

## SURVEYS OF THE DEMERSAL FISH RESOURCES OF THE OUTER SHELF AND SLOPE OFF GHANA

30 April - 07 May 2010

Institute of Marine Research  
Norway

Marine Fisheries Research Division  
Ghana

Bergen November 2010



## THE EAF-NANSEN PROJECT

FAO started the implementation of the project “Strengthening the Knowledge Base for and Implementing an Ecosystem Approach to Marine Fisheries in Developing Countries (EAF-Nansen GCP/INT/003/NOR)” in December 2006 with funding from the Norwegian Agency for Development Cooperation (Norad). The EAF-Nansen project is a follow-up to earlier projects/programmes in a partnership involving FAO, Norad and the Institute of Marine Research (IMR), Bergen, Norway on assessment and management of marine fishery resources in developing countries. The project works in partnership with governments and also GEF-supported Large Marine Ecosystem (LME) projects and other projects that have the potential to contribute to some components of the EAF-Nansen project.

The EAF-Nansen project offers an opportunity to coastal countries in sub-Saharan Africa, working in partnership with the project, to receive technical support from FAO for the development of national and regional frameworks for the implementation of Ecosystem Approach to Fisheries management and to acquire additional knowledge on their marine ecosystems for their use in planning and monitoring. The project contributes to building the capacity of national fisheries management administrations in ecological risk assessment methods to identify critical management issues and in the preparation, operationalization and tracking the progress of implementation of fisheries management plans consistent with the ecosystem approach to fisheries.

### LE PROJET EAF-NANSEN

La FAO a initié la mise en oeuvre du projet "Renforcement de la base des connaissances pour mettre en œuvre une approche écosystémique des pêcheries marines dans les pays en développement (EAF-Nansen GCP/INT/003/NOR)" en décembre 2006. Le projet est financé par de l'Agence norvégienne de coopération pour le développement (Norad). Le projet EAF-Nansen fait suite aux précédents projets/ programmes dans le cadre du partenariat entre la FAO, Norad et l'Institut de recherche marine (IMR) de Bergen en Norvège, sur l'évaluation et l'aménagement des ressources halieutiques dans les pays en développement. Le projet est mis en oeuvre en partenariat avec les gouvernements et en collaboration avec les projets grands écosystèmes marins (GEM) soutenus par le Fonds pour l'Environnement Mondial (FEM) et d'autres projets régionaux qui ont le potentiel de contribuer à certains éléments du projet EAF-Nansen.

Le projet EAF-Nansen offre l'opportunité aux pays côtiers de l'Afrique subsaharienne partenaires de recevoir un appui technique de la FAO pour le développement de cadres nationaux et régionaux visant une approche écosystémique de l'aménagement des pêches et la possibilité d'acquérir des connaissances complémentaires sur leurs écosystèmes marins. Ces éléments seront utilisés pour la planification et le suivi des pêcheries et de leurs écosystèmes. Le projet contribue à renforcer les capacités des administrations nationales responsables de l'aménagement des pêches en introduisant des méthodes d'évaluation des risques écologiques pour identifier les questions d'aménagement d'importance majeure ainsi que la préparation, la mise en œuvre et le suivi des progrès de la mise en œuvre de plans d'aménagement des ressources marines conformes à l'approche écosystémique des pêches.



**Cruise reports “Dr. Fridtjof Nansen”**

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SHELF AND SLOPE OFF GHANA**

**30 April - 07 May 2010**

by

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## TABLE OF CONTENTS

CHAPTER 1 INTRODUCTION.....	4
1.1. Objectives.....	4
1.2. Participation.....	4
1.3. Narrative.....	4
1.4. Survey effort.....	5
CHAPTER 2 METHODS.....	6
2.1. Meteorological and hydrographical sampling.....	6
2.2. Biological sampling.....	7
CHAPTER 3 OCEANOGRAPHIC CONDITIONS.....	8
3.1. Along shelf distribution of environmental parameters.....	8
CHAPTER 4 RESULTS FROM THE TRAWL SURVEY.....	10
4.1. Catch rates.....	10
4.2. Biodiversity.....	13
4.3. Consideration for commercial trawling.....	19
Annex I	Records of fishing stations
Annex II	Length distributions of main species
Annex III	Swept-area biomass estimates
Annex IV	Instruments and fishing gear used

## CHAPTER 1 INTRODUCTION

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The survey was organised by IMR and FAO under the project CCP/INT/003/NOR: International cooperation with the Nansen Programme: Fisheries Management and Marine Environment. This project is the continuation of a series of projects and agreements between NORAD, IMR and FAO involving surveys with the research vessel “Dr. Fridtjof Nansen”. The objectives of the survey had been agreed upon during discussions between the cruise leader and Marine Fisheries Research Division, and the Environmental Protection Agency (EPA) in Ghana. The survey is the first to investigate the deepwater fish resources of Ghana on the slope between 100-1000 m depth.

### 1.1. Objectives

The main objectives of the survey were:

- to describe the distribution, composition and estimate the abundance of the main demersal species on the outer shelf and slope from 100 – 1000 m depth by a swept-area trawl programme
- to collect zooplankton samples for distribution and abundance estimation
- to map the general hydrographic regime along the survey transect
- to provide on-the-job training to local participants in relation to the main survey routines

### 1.2. Participation

The participants in the survey came from:

Marine Fisheries Research Division, Tema, Ghana:

Richmond Quartey (team leader), Eunice Anum-Ofoli, Edmund Nii-Anme, Jones Tetteh, Serwa Abogaye and Damoah Kwame

University of Ghana:

Solomon Owiredu Amoah and Ignatius Kweku Williams

California Academy of Sciences, USA:

Tomio Iwamoto

Institute of Marine Research, Bergen, Norway:

Jens-Otto Krakstad (cruise leader), Oddgeir Alvheim, Tore Mørk and Thor Egil Johansson

### 1.3. Narrative

The vessel left Tema (Ghana) in the morning of the 30<sup>th</sup> April and steamed eastwards to the Ghanaian border with Togo where the survey started the same day. The outer shelf and slope of Ghana was surveyed between 100 m – 1000 m depth by parallel course tracks about 15 NM (nautical miles) apart. Semi-random swept-area hauls were carried out on the shelf and slope within the depth zones <100 m, 100 - 300 m, 300 - 600 m and 600 - 1000 m in all areas with suitable trawling grounds. Continuous acoustic registrations were done throughout the survey.

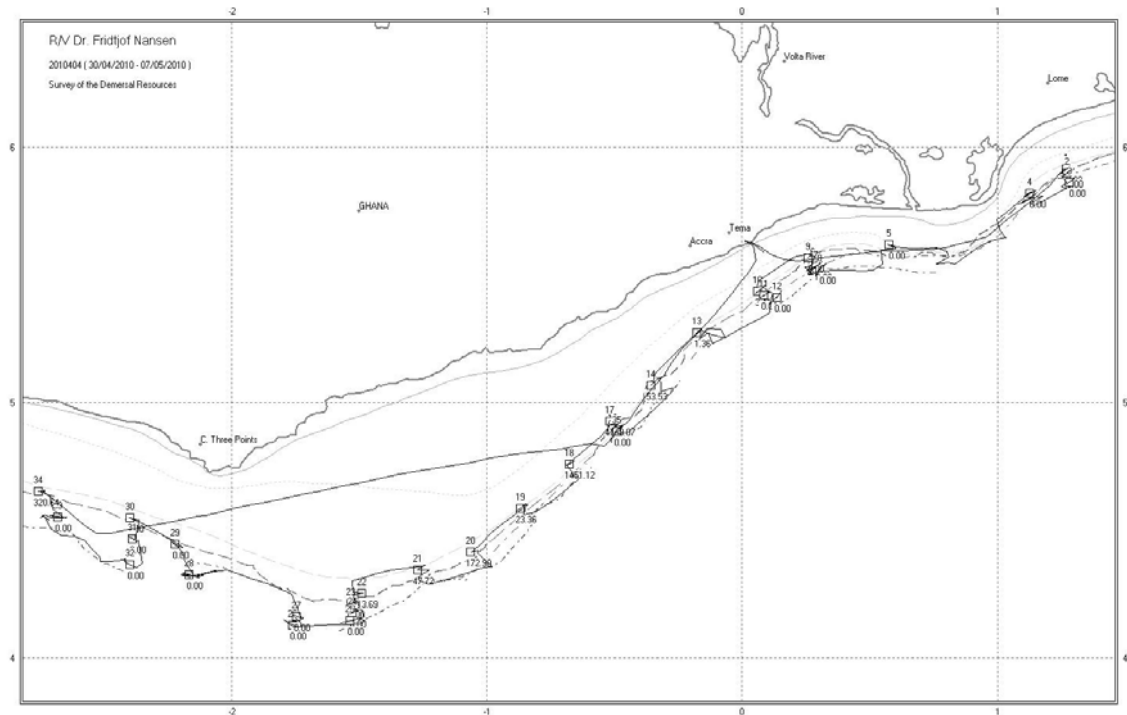
CTD-stations were taken at the bottom trawl stations. In addition, CTD's from surface down to the bottom was taken at 100 m depth and 1000 m depth at every 30 NM along the transects. The main part of the survey was completed in the evening of 6<sup>th</sup> May and the vessel arrived in Tema in the morning of the 7<sup>th</sup> May. Minor problems were experienced with the deepwater trawling because of a drum axel broke and caused an interruption to the trawling operation for some 10h during the last day of the survey. Problems were also experienced with the CTD that had a circuit failure. The failure was fixed onboard within 24 h. As a consequence some trawls do not have an accompanying CTD station.

### 1.4. Survey effort

The cruise tracks with trawl, hydrographic and plankton stations are shown in Figure 1.1. Table 1.1 summarises the survey effort in each sector.

**Table 1.1** Number of bottom trawl (BT) stations, plankton (P), hydrographic (CTD) stations and distance surveyed (NM).

Regions	Date	BT Stations	Plankton stations	CTD Station	Distance travelled
Ghana	30/04 - 07/05-2010	35	11	39	907



**Figure 1.1** Course track with fishing stations Depth contours at 20 m, 50 m, 100 m, 200 m and 500 m are indicated.

## CHAPTER 2      METHODS

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### 2.1.    Meteorological and hydrographical sampling

#### *Temperature, salinity and oxygen*

A Seabird 911 CTD plus was used to obtain vertical profiles of temperature, salinity and oxygen. Real time plotting and logging was done using the Seabird Seasave software installed on a PC. The profiles were usually taken down to a few metres above the bottom, but not deeper than 1500 m.

The SBE 21 Seacat thermosalinograph was running routinely during the survey, obtaining samples of sea surface salinity and relative temperature (5 m depth) every 10 seconds. An attached in-line Turner Design SCUFA Fluorometer continuously measured Chlorophyll A levels [RFU] at 5 m below the sea surface while underway during the entire cruise.

Meteorological observations including wind direction and speed, air temperature, global radiation and sea surface temperature (SST) were automatically logged using a WIMDA meteorological station and averaged by every nautical mile distance sailed.

A vessel-mounted Acoustic Doppler Current Profiler (VMADCP) from RD Instruments logged the current profiles continuously, and was set to ping synchronously with the echo sounders. The frequency of the VMADCP is 150 kHz, and data were averaged and stored in 4 m vertical bins in shallow water to approximately 400 m bottom depth and 8 m bins deeper than this.

#### *Zooplankton*

The sampling was conducted by means of HYDROBIOS Multinet with 5 nets at the monitoring lines. The nets (180 µm) were remotely opened from the bridge of the vessel. The depth intervals covered in 2010 were: 200-100 m, 100 -75 m, 75-50 m, 50-25 m and from 25 m to the surface. In the case of stations shallower than 25 m, the sample was taken from the bottom and up to the surface. A SCANMAR depth sensor gave real-time information of the depth and a flow meter inside the net was used to estimate the sampling volume. The samples were preserved in 4% formalin to be taken to the University of Ghana for further analysis.

### 2.2.    Biological sampling

#### *Sampling gear*

A Gisund Super bottom trawl with a headline height of about 4.5 m was used during the survey, the doors are of the Thyborøn' combi type. The distance between the front parts of the wings was about 21 m during deployment at a speed of 3 NM h<sup>-1</sup>. These settings have been the standard on all swept area surveys with R/V "Dr. Fridtjof Nansen". During all tows



deeper than 80 m, a 9 m long constraining rope was attached between the wires 120 m in front of the trawl doors. This kept a constant distance between the doors of about 50 m during the trawling. In shallow stations with depths of less than 80 m, the door-to-door distance varied more, depending on bottom type and currents. Data from the door and depth/trawl-height sensors were logged for all tows and are stored in files with CMG format, which makes it possible to study the trawl performance in more detail.

Trawl duration was standardized to 30 minutes. The trawling start time is controlled by using SCANMAR sensors to detect the landing of the trawl on the bottom, and the stop-time is defined as the time when the wires start to haul the net. In some cases the towing was interrupted before 30 minutes either due to poor bottom conditions or too high catches of fish indicated by the installed catch sensors. If the stations were not trusted to reflect the density of fish on the bottom they were recorded as invalid in the Nansis database.

#### *Catch sampling*

The trawl catches were sampled for species composition by weight and numbers. The deck sampling procedure is described in more detail by Strømme (1992). Length measurements (total length) were taken for target species. The length of each fish was recorded to the nearest 1 cm below. The mantle length was measured to the nearest 1 cm below for *Sepia* spp. Basic information recorded at each fishing stations, i.e. trawl hauls, is presented in Annex I. Pooled length frequency distributions, raised to catch per hour, of selected species are shown in Annex II. The swept-area estimates are presented in Annex III. A description of the fishing gears used, acoustic instruments and their standard settings is given in Annex IV.

## CHAPTER 3 OCEANOGRAPHIC CONDITIONS

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### 3.1. Along shelf distribution of environmental parameters

CTD profiles were taken on all trawl stations along the survey transect. From these alongshore figures of temperature, salinity, oxygen and relative fluorescence were extracted at stations just off the shelf break at approximately 500 m bottom depth (Figure 3.1). Generally the profiles show great along shelf stability in the water masses with only minor variation from station to station. Cross shelf profiles of temperature, salinity, oxygen and relative fluorescence were taken on the previous environmental survey off Ghana, 2010403 together with current measurements from the same transects.

The temperature profile show maximum surface temperature on the central part of the shelf at 30 °C. A thermocline can be observed at 30-60 m depth where temperatures are dropping from about 28-21°C. The temperature at the bottom at 500 m depth was <8°C.

The salinity profile show lowest salinity in the surface waters (34.9). It was especially pronounced in the eastern end of the survey area where surface waters are affected by the Volta river plume (34.7). There was a strong salinity gradient in the upper 25 m with salinity increasing to a maximum of 35.9 between 30-130 m depth before decreasing gradually at deeper depths. Salinity at 500 m depth was around 34.7.

The oxygen profile show a oxygen maximum > 4.5 ml/l around 50 m depth and decreasing oxygen to a minimum of < 1.5 around 200 – 400 m depth.

The relative fluorescence profile show a surface values of fluorescence < 0.1 and a fluorescence maximum around 0.3 around 60 m depth and decreasing fluorescence to 100 m depth where from the values where < 0.1.

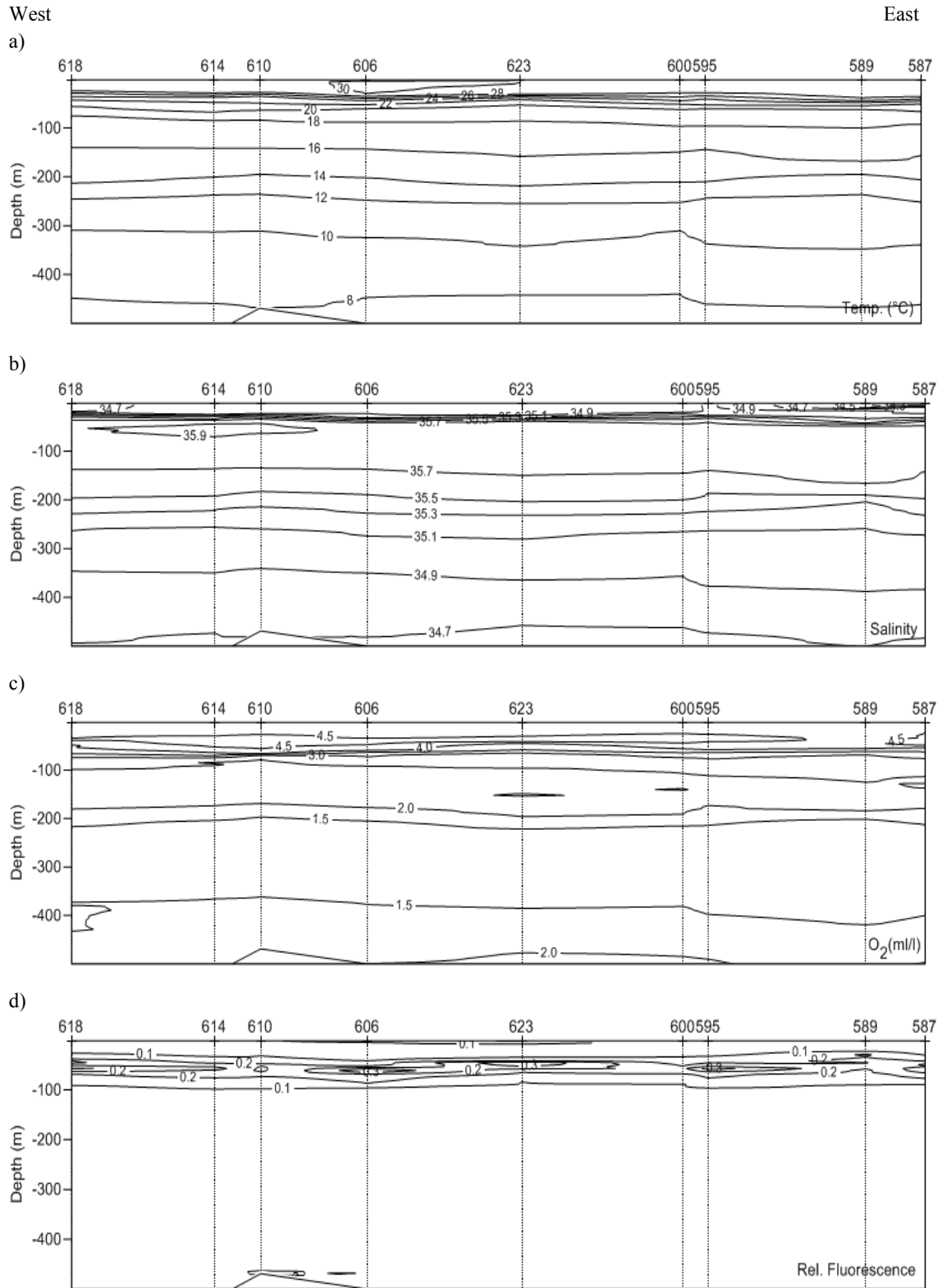


Figure 3.1 Along shelf distribution of environmental parameters along the shelf break. The temperature a), salinity b), oxygen c), relative fluorescence d)

## CHAPTER 4 RESULTS FROM THE TRAWL SURVEY

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The composition of the fish fauna on the continental shelf and slope of the western Gulf of Guinea changes with depth (Williams 1968). This survey only focused on the outer shelf and deep water slope off Ghana and the catch-distribution analyses were therefore performed for four depth strata, outer shelf (< 100 m), upper slope (100-300 m) mid slope (300-600 m) and lower slope (>600 m). In the analyses the “Demersal” group includes commercially important families as Sciaenidae, Haemulidae (=Pomadasyidae), Serranidae, Sparidae and Lutjanidae, and especially in deeper waters the Merluccidae, Macrouridae and Moridae. The “Pelagic” group includes Engraulidae, Clupeidae, Carangidae, Scombridae, Sphyrnidae, Gempylidae and Trichiuridae (the latter family is actually mainly benthopelagic). For the analysis the “other” group includes all species not accounted for in the groups listed. Therefore, the content of “other” will change from table to table. The locations of the trawl stations are shown in Figure 1.1. Records of fishing stations and catches are presented in Annex I, and pooled length distributions (weighted by catch) of main species by area are shown in Annex II.

### 4.1. Catch rates

A total of 35 swept-area trawl hauls were made in Ghana. Of these 7 trawls were conducted on the outer shelf, 12 on the upper slope, 8 on the mid slope, and 8 on the lower slope. The catch data are presented as catch/h per depth region. No trawling was conducted on the inner shelf and no swept area biomass estimates are available from this survey. The catch rates declined with depth (Table 4.1). The catch rates within each depth region was 1622 kg/h on the outer shelf, 1093 kg/h on the upper slope, 612 kg/h on the mid slope and 813 kg/h on the lower slope. As expected also the valuable demersal species declined rapidly with depth while the non commercial species in the “other” group increased. In general, the average catch rates were highest in the western part of Ghana as has also been observed on the surveys on the shelf.

The most abundant species group on the outer shelf was the pelagic group with average catch rates of 759 kg/h. However the variance was high and the large average catch was mainly due to a large catch on one station. The pelagic group contributed 47% to the overall catch in this depth region. Within this group it was *Trachurus trecae* that was the most important species. Commercially important demersal species where the second most important group with 38 % and average catch rates of 615 kg/h. *Boops boops* and *Dentex congoensis* were the most dominant species. Cephalopods, sharks and shrimps were not important in the catches in this depth region. The group of other species contributed 12% and 200 kg/h to the overall catch.

On the upper slope the “other” group was the most abundant. This group contributed 67% of the total catch with catch rates of 731 kg/h. Figure 5.1 show the most abundant species within

this depth region. Both the demersal and the pelagic group contributed with 15% of the total catch. The average catch rate was 164 and 169 kg/h respectively. Sharks, cephalopods and shrimps contributed 1.6%, 0.9% and 0.2% of the catch.

The most abundant group on the mid slope continued to be the group of “other” species with average catches of 444 kg/h and 73% of the overall catch. Shrimps were the second most important group with average catches of 101 kg/h and 17%. The most abundant species in this group was *Nematocarcinus africanus*, a non commercial small shrimp. Sharks had average catch rates of 34 kg/h, 5.5% of total. Pelagic species had average catch rates of 22 kg/h and 3.5% of the overall catch. Cephalopods had mean catch rate of 7 kg/h and 1.2% while demersal species contributed with 0.9% of the overall catch with average catch rates of 5 kg/h.

The group of “other” species continued to dominate on the lower slope with 87% of the overall catch and average catch rates of 708 kg/h. Sharks contributed with 70 kg/h and 8.5% of the overall catch while the demersal group contributed with 21 kg/h and 2.6%. Shrimps and Cephalopods were not important

**Table 4.1** Catch rates (kg/h) by main groups in swept-area bottom-trawl hauls on the a) outer shelf (< 100 m), b) upper slope (100-300 m), c) mid slope (300-600 m) and d) lower slope (>600 m)

a)

Station	Gear depth	Cephalopods	Demersal	Pelagic	Sharks	Shrimps	Other	Total
1	94.5	62.7	472.6	0	8.7	0	171	715
4	77	114.2	315.5	14.7	0	0	135.3	579.8
5	45.5	3.4	43.2	17.4	0	0.4	275.2	339.5
10	86	22.7	519.3	23.4	2.4	0	33.8	601.6
13	89.5	21.1	44.8	1.4	0	0	21.7	88.9
17	98.5	65.5	2624.8	5086.2	7.4	0	128.7	7912.6
20	99	29.1	281.1	172.9	0	0	635.6	1118.7
Mean	84.3	45.5	614.5	759.4	2.6	0.1	200.2	1622.3
St dev	18.8	37.8	905.7	1908.9	3.8	0.1	210.1	2792
%	-	2.8	37.9	46.8	0.2	0.0	12.3	100.0

b)

Station	Gear depth	Cephalopods	Demersal	Pelagic	Sharks	Shrimps	Other	Total
2	204.5	6.9	91	0	27	3.7	304.1	432.7
9	102.5	3.4	103.5	17.8	0	0	21.7	146.4
11	221.5	14.6	235.7	0	21.8	0	3016.8	3289
14	102	1.4	78	84.7	10.2	0.5	559.9	734.7
16	264	0.5	28.7	0	25.6	1.4	535.6	591.9
18	102.5	19.6	501	1466.9	9.8	0	250.4	2247.7
19	113	11.7	210.2	23.4	4.8	0	19.7	269.8
21	107	11.1	447.4	47.7	15.9	0	153.1	675.3
22	132.5	0	135.4	23.5	19.5	0	692.5	870.9
23	287.5	13	16.7	0	55.6	18.9	1983.9	2088.1
30	204.5	34.3	4.1	0	15.6	0	1127.2	1181.2
34	118.5	1.5	116.2	360.8	0	0	107	585.5
Mean	163.3	9.8	164	168.7	17.2	2	731	1092.8
St dev	68.9	10	161.3	421.2	15.2	5.4	912.9	954.6
%	-	0.9	15.0	15.4	1.6	0.2	66.9	100.0

c)

Station	Gear depth	Cephalopods	Demersal	Pelagic	Sharks	Shrimps	Other	Total
3	553	10.6	7.3	3.4	8.9	7.2	106.8	144.2
6	314.5	2.1	0.4	6.2	32.1	5.4	2101.3	2147.5
15	544	1.3	2.8	6.3	5.4	5.7	258.7	280.2
24	451	1.7	10.5	84.9	1	164	175.2	437.2
27	533	0	0	29.5	181.1	443	130.9	784.6
29	339	13	15	0	9	6.9	552.5	596.5
31	517	27.3	2	24.6	30.1	171.7	84.5	340.2
35	556.5	1.1	5.3	17.3	0.7	2.1	141.4	168
Mean	476	7.2	5.4	21.5	33.5	100.8	443.9	612.3
St dev	98.2	9.5	5.3	27.7	60.9	156.6	686.3	656.6
%	-	1.2	0.9	3.5	5.5	16.5	72.5	100.0

d)

Station	Gear depth	Cephalopods	Demersal	Pelagic	Sharks	Shrimps	Other	Total
7	608	0	73.2	8.2	10.1	2.7	882.5	976.8
8	908.5	0.2	3.4	0.7	0.9	17.6	67.3	90.2
12	602	0.3	13.3	6.5	246.4	18.4	541.1	826.1
25	719	0	33.7	1	224.3	6.2	145.2	410.4
26	822	1.6	1.2	2	17	2.3	42.3	66.5
28	735.5	1.9	10.7	0.9	44.7	20.7	698.4	777.2
32	863.5	1.5	7.8	0.8	0	5.6	2213	2228.8
33	753.5	2.8	26.7	0.6	10.1	10.6	1073.7	1124.4
Mean	751.5	1	21.2	2.6	69.2	10.5	707.9	812.5
St dev	111.1	1	23.8	3	103.7	7.4	719.9	694
%	-	0.1	2.6	0.3	8.5	1.3	87.1	100.0

## 4.2. Biodiversity

The fish fauna of the outer shelf and slope of Ghana are poorly known and have been little collected, although several major initiatives in the past have focused on investigating the marine fauna of the broad area encompassing the Gulf of Guinea. Examples of past investigations trawling in Ghanaian waters include the Danish Expedition to the Coasts of Tropical West Africa, which made numerous demersal hauls off Ghana with small trawls or dredges but mostly in shallow shelf waters. The *Galathea* passed through the country on its round-the-world expedition, but occupied only a few stations off Ghana. In 1964 and 1965, the R/V *Pillsbury* conducted two cruises to the Gulf of Guinea (*Studies in Tropical Oceanography, Miami*, no. 4, parts 1 and 2), the first in 1964 began in Lagos and ended in Monrovia (the second cruise explored the eastern part of the Gulf). During that 1964 cruise, the vessel made a series of 22 stations off Ghana, 15 of which were on the bottom using mostly a 2-m otter trawl, but also a Blake [beam] trawl (3 stations), and a 12.5-m otter trawl (3 stations). The three Blake trawl stations were deployed at depths from 1353 to 3129 m; all but one of the other trawls were fished at depths between 20 and 64 m; the one exception was in 110 m using a 12.5-m trawl. Ships participating in the Guinean Trawling Survey in the mid-1960s made collections (again mostly in shelf waters) that have been reported in widely disparate journals. The former Soviet ship *Zveda Kryma* has also made deepwater collections off Ghana, but a comprehensive list of the species collected by that vessel are not available.

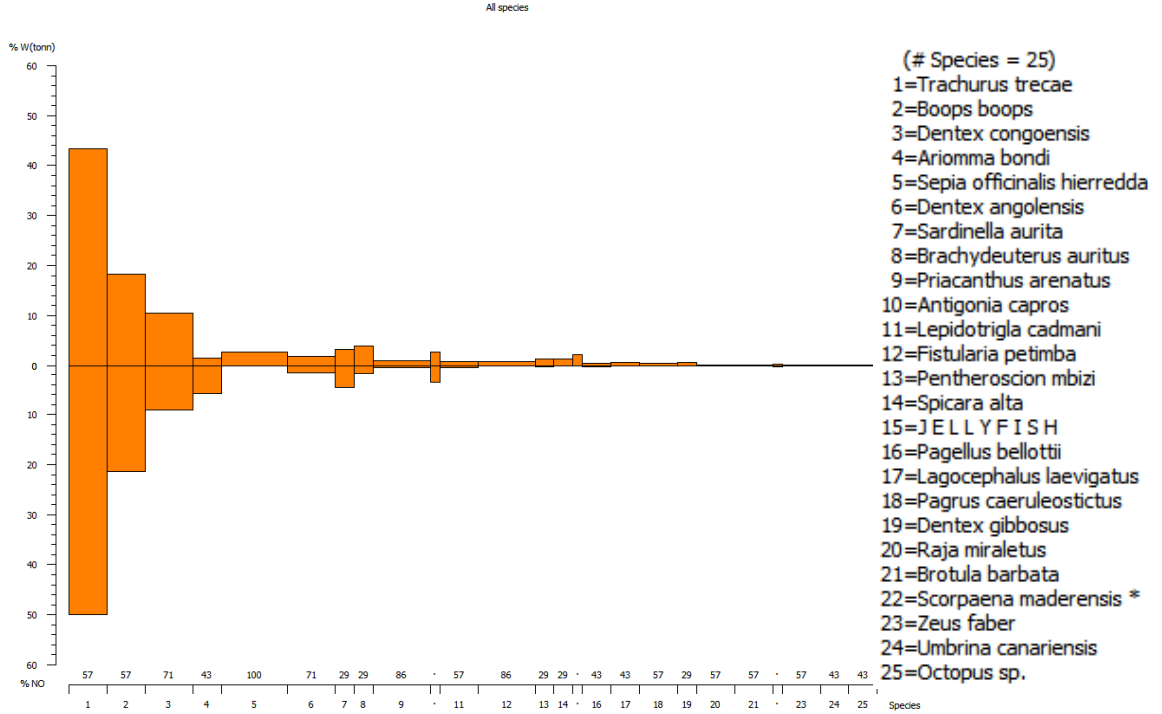
The paucity of past deep-water trawl collections made off Ghana make it likely that a large percentage of the slope fishes taken during the current *Nansen* survey represent species that have not previously been recorded in these waters. Because there is no current list of marine fish species of Ghana, confirming such records becomes a laborious task that will require searches of the primary literature. It is for that reason that we cannot now provide a list of the new records. With some confidence, however, we can say that certain groups collected during the survey likely contain species that have not been previously recorded, including the grenadiers (Macrouridae, Bathygadidae), deepsea anglerfishes (Ceratiidae, Diceratiidae), Congrid eels, tripod fishes (Bathypterois 3 spp.), cusk eels (Ophidiidae), slickheads (Alepocephalidae), soles (Soleidae), and snake mackerels (Gempylidae).

Figure 4.1 a-d reports the most common species in each depth region depicted using an Index of Relative Importance (IRI combining the relative numeric abundance (N), the average size (W) and the commonness (F) of a species,  $IRI = (\%N + \%W) * \%F$ ).

The pelagic *Trachurus trecae* was the most common single species both on the outer shelf and the upper slope; however the catch rate decreased rapidly below 100 m depth. *Priacanthus arenatus* became the second most important species on the upper slope. It was frequently caught but only in very low numbers also on the outer shelf. The species composition changed considerably when moving to deeper waters. At the mid slope the three most common species, *Synagrops bellus*, *Chlorophthalmus atlanticus* and *Nematocarcinus africanus* was not found among the 25 most common species in the depth regions above.

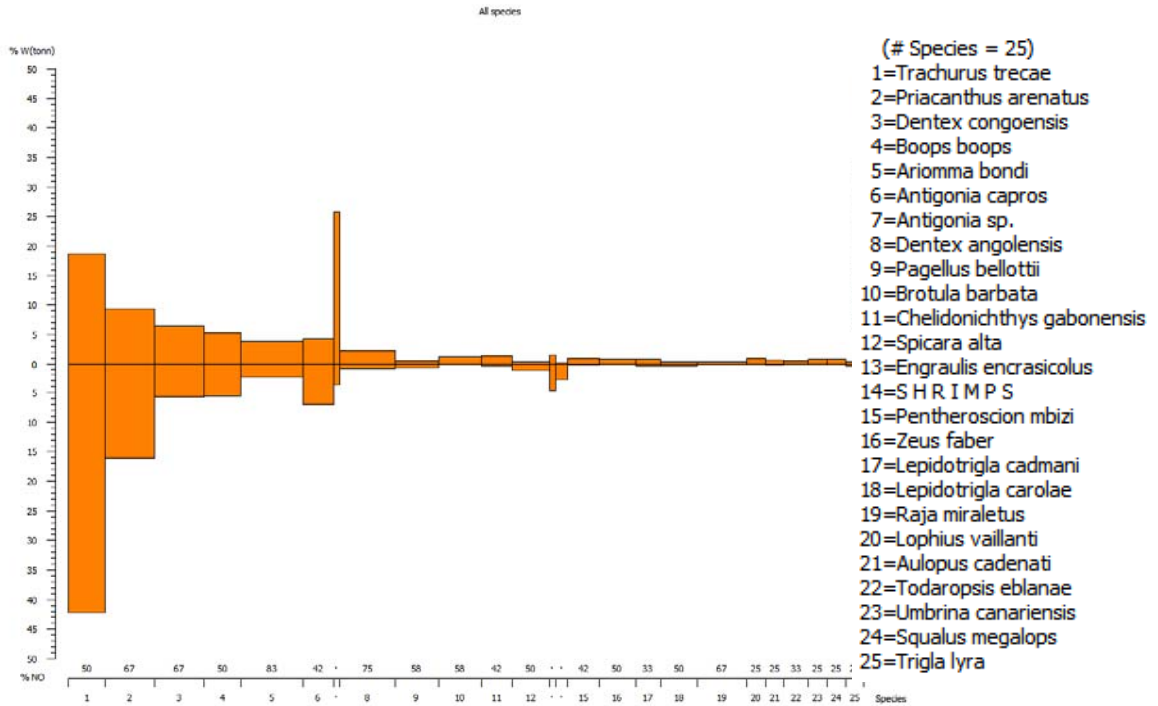
At the lower slope *Yarella blackfordi*, *Stereomastis sp.* and *Aristeus varidens* were the three most common species. All three species has a distribution also in the mid slope but with lower concentrations.

Outer shelf

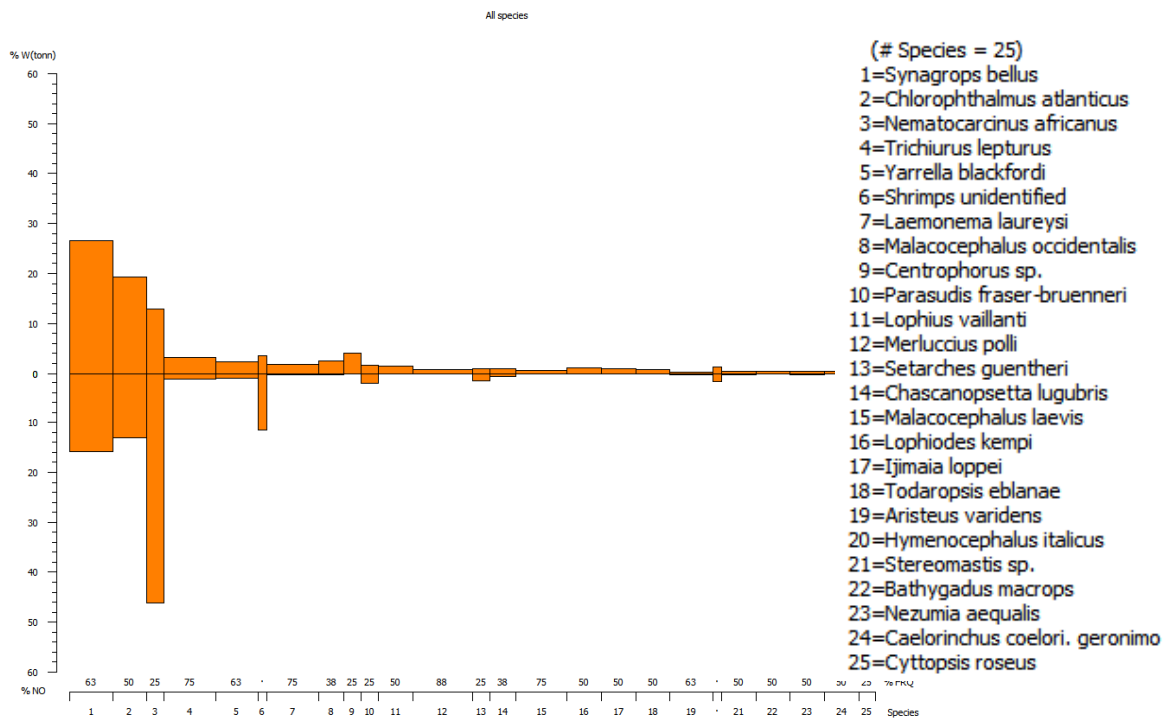




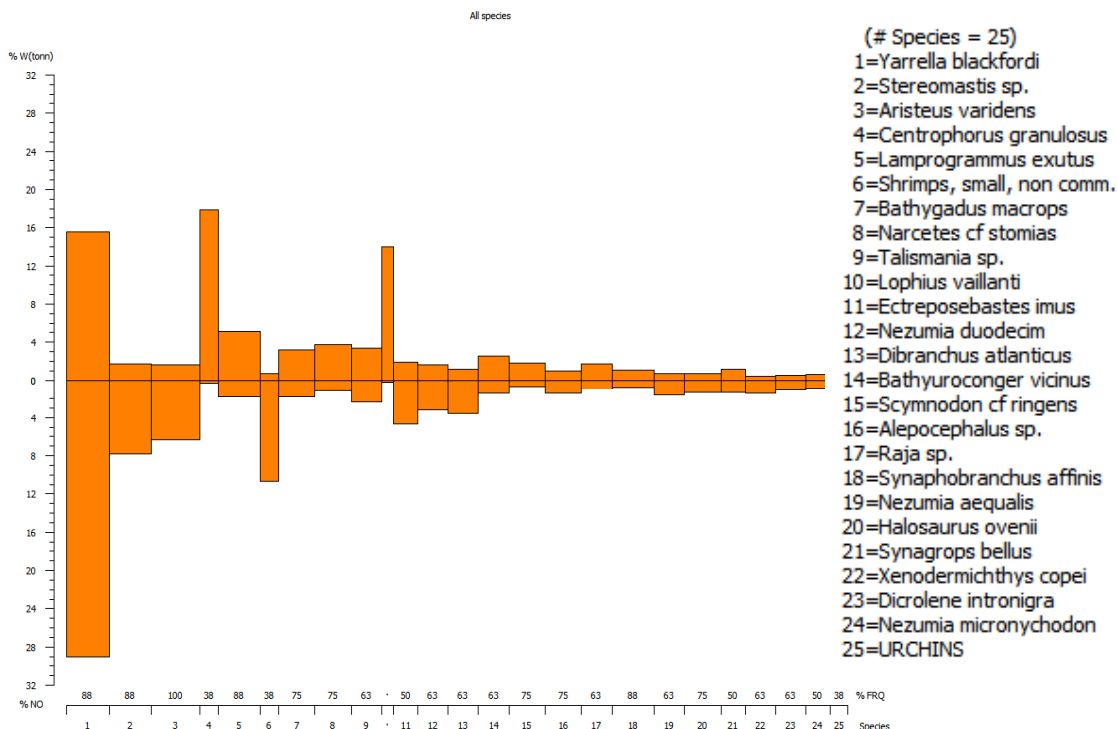
Upper slope



Mid slope



## Lower slope



**Figure 4.1.** Index of relative Importance calculated from swept-area bottom-trawl hauls on per depth region a) outer shelf (< 100 m), b) upper slope (100-300 m), c) mid slope (300-600 m) and d) lower slope (>600 m)

The total number of species and species group identified was 277 (including species only identified to Genus or higher taxa). The total number of species and species group identified per depth region were 84 on the outer shelf, 126 on the upper slope, 127 on the mid slope and 102 at the lower slope. Not taking into account the sampling intensity in each depth the biodiversity is highest on the upper and middle slope.

A number of new species previously not recorded in Ghana was reported during this survey. These species has been identified by Oddgeir Alvheim and Tomio Iwamoto and specimens have been stored for future reference at the California Academy of Sciences, USA. Table 5.2 contains a preliminary list of previously non reported specimens from Ghanaian waters.

Table 4.2 lists all species recorded in the catches of the current survey. A total of 183 species of fishes were identified, but this number should be used cautiously because not all specimens could be determined to species because of limitations in time and references available on the ship. The species for which specimens and tissues were preserved are listed in Table XX. The whole specimens will be deposited in the California Academy of Sciences in San Francisco, USA; the tissue samples will be sent to the University of Kansas for deposit in the Tissue Collection. The preserved specimens and tissues will serve to document the species of the survey and will be used to more-definitively determine their correct identifications.

**Table 4.2.** Preliminary list of species previously not recorded in Ghana

Genus	species	# Spec.	Tissues vial#	Sta.
Adioryx	hastata	1		21
Aldrovandia	phalacra	3		26
Alepocephalus	sp.B	1	54	3
Alepocephalus	sp.B	1		12
Alepocephalus	sp	2		26
Alepocephalus	2 spp	4		33
Alepocephalus	sp	2		35
Alepocephalus	deep-body from <a href="#">DFN 20100403</a>	1	16	[3]
Alepocephalus	filamentous pectoral <a href="#">DFN20100403</a>	1	15	[3]
Anguiliformes	leptocephalus	1		8
Anthias	anthias	1		2
Anthias	anthias	2		19
Antigonia	capros?	2		11
Antigonia	capros?	1		18
Antigonia	capros?	2		20
Argyropelecus	sp	1		26
Ariomma	bondi	1		1
Ariomma	bondi	5		2
Ariomma	bondi	1		20
Ariomma	bondi	1		23
Ariomma	bondi	2		25
Arnoglossus	imperialis	2		1
Arnoglossus	imperialis	2	86, 87	4
Bajacalifornia	megalops?	3		26
Bajacalifornia	megalops?	3		33
Bajacalifornia	megalops?	2		35
Bathophilus	sp.	1		8
Bathygadus	macrops	1	76	3
Bathygadus	macrops	1		8
Bathygadus	melanobranchus	1		8
Bathypterois	phenax	1		8
Bathypterois	phenax	1		26
Bathypterois	viridensis	1		26
Bembrops	greyae	2	50,51	6
Brama	brama	1		3
Branchiostegus	semifasciatus	1		21
Caristius	maderensis	1		8
Caristius	maderensis	1		35
Chaetodon	marcellae	1	100	1
Chaunax	pictus	1	46	6
Cheilodonichthys	gaboensis	1		9
Chiasmodontid	sp	1	33	12
Coelorinchus	geronimoi	2	47,48	6
Coloconger	cadenati	1		35
Congridae	sp	1		2
Congridae	sp	1	45	6
Coryphaenoides	zaniophorus	1	36	8
Coryphaenoides	zaniophorus	1	24	25
Cryptosaras	cousei	1		26
Cynoglossus	canariensis	1		13
Decapterus	punctatus	5	67, 68	5
Dentex	angolensis	1	96, 97	1
Dentex	canariensis	1	98, 98	1
Dentex	congoensis	1		1
Dicologlossus	cuneatus	1	83	4
Diceratias	pileatus	1		33
Dicrolene	intronigra	1	21	25
Diretmoides	parini	4	71,72	3
Diretmoides	parini	1		12
Diretmoides	parini	1		23
Diretmoides	parini	1		24
Diretmoides	parini	1		25
Ebinania	costaecanarie	1	64	3
Ephippion	guttifer			
Epigonus	sp	1		23
Epigonus	pandionus?	1		24
Gadomus	arcuatus	1		8
Gobiidae	sp white spots	1	82	4

Halosaurus	ovenii	1		26
Histiobranchus	bathybius	1		8
Hoplostethus	mediterraneus	1		2
Hymenocephalus	italicus	2	22,23	24
Lamprogrammus	niger	1		26
Lepidotrigla	cadmani	1		21
Lepidotrigla	carolae	2	94, 95	4
Lepidotrigla	carolae	2		21
Leseurogobius	sp	1		2
Leseurogobius	koumansii?	5	88, 89, 90	4
Lophioides	kempi	1		2
Luciobrotula	nolfi	1		12
Luciobrotula	nolfi	1		35
Melanocetus	johnsoni	1		8
Melanocetus	johnsoni	1		26
Melanostomias	sp	1	62	3
Melanostomias	sp	1		12
Microchirus	frechkopi	1		1
Microchirus	frechkopi	4	85	4
Microchirus	wittei	2		2
Monolene	microstoma	2		2
Monomitopus	metriosoma	2	55	3
Myctophids	sp.	4		2
Myctophids	sp.	7		4
Myctophids	2 spp	3		24
Myctophids	sp	1		27
Narcetes	stomias?	2	56, 57	3
Narcetes	stomias?	1		8
Nettastomatid	sp	3		2
Nezumia	aequalis	1	75	3
Nezumia	aequalis	1	49	6
Nezumia	aequalis	1	31	8
Nezumia	aequalis	1		25
Nezumia	africana	1	20	26
Nezumia	duodecim	1	25	25
Nezumia	micronychodon	3	34,35	8
Notocanthus	sexspinis	1		32
Ophichthid	sp	2		29
Ophidion	lozanoi	4	52,53	2
Pachycara	crossacanthum	1		12
Pagrus	pagrus africanus	1		1
Paralepidid	Lestidiops?	2		23
Parasudis?	sp	6	17	31
Pentheroscion	mbizi	1	93	4
Photonectes	braueri?	1		35
Physiculus	cyanostrophus	1	39	9
Physiculus	huloti	7	41,42	2
Physiculus	huloti	3	40	9
Polyacanthonotus	cf africanus	1		8
Pontinus	kuhlii	1		30
Priacanthus	arenatus	1		20
Prometichthys	prometheus	1		
Prometichthys	prometheus	2	26	25
Prometichthys	prometheus	2		26
Psenes	sp	1		11
Pythonichthys	microphthalmus	2	80, 81	1
Rouleina	maderensis	1		8
Scomber	japonicus	1		20
Scombrobrax	heterolepis	2	29,30	15
Scopelarchoides	danae?	2	18,19	31
Scorpaena	normani	1		22
Serranus	accraensis	1		1
Serranus	africanus	1		13
Serranus	cabrilla	1		1
Serranus	sp	1		4
Serranus	sp	2	66	5
Sigmops	elongatum	2	60, 63	3
Sigmops	elongatum	1		35
Snyderidia	canina	1	32	8
Snyderidia	canina	2		12
Snyderidia	canina	3	27,28	25

Spicara	alta	1	1
Synchiropus	phaeton	2	29
Synchiropus	phaeton	1	30
Synaphobranchus	affinis	1	12
Talismania	sp	1	15
Thorogobius	sp	1	13
Trachinus	pellegrini	2	21
Uranoscopus	albesca	2	91, 92 4
Uroconger?	sp	1	23
Xenodermichthys	copei	2	58, 59 3
Xenodermichthys	copei	1	26
Xenolepidichthys	dahlgleishi	1	24
Yarrella	blackfordi	1	61 3
Zenion	longipinnis	2	23
<b>TOTAL TELEOSTS</b>		<b>245</b>	
<b>CONDRICTHYANS</b>			
Deania	profundorum	1	8
Deania	profundorum	1	25
Oxynotus	centrina	1	6
Heptranchus	perlo	1	23
Hydrolagus	alberti	1	25
Neoharriota	pinnata	1	31
Skate egg case		1	4
Zameus?	sp	1	8
<b>TOTAL CHONDRICHTHYANS</b>		<b>8</b>	
<b>TOTAL ALL FISHES</b>		<b>253</b>	
<b>INVERTEBRATES</b>			
Sea fans	branching	2	32
barnacles	big	2	28
barnacles & scallops	from lithodid legs	10	29
Calappa	species	1	6
Canthro1id squid	species	1	26
Crabs	species	1	3
Crabs	lithodid	1	29
Gastropods	species	14	3
Pelecypods	species	4	3
Todaroides?	species	1	20
<b>TOTAL INVERTEBRATES</b>		<b>37</b>	

### 4.3. Consideration for commercial trawling

The purpose of this survey was to investigate the fish resources on the slope of Ghana. Previous surveys have only covered the shelf of Ghana with an occasional trawl in deeper depths. The observations from this survey will guide in the management also of the deep water slope. The slope off Ghana is falling rapidly at depths around 100 m to depths beyond 1000 m. Large areas of the slope is steep and rugged with canyons tearing trough making these areas mostly inaccessible to bottom trawling. This applies specifically to an area just of Volta river moth, to the south west of Accra and off three points. Commercially valuable demersal species were only caught in very small amounts on the slope with declining densities with depth.











R/V Dr. Fridtjof Nansen SURVEY:2010404 STATION: 20  
 DATE :03/05/2010 GEAR TYPE: BT NO: 21 POSITION:Lat N 4°24.91  
 start stop duration Lon W 1°3.79  
 TIME :17:52:53 18:22:33 29.7 (min) Purpose : 3  
 LOG : 8386.70 8388.24 1.5 Region : 2600  
 FDEPTH: 99 99 Gear cond.: 0  
 BDEPTH: 99 99 Validity : 0  
 Towing dir: 0° Wire out : 295 m Speed : 3.1 kn  
 Sorted : 73 Total catch: 553.20 Catch/hour: 1118.71

R/V Dr. Fridtjof Nansen SURVEY:2010404 STATION: 22  
 DATE :04/05/2010 GEAR TYPE: BT NO: 21 POSITION:Lat N 4°15.23  
 start stop duration Lon W 1°29.46  
 TIME :04:00:41 04:29:53 29.2 (min) Purpose : 3  
 LOG : 8453.82 8455.31 1.5 Region : 2600  
 FDEPTH: 130 135 Gear cond.: 1  
 BDEPTH: 130 135 Validity : 0  
 Towing dir: 0° Wire out : 365 m Speed : 3.1 kn  
 Sorted : 146 Total catch: 423.69 Catch/hour: 870.89

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Antigonia capros	303.34	15666	27.11	
Boops boops	174.92	8164	15.64	
Trachurus trecae	172.90	13385	15.46	59
Ariomma bondi	160.77	25970	14.37	
Dentex congongensis	106.17	2552	9.49	60
Priacanthus arenatus	83.32	1167	7.45	
Lagocephalus laevigatus	39.84	243	3.56	0
Sepia officinalis hierredda	17.59	26	1.57	58
Zeus faber	9.61	36	0.86	
Octopus sp.	9.10	20	0.81	
Lepidotrigla cadmani	8.70	162	0.78	
Raja miraletus	7.08	16	0.63	
Lepidotrigla carolae	5.26	121	0.47	
Syacium microrum	4.85	101	0.43	
Chelidichthys gabonensis	4.85	61	0.43	
Lagocephalus laevigatus	4.85	12	0.43	
Sepia sp.	2.43	142	0.22	
Dactylopterus volitans	1.21	2	0.11	
Grammolites gruvelli	0.81	40	0.07	
Lophiodes kempi	0.40	20	0.04	
Monoleme microstoma	0.40	61	0.04	
Engraulis encrasicolus	0.20	40	0.02	
Monoleme sp.	0.10	20	0.01	
Total	1118.71		100.00	

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Antigonia capros	378.31	20267	43.44	
Ariomma bondi	131.35	1702	15.08	
Boops boops	54.76	1054	6.29	70
Dentex congongensis	51.80	592	5.95	89
Aulopus cadenati	37.00	740	4.25	
Chelidichthys gabonensis	32.00	146	3.67	
Pagellus bellottii	23.49	832	2.70	71
Priacanthus arenatus	23.49	222	2.70	
Anthias anthias	19.24	1350	2.21	
Spherooides pachgaster	19.05	111	2.19	
Trigla lyra	17.76	814	2.04	
Trachurus trecae	13.69	1091	1.57	
Torpedo nobiliana	13.67	2	1.57	
Squalus megalops	10.79	10	1.24	
Scomber japonicus	9.80	185	1.13	69
Uranoscopus cadenati	6.84	37	0.79	
Dentex angolensis	5.36	314	0.62	68
Mustelus mustelus	4.93	2	0.57	
Squatina oculata	3.80	4	0.44	
Synagrops bellus	3.14	92	0.36	
Trachinus pellegrini	2.77	92	0.32	
Raja miraletus	2.77	8	0.32	
Torpedo torpedo	2.26	4	0.26	
Scorpaena normani	2.03	18	0.23	
Branchiostegus semifasciatus *	0.74	18	0.08	
Total	870.89		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010404 STATION: 21  
 DATE :04/05/2010 GEAR TYPE: BT NO: 21 POSITION:Lat N 4°20.69  
 start stop duration Lon W 1°16.24  
 TIME :00:29:47 00:59:58 30.2 (min) Purpose : 3  
 LOG : 8427.19 8428.82 1.6 Region : 2600  
 FDEPTH: 108 106 Gear cond.: 0  
 BDEPTH: 108 106 Validity : 0  
 Towing dir: 0° Wire out : 320 m Speed : 3.2 kn  
 Sorted : 71 Total catch: 339.77 Catch/hour: 675.26

R/V Dr. Fridtjof Nansen SURVEY:2010404 STATION: 23  
 DATE :04/05/2010 GEAR TYPE: BT NO: 21 POSITION:Lat N 4°12.79  
 start stop duration Lon W 1°31.97  
 TIME :05:49:18 06:12:10 22.9 (min) Purpose : 3  
 LOG : 8462.24 8463.39 1.1 Region : 2600  
 FDEPTH: 287 288 Gear cond.: 0  
 BDEPTH: 287 288 Validity : 0  
 Towing dir: 0° Wire out : 725 m Speed : 3.0 kn  
 Sorted : 105 Total catch: 795.87 Catch/hour: 2087.98

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Boops boops	386.75	13369	57.27	
Chelidichthys gabonensis	58.99	556	8.74	
Trachurus trecae	47.72	3309	7.07	64
Pentheroscion mbizi	15.02	111	2.23	
Umbria canariensis	13.22	42	1.96	
Ariomma bondi	12.80	181	1.90	
Priacanthus arenatus	10.16	209	1.50	0
Raja miraletus	10.14	26	1.50	
Raja miraletus	9.88	28	1.46	0
Lepidotrigla carolae	9.46	584	1.40	
Lepidotrigla cadmani	9.46	181	1.40	
Dentex congongensis	9.04	237	1.34	65
Spicara alta	8.76	1868	1.30	
Squatina oculata	8.65	4	1.28	
Pagellus bellottii	8.21	306	1.22	66
Mustelus mustelus	7.25	4	1.07	
Sepia officinalis hierredda	6.66	8	0.99	67
Pentheroscion mbizi	5.37	42	0.79	61
Uranoscopus cadenati	4.87	56	0.72	0
Scorpaena normani	4.73	14	0.70	
Trotula barbata	4.37	4	0.65	62
Todaropsis eblanae	2.92	14	0.43	
Priacanthus arenatus	2.48	12	0.37	
Microchirus frechkopi	2.37	42	0.35	
Umbria canariensis	2.19	8	0.32	63
Dactylopterus volitans	1.81	14	0.27	0
Synagrops bellus	1.67	42	0.25	
Pagrus caeruleostictus	1.67	14	0.25	0
Uranoscopus cadenati	1.55	4	0.23	
Citharus linguatula	1.53	83	0.23	0
Sepia sp.	1.53	42	0.23	
Sargocentron hastatus	1.39	14	0.21	
Pagrus caeruleostictus	0.87	2	0.13	
Pagellus bellottii	0.70	2	0.10	
Zeus faber	0.52	2	0.08	
Dactylopterus volitans	0.44	2	0.06	
Citharus linguatula	0.14	2	0.02	
Total	675.26		100.00	

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Zenion hololepis	1561.52	0	74.79	
Synagrops bellus	153.21	0	7.34	
Squalus megalops	55.62	42	2.66	
Lophius vaillanti	45.65	8	2.19	
Parasudis fraser-bruenneri	26.03	756	1.25	
Ariomma bondi	25.19	588	1.21	
Bembrops sp.	24.77	252	1.19	
Lophiodes kempi	22.67	42	1.09	
S H R I M P S	18.89	8311	0.90	
Trigla lyra	17.84	52	0.85	
Merluccius polli	16.66	29	0.80	
Xenodermichthys copei	14.69	965	0.70	
Todaropsis eblanae	11.33	84	0.54	
Aulopus cadenati	10.91	84	0.52	
Munidopsis sp.	10.07	0	0.48	
Calappa-like with spines	9.65	126	0.46	
Synagrops microlepis	8.40	294	0.40	
Raja alba	7.61	5	0.36	
Antigonia capros	7.14	168	0.34	
Torpedo nobiliana	6.69	3	0.32	
Lepidotrigla carolae	5.88	42	0.28	
Lestidiops sp.	5.04	126	0.24	
Chlorophthalmus atlanticus	4.62	0	0.22	
Malacocephalus occidentalis	4.20	42	0.20	
Epigonus sp.	3.78	798	0.18	
Chascanopsetta lugubris	2.52	42	0.12	
Sepia sp.	1.68	168	0.08	
Monoleme microstoma	1.68	84	0.08	
Spicara alta	1.26	42	0.06	
SOLEIDAE	1.26	42	0.06	
Trigla lyra	0.84	84	0.04	0
Priacanthus arenatus	0.84	84	0.04	
Total	2088.12		100.01	

R/V Dr. Fridtjof Nansen SURVEY:2010404 STATION: 24  
 DATE :04/05/2010 GEAR TYPE: BT NO: 21 POSITION:Lat N 4°10.74  
 start stop duration Lon W 1°31.60  
 TIME :07:47:04 08:17:08 30.1 (min) Purpose : 3  
 LOG : 8470.81 8472.36 1.6 Region : 2600  
 FDEPTH: 447 455 Gear cond.: 0  
 BDEPTH: 447 455 Validity : 0  
 Towing dir: 0° Wire out : 1000 m Speed : 3.1 kn  
 Sorted : 58 Total catch: 219.09 Catch/hour: 437.16

R/V Dr. Fridtjof Nansen SURVEY:2010404 STATION: 26  
 DATE :04/05/2010 GEAR TYPE: BT NO: 24 POSITION:Lat N 4°7.84  
 start stop duration Lon W 1°45.82  
 TIME :15:51:41 16:21:30 29.8 (min) Purpose : 3  
 LOG : 8509.43 8510.98 1.6 Region : 2600  
 FDEPTH: 814 830 Gear cond.: 0  
 BDEPTH: 814 830 Validity : 0  
 Towing dir: 0° Wire out : 1910 m Speed : 3.1 kn  
 Sorted : 33 Total catch: 33.06 Catch/hour: 66.52

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Nematocarcinus africanus	157.13 54996	35.94	
Trichiurus lepturus	80.81 1947	18.49	
Hymenocephalus italicus	59.36 4799	13.58	
Synagrops bellus	38.17 1273	8.73	
Merluccius polli	10.48 6	2.40	73
Chascanopsetta lugubris	8.44 305	1.93	0
Setarches quentheri	7.90 457	1.81	
Malacocephalus occidentalis	7.36 99	1.68	
Raja sp.	7.10 9	1.62	0
S H R I M P S	6.82 423	1.56	
Chlorophthalmus atlanticus	6.64 108	1.52	
Bembrops greyi	4.95 36	1.13	
Malacocephalus laevis	4.59 108	1.05	
Raja sp.	4.39 4	1.00	
Laemonema laureysi	4.22 18	0.97	
Helicolenus dactylopterus	4.11 6	0.94	
Benthodesmus tenuis	4.05 9	0.93	
Xenolepidichthys dagleishi	2.69 99	0.62	
Chaunax pictus	2.43 4	0.56	
Epigonus pandionis	2.15 27	0.49	0
Helicolenus dactylopterus	2.15 18	0.49	0
Chaunax pictus	1.80 9	0.41	
Zenopsis conchifer	1.72 4	0.39	
Parasudis fraser-bruenneri	1.17 68	0.27	
Todaropsis eblanae	1.06 8	0.24	
Etmopterus pusillus	0.99 9	0.23	
Zenion hololepis	0.90 108	0.21	
Synagrops microlepis	0.64 18	0.15	
PORTUNIDAE	0.64 9	0.15	
Todaropsis eblanae	0.64 27	0.15	0
Promethichthys prometheus	0.45 9	0.10	
Trigla lyra	0.44 2	0.10	
Chascanopsetta lugubris	0.40 2	0.09	
Caelorinchus coelori. geronimo	0.36 9	0.08	
Total	437.16	100.00	

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Centrophorus granulosus	14.89 4	22.38	
Yarella blackfordi	11.67 64	17.54	
Narctetes cf stomias	9.11 24	13.70	
Coryphaenoides zaniophorus	3.88 24	5.84	
Melanostomias sp.	2.54 36	3.81	
Talismania sp.	2.47 10	3.72	
Bathygadus macrops	2.29 12	3.45	
Aristeus varidens	2.21 2	3.33	
CENTROLOPHIDAE	1.83 2	2.75	
Trichiurus lepturus	1.51 68	2.27	
Melanonus zugmayeri	1.43 26	2.15	
Synaphobranchus affinis	1.31 12	1.97	
Nezumia duodecim	1.23 18	1.85	
Deania sp.	1.19 8	1.78	
Octopus sp.	1.03 0	1.54	
MYCTOPHIDAE	1.03 8	1.54	
Hydrolagus sp.	0.97 2	1.45	
Dicrolene intronigra	0.76 14	1.15	
Alepocephalus sp.	0.62 22	0.94	
Cranchia sp.	0.62 2	0.94	
Halosaurus ovenii	0.58 24	0.88	
Scombrolabrax heterolepis	0.52 4	0.79	
Benthodesmus tenuis	0.52 2	0.79	
Lamprogrammus exutus	0.44 2	0.67	
Priacanthus arenatus	0.40 34	0.60	
Nesiarchus nasutus	0.30 2	0.45	
Diretmoides parini	0.28 6	0.42	
Nezumia africana	0.20 2	0.30	
Snyderidia sp.	0.20 4	0.30	
Rouleina sp.	0.12 2	0.18	
Glyphus marupialis	0.08 2	0.12	
Xenodermichthys copei	0.08 2	0.12	
Melanocetus johnsoni	0.04 2	0.06	
Gonostoma elongatum	0.04 2	0.06	
Bathypterois viridensis	0.04 2	0.06	
Nephropsis atlantica	0.02 2	0.03	
Bathypterois phenax	0.02 2	0.03	
S H R I M P S	0.02 2	0.03	
Total	66.52	100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010404 STATION: 25  
 DATE :04/05/2010 GEAR TYPE: BT NO: 21 POSITION:Lat N 4°8.78  
 start stop duration Lon W 1°32.15  
 TIME :10:29:55 11:00:33 30.6 (min) Purpose : 3  
 LOG : 8483.07 8484.57 1.5 Region : 2600  
 FDEPTH: 710 728 Gear cond.: 0  
 BDEPTH: 710 728 Validity : 0  
 Towing dir: 0° Wire out : 1550 m Speed : 2.9 kn  
 Sorted : 103 Total catch: 209.49 Catch/hour: 410.36

R/V Dr. Fridtjof Nansen SURVEY:2010404 STATION: 27  
 DATE :04/05/2010 GEAR TYPE: BT NO: 24 POSITION:Lat N 4°9.79  
 start stop duration Lon W 1°44.71  
 TIME :18:29:04 18:59:06 30.0 (min) Purpose : 3  
 LOG : 8519.05 8520.61 1.6 Region : 2600  
 FDEPTH: 531 535 Gear cond.: 0  
 BDEPTH: 531 535 Validity : 0  
 Towing dir: 0° Wire out : 1230 m Speed : 3.1 kn  
 Sorted : 154 Total catch: 392.80 Catch/hour: 784.55

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Centrophorus granulosus	199.80 43	48.69	
Lamprogrammus exutus	33.50 118	8.16	
Yarella blackfordi	25.27 521	6.16	
Talismania sp.	22.41 168	5.46	
Scymnodon cf ringens	19.63 59	4.78	
Synagrops bellus	17.04 217	4.15	
Bathygadus macrops	12.22 43	2.98	
Bathyrcongiger vicinus	10.15 74	2.47	
Snyderidia sp.	9.29 180	2.26	
Sea cucumber	8.23 0	2.00	
Narctetes cf stomias	8.11 24	1.98	
Chaunax pictus	5.45 4	1.33	
Melanostomias sp.	5.17 67	1.26	
Aristeus varidens	5.01 192	1.22	
Hydrolagus alberti	4.86 12	1.18	
Malacocephalus laevis	4.27 16	1.04	
Synaphobranchus affinis	3.17 20	0.77	
Ectreposebastes imus	2.82 31	0.69	
Melanonus zugmayeri	2.78 16	0.68	
Nezumia duodecim	2.04 24	0.50	
Ariomma bondi	1.25 16	0.31	
Ebinania costaecanarie	1.18 4	0.29	
Plesiopenaeus edwardsianus	1.14 12	0.28	
Alepocephalus sp.	1.06 43	0.26	
Benthodesmus tenuis	0.98 4	0.24	
Diretmoides parini	0.86 24	0.21	
Promethichthys prometheus	0.82 20	0.20	
Nezumia aequalis	0.72 24	0.18	
Stereomastis sp.	0.39 20	0.10	
Coryphaenoides zaniophorus	0.31 4	0.08	
Nephropsis atlantica	0.24 4	0.06	
Monomitopus metriostoma	0.20 4	0.05	
Total	410.36	100.00	

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Nematocarcinus africanus	432.92 83792	55.18	
Centrophorus sp.	181.08 34	23.08	
Ijimaia loppel	37.45 8	4.77	
Trichiurus lepturus	29.52 541	3.76	
Melanostomias sp.	24.27 397	3.09	
Gadella imberbis	13.18 30	1.68	
Unidentified fish	11.53 30	1.47	
Yarella blackfordi	10.64 256	1.36	
Lophiodes kempi	9.99 4	1.27	
Xenodermichthys copei	5.25 180	0.67	
Diretmoides parini	4.65 165	0.59	
Aristeus varidens	3.89 225	0.50	0
Raja sp.	3.10 2	0.39	
Plesiopenaeus edwardsianus	3.00 45	0.38	0
Bathygadus macrops	2.56 60	0.33	
Bathyrcongiger vicinus	2.40 30	0.31	
Plesiopenaeus edwardsianus	2.10 28	0.27	
Priacanthus arenatus	2.10 90	0.27	
Chaceon maritae	1.66 15	0.21	
Aristeus varidens	1.10 38	0.14	
Gempylus serpens	0.82 2	0.10	
Polymetme corythaeola	0.60 30	0.08	
Dibranchius atlanticus	0.60 75	0.08	
Caristius maderensis	0.16 15	0.02	
Total	784.55	100.00	



R/V Dr. Fridtjof Nansen SURVEY:2010404 STATION: 32  
 DATE :05/05/2010 GEAR TYPE: BT NO: 21 POSITION:Lat N 4°22.00  
 start stop duration Lon W 2°23.90  
 TIME :18:27:42 18:57:35 29.9 (min) Purpose : 3  
 LOG : 8636.36 8637.85 1.5 Region : 2600  
 FDEPTH: 867 860 Gear cond.: 0  
 BDEPTH: 867 860 Validity : 0  
 Towing dir: 0° Wire out : 1920 m Speed : 3.0 kn  
 Sorted : 29 Total catch: 1110.30 Catch/hour: 2228.77

R/V Dr. Fridtjof Nansen SURVEY:2010404 STATION: 34  
 DATE :06/05/2010 GEAR TYPE: BT NO: 21 POSITION:Lat N 4°39.24  
 start stop duration Lon W 2°45.41  
 TIME :08:20:12 08:50:08 29.9 (min) Purpose : 3  
 LOG : 8705.45 8706.93 1.5 Region : 2600  
 FDEPTH: 117 120 Gear cond.: 0  
 BDEPTH: 117 120 Validity : 0  
 Towing dir: 0° Wire out : 310 m Speed : 3.0 kn  
 Sorted : 89 Total catch: 292.15 Catch/hour: 585.48

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sea cucumber	2007.36	0	90.07	
Yarella blackfordi	71.96	542	3.23	
Bathyrcoconger vicinus	34.13	161	1.53	
Narcetes cf stomias	24.49	110	1.10	0
Bathygadus macrops	14.35	201	0.64	
Synaphobranchus affinis	10.34	50	0.46	
Halosaurus ovenii	9.13	151	0.41	
Narcetes cf stomias	8.53	2	0.38	
Dicrolene intronigra	6.12	130	0.27	
Nezumia aequalis	5.92	100	0.27	
Glyphus marsupialis	5.22	141	0.23	
Raja sp.	5.22	2	0.23	
Nezumia micronychodon	4.72	70	0.21	
Rouleina sp.	4.22	30	0.19	
Nezumia africana	3.81	10	0.17	
Stereomastis sp.	3.61	191	0.16	
Talismania sp.	2.91	10	0.13	
Lamprogrammus niger	1.71	10	0.08	
Todaropsis eblanae	1.51	10	0.07	
Coryphaenoides zaniophorus	0.90	10	0.04	
Trichiurus lepturus	0.80	50	0.04	
Notacanthus cf sexspinus	0.60	10	0.03	
Melanonus zugmayeri	0.50	10	0.02	
Aristeus varidens	0.40	10	0.02	
Dibranchius atlanticus	0.30	20	0.01	
Total	2228.77		100.00	

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trachurus trecae	320.64	6038	54.77	78
Ariomma bondi	86.77	1735	14.82	
Pentheroscion mbizi	54.11	414	9.24	79
Scomber japonicus	39.54	381	6.75	82
Boops boops	25.51	377	4.56	
Dentex congosensis	23.45	415	4.00	80
Priacanthus arenatus	14.03	100	2.40	
Dentex angolensis	8.02	94	1.37	81
Raja miraletus	4.07	20	0.69	
Brotula barbata	3.11	2	0.53	
Pagellus bellottii	2.00	40	0.34	83
Sepia officinalis hierredda	1.47	13	0.25	
Zeus faber	1.26	6	0.22	
Fistularia petimba	0.90	4	0.15	
Sphyræna sphyraena	0.60	2	0.10	
Total	585.48		100.00	

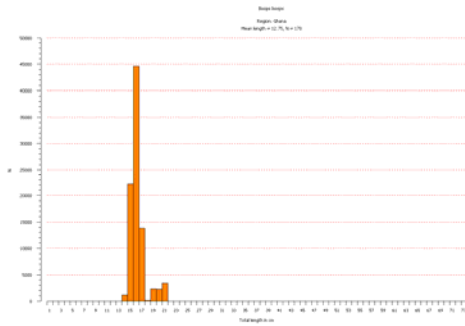
R/V Dr. Fridtjof Nansen SURVEY:2010404 STATION: 35  
 DATE :07/05/2010 GEAR TYPE: BT NO: 24 POSITION:Lat N 4°53.19  
 start stop duration Lon W 0°29.45  
 TIME :00:00:50 00:31:18 30.5 (min) Purpose : 3  
 LOG : 8850.89 8852.34 1.5 Region : 2600  
 FDEPTH: 584 529 Gear cond.: 0  
 BDEPTH: 584 529 Validity : 0  
 Towing dir: 0° Wire out : 1280 m Speed : 2.9 kn  
 Sorted : 85 Total catch: 85.30 Catch/hour: 167.97

R/V Dr. Fridtjof Nansen SURVEY:2010404 STATION: 33  
 DATE :06/05/2010 GEAR TYPE: BT NO: 21 POSITION:Lat N 4°33.24  
 start stop duration Lon W 2°40.77  
 TIME :05:11:04 05:40:28 29.4 (min) Purpose : 3  
 LOG : 8690.13 8691.63 1.5 Region : 2600  
 FDEPTH: 756 751 Gear cond.: 0  
 BDEPTH: 756 751 Validity : 0  
 Towing dir: 0° Wire out : 1700 m Speed : 3.1 kn  
 Sorted : 116 Total catch: 550.84 Catch/hour: 1124.16

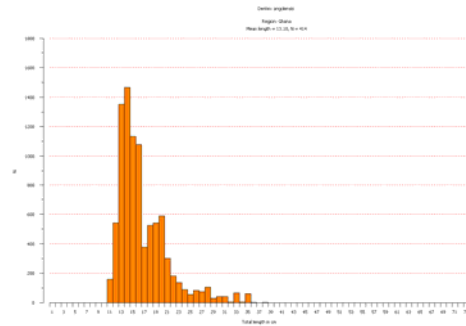
SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
J E L Y F I S H	78.77	0	46.89	
Yarella blackfordi	23.83	553	14.19	
Benthodesmus tenuis	17.33	358	10.32	
Laemonema laureysi	9.69	75	5.77	
MELANOSTOMIATIDAE	7.48	112	4.45	
Lophius vaillanti	5.71	2	3.40	
Merluccius polli	4.92	4	2.93	84
Bathygadus macrops	4.41	18	2.63	
Stereomastis sp.	2.76	104	1.64	
Nezumia aequalis	1.50	43	0.89	
Narcetes cf stomias	1.36	6	0.81	
Malacocephalus laevis	1.28	18	0.76	
Aristeus varidens	1.18	146	0.70	
Histioteuthis sp.	1.10	10	0.66	
Anemones, white	0.81	2	0.48	
Etmopterus pusillus	0.73	2	0.43	
Xenodermichthys copei	0.71	30	0.42	
Shrimps, small, non comm.	0.61	89	0.36	
Hoplostethus cadenati	0.57	12	0.34	
NETTASTOMATIDAE	0.43	4	0.26	
Halosaurus ovenii	0.33	6	0.20	
Narcetes cf stomias	0.32	6	0.19	0
Coloconger sp.	0.26	2	0.15	
Gnatophausia zoea	0.26	49	0.15	
Bajacalifornia magalops	0.20	6	0.12	
Neoscopelus macrolepidotus	0.18	6	0.11	
Alepocephalus sp.	0.16	10	0.09	
Lucibrotula nolfi	0.16	2	0.09	
Monomitopus metriostoma	0.14	6	0.08	
Diretmoides parini	0.14	4	0.08	
SOLEIDAE	0.12	2	0.07	
Dibranchius atlanticus	0.10	2	0.06	
Priacanthus arenatus	0.10	6	0.06	
Chlorophthalmus atlanticus	0.08	2	0.05	
Glyphus marsupialis	0.08	2	0.05	
Lamprogrammus exutus	0.06	4	0.04	
Synaphobranchus affinis	0.04	2	0.02	
Gonostoma elongatum	0.04	2	0.02	
Raja sp., juvenile	0.02	2	0.01	
Nemichthys scolopaceus	0.02	2	0.01	
Stomias sp.	0.02	2	0.01	
Total	167.97		100.00	

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sea cucumber	773.47	0	68.80	
Yarella blackfordi	111.02	2141	9.88	
Talismania sp.	41.57	294	3.70	
Lamprogrammus exutus	25.24	88	2.25	
Anemones, white	22.86	29	2.03	
Narcetes cf stomias	17.96	54	1.60	0
Stereomastis sp.	13.39	922	1.19	
Raja sp.	12.86	14	1.14	
Alepocephalus sp.	11.53	131	1.03	
Scymnodon cf ringens	10.12	43	0.90	
Nezumia duodecim	9.80	163	0.87	
Xenodermichthys copei	9.47	271	0.84	
Bassanago albescens	8.92	65	0.79	
Aristeus varidens	8.71	265	0.78	
Narcetes cf stomias	8.57	12	0.76	
Raja sp.	7.84	120	0.70	0
Dibranchius atlanticus	5.78	251	0.51	
Chaceon maritae	5.51	8	0.49	
MELANOSTOMIATIDAE	1.96	414	0.17	
Synaphobranchus affinis	1.96	11	0.17	
Octopus sp.	1.69	2	0.15	
Ebinania costaeacanarie	1.47	2	0.13	
Dicrolene intronigra	1.41	54	0.13	
Alepocephalus sp.	1.31	0	0.12	0
Bajacalifornia magalops	1.20	65	0.11	
Gnatophausia zoea	1.20	196	0.11	
Octopus sp.	1.08	11	0.10	0
MELANOSTOMIATIDAE	1.08	0	0.10	0
Nephropsis atlantica	0.88	65	0.08	
Diceratias pileatus	0.84	2	0.07	
Nezumia africana	0.76	11	0.07	
Halosaurus ovenii	0.65	22	0.06	
Gonostoma elongatum	0.55	11	0.05	
Benthodesmus tenuis	0.55	11	0.05	
Bassanago albescens	0.51	2	0.05	
Heterocarpus laevigatus	0.33	11	0.03	
Shrimps, small, non comm.	0.33	65	0.03	
Total	1124.36		100.02	

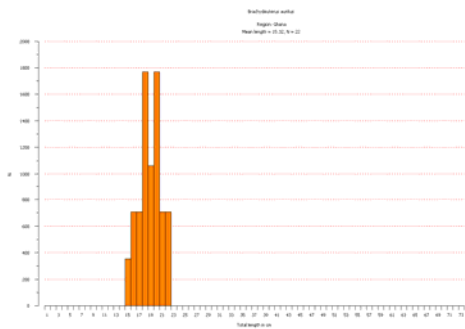
## Annex II Length distributions of main species



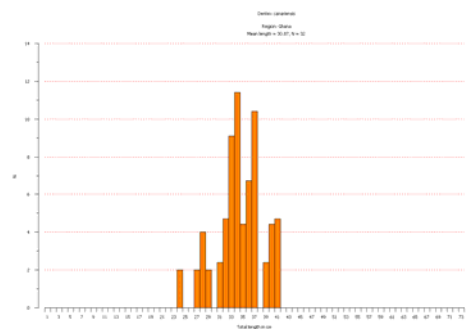
*Boops boops* N = 170



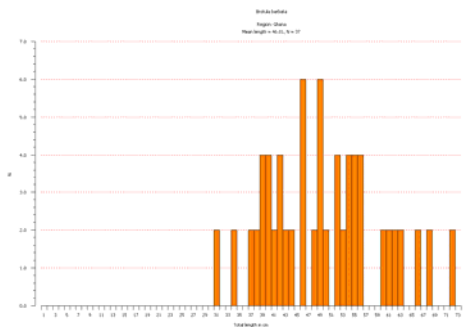
*Dentex angolensis* N = 414



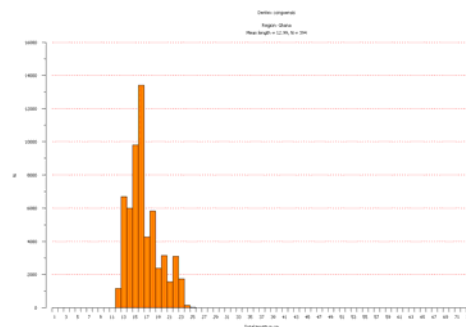
*Brachydeuterus auritus* N = 22



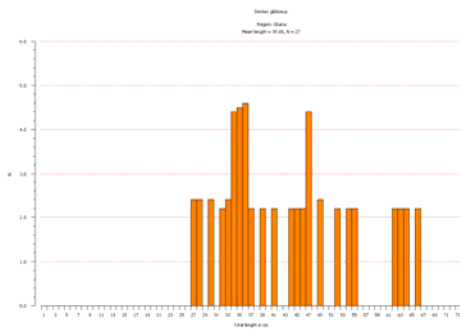
*Dentex canariensis* N = 32



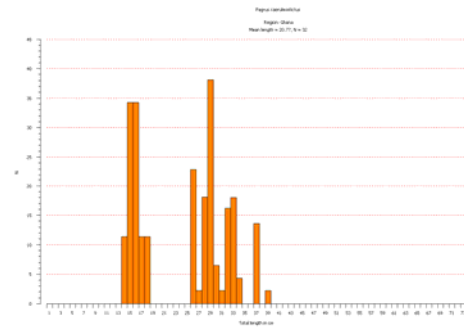
*Brotula barbata* Total length N = 37



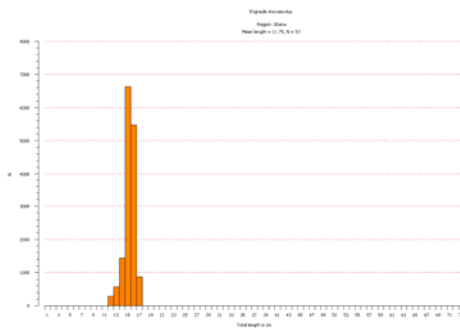
*Dentex congoensis* N = 394



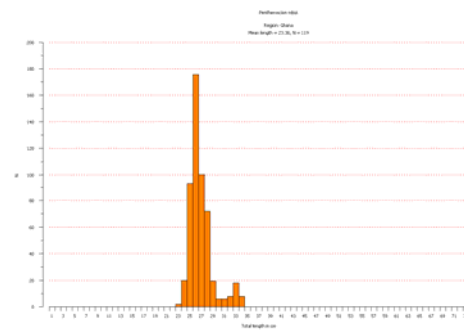
*Dentex gibbosus* N = 27



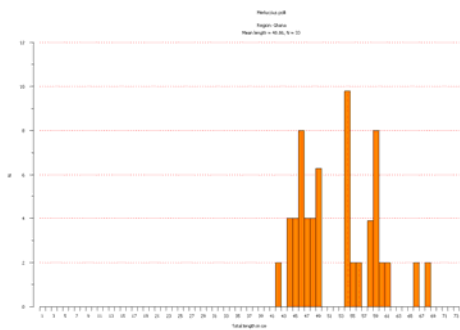
*Pagrus caeruleostictus* N = 32



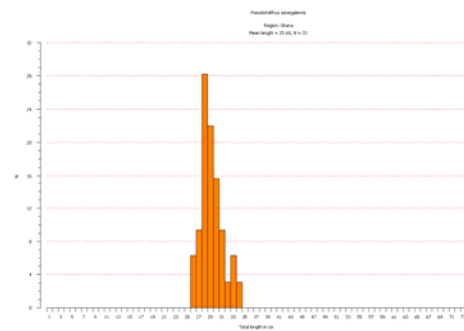
*Engraulis encrasicolus* N = 53



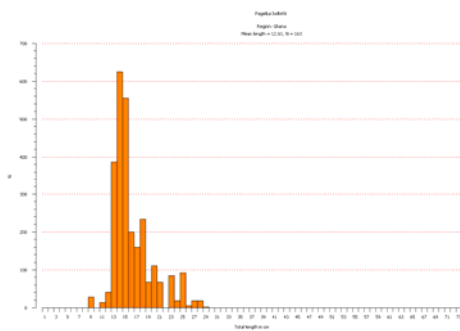
*Pentheroscion mbizi* N = 119



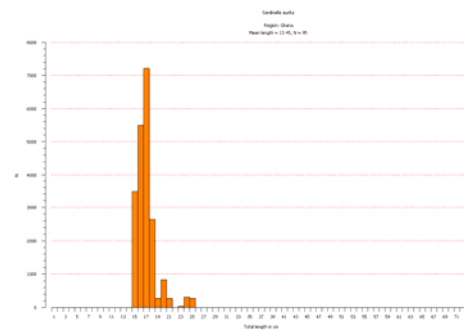
*Merluccius polli* N = 33



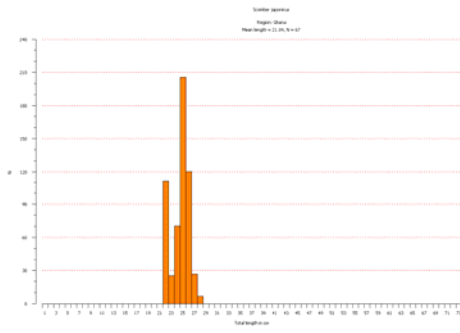
*Pseudolithus senegalensis* N = 33



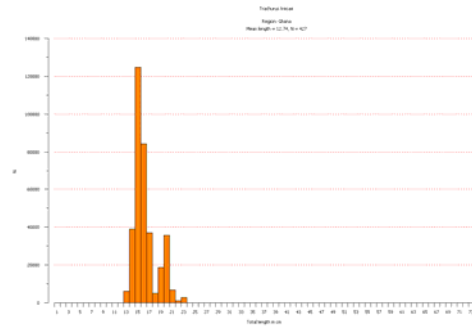
*Pagellus bellottii* N = 163



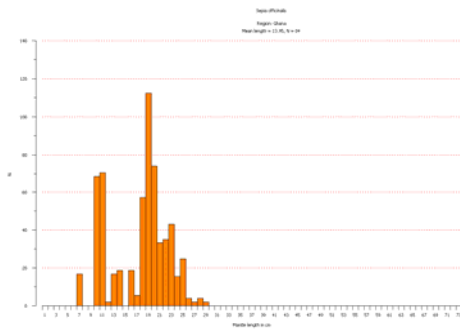
*Sardinella aurita* N = 95



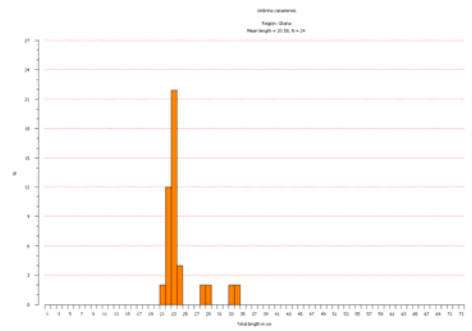
*Scomber japonicus* N = 67



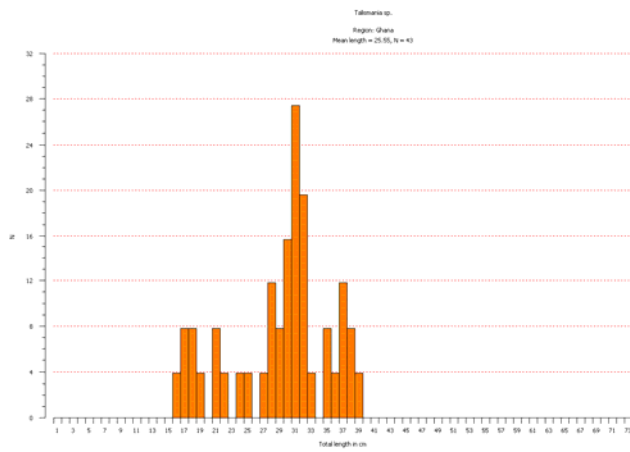
*Trachurus trecae* N = 427



*Sepia officinalis* N = 84



*Umbrina canariensis* N = 24



*Talismania* sp. N = 43



### Annex III Swept-area estimate per depth region

SPECIES NAME	SAMPLE DISTRIB. BY CATCH CLASSES						% Inci- dence	Mean Dens. t/nm <sup>2</sup>	Mean densities by bottom depth strata t/nm <sup>2</sup>				
	Lower limits, Kg/nm								>0	10	30	100	300
<i>Trachurus trecae</i>	4	2	1	1	1	1	28.6	6.5	23.5	5.2			
<i>Sea cucumber</i>	3		3	3	1		28.6	3.9		0.0	0.8	16.3	
<i>Antigonia</i> sp.					1		2.9	2.6		7.4			
<i>Dentex congoensis</i>	8	1	2	3			40.0	1.8	5.8	1.7			
<i>Zenion hololepis</i>	3				1		11.4	1.5		4.3	0.0		
<i>Synagrops bellus</i>	12	2	1		1		45.7	1.4		0.5	5.1	0.1	
<i>Priacanthus arenatus</i>	16	1		2			54.3	1.4	0.5	3.7	0.0	0.0	
<i>Ariomma bondi</i>	12	1	3	1			48.6	0.9	0.8	2.1	0.1	0.0	
<i>Chlorophthalmus atlanticus</i>	3		1	1			14.3	0.8		0.0	3.7		
<i>Antigonia capros</i>	3	1	1	1			17.1	0.7	1.4	1.2			
<i>Lophius vaillanti</i>	7	4		1			34.3	0.6	0.1	0.3	0.5	1.5	
<i>Nematocarcinus africanus</i>			1	1			5.7	0.5			2.4		
<i>Yarella blackfordi</i>	7	3	2				34.3	0.5			0.5	1.7	
<i>Centrophorus granulosus</i>	2		2				11.4	0.5			0.1	1.9	
<i>Brachydeuterus auritus</i>	1			1			5.7	0.4	2.2				
<i>Dentex angolensis</i>	10	3	1				40.0	0.4	1.0	0.6			
<i>Sardinella aurita</i>	2			1			8.6	0.4	1.8	0.0			
<i>Sepia officinalis hierredda</i>	10	2	1				37.1	0.3	1.5	0.1			
J E L L Y F I S H		1	1				5.7	0.3	1.2		0.3		
<i>Pentheroscion mbizi</i>	5	1	1				20.0	0.2	0.7	0.3			
<i>Rhinobatos albomaculatus</i>	3		1				11.4	0.2	0.0	0.6		0.0	
<i>Trichiurus lepturus</i>	14	1					42.9	0.2	0.0	0.1	0.6	0.0	
<i>Spicara alta</i>	8		1				25.7	0.2	0.8	0.1			
<i>Centrophorus</i> sp.	1		1				5.7	0.2			0.7		
<i>Lepidotrigla cadmani</i>	6	2					22.9	0.2	0.5	0.2			
<i>Shrimps unidentified</i>			1				2.9	0.2			0.7		
<i>Engraulis encrasicolus</i>	2		1				8.6	0.2	0.1	0.4			
<i>Chelidonichthys gabonensis</i>	5	3					22.9	0.1	0.0	0.4			
<i>Brotula barbata</i>	10	1					31.4	0.1	0.1	0.3			
<i>Lamprogrammus exutus</i>	8	2					28.6	0.1			0.0	0.6	
<i>Malacocephalus occidentalis</i>	5	1					17.1	0.1		0.0	0.5	0.0	
<i>Ephippion guttifer</i>			1				2.9	0.1		0.3			
<i>Laemonema laureysi</i>	8	1					25.7	0.1		0.0	0.4	0.1	
<i>Bathygadus macrops</i>	10						28.6	0.1			0.1	0.3	
<i>Unidentified fish</i>	6	1					20.0	0.1	0.0	0.2	0.1		
<i>Pagellus bellottii</i>	9	1					28.6	0.1	0.2	0.2			
<i>Parasudis fraser-bruenneri</i>	3	1					11.4	0.1		0.1	0.3		
<i>Zeus faber</i>	9	1					28.6	0.1	0.1	0.2			
<i>Narctes cf stomias</i>	8						22.9	0.1			0.0	0.4	
<i>Umbrina canariensis</i>	5	1					17.1	0.1	0.1	0.2			
<i>Fistularia petimba</i>	8	1					25.7	0.1	0.4	0.0			
<i>Todaropsis eblanae</i>	9	1					28.6	0.1		0.1	0.2	0.0	
<i>Lophiodes kempfi</i>	9	1					28.6	0.1	0.0	0.1	0.2		
<i>Squalus megalops</i>	4	1					14.3	0.1		0.2	0.0		
<i>Talismania</i> sp.	5	1					17.1	0.1			0.0	0.4	
<i>Merluccius polli</i>	10						28.6	0.1		0.0	0.2	0.1	
<i>Dentex gibbosus</i>	2	1					8.6	0.1	0.3	0.0			
<i>Lagocephalus laevigatus</i>	5	1					17.1	0.1	0.3	0.0			
<i>Bathyroconger vicinus</i>	6	1					20.0	0.1			0.0	0.3	
<i>Ijimaia loppei</i>	5	1					17.1	0.1			0.2	0.1	
<i>Raja miraletus</i>	15						42.9	0.1	0.1	0.1	0.0	0.0	
<i>Aulopus cadenati</i>	2	1					8.6	0.1		0.2			
<i>Stereomastis</i> sp.	11						31.4	0.1			0.1	0.2	
<i>Aristeus varidens</i>	14						40.0	0.1		0.0	0.1	0.2	
<i>Raja</i> sp.	9						25.7	0.1			0.1	0.2	
<i>Pagrus caeruleostictus</i>	7						20.0	0.1	0.2	0.1			
<i>Uranoscopus cadenati</i>	2	1					8.6	0.1		0.2			

<i>Hymenocephalus italicus</i>		1	2.9	0.1			0.2	
<i>Pseudolithus senegalensis</i>	2		5.7	0.0	0.1	0.1		
<i>Scymnodon cf ringens</i>	8		22.9	0.0			0.0	0.2
<i>Scomber japonicus</i>	1	1	5.7	0.0		0.1		
<i>Ectreposebastes imus</i>	5		14.3	0.0			0.0	0.2
<i>Anemones, white</i>	5		14.3	0.0			0.0	0.2
<i>Chascanopsetta lugubris</i>	5		14.3	0.0		0.0	0.2	0.0
<i>Trigla lyra</i>	7		20.0	0.0		0.1	0.0	
<i>Setarches guentheri</i>	2	1	8.6	0.0			0.2	
<i>Nezumia duodecim</i>	5		14.3	0.0				0.2
TRIGLIDAE	3		8.6	0.0	0.1	0.1		
<i>Diplodus sp.</i>		1	2.9	0.0		0.1		
<i>Melanostomias sp.</i>	4		11.4	0.0			0.1	0.0
<i>Antigonia sp capros</i>		1	2.9	0.0		0.1		
<i>Dibranchius atlanticus</i>	11		31.4	0.0		0.0	0.0	0.1
<i>Lepidotrigla carolae</i>	7		20.0	0.0	0.0	0.1		
<i>Malacocephalus laevis</i>	11		31.4	0.0		0.0	0.1	0.0
<i>Nezumia aequalis</i>	9		25.7	0.0			0.1	0.1
<i>Mustelus mustelus</i>	5		14.3	0.0	0.0	0.1		
<i>Rhizoprionodon acutus</i>	2		5.7	0.0		0.1		
<i>Benthodesmus tenuis</i>	8		22.9	0.0			0.1	0.0
<i>Xenodermichthys copei</i>	11		31.4	0.0		0.0	0.0	0.0
<i>Dentex canariensis</i>	3		8.6	0.0	0.1	0.1		
Shrimps, small, non comm.	7		20.0	0.0			0.0	0.1
<i>Scorpaena maderensis</i> *		1	2.9	0.0	0.2			
URCHINS	4		11.4	0.0		0.0		0.1
<i>Squalus sp.</i>	2		5.7	0.0		0.1		
<i>Dasyatis marmorata</i>	1		2.9	0.0		0.1		
<i>Squatina oculata</i>	4		11.4	0.0	0.0	0.1		
<i>Cyttopsis roseus</i>	3		8.6	0.0		0.0	0.1	
<i>Synphobranchus affinis</i>	8		22.9	0.0				0.1
ALEPOCEPHALIDAE	3		8.6	0.0			0.0	0.1
<i>Torpedo nobiliana</i>	3		8.6	0.0		0.1	0.0	
S H R I M P S	4		11.4	0.0		0.1	0.0	
<i>Alepocephalus sp.</i>	7		20.0	0.0			0.0	0.1
Shark eggs	2		5.7	0.0			0.0	0.1
<i>Bembrops sp.</i>	1		2.9	0.0		0.1		
RHINOBATIDAE	1		2.9	0.0		0.1		
<i>Physiculus huloti</i>	3		8.6	0.0		0.1		
<i>Bembrops greyi</i>	4		11.4	0.0		0.0	0.1	
Starfish	2		5.7	0.0		0.1		0.0
<i>Hydrolagus sp.</i>	3		8.6	0.0			0.0	0.1
<i>Galeus polli</i>	2		5.7	0.0			0.1	
<i>Anthias anthias</i>	2		5.7	0.0		0.1		
<i>Sphoeroides pachgaster</i>	2		5.7	0.0		0.1		
<i>Dasyatis sp.</i>	1		2.9	0.0		0.1		
<i>Chaceon maritae</i>	7		20.0	0.0			0.0	0.1
<i>Caelorinchus coelori. geronimo</i>	4		11.4	0.0			0.1	
<i>Halosaurus ovenii</i>	7		20.0	0.0			0.0	0.1
<i>Gadella imberbis</i>	3		8.6	0.0		0.0	0.1	0.0
<i>Calappa-like with spines</i>	3		8.6	0.0		0.0	0.0	
<i>Centrophorus lusitanicus</i>	3		8.6	0.0			0.0	0.0
<i>Nezumia micronychodon</i>	4		11.4	0.0				0.1
<i>Plesiopterus edwardsianus</i>	6		17.1	0.0			0.0	0.0
<i>Illex coindetii</i>	2		5.7	0.0		0.0		
<i>Scorpaena scrofa</i>	2		5.7	0.0	0.1	0.0		
<i>Chaunax pictus</i>	4		11.4	0.0			0.0	0.0
<i>Octopus vulgaris</i>	5		14.3	0.0	0.0	0.0	0.0	
<i>Octopus sp.</i>	6		17.1	0.0	0.1			0.0
<i>Peristedion cataphractum</i>	5		14.3	0.0		0.0	0.0	
<i>Syacium micrurum</i>	7		20.0	0.0	0.0	0.0		
MELANOSTOMIATIDAE	4		11.4	0.0			0.0	0.0
<i>Alectis alexandrinus</i>	1		2.9	0.0	0.1			
<i>Coryphaenoides zaniophorus</i>	5		14.3	0.0				0.1
<i>Torpedo torpedo</i>	4		11.4	0.0		0.0		
<i>Raja doutrei</i>	1		2.9	0.0			0.1	

<i>Dicrolene intronigra</i>	5	14.3	0.0				0.1
<i>Oxynotus centrina</i>	2	5.7	0.0		0.0	0.0	
<i>Sepia</i> sp.	7	20.0	0.0	0.0	0.0	0.0	
<i>Glyphus marsupialis</i>	6	17.1	0.0			0.0	0.0
<i>Munidopsis</i> sp.	2	5.7	0.0		0.0	0.0	
<i>Rouleina</i> sp.	3	8.6	0.0				0.0
<i>Parapenaeus longirostris</i>	3	8.6	0.0		0.0	0.0	
<i>Synagrops microlepis</i>	3	8.6	0.0		0.0	0.0	
Sum all species			31.5	44.5	34.2	20.3	27.1
Sum SNAPPERS, JOBFISHES							
Sum GROUPERS, SEABASSES			0.0	0.1			
Sum GRUNTS, SWEETLIPS			0.4	2.2			
Sum CROAKERS, DRUMS, WEAKF., KOBBS			0.4	0.9	0.6		
Sum PANDORAS, PORGIES, SEABREAMS,			2.5	7.6	2.8		
Sum SHARKS, CHIMAERAS			1.0	0.1	0.6	1.1	2.3
Sum BATOID FISHES, RAYS			0.5	0.1	1.1	0.2	0.2
Sum CEPHALOPODS			0.5	1.5	0.3	0.2	0.0
Numbers of stations included in analysis, total and by depth strata			35	7	12	8	8

## **Annex IV Instruments and fishing gear used**

The Simrad ER-60 scientific echo sounder connected to 18, 38, 120 and 200 kHz transducers was run during the survey only for observation of fish and bottom conditions. No scrutinizing of the recordings was done.

Last standard sphere calibrations were carried out 07.03.2010 in Baia dos Elefantes. Angola using Cu-64, Cu-60, WC-38.1 and WC-38.1 spheres for 18, 38, 120 and 200 kHz, respectively. The details of the settings of the 38 kHz echo sounder were as follows:

### **Transceiver-2 menu (38 kHz)**

Transducer depth	5.50 m
Absorption coeff.	8,5 dB/km
Pulse duration	medium (1,024ms)
Bandwidth	2,43 kHz
Max power	2000 Watt
2-way beam angle	-20,6dB
gain	25,23 dB
SA correction	-0,51 dB
Angle sensitivity	21.9
3 dB beamwidth	7,35° along ship
	7,31° athwardship
Alongship offset	-0.05°
Athwardship offset	0.06°

**Bottom detection menu      Minimum level -40 dB**

## **Fishing gear**

The vessel has two different sized "Åkrahamn" pelagic trawls and one "Gisund super bottom trawl". During the present survey only the bottom trawl was used.

The bottom trawl has a headline of 31 m, footrope 47 m and 20 mm mesh size in the codend with an inner net of 10 mm mesh size. The trawl height was about 4.5 m and distance between wings during towing about 21 m. The sweeps are 40 m long. The trawl is equipped with a 12" rubber bobbins gear. Since 19.02.08 new and heavier "Thyborøn" combi trawl doors (7.41 m<sup>2</sup>, 1720 kg) have been in used. During the present survey the door distance was kept nearly constant at about 50 m at all depths by the use of a 9 m strap between the wires at 120 m distance from the doors (normally applied at depths greater than 80 m). At depths greater than 300 m the trawl was equipped with a tickler chain, which improves the catchability of bottom living and borrowing species, particularly shrimps.

The SCANMAR system was used on 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 distance, and the trawl was equipped with a trawl eye that provides information about the trawl opening. A catch sensor on the cod-end indicated the size of the catch.