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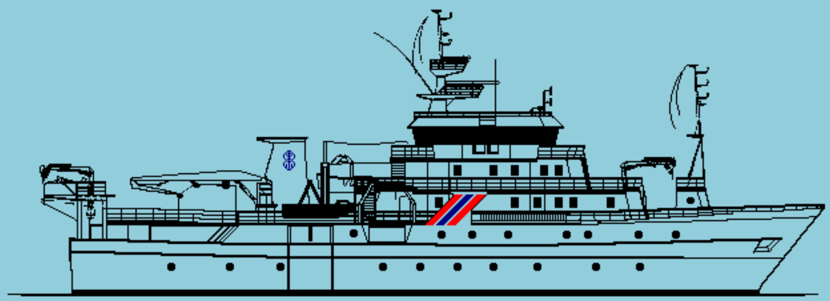

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PORT LOUIS to Durban, IOS leg II

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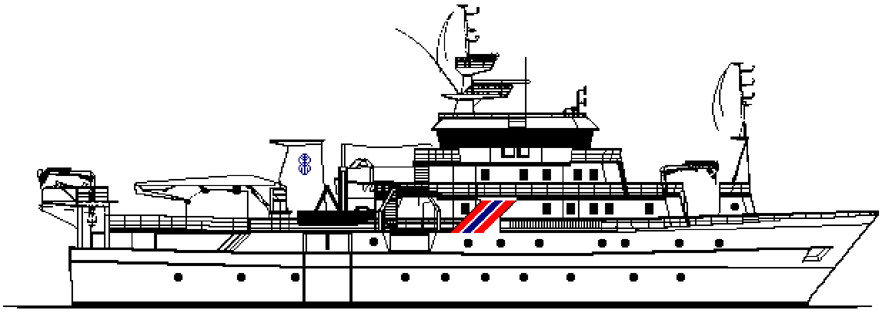

SURVEY OF THE SOUTHERN INDIAN OCEAN

PORT LOUIS to Durban, IOS leg II

June 18th – July 6th 2015

By

Bjørn Serigstad, Sundy Ramah, Karen Fosse Sivertsen, Tor Ensrud, Magne Olsen Lindsey Beazley,

Francisco Javier Murillo Perez, Bradly Blows and Zo Tsihoarana Rasoloarijao

Institute of Marine Research

Bergen, Norway

THE EAF-NANSEN PROJECT

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

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

LE PROJET EAF-NANSEN

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

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

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1 INTRODUCTION

Foreword.

The Indian ocean surveys in 2015 onboard the RV. Dr. Fridtjof Nansen was planned as a preparation to the new phase of international research beginning in late 2015 and continuing through 2020 focusing on the Indian Ocean and is a runner up to the second International Indian Ocean Expedition - IIOE-2.

The aim of the survey was to map the ecology in local areas with assumed local upwelling and compare the habitat on the eastern and western part of the location to observe possible differences in plankton biomass due to the influence of upwelling and direction of currents. It was also a pilot survey to test the suitability of video based techniques combined with benthos and pelagic sampling to characterize local ecosystems for habitat classification in tropical high seas and to adopt and standardize these techniques to the VAMS (Video Assisted Multi Sampler).

The second leg of the survey took place between 18th of July and August 10th. work on selected habitats on the Mascarene Plateau and Madagascar Ridge to develop methods for habitat mapping and ecosystem classification. Two locations on the Madagascar Ridge were chosen for this special study. The Northern location on the Madagascar Ridge was a seamount at position 26°55.241S and 46°13.728E within the EEZ of Madagascar and southern part was the Walther Shoals at position 33^{o} 10'S and 43^{o} 53'E, in international waters. The results of this work will be used to discuss a more extensive use of this equipment for habitat mapping in the period towards 2020.

1.1 Scientific rationale

The International Council for Science's Scientific Committee on Oceanic Research (SCOR) and UNESCO's Intergovernmental Oceanographic Commission (IOC-UNESCO) are coordinating a new phase of international research beginning in late 2015 and continuing through 2020 as part of the second International Indian Ocean Expedition - IIOE-2. The EAF-Nansen Project of FAO scheduled a demonstration survey across the southern Indian Ocean in 2015 as an early contribution towards the expedition, with a likely follow up in the next phase of the EAF-Nansen Project.

The survey was planned in two stages: Leg 1 started from Jakarta, Indonesia on June 26th and ended in Port Louis, Mauritius on July 16th.

The first leg focused on collecting information at an ecological level from the Southern Indian Ocean gyre and, especially, investigated the role of mesopelagic fish across the gyre, made an effort to verify to what extent the gyre functions as an aggregation location for floating plastics.

The second leg, this survey, scheduled in the period, July 18th to August 6th were to focus on selected habitats on the Madagascar Ridge to develop methods for habitat mapping and ecosystem classification using the newly developed VAMS (video assisted multi sampler) and couple them to plankton in the water column , in addition to this monitoring and investigation of the oceanographic features using the CTD and a set of LADCP's to describe the water composition and currents in the working area. The plastic sampling was also followed up on the second leg.

The official owner of the data is FAO and local authorities. The survey was carried out in the EEZ surrounding Madagascar and in international waters.

1.2. Survey objectives

a. Benthic habitat mapping with focus on two pre-selected areas with assumed local upwelling's, using a video assisted sampling device (VAMS) for video identification of benthic communities, in fauna and macro fauna sampling as well as determination of sediment composition and status.

b. Bathymetric mapping using a multi beam echo sounder to create detailed bathymetric profiles where necessary. In addition to this, sampling of physical and biological oceanographic parameters in order to observe the ecology of the whole habitat, including the pelagic zone.

c. Collect oceanographic data (temperature, density, oxygen, nutrient salts, chlorophyll and current measurements based on LADCP) along the route, to study biological productivity.

d. Collect plankton samples from the water column and its main scattering layers, to estimate the horizontal and vertical distribution, abundance, biomass, taxonomic and size composition of meso-zooplankton and link them to the oceanographic data.

e. Continue the plastic sampling from the first part of the survey to expand the data set.

f. Collect acoustic data for interpretation.

1.3. Participants

The participants of the IO II survey (18 July-06 August 2015) were:

Participants:	*E-mail address*	*Gender:*	*Institution*:	*Country:*
Bjørn Serigstad (cruise leader)	bjornser@imr.no	*M*	IMR	Norway
Tore Mørk (Instrument chief)	tore.moerk@imr.no	*M*	IMR	Norway
Kåre Tveit (Instrument operator)	ktv2@online.no	*M*	IMR	Norway
Magne Olsen	magneo@imr.no	*M*	IMR	Norway
Tor Ensrud	tormagne@imr.no	*M*	IMR	Norway
Dag Rune Nedrevaage	dag.rune.nedrevaage@argus-rs.no	*M*	ARGUS	Norway
Kenneth Loven	kenneth.loven@argus-rs.no	*M*	ARGUS	Norway
Karen Fosse Sivertsen	karen.f.sivertsen@gmail.com	*F*	UIB	Norway
Asma Damon	asmadamon@gmail.com	*F*	UWC	South Africa
Kamlesh Ramdhony	kramdhony@moi.intnet.mu	*M*	DOF	Mauritius
Zo Tsihoarana Rasoloarijao	zorasoloarijao@ihsm.mg	*M*	UDT	Madagascar
Lindsay Beazley	Lindsay.Beazley@dfo-mpo.gc.ca	*F*	DOF Ca.	Canada
Ramah Sundy	sundy.ramah@gmail.com	*M*	MOE	Mauritius
Patroba Patrick Matiku	patrobamatiku@gmail.com	*M*	TAFIRI	Tanzania
Jean Jacques	bejeanjacques@moov.mg	*M*	CSDF	Madagascar
Bradley Marlon Blows	bradley@oceanafrica.com	*M*	BCRE	South Africa
Francisco Javier Murillo Perez	javier.murillo@hotmail.com	*M*	DFO Ca.	Canada
Calvin G. Gerry	calvingerry@gmail.com	*M*	SFA	Seychelles

All participants contributed very well.

List of acronyms:

IMR – Institute of Marine Research	TAFIRI – Tanzania Fisheries Research Institute
ARGUS – Argus Remote Systems AS	CSDF – Centre of Studies and Development of Fisheries
UIB – University of Bergen	BCRE – Bayworld Centre for Research and Education
UWC – University of Western Cape SA	DFO Ca - Department of fisheries and Oceans, Canada
DOF – Department of Fisheries	MOE – Ministry of Ocean Economy
UDT – Universite De Toliara	CDCF- Centre for development cooperation in fisheries

1.4. Responsibilities during the survey

The cruise leader

The cruise leader has the overall responsibility for the aim of the survey, and has to see to it that the goals of the survey are met as well as possible.

The cruise leader is responsible for organizing the work in teams and in watches so that the competence of the participants is used for the fulfilment of the aims of the survey.

During the survey, regular meetings should be held, to inform about findings and how the sampling and analyses of data is developing so that adjustments of the working procedures can be done in order to optimize the possibility of the collection of high quality data.

Team leaders

The team leaders should organize the sampling of the data within their field, and make sure that data are sampled in the best way possible. The team leader report regularly to the cruise leader on how data collection is going and if problems occur. Team leaders should strive to optimize the quality of the data sampled, but should not change sampling procedures without discussing it with the cruise leader.

Scientists

During the survey the scientists and technicians are expected to:

- take active part in the fulfilment of the aim of the survey
- follow the agreed sampling procedures
- when on watch, to be where the sampling and scientific activity takes place
- keeping their working areas and equipment clean and in place

1.4.1 Teams

The work was organized in four teams:

Communication team

- make daily reports for the FAO blog from the different activities.

Oceanographic team

- to collect water samples from the Niskin bottles for nutrient and chlorophyll analysis
- to assist, if necessary on the collection of LADCP data.

Plankton team

- to collect samples from the plankton nets and preserve these as agreed
- to collect samples from the Manta trawl, analyze and preserve as agreed
- to collect samples of plastic particles in any other gear, analyze and preserve as agreed.

Benthos / Habitat mapping team

- fill in the video analysis observation form identifying benthic macro fauna and fish. Characterization of habitats related to bottom type, topography and selected hydrographical parameters using the Campod-Logger software.
- collect and process sediment and fauna samples from the VAMS and the Van Veen grabs, preserve and label these as agreed.

1.5 Narrative

18.07.2015

The participants arrived on board at 0930-1130. There was a meeting with the scientists to discuss the scientific work for the cruise and to finalize the Sailing Order. The vessel left Port Louis harbour, Mauritius at 1600 (local time) while working on mobilisation of the equipment. The first station for CTD and Manta Trawl west of Mauritius was sampled successfully at 1508 GMT.

19.07.15

Function tests of the VAMS on board shows that the system is operational. Sampling with CTD/ LADCP and Manta trawl on stations south of Mauritius.

20-23.07.15

Sampling with CTD/ LADCP, Manta Trawl, Multinet and CPR on the way west to Madagascar Ridge.

Collecting plastic samples, neuston, plankton, CTD and LADCP data.

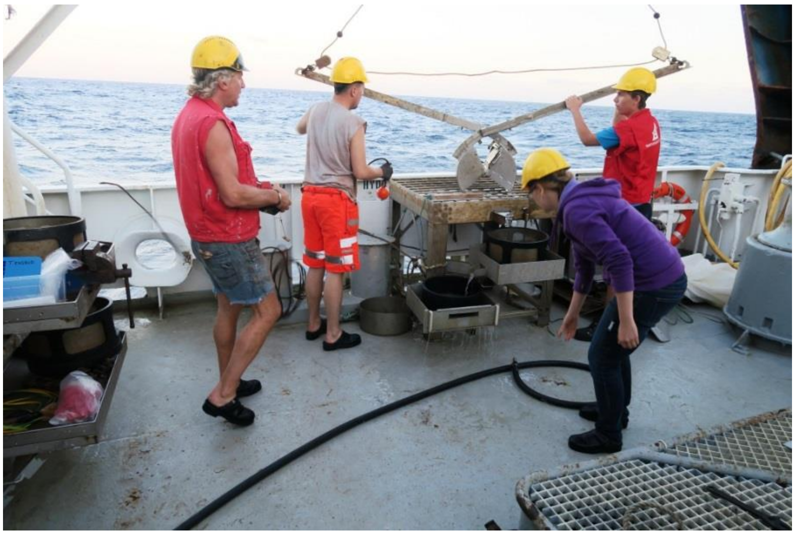
24.07.15

Three stations on the Northern part of the Madagascar Ridge were sampled. We tried to follow the same sampling regime as yesterday; CTD/ LADCP, Manta Trawl, Multinet and CPR. There was damage to the Multinet due to the bad weather conditions and we had to use the WP2 net for plankton sampling. The Multinet was repaired and ready for use.

25-28.07.15

Ten stations on the Madagascar Ridge were sampled using; CTD/ LADCP, Manta Trawl, Multinet and Van Veen Grabs. Due to bad weather conditions the ship was not able to hold the speed required for deployment of the CRP on the 25th.

Picture 1.5.1 Asma, Javier and Lindsay sieving the sample from the Van Veen grab

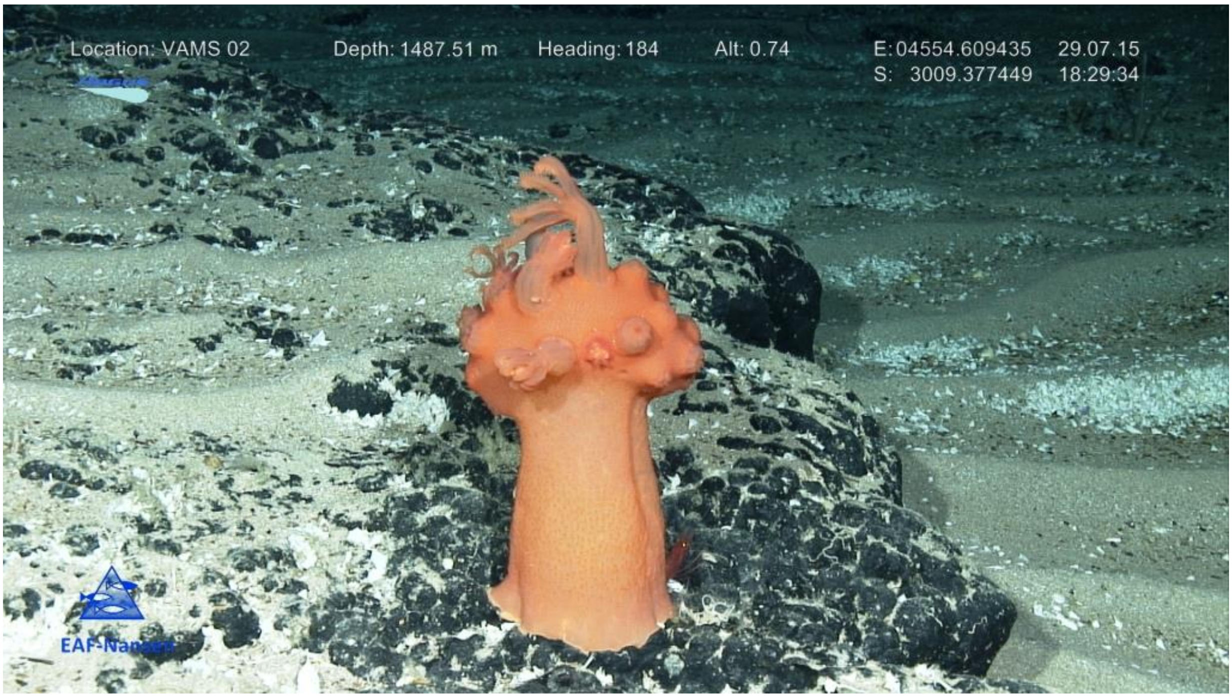


Picture 1.5.2 Sampling with the Van Veen grab.

29.07.15

We had the first two dives with the VAMS. Everything went well, we got interesting videos and samples from the very hard bottom in the middle part of the Madagascar Ridge. In addition, we used; CTD/ LADCP, Manta Trawl and the Multinet

Picture 1.5.3 Berycidea from 840 meters dept at Madagascar Ridge



Picture 1.5.4 “Mushroom coral” from 1487 meters at Madagascar Ridge

30.07

We reached the Walter’s Shoals. There was too much wind and waves to use the VAMS. Samples were collected using CTD/ LADCP, Manta Trawl, Multinet and CPR. In addition, we worked on the material collected and recorded on the 29th using the VAMS.

01.08

Due to bad weather all work were stopped early in the morning. Strong wind and big waves made work impossible until the storm had passed.

Picture 1.5.5 Storm today, not possible to work outside

Picture 1.5.6 High sea

02.08

Two oceanographic ADCP moorings were released from 500 meter depth at Walter's Shoals and taken on board Nansen for transport back to Cape Town.

Three locations on Walter's Shoals were sampled using the Van Veen grab.

03-06.08.15

Transit to Durban, one sampling station on the 3rd; CTD/LADCP, Manta trawl, Multinet and CPR. The weather during the transit back to Durban was rough and stormy to the degree that all work regarding the scientific part on board was stopped.

Table 1.5.1 Weather conditions during the cruise period.

Date	temp °C	wind	waves
18.07.15	24	near gale	very rough
19.07.15	22	Gale	very rough sea 4-6 m
20.07.15	20	Gale	very rough sea 4-6 m
21.07.15	21	Moderate breeze	Moderate 2.5-4 m
22.07.15	23	Gentle breeze	Moderate sea 1.25-2.5
23.07.15	24	Gentle breeze	Moderate sea 1.25-2.5
24.07.15	22	Near Gale	Rough sea 4-6 m

25.07.15	24	Near Gale	Rough sea 4-6 m
26.07.15	24	Fresh breeze	Rough sea 4-6 m
27.07.15	20	Strong breeze	Rough sea 4-6 m
28.07.15	24	Gentle breeze	Rough sea 4-6 m
29.07.15	24	Gentle breeze	Moderate sea 1.25-2.5
30.07.15	19	Near Gale	Rough sea 4-6 m
01.08.15	14	Storm	High sea 6-9 m
02.08.15	17	Moderate breeze	very rough sea 4-6 m
03.08.15	18	Light breeze	Rough sea 2.5-4 m
04.08.15		Storm	
05.08.15		Storm	
06.08.15			
07.08.15			
Range	14-24	Light breeze -Storm	1-9m

1.6. Surveyed areas

Two locations on the Madagascar Ridge was chosen for this special study. The Northern location on the Madagascar Ridge was a seamount at position 26°55.241S and 46°13.728E within the EEZ of Madagascar and southern part was the Walther Shoals at position 33^{o} 10’S and 43^{o} 53’E, in international waters (Figure 1.6.1). In each location two transects across the seamount/shoal starting from the lower plateau on the eastern side (across the eastern slope, across the plateau/peak, down the western slope) to the lower plateau on the western side.

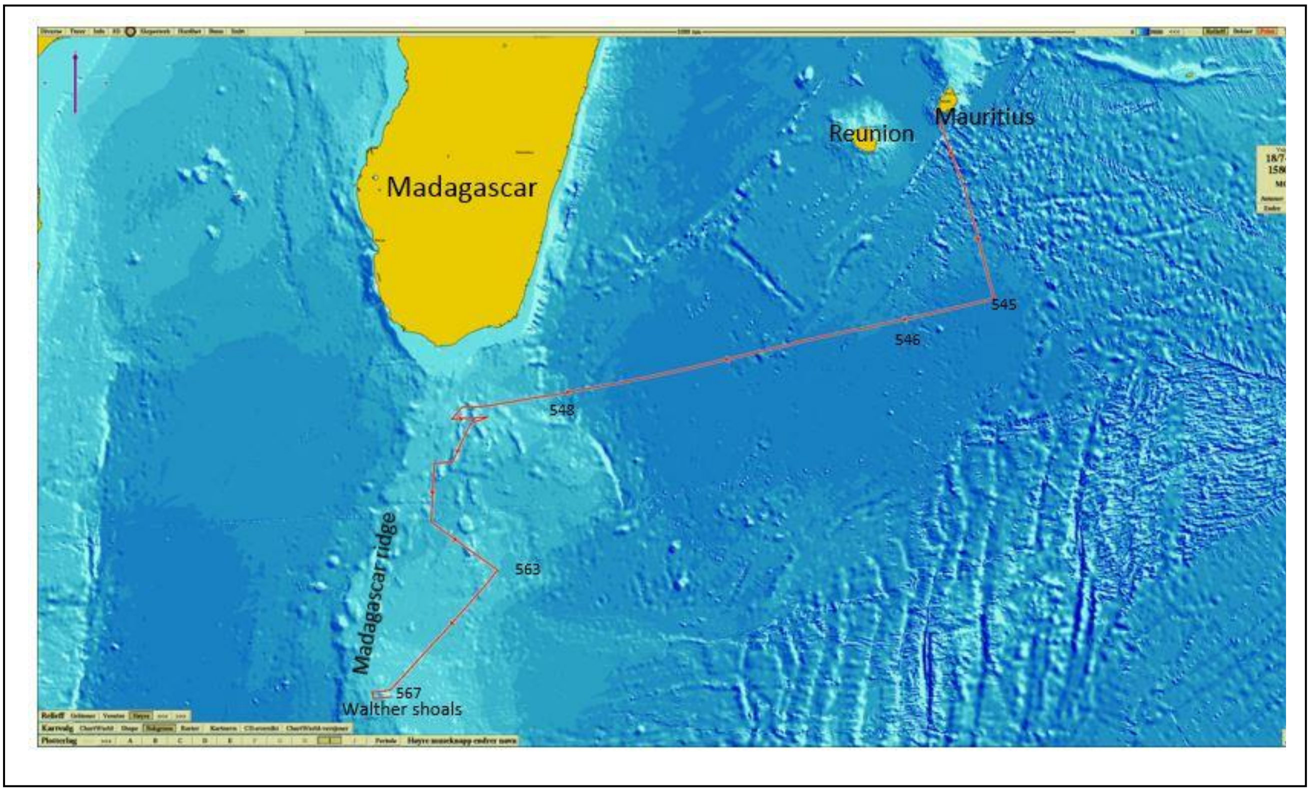


Figure 1.6.1. Sailing route, Indian Ocean (IO) part II (From Port-Louis, Mauritius, through Madagascar Ridge to Durban, South Africa)

1.7 Survey effort

The following is an overview of the number of stations and collected samples (Table 1.7.1). As mentioned in 1.5 the cruise consisted of two station types: **Station type 1:** CTD, water sampling, Multinet, Manta-trawl, collecting LADCP data for current measurements and interpretation. **Station type 2**: VAMS (Video Assisted Multi Sampler) or Van Veen samples in addition to the other parameters.

The CPR (Continuous Plankton Recorder) was towed between stations. An overview of how the different stations relate to each other in time and space is given in Annex: 3A.

Table 1.7.1 Collected samples.

Gear	Stations	Sample type	Amount	Preservation	Holder	Institution	Country	Level of prosessing	Deadline
CTD.	28	Nutrients	224	Chloroform 2‰	Tom Bornman	Grahamstown	ZA	Not processed	
		Chl.A	109	frozen	Tom Bornman	Grahamstown	ZA	Not Processed	
		ADCP	28	(Data series)	Karen Sivertsen	UIB	NO	Completed	2 weeks
Mantatrawl	29	Plastic	87	None	CDCF	IMR	NO	Not processed	
		Neuston	27 *	Formaldehyde 4%	CDCF	IMR	NO	Not Processed	
Multinet	19	Zooplankton	83	Formaldehyde 4%	Zo Rasoloarjao	UWC	MA/ZA	Not processed	5 Months
		Plankton weight	83	Dried	CDCF	IMR	NO	Completed	
Grab/Vams	13	Macro fauna	22	Formaldehyde 4% / eth. 96	Asma Damon	UWC	ZA/IMR	Not processed	
		Chemical comp.	3 (set)	frozen	CDCF	IMR	NO	Not processed	
		Grain size	3						
		Video	3	None	Lindsey Beazly	DFO / IMR	CA/NO	Not processed	
CPR.	17	Zooplankton	17	Formaldehyde 4%	Bradley Blows	Oceans Africa	ZA	Not processed	DEA

WP2	5	Zooplankton	9	Formaldehyde 4%	Zo Rasoloarjao	UWC	MA/ZA	Not processed	5 Months

2 METHODS

2.1 Meteorological and hydrographical sampling

Meteorological data including wind direction and speed, air temperature and sea surface temperature (SST) are logged automatically into the system using a WIMDA meteorological station and averaged by every nautical mile distance sailed.

2.2 Hydrographic sampling

One of the objectives of the cruise was to gather physical and biogeochemical data in order to gain a better understanding of the properties of the Indian Ocean. The Indian Ocean in general has been under-sampled within the last few decades, and numerous questions remain about the variability of the biogeochemical cycle.

2.2.1 CTD profiles

CTD profiles was deployed on all planned stations except one due to weather conditions. The Seabird 911 CTD Plus was used to obtain vertical profiles of temperature, salinity, oxygen and fluorescence. Real time plotting and logging was conducted using the Seabird Seasave software installed on a computer. The profiles were taken down to a few meters above the sea floor. The CTD data has been post processed in the Quick cast database and displayed with the software package Ocean Data Viewer.

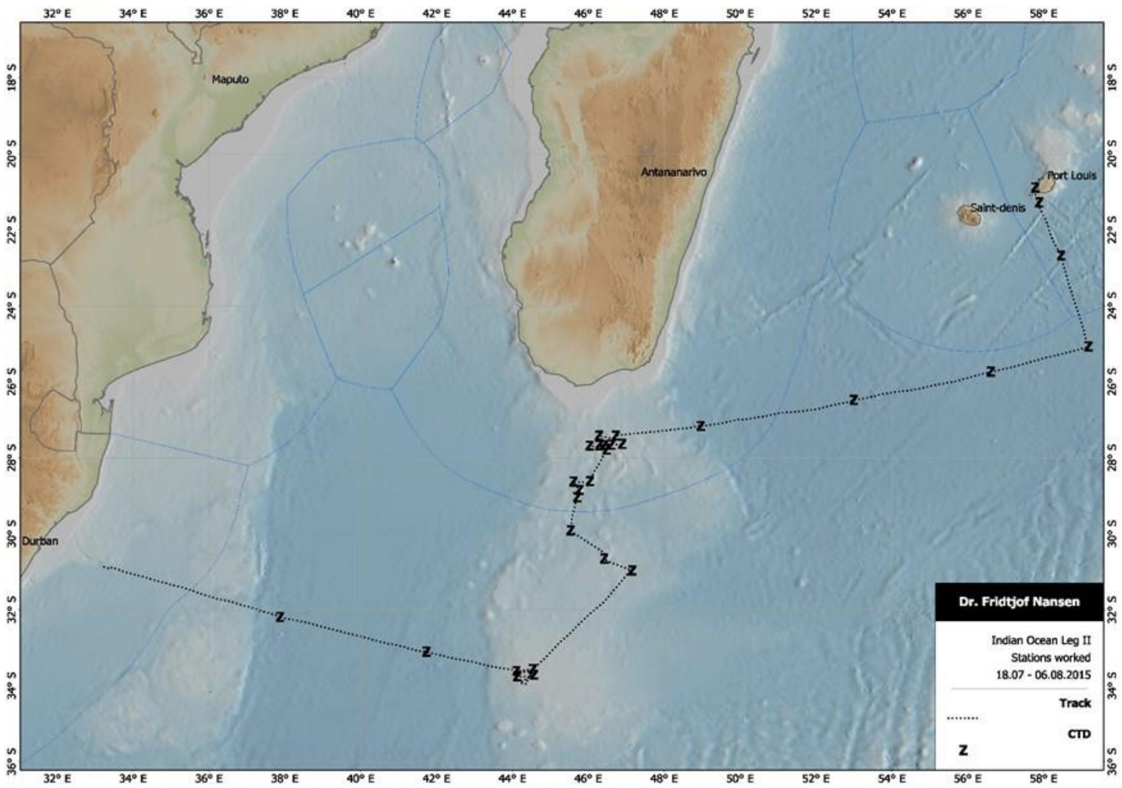


Figure 2.2.1: Map showing CTD stations

The SBE 21 Seacat thermo-salinograph has been running continuously during the survey, collecting data for salinity and relative temperature, at 5 m depth every 10 seconds. An attached in-line Turner Design SCUFA Fluorometer was used to supplement these data with the underway measurements of Chlorophyll-a levels [RFU] at 5 m below the sea surface during the entire cruise. The instrument was configured with a bright blue photodiode, a 420 nm Excitation filter and a 680 nm emission filter. It was calibrated against the secondary orange standard dye. The maximum output was equivalent to 5 Volt = 100%. It had a linear temperature compensation of 2.14% per °C. The water from the CTD mounted Niskin bottles were used for:

- Sampling of nutrients
- Filter samples for Chlorophyll *a*

2.2.2 Lowered Acoustic Doppler Current Profiler (LADCP)

A Lowered Acoustic Doppler Current Profiler (LADCP) was used to measure the current profiles at the various stations (Fig. 2.3.1) of the survey.

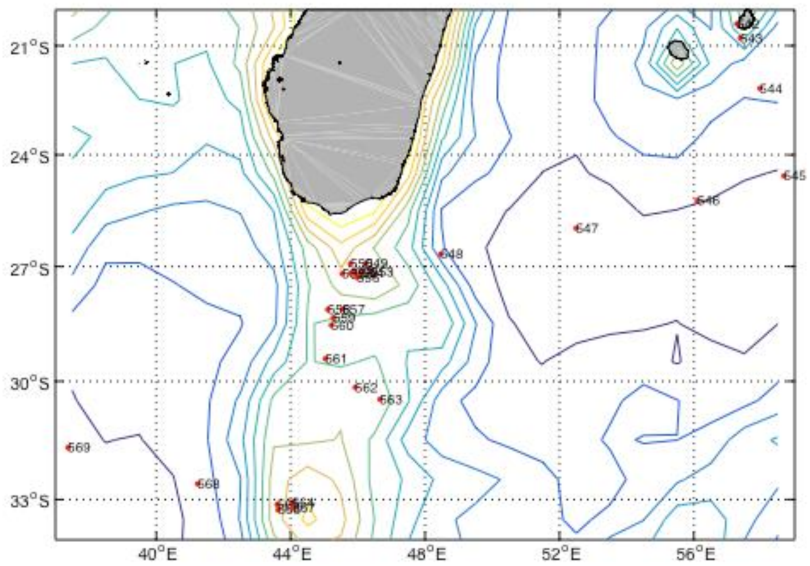


Figure 2.2.2: Map of stations where CTD and LADCP profiles were conducted (except LADCP data from station 543). Bathymetry lines for every 500m are shown.

As the name implies the Lowered Acoustic Doppler Current Profiler (LADCP) uses the principle of Doppler Shift to measure the velocity and direction of ocean currents. Unlike the more common shipborne (vessel-mounted) ADCP, fixed at the ship, the LADCP is attached to the CTD rosette and follows the down- and up-cast at every station.

Two 75/150/300 kHz Teledyne/RDI ADCPs are attached on the CTD rosette, one up-looking and the other down-looking. Each ADCP has four beams, spread out 90 degrees around a circle, which emit and receive sound waves or pings. As the sound waves reaches particles in the water column, assumed to flow with the currents, they get backscattered to the ADCP. If the particle has a velocity relative to the CTD rosette the backscattered sound waves will be Doppler shifted. For currents moving away from the ADCP the frequency of the backscattered sound waves will be lower and for currents moving towards the ADCP the frequency will be higher. The change in frequency is proportional to the speed of the currents. Opposite beams work as a pair and the current velocity is measured along the beams leading to a vertical and horizontal velocity component for each orthogonal beam pair. The two horizontal components are now in instrument coordinates. The average of the two vertical components is the vertical velocity, the difference of the two vertical components is called the error velocity and is used as a measure of consistency.

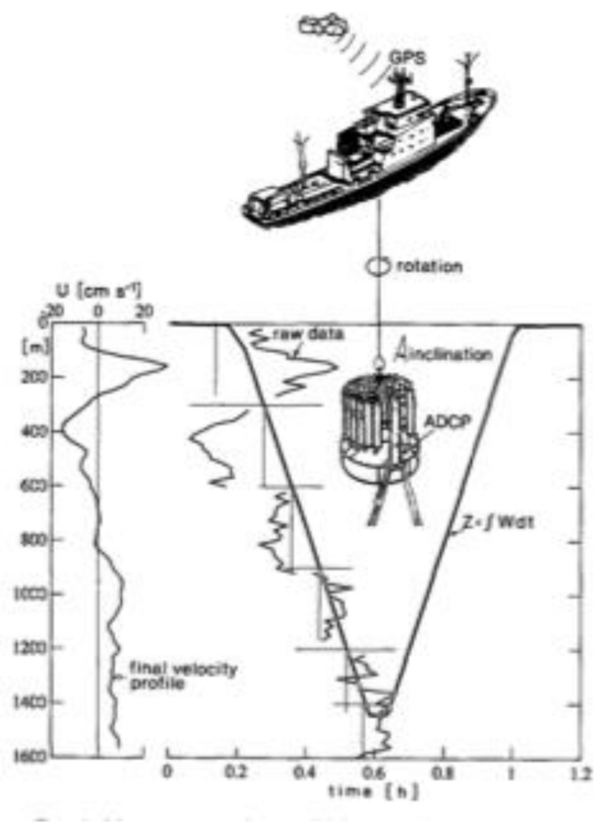


Figure 2.2.3 LADCP measurement and processing scheme. Right: Scheme of the depth-time diagram with individual raw velocity profiles. Left: final absolute velocity profile. Adapted from Fischer and Visbeck (2002).

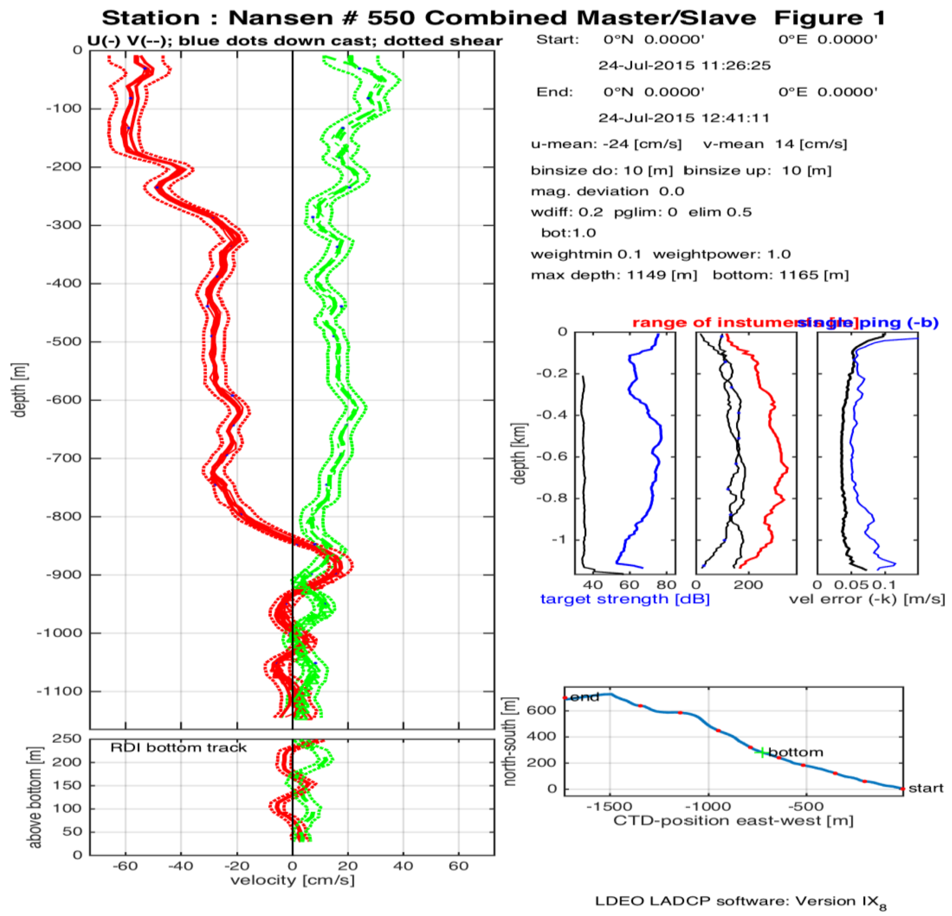
The CTD/LADCP instrument package moves during down and up cast. This means that the ADCP does not always measure the true ocean velocity but a combination of ocean currents and the movement of itself. Motions of the instrument package include vertical motion (lowering speed), horizontal motion (ship drift), inclination/tilt (pitch and roll) and heading (rotation) (Fig. 2.2.3). The lowering speed is known, ship drift can be monitored by navigation (GPS), two perpendicular tilt sensors measure pitch and roll angles and the heading is measured by a flux gate compass (Fischer and Visbeck, 1993).

These factors must be compensated for to transform from beam coordinates to earth coordinates. To find the true ocean velocity two processing methods are used: the velocity shear-based method and the linear inverse method based on least square fit. Both the down-looking and up-looking instruments have a range of 40 bins, the bin length is 10m (10.146m) and the ping rate is 1 second throughout each profile. The lowering speed was set to 0.5ms^{-1} except at station 542 where it was 1ms^{-1}. Bottle stops for water sampling do not affect the LADCP data quality (Thurnherr *et al.,* 2008). Data of each profile contain the three velocity components in earth coordinates plus the so-called error velocity (Fischer and Visbeck, 1993).

After the effects of the instrument motion have been removed, additional constraints must be used to reference the velocities. Every LADCP cast begins and ends at the ship's position and this can be used to constrain the mean horizontal velocities, as we know the ship's drift from navigational records. When the down-looking ADCP is within the acoustic range of the seabed, the instrument velocity over the ground can be tracked and constrain the LADCP profiles near the seabed. (For vessels with shipborne ADCP, data from this can be used as a constrain for the LADCP profiles near the sea surface.) The processed profiles of the zonal and meridional velocity components for station 550 and 561 (Fig. 2.2.4) with bottom track reference are displayed with different solutions (best fit, shear solution, separate up- and down-cast solution).

One can also follow the position of the instrument package. The profiles have been through the following data processing using the LDEO software: velocity scaling as the transformation from the raw Doppler frequencies to velocity units depends on the sound speed which depends on temperature, depth and salinity; bottom detection as the bottom is assumed to have no motion; derivation of instrument depth by time-integrate the vertical velocity; raw velocity shears are used as the instrument velocity contribution has no vertical shear in an individual profile and vertical differentiation of the horizontal velocities rejects this unwanted motion; editing by removing bad data e.g. when the signal to noise ratio is too big, data too close to the instrument or data where the pitch and roll angles are too large; mean shears are vertically integrated to obtain relative velocities; determination of the absolute velocity profile by reference to known velocities. The data from the different solutions are saved in matrices for further analysis.
Station 550 and 561 (Fig. 2.2.4) was chosen as they are shallow enough for the LADCP to sense the bottom topography, and hence the bottom track solution is included. They are also representatives

for each of the sections defined: the transit from Mauritius to the Madagascar ridge (section B), and the north-south transect over the Madagascar ridge (section C). By combining current data from the LADCP with the hydrographic data from the CTD, changes in current direction and speed throughout the profile can be linked to different water masses. Typical properties for known water masses in this area, compare well to the structures of the velocity components, and are recognisable even after scaling.



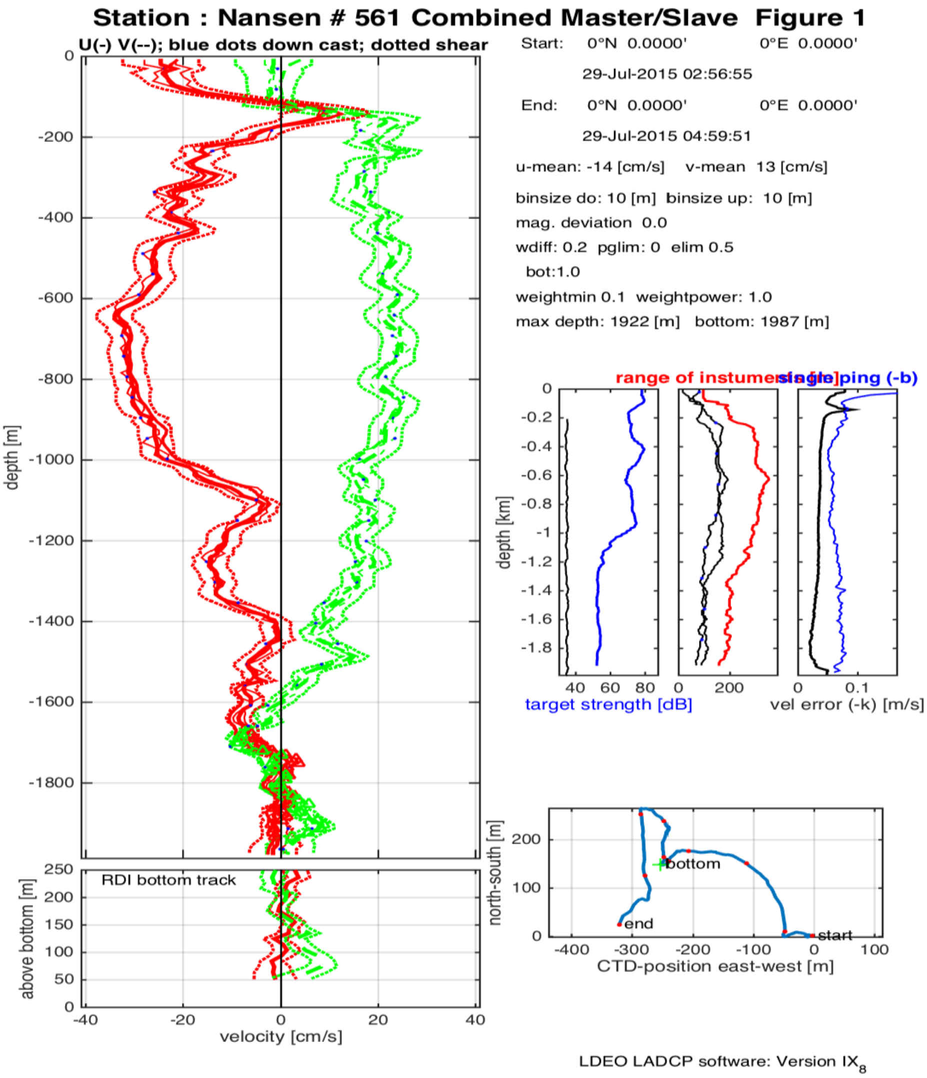


Figure 2.2.4 Left: Velocity profile from processed LADCP cast without GPS data from (a) station 550 and (b) station 561, with zonal velocity component (red line) and meridional velocity component (green line). Thinner lines show the down- (blue dots) and up-cast solutions. Dotted line is the shear solution only. Triangles show what depths that are referenced to the bottom track. Bottom left: Bottom track velocities. Bottom right: Start and end position for the CTD/LADCP package.

2.3 Sediment sampling and video analysis

2.3.1 VAMS

The Video Assisted Multi Sampler (VAMS) was developed to improve the sampling technique in terms of visual inspections, reliability, speed, accuracy and the ability to carry an array of relevant sensors. The current version of the VAMS can operate to 2500 meters' depth and collect 8 parallel sediment samples on one dive, in addition to various sensor outputs, high resolution video and still pictures from the Seabed.

The VAMS consist of a sampling platform with hydraulic operated grabs, current meter, CTD and sonar. An ROV with a 30 meters' umbilical is integrated in the sampling platform. The ROV is equipped with a HD camera for documentation, guidance and visual inspection of the sampling. It has also been used for habitat characterization in the vicinity of the sampling platform. The Video Assisted Multi Sampler (VAMS) was deployed on three occasions during the EAF-Nansen Indian Ocean II mission (see Table 3.4.1 and Figure 3.4.1). The first two deployments, termed VAMS 01 and VAMS 02, were made on the southern Madagascar Ridge at 841 and 1480 m depth, respectively. The third deployment (VAMS 03) was made at 793 m depth on Walters Shoal.
During live collection of the video transects, motile and sessile fauna were recorded as they were observed from the video footage using an IMR software program called 'CAMPOD Logger'. This system allows the user to enter information on the biology (e.g. taxonomic identification) of the organisms observed, and any associated comments. Each biological entry stored in CAMPOD logger is associated with the video time stamp and ship's latitude and longitude. Effort was made to record fauna only during the 'transect' mode (e.g. recording of east, west, north, and south transect lines), however, any interesting or unique fauna were occasionally recorded when the ROV was in 'explorer' mode. The video transect was conducted with the ROV from the center platform out to 15 meters in four directions N, S,E and W, a total of 120 m^2 for each station. All information about the sampling and the samples are recorded in a sampling journal recording all relevant information about the process.

2.3.2 Benthos, sampling and sample treatment

The samples were either collected using a long armed Van Veen grab or the grabs mounted on the VAMS. Once the sampling equipment was landed on deck and secured the surface water was drained, the volume measured and the sample validated in terms of volume, undisturbed surface and leakage. The drained water was sieved to obtain fauna from the drainage water. The surveyed area for sediment sampling and habitat mapping stretched along the Madagascar ridge from 26°55.241S and 46°13.728E degrees in the north to the Walter Shoals at 33°12.916S and 44°04.257E in the southern part and consisted of 13 stations. The water depths were in the range of 79-2487 m.

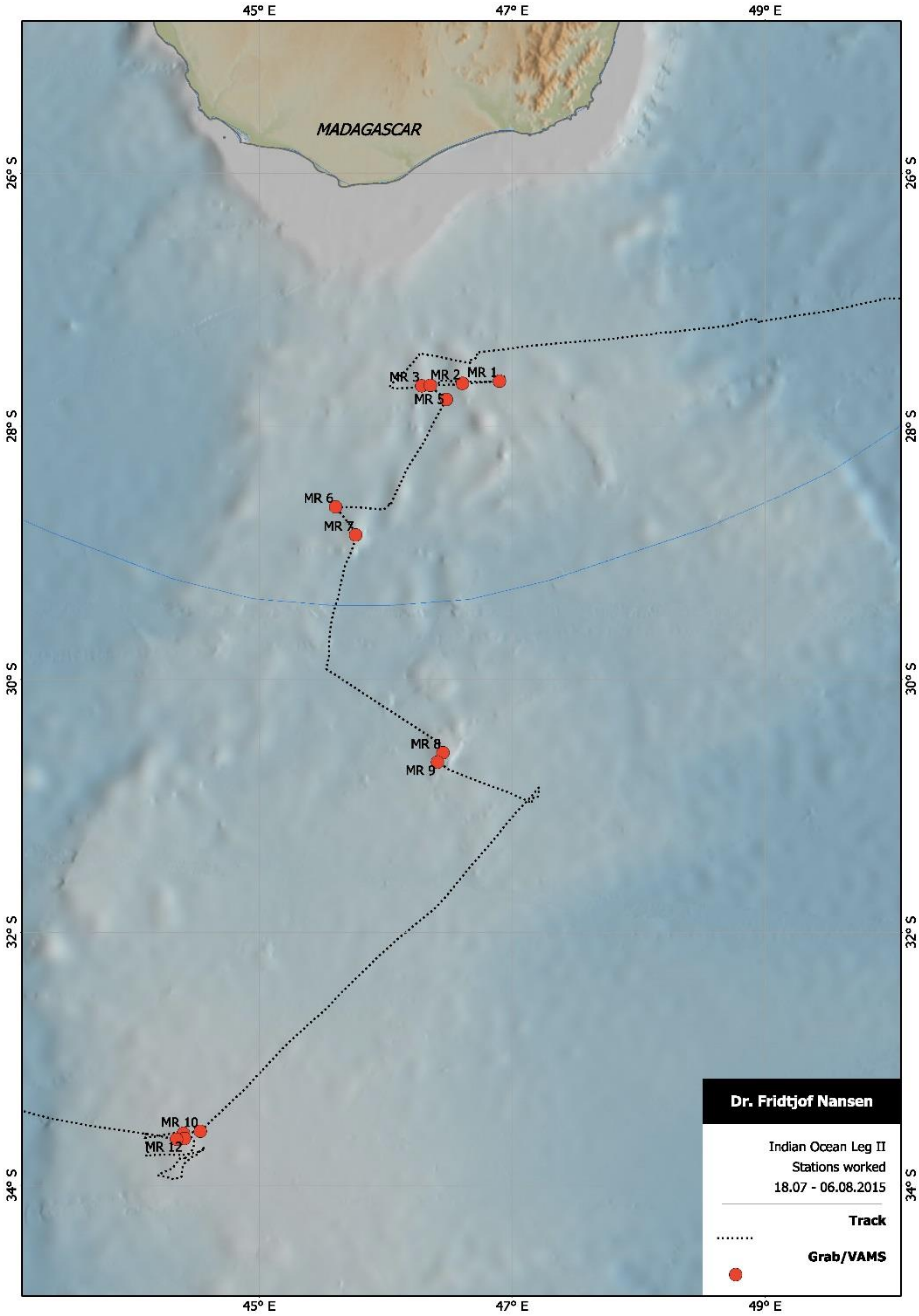


Figure 2.3.2. Location of the Video Assisted Multi Sampler (VAMS) deployments and grab stations on the Madagascar Ridge and Walters Shoal.

The material for biological samples was washed and sieved carefully through a descending set of sieves (1 mm and 0,3 mm). RSW (refrigerated sea water) was used to provide an ideal temperature for washing the deep water samples. After sieving, the material left in the sieves were carefully transferred to containers and fixed as soon as possible in either pre-buffered[1] formaldehyde solution at 4%[2] (Diluted in sea water) or preserved in (70) 96% ethanol. Samples preserved in ethanol can be used for genetic analysis (bar coding). (70 % ethanol were used on Sipuncula and Priapulida.

The sieves were washed carefully between each sample to avoid contamination. The containers were filled to a maximum of 2/3 sediment filling to ensure adequate formaldehyde/ethanol concentration for fixation/conservation. The samples preserved in ethanol, had the ethanol changed within a 24 hours' period to ensure good quality for DNA analysis. The samples were then labelled with the station notation, date, depth, sample number and number of containers (1/X-X/X), and stored in boxes labelled with the contents. The container was then placed in a transparent plastic bag with the label inside facing out for easy identification, an additional label was placed in the inner cap of the container or inside the container. A sample inventory was also made.

Samples for chemical analysis was collected with a special spatula from the upper centimetre of the sediment surface. The samples were bagged in Rilsan bags and labelled with station notation, date, depth and sample number and stored in the ships fridge before shipment on dry ice to Norway for analysis. Samples for sediment composition and organic matter were also collected from the upper centimetre of the sediment labelled and frozen. All information about the sampling and the samples are recorded in a sampling journal containing all relevant information about the process (Annex I).

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[1] Borax is added to formaldehyde to raise the pH of the sample, preventing the dissolution of calcified structure or other tissues. Approximately, 1 ss (soup spoon) is added for each liter of 4 % formaldehyde.

[2] To ensure the sample final concentration is 4 %, might be useful to make the formaldehyde solution at 8 %. As such, you can fill the container up to half and fill the other half with the formaldehyde at 8 %. This will reduce the fixation to 4 %.

2.4 Zooplankton sampling

2.4.1 Multi-net

Zooplankton were collected with a Hydro-Bios Multinet (Anonymous 1990) at 19 stations throughout the cruise (see Annex IV for details). The Multinet has a square mouth-opening area of 0.25 m^2, 5 nets of mesh-size 180 μm, a pressure sensor, and two electronic flowmeters mounted inside and outside the net-opening (Figure 8). Each haul provides 5 depth-stratified samples. The Multinet samples were collected obliquely during upcast, with the typical towing speed of the net being 2knots/hour as measured by the flowmeter inside of the mouth-opening Results from the CTD cast were used to determine the 5 standardized sampling-depths which were as follows: 600-400 m, 400-200 m, 200-100 m, 100m to depth-of-thermocline, and depth-of-thermocline to 0 m.

After each haul, jellyfish were removed before splitting the sample and their volume measured, in some cases the individuals were photographed. The sample was then split in 2 equal parts: one half was fixed with 10 ml 40% formaldehyde and borax in a 100ml plastic bottle giving a concentration of approximately 4% formaldehyde for taxonomy analysis. The remaining half, to be used for biomass estimates were sieved through 3 sieves (2000,1000,180µm) and dried (at approx. 70ºC) on pre weighted and labelled aluminium trays for ca. 24h. Large organisms as krill and fish from the 2000µm fraction were placed on separate trays. The numbers of the trays, and which samples and size fractions each tray represent were noted in the Zooplankton survey log. These sample treys were shipped back to Bergen to be measured on the scale they were originally calibrated to get an accurate estimate of the dry weight.

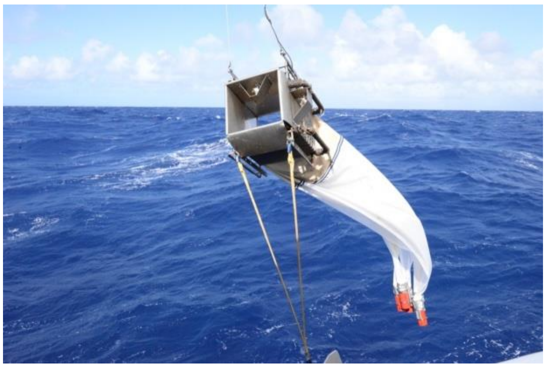


Figure 2.4.1.1. Deployment of the HYDRO-BIOS Multinet from *Dr Fridtjof Nansen*.

In addition, neuston samples were obtained ad hoc from the Manta trawl (see description in Micro plastics section). Alternate stations were fixed in formalin and 96% ethanol. In total, around 30 samples were collected along the cruise transect. This enables subsequent identification and possibly quantification of zooplankton inhabiting the surface waters of the southern Indian Ocean.

2.4.2 WP2-net

In addition, the WP2-net (opening diameter 0.56 m, mouth-opening area 0.25 m2, mesh-size 180 µm) (Frazer 1966; Anonymous 1968) was applied at 5 stations when weather conditions were too rough for the Multi-net. The WP2-net was hauled vertically from 600 – 0 m and from 100-0 m with a speed of ca. 0.5 ms-1. These samples were fixed with 10ml 40% formalin and med borax on 100 ml plastic bottles for taxonomy.

2.4.3 Continuous Plankton Recorder (CPR)

During transits a CPR was towed at approx. 10 knots speed. The main transits were: 1) Mauritius to Walther Shoals (11 days) 2: Walther Shoals to Durban (3 days). The CPR is a plankton sampling instrument that was designed to be towed from merchant ships on their normal sailings in the 1920's. Time series using this instrument goes back to the 1925 when the first prototype was used by Allister Hardy sampling krill in Antarctica (1925 -27) and the design has been more or less unaltered since 1946. The CPR was deployed in the North Sea regularly from 1946, on a number of routes. the CPR survey's methods of sampling and plankton analysis remain unchanged since 1948.

The CPR is about one meter in length. The body is made of gunmetal, (phosphor bronze), or stainless steel in later versions from 1997. The nose cone is filled with lead. The tail section is made of mild steel which is rust proofed. The CPR is towed on a 10mm diameter wire rope at a depth of about 10 meters. The wire is connected to the CPR nose via a shock absorber. The CPR was operated at around 10 knots. Its robust design allows deployment in rough seas without fear of excessive damage. Successful tows have been continued through sea states of up to wind force 11. Deployments and recoveries have been made in wind force 8 conditions from larger merchant ships. Each CPR is now fitted with a fender to reduce the risk of damage on deployment and recovery.

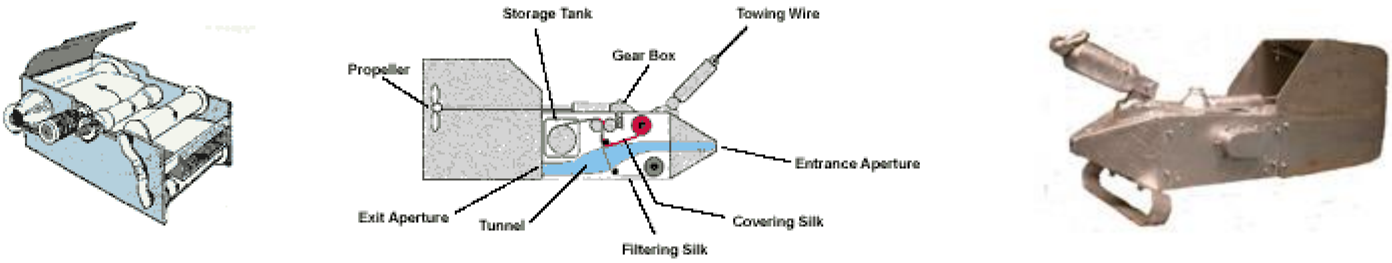


Figure 2.4.3.1: CPR equipment

The CPR works by filtering plankton from the water over long distances (up to 500 nautical miles) on a moving filter band of silk (270-micron mesh size). The filter silk band is wound through the CPR on rollers turned by gears, which are powered by an impeller. The silks and plankton are then spooled into a storage tank containing formaldehyde. On return to the laboratory, the silk is removed from the mechanism and divided into samples representing 10 nautical miles (19 km) of tow. The cut away diagram shows the layout of the plankton filtering mechanism (sometimes described as the 'internal mechanism' or 'cassette') and the impeller.

The internal mechanism is a self-contained cartridge that is loaded with the filtering silk at the laboratory and placed inside the CPR prior to deployment. On some tows, the ships are supplied with several internal mechanisms, which they load into the CPR to increase the sampling range. On return to the laboratory, the silk is removed from the mechanism and divided into samples (known as blocks) representing 10 nautical miles of towing. The plankton on these samples are then analyzed according to standard procedures.

Before cutting, the color of the silk is compared to a color chart and given a 'greenness' value of 0 (no greenness), 1 (very pale green), 2 (pale green) or 6.5 (green). Other colors are not recorded. This is a subjective analysis, with arbitrary values returned, but it can be the first indication of phytoplankton blooms on our samples.

After cutting into blocks, microscopic analysis of the plankton contained on the sample is undertaken. A subsample of the block is examined under high power magnification to identify and count phytoplankton species present. (the sub-sample is about 0.001 of the whole sample). This analysis is known as 'Phytoplankton field analysis'.

Another sub-sample analysis for small zooplankton is then carried out under a lower magnification, where all individuals seen in a traverse of the silk are identified and counted. (This sub sample is about 0.02 of the whole sample). This analysis is known as 'zooplankton traverse analysis'. The last part of the analysis process is that all zooplankton larger than about 2mm are identified and counted from the whole sample. They are spotted by eye, but identified under the microscope. This is known as 'zooplankton eye count analysis'.

The zooplankton samples will be analysed by IH.SM in collaboration with the Department of Environmental Affairs, South Africa. A more comprehensive estimation of zooplankton bio-volumes and taxonomic work will be performed through this collaboration.

2.5 Sampling of plastic and micro plastic particles

Micro plastics were collected from the sea surface as well as at the subsurface waters. Micro plastic collection was carried out at 29 stations (Figure 2.5.1) in triplicate for 15 minutes at 2-3 knots (depending on the weather condition). The main gear used was the Manta-trawl, which samples the surface layer. The Manta Trawl has a mouth opening of 70x20 cm and is fitted with a 375 µm mesh size net. Once the trawl was brought onboard, the sampled material including plankton and micro plastics were transferred to a sieve with pore-size 200 µm. The sample was scrutinized under a microscope and particles assumed to represent micro plastics was sorted out and classified according to size, shape, color and texture.

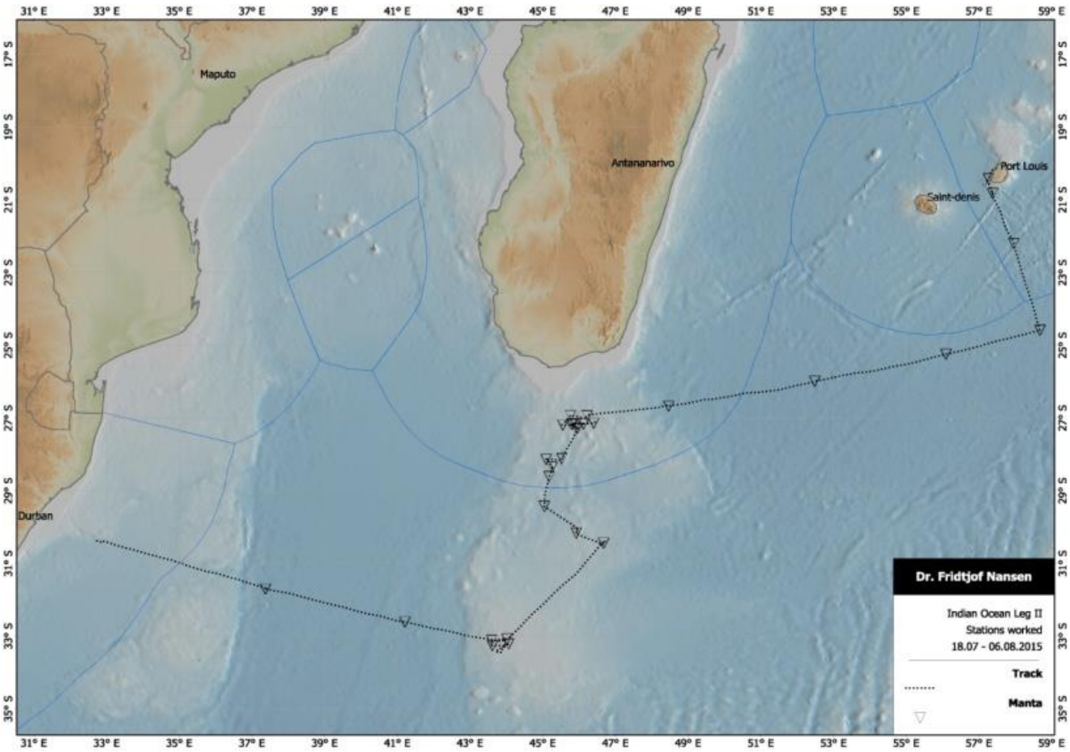


Figure 2.5.1 Manta trawl stations. Manta trawls were taken at 29 stations (3 x 15 minute's towing time per station) during the survey.

The following procedure was applied for the collection of micro plastic:

i. Micro plastic samples were collected with the Manta trawl in triplicate at each stations.
ii. Once onboard, the sample was sieved through a stainless steel sieve with pore-size 180 µm.
iii. The sample was then scrutinized under the microscope and all particles that seem to be micro plastics were sorted out depending on size, shape, color and texture.
iv. After microscopy classification, the particles were deep-frozen.

2.6 Single beam acoustic sampling

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. The survey was started without *a priori* calibration.

Acoustic data were logged and post-processed using the latest acoustic data post-processing software, the Large Scale Survey System (LSSS) Version 1.25. The technical specifications and operational settings of the echo sounder used during the survey are given in Annex I.

2.7 Multi-beam echo sounder for bottom mapping

The R/V Dr. Fridtjof Nansen is equipped with the Kongsberg Maritime EM710 multibeam echo sounder with positioning and motion data from Seapath 200. The positioning system mounted is Fugro SeaStar. Seabed Information System (SIS) software will be used for online logging and echo sounder control. Post-processing of data will be performed using Neptune, which is also used for the calibration of the EM710.

2.7.1 Seabed Information System (SIS)

SIS is used for the online operation of Kongsberg Maritime multibeam echo sounder systems. The application is used by the operator to control all settings and logging during the survey.

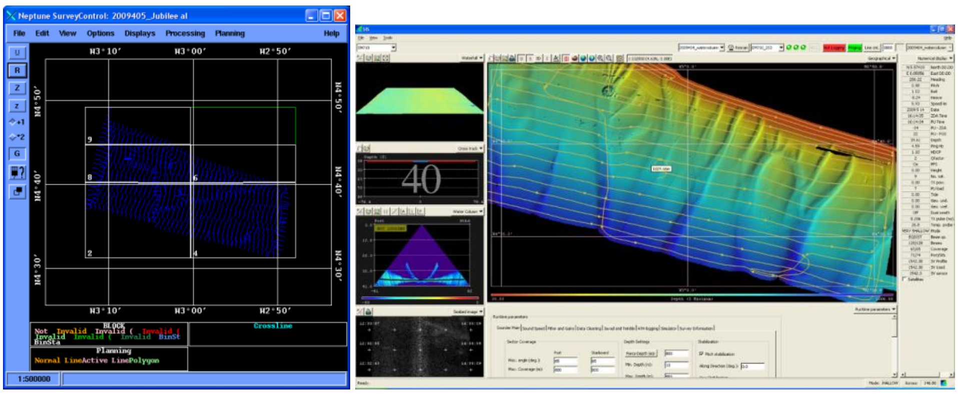


Figure 2.7.1.1. Screenshot from the Seabed information system

2.7.2 NEPTUNE – Post Processing

Prepared raw data from SIS are processed using Neptune post-processing software. All depths are corrected for tidal influence using post-processed GPS data and reduced to mean sea level.

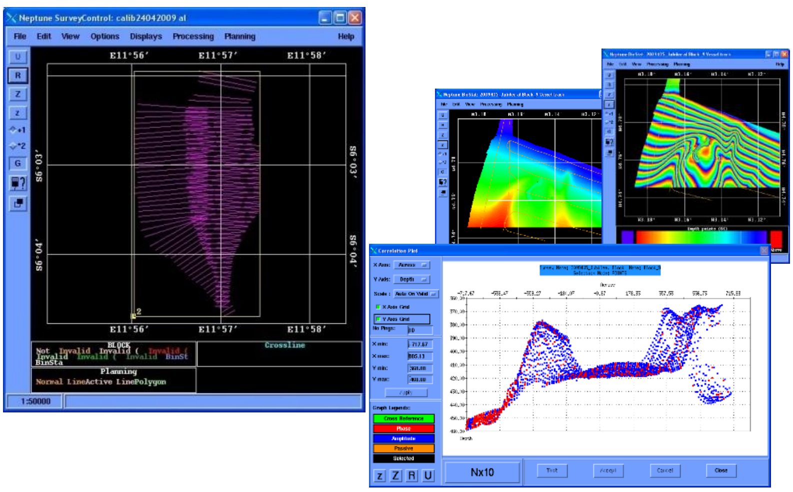


Figure 2.7.2.1. Screenshots from Neptune Post-processing software

After tide correction, spurious soundings are removed/flagged invalid using the BinStat module. Cleaned accepted data are exported to ASCII files as formatted as latitude, longitude and depth. In addition, mean depths are exported for each processing cell (30x30m). Fledermaus – Visualization. Exported ASCII data can be imported into Fledermaus visualization and DTM software.

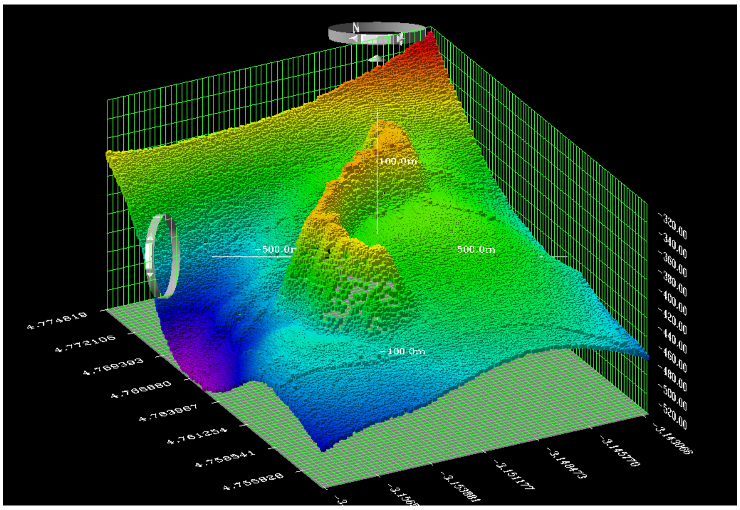


Figure 2.7.2.2. Visualization of details in benthic structure by use of the software Fledermaus.

The vessel is not equipped with a functional transceiver, HiPAP system to receive navigation signals from the VAMS for underwater positioning. She also lacks dynamic positioning. This will limit the accuracy of positioning of the vessel and make operations in rough weather and strong currents challenging.

3 SURVEY RESULTS

3.1 Hydrography

The CTD stations are presented in hydrographic sections to display layers of different water masses that will help detect a current system. From the map of CTD stations along the survey track (Fig. 3.1) four sections are chosen along the straighter transects among the stations. Section A is starting at Mauritius and going south. Section B is along the transit from south of Mauritius to the Madagascar ridge. Along the Madagascar ridge some, more or less evenly spread, stations are selected as section C. Finally section D is set on the transit from Walters Shoal to Durban.

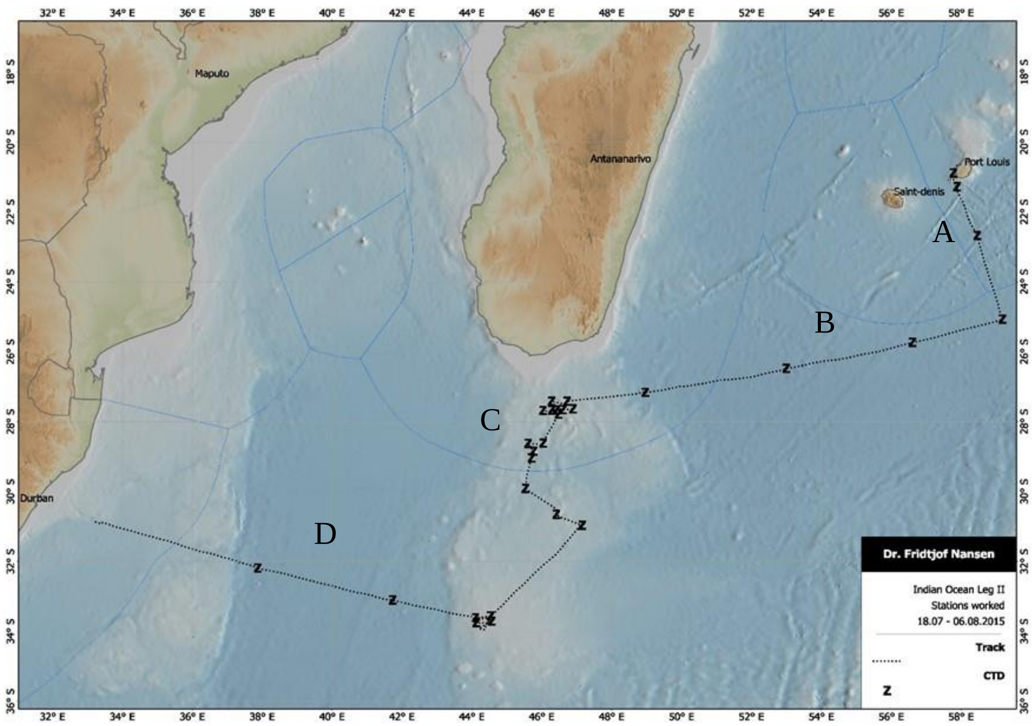
Stations making up the four sections:

Section A (from north to south): 542, 543, 544, 545

Section B (from west to east): 551, 555, 552, 554, 553, 548, 547, 546, 545

Section C (from north to south): 549, 554, 556, 557, 559, 560, 561

Section D (from west to east): 569, 568, 565, 567



Map. 3.1 Map showing the CTD stations and the course track.

Table 3.1 List of CTD stations, with time and date, longitude and latitude, and depth of the stations.

STATION	DATE	TIME	LON	LAT	DEP	EVENT	REMARK
HD542	7/18/2015	15:08:05	57.2776	-20.3928	1057	H	Section A
HD543	7/19/2015	3:49:09	57.373	-20.7858	3670	H	No LADCP data Section A
HD543	7/19/2015	7:53:20	57.3817	-20.7905	3683	H	Section A
HD544	7/19/2015	21:29:06	57.9637	-22.1818	4717	H	Section A
HD545	7/20/2015	15:15:12	58.6808	-24.5754	5001	H	Section A Section B
HD546	7/21/2015	7:43:21	56.1067	-25.239	4972	H	Section B
HD547	7/22/2015	7:09:48	52.4968	-25.9821	5200	H	Section B
HD548	7/23/2015	8:53:13	48.4621	-26.6715	4300	H	Section B
HD549	7/24/2015	1:41:08	46.2266	-26.9217	1755	H	Section C
HD550	7/24/2015	11:22:43	45.7799	-26.9229	1176	H	
HD551	7/24/2015	16:40:35	45.5336	-27.1891	1287	H	Section B
HD552	7/24/2015	21:56:36	45.9177	-27.1727	1943	H	Section B
HD553	7/25/2015	5:10:31	46.3974	-27.1402	1523	H	Section B
HD554	7/25/2015	19:43:20	46.1053	-27.1612	569	H	Section B Section C
HD555	7/26/2015	1:35:58	45.7861	-27.1791	543	H	Section B
HD556	7/26/2015	22:36:30	45.9798	-27.2895	1953	H	Section C
HD557	7/27/2015	17:32:20	45.5437	-28.1221	2413	H	Section C
HD558	7/28/2015	1:25:30	45.1071	-28.1358	2491	H	
HD559	7/28/2015	10:02:11	45.2656	-28.3539	736	H	Section C
HD560	7/28/2015	17:12:16	45.2077	-28.5465	2856	H	Section C
HD561	7/29/2015	2:50:31	45.0311	-29.4191	2920	H	Section C
HD562	7/29/2015	19:51:53	45.9198	-30.1591	1428	H	
HD563	7/30/2015	4:01:53	46.655	-30.4784	2515	H	
HD563	7/30/2015	5:04:55	46.6578	-30.4663	2512	H	
HD564	7/31/2015	7:57:08	44.0366	-33.0703	796	H	
HD565	7/31/2015	15:40:42	43.5985	-33.122	1028	H	Section D
HD566	7/31/2015	20:26:51	43.6262	-33.2571	990	H	
HD567	1/ 8/15	1:14:50	44.0692	-33.2159	729	H	Section D
HD568	3/ 8/15	5:03:14	41.2336	-32.6096	4875	H	Section D
HD569	4/ 8/15	6:39:59	37.3753	-31.6949	4811	H	Section D

In this area the density profile corresponds to that of temperature, and so is true for section A (Fig. 3.1.1). There is a maximum salinity layer around 400m and a salinity minimum layer around 1000m. An oxygen minimum is found around 200m, the absolute maximum is found around 600m, and the absolute minimum layer is around 1200m.

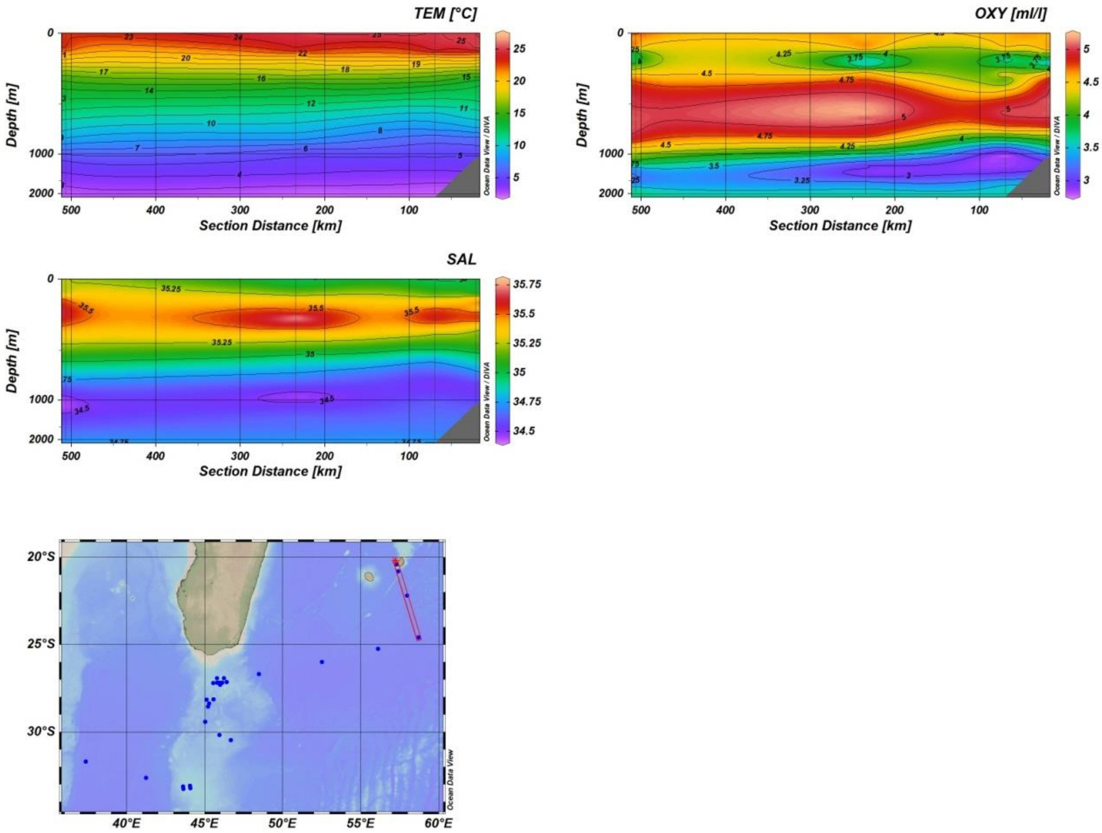


Figure 3.1.1 Section A marked with red in the map. Temperature, salinity and dissolved oxygen sections made in ODW. North is to the right and south is to the left.

In this area the density profile corresponds to that of temperature, and for section B (Fig. 3.1.2) there is a dominant layered structure. The surface layer is less saline in the western part of the section. A salinity maximum is found at 200m depth, and a salinity minimum is found between 900m and 1500m. The dissolved oxygen content is layered with a maximum in the top 100m, a minimum between 100m and 300m, a new maximum layer between 300m and 900m with an absolute maximum for this section around 700m, then there is minima towards the bottom of the section with an absolute minimum tongue from the east between 1300m and 1500m.

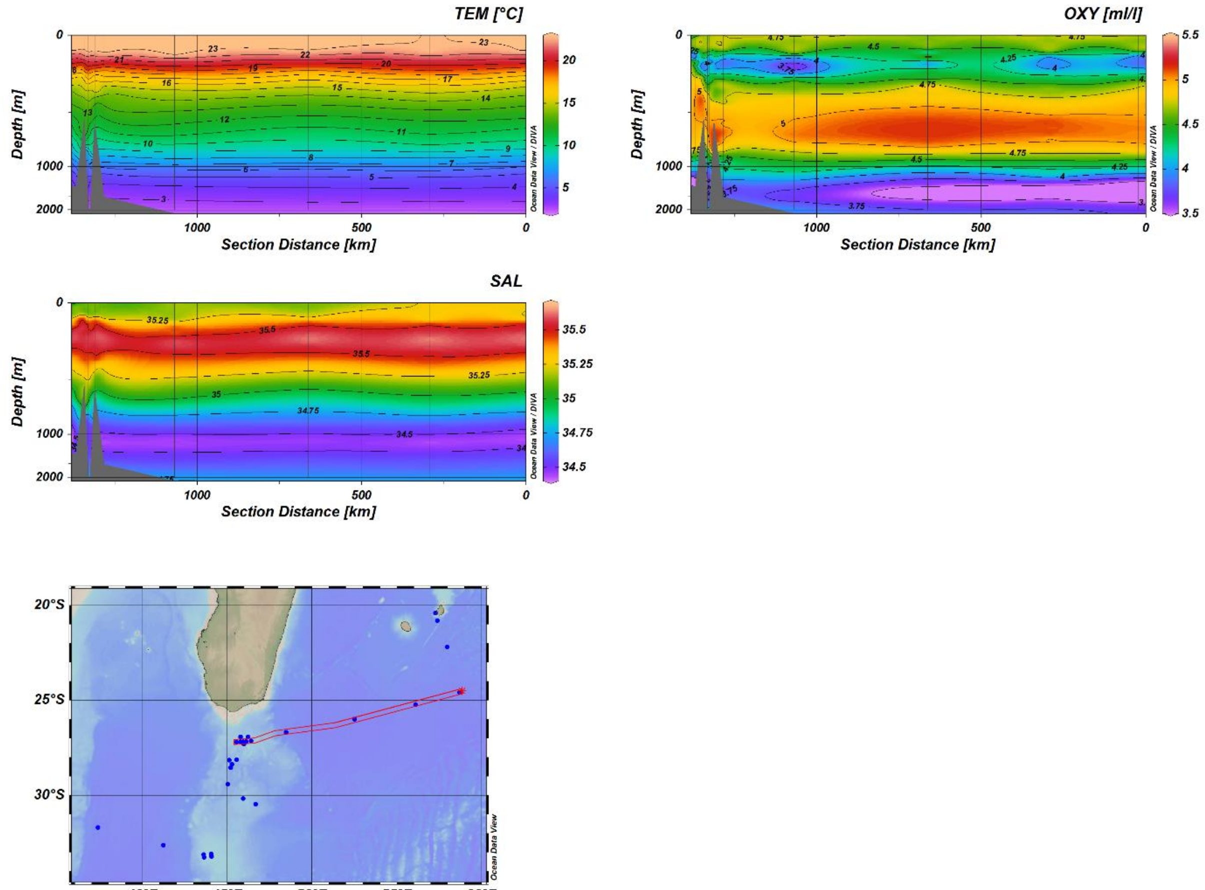


Figure 3.1.2 Temperature, salinity and dissolved oxygen for section B. West is to the left

Section C (Fig. 3.1.3) goes North-South and the surface layer is naturally warmer in the north than in the south. The warmer surface layer also penetrates deeper in the north than in the south. The temperature profile is dominant for the density profile also in this section. In the north there is a salinity maximum around 300m, but in the middle of this section this salinity maximum reaches the surface. The salinity minimum is found around 1200m in the whole transect. Dissolved oxygen varies more in this section. The middle part of the section, around station 557, has a weaker gradient throughout the profile. A minimum is found around 200m and has lowest values in the north. A maximum is found around 700m and has highest values in the south. Another minimum layer is found between 1200m and 1600m in the north and 1500m and 1700m in the south.

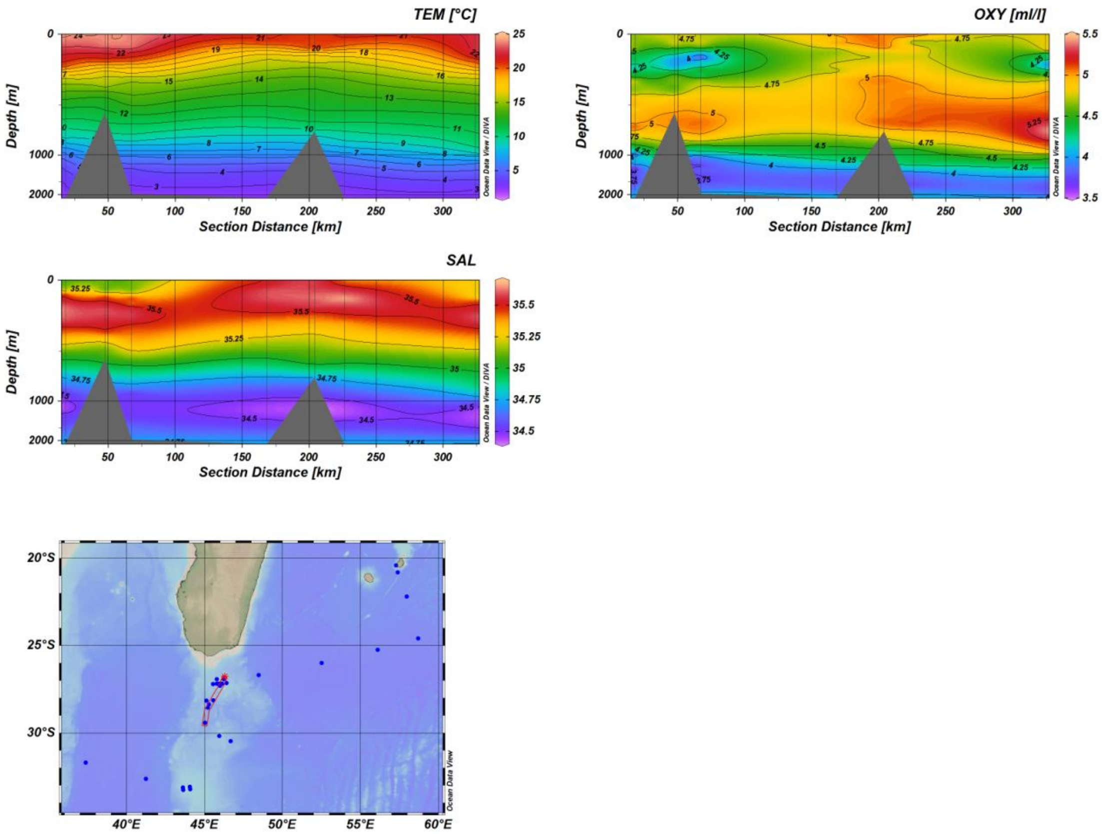


Figure 3.1.3 Section C marked with red in the map. Temperature, salinity and dissolved oxygen sections made in ODW. North is to the left and south is to the right.

Section D (Fig. 3.1.4) also has a layered density structure dominated by the temperature profile. The surface layer is the most saline layer and it is most saline in the eastern part of the section. The salinity minimum is found between 900m and 1600m depth. Section D is more oxygen rich in the eastern part, with the highest maximum in the surface layer and another maximum around 600m. An oxygen minimum layer is found from 100m to 200m in the western part, and the absolute minimum layer starts at 1400m depth and goes down to 2000m.

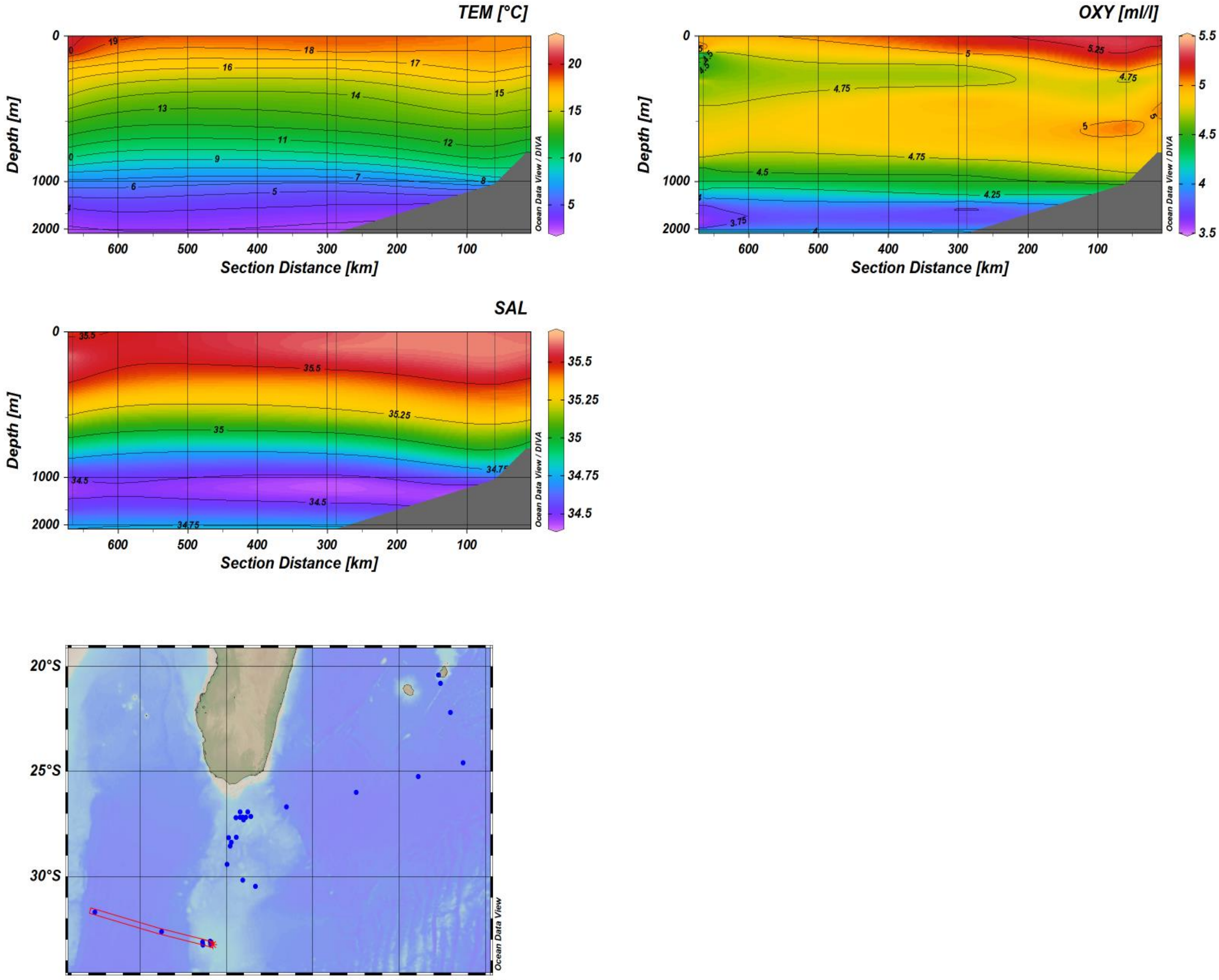


Figure 3.1.4 Section D marked with red in the map. Temperature, salinity and dissolved oxygen sections made in ODW. West is to the left and east is to the right.

Station 550 and 561 are chosen as example stations as their maximum depth is 2000m or less so that there are data from the whole water column. Based on the hydrographic data from station 550 (Fig. 3.1.5) and 561 (Fig. 3.1.6) some water masses with known properties can be identified. Tropical surface water (TSW) is usually found in the topmost 100m in the area south of Madagascar, with a temperature around 23°C, salinity of about 35.1 and an oxygen level of around 4.7 ml/l. Sub-tropical surface water (STSW) has a temperature of about 18°C, salinity of 35.6 with a oxygen minimum and is found around 200-300m depth. South Indian central water (SICW) is found between 400-800m with a temperature of 12°C, salinity of 35.1 and oxygen level of 4.9 ml/l. Antarctic intermediate water (AAIW) has a temperature of about 5°C, salinity of 34.5, oxygen level of 4.1 ml/l, and is found around 1000m depth. Density is almost solely depending on temperature in both stations, as expected for this area.

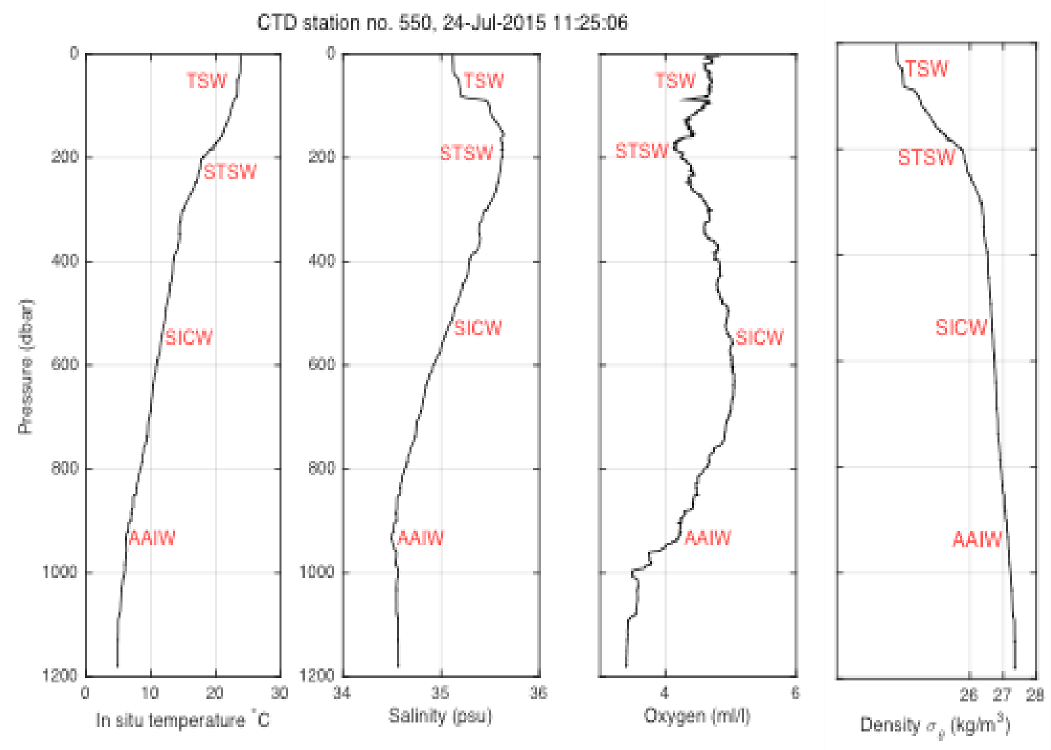


Figure 3.1,5: Station 550: Temperature, Salinity, dissolved oxygen, and density profiles. Tropical Surface Water (TSW), Sub-Tropical Surface Water (STSW), South Indian Central Water (SICW) and Antarctic Intermediate Water (AAIW).

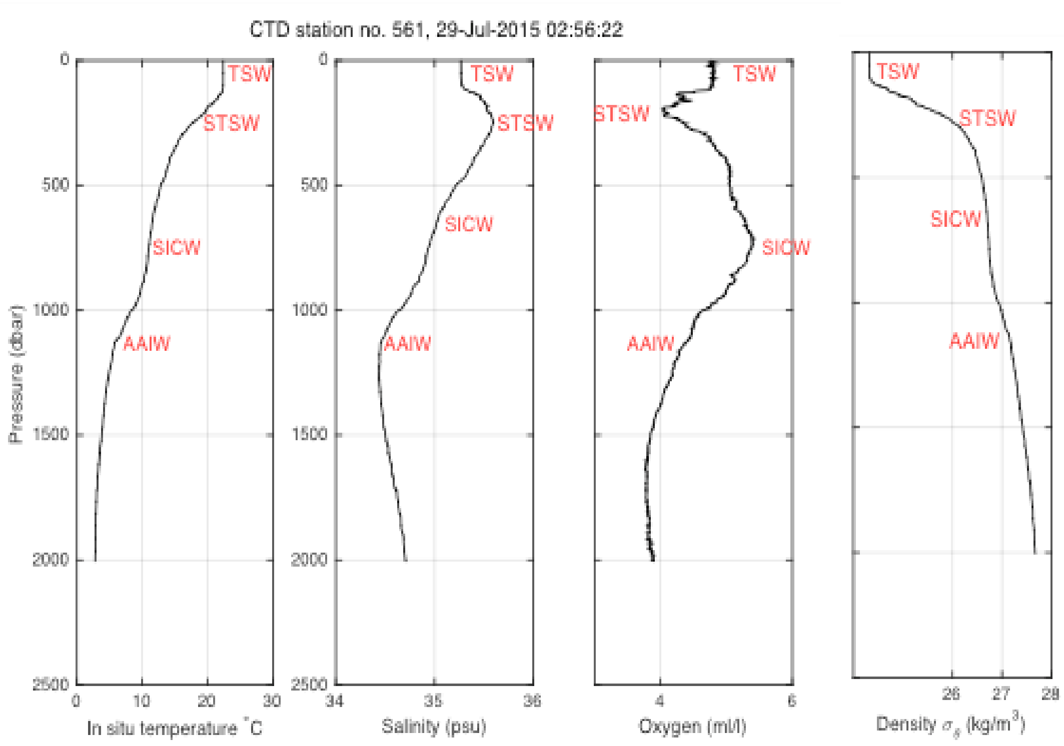


Figure 3.1.6: Station 561: Temperature, Salinity, dissolved oxygen, and density profiles. Tropical Surface Water (TSW), Sub-Tropical Surface Water (STSW), South Indian Central Water (SICW) and Antarctic Intermediate Water (AAIW).

The TS-diagram (Fig. 3.1.7) displays the temperature and salinity properties for the different water masses in comparison with each other. Red Sea intermediate water (RSIW) is probably mixed in with the lower layers, and its properties for this area is a temperature of 5°C, salinity of 43.8, a low oxygen content of 2.5ml/l, and is expected to be found around 1200-1400m. The profile maximum depth of 2000m is too shallow to detect any of the deep waters.

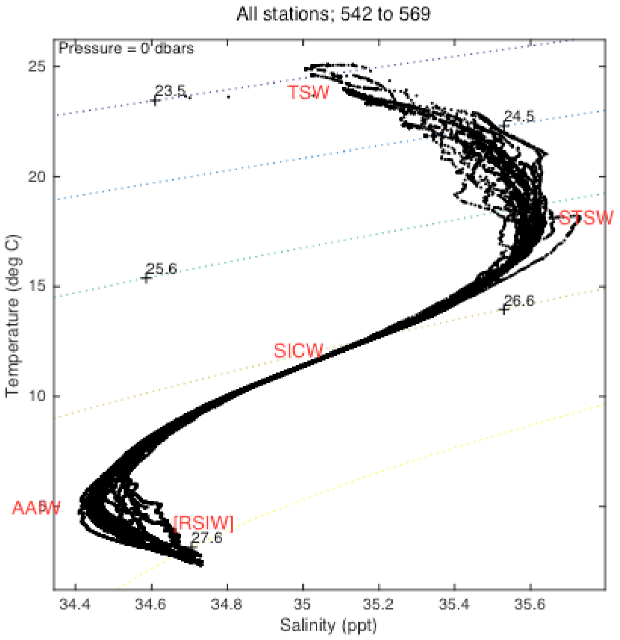


Figure 3.1.7: TS-diagram for all stations (542-569). Tropical Surface Water (TSW), Sub-Tropical Surface Water (STSW), South Indian Central Water (SICW) and Antarctic Intermediate Water (AAIW).

3.2 Currents (LADCP)

The water masses defined in chapter 3.1 and their abbreviations are listed in table 3.2.1 Using hydrographic properties while looking at LADCP data can help detect or confirm different current patterns.

Table 3.2.1: Abbreviations for the different water masses defined in chapter 3.1.

TSW	Tropical Surface Water
STSW	Sub-Tropical Surface Water
SICW	South Indian Central Water
AAIW	Antarctic Intermediate Water
RSIW	Red Sea Intermediate Water

Section A (Fig. 3.2.1) goes north-south and the strongest current is in the surface layer in the middle of the section going westwards. This corresponds to the natural north-south temperature gradient, hence difference in density, in the surface layer of this section (Fig. 3.1.1). In the southernmost part of the section the current is towards northeast in the topmost 1500m and towards west-northwest below that. In the north the currents are weak southwards.

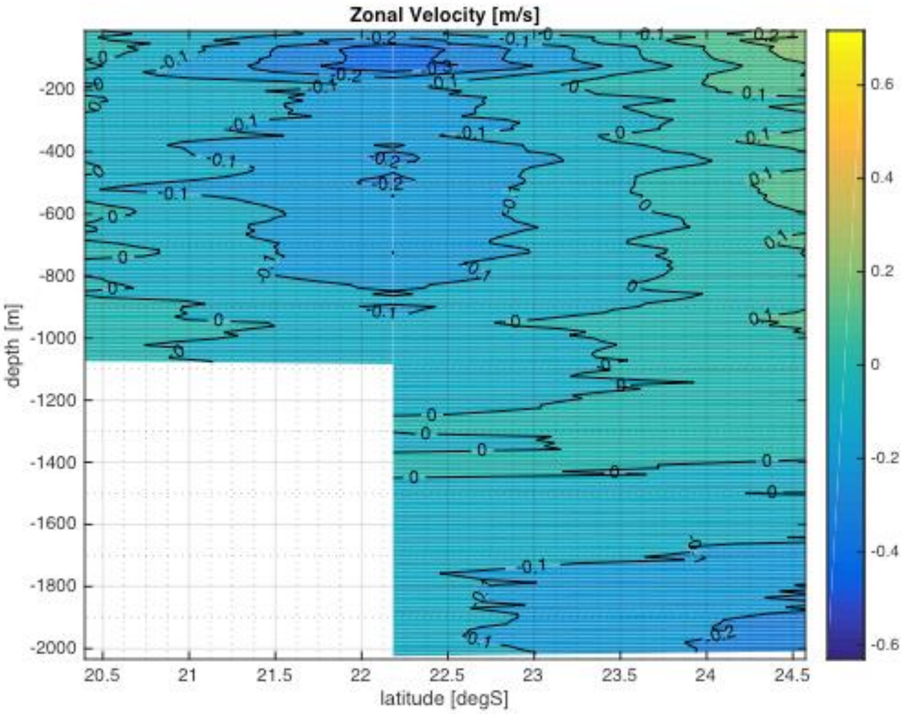


Figure 3.2.1 a: Zonal velocity components for section A.

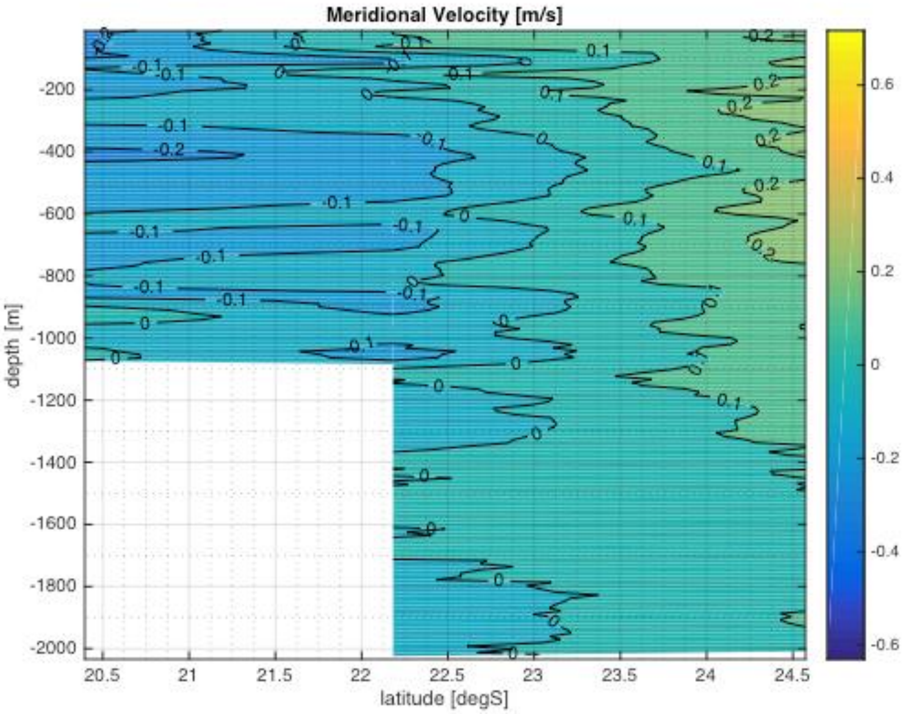


Figure 3.2.1 b: Meridional velocity components for section A.

For section B (Fig. 3.2.2) the zonal velocity component is dominant, especially above 1000m in the western part of the section. In the topmost 200m in this region the velocity ranges between 0.4ms^{-1} towards west at 46°E and 0.6ms^{-1} in eastward direction at 48.5°E. For the meridional velocity component there is a weak southward flow in the topmost 200m between 47°E and 51°E. Elsewhere in this section the current is weak towards northeast.

The fact that the zonal velocity component is dominating, is as expected due to the layered structure in temperature (Fig. 3.1.2) and hence also density for this section. There is little or very small horizontal gradients to set up any meridional current flow. The relative high velocities, with changing direction, in the western part of this region are due to the highly dynamic nature of this region. The East Madagascar current flows southwards on the eastern side of Madagascar, and has a looping structure as it leaves the island to the south where it set up meanders and eddies (Fig.

3.2.8). During the time of survey, strong surface winds also had an effect on the currents direction and strength in the surface layers.

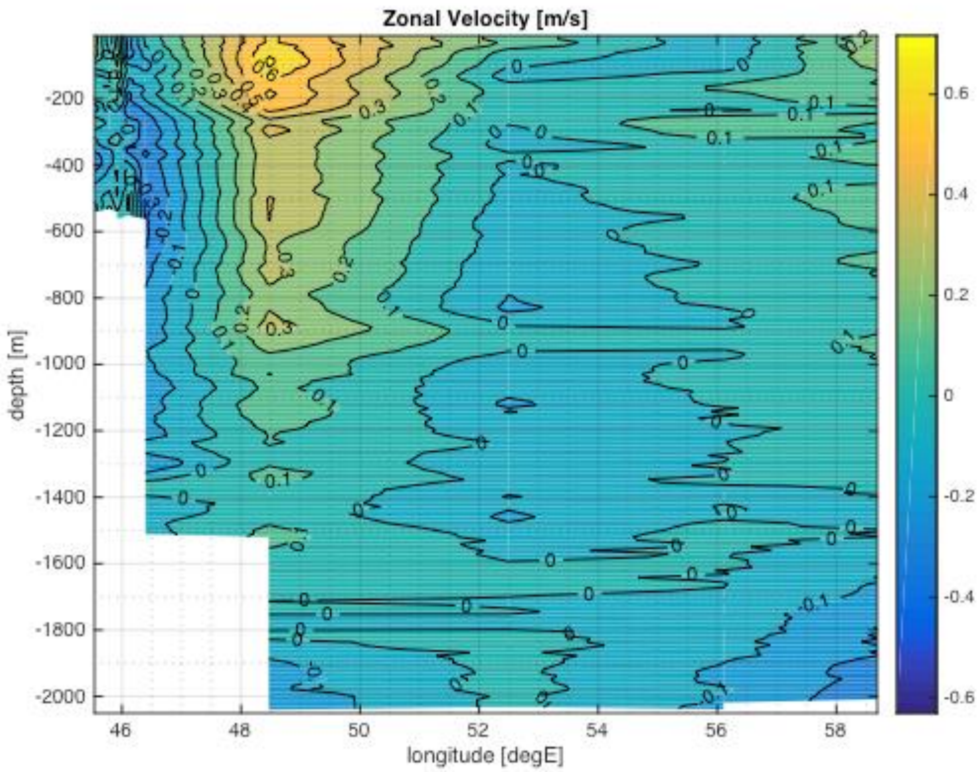


Figure 3.2.2 a: Zonal velocity components for section B.

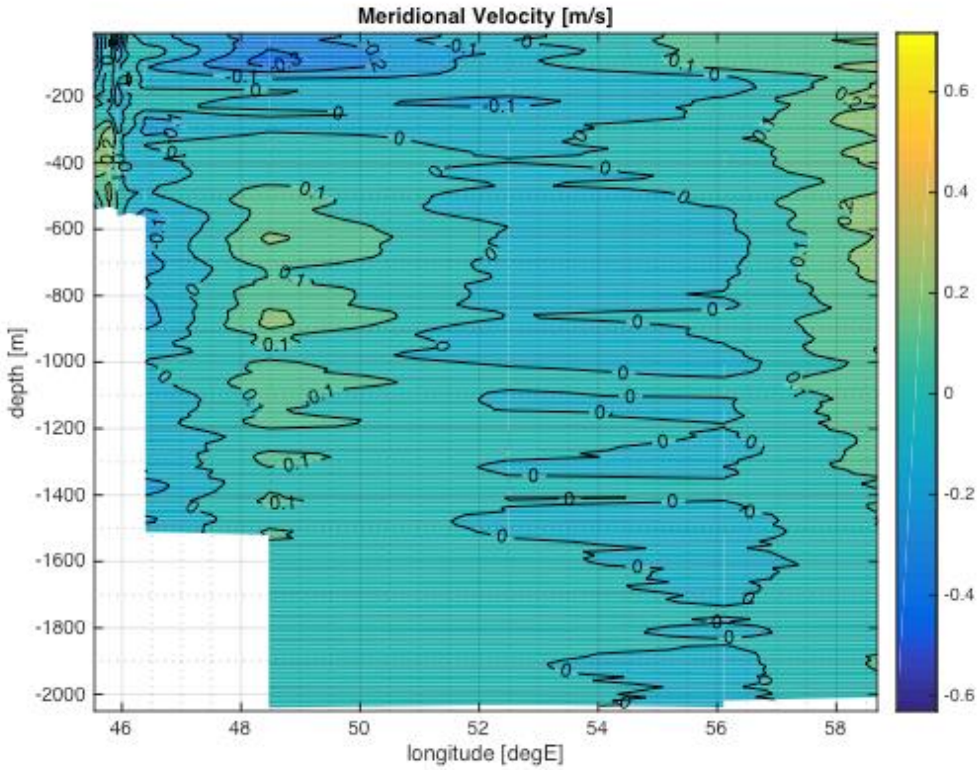


Figure 3.2.2 b: Meridional velocity components for section B.

For section C (Fig. 3.2.3), a line of chosen stations across the Madagascar ridge, the meridional velocity component dominates the top 500m in the southernmost part of the region, reaching up to 0.5 ms^{-1} flowing southwards. The zonal component is mostly to the west, and the meridional component is directed northward in the northern part of the section, both components reaching up to 0.2ms^{-1}. The strong current flowing southwards in the surface layer in the south is colder, relatively saline and oxygen rich, and implies that the STSW is no longer overlaid by TSW this far south. Elsewhere in the region the current is weaker and towards the northwest, with a mix of water masses.

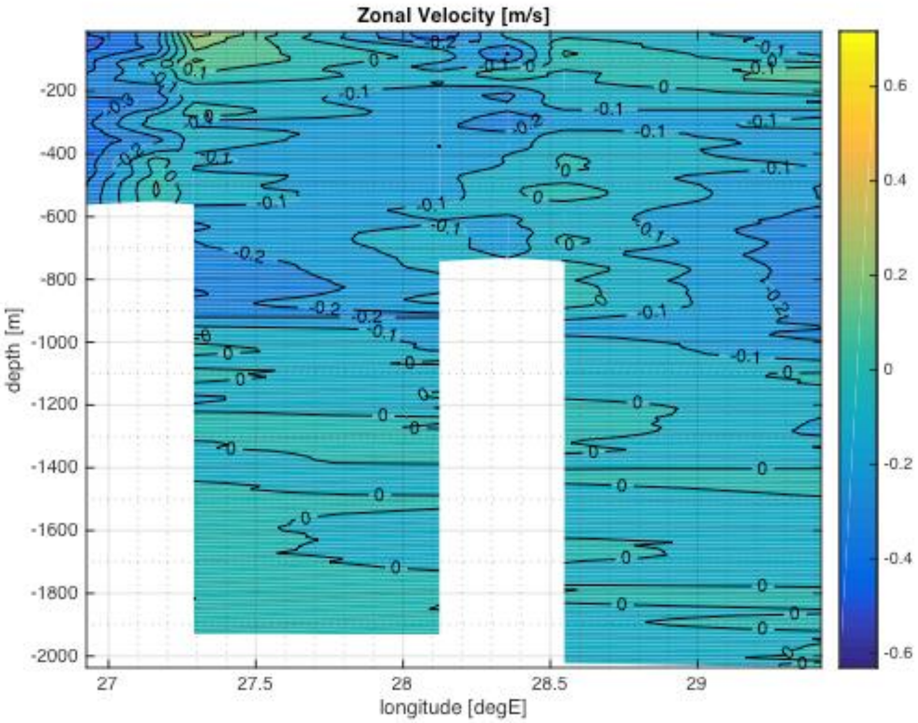


Figure 3.2.3 a: Zonal velocity components for section C.

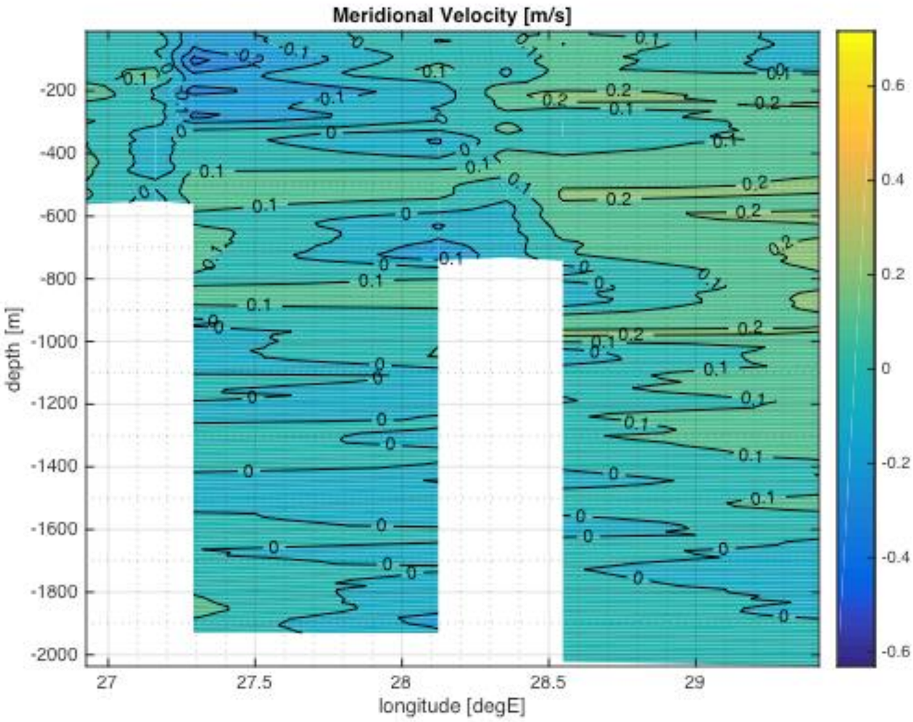


Figure 3.2.3 b: Meridional velocity components for section C.

Section D (Fig. 3.2.4) has a relatively strong southward current in the surface layer of the easternmost part. The currents in this area may be topographically steered by Walter Shoals. In most of the top 1000m of this section the currents are towards west or southwest. In the part of the section that goes below 1800m the current is weak and towards east.

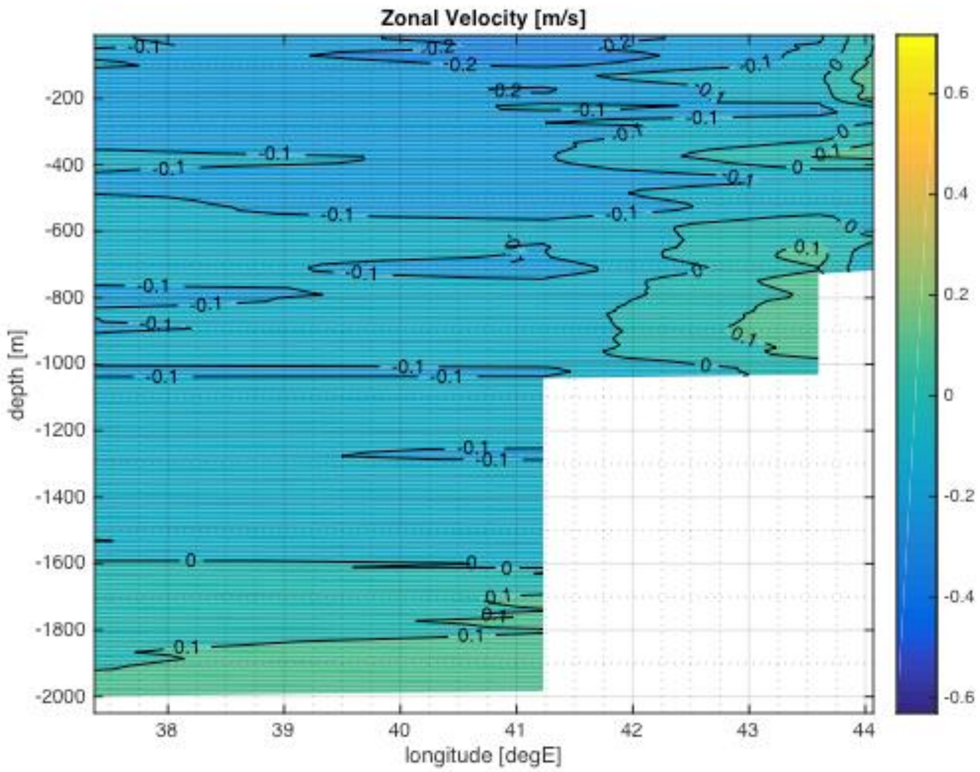


Figure 3.2.4 a: Zonal velocity components for section D.

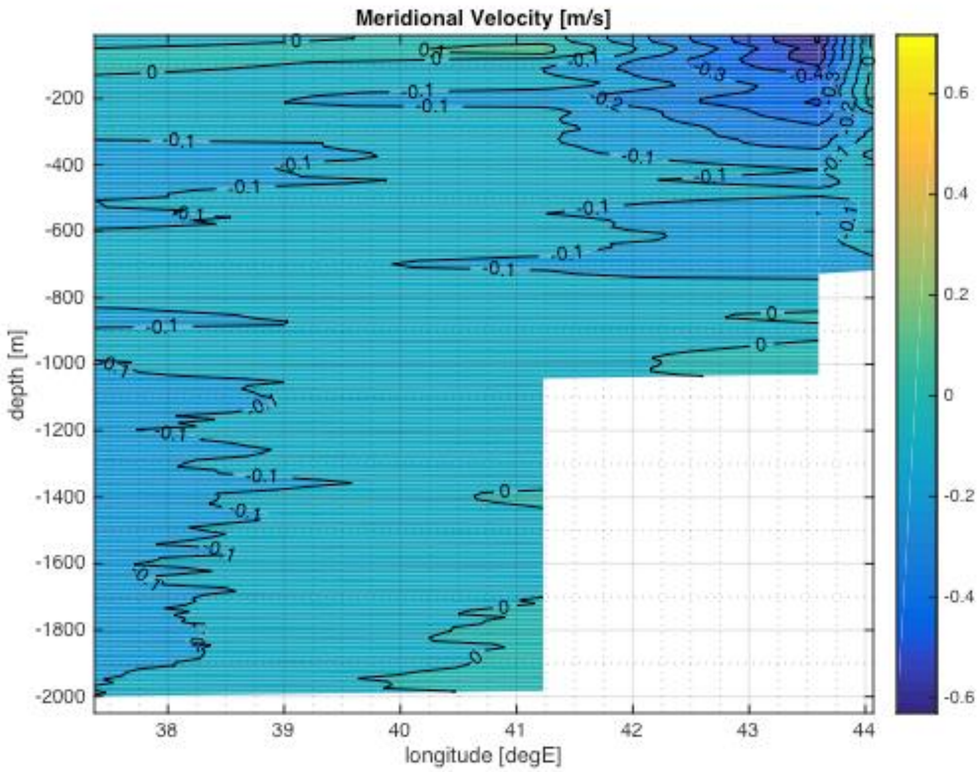


Figure 3.2.4 b: Meridional velocity components for section D.

For station 550 (Fig. 3.2.5) the zonal component is dominating the current for the topmost 900m, reaching more than 0.5ms^{-1} towards the west in the 200m deep surface layer. From around 300m to 800m the velocity is around 0.2ms^{-1} still in a westward direction. The meridional component in the topmost 900m is mostly towards the south, and at around 300m depth it reaches 0.1ms^{-1} going southwards as the zonal components drops in strength. This may imply the end of the surface layer impacted by the strong winds in the area at the time of the survey, or a boundary between two water masses (TSW and STSW).

At around 900m depth the zonal current component changes direction towards the east, still with a weak and variable meridional component. From the hydrographic data (Fig. 3.2.5) it is evident that this flow is AAIW. Below this and towards the bottom of the profile the velocity gets weaker, as expected near the ocean bottom.

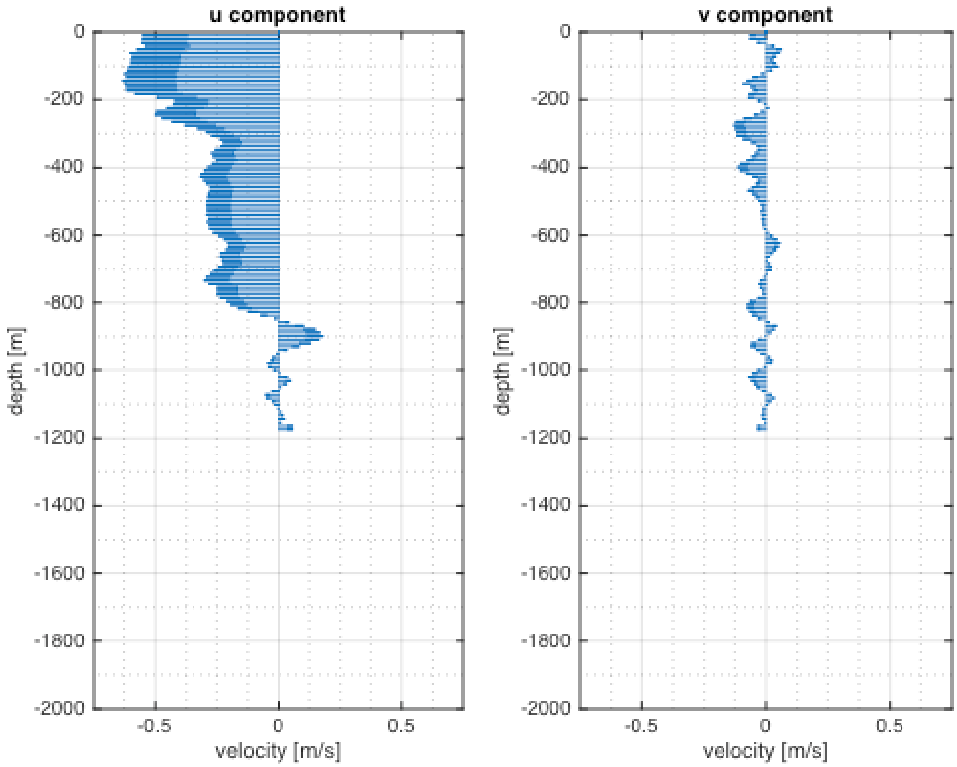


Figure 3.2.5: Station 550: zonal (u component) and meridional (v component) velocity.

At station 561 (Fig. 3.2.6) the flow pattern is very clear and coincides with the water masses depicted by the hydrographic data (Fig. 3.1.6). In the top 100m the flow (TSW) is southwest-westerly with a speed just above $0.1ms^{-1}$, between 100m and 200m the flow changes towards northwest and is slightly stronger (STSW), and from 200m and down to 1400m the direction of the flow (SICW) is towards northwest reaching $0.25ms^{-1}$ except at 1100m where it is strictly towards the north (AAIW). From 1400m to 1600m the flow is dominantly northward, and below this the current velocities decay towards the bottom.

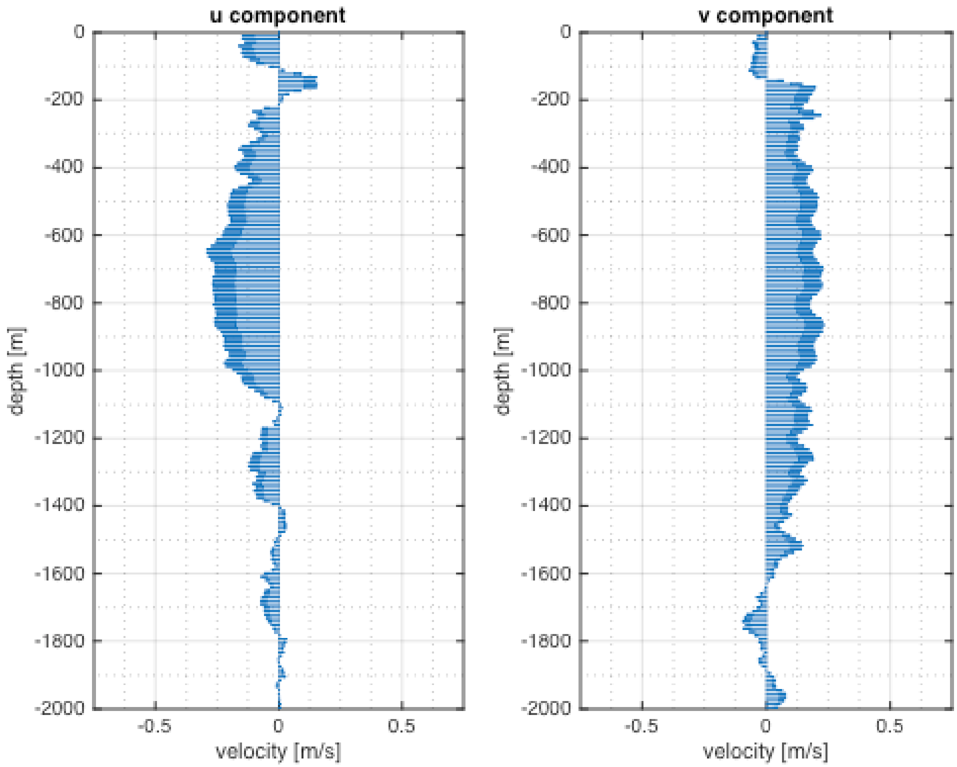


Figure 3.2.6: Station 561: zonal (u component) and meridional (v component) velocity.

The current vectors for the topmost bin (10m) at all stations (Fig. 3.2.7) display a rather messy picture of the surface currents. The surface layer is mostly represented by TSW, except in the south where STSW dominates the surface layer as seen in section B. The lack of a current patter in this layer is partly explained by dynamics of the region, and partly by the strong and variable winds experienced during the survey, but also the separation in time and distance between the stations.

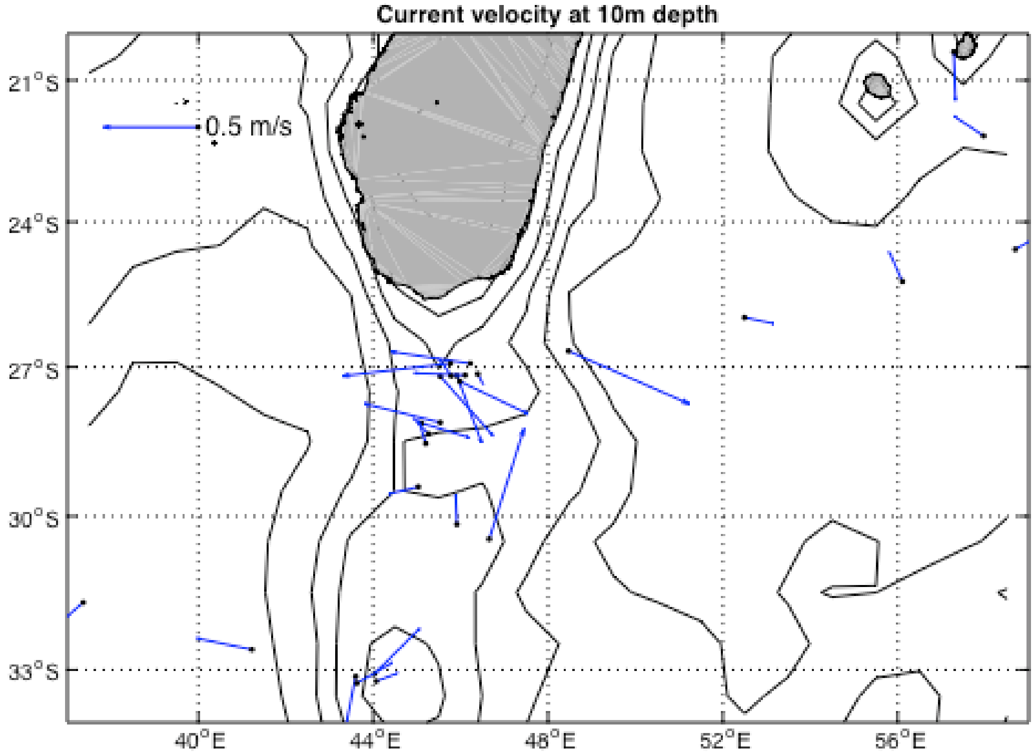


Figure 3.2.7: Velocity vectors from the topmost bin (10m) from all LADCP stations.

The dynamics of the area is highly variable as it is affected by i.a. the southwest Indian Ocean sub-gyre and meanders from the East Madagascar Current. The absolute dynamic topography (Fig. 3.2.8) from the 28th of July 2015 (midway through the survey) represents a picture of the dynamics of the region. Currents are expected to flow along gradients in absolute dynamic topography. For this area the flow will have high absolute dynamic topography to the left, and low absolute dynamic topography to the right of the flow direction.

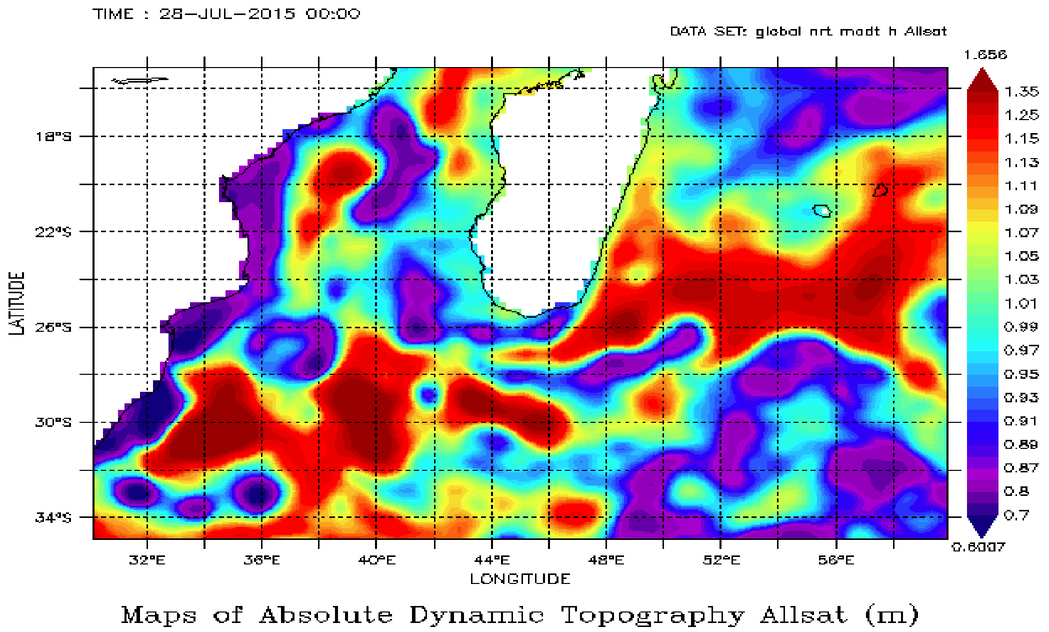


Figure 3.2.8: Absolute dynamic topography of the area of the survey from the 28th of July 2015, midway through the survey. Obtained from Aviso, Live Access Server.

Current vectors at 500m depth over the Madagascar ridge (Fig. 3.2.9) are mostly pointing in a north-westerly or westerly direction; some exceptions around shallow areas are expected due to steering from bathymetry. The water mass at this depth is the South Indian central water (SICW).

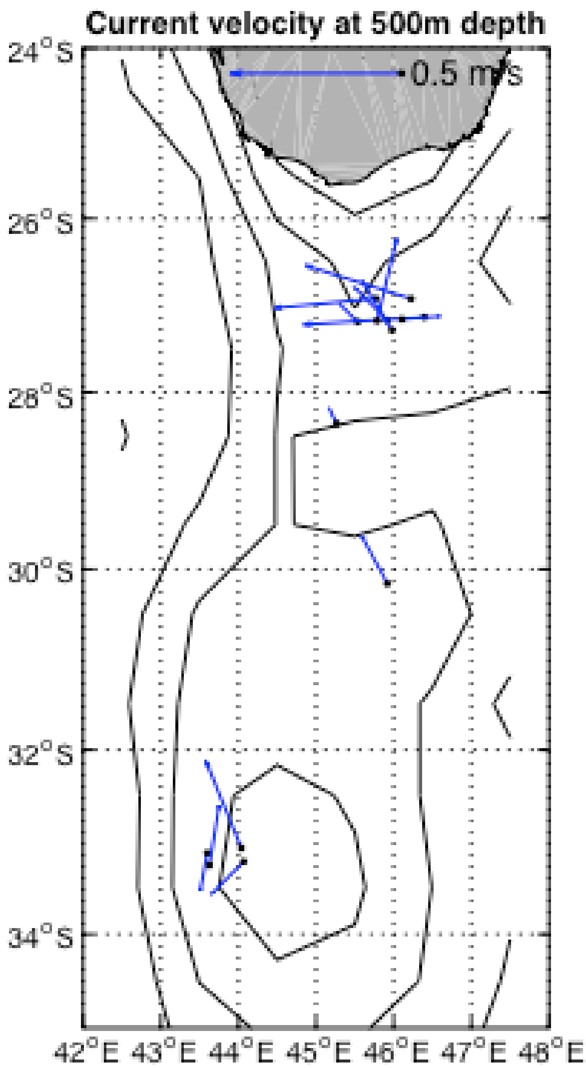


Figure 3.2.9: Velocity vectors at 500m over the Madagascar ridge.

At around 1000m depth it is expected to find Antarctic intermediate water (AAIW). The current vectors at 1000m (Fig. 3.2.10) are therefore expected to change direction compared to those at 500m, as seen in station 550 and 561. Many stations however does not have a velocity component at this depth, due to the fact that they are too shallow, and for some stations the AAIW does not reach the station at exactly 1000m and no change is despicable. Most of the vectors representing this depth are also weaker than at 500m, because of the proximity to the bottom.

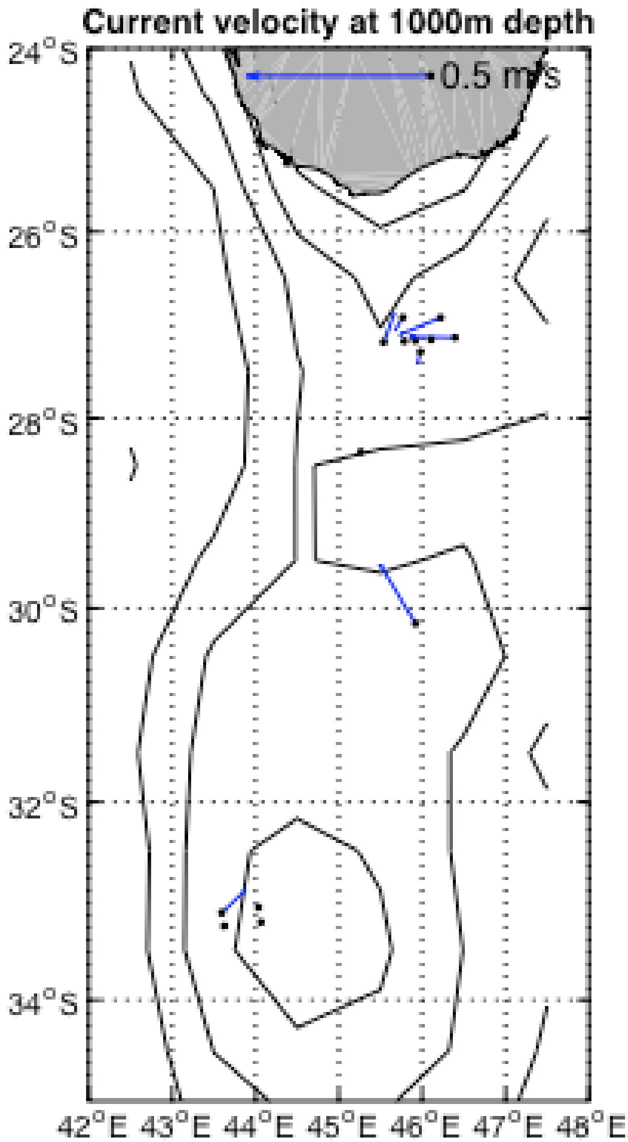
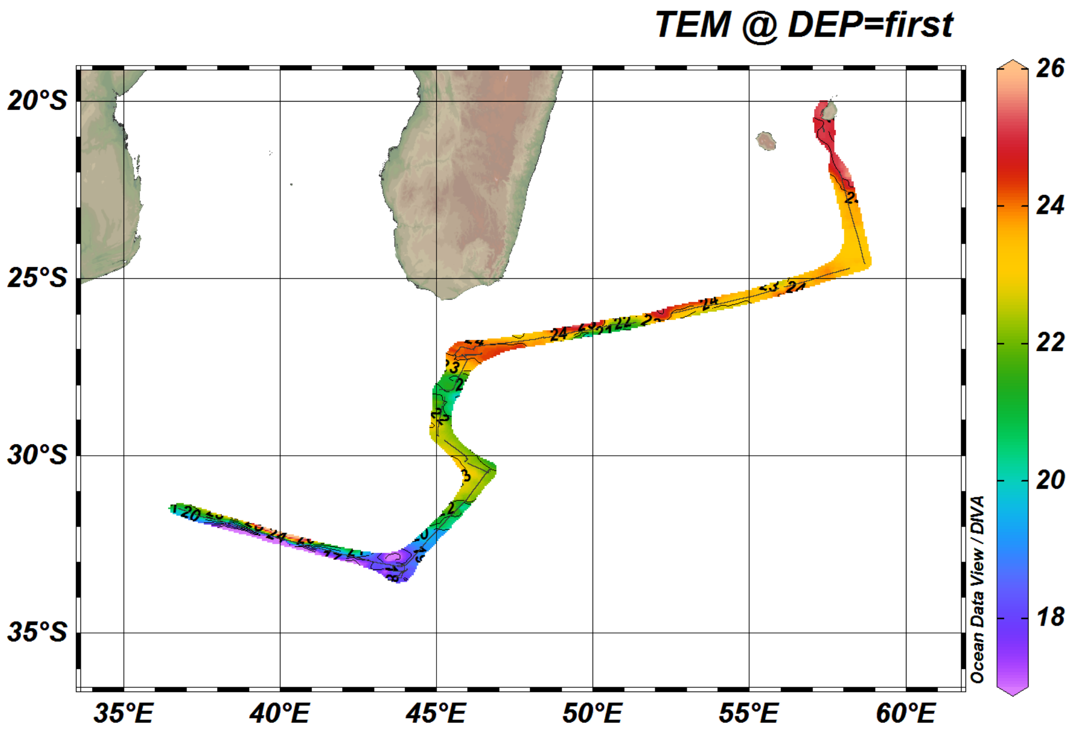


Figure 3.2.10: Velocity vectors at 1000m over the Madagascar ridge.


TEM @ DEP=first
20°S
25°S
30°S
35°S
35°E
40°E
45°E
50°E
55°E
60°E
26
24
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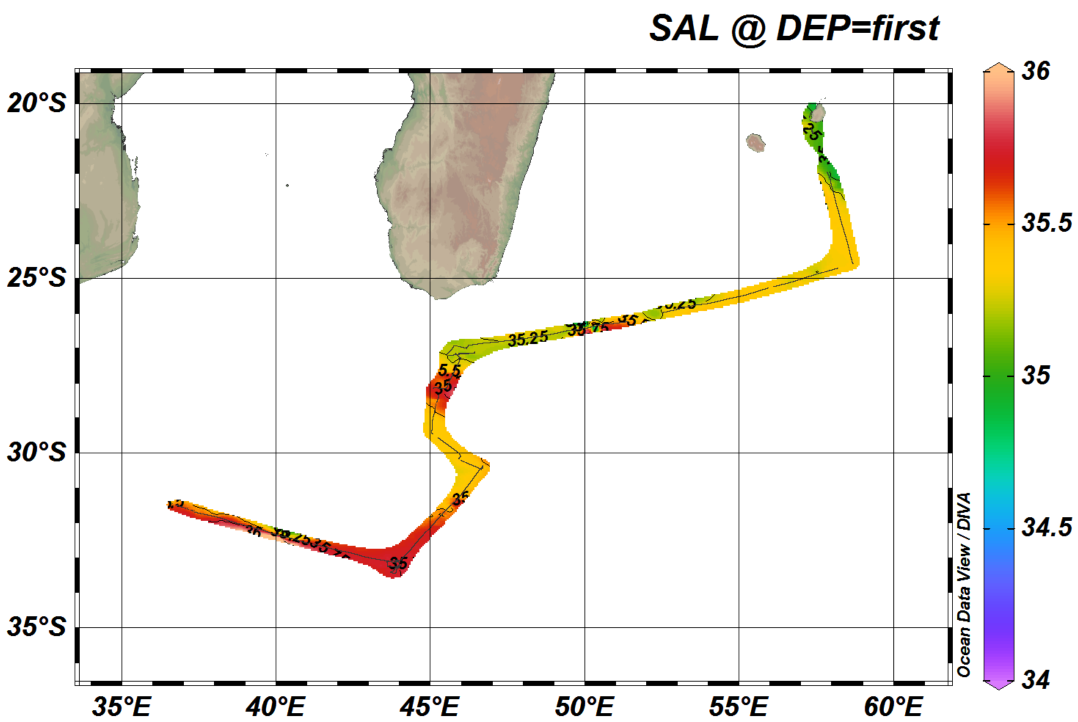
20
18
Ocean Data View / DIVA


SAL @ DEP=first
20°S
25°S
30°S
35°S
35°E
40°E
45°E
50°E
55°E
60°E
36
35.5
35
34.5
34
Ocean Data View / DIVA

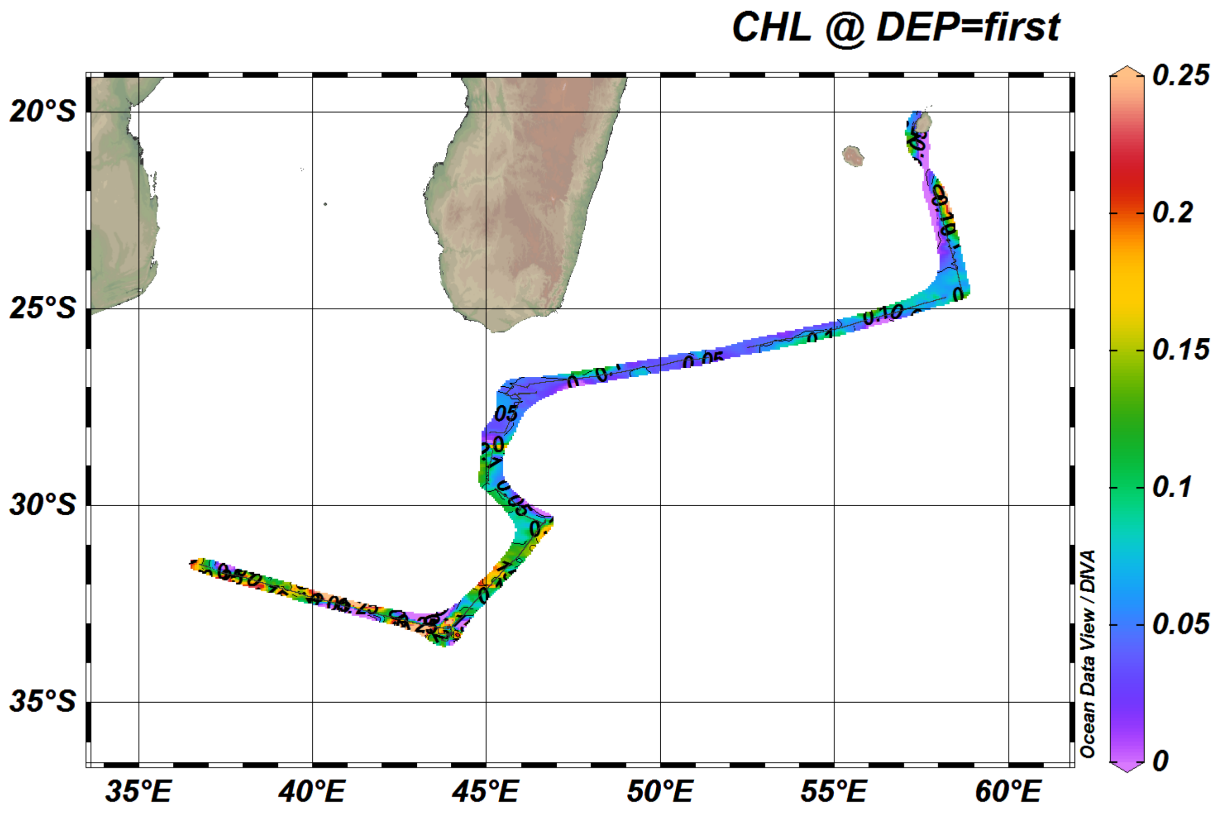


Fig. 3.2.11 Data from the thermosalinograph showing: Temperature, salinity and Chlorophyll A.

The figures 3.2.11 a,b,c above are DIVA gridded with 8 per mile in the X direction and 8 per mille in the Y direction.

Nutrients analysis (nitrate, phosphate, ammonia, nitrate, silicate) will be performed after the cruise using an auto-analyzer at Grahamstone.

3.3 Plankton

3.3.1 Zooplankton

During the sampling process, 12 day stations and 7 night stations were undertaken and we lost samples in three station (554, 559 and 569) due to the bad weather. At the end of the cruise 88 samples were collected from the multi-net in 19 stations, 9 samples from 6 VP2 stations and 17 CPR hauls. 1254 nautical miles were covered by the CPR during the survey.

The mean biomass from the multinet (figure 3.3.1) was 21.98mg/m^3, with minimum value 0.59mg/m^3 at western side of the sampling zone, near the South African EEZ, the maximum value (48.16mg/m^3) was localised in the Walter Shoal's. This high biomass could be attributed to presence of the fish larvae and shrimps in the sample.

The biomasses for each station are given in the annex IV

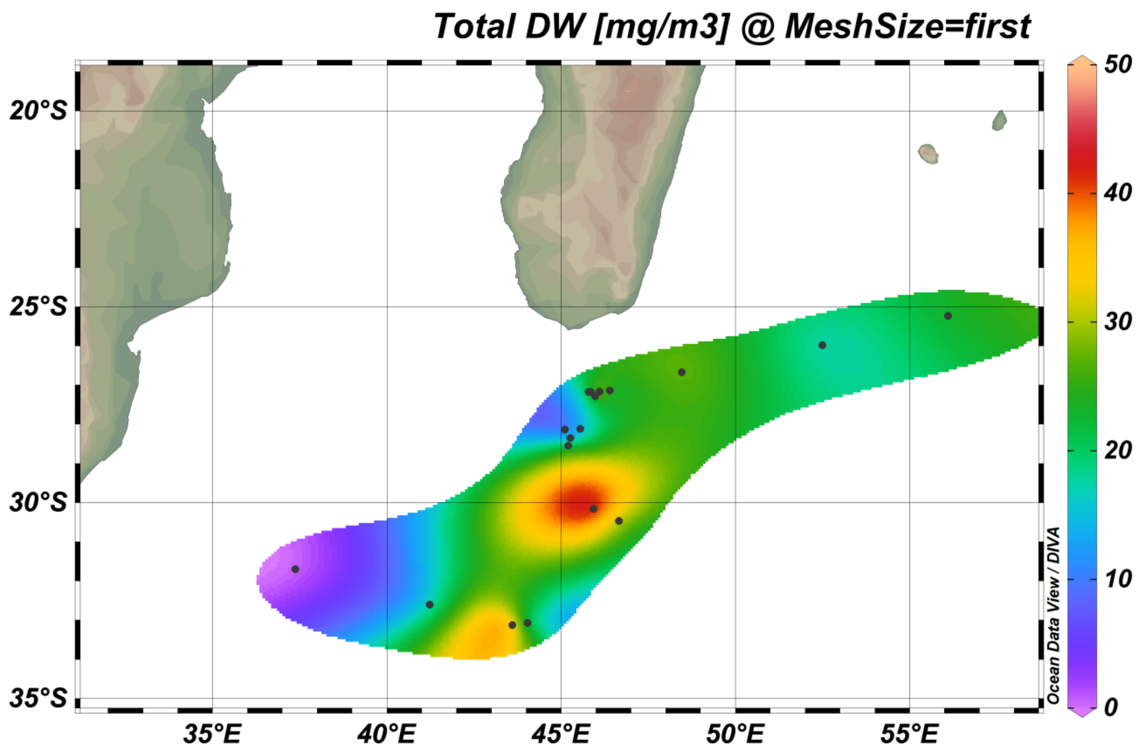


Fig. 3.3.1 Zooplankton dry weight during the southern Indian Ocean survey 2015

3.4 Benthic sampling

From the observations of the samples and the video recordings the sea bed seemed relatively hard on most locations. Fine sand was collected from two locations yielding half full grabs (MR 4 and 5). Coarser sand and coral debris was found on location MR 10. Only these three locations had sufficient amounts of sediments for chemical analysis. Apart from these three locations bottom seemed hard and sediment were sparse. This impression was supported by the video from the three VAMS dives showing bedrock, sand covered by a volcanic crust layer and a hardened sediment.

There were no observations of the muddy sediments often recorded in deeper waters. The recorded macro fauna was sparse in abundance and distributions as suggested from the sample observations. The sampling stations included coordinates, depth, gear type and sediment composition as per table in ANNEX IV.

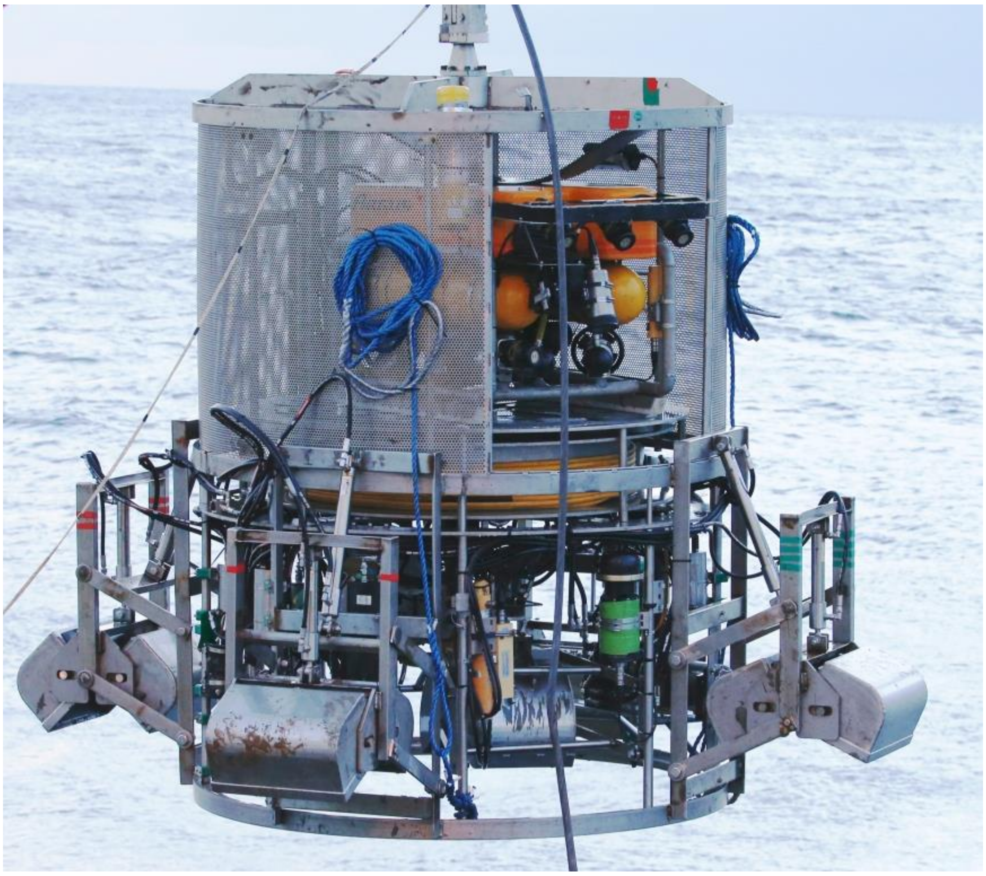


Figure 3.4.1 VAMS Video Assisted Multi Sampler

3.4.1 Video Assisted Multi Sampler (VAMS)

Organisms were identified to the lowest taxonomic classification level possible. Organisms not identified to the species level were assigned unique numbers (e.g. Anthozoa sp. 1). Unknown organisms (i.e. organisms not identified to a particular phylum) were also recorded in the CAMPOD logger as ‘Unknown’ and were usually accompanied with an additional comment describing the organism and its possible taxonomic identity. A certain level of overlap in species composition was assumed for both stations conducted on the southern Madagascar Ridge (VAMS 01 and VAMS 02), therefore, the same numbering system for organisms not identified to the species level was used for both stations. For station VAMS 03, the numbering system for higher-level taxa was reset at 1. Microsoft PowerPoint ‘photo catalogues’ depicting each organism recorded from the video footage and their taxonomic identities were created separately for station VAMS 03, and for VAMS 01 and VAMS 02 combined.

Below is a detailed summary of the video transects recorded at each of the three stations. Substrate type and biological observations are summarized. The limitations of this dataset are briefly discussed.

3.4.1.1 Station MR. 08 (VAMS 01)

The substrate at station VAMS 01 was considered hard bottom with a thin layer of fine sediment overtop. Attempts to close the VAMS grabs on this substrate were unsuccessful due to the compact bottom. The seabed was overlain with gravel-type rock, providing substrate for the settlement of sessile organisms. A total of 47 taxa and 2 unknown organisms were recorded from the video footage collected at station MR. 08 (VAMS 01). The most diverse phylum was the Echinodermata, followed by the Cnidaria and Arthropoda.

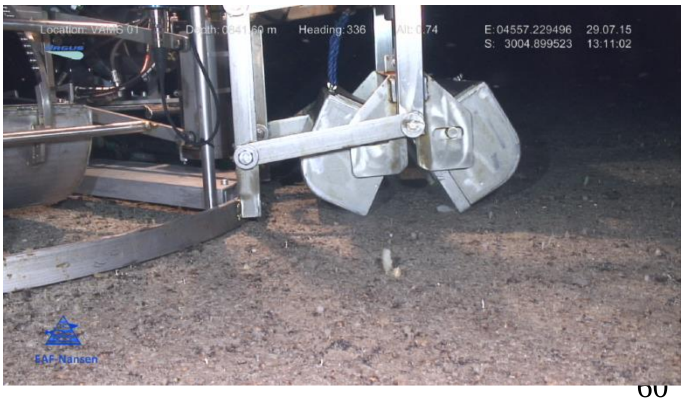


Figure 3.4.2. Image of the seabed observed at station MR. 08 (VAMS 01). The VAMS is attempting to close a grab on the hard substrate.

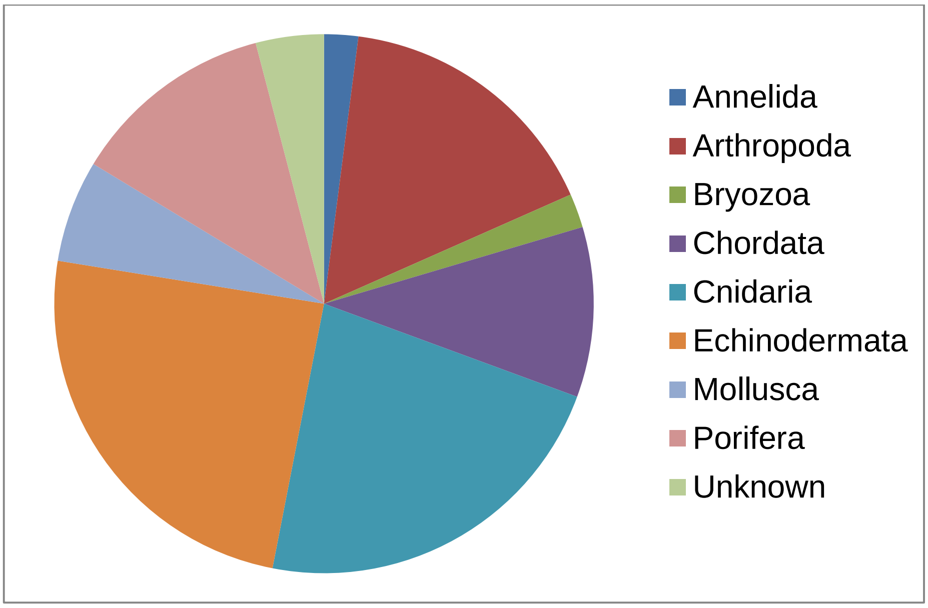


Figure 3.4.3 Number of taxa per phylum observed at station MR. 08 (VAMS 01). The Echinodermata was the most diverse phylum.

Where possible, the taxonomic identities were further revised (Revised Taxon field) after the data was collected. Comprising a large portion of the Phylum Cnidaria were dead skeletons and bases of branching corals (identified as Cnidaria in Annex IV, Table 2).

The pictures below show some of the more interesting members of the demersal community observed at station MR. 08 (VAMS 01). This station was characterized by a large number of unidentified dead cup corals (Scleractinia sp. 1). An unknown branching coral was also observed. The calcified nature of this specimen suggests that this is a scleractinian coral, however, it may be a species of soft coral.

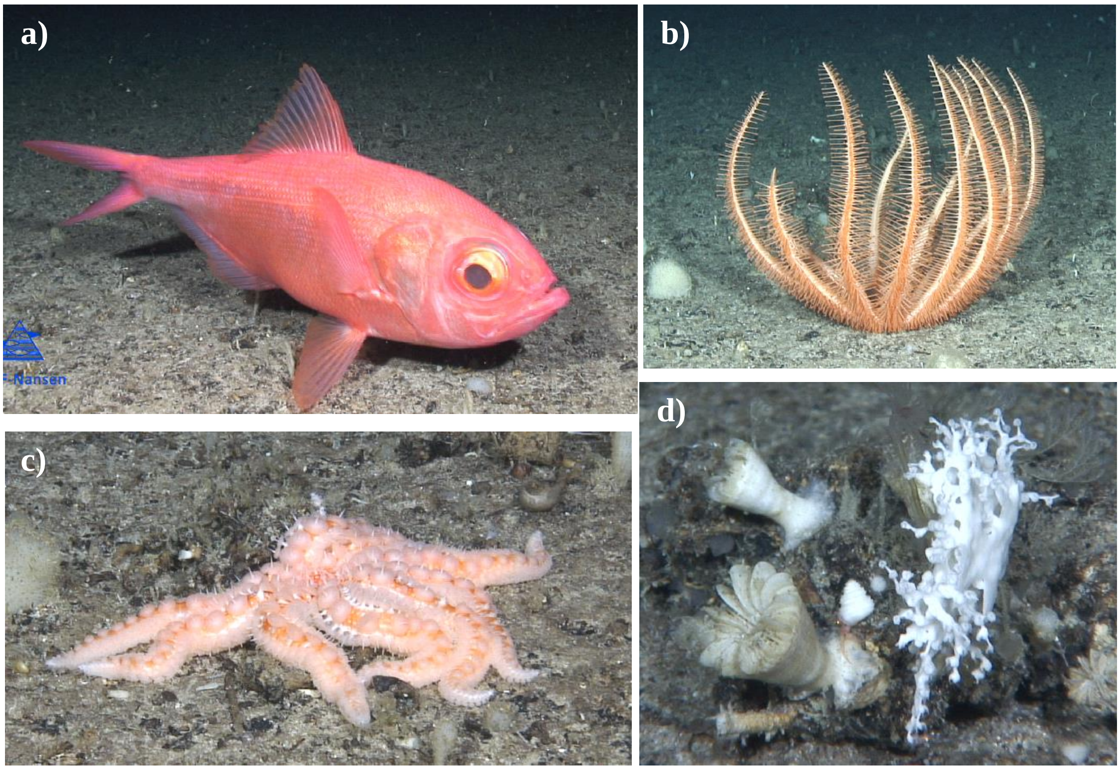


Figure 3.4.4. Various fauna observed at station MR. 08 (VAMS 01): a) member of the Family Berycidae (identified as *Beryx* sp. 1), b) sea star of the Order Brisingida (identified as Brisingidae sp. 1), c) unknown sea star (Asteroidea sp. 4), and d) dead scleractinian cup corals (Scleractinia sp. 1, left) and possibly a branching scleractinian (Scleractinia sp. 2) (right**).**

3.4.1.2 VAMS 02

The seabed at station MR. 09 (VAMS 02) was primary hard with pockets of soft substrate. The hard substrate appeared volcanic in origin, and large 'conduits' were evident. A total of 40 taxa and 5 unknown organisms were recorded from the video footage collected at station MR.9 (VAMS 02). A shark egg case (listed under the Phylum Chordata) was also observed. The most diverse phylum at this station was the Cnidaria, followed by the Echinodermata and Porifera.

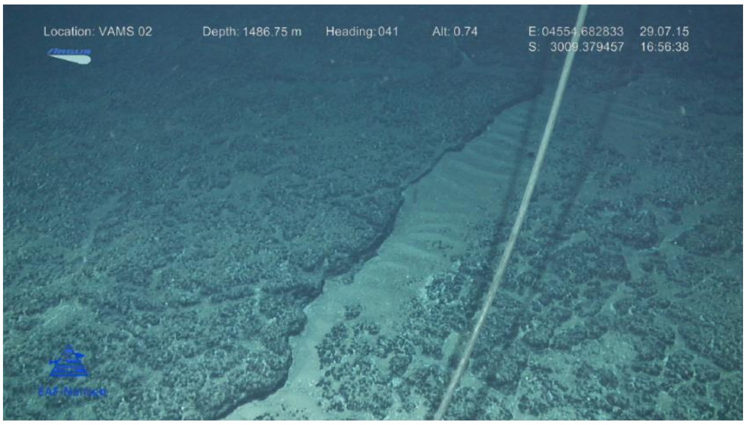


Figure 3.4.5. Image of the seabed observed at station MR.9 (VAMS 02). The substrate type here was classified as hard with pockets of soft substrate.

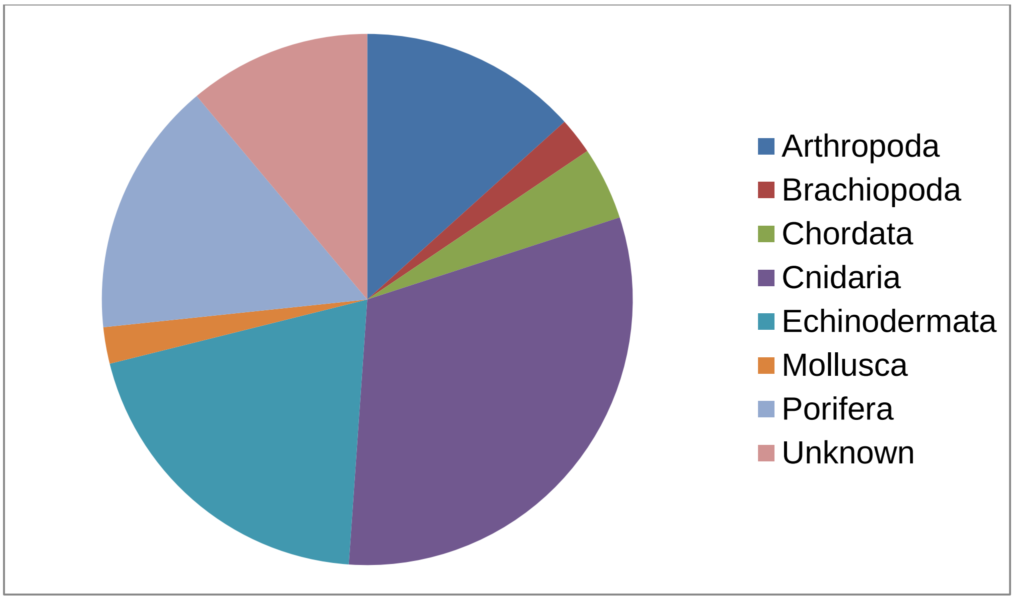


Figure 3.4.6. Number of taxa per phylum observed at station MR.9 (VAMS 02). The Cnidaria was the most diverse phylum at this station.

The pictures below depict the highlights of the demersal community observed at station MR.9 (VAMS 02). This station was characterized by long branching corals of the Family Chrysogorgiidae (see Annex IV, Table 3 for taxonomic identification). These branching corals are possibly from the genus *Metallogorgia*, and were often associated with a large brittle star (probably *Ophiocreas oedipu;* see Mosher and Watling, 2009) that was found wrapped around the branches of the coral. Also observed at this station was a red soft coral from the genus *Anthomastus*. Corals from this genus are commonly called ‘mushroom corals’ due to the mushroom-like appearance of the colony when the tentacles are retracted.

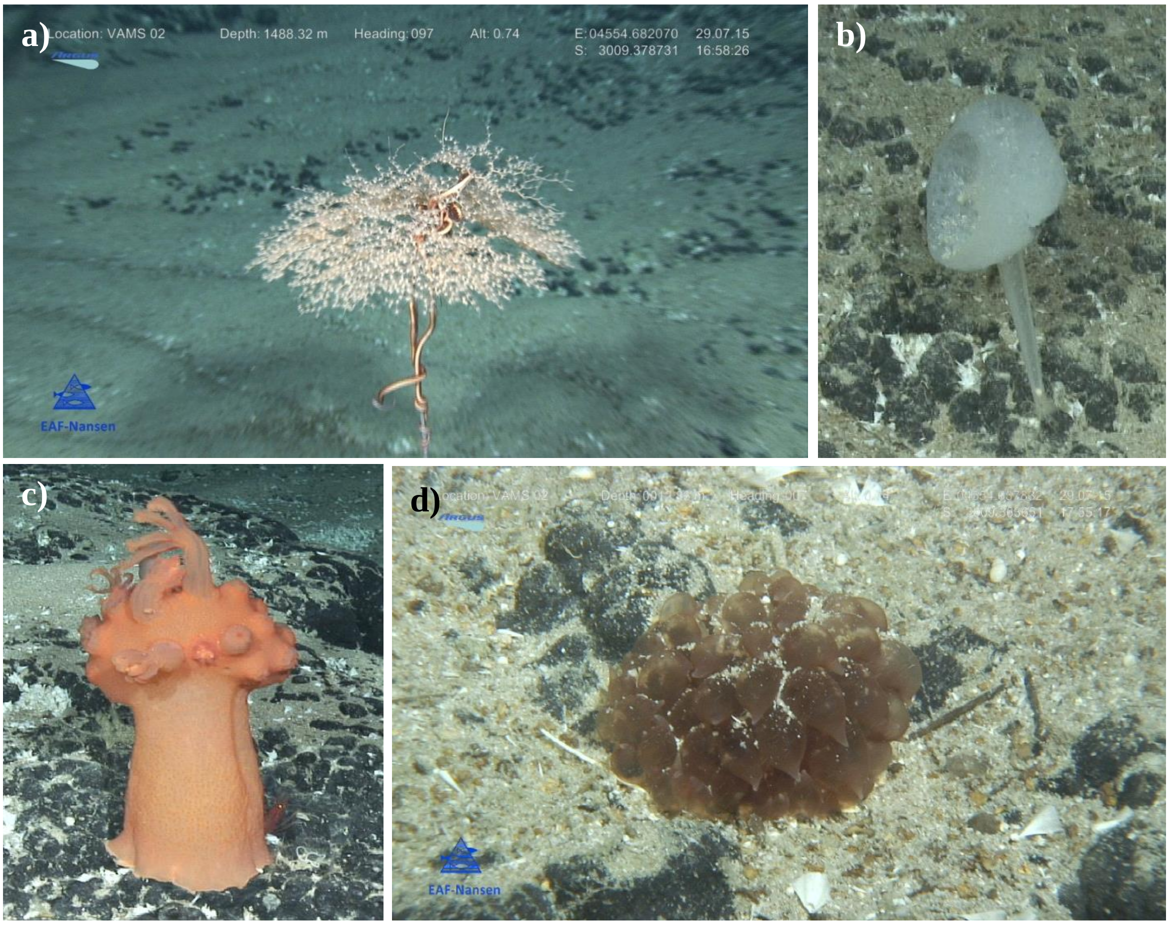


Figure 3.4.7. Various fauna observed at station VAMS 02: a) a gorgonian coral of the Family Chrysogorgiidae, likely from the genus *Metallogorgia* (identified as Anthozoa sp. 1), b) a possible glass sponge (Hexactinellida sp. 1), c) soft coral *Anthomastus* sp. 1, and d) possible unknown egg mass.

3.4.1.3 VAMS 03

The substrate at station VAMS 03 consisted of fine sediments that appeared rippled on the surface. Sediment grab samples at this station revealed that the sediment was composed of very fine sand. Few gravel-sized rocks were observed. The benthic community at Station MR.10 (VAMS 03) was much less diverse than that of the previous two stations. A total of 15 taxa from 5 different phyla and 5 unknown organisms were recorded. The most diverse phylum was the Chordata, comprised entirely of unknown fish and elasmobranch species. The lower species diversity at this station can likely be attributed to the absence of hard substrate required by many benthic species for attachment. Annex IV, Table 4.

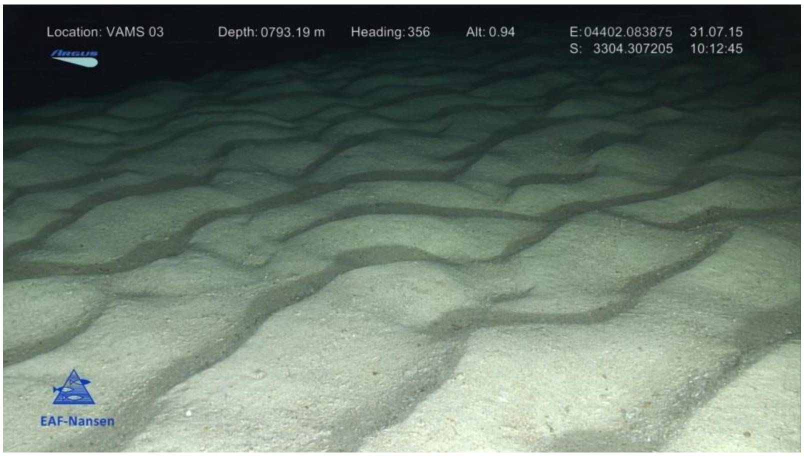


Figure 3.4.8. Image of the seabed observed at station VAMS 03. The substrate type here was classified as soft and consisted of very fine sand

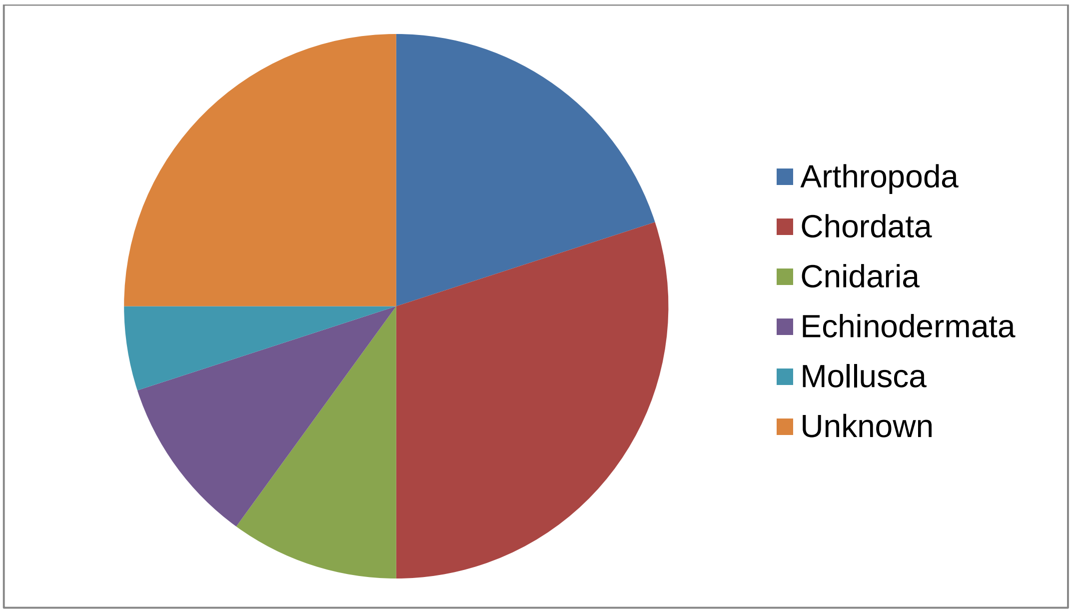


Figure 3.4.9 Number of taxa per phylum observed at Station MR.10 (VAMS 03). The Chordata was the most diverse phylum at this station.

The pictures below show some of the more interesting benthic and pelagic fauna observed at Station MR.10 (VAMS 03). Two unknown anthozoan taxa were observed at this station that may be a scleractinian cup coral. An unknown shark species was observed on two separate occasions on at this station.

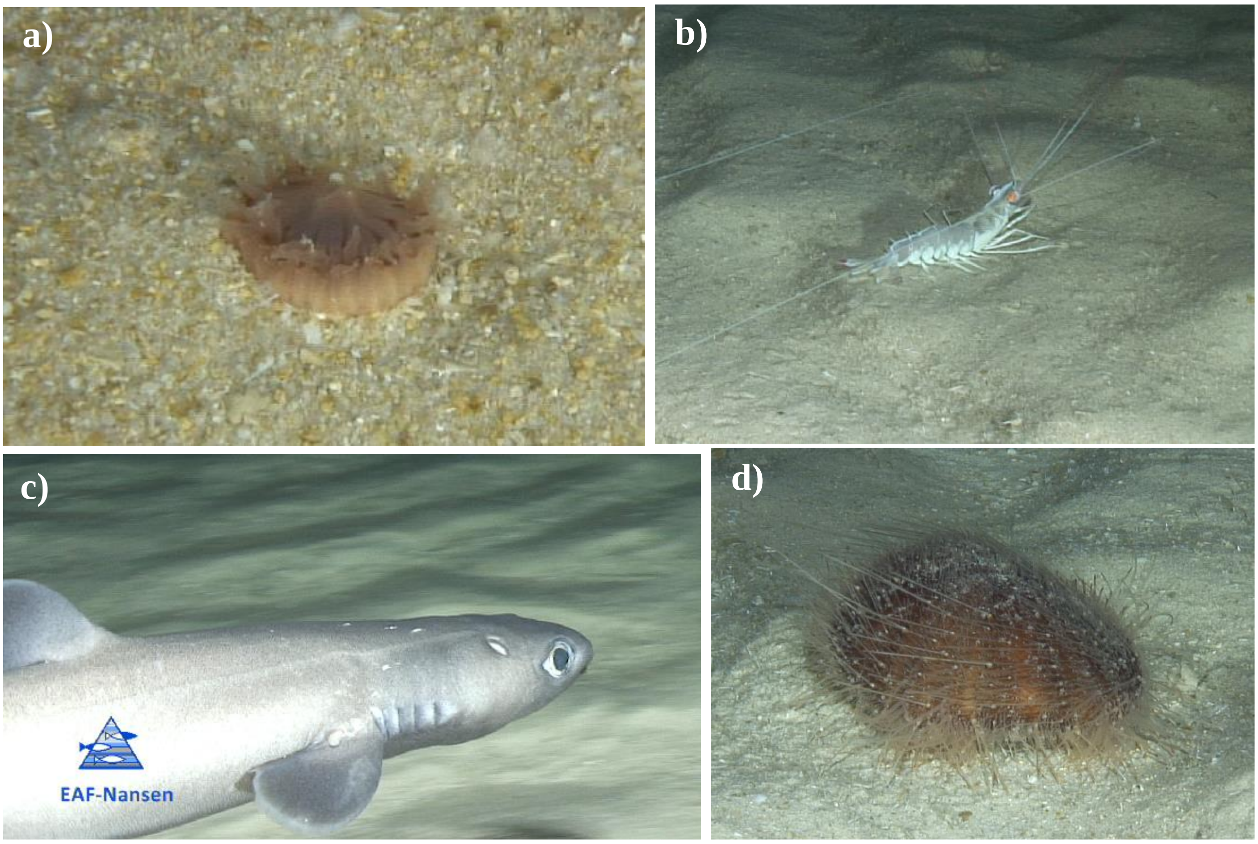


Figure 3.4.10. Various fauna observed at station VAMS 03: a) an unknown anthozoan (Anthozoa sp. 1), b) an unknown crustacean (Malacostraca sp. 3), c) an unknown elasmobranch species, and 4) an unknown sea urchin (Echinoidea sp. 1).

3.4.2. Limitations of Data

It is important to note that while best efforts were made to identify and record all individuals observed in the video, the fast-paced nature of the live recording meant that not all organisms were recorded or identified accurately. Any abundance data recorded in the logging software is unreliable. Should abundance data be required for quantitative analysis, each video segment should be analyzed in detail to ensure that all organisms and the correct abundances are recorded.

3.5 Micro-Plastic sampling using Manta Trawl

Micro plastics have been defined as plastic particles <5 mm and typically over 333 µm, while smaller particles (>1 µm) are also included but less often detected (Arthur *et al.,* 2009). Micro plastics have been recognized as emerging marine pollutants of significant concern due to their persistence, ubiquity and toxic potential (Endo *et al.,* 2005; Engler, 2012). It is though known that Large plastic debris disintegrates and becomes smaller (<1 mm) micro plastics, through photolytic, mechanical and biological degradation processes in the marine environment (Browne *et al.,* 2007; Andrady, 2011; Cooper and Corcoran, 2010). Although the harmful effects of large plastic debris on marine wildlife have been well documented (i.e. Derraik, 2002), many more research is needed to know about the exact effect of micro plastics in marine organism diet and how these micro plastics affect the food chain. However, it is known that the potential threats to biota may include physical harm from ingestion, leaching of toxic additives, desorption of persistent, bio-accumulative and toxic (PBT) chemicals (GESAMP, 2010).

The aim of this study was to investigate the abundance, composition and distribution of marine micro plastics in the international waters from Mauritius to Durban while special attention was given to the region of the Mascarene Ridge and Walters shoal. The trend in the number of micro plastics recorded showed an increase in particles as the samplings were done nearer to Madagascar. Figure 3.5.1 below shows the average number of plastic recorded during the cruise.

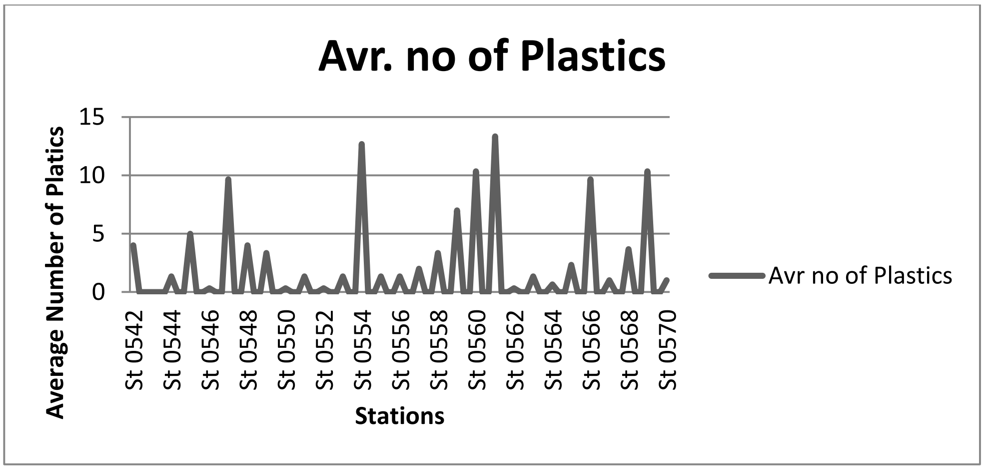


Figure 3.5.1 Shows the trend of the average number of Micro plastic (n=3) recorded during the cruise.

The trend demonstrates that as we reached closer to Madagascar, the number of micro plastic recorded increases as well. As compared to the first leg, the number of colored plastic collected (including white, blue, pink & green amongst others) was much more as compared to transparent ones being reported from the first leg cruise members (Figure 3.5.2).

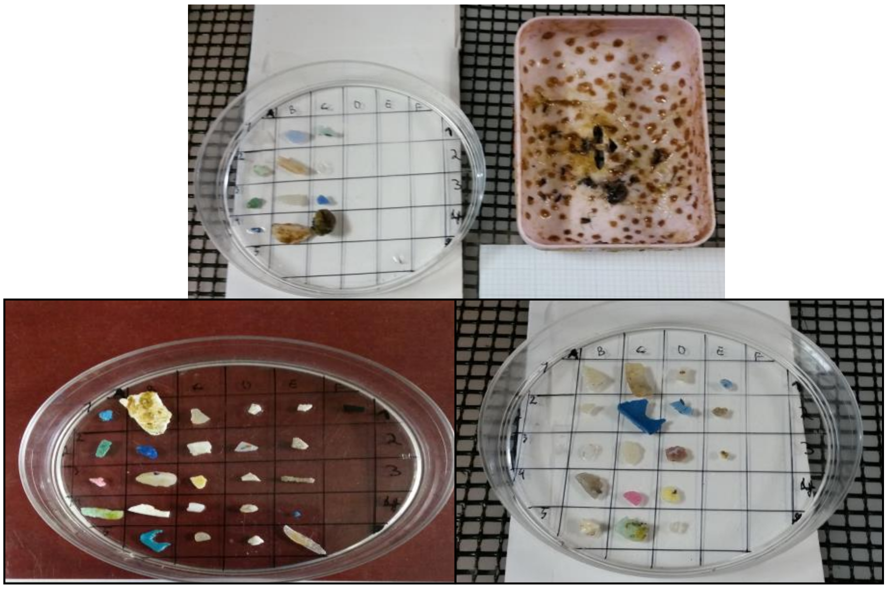


Figure 3.5.2 Shows few of the different types of plastic caught by the Manta Trawl.

It was noted that most of the macro plastics caught with the Manta trawl were mostly land use materials such as soap holder, piece of PVC pipes and plastic wheels for toy cars. It was also observed that there were several fishing vessels around the Madagascar ridge where an increase of micro plastics were recorded. Observations also showed that when the higher amount of micro plastic were recorded at different stations, the wind speed were recorded to be minimum at the same stations (Figure 3.5.3). However, it was also observed that the collection of micro plastic increases after strong wind which could cause an upwelling and taking micro plastic up to the sea surface water at calmer sea conditions which could account for the increase of plastic collections during calmer weather conditions.

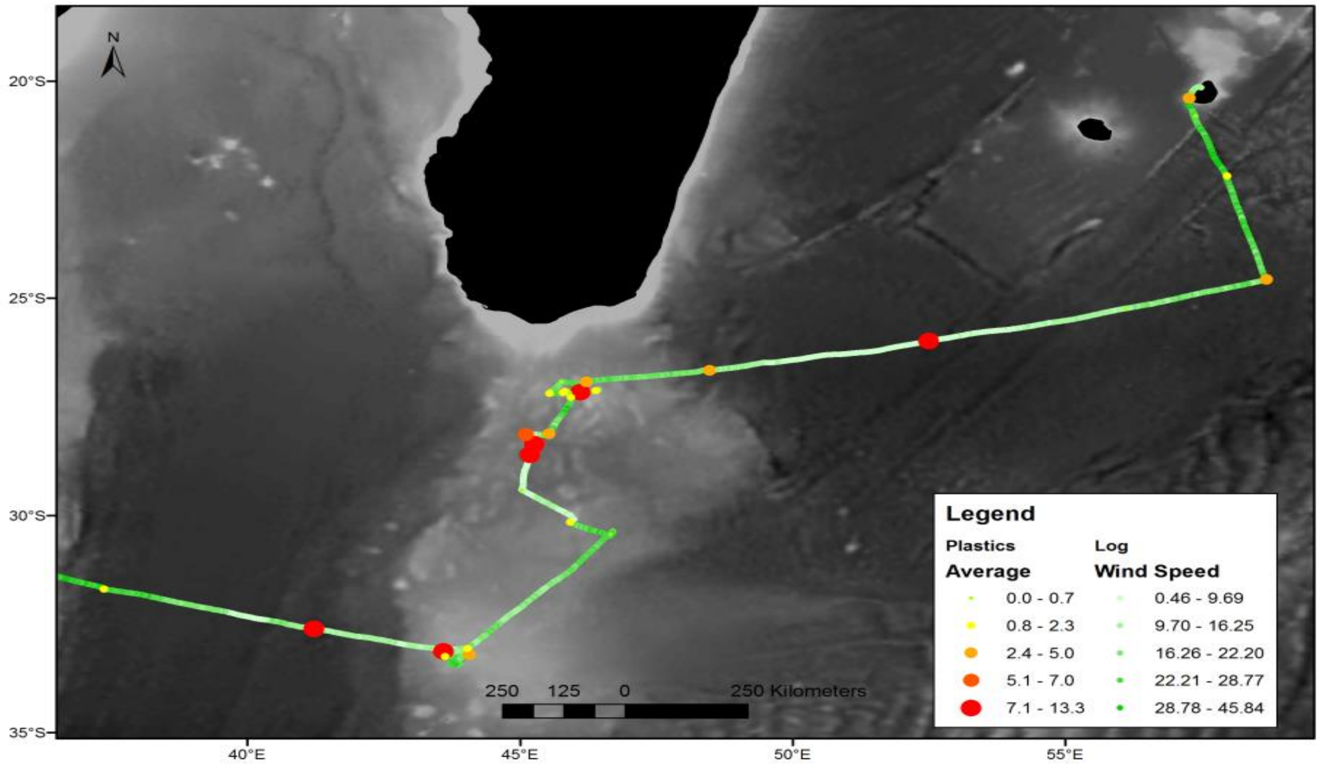


Figure 3.5.3 Average number of micro plastics recorded in relation with the wind speed.

The way forward would be to find the relation of the sampled plastic to the ocean current thus determining the effect of current on the transportation of plastic in the ocean. Also, determination of the chemical composition of the plastic sample collected would give an insight of the major type of plastic that are being dumped into the sea. Several whales were observed at the different sampling sites. A study would be very interesting to be carried out to know how much micro plastics are being swallowed by whales per day.

4. LITERATURE

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EUROPÄISCHE NORM **EN 16260** October 2012 ICS 13.060.45 Supersedes for EN 16260:2011

5 ANNEX

I. Sampling equipment and instrumentes

II. Sampling procedures:

- A) Benthos samples flow chart macro fauna.
- B) Benthos samples flow chart Samples for chemical analysis.
- C) Flowchart multinet samples.
- D) Sampling protocols for micro plastics.

III: Survey effort:

- A) Station and gear overview.
- B) Sampling journal(Benthos).
- C) Multinet stations.
- D) VP2 stations.
- E) CPR tracks.
- F) Manta trawls.

III. Results

IV. Samples and responsibilities after the survey.

V. Proposed papers and supplementary work based on collected materials.

VI. European standard 16260 for committee work and adjustment to the VAMS .

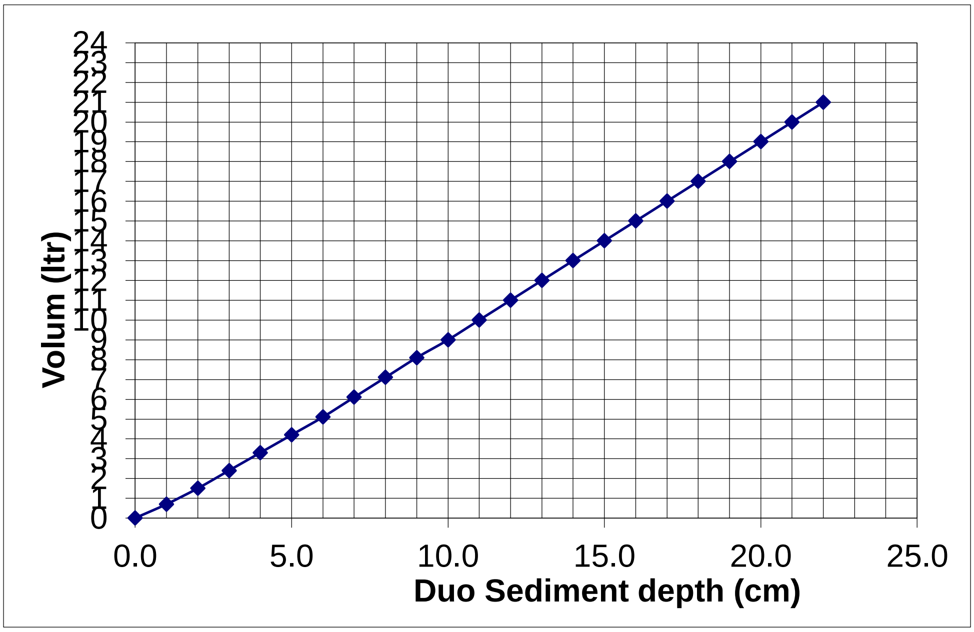
ANNEX I Sampling equipment and instruments .

Three main types of grabs were used during the survey: long arm, the Danish grab and the duo Grab.

Duo grab.

X is the depth measured from the lid to the sediment surface.

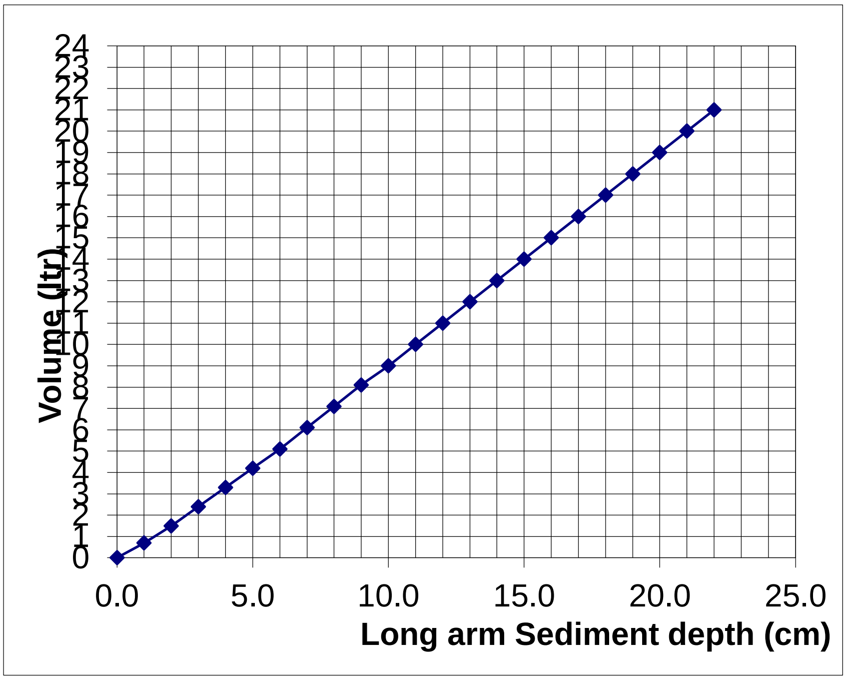
Sediment depth	X- value (cm)	vol in ltr.
22.0	0	21.00
21.0	1	20.00
20.0	2	19.00
19.0	3	18.00
18.0	4	17.00
17.0	5	16.00
16.0	6	15.00
15.0	7	14.00
14.0	8	13.00
13.0	9	12.00
12.0	10	11.00
11.0	11	10.00
10.0	12	9.00
9.0	13	8.10
8.0	14	7.10
7.0	15	6.10
6.0	16	5.10
5.0	17	4.20
4.0	18	3.30
3.0	19	2.40
2.0	20	1.50
1.0	21	0.70



Long arm

X is the depth measured from the lid to the sediment surface.

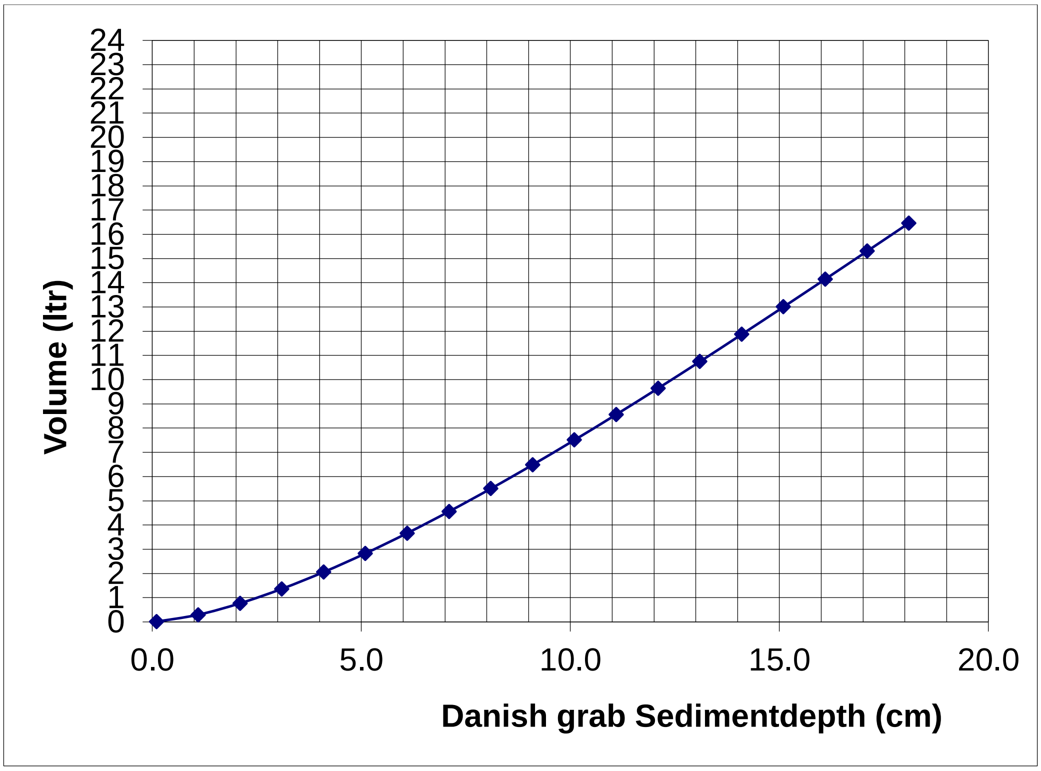
Sediment depth	X- value (cm)	Volum	vol in ltr.
22.0	0	22808.0	22.81
21.0	1	21488.4	21.49
20.0	2	20171.6	20.17
19.0	3	18860.3	18.86
18.0	4	17557.2	17.56
17.0	5	16265.2	16.27
16.0	6	14987.3	14.99
15.0	7	13726.3	13.73
14.0	8	12485.5	12.49
13.0	9	11268.2	11.27
12.0	10	10077.8	10.08
11.0	11	8918.0	8.92
10.0	12	7792.8	7.79
9.0	13	6706.8	6.71
8.0	14	5664.8	5.66
7.0	15	4672.3	4.67
6.0	16	3735.9	3.74
5.0	17	2863.2	2.86
4.0	18	2063.8	2.06
3.0	19	1350.1	1.35
2.0	20	740.1	0.74



Danish grab

X is the depth measured from the lid to the sediment surface.

Sediment depth	X-value (cm)	vol in ltr.
18.1	0	16.47
17.1	1	15.31
16.1	2	14.16
15.1	3	13.01
14.1	4	11.87
13.1	5	10.75
12.1	6	9.65
11.1	7	8.57
10.1	8	7.51
9.1	9	6.49
8.1	10	5.50
7.1	11	4.56
6.1	12	3.67
5.1	13	2.83
4.1	14	2.06
3.1	15	1.36
2.1	16	0.77
1.1	17	0.29
0.1	18	0.01



Acoustic instruments

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 checked on the 07.07.2013 in Baía 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 for the 38 kHz echo sounder were as follows:

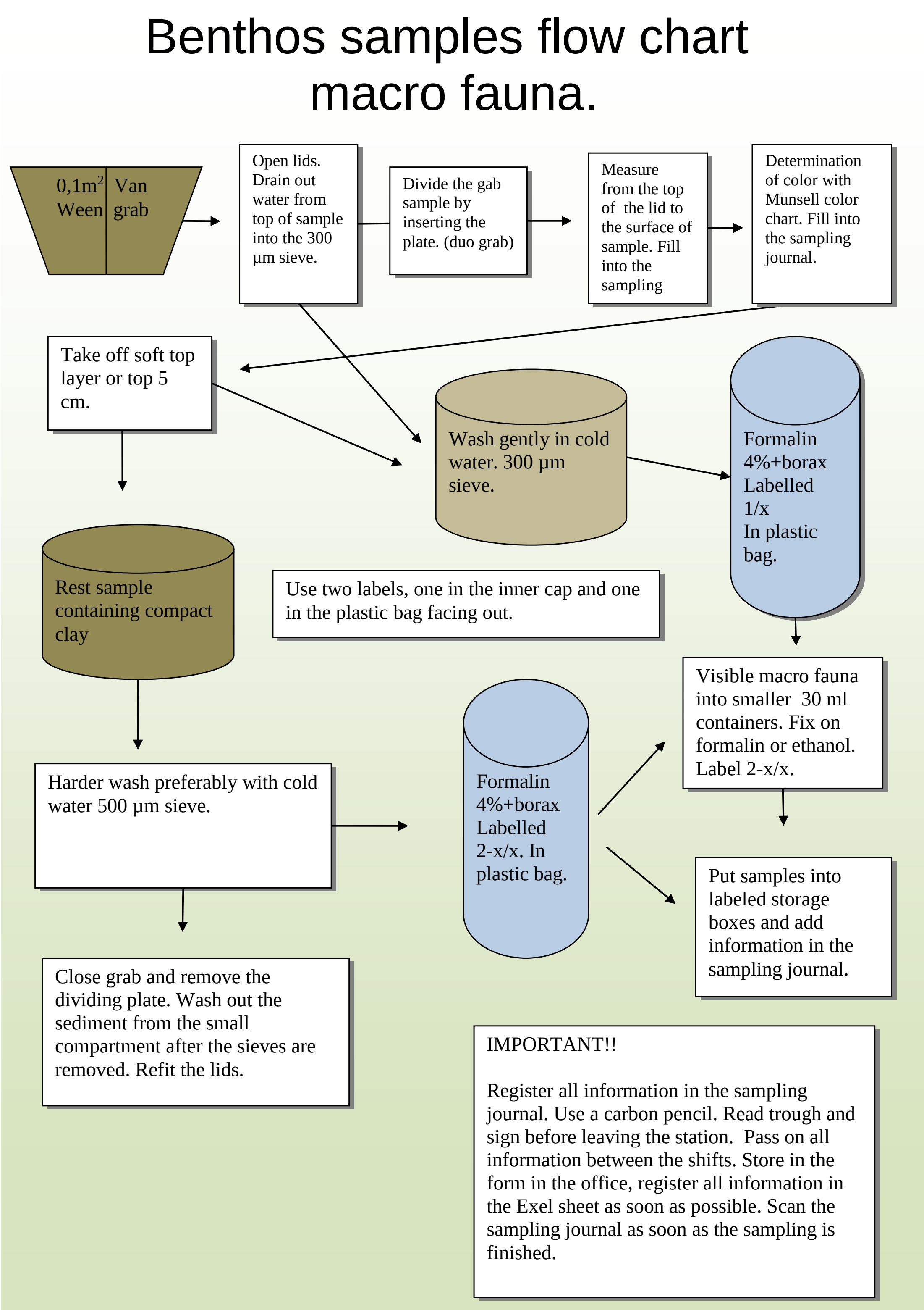
Transceiver-2 menu (38 kHz)

Transducer depth	6.50 m
Absorption coeff.	9.6 dB/km
Pulse duration	medium (1,024ms)
Bandwidth	2.43 kHz
Max power	2000 Watt
2-way beam angle	-20,6dB
gain	25,11 dB

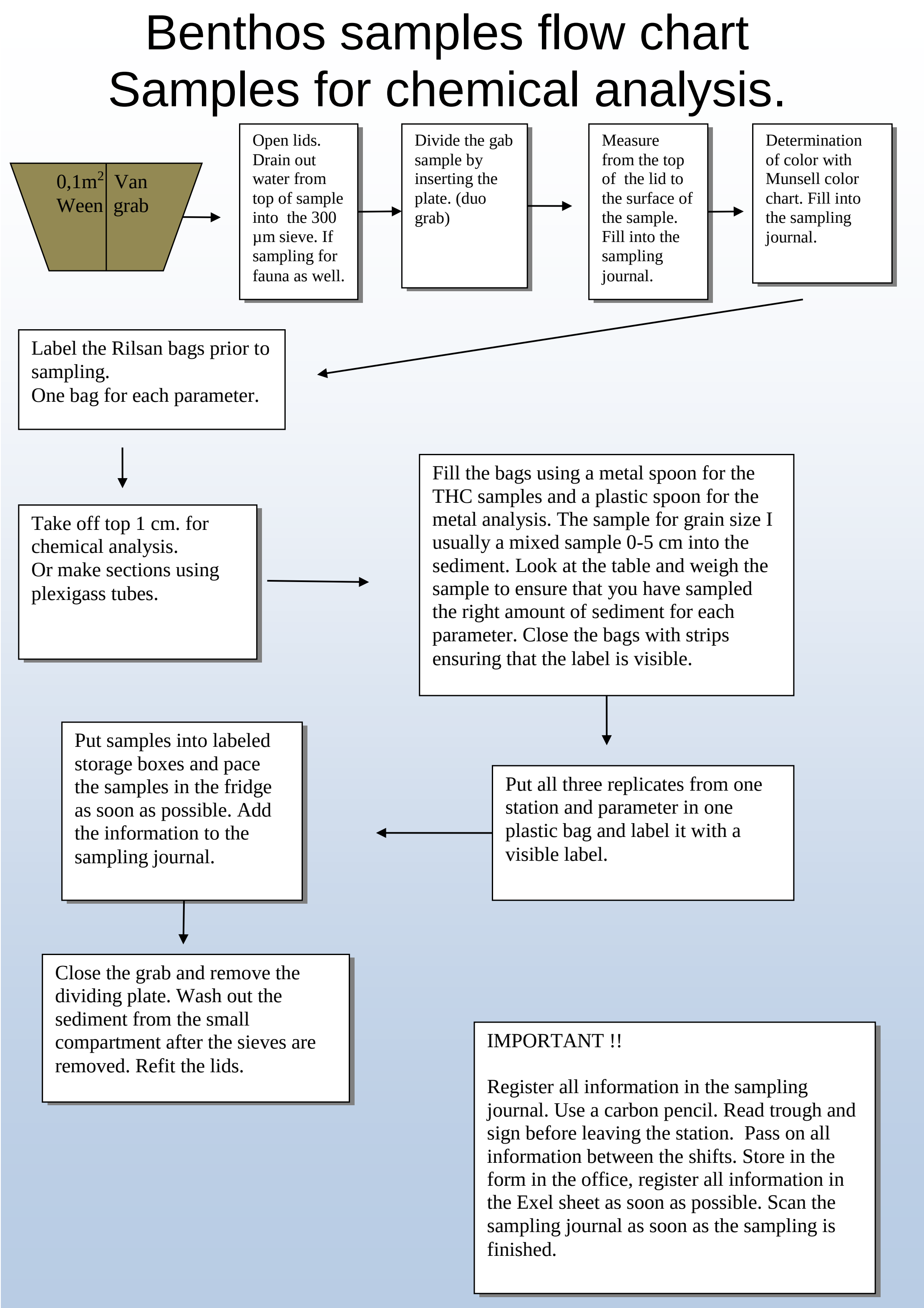
SA correction	-0.60 dB
Angle sensitivity	21.9
3 dB beam width	7.43º along ship
7.38º athwardship	
Along ship offset	0.06º
Athwardship offset	0.04º
Bottom detection menu	Minimum level -40 dB

ANNEX II Sampling procedures.

Annex II. A) Benthic macro fauna.

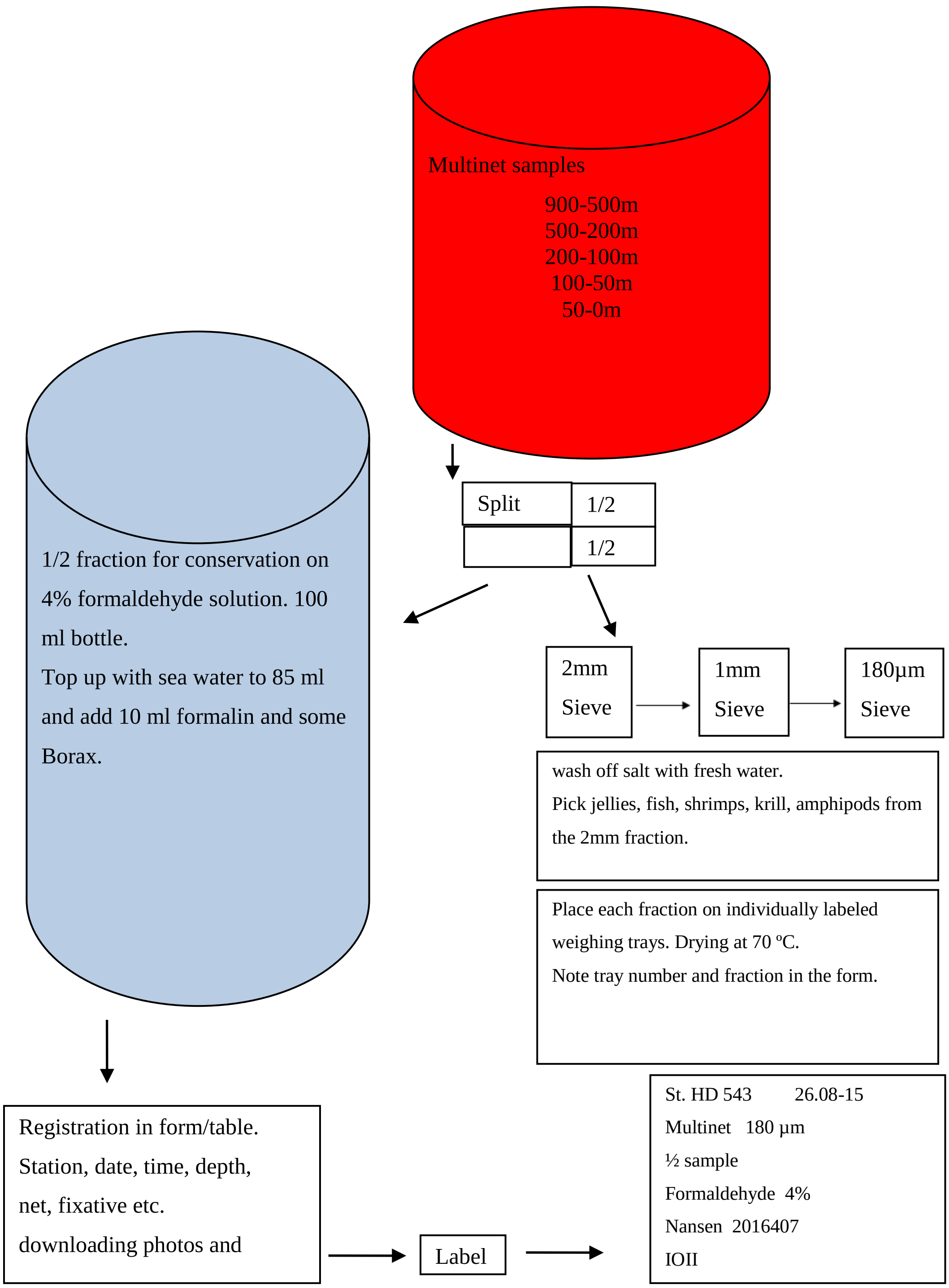


Annex II. B) Benthos samples flow chart chemical analysis.



Annex II. C) plankton samples from the multinet.

Multinet Flow chart 900-0m



Annex II D) SAMPLING PROTOCOLS FOR MICROPLASTICS

Net: Manta or neuston surface trawl
Trawl duration: 3 x 15 minute trawls
Towing speed: 2 – 3 knots
Tow position: Outside the wake of the vessel

Prior to deploying:

Check a clean cod end is attached

Attach flow meter to net ensuring the propeller will run free and flow meter is facing in the direction of the trawl.

Record the flow meter

Record the weather conditions, wind speed, direction, wave height and vessel direction.

Record the time, date and location (lat/long)

Deployment:

Deploy the trawl gently – do not drop the net as it can damage the flow meter. Once it is in the water, start timing on a stopwatch

Monitor the performance of the net and adjust boat speed if the net is affect by the wake of the vessel.

At ~ 14 mins 30 seconds start getting ready to retrieve the net. It should break the surface at approximately 15 minutes.

Record the stop position

Record the flow meter. Calculate the difference between the start and stop reading.

Wash the net down.

Remove the cod end and gently rinse contents into a sorting tray. Alternatively, can leave contents inside cod end to dry and then empty these contents into a zip lock bag for sorting at a later date.

Wash net and cod ends thoroughly before redeployment to ensure no cross contamination.

Sorting:

Using a head torch and forceps, place all suspected plastic items on a gridded petri dish for examination under microscope (watch for shell fragments and jellyfish film etc.)

Photograph gridded Petri dish with a label and scale.

Record debris items on datasheet.

Wrap debris items in foil and label

Annex III. Survey effort.

Annex III A. Sampling effort, Connecting gears and samples in time and space.

CTD	DATE	TIME	LON	LAT	Depth	Manta PL.	multinet PL.	CPR PL.	WP2	Benthos	Log. GR	Filter	Nutr.	zoo pl.	pl. W.
HD542	18.7.15	15:08:05	57.2776	-20.3928	1057	1-3						x	x		
HD543	19.7.15	7:53:20	57.3817	-20.7905	3683	4-6						x	x		
HD544	19.7.15	21:29:06	57.9637	-22.1818	4717	7-9		10				x	x		
HD545	20.7.15	15:15:12	58.6808	-24.5754	5001	11-13		14				x	x		
HD546	21.7.15	7:43:21	56.1067	-25.239	4972	15-17	18	19				x	x	x	x
HD547	22.7.15	7:09:48	52.4968	-25.9821	5200	20-22	23	24				x	x	x	x
HD548	23.7.15	8:53:13	48.4621	-26.6715	4300	25-27	28	29, 30				x	x	x	x
HD549	24.7.15	1:41:08	46.2266	-26.9217	1755	31-33	34	35, 37	34, 36			x	x	x	x
HD550	24.7.15	11:22:43	45.7799	-26.9229	1176	38-40		42	41			x	x		
HD551	24.7.15	16:40:35	45.5336	-27.1891	1287	43-45		48	46, 47			x	x		
HD552	24.7.15	21:56:36	45.9177	-27.1727	1943	49-51			52, 53			x	x		
HD553	25.7.15	5:10:31	46.3974	-27.1402	1523	54-56	57			MR.1	1-3	x	x	x	x
HD554	25.7.15	19:43:20	46.1053	-27.1612	569	58-60	61			MR.2	4	x	x	x	x
HD555	26.7.15	1:35:58	45.7861	-27.1791	543	62-64	65					x	x	x	x
MR.3	26.7.15		45°47.235	27°10.7485	542					MR.3	NA				
PL66	26.7.15	19:10:05	45.8507	-27.1746	1804	67-69	66							x	x
HD556	26.7.15	22:36:30	45.9798	-27.2895	1953	71-73	70			MR.5	8-12	x	x	x	x
HD557	27.7.15	17:32:20	45.5437	-28.1221	2413	74-76	77					x	x	x	x
HD558	28.7.15	1:25:30	45.1071	-28.1358	2491	78-80	81			MR.6	13	x	x	x	x
HD559	28.7.15	10:02:11	45.2656	-28.3539	736	82-84	85	86		MR.7	14	x	x	x	x
HD560	28.7.15	17:12:16	45.2077	-28.5465	2856	88-90	87	91				x	x	x	x
HD561	29.7.15	2:50:31	45.0311	-29.4191	2920	92-94		95				x	x		
MR.8	29.7.15	13:05:13	45.9537	-30.0817	841					MR.8	15				
HD562	29.7.15	19:51:53	45.9198	-30.1591	1428	96-98	99	100		MR.9	16	x	x	x	x
HD563	30.7.15	5:04:55	46.6578	-30.4663	2512	101-103	104	105, 106				x	x	x	x
HD564	31.7.15	7:57:08	44.0366	-33.0703	796	107-109	110			MR.10	17	x	x	x	x
HD565	31.7.15	15:40:42	43.5985	-33.122	1028	111-113	114					x	x	x	x
HD566	31.7.15	20:26:51	43.6262	-33.2571	990	115-117						x	x		
HD567	8.1.15	1:14:50	44.0692	-33.2159	729	118-120		123, 124	121, 122			x	x		
MR.11	2.8.15	10:44:30	43.9025	-33.0885	507					MR.11	18-21				
MR.12	2.8.15	13:30:35	43.9105	-33.1286	79					MR.12	22				
MR.13	2.8.15	14:31:40	43.8472	-33.1346	150					MR.13	23,24				
HD568	3.8.15	5:03:14	41.2336	-32.6096	4875	125-127	128	129, 130				x	x	x	x
HD569	4.8.15	6:39:59	37.3753	-31.6949	4811	131-133	134					x	x	x	x

Vessel: Nansen	Area: Madagascar ridge	Project code:	Survey nr: 2015407 Indian ocean II

Grab station nr.:	Date: 25/7-2015	Position		Depth 1518 m
		Longitude E/W	Latitude N/S	
MR 1.		46.3991	-27.1409	Positioning control:

Weather:	Wind:	Wave height (m):
Time Start:	Time Finish:	Duration:
Sample equipment used (name, bite area, weight): 0.1 m² Van Veen Grab and 0,3 mm sieve (round holes)		

Type of bottom sediment: Sand, consolidated sand clumps.			
Color:	Odor: None		
Observation of animals: Broken shells possibly brachiopods or mollusks.	No. rejected samples: 2		
Observation of waste, pollutants etc.: None	Empty: 1	Stone:	Open: 1

Sample nr.	Diary nr.	Volume (cm)	Metals:	THC:	box		Remarks : chemical	Toc:	granulometry geo.		G. nr	Ex. w	Br. Surf
									Sec.	0-5			
1													
2													

Sample nr.	Diary nr.	Vol. (cm)	Bottle number	bottles 0,3 mm	Bottles 0,5 mm	Remarks: Bio sample	Box nr.	Pallet nr.	fixation	Grab nr.	Extra weights
4	Gr.2	-	2		2	Grab nearly empty, single specimen in 96% ethanol			4% Form	Long	Yes + heavy lid
5	Gr.3	-	2	1	1	Grab nearly empty					Yes + heavy lid
6											
7											
8											

Sign. out:

SAMPLING JOURNAL **Sign. in:** **Page nr: 2 of 13**

Vessel: **Nansen**	Area: **Madagascar ridge**	Project code:	Survey nr: **2015407 Indian ocean II**

Grab station nr.:	**Date: 25 / 7-2015**	**Position**		**Depth m**
		Longitude E/W	**Latitude N/S**	
MR.2		46.1083	-27.1607	**Positioning control:**

Weather: Clear	**Wind: 18,93**	**Wave height (m): 1-2 m**
Time Start:17:15	**Time Finish: 19:40**	**Duration:**
Sample equipment used (name, bite area, weight): m² Van Veen Grab and mm sieve (round holes)		

Type of bottom sediment: Top of mountain, hard bottom? no successful samples. Log entry: GR. 4			
Color:	**Odor:**		
Observation of animals:	**No. rejected samples: 5**		
Observation of waste, pollutants etc.:	Empty: 3	Stone:	Open: 2

Sample nr.	Diary nr.	Volume (cm)	Metals:	THC:	box		Remarks : chemical	Toc:	granulometry geo.		G. nr	Ex. w	Br. Surf
									Sec.	0-5			
1													
2													

Sample nr.	Diary nr.	Vol. (cm)	Bottle number	bottles 0,3 mm	Bottles 0,5 mm	Remarks: Bio sample	Box nr.	Pallet nr.	fixation	Grab nr.	Extra weights
4											
5											
6											
7											

8											

Sign. out:

SAMPLING JOURNAL **Sign. in:** **Page nr: 3 of 13**

Vessel: **Nansen**	Area: **Madagascar ridge**	Project code:	Survey nr: **2015407 Indian ocean II**

Grab station nr.:	**Date: 26/7 -2015**	**Position**		**Depth m**
		Longitude E/W	**Latitude N/S**	
MR. 3				**Positioning control:**

Weather: Clear	**Wind:**	**Wave height (m): 1-2 m**
Time Start:	**Time Finish:**	**Duration:**
Sample equipment used (name, bite area, weight): 0,1 m² Van Veen Grab and 0,3 and 0,5 mm sieve (round holes)		

Type of bottom sediment:			
Color:	**Odor:**		
Observation of animals:	**No. rejected samples: 2**		
Observation of waste, pollutants etc.:	**Empty: 2**	**Stone:**	**Open:**

Sample nr.	**Diary nr.**	**Volume (cm)**	**Metals:**	**THC:**	**box**		**Remarks : chemical**	**Toc:**	**granulometry geo.**		**G. nr**	**Ex. w**	**Br. Surf**
									Sec.	**0-5**			
1													
2													

Sample nr.	**Diary nr.**	**Vol. (cm)**	**Bottle number**	**bottles 0,3 mm**	**Bottles 0,5 mm**	**Remarks: Bio sample**	**Box nr.**	**Pallet nr.**	**fixation**	**Grab nr.**	**Extra weights**
4						**Missing log entry**					

5											
6											
7											
8											

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SAMPLING JOURNAL **Sign. in:** **Page nr: 4 of 13**

Vessel: **Nansen**	Area: **Madagascar ridge**	Project code:	Survey nr: **2015407 Indian ocean II**

Grab station nr.:	Date: 26/7 -2015	Position		Depth 1846 m
		Longitude E/W	Latitude N/S	
MR. 4		45.8552	-27.1756	Positioning control:

Weather: Clear	Wind: 17,31	Wave height (m): 1-2 m
Time Start: 11:17	Time Finish: 16:55	Duration: 5,5 hours
Sample equipment used (name, bite area, weight): 0,1 m^2 Van Veen Grab and 0,3 and 0,5 mm sieve (round holes)		

Type of bottom sediment: Sand, fine grained compact.			
Color: 10YR 5/4 Yellowish brown	Odor: None		
Observation of animals:	No. rejected samples: 6		
Observation of waste, pollutants etc.: None	Empty: 2	Stone:	Open: 4

Sample nr.	Diary nr.	Volume (cm)	Metals:	THC:	box		Remarks : chemical	Toc:	granulometry geo.		G. nr	Ex. w	Br. Surf
									Sec.	0-5			
1													
2	GR.6		1	1	1	1		1		1	LA	Y	N

Sample nr.	Diary nr.	Vol. (cm)	Bottle number	bottles 0,3 mm	Bottles 0,5 mm	Remarks: Bio sample	Box nr.	Pallet nr.	fixation	Grab nr.	Extra weights

4	GR.5	13,7	17	4	13	Fixed on formaldehyde and ethanol. For all three.			4/96	long	Yes + heavy lid
5	GR.6	15	9	3	6	Upper 1 cm for chemicals.			4/96	long	Yes + heavy lid
6	GR.7	13,7	17	5	12				4/96	long	Yes + heavy lid
7											
8											

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SAMPLING JOURNAL **Sign. in:** **Page nr: 5 of 13**

Vessel: Nansen	Area: Madagascar ridge	Project code:	Survey nr: 2015407 Indian ocean II

Grab station nr.:	Date: 27/7 -2015	Position		Depth 1934 m
		Longitude E/W	Latitude N/S	
MR. 5		45.9811	-27.2868	Positioning control:

Weather: Clear	Wind:	Wave height (m): 3-4 m
Time Start: 05:53	Time Finish: 14:00	Duration: 8 hrs. 7 min
Sample equipment used (name, bite area, weight): 0,1 m^2 Van Veen Grab and 0,3 and 0,5 mm sieve (round holes)		

Type of bottom sediment: Fine sand			
Color: 10YR 5/3 Brown	Odor: None		
Observation of animals: Few Pteropods, single Psolus sea cucumber.	No. rejected samples: 2		
Observation of waste, pollutants etc.: N/A	Empty: 1	Stone:	Open: 1

Sample nr.	Diary nr.	Volume (cm)	Metals:	THC:	Misc.	Box.	Remarks : chemical	Toc:	granulometry geo.		G. nr	Ex. w	Br. Surf
									Sec.	0-1			
1													
2	GR.11	11,3	1	1	1	1		1		1	LA	Y	N
3													

Sample nr.	Diary nr.	Vol. (cm)	Bottle number	bottles 0,3 mm	Bottles 0,5 mm	Remarks: Bio sample	Box nr.	Pallet nr.	fixation	Grab nr.	Extra weights
4	GR.9	12,5	11	3	8	Fixed on formaldehyde and ethanol. For all three.			4/96	long arm	Yes + heavy lid
5	GR.11	11,3	13	3	10	Upper 1 cm for chemical analysis			4/96	long arm	Yes + heavy lid
6	GR.12	13,7	9	2	7				4/96	long arm	Yes + heavy lid
7											
8											

Sign. out:

SAMPLING JOURNAL **Sign. In:** **Page nr: 6 of 13**

Vessel: Nansen	Area: Madagascar ridge	Project code:	Survey nr: 2015407 Indian ocean II

Grab station nr.:	Date: 28/7 -2015	Position		Depth 2487 m
		Longitude E/W	Latitude N/S	
MR. 6		45.1064	-28.1361	Positioning control:

Weather: Clear	Wind:	Wave height (m): 2-3 m
Time Start: 07:45	Time Finish: 09:00	Duration: 1 hrs. 15 min.
Sample equipment used (name, bite area, weight): 0,1 m^2 Van Veen Grab and 0,3 and 0,5 mm sieve (round holes)		

Type of bottom sediment: Hard, pebbles and clumps of foraminifera picture taken. GR.13			
Color:	Odor:		
Observation of animals: Foraminifera	No. rejected samples: 1		
Observation of waste, pollutants etc.: None	Empty: 1	Stone:	Open:

Sample nr.	Diary nr.	Volume (cm)	Metals:	THC:	box		Remarks : chemical	Toc:	granulometry geo.		G. nr	Ex. w	Br. Surf
									Sec.	0-5			
1													
2													

3													

Sample nr.	Diary nr.	Vol. (cm)	Bottle number	bottles 0,3 mm	Bottles 0,5 mm	Remarks: Bio sample	Box nr.	Pallet nr.	fixation	Grab nr.	Extra weights
4	GR13	12,5	1		1	ethanol.			96 eth.	long arm	Yes + heavy lid
5											
6											
7											
8											

Sign. out:

SAMPLING JOURNAL **Sign. in:** **Page nr: 7 of 13**

Vessel: **Nansen**	Area: **Madagascar ridge**	Project code:	Survey nr: **2015407 Indian ocean II**

Grab station nr.:	Date: 28/7 -2015	Position		Depth 745 m
		Longitude E/W	Latitude N/S	
MR. 7		45.2655	-28.3575	Positioning control:

Weather: Clear	Wind:	Wave height (m): 2-3 m
Time Start:15:11	Time Finish: 16:30	Duration: 1:20
Sample equipment used (name, bite area, weight): 0,1 m^2 Van Veen Grab and 0,3 and 0,5 mm sieve (round holes)		

Type of bottom sediment: no successful samples GR.14.			
Color:	Odor:		
Observation of animals:	No. rejected samples: 2		
Observation of waste, pollutants etc.:	Empty: 2	Stone:	Open:

Sample nr.	Diary nr.	Volume (cm)	Metals:	THC:	box		Remarks : chemical	Toc:	granulometry geo.		G. nr	Ex. w	Br. Surf
									Sec.	0-5			

1													
2													

Sample nr.	Diary nr.	Vol. (cm)	Bottle number	bottles 0,3 mm	Bottles 0,5 mm	Remarks: Bio sample	Box nr.	Pallet nr.	fixation	Grab nr.	Extra weights
4						Missing log entry					
5											
6											
7											
8											

Sign. out:

SAMPLING JOURNAL **Sign. in:** **Page nr: 8 of 13**

Vessel: Nansen	Area: Madagascar ridge	Project code:	Survey nr: 2015407 Indian ocean II

Grab station nr.:	Date: 29/7-2015	Position		Depth 841 m
		Longitude E/W	Latitude N/S	
MR. 8 (Vams 1)		45.9537	-30.0817	Positioning control:

Weather: Clear	Wind:	Wave height (m): 1m
Time Start: 13:05	Time Finish:	Duration:
Sample equipment used (name, bite area, weight): 0,1 m^2 Van Veen Grab and 0,3 and 0,5 mm sieve (round holes) VAMS		

Type of bottom sediment: Hard bottom no sediments collected, only dead coral pieces and sponges			
Color:	Odor:		
Observation of animals: Dead Scleactinian cup corals and sponges.	No. rejected samples: 2		
Observation of waste, pollutants etc.: None	Empty: 2	Stone:	Open:

Sample nr.	Diary nr.	Volume (cm)	Metals:	THC:	box		Remarks : chemical	Toc:	granulometry geo.		G. nr	Ex. w	Br. Surf
									Sec.	0-5			
1													
2													
3													

Sample nr.	Diary nr.	Vol. (cm)	Bottle number	bottles 0,3 mm	Bottles 0,5 mm	Remarks: Bio sample	Box nr.	Pallet nr.	fixation	Grab nr.	Extra weights
4		0				No sorting into size fractions			96% eth.		
5		0							96% eth.		
6		0							96% eth.		
7											
8											

Sign. out:

SAMPLING JOURNAL **Sign. in:** **Page nr: 9 of 13**

Vessel: Nansen	Area: Madagascar ridge	Project code:	Survey nr: 2015407 Indian ocean II

Grab station nr.:	Date: 29/7-2015	Position		Depth 1480 m
		Longitude E/W	Latitude N/S	
MR. 9		45.9114	-30.1563	Positioning control:

Weather: Clear	Wind:	Wave height (m): 1-2 m
Time Start:	Time Finish:	Duration:
Sample equipment used (name, bite area, weight): 0,1 m^2 Van Veen Grab and 0,3 and 0,5 mm sieve (round holes) VAMS		

Type of bottom sediment: Hard bottom, volcanic origin with a thin sand layer and sand patches in between.	
Color: light grey sand and blackish lava formations.	Odor: None
Observation of animals: Foraminifera	No. rejected samples:

Observation of waste, pollutants etc.: None	Empty:	Stone:	Open:

Sample nr.	Diary nr.	Volume (cm)	Metals:	THC:	box		Remarks : chemical	Toc:	granulometry geo.		G. nr	Ex. w	Br. Surf
									Sec.	0-5			
1													
2													

Sample nr.	Diary nr.	Vol. (cm)	Bottle number	bottles 0,3 mm	Bottles 0,5 mm	Remarks: Bio sample	Box nr.	Pallet nr.	fixation	Grab nr.	Extra weights
1			1	1		Small sample, no sediment depth			4% F		
2			1	1		recorded. < 1cm sediment in the grabs.			4% F		
3			1	1	1				4% F		

Sign. out:

SAMPLING JOURNAL **Sign. in:** **Page nr: 10 of 13**

Vessel: Nansen	Area: Madagascar ridge	Project code:	Survey nr: 2015407 Indian ocean II

Grab station nr.:	Date: 31/07-2015	Position		Depth 793 m
		Longitude E/W	Latitude N/S	
MR. 10 VAMS 3		44.0355	-33.0717	Positioning control:

Weather: Cloudy	Wind:	Wave height (m): 1-2 m
Time Start: 12:00	Time Finish: 16:00	Duration: 4 hrs.
Sample equipment used (name, bite area, weight): 0,1 m^2 Van Veen Grab and 0,3 and 0,5 mm sieve (round holes) long arm		

Type of bottom sediment: sandy bottom with ripples and shells of terapods.

Color: 10 YR 7/3 very pale brown			Odor:
Observation of animals:			No. rejected samples:
Observation of waste, pollutants etc.:	Empty:	Stone:	Open:

Sample nr.	Diary nr.	Volume (cm)	Metals:	THC:	Misc.:	Box:	Remarks : chemical	Toc:	granulometry geo.		G. nr	Ex. w	Br. Surf
									Sec.	0-5			
1													
2	11	1	1	1	1			1		1	LA?	Y	N

Sample nr.	Diary nr.	Vol. (cm)	Bottle number	bottles 0,3 mm	Bottles 0,5 mm	Remarks: Bio sample	Box nr.	Pallet nr.	fixation	Grab nr.	Extra weights
1			10	4	6				4/96		
2		11	12	5	7				4/96	DUO	
3		??	3	1	2				4/96	DUO	

Sign. out:

SAMPLING JOURNAL **Sign. in:** **Page nr: 11 of 13**

Vessel: Nansen	Area: Madagascar ridge	Project code:	Survey nr: 2015407 Indian ocean II

Grab station nr.:	Date: 02/08-2015	Position		Depth 507 m
		Longitude E/W	Latitude N/S	
MR. 11		43.9105	-33.1286	Positioning control:

Weather: Clear	Wind:	Wave height (m): 1-2 m
Time Start: 10:44	Time Finish: 12:38	Duration: 2 hrs.
Sample equipment used (name, bite area, weight): 0,1 m^2 Van Veen Grab and 0,3 and 0,5 mm sieve (round holes) long arm		

Type of bottom sediment: Sand with coral debris and forams.			
Color:	Odor:		
Observation of animals: dead corals, mollusks and shells	No. rejected samples: 3		
Observation of waste, pollutants etc.: None	Empty: 3	Stone:	Open:

Sample nr.	Diary nr.	Volume (cm)	Metals:	THC:	Misc.:	Box:	Remarks : chemical	Toc:	granulometry geo.		G. nr	Ex. w	Br. Surf
									Sec.	0-5			
1													
2													

Sample nr.	Diary nr.	Vol. (cm)	Bottle number	bottles 0,3 mm	Bottles 0,5 mm	Remarks: Bio sample	Box nr.	Pallet nr.	fixation	Grab nr.	Extra weights
1	GR.18		5	2	3				4/96	Long arm	Yes 2+lids
2											
3											

Sign. out:

SAMPLING JOURNAL **Sign. in:** **Page nr: 12 of 13**

Vessel: Nansen	Area: Walter shoales Madagascar ridge	Project code:	Survey nr: 2015407 Indian ocean II

Grab station nr.:	Date: 02/08-2015	Position		Depth 79 m
		Longitude E/W	Latitude N/S	
MR. 12		43.9105	-33.1286	Positioning control:

Weather: Cloudy	Wind:	Wave height (m): 1-2 m

Time Start: 13:30	Time Finish: 14:00	Duration: 1 hrs.
Sample equipment used (name, bite area, weight): 0,1 m² Van Veen Grab and 0,3 and 0,5 mm sieve (round holes) long arm		

Type of bottom sediment: Corraline algae			
Color:	Odor:		
Observation of animals: see below	No. rejected samples:		
Observation of waste, pollutants etc.:	Empty:	Stone:	Open:

Sample nr.	Diary nr.	Volume (cm)	Metals:	THC:	Misc.:	Box:	Remarks : chemical	Toc:	granulometry geo.		G. nr	Ex. w	Br. Surf
									Sec.	0-5			
1													
2													

Sample nr.	Diary nr.	Vol. (cm)	Bottle number	bottles 0,3 mm	Bottles 0,5 mm	Remarks: Bio sample	Box nr.	Pallet nr.	fixation	Grab nr.	Extra weights
1	GR.22		8			Coralline algae with epifauna *			70% eth	Long arm	Yes 2+lids
2			1						70% eth	Long arm	Yes 2+lids
3						* 1. Bryozoa sp. 1 2pcs. 2. Bryozoa sp.2 1 pice.					
						3. Comatulida 4 ind. Possibly 2 spp. 4. Hydrozoa indet 2 colonies. 5. Porifera sp.1 1 ind. On coralline algae yellow					
						6. Coralline algae + Bivalvia indet several. 7. Galatidae indet 2 ind < 1 cm.					
						8. Others 0,18 fraction.					

Sign. out:

SAMPLING JOURNAL **Sign. in:** **Page nr: 13 of 13**

Vessel: Nansen	Area: Madagascar ridge	Project code:	Survey nr: 2015407 Indian ocean II

Grab station nr.:	Date: 02/08-2015	Position		Depth 793 m
		Longitude E/W	Latitude N/S	
MR. 13		44.0355	-33.0717	Positioning control:

Weather: Cloudy	Wind:	Wave height (m): 1-2 m
Time Start: 12:00	Time Finish: 16:00	Duration: 4 hrs.
Sample equipment used (name, bite area, weight): 0,1 m² Van Veen Grab and 0,3 and 0,5 mm sieve (round holes) long arm		

Type of bottom sediment: sandy bottom with ripples and shells of terapods.			
Color: 10 YR 7/3 very pale brown	Odor:		
Observation of animals:	No. rejected samples:		
Observation of waste, pollutants etc.:	Empty:	Stone:	Open:

Sample nr.	Diary nr.	Volume (cm)	Metals:	THC:	Misc.:	Box:	Remarks : chemical	Toc:	granulometry geo.		G. nr	Ex. w	Br. Surf
									Sec.	0-5			
1													
2	11	1	1	1	1			1		1	LA?	Y	N

Sample nr.	Diary nr.	Vol. (cm)	Bottle number	bottles 0,3 mm	Bottles 0,5 mm	Remarks: Bio sample	Box nr.	Pallet nr.	fixation	Grab nr.	Extra weights
1			10	4	6				4/96		
2		11	12	5	7				4/96	DUO	
3		??	3	1	2				4/96	DUO	

Sign. out:

Annex III C. Multinet stations.

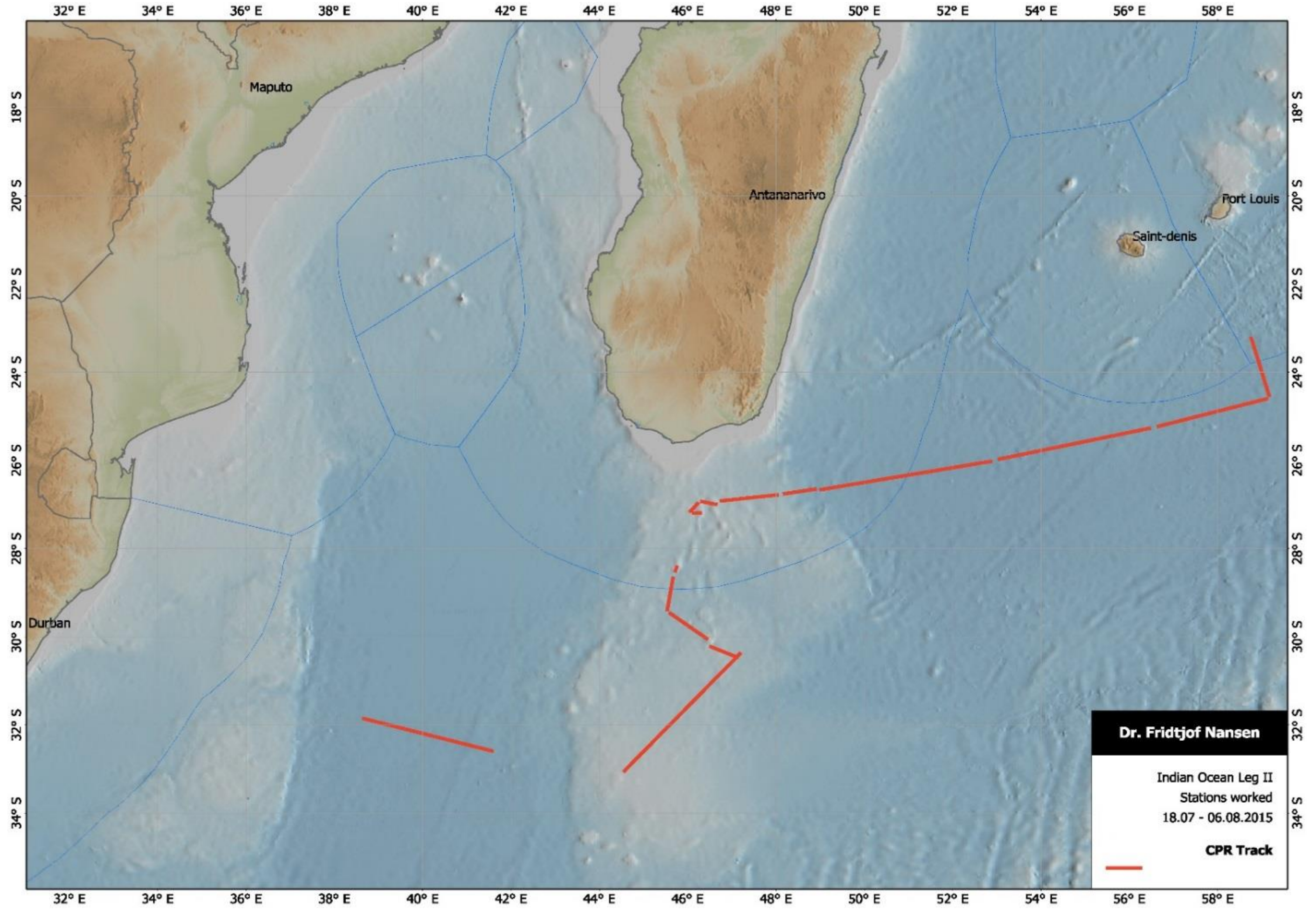
STA	DATE	TIME	LON	LAT	DEP	EVENT	Samples	REMARK	SUPERSTATION
PL18	7/21/2015	10:03:15	56.071	-25.2481	4968	P	5	Multinet	HD546
PL23	7/22/2015	9:23:23	52.4603	-25.9922	0	P	5	Multinet	HD547
PL28	7/23/2015	11:03:01	48.4548	-26.6752	0	P	5	Multinet	HD548
PL34	7/24/2015	5:06:11	46.2219	-26.9559	1699	P	5	Multinet	HD549
PL57	7/25/2015	7:51:52	46.4283	-27.1385	1520	P	5	Multinet	HD553
PL61	7/25/2015	21:39:21	46.1457	-27.1655	691	P	4	Multinet	HD554
PL65	7/26/2015	5:19:11	45.7914	-27.178	530	P	5	Multinet	HD555
PL66	7/26/2015	19:10:05	45.8507	-27.1746	1804	P	5	Multinet	
PL70	7/27/2015	0:43:33	45.9781	-27.2898	1959	P	5	Multinet	HD556
PL77	7/27/2015	21:07:41	45.5348	-28.1165	2862	P	5	Multinet	HD557
PL81	7/28/2015	5:01:39	45.0774	-28.1454	2469	P	5	Multinet	HD558
PL85	7/28/2015	11:51:19	45.2463	-28.3249	876	P	3	Multinet	HD559
PL87	7/28/2015	19:52:31	45.1998	-28.5576	2846	P	5	Multinet	HD560
PL99	7/29/2015	22:15:41	45.9502	-30.176	1350	P	5	Multinet	HD562
PL104	7/30/2015	8:23:01	46.7043	-30.4299	2544	P	5	Multinet	HD563
PL110	7/31/2015	12:07:44	43.9934	-33.0848	743	P	5	Multinet	HD564
PL114	7/31/2015	17:47:48	43.607	-33.0918	1010	P	5	Multinet	HD565
PL128	3/ 8/15	8:06:33	41.179	-32.6031	4734	P	5	Multinet	HD568
PL134	4/ 8/15	9:51:04	37.4029	-31.6964	4898	P	1	Multinet	HD569

Annex III D. WP2 stations

STATION	DATE	TIME	LON	LAT	DEP	EVENT	REMARK	SUPERSTATION
PL34	7/24/2015	8:09:37	46.1835	-27.0061	1286	P	WP2 600-0	HD549
PL36	7/24/2015	9:27:05	46.094	-26.9869	1214	P	WP2 100-0	
PL41	7/24/2015	13:40:49	45.7708	-26.9366	1163	P	WP2 600-0	HD550
PL46	7/24/2015	19:08:12	45.5796	-27.201	1351	P	WP2 600-0	HD551
PL47	7/24/2015	19:50:38	45.5812	-27.2016	1345	P	WP2 100-0	
PL52	7/25/2015	1:08:53	45.9223	-27.1449	1942	P	WP2 600-0	HD552
PL53	7/25/2015	1:47:07	45.9159	-27.1402	1932	P	WP2 100-0	
PL121	1/ 8/2015	3:08:49	44.0557	-33.1878	723	P	WP2 600-0	HD567
PL122	1/ 8/2015	3:54:49	44.0624	-33.1917	730	P	WP2 100-0	

Annex III E. CPR tracks.

STA	DATE	TIME	LON	LAT	DEP	EVENT	REMARK	SUPERSTATION
PL10	7/20/2015	6:31:25	58.2534	-23.1989	5115	P	CPR start	HD544
PL10	7/20/2015	15:02:02	58.6732	-24.5562	5217	P	CRP Stop	
PL14	7/20/2015	17:30:45	58.6411	-24.597	4946	P	CPR start	HD545
PL14	7/21/2015	7:36:15	56.1253	-25.2358	5043	P	CRP Stop	
PL19	7/21/2015	12:22:30	55.9862	-25.2669	4910	P	CPR start	HD546
PL19	7/22/2015	6:59:42	52.5241	-25.9771	0	P	CRP Stop	
PL24	7/22/2015	11:18:28	52.3956	-26.0168	0	P	CPR start	HD547
PL24	7/23/2015	8:42:24	48.4817	-26.6683	0	P	CRP Stop	
PL29	7/23/2015	13:33:11	48.4173	-26.6476	0	P	CPR start	HD548
PL29	7/23/2015	17:33:49	47.6569	-26.7615	0	P	CPR Stop	
PL30	7/23/2015	18:17:46	47.5579	-26.7784	0	P	CPR start	HD548
PL30	7/24/2015	1:22:01	46.2264	-26.922	0	P	CPR Stop	
PL35	7/24/2015	8:55:22	46.1706	-27.0009	1276	P	CPR start	HD549
PL35	7/24/2015	9:18:11	46.1003	-26.9869	1210	P	CPR Stop	
PL37	7/24/2015	9:38:29	46.0857	-26.9864	1201	P	CPR start	HD549
PL37	7/24/2015	11:11:28	45.7829	-26.9261	1155	P	CPR Stop	
PL42	7/24/2015	14:42:57	45.7451	-26.9586	1143	P	CPR start	HD550
PL42	7/24/2015	16:25:03	45.5413	-27.1754	1310	P	CPR Stop	
PL48	7/24/2015	20:06:38	45.5997	-27.1993	1371	P	CPR start	
PL48	7/24/2015	21:20:36	45.8222	-27.1864	1393	P	CPR Stop	
PL86	7/28/2015	16:11:14	45.2634	-28.3873	896	P	CPR start	HD559
PL86	7/28/2015	17:07:42	45.2109	-28.5387	2871	P	CPR Stop	
PL91	7/28/2015	22:05:28	45.1716	-28.6372	2780	P	CPR start	HD560
PL91	7/29/2015	2:40:21	45.0339	-29.4173	2916	P	CPR Stop	
PL95	7/29/2015	6:02:38	45.0806	-29.4508	2924	P	CPR start	HD561
PL95	7/29/2015	11:52:47	45.9555	-30.0563	953	P	CPR Stop	
PL100	7/30/2015	0:13:23	45.9979	-30.2129	1781	P	CPR start	HD562
PL100	7/30/2015	3:49:50	46.6507	-30.4757	2515	P	CPR Stop	
PL105	7/30/2015	10:39:49	46.7064	-30.3614	2538	P	CPR start	HD563
PL106	7/31/2015	7:51:26	44.0441	-33.0626	804	P	CPR Stop	HD563
PL123	8/ 2/2015	15:23:12	43.8172	-33.1326	431	P	CPR start	HD567
PL124	8/ 3/2015	4:57:58	41.2398	-32.6109	4895	P	CPR Stop	HD567
PL129	8/ 3/2015	10:00:02	41.1026	-32.596	4701	P	CPR start	HD568
PL130	8/ 4/2015	2:09:48	38.1324	-31.8458	4944	P	CPR Stop	HD568



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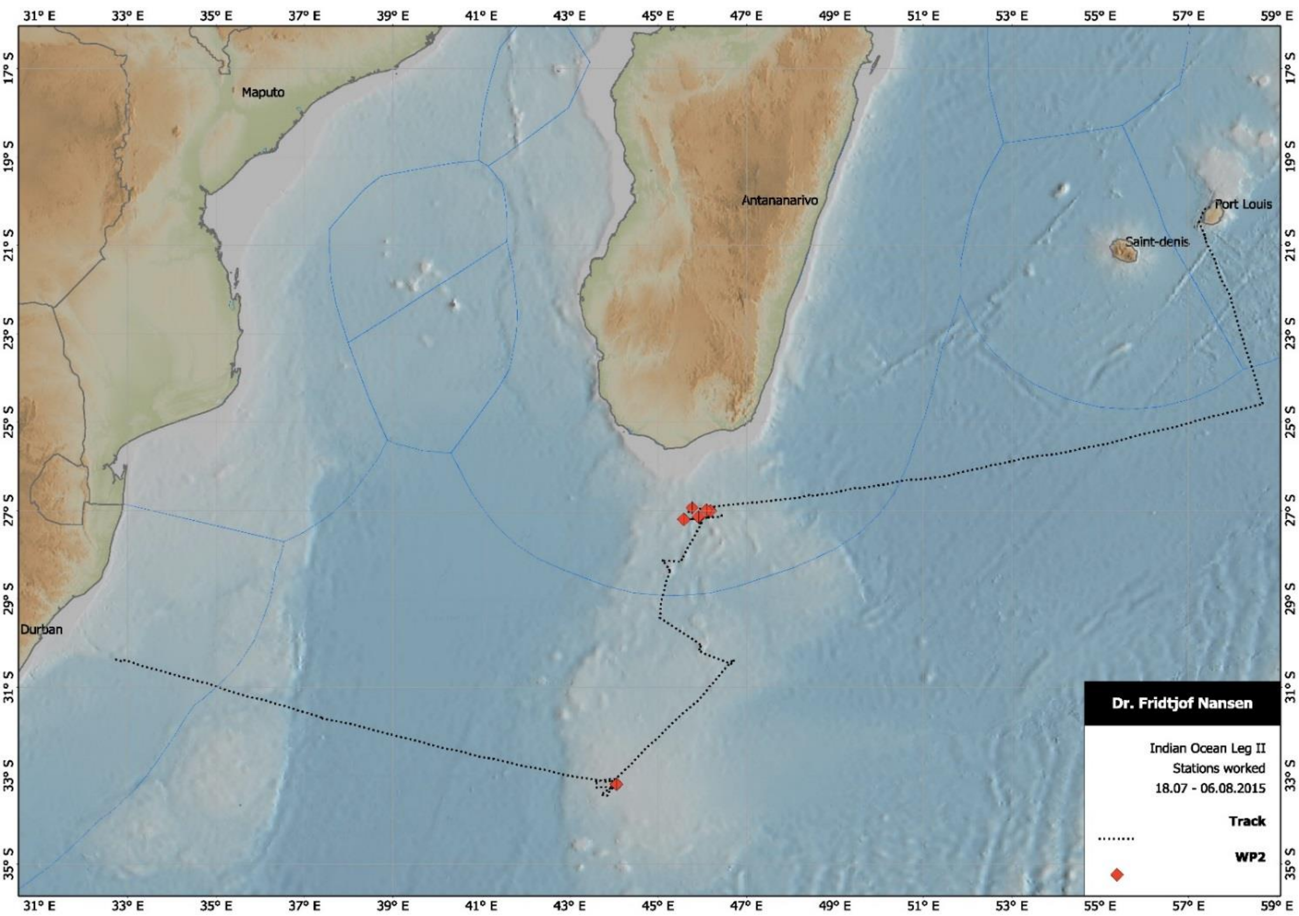
28° S
30° S
32° S
34° S
Maputo
Antananarivo
Port Louis
Saint-denis
Durban
Dr. Fridtjof Nansen
Indian Ocean Leg II
Stations worked
18.07 - 06.08.2015
CPR Track

CPR tracks.



WP2 stations.

ANNEX III F MANTA TRAWLS

Annex III F. Manta trawls 1.

STATION	DATE	TIME	LON	LAT	DEP	REMARK	SUPERST.
PL1	7/18/2015	16:56:49	57.2738	-20.4018	1267	mantatr. 1 start	HD542
PL1	7/18/2015	17:12:05	57.2751	-20.4093	1122	mantatr. 1 stop	
PL2	7/18/2015	17:15:23	57.2689	-20.4195	1066	mantatr. 2 start	
PL2	7/18/2015	17:31:53	57.2625	-20.4293	1043	mantatr. 2 stop	
PL3	7/18/2015	17:34:14	57.2625	-20.4295	1039	mantatr. 3 start	
PL3	7/18/2015	17:49:17	57.255	-20.4398	1047	mantatr. 3 stop	
PL4	7/19/2015	9:16:11	57.384	-20.8056	3569	mantatr. 1 start	HD543
PL4	7/19/2015	9:31:33	57.3813	-20.8154	3757	mantatr. 1 stop	
PL5	7/19/2015	9:35:01	57.3804	-20.8177	3747	mantatr. 2 start	
PL5	7/19/2015	9:51:06	57.3764	-20.8274	3693	mantatr. 2 stop	
PL6	7/19/2015	9:52:04	57.3759	-20.8282	3687	mantatr. 3 start	
PL6	7/19/2015	10:11:59	57.3703	-20.841	3726	mantatr. 3 stop	
PL7	7/19/2015	22:46:14	57.964	-22.1837	4708	mantatr. 1 start	HD544
PL7	7/19/2015	23:01:15	57.9639	-22.184	4692	mantatr. 1 stop	
PL8	7/19/2015	23:02:59	57.9609	-22.1938	4771	mantatr. 2 start	
PL8	7/19/2015	23:19:26	57.9606	-22.1952	4717	mantatr. 2 stop	
PL9	7/19/2015	23:20:44	57.9579	-22.2042	4694	mantatr. 3 start	
PL9	7/19/2015	23:36:46	57.9578	-22.205	4863	mantatr. 3 stop	
PL11	7/20/2015	16:31:41	58.6925	-24.5709	4444	mantatr. 1 start	HD545
PL11	7/20/2015	16:46:45	58.6825	-24.5788	5007	mantatr. 1 stop	
PL12	7/20/2015	16:49:01	58.681	-24.5798	5000	mantatr. 2 start	
PL12	7/20/2015	17:04:02	58.6716	-24.5861	4982	mantatr. 2 stop	
PL13	7/20/2015	17:06:22	58.6701	-24.587	4983	mantatr. 3 start	
PL13	7/20/2015	17:21:24	58.6611	-24.5926	4980	mantatr. 3 stop	
PL15	7/21/2015	9:11:54	56.1078	-25.2368	5153	mantatr. 1 start	HD546
PL15	7/21/2015	9:26:53	56.0976	-25.2402	4993	mantatr. 1 stop	
PL16	7/21/2015	9:28:44	56.0953	-25.241	5003	mantatr. 2 start	
PL16	7/21/2015	9:43:49	56.0948	-25.2411	5004	mantatr. 2 stop	
PL17	7/21/2015	9:45:58	56.084	-25.2446	5023	mantatr. 3 start	
PL17	7/21/2015	10:01:01	56.0819	-25.2452	5017	mantatr. 3 stop	
PL20	7/22/2015	8:22:16	52.4968	-25.9786	0	mantatr. 1 start	HD547
PL20	7/22/2015	8:37:42	52.4867	-25.9824	0	mantatr. 1 stop	
PL21	7/22/2015	8:39:18	52.4855	-25.9829	0	mantatr. 2 start	
PL21	7/22/2015	8:54:43	52.4759	-25.9863	0	mantatr. 2 stop	
PL22	7/22/2015	8:56:23	52.4749	-25.9867	0	mantatr. 3 start	
PL22	7/22/2015	9:12:02	52.4652	-25.9903	0	mantatr. 3 stop	
PL25	7/23/2015	10:09:28	48.4743	-26.6687	0	mantatr. 1 start	HD548
PL25	7/23/2015	10:25:20	48.4684	-26.6707	0	mantatr. 1 stop	
PL26	7/23/2015	10:26:54	48.4678	-26.671	0	mantatr. 2 start	
PL26	7/23/2015	10:43:42	48.462	-26.6731	0	mantatr. 2 stop	
PL27	7/23/2015	10:45:12	48.4615	-26.6732	0	mantatr. 3 start	
PL27	7/23/2015	10:57:24	48.457	-26.6747	0	mantatr. 3 stop	
PL31	7/24/2015	3:55:01	46.2191	-26.9286	1755	mantatr. 1 start	HD549
PL31	7/24/2015	4:11:55	46.2223	-26.9309	1757	mantatr. 1 stop	
PL32	7/24/2015	4:16:40	46.2221	-26.9333	1751	mantatr. 2 start	
PL32	7/24/2015	4:32:10	46.2256	-26.9405	1742	mantatr. 2 stop	

Annex III F. Manta trawls 2.

STATION	DATE	TIME	LON	LAT	DEP	REMARK	SUPERST.
PL33	7/24/2015	4:35:37	46.2266	-26.9423	1733	mantatr. 3 start	
PL33	7/24/2015	4:51:18	46.2311	-26.95	1734	mantatr. 3 stop	
PL38	7/24/2015	12:46:27	45.7608	-26.9233	1190	mantatr. 1 start	HD550
PL38	7/24/2015	13:01:57	45.7643	-26.9259	1165	mantatr. 1 stop	
PL39	7/24/2015	13:03:23	45.7645	-26.9264	1166	mantatr. 2 start	
PL39	7/24/2015	13:18:53	45.7672	-26.9315	1166	mantatr. 2 stop	
PL40	7/24/2015	13:19:17	45.7673	-26.9316	1165	mantatr. 3 start	
PL40	7/24/2015	13:34:48	45.7712	-26.9363	1162	mantatr. 3 stop	
PL43	7/24/2015	18:14:32	45.5412	-27.1906	1314	mantatr. 1 start	HD551
PL43	7/24/2015	18:29:44	45.5531	-27.1938	1346	mantatr. 1 stop	
PL44	7/24/2015	18:31:22	45.5543	-27.1942	1347	mantatr. 2 start	
PL44	7/24/2015	18:46:33	45.5651	-27.1974	1361	mantatr. 2 stop	
PL45	7/24/2015	18:48:12	45.5663	-27.1977	1364	mantatr. 3 start	
PL45	7/24/2015	19:03:24	45.5777	-27.2006	1354	mantatr. 3 stop	
PL49	7/25/2015	0:11:45	45.9152	-27.1711	1936	mantatr. 1 start	HD552
PL49	7/25/2015	0:26:57	45.919	-27.1637	1934	mantatr. 1 stop	
PL50	7/25/2015	0:28:19	45.9192	-27.1631	1935	mantatr. 2 start	
PL50	7/25/2015	0:46:05	45.9218	-27.154	1940	mantatr. 2 stop	
PL51	7/25/2015	0:47:59	45.922	-27.153	1937	mantatr. 3 start	
PL51	7/25/2015	1:03:17	45.9229	-27.1461	1944	mantatr. 3 stop	
PL54	7/25/2015	6:51:26	46.392	-27.1351	1530	mantatr. 1 start	HD553
PL54	7/25/2015	7:09:02	46.4033	-27.1372	1523	mantatr. 1 stop	
PL55	7/25/2015	7:11:04	46.4046	-27.1375	1523	mantatr. 2 start	
PL55	7/25/2015	7:26:29	46.4148	-27.1391	1520	mantatr. 2 stop	
PL56	7/25/2015	7:28:35	46.4161	-27.1393	1521	mantatr. 3 start	
PL56	7/25/2015	7:44:38	46.4264	-27.1409	1517	mantatr. 3 stop	
PL58	7/25/2015	20:29:18	46.1074	-27.1591	566	mantatr. 1 start	HD554
PL58	7/25/2015	20:45:25	46.12	-27.1608	572	mantatr. 1 stop	
PL59	7/25/2015	20:49:18	46.1231	-27.162	577	mantatr. 2 start	
PL59	7/25/2015	21:04:20	46.1321	-27.1652	598	mantatr. 2 stop	
PL60	7/25/2015	21:05:42	46.136	-27.1665	612	mantatr. 3 start	
PL60	7/25/2015	21:20:44	46.1481	-27.1705	757	mantatr. 3 stop	
PL62	7/26/2015	2:24:05	45.7869	-27.1777	541	mantatr. 1 start	HD555
PL62	7/26/2015	2:39:07	45.7934	-27.1789	526	mantatr. 1 stop	
PL63	7/26/2015	2:39:31	45.7936	-27.1791	526	mantatr. 2 start	
PL63	7/26/2015	2:55:28	45.7951	-27.1856	532	mantatr. 2 stop	
PL64	7/26/2015	2:57:06	45.7936	-27.1858	524	mantatr. 3 start	
PL64	7/26/2015	3:15:13	45.7774	-27.1892	583	mantatr. 3 stop	HD555
PL67	7/26/2015	20:42:39	45.8182	-27.1486	1098	mantatr. 1 start	
PL67	7/26/2015	20:57:43	45.8279	-27.1571	1342	mantatr. 1 stop	
PL68	7/26/2015	20:59:26	45.829	-27.1581	1346	mantatr. 2 start	
PL68	7/26/2015	21:14:54	45.8317	-27.1605	1430	mantatr. 2 stop	
PL69	7/26/2015	21:16:36	45.8392	-27.1674	1652	mantatr. 3 start	
PL69	7/26/2015	21:32:44	45.8404	-27.1685	1678	mantatr. 3 stop	
PL71	7/27/2015	2:52:18	45.9257	-27.2828	2070	mantatr. 1 start	HD556
PL71	7/27/2015	3:07:22	45.9428	-27.2855	2074	mantatr. 1 stop	

Annex III F. Manta trawls 3.

STATION	DATE	TIME	LON	LAT	DEP	REMARK	SUPERST.
PL72	7/27/2015	3:16:34	45.9515	-27.2854	2064	mantatr. 2 start	
PL72	7/27/2015	3:31:37	45.9526	-27.2848	2059	mantatr. 2 stop	
PL73	7/27/2015	3:34:56	45.9659	-27.2754	1988	mantatr. 3 start	
PL73	7/27/2015	3:50:06	45.9841	-27.2703	1906	mantatr. 3 stop	
PL74	7/27/2015	19:50:08	45.5282	-28.1245	2870	mantatr. 1 start	HD557
PL74	7/27/2015	20:05:08	45.5305	-28.1149	2866	mantatr. 1 stop	
PL75	7/27/2015	20:08:52	45.531	-28.1126	2868	mantatr. 2 start	
PL75	7/27/2015	20:24:45	45.5338	-28.1032	2841	mantatr. 2 stop	
PL76	7/27/2015	20:27:10	45.5344	-28.1023	2836	mantatr. 3 start	
PL76	7/27/2015	20:43:13	45.5395	-28.1104	2637	mantatr. 3 stop	
PL78	7/28/2015	3:37:29	45.1063	-28.1361	2488	mantatr. 1 start	HD558
PL78	7/28/2015	3:52:46	45.0981	-28.1399	2481	mantatr. 1 stop	
PL79	7/28/2015	3:56:00	45.0963	-28.1407	2483	mantatr. 2 start	
PL79	7/28/2015	4:11:00	45.0891	-28.1436	2478	mantatr. 2 stop	
PL80	7/28/2015	4:13:05	45.0873	-28.1443	2479	mantatr. 3 start	
PL80	7/28/2015	4:28:07	45.0802	-28.1471	2469	mantatr. 3 stop	
PL82	7/28/2015	11:00:44	45.2641	-28.3566	737	mantatr. 1 start	HD559
PL82	7/28/2015	11:16:25	45.261	-28.3526	739	mantatr. 1 stop	
PL83	7/28/2015	11:17:40	45.2584	-28.3473	743	mantatr. 2 start	
PL83	7/28/2015	11:32:43	45.2578	-28.3462	744	mantatr. 2 stop	
PL84	7/28/2015	11:34:42	45.2527	-28.3367	762	mantatr. 3 start	
PL84	7/28/2015	11:49:45	45.252	-28.3352	767	mantatr. 3 stop	
PL88	7/28/2015	21:12:32	45.1832	-28.5999	2812	mantatr. 1 start	HD560
PL88	7/28/2015	21:27:32	45.1831	-28.6003	2811	mantatr. 1 stop	
PL89	7/28/2015	21:28:53	45.1798	-28.6084	2785	mantatr. 2 start	
PL89	7/28/2015	21:43:55	45.1794	-28.6093	2784	mantatr. 2 stop	
PL90	7/28/2015	21:44:49	45.1766	-28.6174	2789	mantatr. 3 start	
PL90	7/28/2015	21:59:52	45.1764	-28.6182	2790	mantatr. 3 stop	
PL92	7/29/2015	5:04:36	45.0317	-29.4204	2921	mantatr. 1 start	HD561
PL92	7/29/2015	5:19:43	45.0427	-29.4276	2922	mantatr. 1 stop	
PL93	7/29/2015	5:21:36	45.0438	-29.4284	2921	mantatr. 2 start	
PL93	7/29/2015	5:37:09	45.054	-29.4348	2920	mantatr. 2 stop	
PL94	7/29/2015	5:38:28	45.0548	-29.4354	2919	mantatr. 3 start	
PL94	7/29/2015	5:53:54	45.0651	-29.4417	2914	mantatr. 3 stop	
PL96	7/29/2015	21:24:18	45.9168	-30.1578	1438	mantatr. 1 start	HD562
PL96	7/29/2015	21:39:20	45.9258	-30.1625	1410	mantatr. 1 stop	
PL97	7/29/2015	21:41:54	45.9269	-30.1631	1406	mantatr. 2 start	
PL97	7/29/2015	21:56:54	45.9375	-30.1692	1382	mantatr. 2 stop	
PL98	7/29/2015	21:58:29	45.9382	-30.1696	1378	mantatr. 3 start	
PL98	7/29/2015	22:13:32	45.9416	-30.1714	1371	mantatr. 3 stop	
PL101	7/30/2015	7:24:12	46.6623	-30.4388	2534	mantatr. 1 start	HD563
PL101	7/30/2015	7:39:46	46.6748	-30.4375	2535	mantatr. 1 stop	
PL102	7/30/2015	7:41:29	46.6763	-30.4373	2535	mantatr. 2 start	
PL102	7/30/2015	7:56:37	46.6886	-30.436	2540	mantatr. 2 stop	
PL103	7/30/2015	7:58:39	46.6901	-30.4358	2541	mantatr. 3 start	
PL103	7/30/2015	8:15:20	46.7017	-30.4341	2546	mantatr. 3 stop	

Annex III F. Manta trawls 4.

STATION	DATE	TIME	LON	LAT	DEP	REMARK	SUPERST.
PL107	7/31/2015	11:16:18	44.0316	-33.0742	788	mantatr. 1 start	HD564
PL107	7/31/2015	11:32:00	44.0198	-33.0772	777	mantatr. 1 stop	
PL108	7/31/2015	11:34:07	44.0186	-33.0774	785	mantatr. 2 start	
PL108	7/31/2015	11:49:47	44.0072	-33.0804	771	mantatr. 2 stop	
PL109	7/31/2015	11:51:10	44.0061	-33.0807	769	mantatr. 3 start	
PL109	7/31/2015	12:06:11	43.9945	-33.0844	746	mantatr. 3 stop	
PL111	7/31/2015	16:51:19	43.596	-33.1265	1062	mantatr. 1 start	HD565
PL111	7/31/2015	17:06:56	43.5981	-33.1162	1028	mantatr. 1 stop	
PL112	7/31/2015	17:09:23	43.5983	-33.1157	1025	mantatr. 2 start	
PL112	7/31/2015	17:24:24	43.6021	-33.1046	1009	mantatr. 2 stop	
PL113	7/31/2015	17:26:12	43.6026	-33.1029	1004	mantatr. 3 start	
PL113	7/31/2015	17:41:15	43.606	-33.0923	1014	mantatr. 3 stop	
PL115	7/31/2015	21:45:44	43.6271	-33.2561	989	mantatr. 1 start	HD566
PL115	7/31/2015	22:02:22	43.6167	-33.2608	1005	mantatr. 1 stop	
PL116	7/31/2015	22:03:17	43.6161	-33.261	1005	mantatr. 2 start	
PL116	7/31/2015	22:18:44	43.6088	-33.2638	1021	mantatr. 2 stop	
PL117	7/31/2015	22:20:52	43.608	-33.2641	1023	mantatr. 3 start	
PL117	7/31/2015	22:35:22	43.6062	-33.2645	1025	mantatr. 3 stop	
PL118	1/ 8/2015	2:11:57	44.0671	-33.2199	729	mantatr. 1 start	HD567
PL118	1/ 8/2015	2:28:05	44.063	-33.2095	733	mantatr. 1 stop	
PL119	1/ 8/2015	2:30:11	44.0629	-33.2092	733	mantatr. 2 start	
PL119	1/ 8/2015	2:45:15	44.062	-33.2071	737	mantatr. 2 stop	
PL120	1/ 8/2015	2:46:39	44.0592	-33.1988	725	mantatr. 3 start	
PL120	1/ 8/2015	3:01:43	44.0588	-33.1978	726	mantatr. 3 stop	
PL125	3/ 8/2015	7:11:04	41.2225	-32.6103	4819	mantatr. 1 start	HD568
PL125	3/ 8/2015	7:26:10	41.2105	-32.6088	4799	mantatr. 1 stop	
PL126	3/ 8/2015	7:27:33	41.2095	-32.6086	4798	mantatr. 2 start	
PL126	3/ 8/2015	7:42:57	41.1976	-32.6065	4774	mantatr. 2 stop	
PL127	3/ 8/2015	7:45:17	41.1959	-32.6062	4773	mantatr. 3 start	
PL127	3/ 8/2015	8:00:26	41.1836	-32.6039	4749	mantatr. 3 stop	
PL131	4/ 8/2015	8:53:05	37.3622	-31.6991	4803	mantatr. 1 start	HD569
PL131	4/ 8/2015	9:08:12	37.3762	-31.6988	4813	mantatr. 1 stop	
PL132	4/ 8/2015	9:09:31	37.3774	-31.6988	4818	mantatr. 2 start	
PL132	4/ 8/2015	9:24:26	37.3898	-31.699	4854	mantatr. 2 stop	
PL133	4/ 8/2015	9:26:27	37.3905	-31.699	4854	mantatr. 3 start	
PL133	4/ 8/2015	9:40:35	37.4028	-31.6989	4902	mantatr. 3 stop	

Annex IV. Results.

Plankton weights from the multinet samples gr/m^3 dry weight (dw)

Station	Net	depth	Lat	Long	B. Depth	tot. Vol.	>2mm	1-2 mm	<1 mm	Sum_dw
66	1-5	1.3-601.1	-27.1747	45.8507	1804	926	0.004209	0.001703	0.00382	0.009732
546	1-5	1.4-599	-25.2373	56.1033	4972	1485	0.003765	0.003478	0.004271	0.011514
547	1-5	0.4-604	-25.9816	52.4963	4962	1355	0.00261	0.001948	0.00426	0.008818
548	1-5	0-598	-26.6718	48.462	4960	1525	0.005064	0.003038	0.00564	0.013742
553	1-5	2.5-599	-27.14	46.3975	1523	1096	0.001479	0.000933	0.004459	0.006871
554	1-4*	2.3-401	-27.1622	46.1042	569	1028	0.002156	0.007109	0.014815	0.02408
555	1-5	0.2-540.7	-27.1792	45.7858	543	934	0.001429	0.002136	0.003854	0.007419
556	1-5	1.4-602.3	-27.2895	45.98	1953	1255	0.001367	0.002312	0.008019	0.011698
557	1-5	1.2-603.8	-28.1222	45.5438	2413	1212	0.000915	0.001935	0.004774	0.007624
558	1-5	2.4-592.9	-28.136	45.1065	2491	1282	0.002667	0.00087	0.001384	0.004921
559	1,3,4*	51.2-602.7*	-28.3553	45.265	736	986	0.000368	0.002277	0.000828	0.003473
560	1-5	0.8-601.2	-28.5473	45.2063	2856	1043	0.006573	0.002942	0.004642	0.014157
562	1-5	0.7-600.5	-30.1603	45.9213	1428	1267	0.007003	0.00605	0.009082	0.022135
563	1-5	0.7-600.3	-30.4648	46.6572	2512	1649	0.004361	0.004612	0.00567	0.014643
564	1-5	0.9-600.5	-33.0705	44.0367	796	1052	0.000906	0.002859	0.004121	0.007886
565	1-5	0.6-600.1	-33.1228	43.5988	1027	1349	0.006749	0.005048	0.009102	0.020899
568	1-5	1-601.1	-32.6088	41.2323	4875	1047	0.001635	0.003099	0.003215	0.007949
569	1*	399.7-601.1	-31.6955	37.3748	4811	223	0.000011	0.000151	0.000135	0.000297

Table 2. List of taxa recorded at MR. 08 (VAMS 01) during live collection of the video footage. Comments entered with each taxonomic record are also included. In the Log files, the taxon was recorded in the 'Biology' field, while the comments were recorded in the 'Comments' field. Revised taxonomic identification is included where further resolution could be provided.

Phylum	Taxon	Comments	Revised Taxon
Annelida	Serpulidae sp. 1		
Arthropoda	Galatheidae sp. 1	Squat lobster	
	Malacostraca sp.		
	Malacostraca sp. 1	Large pelagic crustacean	
	Malacostraca sp. 2	Small, on Bryozoa sp. 1	
	Paguroidea sp. 1		
	Paguroidea sp. 2	With Actiniaria sp. 2 and Scapellidae	
	Scalpellidae sp. 1	Barnacle	Cirripedia sp. 1
	Scalpellidae sp. 2	On Paguroidea	Cirripedia sp. 2
Bryozoa	Bryozoa sp. 1	Branching, small, white	Bryozoa spp.
Chordata	Beryx sp. 1		Berycidae sp. 1
	Osteichthyes sp. 1	Possible Macrourid fish	
	Osteichthyes sp. 2		
	Osteichthyes sp.	Unknown species	Osteichthyes sp. 3
	Shark	White tail	Elasmobranchii sp. 1
Cnidaria	Actiniaria sp. 1	White column, light pink tentacles	
	Actiniaria sp. 2	Growing on Paguroidea sp. 2	
	Cnidaria	Dead coral?	
	Cnidaria	Dead coral base\skeleton	
	Cnidaria	Dead skeleton	
	Cnidaria	Denuded branching coral base	
	Pennatulacea sp. 1	Possible sea pen	
	Scleractinia sp. 1	Cup coral, may be dead	
	Scleractinia sp. 2	2 dead individuals	Possibly a soft coral (Alcyonacea sp.)

Phylum	Taxon	Comments	Revised Taxon
	Scleractinia sp. 3	Cup coral with yellow tissue and tentacles, 8 individuals forming a clump	
	Scleractinia	Dead cup coral	cf. Scleractinia sp. 1
Echinodermata	Asteroidea sp. 1	White sea star	
	Asteroidea sp. 2	Pink many arms	
	Asteroidea sp. 3	Large, white, spikes	
	Asteroidea sp. 4	Possibly 9 arms	
	Brisingidae sp. 1		Brisingida sp. 1
	Brisingidae sp. 2	12 arms	
	Crinoidea sp. 1	Yellow	Comatulida sp. 1
	Crinoidea sp. 2		Comatulida sp. 2
	Echinoidea sp. 1		
	Echinoidea sp. 2	Larger than sp. 1	
	Ophiuroidea sp. 1	Red oral disc	
	Psolus sp. 1	Brownish body, white tentacles	
Mollusca	Cephalopoda sp. 1	Squid	Teuthida sp. 1
	Gastropoda sp. 1	Brown shell	
	Gastropoda sp. 2	Possibly Tachyrhyinchus sp.	
Porifera	Demospongiae sp. 1		
	Porifera sp. 1	Fan shaped sponge	
	Porifera sp. 2	Glass sponge	
	Porifera sp. 3		
	Porifera sp. 4	Yellow, encrusting	
Phylum	**Taxon**	**Comments**	**Revised Taxon**
	Porifera, encrusting		
Unknown	Tube	Unknown organism	
	Unknown tube		

Table 3. List of taxa recorded at MR.9 (VAMS 02). using the CAMPOD Logger during live collection of the video footage. Comments entered with each taxonomic record are also included. In the CAMPOD Logger files, the taxon was recorded in the 'Biology' field, while the comments were recorded in the 'Comments' field. Revised taxonomic identification is included where further resolution could be provided. *Not found in VAMS 01-02 photo catalogue as it was recorded during a non-transect and clipped out of the video. † Not included in total taxon diversity as it was mistakenly identified as a new species.

Phylum	Taxon	Comments	Revised Taxon
Arthropoda	Crustacea	Possible Amphipods attached to unknown stalk\Hydrozoa sp. 1	Crustacea sp. 1
	Isopoda sp. 1	2 individuals	
	Malacostraca sp. 2	Red	Malacostraca sp. 3
	Malacostraca sp. 3		Malacostraca sp. 4
	Paguroidea sp. 3		
	Scalpellidae sp. 2	Possibly 7 individuals	Cirripedia sp. 2
Brachiopoda	cf. Brachiopoda sp. 1		
Chordata	Ascidiacea sp. 1		
	Shark eggs	Mermaid's purse	
Cnidaria	Actiniaria sp. 3	On Alcyonacea sp. 1, possibly a species of Stephanauge	
	Actiniaria sp. 4	Red\brown anemone, thick, short tentacles	
	Actiniaria sp. 5	Large, orange column and tentacles	
	Alcyonacea sp. 1	White branching octocoral	
	Alcyonacea sp. 1 or 2		
	Alcyonacea sp. 2		
	Alcyonacea sp. 3	Possible Anthomastus species. 2 individuals on rock	
	Anthomastus sp. 1		
	Anthozoa sp. 1	Possibly Chrysogorgiidae, or Antipatharia	cf. Metallogorgia sp. 1
	Anthozoa sp. 2*	Similar to Anthozoa sp. 1, but with no stalk. Possible Chrysogorgiidae species.	
	Ceriantharia sp. 1		
	Chrysogorgiidae sp. 1	Bottlebrush morphology, possibly a Chrysogorgia sp.	
	Hydrozoa sp. 2	Attached to Porifera sp. 8	
	Hydrozoa- stalk		

Phylum	Taxon	Comments	Revised Taxon
Echinodermata	Asteroidea sp.	Yellow	Asteroidea sp. 5
	Bourgueticrinida sp. 1	Stalked crinoid	
	Comatulida sp. 1	Unstalked crinoid	Comatulida sp. 3
	Comatulida sp. 2†		Bourgueticrinida sp. 1
	Crinoidea sp. 1		Comatulida sp. 1
	Echinoidea sp. 3	Long spines, pinkish test	
	Holothuroidea sp. 1		
	Ophiuroidea	Under sponge	
	Ophiuroidea sp. 2	Resembles Asteronyx loveni	cf. Ophiocreas oedipu
	Ophiuroidea sp. 3		
Mollusca	Gastropoda sp. 2	White shell	
Porifera	Hexactinellida sp. 1	Glass sponge, stalked with hollow round top	
	Porifera sp. 2		
	Porifera sp. 5		
	Porifera sp. 6	Possible glass sponge	
	Porifera sp. 7	Small, ball-shaped	
	Porifera sp. 8	Tipped over	
	Porifera sp. 9		
Unknown	Possible egg mass		
	Unknown stalk		
	Unknown stalks, possibly hydroids		
	Unknown stalks, possibly hydrozoa		
	Unknown, possibly Psolus on rock		

Table 4. List of taxa recorded at Station MR.10 (VAMS 03) using the logging software during live collection of the video footage. Comments entered with each taxonomic record are also included. In the Log files, the taxon was recorded in the 'Biology' field, while the comments were recorded in the 'Comments' field. Revised taxonomic identification is included where further resolution could be provided.

Phylum	Taxon	Comments	Revised Taxon
Arthropoda	Malacostraca sp. 1	Small, red	
	Malacostraca sp. 2	Resembles Pandalidae	
	Malacostraca sp. 3	White, very long anthennae, swims	
	Paguroidea sp. 1		
Chordata	Macrouridae sp. 1		
	Osteichthyes sp. 1		
	Osteichthyes sp. 2		
	Osteichthyes sp. 3	Long slender body, possibly Macrouridae	
	Osteichthyes sp. 4		
	Shark		Elasmobranchii sp. 1
Cnidaria	Anthozoa sp. 1	Possible cup coral	
	Anthozoa sp. 2	Possibly Anthozoa sp. 1	
Echinodermata	Echinoidea sp. 1	Red urchin	
	Echinoidea sp. 2	Small, white test, purplish upper test	
Mollusca	Gastropoda sp. 1	Small, white shell	
Unknown	Unknown	Possibly crab	
	Unknown	Small, purple blob, possibly a shell or polychaete	
	Unknown	Purple, possible holothurian	
	Unknown	Possibly a holothurian. Yellowish in colour	
	Unknown	Presence of large hole, white, sediment on top, possibly dead	

Annex V Samples and responsibilities of them after the survey

List of Samples:

Type	Number/Type	Responsible
Benthos samples	Samples for macro fauna: 22 samples from 10 stations.	Asma Damon Jean Jacques
	Samples for chemical analysis: 9 samples from 3 stations. 3 samples for grain size.	IMR Norway
	Video for habitat and macro fauna: 3 video rec.	**Lindsey Beazley** Francisco Javier Murillo Perez
Nutrient Samples	Type of sample: Seawater No. Of samples: 113 Volume per unit: 20 ml Total volume: 2,260 l Stations: Collected at all CTD stations (Stations 542 to 569, Total 28 stations)	Tom Bornman (Grahamstone)
Zooplankton samples	Type of sample: Zooplankton No. of samples: 88 multinet, 9 VP2, 19 CPR Volume per unit: 100 ml Total volume: 97*100 ml Stations: 19 M, 5 VP2 and	**Zo Tsihoarana Rasoloarijao**
	19 CPR stations.	**Bradley Marlon Blows**
Neuston samples	Type of sample: Zooplankton No. of samples: 27 Volume per unit: 100 ml Total volume:27*100 ml Stations: Collected at all mantra trawl stations (Stations 542 to 596)	**IMR Norway**
Micro plastic samples	Type of sample: Plastic particles No of samples: 77 with or without plastics Stations: 29 manta trawl stations	IMR Norway Kamlesh Ramdhony Ramah Sundy Calvin G. Gerry Jean Jacques
Acoustic Data	Type of sample: Raw acoustic data and post-processed LSSS No. Of samples: all transects	Karen Fosse Sivertsen Patroba Patrick Matiku

ANNEX VI PROPOSED ARTICLES

Draft papers

Name of Papers		Authors	Analysis to be completed	Time Frame for Analysis	Time for First Paper Draft to be completed
1	Micro plastic distribution and estimation from the sea surface water of the southern Indian Ocean- A correlation with the current pattern and hydrographic data	S. Ramah, K.F. Sivertsen, B. Serigstad, M.N. Olsen,	1. Identification of Plastic Samples (Size, Color)		**.August 2016**
			2. Chemical Analysis of Plastic Samples		
2	A mathematical modelling review of an estimate micro plastic intake by Humpback whales around the Madagascar Ridge	B. Serigstad, S. Ramah	1. Chemical Analysis of Plastic Samples		**.August 2016**
			2. Statistical Modelling Analysis		
3	Structure of the mesozooplankton in the Madagascar Ridge and the Walter Shoals	Z.T Rasoloarijao, K. F. Sivertsen	1. Sample Processing (WP2, CPR, Multinet)		**.September 2016**
			2. Zooplankton Identification		

4 Karen will include a hydrographic paper's title and all the necessary information

5 Video analysis, to be decided when further analysis are finished.

Annex VII European standard 16260

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 16260

October 2012

ICS 13.060.45

English Version

Water quality - Visual seabed surveys using remotely operated and/or towed observation gear for collection of environmental data

Qualité de l'eau - Études visuelles des fonds marins utilisant un matériel d'observation commandé à distance et/ou tracté pour la collecte de données environnementales

Wasserbeschaffenheit - Visuelle Meeresbodenuntersuchungen mittels ferngesteuerter Geräte und/oder Schleppgeräten zur Erhebung von Umweltdaten

This European Standard was approved by CEN on 15 September 2012.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 16260:2012: E

Contents

Foreword

This document (EN 16260:2012) has been prepared by Technical Committee CEN/TC 230 "Water analysis", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2013, and conflicting national standards shall be withdrawn at the latest by April 2013.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

According to the CEN/CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

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Introduction

Information on the habitats, biotopes, substrates and species diversity on the seabed is an important part of ecosystem-based environmental management, and necessary in order to evaluate the consequences of various anthropogenic activities. Implementing European Directives and required monitoring of substrates and species diversity will require documentation and monitoring of different types of seabed types using inter-comparable and generally non-destructive methods. Many seabed areas are difficult, if not impossible to investigate using traditional sampling such as grabs and dredges or may host fragile communities such as cold-water coral reefs. Visual surveillance using geo-referenced positions is essential to allow revisiting of locations, documentation of environmental conditions and detection of changes in species composition which otherwise would be difficult to achieve. The equipment and methods described here may also be used in combination with acoustic equipment for seabed characterisation.

The methods presented in this European Standard are particularly suitable for seabed mapping and monitoring at depths below depths achievable using traditional SCUBA diving, and in cases where safety or economical issues limit the use of SCUBA diving. They are also suitable for the description of distribution and occurrence of large and scattered organisms on substrates, where sampling with grabs do not provide representative results. For investigations on soft seabed substrate please refer to EN ISO 16665 [1] and for investigations on shallower hard seabed to EN ISO 19493 [2].

This European Standard is also suitable within the operational depth of SCUBA-diving, e.g. for large scale surveys and mapping of the seabed composition, characteristic plant and animal species occurrence and depth distribution.

Remotely Operated Vehicles (ROVs) and passive tethered observation platforms are used for mapping and environmental surveys of the seabed via video and still photographs. However, the methods used and the results obtained can be rather variable without proposed consideration of geographic positioning, taxonomic precision and quantification. It is therefore important that the methods used are standardised in order to compare results.

WARNING — Persons using this European Standard should be familiar with normal laboratory and fieldwork practice. This European Standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

1 Scope

This European Standard describes methods, requirements and equipment for remote visual surveillance of organisms and the seabed using still photography and video recording to ensure precise and reproducible data. The main aims of the methods are to record or monitor seabed conditions and organisms on and just above the seabed in a reproducible way at a resolution that is appropriate to the aims of the survey.

In caves and overhangs this standard may not be suitable due to technological limitations related to navigation and movement of the observation platform.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 14996, *Water quality — Guidance on assuring the quality of biological and ecological assessments in the aquatic environment*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
sonar altimeter
acoustic instrument measuring the elevation above seabed

3.2
box-in-test
test to determine alignment/attitude errors in the navigational data, involving four different positions of the vessel relative to a fixed transponder

3.3
drop camera
video and/or still camera that is either lowered down to the seabed or suspended just above it, generally used for imaging at a single location, or manoeuvred along a set transect using the ships propulsion system on the surface

3.4
frame grab
still image obtained from video record

3.5
geographic precision
accuracy with which a given point can be relocated within a geodetic reference system

3.6
geographic resolution
lowest unit of measurement at which a geographic distribution can be reproduced

3.7
kalman filtration
sequential smoothing method where the most likely result is achieved through a combination of earlier results using the relevant measuring point

Note 1 to entry: This type of data filter is often integrated in navigation software packages, but can also be applied separately [3].

3.8
locality
geographic description of a place or an area where samples are collected, covered by one or more sampling stations

Note 1 to entry: Description is based on habitat, terrain, depth and name of geographic area.

3.9
macrofauna
animal species ranging from 1 mm to 50 mm

3.10
megafauna
animal species larger than 50 mm

3.11
monitoring
investigation via repeated sampling to record eventual changes in environmental conditions or community composition over time

3.12
morphological species
organism that belong to a unidentified species that clearly can be distinguished from other observed, identified or unidentified species, and that may be described based on shape and colour and size

3.13
observation platform
passive sampling gear comprising a supporting construction onto which a video camera and light and/or a still camera (and environmental sensors if required) can be mounted

Note 1 to entry: An observation platform can be tethered to a fixed point or towed.

3.14
PAL-standard
analogue television colour encoding system used as a standard for video recording

Note 1 to entry: Video format used in most European countries

3.15
reference location
location representing presumed natural environmental conditions

3.16
remotely operated vehicle
ROV
remotely operated motorised underwater vehicle equipped with video and/or still camera and often has the capacity to mount additional equipment such as sonar, environmental probes, manipulator arms and sampling equipment

3.17
sample
single photograph, frame grab or uninterrupted video sequence

3.18
sampling station
geographically defined area where still photographs or video recordings are taken

Note 1 to entry: Still photographs cover a defined area, which for practical purposes can be represented by a point on a map. Video recordings carried out by means of a vehicle in motion cover a larger sampling area and the location of the start and end of the line become more important when repeating or relocating sampling stations. Therefore, for video recordings, the starting point is used as the station position.

Note 2 to entry: A station is defined by its geographic position, together with any additional information on features on the seabed (for example rocky outcrops or large stones) recognisable by either direct observation or by acoustic surveillance (for example multi-beam echo-sounder or side-scan sonar). The station is delimited at the given level of precision.

3.19
still image
single photograph or frame grab

3.20
spin-test
test to identify navigational offset errors, involving rotation of the ship above a fixed transponder

3.21
transect
defined and continuous line or belt of pictures or video sequences across a delimited area

Note 1 to entry: The position of the transect can be random or located to reveal different (various gradients of) environmental conditions (for example gradually increasing depth etc.).

3.22
video sequence
continuous part of a video film

4 Principle

Remotely operated vehicles (ROVs) and passive tethered observation platforms are used for mapping and for environmental surveys of the seabed. Still photographs and video recordings are used in a variety of ways to obtain visual data for mapping and/or monitoring the seabed and organisms on or near the seabed. This European Standard gives guidance with respect to sampling strategies, geographic positioning, taxonomic identification and quantification and determination of seabed substrates and/or the organisms living on or above the seabed.

5 Equipment

5.1 General

The technical specifications for the equipment used shall be described when reporting the results. The requirements made for the equipment are dependent on the aims of the survey. For mapping and monitoring, a colour camera should be used together with underwater positioning equipment. The positioning equipmen should have an appropriate error margin for the survey objectives with a minimum of ≤ 2 m, with a relative tolerance of + 5 % of the water depth (measured in metres) for depths equal or greater than 20 m and ≤ 3 m, with a relative tolerance of + 3 % of the water depth for depths shallower than 20 m, respectively.

EXAMPLE Water depth: 15 m appropriate error margin: ≤ 3 m + (15 m × 0,03) ≤ 3,45 m
Water depth: 40 m appropriate error margin: ≤ 2 m + (40 m × 0,05) ≤ 4 m

5.2 Cameras and light

Video recordings and still photographs should not contain electric or electronic noise. The minimum requirements of cameras (video recordings and still photographs) differ for the three types of investigations (pilot surveys, mapping and trend monitoring). For pilot surveys (see 7.4), low light, composite video PAL standard should be used. A colour camera is not a requirement for this type of survey. The minimum requirement for mapping (see 7.5) is a high resolution PAL colour camera (e.g. 400 TV lines). The application of a colour HD (high definition), 1080 interlaced is recommended. Still photographs for use in trend monitoring (see 7.6) should document an area of between 0,25 m^2 and 1 m^2 with a good image quality (focus and contrast) with a minimum resolution of 1 080 x 1 560 pixels (HD-format, equivalent to 300 DPI at 9 cm × 13 cm). Lights should be strong enough to provide a fully illuminated surface, at heights ≤ 3 m above seabed surface.

5.3 Sonar altimeter

The elevation above seabed should be measured by a sonar altimeter or by using trigonometry.

NOTE Estimation of height using trigonometry demands that the distance from camera lens to the centre of the image and the camera's inclination angle is known. The distance is from the lens to the centre of the image from the width of the field view (scaled by parallel laser points) and the angle of view.

A simpler method for keeping constant height above the seabed is to use a rope with weight, or a chain suspended from the observation platform. This method is not suitable for sensitive habitats such as coral habitats and sponge communities. Furthermore, it may also represent a safety hazard since the rope may stick to obstacles on the seabed. As far as possible, an even height (1 m to 3 m for mapping) and speed (0,5 kn to 2 kn for pilot surveys and 0,5 kn to 1 kn for mapping) should be maintained. Ideally the lower the speed, the better; but with certain sites it would be impossible to keep speeds consistently down to these levels without resorting to just working at slack water only. An increased video frame capture-rate would allow better slow-motion replay and therefore allow a camera to travel quicker over the seabed. In all cases the camera should travel at an appropriate speed such that images obtained using video or still photograph are not overly blurred.

5.4 Data recording equipment

Video records should be stored in a format (e. g. storage of video files on a hard disc or directly recorded onto a DVD burner or a DV tape recorder), that avoids loss of data quality when copying. For video recordings, the position should be inserted as text on the image, or logged in a data file where the time of the video recording can be used to synchronize the time logged together with the GPS signal, as well as other environmental data (depth, temperature, angle of camera etc.). Alternatively these data can be stored on the audio track of the video. These audio data should always follow the picture and should not be stored on a (or several) separate file(s).

6 Positioning

6.1 General

Geographic references for observations should be accompanied by information on the accuracy obtained using the combination of equipment and method. Positioning should be carried out with reference to a grid net or geodetic reference system.

NOTE 1 Examples on grid-net systems are EUREF89 (European Reference Frame 1989), and UTM coordinate system (Universal Transverse Mercator coordinate system). Examples for geodetic reference systems are ETRS89 (European terrestrial reference system 1989) and WGS-84 (World Geodetic system 1984).

For the purpose of mapping shallow (< 15 m) coastal areas using a drop camera the ship's GPS can be used without hydro acoustic positioning, except for pilot surveys (see 6.3). If using an ROV in open sea areas and in areas with strong currents, the ROV shall be equipped with a sufficiently strong motor or "garage" to avoid drift from the targeted locality (at a fixed position or between two fixed positions). If a towed platform is used in similar areas the observation platform should be heavy enough to prevent too large offset, which will disable reliable hydroacoustic positioning.

Geographic references (beyond general locality: approximately ± 100 m) should be based on hydro-acoustic positioning. When using a towed observation platform or drop camera, its position at the seabed can be estimated from the vessel's position by correcting for deviations in relation to the observation platform (cable length, angle and direction). In all cases, the method used shall be documented.

NOTE 2 There are several sources of errors in the positioning of underwater equipment. The main components in underwater positioning provide transmission of satellite signals to the ship and calculation of the distance and direction to the observation platform. The quality of underwater positioning is mainly depending on how the ship is equipped, but the setting and calibration of this equipment is also very important.

6.2 Calibration of positioning equipment

For mapping and monitoring the hydro-acoustic positioning equipment needs to be calibrated on an annual basis. If a calibration has been performed for instance by comparison with a transponder placed on the seabed, values for the error should be provided in the report. If such a calibration has not been made the errors provided by the producers of the equipment should be used instead.

Filtering of navigational data can significantly reduce noise. The recommended method for this is Kalman filtering [3].

NOTE Many GPS navigation systems on the market already "smoothen" the position, based on previous positions and estimated compass direction, before they are shown in the display. The method used for filtering varies, but most common is the *Kalman filtering*. A simpler method for filtering navigational data is to remove deviant recordings that are obvious outliers from the remainder of the recordings. Deviant values can be replaced by a value derived from the running mean of five records (two before and two after the point of the deviant record) in the series of navigational recordings. If filtering of navigational data is used, the method used should be documented when reporting the results.

The geographic resolution can be obtained by comparing the distances covered by video sequences of similar lengths with the distance as calculated using speed.

6.3 Positioning of the different types of survey

For pilot surveys, positioning may refer to the position of the vessel. The positions of video transects should as a minimum be defined by the vessel´s start and end positions. The precision of positional information should fulfil the requirements of Order-2 in S-44 [4] (≤ 20 m, with a relative tolerance of + 5 % of water depth in meter).

Approximate positions along a towed transect may be calculated based on speed of the equipment together with the compass direction.

For a drop camera, a calculated position for where it hit the seabed is satisfactory. This position is estimated based on the offset between the location of the ship positioning system's centre point and the location on the ship where the drop camera is deployed.

For mapping, positions should be recorded at regular intervals (at least one record per 10 s) during the video recordings. The precision of the positional information should as a minimum be ≤ 2 m , with a relative tolerance of + 5 % of water depth in meter for water depth ≥ 20 m and ≤ 3 m , with a relative tolerance of + 3 % for water depth < 20 m.

For trend monitoring using still photography, the positioning shall be accurate enough to allow relocation of the exact location on the seabed in order to be able to follow developments in individuals/populations using positional data for markers and/or photographs/video recordings from previous surveys. See Table 1 for an overview of the recommended minimum quality requirements of the different methods for positioning.

The exact positioning of hanging or towed video with a standard vehicle is almost impossible. Therefore, it is recommended that if an exact position is required, it should be done by placing or choosing a well recognizable obstacle on the sea floor (see 7.6.2). For ROV exact positioning is possible.

For a description and comparison of different crude positioning methods suitable for pilot surveys see Coggan et al 2007 [5].

6.4 Underwater positioning

The degree of accuracy varies depending on the type and aim of the investigation. Where a high accuracy of geographic positions is required, use of the Ultra Short Base Line/Super Short Base Line system (USBL/SSBL-system) should be carried out with reference to appropriate calibration of at least the USBL-system, satellite navigation system and gyro- and navigational software. If this is not available, or changes have been made to the set-up since the last calibration, the system should be re-calibrated. During calibration, a "box-in-test" (see NOTE 1) and a "spin-test" (see NOTE 2) should be carried out in accordance with the manufacturers instructions for the equipment/software.

NOTE 1 During a "box-in-test", all four quadrants of a transponder's position is recorded. The vessel is aligned in four different positions such that by the end of the procedure, recordings are made of where the transponder has been relative to the bow, stern, port- and starboard sides of the vessel.

NOTE 2 In a spin-test, the vessel rotates directly over the transponder whilst the positions are recorded.

The use of an LBL-system (Long Base Line) for positioning during a survey should be carried out with reference to a calibration report.

To provide quantitative or semi-quantitative data, the geographic position of the observation platform on the seabed should be known alongside the error margin (see 6.2).

If using hydro-acoustic positioning equipment, the position should be recorded continuously during the survey. When using a towed observation platform, the vessel's positions may be used, after correction for the known deviation, provided that the vessel's course and speed are stable.

Calculation of the spatial extent of structures should not be based on hydro-acoustic underwater positioning if the error margins of the recordings exceed 10 % of the extent of the structure.

For underwater positioning, the precision of the equipment should be documented.

NOTE 3 Hydroacoustic signals are influenced by the sound velocity of the water (which varies with temperature and salinity). Thus, estimates of sound velocities should be performed at the start of a survey and when moving into areas with different water characteristics. These data should be used for calibration of the positioning equipment as explained by the navigation system's user manuals.

7 Collecting data

7.1 Quality assurance and quality control

Vessels used for the investigations shall be in accordance to the relevant safety standards and manned by crew qualified to carry out their required tasks.

Equipment and methods used shall have documented technical specifications (see 7.3 and Table 1) which allow an assessment of the quality of the results. Quality assurance and quality control measures shall be included in all parts of the investigation.

All procedures shall be described, and all tasks and parts of the work shall be performed in a standardised and reproducible way. The investigation shall be undertaken by qualified personnel with a relevant education. The reader is referred to EN 14996 on the quality assurance of biological and ecological investigations. The overall goal is to ensure documentation and tracking of all fieldwork procedures, samples and equipment from start to end of an investigation.

For quantitative image analysis, the aim should be to take the pictures perpendicular to the surface unless alternative angles provide better quality data to ensure a correct calculation of area and best possible identification of organisms. Alternative angles of alignment may benefit certain surveys design e.g. cameras may be angled forwards where this can improve image ID. Calculation of area may be carried out on sloping surfaces if the image can be scaled (for example by parallel laser points at known distances) and if the angle of the camera relative to the seabed is known.

7.2 Survey plan

A survey programme should be designed in accordance with the aims of the investigation, required precision of results, local topographical and hydrographical conditions in the survey area, information on local sources of pollution, experience from previous investigations and any other factors that can be of significance for the surveys. The survey programme shall be established before commencement of the survey, but appropriate modifications may be made during the fieldwork, as judged necessary.

Visual surveys of the seabed should be carried out by still photography or video, and may be divided into three main types as follows:

— Pilot survey, see 7.4;

— Mapping, see 7.5;

— Trend monitoring, investigations over time, see 7.6.

Table 1 gives an overview of the recommended minimum requirements of the three main survey types.

NOTE Mapping using still photographs and video does not provide complete information about the total species diversity in an area, but provides important additional information about the epi-flora and fauna represented and their local spatial distribution, that traditional sampling gear cannot provide.

7.3 Transect surveys

Except for pilot survey, the camera should be at least 3 m or closer to the seabed in order to identify organisms with a size < 10 cm, or to estimate percentage composition of seabed substrates, but this will depend on video quality. Records from a greater height can only be used for mapping of dominating species > 10 cm or qualitative registration of coarser seabed substrates (cobble, boulder and bed rock).

For quantitative mapping of flora and fauna, the areas covered shall be estimated based on the field of vision and the distance travelled. For calculation of observed area, the photographic field shall be scaled using laser points or calculated using the lens and camera angles together with height above the seabed. Height shall be recorded to the nearest decimetre. The angle of the lens and the angle of the camera relative to the seabed shall be recorded in degrees.

NOTE On a sloping or uneven seabed calculation of areas based on trigonometry using height above the seabed is complicated and not practical. In such cases laser scaling points are needed.

For mapping where the field of vision is 1,5 m to 3 m, a distance of 10 cm between the laser points is recommended. For pilot surveys conducted at a greater height above the seabed and a wider field of vision, the distance between the laser points can be increased to 20 cm.

The length of transects to be covered in order to ensure comparable results is dependent on the aims of the survey. For mapping of species diversity and abundance distribution, the transect length should as a minimum ensure that a further 10 % increase in transect length would not result in more than a 10 % local (within the transect) increase in recorded taxa. In practice, this is equivalent to approximately 400 m in areas with a uniform habitat. In areas of habitat heterogeneity, this length should be increased to 500 m. It can be difficult to control the distance covered in "real time" and therefore it may be practical to calculate the distance covered based on the speed of the ROV or vessel in the case of towed observation platforms. See Table 1 for recommended transect length for the different types of surveys.

In areas with homogeneous substrate types and evenly distributed flora and fauna shorter transects may be sufficient to represent the diversity of taxa. However, this shall be documented by a graph showing the cumulative numbers of taxa in relation to distance along a video transect from the general survey area.

7.4 Pilot survey

A pilot survey is used as a reconnaissance survey for future more comprehensive recording and surveying of environmental conditions. This type of survey is not suitable for recording changes over time, with the exception of major changes in dominant organisms and seabed conditions (underwater sediment slide, seabed trawl marks etc.). The requirements for methodology and reproducibility are generally relatively simple.

NOTE Side scan sonar is a very helpful tool for the pilot survey and should be used - as far as possible - to identify potential habitats (e.g. mussel banks, boulders/stones, ripple fields, seagrass meadows) for further visual seabed surveys.

No particular requirements are made for identifying the location or number of stations, but the stations should be as far as possible representative for the area under investigation. Precise station positions and water depth shall be recorded.

7.5 Mapping

This is a survey to describe the distribution of seabed types and organisms in a given area. Visible organisms should be identified to lowest possible taxonomic level required by the survey objectives and their abundance should be estimated. Seabed types shall be described in accordance with Table 2, and the relative composition shall be determined.

The survey shall be carried out using semi-quantitative or quantitative methods (see Clause 8). The specified requirements for numbers of stations and station positioning are determined in accordance with the aims of the investigation (requirement of geographical resolution) and size of the mapping area.

Transects for video recording and still photography can be located as single lines in a variety of directions and locations, or in a pattern of parallel lines. The distance between transects and still photographs should be determined by the demand for geographical resolution in accordance with the aims of the survey. Knowledge of the degree of spatial variation of habitat, species and/or biotopes is used to inform the survey design to produce reliable maps. For areal mapping where this variation is not known, transects should be paralleled separated with a distance of maximum 50 m. Information from more widely scattered transects can be used for generating areal maps combined with prediction and verification. Still photographs should be more than 20 m apart, corresponding to one photograph per minute at a stable speed of 0,7 kn. These photographs provide data for statistical analysis and are also helpful in providing a reference photograph for segments of the video. Additional photographs can be taken of particular species or habitats of interest.

The total length of transects should be determined by the aims of the mapping. If the aim is a representative description of species diversity of observed flora and fauna (large macrofauna and flora and megafauna), the total length of transects on a location should be at least 500 m. Minimum transect length should take into account any distances covered during deployment and retrieval time. This will be longer with increasing water depth.

Mapping using video recordings/still photographs is often used to ground-truth/validate acoustic remote sensed data such as multibeam/sidescan data. The minimum number of validation samples needed for that purpose should depend on the number of ground-types that have been provisionally identified from the acoustic data. Positions should be recorded on the images at all times. To avoid loss of data electronic and image figures should be separated.

For mapping of smaller areas or single habitats the length of individual transects should be adjusted to fit the shape of the area or the extent of the habitat. For areas smaller than 500 m in longest direction the required minimum distance of 500 m transect length is not relevant. In addition to positioning of start and end points geographical positions should be recorded continuously along the transects. Start and end point noted on a log sheet for each transect, and continuous recording of positions and time should be logged by a computer with exact reference to starting time of video record. Alternatively, the positions and time should be recorded as a text overlap on the video records and/or on the sound track of the video.

7.6 Trend monitoring

7.6.1 General

The aim of this type of survey is to investigate seabed types and assemblages of organisms, or one or more selected seabed-dwelling taxa over time, in order to document natural variations and any changes over time due to environmental or anthropogenic influences. Changes may be detected in the abundance and distribution of individual species, selected indicators such as individual size, and observed mortality, or the composition of seabed substrates. Monitoring can be carried out at fixed locations by random or random stratified transects or repeated parallel transects. Again, the survey design is dependent on the objectives of the survey and knowledge of variability at the location. Care should be taken when repeating transect in the same location using towed sledges over the bottom, as this in itself can affect the data over time. The survey shall be carried out using semi-quantitative or quantitative methods following a predefined plan. A reference location or reference area should be sampled (see 7.7) to ensure that the data can be used for comparison with the environmental conditions in adjacent areas.

7.6.2 Trend monitoring at fixed stations

Trend monitoring at fixed stations is carried out by collecting still photographs from a unit area that can be identified and relocated by means of markers or naturally occurring points of reference, such as large rocks or bedrock features. The sampling area to be monitored may be marked using positioned air-filled glass buoys anchored to the seabed with lead weights (gas filled objects are clearly detected by sonar, and therefore facilitate relocation). The geographical position of the marker shall be noted in order to revisit the exact area. An area in the immediate vicinity of the marker can be photographed to help relocate the sampling location.

NOTE Gas filled objects reflect strongly on sonar and aids locating the areas.

Trend monitoring at fixed locations requires the use of a stills camera that can be positioned to take still photographs from exactly the same position on the seabed. A video camera may also be used to obtain images from fixed points, but is more suited to trend monitoring along transects. When photographing the fixed locations, the ROV shall be positioned at the same place and in the same direction relative to the marker, for each sampling session. Photographs or video recordings from previous field surveys can be used as references for exact positioning. Information concerning each photograph should be noted in the sampling logbook, as described under the section for recording, see 8.7. A minimum of three fixed locations should be photographed at each station in order to ensure that these are representative of the area at large.

7.6.3 Trend monitoring using video transects

Trend monitoring using transects is suitable for documentation of changes within areas with only slight variations in habitat/seabed type. Parallel transects give representative observations and are also suitable for mapping of local distributions of organisms and seabed types. A minimum of three transects is required. The minimum combined length of the transects is dependent on the aims of the individual survey. If the aim is to detect changes in the diversity of organisms, the combined transect lengths should be at least 500 m. The number and length of transects should be adjusted in accordance with the aim of the investigation and the local conditions. In all other aspects the surveys are carried out as described for transect survey as described in 7.3.

Table 1 — Recommended minimum quality requirements for the parameters included within pilot surveys, mapping and trend monitoring

Method	Parameter	Pilot survey	Mapping	Trend monitoring
Video transects	Number/distribution	No specific requirements	variable[a]	3 transects
	Total length (per location)	No specific requirements	500 m[b]	500 m[b]
	Average speed over seabed	2 kn	1 kn	1 kn
	Height over seabed (max)	No specific requirements	3 m[c]	3 m[c]
	Image quality (size of detectable objects)[d]	4 cm	1 cm	1 cm
	Accuracy of positioning	≤ 20 m, relative tolerance + 5 % of depth Start and end	≤ 2 m, relative tolerance + 5 % of depth[e] Running positions	≤ 2 m, relative tolerance + 5 % of depth[e] Running positions
	Depth recording	Start point, end point max. depth, min. depth	For each position	For each position
Still photo-graphs	Number	1 per 100 m[a]	1 per 30 m[a]	5 per station
	Area	0,25 m^2 to 4 m^2	0,25 m^2 to 2 m^2	0,25 m^2 to 1 m^2
	Image quality (size of detectable objects)[d]	20 mm	5 mm	2 mm
	Accuracy of positioning	≤20 m, relative tolerance + 5 % of depth For each photo	≤ 2 m, relative tolerance + 5 % of depth[e] For each photo	0 (marker on the seabed)
	Depth recording	For each photograph	For each photograph	For each photograph

[a] Depending on required geographical resolution and the size of the mapping area, see 5.3.

[b] Only required for investigation of biological diversity.

[c] For mapping species > 10 cm a greater height from the seabed can be used.

[d] Image quality is here in the sense of identification of objects/organisms (size of object that can be identified, but not necessarily species determined).

[e] For water depth ≤ 20 m: 3 m with a relative tolerance of 3 % of the depth.

Video sequences or still photographs shall be calibrated with regard to field width either by controlling the height over ground or by at least two parallel laser pointers with calibrated distance between them.

NOTE For pilot surveys and mapping in depths less than 15 m it is also possible to give an estimation of the position of the under water system to the measured ship position including the estimated failure. The accuracy of the ship position is necessary.

7.7 Reference location

As part of surveys of areas affected by natural or human caused factors, a reference location outside the impacted area should be selected. Reference locations are decided according to whether a control or other reference needs to be provided. This is not necessarily a different location but can be the same location at a different point in time. Reference locations should to a largest possible degree represent the natural state without influence of any local sources, and should provide a measure of natural temporal and spatial variation in benthic communities. Reference locations should be included in surveys where comparison of the flora and fauna outside the influenced area is needed, or where knowledge about the natural variation is crucial. If reference locations are used these should be comparable with the impact locations, and the investigations should be performed in similar ways under similar conditions.

8 Image analysis

8.1 General

In this European Standard two types of image analyses are described:

— analyses of video sequences;

— analyses of still images (photographs or video "frame grabs").

The analyses should be standardised with respect to distance covered, e. g. by counting the numbers of organisms recorded per unit time. For colonial or encrusting organisms, the most common means of quantification is an estimate of the percent coverage of a specified unit area.

The choice of analytical approach depends on the objective of the survey and the characteristics of the habitat.

8.2 Analyses of video sequences

For quantitative analyses of video, the sequence lengths (sample size) should not be less than four times the error margins of the navigational data. For a navigational uncertainty of > 5 m, the use of video sequences < 20 m will carry an error margin of over 50 % of its actual length, thus the shortest sequence should not exceed 40 m. Solitary taxa should be counted within the video sequences, whereas encrusting and colonial taxa should be estimated as percentage coverage (see Table 3) from a representative subset of frozen video images.

8.3 Analyses of still images

Quantitative data should be presented as numbers of individuals or colonies per unit area, or as percent coverage. The percent coverage should either be measured directly, or by means of a "point count" method with 100 points evenly distributed along parallel lines placed both horizontally and vertically on the picture. The extent of coverage of organisms or habitats is then given as the percent of the points that coincide with organisms or substrate. In cases where the image is not taken perpendicular to the seabed, the network of points should be adjusted such that the distance between the points reflects the perspective of the image. For analysis of flora and macrofauna, the standard unit area is given as a 50 cm × 50 cm frame. This area should be marked as a central field on the images after photographing/recording.

8.4 Seabed substrates

Seabed substrates should be classified in accordance with the EN ISO 14688-1 for granulometric composition, see Table 2.

Table 2 — Particle size fractions and categories of seabed substrate for visual surveys of the seabed

EN ISO 14688-1		Survey type and minimum category	
Grain size	**Seabed substrate**	**Pilot**	**Mapping/Trend**
≤ 0,002 mm	Clay	Mud	Mud
> 0,002 mm to 0,063 mm	Silt		
> 0,063 mm to 2,0 mm	Sand	Coarse sediment	Coarse sediment
> 2 mm to 63 mm	Gravel		
> 63 mm to 200 mm	Cobble	Very coarse sediment	Cobble
> 200 mm to 630 mm	Boulder		Boulder
> 630 mm	Larger boulder/Bedrock[a]	Larger boulder/Bedrock[a]	Larger boulder/Bedrock[a]

[a] The definition of seabed type "bedrock" varies between standards. In EN ISO 14688-1 it is not defined as a particle with a certain minimum size because it is not part of the "soil"

Boulder with an extension larger than the visual field should be interpreted as bedrock as long as there are no clear indications of a separation from likely buried bedrock. For the finer sediment fractions, silt and clay, which are difficult to distinguish on video recordings, the combined term "mud" should be used. In the same way, sand and granule are combined as sand/granule. Recognition of mud and sand is based on structure in the image and not identification of single grains. Identification of grain size can be aided by letting the observation platform/ROV touch the seabed to stir up some sediment. In cases of uncertainty about the seabed substrate category a sediment sample should be taken for ground truthing. This can be made using a grab from the ship or using a small sediment corer mounted on the ROV or the towed observation platform.

If the percent composition of seabed types is to be recorded, this should be estimated as described above for analyses of flora and macrofauna from still images, following the scales given in Table 3.

8.5 Taxonomic identification

Identification of organisms should be carried out by personnel with documented education or experience within relevant areas of marine taxonomy. If the competence is not documented, the identification should be controlled by experts. Where available, identifiers should participate in national/international ring tests and other efforts towards taxonomic standardisation. Responsible institution should establish an image based reference collection from each investigation to document the taxonomical quality.

Images in a reference collection should as a minimum requirement be labelled with reference to the following data:

— Identification to lowest confident taxonomic level. If possible, species level is recommended;

— Geographic spatial location (with clear reference to which geodetic datum was used)/station number and water depth;

— Date and time of observation;

— Scientific name of the observed taxon according to ERMS (European Register of Marine Species);

— Morphological species if relevant;

— Information relating to copyright/freedom of use;

— Name of identifying person.

The nomenclature used should be in accordance with recent editions of general faunal works and an agreed regularly updated literature checklist or relevant catalogues of benthic fauna, such as the European Register of Marine Species (ERMS) [6] and/or World Register of Marine Species (WoRMS) [7]. Where a taxon is not listed in a catalogue, the reference to the original description should be given together with any additional identification literature used. Where a taxon has changed its name since list publication, then the new reference should be cited.

8.6 Identification and quantification of organisms

For mapping and monitoring surveys of biological communities and diversity of flora and megafaunal organisms should be identified to lowest possible taxonomic level.

Abundances should be recorded as numbers per unit area, for example per 10 m^2 for mapping and per m^2 for trend monitoring using still images covering a smaller area. A qualitative abundance scale (Table 3) can be used if quantification is of little relevance, for example for colonial organisms and in areas with mass occurrences of organisms. There are several similar scales that can be used for example the SACFOR scale.

NOTE The SACFOR scale provides intervals for relative abundance, relating to growth form and size of organisms.

Table 3 — Scale for calculation of extent of coverage for qualitative recordings of organisms

Interval-code	Coverage (colonial/encrusting organisms) or substrate %	Mass-occurring organisms (number of individuals or colonies per m^2)
6	100	>100
5	75 > 100	50 > 100
4	50 > 75	25 > 50
3	25 > 50	10 > 25
2	10 > 25	5 > 10
1	0 > 10	1 > 5
0	Not present	Not present

Alternatively, abundance quantification may be carried out on sub-samples ("frozen" video images). It is often not possible to identify specimens with certainty, and also there may be considerable variation between individuals within the same taxon. In such cases 'morphological species' should be used if their form, colour and size is described. For this purpose, a photographic reference collection should be included for all taxa and 'morphological species' in the reporting of results.

8.7 Reporting and archiving

8.7.1 Field report

Before recording, the storage medium (e.g. video cassette, DVD, or data file and hard disk) should be clearly labelled with the project or assignment code, station and sample number. Information on the date, time, geographic position and depth (metadata) should be noted on the form (see Annex A) at the start and end of recording. For mapping and trend monitoring, the same metadata should be logged during the video recording, or for each picture taken. Each still photograph should be given a separate sample number. This information can be stored as text directly on the recording/photograph or as a separate data file. The required frequency of logging of time and geo-references depends on the method and type of survey. If the observations are to be geo-referenced or quantified in relation to area, geographic data should as a minimum be logged at the beginning of each interval that marks a sequence in the video recording. The minimum geographic resolution should not exceed the limits set by the relative accuracy of the logged geographic data set. Additional information that may be useful during interpretation of results, for example weather conditions or limitations of the vessel shall also be noted on the registration form. Annex A gives an example for a registration form.

Information on geographic position, depth and time, together with height above the seabed and camera angle if appropriate, should be recorded with reference to the image material in the form of time codes. This should be stored either as text on the video recordings or as a separate date file. For stored data files a record of time of sampling, given as GPS-time, for the start of the video recording (see informative Annex A) should be included.

As minimum the following information should be recorded during fieldwork:

- project identifier or contract code;
- institute responsible for the recordings;
- person(s) who carried out the recordings;
- locality identifier (station and sample/image number);
- date and time (start – stop);
- geographic datum and the method used (6.1);
- geographic coordinates (start point – end point);
- geographic coordinates for fixed reference points (for photographing);
- error margins for geographic positioning (specified by the manufacturer);
- type of equipment;
- water depth (start, stop, maximum and minimum for transect; or for each still photograph as appropriate);
- general description of seabed type (for example: mud, sand/granule, cobble, boulder, larger boulder);
- remarks on special observations.

8.7.2 Survey report

After survey, a report should be provided including all information noted in the forms (see Annex A) as well as a description of methods and equipment used and a copy of calibration report for hydroacoustic positioning equipment if such methods have been used.

Annex A
(informative)

Example for a fieldwork registration form for visual seabed surveys

Form 1 – Registration form for visual seabed surveys should be filled out during all types of surveys. This form provides general information about the project and the methods, as well as geographical positions for start and end points for inspection at each location. For trend monitoring using still photography of closely situated areas start and end points will often be identical.

Form 2 – Registration form for still photographs. This form is not relevant for video transects where still photography is not used.

The user of these forms is allowed to copy the present forms given below.

Form 1 – Fieldwork registration form for visual seabed surveys

Project no./name:	Date:
Responsible institution:	Aim:
Project leader:	
Personnel in field:	

Positions from:		Geographic datum:		Video storage medium:	
Map	☐	EUREF 89	☐	DV	☐
GPS	☐	WGS 84	☐	VHS	☐
DGPS	☐	ED 50	☐	DVD	☐
		UTM	☐	Hard disc	☐
		Other	☐	Other	☐

Field view calculation using:		Trigonometric values:
Laser points:	☐	Angle of view:
Trigonometry:*	☐	Camera angle:
*Demands logging of height above seabed and camera angle if varying		

Surveyed locations and video transects

Date and time:	Locality no.:	Transect no.:	Position, start:	Position, end:

Form 2 – Fieldwork registration form for still photography

Project no./name:	**Date:**
Responsible institution:	**Station no.:**
Project leader:	**Persons in field:**
Geographic datum:	

Ref. point no.:	Time:	Latitude:	Longitude:	Depth:	Image no.:

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