

Gabon Ecosystem Survey

9 – 23 MAY 2014



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 GEF-supported Large Marine Ecosystem (LME) projects and other projects that have the potential to contribute to some components of the EAF-Nansen project.

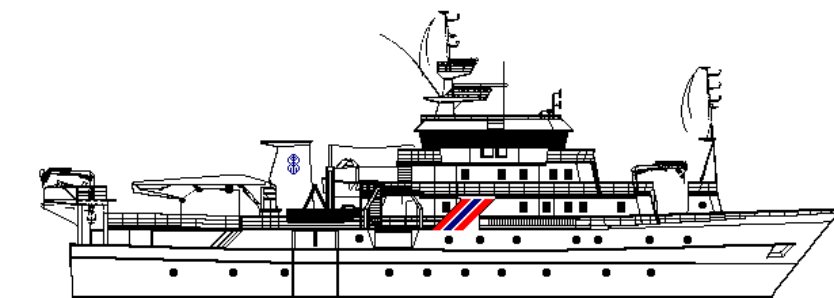
The EAF-Nansen project offers an opportunity to coastal countries in sub-Saharan Africa, working in partnership with the project, to receive technical support from FAO for the development of national and regional frameworks for the implementation of the Ecosystem Approach to Fisheries management and to acquire additional knowledge on 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, operation 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 oeuvre 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 oeuvre et le suivi des progrès de la mise en oeuvre de plans d'aménagement des ressources marines conformes à l'approche écosystémique des pêches.

SURVEY REPORT "DR FRIDTJOF NANSEN"



Gabon Ecosystem Survey Report

09–23 May 2014

by

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Executive summary

In the last assessment of the demersal resources in the southern CECAF area it was concluded that most of the stocks that were analyzed are fully to over-exploited (CECAF/ECAF SERIES 11/73). It was however noted that for most of the stocks, the only series of stock abundance indices available were commercial catch per unit effort (CPUE) data series. A scientific survey giving an overview of the status of the main fish stocks is therefore very valuable for improved management of the fish stocks in the area.

The research vessel (R/V) Dr Fridtjof Nansen has previously been in the area off Gabon on six occasions over the last ten years; in 2010, 2008, 2007, 2006, 2005 and 2004. In the first and the two last surveys, pelagic resources were studied, while in the remaining surveys, the hydrographical conditions and demersal fish resources were also covered. In 2014 an ecosystem survey was carried out. This involved a sampling design covering most of the living resources of the continental shelf and linkage to their environment. The main objective of the survey was, however, to estimate abundance and map the distributions of demersal and pelagic fish species in the area.

The most notable oceanographic features were the comparatively warmer upper water-masses in the northern part of the coastal area, along with the more saline upper water-masses towards the south. This is probably a result of the timing of the survey which is coincident with the late phase of the wet season, causing lower salinity in the surface waters on the shelf off northern Gabon due to freshwater runoff from the coastal rivers.

The bottom trawl catches in the area north of Cape Lopez were small; while south of Cape Lopez the catches were considerably higher, especially in the area with depths between 100-200 m (upper slope). The highest catch occurred on the upper slope, with 2 850 kg/h, mainly consisting of various non-commercial fish species, but also one catch above 800 kg/h was recorded for the group demersal fish (dominated by *Dentex Congoensis*).

The biomass of the main commercial demersal species (Sciaenidae, Serranidae, Pomadasyidae, Lutjanidae and Sparidae) showed a steady decreasing trend. The occurrence of pelagic fish was too low to permit any reliable biomass calculation for the 2014 survey, but calculations from previous surveys indicate a strong decreasing trend. Both findings indicate that it is time to conduct an annual assessment workshop for the demersal and pelagic resources in order to establish long term beneficial management measures and goals. It is of special importance to adopt precautionary measures for the exploitation of small pelagics like sardinella which is a transboundary resource that needs to be monitored at a regional level.

In general, biodiversity indices score lower in deeper waters, almost represented by an inverse relationship between species richness and catch size, with the exception of a few shallow stations scoring low and occurring in heavy trawled areas close to the coast. The biodiversity in a given area is highly dependent on local environmental conditions (i.e. substrate type, temperature and nutrients available) and the best use of these indices is their use for habitat monitoring.

Of particular interest was the study comparing fish abundance and habitat damage, inside and outside the marine park of Mayumba. A great effort has been made to stop all illegal fishing activity inside the park and nowadays it is a no-take area, whereas only regulated industrial fishing activity takes place outside the park. Preliminary results show that, not only are the catch rates in the national park higher and with higher species richness; the species composition has also changed compared to previous surveys. Further research on this topic is needed. Sediment and benthos analysis will determine if these differences are due to a change in the environmental conditions, or explained by effects of the national park being protected from the fishing activity.

1. INTRODUCTION

1.1. Aims and objectives

The purpose of the R/V Dr Fridtjof Nansen survey was established during a meeting held on 23 April 2014 in the Gabon capital Libreville, between representatives from the Gabon Department of Fisheries, Gabon Bleu, CENAREST, IMR and FAO.

The Gabon ecosystem survey was carried out from 9 to 23 May 2014. Following requests from Gabon, the main objectives of the survey were:

- To estimate the abundance and map the distribution of the main demersal fish species on the shelf by bottom trawling and acoustic recording
- To map the distribution and estimate the acoustic abundance of the main pelagic fish species groups in the region
- To map the distribution and abundance of marine mammals, turtles and birds on the continental shelf
- To collect bottom sediment samples, map the bottom type and bottom hardness in the region
- To collect phytoplankton and zooplankton samples for estimation of biomasses and species identification
- To map the general hydrographical regime by using a CTD to monitor the temperature, salinity and oxygen
- To collect benthos samples in specific areas of interest
- Capacity building of local scientists, covering the main survey routines

1.2. Participation

A total of ten scientists and technicians from Gabon participated in the survey. The full list of the participants and their affiliations is given in Table 1.1 below.

Table 1.1 . List of participants. Gender is indicated in brackets (F) = Female, (M) = male

<i>Participants:</i>	<i>Institution</i>	<i>Period:</i>	<i>e-mail</i>
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DE BRUYNE Godefroy (M)	G Bleu	09.05-23.05	godefroy.debruyne@gmail.com

List of institution abbreviations:

IMR - Institute of Marine Research

DGPA - Direction Generale des Peches et de l'Aquaculture

Cenarest - Centre National de la Recherche Scientifique

G Bleu - Gabon Bleu

1.3. Narrative

The vessel left port in Port Gentil, Gabon on 9 May at 16:00 local time (local time = UTC+1 hour) to go to the northern part of the survey area to start the sampling program. The first transect at 0°36' N and 8°50' E, was reached on 9 May at 21:00 local time close to the northern line transect in front of Cape Esterias. The coverage of the northern region was completed on 11 May at 21:00 local time. After a stop to fuel the vessel, the cruise continued. The next region, south of Cape Lopez was commenced immediately after this on 12 May at 21:00 local time. The coverage of the area was completed 18 May at 20:00 local time. In the third region, Mayumba, van-veen grab and bottom trawling were used to compare biodiversity inside and outside the Mayumba National Park. The coverage of this region was completed on 19 May at 22:00. The next morning, the vessel headed northwards, giving an opportunity for observation of marine mammals, following the 500 m depth contour for 130 nm from 06:00 in the morning to 19:00 in the evening. On 21 May at 03:00 bottom trawling was conducted outside the oil exclusion zone, close to Cape Lopez. At 08:00 the same day a bottom trawl station was conducted on the plateau above the deep canyon outside Cape Lopez. The rest of the day and the following night, van-veen grabbing was conducted (five stations, with two replicates each). The last day at sea, the time was used for washing of laboratories and equipment, packing of samples and fish. A wrap-up meeting was held where the main results were presented and hard drives containing all data collected onboard were handed over to representatives of the three institutions that had participated on board. The vessel entered the harbour in Port Gentil on 23 May.

1.4. Survey effort

The coast of Gabon is generally characterized by a relatively wide shelf that breaks at around 100 m depth in the north and at approximately 200 m depth in the south of the country. Cape Lopez divides the shelf into two separate shelf zones, which are separated by a strong temperature front, especially during the winter. Previously surveys in the area have also shown that fish communities are different in these regions. Thus, for the purpose of acoustic and swept area biomass estimation, the coast was divided into two regions. The first region (North of Cape Lopez) included the area from the border to Equatorial Guinea to Cape Lopez, and the second region covered the area 60 nautical miles (nm) south of Cape Lopez and ended close to the border of Congo.

The survey was carried out around the clock. The cruise ended with a wrap-up meeting and offloading of samples in Port Gentil on 23 May.

The survey transects were made perpendicular to depth isobaths and spaced 20 nm apart, north of Cape Lopez, and 17 nm apart south of Cape Lopez. They covered the depth-interval from 20 m depth near the coast to 800 m depth offshore. Bottom trawling was conducted within four different depth-strata on each of these transects between 20-50 m, 50-100 m and 100-500 m depth. When time and bottom conditions permitted, occasional trawls were conducted deeper than 500 m. Pelagic trawls were supposed to be used to sample and verify acoustic targets, but due to low acoustic signals only one pelagic trawl haul was conducted. CTD's were taken at each bottom-trawl station.

Every third transect was termed an "Ecosystem transect" with a more elaborate sampling activity. These transects extended to depths of 1000 m. CTD's were taken at bottom-depths of 1000 m, 500 m, 100 m and 30 m. Additionally, three stations for sampling of chlorophyll, phyto- and zooplankton, fish eggs and larvae (using algae net, WP 2 and Multinet, respectively) were conducted at positions with bottom-depths of 500 m, 100 m, and 30 m. Trawling was undertaken within the same depth-regions as for all other transects.

Acoustic data from the ER 60 echo sounder (18 kHz, 38 kHz, 120 kHz and 200 kHz transducers), ADCP data and data from the thermosalinograph and weather station were recorded continuously during the survey. The multibeam bottom mapping echo sounder SM710 was unfortunately not working during the survey.

In addition to bottom trawls, a Van-Veen Grab was used to study the biodiversity in the marine protected area in the south (Mayumba) and the canyon area off Port Gentil. A steel cylinder was attached to the trawl gear to collect bottom sediments.

Two dedicated observers conducted visual inspection of whales, sharks, turtles and birds along the route.

The cruise tracks with bottom-trawls, pelagic trawls, hydrographical stations, plankton stations and grabs can be found in Figure 1.1. Table 1.2 summarises the survey effort in each sub-area.

By the end of the survey, all data recorded and samples collected during the survey were handed over to the participants from the three institutions. A list of responsible persons for each group of samples is given in Table 1.3.

A post survey meeting was conducted in Libreville, Gabon, 10-12 December 2014. Here the results were discussed and the survey report finalized. The results were then presented to representatives of the Government of Gabon.

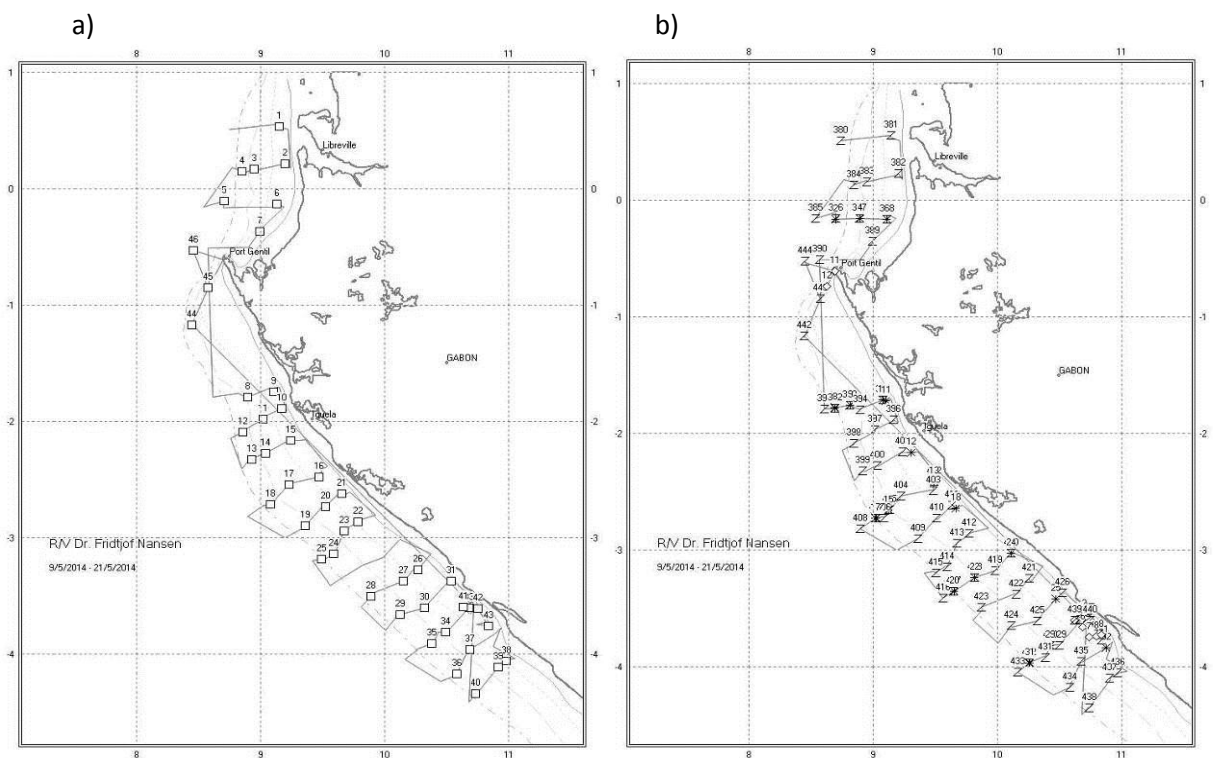


Figure 1.1. Course track. a) bottom trawl (□) and pelagic (Δ) trawl stations. b) Hydrographical (Z), plankton (x) stations and van-veen grab stations (◇). The depth contour is indicated.

Table 1.2. Number of hydrographical (CTD), plankton (PL), pelagic trawl (PT), and bottom-trawl (BT), sediment and benthos sampling stations (van-veen grab), as well as the distance covered (nm) during the survey by sub-areas

Sub region/Country	Nautical miles	Bottom trawls per depth region					Pelagic trawls	CTD	Plankton	Sediment	Grab
		Total	>20	>50	>100	>500					
North of Cape Lopez	500	6	4	1	1		11	6			
South of Cape Lopez	882	32	10	11	10	1	48	21	31		
Mayumba		3	3				3			18	
Port Gentil		3	1		1	1	3			10	
Total	1382	44	18	12	12	2	1	65	27	31	28

Table 1.3 List of responsible persons for each group of samples

Type of sample	Volume /numbers	Conservation	Responsible institute	Responsible person
Phytoplankton, species id. (qualitative)	12 samples	Formalin	Gabon Bleu, DGPA	Raul Vilela
Phytoplankton, species id. (quantitative)	15 samples	Lugol	CENAREST	Blaise M Boye
Zooplankton, species id.	17 samples (14WP2+3Multinet)	Formalin	CENAREST	Blaise M Boye
Zooplankton, biomass	42 samples	(Size-fractionated dry weight)	Institute of Marine Research	Espen Bagøien
Chlorophyll	124 samples	Deep-frozen	Institute of Marine Research	Espen Bagøien
Invertebrates from van veen grab	28 samples 14 stations	Formalin/ ethanol	Gabon Bleu, DGPA	Raul Vilela
Sediment samples from bottom trawl	31 samples	frozen	Gabon Bleu	Raul Vilela
fish, taxonomic samples	10	formalin	CENAREST	MVE BEH Jean Hervé
Catch data	44 stations	Hard drive	G Bleu, Cenarest, DGPA	Raul Vilela
Acoustic recordings	1382 NM	Hard drive	G Bleu, Cenarest, DGPA	Raul Vilela
Pictures of fish from the trawl catch	400 pictures of fish and 200 of invertebrates	Hard drive	G Bleu, Cenarest, DGPA	Raul Vilela
CTD	65 stations	Hard drive	G Bleu, Cenarest, DGPA	Raul Vilela
Recordings of bottom depth from Olex	From current and previous surveys in Gabon	Hard drive - post survey meeting	G Bleu	Raul Vilela
Preliminary survey report		Hard drive	G Bleu, Cenarest, DGPA	Raul Vilela

2. METHODS

2.1. Meteorological and hydrographical sampling

Meteorological observations

Wind direction and speed, air temperature, air pressure, relative humidity and sea-surface temperature (5 m depth) were logged automatically every 60 sec. with an DNMI automatic weather station.

CTD

Vertical profiles of temperature, salinity, fluorescence, and oxygen were obtained by the Seabird 911 plus probe. The CTD was equipped with an uncalibrated Aqua Tracka MK III fluorometer, SBE 3plus temperature sensor, SBE 4C conductivity sensor, and a SBE 43 oxygen sensor. Real-time logging and plotting was done using the Seabird Seasave software installed on a PC. Above the shelf and slope the profiles ranged from the surface to within a few metres above the bottom. Offshore the maximum sampling depth was 1000 m. Horizontal distributions of near-surface (5m depth) temperature (°C), salinity, oxygen (ml/l) and fluorescence (index on relative scale) for the coastal area of Gabon were made with the software Ocean Data View, interpolating by DIVA gridding (Ocean Data View, Schlitzer, R., <http://odv.awi.de>, 2013). Vertical distributions of the same variables for selected oceanographic transects were made the same way (see Results).

Twelve Niskin water-bottles (10 l) attached to a CTD-mounted rosette were used to collect sea-water from predefined depths (see below).

For validation of the oxygen-measurements from the CTD-mounted sensor, the oxygen-concentrations in sea-water samples collected from all 12 Niskin-bottles at a deep plankton-station on 12 May 2014 were analyzed by the Winkler redox titration method, following the procedures of Hagebø (2008). On this occasion, sea-water was collected from 12 depths between 1000 m and the surface. The oxygen-concentrations calculated from the Winkler method were generally in agreement with the values from the oxygen-sensor. Still, we note that the laboratory-analysis of the deepest sample failed, and that the laboratory results for the three samples collected in the uppermost 20 m indicated slightly higher oxygen concentrations than the sensor, although these differences were less than 0.08 ml/l.

Chlorophyll *a* is a plant pigment, which in oceanography typically is used as an indirect measure for phytoplankton biomass. For analysis of chlorophyll *a* and phaeopigment concentrations, sea-water samples (263 ml) were collected from the Niskin-bottles released at the standardized depths of 500, 400, 300, 200, 150, 100, 75, 50, 30, 20, 10 and 5 m, but also from the surface using a bucket. The water-samples were filtered on Munktell glass-fibre filters (GF/C, 25 mm diameter) using a custom-made filtration system. The filters were then stored in the dark at ca. -18 °C for subsequent analysis on shore. After the cruise, the pigment samples were transported for 48 hours to the laboratory in Bergen (Norway) in a cooling-box with freezing-elements while held dark. The analyses were made on shore by IMR, and completed by 29 September 2014. The pigments were then extracted with 90% acetone in darkness over night in the laboratory, and the extracts centrifuged and analysed using a Turner Design fluorometer model 10 AU calibrated with pure chlorophyll *a* (Sigma Inc) (Jeffrey and Humphrey, 1975). Fluorescence was measured before and after acidification by a drop of 5% HCl, and concentrations of chlorophyll *a* and phaeorbides estimated according to Holm-Hansen *et al.* (1965). As part of the post-analysis quality control, the depth profiles of chlorophyll *a* as well as the chlorophyll/phaeophytin ratios were evaluated. This revealed two values that were believed to be incorrect, and for that reason were excluded from the dataset. In the first case the chlorophyll level for one sample was conspicuously low compared to

the values for the depths immediately above and below within the same station, while in the other case a value stood strongly out from all the others due to a very low chlorophyll/phaeophytin ratio.

The Mk III Aquatracka fluorometer measures *in situ* fluorescence on relative scale, and can later be compared to absolute chlorophyll concentrations obtained from the laboratory analyses of the samples collected from the water-bottles.

Thermosalinograph

The SBE 21 Seacat thermosalinograph was running continuously during the survey obtaining samples of sea surface (5 m depth) salinity and relative temperature every 10 seconds. An attached in-line C3 Turner Design Submersible Fluorometer measured turbidity and chlorophyll *a* levels.

Current speed and direction measurements (ADCP)

The current profiles were continuously recorded along the path of the vessel by the vessel mounted Ocean Surveyor 150 kHz ADCP. The ADCP has a maximum range between 200–400 m depth and transmission of transducer pulses was synchronized with the echo sounder. The system was run in narrow band mode and data were averaged in 8 m vertical bins and stored on files for post survey processing.

All data from the ADCPs will be processed on land after the survey.

2.2. Phytoplankton sampling

At each plankton-station, qualitative phytoplankton samples were collected with a net (35 cm in diameter and mesh-size of 10 μm), hauled vertically at a speed of ca. $\sim 0.1 \text{ ms}^{-1}$, from 30 m depth to the surface (30 - 0 m at the shallow stations). The samples were preserved with 2 ml 20% formalin on dark 100 ml glass bottles for subsequent taxonomic analyses on shore.

In addition, quantitative mixed seawater-samples with phytoplankton were collected from the CTD-attached Niskin-bottles. 20 ml samples were taken from each of the bottles representing the depths of 20, 10, and 0 m for the 30 m stations, and 30, 20, 10, and 0 m for the 100 m and 500 m stations. The 0 m samples were taken with a bucket. These 20 ml samples for a given station were then mixed, and preserved with 2 ml of lugol on dark 100 ml glass bottles for subsequent taxonomic analysis on shore.

2.3. Zooplankton sampling

Zooplankton were collected with a WP2 net (diameter 56 cm, mesh size 180 μm) (Fraser, 1966; Anonymous, 1968) at all plankton-stations. The net was hauled vertically from near-bottom to the surface at the shallow and intermediately deep plankton-stations (bottom-depths of ca. 30 m and 100 m), and from the depth of 200 m to the surface at the deepest plankton-stations (bottom-depths of ca. 500 m). WP2 hauling speed during the sampling was ca. 0.5 ms^{-1} .

Samples from each zooplankton station was divided into two equally large parts using a Motoda plankton splitter (Motoda, 1959), after first having removed and measured the total volume of all visible jellyfish. 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 sieved through three filters to obtain the plankton biomasses representing the size-fractions $>2000 \mu\text{m}$, 2000-1000 μm , and 1000-180 μm . The biomass samples were stored on preweighed aluminium dishes and dried at $\sim 70 \text{ }^\circ\text{C}$ for periods of $\sim 24 \text{ h}$. After drying, the samples were stored deep-frozen at -18°C for subsequent weighing of biomass dry weight on shore (after a second period of drying).

Fish eggs and larvae, as well as other larger zooplankton, were collected with a Hydro-Bios Multinet on four occasions. This Multinet has a mouth-opening area of 0.25 m², and was equipped with five nets of mesh-size 405 µm for depth-stratified sampling. The net is equipped with a pressure sensor and two electronic flowmeters. The Multinet sampling was done by oblique hauls. Multinet-sampling was only undertaken at selected coast-near shallow stations with bottom-depths of ~ 30 m. Only one net used per station, and that net was towed in the 25-0 depth-stratum. The purpose for this sampling was to scan larger volumes for presence of fish eggs and larvae than would be possible by using vertical WP2 hauls (due to the lower volumes of filtered water). The samples were preserved in borax-buffered formalin (ca. ~4 % in final solution).

2.4. Sediment sampling

A stainless steel cylinder was mounted on the footrope of the trawl to collect bottom sediment samples at every trawl station. The samples were collected from the cylinder when the trawl was hauled on deck and stored frozen for further analyses of sedimentological and chemical composition.

2.5. Biological fish sampling

A "Gisund Super" bottom trawl with a headline height of about 4.5 m was used during the survey, and 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⁻¹. These settings have been the standard on all swept area surveys with R/V Dr Fridtjof Nansen. An Åkrahamn trawl was used to catch pelagic fish.

Trawl duration was standardized to 30 minutes. The trawling start time is controlled by using a "SCANMAR" sensor 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. Table 2.1 shows the numbers of valid and invalid stations. A detailed description of the fishing gear is given in Annex II.

Demersal trawl hauls were taken randomly (within the depth strata described above) on the shelf, while pelagic hauls were taken randomly throughout the survey to catch acoustic targets.

Trawl hauls were sampled for species composition by weight and number. The deck sampling procedure is described in detail by Strømme (1992). The total body length of the fish (cm) was measured to the nearest 1 cm below, the carapace length of shrimps and carapace width of crabs to 1 mm below. The carapace length for crustaceans was measured to the nearest 0.1 cm below, sex and maturity state were also recorded but not included in Nansis. An Electronic Fish Meter (SCANTROL) connected to a customised data acquisition system (Nansis) running on a Windows PC was used for length measurements. All biological data records were entered in the Nansis database and were quality controlled during the survey.

Basic information recorded at each fishing station i.e. trawl hauls is presented in Annex I.

2.6. Multibeam echo sounder for bottom mapping

The EM 710 multibeam echo sounder is a high to very high-resolution seabed mapping system. Acquisition depth is approximately 3 m below the transducers and the maximum acquisition depth is limited in practice to 1000 - 1500 m on R/V Dr Fridtjof Nansen. Across track coverage (swath width) is up to 5.5 times water depth and may be limited by the operator either in angle or in swath width without reducing the number of beams. The operating frequencies are between 70 and 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 (manually) according to depth. The receiving beam width is 2 degrees. All raw data from the EM 710 multibeam echo sounder are normally stored to disk for later analyses. Unfortunately, the multibeam echo sounder did not work during this survey and spare parts were ordered from Norway. No detailed information about bottom depth could therefore be recorded. However, less detailed data from a narrower beam width were logged to the Olex plotting system onboard.

2.7. Single beam acoustic sampling

Acoustic equipment

Acoustic data were recorded using a Simrad ER60 scientific echo sounder equipped with keel-mounted transducers at nominal operating frequencies of 18, 38, 120 and 200 kHz. All transceivers were calibrated close to Kyun Phi Lar, in the southern part of Myanmar on 14 December 2013.

Acoustic data were logged and post-processed using the latest acoustic data post-processing software the Large Scale Survey System (LSSS) Version 1.6.1. The technical specifications and operational settings of the echo sounder used during the survey are given in Annex II.

Allocation of acoustic energy to species group

The acoustic data were scrutinized using the LSSS version 1.6.1. Backscatters were displayed at 38 kHz. The mean 5 nm area backscattering coefficient s_A (m^2/NM^2) was allocated to a predefined set of species groups on the basis of established echogram features. Ground truthing and estimation of mean length and weight were accomplished by means of targeted pelagic and demersal trawling. For carangids and associated species an overall average length of 23 cm and a condition factor of 0.88 were applied. The target groups used during the survey can be found in Table 2.1, the geographic distribution of the acoustic densities are shown in Figures 3.1 and 3.2, and the complete records of fishing stations and catches are shown in Annex I.

Table 2.1. Allocation of acoustic densities to species groups. Note that for the species groups only the main species are listed.

Group	Taxon	Species
Pelagic species 1	Clupeidae	<i>Sardinella maderensis</i> <i>Sardinella aurita</i> <i>Ilisha africana</i> <i>Engraulis encrasicolus</i>
Pelagic species 2	Carangidae	<i>Alectis alexandrinus</i> <i>Caranx hippos</i> <i>Chloroscombrus chrysurus</i> <i>Decapterus rhonchus</i> <i>Decapterus punctatus</i> <i>Selar crumenophthalmus</i> <i>Selene dorsalis</i>
	Scombridae	<i>Sarda sarda</i> <i>Scomber japonicus</i> <i>Scomberomorus tritor</i>
	Sphyraenidae	<i>Sphyraena guachancho</i> <i>Sphyraena sphyraena</i>
	Big-eye grunt	<i>Brachydeuterus auritus</i>
Demersal species	Sparidae	<i>Dentex angolensis</i> <i>Dentex congoensis</i> <i>Pagellus bellottii</i> <i>Boops boops</i>
	Other taxa	<i>Saurida brasiliensis</i> <i>Arioma bondi</i>
Plankton	Calanoidae	<i>Calanus sp.</i>
	Euphausiidae Other plankton	<i>Meganyctiphanes sp.</i>

The following target strength (TS) function was applied to convert s_A -values (mean integrator value for a given area) to number of fish by category:

$$TS = 20 \log L - 72 \text{ dB} \quad (1)$$

or in the form

$$C_F = 1.26 \cdot 10^6 \cdot L^{-2} \quad (2)$$

Where L is the total length and C_F is the reciprocal back scattering strength or the so-called fish conversion factor. Generally in order to split and convert the allocated s_A -values (m^2/NM^2) to fish densities (number per length group per NM^2) the following formula was used

$$N_i = A \cdot s_A \cdot \frac{p_i}{\sum_{i=1}^n \frac{p_i}{C_{Fi}}} \quad (3)$$

Where: N_i = number of fish in length group i

A = area (NM^2) of fish concentration

s_A = mean integrator value (echo density) in area A (m^2/NM^2)

p_i = proportion of fish in length group i in samples from the area

C_{Fi} = fish conversion factor for length group i

Further the traditional method is to sum the number per length group (N_i) to obtain the total number of fish:

$$N = \sum_{i=1}^n N_i \quad (4)$$

The length distribution of a given species within an area is computed by simple addition of the length frequencies obtained in the pelagic trawl samples within the area sampled. In the case of co-occurrence of target species the s_A value is split in accordance with length distribution and the catch rate in numbers in the trawl catches. Biomass per length group (B_i) is estimated by applying measured weights by length (W_i) when available or theoretical weights (calculated by using condition factors) multiplied by the number of fish in the same length group (N_i). The total biomass in each area is obtained by summing the biomass of each length group:

$$B = \sum_{i=1}^n N_i \overline{W}_i \quad (5)$$

The number and biomass per length group in each concentration are then added to obtain totals for each region.

However, the combination of low s_A values recorded in the water column, longer distance between transects than normally used on pelagic surveys and few pelagic species caught in the bottom trawl catches, the acoustic biomass estimates are not calculated for this survey.

A description of the fishing gears and acoustic instruments used and their standard settings are given in Annex II.

2.8. Swept area biomass calculations

The coast of Gabon is generally characterized by a relatively wide shelf with a shelf that breaks at around 100 m depth in the north and approximately 200 m depth in the south of the country. Cape Lopez divides the shelf into two separate shelf zones, which are separated by a strong temperature front during the winter. Because of this, fish communities are different between these regions and swept area analyses have consequently been carried out for each region separately. Bottom substrate is variable with hard rocky patches between softer substrates. The midshelf immediately north of Cape Lopez is very soft.

The area, in NM2, for the northern region (north of Cape Lopez) and the southern region (south of Cape Lopez) is shown by depth strata in Table 4.5. These strata are used to calculate the swept-area biomass estimates. All valid stations are treated as representative of the relevant depth intervals where the species or group of species were caught. All biomass calculations were done in the software program Nansis.

All equations for the calculations are given in Annex IV. The effective fishing width of trawl gear used by R/V Dr Fridtjof Nansen is 18.5 m. The effective fishing area is the product of the fishing width multiplied by the towing distance measured by the GPS. It is assumed that all fish within the trawling path are caught which gives a catchability coefficient (q) *i.e.* the fraction of the fish encountered by the trawl that was actually caught equal to 1. The catchability coefficient is seldom known but because the coefficient is assumed to be constant between surveys the swept-area index will reflect any change in population abundances between surveys.

Data from the “Nansis” database were exported to flat ASCII text files. The software R 3.0.2[®] was used to calculate stratified density estimates sorted by survey and stratified by depth and latitude. Biomass estimates by species or species groups were obtained from a stratified mean density estimator.

[®] R Development Core Team (2005). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL <http://www.R-project.org>.

3. RESULTS

3.1. Wind, Hydrography, Oxygen and Fluorescence

Horizontal patterns of wind, near-surface hydrography, oxygen and fluorescence.

Wind speed and direction were recorded from the vessels weather station located in the mast above the wheel house, and the results are illustrated in Figure 3.1. The horizontal distributions of near-surface temperature, salinity, oxygen and fluorescence, all measured at depth of 5m, are presented in Figure 3.2. The data presented in these figures were collected by the CTD and its attached sensors. The temperature data from the thermosalinograph gives slightly higher values than real data due to a heating in the vessel pipes systems. However, the large number of data points (>100 000 recordings) from this instrument (compared with CTD data) makes it interesting to show the data due to the higher dynamics that can be observed.

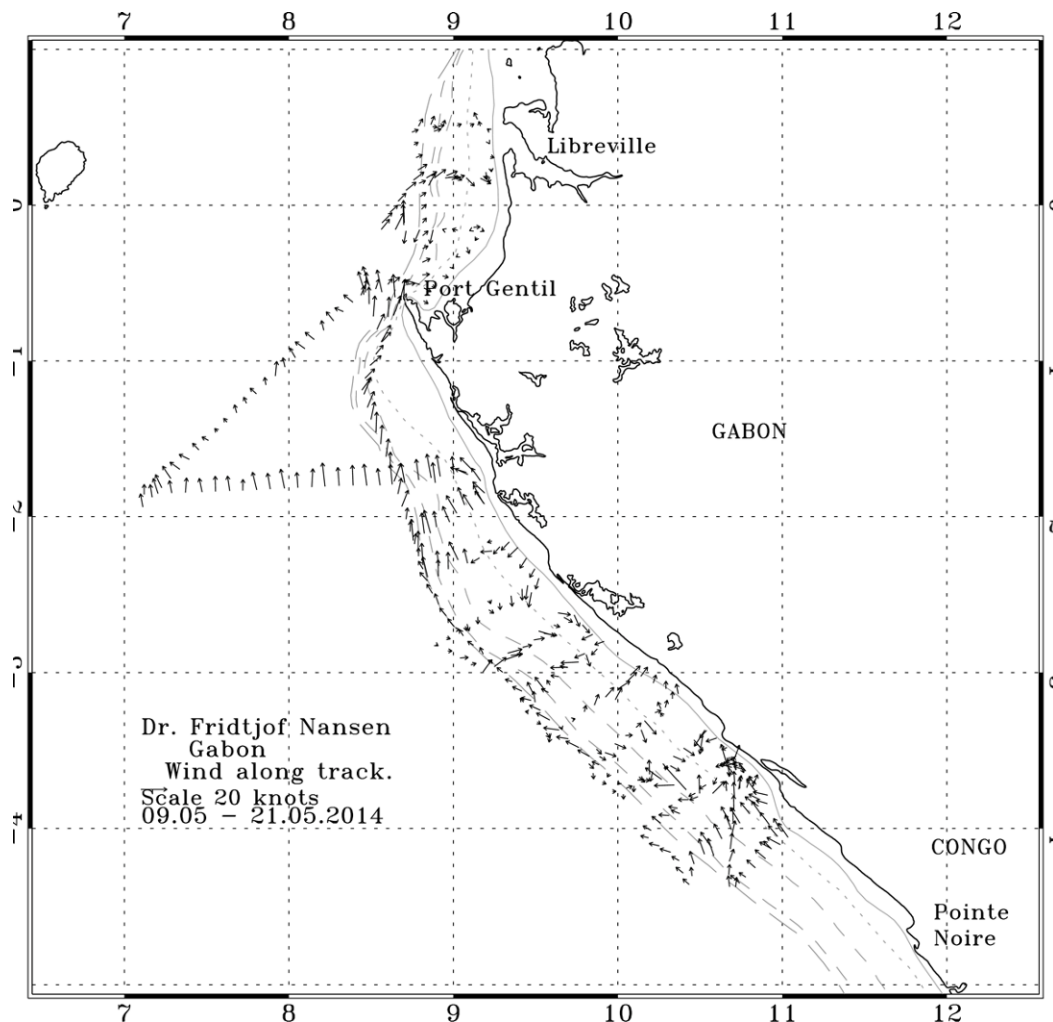


Figure 3.1. Wind speed and direction as recorded from the vessels weather station.

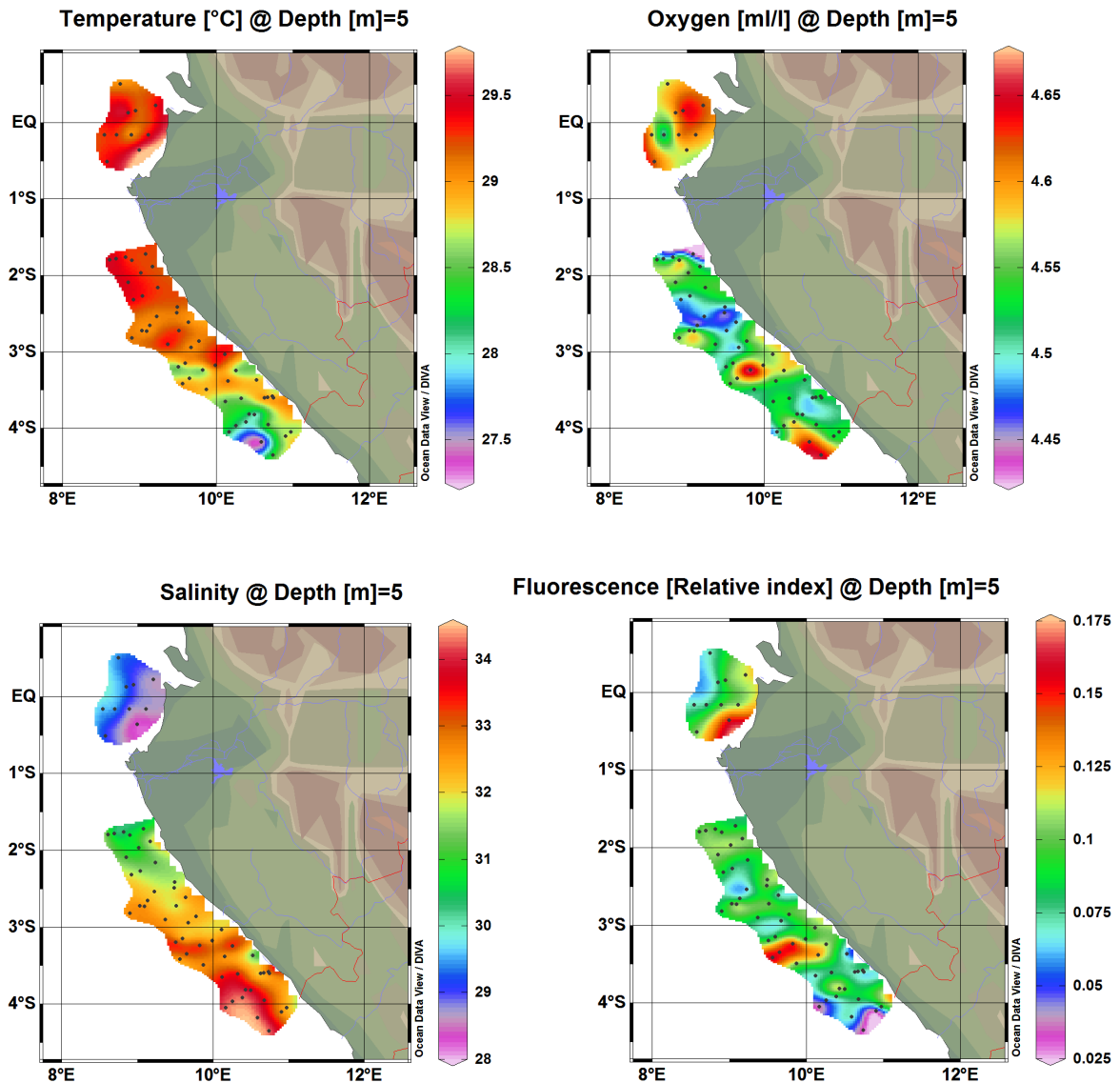


Figure 3.2. Horizontal near-surface (5m depth) distributions of temperature, salinity, oxygen and fluorescence for the Gabon coastal area. Station positions are indicated as black dots. Produced with the software Ocean Data View, interpolating by DIVA gridding (Ocean Data View, Schlitzer, R., <http://odv.awi.de>, 2013).

The large-scale spatial patterns in near-surface (5 m depth) temperature, salinity, oxygen and relative fluorescence within the whole Gabon coastal area are visualized in Figure 3.2. The most notable features are the comparatively warmer upper water-masses in the northern part of the coastal area, along with the more saline upper water-masses towards the south (Figure 3.2). With respect to near-surface dissolved oxygen and relative fluorescence, the levels varied within rather limited ranges and the indicated dynamics occurred over relatively short spatial scales (Figure 3.2). We also note the relatively large restricted area around 1 °S, where no sampling was done.

North of Cape Lopez

There was almost no wind during the first days of the cruise. The direction was generally from SW but mostly in the deeper areas, farther away from the coast.

Near-surface (5 m) temperature in the study-area north of Cape Lopez was ~ 29.0 - 29.7 °C, thereby representing the higher end of the temperature-range detected for the whole study-area (Figure 3.2). Salinity at depth of 5 m varied between ~ 28.3 - 29.6 within the sampling area north of Cape Lopez, with the water nearest to the coast tending to be fresher than further offshore. The

near-surface salinities measured north of Cape Lopez were markedly lower than those recorded further south. Near-surface concentrations of dissolved oxygen were $\sim 4.5 - 4.6$ ml/l, and fluorescence (relative index) $\sim 0.07 - 0.15$, which was comparable to the values observed in the area further south.

South of Cape Lopez

A generally calm wind averaging 20 m/s, increasing slightly as the vessel moved southward (Figure 3.1). The direction was in the beginning from S-SE, but with quite a few changes in direction further south.

Near-surface (5 m) temperature in the study area south of Cape Lopez varied between ~ 27.4 and 29.3 °C, and was markedly higher in the northern part than further south. Near-surface salinity displayed more or less the opposite pattern of temperature in this area, with the salinity increasing towards the south. The salinity at depth of 5 m within the sampling area south of Cape Lopez ranged within $\sim 30.6 - 34.3$. Oxygen concentrations at 5 m depth varied between $\sim 4.4 - 4.7$ ml/l, in the area south of Cape Lopez, displaying some spatial dynamics but no clear large-scale trends. Likewise, fluorescence levels near the surface in the area south of Cape Lopez varied between $\sim 0.03 - 0.15$, revealing some local variability but not clear large-scale patterns.

Cross-shelf vertical profiles for hydrography, oxygen and fluorescence

North of Cape Lopez

One hydrographical transect with cross-shelf vertical profiles was made in the study area north of Cape Lopez (see Figure 3.3). This transect comprises four stations, that are shown within the red frame in the lowest panel of the figure. The surface waters in this northern region were relatively warm ($\sim 29.0 - 29.5$ °C), and temperatures decreased with depth. Variations in temperature between corresponding depths near the coast versus offshore were limited. At 100 m depth, temperatures were about $18.3 - 18.8$ °C (Figure 3.3). Temperatures at 500 m were roughly 7.4 °C, and at 930 m about 4.6 °C (not shown). The surface layer had a comparatively low salinity, generally $\sim 29.1 - 29.5$, being only 28.7 at the station furthest inshore (1 m depth). The salinity increased rapidly down to about 30 m, where values typically surpassed 36. Below this depth, the levels would increase slowly down to about 50 m, after which the salinity would slowly decrease. At about 300 m the salinity would be ca. 35, thereafter decreasing with depth. At the most oceanic station, the salinity was 34.64 at depth of 930 m. Oxygen concentrations were highest in the surface (ca. $4.6 - 4.9$ ml/l), and decreased with depth. The lowest levels were measured at about 320 m, where levels were about 1.3 ml/l. Deeper than this, the levels increased somewhat, and at the most oceanic station reached 2.3 at 500 m, increasing to 3.4 ml/l at 930 m. The fluorescence was rather homogeneous with depth at the shallowest station near the coast, and when moving towards the open ocean the maximum was generally found at depths of about 30 – 50 m.

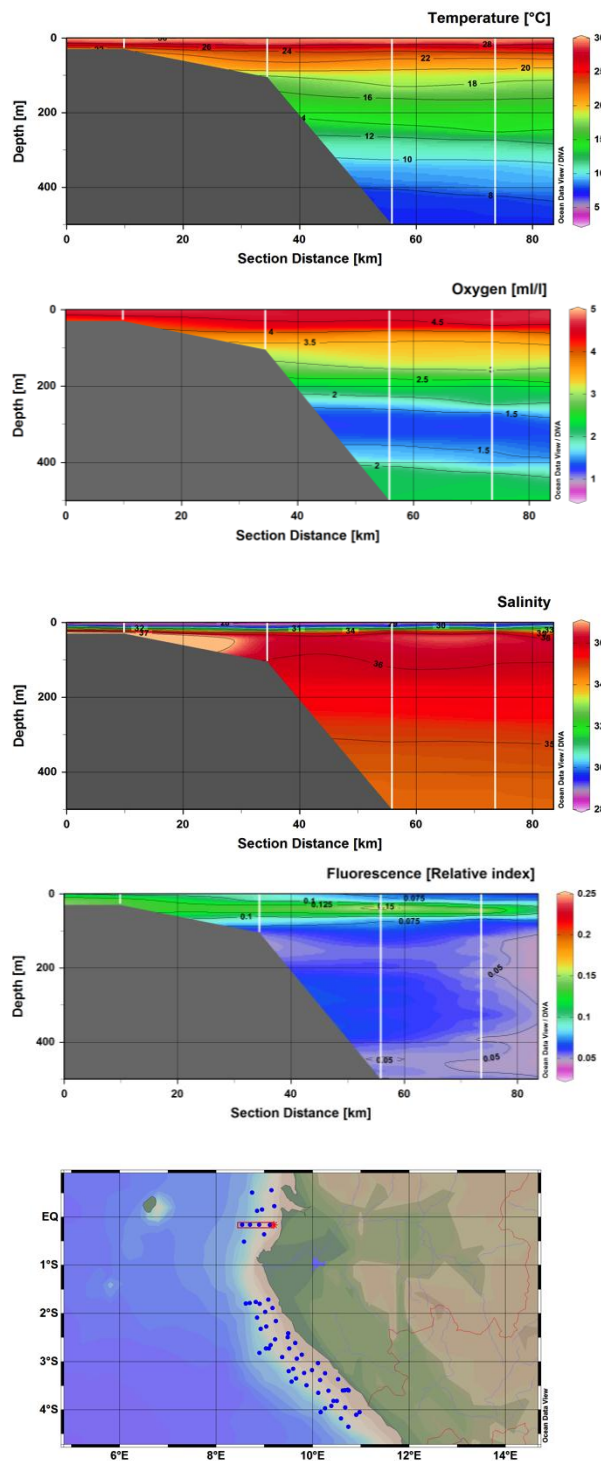


Figure 3.3. Cross-shelf distributions of temperature, salinity, oxygen and fluorescence at a hydrographical transect off the Gabon coast, north of Cape Lopez. Location of the section is shown in red on the map. CTD stations indicated by white vertical lines. Produced with the software Ocean Data View, interpolating by DIVA gridding (Ocean Data View, Schlitzer, R., <http://odv.awi.de>, 2013).

South of Cape Lopez

Cross-shelf vertical profiles for four hydrographical transects from the study area south of Cape Lopez are presented in Figures 3.4 to 3.7. The temperature profiles in the region showed relatively warm surface waters, typically $\sim 28.0 - 29.5$ °C in the uppermost meters, and decreasing temperature with depth. The vertical temperature profiles for upper depths in coastal and offshore

waters were rather similar. At 100 m depth, temperatures were generally about 18 - 20 °C. Temperatures at 500 m were roughly 7.1 – 7.4 °C, and around 4.5-4.6°C at 1000 m depth. The profiles generally showed a surface layer of low salinity, ~31 – 34 (35), with the uppermost waters tending to be a little fresher at inshore than offshore stations. The salinity typically increased rapidly down to about 30 m, thereafter increasing slowly down to depths of ~ 50 m where the values typically were > 36. The salinity then decreased slowly with depth, to about 34.6 - 34.7 at both 500 m and 1000 m. Oxygen concentrations were highest at the surface (~4.5 - 4.7 ml/l), and decreasing with depth (Figures 3.4 to 3.7). Minimum levels were measured at depths of ca. 300 - 320 m (1.1 - 1.3 ml/l), but the concentrations increased again at greater depths, reaching about 2.0 - 2.3 ml/l at 500 m. Oxygen concentrations increased below this, approaching ~ 3.4 - 3.6 ml/l at around 1000 m depth. The fluorescence-maximum was generally found at depths of about 20–50 m below the surface, both onshore and offshore.

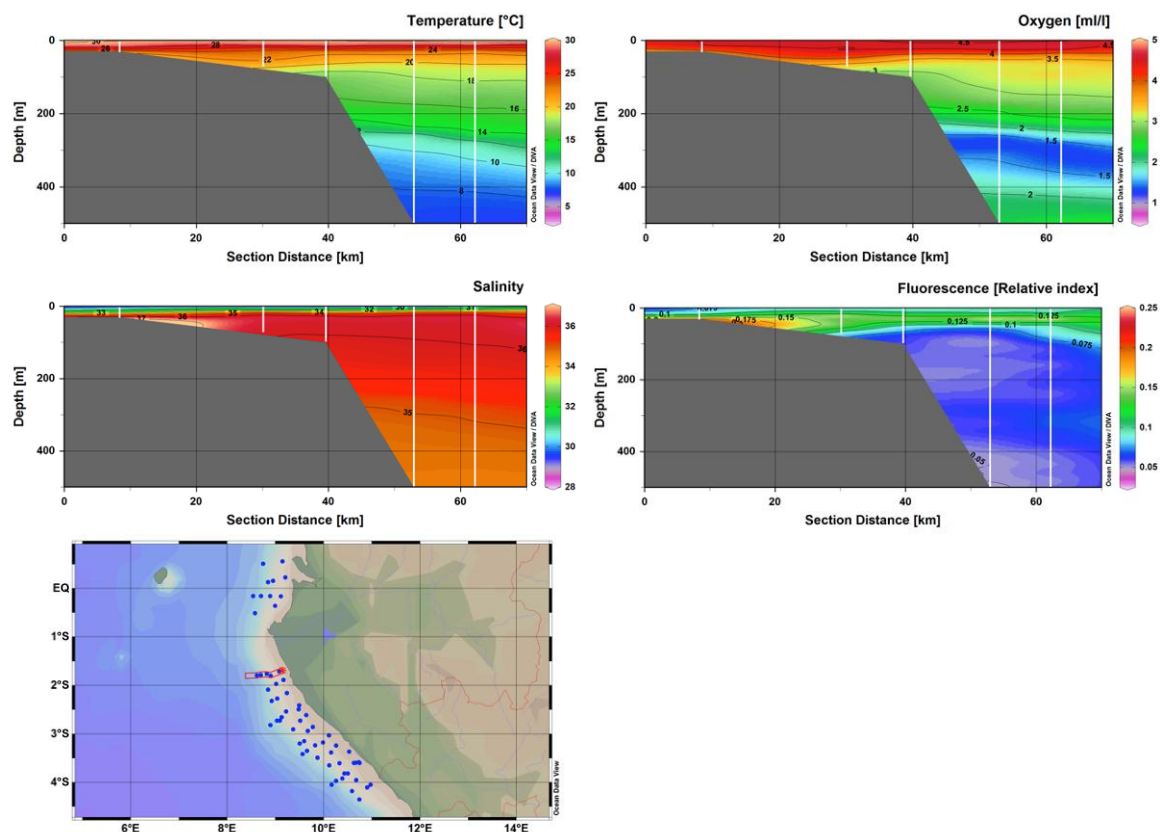


Figure 3.4. Cross-shelf distributions of temperature, salinity, oxygen and fluorescence at selected southerly hydrographical transect of the Gabon coast, south of Cape Lopez. Location of the section is shown in the map. CTD stations indicated by white vertical lines. Produced with the software Ocean Data View, interpolating by DIVA gridding (Ocean Data View, Schlitzer, R., <http://odv.awi.de>, 2013).

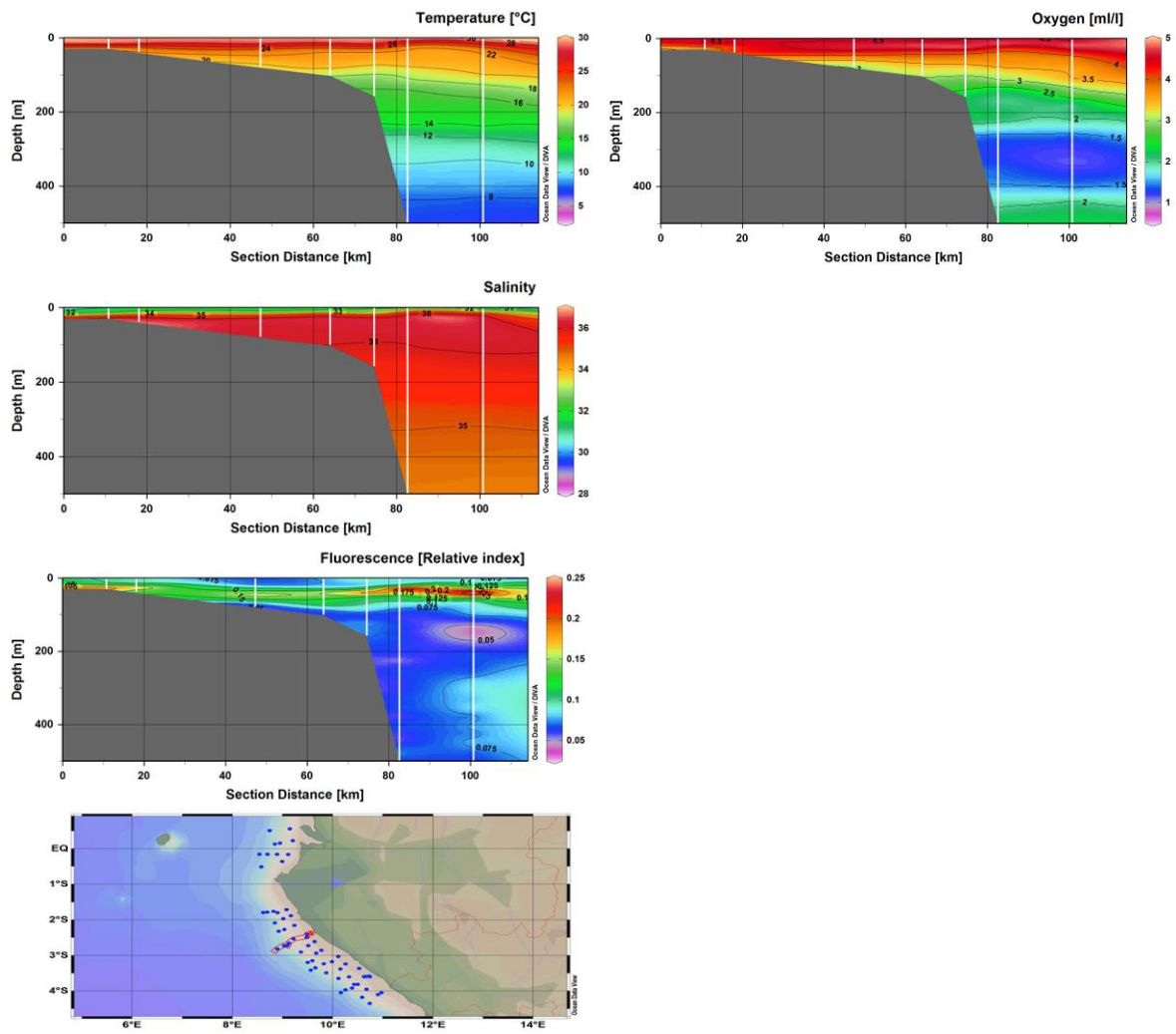


Figure 3.5. Cross-shelf distributions of temperature, salinity, oxygen and fluorescence at selected southerly hydrographical transect of the Gabon coast, south of Cape Lopez. Location of the section is shown in the map. CTD stations indicated by white vertical lines.

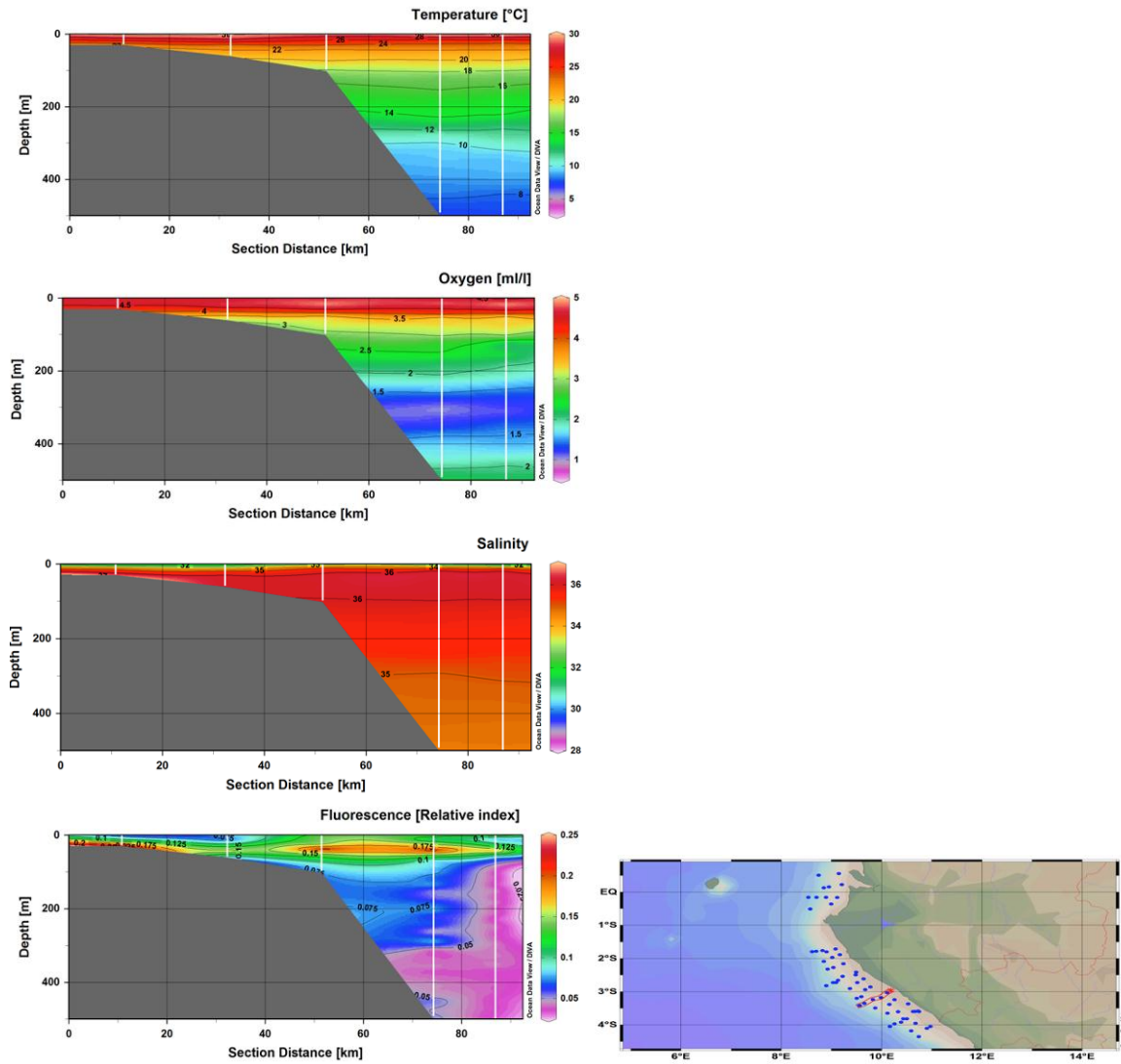


Figure 3.6. Cross-shelf distributions of temperature, salinity, oxygen and fluorescence at selected southerly hydrographical transect off the Gabon coast, south of Cape Lopez. Location of the section is shown in the map. CTD stations indicated by white vertical lines.

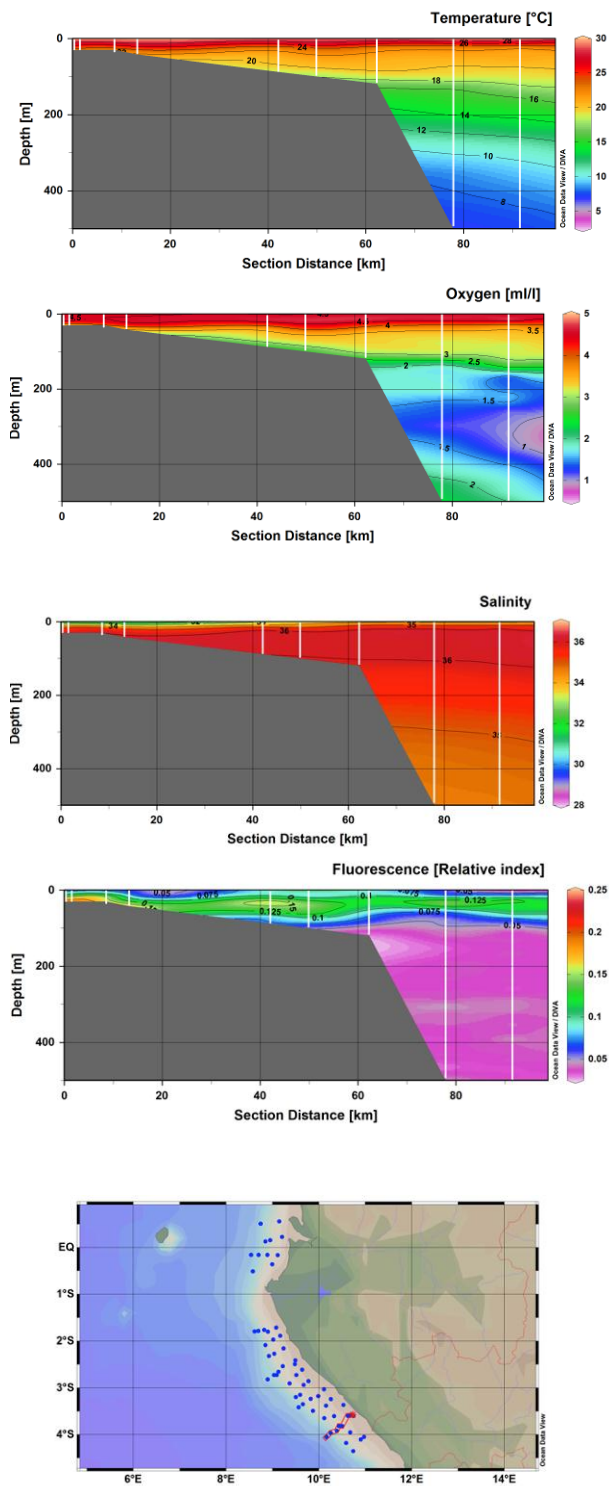


Figure 3.7. Cross-shelf distributions of temperature, salinity, oxygen and fluorescence at a southerly hydrographical transect off the Gabon coast, south of Cape Lopez. Location of the section is marked in red on the map. CTD stations indicated by white vertical lines. Produced with the software Ocean Data View, interpolating by DIVA gridding (Ocean Data View, Schlitzer, R., <http://odv.awi.de>, 2013).

3.2. Chlorophyll and plankton samples

Chlorophyll

Chlorophyll *a* is a plant pigment, which in oceanography typically is used as an indirect measure for phytoplankton biomass. The chlorophyll *a* levels measured in the coastal area of Gabon were generally rather low during the cruise (Figure 3.8). When considering all sampling depths, the measured values ranged between near zero and $1.15 \text{ mg chl.}a \text{ m}^{-3}$. Apart from a tendency of higher concentrations at 20 m for the shallowest stations closest to land compared to stations further offshore, no clear patterns in geographic distributions are evident from Figure 3.8. However, due to the large survey area and our limited horizontal sampling resolution for chlorophyll (when considering the typically patchy nature of plankton distributions), there may well have been regional patterns that we were not able to detect from our chlorophyll results.

The vertical distributions of chlorophyll revealed clear patterns (see two examples in Figure 3.9). For stations with bottom-depths of 500 and 100 m the chlorophyll concentrations typically increased with depth from the surface to about 20-30m, and had decreased again at the next sampling depth of 50 m. Thereafter the concentrations decreased with depth, and from 100 m and deeper the concentrations were very low (Figure 3.9).

For the shallowest stations, with bottom-depths of about 30 m, the chlorophyll concentrations typically increased from the surface, displaying some variation in the depth-patterns (Fig. 3.9). The chlorophyll/phaeophytin ratio showed a strong exponential decline when plotted against increasing depth (not shown).

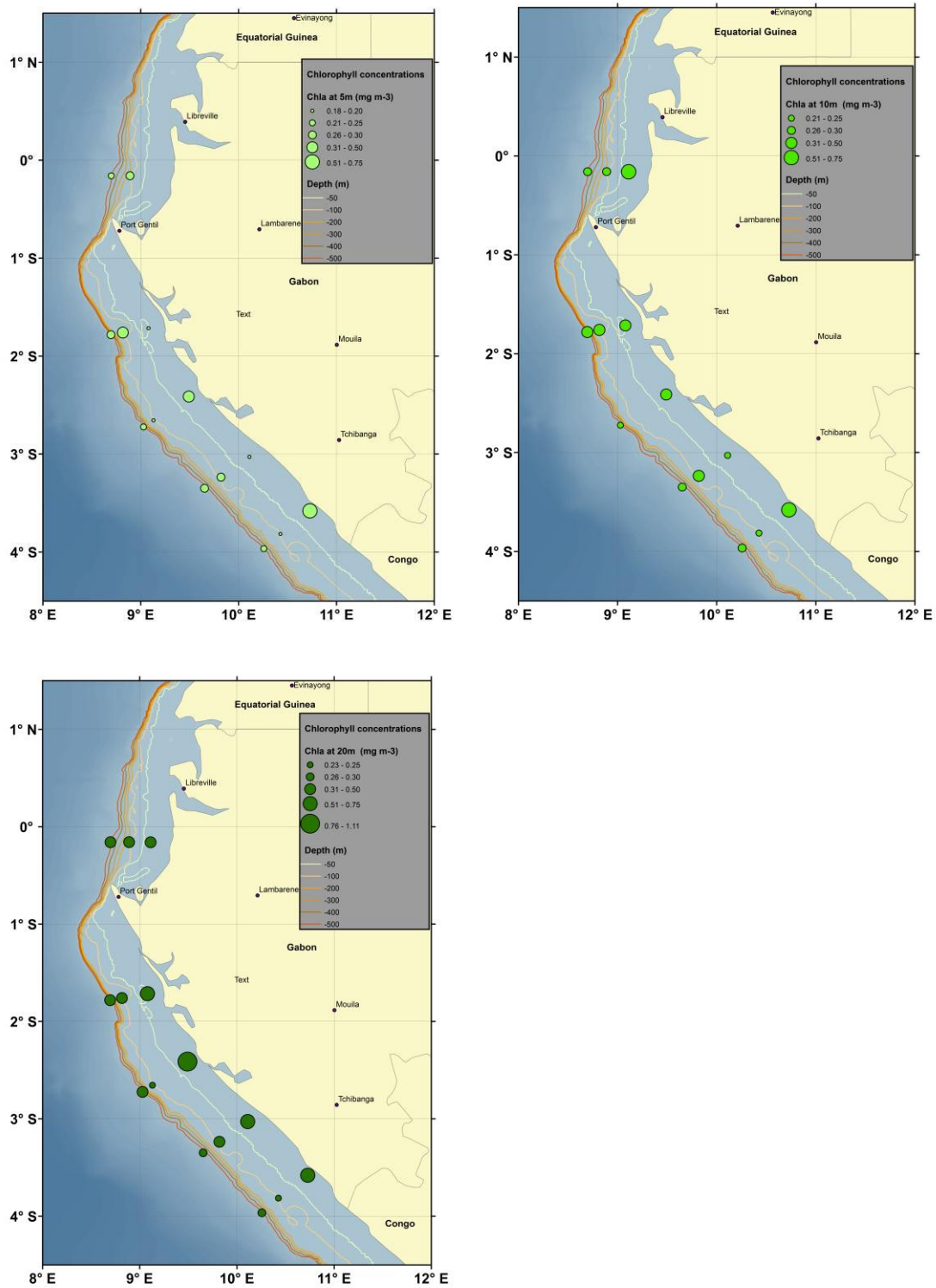


Figure 3.8. Chlorophyll *a* concentrations in the coastal area of Gabon. The figures show levels of chlorophyll *a* (mg per cubic meter) at 5 m depth (upper left), at 10 m depth (upper right), and at 20 m depth (lower left). Depth-contours indicated by continuous lines.

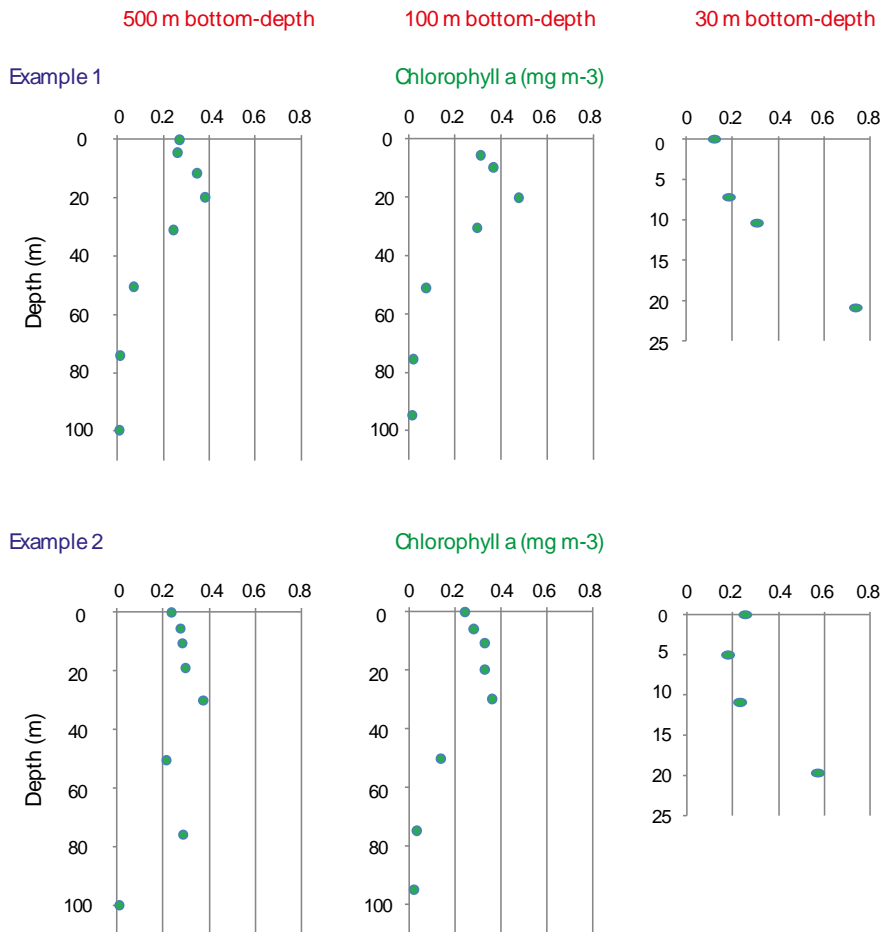


Figure 3.9. Vertical distributions of chlorophyll *a* concentrations exemplified by two selected plankton-sections across the shelf off Gabon. Upper figures show the second northernmost environmental-section, and the lower figures show the second most southern environmental-section (see Fig. 3.8 for locations of these two sections). Leftmost figures show stations with bottom-depth of 500 m, central figures show stations with bottom-depths of 100 m, and rightmost figures show stations with bottom-depths of ca. 30 m. Note that the scales for Y-axes in the rightmost figures differ from the rest. Only values in the uppermost 100 m of the water-column are presented.

Phytoplankton samples

Phytoplankton samples (both qualitative net samples preserved with formalin and quantitative samples from water bottles preserved with lugol) are currently stored for taxonomic analysis at DGPA, Gabon.

Zooplankton

Size-fractionated zooplankton biomasses were estimated from samples collected in the coastal region of Gabon and are shown in Figure 3.10. Zooplankton were collected with a WP2 net (diameter 56 cm, mesh size 180 μm) at all plankton-stations. The net was hauled vertically from near the bottom to the surface at the shallow and intermediately deep plankton-stations (bottom-depths of ca. 30 and 100 m), and from the depth of 200 m to the surface at the deepest plankton-stations (bottom-depths of ca. 500 m). The zooplankton catches were size-fractionated, and biomasses estimated separately for the size fractions 0.18-1mm, 1-2 mm, and >2mm. WP2 hauling speed during the vertical sampling was ca. 0.5 ms^{-1} , and all visible jellyfish were excluded from the samples prior to estimation of biomass. As seen in Figure 3.10, the results for one station located between 2-3 $^{\circ}\text{S}$ and with a bottom-depth of ca. 100 m is missing. This sample was discarded because it contained sediments, apparently due to the plankton-net being in contact with the bottom.

The estimated total zooplankton biomass varied between 0.7 and 3 grams of dry-weight per square meter surface for the depth-strata sampled (explained above). Due to the differing depth-strata sampled among shallow, intermediate and deep stations, the results from these three different station-depths are not directly inter-comparable. However, our aim was to provide fundamental information on how large the zooplankton biomasses were within each of the three different depth-strata, rather than to compare biomasses across the shelf. In this context, it is worth noting that as the vertical zooplankton distributions cannot be assumed to be homogenous, considering concentrations instead of surface-integrated values, would not be a meaningful remedy for comparing stations where the depth-strata sampled were different. When considering the total biomass, no patterns for stations with the same sampling-depth along the latitudinal gradient are clear (Fig. 3.10 - right panel). For the shallowest stations, close to land, that were sampled between ~25-0 m, the estimated biomasses ranged within 0.69 and 1.53 g DW m⁻², with an average of 1.05 g DW m⁻². For the stations with intermediate bottom-depths (sampled between ca. 100-0 m), the estimated biomasses ranged within 1.17 and 3.03 g DW m⁻², with an average of 1.97 g DW m⁻². For deepest stations, furthest from land (bottom-depth ca. 500m, sampling stratum ca. 200-0m), the estimated biomasses ranged within 1.02 and 2.46 g DW m⁻², with an average of 1.57 g DW m⁻². When considering the proportions of the different biomass size-fractions, no clear patterns for stations within the same sampling-depth along the latitudinal gradient emerged (Fig. 3.10 - right panel).

All formalin-preserved zooplankton samples from the WP2 net and Multinet are currently stored for taxonomic analysis at DGPA, Gabon.

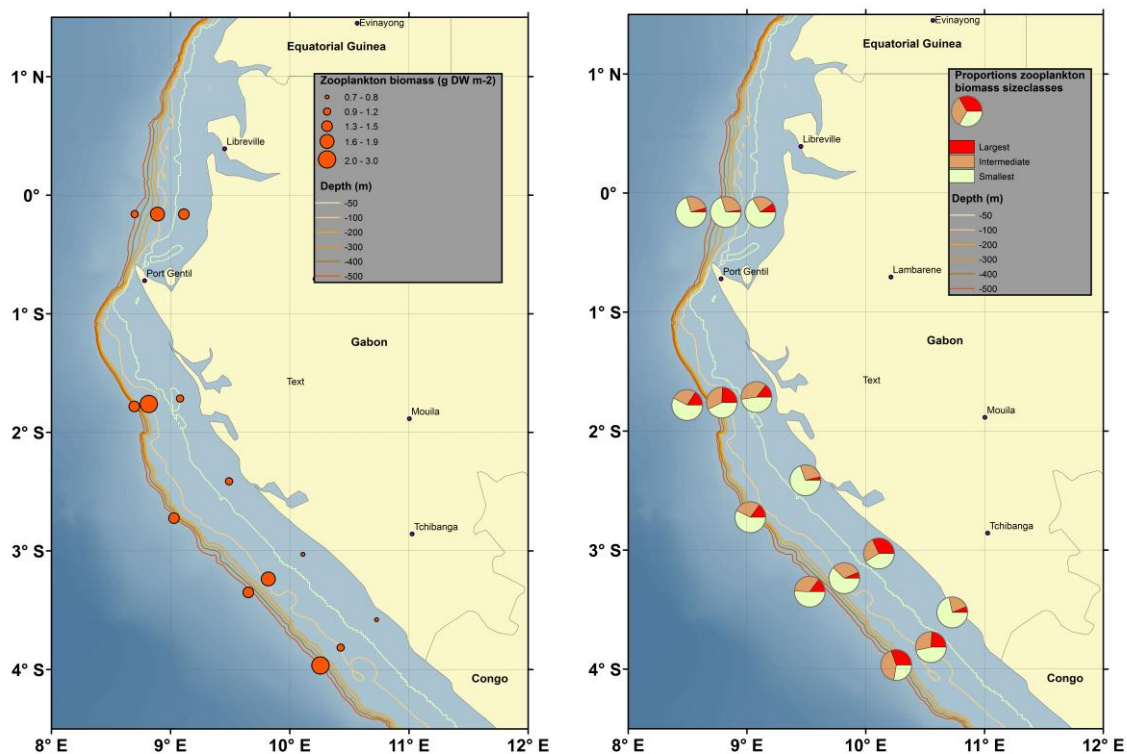


Figure 3.10. Zooplankton biomasses in the coastal area of Gabon. Total biomass (g dry-weight per m² surface) shown in left panel, and its proportions of the three different size classes (0.18-1 mm, 1-2 mm, and >2 mm) shown in right panel. All visible jellyfish were excluded from the results here presented. The samples were collected with the WP2-net (mesh-size 180µm) hauled vertically at 0.5 ms⁻¹. Note that for stations with bottom-depth of ~500 m, the results represent the uppermost 200 m of the water-column, while for stations with bottom-depths of ~100 and ~30m the results represent the whole water-column. Hence, the results from stations with different bottom-depths (500 m, 100 m, and 30 m) are not directly inter-comparable due to differing sampling efforts. Depth-contours indicated by continuous lines.

Sediment samples

All sediment samples were offloaded in Port Gentil and sent to Libreville for further analyses at DGPA, Gabon.

3.3. ACOUSTIC DENSITY AND DISTRIBUTION

The hydro acoustic survey covered the shelf and slope from roughly 20 m to 800 m bottom depth (1000 m depth on the ecosystem transects). Continuous acoustic recording and analysis were carried out throughout the survey. Extremely low acoustic recordings were observed during this survey which did not create the basis for further calculations or obtaining reliable biomass estimations. However, the acoustic densities (average S_A values per NM^2) allocated to the main species group per region and the geographic distributions, were plotted in Figure 3.1 and 3.2.

Acoustic density and distribution was estimated for the two main groups; Pelagic 1 (Pel 1) and Pelagic 2 (Pel 2). The Pel 1 group of species consists of pelagic fish of the families Clupeidae and Engraulidae, while the Pel 2 species belong to the families Carangidae, Scombridae, Sphyraenidae and Big-eye grunt (*Brachydeuterus auritus*) and the group "other demersal species" (which includes all demersal fish). Table 2.1 gives an overview of the most common species belonging to each of these groups. The Pelagic 1 species are typically separated from the Pelagic 2 species based on the presence of the two groups in the trawl catches, and the fact that the Clupeidae and Engraulidae has a much stronger backscattering signal than e.g. the Carangidae and other Pel 2 species. Big-eye grunt is a semi-demersal species which normally has its own category but due to low occurrence, it is shown together with the group Pel 2 in this survey.

The data are presented for two main regions; 1) North of Cape Lopez, and 2) South of Cape Lopez. The estimates presented in this report only include the geographic areas covered by the vessel and do not include any evaluation/quantification of how much fish is found inshore of the surveyed area. Gabon has relatively large shallow water areas and river mouths. Many of the species found during this survey are known to thrive in such environments and it is likely that the biomass of some of these inshore of the survey area was considerable.

North of Cape Lopez

Pel1

Low densities of Pel 1 were found in this area (Figure 3.11 a). The most common Clupeoid species in the region was the Sardinella (*Sardinella madrensis*). The densities were $<3 m^2/NM^2$ in most of the area of distribution, with a small spot of densities from 300 to $1000 m^2/NM^2$ on the shelf outside Libreville.

Pel2

The distribution of these species was found in low density over most of the area north of Cape Lopez (Figure 3.11 b). The highest densities were found in depths between 50 - 100 m. The densities were $<300 m^2/NM^2$ in most of the area of distribution.

Other demersal fish

Generally, low densities of demersal fish were found (less than $300 m^2/NM^2$) and recorded. They occurred on the shelf outside Libreville (Figure 3.11 c). The most common demersal fish group found in the region was grunt.

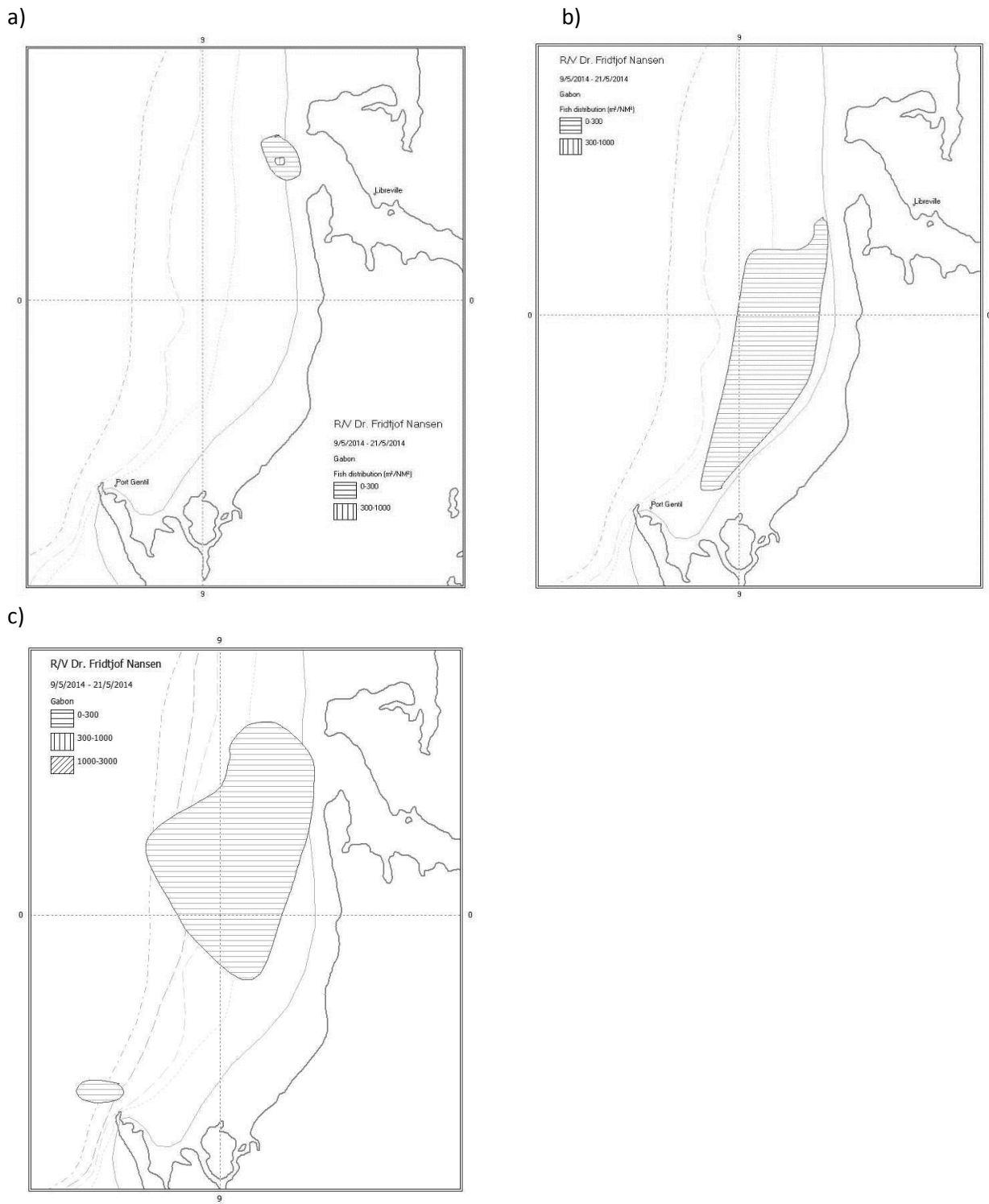


Figure 3.11. Distribution of acoustic densities (average S_A values m^2/NM^2) of a) Pel 1, b) Pel 2 and c) other demersal species north of Cape Lopez

South of Cape Lopez

Pel1

Low acoustic values for Pel 1 were recorded, with only a few spots of low densities ($<300 \text{ m}^2/\text{NM}^2$). Most of the fish was found between 20 and 50 m depth. In the southern area, on the shelf outside Myumba, higher densities (from 300 to $1000 \text{ m}^2/\text{NM}^2$) were recorded (Figure 3.12 a). These densities were mainly caused by *Sardinella aurita*.

Pel2

The distribution of these species was found in low density, but over a wide area (Figure 3.12 b). The densities decreased slightly southwards from Cape Lopez. The densities were $<300 \text{ m}^2/\text{NM}^2$ in most of the area of distribution, with one small area with densities from 300 to $1000 \text{ m}^2/\text{NM}^2$ and one spot with densities between 1000 to $3000 \text{ m}^2/\text{NM}^2$, on the shelf outside Myumba. The most common Pel 2 species found in the region was the Sphyranidae *Sphyraena guachancho*, and the Carangidae *Chloroscombrus chrysurus*.

Other demersal fish

Generally, low and scattered densities of demersal fish were found. The most common demersal fish group found in the region was made up of sea breams. The densities were $< 300 \text{ m}^2/\text{NM}^2$ in most of the area of distribution (Figure 3.12 c)

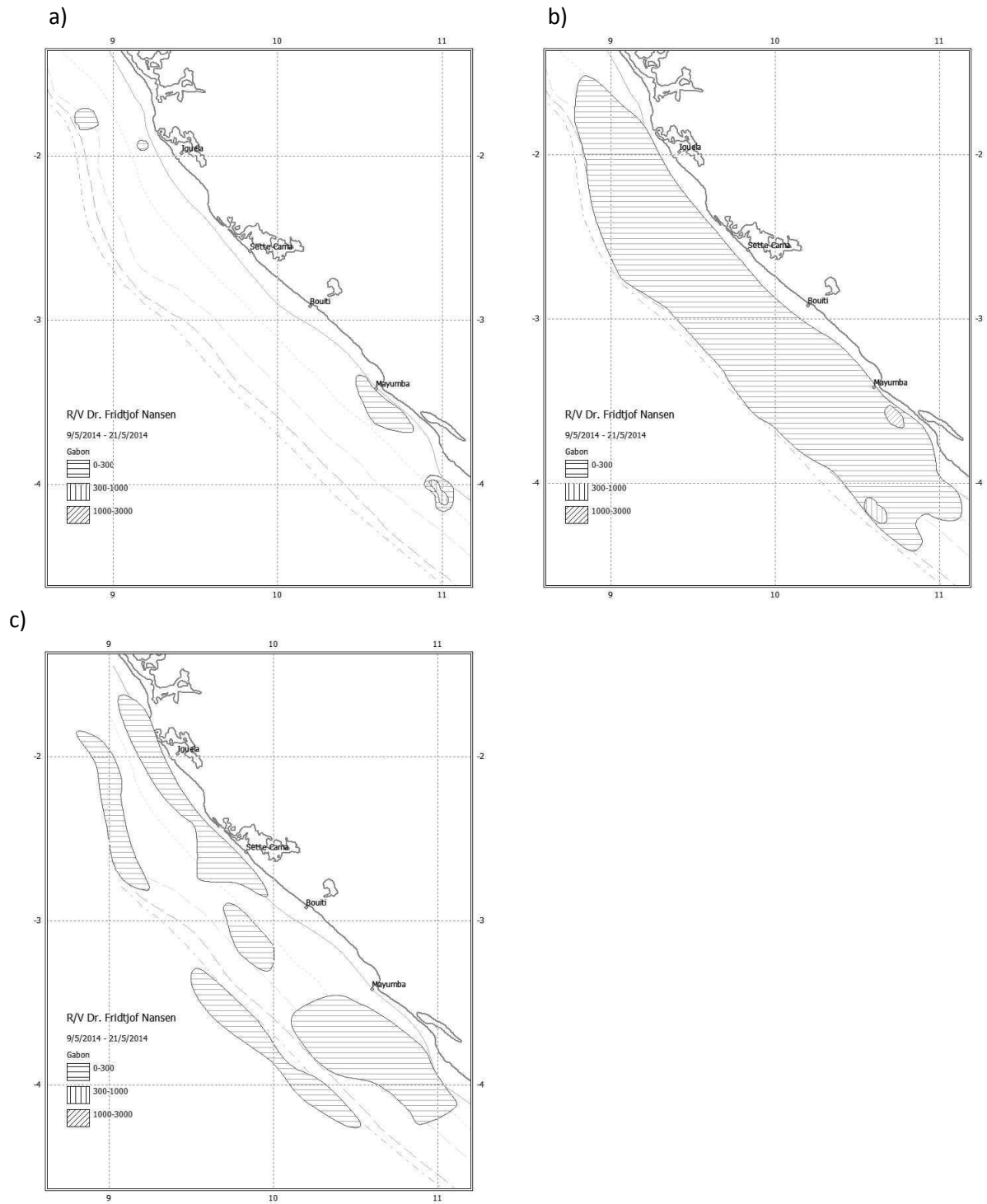


Figure 3.12. Distribution of acoustic densities (average S_A values m^2/NM^2) of a) Pel 1, b) Pel 2 and c) other demersal species south of Cape Lopez.

3.4. Catch rates, distribution and swept area biomass

Four depth strata were defined prior to the survey at 20 -50 m depth (shelf), 50 - 100 m depth (outer shelf), 100 - 500 m depth (upper slope) and 500 - 800 m depth (lower slope). Normally we would have split the depth interval between 100 m and 500 m into two (100 – 200 m and 200 – 500 m), but due to the steep slope and rough bottom, it was impossible in many areas to trawl between 200 m and 500 m. The situation was even worse for the depth stratum deeper than 500 m. Here only a couple of trawls could be conducted. The trawl positions and total catch per station (kg per hour) are mapped in Figure 3.13. In the area north of Cape Lopez the catches are small, while south of Cape Lopez the catches are considerably higher, especially in the zone between 100 m and 200 m depth (upper slope). The highest catch was above 2850 kg /hour (Table 3.1, c) and consisted mainly of non-commercial species (more than 2040 kg/hour) but also a considerable amount of sea bream (~ 800 kg/hour, Table 3.1,c). Further analysis of catch rates and swept area biomass estimation is given below. Detailed information about bottom trawl stations and catch by species are presented in Annex I.

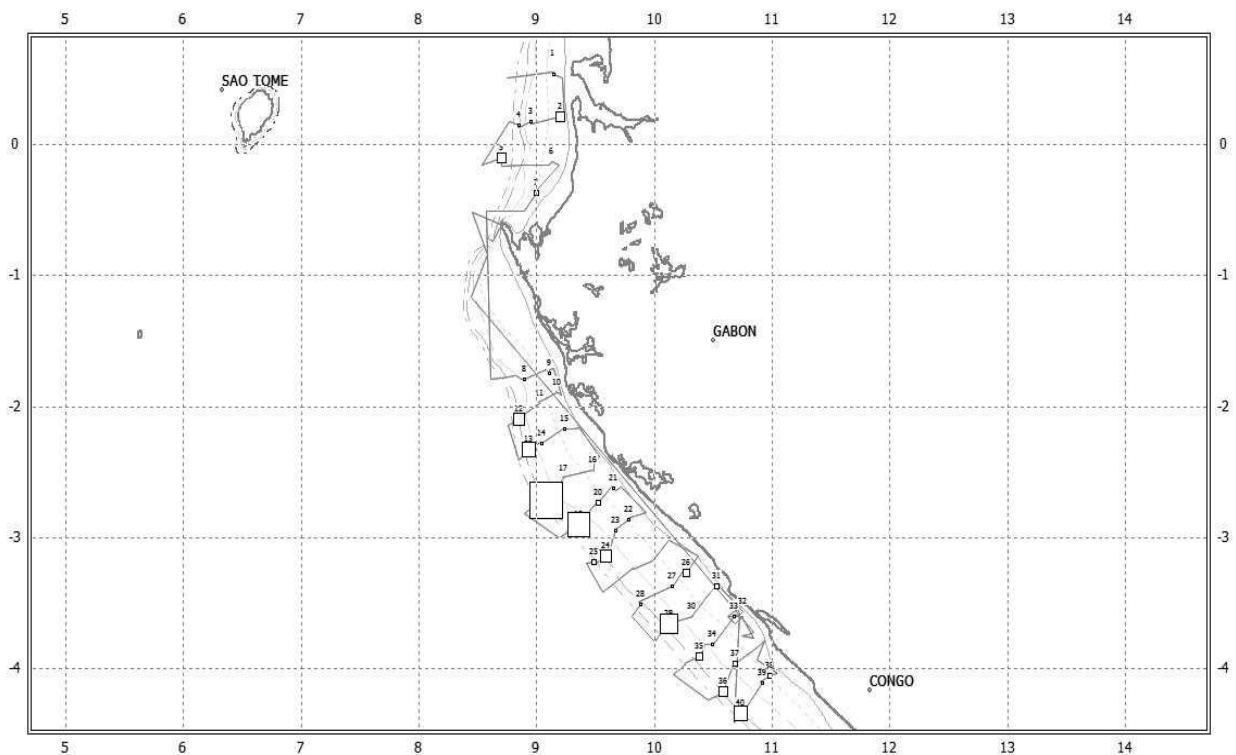


Figure 3.13. Total catch per bottom trawl station. The numbers refer to the station number, while the size of the squares illustrates the catch rate (kg per hour). The full line between the stations represents the survey track, while the spotted lines represent depth intervals (20, 50, 100, 200 and 500m). Only bottom trawl catches used in analyses of catch rates are included.

Analyses of catch rates and distribution

For the two regions (north and south of Cape Lopez), catch rates for the main fish groups are presented per depth strata (Table 3.1 and 3.3); demersal fish, pelagic fish, sharks, cephalopods, shrimps and other (comprises other species not defined within any of the previously mentioned groups). In addition, the catch rates of the demersal species group are split into the main commercial species and presented in Tables 3.2 and 3.4. The group “other” now comprise all the other species.

North of Cape Lopez

A total of six valid trawl stations were analysed in this region. From these, four stations were between 20 - 50 m depth, one between 50 - 100 m depth, one between 100 - 500 m depth and no stations above 500 m. Table 3.1 shows the catch rates of main groups while Table 3.2 shows catch rate for the main demersal species groups.

The mean catch rate in the depth strata between 20-50 m was 150.7 kg/h (Table 3.1). The demersal group was the most dominant with average catch rates of 92.7 kg/h. The “other” group reached catch rates of 32.4 kg/h while pelagic showed an average catch rate of 22.8 kg/h. The group of shrimps had catch rates of 1.3kg/h while cephalopods had catches of 1.4 kg/h. No sharks were found in this depth region. On the outer shelf between 50 - 100 m depth the catch rates decreased to 121.1 kg/h. The pelagic species declined in abundance compared to further inshore, and had a catch rate of 2.2 kg/h. The Cephalopods and sharks became more important and showed catch rates of 21.1 and 15.4 kg/h. The upper slope had a catch rate of 266.5 kg/h, almost entirely consisting of the “other” group. There were no stations above 500 m in this region.

Table 3.1. Mean catch rates (in kg/hour) and standard deviation (Std.dev.) of main fish groups caught in valid swept area bottom trawl hauls, at 20-50 m, 50-100 m, 100-500, north of Cape Lopez. The groups listed are; demersal fish (main commercial species), pelagic fish, sharks, cephalopods, shrimps and other (comprises other species not defined within any of the previously mentioned groups). There were no stations above 500m in this region.

a) 20-50 m

Station	Depth	Demersal	Pelagic	Sharks	Cephalopods	Shrimps	Other	Total
1	40	20	10	0	3.9	5.2	116.6	155.7
2	37	0	0	0	0	0	0	0
6	33	5.2	4.1	0	1.8	0	1.8	12.9
7	32	345.6	77.3	0	0	0	11.3	434.2
Mean	35.2	92.7	22.8	0	1.4	1.3	32.4	150.7
Std dev		168.8	36.5	0	1.8	2.6	56.3	201.7

b) 50-100 m

Station	Depth	Demersal	Pelagic	Sharks	Cephalopods	Shrimps	Other	Total
3	74	46.5	2.2	15.4	21.1	2	33.9	121.1

c) 100-500 m

Station	Depth	Demersal	Pelagic	Sharks	Cephalopods	Shrimps	Other	Total
4	313	12,1	0,2	8,1	21,4	7,8	216,9	266,5

The catch rate for the main commercially important demersal fish groups are shown in Table 3.2. The most abundant species group in the depth region 20-50 m were grunts, with average catch rates of 74.6 kg/h, but this number was due to one large catch, so the standard deviation is large (148.8). In deeper water, between 50-100 m depth, species composition changed and the Sea bream had the highest catch rate with 33.7 kg/h.

Table 3.2. Mean catch rates (in kg/hour) and Std. deviation of the main commercial demersal fish groups caught in valid swept area bottom trawl hauls, 20-50 m, 50-100 m, 100-500 m and 500-800 m, north of Cape Lopez. The group of "other" comprises all the other species caught.

a) 20-50 m									
Station	Depth	Croakers	Groupers	Grunts	Seabream	Snappers	Other	Total	
1	40	0	1,5	0,7	0,1	0,8	152,5	155,6	
2	36,5	0	0	0	0	0	0	0	
6	32,5	0	0	0	5,2	0	7,7	12,9	
7	32	0	8,1	297,9	39,5	0	88,6	434,2	
Mean	35,2	0	2,4	74,6	11,2	0,2	62,2	150,7	
Std dev		0	3,9	148,8	19,1	0,4	72,3	201,7	

b) 50-100 m									
Station	Depth	Croakers	Groupers	Grunts	Seabream	Snappers	Other	Total	
3	73,5	0	12,6	0	33,7	0	74,8	121,1	

c) 100-500 m									
Station	Depth	Croakers	Groupers	Grunts	Seabream	Snappers	Other	Total	
4	313	0	0	0	1,8	0	264,7	266,5	

South of Cape Lopez

A total of 32 valid trawl stations were analysed in this region. Of these, ten stations were between 20 - 50 m depth, 11 between 50 - 100 m depth, ten between 100 - 500 m depth and one station above 500m in this region. Table 3.3 shows the catch rates of main groups while Table 3.4 shows catch rate for the main demersal fish groups.

The mean catch rate in the depth strata between 20-50 m was 210.3 kg/h (Table 3.3). The demersal group was the most dominant with average catch rate of almost 98 kg/h, slightly higher than north of Cape Lopez. The "other" group reached catch rates of 60 kg/h while pelagic showed an average catch rate of close to 50 kg/h. The group of shrimps had catch rates of 2.1 kg/h while cephalopods had catch rates of 1.6 kg/h. A few sharks were found in the depth region (0.5 kg/h). On the outer shelf between 50 - 100 m depth, the catch rates decreased to 195 kg/h. The pelagic species declined in abundance compared to inshore waters, and showed a catch rate of 26.3 kg/h. Cephalopods and sharks become more important and showed catch rates of 6 and 5 kg/h, respectively. The highest average catch rates were found on the upper slope, with 2850 kg/h mainly consisting of the "other" group, but also catch rates above 800 were found for demersal species (mostly *Dentex Congoensis*). At the lower slope the catch rates decreased slightly again to 297.2 kg/h, dominated by the "other" group and shrimps.

Table 3.3. Mean catch rates in (kg/hour) and standard deviation (Std.dev.) of main fish groups caught in valid swept area bottom trawl hauls, at 20–50 m, 50-100 m, 100-500, south of Cape Lopez.. The groups listed are; Demersal fish (main commercial species), pelagic fish, sharks, cephalopods, shrimps and other (comprises other species not defined within any of the previously mentioned groups).

a) 20-50 m

Station	Depth	Demersal	Pelagic	Sharks	Cephalopods	Shrimps	Other	Total
9	29,5	22,8	8,1	0	9,9	5,3	62,5	108,7
10	32	3,5	21,7	0	3,4	0	1,9	30,6
15	42	51,6	0,7	0	1,8	5,1	79,4	138,6
16	41	27,9	1,7	0	0,2	2	49,8	81,6
21	37	94,3	13,6	0	0	2,5	24,2	134,6
22	48	48,8	0,2	0	0	0,1	54,2	103,2
26	40	446,2	6,1	0	0	0	141,4	593,6
31	25,5	81,3	205	1,6	0	0	69,2	357
33	37	39,9	28,3	0	0,3	2	33	103,5
38	47	158,5	201	3,6	0	3,8	85,1	452
Mean	37,9	97,5	48,6	0,5	1,6	2,1	60,1	210,3
Std dev		130,2	81,9	1,2	3,1	2,1	38,3	188,5

b) 50-100 m

Station	Depth	Demersal	Pelagic	Sharks	Cephalopods	Shrimps	Other	Total
8	78,5	91,7	96,2	2,7	8,7	7,8	64,7	271,8
11	64	1,8	2,4	10,6	0,6	0	58,4	73,8
14	80	117,4	1,1	2,8	15	0	73,6	209,9
17	81,5	9,3	1,9	6,1	5,3	0	62,8	85,4
20	70,5	28	11	0	1,8	0	252,1	292,8
23	79	26,2	1,7	0	11,9	0	94,1	134
27	68,5	64,2	12,9	0	0	0	170,4	247,5
30	81	13,7	4,2	0	7	0	58,1	82,9
34	87	71,1	24,8	9,5	8,6	5,2	61	180,2
37	85	223,6	41,4	22,4	5,7	0	67,1	360,2
39	76,5	62,9	91,5	3,5	3,3	1	45,5	207,7
Mean	77,4	64,5	26,3	5,2	6,2	1,3	91,6	195,1
Std dev		64,2	35,6	6,8	4,7	2,7	63	94,4

c) 100-500m

Station	Depth	Demersal	Pelagic	Sharks	Cephalopods	Shrimps	Other	Total
12	130,5	468,4	354,9	12,6	5,1	0	92,3	933,3
13	136	147	290,3	4,2	43,1	0	707	1191,6
18	163	804,3	304,8	39,4	0	0	1703	2851,6
19	125	43,5	1090,8	0	36	0	682,9	1853,3
24	155	225,3	188,9	22	10	0	576,5	1022,8
28	228	65,7	0,6	68,5	8,8	0	43,1	186,7
29	118,5	407,3	905,1	40,1	0	0	216,6	1569
35	118,5	123,1	164,2	0	6,4	0	211,7	505,5
36	142	169,6	34,9	15,9	9,7	0,9	485,7	716,8
40	243,5	551,2	68,1	9,5	8,5	11,3	518	1166,6
Mean	156	300,5	340,3	21,2	12,8	1,2	523,7	1199,7
Std dev		248,4	368,6	22	14,7	3,6	478,7	755,5

d) 500-800 m

Station	Depth	Demersal	Pelagic	Sharks	Cephalopods	Shrimps	Other	Total
25	517,5	56,1	7,3	29,9	0	96,1	107,9	297,2

The catch rate for the main commercially important demersal fish groups are shown in Table 3.4. Catch rates were generally very low, with some occasional high yields. The far most abundant fish group in the depth strata 20 - 50 m were “others”, with average catches of 134.3 kg/h, while sea bream gave catch rates of 27.7 kg/h. In deeper water, between 50-100 m depth, the group “other” was still dominant and at the same level as in shallower waters. At the upper slope (100 - 500 m), the catches increased dramatically but the species composition changed only slightly, with “other” again as the main group followed by sea breams. Beyond 500 m depth none of the commercial species groups were important in the catches and “other” was still the dominating group.

Table 3.4. Mean catch rates in (kg/hour) and Std. deviation of the main commercial demersal fish groups caught in valid swept area bottom trawl hauls, 20–50 m, 50-100 m, 100-500 m and 500-800 m, south of Cape Lopez. The “other” group comprises all the other species caught.

a) 20-50 m

Station	Depth	Croakers	Groupers	Grunts	Seabream	Snappers	Other	Total
9	29,5	0	0	0	0,3	10,3	98,1	108,7
10	32	0	0,1	0,1	1,2	0	29,2	30,6
15	42	3,9	0	0	42,2	0	92,5	138,6
16	41	4,1	0,9	13,4	6,8	0	56,5	81,6
21	37	6,8	0	7,3	23,7	45	51,8	134,6
22	48	1,3	0,2	11,2	32,4	1,2	57	103,2
26	40	9,3	0,2	66,9	169,3	186,8	161,1	593,6
31	25,5	50,1	0	14,6	0	0	292,3	357
33	37	11,7	1,6	4,9	1,2	0	84,1	103,5
38	47	30,1	0	3	0	0	418,8	452
Mean	37,9	11,7	0,3	12,1	27,7	24,3	134,1	210,3
Std dev		16,2	0,5	20	52,1	58,8	125,6	188,5

b) 50-100 m

Station	Depth	Croakers	Groupers	Grunts	Seabream	Snappers	Other	Total
8	78,5	2,3	0	0	89,2	0	180,3	271,8
11	64	0	0	0	1,8	0	72,1	73,8
14	80	27,7	0	0	87,9	0	94,2	209,9
17	81,5	0	0	0,6	8,3	0	76,5	85,4
20	70,5	0	0	0	23,8	0	269	292,8
23	79	0	0	1,2	22,1	0	110,7	134
27	68,5	0	1,6	7,1	48,9	0	189,9	247,5
30	81	0	0,1	0	13,5	0	69,3	82,9
34	87	26,3	0	0	37,2	0	116,7	180,2
37	85	0	1,7	0	221,1	0	137,4	360,2
39	76,5	5,3	0,2	0	16,9	0	185,3	207,7
Mean	77,4	5,6	0,3	0,8	51,9	0	136,5	195,1
Std dev		10,7	0,6	2,1	63,5	0	63,1	94,4

c) 100-500 m

Station	Depth	Croakers	Groupers	Grunts	Seabream	Snappers	Other	Total
12	130,5	0	0	0	468,4	0	464,9	933,3
13	136	0	0	0	147	0	1044,6	1191,6
18	163	0	0	0	804,3	0	2047,2	2851,6
19	125	0	0	0	43,5	0	1809,8	1853,3
24	155	0	0	0	224,7	0	798,1	1022,8
28	228	0	0	0	29,5	0	157,3	186,7
29	118,5	0	0	0	401,1	0	1168	1569
35	118,5	8,9	0	0	108,9	0	387,6	505,5
36	142	5,9	0	0	84,3	0	626,6	716,8
40	243,5	0	0	0	24,1	0	1142,5	1166,6
Mean	156	1,5	0	0	233,6	0	964,7	1199,7
Std dev		3,2	0	0	253	0	609,4	755,5

d) 500-1000 m

Station	Depth	Croakers	Groupers	Grunts	Seabream	Snappers	Other	Total
25	517,5	0	0	0	0	0	297,2	297,2

Swept area biomass index

The distance between survey tracks were longer in the north than in the south (20 NM north of Cape Lopez as compared to 17 NM south of Cape Lopez). Due to bad bottom conditions, several of the planned bottom trawl stations had to be cancelled or catches were lost due to problems during trawling. This was especially a problem in the area north of Cape Lopez. In addition, the catches north of Cape Lopez were relatively small (see Figure 3.13) and had a large variation in species composition between stations, leading to higher standard deviation than the mean values. Due to these circumstances, no biomass estimates will be provided for the area north of Cape Lopez. South of Cape Lopez only one bottom trawl station was conducted in waters deeper than 500 m. Therefore no biomass estimates will be given for this depth stratum.

The calculated areas (in NM²) of the different depth strata regions covered by the survey are shown in Table 3.5. The swept area biomass estimates of the various demersal fish groups and invertebrates can be found in Table 3.6. The estimates were calculated by stratifying trawl catches by depth (20 – 49 m, 50 – 99 m, 100 – 499 m, 500 - 799 m) and by multiply this by the calculated area of the representative depth strata. More detailed information about catch rates per station can be found in Annex III. The individual species groups are not covered further in the text as a description of the most common groups has been presented above (in kg/h). Pelagic fish groups are not considered to have been sampled representatively in the bottom trawl catches and the results have to be used with caution.

South of Cape Lopez

The area south of Cape Lopez gave a total swept area biomass estimate for demersal fishes of less than 41 000 tonnes. From which 8 000 tonnes were found inshore between 20 - 50 m depth, further offshore the biomass decreased slightly to 5 700 tonnes. On the upper slope the biomass increased again to 26 000 tonnes (Table 3.6 a). Even though the total biomass for pelagic fish species was slightly lower than the demersal group (36 000 tonnes compared to 41 000 tonnes), pelagic species were more abundant than demersal species on the upper slope. The biomass of rays and sharks was almost as high as for the pelagic species (33 000 and 24 000 tonnes, respectively) and also highest between 100 and 500 m depth (Table 3.6 a). The biomass of Cephalopods reached

1 600 tonnes but was as low as 286 tonnes for shrimps. The highest biomass of cephalopods was found on the upper slope while the highest biomass of shrimps was found at the shelf (20 - 50 m).

The main demersal species was sea bream with a total biomass of 28 000 tonnes, from which the Congo dentex (*Dentex congoensis*) contributed with 18 000 tonnes (Table 3.6 b and Annex III). The highest biomass of sea breams was found in the 100 - 500 m depth strata (Table 3.6 b). The biomass of snappers, grunts, croakers and barracudas was highest below 50 m and almost non-existent in deeper waters. The catches of groupers were so low and variable that no biomass estimate is given for this fish group. Looking into details of differences between different species of fish, shows that the red Pandora (*Pagellus belotti*) was dominating, with a biomass of 3 500 tonnes (Table 3.6 c). The highest biomass of the pelagic species group was recorded by Cunene horse mackerel (*Trachurus trecae*), with more than 26 000 tonnes, from which the highest biomass occurred at depths deeper than 100 m (Table 3.6 c).

Table 3.5. Calculated areas in NM² of the different depth strata covered by the survey, and the percentage that each depth strata represents from the total of each region.

Depth strata	North (NM ²)	South (NM ²)	North (%)	South (%)	Total (NM ²)
20-49	824	2864	22,3	77,7	3688
50-99	560	2875	16,3	83,7	3435
100-499	577	2734	17,4	82,6	3311
Total	1961	8473	18,8	81,2	10434

Table 3.6. Swept area biomass estimates for a) the main groups of fish and vertebrates and b) the most important fish groups and c) the most important fish species.

a)

Depth (m)	# Stations	Demersal			Pelagic			Cephalopods			Rays			Sharks			Shrimps		
		t/nm2	Std.dev.	Biom. (t)	t/nm2	Std.dev.	Biom. (t)	t/nm2	Std.dev.	Biom. (t)	t/nm2	Std.dev.	Biom. (t)	t/nm2	Std.dev.	Biom. (t)	t/nm2	Std.dev.	Biom. (t)
20-49	10	3	4,3	8592	1,4	2,3	4010	0	0,1	0	0,2	0,2	573	0	0	0	0,1	0,1	286
50-99	11	2,1	2,1	5741	0,8	1,1	2187	0,2	0,2	547	0,3	0,3	820	0,2	0,2	547	0	0,1	0
100-500	10	9,7	8,3	26520	11	11,9	30074	0,4	0,5	1094	0,7	0,9	1914	0,7	0,7	1914	0	0,1	0
total				40853			36271			1640			3307			2461			286

b)

Depth (m)	# Stations	Croakers			Grunts			Seabream			Snappers			Barracuda			Carangids		
		t/nm2	Std.dev.	Biom. (t)	t/nm2	Std.dev.	Biom. (t)	t/nm2	Std.dev.	Biom. (t)	t/nm2	Std.dev.	Biom. (t)	t/nm2	Std.dev.	Biom. (t)	t/nm2	Std.dev.	Biom. (t)
20-49	10	0,3	0,5	859	0,4	0,7	1146	0,9	1,7	2578	0,8	1,9	2291	0,5	1	1432	0,5	0,8	1432
50-99	11	0,2	0,4	547	0	0,1	0	1,7	2	4648	0	0	0	0	0	0	0,5	0,9	1367
100-500	10	0	0,1	0	0	0	0	7,6	8,4	20778	0	0	0	0	0	0	10,3	11,7	28160
total				1406			1146			28004			2291			1432			30959

.....b)

Depth (m)	# Stations	Clupeoids			Hairtails			Scombrids			Ariommidae		
		t/nm2	Std.dev.	Biom. (t)	t/nm2	Std.dev.	Biom. (t)	t/nm2	Std.dev.	Biom. (t)	t/nm2	Std.dev.	Biom. (t)
20-49	10	0,2	0,4	573	0,1	0,1	286	0	0	0	0	0	0
50-99	11	0	0,1	0	0,2	0,5	547	0	0	0	0	0	0
100-500	10	0	0,1	0	0,3	0,7	820	0,3	0,8	820	2	4,3	5468
total				573			1653			820			5468

c)

Depth (m)	# Stations	Dentex angolensis			Dentex canariensis			Dentex congoensis			Pagellus bellottii			Trachurus trecae		
		t/nm2	Std.dev.	Biom. (t)	t/nm2	Std.dev.	Biom. (t)	t/nm2	Std.dev.	Biom. (t)	t/nm2	Std.dev.	Biom. (t)	t/nm2	Std.dev.	Biom. (t)
20-49	10	0	0	0	0	0	0	0,1	0,4	286	0,2	0,3	573	0	0	0
50-99	11	0,1	0,4	273	0,2	0,7	547	0,8	2	2187	0,3	0,5	820	0,2	0,3	547
100-500	10	0,1	0,2	273	0	0	0	5,7	7,8	15584	0,8	2,3	2187	9,5	12	25973
total				547			547			18057			3580			26520

3.5. Biodiversity

Biodiversity is the degree of variation of life, and in this report we refer mainly to species variation, and ecosystem variation. This section tries to highlight the main trends in animal biodiversity recorded by the marine mammal observers and vessel trawl catches along the coast of Gabon. A total of 120 hours and 35 minutes of sighting effort and 44 fishing stations with all together 203 fish and elasmobranch species were identified.

Marine mammals

Two dedicated Marine Mammal Observers (MMO) undertook observations during daylight periods.

The number of hours dedicated by the MMOs for marine mammal's observation during the survey summed up to 120 hours and 35 minutes. Weather conditions were good and mostly constant during all the survey with low swell and good sighting conditions.

A total of 27 sightings were made during this survey, 19 whale and 8 dolphin sightings (Figure 3.14). The species recorded were: *Grampus griseus*, *Balaenoptera acutorostrata*, *Stenella frontalis*, *Balaenoptera physalus*, *Balaenoptera brydei*, *Tursiops truncatus*, *Steno bradenensis*, and a number of unidentified dolphins and whales. Since the linear transects could not always be followed during daylight conditions, the data are not suitable for abundance estimation of marine mammals but it offers interesting information about their distribution on the continental shelf. Most of the sightings, mainly whales, were on the southern slope around the 500 m isobath. Only one sighting (*T. truncatus*) was registered north of Cape Lopez.

Dolphins were spotted in groups ranging from 1 to 175 individuals, whereas whales were spotted alone or in couples.

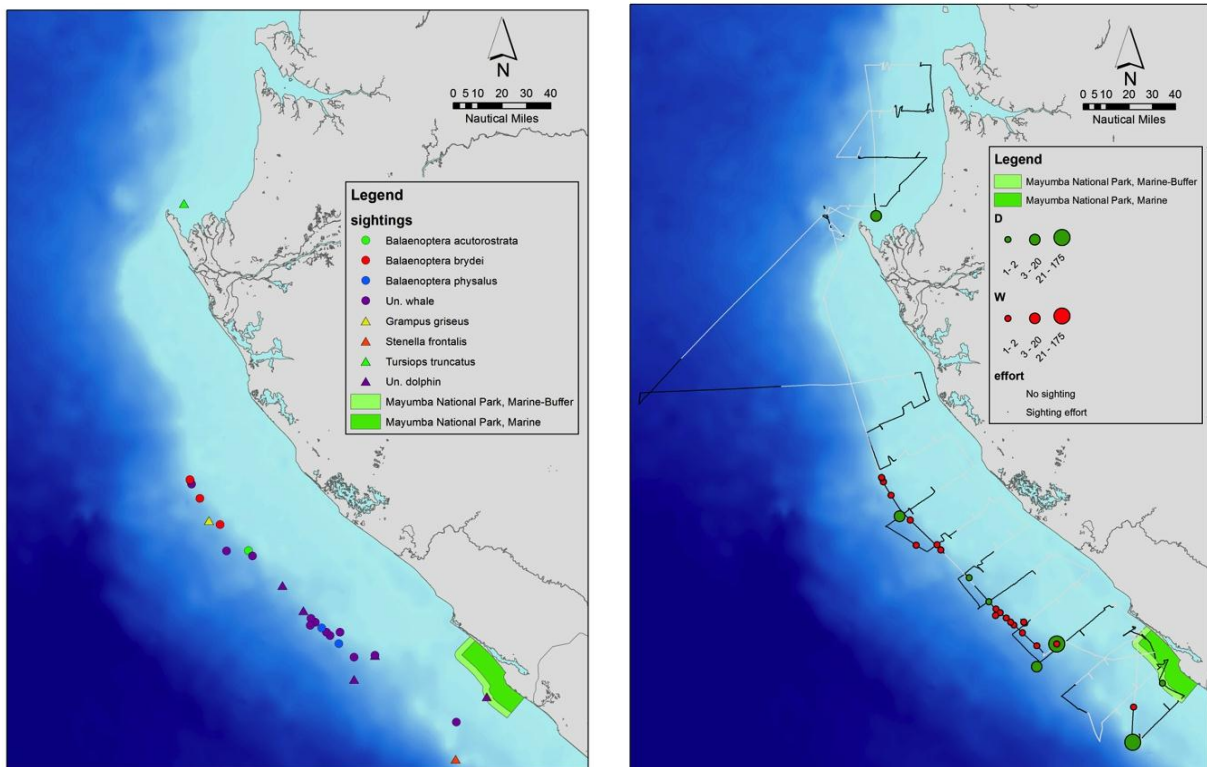


Figure 3.14. Left image shows marine mammal species sighted during the research cruise. Right image shows in the sighting effort compared with the itinerary of the research survey (black means sighting effort and white resting time) and location and group size for each group sighted (green are dolphins and red are whales)

Birds

The two dedicated MMOs also recorded bird distribution during the survey, observing *Sterna sandwicensis*, *Sterna royal*, *Oceanodroma castro*, *Sterna fuscata*, *Sterna caspia*, *Sterna albifrons*, *Sterna hirunda*, and *Xema sabini* (Figure 3.15).

During the refuelling in deep waters, a maximum distance to the coast of 120 NM was reached, during the trip *S. caspia* and *S. albifrons* were observed. *O. Castro* was mainly observed on the slope while *S. Sandwicensis* was observed from shallow to deeper waters along the entire continental shelf. A still non-identified species of the genus *Sterna* was only observed north of Cape Lopez.

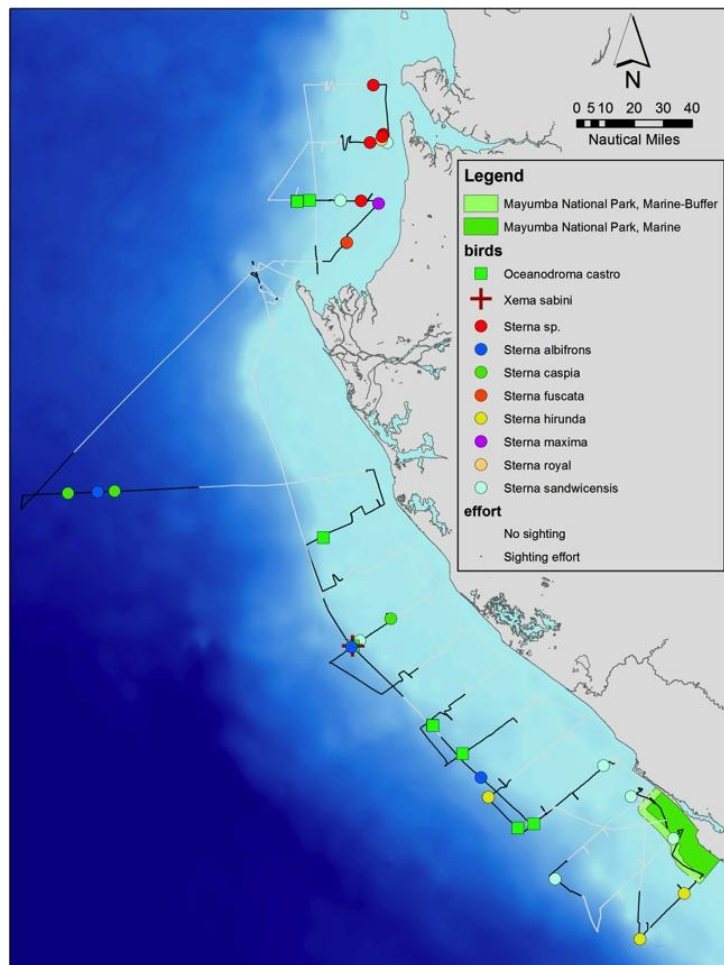


Figure 3.15. Bird species sighted during the research cruise by the MMOs. Figure also shows periods of sighting effort (black lines) and rest or no good sighting conditions (white line).

Turtles

One Olive ridley turtle (*Lepidochelys olivacea*) was caught during fishing operation number 37. The turtle was released alive.

Fisheries species diversity

Biodiversity indices were calculated for the bottom trawling stations. Species diversity relates to the number of the different species and the number of individuals of each species within a community. In general, high species diversity suggests more stable ecosystems, more complex food webs and more resilience to ecosystem damage, thus they are used to indicate the biological health of a particular habitat.

Different indices have been computed to assess species richness and evenness in the fishing locations, such as species richness component, species evenness component and heterogeneous indices. The methods are described below, a comparison of the values listed in Table 3.7 and the spatial variation of the calculated biodiversity indices are shown in Figure 3.16.

Species richness component

Numerical species richness (S)

The easiest, most intuitive method for describing species diversity, the more species present in the sample, the 'richer' the area. However it is sensitive to sample size.

Margalef's species richness index (M) (Margalef, 1958)

The Margalef diversity index is easy to calculate and widely used (Magurran, 2004). It is calculated from the total number of species present and the total number of individuals sampled, the higher the index, the greater the diversity. Values less than 2 are related with low diversity areas (usually by anthropogenic effects)

$$M = \frac{(S - 1)}{\ln N}$$

Where, M is the Margalef index

S= Number of species

N= total number of individuals

Species evenness component

Evenness is complementary to species richness and provides complimentary assessment in both monitoring species diversity and ecosystem functioning studies (Hillebrand *et al.*, 2008; Chiarucci *et al.*, 2011).

Pielou J' index (Pielou, 1966)

$$J = \frac{H'}{H_{max}} = \frac{H'}{\ln S}$$

Where H' is the Shannon-Wiener Index (see below)

Heterogeneous indices

Heterogeneous indices combine both the number of species and the evenness components in a single value. They are useful to facilitate comparisons of results with future or previous studies.

Shannon-Wiener Index H' (Shannon and Weaver, 1949) is assumed to be sensitive to changes in abundance of relatively rare species.

$$H' = \sum_{i=1}^s p_i \ln(p_i)$$

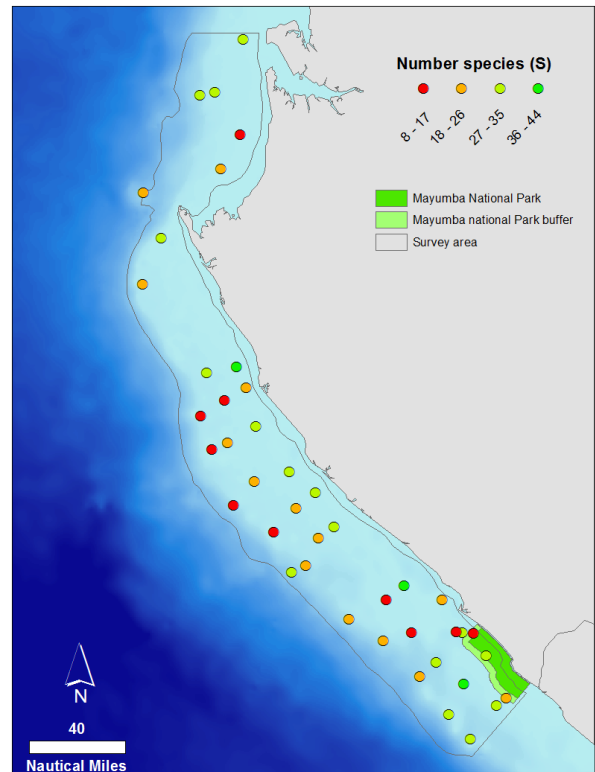
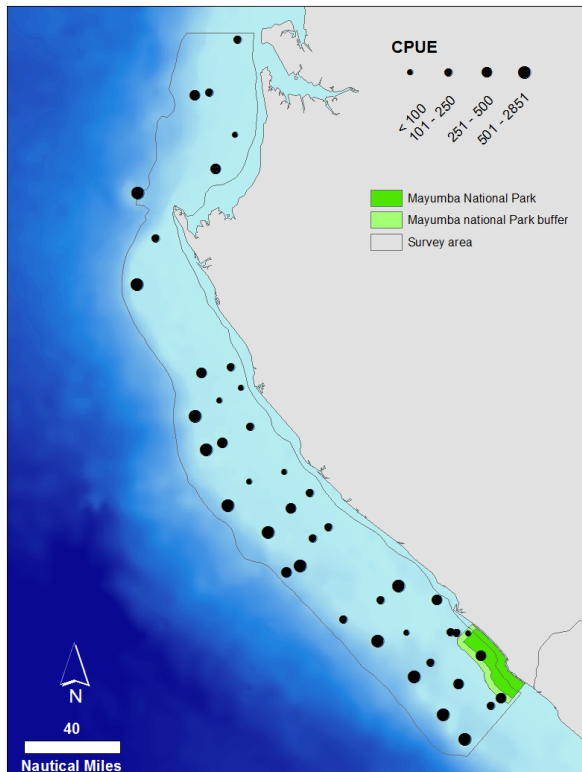
Where p_i is the proportion of individuals found in species i ($p_i = n_i/N$), where n_i is the number of individuals in species i and N is the total number of individuals in the community.

Typical values are generally between 1,5 and 3,5 and are rarely greater than 4.

Simpson diversity index (1-D) (Simpson, 1949).

$$D = \sum p_i^2 = \sum \frac{n_i(n_i - 1)}{N(N - 1)}$$

1-D being an intuitive measure of diversity. In essence, 1-D measures the probability that two individuals randomly selected from a sample will belong to different species. The index value increases with diversity and is considered not to be sensitive to sample size (Lande *et al.*, 2000) and is heavily weighted towards the dominant species and less sensitive to species richness than H' (Boyle *et al.*, 1990)



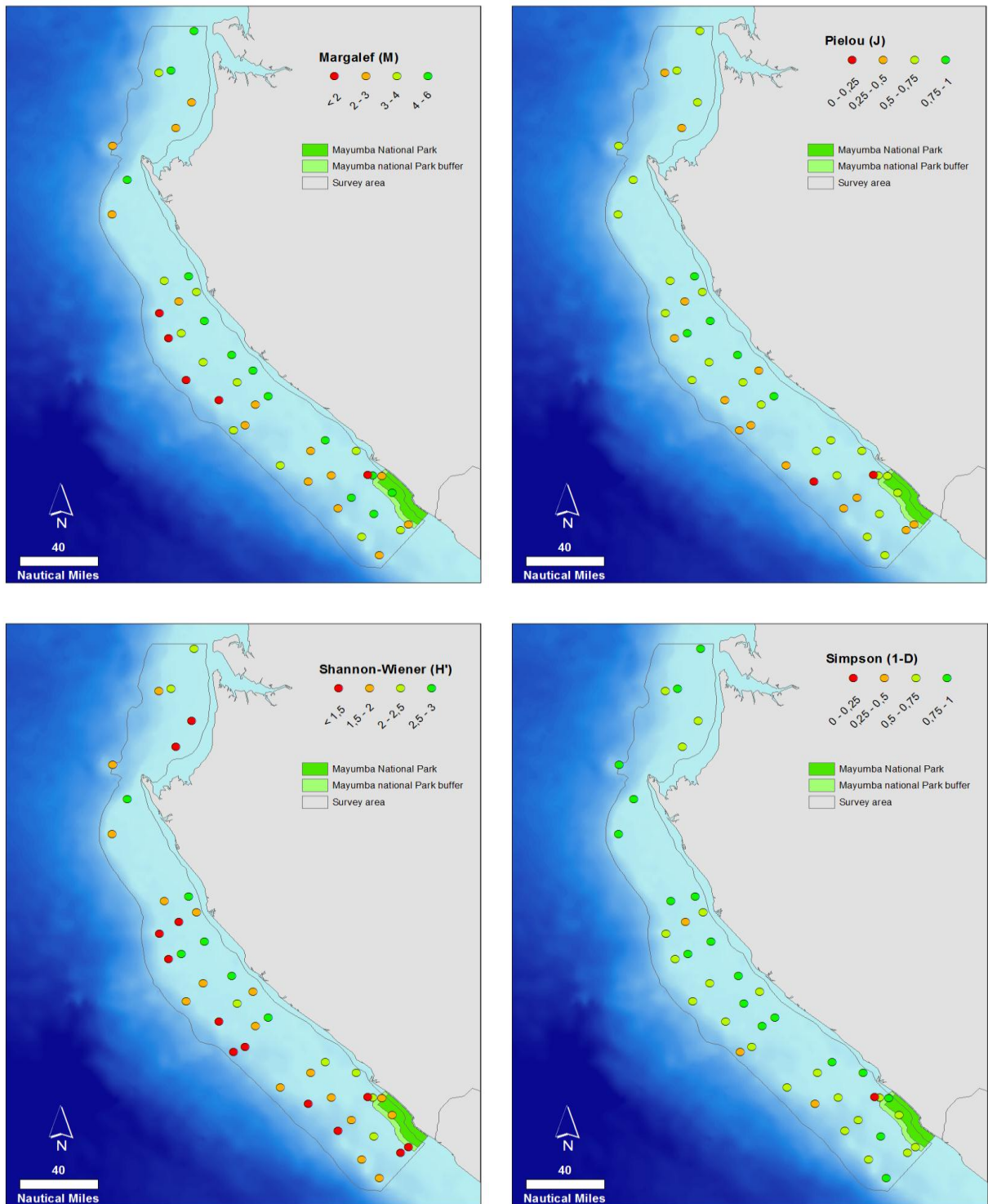


Figure 3.16. Spatial variation of the calculated biodiversity indices:

- Catch per Unit Effort by station
- Species richness (Low in diversity in red, high diversity in green)
- Margalef's index (Low in diversity in red, high diversity in green)
- Pielou's index, values ranging from 0 (null evenness) to 1 (total evenness)
- Shannon-Wiener index (Low in diversity in red, high diversity in green)
- Simpson diversity index (ranging from 0 (0% probability that two individuals at random belong to the same species) to 1 (100% probability that two individuals at random belong to the same species)).

Table 3.7. Numerical values for the biodiversity indices calculated for each bottom trawling fishing station

Station	CPUE	Spp Richness (S)	Margalef (M)	Pielou (J)	Shannon (H')	Simpson (1-D)
st1	155,62	35	5,043	0,58	2,063	4,976
st3	121,11	31	4,157	0,591	2,029	4,547
st4	274,32	32	3,483	0,477	1,654	3,291
st6	12,914	8	2,101	0,628	1,307	2,292
st7	434,225	19	2,81	0,435	1,281	2,055
st8	271,752	29	3,291	0,534	1,798	4,156
st9	124,489	44	5,696	0,786	2,976	13,634
st10	30,567	26	3,996	0,535	1,744	3,151
st11	73,835	15	2,468	0,372	1,008	1,66
st12	933,286	14	1,284	0,507	1,338	3,365
st13	1191,574	15	1,337	0,389	1,053	2,15
st14	258,275	26	3,559	0,768	2,502	8,762
st15	138,575	30	4,156	0,806	2,742	12,261
st16	81,589	30	4,697	0,825	2,806	12,02
st17	85,443	23	3,661	0,513	1,609	2,564
st18	2851,567	17	1,541	0,532	1,508	3,936
st19	1853,333	11	0,989	0,387	0,927	2,118
st20	292,835	25	3,089	0,676	2,175	5,32
st21	134,613	33	4,526	0,473	1,655	2,603
st22	103,232	32	4,921	0,767	2,659	8,817
st23	133,956	18	2,247	0,687	1,987	5,314
st24	1022,753	24	2,452	0,451	1,433	3,343
st25	297,192	31	3,951	0,365	1,253	1,841
st26	593,648	37	4,68	0,663	2,394	6,858
st27	247,515	16	2,148	0,592	1,642	3,526
st28	186,706	26	3,43	0,473	1,542	2,592
st29	1569,039	23	2,131	0,226	0,709	1,416
st30	82,942	14	2,024	0,609	1,608	3,799
st31	357,003	24	3,017	0,719	2,286	7,876
st33	103,48	32	4,506	0,581	2,013	3,688
st34	180,186	35	4,536	0,424	1,509	2,468
st35	505,487	23	2,446	0,404	1,267	2,347
st36	716,794	30	3,253	0,502	1,709	3,491
st37	360,179	37	4,843	0,617	2,227	5,009
st38	451,968	25	2,845	0,442	1,422	2,754
st39	207,544	31	3,878	0,407	1,397	2,103
st40	1166,592	28	2,965	0,584	1,946	4,913
st41	126,554	13	1,707	0,207	0,532	1,243
st42	70,476	15	2,554	0,679	1,84	4,508
st43	276,517	28	4,353	0,537	1,789	3,461
st44	521,099	21	2,422	0,59	1,795	4,732
st45	205,241	34	4,544	0,733	2,585	8,366
st46	1700,64	22	2,274	0,61	1,887	4,301

3.6. Comparison between fish abundance inside and outside the marine park of Mayumba

A study regarding the impact of bottom trawling was carried out in the Mayumba National Park. Situated in the southern part of Gabon, Mayumba is the only Marine National Park of Gabon and it extends for 60 kilometres until the border with Congo. Not only is it one of the most important nesting sites for Leatherback turtles in the world, but other turtle species also use this beach as a nesting site. In its waters, humpback whales can be found during their breeding migration; rays, sharks, dolphins are also present. Until a few years ago, intensively and uncontrolled industrial fishing occurred in this area. A great effort has been made to stop all illegal fishing activity inside the park and nowadays it is a no-take area, whereas only regulated industrial fishing activity takes place outside the park.

During the survey onboard the R/V Dr Fridtjof Nansen, we assessed fisheries resources and collected benthos samples, both inside and outside the Marine Park with the intention of monitoring changes in the ecosystem between a recently closed fishing zone, and a contiguous currently trawled area.

Stations were located at similar depths (30-40 m depth) and closeby (maximum distance 16 nautical miles). A total of nine Benthos stations were worked in order to assess the current state of the bottom floor in the three areas: three replicated van-veen grabs in current fishing zone, three in the buffer area and three inside the national park. Eighteen sediment and benthos samples were collected for further laboratory analysis in granulometry, organic matter content and benthos species identification. A list of stations included in the Mayumba National Park habitat damage study is given in Table 3.8 and the spatial variation in the calculated biodiversity is shown in Figure 3.17.

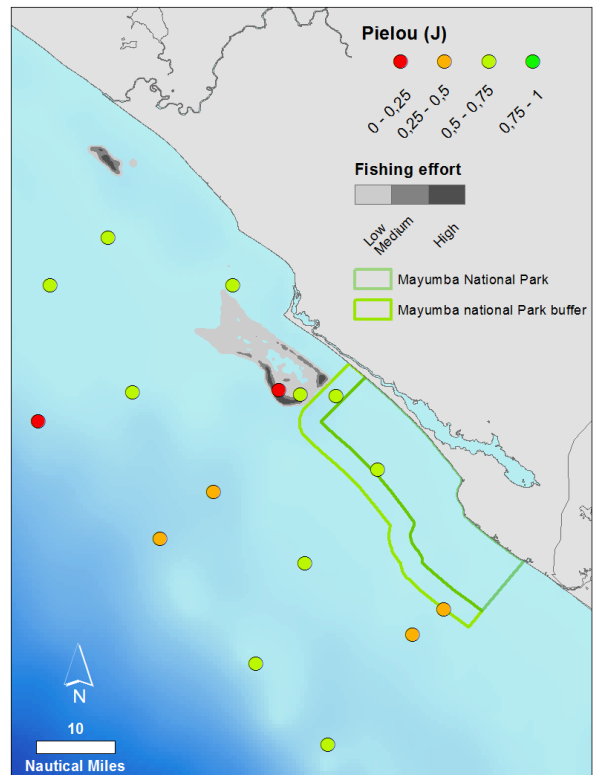
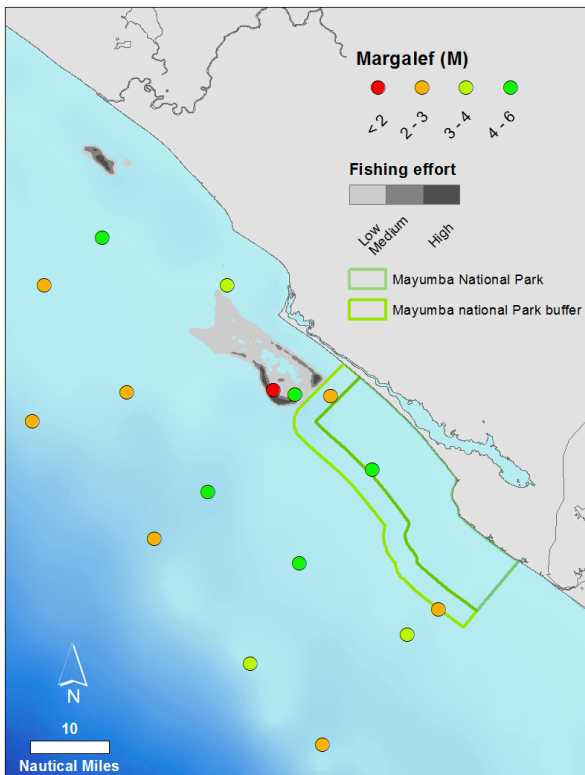
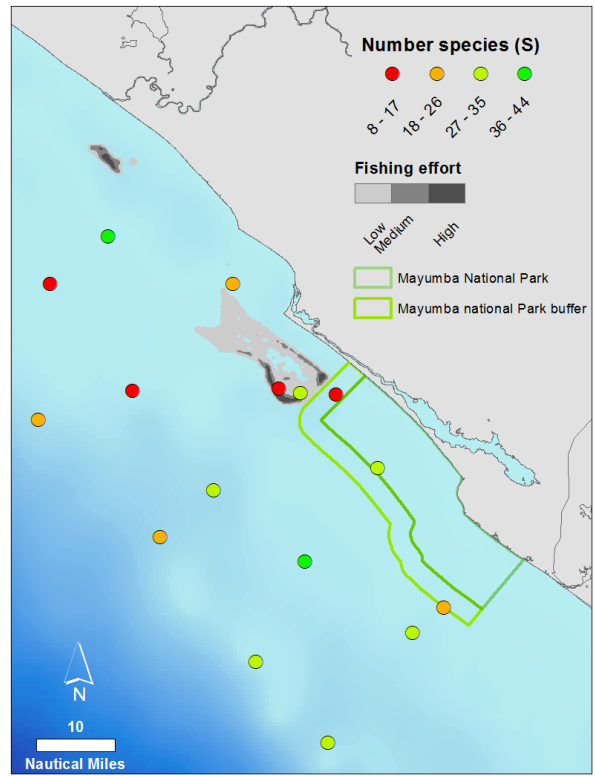
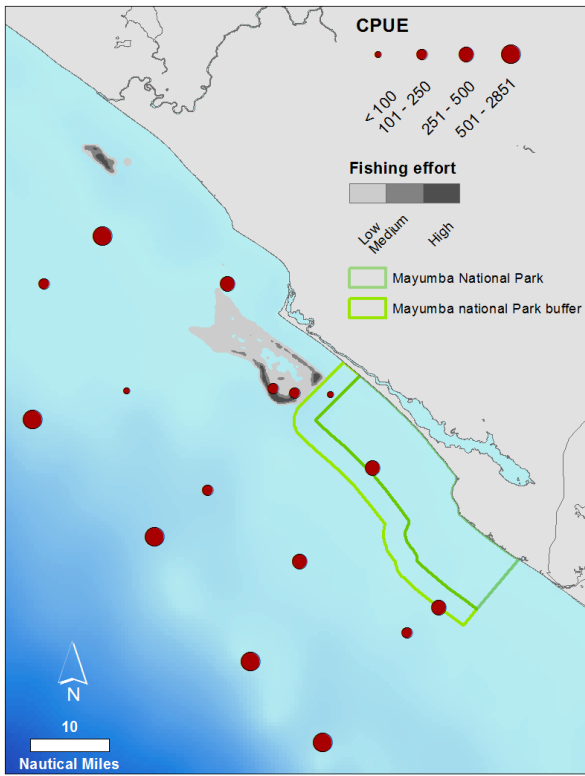
In addition, and due to time constraints, four bottom trawl hauls were made in the area: two in the current fishing zone, one in the buffer area and one in the national park. The precise location of each fishing station was chosen according to their suitability to perform the bottom trawling operation.

Even though the low number of fishing operations is not enough to extract a conclusion, it is expected to revisit the area in following surveys to monitor the evolution of the ecosystems.

The predominant species in the fishing zone were benthopelagic coastal species associated with muddy-sandy bottoms. Further research is needed in order to explore this in more detail. Sediment and benthos analysis will also determine if these differences are due to a change in the environmental conditions or if it could be understood as an effect of the national park being protected from fishing activity.

Table 3.8. List of stations included in the Mayumba National Park habitat damage study

Fishing station	33	41	42	43
Zone	Fishing zone	Fishing zone	Buffer zone	National park
Depth (m)	37	40	31	32
CPUE (Kg/h)	103,48	126,55	70,47	276,5
Number species	11	13	15	28
Dominant species	<i>B. auritus</i> <i>P. senegalensis</i> <i>G. decadactylus</i> <i>P. incisus</i>	<i>B. auritus</i> <i>S. guancho</i> <i>P. bellottii</i>	<i>P. typus</i> <i>P. peroteti</i> <i>C. chrysurus</i> <i>A. parkii</i>	<i>G. decadactylus</i> <i>P. coerureostictus</i> <i>D. africana</i> <i>S. dorsalis</i>



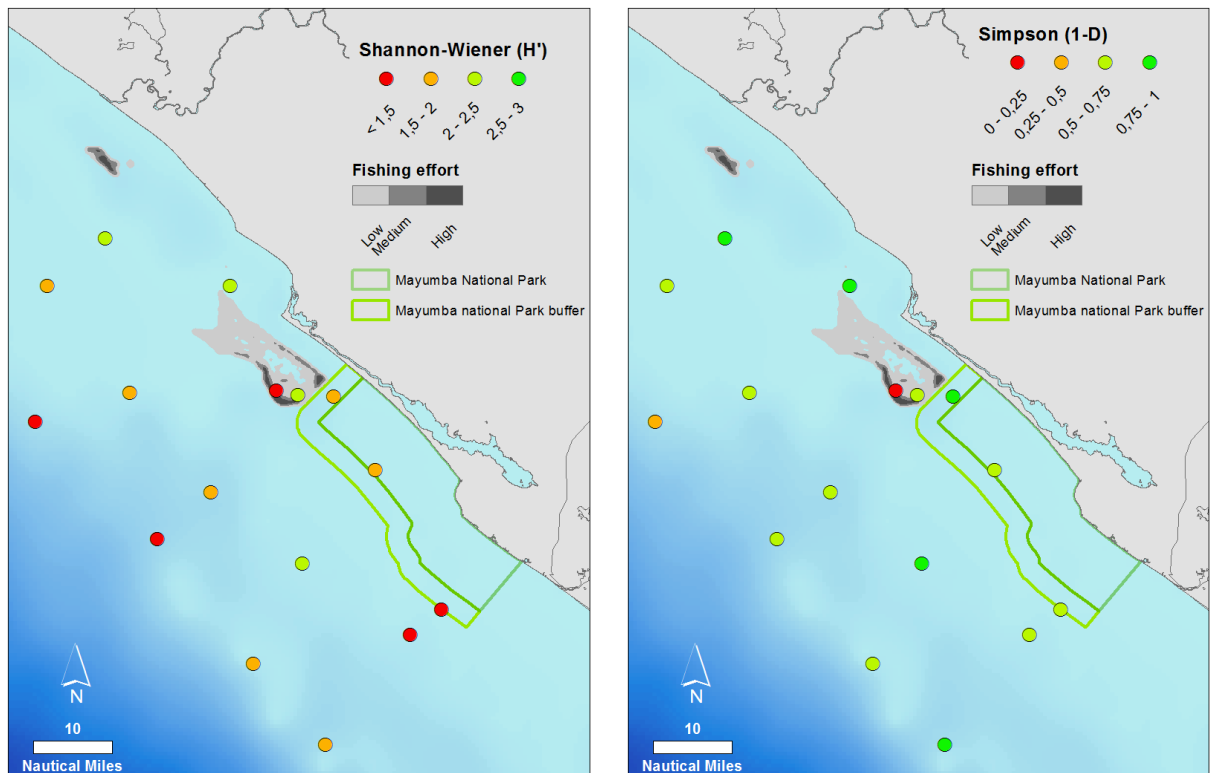


Figure 3.17. Spatial variation of the calculated biodiversity indices in and around the Mayumba National Park. Commercial fishing footprint is also shown:

- a) Catch per Unit Effort by station
- b) Species richness (Low in diversity in red, high diversity in green)
- c) Margalef's index (Low in diversity in red, high diversity in green)
- d) Pielou's index, values ranging from 0 (null evenness) to 1 (total evenness)
- e) Shannon-Wiener index (Low in diversity in red, high diversity in green)
- d) Simpson diversity index (ranging from 0 (0% probability that two individuals at random belong to the same species) to 1 (100% probability that two individuals at random belong to the same species))

Although biodiversity index values change largely for the same stations, making their interpretation difficult, most of the changes are related to the effect of the sample size (CPUE) and the presence of rare species (species with a low number of individuals) on the indices, even though all of them are useful indices for ecological monitoring. We are going to focus on the results offered by the Pielou's evenness index and the Simpson diversity index.

Worst results were obtained by stations 29 and 41 (see Figure 3.18) with a $J=0,473$; $(S-1) =1,416$ and $=0,207$; $(S-1) =1,243$ respectively, being the last the station scoring low biodiversity and evenness in the whole survey and corresponding to a heavily trawled fishing zone. In general, the remaining values inside and outside the park lie out of fishing grounds and reach average-high biodiversity values in comparison with the rest of the region.



Figure 3.18. Stations numbers showed in the Mayumba area figures

Results from this and following surveys will help us to understand how ecosystems recover after the closure of fishing activities and what effects the creation of new Marine Parks can bring to the marine biodiversity of West Africa. Preliminary results from trawl catches suggest bigger size and higher species diversity inside the park than outside, for similar depth strata stations. Two distinguished differences are that inside the park we got several big royal spiny lobsters (*Panulirus regius*) and that station sited in the high density trawl area got the worst bottom trawling biodiversity results (i.e. less species richness and evenness in the region) in the region.

Results from the sediment and benthos diversity analysis and annual monitoring will bring more information about the impact of bottom trawling activity in the area and the role of Marine reserves as tools for habitat restoration.

4. CONCLUSIONS AND RECOMMENDATIONS

In Gabon, the demersal species are exploited by the industrial and artisanal fisheries. The artisanal fishery lands about half the total catch of fish with a mean annual production of around 25 000 tonnes, with 80 percent composed of demersal species. The annual catches of the industrial fishery were around 13 000–14 000 tonnes (CECAF/ECAF SERIES 11/73) in 2008. The main commercial species are croakers (*Pseudotolithus senegalensis* and *Pseudoplesiops typus*) and threadfin (*Galeoides decadactylus*). Other important species are sea breams (*Dentex* spp., *Pagrus* spp.), Atlantic spotted grunter (*Pomadasys jubelini*), bobo croaker (*Pseudotolithus elongatus*), and catfish (*Arius* spp.). These bottom fish are also important for artisanal fishers. The artisanal fishery is carried out with canoes and different types of gear. Traditionally, gears such as purse seine and beach seine are distinguished from the more individual gears such as gillnet, handlines, longlines and castnets. In the last assessment of the demersal resources in the southern CECAF area it was concluded that most of the stocks that were analyzed are fully to overexploited (CECAF/ECAF SERIES 11/73). It was however noted that for most of the stocks, the only series of stock abundance indices available were commercial catch per unit effort (CPUE) data series. A scientific survey giving an overview of the status of the main fish stocks is therefore very valuable in order to improve on the management of the fish stock in the area.

The R/V Dr Fridtjof Nansen has previously been in the area off Gabon on six occasions over the last ten years; in 2010, 2008, 2007, 2006, 2005 and 2004. In the first and two last surveys pelagic resources were studied, while in the remaining surveys, hydrographical conditions and demersal fish resources were also covered. In 2014 an ecosystem survey was carried out. This involved a sampling design covering most of the living resources of the continental shelf and linkage to their environment. We conducted different studies during the 14 days of survey including bottom trawling of the demersal fish stocks, acoustic recordings of pelagic fishes, oceanographic measures (temperature, salinity and oxygen), and estimates of plankton biomass, recordings of marine mammals, birds and turtle's distribution, comparison of different habitats and sea-bottom impact of bottom trawling. The main objective of the survey was however to estimate the abundance and to map the distribution of demersal fish species in the region. All these activities conducted during the survey generated a great amount of data that needs to be processed and analyzed on land. The results from these analyses should be presented as a technical survey report at a later stage.

The most notable oceanographic features were the comparatively warmer upper water-masses in the northern part of the coastal area, along with the more saline upper water masses towards the south. This is probably a result of the timing of the survey which is coincident with the late phase of the wet season, causing lower salinity in the surface waters on the shelf off northern Gabon due to the freshwater coming from the coastal rivers. With respect to near-surface dissolved oxygen and relative fluorescence, the levels varied within rather limited ranges and the indicated dynamics occurred over relatively short spatial scales.

Separate catch rates for the region north and south of Cape Lopez have been calculated and presented. For various reasons given in the text, the swept area biomass is presented only for the region south of Cape Lopez. Figure 3.13 shows that the bottom trawl catches in the area north of Cape Lopez were small, while south of Cape Lopez the catches are considerably higher, especially in the area between 100-200 m depth (upper slope). The highest catch occurred on the upper slope, with 2 850 kg/h, mainly consisting of various non-commercial fish species, but also one catch above 800 kg/h was recorded for the group demersal fish (dominated by *Dentex Congoensis*).

The area south of Cape Lopez gave a total swept area biomass estimate for demersal fishes of less than 41 000 tonnes. The biomass for the pelagic fish species was slightly lower than for the demersal

group (36 000 tonnes), but it must be kept in mind that the bottom trawl will not give a representative picture of the abundance and length of pelagic fish and the results should be used with caution.

The biomass of the main commercial demersal species (*Sciaenidae*, *Serranidae*, *Pomadasyidae*, *Lutjanidae* and sea bream) has decreased compared to the first survey with Dr Fridtjof Nansen in 2005, from 180 000 tonnes to slightly above 20 000 tonnes in 2014 (Figure 4.1). The biomass of the main demersal fish group, sea bream (*Sparidae*) shows a slightly decreasing trend compared to previous years (28 000 tonnes this year, compared to 80 000 tonnes in 2005 and 2006). The grunts have decreased from 79 000 tonnes in 2005 to about 1 000 tonnes in 2014. The same trend is also seen for croakers, groupers and snappers.

Another demersal species with relatively high biomass in the 2014 survey was the red Pandora (*Pagellus belotti*), with a biomass of 3 500 tonnes. This is a relatively small fish that can reach 42 cm, but has an average length of 25 cm. This is a protogynic hermaphrodite where individuals start out life as females, and some become male later on. This shows the importance of keeping the fishing pressure at levels which will allow for a healthy sex ratio. What levels these are, is not clear and further studies should be conducted.

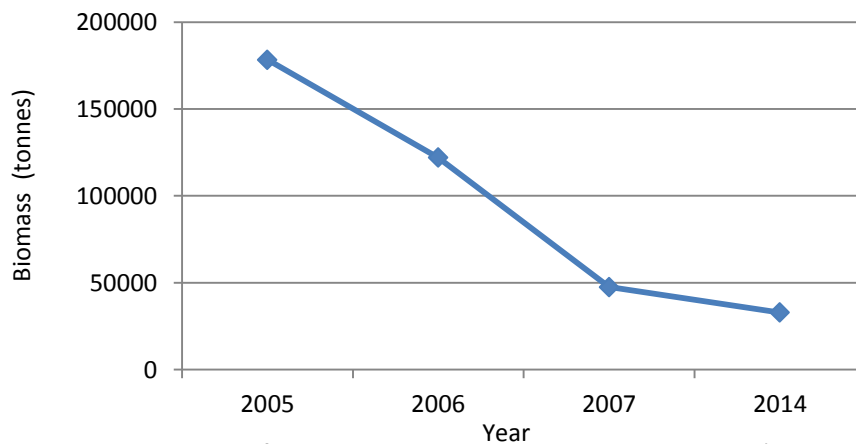


Figure 4.1. Biomass of the main commercial demersal species (*Sciaenidae*, *Serranidae*, *Pomadasyidae*, *Lutjanidae* and *Sparidae*) from the 2014 and previous surveys with Dr Fridtjof Nansen.

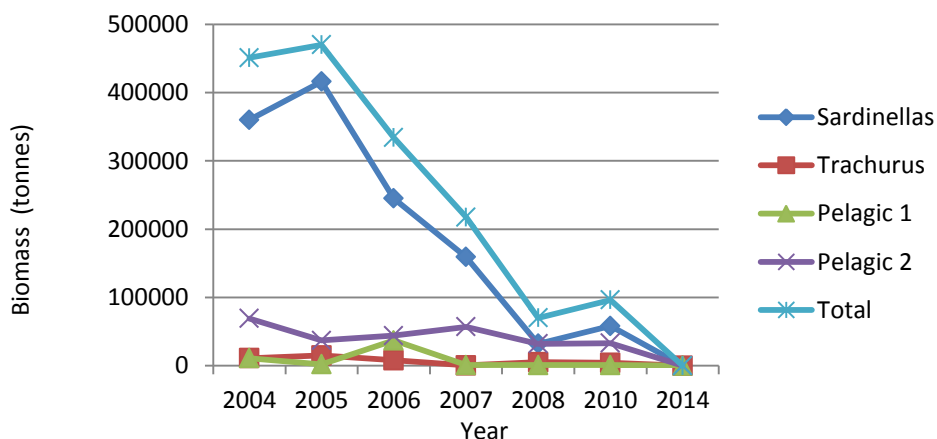


Figure 4.2. Biomass of the main commercial pelagic species from the 2014 and previous surveys with Dr Fridtjof Nansen.

The occurrence of pelagic fish was too low to permit any reliable biomass calculation for the 2014 survey, but calculations from previous surveys indicate a strong decreasing trend (Figure 4.2).

Previously, pelagic catches were dominated by two sardinella species, but for the 2014 survey, the abundance of these species was low and the pelagic group was dominated more by Cunene horse mackerel (*Trachurus trecae*). The biomass of this species was more than 26 000 tonnes, of which the highest biomass occurred at depths greater than 100 m. As mentioned before, the swept area biomass estimates for pelagic species have to be used with great care. The biomass of the pelagic species is considered to be highly variable in time and space due to schooling behaviour and seasonal migration to spawning areas. It is expected that Cunene horse mackerel (*Trachurus trecae*), in similar ways to sardinella, migrates across the border between Angola and Congo. However, the proportion of the biomass for this species in Gabon should be looked into more closely. Also the genetic structure of horse mackerel and sardinella in the different regions in West Africa ought to be examined.

In general, biodiversity indices score lower in deeper areas than in the shallow stations on the shelf, almost represented by an inverse relationship between species richness and catch size. The exception is a few shallow stations occurring in heavy trawled areas close to the coast. The biodiversity in a given area is highly dependent on local environmental conditions (i.e. substrate type, temperature and nutrients available) and the best use of these indices is for future habitat monitoring.

As Marine Protected Areas (MPAs) have now been established throughout the world, oceans being more and more used as management tools for fisheries management (Leleu *et al.*, 2014), the efficiency of MPAs in marine resources protection has been widely scientifically monitored, showing how well-designed and effectively managed marine reserve networks can reduce local threats and contribute to a better management of marine resources (Green *et al.*, 2014). Similar long term experiments have shown the importance of the non-take areas in increased fisheries incomes, helping to preserve not only fish populations but also marine ecosystem's health and biodiversity (Mesnildrey *et al.*, 2013, Abecansis *et al.*, 2014).

We show here some promising results, however further analysis of benthic communities and sediments in the area will help to understand better the effect of trawling in the marine park. In addition, the area should be kept monitored during future surveys, achieving this way a double objective: increase our understanding of the role of the MPAs in the protection of marine resources in tropical waters and assess the long-term socio-economic and ecological impact for the country of this no-take area.

The detailed records of position of all samples taken during the survey could be used as the basis for a species atlas or serve as input to regional management plans considering identification of areas with vulnerable species, high biological production, low oxygen etc.

Based on the findings from the surveys, we have the following recommendations:

- Conduct annual assessment workshop for the demersal and pelagic resources in order to establish long term beneficial management measures and goals;
- Establish and develop a national strategy for monitoring the marine ecosystem;
- Adopt precautionary measures for the exploitation of small pelagics;
- Conduct studies designed to increase the understanding of stock dynamics;
- Train staff in the various aspects of ecosystem-monitoring the oil zone south of Cape Lopez in future surveys.

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ANNEX I Records of fishing stations

R/V

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 1
 DATE :10/05/14 GEAR TYPE: BT NO: 27 POSITION:Lat N 0°32.20
 TIME :21:30:46 22:00:51 30.1 (min) Purpose : 3
 LOG : 446.38 447.87 1.5 Region : 3310
 FDEPTH: 318 308 FDEPTH: 318 308 Gear cond.: 0
 BDEPTH: 318 308 Validity : 0
 Towing dir: 0° Wire out : 740 m Speed : 3.0 kn
 Sorted : 33 Total catch: 133.56 Catch/hour: 266.50

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP	SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers				weight	numbers		
Zenion hololepis	89.39	6385	33.54		Chlorophthalmus atlanticus	50.12	4789	18.81	
Brachydeuterus auritus	16.84	570	10.82		Ophisurus serpens	33.68	575	12.64	
Sphyraena guachancho	9.25	39	5.94	4	Ommastrephes bartramii	21.39	247	8.03	16
Penaeus notialis	5.00	256	3.21	4	Peristedion cataphractum	12.45	487	4.67	
Cynoponticus ferox	3.97	2	2.55	6	Merluccius polli	10.38	56	3.89	
Sepia sp	2.95	47	1.90		Penaeus notialis	7.82	774	2.94	
Portunus validus	1.50	2	0.96		Scyllorhinus cervigoni	5.11	24	1.92	
Epinephelus aeneus	0.98	4	0.63	1	Coelorrhinus coelorrhinus	4.15	104	1.56	
Eucinostomus melanopterus	0.94	22	0.61		Cyttopsis rosea	3.19	239	1.20	
Citharichthys stampfili	0.94	53	0.61		Centrophorus sp.	3.03	8	1.14	
Alloteuthis africana	0.90	376	0.58		Malacocephalus laevis	2.87	88	1.08	
Lutjanus fulgens	0.79	4	0.51		Lophius vaillanti	2.71	48	1.02	15
Pomadasy incinus	0.71	4	0.46		Dactylopterus volitans	2.23	8	0.84	
Serranus accraensis	0.47	30	0.30	2	Dibranchius atlanticus	2.23	375	0.84	
Selene dorsalis	0.39	31	0.25	7	Bathygadus melanobranchus	2.08	16	0.78	
Selar crumenophthalmus	0.28	41	0.18		C R A B S	2.08	104	0.78	
Raja miraletus	0.24	2	0.15	3	Chascanopsetta lugubris	1.92	40	0.72	
Pseudupeneus prayensis	0.20	8	0.13	9	Boops boops	1.76	40	0.66	14
Penaeus kerathurus	0.20	2	0.13		Lophiodes kempi	1.60	8	0.60	
Dicologlossa cuneata	0.16	2	0.10	5	Pterothrissus bellocci	0.80	8	0.30	
Saurida brasiliensis	0.12	122	0.08		Gadella imberbis	0.80	32	0.30	
Pagrus caeruleostictus	0.08	4	0.05		Stereomastis sculpta	0.80	8	0.30	
Ophidion sp.	0.08	8	0.05		Sycaium micrum	0.80	96	0.30	
Scyllarides herklotsii	0.06	8	0.04		Raja miraletus	0.80	8	0.30	
Sicyonia galeata	0.05	2	0.03		Laemonema laureysi	0.64	8	0.24	
UNIDENTIFIED FISH	0.04	4	0.03		Setarches guentheri	0.64	16	0.24	
Paronchelius stauchi	0.04	4	0.03		Rajella leopardus	0.32	8	0.12	
Sardinella maderensis	0.04	2	0.03	0	Chelidonichthys gabonensis	0.32	16	0.12	
Epinephelus marginatus	0.04	2	0.03		Epigonus telescopus	0.16	16	0.06	
Trachinocephalus myops	0.04	2	0.03	8	Caranx rhonchus	0.16	8	0.06	17
Fistularia tabacaria	0.02	2	0.01		Synagrops microlepis	0.08	8	0.03	
Prognathodes marcellae	0.02	2	0.01		Total	266.50		100.00	
Acanthurus monroviae	0.02	4	0.01						
TETRAODONTIDAE	0.02	2	0.01						
UNIDENTIFIED FISH	0.02	2	0.01						
Scorpaena normani	0.02	2	0.01						
Total	155.59		100.00						

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 2
 DATE :10/05/14 GEAR TYPE: BT NO: 27 POSITION:Lat N 0°12.83
 TIME :10:25:49 10:39:52 14.1 (min) Purpose : 3
 LOG : 399.23 399.62 0.4 Region : 3310
 FDEPTH: 36 37 FDEPTH: 36 37 Gear cond.: 0
 BDEPTH: 36 37 Validity : 5
 Towing dir: 0° Wire out : 80 m Speed : 1.6 kn
 Sorted : 0 Total catch: 0.00 Catch/hour: 0.00

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

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 3
 DATE :10/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat N 0°10.13
 TIME :18:44:40 19:14:57 30.3 (min) Purpose : 3
 LOG : 432.49 434.13 1.6 Region : 3310
 FDEPTH: 74 73 FDEPTH: 74 73 Gear cond.: 0
 BDEPTH: 74 73 Validity : 5
 Towing dir: 0° Wire out : 200 m Speed : 3.3 kn
 Sorted : 61 Total catch: 61.15 Catch/hour: 121.09

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP	SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers				weight	numbers		
Pagellus bellottii	28.28	1075	23.35	12	Dentex congoensis	5.17	36	40.00	18
Sepia sp	19.96	453	16.48		Caranx crysos	4.13	6	32.00	
Squatina oculata	15.45	14	12.76		Sepia officinalis	1.79	2	13.85	
Epinephelus aeneus	12.55	2	10.37		Lagocephalus laevigatus	0.79	2	6.15	
Chelidonichthys gabonensis	8.59	430	7.10	10	Fistularia petimba	0.40	2	3.08	
Dactylopterus volitans	7.96	113	6.57		Dactylopterus volitans	0.24	2	1.85	
Dasyatis marmorata	7.17	2	5.92		Echelus myrus	0.20	2	1.54	
Boops boops	5.43	115	4.48		Sphoeroides spengleri	0.20	4	1.54	
Trachinus lineolatus	2.97	99	2.45		Total	12.91		100.00	
Decapterus punctatus	2.22	73	1.83						
Penaeus notialis	1.98	57	1.64						
Pseudupeneus prayensis	1.35	12	1.11						
C R A B S	1.27	91	1.05						
Octopus vulgaris	1.19	6	0.98						
Priacanthus arenatus	1.03	12	0.85						
Ephippion guttifer	0.48	18	0.39						
Dicologlossa cuneata	0.48	24	0.39						
Platycephalus sp.	0.40	20	0.33						
Raja miraletus	0.40	6	0.33						
Scorpaena normani	0.32	18	0.26						
Microchirus ocellatus	0.28	10	0.23						
Lophiodes kempi	0.24	4	0.20						
Fistularia petimba	0.24	4	0.20						
Citharichthys stampfili	0.24	6	0.20						
Ophidion sp.	0.20	4	0.16						
Paronchelius stauchi	0.16	8	0.13						
Microchirus frechkopi	0.12	6	0.10						
Cynoponticus ferox	0.12	10	0.10						
UNIDENTIFIED FISH	0.04	2	0.03						
Chromis cadenati	0.02	2	0.02						
Selene dorsalis	0.00	2	0.00						
Total	121.09		100.00						

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 6
 DATE :11/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 0°7.88
 TIME :12:45:16 13:15:28 30.2 (min) Purpose : 3
 LOG : 529.29 530.93 1.6 Region : 3310
 FDEPTH: 34 31 FDEPTH: 34 31 Gear cond.: 0
 BDEPTH: 34 31 Validity : 5
 Towing dir: 0° Wire out : 95 m Speed : 3.2 kn
 Sorted : 0 Total catch: 6.50 Catch/hour: 12.91

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP	SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers				weight	numbers		
Pomadasy rogeri	297.88	827	68.60	19	Pomadasy rogeri	297.88	827	68.60	19
Caranx senegallus	40.19	78	9.25		Pagellus bellottii	39.55	130	9.11	21
Pagellus bellottii	39.55	130	9.11		Alectis alexandrina	22.85	24	5.26	
Alectis alexandrina	22.85	24	5.26		Epinephelus aeneus	8.15	16	1.88	20
Epinephelus aeneus	8.15	16	1.88		Selar crumenophthalmus	7.31	32	1.68	23
Selar crumenophthalmus	7.31	32	1.68		Balistes capricus	6.79	16	1.56	
Balistes capricus	6.79	16	1.56		Selene dorsalis	3.48	24	0.80	
Selene dorsalis	3.48	24	0.80		Caranx crysos	2.60	4	0.60	
Caranx crysos	2.60	4	0.60		Fistularia petimba	1.36	10	0.31	
Fistularia petimba	1.36	10	0.31		Lagocephalus laevigatus	1.04	2	0.24	
Lagocephalus laevigatus	1.04	2	0.24		Sphyraena guachancho	0.88	2	0.20	22
Sphyraena guachancho	0.88	2	0.20		Priacanthus arenatus	0.68	32	0.16	
Priacanthus arenatus	0.68	32	0.16		Chilomycterus spinosus mauret.	0.40	2	0.09	
Chilomycterus spinosus mauret.	0.40	2	0.09		Torpedo torpedo	0.40	2	0.09	
Torpedo torpedo	0.40	2	0.09		Pseudupeneus prayensis	0.40	2	0.09	
Pseudupeneus prayensis	0.40	2	0.09		Aluterus heudelotii	0.24	2	0.06	
Aluterus heudelotii	0.24	2	0.06		Dibranchius atlanticus	0.04	2	0.01	
Dibranchius atlanticus	0.04	2	0.01		Decapterus punctatus	0.00	2	0.00	
Decapterus punctatus	0.00	2	0.00		Total	434.23		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 8
 DATE :13/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 1°47.39
 Lon E 8°53.69
 start stop duration Purpose : 3
 TIME :00:44:21 01:13:48 29.5 (min) LOG : 869.63 871.13 1.5
 LOG : 825.54 827.17 1.6 FDEPTH: 32 32 Region : 3320
 FDEPTH: 79 78 Gear cond.: 0 BDEPTH: 32 32 Validity : 0
 BDEPTH: 79 78 Validity : 0 Towing dir: 0° Wire out : 90 m Speed : 3.0 kn
 Towing dir: 0° Wire out : 205 m Speed : 3.3 kn Catch/hour: 30.57
 Sorted : 0 Total catch: 133.43 Catch/hour: 271.75

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP	SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers				weight	numbers		
Caranx rhonchus	95.32	3953	35.07	24	Caranx crysos	6.32	18	20.69	
Dentex congoensis	45.82	2291	16.86	26	Sardinella maderensis	4.18	141	13.66	46
Boops boops	26.27	788	9.67	25	Chloroscombrus chrysurus	3.34	44	10.93	44
Chelidonichthys gabonensis	19.55	1656	7.19		Scomberomorus tritor	2.66	2	8.72	
Lagocephalus laevigatus	17.60	18	6.48		Brachydeuterus auritus	2.19	113	7.16	45
Pagrus caeruleostictus	17.11	43	6.30	27	Sepia sp	2.01	40	6.57	
Sepia officinalis	8.55	134	3.15		Alloteuthis africana	1.43	549	4.68	
Penaeus notialis	7.82	232	2.88		Pagellus bellottii	1.15	2	3.77	42
Arnoglossus imperialis	6.48	409	2.38		Citharus linguatula	0.60	8	1.95	
Torpedo torpedo	4.40	6	1.62		Selene dorsalis	0.36	6	1.17	43
Trachinus lineolatus	3.79	214	1.39		Galeoides decadactylus	0.32	8	1.04	
Rhinobatos irvinei	2.73	2	1.00		Torpedo torpedo	0.32	4	1.04	
Squatina oculata	2.69	2	0.99		C R A B S	0.28	48	0.91	
Chilomycterus spinosus mauret.	2.44	6	0.90		Sphyræna guachancho	0.24	6	0.78	47
Umbrina canariensis	2.28	4	0.84	29	Grammoplites gruvelli **	0.16	14	0.52	
Raja miraletus	1.63	4	0.60		Pomadourus perotaei	0.12	2	0.39	49
Uranoscopus albesca	1.22	18	0.45		Epinephelus aeneus	0.08	2	0.26	48
Pseudupeneus prayensis	1.22	24	0.45	28	Eucinostomus melanopterus	0.08	2	0.26	
Selar crumenophthalmus	0.86	24	0.31	20	Acanthurus monroviae	0.04	2	0.13	
Priacanthus arenatus	0.73	12	0.27		Bothus podas	0.04	4	0.13	
Grammoplites gruvelli **	0.73	37	0.27		Monochirus hispidus	0.02	4	0.07	
Fistularia tabacaria	0.73	6	0.27		Aluterus heudelotii	0.02	2	0.07	
Dactylopterus volitans	0.49	61	0.18		Sphoeroides spengleri	0.02	2	0.07	
Microchirus boscanion	0.49	43	0.18		Uranoscopus polli	0.02	2	0.07	
Ophidion sp.	0.24	18	0.09		UNIDENTIFIED FISH	0.00	4	0.00	
Arnoglossus capensis	0.24	67	0.09						
Ommastrephes bartramii	0.12	6	0.04						
Scorpaena normani	0.12	12	0.04						
Microchirus frechkopi	0.06	6	0.02						
Total	271.75		100.00		Total	30.57		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 11
 DATE :13/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 1°58.81
 Lon E 9°1.28
 start stop duration Purpose : 3
 TIME :09:55:11 10:25:20 30.1 (min) LOG : 886.17 887.75 1.6
 LOG : 844.52 846.15 1.6 FDEPTH: 63 65 Region : 3320
 FDEPTH: 63 65 Gear cond.: 0 BDEPTH: 63 65 Validity : 0
 BDEPTH: 29 30 Validity : 0 Towing dir: 0° Wire out : 150 m Speed : 3.1 kn
 Towing dir: 0° Wire out : 88 m Speed : 3.2 kn Catch/hour: 73.84
 Sorted : 0 Total catch: 37.09 Catch/hour: 108.70

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP	SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers				weight	numbers		
Galeoides decadactylus	15.87	251	14.60		Lagocephalus laevigatus	44.59	48	60.39	
Trachinocephalus myops	12.52	199	11.52		Squatina aculeata	10.59	2	14.34	
Brachydeuterus auritus	11.48	335	10.56		Dactylopterus volitans	5.85	14	7.93	
Citharus linguatula	8.37	136	7.70		Fistularia petimba	3.11	12	4.21	
Sepia sp.	5.82	20	5.35		Caranx crysos	2.23	2	3.02	
Bothus podas	5.26	251	4.84		Pagellus bellottii	1.75	20	2.37	50
Lutjanus dentatus	5.18	8	4.77	37	Lagocephalus lagocephalus	1.59	2	2.16	
Lutjanus goreensis	5.10	8	4.69		Raja miraletus	1.31	2	1.78	
Rhinobatos irvinei	4.31	4	3.96	0	Torpedo torpedo	1.23	2	1.67	
Sepia sp.	4.07	227	3.74		Arnoglossus capensis	0.68	10	0.92	
Uranoscopus polli	2.95	52	2.71		Alloteuthis africana	0.64	446	0.86	
Sphyræna guachancho	2.71	24	2.49	33	Sardinella maderensis	0.16	14	0.22	
Grammoplites gruvelli **	2.39	159	2.20		Decapterus punctatus	0.04	2	0.05	
Penaeus kerathurus	2.27	68	2.09		Chelidonichthys gabonensis	0.04	2	0.05	
Penaeus notialis	2.15	56	1.98		Grammoplites gruvelli **	0.02	2	0.03	
C R A B S	1.99	323	1.83	34					
Trachurus trecae	1.99	100	1.83		Total	73.84		100.00	
Pseudupeneus prayensis	1.67	40	1.54	106					
Chilomycterus spinosus mauret.	1.59	12	1.47	41					
Raja miraletus	1.20	4	1.10						
Selene dorsalis	1.04	36	0.95						
Penaeus japonicus	0.92	680	0.84						
Sardinella maderensis	0.88	8	0.81						
Caranx rhonchus	0.80	4	0.73						
Eucinostomus melanopterus	0.80	8	0.73						
Ophidion sp.	0.76	100	0.70						
Pegusa triophthalmus	0.72	4	0.66						
Chloroscombrus chrysurus	0.72	12	0.66						
Microchirus variegatus	0.56	76	0.51						
Paronchellius stauchi	0.48	136	0.44						
Scyllarides herklotsii	0.48	151	0.44						
Saurida brasiliensis	0.40	108	0.37						
Sphoeroides spengleri	0.32	32	0.29						
Pagellus bellottii	0.32	24	0.29						
Chelidonichthys capensis	0.16	8	0.15						
Dicologlossa hexophthalma	0.10	16	0.09						
Squilla mantis	0.08	4	0.07						
Dicologlossa cuneata	0.08	4	0.07						
Chaetodipterus goreensis	0.08	4	0.07						
Dactylopterus volitans	0.08	8	0.07						
Sphoeroides spengleri	0.04	4	0.04						
Trachinus lineolatus	0.00	4	0.00						
Torpedo torpedo	0.00	4	0.00						
Total	108.70		100.00		Total	933.29		100.00	

R/V

Dr. Fridtjof Nansen SURVEY:2014403 STATION: 13 R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 16
 DATE :13/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 2°19.62 DATE :14/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 2°28.81
 start stop duration Purpose : 3 Lon E 8°55.77 TIME :03:03:20 03:33:48 30.5 (min) Purpose : 3
 LOG : 937.85 939.34 1.5 Region : 3320 LOG : 1006.65 1008.29 1.6 Region : 3320
 FDEPTH: 136 136 Gear cond.: 0 FDEPTH: 41 41 Gear cond.: 0
 BDEPTH: 136 136 Validity : 0 BDEPTH: 41 41 Validity : 0
 Towing dir: 0° Wire out : 345 m Speed : 3.0 km Towing dir: 0° Wire out : 135 m Speed : 3.2 km
 Sorted : 0 Total catch: 596.78 Catch/hour: 1191.57 Sorted : 0 Total catch: 41.52 Catch/hour: 81.59

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP	SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers				weight numbers			
Spicara alta	595.01	44626	49.93	Pomadasy inciscus	13.39	87	16.42
Trachurus trecae	290.32	17419	24.36	56 CONGER SP	11.35	24	13.91
Dentex congoensis	129.38	4219	10.86	55 Chelidonichthys gabonensis	9.53	98	11.69
UNIDENTIFIED FISH	79.87	2496	6.70	Dentex congoensis	6.78	55	8.31
Sepia sp	38.34	54	3.22	Galeoides decadactylus	6.30	146	7.73
Boops boops	17.57	699	1.47	Arnoglossus capensis	5.04	95	6.18
Chelidonichthys gabonensis	15.57	759	1.31	Dasyatis marmorata	4.18	4	5.12
Lagocephalus laevigatus	5.55	6	0.47	Pseudotolithus senegalensis	4.10	12	5.02
Torpedo torpedo	4.79	12	0.40	Torpedo torpedo	3.23	8	3.96
Ommastrephes bartramii	4.79	240	0.40	Ballistes capriscus	2.92	4	3.57
Squatina aculeata	4.19	2	0.35	Brachydeuterus auritus	2.76	126	3.38
Dicologlossa hexophthalma	2.40	80	0.20	Penaeus notialis	1.42	43	1.74
Fistularia petimba	1.80	6	0.15	Raja miraletus	1.26	4	1.55
Raja miraletus	1.32	4	0.11	Uranoscopus polli	1.18	16	1.45
Priacanthus arenatus	0.68	2	0.06	Trachinocephalus myops	1.10	16	1.35
				Sphyræna barracuda	1.02	4	1.26
Total	1191.57		100.00	Squilla mantis	0.95	43	1.16
				Serranus accraensis	0.87	32	1.06
				Eucinostomus melanopterus	0.71	20	0.87
				Calappa rubroguttata	0.55	8	0.68
				Penaeus kerathurus	0.55	16	0.68
				Chloroscombrus chrysurus	0.39	4	0.48
				Chilomycterus spinosus mauret.	0.39	4	0.48
				Trachinus armatus	0.32	12	0.39
				Dactylopterus volitans	0.32	4	0.39
				Ilisha africana	0.24	8	0.29
				Grammolites gruvelli **	0.24	24	0.29
				Bothus podas	0.24	20	0.29
				Sepia officinalis	0.24	8	0.29
				Trachinus pellegrini	0.04	4	0.05

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 14
 DATE :13/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 2°16.70
 start stop duration Purpose : 3 Lon E 9°2.51
 TIME :18:54:31 19:24:40 30.1 (min) Purpose : 3
 LOG : 947.52 949.01 1.5 Region : 3320
 FDEPTH: 81 79 Gear cond.: 0
 BDEPTH: 81 79 Validity : 0
 Towing dir: 0° Wire out : 190 m Speed : 3.0 km
 Sorted : 0 Total catch: 105.42 Catch/hour: 209.86

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP	SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers				weight numbers			
Dentex canariensis	66.89	111	31.87	60 Total	81.59	100.00	
Umbrina canariensis	27.71	64	13.20	61			
Chelidonichthys gabonensis	21.82	454	10.40	R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 17			
Sepia sp	14.97	151	7.13	DATE :14/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 2°32.73			
Chromis chromis	12.42	239	5.92	start stop duration Purpose : 3 Lon E 9°13.68			
Boops boops	10.99	438	5.24	59TIME :05:48:57 06:19:03 30.1 (min) Purpose : 3			
Dentex congoensis	10.03	135	4.78	LOG : 1026.77 1028.29 1.5 Region : 3320			
Rhinobatos irvinei	9.24	6	4.40	FDEPTH: 82 81 Gear cond.: 0			
Sargocentron hastatus	7.96	48	3.79	BDEPTH: 82 81 Validity : 0			
Scorpaena normani	4.78	16	2.28	Towing dir: 0° Wire out : 190 m Speed : 3.0 km			
Torpedo torpedo	4.10	6	1.95	58Sorted : 0 Total catch: 45.44 Catch/hour: 85.44			
Pseudupeneus prayensis	3.50	96	1.67				
Squatina aculeata	2.83	2	1.35	SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
Citharus linguatula	2.55	127	1.21	weight numbers			
Raja miraletus	2.07	8	0.99	Lagocephalus laevigatus	50.83	58	59.49
Ophidion barbatum	1.75	159	0.83	Dentex congoensis	8.33	90	9.75
Torpedo marmorata	1.67	2	0.80	58 Squatina aculeata	6.14	2	7.19
Trachurus trecae	1.11	40	0.53	Dactylopterus volitans	5.34	14	6.25
Trachinus radiatus	1.11	8	0.53	Sepia officinalis	3.99	12	4.67
Fistularia petimba	0.84	8	0.40	Citharus linguatula	1.95	22	2.29
Trachinus pellegrini	0.64	16	0.30	Caranx crysos	1.87	2	2.19
Arnoglossus capensis	0.32	48	0.15	Fistularia petimba	1.71	32	2.01
Grammolites gruvelli **	0.32	32	0.15	Alloteuthis africana	1.32	493	1.54
Bothus podas	0.08	8	0.04	Raja miraletus	1.28	4	1.49
Microchirus variegatus	0.08	8	0.04	Chelidonichthys gabonensis	0.80	12	0.93
Prognathodes marcellae	0.08	8	0.04	Pomadasy inciscus	0.60	4	0.70
Total	209.86		100.00	Torpedo torpedo	0.48	4	0.56
				Brachydeuterus auritus	0.28	4	0.33
				C R A B S	0.16	26	0.19
				Antennarius striatus	0.12	6	0.14
				Ophidion barbatum	0.08	10	0.09
				Squilla mantis	0.04	4	0.05
				Grammolites gruvelli **	0.04	6	0.05
				Trachinus pellegrini	0.04	2	0.05
				Bothus podas	0.02	2	0.02
				Aluterus heudelotii	0.02	2	0.02
				Arnoglossus capensis	0.01	2	0.02
				Total	85.44	100.00	

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 15
 DATE :13/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 2°9.97
 start stop duration Purpose : 3 Lon E 9°14.31
 TIME :21:34:28 22:04:38 30.2 (min) Purpose : 3
 LOG : 966.81 968.49 1.7 Region : 3320
 FDEPTH: 42 42 Gear cond.: 0
 BDEPTH: 42 42 Validity : 0
 Towing dir: 0° Wire out : 120 m Speed : 3.3 km
 Sorted : 0 Total catch: 69.68 Catch/hour: 138.57

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP	SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight numbers				weight numbers			
Dentex congoensis	42.16	338	30.42	6R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 18			
Chelidonichthys gabonensis	24.10	278	17.39	DATE :14/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 2°42.76			
Trachinocephalus myops	8.27	159	5.97	start stop duration Purpose : 3 Lon E 9°4.75			
Uranoscopus polli	7.08	80	5.11	TIME :09:04:55 09:34:58 30.1 (min) Purpose : 3			
Arnoglossus capensis	6.20	91	4.48	LOG : 1045.42 1046.91 1.5 Region : 3320			
Galeoides decadactylus	5.73	103	4.13	FDEPTH: 160 166 Gear cond.: 0			
Arnoglossus imperialis	4.53	111	3.27	BDEPTH: 160 166 Validity : 0			
Pseudotolithus senegalensis	3.90	8	2.81	65Towing dir: 0° Wire out : 370 m Speed : 3.0 km			
Brachydeuterus auritus	3.82	159	2.76	68Sorted : 0 Total catch: 1428.16 Catch/hour: 2851.57			
Trachinus draco	3.82	163	2.76				
Dicologlossa hexophthalma	2.86	40	2.07	SPECIES	CATCH/HOUR	% OF TOT. C <td>SAMP</td>	SAMP
Penaeus kerathurus	2.70	60	1.95	weight numbers			
Synapturichthys kleini	2.55	24	1.84	Spicara alta	1058.80	23397	37.13
Bothus podas	2.47	191	1.78	Dentex congoensis	728.87	14987	25.56
Penaeus notialis	2.39	95	1.72	Antigonia capros	508.91	14556	17.85
Ophidion sp.	1.75	84	1.26	Selar crumenophthalmus	243.67	8626	8.55
Sepia hieredda	1.75	20	1.26	Chelidonichthys gabonensis	120.76	323	4.23
Dactylopterus volitans	1.51	4	1.09	Boops boops	75.47	1617	2.65
Trachinus armatus	1.35	20	0.98	Trachurus trecae	60.38	1078	2.12
Albula vulpes	1.27	4	0.92	Squalus mitsukurii	24.76	34	0.87
Ballistes capriscus	1.23	2	0.89	Squatina aculeata	14.66	6	0.51
Grammolites gruvelli **	1.11	68	0.80	Torpedo torpedo	4.87	8	0.17
SOLEIDAE	1.11	4	0.80	Fistularia petimba	2.72	4	0.10
Raja miraletus	0.95	4	0.69	Torpedo marmorata	2.60	2	0.09
Psettodes belcheri	0.88	4	0.63	Priacanthus arenatus	2.00	6	0.07
Stephanolepis hispidus	0.84	2	0.60	Zeus faber	1.32	10	0.05
Trachinus radiatus	0.80	4	0.57	Scorpaena angolensis	0.92	2	0.03
Sphyræna barracuda	0.68	2	0.49	Trichiurus lepturus	0.72	2	0.03
Trachinus pellegrini	0.40	8	0.29	Lophiodes kempii	0.16	2	0.01
Chilomycterus spinosus mauret.	0.36	2	0.26	Total	2851.57	100.00	
Total	138.57		100.00				

Dr. Fridtjof Nansen SURVEY:2014403 STATION: 19 R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 22
 DATE :14/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 2°53.97 Lon E 9°21.66 DATE :15/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 2°51.78 Lon E 9°46.86
 start stop duration Purpose : 3 TIME :02:06:25 02:36:48 30.4 (min) Purpose : 3
 LOG : 1099.76 1100.30 0.5 Region : 3320 LOG : 1169.61 1171.31 1.7 Region : 3320
 FDEPTH: 124 126 Gear cond.: 0 BDEPTH: 48 48 Gear cond.: 0
 BDEPTH: 124 126 Validity : 0 BDEPTH: 48 48 Validity : 0
 Towing dir: 0° Wire out : 320 m Speed : 3.0 kn Towing dir: 0° Wire out : 135 m Speed : 3.4 kn
 Sorted : 1 Total catch: 328.04 Catch/hour: 1853.33 Sorted : 0 Total catch: 103.23 Catch/hour: 103.23

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP	SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers				weight numbers		
Trachurus trecae	1085.08	84395	58.55	81	Pagellus bellottii	32.07	354
Spicara alta	432.54	43254	23.34		Crabs - hairy	18.72	0
Ariomma bondi	239.89	8763	12.94		Pomadasy incisus	11.18	67
Sepia officinalis	36.05	435	1.94		Chelidonichthys gabonensis	8.06	79
Dentex congoensis	23.62	1119	1.27	80	Bothus podas	4.38	28
Boops boops	19.89	311	1.07		Lagocephalus laevisgatus	3.83	2
Raja miraletus	4.18	11	0.23		Arnoglossus imperialis	3.75	75
Scomber japonicus	3.73	62	0.20		Trachinocephalus myops	2.73	41
Chelidonichthys gabonensis	3.73	249	0.20		Pseudupeneus prayensis	2.17	55
Fistularia petimba	2.60	6	0.14		Gymnura micrura	2.13	2
Trichiurus lepturus	2.03	6	0.11		Brachydeuterus auritus	1.86	41
					Psettodes belcheri	1.62	2
Total	1853.33	100.00			Pseudotolithus senegalensis	1.26	4
					Lutjanus fulgens	1.18	2
					Torpedo torpedo	0.99	4
					Eucinostomus melanopterus	0.91	22
					Uranoscopus polli	0.83	24
					Trachinus sp.	0.79	75
					Ophidion barbatum	0.71	59
					Chilomycterus spinosus mauret.	0.67	2
					Galeoides decadactylus	0.63	10
					Squilla mantis	0.59	51
					Grammolites gruvelli **	0.51	53
					Trachinus armatus	0.39	8
					Boops boops	0.28	28
					Dactylopterus volitans	0.24	2
					Serranus accraensis	0.24	22
					Chloroscombrus chrysurus	0.16	2
					Dicologlossa hexophthalma	0.12	4
					Penaeus kerathurus	0.12	2
					Microchirus ocellatus	0.04	4
					82 Raja miraletus	0.04	2
					Apogon sp.	0.02	2
					Total	103.23	100.00

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 20
 DATE :14/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 2°44.10 Lon E 9°31.17
 start stop duration Purpose : 3
 LOG : 1117.88 1119.55 1.7 Region : 3320
 FDEPTH: 70 71 Gear cond.: 0
 BDEPTH: 70 71 Validity : 0
 Towing dir: 0° Wire out : 180 m Speed : 3.3 kn
 Sorted : 0 Total catch: 146.56 Catch/hour: 292.84

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Dactylopterus volitans	181.43	675	61.96
Chelidonichthys gabonensis	35.80	320	12.23
Dentex congoensis	22.38	1764	7.64
Citharus linguatula	16.38	216	5.59
Trachurus trecae	7.35	559	2.51
Fistularia petimba	5.43	24	1.86
Priacanthus arenatus	4.96	16	1.69
Ophidion barbatum	4.16	248	1.42
Trichiurus lepturus	3.68	8	1.26
Raja miraletus	3.52	8	1.20
Sepia sp	1.76	152	0.60
Chilomycterus spinosus mauret.	1.44	8	0.49
Boops boops	1.44	128	0.49
Pseudupeneus prayensis	0.64	8	0.22
C R A B S	0.48	72	0.16
Dicologlossa cuneata	0.48	168	0.16
Faronchelius stauchi	0.32	64	0.11
Trachinus pellegrini	0.32	152	0.11
Trigla sp.	0.32	56	0.11
Grammolites gruvelli **	0.16	16	0.05
Spicara alta	0.16	8	0.05
Saurida brasiliensis	0.16	24	0.05
UNIDENTIFIED FISH	0.05	16	0.02
Squilla mantis	0.02	8	0.01
Blennius sp.	0.02	8	0.01
Total	292.84	100.00	

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 23
 DATE :15/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 2°56.67 Lon E 9°40.53
 start stop duration Purpose : 3
 LOG : 1184.18 1185.86 1.7 Region : 3320
 FDEPTH: 79 79 Gear cond.: 0
 BDEPTH: 79 79 Validity : 0
 Towing dir: 0° Wire out : 195 m Speed : 3.3 kn
 Sorted : 0 Total catch: 67.38 Catch/hour: 133.96

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Chelidonichthys gabonensis	43.54	583	32.50
Lagocephalus laevisgatus	22.66	24	16.92
Pagellus bellottii	22.07	467	16.47
C R A B S	7.87	1312	5.88
Trachinus pellegrini	7.75	583	5.79
Sepia officinalis	7.63	30	5.70
Dactylopterus volitans	7.40	24	5.52
Sepia orbignyana	4.29	179	3.21
Ophidion barbatum	2.98	227	2.23
Citharichthys stampfilii	2.39	12	1.78
Trichiurus lepturus	1.67	6	1.25
Pomadasy incisus	1.19	6	0.89
Dicologlossa cuneata	0.95	250	0.71
Citharus linguatula	0.95	66	0.71
Saurida brasiliensis	0.24	42	0.18
Priacanthus arenatus	0.12	6	0.09
Grammolites gruvelli **	0.12	12	0.09
Squilla mantis	0.12	12	0.09
Total	133.96	100.00	

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 21
 DATE :14/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 2°37.48 Lon E 9°39.00
 start stop duration Purpose : 3
 LOG : 1132.43 1133.78 1.4 Region : 3320
 FDEPTH: 37 37 Gear cond.: 0
 BDEPTH: 37 37 Validity : 0
 Towing dir: 0° Wire out : 90 m Speed : 3.3 kn
 Sorted : 0 Total catch: 55.64 Catch/hour: 134.61

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Lutjanus fulgens	45.00	109	33.43
Brachydeuterus auritus	11.49	1713	8.54
Pagrus caeruleostictus	9.92	31	7.37
Pagellus bellottii	8.52	36	6.33
Sphyraena guachancho	7.50	63	5.57
Pomadasy incisus	7.26	70	5.39
Ilisha africana	6.82	351	5.07
Dentex canariensis	5.27	2	3.92
Selene dorsalis	5.03	70	3.74
Pseudotolithus senegalensis	4.89	10	3.63
Galeoides decadactylus	4.40	41	3.27
Psettodes belcheri	3.10	5	2.30
Penaeus notialis	2.47	150	1.83
Lagocephalus laevisgatus	2.27	2	1.69
Torpedo torpedo	2.27	5	1.69
Dactylopterus volitans	2.23	7	1.65
Umbria canariensis	1.89	2	1.40
Chloroscombrus chrysurus	0.97	10	0.72
Pseudupeneus prayensis	0.73	53	0.54
Chelidonichthys gabonensis	0.73	10	0.54
Apogon sp.	0.53	53	0.40
Cynoglossus canariensis	0.53	2	0.40
Arnoglossus imperialis	0.34	15	0.25
Citharus linguatula	0.10	2	0.07
Ophidion barbatum	0.07	7	0.05
Synagrops microlepis	0.05	2	0.04
Sardinella maderensis	0.05	5	0.04
Stephanolepis diaspros	0.05	2	0.04
Uranoscopus polli	0.05	2	0.04
Saurida brasiliensis	0.02	5	0.02
Grammolites gruvelli **	0.02	5	0.02
Trachurus trecae	0.02	2	0.02
Serranus accraensis	0.02	2	0.02
Total	134.61	100.00	

98/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 24
 DATE :15/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 3°8.17 Lon E 9°35.16
 start stop duration Purpose : 3
 TIME :07:26:10 07:46:51 20.7 (min) Purpose : 3
 LOG : 1204.04 1205.09 1.1 Region : 3320
 8BDEPTH: 154 156 Gear cond.: 0
 8BDEPTH: 154 156 Validity : 0
 Towing dir: 0° Wire out : 380 m Speed : 3.0 kn
 Sorted : 0 Total catch: 352.51 Catch/hour: 1022.75

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Ariomma bondi	365.11	14411	35.70
90 Pagellus bellottii	224.68	4747	21.97
86 Trachurus trecae	169.79	7958	16.60
Spicara alta	142.98	8954	13.98
Torpedo torpedo	19.21	32	1.88
Scomber japonicus	19.15	32	1.87
Chelidonichthys gabonensis	12.13	255	1.19
Squatina aculeata	11.49	6	1.12
Squalus mitsukurii	10.50	32	1.03
Sepia orbignyana	9.57	128	0.94
C R A B S	8.30	1564	0.81
93 Peristedion cataphractum	5.74	96	0.56
Raja miraletus	4.64	12	0.45
Fistularia petimba	3.19	6	0.31
Antigonia capros	3.19	479	0.31
Scorpaena normani	2.55	32	0.25
91 Torpedo marmorata	2.50	3	0.24
Zeus faber	2.32	20	0.23
Pseudupeneus prayensis	1.91	32	0.19
Aulopus cadenati	1.34	32	0.13
Uroconger lepturus	1.28	32	0.12
Ophidion barbatum	0.64	64	0.06
Todarodes sagittatus	0.47	32	0.05
Grammolites gruvelli **	0.08	32	0.01
Total	1022.75	100.00	

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 25 Trachinus pellegrini 2.36 47 0.95
 DATE :15/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 3°10.99 Plectorhinchus mediterraneus 2.32 2 0.94
 Lon E 9°29.25 Epinephelus aeneus 1.57 2 0.64
 start stop duration Purpose : 3 Raja miraletus 1.26 2 0.51
 LOG : 1217.78 1219.17 1.4 Region : 3320 Squilla mantis 0.63 31 0.25
 FDEPTH: 515 520 Gear cond.: 0
 BDEPTH: 515 520 Validity : 0
 Towing dir: 0° Wire out : 1150 m Speed : 2.8 kn
 Sorted : 0 Total catch: 149.24 Catch/hour: 297.19

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Nematocarcinus africanus	96.06	2	32.32	
Merluccius polli	56.08	96	18.87	
Lophiodes kempi	54.96	32	18.49	
Pseudocarcharias kamoharai	19.36	4	6.51	
Triplophos hemingi	18.16	2884	6.11	
Yarrella blackfordi	12.59	343	4.23	
Centrophorus granulosus	8.12	6	2.73	
Benthodesmus tenuis	6.37	143	2.14	
Chaunax pictus	3.19	24	1.07	
Malacocephalus occidentalis	2.71	32	0.91	
Astronesthes sp.	2.71	48	0.91	
Laemonema laureysi	2.55	16	0.86	
Bathygadus melanobranchus	2.39	24	0.80	
Geryon maritae	2.23	8	0.75	
Diaphys fulgens	2.07	88	0.70	
Nezumia duodecim	1.43	32	0.48	
Gephyroberyx darwini	1.27	40	0.43	
Squalus megalops	1.23	2	0.42	
Decapterus punctatus	0.96	48	0.32	
Dalatias licha	0.88	2	0.29	
Zeus faber	0.64	8	0.21	
Laemonema globiceps	0.48	24	0.16	
Etmopterus polli	0.28	2	0.09	
Macroparalepis affinis	0.16	8	0.05	
Zenion hololepis	0.08	8	0.03	
Chauliodus sloani	0.08	8	0.03	
Neonesthes microcephalus	0.08	8	0.03	
Nemichthys scolopaceus	0.08	8	0.03	
Heterocarpus sp.	0.00	0	0.00	
Plesiopenaeus sp.	0.00	0	0.00	
Aristeus varidens	0.00	0	0.00	
Total	297.19		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 26
 DATE :16/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 3°16.39
 Lon E 10°16.21
 start stop duration Purpose : 3
 LOG : 1327.57 1329.10 1.5 Region : 3320
 FDEPTH: 40 40 Gear cond.: 0
 BDEPTH: 40 40 Validity : 0
 Towing dir: 0° Wire out : 110 m Speed : 3.0 kn
 Sorted : 0 Total catch: 299.99 Catch/hour: 593.65

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Pagrus caeruleostictus	138.32	228	23.30	
Lutjanus fulgens	131.60	356	22.17	
Pomadasy incisus	66.89	435	11.27	
Lutjanus dentatus	31.98	2	5.39	
Lutjanus goreensis	23.27	2	3.92	
Acanthurus monroviae	21.57	20	3.63	
Chromis cadenati	20.38	960	3.43	
Pagellus bellottii	16.82	129	2.83	
Lethrinus atlanticus	13.65	20	2.30	
Pagellus sp.	11.95	4	2.01	
Dactylopterus volitans	11.48	20	1.93	
Trachinus radiatus	11.28	40	1.90	
Pseudupeneus prayensis	10.69	287	1.80	
Rhinobatos irvinei	10.29	4	1.73	
Chelidonichthys gabonensis	10.09	49	1.70	
Umbrina canariensis	9.30	10	1.57	
Sargocentron hastatus	8.31	49	1.40	
Arnoglossus capensis	7.52	49	1.27	
Caranx rhonchus	6.13	10	1.03	
Paronchelius stauchi	5.74	1138	0.97	
Uranoscopus polli	4.75	49	0.80	
Lagocephalus laevigatus	3.56	10	0.60	
Trachinocephalus myops	3.17	89	0.53	
Dasyatis marmorata	2.37	2	0.40	
Trachinus armatus	2.18	59	0.37	
Boops boops	2.18	139	0.37	
Fistularia petimba	1.78	10	0.30	
Prognathodes marcellae	1.58	30	0.27	
Torpedo marmorata	1.31	2	0.22	
Raja miraletus	1.15	2	0.19	
Zanobatus schoenleinii	1.07	2	0.18	
Chromis limbatus	0.40	20	0.07	
Dicologlossa hexophthalma	0.40	10	0.07	
Serranus scriba	0.20	30	0.03	
Trachinus lineolatus	0.10	10	0.02	
Monochirus hispidus	0.10	10	0.02	
Bothus podas	0.10	20	0.02	
Total	593.65		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 27
 DATE :16/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 3°22.42
 Lon E 10°8.82
 start stop duration Purpose : 3
 LOG : 1343.82 1345.38 1.6 Region : 3320
 FDEPTH: 69 68 Gear cond.: 0
 BDEPTH: 69 68 Validity : 0
 Towing dir: 0° Wire out : 180 m Speed : 3.1 kn
 Sorted : 0 Total catch: 125.82 Catch/hour: 247.51

SPECIES	weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Lagocephalus laevigatus	34.54	46	41.65	
Pagellus bellottii	13.54	298	16.32	129
Dactylopterus volitans	9.18	20	11.07	
Chelidonichthys gabonensis	7.43	112	8.96	
Sepia officinalis	5.39	12	6.50	
Trachurus tereca	4.19	210	5.06	128
Raja miraletus	3.75	6	4.53	
Fistularia petimba	2.12	6	2.55	
Alloteuthis africana	1.60	499	1.93	
Arnoglossus capensis	0.84	6	1.01	
Serranus accraensis	0.12	4	0.14	
Saurida brasiliensis	0.08	6	0.10	
Grammolites gruvelli **	0.08	2	0.10	
Citharus linguatula	0.08	2	0.10	
Total	82.94		100.00	

Dr. Fridtjof Nansen SURVEY:2014403 STATION: 31 R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 34
 DATE :16/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 3°22.42 DATE :17/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 3°48.57
 start stop duration Lon E 10°32.02 start stop duration Lon E 10°29.54
 TIME :17:39:40 18:09:42 30.0 (min) Purpose : 3 TIME :00:50:02 01:06:09 16.1 (min) Purpose : 3
 LOG : 1452.47 1454.22 1.8 Region : 3320 LOG : 1505.97 1506.58 0.6 Region : 3320
 FDEPTH: 25 26 Gear cond.: 0 FDEPTH: 87 87 Gear cond.: 0
 BDEPTH: 25 26 Validity : 0 BDEPTH: 87 87 Validity : 0
 Towing dir: 0° Wire out : 70 m Speed : 3.5 kn Towing dir: 0° Wire out : 200 m Speed : 2.3 kn
 Sorted : 0 Total catch: 178.68 Catch/hour: 357.00 Sorted : 0 Total catch: 48.38 Catch/hour: 180.19

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP	SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers				weight	numbers		
Sphyræna guachancho	94.31	324	26.42	138	Dentex angolensis	33.89	443	18.81	161
Sardinella aurita	43.56	573	12.20	135	Umbrina canariensis	26.26	48	14.57	163
Galeoides decadactylus	31.37	340	8.79		Chelidonichthys gabonensis	24.95	253	13.85	
Pseudotolithus typus	26.77	40	7.50	136	Trachurus trecae	17.95	1058	9.96	158
Pseudotolithus elongatus	23.38	661	6.55		Squatina oculata	9.53	7	5.29	
Alectis alexandrina	20.94	4	5.87		Sepia officinalis	8.57	56	4.75	
Stromateus fiatola	19.58	60	5.48		Rhinobatos irvinei	8.27	7	4.59	
Ilisha africana	19.18	871	5.37		Chromis chromis	6.11	56	3.39	
Chloroscombrus chrysurus	17.38	380	4.87	133	Brotula barbata	5.44	4	3.02	
Brachydeuterus auritus	15.18	448	4.25	137	Nematocarcinus africanus	5.14	4097	2.85	
Pomadasys jubelini	14.59	60	4.09	134	Scorpaena scrofa	4.39	7	2.44	
Rhinoptera sp.	9.07	2	2.54		Sardinella maderensis	3.05	60	1.69	154
Trichiurus lepturus	8.19	120	2.29	132	Sardinella aurita	3.05	45	1.69	155
Eucinostomus melanopterus	3.20	70	0.90		Dasyatris marmorata	2.98	4	1.65	
Raja miraletus	2.40	4	0.67		Portunus validus	2.83	4	1.57	
Ephippion guttifer	1.80	2	0.50		Raja miraletus	2.76	7	1.53	
Rhizoprionodon acutus	1.56	2	0.44		Brachydeuterus auritus	2.16	48	1.20	153
Arius parkii	1.40	2	0.39		Boops boops	2.16	71	1.20	152
Dasyatis margarita	0.96	4	0.27		Fistularia petimba	1.86	7	1.03	
Selene dorsalis	0.80	70	0.22	130	Arnoglossus linguatula	1.79	93	0.99	
Chilomycterus spinosus mauret.	0.48	2	0.13		Sargocentron hastatus	1.56	7	0.87	
Pentanemus quinguaris	0.40	20	0.11		Pagellus bellottii	1.19	7	0.66	162
Portunus validus	0.32	2	0.09		Pseudupeneus prayensis	1.12	7	0.62	156
Sardinella maderensis	0.20	30	0.06	131	Arnoglossus imperialis	0.74	115	0.41	
Total	357.00		100.00		Saurida brasiliensis	0.67	138	0.37	

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 32 R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 35
 DATE :16/05/14 GEAR TYPE: PT NO: 7 POSITION:Lat S 3°33.81 DATE :17/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 3°54.50
 start stop duration Lon E 10°44.80 start stop duration Lon E 10°22.77
 TIME :20:31:35 20:32:58 1.4 (min) Purpose : 1 TIME :03:35:54 04:06:05 30.2 (min) Purpose : 3
 LOG : 1475.82 1475.86 0.0 Region : 3320 LOG : 1521.69 1523.27 1.6 Region : 3320
 FDEPTH: 15 15 Gear cond.: 0 FDEPTH: 118 119 Gear cond.: 0
 BDEPTH: 28 28 Validity : 0 BDEPTH: 118 119 Validity : 0
 Towing dir: 0° Wire out : 80 m Speed : 1.5 kn Towing dir: 0° Wire out : 290 m Speed : 3.1 kn
 Sorted : 0 Total catch: 601.00 Catch/hour: 26130.43 Sorted : 0 Total catch: 254.26 Catch/hour: 505.49

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP	SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers				weight	numbers		
Chloroscombrus chrysurus	26086.96	5217391	99.83		Trachurus trecae	160.32	9940	31.72	169
Sardinella maderensis	43.48	0	0.17		Chelidonichthys gabonensis	135.83	2612	26.87	
Total	26130.43		100.00		Dentex congoensis	108.55	1481	21.47	168

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 33 R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 35
 DATE :16/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 3°36.20 DATE :17/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 3°54.50
 start stop duration Lon E 10°40.57 start stop duration Lon E 10°22.77
 TIME :21:58:10 22:28:10 30.0 (min) Purpose : 3 TIME :03:35:54 04:06:05 30.2 (min) Purpose : 3
 LOG : 1483.50 1485.25 1.8 Region : 3320 LOG : 1521.69 1523.27 1.6 Region : 3320
 FDEPTH: 37 37 Gear cond.: 0 FDEPTH: 118 119 Gear cond.: 0
 BDEPTH: 37 37 Validity : 0 BDEPTH: 118 119 Validity : 0
 Towing dir: 0° Wire out : 100 m Speed : 3.5 kn Towing dir: 0° Wire out : 290 m Speed : 3.1 kn
 Sorted : 0 Total catch: 51.74 Catch/hour: 103.48 Sorted : 0 Total catch: 254.26 Catch/hour: 505.49

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP	SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers				weight	numbers		
Brachydeuterus auritus	20.48	482	19.79	147	Trachurus trecae	160.32	9940	31.72	169
Pseudotolithus senegalensis	11.04	18	10.67	140	Brotula barbata	5.29	14	1.05	
Galeoides decadactylus	10.72	174	10.36		Chelidonichthys gabonensis	135.83	2612	26.87	
Sardinella aurita	10.44	156	10.09	149	Dentex congoensis	108.55	1481	21.47	168
Sardinella maderensis	8.64	146	8.35	148	Scorpaena scrofa	3.90	14	0.77	
Stromateus fiatola	5.12	10	4.95		Priacanthus arenatus	2.09	8	0.41	
Chelidonichthys gabonensis	4.92	28	4.75		Trichiurus lepturus	1.95	7	0.39	167
Pomadasys incisus	3.72	18	3.59	139	Scomber japonicus	1.81	28	0.36	
Uranoscopus polli	2.92	26	2.82		Ariomma bondi	1.39	8	0.28	
Chloroscombrus chrysurus	2.88	78	2.78	141	Ommastrephes bartramii	0.83	8	0.17	
Arnoglossus capensis	2.88	48	2.78		Arnoglossus imperialis	0.70	125	0.14	
Ilisha africana	2.24	74	2.16		Boops boops	0.40	10	0.08	165
Zanobatus shoeneleini **	2.00	4	1.93		UNIDENTIFIED FISH	0.28	8	0.06	
Penaeus kerathurus	1.96	62	1.89		Chloroscombrus chrysurus	0.14	7	0.03	164
Epinephelus aeneus	1.60	2	1.55	143	Dicologlossa hexophthalma	0.14	8	0.03	
Balistes capricus	1.44	2	1.39		Trachinus armatus	0.14	8	0.03	
Pagellus bellottii	1.20	8	1.16	145	Uranoscopus polli	0.06	8	0.01	
Pseudupeneus prayensis	1.20	10	1.16	150	Total	505.49		100.00	
Pomadasys perotaei	1.16	2	1.12	144					
Cynoglossus senegalensis	1.04	2	1.01						
Scyllarides herklotsii	0.72	2	0.70	R/V					
Pteroscion pelti	0.68	10	0.66	142					
Sphyræna guachancho	0.68	4	0.66	151					
Bothus podas	0.64	48	0.62						
Trachinocephalus myops	0.64	22	0.62						
Eucinostomus melanopterus	0.56	12	0.54						
Trichiurus lepturus	0.52	2	0.50	146					
Chilomycterus spinosus mauret.	0.48	2	0.46						
Cynoglossus canariensis	0.48	2	0.46						
Sepia officinalis	0.32	2	0.31						
Trachinus armatus	0.08	6	0.08						
Pegusa lascaris	0.08	2	0.08						
Total	103.48		100.00						

Dr. Fridtjof Nansen SURVEY:2014403 STATION: 36 Scomberomorus tritor 4.35 10 0.96
 DATE :18/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 4°10.28 Penaeus notialis 3.76 0 0.83
 start stop duration Lon E 10°34.88 Carcharhinus limbatus 3.64 2 0.81
 TIME :00:06:02 00:36:21 30.3 (min) Purpose : 3 Lagocephalus laevigatus 3.13 2 0.69
 LOG : 1588.55 1590.15 1.6 Region : 3320 Pomadasys perotaei 3.01 8 0.67
 FDEPTH: 143 141 Gear cond.: 0 Sardinella maderensis 2.37 49 0.53 187
 BDEPTH: 143 141 Validity : 0 Panulirus regius 1.78 10 0.39
 Towing dir: 0° Wire out : 335 m Speed : 3.2 kn Raja miraletus 1.78 4 0.39
 Sorted : 0 Total catch: 362.22 Catch/hour: 716.79 Trachurus trecae 0.79 40 0.18 191
 Selene dorsalis 0.79 20 0.18

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight	numbers		
Spicara alta	316.42	3728	44.14
Dentex congoensis	84.30	1094	11.76
Brotula barbata	66.73	71	9.31
Aulopus cadenati	66.49	1009	9.28
Trichiurus lepturus	21.37	36	2.98
Diaphus effulgens	20.18	6720	2.82
Torpedo marmorata	18.28	12	2.55
Acropoma sp.	14.49	546	2.02
Ruvettus pretiosus	13.73	2	1.92
Torpedo torpedo	13.54	12	1.89
Trachurus trecae	13.54	546	1.89
Merluccius polli	12.59	83	1.76
Squatina oculata	10.17	4	1.42
Octopus sp.	6.41	24	0.89
Umbalina canariensis	5.94	12	0.83
Squalus megalops	5.78	4	0.81
Pterothrissus belloci	4.75	36	0.66
Lophiodes kempi	4.04	12	0.56
Sepia officinalis	3.32	47	0.46
Antigonia capros	2.61	154	0.36
Zeus faber	2.14	24	0.30
Echelus myrus	2.14	12	0.30
Uranoscopus polli	2.14	36	0.30
Arnoglossus imperialis	1.90	237	0.27
Chelidonichthys gabonensis	1.42	59	0.20
Penaeus notialis	0.95	95	0.13
Dicologoglossa hexopthalma	0.71	59	0.10
Synagrops microlepis	0.47	12	0.07
Blennius normani	0.12	12	0.02
Microchirus boscanion	0.12	12	0.02
Total	716.79		100.00

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 37
 DATE :18/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 3°57.61
 start stop duration Lon E 10°41.11
 TIME :02:45:56 03:16:09 30.2 (min) Purpose : 3
 LOG : 1607.62 1609.20 1.6 Region : 3320
 FDEPTH: 85 85 Gear cond.: 0
 BDEPTH: 85 85 Validity : 0
 Towing dir: 0° Wire out : 215 m Speed : 3.1 kn
 Sorted : 0 Total catch: 181.41 Catch/hour: 360.18

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight	numbers		
Dentex congoensis	208.47	4169	57.88
Trachurus trecae	26.27	1237	7.29
Squatina oculata	19.85	4	5.51
Chelidonichthys gabonensis	18.21	731	5.05
Pagellus bellottii	12.51	91	3.47
Trichiurus lepturus	10.98	42	3.05
Raja miraletus	7.50	36	2.08
Rhinobatos irvinei	7.11	2	1.97
Fistularia petimba	6.12	14	1.70
Lagocephalus laevigatus	5.98	8	1.66
Octopus sp.	5.64	4	1.57
Cynoglossus canariensis	5.28	8	1.47
Torpedo torpedo	4.31	14	1.20
Sphyræna guanchancho	2.78	14	0.77
Mustelus mustelus	2.50	2	0.69
Pseudopeneus prayensis	2.08	42	0.58
Zeus faber	1.81	22	0.50
Serranus scriba	1.67	42	0.46
Arnoglossus sp.	1.53	161	0.42
Citharichthys stamphilii	1.39	222	0.39
Microchirus frechkopi	1.25	42	0.35
Uranoscopus polli	0.97	14	0.27
Branchiostegus semifasciatus	0.83	22	0.23
Brotula barbata	0.83	8	0.23
Sardinella aurita	0.83	14	0.23
Grammoplites gruvelli **	0.83	36	0.23
Scomber japonicus	0.56	8	0.15
Aulopus cadenati	0.56	8	0.15
C R A B S	0.56	105	0.15
Microchirus boscanion	0.28	14	0.08
Saurida brasiliensis	0.14	28	0.04
Roops boops	0.14	7	0.04
Antigonia capros	0.14	14	0.04
Acropoma sp.	0.07	8	0.02
Sepia officinalis	0.07	8	0.02
UNIDENTIFIED FISH	0.07	36	0.02
Spicara alta	0.07	14	0.02
Total	360.18		100.00

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 38
 DATE :18/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 4°3.42
 start stop duration Lon E 10°58.74
 TIME :09:28:18 09:58:38 30.3 (min) Purpose : 3
 LOG : 1663.17 1664.97 1.8 Region : 3320
 FDEPTH: 47 47 Gear cond.: 0
 BDEPTH: 47 47 Validity : 0
 Towing dir: 0° Wire out : 130 m Speed : 3.6 kn
 Sorted : 0 Total catch: 228.47 Catch/hour: 451.97

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight	numbers		
Brachydeuterus auritus	118.40	5092	26.20
Chloroscombrus chrysurus	87.83	2324	19.43
Sphyræna guanchancho	64.89	267	14.36
Portunus validus	39.17	129	8.67
Stromateus fiatola	25.32	59	5.60
Pseudotolithus senegalensis	23.62	24	5.23
Ilisha africana	22.16	613	4.90
Trichiurus lepturus	14.44	465	3.20
Galeoides decadactylus	11.20	28	2.48
Arius latiscutatus	6.92	6	1.53
Pteroscion pelli	6.53	129	1.44
Priacanthus arenatus	4.95	10	1.09
Total	1166.59		100.00

Dr. Fridtjof Nansen SURVEY:2014403 STATION: 41 R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 44
 DATE :19/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 3°35.66 DATE :21/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 1°10.45
 start stop duration Purpose : 3 Lon E 10°37.86 TIME :00:22:26 00:34:05 11.7 (min) Purpose : 3
 LOG : 1797.69 1799.27 1.6 Region : 3300 LOG : 2081.99 2082.59 0.6 Region : 3300
 FDEPTH: 42 39 Gear cond.: 0 BDEPTH: 115 116 Gear cond.: 0
 BDEPTH: 42 39 Validity : 2 BDEPTH: 115 116 Validity : 2
 Towing dir: 0° Wire out : 100 m Speed : 3.1 kn Towing dir: 0° Wire out : 278 m Speed : 3.1 kn
 Sorted : 0 Total catch: 63.51 Catch/hour: 126.55 Sorted : 0 Total catch: 101.18 Catch/hour: 521.10

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP	SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers				weight numbers		
Brachydeuterus auritus	98.12	2017	77.53	204	Dentex congoensis	140.50	5253
Sphyraena guachancho	13.59	90	10.74	207	Trachurus trecae	119.48	4718
Pagellus bellottii	3.91	32	3.09	206	Boops boops	76.22	4728
Trichiurus lepturus	2.83	12	2.24	210	Chelidonichthys gabonensis	47.38	1442
Chloroscombrus chrysurus	2.23	26	1.76	208	Squatina oculata	42.90	15
Selene dorsalis	2.03	38	1.61	209	Ariomma bondi	19.36	376
Galeoides decadactylus	1.43	16	1.13		Arnoglossus imperialis	17.30	1586
Pseudotolithus typus	0.96	2	0.76	205	Sepia officinalis	12.36	124
Uranoscopus polli	0.92	6	0.72		Spicara alta	11.12	536
Trachinocephalus myops	0.28	6	0.22		Priacanthus arenatus	7.42	41
Caranx rhonchus	0.16	2	0.13		Fistularia petimba	5.77	41
Citharichthys stampflii	0.08	2	0.06		Synagrops microlepis	4.12	62
Alloteuthis africana	0.02	4	0.01		Illex coindetii	3.71	41
Total	126.55		100.00		Pontinus accraensis	3.71	62
					Rhinobatos irvinei	2.99	5
					Scomber japonicus	2.06	21
					Microchirus frechkopi	1.85	41
					Urocyon lepturus	1.24	21
					Physiculus huloti	1.03	62
					Nettastoma parviceps	0.41	62
					Diaphuhs fulgens	0.21	21
					Total	521.15	100.01

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 42
 DATE :19/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 3°36.38
 start stop duration Purpose : 3 Lon E 10°45.06
 TIME :09:39:01 10:09:05 30.1 (min) Purpose : 3
 LOG : 1810.89 1812.49 1.6 Region : 3300
 FDEPTH: 31 31 Gear cond.: 0
 BDEPTH: 31 31 Validity : 2
 Towing dir: 0° Wire out : 90 m Speed : 3.2 kn
 Sorted : 0 Total catch: 35.32 Catch/hour: 70.48

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Pseudotolithus typus	17.20	24	24.41
Pomadasys perotaei	11.37	30	16.14
Chloroscombrus chrysurus	10.06	146	14.27
Arius parkii	6.78	16	9.63
Pagellus bellottii	5.67	30	8.04
Brachydeuterus auritus	4.59	156	6.51
Panulirus regius	4.47	4	6.34
Galeoides decadactylus	3.55	14	5.04
Selene dorsalis	2.91	52	4.13
Rhinobatos albomaculatus	2.08	2	2.94
Pseudupeneus prayensis	0.84	8	1.19
Stromateus fiatola	0.44	2	0.62
Eucinostomus melanopterus	0.28	4	0.40
Sphyraena guachancho	0.20	2	0.28
Arnoglossus imperialis	0.04	2	0.06
Total	70.48		100.00

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 45
 DATE :21/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 0°51.16
 start stop duration Purpose : 3 Lon E 8°34.65
 TIME :03:22:49 03:53:12 30.4 (min) Purpose : 3
 LOG : 2106.08 2107.65 1.6 Region : 3300
 FDEPTH: 47 44 Gear cond.: 0
 BDEPTH: 47 44 Validity : 2
 Towing dir: 0° Wire out : 115 m Speed : 3.1 kn
 Sorted : 0 Total catch: 103.92 Catch/hour: 205.24

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
211	Galeoides decadactylus	40.05	551
	Trachinus armatus	38.99	628
217	Pseudotolithus typus	16.71	65
	Brachydeuterus auritus	14.81	350
	Portunus validus	13.63	24
218	Sphyraena guachancho	11.14	36
	Mustelus mustelus	6.64	6
	Botus podas	5.10	196
	Iagocephalus laevigatus	4.74	6
	Balistes capricus	4.50	6
	Trachinocephalus myops	4.27	53
	Pisodonophis semicinctus	4.09	6
	Pteroscopus peli	4.03	83
	Rhizoprionodon acutus	3.79	6
	Chelidonichthys gabonensis	3.67	30
	Torpedo torpedo	3.24	4
	Myristicichthys rostellatus	2.90	6
	Arnoglossus imperialis	2.84	83
	Selene dorsalis	2.37	65
	Priacanthus arenatus	2.25	12
	Raja miraletus	2.01	12
	Penaeus notialis	1.78	113
	Trichiurus lepturus	1.42	59
	Chilomycterus spinosus mauret.	1.42	12
	Penaeus kerathurus	1.42	41
	Pagellus bellottii	1.42	12
	Uranoscopus polli	1.30	24
	Rhinobatos irvinei	1.18	2
	Grammolites gruvelli **	1.01	71
	C R A B S	0.95	184
	Sphoeroides spengleri	0.83	47
227	Eucinostomus melanopterus	0.47	6
228	Citharus linguatula	0.24	6
	Pseudupeneus prayensis	0.02	12
Total	205.24		100.00

R/V Dr. Fridtjof Nansen SURVEY:2014403 STATION: 43
 DATE :19/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 3°45.73
 start stop duration Purpose : 3 Lon E 10°50.32
 TIME :11:34:22 12:04:48 30.4 (min) Purpose : 3
 LOG : 1823.20 1824.88 1.7 Region : 3300
 FDEPTH: 32 32 Gear cond.: 0
 BDEPTH: 32 32 Validity : 2
 Towing dir: 0° Wire out : 86 m Speed : 3.3 kn
 Sorted : 0 Total catch: 140.24 Catch/hour: 276.52

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
	weight numbers		
Galeoides decadactylus	132.11	461	47.78
Pagrus caeruleostictus	29.30	51	10.60
Drepane africana	22.99	73	8.31
Selene dorsalis	18.10	225	6.55
Panulirus regius	17.27	37	6.25
Pseudotolithus senegalensis	7.41	12	2.68
Rhizoprionodon acutus	6.35	2	2.30
Rhinobatos irvinei	5.72	6	2.07
Sphyraena guachancho	5.32	14	1.93
Selar crumenophthalmus	4.38	20	1.58
Arius parkii	3.75	2	1.35
Ephippion guttifer	3.31	2	1.20
Balistes punctatus	3.23	8	1.17
Stromateus fiatola	3.00	4	1.08
Acanthurus monroviae	2.88	4	1.04
Lutjanus fulgens	2.25	4	0.81
Zanobatus shoeneleini **	2.01	6	0.73
Bodianus speciosus	1.62	2	0.58
Chloroscombrus chrysurus	1.62	20	0.58
Chilomycterus spinosus mauret.	0.87	4	0.31
Alectis alexandrina	0.67	4	0.24
Chaetodipterus lippei	0.59	2	0.21
Chaetodipterus goreensis	0.55	2	0.20
Pagellus bellottii	0.47	2	0.17
Sardinella maderensis	0.32	2	0.11
Eucinostomus melanopterus	0.20	2	0.07
Brachydeuterus auritus	0.16	2	0.06
Pomadasys incisus	0.08	2	0.03
Total	276.52		100.00


Dr. Fridtjof Nansen SURVEY:2014403 STATION: 46
 DATE :21/05/14 GEAR TYPE: BT NO: 26 POSITION:Lat S 0°32.10
 start stop duration Lon E 8°27.32
 TIME :08:04:07 08:35:41 31.6 (min) Purpose : 3
 LOG : 2137.89 2139.50 1.6 Region : 3300
 FDEPTH: 625 613 Gear cond.: 0
 BDEPTH: 625 613 Validity : 2
 Towing dir: 0° Wire out : 1300 m Speed : 3.1 kn
 Sorted : 0 Total catch: 894.82 Catch/hour: 1700.64

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Malacocephalus occidentalis	925.94	5245	54.45	
Ommastrephes bartramii	323.09	152	19.00	
Ectreposebastes imus	82.10	1064	4.83	
Ateleopus natalensis	50.93	25	3.00	
Raja miraletus	38.01	76	2.24	
Lophius vaillanti	36.60	13	2.15	239
Aristeus varidens	34.97	2433	2.06	
UNIDENTIFIED FISH	28.13	7222	1.65	
Fleisipopenaeus edwardsianus	27.37	836	1.61	
Alepocephalus sp.	25.85	304	1.52	
Priacanthus arenatus	22.81	76	1.34	
Lamprogrammus exutus	21.29	76	1.25	
Centrophorus sp.	16.19	4	0.95	
Bathyracoconger vicinus	12.16	228	0.72	
Ascidacea	11.10	49	0.65	
Dibranchius atlanticus	10.64	608	0.63	
Brachydeuterus auritus	8.36	152	0.49	240
Halosaurus ovenii	6.08	228	0.36	
C R A B S	6.08	76	0.36	
Rhinobatos cemiculus	6.08	228	0.36	
UNIDENTIFIED FISH	5.32	152	0.31	0
Nezumia aequalis	1.52	228	0.09	
Total	1700.64		100.00	

Annex II INSTRUMENTS AND FISHING GEAR USED

Echo sounder

The SIMRAD ER60/38 kHz scientific sounder was used during the survey for fish abundance estimation. The LSSS Integrator system was used to scrutinise the acoustic records. The settings of the echo sounders were as follows:

 HAVFORSKNINGSINSTITUTTET REDERIAVDELINGEN SEKSJON ELEKTRONISK INSTRUMENTERING			
DRIFTSJOURNAL 1		Kalibrering med referanseku Rev:2006	
Fartøy :	F/F Dr. Fridtjof Nansen	Dato :	14.12.2013
Ekkolodd :	DFNer60-2	Lokalitet :	Kyunn Phi Lar, Myanmar
Kule :	CU-60	TS _{kule} :	-34.70 dB (korrigert for lydshastighet eller)
		Bunndyp :	28 m
Calibration Version 2.1.0.12			
Comments: Myanmar 38kHz			
Reference Target:			
TS	-34.70 dB	Min. Distance	18.00 m
TS Deviation	5.0 dB	Max. Distance	23.00 m
Transducer: ES38B Serial No. 38000			
Frequency	38000 Hz	Beamtype	Split
Gain	25.13 dB	Two Way Beam Angle	-20.6 dB
Athw. Angle Sens.	21.90	Along. Angle Sens.	21.90
Athw. Beam Angle	6.98 deg	Along. Beam Angle	7.01 deg
Athw. Offset Angle	0.02 deg	Along. Offset Angl	0.12 deg
SaCorrection	-0.55 dB	Depth	5.50 m
Transceiver: GPT 38 kHz 009072057b8a 2-1 ES38B			
Pulse Duration	1.024 ms	Sample Interval	0.197 m
Power	2000 W	Receiver Bandwidth	2.43 kHz
Sounder Type: EK60 Version 2.4.3			
TS Detection:			
Min. Value	-40.0 dB	Min. Spacing	100 %
Max. Beam Comp.	6.0 dB	Min. Echolength	80 %
Max. Phase Dev.	8.0	Max. Echolength	180 %
Environment:			
Absorption Coeff.	9.5 dB/km	Sound Velocity	1538.0 m/s
Beam Model results:			
Transducer Gain =	26.13 dB	SaCorrection =	-0.71 dB
Athw. Beam Angle =	6.95 deg	Along. Beam Angle =	6.75 deg
Athw. Offset Angle =	0.05 deg	Along. Offset Angle=	0.11 deg
Data deviation from beam model:			
RMS = 0.56 dB			
Max = 1.51 dB No. = 78 Athw. = 3.4 deg Along = 2.3 deg			
Min = -1.82 dB No. = 248 Athw. = -1.2 deg Along = -1.7 deg			
Data deviation from polynomial model:			
RMS = 0.55 dB			
Max = 1.48 dB No. = 78 Athw. = 3.4 deg Along = 2.3 deg			
Min = -1.77 dB No. = 248 Athw. = -1.2 deg Along = -1.7 deg			
Bemerkninger : Sterk tidevannsstrøm, noe plankton og noe vind Vindstyrke : 10 kn. Vindretning 130 grader			
Rådatafil:	D:\ER60_CALIBRATION\ER60_CALIBRATION_RAWDATA\2013-12-14\038 kHz\2013409-D20131214-T05393		
Filnavn:	D:\ER60_CALIBRATION\ER60_CALIBRATION_FILES\2013-12-14\038 khz\38kHz-2013-12-14.txt		
Kalibrering utført av:	Jarle Kristiansen og Tore Mørk		

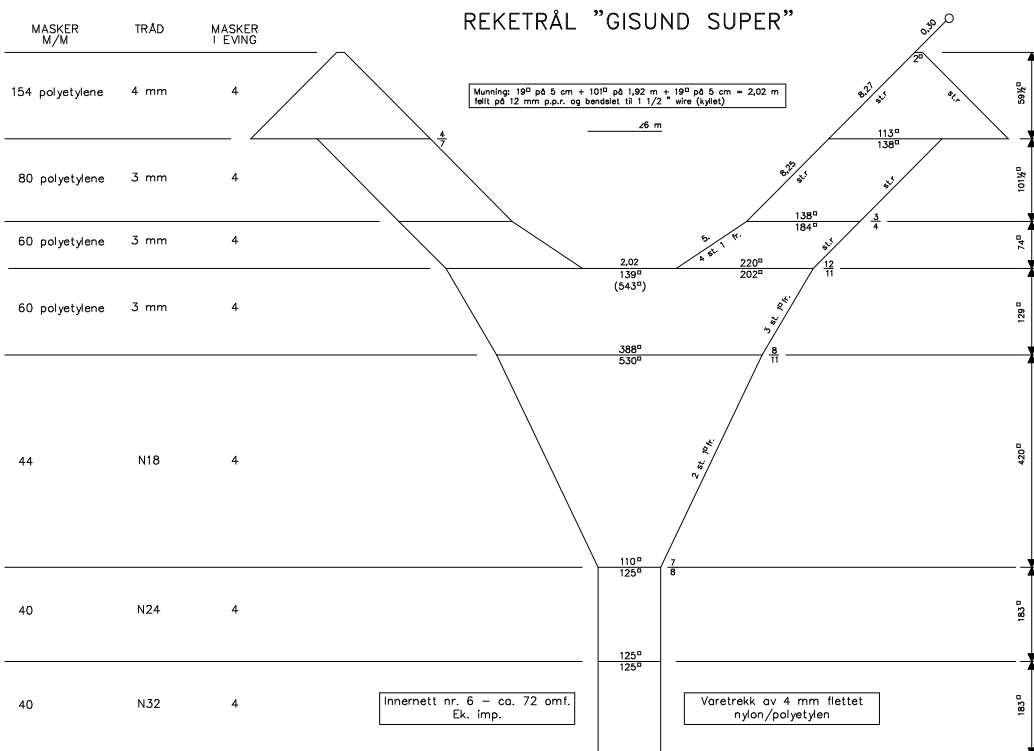
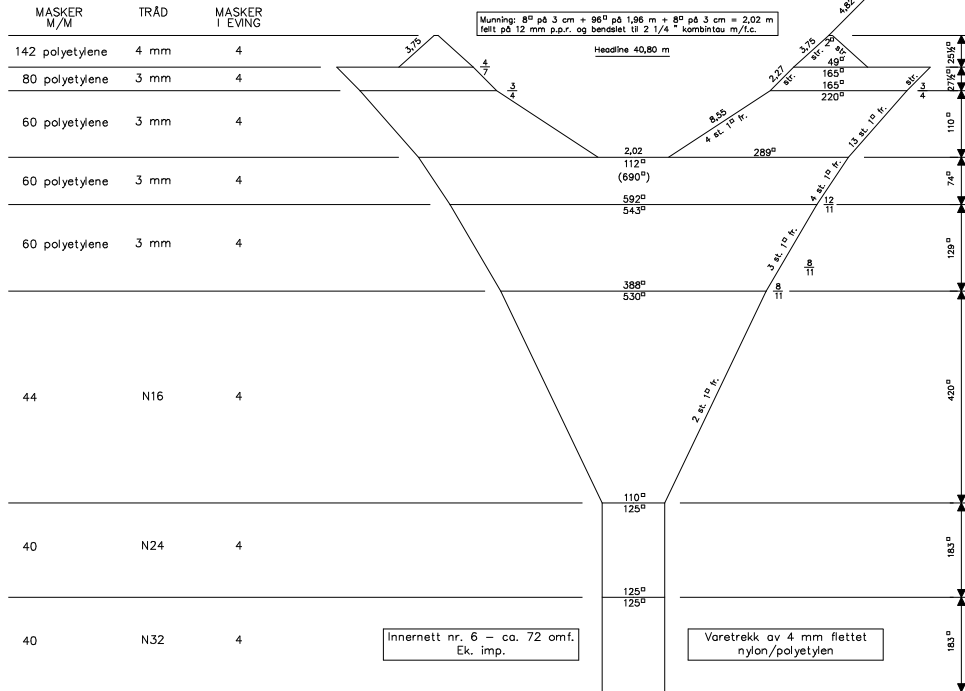
Fishing gear

The vessel uses an "Åkrahamn" pelagic trawl and a "Gisund super bottom trawl".

The bottom trawl has a headline of 31 m, footrope 47 m and 20 mm mesh size in the cod end with an inner net of 10 mm mesh size (see drawings below). The estimated opening is 6 m (observed 5.7) and distance between wings during towing about 18 m. The sweeps are 40 m long. The trawl is equipped with a 12" rubber bobbins gear. The doors are of 'Thyborøn' combi type, 7.81 m², 1670 kg, their distance while trawling about 45 - 55 m on average, depending on the depth (least distance at low depths). This distance can be kept constant (about 50 m) at all depths by the use of a 9.5 m strap between the wires at 130 m distance from the doors, normally applied at depths greater than 80 m.

The SCANBAS 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 with a trawl eye that provides information on the trawl opening, the distance of the footrope to the bottom, bottom contact and fish entering the trawl.

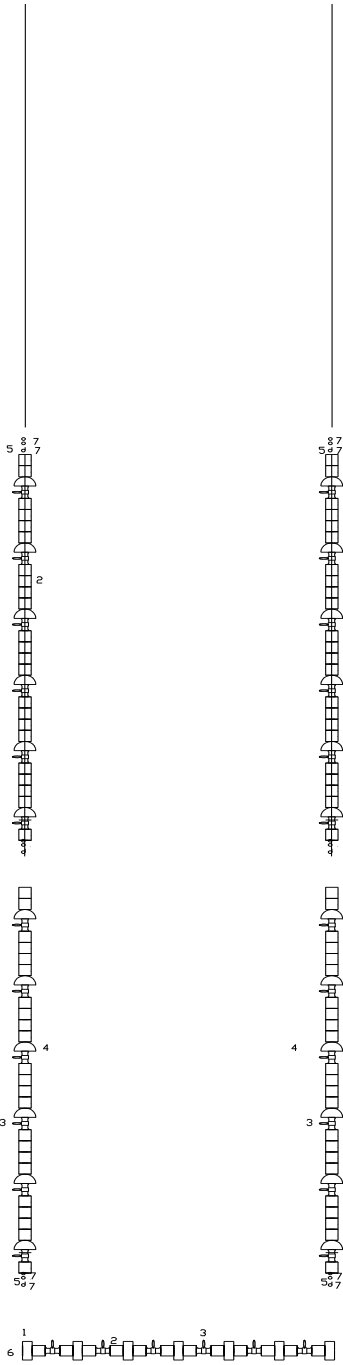
REKETRÅL "GISUND SUPER" OVERDEL



DEKINTROH
NACH MMG
M28

M27
R A E G E D

M27
R A E G E D



Annex III Swept area biomass estimates by stations

 GROUPED SPECIES OUTPUT:

Output variable: Tonnes / Nm^2

Purpose: Random station for swept area analysis

Max validity: Species identification and biomass analysis

Gear: Bottom

trawl

Survey: 2014403, Species set: Main groups

Region: Gabon north of Cap Lopez

Bottom depth interval: 20 to 50

Number of stations: 2

St.no	Gear depth	Cephalopods	Demersal	Pelagic	Rays	Sharks	Shrimps	Croakers	Grouper	Grunts	Sea bream	Snappers	Barracuda	Carangids	Clupeoids	Hairtails	Scombrids	Ariommidae	Brachideurus	D. angolensis	D.canariensis	D. congoensis	Pagellus bellottii	T. trecae	Total
6	32,5	0,1	0,2	0,1	0	0	0	0	0	0	0,2	0	0	0,1	0	0	0	0	0	0	0	0,2	0	0	0,4
7	32	0	10,1	2,3	0	0	0	0	0,2	8,7	1,2	0	0	2,2	0	0	0	0	0	0	0	0	1,2	0	12,6
Mean	32,2	0	5,1	1,2	0	0	0	0	0,1	4,3	0,7	0	0	1,2	0	0	0	0	0	0	0	0,1	0,6	0	6,5
Std dev	0,4	0	7	1,5	0	0	0	0	0,2	6,1	0,7	0	0	1,5	0	0	0	0	0	0	0	0,1	0,8	0	8,7
Biom	824	0	4202,4	988,8	0	0	0	0	82,4	3543,2	576,8	0	0	988,8	0	0	0	0	0	0	0	82,4	494,4	0	5356

Survey: 2014403, Species set: Main groups

Region: Gabon north of Cap Lopez

Bottom depth interval: 50 to 100

Number of stations: 1

St. no	Gear depth	Cephalopods	Demersal	Pelagic	Rays	Sharks	Shrimps	Croakers	Groupers	Grunts	Sea bream	Snappers	Barracuda	Carangids	Clupeoids	Hairtails	Scombrids	Ariommidae	Brachideurus	D. angolensis	D.canariensis	D. congoensis	Pagellus bellottii	T. trecae	Total	
3	73,5	0,7	1,4	0,1	0,2	0,5	0,1	0	0,4	0	1	0	0	0,1	0	0	0	0	0	0	0	0	0	0,9	0	3,7

Biom

Survey: 2014403, Species set: Main groups

Region: Gabon north of Cap Lopez

Bottom depth interval: 100 to 500

Number of stations: 1

St. no.	Gear depth	Cephalopods	Demersal	Pelagic	Rays	Sharks	Shrimps	Croakers	Groupers	Grunts	Sea bream	Snappers	Barracuda	Carangids	Clupeoids	Hairtails	Scombrids	Ariommidae	Brachideurus	D. angolensis	D.canariensis	D. congoensis	Pagellus bellottii	T. trecae	Total	
4	313	0,7	0,4	0	0	0,3	0,3	0	0	0	0,1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9

Biom

Survey: 2014403, Species set: Main groups

Region: Gabon south of Cap Lopez

Bottom depth interval: 20 to 50

Number of stations: 10

St. no	Gear depth	Cephalopods	Demersal	Pelagic	Rays	Sharks	Shrimps	Croakers	Groupers	Grunts	Seabream	Snappers	Barracuda	Carangids	Clupeoids	Hairtails	Scombrids	Ariommidae	Brachideuterus	D. angolensis	D.canariensis	D. congoensis	Pagellus bellottii	T. trecae	Total	
9	29,5	0,3	0,7	0,3	0,2	0	0,2	0	0	0	0	0,3	0,1	0,1	0	0	0	0	0	0	0	0	0	0	0,1	3,3
10	32	0,1	0,1	0,7	0	0	0	0	0	0	0	0	0	0,5	0,1	0	0,1	0	0	0	0	0	0	0	0	1
15	42	0,1	1,5	0	0	0	0,2	0,1	0	0	1,3	0	0	0	0	0	0	0	0	0	0	0	1,3	0	0	4,1
16	41	0	0,9	0,1	0,3	0	0,1	0,1	0	0,4	0,2	0	0	0	0	0	0	0	0	0	0	0	0,2	0	0	2,5
21	37	0	2,9	0,4	0,1	0	0,1	0,2	0	0,2	0,7	1,4	0,2	0,2	0	0	0	0	0	0	0,2	0	0,3	0	0	4,1
22	48	0	1,5	0	0,1	0	0	0	0	0,3	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3,1
26	40	0	14,7	0,2	0,5	0	0	0,3	0	2,2	5,6	6,2	0	0,2	0	0	0	0	0	0	0	0	0	0,6	0	19,6
31	25,5	0	2,3	5,9	0,4	0	0	1,4	0	0,4	0	0	2,7	1,1	1,3	0,2	0	0	0	0	0	0	0	0	0	10,2
33	37	0	1,1	0,8	0,1	0	0,1	0,3	0	0,1	0	0	0	0,1	0,5	0	0	0	0	0	0	0	0	0	0	3
38	47	0	4,5	5,6	0,1	0,1	0,1	0,8	0	0,1	0	0	1,8	2,5	0,1	0,4	0,1	0	0	0	0	0	0	0	0	12,7
Mean	37,9	0	3	1,4	0,2	0	0,1	0,3	0	0,4	0,9	0,8	0,5	0,5	0,2	0,1	0	0	0	0	0	0,1	0,2	0	0	6,4
Std dev	7,3	0,1	4,3	2,3	0,2	0	0,1	0,5	0	0,7	1,7	1,9	1	0,8	0,4	0,1	0	0	0	0	0,1	0,4	0,3	0	0	5,9
Biom.	2864	0	8592	4010	573	0	286	859	0	1146	2578	2291	1432	1432	573	286	0	0	0	0	0	0	286	573	0	1833
																										0

65

Survey: 2014403, Species set: Main groups

Region: Gabon south of Cap Lopez
 Bottom depth interval: 50 to 100

Number of stations: 11

St. no.	Gear depth	Cephalopods	Demersal	Pelagic	Rays	Sharks	Shrimps	Croakers	Groupers	Grunts	Sea bream	Snappers	Barracuda	Carangids	Clupeoids	Hairtails	Scombrids	Ariommidae	Brachideuterus	D. angolensis	D.canariensis	D. congoensis	Pagellus bellottii	T. trecae	Total	
8	78,5	0,3	2,8	2,9	0,3	0,1	0,2	0,1	0	0	2,7	0	0	2,9	0	0	0	0	0	0	0	1,4	0	0	8,2	
11	64	0	0,1	0,1	0,1	0,3	0	0	0	0	0,1	0	0	0,1	0	0	0	0	0	0	0	0	0,1	0	2,3	
14	80	0,5	4	0	0,6	0,1	0	0,9	0	0	3	0	0	0	0	0	0	0	0	0	2,3	0,3	0	0	7,1	
17	81,5	0,2	0,3	0,1	0,1	0,2	0	0	0	0	0,3	0	0	0,1	0	0	0	0	0	0	0	0,3	0	0	2,8	
20	70,5	0,1	0,8	0,3	0,1	0	0	0	0	0	0,7	0	0	0,2	0	0,1	0	0	0	0	0	0,7	0	0,2	8,8	
23	79	0,4	0,8	0,1	0	0	0	0	0	0	0,7	0	0	0	0	0,1	0	0	0	0	0	0	0,7	0	4	
27	68,5	0	2,1	0,4	0,2	0	0	0	0,1	0,2	1,6	0	0	0	0	0,4	0	0	0	0	0	0	1,6	0	8,1	
30	81	0,2	0,4	0,1	0,1	0	0	0	0	0	0,4	0	0	0,1	0	0	0	0	0	0	0	0	0,4	0,1	2,5	
34	87	0,4	3,1	1,1	0,6	0,4	0,2	1,2	0	0	1,6	0	0	0,8	0,3	0	0	0	0	0	1,5	0	0	0,1	0,8	7,9
37	85	0,2	7,1	1,3	0,6	0,7	0	0	0,1	0	7	0	0,1	0,8	0	0,3	0	0	0	0	0	6,6	0,4	0,8	11,4	
39	76,5	0,1	1,8	2,6	1	0,1	0	0,1	0	0	0,5	0	0,2	0,5	0	1,6	0	0	0	0	0	0	0,5	0	5,9	
Mean	77,4	0,2	2,1	0,8	0,3	0,2	0	0,2	0	0	1,7	0	0	0,5	0	0,2	0	0	0	0,1	0,2	0,8	0,3	0,2	6,3	
Std dev	7,1	0,2	2,1	1,1	0,3	0,2	0,1	0,4	0	0,1	2	0	0,1	0,9	0,1	0,5	0	0	0	0,4	0,7	2	0,5	0,3	3	
Biom	2734	547	5741	2187	820	547	0	547	0	0	4648	0	0	1367	0	547	0	0	0	273	547	2187	820	547	1722 4	

Survey: 2014403, Species set: Main groups

Region: Gabon south of Cap Lopez

Bottom depth interval: 100 to 500

Number of stations: 10

St.no.	Gear depth	Cephalopods	Demersal	Pelagic	Rays	Sharks	Shrimps	Croakers	Groupers	Grunts	Sea bream	Snappers	Barracuda	Carangids	Clupeoids	Hairtails	Scombrids	Ariommidae	Brachideurus	D. angolensis	D.canariensis	D. congoensis	Pagellus bellottii	T. trecae	Total	
12	130,5	0,2	14,8	11,2	0,2	0,4	0	0	0	0	14,8	0	0	11,2	0	0	0	0	0	0	0	0	8,7	0	11	29,5
13	136	1,4	4,9	9,8	0,2	0,1	0	0	0	0	4,9	0	0	9,8	0	0	0	0	0	0	0	0	4,3	0	9,8	40,1
18	163	0	27	10,2	0,3	1,3	0	0	0	0	27	0	0	10,2	0	0	0	0	0	0	0	0	24,5	0	2	95,8
19	125	1,2	1,4	35,8	0,1	0	0	0	0	0	1,4	0	0	35,6	0	0,1	0,1	7,9	0	0	0	0	0,8	0	35,6	60,7
24	155	0,3	7,4	6,2	0,9	0,7	0	0	0	0	7,4	0	0	5,6	0	0	0,6	12	0	0	0	0	7,4	5,6	33,6	
28	228	0,3	1,9	0	0,5	2	0	0	0	0	0,9	0	0	0	0	0	0	0	0	0	0	0	0	0,9	0	5,5
29	118,5	0	12,7	28,3	1	1,3	0	0	0	0	12,5	0	0	25,6	0,3	0	2,4	0	0	0	0	0	12,2	0	25,4	49,1
35	118,5	0,2	3,9	5,2	0,2	0	0	0,3	0	0	3,5	0	0	5,1	0	0,1	0,1	0	0	0	0	0	3,5	0	5,1	16,1
36	142	0,3	5,3	1,1	1	0,5	0	0,2	0	0	2,6	0	0	0,4	0	0,7	0	0	0	0	0	0	2,6	0	0,4	22,5
40	243,5	0,3	17,9	2,2	3	0,3	0,4	0	0	0	0,8	0	0	0	0	2,2	0	0	0	0,8	0	0	0	0	0	38
Mean	156	0,4	9,7	11	0,7	0,7	0	0	0	0	7,6	0	0	10,3	0	0,3	0,3	2	0	0,1	0	5,7	0,8	9,5	39,1	
Std dev	44,6	0,5	8,3	11,9	0,9	0,7	0,1	0,1	0	0	8,4	0	0	11,7	0,1	0,7	0,8	4,3	0	0,2	0	7,8	2,3	12	25,5	
Biom	2734	1094	26520	3007	4	4	1914	0	0	0	20778	0	0	28160	0	820	820	5468	0	273	0	15584	2187	25973	99	