before it gradually becomes narrower (10 NM) towards the border with Togo (Volta River estuary). Hydrographic variables were measured on transects approximately perpendicular to the coastline (Figure 19) and water samples for pH and total alkalinity, nutrients, chlorophyll, salinity and oxygen were collected from surface to bottom at selected intervals along these transects. The sampling effort is shown in Table 7. In addition, the sensors on the Seabird CTD recorded temperature, salinity, oxygen and fluorescence at 1 m intervals throughout the waters of Ghana.

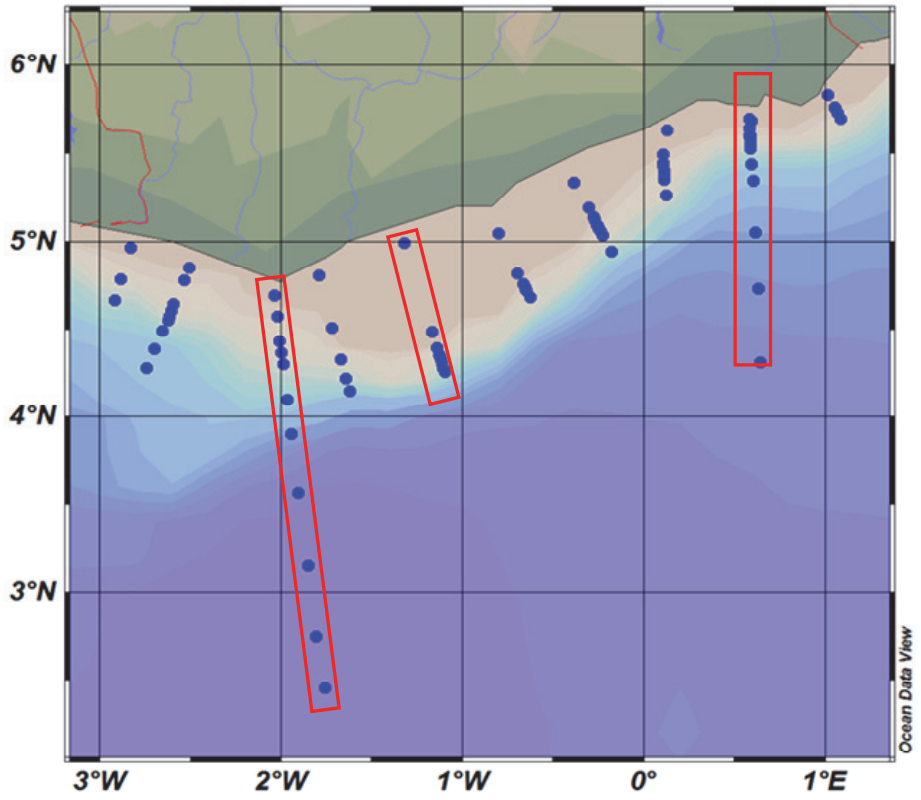

Figure 19. Positions of the CTD stations in waters off Ghana. Red squares indicate hydrographic transects used to produced vertical profiles for oxygen, salinity and temperature. Cape Three Points app. 2°W), Komenda (app. 1°W), Volta River (app. 0.36°E).

Table 7. Water samples for chlorophyll, nutrients, pH, alkalinity, oxygen and salinity analysis from the continental shelf off Ghana.

Cruise no.:	2017406	Ghana						
Transect no:	St. no:	Date :	Nutrients	Chl.A	Oxygen	Salinity	pH/Alk.	Visibility
30	418	30.08.2017	9	6			9	
30	419	30.08.2017	5	5			5	
30	420	30.08.2017	2	2			2	
32m	421	31.08.2017	2	2			2	
32m	423	31.08.2017	5	5			5	
32m	425	31.08.2017	9	6			9	
32m	427	31.08.2017	11	6			11	
snitt	430	01.09.2017			12	12		
snitt	431	01.09.2017	12	5			12	
snitt	433	02.09.2017	12	5			12	
snitt	436	02.09.2017	9	6			9	
snitt	438	03.09.2017	5	5			5	
snitt	440	03.09.2017	2	2			2	
39M	446	04.09.2017	2	2				
39M	450	04.09.2017	9	6				
39M	454	04.09.2017	12	5	12	12		
42	456	05.09.2017	12	5			12	
42	458	05.09.2017	9	6			9	
42	460	06.09.2017	5	5			5	
42	462	06.09.2017	2	2			2	
45M	463	06.09.2017	2	2			2	
45M	465	06.09.2017	5	5			5	
45M	467	06.09.2017	9	6			9	
45M	469	07.09.2017	10					
45M	471	07.09.2017	12	5			12	
48	473	08.09.2017	12	7			12	
48	476	08.09.2017	9	6			9	
48	478	08.09.2017	5	5			5	
48	480	08.09.2017	2	2			2	
51M	481	09.09.2017	2	2			2	
51M	482	09.09.2017	5	5			5	
51M	484	09.09.2017	9	6			9	
54	486	09.09.2017	9	6			9	
54	488	09.09.2017	5	5			5	
54	490	09.09.2017	2	2			2	
51M	491	10.09.2017	2	2			2	
51M	493	10.09.2017	5	5			5	
51M	495	10.09.2017	9	6			9	
51M	497	10.09.2017	9	5			9	
51M	499	10.09.2017	11	5			11	
51M	501	11.09.2017	12	5	12	12	12	
sum	41		280	178	36	36	247	

3.1.2.1 Cross shelf distribution of hydrographic variables

Dissolved oxygen

Off Cape Three Points dissolved oxygen (DO) in the surface layer was 4.5 ml/l offshore and decreased to 2.5 ml/l inshore. DO gradually decreased with depth, regardless of distance from shore (Figure 3.10), with a OMZ (< 2ml/l) visible at app. 200 to 500m depth along the entire slope. Off Komenda oxygen concentrations showed a similar pattern as off Cape Three Points, though low bottom oxygen concentrations (< 2ml/l) could be observed on the upper and middle shelf (Figure 20 middle). DO at the surface was high (>4.5 ml/l) along the entire Volta River estuary transect, and as off Cape Three Points, DO gradually increased below the OMZ to levels above 5 ml/l at 2000m depth.

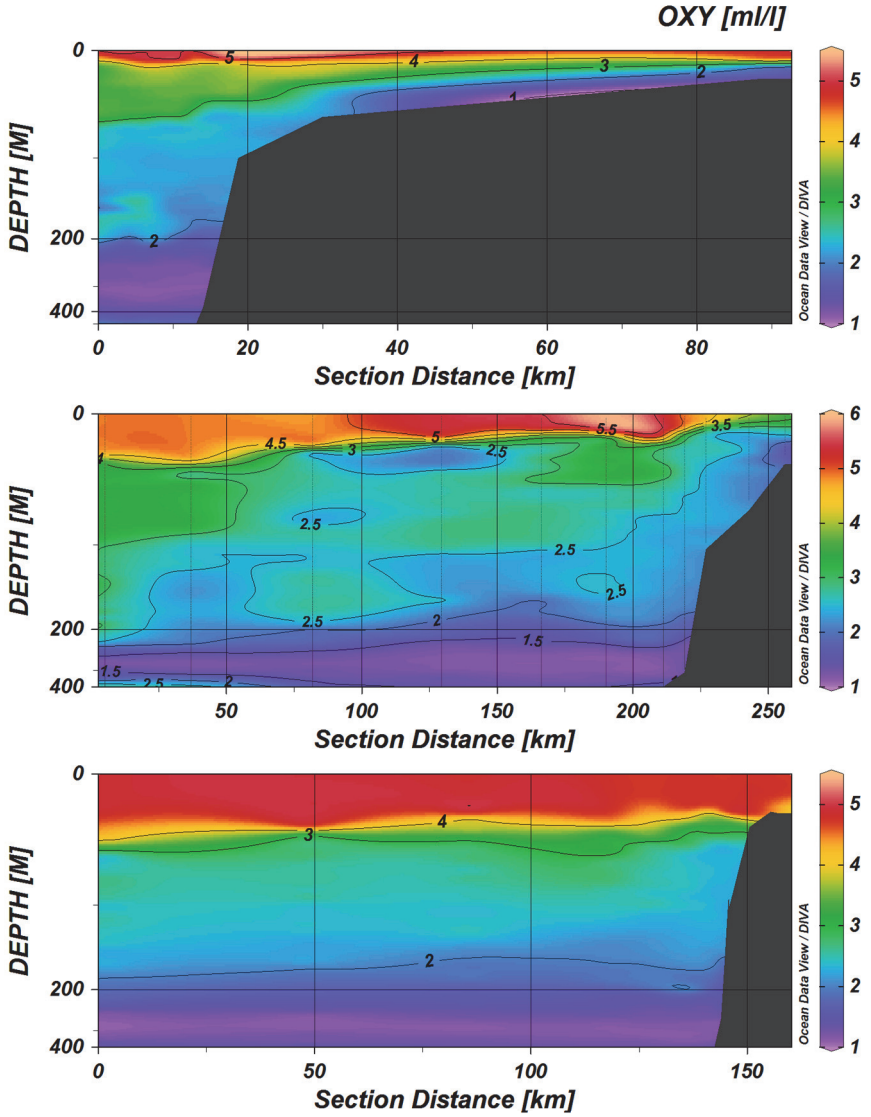

Figure 20. Vertical profiles of dissolved oxygen on three extended transects in waters off Ghana. Top to bottom: Cape Three Points (app. 2°W), Komenda (app. 1°W), Volta River estuary (app. 0.36°E).

Temperature

Surface temperature ranged between 22-26°C, with temperature increasing towards offshore. Lower surface temperatures off Cape Three Points may indicate some locally occurring upwelling. The temperature gradient was highest in the upper 50m, decreasing with app. 5-6°C from the surface. Bottom temperature on the shelf was generally 17-18°C. At 200m depth temperature was 14-15°C (Figure 21).

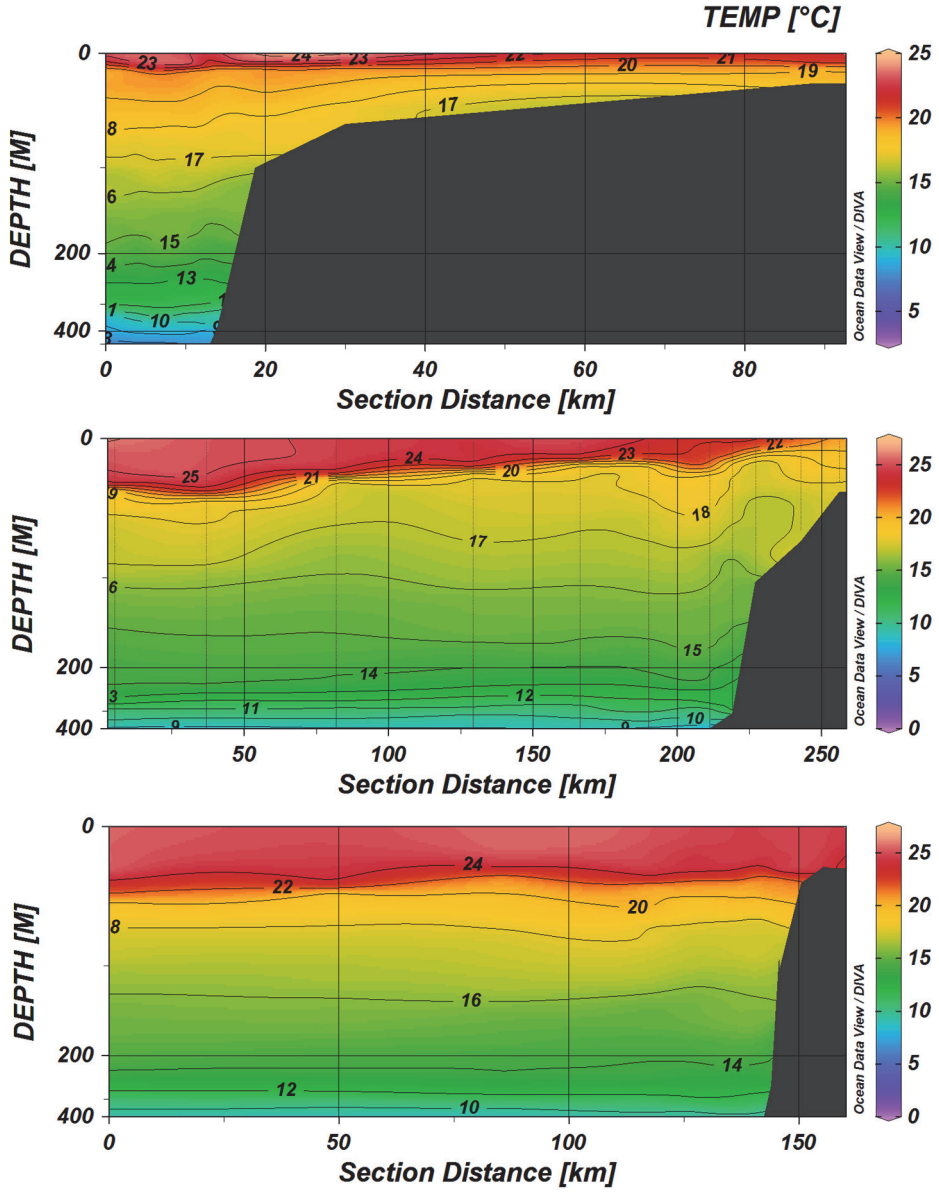

Figure 21. Vertical profiles of temperature on three extended transects in waters off Ghana. Top to bottom: Cape Three Points (app. 2°W), Komenda (app. 1°W), Volta River (app. 0.36°E).

Salinity

Bottom salinity was above 35.8 along the entire shelf (Figure 22 middle). A layer with salinity >36 was observed further offshore at depths 25-100 m off Komenda. Below app. 100m salinity decreased from approximately 35.8 gradually to 34.5 at 700-800m before increasing again to above 34.8 at app. 1300m depth.

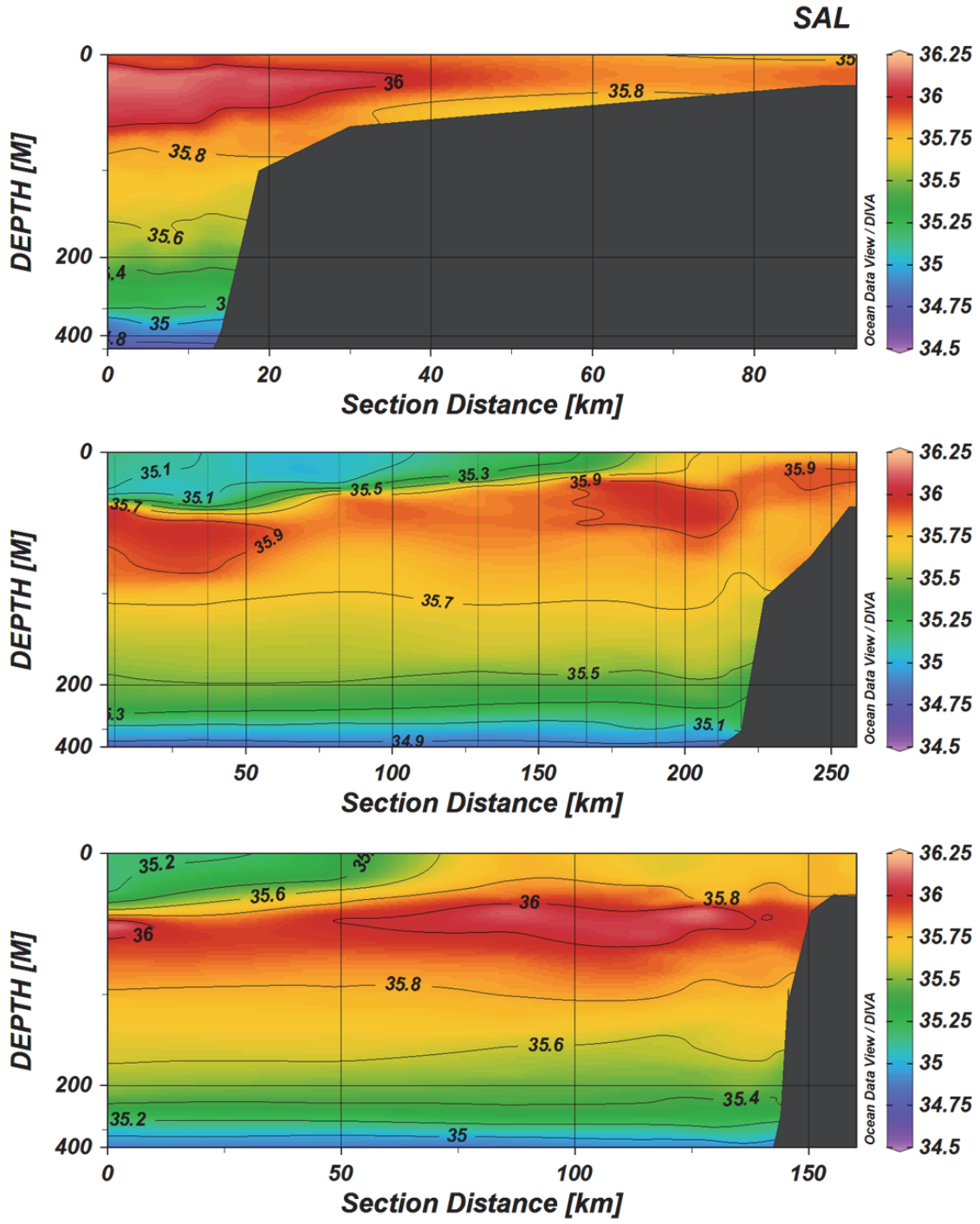

Figure 22. Vertical profiles of salinity on three extended transects in waters off Ghana. Top to bottom: Cape Three Points (app. 2°W), Komenda (app. 1°W), Volta River (app. 0.36°E).

Fluorescence

High flurorescence of 2-3 µg/l was observed offshore (60m bottom depth) on the Komenda transect (Figure 23 middle). On both the Cape Three Points and Volta River transect lower fluorescence (0.6-0.8 µg/l) could be observed offshore (2000-5000m bottom depth) at 40m depth. Below 100m depth fluorescence was 0.1 µg/l or lower.

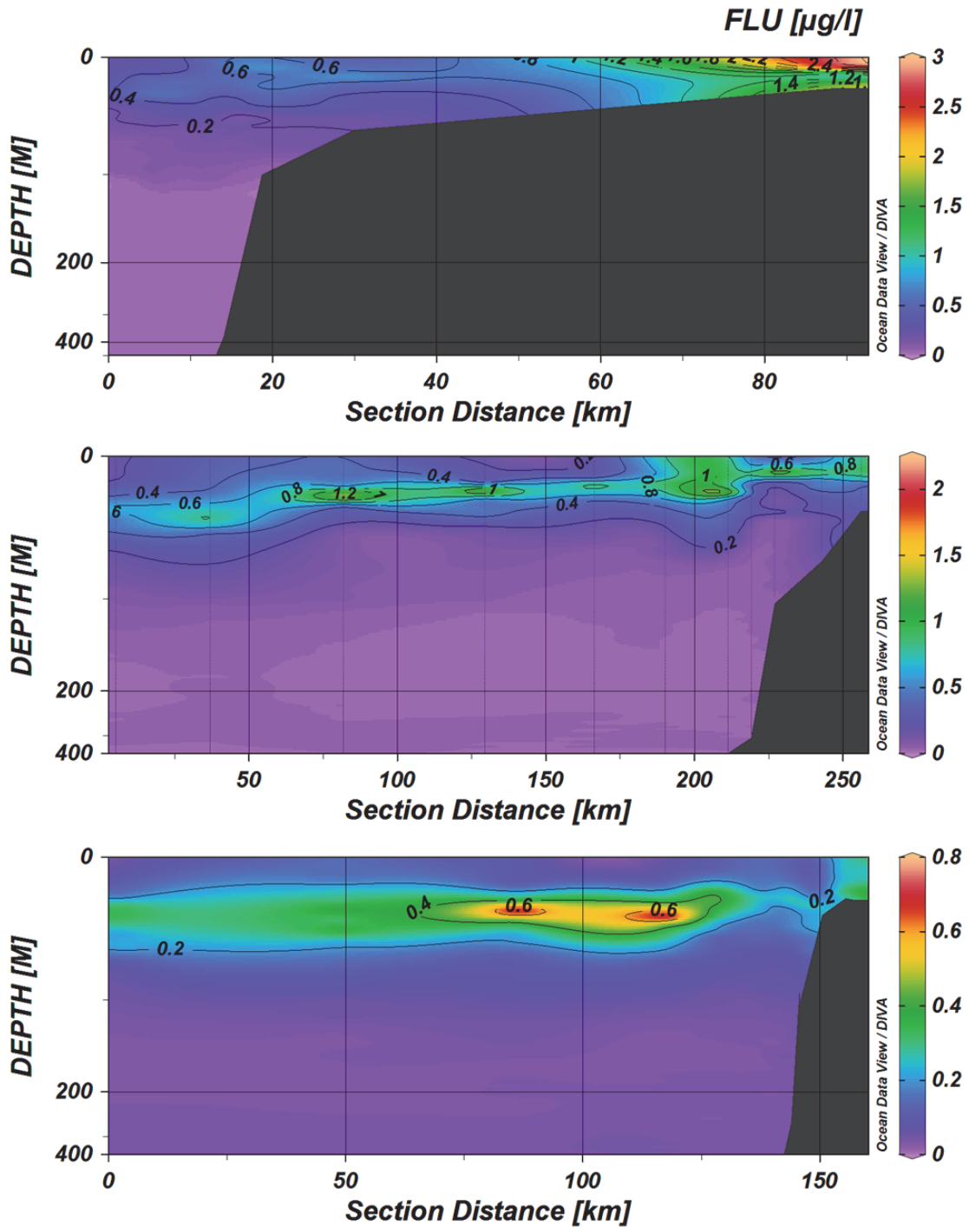

Figure 23. Vertical profiles of fluorescence on three extended transects in waters off Ghana. Top to bottom: Cape Three Points (app. 20W), Komenda (app. 10W), Volta River (app. 0.360E).

3.1.2.2 Surface horizonal distribution of hydrographic variables

The horizontal distributions of oxygen, temperature, salinity and fluorescence in surface waters (5m depth) are respectively shown in Figure 24. It is clear from these plots that inshore between 1-2°W (between Cape Three Points and to the east of Cape Coast), where dissolved oxygen concentration is below 2.4 ml/l, temperature below 23°C, and fluorescence above 1 µg/l, is an indication of high primary production.

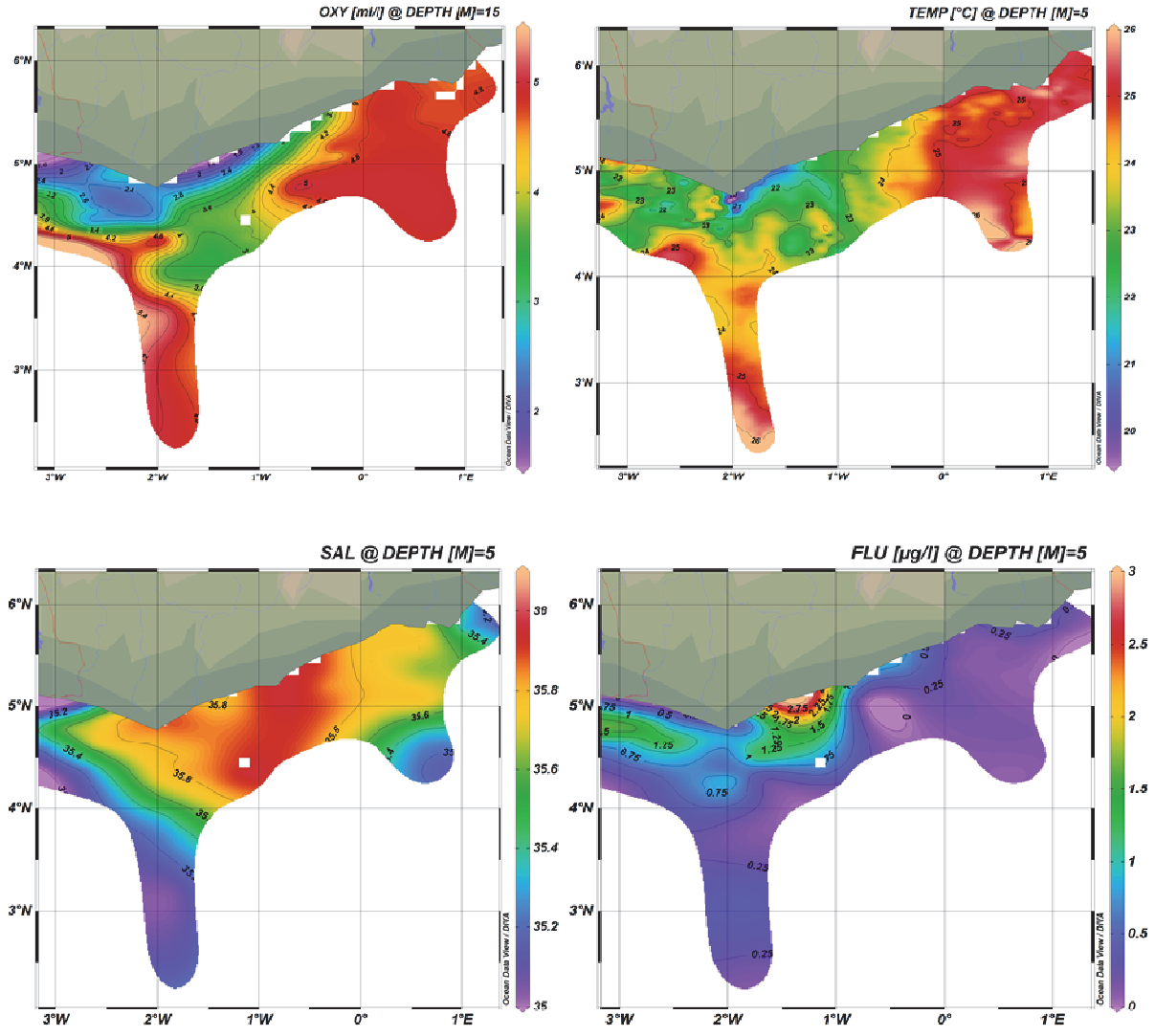

Figure 24. Horizontal distribution of oxygen, temperature, salinity, and fluorescence in waters off Ghana.

3.2 Fish eggs and larvae

The number of fish egg and larvae samples collected off Côte d'Ivoire and Ghana for further analysis on-shore are presented in Table 8.

Table 8. Overview of fish eggs and larvae samples collected in Côte d'Ivoire and Ghana.

No. of samples	Units	Description
12	Bottles	Cotè d'Ivoire – eggs and larvae samples in formalin from multinet
17	Bottles	Ghana – egg and larvae samples in formalin from multinet

3.3 Phyto- and zooplankton

Samples collected for phytoplankton with the vertical haul net and for zooplankton with the l WP2 net, will be analysed onshore and reported separately.

Table 9. Overview of phyto and zooplankton samples collected in Côte d'Ivoire and Ghana.

No. of samples	Units	Description
12	Bottles	Cotè d'Ivoire – phytoplankton samples in formalin from phytoplankton vertical net haul, for later analysis
24	Bottles	Cotè d'Ivoire – zooplankton samples in formalin from WP2 vertical net hauls, for later analysis
72	Trays	Cotè d'Ivoire – zooplankton samples dried (60°C >24 h), from WP2 vertical net hauls, for later analysis of biomass
17	Bottles	Ghana - phytoplankton samples in formalin from phytoplankton vertical net haul, for later analysis
42	Bottles	Ghana - zooplankton samples in formalin from WP2 vertical net hauls, for later analysis
26	Trays	Ghana - zooplankton samples dried (60°C >24 h), from WP2 vertical net hauls, for later analysis of biomass

3.4 Microplastics

Microplastic (Figure 25) was observed on several stations and often with a tendency of higher concentrations further offshore.

While few fish eggs and larvae were collected with the multinet many more larvae were often sampled with the Manta trawl (Figure 26).

Table 10. Overview of net samples for microplastics, fish-eggs and larvae, phyto and zooplankton from the continental shelf off Côte d'Ivoire and Ghana.

No. of samples	Units	Description
12	Trays	Cotè d'Ivoire - Samples of dried (20°C > 24h) plastics from Manta net
17	Trays	Ghana - Samples of dried (20°C > 24h) plastics from Manta net

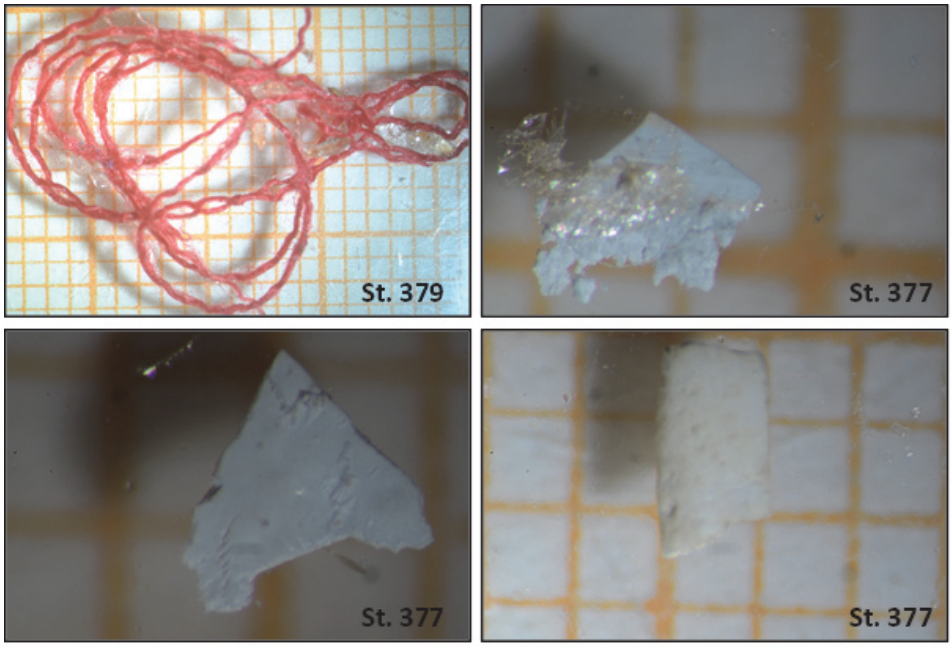

Figure 25. Marine anthropogenic litter detected in Manta-net samples towed at surface during the survey off Côte d'Ivoire and Ghana.

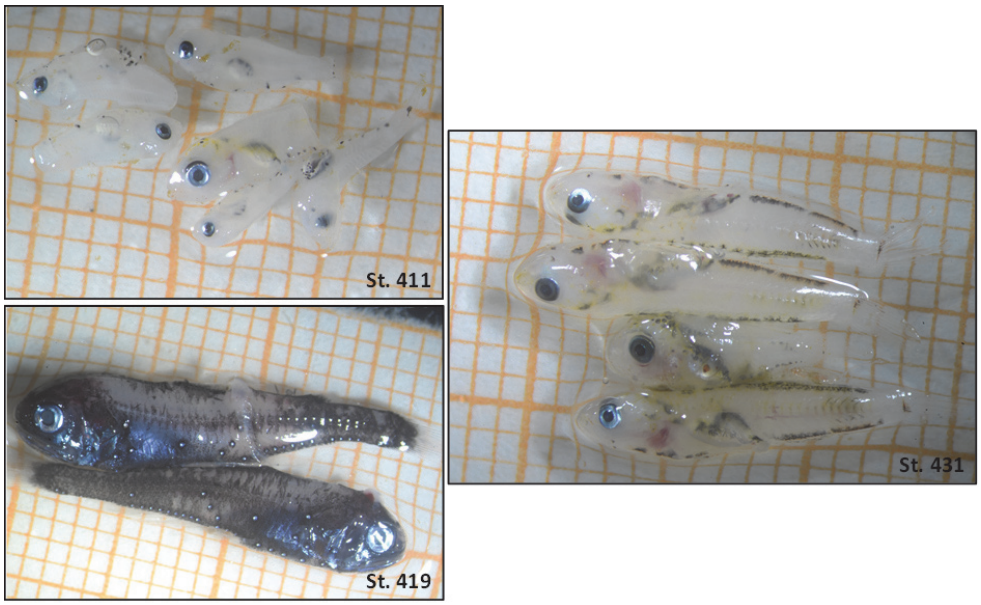

Figure 26. Fish larvae collected with Hydro-Bios Multinet MIDI system (405 µm) during the survey off Côte d'Ivoire and Ghana.

3.5 Food safety

Both non-commercial and commercial fish species were collected during the survey for nutrients and contaminants such as heavy metals and dioxins, andwill be analysed at a later stage at IMR, Bergen. Table 11 shows the number of collected samples by species, which will be analysed at NIFES, Bergen, Norway for contaminants such as heavy metals, dioxin etc.

Table 11. Overview of samples collected of various species for analysis of contaminants and and for nutritional value.

Date	Species	Number of Fish		Station No.	Homogenized	Weight before	Freeze	Homogenization	Vacuum	Country
		Large Fish	Small fish			freeze drying	dried	after freeze drying	sealed	
26.08.2017	*Selene dorsalis*	9		3	X	X	X	X	X	Cote d'Ivory
26.08.2017	*Trachurus trecae*		150	5	X	X	X	X	X	Cote d'Ivory
27.08.2017	*Stromateus fiatola*	11		8	X	X	X	X	X	Cote d'Ivory
27.08.2017	*Trachurus trecae*		150	9	X	X	X	X	X	Cote d'Ivory
27.08.2017	*Sphyraena guachancho*	22		11	X	X	X	X	X	Cote d'Ivory
28.08.2017	*Ilisha africana*		150	13	X	X	X	X	X	Cote d'Ivory
29.08.2017	*Trachurus trecae*		150	14	X	X	X	X	X	Cote d'Ivory
31.08.2017	*Zenion hololepis*		150	19	X	X	X	X	X	Ghana
01.09.2017	*Cubiceps sp.*		150	21	X	X	X	X	X	Ghana
03.09.2017	*Trachurus trecae*		150	25	X	X				Ghana
03.09.2017	*Engraulis encrasicolus*		150	27	X	X				Ghana
03.09.2017	*Saurida brasiliensis*		150	27	X	X	X	X	X	Ghana
04.09.2017	*Brachydeuterus auritus*		150	29	X	X	X	X	X	Ghana
04.09.2017	*Pagellus bellottii*		150	31	X	X	X	X	X	Ghana
04.09.2017	*Apsilus fuscus*	25		31	X	X				Ghana
05.09.2017	*Engraulis encrasicolus*		150	33	X	X				Ghana
05.09.2017	*Sardinella aurita*		150	33	X	X				Ghana
06.09.2017	*Scomber colias*		150	36	X	X	X	X	X	Ghana
09.09.2017	*Selene dorsalis*	16		38	X	X				Ghana

3.6 Biology of target pelagic fish species

With the expanding scope of the research to be carried out in the context of the EAF-Nansen Programme, the survey objectives and related sampling strategy have been expanded to support research on life cycles, stock identities, and trophic relationships of pelagic fish. For these facets, special effort was carried out to collect several biological parameters (otoliths, fin clips, stomachs) and stage gonad maturity for post-survey age and growth, stock structure, population biology and trophic interaction studies. Annex IV reports the numbers of samples collected. These samples will be analysed later and the results reported separately.

The on-board analysis of several key biological parameters, notably length-weight, sex, maturity and stomach fullness are presented in the results section.

Mesopelagics were sampled at 4 stations for IMR. Three stations, with approximately 25 samples of jellyfish (for Mark Gibbons at UWC, Cape Town, South Africa) were also collected.

3.6.1 Côte d'Ivoire

3.6.1.1 Sex-ratio and gonad development

Very few fish of the main target groups (sardinellas, horse mackerels, and pelagic I) were recorded and caught in Côte d'Ivoire, and hence the sample sizes are small. Most biological data and samples (including otoliths, sex, gonad maturity, stomachs) were collected for *Trachurus trecae* (133 samples) and for *sardinellas* (24 samples). Since in several instances the measured fish were small, it was decided to freeze these down, such that otoliths and stomachs could be obtained on land. Sex ratios and proportions of gonad maturity stages (females only) by length were calculated for *T. trecae* (Figure 27). No clear changes in sex ratio by length could be observed, whereas gonad maturity data indicated that i) fish started maturing at small sizes, ii) that most female indivduals > 15 cm had well developed (ripe) gonads. (Figure 27).

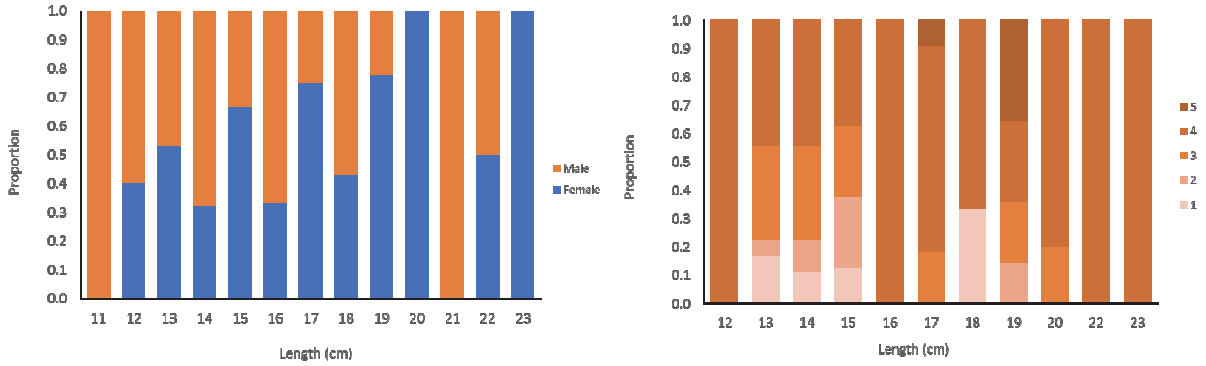

Figure 27. Proportions of sexes (left) and gonad maturity stages (right) by length for *T. trecae.*

3.6.2 Ghana

3.6.2.1 Sex-ratio and gonad development

The proportion of female *Engraulis encrasicolus* increased with size (>10cm, Figure 28), while for the sardinellas most of fish sampled were males (Figure 29). The number of maturing anchovy increased with size, and most fish > 10 cm appeared to have mature gonads. Of the sardinellas sampled most fish were either immature or in the process of developing their gonads (stage 2; Figure 29). Only sardinellas ≥ 20 cm were identified with gonad stage 4, indicating that the bigger individuals were in spawning condition (though very few of these were caught).

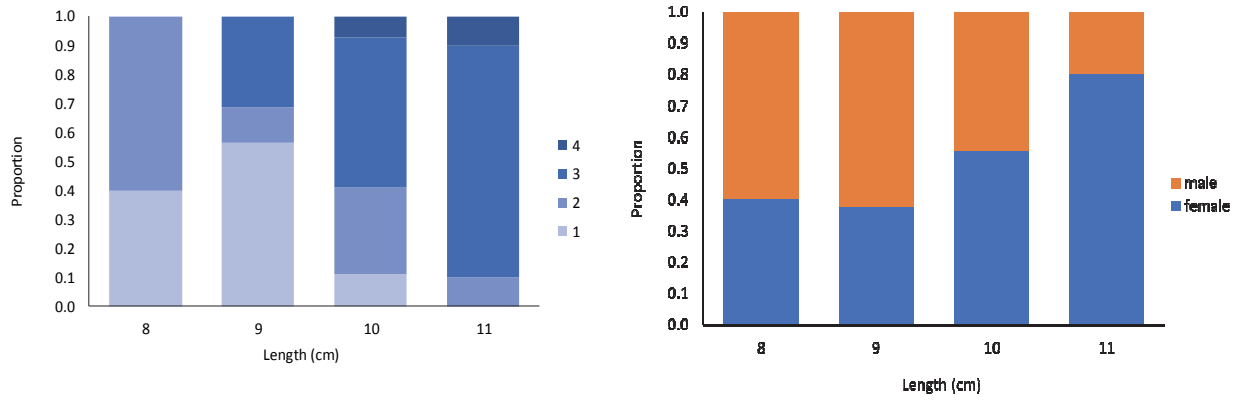

Figure 28. Proportions of gonad maturity stages (left) and sexes (right) by length for *Engraulis encrasicolus*.

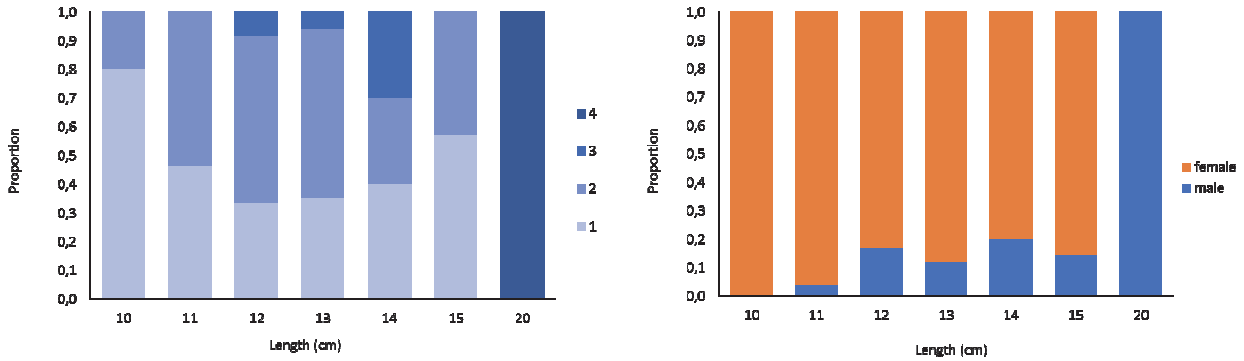

Figure 29. Proportions of gonad maturity stages (left) and sexes (right) by length for *sardinellas*.

3.7 Distribution and size of pelagic fish

3.7.1 Côte d'Ivoire

Overall few distinct and well-defined acoustic registrations reminiscent of schooling pelagic fish were observed off Côte d'Ivoire, and if they did occur, then the extent was usually limited to a narrow depth range and short distance. Most acoustic backscatter attributed to five pelagic groups during the scrutinisation process was recorded in waters shallower than 50 m, with the exception of acoustic echos assigned to horse mackerel, which could be observed at depths up to 80 m.

Of the main target species only *Trachurs trecae* was found over an extended area. Sardinellas and anchovy (*Engraulis encrasicolus*) were caught in very low numbers and on respectively 3 and 2 stations only. Species more frequently caught belonged to the 'Pelagic II' group and 'Other pelagics' and included *Brachydeuterus auritus*, *Sphyraena guachancho*, *Selene dorsalis,* and *Trichurus lepturus.*

3.7.1.1 Horse mackerel

The size distribution of horse mackerel varied between trawl catches. Shallow pelagic tows generally contained juvenile (4-6 cm) fish, whereas deeper pelagic and demersal trawls caught large (> 10cm) individuals. Resultingly the overall length distribution seemingly consisted of three age cohorts, with modes at 6, 14 and 19 cm (Figure 30).

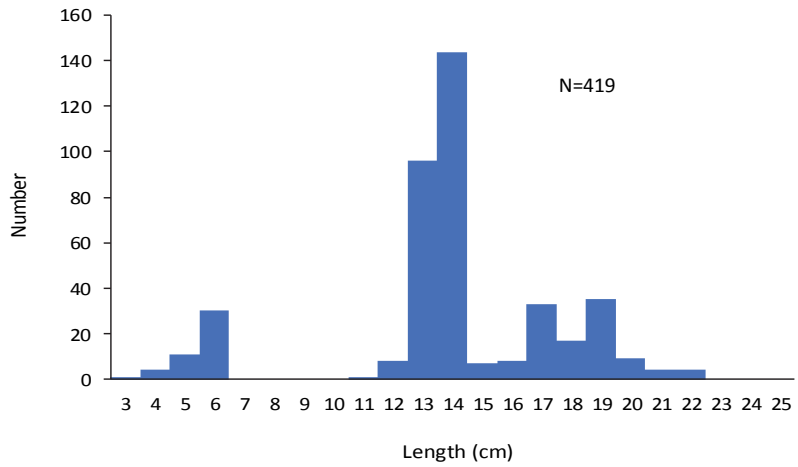

Figure 30. Length distribution of *Trachurus trecae* off Côte d'Ivoire.

The horse mackerel distribution covered large areas of the Côte d'Ivorian shelf between 30-80 m (Figure 31). Catch rate was however generally low (average 14 kg/hr), regardless of depth and location. Especially during day time horsemackerel was mainly observed close to the bottom at 50-80m depths.

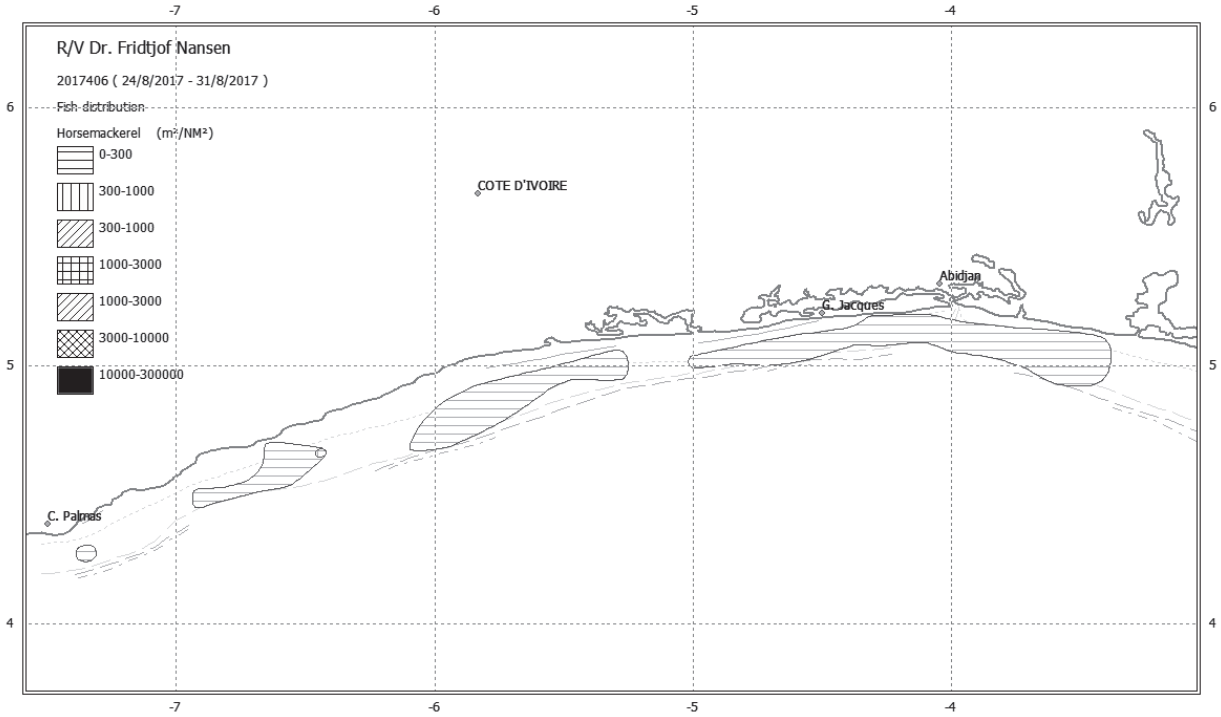

Figure 31. Distribution of *Trachurus trecae* off Côte d'Ivoire. Depth contours as in Figure 2.

3.7.1.2 Pelagic I fish

Engraulis encrasicolus and *Scomber colias* were the only two species belonging to the acoustic category 'Pelagic I' that were caught, both in pelagic and bottom trawls at 40-70 m depth. Catch rates of both species were very low (approximately 0.2 kg/hr) and catches (Stations 9 & 10) used for biomass estimate purposes were limited to a small area.

3.7.1.3 Pelagic II fish

Trichiurus lepturus and *Selene dorsalis* were the most frequently caught species in the acoustic category 'Pelagic II', covering most parts of the upper shelf between 30-70 m depth (Figure 32). Although both species were identified in 12 of the 17 acoustic identification trawls, average catch rates were low, 8.8 kg/hr and 4.1 kg/hr respectively. *Illisha africana* was caught in a single trawl with a total catch of 45.3 kg. Length distributions for *Selene dorsalis* (average length 28 cm) and *Illisha africana* (average length 14.4 cm) from two trawls were used for biomass estimation, while length distributions of *Trichiurus lepturus* were not considered in the biomass estimation.

3.7.1.4 Other fish

Three species in the acoustic category 'Other' - *Brachydeuterus auritus* and two *Sphyarena spp.*-were caught in 8 and 7 trawl hauls respectively. Average catch rate of *B. aurita* was 33.9 kg/hr (due to a single 98 kg haul), while catch rates for *Sphyarena sp.* were 2.1 and 5.5 kg/hr. The species were distributed mainly in the eastern parts of Côte d'Ivoire (Figure 33).

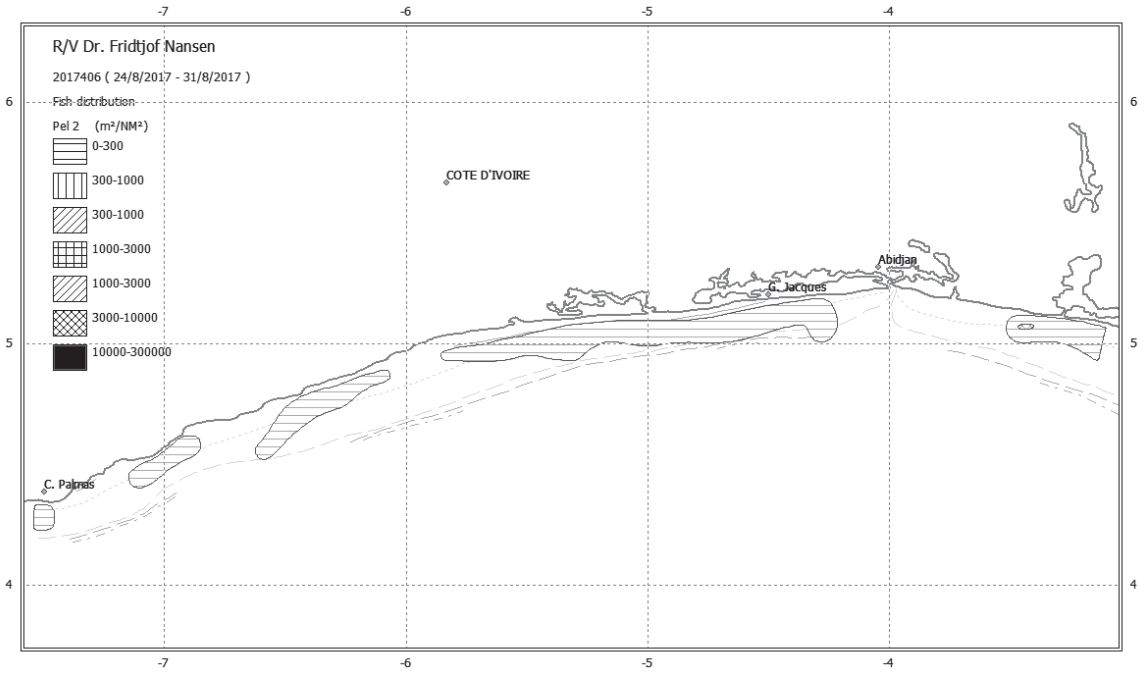

Figure 32. Distribution of *Pelagic II* off Côte d'Ivoire. Depth contours as in Figure 2.

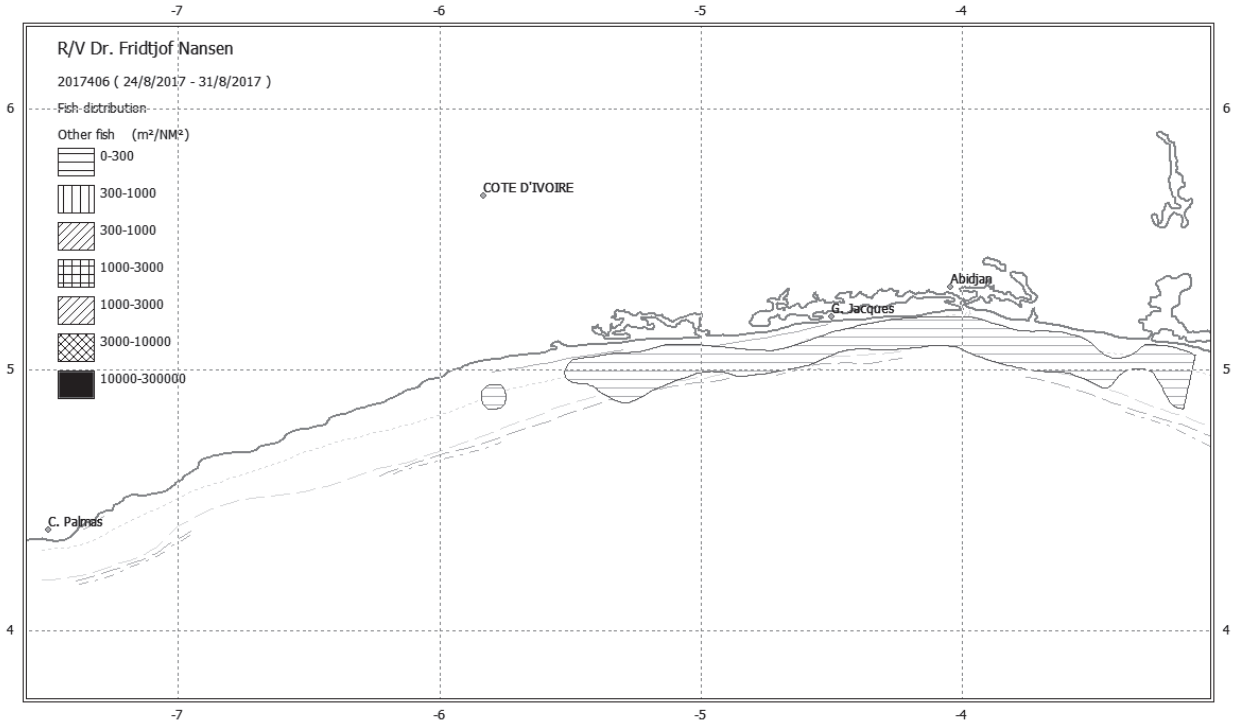

Figure 33. Distribution of '*Other pelagics'* off Côte d'Ivoire. Depth contours as in Figure 2.

3.7.2 Ghana

High acoustic registrations of *Engraulis encrasicolus (*Pelagic I category), and to a lesser extent of *Sardinellas* sp., and *Trachurus trecae* were recorded in large areas along the upper shelf.

3.7.2.1 Sardinellas

As shown in Figure 34 *S. aurita* sampled from the trawl catches was larger (mode at 11cm, mean L 11,8 cm) than *S. maderensis* (mode at 8 cm, mean L 8.9 cm). *S. aurita* was caught more frequently and in higher numbers than *S. maderensis* (Annex IX).

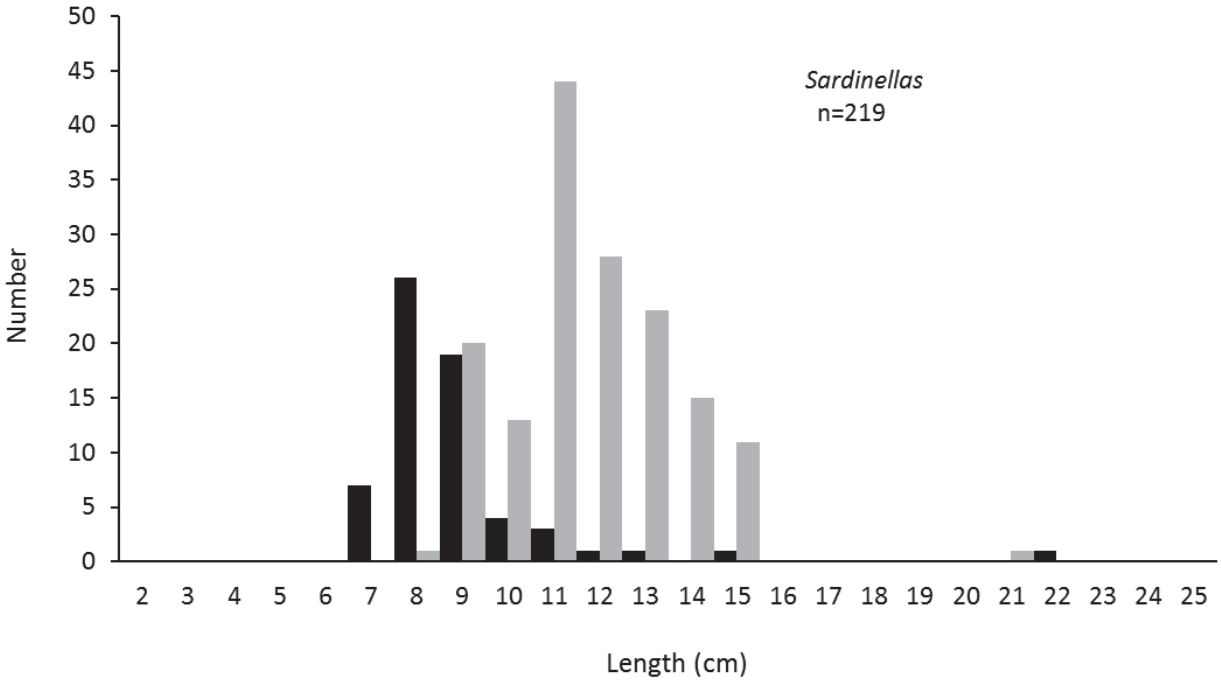

Figure 34. Length distribution of *Sardinellas* off Ghana. Blue – *Sardinella maderensis*; orange – *Sardinella aurita.* The distributions are not weighted by catch size.

The average catch rate *S. aurita* was 303,7 kg/hr compared to 1,1 kg/hr for *S. maderensis.* The average contribution in trawl catches containing either of the two species was 9.2 % for *S. aurita* nad 0.4 % for *S. maderensis.* The main area of distribution of sardinellas was confined to three areas on the upper shelf (< 50 m bottom depth, Figure 35). The highest contribution to the estimated biomass came from the largest of these three areas located to the west of Accra. Trawl catches from this area contained nearly exclusively *S. aurita*, whilst trawl catches in two smaller areas to the east of Accra contained only *S. madernesis*, but in very low quantities (1.3 kg/hr).

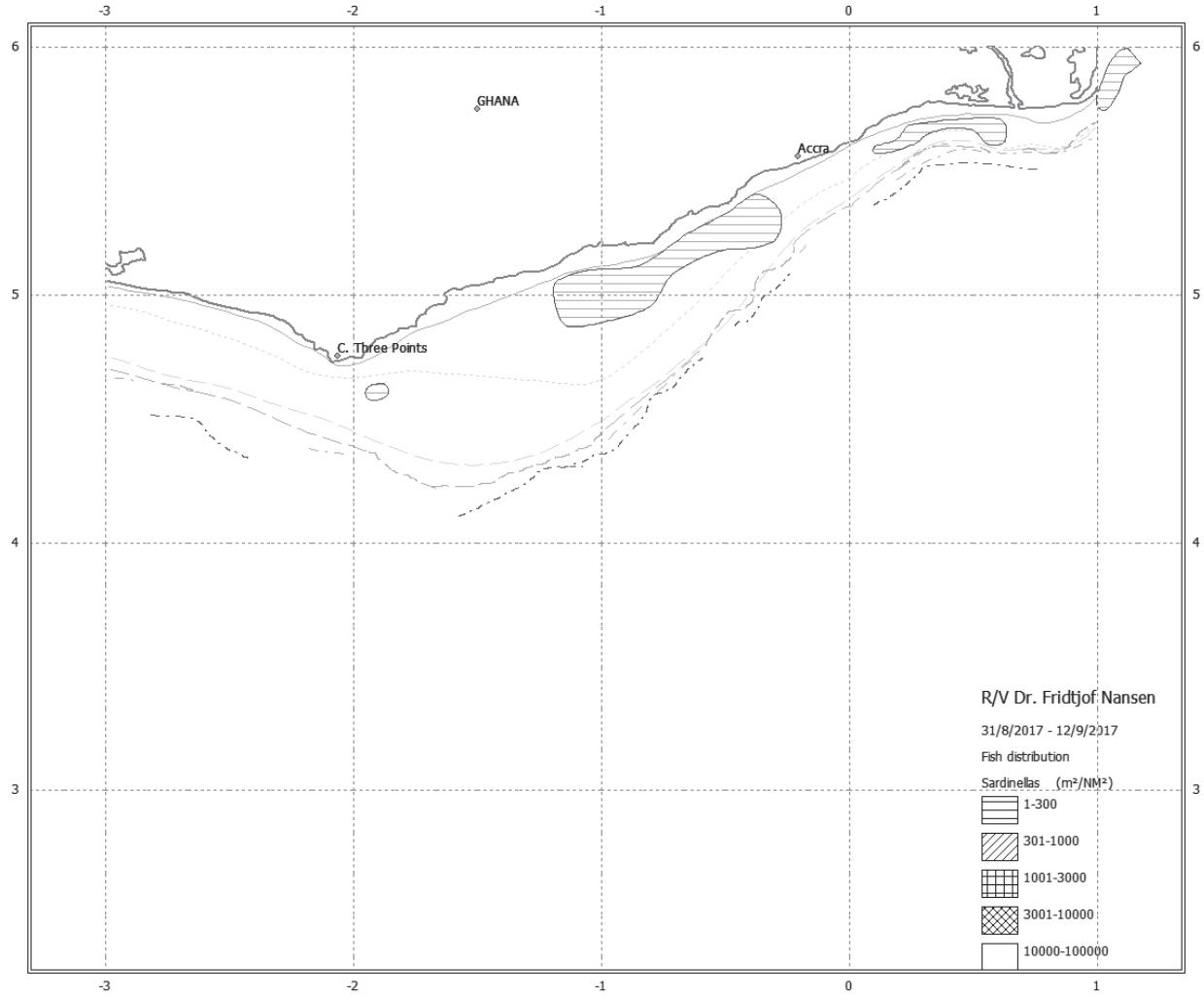

Figure 35. Distribution of *Sardinellas* off Ghana. Depth contours as in Figure 5.

3.7.2.2 Horse mackerel

Of the major species, horse mackerel was the most frequently caught in Ghanaian waters. The species was caught in 13 target identification trawls, with a maximum recorded catch rate of 2340 kg/hr and an average catch rate of 286 kg/hr. The average contribution of horse mackerel in respective trawl catches was approximately 20%. The combined length frequency distribution indicates three modes at respectively 9 cm, 16 cm, and 27 cm, with the majority of fish below 10cm in length (Figure 36). There did not seem to be a length segregation by depth, i.e. small and large fish were equally found in shallow and deeper waters.

Most of the horse mackerel biomass was distributed on the broader shelf area (30 – 80 m depth) between Cape Three Points and approximately Winneba (Figure 37). It was also in this area where sporadically high acoustic observations of horse mackerel were made. Between Accra and the Togo border catch rates were somewhat lower than those observed further west. Acoustic registrations from this area are attributed to mainly small fish (< 10 cm). and the estimated biomass from this area resultingly low.

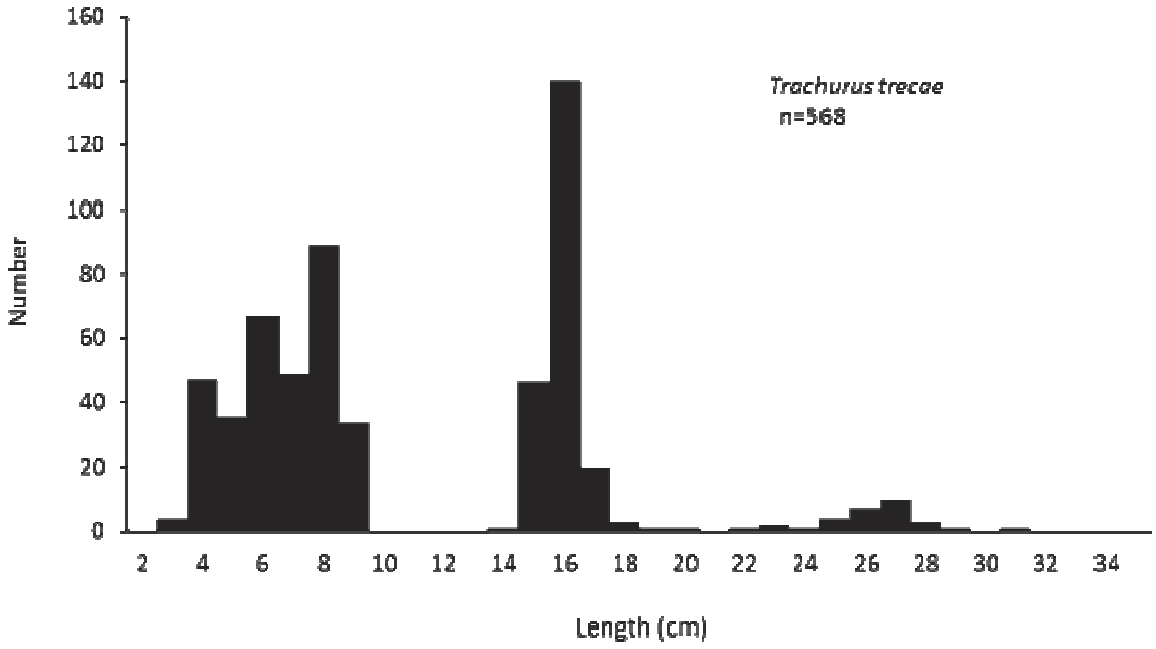

Figure 36. Length frequency distribution of *Trachurus trecae* off Ghana. The distribution is not weighted by catch size.

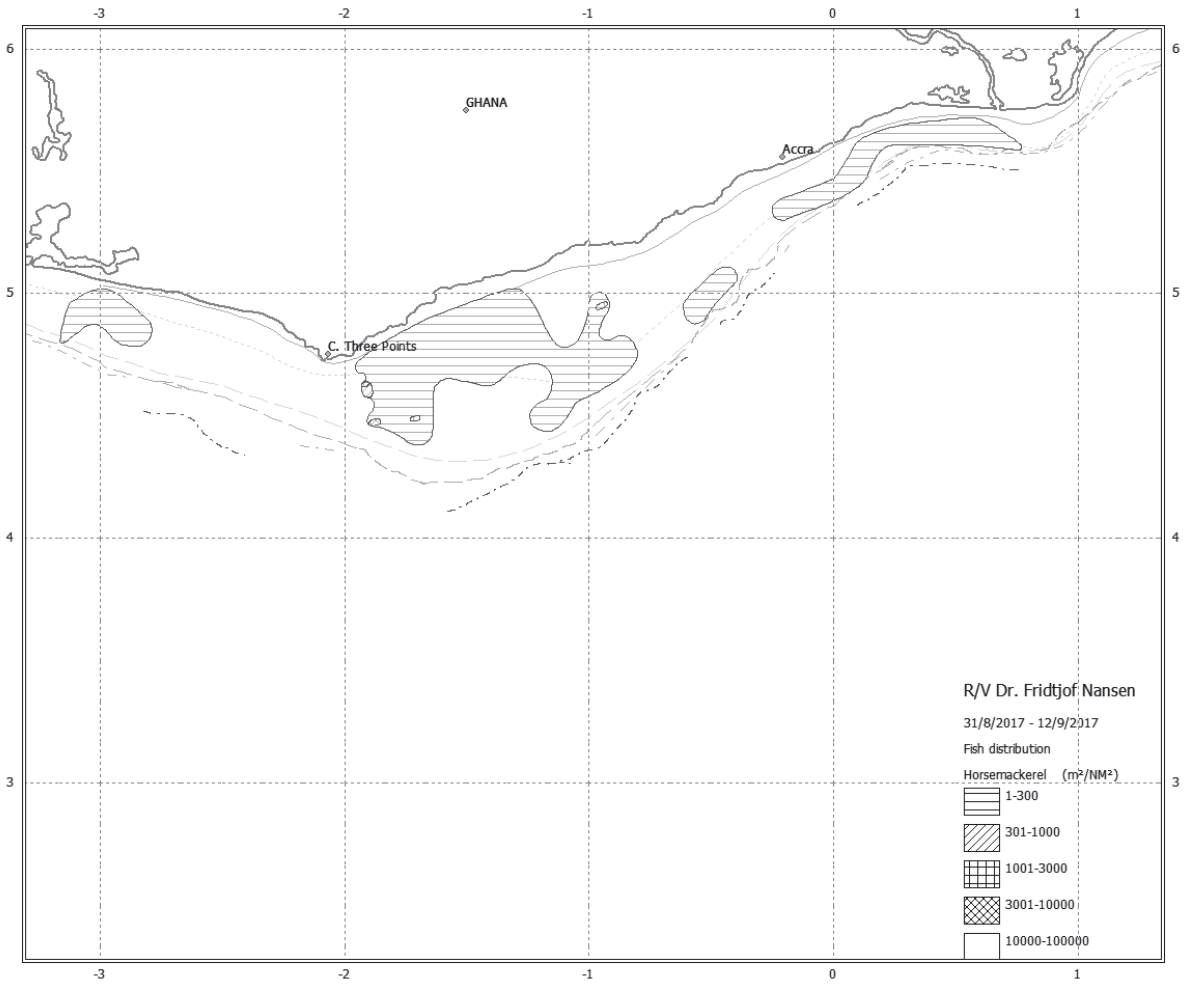

Figure 37. Distribution of *Trachurus trecae* off Ghana. Depth contours as in Figure 5.

3.7.2.3 Pelagic I fish

Most acoustically scrutinized pelagic fish schools in Ghanaian waters were composed of species in the acoustic group 'Pelagic I', in particular the anchovy (*Engraulis encrasicolus*) The bulk of these acoustic targets was distributed on the entire upper shelf from east of Cape Three points to the Togo border (Figure 39). The anchovy was by far the most abundant species in this group, followed by *Scomber colias* and *Decapterus punctatus*. The respective average catch rates in acoustic target identification trawls was 1187 kg/hr, 53 kg/hr and 36 kg/hr. The contribution of anchovy in terms of weight in the target id trawls was 43.1%, compared to 2.2% of *Scomber colias* and 0.9% of *Decapterus punctatus*. The contribution of species other than anchovy to the total Pelagic I biomasss was thus marginal, implying that the distribution of Pelagic I in essence reflects the distribution of anchovy. The length distribution of anchovy varied little between catches, ranging from 6 cm to 11 cm, with a mode at 8 cm (Figure 38).

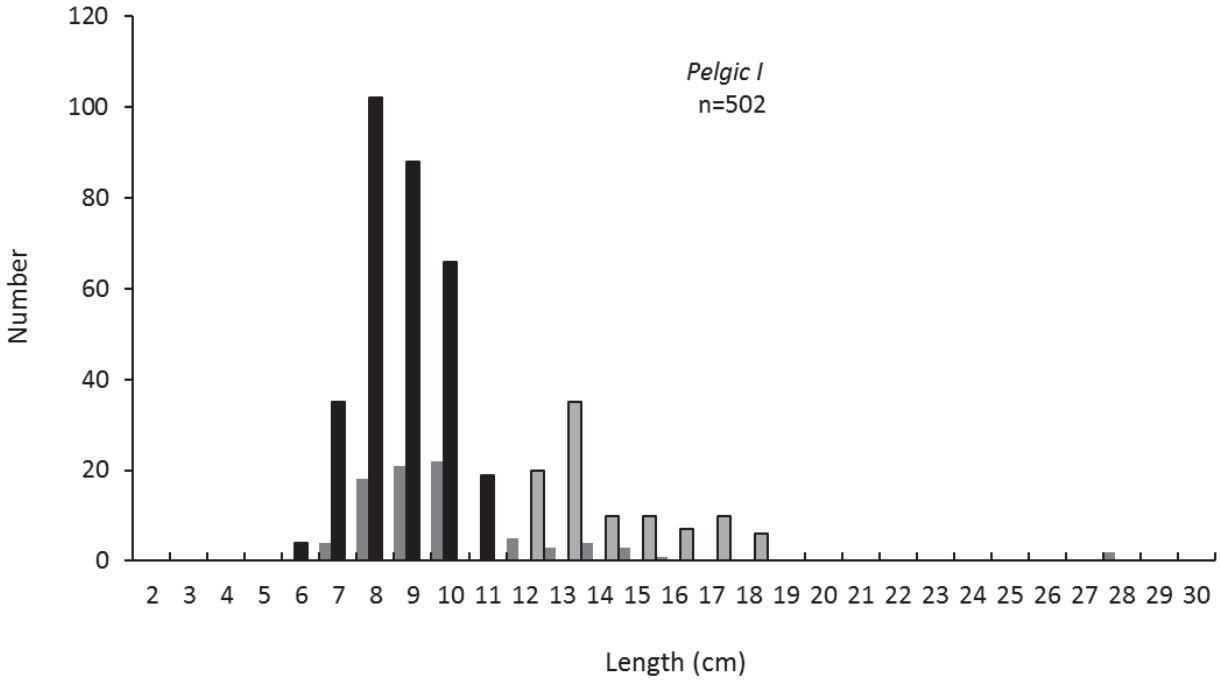

Figure 38. Length distribution of *Pelagic I* species off Ghana. Black – *Engraulis encrasicolus*; dark grey– *Carangidae*; light grey – *Scombridae*. The distributions are not weighted by catch size.

3.7.2.4 Pelagic II fish

The most frequently caught species in the Pelagic II category were Selene dorsalis (11 tows), Trichurus lepturus (4 tows), and Chloroscomburs chrysurus (2 tows). However, catch rates of all three species were very low, respectively 2.3, 1.1, and 2.1 Kg/hr, and therefore their overall contribution to the acoustic backscatter low. Two small areas were identified where these species occurred – one in the far west and one on the border to Togo.

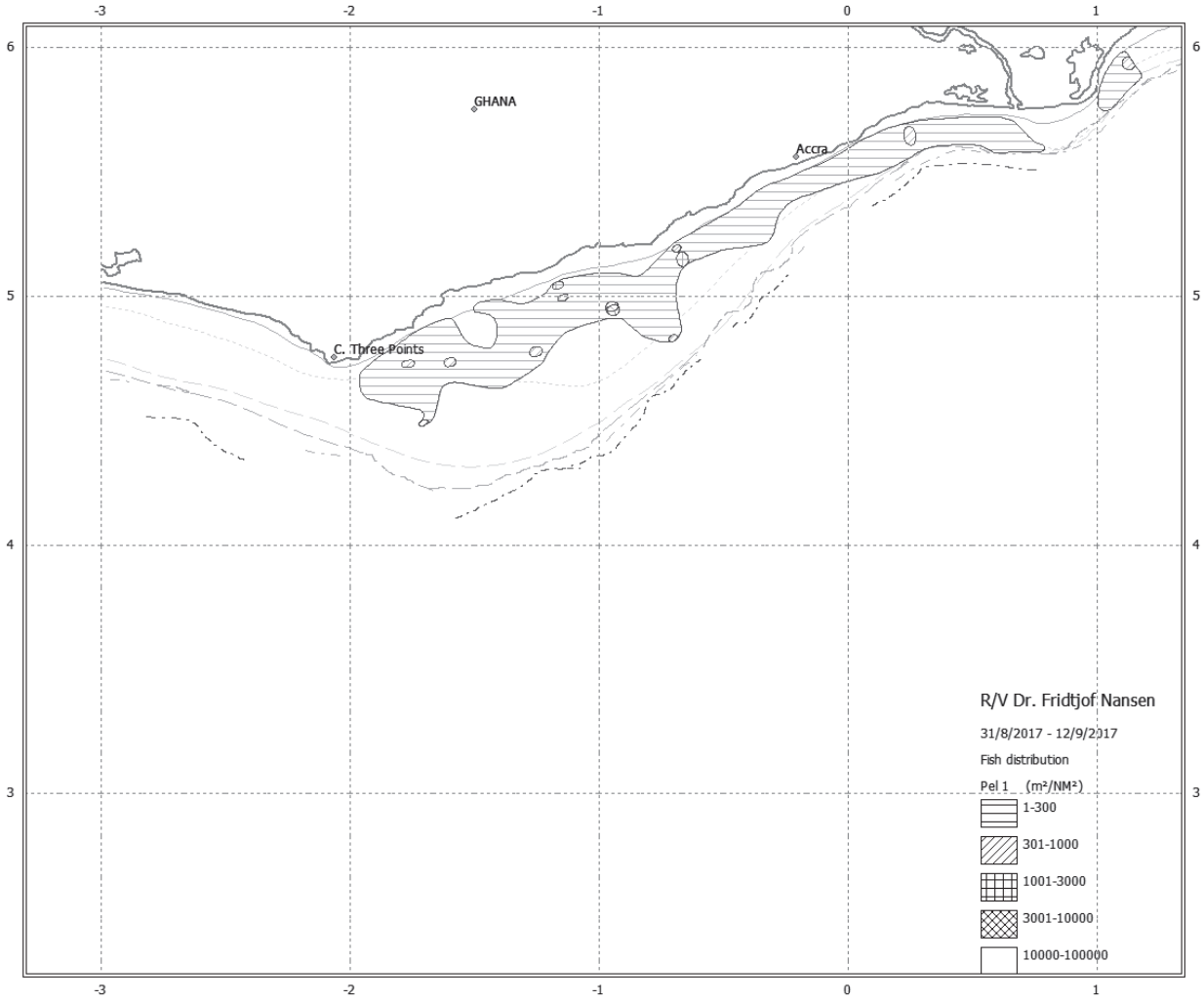

Figure 39. Distribution of *Pelagic I* off Ghana. Depth contours as in Figure 5.

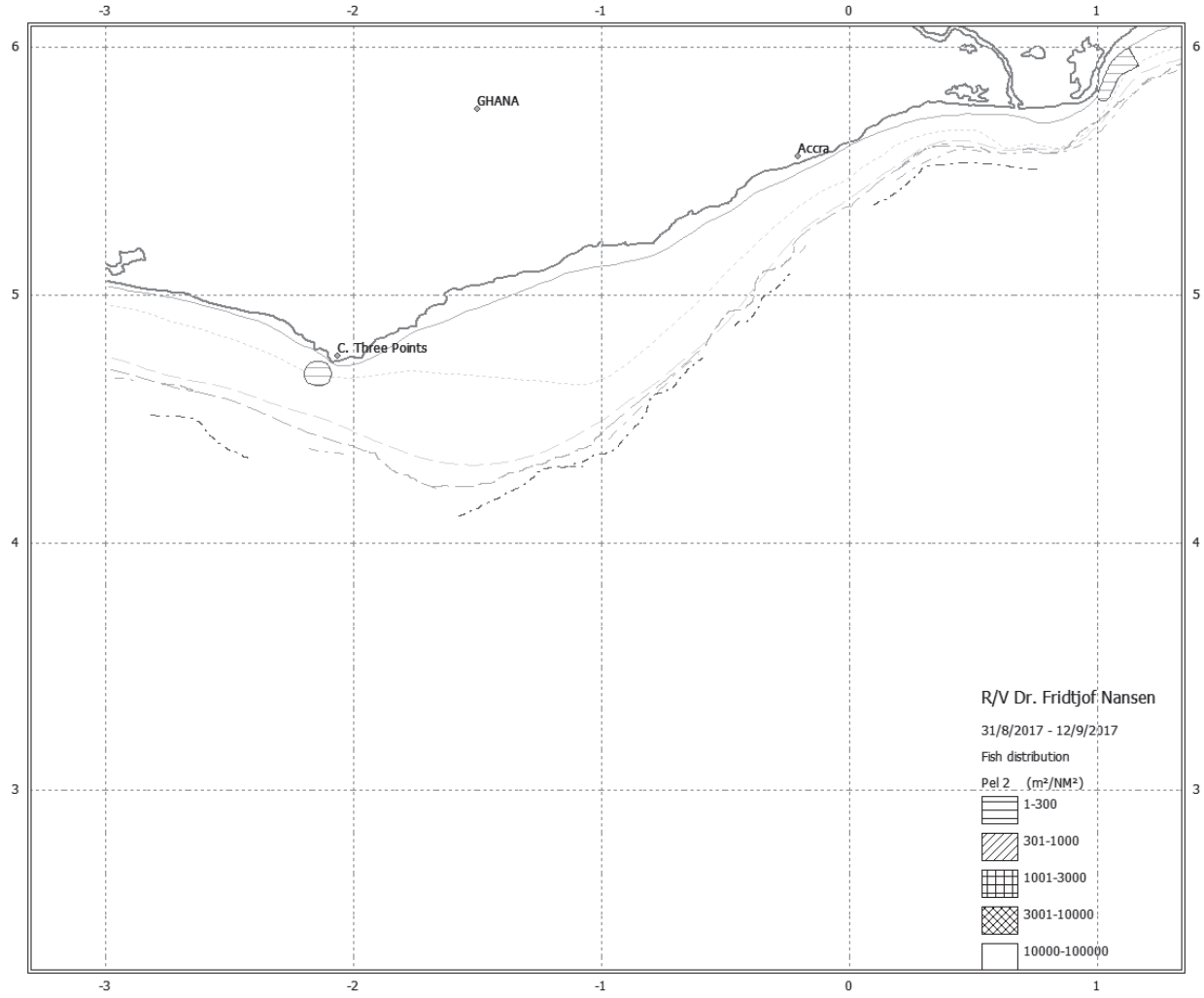

Figure 40. Distribution of *Pelagic II* off Ghana. Depth contours as in Figure 5.

3.7.2.5 Other fish

Brachydeuterus auritus (4 trawls, max 260.1 kg/hr), *Sphyraena guanchancho* (max 13 kg/hr, 3trawls), *Sphyraena sphyarena* (max 6 kg/hr, 3 trawls), and *Pagellus belloti* (max 20.2 kg/hr, 6 trawls) were the most commonly caught other species (noting that many of these are primarily demersal fish and were caught in widespread dispersed layers occurring in close association with the seabed).

3.8 Biomass estimates

Acoustic registrations were integrated every 1NM, and allocated to defined acoustic groups based on pelagic and bottom trawl catches, vertical distribution, and depth distribution. Different to prior surveys anchovy were not scrutinized separately but included in the acoustic group 'Pelagic 1'. Also, the species *IIisha Africana* was on this survey part of the group 'Pelagic 2', while *Decapterus* sp. were included in the group 'Pelagic 1'. These changes in grouping of species did not have a major influence on the overall estimation of biomass of the different species, because i) anchovy was the dominating species in the 'Pelagic 1' group, and ii) *Illisha Africana* was caught in one single trawl. However, the length distribution of this species was used in the estimation the biomass for Pelagic 2.

A summary of the biomass estimates is given in Table 12 below. Biomasses per strata and length-weight relationships obtained from the biological samples used in the biomass estimation are provided in Annex IX.

Table 12. Summary of biomass estimates of pelagic fish (tonnes).

Country	Sardinellas	Horse mackerel	Pelagic I fish		Pelagic II fish
			Anchovy	Total	
Côte d'Ivoire	750	5 150	610	610	10 700
Ghana	4 000	29 400	73 140	76 170	2 400
Totals	**4 750**	**34 550**	**73 750**	**76 780**	**10 720**

The main species of the pelagic community comparatively abundant in both countries assessed was horse mackerel, with a total biomass of respectively 5,150 tonnes and 29,400 tonnes. Off Ghana most of the pelagic biomass was attributed to *Engraulis encrasicolus*, with roughly 73,000 tonnes. A further 3,000 tonnes was assigned to *Decapterus sp*. and *Scomber colias* (Pelagic I fish). Off Côte d'Ivoire close to two thirds of the biomass was dedicated to Pelagic II fish, with *Trichiurus lepturus, Selene dorsalis* and *Ilisha africana* the main species. Biomass of the *sardinellas* and *anchovy* off Côte d'Ivoire were estimated to be very low (< 1,000 tonnes).

3.9 Comparison with earlier surveys with the RV *Dr Fridtjof Nansen*

The overall biomass of sardinella in Côte d'Ivoire was similar to the 2007 value, but the lowest in the time series, which shows high interannual variation prior to 2007 (Table 13 a). The estimate of sardinellas and anchovy in Ghana was dominated by anchovy, with sardinellas contributing approximately 4,000 tonnes. The total biomass of the other species of pelagic fish that were assessed, the carangids, scombrids, barracudas and hairtails, was in the range of previous estimates in both countries, though the estimate for Ghana was much lower than the 2016 estimate (Table 13 b).

Table 13 a. Biomass estimates of sardinellas and anchovies, RV *Dr Fridtjof Nansen.*

Survey Year	Survey period	Gôte d'Ivoire	Ghana	Total
1981	June	39 000	40 000	**79 000**
1989	12.10 – 20.10	6 000	41 000	**47 000**
1999	19.4 – 8.5	42 000	40 000	**82 000**
2000[1)]	29.8 – 15. 9	111 000	56 500	**167 700**
2002[1)]	16.7 – 9.8	34 000	73 000	**107 500**
2004	16.5 – 9.6	68 000	68 000	**136 000**
2005	4.5 – 27.5	37 000	54 000	**91 000**
2006	19.5 - 5.6	62 000	57 000	**119 000**
2007[2)]	6.6 – 11.6	1 000	20 000	**21 000**
2016	01.04 – 20.04	Not covered	25 000	**----**
2017	24.08 – 13.09	< 1000	77 000	**~ 74 000**

Table 13 b. Biomass estimates of carangids, scombrids, barracudas and hairtail RV *Dr Fridtjof Nansen.*

Survey Year	Survey period	Gôte d'Ivoire	Ghana	Total
1981	June	2 000	10 000	**12 000**
1989	12.10 - 20.10	33 000	57 000	**90 000**
1999	19.4 - 8.5	30 000	50 000	**80 000**
2000[1)]	29.8 - 15. 9	18 000	61 000	**79 000**
2002[1)]	16.7 - 12.8	10 500	52 000	**62 500**
2004	16.5 - 9.6	19 000	37 000	**56 000**
2005	4.5 - 27.5	30 000	46 000	**76 000**
2006	19.5 - 5.6	19 000	37 000	**56 000**
2007[2)]	6.6 – 11.6	2 000	20 000	**22 000**
2016	1.04 – 20.04	Not covered	107 000	**----**
2017	24.08 – 13.09	16 000	28 000	**44 000**

[1)] Upwelling season

[2)] The survey in Cote d'Ivoire and Ghana covered only the area between Abidjan and Tema and data are not directly comparable to previous surveys.

CHAPTER 4. REGIONAL SUMMARY

In this phase of the programme the surveys with the RV *Dr Fridtjof Nansen* are planned regionally to provide synoptic coverages of resources that may be shared. In this summary results from Leg 2.1 and 2.2 (Ivory Coast and Ghana) are presented jointly to provide such a regional overview, with emphasis on the pelagic resources.

Sardinella (*Sardinella aurita* and *S. maderensis*): Low densities were recorded in all the regions, with the exception of Guineé. In the southern part of the area sardinella was only found off Ghana, consisting only of juveniles.

In the case of *S. aurita*, it was mostly found beyond the 100 m isobaths which confirms the species higher affinity for more saline water.

Anchovies (*Engraulis encrasicolus*) were only recorde in small to high densities in Côte d'Ivoire and Ghana, respectively.

Horse mackerel (*T. trecae*) was mostly found in the southern part of the area (Figure 42).

Atlantic chub mackerel (*S. colias*): Generally, this species was absent in all the region except for Liberia and Guinea Bissau where they were found in small densities.

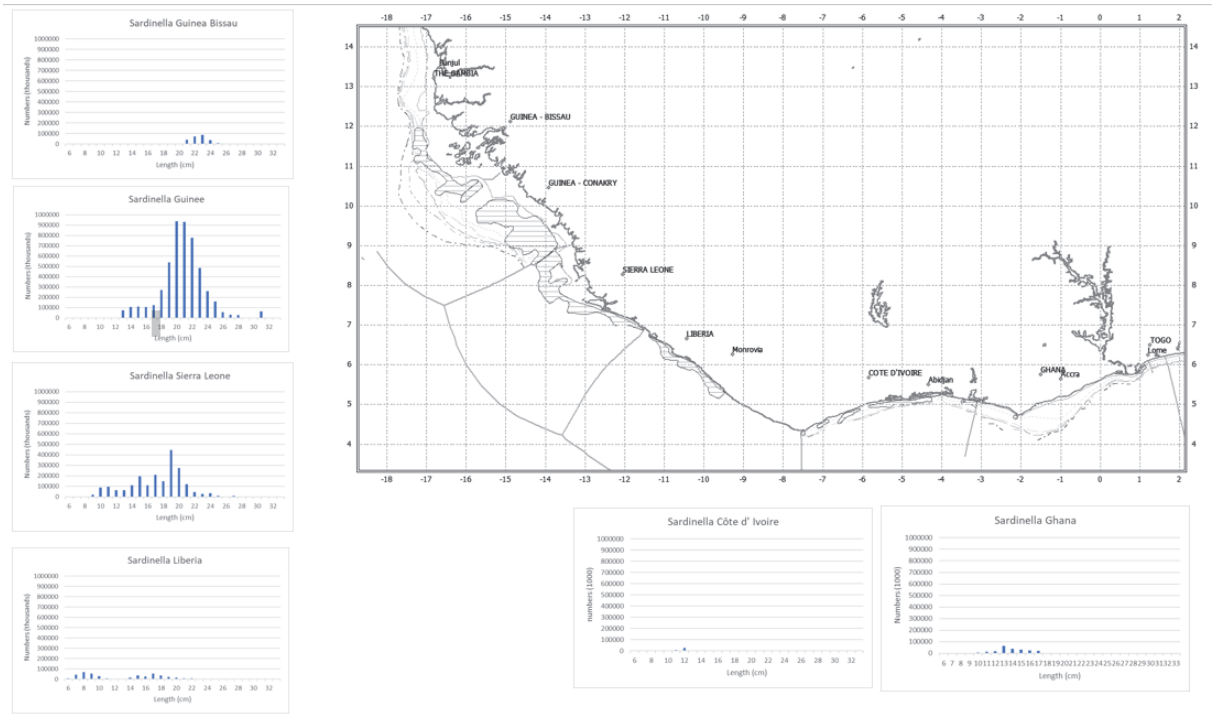

Figure 41. Distribution and length-frequency of sardinella, Legs 2.1 and 2.2.

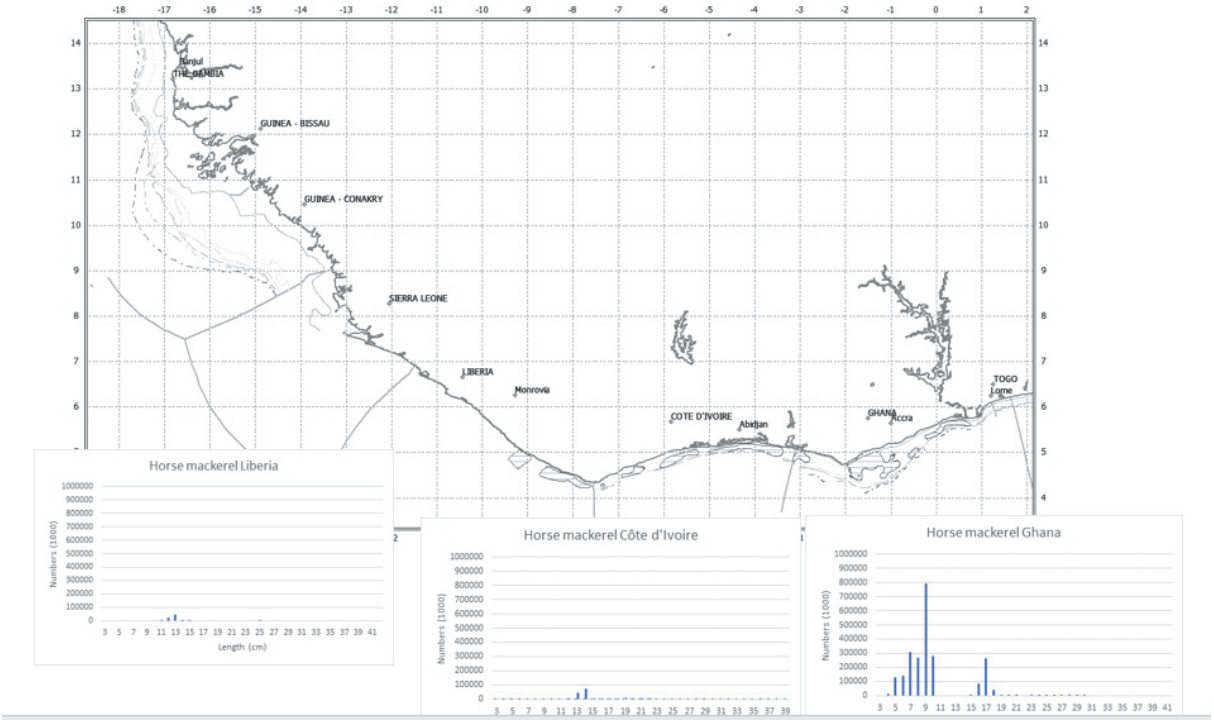

Figure 42. Distribution and length-frequency for horse mackerel, Legs 2.1 and 2.2.

The total biomass of small pelagic fish in Legs 2.1 and 2.2 is estimated at 915 562 tonnes (Table 13). The biomass of pelagic fish is largely dominated by sardinella (66% of the total biomass) followed by other pelagic II fish with 14%. Sardinella is mainly located in the area of Guinea Bissau to Sierra Leone.

Table 13. Biomass estimates (tonnes).

Period survey	**Country**	**Sardinellas**	**Horse mackerel**	***Illisha africana***	***Decapterus* sp.**	***Scomber colias***	***Anchovy***	**Other Pelagic II fish**	***Total***
21/07 – 20/08/17	Guinea Bissau	32 401	/	/	3 957	10 000	/	19 159	65 517
21/07 – 20/08/17	Guinea	436 287	/	/	33 710	4 585	/	66 573	541 155
21/07 – 20/08/17	Sierra Leone	115 285	/	9 352	6 150	/	/	22 646	153 433
21/07 – 20/08/17	Liberia	16 434	2 552	5 179	59	1 909	/	3 174	29 307
22/08 – 13/09/17	Côte d'Ivoire	750	5 150	/	/	/	610	10 700	17 210
22/08 – 13/09/17	Ghana	4 000	29 400	/	/	/	73 140	2 400	108 940
	Totals	**605 157**	**37 102**	**14 531**	**43 876**	**16 494**	**73 750**	**124 652**	**915 562**

Many samples and much data remains to be analysed; the results of which will be disseminated in separate reports. Catch and biological data on demersal fish species were collected in both bottom and deep pelagic trawls. These data are not presented in this report but are available on the NANSIS database.

The hydrographic data suggested a well stratified system with no signs of active upwelling; such stability is expected at this time of year. Long-term SST data from coastal monitoring stations in Liberia suggest that the conditions found during the survey may be within the expected range (https://www.seatemperature.org/africa/liberia/monrovia.htm). However, a lack of comparable previous data from the open ocean and other countries in the region means that no conclusions can be made.

Phytoplankton was concentrated around at the bottom of the mixed layer, forming much higher densities than in the mixed layer above.

While the microplastics samplings remain to be analysed, a visual inspection indicated that the highest densities of microplastics, and certainly marine debris, were recorded around population centres and fishing grounds.

Large rafts of sargassum weed were found throughout and appears to represent a dramatic increase in recent years warrants investigation.

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ANNEX I. DESCRIPTION OF INSTRUMENTS AND FISHING GEAR

Acoustic instruments

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

Transceiver 2 menu (38 kHz)	
Transducer depth	5.8 m
Absorption coeff.	8.3 dB/km
Pulse duration	Medium (1,024 ms)
Bandwidth	2.43 kHz
Max power	2000 Watt
2-way beam angle	20,6 dB
Gain	26,95 dB
$_{S}$A correction	0.03 dB
Angle sensitivity	21.9
3 dB beamwidth	6.22º alongship
	6.28° athwartship
Alongship offset	0.10º
Athwartship 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, new in 2017) and one 'Gisund super bottom trawl'. All trawls were used during the survey. The smallest pelagic trawl has 8 to 12 m vertical opening under normal operation, whereas the MultPelt 624 trawl has 25 to 35 m opening.

The bottom trawl has a 31-m headline and a 47-m footrope fitted with a 12" rubber bobbins gear. The codend has 20 mm meshes, and has an inner net with 10 mm mesh size. The vertical opening is about 5.5 m. The distance between the wing tips is about 18 m during towing. The sweeps are 40 m long. The trawl doors are 'Thyborøen' combi, 8 m^2 and weigh 2000 kg. The door spreading is about 45 m when using restraining rope. Trawling was conducted for species identification only and no restraining rope was therefore used during the survey.

The SCANMAR system was used during all trawl hauls. This equipment consists of sensors, a hydrophone, a receiver, a display unit and a battery charger. Communication between sensors and ship is based on acoustic transmission. The doors are fitted with sensors to

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

All trawls are equipped with a trawl eye that provides information about the trawl opening and the distance of the footrope to the bottom. A pressure sensor is used to show the depth on the headline.

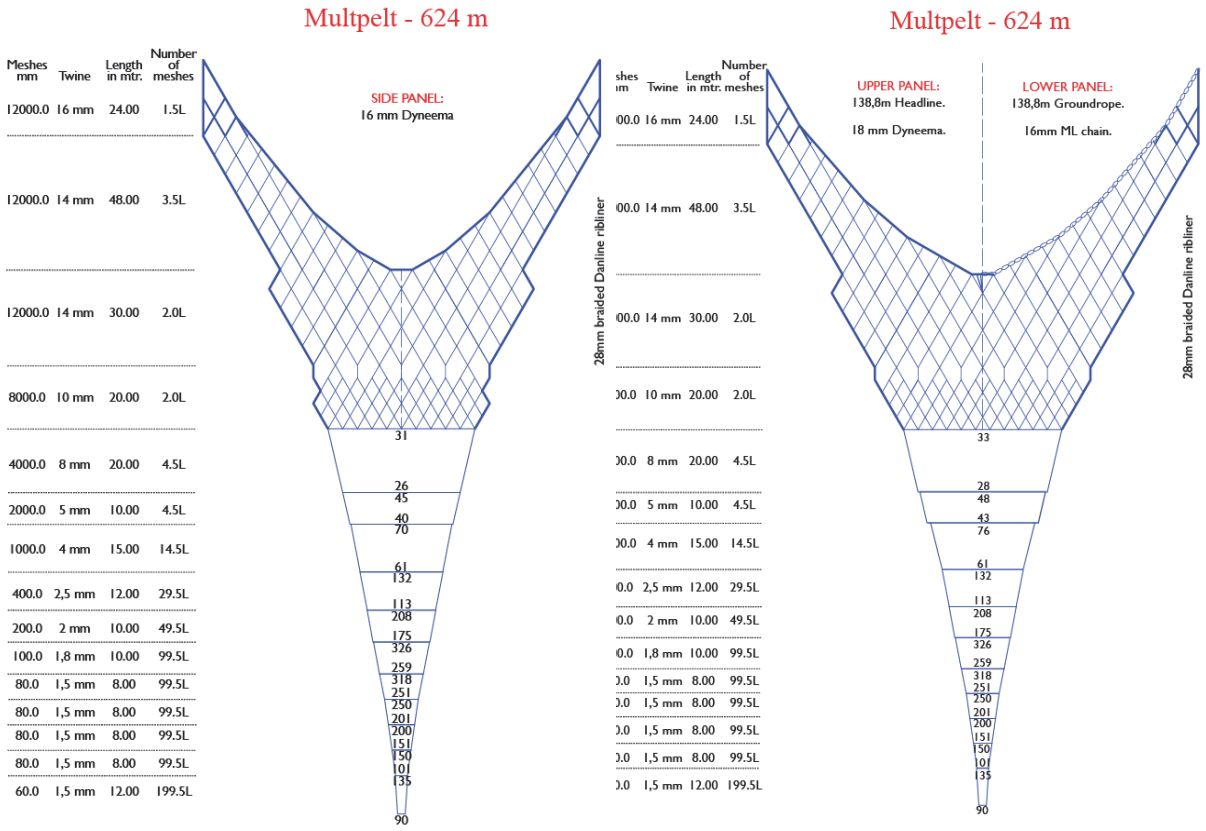


Figure 1. Schematic drawing of the MultPelt 624.

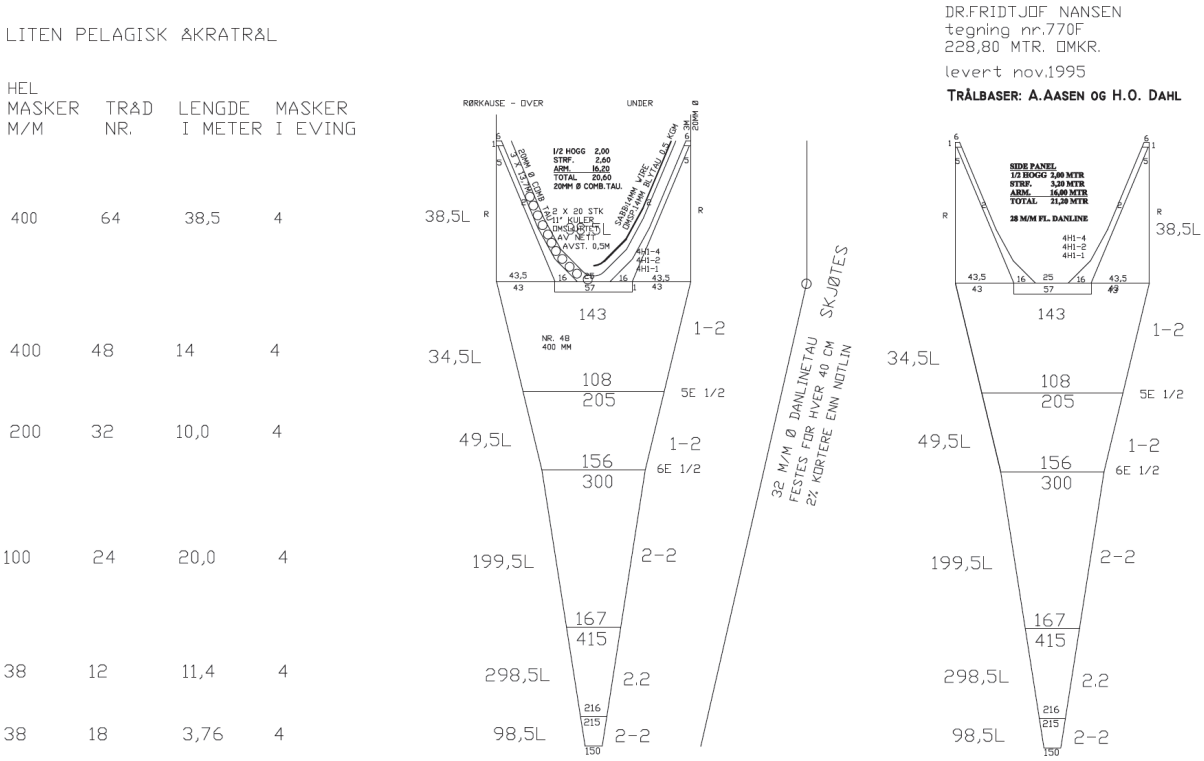


Figure 2. Schematic drawing of the small pelagic Åkratrawl.

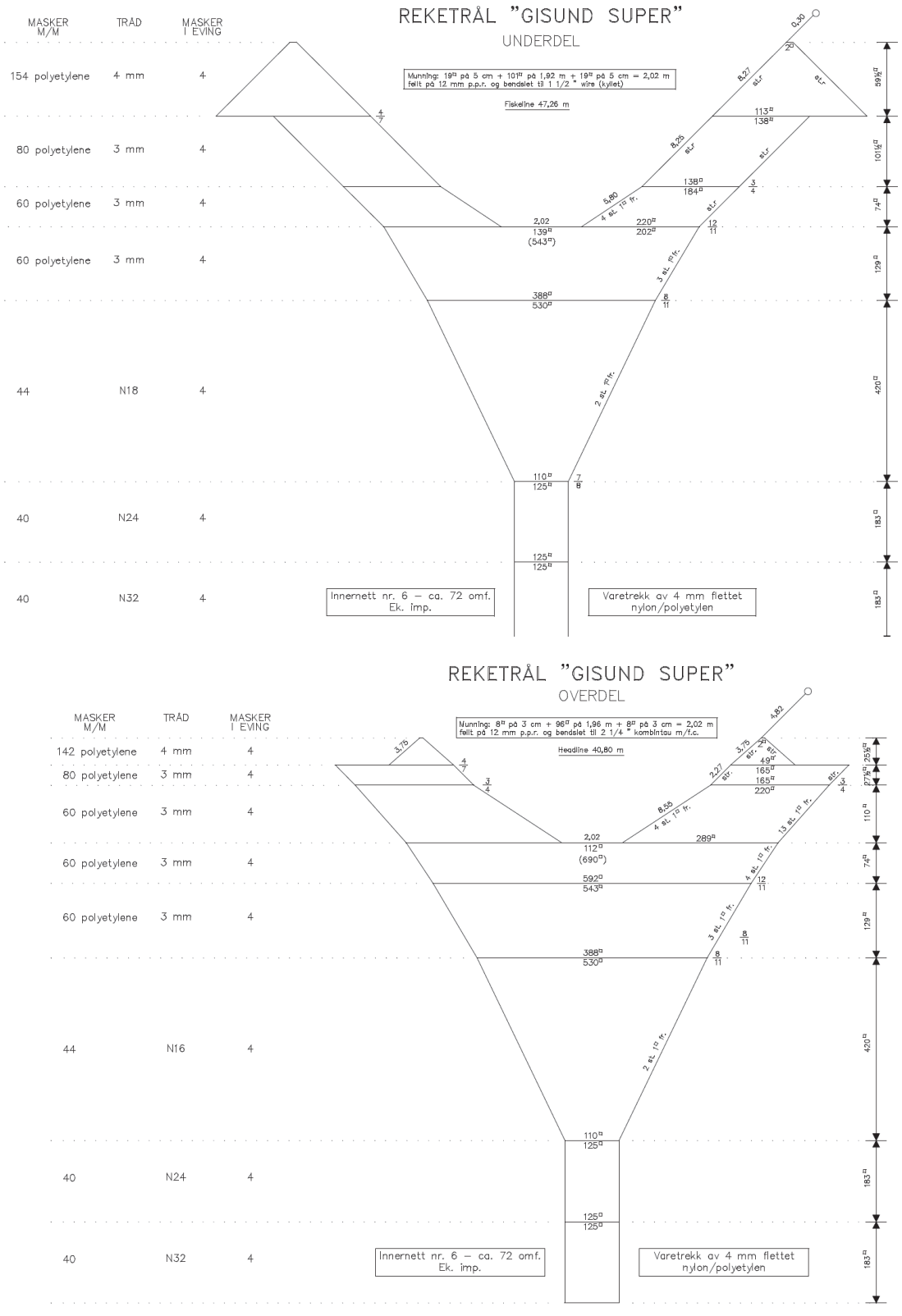


Figure 3. Schematic drawing of the Super Gisund bottom trawl.

ANNEX II. RECORDS OF FISHING STATIONS

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 1
DATE :25/08/17 GEAR TYPE: BT NO: 2 POSITION:Lat N 4°15.55
start stop duration Lon W 7°31.07
TIME :11:48:43 12:09:15 20.5 (min) Purpose : 1
LOG : 6770.40 6771.57 1.2 Region : 2500
FDEPTH: 48 49 Gear cond.: 0
BDEPTH: 48 49 Validity : 0
Towing dir: 0° Wire out : 145 m Speed : 3.4 kn
Sorted : 0 Total catch: 64.03 Catch/hour: 187.14

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Jellyfish	157.23	6552	84.02	
Cymbium sp.	14.85	15	7.93	
Brachydeuterus auritus	3.33	278	1.78	
Raja miraletus	2.34	3	1.25	
Illex coindetii	2.10	421	1.12	
Selene dorsalis	1.81	6	0.97	
Penaeus notialis	1.75	170	0.94	
Coral	1.17	0	0.62	
Trachurus trecae	0.82	430	0.44	1
Alloteuthis africana	0.47	152	0.25	
Solitas gruveli	0.29	12	0.16	
Sea anemone sp	0.29	85	0.16	
Schedophilus pemarco	0.20	9	0.11	
Lesueurigobius sp.	0.12	23	0.06	
Syacium micrurum	0.06	3	0.03	
Serranus accraensis	0.06	3	0.03	
Octopus sp.	0.06	3	0.03	
Scyllarides sp.	0.05	9	0.02	
Sepia officinalis	0.03	6	0.02	
Scorpaena laevis	0.02	32	0.01	
Sphoeroides marmoratus	0.02	6	0.01	
Squilla mantis	0.02	3	0.01	
Plastic	0.01	12	0.01	
Trichiurus lepturus	0.01	15	0.01	
Saurida brasiliensis	0.01	3	0.01	
Sea urchins (waek spines)	0.01	3	0.01	
Total	187.14		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 2
DATE :25/08/17 GEAR TYPE: BT NO: 2 POSITION:Lat N 4°17.04
start stop duration Lon W 7°21.74
TIME :15:42:59 15:57:12 14.2 (min) Purpose : 1
LOG : 6801.30 6802.07 0.8 Region : 2500
FDEPTH: 72 73 Gear cond.: 0
BDEPTH: 72 73 Validity : 0
Towing dir: 0° Wire out : 200 m Speed : 3.2 kn
Sorted : 0 Total catch: 43.55 Catch/hour: 183.76

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Jellyfish	148.10	2312	80.60	
Octopus vulgaris	15.36	8	8.36	
Illex coindetii	6.24	1000	3.40	
Dentex angolensis	5.32	312	2.89	2
Priacanthus arenatus	1.86	21	1.01	
Trachurus trecae	1.18	46	0.64	3
Uranoscopus cadenati	1.10	8	0.60	
Citharus linguatula	0.93	17	0.51	
Trachurus trecae, juvenile	0.51	300	0.28	
Sepia officinalis	0.44	13	0.24	
Solitas gruveli	0.42	8	0.23	
Boops boops	0.42	13	0.23	
Fistularia petimba	0.34	4	0.18	
Trichiurus lepturus	0.25	4	0.14	
Sphyraena sphyraena	0.25	13	0.14	
Lepidotrigla cadmani	0.22	4	0.12	
Pontinus accraensis	0.18	4	0.10	
Sea anemone sp	0.15	59	0.08	
Penaeus notialis	0.09	8	0.05	
Todaropsis eblanae	0.09	8	0.05	
VENERIDAE	0.07	8	0.04	
Sphoeroides marmoratus	0.06	4	0.03	
Sea urchin	0.06	4	0.03	
Engraulis encrasicolus	0.04	4	0.02	
Lesueurigobius sp.	0.04	4	0.02	
Saurida brasiliensis	0.03	4	0.01	
Bristle worms	0.01	8	0.01	
Total	183.76		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 3
DATE :26/08/17 GEAR TYPE: PT NO: 1 POSITION:Lat N 4°30.69
start stop duration Lon W 7°0.98
TIME :05:36:30 05:56:16 19.8 (min) Purpose : 1
LOG : 6867.44 6868.53 1.1 Region : 2500
FDEPTH: 10 30 Gear cond.: 0
BDEPTH: 51 51 Validity : 0
Towing dir: 0° Wire out : 105 m Speed : 3.3 kn
Sorted : 0 Total catch: 6.99 Catch/hour: 21.22

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Selene dorsalis	10.68	36	50.34	5
J E L L Y F I S H	4.13	206	19.45	
Stromateus fiatola	2.73	3	12.84	
Sardinella maderensis	0.98	61	4.61	4
Saurida brasiliensis	0.91	316	4.30	
Brachydeuterus auritus	0.65	52	3.06	
Alloteuthis africana	0.49	182	2.33	
Sphyraena guachancho	0.32	6	1.50	
Trichiurus lepturus	0.24	100	1.13	
Apsilus fuscus	0.03	9	0.14	
Trachurus trecae	0.03	18	0.13	6
Todaropsis eblanae	0.02	3	0.09	
L O B S T E R S	0.01	15	0.03	
Waste General	0.00	3	0.01	
Sepia officinalis	0.00	3	0.01	
Squilla mantis	0.00	3	0.01	
Krill	0.00	9	0.01	
Total	21.22		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 4
DATE :26/08/17 GEAR TYPE: PT NO: 1 POSITION:Lat N 4°27.64
start stop duration Lon W 6°53.41
TIME :08:01:17 08:23:35 22.3 (min) Purpose : 1
LOG : 6884.87 6886.19 1.3 Region : 2500
FDEPTH: 30 35 Gear cond.: 0
BDEPTH: 89 78 Validity : 0
Towing dir: 0° Wire out : 130 m Speed : 3.5 kn
Sorted : 0 Total catch: 0.17 Catch/hour: 0.45

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Jellyfish	0.36	51	80.00	
Ommastrephes bartrami	0.05	8	11.34	
Octopus sp.	0.02	16	4.78	
Trichiurus lepturus	0.01	19	1.79	
Ostracion sp.	0.01	5	1.19	
L O B S T E R S	0.00	5	0.60	
Leptocephalus	0.00	3	0.30	
Total	0.45		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 5
DATE :26/08/17 GEAR TYPE: BT NO: 2 POSITION:Lat N 4°32.29
start stop duration Lon W 6°46.06
TIME :16:37:47 17:11:33 33.8 (min) Purpose : 1
LOG : 6918.66 6920.35 1.7 Region : 2500
FDEPTH: 74 70 Gear cond.: 0
BDEPTH: 74 70 Validity : 0
Towing dir: 0° Wire out : 200 m Speed : 3.0 kn
Sorted : 0 Total catch: 35.70 Catch/hour: 63.43

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Illex coindetii	29.21	2434	46.05	
Trachurus trecae	13.22	359	20.84	9
Octopus vulgaris	3.13	5	4.93	
Trichiurus lepturus	2.88	37	4.54	
Sarda sarda	2.27	2	3.59	
Sphyraena sphyraena	2.10	9	3.31	
Boops boops	1.53	62	2.41	
Selene dorsalis	1.28	7	2.02	
Branchiostegus semifasciatus	1.14	2	1.79	
Dentex angolensis	0.96	16	1.51	8
Priacanthus arenatus	0.89	2	1.40	
Brotula barbata	0.85	5	1.34	
G A S T R O P O D S	0.64	98	1.01	
Fistularia petimba	0.53	4	0.84	
Saurida brasiliensis	0.50	73	0.78	
Lesueurigobius sanzi	0.46	36	0.73	
Penaeus notialis	0.39	34	0.62	
Sepia officinalis	0.32	9	0.50	
Dicologoglossa cuneata	0.28	2	0.45	
Citharus linguatula	0.25	5	0.39	
Chelidonichthys gabonensis	0.21	2	0.34	
Sardinella aurita	0.18	7	0.28	7
Solitas gruveli	0.11	4	0.17	
Sphoeroides marmoratus	0.02	2	0.03	
Scomber colias	0.01	2	0.02	
Ariomma melanum	0.01	2	0.02	
Serranus accraensis	0.01	2	0.01	
Total	63.38		99.92	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 6
DATE :27/08/17 GEAR TYPE: PT NO: 1 POSITION:Lat N 4°35.11
start stop duration Lon W 6°13.02
TIME :05:21:12 05:30:03 8.8 (min) Purpose : 1
LOG : 7004.44 7004.90 0.5 Region : 2500
FDEPTH: 40 60 Gear cond.: 0
BDEPTH: 56 44 Validity : 0
Towing dir: 0° Wire out : 200 m Speed : 3.1 kn
Sorted : 0 Total catch: 19.21 Catch/hour: 130.26

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Shrimps unidentified	120.00	372000	92.13	
Trichiurus lepturus	3.53	14	2.71	
Myctophidae sp. large	3.17	936	2.44	
Illex coindetii	2.03	461	1.56	
Stomias sp.	0.54	7	0.42	
Myctophidae sp. small/mix	0.33	305	0.25	
Diaphus sp.	0.21	258	0.16	
Leptocephalus	0.14	68	0.10	
Jellyfish	0.08	7	0.06	
Triplophos sp.	0.06	292	0.04	
TRICHIURIDAE	0.03	27	0.02	
LINOPHRYNIDAE	0.02	7	0.02	
Maurolicus sp.	0.02	81	0.02	
Lagocephalus sp.	0.02	7	0.02	
Selene dorsalis	0.01	7	0.01	
OMMASTREPHIDAE	0.01	7	0.01	
CARANGIDAE	0.01	27	0.01	
Sphoeroides sp.	0.01	7	0.01	
Unidentified fish	0.01	7	0.01	
Bothidae - juvenile	0.01	27	0.01	
Paralepis sp.	0.01	7	0.01	
Stomias boa boa	0.01	7	0.01	
Total	130.26		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 7
DATE :27/08/17 GEAR TYPE: PT NO: 1 POSITION:Lat N 4°41.19
start stop duration Lon W 6°5.31
TIME :07:14:08 07:44:55 30.8 (min) Purpose : 1
LOG : 7018.84 7020.52 1.7 Region : 2500
FDEPTH: 30 35 Gear cond.: 0
BDEPTH: 81 91 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.3 kn
Sorted : 0 Total catch: 1.50 Catch/hour: 2.92

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Shrimps unidentified	2.07	4591	70.81	
Ommastrephes bartrami	0.57	12	19.37	
Jellyfish	0.17	2	5.74	
Unidentified invertebrate	0.13	33	4.34	
L O B S T E R S	0.05	936	1.60	
Illex coindetii	0.04	2	1.27	
Leptocephalus	0.00	4	0.10	
TRIGLIDAE	0.00	6	0.10	
LINOPHRYNIDAE	0.00	2	0.07	
OSTRACIIDAE	0.00	4	0.07	
Unidentified crustacean	0.00	2	0.07	
Krill	0.00	14	0.03	
Selene dorsalis, juvenile	0.00	4	0.03	
Total	3.02		103.61	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 8
DATE :27/08/17 GEAR TYPE: PT NO: 4 POSITION:Lat N 4°51.97
start stop duration Lon W 5°58.43
TIME :10:55:36 11:10:49 15.2 (min) Purpose : 1
LOG : 7046.81 7047.64 0.8 Region : 2500
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 39 41 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 3.3 kn
Sorted : 0 Total catch: 17.63 Catch/hour: 69.50

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Jellyfish	38.87	1021	55.93	
Stromateus fiatola	27.91	43	40.16	
Echeneis naucrates	2.55	8	3.66	
Sepiella ornata	0.08	32	0.12	

Ommastrephes bartrami	0.04	8	0.06
Selene dorsalis	0.01	4	0.02
OMMASTREPHIDAE	0.01	4	0.01
Trachurus trecae, juvenile	0.01	4	0.01
Alectis alexandrinus	0.01	16	0.01
Chaetodon sp.	0.00	4	0.01
OSTRACIIDAE	0.00	8	0.01
Total	69.50		100.00

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 9
DATE :27/08/17 GEAR TYPE: BT NO: 2 POSITION:Lat N 4°51.94
start stop duration Lon W 5°57.66
TIME :11:38:34 11:59:14 20.7 (min) Purpose : 1
LOG : 7049.06 7050.11 1.0 Region : 2500
FDEPTH: 40 38 Gear cond.: 0
BDEPTH: 40 38 Validity : 0
Towing dir: 0° Wire out : 110 m Speed : 3.0 kn
Sorted : 0 Total catch: 31.23 Catch/hour: 90.65

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Trachurus trecae	38.75	20343	42.75	10
Jellyfish	33.56	0	37.02	
Illex coindetii	9.73	1843	10.73	
Sphyraena sphyraena	4.06	15	4.48	
Echeneis naucrates	2.22	6	2.45	
Brachydeuterus auritus	0.98	177	1.08	13
Schedophilus pemarco	0.61	15	0.67	
Scomber colias	0.27	41	0.30	11
Engraulis encrasicolus	0.25	110	0.27	12
Solitas gruveli	0.22	6	0.24	
Total	90.65		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 10
DATE :27/08/17 GEAR TYPE: PT NO: 4 POSITION:Lat N 4°55.89
start stop duration Lon W 5°49.24
TIME :20:24:50 20:38:01 13.2 (min) Purpose : 1
LOG : 7091.14 7091.84 0.7 Region : 2500
FDEPTH: 5 5 Gear cond.: 0
BDEPTH: 39 39 Validity : 0
Towing dir: 0° Wire out : 110 m Speed : 3.2 kn
Sorted : 0 Total catch: 13.99 Catch/hour: 63.68

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Jellyfish	32.41	901	50.90	
Sphyraena guachancho	19.30	127	30.31	
Stromateus fiatola	3.00	5	4.71	
Brachydeuterus auritus	2.09	127	3.29	15
Illex coindetii	1.61	241	2.52	
Trachurus trecae, juvenile	1.55	1106	2.43	
Echeneis naucrates	1.31	5	2.06	
Trachurus trecae	0.73	9	1.14	17
Saurida brasiliensis	0.57	373	0.89	
Sardinella maderensis	0.36	23	0.57	16
Uranoscopus sp., juvenile	0.30	18	0.46	
Engraulis encrasicolus	0.22	77	0.35	14
Sepiella ornata	0.15	5	0.24	
Trichiurus lepturus	0.04	5	0.06	
Scomber colias	0.01	5	0.02	18
Selene dorsalis	0.01	5	0.02	
Alectis alexandrinus, juvenile	0.00	14	0.01	
PALINURIDAE	0.00	5	0.00	
Total	63.68		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 11
DATE :28/08/17 GEAR TYPE: PT NO: 1 POSITION:Lat N 4°54.31
start stop duration Lon W 5°28.01
TIME :03:03:40 03:21:48 18.1 (min) Purpose : 1
LOG : 7139.71 7140.69 1.0 Region : 2500
FDEPTH: 5 15 Gear cond.: 0
BDEPTH: 83 84 Validity : 0
Towing dir: 0° Wire out : 85 m Speed : 3.3 kn
Sorted : 0 Total catch: 3.96 Catch/hour: 13.10

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Jellyfish	4.83	387	36.89	
Rachycentron canadum	3.97	17	30.32	
Saurida brasiliensis	3.03	93	23.17	
Sepiella ornata	0.49	53	3.76	
TRICHIURIDAE	0.40	903	3.07	
Illex coindetii	0.17	13	1.29	
Trachurus trecae	0.10	113	0.75	
Ariomma melanum	0.06	30	0.49	
Apsilus fuscus	0.01	3	0.10	
Alloteuthis africana	0.01	3	0.06	
CARANGIDAE	0.00	3	0.04	
TETRAODONTIDAE	0.00	3	0.03	
CHAETODONTIDAE	0.00	3	0.03	
Total	13.10		99.99	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 12
DATE :28/08/17 GEAR TYPE: BT NO: 2 POSITION:Lat N 5°0.71
start stop duration Lon W 5°9.69
TIME :11:04:42 11:28:10 23.5 (min) Purpose : 1
LOG : 7190.52 7191.85 1.3 Region : 2500
FDEPTH: 50 50 Gear cond.: 0
BDEPTH: 50 50 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.4 kn
Sorted : 0 Total catch: 122.61 Catch/hour: 313.44

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
JELLYFISH	239.39	368	76.37	
Trichiurus lepturus	42.39	6642	13.52	
Trachurus trecae	9.77	135	3.12	19
Mustelus mustelus	6.54	5	2.09	
Jellyfish	5.22	153	1.66	
Lagocephalus laevigatus	1.98	5	0.63	
Illex coindetii	1.61	6274	0.52	
Boops boops	1.41	13	0.45	
Alloteuthis africana	1.28	654	0.41	
Sepiella ornata	0.70	41	0.22	
Schedophilus pemarco	0.61	5	0.19	
Brachydeuterus auritus	0.53	18	0.17	
Chelidonichthys gabonensis	0.33	3	0.11	
Lesueurigobius sanzi	0.16	23	0.05	
Citharus linguatula	0.15	5	0.05	
Selene dorsalis	0.13	5	0.04	
Trachurus trecae, juvenile	0.09	69	0.03	
Sea cucumber (bread like)	0.05	3	0.02	
Zeus faber, juvenile	0.04	5	0.01	
SCYLLARIDAE	0.01	3	0.00	
Sicyonia carinata	0.00	3	0.00	
Total	312.37		99.66	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 13
DATE :28/08/17 GEAR TYPE: BT NO: 2 POSITION:Lat N 5°4.35
start stop duration Lon W 5°7.41
TIME :12:57:15 13:21:29 24.2 (min) Purpose : 1
LOG : 7202.25 7203.52 1.3 Region : 2500
FDEPTH: 31 31 Gear cond.: 0
BDEPTH: 31 31 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 3.1 kn
Sorted : 0 Total catch: 1187.28 Catch/hour: 2940.01

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
JELLYFISH	2666.15	10460	90.68	
Ilisha africana	112.22	8117	3.82	20
Trichiurus lepturus	51.21	1090	1.74	
Synagrops microlepis	47.94	1716	1.63	
Selene dorsalis	35.41	1553	1.20	
Schedophilus pemarco	14.93	354	0.51	
Pseudotolithus typus	4.75	7	0.16	
Cynoponticus ferox	2.53	7	0.09	
Sphyraena guachancho	1.88	7	0.06	
Portunus validus	1.02	27	0.03	
Pisodonophis semicinctus	0.50	2	0.02	
Penaeus sp.	0.46	82	0.02	
Trachurus trecae, juvenile	0.35	409	0.01	
Antennarius pardalis	0.25	27	0.01	
Scyllarus sp.	0.18	27	0.01	
Alectis alexandrinus	0.16	82	0.01	
Ommastrephes sp.	0.07	27	0.00	
Total	2940.01		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 14
DATE :29/08/17 GEAR TYPE: BT NO: 2 POSITION:Lat N 5°8.50
start stop duration Lon W 4°11.50
TIME :12:56:33 13:10:31 14.0 (min) Purpose : 1
LOG : 7329.94 7330.69 0.8 Region : 2500
FDEPTH: 78 78 Gear cond.: 0
BDEPTH: 78 78 Validity : 0
Towing dir: 0° Wire out : 210 m Speed : 3.2 kn
Sorted : 0 Total catch: 25.66 Catch/hour: 110.22

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Trachurus trecae	47.50	1774	43.10	21
Dentex angolensis	14.52	99	13.17	22
Jellyfish	12.88	0	11.69	
Scorpaena scrofa	8.16	17	7.40	
Brotula barbata	7.30	9	6.62	
Pagellus bellottii	4.38	52	3.97	23
Priacanthus arenatus	2.27	21	2.06	
Trichiurus lepturus	2.01	202	1.82	
Zeus faber	1.74	4	1.58	
Raja miraletus	1.61	4	1.46	
Uranoscopus cadenati	1.37	4	1.25	
Boops boops	1.32	21	1.20	
Pseudupeneus prayensis	1.08	9	0.98	
Ariomma melanum	0.92	17	0.84	
Alloteuthis africana	0.70	137	0.64	
Fistularia petimba	0.58	4	0.52	
Illex coindetii	0.49	17	0.44	
Solitas gruveli	0.30	4	0.27	
Saurida brasiliensis	0.29	69	0.26	
Citharus linguatula	0.26	4	0.24	
Ariomma melanum, juvenile	0.22	43	0.20	
Sepia officinalis	0.12	4	0.11	
G A S T R O P O D S	0.09	4	0.08	
Dead shells	0.04	21	0.04	
DORIPPIDAE	0.03	9	0.02	
Selene dorsalis, juvenile	0.02	4	0.02	
ECHINOMETRIDAE	0.01	4	0.01	
INACHIDAE	0.01	4	0.01	
Total	110.22		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 15
DATE :29/08/17 GEAR TYPE: BT NO: 2 POSITION:Lat N 5°8.09
start stop duration Lon W 3°44.17
TIME :23:13:10 23:35:41 22.5 (min) Purpose : 1
LOG : 7384.18 7385.27 1.1 Region : 2500
FDEPTH: 32 39 Gear cond.: 0
BDEPTH: 32 39 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 2.9 kn
Sorted : 0 Total catch: 143.42 Catch/hour: 382.11

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Brachydeuterus auritus	261.63	10063	68.47	
Trachurus trecae	67.78	1873	17.74	24
Jellyfish	16.84	0	4.41	
Pagellus bellottii	7.46	112	1.95	0
Penaeus notialis	4.32	11	1.13	
Syacium micrurum	3.90	85	1.02	
VOLUTIDAE	2.86	11	0.75	
Sepia officinalis	2.57	16	0.67	
Trachinocephalus myops	2.50	11	0.66	
Pseudupeneus prayensis	2.22	21	0.58	
Pisodonophis semicinctus	1.39	5	0.36	
Ommastrephes sp.	1.28	59	0.33	
SCYLLARIDAE	0.91	85	0.24	
Perulibatrachus elminensis	0.85	5	0.22	
Boops boops	0.84	21	0.22	
Pteroscion peli	0.74	16	0.19	
Sphyraena guachancho	0.59	5	0.15	
Trichiurus lepturus	0.52	53	0.14	
Rypticus saponaceus	0.46	5	0.12	
Priacanthus arenatus	0.39	5	0.10	
Monochirus hispidus	0.37	5	0.10	
Portunus validus	0.31	32	0.08	
Penaeus sp.	0.26	27	0.07	
Zeus faber	0.20	21	0.05	
Paraconger notialis	0.17	5	0.04	
Galeoides decadactylus	0.16	5	0.04	
Squilla mantis	0.15	133	0.04	
Arnoglossus imperialis	0.12	16	0.03	
Pteroscion peli, juvenile	0.06	16	0.02	
Bothus podas	0.06	5	0.02	
Plastic	0.05	5	0.01	
Chelidonichthys gabonensis	0.05	21	0.01	
Sicyonia carinata	0.05	32	0.01	
Pseudupeneus prayensis, juvenile	0.05	21	0.01	
Pagellus bellottii	0.04	64	0.01	
Bregmaceros sp.	0.02	11	0.01	
Saurida brasiliensis	0.02	5	0.00	
Brotula barbata, juvenile	0.02	3	0.00	
Dactylopterus volitans	0.02	5	0.00	
Solitas gruveli	0.01	5	0.00	
Leptocephalus	0.01	5	0.00	
Callinectes pallidus	0.01	21	0.00	
Selene dorsalis, juvenile	0.01	16	0.00	
Total	382.24		100.03	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 16
DATE :30/08/17 GEAR TYPE: PT NO: 4 POSITION:Lat N 5°2.52
start stop duration Lon W 3°35.80
TIME :01:52:42 02:13:31 20.8 (min) Purpose : 1
LOG : 7401.25 7402.31 1.1 Region : 2500
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 68 60 Validity : 0

Towing dir: 0° Wire out : 140 m Speed : 3.0 kn
Sorted : 0 Total catch: 7.62 Catch/hour: 21.95

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Saurida brasiliensis	10.84	3870	49.38	
Trichiurus lepturus	2.81	159	12.82	
Jellyfish	2.43	0	11.06	
Brachydeuterus auritus	2.19	72	9.97	
Lagocephalus laevigatus	2.04	3	9.30	
Illex coindetii	0.78	86	3.53	
Sepiella ornata	0.73	14	3.31	
Ariomma melanum	0.06	9	0.28	
Ariomma melanum, juvenile	0.03	52	0.12	
Chelidonichthys sp.	0.02	3	0.08	
Lagocephalus laevigatus, juvenile	0.01	3	0.07	
Trachurus trecae, juvenile	0.01	6	0.05	
Selene dorsalis	0.01	3	0.03	
Penaeus notialis	0.01	3	0.03	
Total	21.95		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 17
DATE :30/08/17 GEAR TYPE: PT NO: 1 POSITION:Lat N 5°2.09
start stop duration Lon W 3°26.66
TIME :06:22:06 06:41:58 19.9 (min) Purpose : 1
LOG : 7435.95 7437.08 1.1 Region : 2500
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 63 57 Validity : 0
Towing dir: 0° Wire out : 140 m Speed : 3.4 kn
Sorted : 0 Total catch: 2.79 Catch/hour: 8.42

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sepiella ornata	3.08	163	36.54	
Saurida brasiliensis	1.39	450	16.46	
C R U S T A C E A N S	0.97	14540	11.51	
Trachinotus ovatus	0.78	3	9.25	
Trachurus trecae, juvenile	0.74	1842	8.75	
Alloteuthis africana	0.47	106	5.63	
Schedophilus pemarco	0.46	3	5.49	
CARANGIDAE, juvenile	0.15	217	1.79	
Brachydeuterus auritus	0.14	6	1.72	
JELLYFISH	0.06	3	0.72	
Leptocephalus	0.05	1933	0.57	
Ariomma melanum	0.02	21	0.29	
Krill	0.01	12	0.14	
Lagocephalus laevigatus	0.01	3	0.14	
INACHIDAE	0.01	3	0.14	
Scomberomorus tritor, juvenile	0.01	12	0.14	
FISH LARVAE	0.01	48	0.14	
BOTHIDAE	0.01	27	0.11	
Selene dorsalis	0.01	3	0.11	
SALPS	0.01	21	0.07	
Chelidonichthys sp., juvenile	0.01	18	0.07	
Uranoscopus sp., juvenile	0.00	3	0.04	
CHAETODONTIDAE	0.00	3	0.04	
OSTRACIIDAE	0.00	3	0.04	
Sphyraena sp., juvenile	0.00	3	0.04	
Bregmaceros sp.	0.00	3	0.04	
PORTUNIDAE	0.00	3	0.04	
Total	8.42		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 18
DATE :30/08/17 GEAR TYPE: PT NO: 4 POSITION:Lat N 4°55.31
start stop duration Lon W 2°50.76
TIME :22:11:56 22:37:31 25.6 (min) Purpose : 1
LOG : 7551.73 7553.13 1.4 Region : 2600
FDEPTH: 5 5 Gear cond.: 0
BDEPTH: 50 45 Validity : 0
Towing dir: 0° Wire out : 130 m Speed : 3.3 kn
Sorted : 0 Total catch: 9.93 Catch/hour: 23.29

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Saurida brasiliensis	12.38	2655	53.17	
Dactylopterus volitans	6.19	138	26.58	
Lagocephalus laevigatus	1.31	12	5.64	
Jellyfish	0.89	80	3.83	
Trachurus trecae, juvenile	0.52	774	2.22	
C R U S T A C E A N S	0.45	638	1.91	
Ommastrephes bartrami	0.42	21	1.81	
Alloteuthis africana	0.38	84	1.61	
Sepiella ornata	0.33	9	1.41	
Scomber colias	0.23	12	1.01	26
CARANGIDAE	0.07	113	0.31	
Trachurus trecae	0.05	14	0.20	25
Ariomma melanum	0.03	21	0.13	
Leptocephalus	0.03	45	0.12	
Trichiurus lepturus	0.01	2	0.04	
PENAEIDAE	0.00	2	0.01	
Total	23.29		99.99	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 19
DATE :31/08/17 GEAR TYPE: PT NO: 1 POSITION:Lat N 4°32.74
start stop duration Lon W 2°22.53
TIME :15:58:30 16:27:38 29.0 (min) Purpose : 1
LOG : 7645.93 7647.57 1.6 Region : 2600
FDEPTH: 120 130 Gear cond.: 0
BDEPTH: 183 206 Validity : 0
Towing dir: 0° Wire out : 370 m Speed : 3.5 kn
Sorted : 0 Total catch: 56.23 Catch/hour: 116.35

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Zenion hololepis	103.84	19529	89.25	
Xenolepidichthys dagleishi	11.67	1252	10.03	
Antigonia capros	0.84	6	0.72	
Total	116.35		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 20
DATE :31/08/17 GEAR TYPE: PT NO: 1 POSITION:Lat N 4°39.28
start stop duration Lon W 2°9.26
TIME :20:51:33 21:30:21 38.8 (min) Purpose : 1
LOG : 7684.46 7686.64 2.2 Region : 2600
FDEPTH: 20 25 Gear cond.: 0
BDEPTH: 57 55 Validity : 0
Towing dir: 0° Wire out : 95 m Speed : 3.4 kn
Sorted : 0 Total catch: 44.65 Catch/hour: 69.05

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
J E L L Y F I S H	63.59	196	92.09	
Saurida brasiliensis	2.47	619	3.58	
Trichiurus lepturus	1.19	84	1.72	27
Sphyraena sphyraena	0.62	2	0.90	
Dactylopterus volitans	0.36	6	0.52	
Illex coindetii	0.26	11	0.38	
Sepiella ornata	0.23	9	0.33	
Trachurus trecae, juvenile	0.07	155	0.10	
Brachydeuterus auritus	0.07	19	0.10	
Alloteuthis africana	0.06	15	0.09	
Bregmaceros sp.	0.04	74	0.06	
Selene dorsalis, juvenile	0.03	8	0.05	
OMMASTREPHIDAE	0.03	2	0.04	
C R U S T A C E A N S	0.01	12	0.01	
Uranoscopus sp.	0.00	2	0.00	0
SALPS	0.00	2	0.00	
Leptocephalus	0.00	3	0.00	
Solenocera africana	0.00	2	0.00	
Uranoscopus sp.	0.00	2	0.00	
Stromateus fiatola, juvenile	0.00	2	0.00	
Total	69.05		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 21
DATE :01/09/17 GEAR TYPE: PT NO: 1 POSITION:Lat N 4°13.40
start stop duration Lon W 2°10.62
TIME :01:21:38 01:55:00 33.4 (min) Purpose : 1
LOG : 7717.57 7719.32 1.8 Region : 2600
FDEPTH: 30 5 Gear cond.: 0
BDEPTH: 1291 1408 Validity : 0
Towing dir: 0° Wire out : 125 m Speed : 3.1 kn
Sorted : 0 Total catch: 35.70 Catch/hour: 64.19

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Cubiceps sp.	36.86	1230	57.42	
JELLYFISH	17.55	0	27.34	
Ariomma melanum	2.34	113	3.64	
Myctophidae sp. large	1.80	228	2.80	
Schedophilus sp.	1.16	31	1.80	
Myctophidae sp. small/mix	1.06	530	1.65	
Trachipterus trachypterus, juvenile	0.76	27	1.19	
Brama brama	0.47	4	0.73	
Diaphus sp.	0.39	25	0.61	
Nesiarchus nasutus	0.27	20	0.42	
VITRELEDONELLIDAE	0.26	18	0.40	
C E P H A L O P O D A	0.25	45	0.39	
C R U S T A C E A N S	0.20	0	0.31	
Myctophid sp. A	0.17	65	0.27	
Trichiurus lepturus	0.12	56	0.18	
Selene dorsalis	0.12	65	0.18	28
Leptocephalus	0.11	81	0.17	
Illex coindetii	0.09	56	0.14	
NOTOSUDIDAE	0.08	4	0.12	
Myctophidae sp. slender	0.05	22	0.08	
GONOSTOMATIDAE	0.02	20	0.04	
Bothidae - juvenile	0.01	36	0.02	
Saurida brasiliensis	0.01	14	0.02	
Synagrops microlepis	0.01	11	0.01	
Black Paralepididae**	0.01	2	0.01	
Nemichthys scolopaceus	0.01	5	0.01	
INACHIDAE	0.01	2	0.01	
UNIDENTIFIED FISH	0.01	25	0.01	
CHAETODONTIDAE	0.00	2	0.01	
Bregmaceros sp.	0.00	2	0.01	
Trachurus trecae	0.00	2	0.00	
OSTRACIIDAE	0.00	2	0.00	
SCORPAENIDAE, juvenile	0.00	2	0.00	
Lobster larvae	0.00	2	0.00	
Antigonia sp., juvenile	0.00	2	0.00	
Total	64.19		100.01	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 22
DATE :01/09/17 GEAR TYPE: PT NO: 1 POSITION:Lat N 3°47.20
start stop duration Lon W 2°4.87
TIME :05:27:40 05:54:16 26.6 (min) Purpose : 1
LOG : 7746.56 7747.84 1.3 Region : 2600
FDEPTH: 250 40 Gear cond.: 0
BDEPTH: 4709 4729 Validity : 0
Towing dir: 0° Wire out : 550 m Speed : 2.9 kn
Sorted : 0 Total catch: 1.68 Catch/hour: 3.80

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Yarrella sp.	0.54	5	14.10	
S H R I M P S	0.39	341	10.27	
C R U S T A C E A N S	0.26	70	6.83	
OMMASTREPHIDAE	0.25	142	6.53	
Myctophidae sp. large	0.23	38	6.11	
Cubiceps sp.	0.23	9	6.11	
SALPS	0.18	88	4.69	
Nealotus tripes	0.16	18	4.16	
Myctophid sp. A	0.12	74	3.15	
Histioteuthis sp.	0.12	2	3.06	
MYCTOPHIDAE	0.11	43	2.79	
Yarrella blackfordi	0.11	14	2.79	
MACROURIDAE	0.10	5	2.61	
Myctophid sp. B	0.10	77	2.61	
Octopus sp.	0.09	9	2.37	
Gonostoma elongatum	0.08	16	2.20	
Maurolicus sp.	0.07	133	1.78	
Ommastrephes sp.	0.06	9	1.66	
Leptocephalus	0.06	56	1.66	
Melanostomias sp.	0.05	2	1.37	
Argyropelecus aculeatus	0.05	43	1.22	
TRICHIURIDAE	0.05	41	1.19	
Melanocetus johnsoni	0.04	5	1.16	
Illex sp.	0.04	2	1.13	
Myctophidae sp . silver	0.04	61	1.01	
Selene dorsalis, juvenile	0.03	23	0.86	
MELAMPHAIDAE	0.03	16	0.68	
GONOSTOMATIDAE	0.03	20	0.68	
Myctophidae sp. slender	0.02	29	0.65	
BOTHIDAE	0.02	56	0.62	
Nemichthys scolopaceus	0.02	16	0.59	
Aristostomias sp.	0.02	2	0.45	
Melanocetus sp.	0.02	2	0.45	
UNIDENTIFIED FISH	0.01	5	0.36	
Photonectes sp.	0.01	5	0.36	
Antigonia capros	0.01	2	0.30	
Hoplostethus sp.	0.01	9	0.21	
SYNODONTIDAE	0.01	2	0.18	
OPHIDIIDAE	0.01	2	0.15	
Myctophidae sp. small/mix	0.01	11	0.15	
Opisthoproctus grimaldii	0.00	2	0.12	
Stromateus fiatola, juvenile	0.00	2	0.12	
CARANGIDAE, juvenile	0.00	14	0.12	
Uranoscopus sp., juvenile	0.00	9	0.09	
Fish larvae, juvenile	0.00	5	0.09	
PARALEPIDIDAE	0.00	5	0.06	
TRIGLIDAE	0.00	9	0.06	
Zenion hololepis	0.00	2	0.03	
Triplophos hemingi, juvenile	0.00	2	0.03	
Bregmaceros sp.	0.00	2	0.03	
Ariomma melanum, juvenile	0.00	2	0.03	
Scorpaena sp.	0.00	2	0.03	
L O B S T E R S	0.00	2	0.01	
Total	3.80		100.04	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 23
DATE :01/09/17 GEAR TYPE: PT NO: 1 POSITION:Lat N 2°29.90
start stop duration Lon W 1°46.05
TIME :14:31:03 15:00:52 29.8 (min) Purpose : 1
LOG : 7827.36 7828.90 1.5 Region : 2600
FDEPTH: 360 280 Gear cond.: 0
BDEPTH: 5060 5058 Validity : 0

Towing dir: 0° Wire out : 850 m Speed : 3.1 kn
Sorted : 0 Total catch: 2.91 Catch/hour: 5.86

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Ommastrephes pteropus	1.96	2	33.53	
DIRETMIDAE	1.40	412	23.91	
SALPS	0.40	24	6.87	
Leptocephalus	0.40	85	6.84	
Idiacanthus sp.	0.33	2	5.60	
Myctophid sp. A	0.28	42	4.77	
Argyropelecus aculeatus	0.26	89	4.52	
Argyropelecus affinis	0.21	85	3.61	
Thysanoteuthis rhombus	0.20	2	3.47	
Chauliodus sp.	0.15	38	2.61	
Gonostoma denudatum	0.11	60	1.91	
OMMASTREPHIDAE	0.02	12	0.38	
Myctophid sp. B	0.02	8	0.34	
Myctophidae sp . silver	0.02	42	0.33	
Opisthoproctus grimaldii	0.01	2	0.15	
Selene dorsalis, juvenile	0.01	6	0.15	
Nealotus tripes	0.01	2	0.15	
Nemichthys scolopaceus	0.01	12	0.14	
Scopelarchoides sp.	0.01	2	0.14	
Maurolicus muelleri	0.01	8	0.14	
Shrimps, small, non comm.	0.01	12	0.14	
MICROSTOMATIDAE	0.00	2	0.07	
Saurida brasiliensis	0.00	2	0.07	
Shrimps unidentified	0.00	2	0.05	
C R U S T A C E A N S	0.00	4	0.03	
CHAETODONTIDAE	0.00	2	0.03	
BOTHIDAE	0.00	6	0.02	
L O B S T E R S	0.00	4	0.02	
TRICHIURIDAE	0.00	2	0.02	
Total	5.86		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 24
DATE :03/09/17 GEAR TYPE: PT NO: 1 POSITION:Lat N 4°36.29
start stop duration Lon W 1°54.77
TIME :06:45:45 07:02:45 17.0 (min) Purpose : 1
LOG : 7991.58 7992.49 0.9 Region : 2600
FDEPTH: 20 29 Gear cond.: 0
BDEPTH: 61 59 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 3.2 kn
Sorted : 0 Total catch: 2.63 Catch/hour: 9.30

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
JELLYFISH	5.08	4	54.67	
Trachurus trecae	2.82	2824	30.37	30
Schedophilus ovalis	0.49	7	5.24	
Schedophilus pemarco	0.39	18	4.21	
C R U S T A C E A N S	0.16	205	1.75	
SALPS	0.14	138	1.52	
Engraulis encrasicolus	0.12	21	1.29	29
Sepiella ornata	0.08	4	0.87	
PALINURIDAE	0.00	14	0.04	
Bothidae - juvenile	0.00	11	0.04	
Total	9.30		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 25
DATE :03/09/17 GEAR TYPE: PT NO: 1 POSITION:Lat N 4°36.60
start stop duration Lon W 1°55.10
TIME :08:16:36 08:25:53 9.3 (min) Purpose : 1
LOG : 7999.29 7999.81 0.5 Region : 2600
FDEPTH: 30 45 Gear cond.: 0
BDEPTH: 60 61 Validity : 0
Towing dir: 0° Wire out : 145 m Speed : 3.4 kn
Sorted : 37 Total catch: 370.28 Catch/hour: 2394.05

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	2343.10	390517	97.87	31
Engraulis encrasicolus	37.31	6336	1.56	33
Sardinella aurita	11.44	1552	0.48	32
Decapterus punctatus	2.20	129	0.09	
Total	2394.05		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 26
DATE :03/09/17 GEAR TYPE: PT NO: 1 POSITION:Lat N 4°27.51
start stop duration Lon E 1°52.70
TIME :10:09:00 10:32:00 23.0 (min) Purpose : 1
LOG : 7999.81 7999.81 0.0 Region : 2600
FDEPTH: 45 50 Gear cond.: 0
BDEPTH: 74 75 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.2 kn
Sorted : 0 Total catch: 0.20 Catch/hour: 0.52

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	0.34	55	64.84	34
SALPS	0.06	73	11.47	
PALINURIDAE	0.05	300	9.98	
Sphoeroides pachgaster	0.03	3	5.49	
C R U S T A C E A N S	0.02	183	3.49	
Apsilus fuscus, juvenile	0.01	3	2.49	
Schedophilus pemarco	0.01	3	1.50	
BOTHIDAE	0.00	5	0.25	
S H R I M P S	0.00	8	0.25	
Leptocephalus	0.00	3	0.25	
Total	0.52		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 27
DATE :03/09/17 GEAR TYPE: PT NO: 4 POSITION:Lat N 4°44.07
start stop duration Lon W 1°46.63
TIME :19:09:09 19:25:17 16.1 (min) Purpose : 1
LOG : 8080.00 8080.85 0.8 Region : 2600
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 40 40 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.2 kn
Sorted : 40 Total catch: 159.18 Catch/hour: 592.11

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
JELLYFISH	318.41	19908	53.78	
Engraulis encrasicolus	199.38	40694	33.67	36
Trachurus trecae	53.86	49875	9.10	37
Saurida brasiliensis	11.10	1488	1.87	
Apsilus fuscus	6.77	19	1.14	
Sepiella ornata	0.86	30	0.14	
Sardinella maderensis	0.65	30	0.11	35
Alloteuthis africana	0.35	119	0.06	
Schedophilus pemarco	0.31	45	0.05	
Selene dorsalis, juvenile	0.22	74	0.04	
APOGONIDAE	0.10	15	0.02	
SPHYRAENIDAE	0.05	15	0.01	
S H R I M P S	0.05	15	0.01	
Total	592.11		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 28
DATE :04/09/17 GEAR TYPE: PT NO: 4 POSITION:Lat N 4°28.43
start stop duration Lon W 1°21.24
TIME :04:51:05 05:11:18 20.2 (min) Purpose : 1
LOG : 8166.68 8167.69 1.0 Region : 2600
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 58 57 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.0 kn
Sorted : 0 Total catch: 0.79 Catch/hour: 2.35

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
JELLYFISH	1.24	12	52.75	
Sepia officinalis	0.37	6	15.94	
Dactylopterus volitans	0.36	12	15.31	
Jellyfish	0.24	12	10.25	
Sepiella ornata	0.09	3	3.67	
SALPS	0.02	42	1.01	
Saurida brasiliensis	0.01	3	0.63	
Selene dorsalis, juvenile	0.01	3	0.25	
FISH LARVAE	0.00	3	0.06	
CHAETODONTIDAE	0.00	3	0.06	
Lagocephalus laevigatus	0.00	3	0.06	
Total	2.35		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 29
DATE :04/09/17 GEAR TYPE: BT NO: 2 POSITION:Lat N 4°49.88
start stop duration Lon W 1°27.15
TIME :07:57:50 08:30:14 32.4 (min) Purpose : 1
LOG : 8190.31 8192.05 1.7 Region : 2600
FDEPTH: 38 38 Gear cond.: 0
BDEPTH: 38 38 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.2 kn
Sorted : 0 Total catch: 167.00 Catch/hour: 309.26

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Brachydeuterus auritus	260.56	3774	84.25	38
Trachurus trecae	39.07	972	12.63	39
J E L L Y F I S H	2.40	144	0.78	
Alloteuthis africana	1.23	509	0.40	
Priacanthus arenatus	1.01	6	0.33	
Pseudupeneus prayensis	0.97	6	0.31	
Balistes capriscus	0.90	4	0.29	
Sphyraena sphyraena	0.82	4	0.27	
Dentex canariensis	0.69	2	0.22	
Pagellus bellottii	0.48	9	0.16	
Calappa sp.	0.37	6	0.12	
Sepiella ornata	0.33	6	0.11	
Trachinocephalus myops	0.16	2	0.05	
Sepia officinalis	0.13	6	0.04	
Fistularia petimba	0.07	2	0.02	
Saurida brasiliensis	0.05	6	0.01	
Trachurus trecae, juvenile	0.03	15	0.01	
Selene dorsalis, juvenile	0.01	6	0.00	
PORTUNIDAE	0.01	6	0.00	
Total	309.30		100.01	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 30
DATE :04/09/17 GEAR TYPE: PT NO: 1 POSITION:Lat N 4°37.71
start stop duration Lon W 1°12.66
TIME :14:04:59 14:20:07 15.1 (min) Purpose : 1
LOG : 8237.31 8238.04 0.7 Region : 2600
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 51 51 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 2.9 kn
Sorted : 1 Total catch: 1.07 Catch/hour: 4.26

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
JELLYFISH	1.92	87	45.02	
Jellyfish	1.24	2062	29.05	
Ommastrephes bartrami	0.95	289	22.30	
Sepiella ornata	0.10	4	2.23	
Alloteuthis africana	0.02	4	0.42	
Unidentified fish	0.01	4	0.19	
Selene dorsalis	0.01	4	0.19	
Zeus faber, juvenile	0.01	4	0.14	
Bothidae - juvenile	0.01	4	0.14	
Sea cucumber	0.01	24	0.14	
Leptocephalus	0.00	8	0.09	
Fish larvae	0.00	8	0.05	
Unident. crustacean rems	0.00	4	0.05	
Total	4.26		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 31
DATE :04/09/17 GEAR TYPE: BT NO: 2 POSITION:Lat N 4°27.60
start stop duration Lon W 1°9.71
TIME :16:21:14 17:05:30 44.3 (min) Purpose : 1
LOG : 8250.01 8252.33 2.3 Region : 2600
FDEPTH: 64 64 Gear cond.: 0
BDEPTH: 64 64 Validity : 0
Towing dir: 0° Wire out : 170 m Speed : 3.1 kn
Sorted : 0 Total catch: 48.32 Catch/hour: 65.49

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Pagellus bellottii	16.75	629	25.58	40
Apsilus fuscus	15.99	62	24.42	
Trachurus trecae	12.55	270	19.16	41
Chromis cadenati	8.29	106	12.67	
Pseudupeneus prayensis	4.77	52	7.28	
Dentex canariensis	1.08	1	1.66	
Ariomma bondi	1.07	18	1.63	
Boops boops	0.78	14	1.19	
Lepidotrigla carolae	0.75	34	1.14	
Trachinocephalus myops	0.59	5	0.90	
Zeus faber	0.52	1	0.79	
Lutjanus fulgens	0.46	1	0.70	
Priacanthus arenatus	0.38	5	0.58	
Alloteuthis africana	0.27	76	0.41	
Lagocephalus laevigatus	0.22	3	0.33	
Dactylopterus volitans	0.14	7	0.21	
Illex coindetii	0.14	4	0.21	
Synodus saurus	0.11	1	0.17	
JELLYFISH	0.09	7	0.14	
Sepiella ornata	0.09	1	0.14	
Pagrus caeruleostictus	0.08	1	0.12	
Fistularia petimba	0.05	3	0.08	
Apsilus fuscus, juvenile	0.04	27	0.07	
Dead shells	0.03	0	0.04	
Microchirus boscanion	0.03	1	0.04	
SALPS	0.02	27	0.03	
Starfish	0.02	0	0.03	0
Saurida brasiliensis	0.01	1	0.01	
Starfish	0.01	1	0.01	
Total	65.33		99.75	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 32
DATE :05/09/17 GEAR TYPE: BT NO: 2 POSITION:Lat N 4°54.51
start stop duration Lon W 1°7.31
TIME :09:12:24 09:34:42 22.3 (min) Purpose : 1
LOG : 8311.33 8312.47 1.1 Region : 2600

FDEPTH: 36 36 Gear cond.: 0
BDEPTH: 36 36 Validity : 0
Towing dir: 0° Wire out : 110 m Speed : 3.1 kn
Sorted : 0 Total catch: 55.04 Catch/hour: 148.10

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Brachydeuterus auritus	65.00	1598	43.89	48
Jellyfish	49.13	108	33.17	
Scomberomorus tritor	9.20	3	6.21	
Sphyraena sphyraena	6.08	194	4.11	46
Pagellus bellottii	4.74	124	3.20	42
Alloteuthis africana	2.34	745	1.58	
Trichiurus lepturus	2.04	43	1.38	
Engraulis encrasicolus	1.85	2707	1.25	
Decapterus punctatus	1.63	16	1.10	45
Decapterus rhonchus**	1.43	5	0.96	44
Trachurus trecae	1.13	24	0.76	43
Lutjanus fulgens	0.78	3	0.53	
Uranoscopus albesca	0.71	3	0.48	
Pseudupeneus prayensis	0.61	5	0.41	
Trachurus trecae	0.43	277	0.29	49
Schedophilus pemarco	0.32	3	0.22	
Starfish	0.16	11	0.11	
Fistularia petimba	0.12	22	0.08	
Synodus saurus	0.10	3	0.07	
Sardinella aurita	0.07	3	0.05	47
Trachinus armatus	0.05	3	0.03	
Portunus hastatus	0.04	5	0.03	
Lepidotrigla carolae	0.03	3	0.02	
Dead shells	0.03	8	0.02	
Selene dorsalis	0.03	11	0.02	
Trigla lyra	0.03	3	0.02	
Waste General	0.01	3	0.01	
BOTHIDAE	0.01	3	0.01	
Sardinella aurita, juvenile	0.01	19	0.01	
Sphyraena sp., juvenile	0.00	3	0.00	
Chloroscombrus chrysurus	0.00	3	0.00	
Lagocephalus sp.	0.00	3	0.00	
Total	148.11		100.01	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 33
DATE :05/09/17 GEAR TYPE: BT NO: 2 POSITION:Lat N 4°56.88
start stop duration Lon W 0°56.10
TIME :13:32:59 13:38:19 5.3 (min) Purpose : 1
LOG : 8343.36 8343.67 0.3 Region : 2600
FDEPTH: 34 34 Gear cond.: 0
BDEPTH: 34 34 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 3.5 kn
Sorted : 42 Total catch: 670.08 Catch/hour: 7543.11

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Engraulis encrasicolus	5968.93	994942	79.13	50
Trachurus trecae	1217.56	228383	16.14	52
Decapterus punctatus	190.92	31880	2.53	53
Sardinella aurita	126.08	5944	1.67	51
Scomber colias	36.02	1801	0.48	55
Sphyraena guachancho	3.60	180	0.05	54
Total	7543.11		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 34
DATE :06/09/17 GEAR TYPE: PT NO: 7 POSITION:Lat N 5°9.13
start stop duration Lon W 0°40.21
TIME :08:01:37 08:06:19 4.7 (min) Purpose : 1
LOG : 8430.15 8430.46 0.3 Region : 2600
FDEPTH: 20 20 Gear cond.: 0
BDEPTH: 31 31 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 4.0 kn
Sorted : 39 Total catch: 156.73 Catch/hour: 2000.81

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Engraulis encrasicolus	1888.34	271098	94.38	
Sardinella aurita	94.76	8400	4.74	56
Scomber colias	8.50	511	0.42	58
Decapterus punctatus	5.64	689	0.28	57
JELLYFISH	3.86	166	0.19	
Total	2001.10		100.01	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 35
DATE :06/09/17 GEAR TYPE: BT NO: 2 POSITION:Lat N 4°51.60
start stop duration Lon W 0°33.51
TIME :11:27:17 11:57:07 29.8 (min) Purpose : 1
LOG : 8452.16 8453.77 1.6 Region : 2600
FDEPTH: 91 87 Gear cond.: 0
BDEPTH: 91 87 Validity : 0
Towing dir: 0° Wire out : 275 m Speed : 3.2 kn
Sorted : 0 Total catch: 79.27 Catch/hour: 159.44

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Ariomma melanum	30.73	1024	19.28	
Dentex congoensis, juvenile	30.33	1299	19.02	
Dentex angolensis	14.52	84	9.11	62
Branchiostegus semifasciatus	14.48	16	9.08	
Dentex angolensis, juvenile	14.32	354	8.98	
Trachurus trecae	12.91	78	8.10	59
Dentex canariensis	10.31	22	6.47	61
Raja miraletus	8.53	16	5.35	
Umbrina canariensis	7.20	18	4.52	
Squatina oculata	3.26	2	2.04	
Pagellus bellottii	2.74	80	1.72	
Dentex gibbosus	2.37	8	1.49	60
Pagrus caeruleostictus	1.93	8	1.21	
Zeus faber	1.69	6	1.06	
Dentex congoensis	1.45	16	0.91	
Boops boops	0.97	16	0.61	64
Lepidotrigla cadmani	0.64	8	0.40	
Illex coindetii	0.48	24	0.30	
Pseudupeneus prayensis	0.40	2	0.25	63
Saurida brasiliensis	0.16	80	0.10	
Total	159.44		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 36
DATE :06/09/17 GEAR TYPE: PT NO: 1 POSITION:Lat N 5°13.60
start stop duration Lon W 0°31.69
TIME :17:12:27 17:19:41 7.2 (min) Purpose : 1
LOG : 8489.78 8490.25 0.5 Region : 2600
FDEPTH: 15 20 Gear cond.: 0
BDEPTH: 32 33 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 3.9 kn
Sorted : 39 Total catch: 395.13 Catch/hour: 3279.12

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Engraulis encrasicolus	1800.83	168631	54.92	67
Sardinella aurita	1286.31	55436	39.23	69
Scomber colias	167.14	4315	5.10	68
Decapterus punctatus	13.69	996	0.42	66
Jellyfish	5.23	166	0.16	
JELLYFISH	3.47	8	0.11	
Sardinella maderensis	0.88	8	0.03	65
Sardinella rouxi	0.83	8	0.03	
Selene dorsalis, juvenile	0.75	166	0.02	
Total	3279.12		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 37
DATE :08/09/17 GEAR TYPE: PT NO: 7 POSITION:Lat N 5°39.80
start stop duration Lon E 0°14.13
TIME :20:58:21 21:04:38 6.3 (min) Purpose : 1
LOG : 8638.83 8639.20 0.4 Region : 2600
FDEPTH: 20 20 Gear cond.: 0
BDEPTH: 33 33 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 3.6 kn
Sorted : 42 Total catch: 86.73 Catch/hour: 828.60

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Engraulis encrasicolus	717.46	336315	86.59	70
Trachurus trecae	38.86	15755	4.69	72
JELLYFISH	22.19	487	2.68	
Pagellus bellottii	17.39	354	2.10	
Sphyraena guachancho	12.42	29	1.50	
Aluterus monoceros	8.41	10	1.01	
Lagocephalus laevigatus	6.50	19	0.78	
Saurida brasiliensis	4.16	898	0.50	
Pagellus bellottii, juvenile	2.78	2427	0.34	
Alloteuthis africana	2.77	898	0.33	
Pomadasys incisus	1.91	19	0.23	
Fistularia petimba	1.15	76	0.14	
Pseudupeneus prayensis	1.15	10	0.14	
Decapterus punctatus	1.15	86	0.14	71
Sardinella maderensis	0.96	96	0.12	73
Lutjanus fulgens	0.76	10	0.09	
Lepidotrigla carolae	0.75	67	0.09	
Sphyraena guachancho	0.57	76	0.07	74
Brachydeuterus auritus	0.55	67	0.07	
Priacanthus arenatus	0.41	67	0.05	
Myripristis jacobus	0.40	10	0.05	
Penaeus notialis	0.34	210	0.04	
Dicologoglossa hexophthalma	0.30	10	0.04	
Sepiella ornata	0.28	67	0.03	
APOGONIDAE	0.19	38	0.02	
Dactylopterus volitans	0.07	10	0.01	
Total	843.87		101.84	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 38
DATE :09/09/17 GEAR TYPE: BT NO: 2 POSITION:Lat N 5°49.09
start stop duration Lon E 1°1.63
TIME :17:37:06 18:11:11 34.1 (min) Purpose : 1
LOG : 8743.98 8745.83 1.9 Region : 2600
FDEPTH: 39 37 Gear cond.: 0
BDEPTH: 39 37 Validity : 0
Towing dir: 0° Wire out : 115 m Speed : 3.3 kn
Sorted : 0 Total catch: 72.53 Catch/hour: 127.69

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Engraulis encrasicolus	70.75	19475	55.40	75
Selene dorsalis	24.51	69	19.19	79
Pagrus caeruleostictus	6.69	53	5.24	
Alectis alexandrinus	4.75	2	3.72	
Sphyraena guachancho	4.23	7	3.31	78
Chloroscombrus chrysurus	4.15	26	3.25	77
Scomberomorus tritor	2.25	2	1.76	
Trichiurus lepturus	2.05	4	1.61	
Sardinella maderensis	1.85	312	1.44	76
Balistes capriscus	1.48	4	1.16	
Sepia officinalis	1.04	2	0.82	
Pagellus bellottii	0.82	12	0.64	
Lycondontis afer**	0.51	2	0.40	
Chilomycterus spinosus mauretanicus	0.51	2	0.40	
Diodon holocanthus	0.45	2	0.35	
Priacanthus arenatus	0.35	2	0.28	
Alloteuthis africana	0.32	79	0.25	
Galeoides decadactylus	0.29	2	0.22	
Sea urchin	0.19	14	0.15	
Epinephelus aeneus	0.18	2	0.14	
Parapenaeopsis atlantica	0.18	11	0.14	
Syacium micrurum	0.05	2	0.04	
G A S T R O P O D S	0.03	7	0.02	
Plastic	0.02	4	0.02	
Selene dorsalis, juvenile	0.02	7	0.02	
Saurida brasiliensis	0.02	14	0.01	
Total	127.69		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 39
DATE :10/09/17 GEAR TYPE: PT NO: 1 POSITION:Lat N 5°23.40
start stop duration Lon E 0°35.55
TIME :13:14:29 13:49:23 34.9 (min) Purpose : 1
LOG : 8837.81 8839.05 1.2 Region : 2600
FDEPTH: 350 250 Gear cond.: 0
BDEPTH: 1851 1982 Validity : 0
Towing dir: 0° Wire out : 850 m Speed : 0.0 kn
Sorted : 0 Total catch: 1.48 Catch/hour: 2.54

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
SALPS	0.60	5	23.71	
Jelly	0.51	3	19.99	0
Polyipnus sp.	0.35	24	13.89	
Jellyfish	0.30	69	11.65	
Argyropelecus affinis	0.20	57	7.86	
Argyropelecus aculeatus	0.18	53	7.18	
Taractes sp.	0.12	2	4.88	
Leptocephalus	0.07	14	2.78	
Chauliodus sp.	0.04	17	1.69	
Vitredonella sp.	0.02	2	0.95	
Gonostoma denudatum	0.02	9	0.75	
Electrona risso	0.02	5	0.68	
SEPIOLIDAE	0.02	3	0.64	
Jelly	0.01	3	0.44	
Diaphus hudsoni	0.01	3	0.41	
Myctophidae sp. slender	0.01	7	0.40	
Setarches guentheri	0.01	2	0.30	
SALPS, juvenile	0.01	9	0.27	
CRANCHIIDAE	0.01	2	0.24	
CARANGIDAE	0.01	21	0.20	
Zenion sp.	0.00	2	0.17	
Bathophilus sp.	0.00	2	0.17	
Antigonia capros	0.00	2	0.14	
S H R I M P S	0.00	14	0.14	
L O B S T E R S, juvenile	0.00	5	0.14	
OMMASTREPHIDAE	0.00	2	0.13	
PHOSICHTHYIDAE	0.00	2	0.05	
BOTHIDAE	0.00	3	0.04	
STYLEPHORIDAE	0.00	2	0.03	
Myctophid sp. A	0.00	2	0.03	
Triplophos hemingi, juvenile	0.00	2	0.03	
UNIDENTIFIED FISH	0.00	2	0.02	
Total	2.54		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2017406 STATION: 40

DATE :10/09/17 GEAR TYPE: PT NO: 1 POSITION:Lat N 5°3.20
start stop duration Lon E 0°36.33
TIME :22:50:04 23:20:56 30.9 (min) Purpose : 1
LOG : 8860.46 8862.13 1.7 Region : 2600
FDEPTH: 50 0 Gear cond.: 0
BDEPTH: 3049 2928 Validity : 0
Towing dir: 0° Wire out : 60 m Speed : 3.2 kn
Sorted : 0 Total catch: 8.90 Catch/hour: 17.30

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Cubiceps pauciradiatus	6.38	237	36.86	
Cubiceps baxteri	2.80	8	16.18	
Myctophid sp. A	1.89	993	10.92	
Brama brama	1.01	6	5.87	
Leptocephalus	0.86	286	4.94	
Not found	0.78	381	4.51	
Not found	0.65	758	3.78	
JELLYFISH	0.47	4	2.70	
Nealotus tripes	0.39	35	2.25	
Cubiceps sp.	0.27	68	1.57	
Maurolicus sp.	0.19	194	1.12	
JELLYFISH	0.16	52	0.90	0
Diaphus hudsoni	0.16	78	0.90	
Not found	0.13	29	0.74	
S H R I M P S	0.12	117	0.67	
Myctophid sp. B	0.10	41	0.57	
OMMASTREPHIDAE	0.08	49	0.45	
EUPHASIDAE *	0.08	330	0.45	
Lestrolepis intermedia	0.08	21	0.45	
Not found	0.06	111	0.34	
Selene dorsalis	0.06	25	0.33	
CENTROLOPHIDAE	0.05	2	0.31	
Not found	0.05	58	0.31	
Not found	0.05	8	0.29	
Illex coindetii, juvenile	0.04	4	0.22	
Triplophos hemingi, juvenile	0.04	97	0.22	
C R U S T A C E A N S	0.04	1555	0.22	
Illex coindetii	0.04	2	0.22	
SALPS	0.04	47	0.22	
Not found	0.03	52	0.18	
Not found	0.03	12	0.18	
Not found	0.03	16	0.16	
Ariomma melanum	0.03	4	0.15	
Trichiurus lepturus, juvenile	0.03	27	0.15	
BOTHIDAE	0.03	76	0.15	
Chauliodus sloani	0.02	8	0.12	
Not found	0.02	12	0.10	
Not found	0.01	6	0.06	
Not found	0.01	17	0.04	
Gonostoma denudatum	0.01	8	0.04	
SCYLLARIDAE	0.01	8	0.03	
Not found	0.00	6	0.02	
Not found	0.00	12	0.02	
Triplophos hemingi	0.00	6	0.02	
Acanthurus - juvenile	0.00	6	0.02	
Not found	0.00	4	0.01	
CHAUNACIDAE	0.00	4	0.00	
UNIDENTIFIED FISH	0.00	2	0.00	
Total	17.30		100.00	

ANNEX III. BIOLOGICAL SCALES AND STAGES

Gonad maturity staging

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

Stomach content staging

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

ANNEX IV. LIST OF BIOLOGICAL SAMPLES COLLECTED FOR FUTURE ANALYSIS (Copy of ROSCOP report)

SUMMARY OF MEASUREMENTS AND SAMPLES TAKEN

Except for the data already described on page 2 under 'Moorings, Bottom Mounted Gear and Drifting Systems', this section should include a summary of all data collected on the cruise, whether they be measurements (e.g. temperature, salinity values) or samples (e.g. cores, net hauls).

Separate entries should be made for each distinct and coherent set of measurements or samples. Different modes of data collection (e.g. vertical profiles as opposed to underway measurements) should be clearly distinguished, as should measurements/sampling techniques that imply distinctly different accuracy's or spatial/temporal resolutions. Thus, for example, separate entries would be created for i) BT drops, ii) water bottle stations, iii) CTD casts, iv) towed CTD, v) towed undulating CTD profiler, vi) surface water intake measurements, etc.

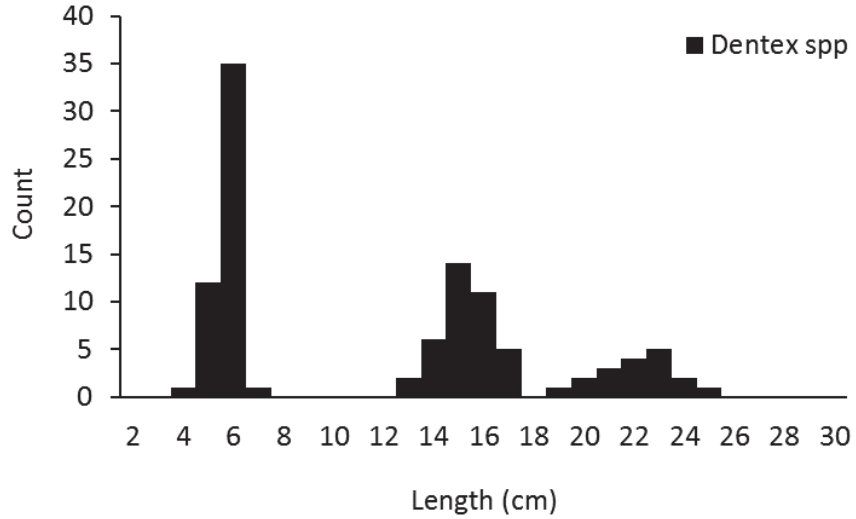
Each data set entry should start on a new line – it's description may extend over several lines if necessary.

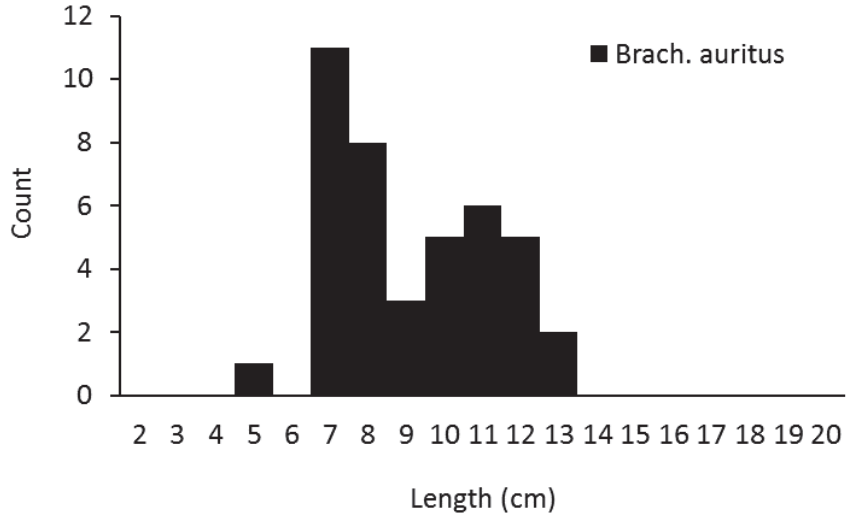
NO, UNITS : for each data set, enter the estimated amount of data collected expressed in terms of the number of 'stations'; miles' of track; 'days' of recording; 'cores' taken; net 'hauls'; balloon 'ascents'; or whatever unit is most appropriate to the data. The amount should be entered under 'NO' and the counting unit should be identified in plain text under 'UNITS'.

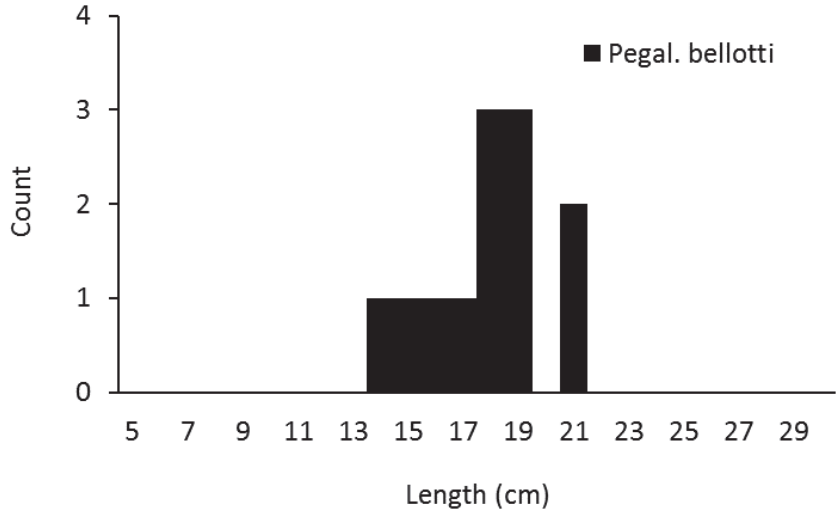
PI see page 2	NO see above	UNITS see above	DATA TYPE Enter code(s) from list on cover page	DESCRIPTION Identify, as appropriate, the nature of the data and of the instrumentation/sampling gear and list the parameters measured. Include any supplementary information that may be appropriate, e. g. vertical or horizontal profiles, depth horizons, continuous recording or discrete samples, etc. For samples taken for later analysis on shore, an indication should be given of the type of analysis planned, i.e. the purpose for which the samples were taken.
A	7	Stations	B14	Coté d'Ivoire - Bottom trawls targeting pelagic fish for identification
A	10	Stations	B14	Coté d'Ivoire -Pelagic trawls targeting pelagic fish for identification
A	712	Samples	B14	Coté d'Ivoire -samples of pelagic fish for length-frequency
A	158	Samples	B14	Coté d'Ivoire -samples of pelagic fish for sex, maturity and stomach fullness
A	223	Samples	B14	Coté d'Ivoire -samples of fish frozen for later analysis of liver, stomach contents and otoliths
A	92	Samples	B14	Coté d'Ivoire - fish otoliths for later age estimation
A	143	Samples	B14	Coté d'Ivoire -samples of fish fin-clips frozen for later genetic analysis
A	81	Samples	B14	Coté d'Ivoire og Ghana -mesopelagic fish samples frozen for identification by IMR
B	18	Samples	H90	Coté d'Ivoire – oxygen
B	96	Samples	H22	Coté d'Ivoire -phosphate samples from CTD rosette water sampler
B	96	Samples	H24	Coté d'Ivoire -nitrate samples from CTD rosette water sampler
B	96	Samples	H25	Coté d'Ivoire -nitrite samples from CTD rosette water sampler
B	96	Samples	H26	Coté d'Ivoire -silicate samples from CTD rosette water sampler
B	66	Samples	H27	Coté d'Ivoire -alkalinity samples from CTD rosette water sampler
B	66	Samples	H28	Coté d'Ivoire -pH samples from CTD rosette water sampler
B	19	Stations	H09	Coté d'Ivoire -water bottle stations using CTD rosette water sampler
B	80	Stations	H10	Coté d'Ivoire -CTD stations
B	18	Samples	H90	Coté d'Ivoire - salinity
C	12	Samples	B08	Coté d'Ivoire -phytoplankton samples in formalin from phytoplankton vertical net haul, for later analysis
C	24	Samples	B09	Coté d'Ivoire -zooplankton samples in formalin from WP2 vertical net haul, for later analysis
C	72	Samples	B09	Coté d'Ivoire -zooplankton samples dried from WP2 vertical net haul, for later analysis

C	12	Samples	B13	Coté d'Ivoire -Egg and Larvae samples in formalin from Multinet sampler hauled obliquely from 100 m, for later analysis
C	12	Samples	P01	Coté d'Ivoire -Samples of plastics freeze-dried from Manta trawl hauled at surface for 15 minutes, for later analysis
D	642	Samples	B14	Coté d'Ivoire -Samples of various fish freeze-dried from trawl, for later analysis for contaminants
E	6	Days	M06	Coté d'Ivoire -Wind direction and speed, air temperature, air pressure, relative humidity logged automatically every 60 sec. throughout survey
E	6	Days	H71	Coté d'Ivoire -underway thermosalinograph throughout survey measuring salinity, temperature, turbidity and chlorophyll-a
E	6	Days	D71	Coté d'Ivoire -Two hull-mounted Acoustic Doppler Current Profiler (VMADCP) run continuously during the survey
A	6	Stations	B14	Ghana-Bottom trawls targeting pelagic fish for identification
A	17	Stations	B14	Ghana -Pelagic trawls targeting pelagic and mesopelagic fish for identification
A	1676	Samples	B14	Ghana -samples of pelagic fish for length-frequency
A	308	Samples	B14	Ghana -samples of pelagic fish for sex, maturity and stomach fullness
A	249	Samples	B14	Ghana -samples of various fish species frozen for later analysis of liver, stomach contents and otolith removal
A	631	Samples	B14	Ghana -samples of various fish frozen for later morthophometric analysis
A	694	Samples	B14	Ghana -samples of fin-clips from various fish frozen for later genetic analysis
B	36	Samples	H90	Ghana – oxygen
B	280	Samples	H22	Ghana -phosphate samples from CTD rosette water sampler
B	280	Samples	H24	Ghana -nitrate samples from CTD rosette water sampler
B	280	Samples	H25	Ghana -nitrite samples from CTD rosette water sampler
B	280	Samples	H26	Ghana -silicate samples from CTD rosette water sampler
B	247	Samples	H27	Ghana -alkalinity samples from CTD rosette water sampler
B	247	Samples	H28	Ghana -pH samples from CTD rosette water sampler
B	41	Stations	H09	Ghana -water bottle stations using CTD rosette water sampler
B	84	Stations	H10	Ghana -CTD stations
B	36	Samples	H90	Ghana -salinity
C	17	Samples	B08	Ghana -phytoplankton samples in formalin from phytoplankton vertical net haul, for later analysis
C	42	Samples	B09	Ghana -zooplankton samples in formalin from WP2 vertical net haul, for later analysis
C	126	Samples	B09	Ghana -zooplankton samples dried from WP2 vertical net haul, for later analysis
C	17	Samples	B13	Ghana -Egg and Larvae samples in formalin from Multinet sampler hauled obliquely from 100 m, for later analysis
C	17	Samples	P01	Ghana -Samples of plastics dried from Manta trawl hauled at surface for 15 minutes, for later analysis
D	1541	Samples	B14	Ghana -Samples of various fish species freeze-dried from trawl, for later analysis for contaminants
E	12	Days	M06	Ghana -Wind direction and speed, air temperature, air pressure, relative humidity logged automatically every 60 sec. throughout survey
E	12	Days	H71	Ghana -underway thermosalinograph throughout survey measuring salinity, temperature, turbidity and chlorophyll-a
E	12	Days	D71	Ghana -Two—hull-mounted Acoustic Doppler Current Profiler (VMADCP) run continuously during the survey

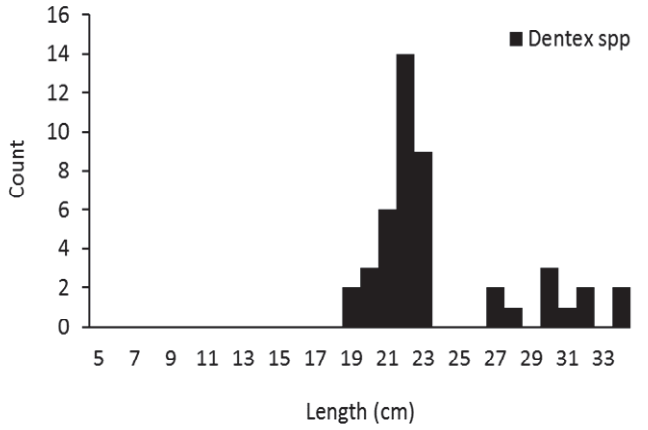
ANNEX V. LENGTH DISTRIBUTIONS - CÔTE D'IVOIRE

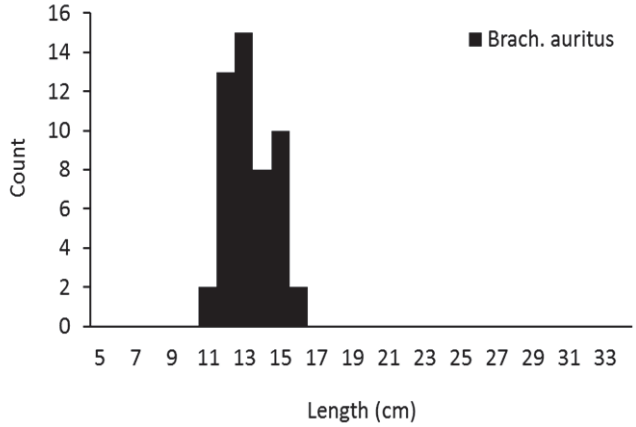


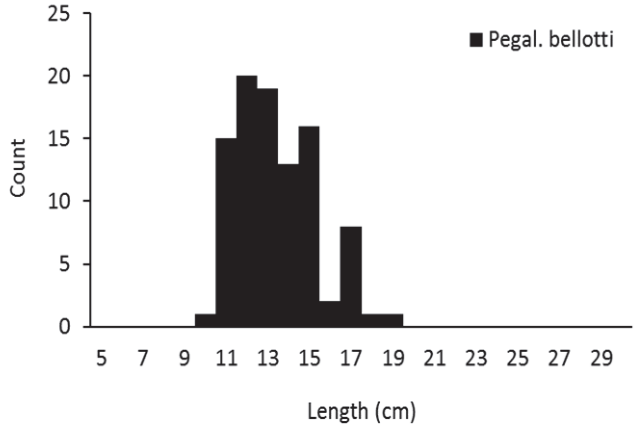


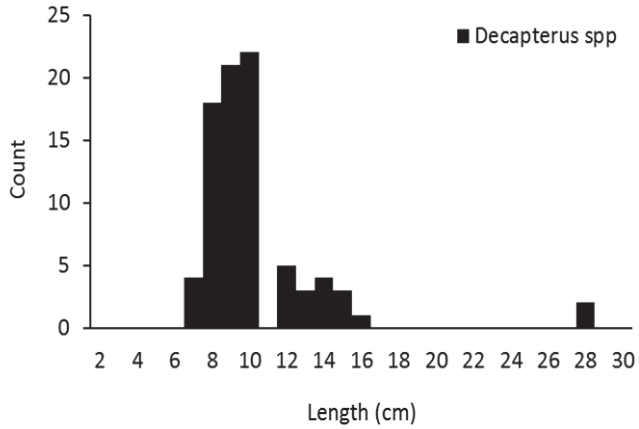


ANNEX VI. LENGTH DISTRIBUTIONS - GHANA









ANNEX VII. CATCH (KG/HOUR) AND PERCENTAGE CONTRIBUTION OF MAJOR ACOUSTIC CATEGORY SPECIES – CÔTE D'IVOIRE

	Sardinellas						Horse mackerels		
Nansis code	CLUSL01			CLUSL02			CARTR02		
Species name	Sardinella aurita			Sardinella maderensis			Trachurus trecae		
	Station	catch	%	Station	catch	%	Station	catch	%
	25	11,4	0,5	27	0,7	0,1	18	0,6	0,1
	32	0,1	0,1	36	0,9	0,0	20	0,1	0,1
	33	126,1	1,7	37	1,0	0,1	21	0,0	0,0
	34	94,8	4,7	38	1,9	1,4	24	2,8	30,4
	36	1286,3	39,2				25	2343,1	97,9
							26	0,3	64,8
							27	53,9	9,1
							29	39,1	12,6
							31	12,6	19,2
							32	1,6	0,8
							33	1217,6	16,1
							35	12,9	8,1
							37	38,9	4,7
min		0,1			0,7			0,0	
max		1286,3			1,9			2343,1	
n		5			4			13	
Average		303,7	9,2		1,1	0,4		286,4	20,3

ANNEX VIII. CATCH (KG/HOUR) AND PERCENTAGE CONTRIBUTION OF MAJOR ACOUSTIC CATEGORIES (SARDINELLAS, HORSE MACKERELS, PELAGIC I) – GHANA

	Sardinellas						Horse mackerels		
Nansis code	CLUSL01			CLUSL02			CARTR02		
Species name	Sardinella aurita			Sardinella maderensis			Trachurus trecae		
	Station	catch	%	Station	catch	%	Station	catch	%
	25	11,4	0,5	27	0,7	0,1	18	0,6	0,1
	32	0,1	0,1	36	0,9	0,0	20	0,1	0,1
	33	126,1	1,7	37	1,0	0,1	21	0,0	0,0
	34	94,8	4,7	38	1,9	1,4	24	2,8	30,4
	36	1286,3	39,2				25	2343,1	97,9
							26	0,3	64,8
							27	53,9	9,1
							29	39,1	12,6
							31	12,6	19,2
							32	1,6	0,8
							33	1217,6	16,1
							35	12,9	8,1
							37	38,9	4,7
min		0,1			0,7			0,0	
max		1286,3			1,9			2343,1	
n		5			4			13	
Average		303,7	9,2		1,1	0,4		286,4	20,3

	Pelagic I								
Nansis code	ENGEN01			SCMSC04			CARDE01		
Species name	Engraulis encrasicolus			Scomber colias			Decapterus punctatus		
	Station	catch	%	Station	catch		Station	catch	
	24	0,1	1,3	18	0,2	1,0	25	2,2	0,1
	25	37,3	1,6	33			32	1,6	1,1
	27	199,4	33,7	34	8,5	0,4	33	190,9	2,5
	32	1,9	1,3	36	167,1	5,1	34	5,6	0,3
	33	5968,9	79,1				36	13,7	0,4
	34	1888,3	94,4				37	1,1	0,8
	36	1800,8	54,9						
	37	717,5	86,6						
	38	70,8	55,4						
min		0,1			0,2			1,1	
max		5968,9			167,1			190,9	
n		9,0			3,0			6,0	
Average		1187,2	45,4		58,6	2,2		35,9	0,9

ANNEX IX. CRITICAL VALUES AND PARAMETERS USED TO ESTIMATE ABUNDANCE AND BIOMASS

a) Sardinellas

	Côte d'Ivoire	
Stratum	1	2
Mean s_A	14	3
Area (nm^2)	304	7
L-W factor a	0.0372	0.0372
L-W factor b	2.4	2.4
r^2	0.79	0.79
Number ('000)	47 242	179
Tonnes	750	2.9

	Ghana			
Stratum	1	2	3	4
Mean s_A	13	44	6	19
Area (nm^2)	18	567	111	70
L-W factor a	0.0078			
L-W factor b	3.053			
r^2	0.93			
Number ('000)	3 132	188 641	8 543	16 945
Tonnes	25	3 762	79	157

b) Horse mackerel

	Côte d'Ivoire				
Stratum	1	2	3	4	5
Mean s_A	15	173	4	385	690
Area (nm^2)	14	3	1 095	13	26
L-W factor a			0.0091		
L-W factor b			3.02		
r^2					
Number ('000)	919	2350	18 244	17 585	111 152
Tonnes	41	105	816	1 197	2 992

	Ghana								
Stratum	1	2	3	4	5	6	7	8	9
Mean s_A	7	64	4 952	848	1 823	1 453	1 329	82	9
Area (nm^2)	193	1295	4	8	2	2	3	91	357
L-W factor a	0.0082								
L-W factor b	3.076								
r^2	0.98								
Number ('000)	26 079	1 564 761	308 065	150 543	59 826	60 098	72 905	14 870	80 328
Tonnes	140	22 800	1947	698	278	371	473	2445	270

c) Pelagic I fish

	Côte d'Ivoire
Stratum	1
Mean s_A	2
Area (nm^2)	133
L-W factor a	0.0062
L-W factor b	3.0390
r^2	0.73
Number	615
Tonnes	18

d) Pelagic I fish

	Ghana							
Stratum	1	2	3	4	5	6	7	8
Mean s_A	207	862	510	380	470	705	1 223	1 046
Area (nm^2)	1 776	2	4	5	6	3	4	6
L-W factor a	0.0025							
L-W factor b	3.5							
r^2	0.95							
Number ('000)	3 721 744	34 415	348 000	29 352	29 598	22 753	49 206	64 140
Tonnes	50 037	182	184	155	348	2 668	579	755

	Ghana							All strata combined
Stratum	9	10	11	12	13	14	15	1 - 15
Mean s_A	7 603	596	377	1 236	966	178	442	308
Area (nm^2)	3	3	3	8	10	77	7	1 917
L-W factor a	0.0025							
L-W factor b	3.5							
r^2	0.95							
Number ('000)	261 732	16 029	7 800	73 497	208 280	285 468	49 797	6 524 448
Tonnes	3 081	189	161	1 520	692	948	247	76 170

e) Pelagic II fish

	Côte d'Ivoire					
Stratum	1	2	3	4	5	6
Mean s_A	3	20	17	48	26	4 022
Area (nm^2)	30	97	190	544	158	4
L-W factor a			0.004			
L-W factor b			3.27			
r^2						
Number ('000)	272	6 817	11 286	135 000	21 289	81 474
Tonnes	22	557	923	5 323	839	3 213