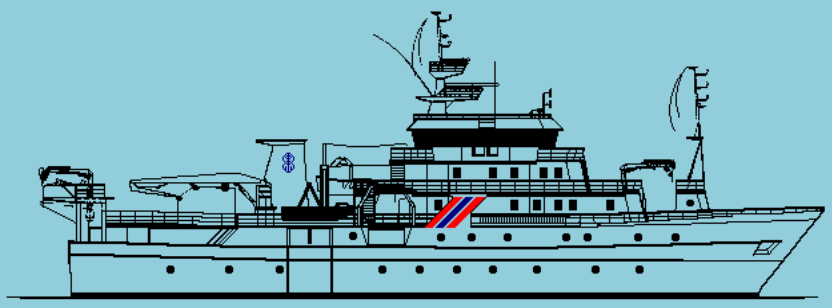

SURVEYS OF THE FISH RESOURCES OF MAURITIUS

Survey of the demersal resources on the western slopes of St. Brandon and Nazareth Bank, Mauritius

16 - 25 September 2010

Institute of Marine Research
Norway

Ministry of Fisheries and Rodrigues
Mauritius

Bergen November 2010

THE EAF-NANSEN PROJECT

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

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

LE PROJET EAF-NANSEN

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

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

CRUISE REPORTS "DR. FRIDTJOF NANSEN"

SURVEYS OF THE FISH RESOURCES OF MAURITIUS

Survey of the demersal resources on the western slopes of St. Brandon and Nazareth Bank, Mauritius

16 - 25 September 2010

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Bergen, 2010

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CHAPTER 1 INTRODUCTION

Under the bilateral agreement between the Ministry of Fisheries & Rodrigues, Mauritius, and Norad, it has been agreed to carry out an acoustic survey of the deepwater fish stocks found on the western slopes of St Brandon and Nazareth Bank located on the Mascarene Plateau. The survey will be implemented within the framework of the Tripartite Agreement between Norad (on behalf of the Norwegian Ministry of Foreign Affairs), the Institute of Marine Research of Bergen (IMR) and FAO, within the scope of the Project *"Strengthening the Knowledge Base for and Implementing an Ecosystem Approach to Marine Fisheries in Developing Countries*" (EAF Project GCP/INT/003/NOR) executed by FAO with the participation of IMR in accordance with the vessel operating arrangements established in the Tripartite Agreement.

1.1 Description of Activities/Services

Under the direct supervision of the Ministry of Fisheries and Rodrigues, Mauritius, and in close collaboration with the responsible FAO Marine Fishery Resources Officer (FIRF), and the IMR-EAF Nansen Research Coordinator, FAO has provided the R/V *Dr Fridtjof Nansen* to conduct one demersal survey using acoustics in Mauritian waters. All completed data sets and analyses is presented to the Albion Fisheries Research Centre (AFRC) in Mauritius.

The objective of the survey was to assess the distribution and abundance of the demersal fish stocks found at depths ranging from 100 to 350 m on the western slopes of the Nazareth Bank and St. Brandon. The data collected will provide support to the Mauritian programme for assessing the dynamics of demersal resources, including biomass and stock discrimination. The survey will aim to identify untapped fishery resources that could eventually be exploited.

It was proposed that the western slopes of the St Brandon and Nazareth Bank would be assessed acoustically during this survey, ascertaining firstly the extent of the potential fishing grounds and secondly the distribution and relative density of the deepwater snappers. Bottom and pelagic trawling will be carried out to validate the acoustic marks. Additionally, it was proposed to carry our fishing test for demersal fish stocks using traps on the shallow areas of Nazareth Bank to demonstrate the feasibility of a basket trap fishery and to adapt the fishing gear to local conditions.

This work was carried out over a period of 10 days, starting on 16 September 2010.

The activities included:

(i) To conduct one demersal resources survey using acoustics within the waters of Mauritius along track lines to be defined in consultations with scientific

experts from FAO, IMR, and participating national scientists involved in the survey. The final definition of the track lines shall be completed prior to the start of each survey operation.

(ii) The survey shall be conducted according to existing survey procedures already established and agreed to by all parties.

(iii) Experts on board shall provide training to national scientists to enable them to conduct regular operations for survey data collection, including use of acoustics and trawl operations

1.2 Objectives

Following the instructions of the Ministry of Fisheries and Rodrigues, Mauritius and the recommendations from the pre survey meeting held onboard the vessel the main objectives of the survey were:

- to describe the distribution, composition and estimate the abundance of the main demersal fish species on the shelf and slope by acoustic surveying and fish identification from fish traps and trawls
- to map the general hydrographic regime by using a CTD to monitor the temperature, salinity and oxygen at bottom trawl stations and on hydrographical transects along the shelf
- on-the-job training covering main survey routines

1.3 Participation

Participants for the survey came from:

Ministry of Fisheries and Rodrigues, Mauritius:
Vishnu Soondron (Local cruise leader), Parmanand Daby, Vishaal Geeane, Vibz Senedhun, Vik Dabychurun, Satish Khadun, Vikash Munbodhe, Moganah Cunnee and Cindy Lutchmanen,

Institute of Marine Research, Bergen, Norway:
Jens-Otto Krakstad (cruise leader), Diana Zaera, Asbjørn Aasen, Tore Mørk and Kåre Tveit

1.4 Narrative

The vessel left Port Louis, Mauritius at 08:30 on the 17th September and started steaming towards the St Brandon group of islands. The archipelago was reached in the early morning of the 18th September and the western part of the bank was surveyed using zig-zag transects during the day. Fish traps were set out on the shelf while surveying and were retrieved during the night. The northern end of St. Brandon was reached on the 19th September in the evening

and the vessel continued over to the Nazareth Bank during the next day while conducting bottom trawls and setting out fish traps en route. The northern part of Nazareth bank was reached on the 23 rd September in the evening. Due to bad weather in the northern part of the survey region no trawls or traps were set during the 23rd September. The vessel returned to Port Louis on the 25th September at 17:00h.

Continuous acoustic registrations were done throughout the survey. Pelagic and demersal trawling on registrations and random blind hauls were carried out during dark hours when time permitted.

CTD-stations were taken at each bottom trawl station. In addition, hydrographical profiles were made with CTD from surface down to the bottom or 1500 m depths.

1.5 Survey effort

The general area to be surveyed was along the western slopes of the St Brandon and north-western Nazareth Banks between 13°S and 17°S and 58°50' and 60°50' E. Figure 1 shows the cruise tracks with trawl and hydrographic stations, while Figure 2 shows trap set stations. Table 1.1 summarises the survey effort.

Table 1.1 Surveyed area and trawl stations separated by bottom (BT) and pelagic (PT), number of fishing trap stations, hydrographic stations (CTD) and distance surveyed in NM.

Area	BT	PT	Traps	CTD	NM
St. Brandon	5	2	5	9	281.7
Nazareth	4		11	20	839.4
Total	9	2	16	29	1121.1

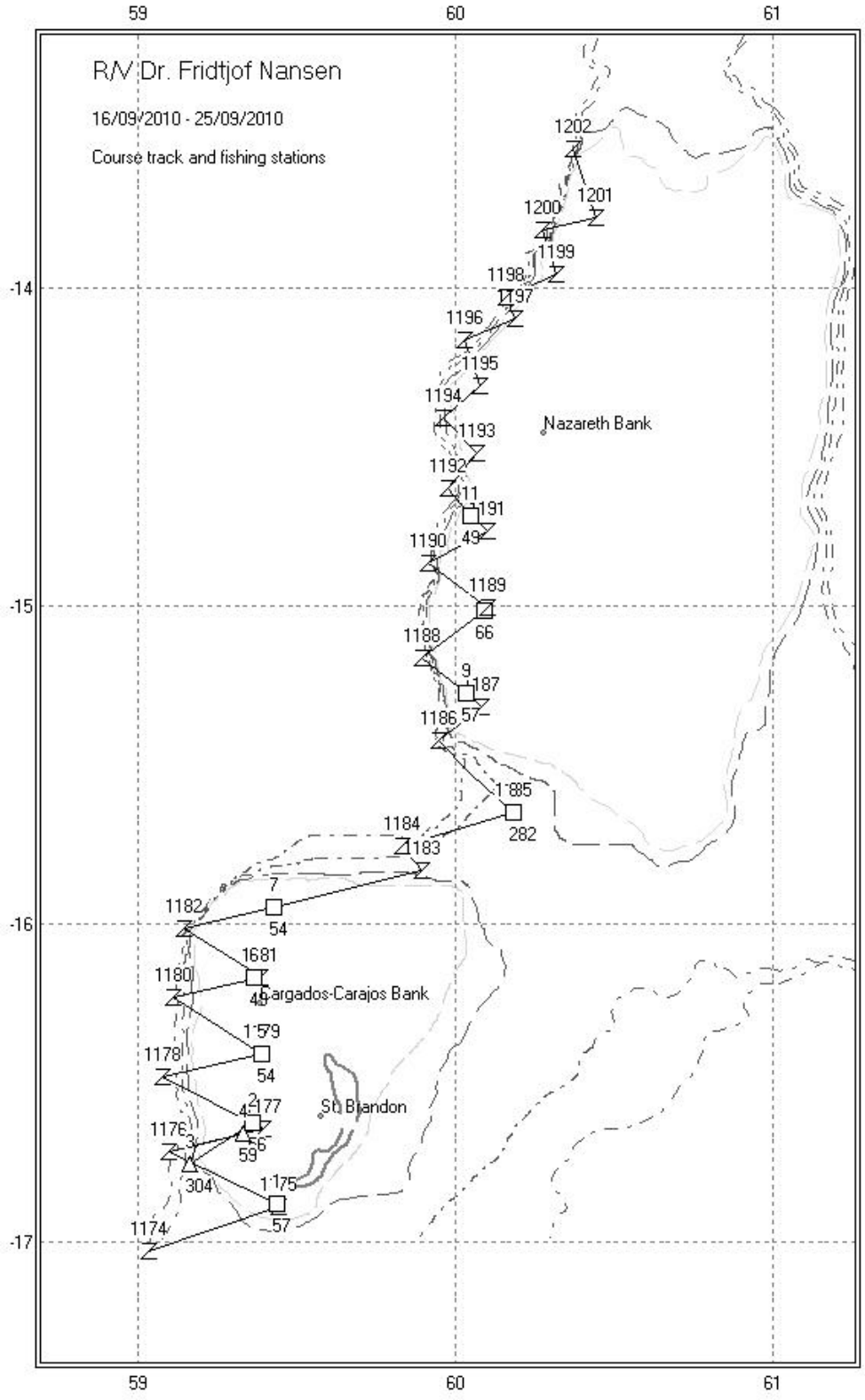


Figure 1 Course track with fishing, and hydrographic stations. Depth contours are indicated.

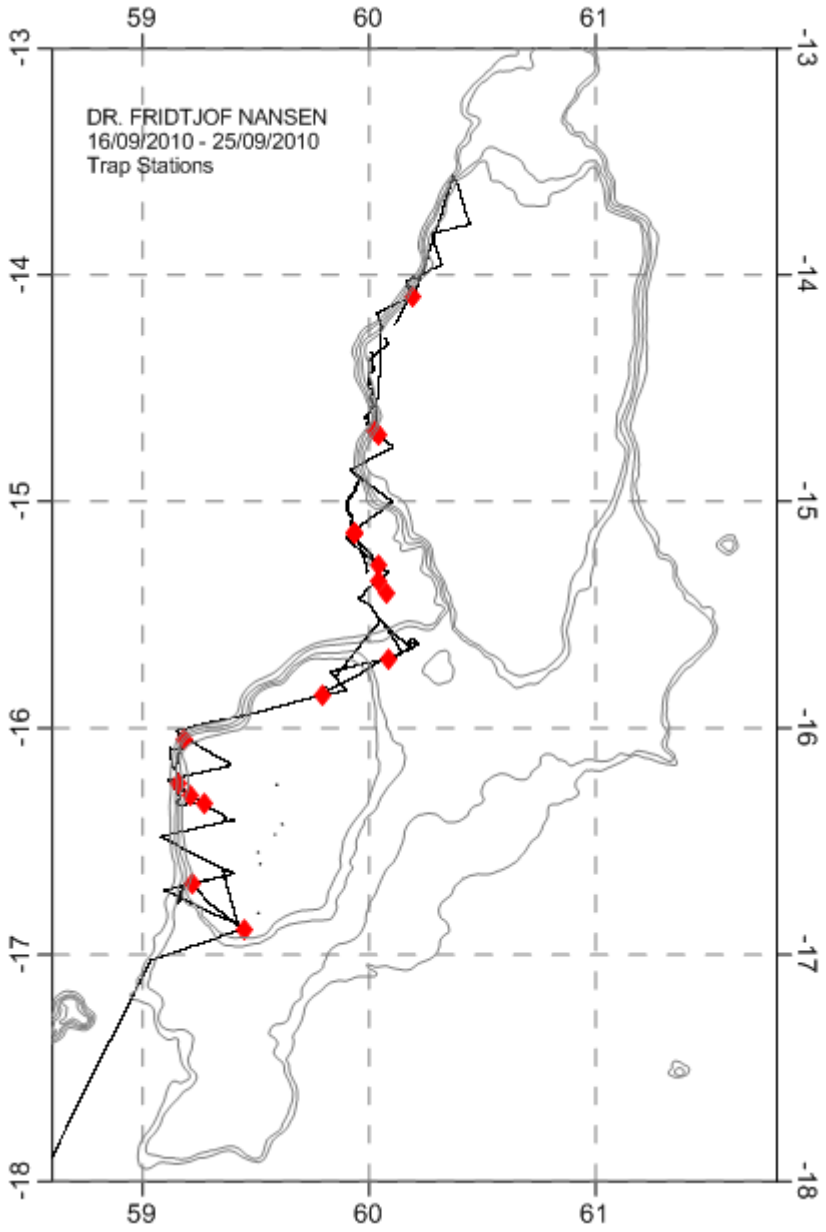


Figure 2 Course track with trap stations. Depth contours are indicated.

CHAPTER 2 METHODS

2.1 Meteorological and hydrographical sampling

Temperature, salinity and oxygen

A Seabird 911 CTD plus was used to obtain vertical profiles of temperature, salinity and oxygen. Real time plotting and logging was done using the Seabird Seasave software installed on a PC. The profiles were taken down to a few metres above the bottom. No calibration of temperature or salinity was performed during the survey

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

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

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

2.2 Biological sampling

Sampling gear

A Gisund Super bottom trawl with a headline height of about 4.5 m was used during the survey, the doors are of the Thyborøn' combi type. Trawl duration was standardized to 30 minutes. The trawling start time is controlled by using SCANMAR sensors to detect the landing of the trawl on the bottom, and the stop-time is defined as the time when the wires start to haul the net. In some cases the towing was interrupted before 30 minutes either due to poor bottom conditions or too high catches of fish indicated by the installed catch sensors.

Large fish traps were also used for fish identification and fishing trials. The traps were used in chains of three traps on the shelf (Figure 3) while in deeper waters 100 – 350 m the traps were used as single traps to reduce the risk of losing them on the very steep slope. The specifications of the fish traps are given below:

Size: 184 L X 153 W X 80 H
Weight 50 kg
Construction: Steel frame
Fencing: Steel
Compact foldable
One vertical opening

The traps can be used in all depths.

The traps are built with steel fencing to be used in waters where predatory fish may chew trough and destroy ordinary traps made of polyester net.

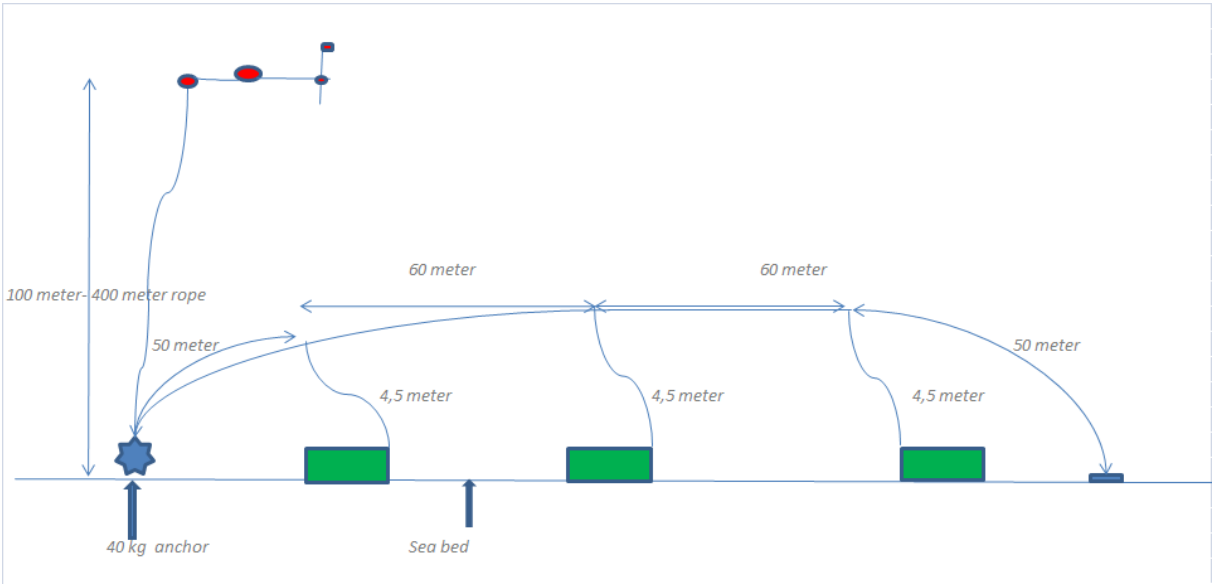


Figure 3. Schematic set up of the trap chains

Catch Sampling

The trawl and trap catches were sampled for species composition by weight and numbers. The deck sampling procedure used for trawl catches is described in more detail by Strømme (1992). Length measurements (total length) were taken for target species. The length of each fish was recorded to the nearest 1 cm below. The mantle length was measured to the nearest 1 cm below for Sepia spp. In addition, at a few stations, total length and body weight (g) were recorded for the target species in the acoustic survey. Basic information recorded at each fishing stations, i.e. trawl hauls, is presented in Annex I. Pooled length frequency distributions

from the trawl hauls, raised to catch per hour, of selected species are shown in Annex II. The swept-area estimates from the trawl hauls are presented in Annex III. A description of the fishing gears used, acoustic instruments and their standard settings is given in Annex IV. Annex V gives particulars for the fish trap stations.

2.3 Acoustic Biomass estimates

A SIMRAD ER 60 Echo sounder connected to four transducers (18, 38, 120 and 200 kHz) was used to survey the water column and the echograms were stored on files. The acoustic biomass estimates were based on the integration technique using data recorded from the Simrad ES38B acoustic transducer. The Large Scale Survey System (LSSS) from MAREC was used for integration and allocation of the integrated s_A-values (average area back scattering coefficient in m^2/NM^2) The splitting and allocation of the integrator outputs (s_A-values) were based on a combination of a visual scrutiny of the behaviour pattern as deduced from echo diagrams, LSSS analysis and the catch composition. The mean integrator value in each sampling unit (s_A-values) was divided between the following standard fish categories/groups: Pel 1 (Clupeoid species, not present in Mauritian waters), Pel 2 (Carangids, Scombrids, Leiognathids and associated pelagic like barracudas and hairtails), Dem (Demersal species), Dem2 (Demersal species on the slope deeper than 60 m), Meso (Meseopelagic species), Plank (Plankton).

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:

$$TS = 20 \log L - 72\ dB \qquad (1)$$

or in the form:

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

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.

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

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:

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

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. In the case of co-occurrence of target species, the s_A value is split in accordance with length distribution and 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 with 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:

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

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

However, the combination of low s_A value recorded and large species diversity makes single species abundance estimates impossible. Therefore, a theoretic mean length of 23 cm was used to convert the s_A values by stratum (Equation 3) to number of fish for pelagic (PEL2) species, demersal and slope demersal species. Equation 5 was used to convert the number of fish in the defined average length class (23 cm) to total estimated biomasses.
A description of the fishing gears used, acoustic instruments and their standard settings is given in Annex IV.

Mean fish densities by species group and strata and the total area surveyed were calculated by the acoustic abundance estimation module in Nansis Maptool.

CHAPTER 3 OCEANOGRAPHIC CONDITIONS

3.1 Background

The Mascarene Plateau, in the South-western Indian Ocean, is a submerged volcanic plateau extending over 2200 km between the Seychelles Bank at 4°S to the island of Mauritius at 20°S (Figure 4).

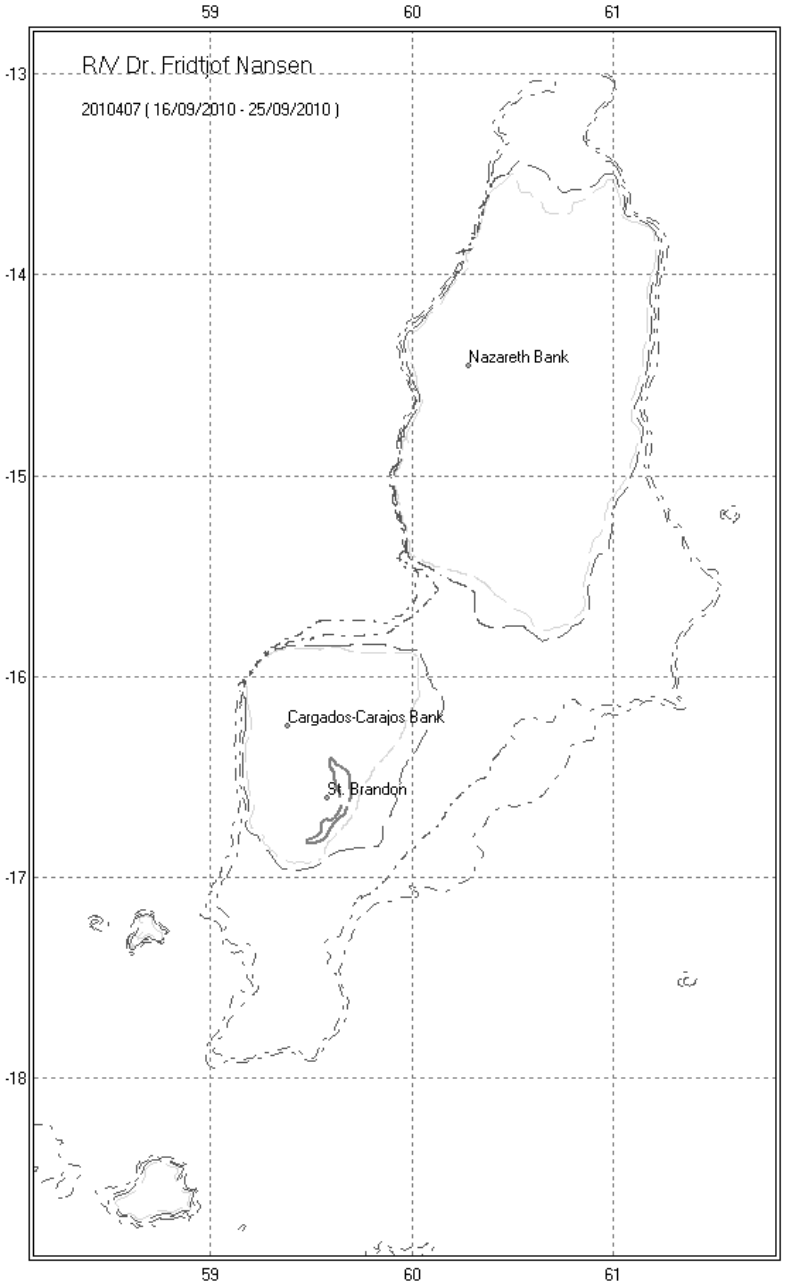


Figure 4: Map showing the location of the Sothern end of the Mascarene Plateau, the Nazareth Bank and Cargados-Carajos Bank. Isolines indicate the 100 m, 200 m, 500 m and 1000 m isobath. Bathymetry on the west coast was updated during the present survey

It is a complex bathymetric feature oriented roughly north–south similar to a crescent, covering an area of over 115 000 km^2 and characterised by a series of islands, banks and shoals which are separated by deep channels. The main banks are known as the Seychelles Plateau, the Saya de Malha Bank, the Nazareth Bank and the Cargados-Carajos Bank. These are typically 20-100 m deep, coral topped, and sometimes break the surface to form small islands.

On either side of the plateau, steep slopes plunge to abyssal depths of 4 000 m. Particularly the western side of the Saya de Malha Bank and the Nazareth Bank is very steep and the shelf breaks at around 60 m depth. In the eastern side it slopes more gently towards deeper waters with a pronounced shelf break at around 500 m depth. The general current circulation pattern in this region is dominated by the South Equatorial Current (SEC), a broad current between 10° and 16°S and carrying approximately 50–55 Sv westwards at velocities rarely exceeding 0.3 m s^{-1} . The South Equatorial Current is directly driven by the trade wind belt and forms the westward limb of the large-scale subtropical Indian Ocean gyre, feeding both the Agulhas Current system and the East African coastal current. To the north of the SEC lies the eastward flowing counter current known as the South Equatorial Counter Current (SECC).

The Plateau's islands, banks and shoals (Figure 4) form a barrier modifying the predominantly westward passage of the South Equatorial Current. Recent studies have shown that this current, on approaching the Mascarene Plateau, branches into a number of tributaries the largest occurring between 12-13°S between the Saya De Malha and Nazareth Banks. Here approximately 50% or 25 Sv of the SEC is forced to flow through the narrow channel separating the Saya De Malha and Nazareth Banks with the remainder of the flow passing in roughly equally volumes around the northern edge of the Saya De Malha Bank (8°–9°S) and between Mauritius and the Cargados-Carajos Bank (18°–20°S). The modifying influence of this barrier to the background circulation provides a rare example of an extensive shallow-shelf sea completely detached from land boundaries, isolated and has remained as an almost completely unexplored marine ecosystem.

3.2 Surface distribution

The surface layer temperature (5 m depth) was continuously recorded during the cruise. Figure 5 shows the horizontal distribution of sea surface temperature (SST) for the western side of the banks.

The SST from Mauritius to the Cargados-Carajos and Nazareth Banks increased gradually northwards from temperatures around 24.2°C off Mauritius to 25.4°C at the northern part of

the Nazareth Bank. Temperatures on the Cargados-Carajos bank was relatively stable around 24.7 °C with slightly cooler water coming in coming in from the south east.

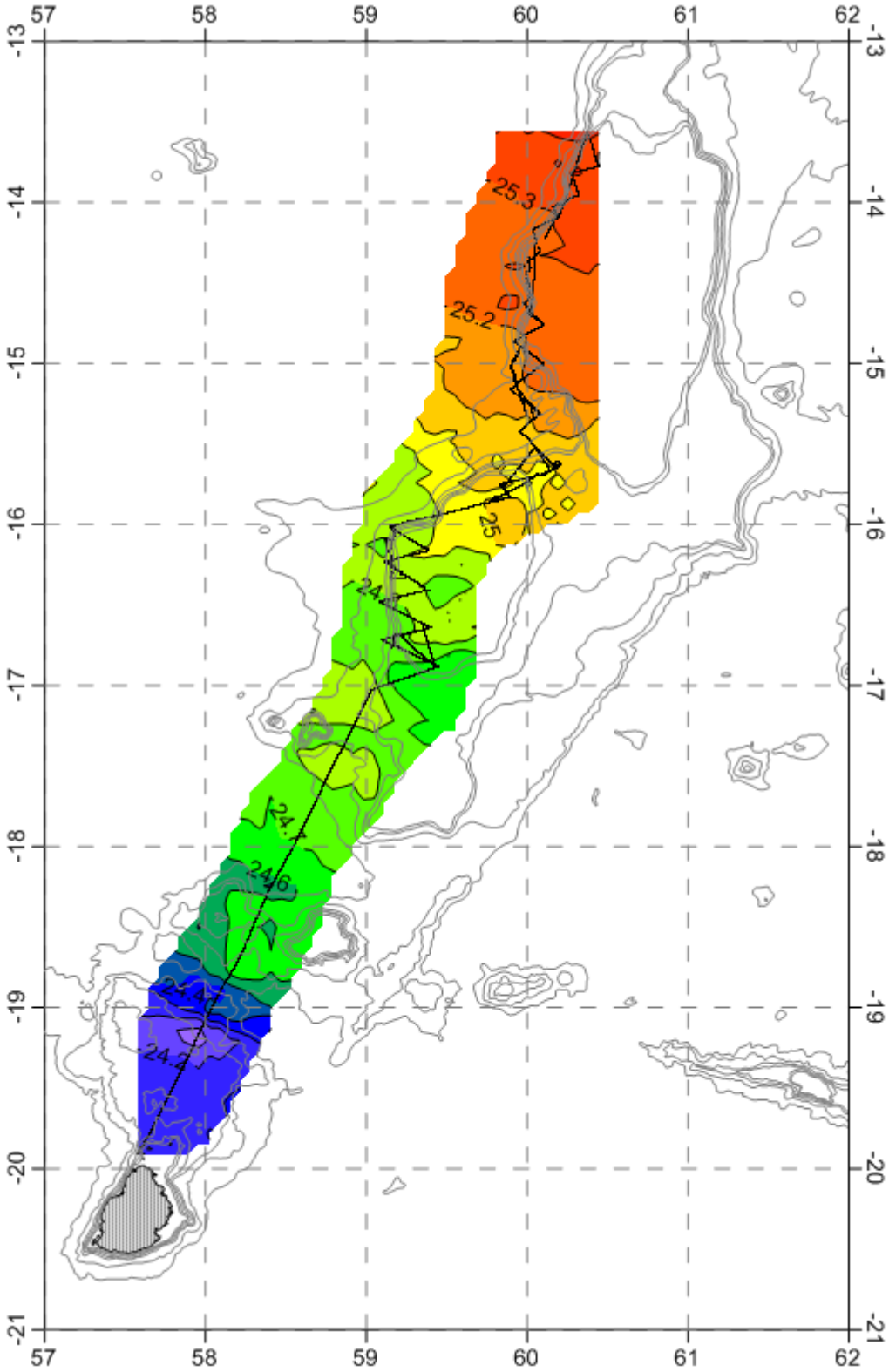


Figure 5 Horizontal distribution of surface temperature (5 m depth) on the Cargados-Carajos and Nazareth Banks

The Sea surface salinity SSS (Figure 6) was recorded from the Thermosalinograph at 5 m depth. The SSS decreased gradually from around 35 around Mauritius to 34.8 in the northern part of the survey area The deeper area between the Cargados-Carajos and Nazareth Banks and the southern shelf of the Cargados-Carajos bank showed slightly elevated salinity (34.9-35.0) probably due to intrusion from the east of Tropical Surface Water (TSW) by the South Equatorial Current.

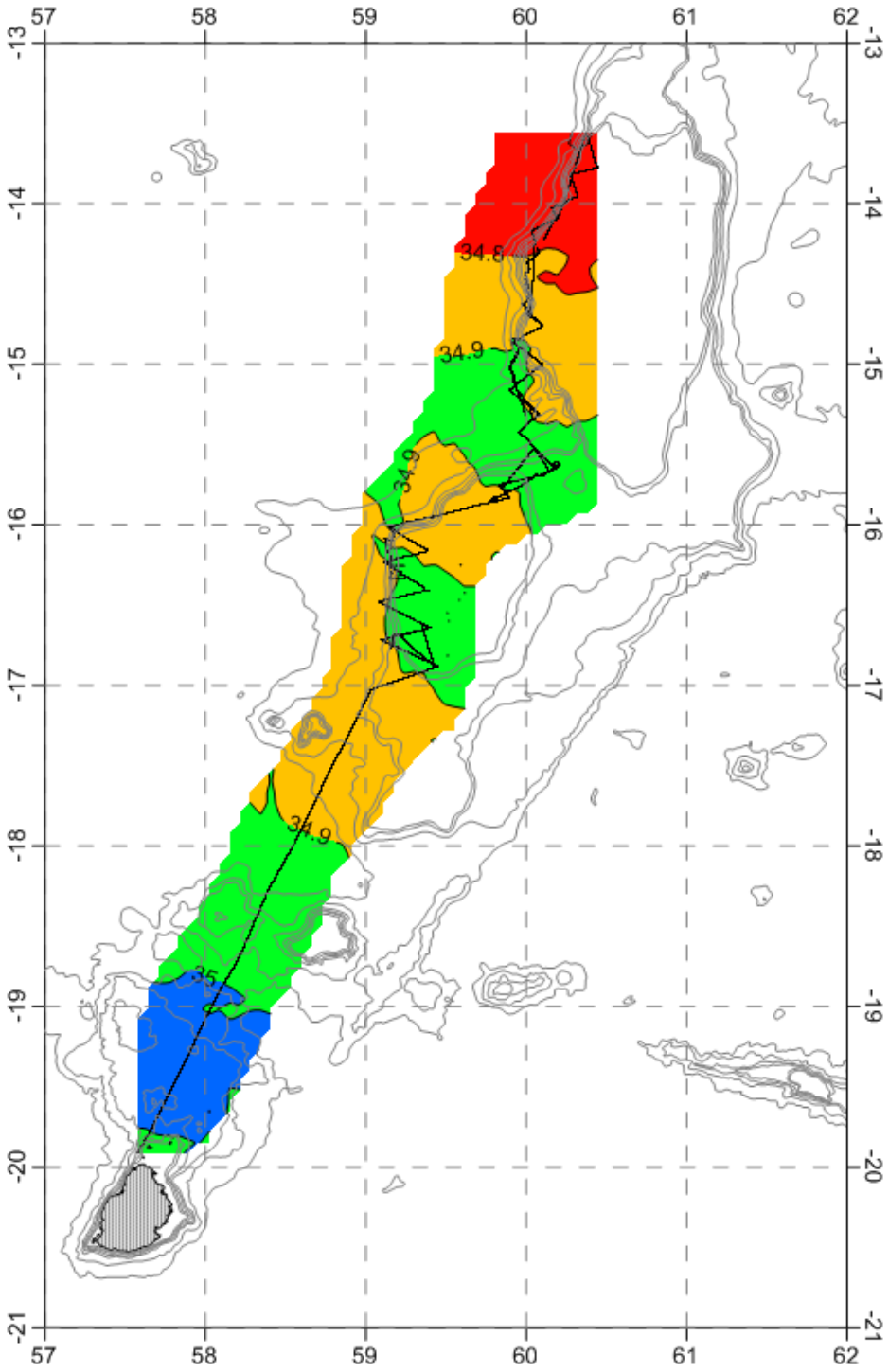


Figure 6 Horizontal distribution of surface salinity (5 m depth) on the Cargados-Carajos and Nazareth Banks

Relative Fluorescence was also recorded from the thermosalinograph. Fluorescence is a proxy for chlorophyll in the water and indicate where the production is highest. The surface values observed along the cruise track where low (around 0.01-0.02 µg/l) and gave no indication of upwelling or high production on the shelf.

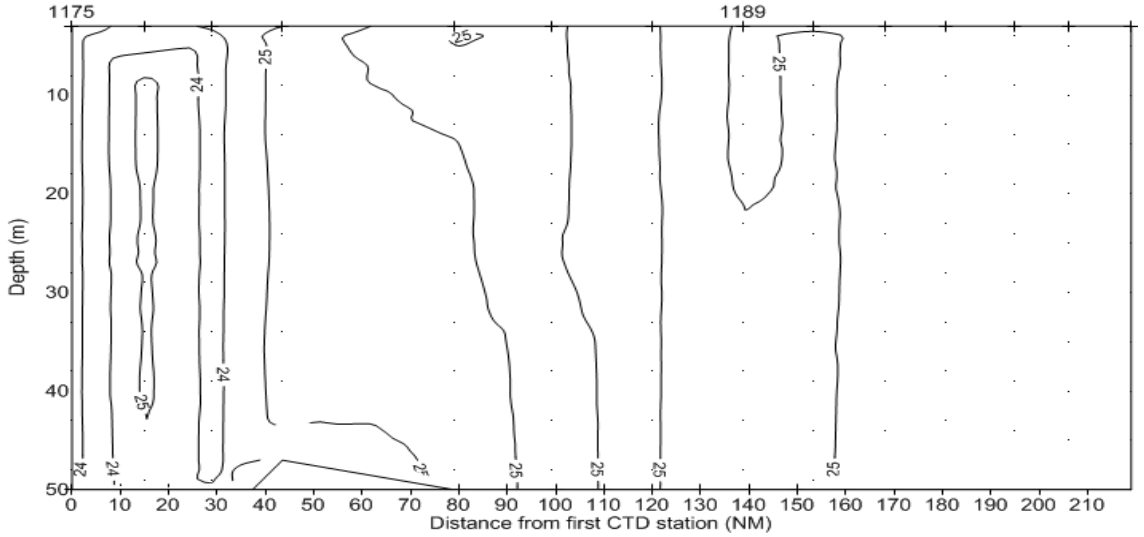
3.3 Vertical sections

CTD's were generally taken at 50 and 1000 m at the end of each transect. The environmental data collected along the shelf is presented as two vertical CTD sections of temperature, salinity and oxygen and relative fluorescence running from south to north along the west coast of the banks (Figure 7 a-h).

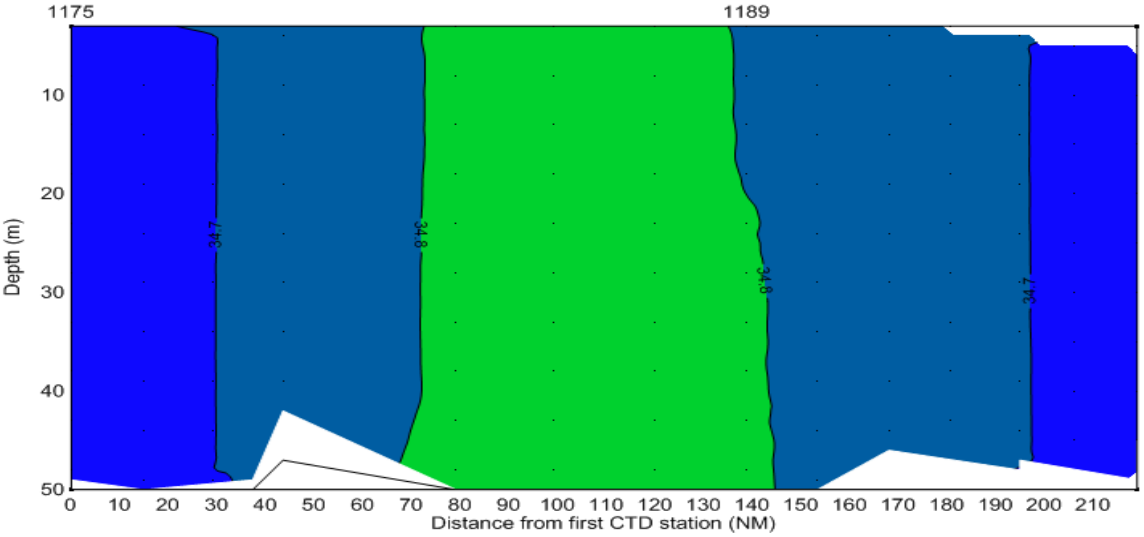
Water masses on the plateau were generally well mixed with isolines for both temperature, salinity oxygen and fluorescence going straight down through the water column. The origin of the water is probably TSW. A water body with temperatures >25°C can be seen at the southern end of the Cargados-Carajos bank before decreasing a bit further up on the bank. Further north temperatures were around 25°C. Salinity was >34.6 and <34.9 in the shallow parts of the whole survey area. The highest salinity was found between the two banks. The water was generally well oxygenated but with the lowest oxygen values near the surface on the Cargados-Carajos bank. An interesting feature, is the high oxygen maximum found close to the bottom on the same bank. The origin of this is not clear. Fluorescence values were generally low over both banks as can be expected in shallow tropical shelf areas.

Water masses in deeper waters were generally slightly cooler than on the shelf. Surface temperatures were around 24°C over the whole survey area except in the far north of the Nazareth Bank where the temperature increased slightly. Water masses were well mixed in the upper 100 m. These water masses are probably TSW pushed in from the east. The thermocline can be observed around 100 m depth and minimum temperatures of 6°C are found around 900 m depth. The highest surface salinity (34.8) was found between the Cargados-Carajos and Nazareth Banks. A salinocline was found below 100 m with values above 35 down to 400 m depth. These water masses are probably Subtropical surface waters (STSW) and are also flowing in an westerly direction. Salinity is decreasing up to <34.5. The source of these water masses is Antarctic Intermediate Water (AAIW). The oxygen maximum was around >4.4 ml/l and can be found in surface waters, while the minimum (2.4 ml/l) can be found below the thermocline at 100 m depth on both sides of the depression between the two banks. Further down another maximum of 4.2 ml/l can be found at 500 m depth.

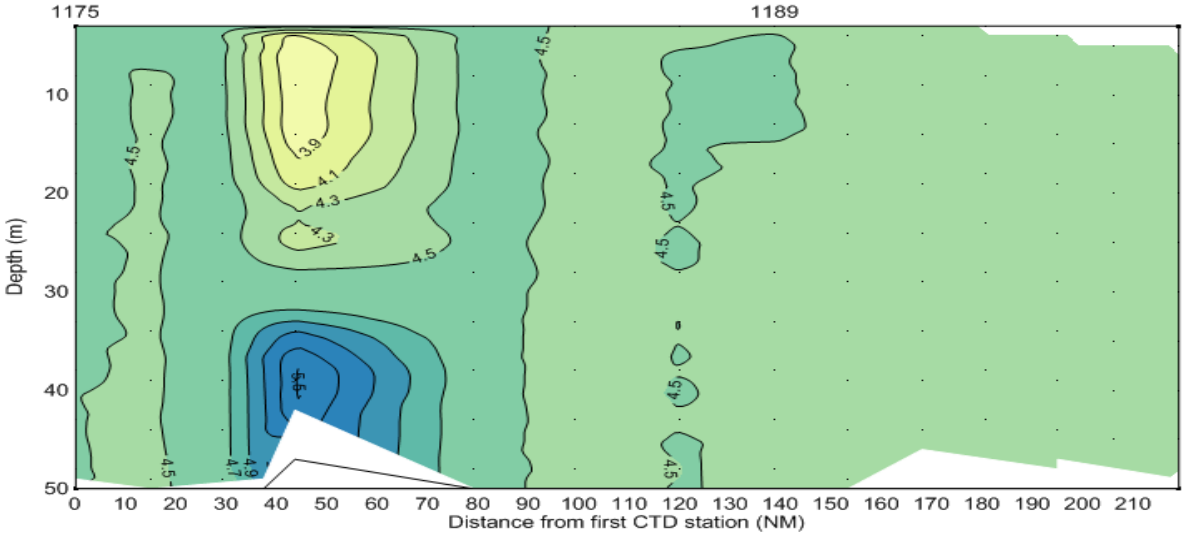
a) Temperature, 50 m depth



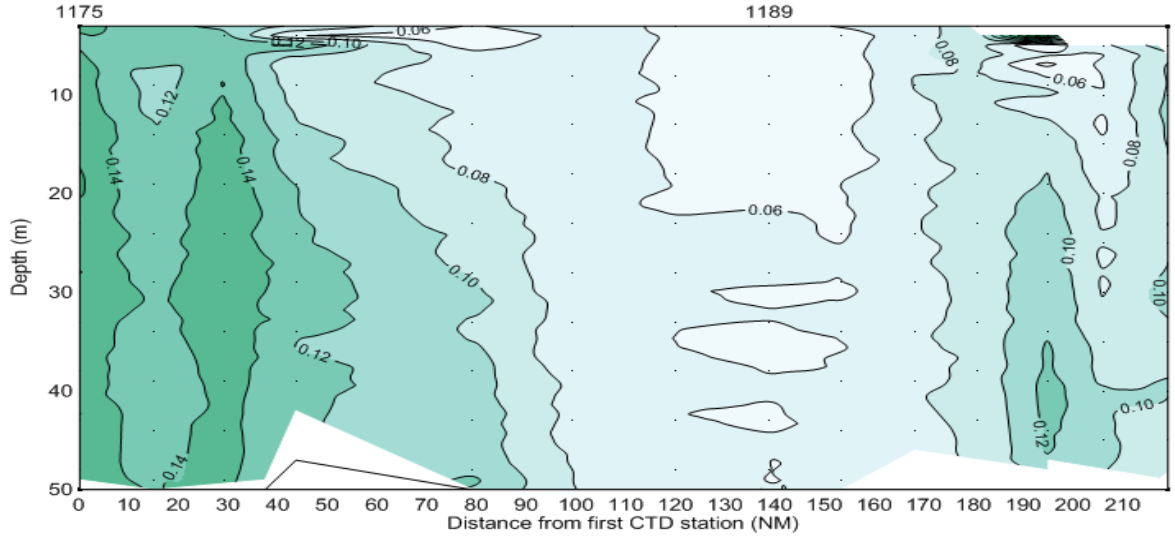
b) Salinity, 50 m depth



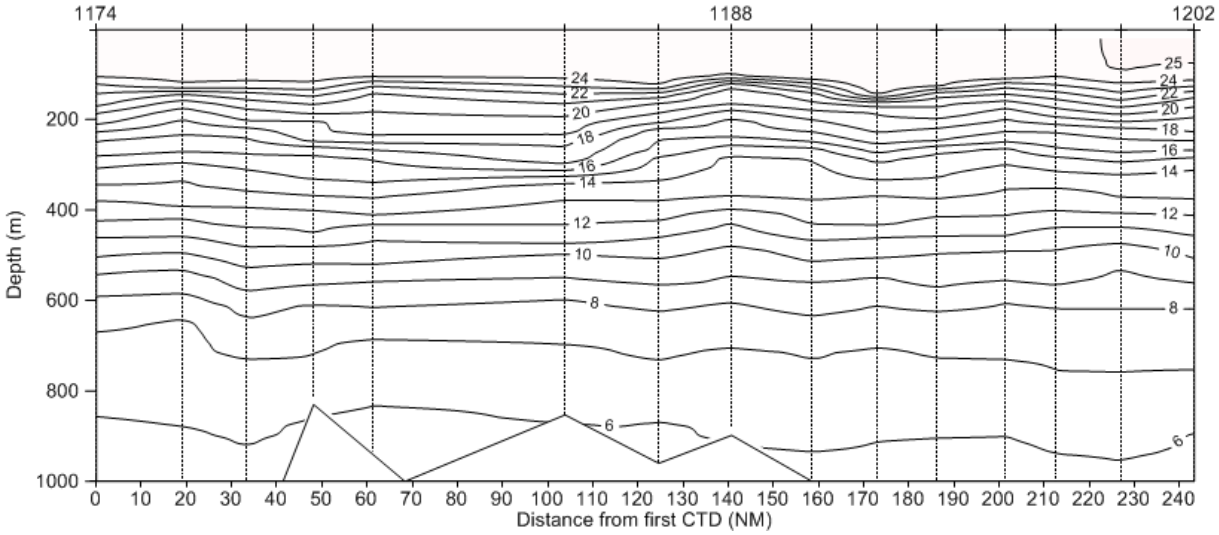
c) Oxygen, 50 m depth



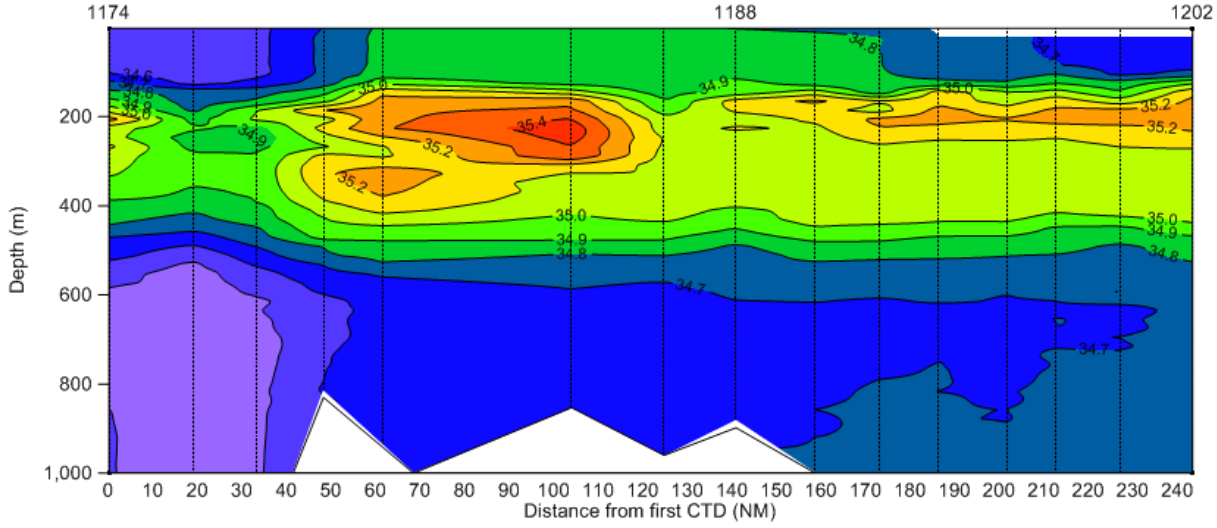
d) Fluorecence, 50 m depth



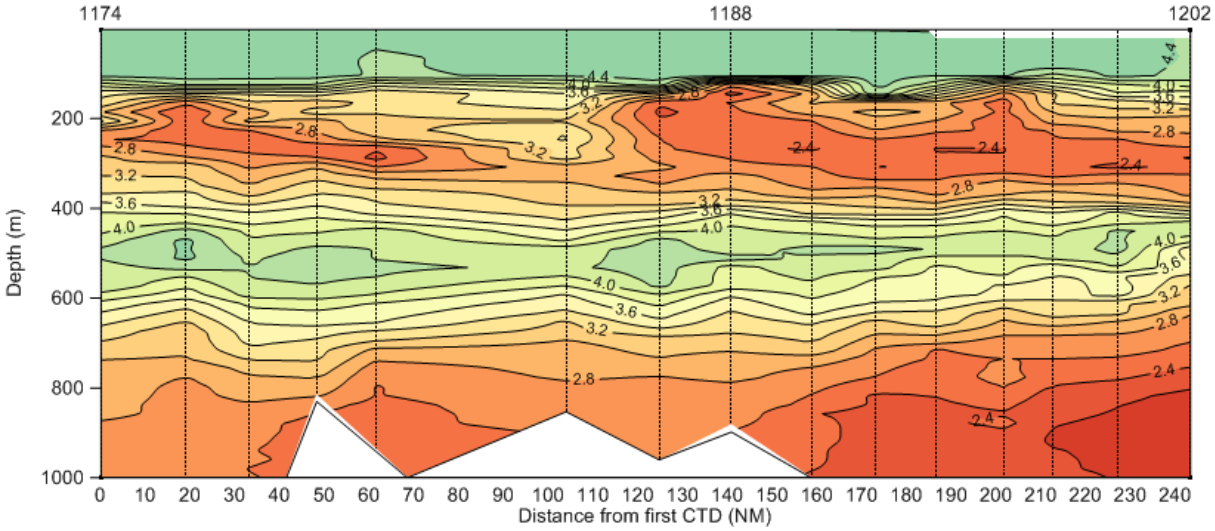
e) Temperature, 1000 m depth



f) Salinity, 1000 m depth



g) Oxygen, 1000 m depth



h) Fluorecence, 1000 m depth

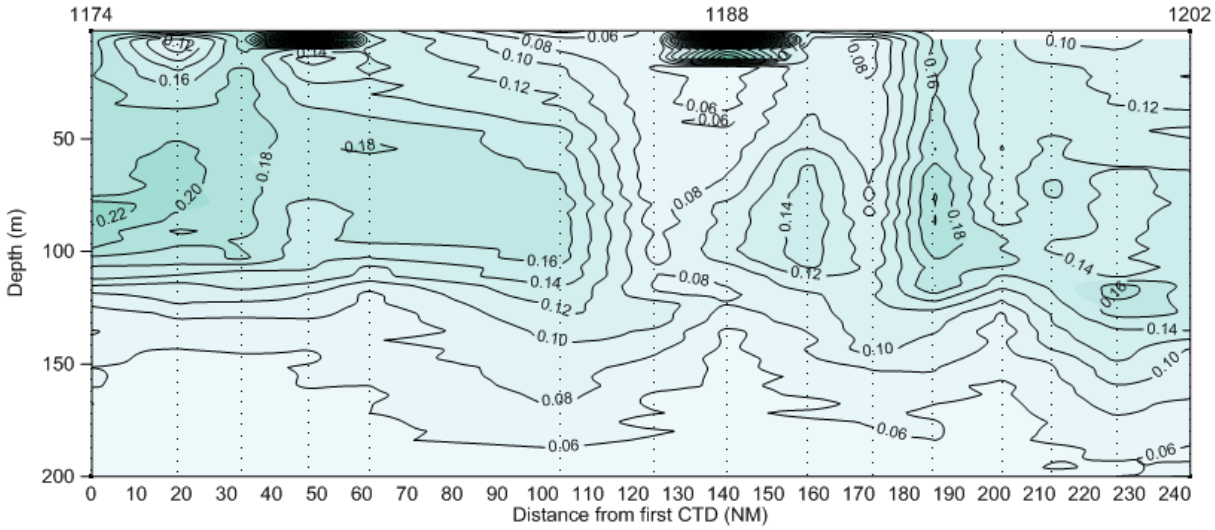


Figure 7 Vertical sections along shelf of temperature, salinity and oxygen and relative fluorescence at 50 and 1000 m depth.

CHAPTER 4 RESULTS

4.1 Results from the acoustic survey

This survey had as one of its purposes to look for demersal resources in depths between 100 and 350 m. The shelf edge was surveyed systematically with zig-zag transects during the day, between 50- > 1000 m depth, in order to cover the area of interest. The distribution area and relative abundance of the main fish groups in the area surveyed, i.e. PEL 2 (mainly carangids), shallow water demersal species (<60 m depth, Figure 8) and deep water demersals (slope demersals, Figure 10) at depth deeper than 60 m, were recorded with the Simrad ER 60 echosounder. Only average s_A values are reported and not biomass estimates due to the fact that the target strength of the surveyed demersal species is unknown and that the surveyed shelf area forms part of a much larger fishing bank, therefore reported values would not be representative for areas outside the one covered by the present survey and would thus, give little meaning. All considerations reported here are made only from acoustic values recorded during the day. During the night plankton lifted from the bottom and dispersed in the water column and made any separation of fish in the echogram difficult.

There were consistent acoustic recordings of demersal fish over the whole shelf area surveyed (Figure 8), deeper water demersal species were however scarce and patchily distributed, particularly on the shelf edge and other untrawlable grounds. Only two distribution areas were identified as indicated on the maps (Figure 10). This is mainly considered to be attributed to the very steep slope found over most of the surveyed area with depths increasing abruptly to >1000 m beyond the shelf edge (typically at 60 m depth). This is largely different from the eastern side of the two banks where the slope is gentler and the habitat for deep water demersal fish is therefore, larger and where new resources also have been found during the previous surveys.

The fish densities were highest on the banks except for the far northern end of Nazareth bank. Very little fish were recorded in the depression between the banks. S_A values attributed to plankton were high on the Cargados-Carajos bank and on the southern end of the Nazareth Banks(Figure 9).

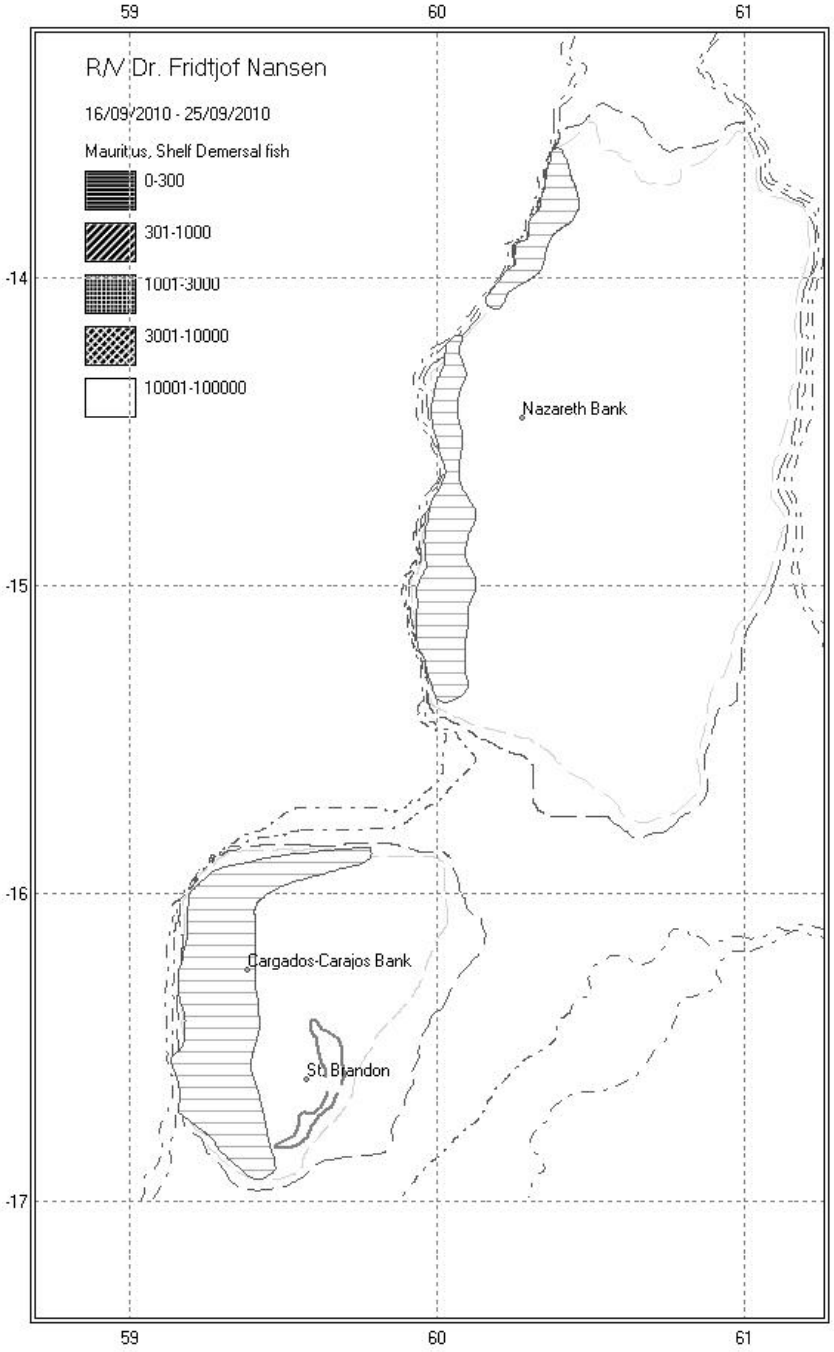


Figure 8. Distribution map indicating the distribution of the bank demersal species on the Nazareth Bank and Cargados-Carajos Bank.

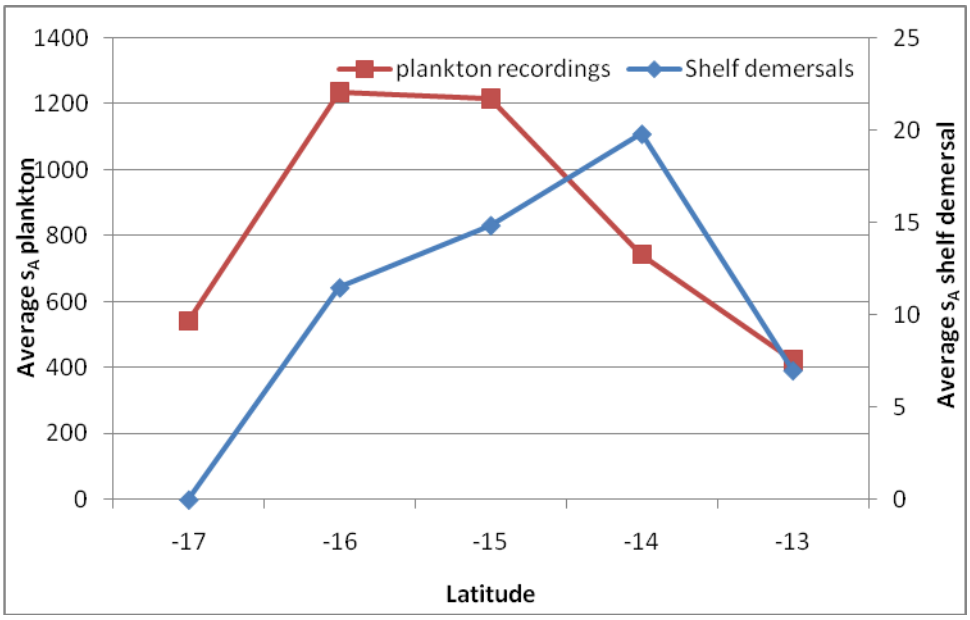


Figure 9. Distribution of average sA values attributed to plankton and to shelf demersal species per degree latitude.

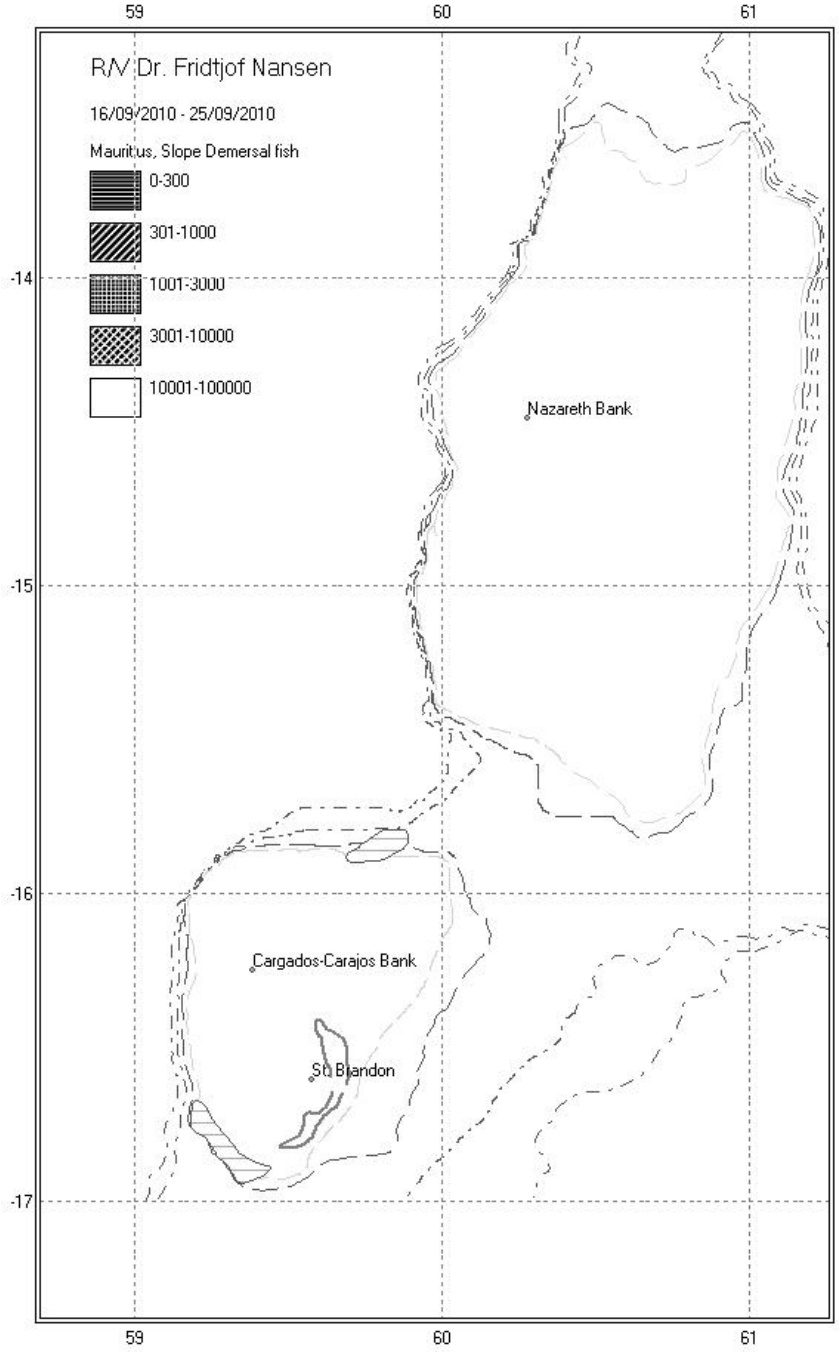


Figure 10. Distribution map indicating the distribution of the slope demersal species on the the Nazareth Bank and Cargados-Carajos Bank

4.2 Fish trap experiments

One of the goals during this survey was to test a prototype of commercial fish trap aimed especially for use in tropical waters. The prototype is based on a commercial trap currently used in Mauritian waters, but improved to be collapsible, giving fishermen the opportunity to bring more traps at sea, and as a consequence, reducing the number of days at sea before landing their catch, which in turns reduces fuel costs and improves the quality of the landed fish. Steel fencing around the trap removes problems with predator attacking the fish caught.

Some traps had attached a video recording camera, and the video observations show that the trap works well: it falls nicely to the bottom, sits stable and fishes well. Undersized fish may pass through the mesh in the fish trap unhindered , and the fish retained look relaxed.

The traps were usually deployed during the day and retrieved during the night. Soaking time varied between 8 to 16 hours. On the shelf (<100 m) traps were deployed in groups of three linked together (Figure 2), while in deeper waters (>100 m) they were deployed individually to reduce the risk of losing them due to the steepness of the slope. Annex V lists particulars of the trap stations and their catch.

To compare the performance between the traditional traps and the prototype, the traps were mixed when deployed in groups. Although some traps fished up to 40 kg, when standardized by soaking time, the values look moderate to low (<2 kg/h) (Table 2). When compared individually, the prototype traps generally performed better, yielding higher catches. The traditional traps came up empty more often than the prototype, this could be just a random effect and more trials need to be performed before reaching any firm conclusion. When comparing the traps within a group it was observed that there was a great variability, probably due to the fact that the traps were not spaced far enough apart creating interference between individual traps on a line. It would be of interest to repeat the experiment increasing the distance between the traps for comparison.

When compared by depth (Figure 11) it was observed that the prototype traps performed better than the traditional ones, but again the results just point to an indication of the trap's performance, and more trials are needed in order to be able to draw definite conclusions.

Table 2. Individual trap's performance, showing the CPUE for each trial (in kg/h), the trap's average CPUE, as well as the number of trials for each individual trap.

Trap type	Trap #	CPUE (kg/h)					average	times used
prototype	1	1.65	0.56	2.17	0.75		1.28	4
traditional	2	0.31	1.32	0	0		0.41	4
prototype	3	1.70	2.01	0.58	1.44		1.43	4
prototype	4	2.67	2.66	0			1.78	3
traditional	5	1.72	0.55	0.43	0	0	0.54	5
traditional	6	0	0	0	0	0.75	0.15	5
prototype	7	0.29	0.36	0.01	0.00	1.36	0.40	5
traditional	8	0.32	0	0			0.11	3
traditional	9	0	0				0.00	2

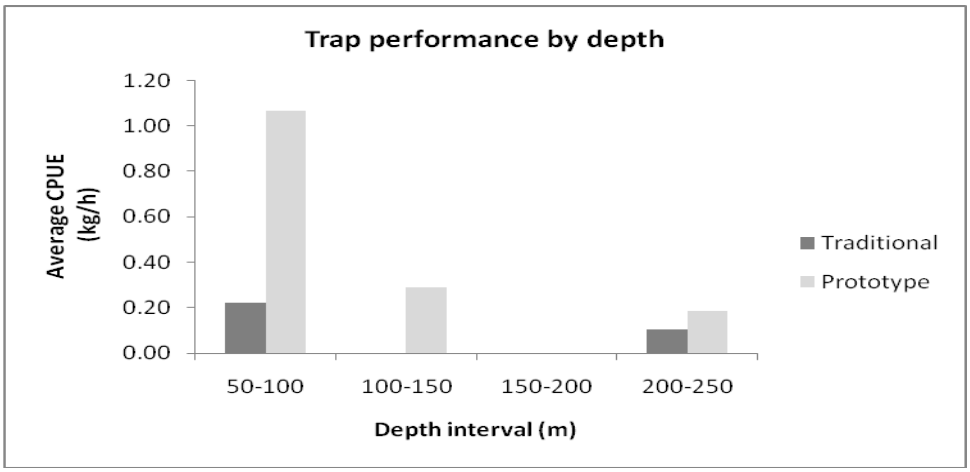


Figure 11. Trap performance by depth comparing traditional vs. prototype

All traps performed better on the shelf (average CPUE of 0.82 Kg/h) than on the slope (max CPUE of 0.15 kg/h between 100 and 150 m depth, Figure 12). This could be attributed to the steepness of the slope and a lower availability of the resources.

It is important to note that not all traps had the same mesh shape. The prototypes had diamond shape mesh, while all the traditional ones had square mesh type. The mesh at the trap's entrance had three different mesh shape in the prototype traps: square (trap 1), diagonal (trap 3) and diamond (trap 4). In the traditional traps the doors had square mesh. From these preliminary results, it seems that the non-square-mesh-type performed better than those having a square mesh. One of the prototype traps (#7) in addition to an entrance with square mesh type, it had a smaller mesh size (25 mm) than the rest of the traps (50 mm).

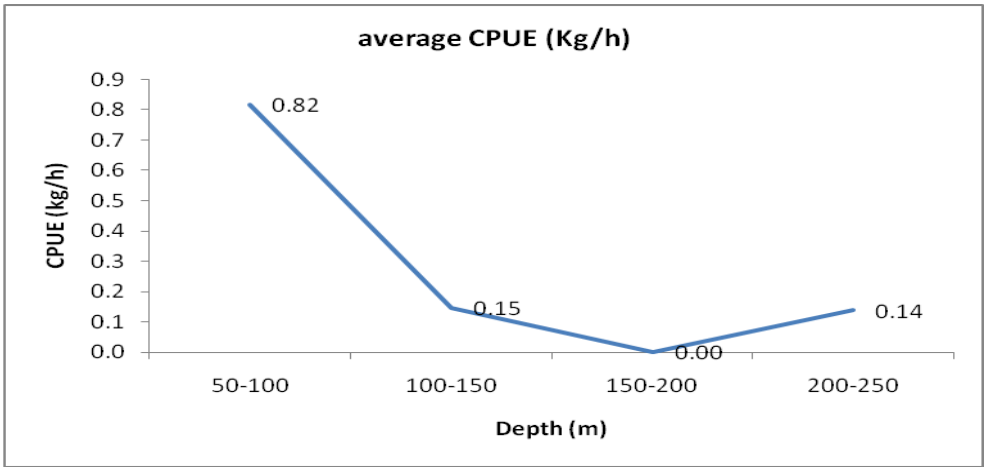


Figure 12. Average CPUE by depth interval, in kg/h. All traps pooled together.

We wanted to see if soaking time had any effect, but we didn't have enough data as to compare. It was not possible to test the influence of diel fishing periods, since traps were deployed during day time and retrieve at night. This is important since depending on the target species and their behaviour, traps should be deployed either during day or night time. At shallower depths (<200 m) some of the commercial target species are nocturnal (e.g. snappers) and night catch rates can be expected to be higher than day catches. On the contrary, emperors are diurnal and day catches might be dominated by this family. This was confirmed in our trials, where the dominant species belonged to the Lethrinidae (emperors), which not only dominated in numbers of individuals caught (160) but in number of different species (5, Figure 13). On the other hand, in deeper waters, there is little difference between day and night, therefore one can expect no big differences during the two diels.

When comparing average fish size caught in the traps deployed on the slope (traps 1 to 6), we found that it was about the same in most traps (ranging between 54 and 56 cm TL), except in two traps where fish were considerably bigger (61 and 64 cm TL in traps 4 and 5 respectively).

Two cameras were mounted in two of the prototype traps (#1 and #4) and in a couple of occasions sharks were observed circling around the trap. Once the shark started circling the trap, all fish activity outside the trap ceased and it can be assumed that the trap stopped fishing.

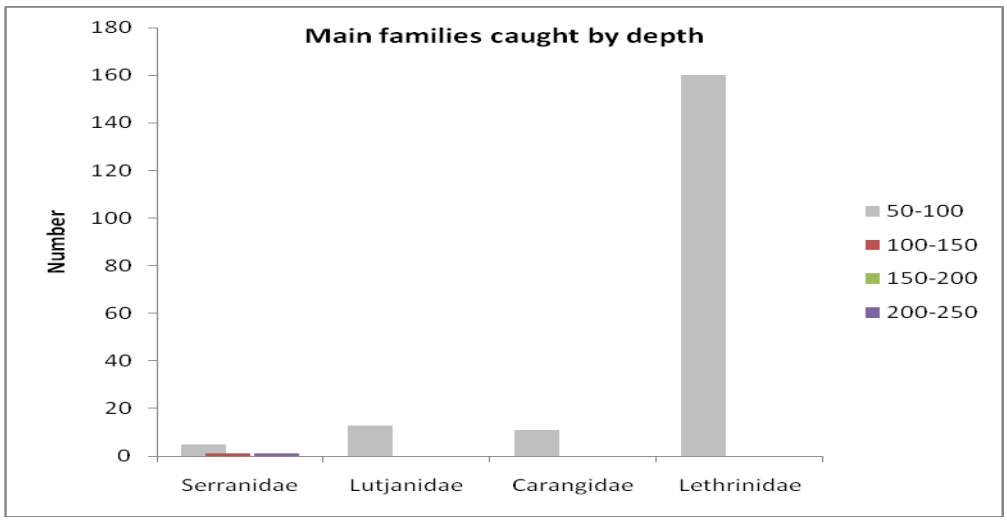


Figure 13. Main families caught in the traps by depth strata.

Observations regarding the trap design

The current trap design has proven to be very successful, and a number of modifications have been proposed after the present survey. These are generally minor, and aimed at improving the ease of use of the traps. The findings during the survey indicate that future traps should have:

- an even easier way to be collapsed.
- A biodegradable panel so that traps lost at sea stop fishing and become artificial reefs for fish until they eventually are broken down.
- A new design of the bait bags to reduce the amount of bait used per set
- Openings in the top panel so that baiting of the traps becomes faster and easier
- A smaller inner chamber for fish in the trap to escape from predators in the trap

There is also a need to study further the best suitable fish entrance to the trap and to determine the best suited mesh size, and shape to be used. Investigations into the optimal soaking time in various situations should also be determined to maximise the catch / effort from the traps.

For scientific purposes, the traps can be fitted with an acoustic release, cameras, fish counters and a variety of sensors like temperature, salinity current speed and direction.

4.3 Results from the trawl survey

The composition of the fish fauna on the bank and slope of the western side of St. Brandon and Nazareth changes with depth. However no trawlable areas were found on the slope and all trawl catches were made in waters <60 m deep. The Demersal group consist of valuable demersal species groups (groupers, snappers and emperors). For the different analysis the "other" group includes all species not accounted for in the main groups. Therefore, the content of "other" will change from table to table.

The locations of the trawl stations are shown in Figure 1. Records of fishing stations and catches are presented in Annex I and pooled length distributions (weighted by catch) of main species by area are shown in Annex II. In the analyses, only the shelf area down to depths of 100 m was included. Mean densities of the main demersal species by depth strata, occurrence and catch distributions are shown in Annex III.

Table 3 Catch rates (kg/h) of main commercial species grouped by families in swept-area bottom-trawl hauls on the shelf a) 0-50 m, b) 50-100 m

a) Shelf (0-50m)

Station	Gear depth	Carangids	Groupers	Letrinidae	Scaridae	Siganidae	Snappers	Other	Total
6	48.0		1.0	73.4	9.7	21.8	0.2	25.1	131.2
11	49.0		50.8	29.6	32.8			96.5	209.7
Mean	48.5		25.9	51.5	21.3	10.9	0.1	60.8	170.5
Std dev			35.2	31.0	16.4	15.4	0.1	50.5	55.6
%Catch			63.3	55.8	29.5	27.7	0.2	90.8	100.0

b) Shelf (50-100m)

Station	Gear depth	Carangids	Groupers	Letrinidae	Scaridae	Siganidae	Snappers	Other	Total
1	56.5			2.0				12.5	14.5
2	55.5	14.4		19.4			0.2	21.6	55.7
4	0.5							9.4	9.4
5	54.0	47.3		83.2			19.1	105.7	255.3
7	54.0			4.0				21.1	25.1
9	57.5			12.4			47.1	22.5	82.0
10	63.5			0.2				6.9	7.1
Mean	48.8	8.8		17.3			9.5	28.5	64.2
Std dev		17.8		29.9			18.0	34.6	88.7
%Catch		20.1		33.7			20.3	39.0	100.0

ANNEX I Records of fishing stations

R/V Dr. Fridtjof Nansen SURVEY:2010407 STATION: 1
DATE :18.09.2010 GEAR TYPE: BT NO: 0 POSITION:Lat S 16°52.80
start stop duration Lon E 59°26.37
TIME :06:00:05 06:36:00 36.0 (min) Purpose : 1
LOG : 3208.71 3210.71 2.0 Region : 7600
FDEPTH: 57 56 Gear cond.: 8
BDEPTH: 57 56 Validity : 4
Towing dir: 0° Wire out : 170 m Speed : 3.0 kn
Sorted : 9 Total catch: 8.70 Catch/hour: 14.50

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Loxodon macrorhinus	8.55	3	58.97	
Chilomycterus reticulatus	1.55	2	10.69	
Gymnocranius griseus	1.17	2	8.05	1
Apogon'pale-stripe'	1.10	405	7.59	
Lethrinus microdon	0.80	5	5.52	2
Canthigaster coronata	0.33	10	2.30	
Emmelichthys sp.	0.18	60	1.26	
Chaetodon kleinii	0.17	3	1.15	
Paramonacanthus sp.	0.17	2	1.15	
Diodon holocanthus	0.17	2	1.15	
Lactoria sp.	0.12	7	0.80	
Pterocaesio tile	0.08	5	0.57	
Dipterygonotus sp	0.07	2	0.46	
Scorpaenodes sp.	0.05	7	0.34	
Decapterus sp.	0.00	3	0.00	
Total	14.50		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010407 STATION: 2
DATE :18.09.2010 GEAR TYPE: BT NO: 21 POSITION:Lat S 16°37.54
start stop duration Lon E 59°21.65
TIME :12:46:22 13:16:38 30.3 (min) Purpose : 1
LOG : 3254.71 3256.39 1.7 Region : 7600
FDEPTH: 56 55 Gear cond.: 0
BDEPTH: 56 55 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.3 kn
Sorted : 28 Total catch: 28.08 Catch/hour: 55.66

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Lethrinus microdon	19.39	3074	34.83	
Loxodon macrorhinus	17.15	8	30.80	
Carangoides fulvoguttatus	14.27	2	25.64	3
Upeneus cf. guttatus	3.63	396	6.52	
Saurida gracilis	0.73	36	1.32	
Pristipomoides sp.	0.24	24	0.43	
Decapterus sp.	0.12	12	0.21	
Bothus myriaster	0.08	12	0.14	
Sepia sp.	0.06	2	0.11	
Total	55.66		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010407 STATION: 3
DATE :18.09.2010 GEAR TYPE: PT NO: 4 POSITION:Lat S 16°45.25
start stop duration Lon E 59°10.04
TIME :20:25:16 20:55:30 30.2 (min) Purpose : 1
LOG : 3305.34 3307.16 1.8 Region : 7600
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 304 272 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 3.6 kn
Sorted : 2 Total catch: 2.06 Catch/hour: 4.08

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Lampanyctodes sp.	2.31	0	56.49	
Symplectoteuthys oualaniensis	1.01	26	24.79	
Scopelosaurus herwigi	0.76	18	18.72	
Total	4.08		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010407 STATION: 4
DATE :18.09.2010 GEAR TYPE: PT NO: 4 POSITION:Lat S 16°39.45
start stop duration Lon E 59°20.05
TIME :22:22:11 22:52:13 30.0 (min) Purpose : 1
LOG : 3317.83 3319.59 1.8 Region : 7600
FDEPTH: 0 1 Gear cond.: 0
BDEPTH: 59 57 Validity : 0
Towing dir: 0° Wire out : 100 m Speed : 3.5 kn
Sorted : 5 Total catch: 4.68 Catch/hour: 9.35

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
CLUSS00	7.13	100	76.28	
Sepia sp	1.04	4	11.09	
Sphyraena forsteri	0.66	2	7.10	4
Thenus orientalis	0.30	2	3.21	6
Saurida gracilis	0.11	12	1.22	
Emmelichthys nitidus	0.07	12	0.79	
Symplectoteuthys oualaniensis	0.03	4	0.30	
Pterocaesio tile	0.00	2	0.03	5
Total	9.35		100.01	

R/V Dr. Fridtjof Nansen SURVEY:2010407 STATION: 5
DATE :19.09.2010 GEAR TYPE: BT NO: 21 POSITION:Lat S 16°24.48
start stop duration Lon E 59°23.49
TIME :04:28:01 04:45:28 17.5 (min) Purpose : 1
LOG : 3362.06 3362.95 0.9 Region : 7600
FDEPTH: 54 54 Gear cond.: 0
BDEPTH: 54 54 Validity : 0
Towing dir: 0° Wire out : 170 m Speed : 3.1 kn
Sorted : 46 Total catch: 74.25 Catch/hour: 255.30

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Lethrinus mahsena	62.72	3366	24.57	7
Decapterus sp.	47.31	5419	18.53	
Diodon sp.	26.82	7	10.51	
Diagramma pictum	24.24	7	9.49	8
Loxodon macrorhinus	20.80	10	8.15	
Lutjanus sebae	19.08	3	7.47	16
Gymnocranius robinsoni	15.47	3	6.06	
Upeneus sp.	12.52	1664	4.90	
Abalistes stellatus	5.85	3	2.29	9
Gymnocranius griseus	5.05	7	1.98	
Cantherhines dumerilii	4.68	69	1.83	
Lactoria sp.	4.47	7	1.75	
Bothus myriaster	1.38	110	0.54	
C E P H A L O P O D A	1.38	41	0.54	
Fistularia commersonii	1.34	28	0.53	
Canthigaster smithae	1.24	110	0.48	
Aluterus monoceros	0.69	151	0.27	
Thysanophrys chiltonae	0.14	28	0.05	
Saurida gracilis	0.07	28	0.03	
Pseudojuloides cerasinus	0.04	41	0.02	
Thalassoma lunare	0.01	14	0.01	
Coris caudimacula	0.01	14	0.01	
Siganus canaliculatus	0.00	7	0.00	
Total	255.30		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010407 STATION: 6
DATE :19.09.2010 GEAR TYPE: BT NO: 21 POSITION:Lat S 16°10.20
start stop duration Lon E 59°22.20
TIME :11:41:30 12:00:30 19.0 (min) Purpose : 1
LOG : 3406.17 3407.22 1.1 Region : 7600
FDEPTH: 48 48 Gear cond.: 8
BDEPTH: 48 48 Validity : 4
Towing dir: 0° Wire out : 150 m Speed : 3.3 kn
Sorted : 42 Total catch: 41.54 Catch/hour: 131.19

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lethrinus microdon	50.84	218	38.76	10
Siganus canaliculatus	21.79	107	16.61	13
Lethrinus mahsena	12.32	117	9.39	11
Lethrinus rubrioperculatus	8.21	44	6.26	12
Scarus ghobban	7.33	6	5.58	
Parupeneus barberinus	6.06	9	4.62	15
Fistularia commersonii	5.53	28	4.21	
Parupeneus rubescens	3.85	16	2.94	14
Ostracion cubicus	2.75	3	2.09	
Scarus sp.	2.37	3	1.81	
Gymnocranius griseus	2.02	25	1.54	
Lactoria fornasini	1.99	19	1.52	
Naso cf. tuberosus	1.71	6	1.30	
Parupeneus macronemus	1.07	6	0.82	
Variola louti	0.98	3	0.75	
Scolopsis frenatus	0.95	9	0.72	
Cantherhines fronticinctus	0.54	16	0.41	
Pseudobalistes fuscus	0.38	3	0.29	
Canthigaster coronata	0.28	9	0.22	
Aprion virescens	0.20	3	0.15	
Chaetodon kleinii	0.03	3	0.02	
Halichoeres sp.	0.00	6	0.00	
Labroides dimidiatus	0.00	3	0.00	
Total	131.19		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010407 STATION: 7
DATE :20.09.2010 GEAR TYPE: BT NO: 21 POSITION:Lat S 15°56.95
start stop duration Lon E 59°25.81
TIME :04:37:21 04:52:23 15.0 (min) Purpose : 1
LOG : 3511.51 3512.40 0.9 Region : 7600
FDEPTH: 54 54 Gear cond.: 0
BDEPTH: 54 54 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.6 kn
Sorted : 6 Total catch: 6.30 Catch/hour: 25.12

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Loxodon macrorhinus	8.38	4	33.35	
Abalistes stellatus	6.58	4	26.21	18
Aluterus scriptus	4.39	4	17.47	19
Gymnocranius griseus	3.99	4	15.88	17
Lactoria cornuta	1.76	4	6.99	
Labroides dimidiatus	0.02	8	0.10	20
Total	25.12		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010407 STATION: 8
DATE :20.09.2010 GEAR TYPE: BT NO: 21 POSITION:Lat S 15°38.87
start stop duration Lon E 60°11.14
TIME :15:49:29 16:19:32 30.1 (min) Purpose : 1
LOG : 3591.31 3592.96 1.7 Region : 7600
FDEPTH: 282 282 Gear cond.: 0
BDEPTH: 282 282 Validity : 0
Towing dir: 0° Wire out : 710 m Speed : 3.3 kn
Sorted : 4 Total catch: 3.83 Catch/hour: 7.64

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Pontinus nigerimum	2.20	14	28.72	
Priacanthus hamrur	1.50	38	19.58	
Puerulus angulatus	1.16	16	15.14	
Pristipomoides sp.	0.62	2	8.09	
Antigonia sp.	0.50	6	6.53	
Chlorophthalmus sp.	0.48	70	6.27	
CONGRIDAE	0.24	4	3.13	
Physiculus sp.	0.20	4	2.61	0
Physiculus sp.	0.20	6	2.61	
Bembrops platyrhynchus	0.20	4	2.61	
Grammatonotus sp.	0.12	6	1.57	
Chlorophthamus sp. juv	0.08	8	1.04	
Plesionika sp.	0.08	20	0.99	
Marleyella bicolorata	0.04	2	0.52	
Zenopsis conchifer	0.04	4	0.52	
CALLIONYMIDAE	0.00	2	0.05	
Unidentified fish	0.00	2	0.00	
Heterocarpus ensifer	0.00	4	0.00	
Total	7.64		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2010407 STATION: 9
DATE :21.09.2010 GEAR TYPE: BT NO: 21 POSITION:Lat S 15°16.55
start stop duration Lon E 60°2.14
TIME :06:14:18 06:40:28 26.2 (min) Purpose : 1
LOG : 3692.26 3693.60 1.3 Region : 7600
FDEPTH: 57 58 Gear cond.: 0
BDEPTH: 57 58 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.1 kn
Sorted : 36 Total catch: 35.78 Catch/hour: 82.03

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lutjanus sebae	25.22	2	30.74	23
Aprion virescens	21.90	5	26.69	21
Gymnocranius griseus	12.38	9	15.09	22
Chilomycterus reticulatus	6.53	5	7.97	
Abalistes stellatus	3.58	5	4.36	
Pomacanthus semicirculatus	2.87	2	3.49	
Tetrosomus concatenatus	2.52	2	3.07	
Teixeirichthys jordani	2.20	108	2.68	
Sepia sp	1.65	2	2.01	
Lactoria fornasini	1.03	5	1.26	
Canthigaster coronata	0.62	34	0.75	
Cantherhines dumerilii	0.60	34	0.73	
Parupeneus 'roundhead-yellow l	0.30	7	0.36	
Scolopsis frenatus	0.23	2	0.28	
Chaetodon kleinii	0.16	11	0.20	
Parupeneus macronemus	0.11	2	0.14	
Pterocaesio capricornis	0.11	2	0.14	
Labroides dimidiatus	0.02	5	0.03	
Aluterus monoceros	0.00	2	0.00	
Chaetodon dolosus	0.00	7	0.00	
Total	82.03		100.00	

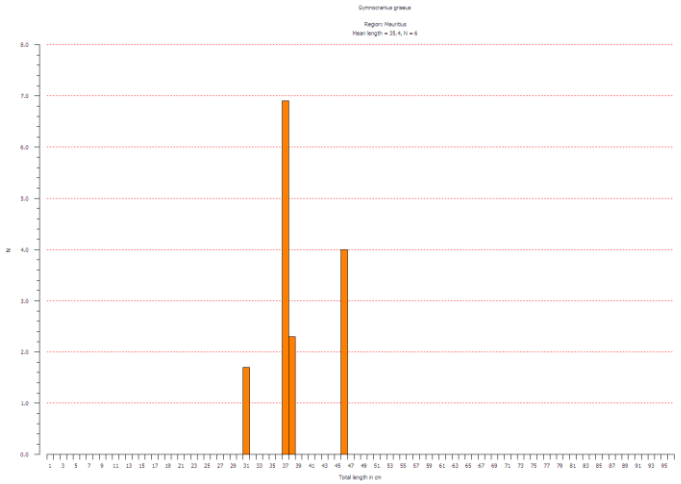
R/V Dr. Fridtjof Nansen SURVEY:2010407 STATION: 10
DATE :21.09.2010 GEAR TYPE: BT NO: 21 POSITION:Lat S 15°0.81
start stop duration Lon E 60°5.50
TIME :12:37:47 13:08:28 30.7 (min) Purpose : 1
LOG : 3728.90 3730.42 1.5 Region : 7600
FDEPTH: 66 61 Gear cond.: 0
BDEPTH: 66 61 Validity : 0
Towing dir: 0° Wire out : 160 m Speed : 3.0 kn
Sorted : 4 Total catch: 3.64 Catch/hour: 7.12

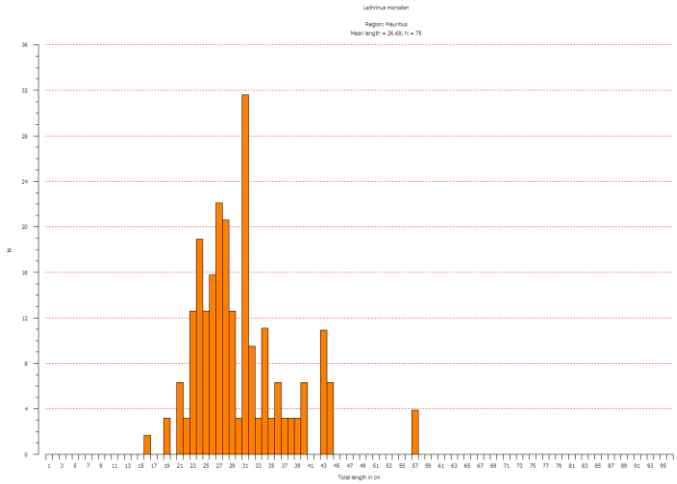
SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Abalistes stellatus	3.68	0	51.62	
Lactoria fornasini	1.13	4	15.93	
Teixeirichthys jordani	0.78	49	10.98	
Pterocaesio capricornis	0.41	12	5.77	
Sufflamen chrysopterum	0.27	6	3.84	
Parupeneus barberinus	0.25	8	3.57	
Lethrinus microdon	0.18	2	2.47	
Aluterus monoceros	0.10	6	1.37	
Cantherhines dumerilii	0.10	4	1.37	
Pseudalutarius nasicornis	0.08	6	1.10	
Stephanolepis auratus	0.06	4	0.82	
ODONTODACTYLIDAE	0.04	2	0.55	
Bothus myriaster	0.04	2	0.55	
POMACENTRIDAE	0.00	2	0.05	
Total	7.12		100.00	

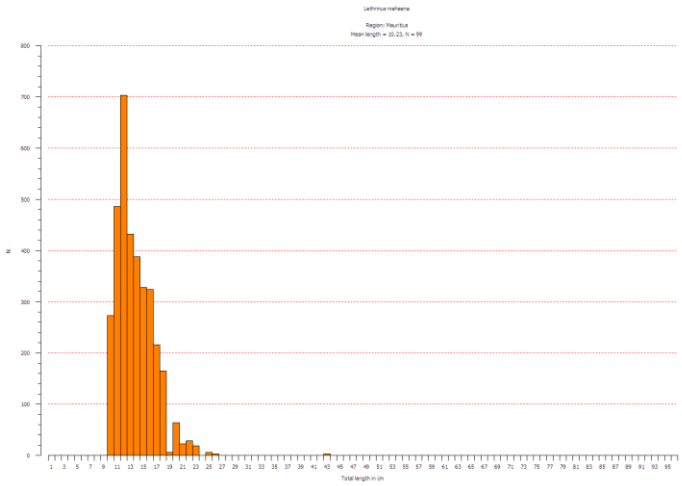
R/V Dr. Fridtjof Nansen SURVEY:2010407 STATION: 11
DATE :22.09.2010 GEAR TYPE: BT NO: 21 POSITION:Lat S 14°42.87
start stop duration Lon E 60°2.93
TIME :07:11:44 07:27:17 15.5 (min) Purpose : 1
LOG : 3844.28 3845.08 0.8 Region : 7600
FDEPTH: 49 49 Gear cond.: 0
BDEPTH: 49 49 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.1 kn
Sorted : 54 Total catch: 54.29 Catch/hour: 209.75

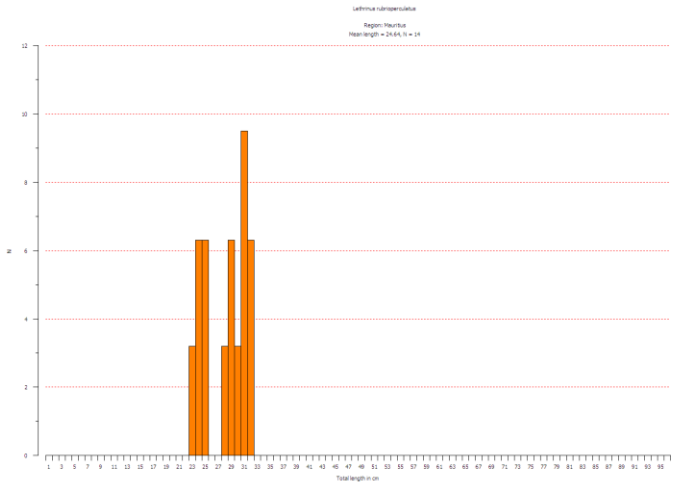
SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Epinephelus flavocaeruleus	36.32	4	17.31	
Scarus ghobban	30.91	4	14.74	
Naso tuberosus	27.62	15	13.17	
Pomacanthus semicirculatus	20.28	12	9.67	
Lethrinus rubrioperculatus	18.16	42	8.66	
Lethrinus microdon	11.40	12	5.43	24
Zanclus canescens	10.43	23	4.97	
Acanthurus dussumieri	10.43	8	4.97	
Teixeirichthys jordani	8.04	1885	3.83	
Balistoides conspicillum	7.92	8	3.78	
Plectropomus sp.	7.53	4	3.59	
Variola louti	6.95	4	3.32	
Pomacanthus imperator	5.80	4	2.76	
Heniochus acuminatus	3.48	12	1.66	
Scarus sp.	1.93	4	0.92	
Zebrasoma sp.	1.55	4	0.74	
Myripristis seychellensis	0.97	4	0.46	
Scolopsis frenatus	0.04	4	0.02	
Total	209.75		100.00	

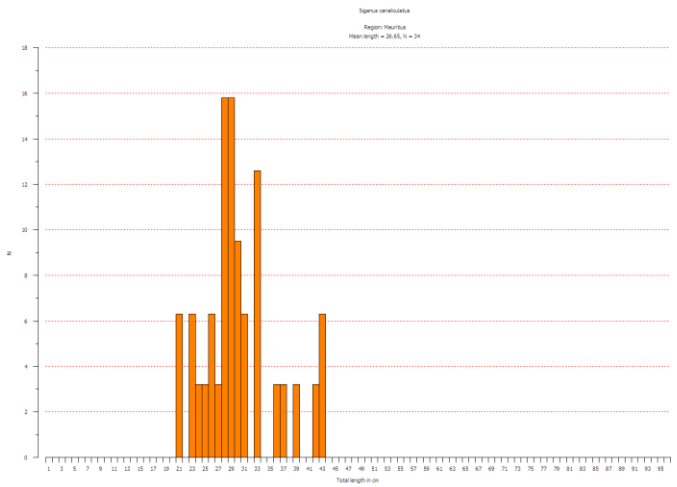
ANNEX II. LENGTH FREQUENCY OF MAIN SPECIES











ANNEX III. SWEPT AREA ANALYSIS

Mauritius. St. Brandon & Nazareth Bank. Shelf

SPECIES NAME	SAMPLE DISTRIB. BY CATCH CLASSES kg/nm				% incidence	Mean dens.	Mean densities by strata t/nm²		
	>0	10	30	100		t/nm²	0-30m	30-50m	50-100m
Lethrinus microdon	4	1			50	0,252		0,953	0,102
Lethrinus mahsena	1	1			20	0,242		0,186	0,342
Loxodon macrorhinus	4				40	0,169			0,281
Decapterus sp.	2	1			30	0,155			0,258
Lutjanus sebae	2				20	0,144			0,241
Scarus ghobban	1	1			20	0,123		0,617	
Epinephelus flavocaeruleus		1			10	0,119		0,595	
Naso tuberosus	1				10	0,091		0,453	
Diodon sp.	1				10	0,088			0,146
Lethrinus rubrioperculatus	2				20	0,084		0,421	
Diagramma pictum	1				10	0,079			0,132
Gymnocranius griseus	5				50	0,078		0,03	0,119
Pomacanthus semicirculatus	2				20	0,076		0,332	0,016
Aprion virescens	2				20	0,072		0,003	0,119
Siganus canaliculatus	2				20	0,066		0,329	
Abalistes stellatus	4				40	0,062			0,103
Gymnocranius robinsoni	1				10	0,051			0,084
Carangoides fulvoguttatus	1				10	0,043			0,071
Upeneus sp.	1				10	0,041			0,068
Teixeirichthys jordani	4				40	0,036		0,132	0,016
Acanthurus dussumieri	1				10	0,034		0,171	
Zanclus canescens	1				10	0,034		0,171	
Balistoides conspicillum	1				10	0,026		0,13	
Chilomycterus reticulatus	2				20	0,026			0,043
Variola louti	2				20	0,026		0,129	
Plectropomus sp.	1				10	0,025		0,123	
Fistularia commersonii	2				20	0,021		0,083	0,007
	1				10	0,02	0,101		
Parupeneus barberinus	2				20	0,019		0,091	0,001
Pomacanthus imperator	1				10	0,019		0,095	
Cantherhines dumerilii	3				30	0,018			0,029
Lactoria sp.	2				20	0,015			0,025
Scarus sp.	2				20	0,013		0,067	
Lactoria fornasini	3				30	0,013		0,03	0,012
Aluterus scriptus	1				10	0,012			0,021
Parupeneus rubescens	1				10	0,012		0,058	
Heniochus acuminatus	1				10	0,011		0,057	
Upeneus cf. guttatus	1				10	0,011			0,018
Other fish						0,103	0,088	0,158	0,089
Sum all species						2,527	0,189	5,414	2,344
Sum SNAPPERS, JOBFISHES						0,217		0,003	0,361
Sum GROUPERS, SEABASSES						0,169		0,847	
Sum GRUNTS, SWEETLIPS						0,079			0,132
Sum CROAKERS, DRUMS, WEAKF., KOBS									
Sum PANDORAS, PORGIES, SEABREAMS,									
Sum SHARKS, CHIMAERAS						0,169			0,281
Sum BATOID FISHES, RAYS									
Sum CEPHALOPODS						0,016	0,029		0,017
Numbers of stations included in analysis, total and by depth strata						10	2	2	6

ANNEX IV. INSTRUMENTS AND FISHING GEAR USED

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

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

Transceiver-2 menu (38 kHz)

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

Bottom detection menu Minimum level -40 dB

4.4 Fishing gear

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

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

The SCANMAR system was used on all trawl hauls. This equipment consists of sensors, a hydrophone, a receiver, a display unit and a battery charger. Communication between sensors and ship is based on acoustic transmission. The doors are fitted with sensors to provide information on their distance, and the trawl was equipped with a trawl eye that provides information about the trawl opening. A catch sensor on the cod-end indicated the size of the catch.

ANNEX V. DETAILS OF TRAP STATIONS

trap number	average depth (m)	soaking time	Catch (kg)	CPUE (kg/h)	species									Total (number)
					Crab	Sharks	Shrimps	Balistidae	Serranidae	Lutjanidae	Letrinidae	Carangidae	Muraenidae	
1	56.0	11	18.10	1.65							20	1		21
2	56.0	11	0.00	0.00										0
3	56.0	11	18.69	1.70					1	1	5			7
4	54.5	8	0.00	0.00										0
5	54.5	8	0.00	0.00										0
6	54.5	8	0.00	0.00										0
1	48.0	13	7.30	0.56							9			9
2	48.0	13	4.05	0.31							2			2
3	48.0	13	26.12	2.01					1	2	27	1		31
4	55.0	13	34.75	2.67								9		9
5	55.0	13	22.40	1.72							10			10
6	55.0	13	0.00	0.00										0
7	141.5	12	3.50	0.29					1				4	5
8	100.5	10	0.00	0.00										0
7	288.0	11	3.94	0.36		2	9							11
8	288.0			0.00										0
9	180.0	12	0.00	0.00										0
1	58.0	16	34.70	2.17				1	1	4	6			12
2	58.0	16	0.00	0.00										0
3	58.0	16	9.25	0.58							7			7
4	57.0	15	39.85	2.66						1	20			21
5	57.0	15	8.20	0.55							2			2
6	57.0	15	0.00	0.00										0
7	252.0	14	0.20	0.01	1									1
8	257.5	14	4.45	0.32					1					1
9	257.5	14	0.00	0.00										0
1	48.0	14	10.45	0.75						1	7			8
2	48.0	14	18.45	1.32					1	1	6			8
3	48.0	14	20.10	1.44						2	21			23
5	47.0	14	6.00	0.43						1				1
6	47.0	14	0.00	0.00										0
7	47.0	14	0.00	0.00										0
5	51.0	13	0.00	0.00										0
6	51.0	13	9.75	0.75					1		3			4
7	51.0	13	17.63	1.36							15	1		16