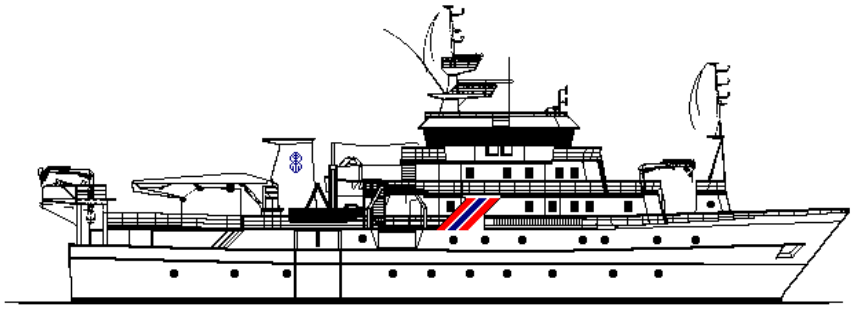
NORAD – FAO PROJECT 2006410
BCLME – PROJECT BEHP/NANSEN/06/01

CRUISE REPORTS "DR. FRIDTJOF NANSEN"



MARINE ENVIRONMENTAL SURVEY OF BOTTOM SEDIMENTS IN CABINDA PROVINCE, ANGOLA

Survey of the bottom fauna and selected physical and chemical compounds in October 2006

Institute of Marine Research (IMR)
Norway

UNIFOB AS, SAM (UiB)
Norway

Instituto Investigação Marinha (INIP)
Angola

Ministry of Petroleum (MinPet)
Angola

Ministry of Urbanisimo e Ambiente (MinUeA)
Angola

Agostinho Neto University
Angola

BCLME

GCLME

Chevron

MARINE ENVIRONMENTAL SURVEY OF BOTTOM SEDIMENTS IN CABINDA PROVINCE, ANGOLA

Survey of the bottom fauna and selected physical and chemical compounds in October 2006

UNIFOB AS

SECTION OF APPLIED ENVIRONMENTAL RESEARCH (SAM)

The evaluations and interpretation of the following chapters are done under accreditation number TEST 157.

4. ENVIRONMENTAL CONDITION – KAMBALA JACKET 132-05
5. ENVIRONMENTAL CONDITION – LOMBA
6. ENVIRONMENTAL CONDITION – NEMBA NORTH

Responsibility:	Date	Signature
Evaluations and interpretations:	10/12-07	Helge Dahlen
Project/investigation at UNIFOB AS/ SAM-Marine:	10/12-07	Gisle Vassenden

Section of Applied Environmental Research
High Technology Center
Thormøhlen gate 49
N-5006 Bergen
Norway

Tlf.: 55 58 44 64
Fax.: 55 58 45 25
Internet: www.sammarin.unifob.uib.no/
E-mail: first name.surname@bio.uib.no
Foretaksreg. nr. 985 827 117 MVA

Acknowledgements

Sampling at *Dr. Fridtfjof Nansen*
Lia Neto Sausa, Tito Milagre Ndumbo, Zabaka R. Joao, Juliana Cristina Muai, Virgilio Estevao, Paulo Coelho, Ines Valente Vicente Quitumba, Domingo Pedro, Hélia Dinah Guise da Piedade (Angola), Mungolu Bongu Mathieu (Congo)
Supervised by Gisle Vassenden (UNIFOB AS) and Bjørn Serigstad (IMR)

Sorting of biological samples
Manuell Paz Luis Pinto, Silvana Manuell Faria, Hélia Dinah Guise da Piedade
Supervised by Amir Amin, Tor Ensrud and Ragna Tveiten (UNIFOB AS)

Identification of biological samples
Per Johannessen (UNIFOB AS), Per-Otto Johansen (UNIFOB AS) and Jon Kongsrud (Bergen Zoological Museum, UiB), Tore Høisæther (University of Bergen), Eivind Oug (NIVA), Per Wikander (Molltax Per Bie Wikander)

Organic chemical analyses
Grethe Tveit (IMR) Kjell Westrheim (IMR), Daniel Cejka (IMR), Jarle Klungsøyr (IMR)

Metal analyses
Personell at the laboratory at Analycen AS

Physical analyses
Helge Grønning (UNIFOB AS)

Computer analyses
Gisle Vassenden (UNIFOB AS), Lia Neto Sausa, Silvana Manuell Faria, Hélia Dinah Guise da Piedade, Ester Moniz Dacosta,

Reporting
Bjørn Serigstad (IMR), Gisle Vassenden (UNIFOB AS), Stephan Boitsov (IMR), Marek Ostrowski, (IMR), Magne Olsen (IMR), Lia Neto Sausa, Silvana Manuell Faria, Hélia Dinah Guise da Piedade, Ester Moniz Dacosta, Ines Valente Vicente Quitumba (INIP)

Photo of fauna
Tor Ensrud

We would like to thank the officers and the crew onboard *Dr. Fridtjof Nansen*.

Table of content

1. INTRODUCTION

The co-existence of the fisheries, sea transport and oil sectors is a worldwide challenge related to sustainable utilisation of marine living resources in particular, and conservation and protection of the marine environment in general.

An important factor in safeguarding this co-existence between different commercial users of the marine environment has been the development of legislation and policy instruments and the establishment of governmental institutions, NGOs and private institutions.

The new monitoring plan for Angola, called "Environmental Monitoring of the Petroleum Activities on the Angolan Continental Shelf" has been the basis for this survey in Cabinda.

The coast of Cabinda from S 5º00 to S 6º00t consists mainly of sandy beaches, lined with sand dunes. The area is part of the marine ecosystem called GCLME (Guinea Current Large Marine Ecosystem). Cabinda is strongly influenced by the fresh water discharge from the Congo River wich has the second largest water flow in the world behind the Amazon. Most of the water from Congo River flows northward affecting the horizontal and vertical gradient of temperature and salinity in the Cabinda area. In addition pollutants from big cities along the river, agriculture and runoff from land may give effects on marine life.

For more than 50 years, oil exploration and production have taken place in Cabinda. The petroleum industry is operating both on land and offshore. There is a concern that this petroleum activity may have negaeentive impact on the marine resourses resulting in reduced recruitment to fishstockes or loss of marine biodiversity. In addition there is a concern among other users of the sea, especially among the artisenal fishermen and other people living along the coast making their income from the sea. Besides the possible impact on the marine ecosystem these people also fear health problems for themselves and coming generation. Another concern in addition to possible pollution is the access to fishing grounds and beaches where they traditionally have made their work and living. A reduced water quality and increased industrial activity will probably also be negative for the tourism industry.

With all these possible impacts on the ecosystem with possible impact on different users of the sea it is important to make as good documentation as possible of the environmental conditions in an area. This makes it possible take action if the conditions show to be severely influenced by some specific activities. To be able to have a good environmental monitoring, an environmental monitoring plan covering the areas of concern must be in place. When timeseries is established it is possible to see if the situation is stable or if pollution is increasing. Hopefully the conclusion can be that the situation is becoming better. That should be possible with modern technology.

The intension is that this survey should be the start of such a systematic monitoring in Angola.

History of petroleum industry in Angola
The Petroleum was first discovered in Angola in the 1800th century, but the first attempts of industrial exploration started in the early 1900th century but it was no commercial success in the beginning.

The first commercial oil well was discovered in the Cabinda province in 1954. It was located in shallow waters in the Basin of Low Congo. The Cabinda Gulf Oil Company (CABGOC) was established and started exploration in 1966.

From 1974 to 1995 the Angolan oil industry was in a structuring phase. SONANGOL (National Society of Fuels of Angola) was founded in June of 1976. SONANGOL was responsible for the concessions of the exploration rights and hydrocarbon production.

The Angolan continental shelf was divided in Blocks by SONANGOL. In 1979 14 blocks (Block 0 – 13) in shallow waters from 0 to 200m depth were defined. In 1990 17 new blocks (Block 14 – 30) in deep water from 200m to 1500m (14 to 30) where defined. The ultra-deep areas were divided in 4 Blocks.

Today the Angolan shelf is divided in 35 Blocks of wich 17 are awarded, 7 are abandoned and 11 are still free.

COOPERATION IN ANGOLA
For Implementation of the National Environmental Monitoring Plan for Angola multisectorial cooperation has been established among the Ministry of Fisheries (National Institute of Fishery Research), Ministry of the Urbanism and Environment, Ministry of Petroleum, Ministry of Geology and Mines and the Agostinho Neto University.

The problems with pollution and transport of pollutants are complex and a transboundary. Petroleum activities are not limited to the Angolan territory; it also takes place north of Angola in Congo and Gabon. In this way it is a shared problem with counties in the large marine ecosystems; GCLME and BCLME. Angola is a link between the two current systems.

The monitoring survey was a joint effort between the BCLME and the GCLME and will hopefully enhanced the understanding of the nature and extend the knowledge of how the offshore oil activities can affect the marine ecosystem. This first survey will hopefully contribute with valuable information especially on the benthic communities and levels of contamination by hydrocarbons and heavy metals in the sediments. This first survey gives information from 3 platforms located in shallow water in Cabinda Province. This is the start.

The Angolan Multisectoral Group of Experts has devided activities in two phases:

1) **The first phase** is to Elaboration the Angolan Environmental legislation for Monitoring of offshore oil activities. The Ministry of the Urbanism and Environment coordinates this activity with assistance from the Ministry of Petroleum and Ministry of the Fisheries.
2) **The second phase** is the Monitoring Strategies which is coordinated by the Ministry of Fisheries (National Institute of Fisheries Research).

2 METHODS

2.1 Sampling cruise

The sampling cruise on board *Dr Fridtjof Nansen* started in Luanda on October 10, 2006. Sampling commenced at Kambala jacket 132-05 site October 14. and the last sample was collected at Nemba North site at October 17. Trawling and CTD registration was done from October 11. to October 13. and October 17. to 18. The results of the trawling are not presented in this report. The vessel returned to Lunada at October 19.

The weather conditions were good during the whole cruise and there were no incidents hurting or damaging crew members, sample equipment, samples or the vessel.

2.2 Survey area and sampling design

Figure 2.1 - 2.3 shows the different sediment sampling sites near the three investigated oilfield Kambala jacket 132-05, Lomba and Nemba North. The investigated sites south of Congo river taken in April 2006 are presented in the map. Map of the hydrographical sampling sites are shown in the map in Figure 3.1. Table 2.1 – 2.3 gives information of the position of sites investigated north of Congo River. The water depth in the sampling area varies between 22 and 34 m at Kambala, 97 to 294 m at Lomba and 115 to 116 m at Nemba North.

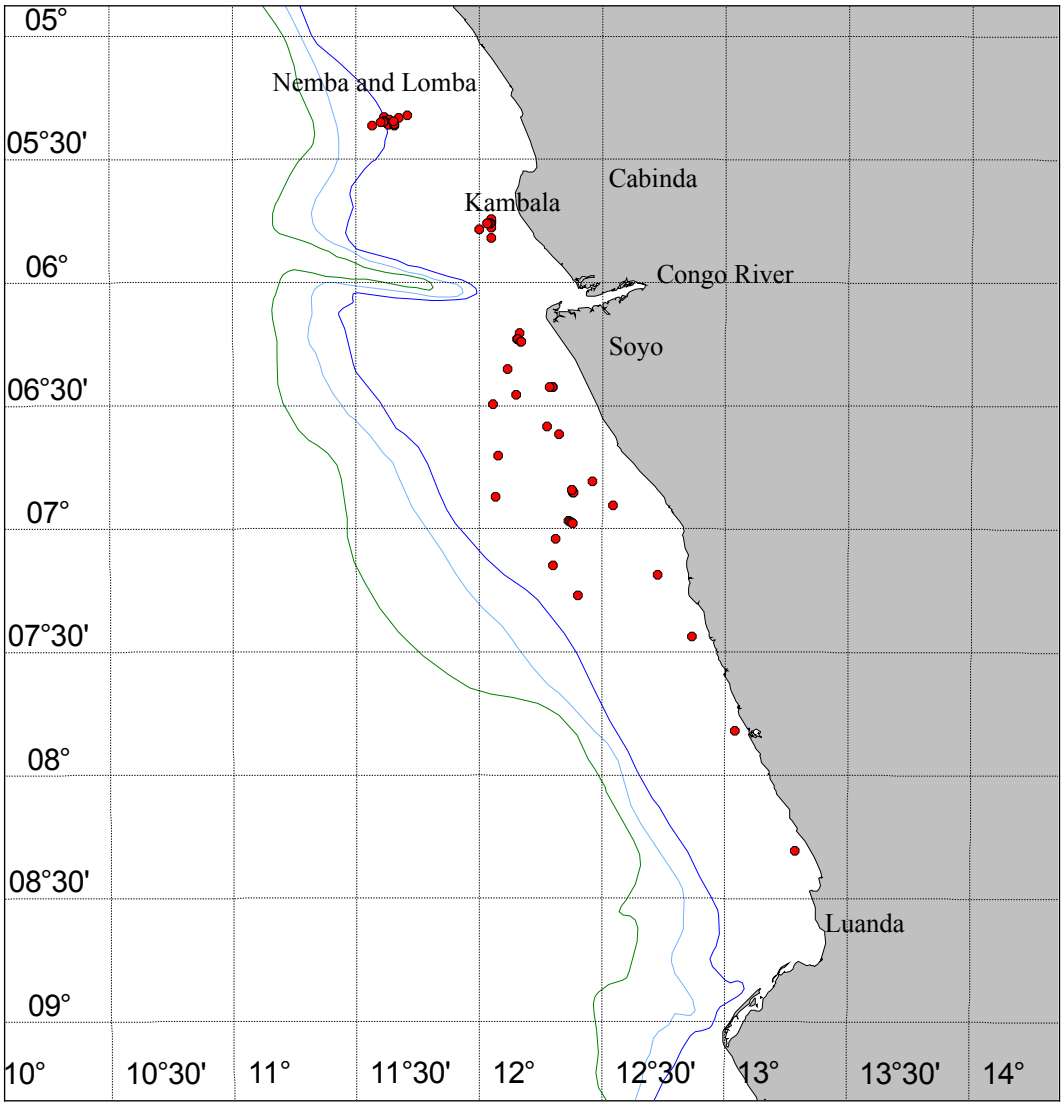


Figure 2.1. Map showing the the three investigated platforms Lomba, Kambala jacket 132-05 and Nemba North. The sites investigated in April 2006 south of Congo River is presented in the map.

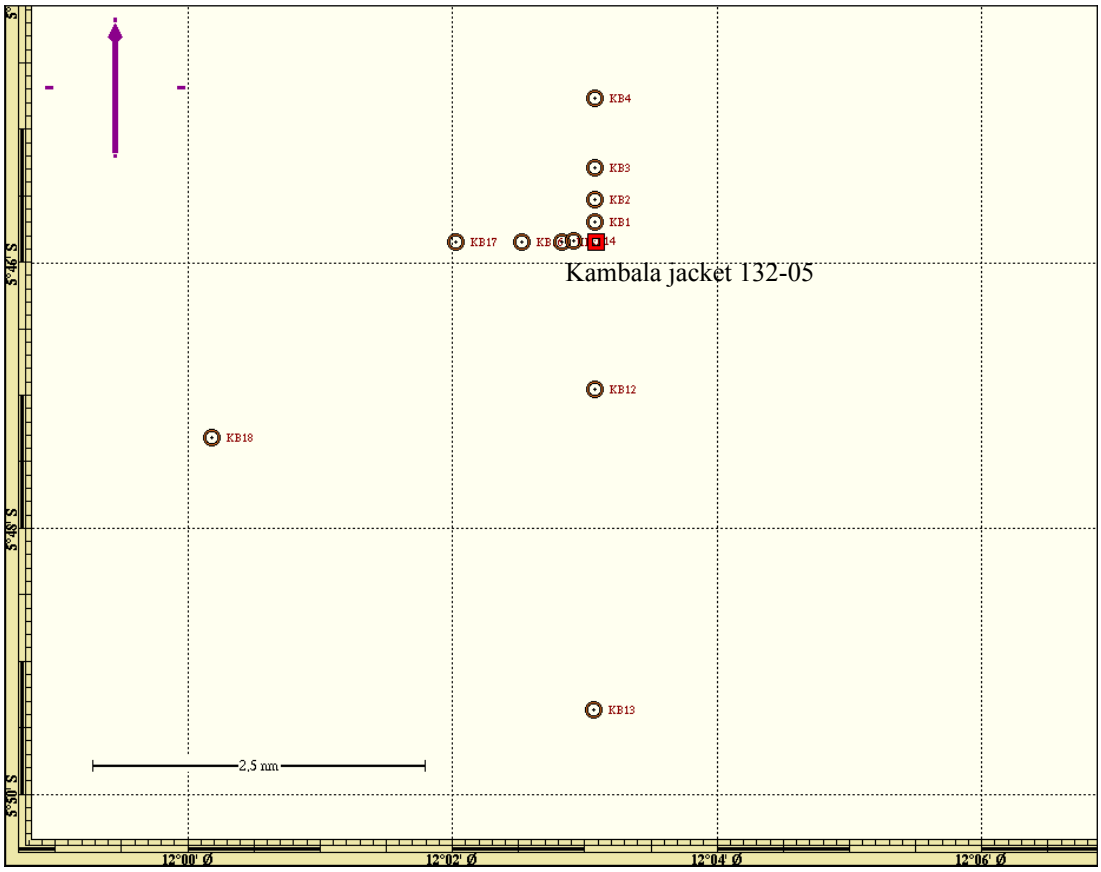


Figure 2.2. Map showing the sampling sites around the Kambala jacket 132-05.

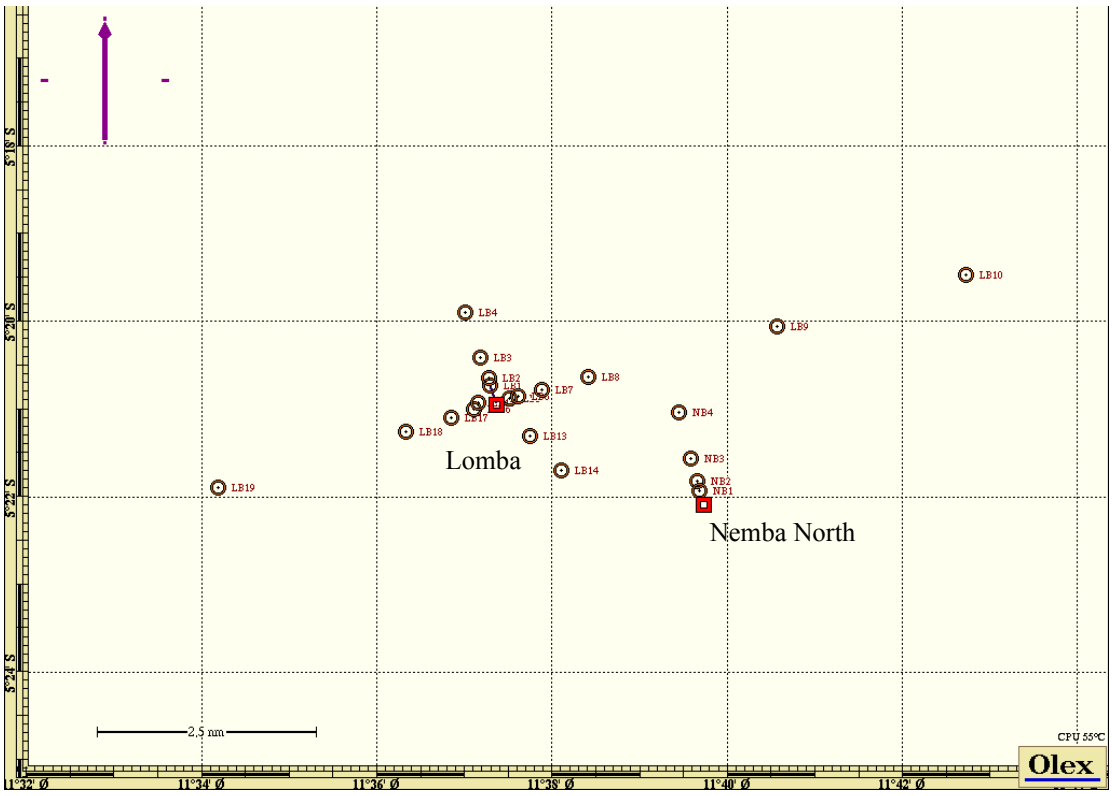


Figure 2.3. Map showing the sampling sites around the platforms Lomba and Nemba North.

Table 2.1. Information of the trawling sites for zooplankton and fish. Positions in WGS84 datum.

Site	Date	Time UTC	Latitude	Longitude	Depth (m)	Course (^{O})	Wind dir	Wind force	Weather	Clouds	Sea	Comment
Zooplankton												
PL 1	11.10.06	08.54	5°41,200` S	11°57,000` E	40	250	187	4,4	2	8	2	Multinett
PL 2	11.10.06	10.55	5°44,400` S	11°48,300` E	72	250	262	3,7	2	8	2	Multinett
PL 3	11.10.06	12.37	5°47,600` S	11°38,600` E	125	250	217	5,2	2	8	2	Multinett
PL 4	11.10.06	16.09	5°51,100` S	11°28,600` E	256	250	222	5,7	2	8	2	Multinett
PL 5	11.10.06	20.12	5°53,150` S	11°19,360` E	>500	100	239	7	2	8	2	Multinett
PL 6	12.10.06	17.06	5°25,620` S	11°48,680` E	64	236	227	6	1	3	2	Multinett
PL 7	12.10.06	20.07	5°31,040` S	11°40,460` E	115	236	260	8	1	4	2	Multinett
PL 8	12.10.06	23.06	5°39,550` S	11°27,660` E	348	236	250	5,7	1	4	2	Multinett
PL 9	17.10.06	21.26	5°9,580` S	11°50,930` E	59	235	190	5	1	4	1	Multinett
PL 10	17.10.06	23.11	5°15,493` S	11°41,587` E	100	200	203	12	1	2	2	Multinett
PL 11	17.10.06	01.14	5°21,013` S	11°34,250` E	250	235	222	12	1	2	2	Multinett
Fish-trawling												
PT 1	17.10.06	19.36	5°08,135` S	11°56,484` E	32	180	193	7	1	3	2	Very small pelagic v/floats
	17.10.06	20.06	5°09,340` S	11°57,010` E	31	360						Stop
PT 2	18.10.06	17.54	5°44,730` S	11°56,460` E	44	230	271	3	1	3	2	Big pel v/floats
	18.10.06	18.35	5°44,320` S	11°54,310` E	52	180						Stop
PT 3	18.10.06	19.26	5°45,750` S	11°53,890` E	53	130	259	3	1	3	2	Big pel v/floats
	18.10.06	20.30	5°48,380` S	11°56,540` E	46	180						Stop

Table 2.2. Information of the CTD, phytoplankton and nutrients sampling sites. The sites are shown in the map in Figure 3.1.

Station nr.	Date	Time UTC	Latitude	Longitude	Depth (m)	Course (^{O})	Wind dir	Wind force	Weather	Clouds	Sea	Comment
HD 1460	11.10.06	06.21	5°39,900` S	12°03,700` E	20	250	187	4,4	2	8	2	
HD 1461	11.10.06	07.31	5°41,380` S	11°58,460` E	40	250	187	4,4	2	8	2	
HD 1462	11.10.06	09.48	5°34,000` S	11°53,700` E	53	250	258	6,68	2	8	2	
HD 1463	11.10.06	10.30	5°44,600` S	11°48,800` E	68	250	337	7,38	2	8	2	
HD 1464	11.10.06	11.44	5°46,200` S	11°43,600` E	95	250	262	5,5	2	8	2	
HD 1465	11.10.06	12.25	5°47,500` S	11°38,900` E	121	250	217	5,2	2	8	2	
HD 1466	11.10.06	13.34	5°49,000` S	11°33,800` E	190	250	243	6,3	2	8	2	
HD 1467	11.10.06	14.19	5°50,500` S	11°28,900` E	245	250	240	5,7	2	8	2	
HD 1468	11.10.06	18.42	5°51,710` S	11°25,500` E	431	250	222	4,65	2	8	2	
HD 1469	11.10.06	19.44	5°53,450` S	11°19,690` E	>500	100	239	5,98	2	8	2	
HD 1470	12.10.06	15.50	5°23,000` S	11°53,200` E	49	238	220	6	1	3	2	
HD 1471	12.10.06	16.43	5°25,730` S	11°48,950` E	63	236	218	6	1	3	2	
HD 1472	12.10.06	17.42	5°28,390` S	11°44,820` E	86	236	260	6	1	3	2	
HD 1473	12.10.06	19.57	5°31,170` S	11°40,560` E	115	236	260	2	1	4	2	
HD 1474	12.10.06	21.17	5°33,970` S	11°35,930` E	209	236	260	9	1	4	2	
HD 1475	12.10.06	22.08	5°37,140` S	11°31,730` E	291	236	266	8	1	4	2	
HD 1476	12.10.06	22.52	5°39,610` S	11°27,730` E	348	236	250	9	1	4	2	
HD 1477	13.10.06	00.43	5°42,170` S	11°23,380` E	414	236	230	6,7	1	4	2	
HD 1478	17.10.06	17.32	5°07,100` S	11°55,320` E	37	235	230	7	1	3	1	
HD 1479	17.10.06	21.17	5°09,520` S	11°50,960` E	59	235	190	5	1	4	1	
HD 1480	17.10.06	2218	5°12,990` S	11°45,790` E	81	235	203	6	1	4	1	
HD 1481	17.10.06	2258	5°15,680` S	11°41,800` E	100	235	203	7	1	2	2	
HD 1482	17.10.06	0014	5°18,050` S	11°38,268` E	118	235	220	10	1	2	2	
HD 1483	17.10.06	00.57	5°21,003` S	11°34,129` E	259	235	222	12	1	2	2	
HD 1484	17.10.06	02.33	5°24,841` S	11°28,297` E	514	235	203	10	1	2	2	

Table 2.3. Information of the bottom fauna sampling sites at Kambala jacket 132-05. Positions in WGS84 datum

Station nr.	Date	Time UTC	Latitude	Longitude	Depth (m)	Wind force	Sediment description	Volume (l)	Sediment layer Chemistry	Comments
Kambala										
KB1	15.10.06	08.30	5°45,702` S	12°03,073` E	22	13	Mud	21	0-1, 1-3, 3-6 cm	
KB2	15.10.06	06.09	5°45,529` S	12°03,073` E	22	14	Mud	21	0-1, 1-3, 3-6 cm	
KB3	15.10.06	05.15	5°45,291` S	12°03,073` E	22	13	Mud	21	0-1 cm	
KB4	14.10.06	22.07	5°44,763` S	12°03,080` E	23	7	Mud	21	0-1 cm	
KB12	14.10.05	15.49	5°46,959` S	12°03,077` E	23	13	Mud	21	0-1 cm	
KB13	14.10.06	17.28	5°49,364` S	12°03,064` E	25	11	Mud	21	0-1 cm	
KB14	14.10.05	13.59	5°45,840` S	12°02,913` E	23	10	Mud	21	0-1 cm	
KB15	14.10.05	12.03	5°45,850` S	12°02,830` E	24	10,5	Mud	21	0-1 cm	
KB16	14.10.06	08.00	5°45,848` S	12°02,572` E	25	10	Mud	21	0-1 cm	
KB17	14.10.06	20.37	5°45,848` S	12°02,029` E	27	12	Mud	21	0-1 cm	
KB18	14.10.06	19.05	5°47,317` S	12°00,183` E	34	12	Mud	21	0-1 cm	

Table 2.3 continue. Information of the bottom fauna sampling sites at Lomba and Nemba North. Positions in WGS84 datum.

Station nr.	Date	Time UTC	Latitude	Longitude	Depth (m)	Wind force	Sediment description	Volume (l)	Sediment layer Chemistry	Comments
Lomba										
LB1	16.10.06	08.01	5°20,735` S	11°37,294` E	130	6	Mud	21	0-1, 1-3, 3-6 cm	Black spots in the sediment
LB2	16.10.06	13.59	5°20,656` S	11°37,278` E	130	4	Mud	21	0-1, 1-3, 3-6 cm	Black spots in the sediment
LB3	16.10.06	16.36	5°20,417` S	11°37,185` E	130	7	Mud	21	0-1 cm	
LB4	16.10.06	03.30	5°19,898` S	11°37,010` E	130	11	Mud	21	0-1 cm	
LB5	16.10.06	10.03	5°20,884` S	11°37,517` E	128	6	Mud	21	0-1 cm	
LB6	16.10.06	11.58	5°20,856` S	11°37,609` E	128	3	Mud	21	0-1 cm	
LB7	16.10.06	18.40	5°20,783` S	11°37,885` E	125	7	Mud	21	0-1 cm	
LB8	16.10.06	20.50	5°20,640` S	11°38,410` E	121	10	Mud	21	0-1 cm	
LB9	16.10.06	01.43	5°20,056` S	11°40,575` E	109	14	Mud	21	0-1 cm	
LB10	16.10.06	00.00	5°19,479` S	11°42,722` E	97	11	Mud	21	0-1 cm	
LB13	16.10.06	22.35	5°21,318` S	11°37,744` E	128	10	Mud	21 (B4=12)	0-1 cm	B4=Sample nr 4
LB14	17.10.06	00.42	5°21,703` S	11°38,108` E	125	10	Mud	21	0-1 cm	
LB15	16.10.06	05.35	5°20,932` S	11°37,160` E	131	8	Mud and shell fragments	21	0-1 cm	
LB16	15.10.06	15.49	5°21,002` S	11°37,106` E	132	10	Mud	21	0-1 cm	
LB17	15.10.06	13.49	5°21,108` S	11°36,854` E	134	8	Mud	21	0-1 cm	
LB18	15.10.06	17.33	5°21,259` S	11°36,330` E	146	11	Mud and shell fragments	21	0-1 cm	
LB19	15.10.06	19.50	5°21,906` S	11°34,191` E	274	14	Mud and shell fragments	21	0-1 cm	
Nemba										
NB1	17.10.06	11.05	5°21,940` S	11°39,687` E	115	10	Mud	21	0-1, 1-3, 3-6 cm	Black spots in the sediment
NB2	17.10.06	08.10	5°21,829` S	11°39,658` E	115	11	Mud	21	0-1, 1-3, 3-6 cm	Black spots in the sediment
NB3	17.10.06	05.20	5°21,567` S	11°39,589` E	115	11	Mud	21	0-1 cm	
NB4	17.10.06	02.35	5°21,046` S	11°39,445` E	116	13	Mud	21	0-1 cm	

2.3 Sampling and sample treatment

All the sampling was done by the crew from Instituto Nacional de Investigação Pesqueira (INIP) and Agostinho Neto University under supervision by Gisle Vassenden (UNIFOB AS/SAM-Marine/UiB) and Bjørn Serigstad (Institure of Marine Research). Section of applied environmental research (SAM-Marine) is accredited by Norsk Akkreditering for sampling, sorting and taxonomic identification under accreditation number Test 057. The sampling was undertaken in accordance with the Norwegian guideline ”Aktivitetsforskriften”, the modification of Requirements for Environmental Monitoring of the Petroleum Activities on the Angolan Continental Shelf and international standards (ISO 5667-19 and ISO 16665).

Positioning of *Dr. Fridtjof Nansen* was done by Global Positioning System (GPS). The positions were approved by the oil company.

2.3.1 Temperature, salinity and oxygen

CTD sites were taken along 3 different transect from the shore to the open water. A Seabird 911 CTD plus was used to obtain vertical profiles of temperature, salinity and oxygen. Real time plotting and logging was done using the Seabird Seasave software installed on a PC. The profiles were taken down to a few metres above the bottom. The new oxygen sensor has shown to be very stable, and no calibration was conducted during the survey. The calibration constant calculated during the survey off the western Gulf of Guinea was applied for the whole survey.

2.3.2 Sediment sampling

Sampling took place at two different types of sampling sites, ordinary field sites and reference sites. Ordinary field sites were the most numerous. At each site, 8 grab samples were taken. Five were used for biological analysis and 3 for chemical analysis (metals and oil hydrocarbons). Sediment that was used for chemical analysis was taken from the upper 0-1 cm of the sample. From field sites downstream and closest to the installation and at some reference sites, additional sectioned samples were taken for chemical analysis from 1-3 and 3-6 cm depth of the sediment.

The field sampling sites were spread out along two transects at a predefined distance from the installation. It was proposed to take the samples 250 m, 500 m, 1000 m, 2000 m distanse from the platform. One transects extended upstream and downstream from the centre of the installation, and the other extended to the right and left at a right angel to the first transect at the centre of the installation. Because of pipelines and electrical cables at the seafloor, and for security reason, some sites are not sampled or they were moved.

Sediment samples were taken by a van Veen grab with adjustable weight and an opening of 0.1 m². The total volume of the grab was 21 litres. Due to soft sediments, the sediment was stuck to the lids of almost every grab samples. A lighter (0.1 m²) van Veen grab would have been a better grab for the sediment at Cabinda, but was not available on board the ship.

On deck the volume of each sample was measured. Sediment was described, and colour was recorded, as well as anomalous odour and conspicuous taxonomic groups. Samples for biological analysis were sieved through sieves with 5 mm and 1 mm round holes. Material retained in the sieves was placed in 250-1000 ml plastic containers where formalin and borax was added. Each sample was marked and stored on board in transport containers. Samples for

chemical analysis were taken through the hatches on top of the grab from the upper 0-1 cm of the sediment sample inside the grab.

Sectioned sediment samples were taken at designated sites. These samples were taken by a corer which was pressed into the sediment inside the grab from the topside. The sediment in the corer was sectioned into 3 subsamples respectively from the 0-1, 1-3 and 3-6 cm layers.

To avoid contamination an ordinary table spoon or special designed metal spoon was used when taking the sediment for hydrocarbon and grain size analyses, but a plastic spoon was used when taken the sediment for metal analyses. The spoons were washed with seawater between each sample. Each sample was put into Rilsan plastic bags which were marked and immediately frozen to prevent evaporation of labile compounds. The samples were kept frozen until further analysis in the onshore laboratory. Samples for TOM and grain size analyses were taken from the upper 0-5 cm of the sediment and put in separate plastic bag, marked and frozen immediately.

At the end of the survey the samples for chemical analyses in Angola were transported to a freezer at INIP. The samples for analyses in Norway were stored onboard in the freezer, and shipped to Norway from Las Palmas in December 2006. The biological samples were stored at INIP and shipped to Norway from Luanda in February 2006.

2.4 Sample analyses

2.4.1 Colour, grain size and TOM

The colour of the sediment was determined according to Munsell® Soil Colour Chart System year 2000 revised (GretagMacbeth, New Windsor, NY, USA) when the sample arrived on deck. A mixture consisting of sediment from the upper 0-5 cm of three separate grab samples was used for the grain size analysis at each sampling site.

The particle size was analysed in the laboratory by disolving the sediment in water and then sieved through a 0,063 mm sieve. The particle bigger than 0,063 mm, was dry sieved on Endecott sieves. The sieves had square holes with opening 16mm (ϕ=-4), 8mm (ϕ=-3), 4mm (ϕ=-2), 2mm (ϕ=-1), 1mm (ϕ=0), 0,5mm (ϕ=1), 0,250mm (ϕ=2), 0,125mm (ϕ=3) and 0,063mm (ϕ=4) (Buchanan 1984). The analysis was performed at SAM.

The median diameter and sorting (Table 2.4) was calculated with the formula in Buchanan (1984) and Folk & Ward (1957), and the program GradiStat versjon 4.01 (Blott & Pye 2001).

Partikkeldiameter: x = Φ-value ($\Phi=-\log_2 x$)

Median partikle diameter: Md Φ = Φ50.

Mean diameter $M_z = \frac{\Phi(16) + \Phi(50) + \Phi(84)}{3}$

Sorting: SD $\Phi = \frac{\Phi(84) - \Phi(16)}{4} + \frac{\Phi(95) - \Phi(5)}{6,6}$

Tabell 2.4. The mesh size of the sieves used for grain size analysis.

Size of the sieve (mm)	Phi class Φ	Description
16	-4	Gravel
16-8	-3	Gravel
8-4	-2	Gravel
4-2	-1	Gravel
2-1	0	Sand
1-0,5	1	Sand
0,5-0,25	2	Sand
0,25-0,0125	3	Sand
0,0125-0,063	4	Sand
< 0,063		Pelite

Deviation
The sediment at Nemba North and Lomba was aggregating during the dry sieving, and this can have affected the grain size analysis to be more sandy than it really was.

TOM
The amount of organic material (TOM) was determined as weight loss in a 2-3 gram dried sample (105° C for about 20 hours) after combustion at 480° C for 2 hour.

2.4.2 Chemical compound analyses

2.4.2.1 The principle of the oil hydrocarbons analysis

All the chemical analyses of sediments have been carried out according to the accredited methods routinely used at IMR for PAH/THC analyses. Frozen sediment samples were thawed at room temperature, extracted by saponification in methanolic KOH followed by extraction by hexane, removal of sulphur by active copper, clean-up on silica Bond-Elute column and then analysed by GC-MS, with gas chromatograph HP-6890 coupled to Micromass Autospec Ultima mass spectrometer, in SIR-mode, «Selected Ion Recording». The results were quantified with Opus Quan software package. Twenty separate PAH compounds and 9 groups of alkylated PAHs are included in the analysis. THC have been analysed by gas chromatography with flame ionization detector (GC-FID).

2.4.2.2 The principle of metal analysis

The metal content is determined by Inductively Coupled Plasma – Atomic Emission Spectrometry (ICP-AES) except mercury which determined by Cold Vapour Atomic Emission Spectrometry (CVAAS) after drying, sieving and digestion.

Procedure
The sediment samples were dried at 105°C or 40°C for samples for mercury determination. The sample was sieved through a 0.5 mm sieve. The fraction <0.5 mm was digested with nitric acid according to NS4770.

Digestion by nitric acid
Digestion was performed in a autoclav. About 1 g of sample was weighed in to a sterile PP testtube with 4 mL of nitric acid. The samples were then autoclaveted in 120 °C in 30 min. After digestion, the samples were filtered and diluted to 50 mL.

Metal analysis by ICP-AES
The metals, except mercury, were analysed by a Varian Vista-PRO ICP-AES. The analytical conditions are found in Table 2.4.

Table 2.4. ICP-AES analytical conditions

Element	Wavelenght	Power (kW)	Background correction
Ba	233.527	1.35	Fitted
Cd	228.802	1.35	One point, left
Cr	267.716	1.35	Fitted
Cu	324.754	1.35	Fitted
Pb	220.353	1.35	Fitted
Zn	213.857	1.35	Fitted

Mercury analysis by CVAAS

Mercury was analyzed by a Cetac M6000-A mercury analyzer. The mercury in the solution was reduced by $SnCl_2$ to its elementary form Hg^0. Elementary mercury is volatile and was separated from the solution in a gas liquid separator by an argon carrier gas. The absorption at 254 nm was measured to determine the concentration of mercury.

Reference materials

CRM015-050 metals on sediment and CRM031-040 metals on soil (Resource Technology Corporation) was use as a reference.

2.4.3 Limits of significant contamination (LSC)

LSC values were calculated from the replicates at the reference sites by using a one-tailed student t-test at 95 % significant level according to the formula given in the the Norwegian guideline ”Aktivitetsforskriften” and Requirements for Environmental Monitoring of the Petroleum Activities on the Angolan Continental Shelf.

Limits of significant contamination (LSC) was calculated with the formula:

$$LSC > \overline{R}_{..} + t_{\alpha(1),\nu} \cdot s \cdot \sqrt{1 + \frac{1}{N_r}}$$

$\overline{R}_{..}$ = the average of mean values for the reference sites.
$t_{\alpha(1),\nu}$ = critical value from the t-distribution, using a unilateral t-test with a level of significance of α (=0.05)
and ν = N_r-1 degrees of freedom.
s = Standard deviation for the spread between the station average.
N_r = Number of reference stations
The standard deviation s is calculated as $s = \sqrt{\frac{\sum_{i=1}^{N_r} (\overline{R}_{i.} - \overline{R}_{..})^2}{N_r - 1}}$
where $\overline{R}_{i.}$ = the mean values of the parallels at reference station no. *i.*

For a further explanation concerning the formula, see memorandum O 99218 from NIVA.

2.4.4 PCA, chemistry and geology

Based on the amount of Cd, Cu, Ba, Zn, Cr, Pb and THC at each sampling site, all sites within each field and nearby reference sites were compared by a PCA analysis. Log (x+1) transformation were used in the analyses. The calculation was performed by the program PRIMER 5 from Plymouth Marine Laboratory in England.

2.4.5 Biological analyses

Prior to sorting and species identification, each sample was sieved and washed once more to remove formalin. Specimens were then sorted out under dissecting microscope, and each taxonomic group placed in a small bottle with ethanol. The specimens were then identified, and enumerated and returned to the fixation fluid.

A complete species list is presented in the appendix. Only the bottom fauna (benthos) was used for further analyses which used:

- Total number of species
- Total number of specimens standardised to 0.5 m² of sea floor
- The ten most abundant species at each site (species name, number of specimens and % of total number of specimens)
- Cumulative species / area graph, for reference sites only (5 samples)
- Species diversity as “Shannon Wiener index” on a $\log_2$ base (Shannon & Weaver 1963)
- Eveness as Pielous’s “J” (Pielou 1966)
- Cluster analysis based on “Bray-Curtis dissimilarity index” (Bray & Curtis 1957), followed by “group average sorting” on 4th root transformed data
- Ordination by “multidimensional scaling”

The analysis is done by the dataprogram PRIMER 5 from Plymouth Marine Laboratory in England.

- Univariate analyses:

The mathematical bases for the diversity indices are outlined as follows:

Diversity H', the Shannon-Wiener function (Shannon & Weaver 1949)

$$H' = -\sum_{i=1}^{s} p_i \log_2 p_i ,$$

where: $p_i = n_i/N$

s = total number of species

n_i = number of individuals of species i

N = total number of individuals

Species diversity (H`) above 4 is considered high, between 3 and 4 is moderate, diversity between 2 and 3 is low and below 2 is very low.

Pielou's measure of evenness, J (Pielou, 1966)

where $H' \max = (\log_2 s)$

Evenness, an estimate of how the individuals are distributed among the species, varies between 0 and 1, with a value close to 0 if all individuals belong to one or a couple of species. Evenness has the value 1 if all individuals are equally distributed between the species.

The species-area curve is produsedby the program EstimateS from University of Connenticut. More about the method see Colwell & al 2004.

- Log-normal curve

An indication of the environmental condition may be gained by using geometric classes. For example, species which are represented by one individual in geometric class I, species which are represented by 2 to 3 individuals are in geometric class II, species which are represented by 4 to 7 individuals are in geometric class III and so on. Geometric classes are plotted against number of species for each station. Good environmental conditions are indicated when there are many species with few individuals and few species with many individuals. Impoverished environmental conditions are indicated by the presence of only a few species with very many individuals. Further information, see Gray & Mirza (1979) and Pearson & al. 1983.

- Multivariate analyses

Multivariate analyses were undertaken to compare the actual species composition at the sites. Two different types of multivariate analyses where executed, a classification (cluster analysis) and an ordination (non-metric multidimensional scaling). The species abundance data were double square root transformed prior to analysis to reduce the effect of the most abundant species and to include more of the rare species. The

calculation was performed by the program PRIMER 5 from Plymouth Marine Laboratory in England.

Cluster analysis

The cluster analysis is a hierarchical agglomerative clustering of stations with the most similar species composition grouped together first at a high similarity level and then grouping the other stations at lower and lower similarity levels together, until all stations are grouped in a single cluster. The comparisons of the fauna at each station were based on Bray-Curtis similarity index (BRAY & CURTIS 1957), while the linking of the groups is based on group average sorting of the similarity indices. The final result is presented as a dendrogram.

Bray-Curtis similarity measure: $$S_{jk} = 100\left\{1 - \frac{\sum_{i=1}^{p} |y_{ij} - y_{ik}|}{\sum_{i=1}^{p} (y_{ij} + y_{ik})}\right\}$$

where:
S_{jk} = similarity between two sample, j and k
Y_{ij} = number of species i in sample j
Y_{ik} = number of species i in sample k

Ordination procedure (MDS)

The non-metric multidimensional scaling (MDS) again groups the stations with the most similar fauna. This analysis presents the results such that the distance between the stations on the plot should reflect the similarity in fauna. Thus the MDS can be used to support the cluster analysis results. More importantly the MDS reveals any existing continuum or gradient in the sampled fauna. The MDS analysis is based on the same similarity matrix as the cluster analysis and the calculation was performed by the PRIMER 5 program.

The goodness of fit are expressed as

$$\text{Stress} = \sum_j \sum_k (d_{jk} - \hat{d}_{jk})^2 / \sum_j \sum_k d_{jk}^2$$

where: $\hat{d}_{jk}$ = the distance predicted from the fitted regression line corresponding to dissimilarity d_{jk}

$$d_{jk} = 100\left\{\frac{\sum_{i=1}^{p} |y_{ij} - y_{ik}|}{\sum_{i=1}^{p} (y_{ij} + y_{ik})}\right\}$$ and distance (d).

2.4.6 Linking biota to multivariate environmental patterns

A BIO-ENV procedure are used for matching biotic to environmental patterns (all combinations of the environmental variables pelite, sand, gravel, median Φ, TOM, Cu, Ba, Zn, Cd, Cr, Pb and THC). A weigthed Spearman rank correlation was used in the analysis. Chemical variable were log(x+1) transformed prior to analysis. The calculation was performed by the program PRIMER from Plymouth Marine Laboratory in England.

2.4.7 Estimation of influenced area

The estimated area of contaminated sediments and disturbed fauna is based on the calculation of an asymmetric ellipse. The distance to contaminated/disturbed sites was used in the calculation of influenced sites. The radius varies from field to field and between transects within a field.

2.4.8 Quality control

Only samples where the grab was completely closed, and with open space between the sediment surface and the lid should be accepted. In this way only complete and undisturbed sediment samples would be collected for further processing. This was not achieved due to too heavy grab.

All laboratories involved in the work are accredited and perform their analysis in accordance to the accreditation.

The samples were sorted by personnel from INIP under supervision by personell from UNIFOB AS. All the samples were control sorted according to UNIFOB AS`s internal routine.

2.4.9 Storage of samples

Biological samples are stored at the Zoological Museum in Bergen, whereas selected specimens of high quality are included in the reference collection kept at UNIFOB AS in Bergen, and at INIP in Angola.

3. OCEANOGRAPHIC CONDITIONS

By Marek Ostrowski

3.1 Vertical sections

The locations of the hydrographic lines sections occupied during the survey are shown in Figure 3.1. Line A (Figure 3.2) was the most closely located to the Congo River Fan region. The 10-15 m thick layer of very low salinity water (S < 29) persisted across the entire section, indicating a direct influence of the river discharge plume. On Line B, (Figure 3.3), the low salinity signature was confined the two offshore stations only, Site HD1474 and 1475. Finally, on the northernmost Line C (Figure 3.3) the low-sallinity signature vanished from the distribution.

Below the top layer affected by the river plume and above the thermocline depth at 40-50 meters there were no significant differences between the sections. The water column was characterized by high temperature, (T > 24ºC), fixed salinity range (S = [30, 35]) and relatively high dissolved oxygen levels (DO > 4 ml l^{-1}). This range of parameters indicates for the presence of the waters advected from the equator with a current associated to coastally-trapped seasonal Kelvin waves. The thermocline was clearly slanted toward the coast indicating for such a southward-flowing geostrophic current.

Below the thermocline, the water column on all sections exhibited a linear decrease with depth of temperature and salinity, as well as low dissolved oxygen levels (DO < 4 ml l^{-1}). These properties indicated South Atlantic Central Water (SACW), a sub-thermocline water mass that is the source of nutrients and high productivity in the coastal zone during upwelling.

The hydrographic observations suggest the following scenario of the circulation in the Congo River Fan area during October. The river plume advects low-salinity water northwestwards. This is consistent with historical data from the Congo River Fan region. However, the flow within the plume may be detached from the mean current of the underlying water column. As suggested by the slant of the thermocline, the direction of the mean current below the plume may be southward thus opposite to the surface current. Altimetry data from satellites (not shown) confirm that southwards intrusions of equatorial water remotely forced by Kelvin waves occur off Angola twice a year, in February-March and in October. The presence of such a southward flow immediately prior or during the survey is corroborated by the presence of the Equatorial Water signatures on all hydrographic sections.

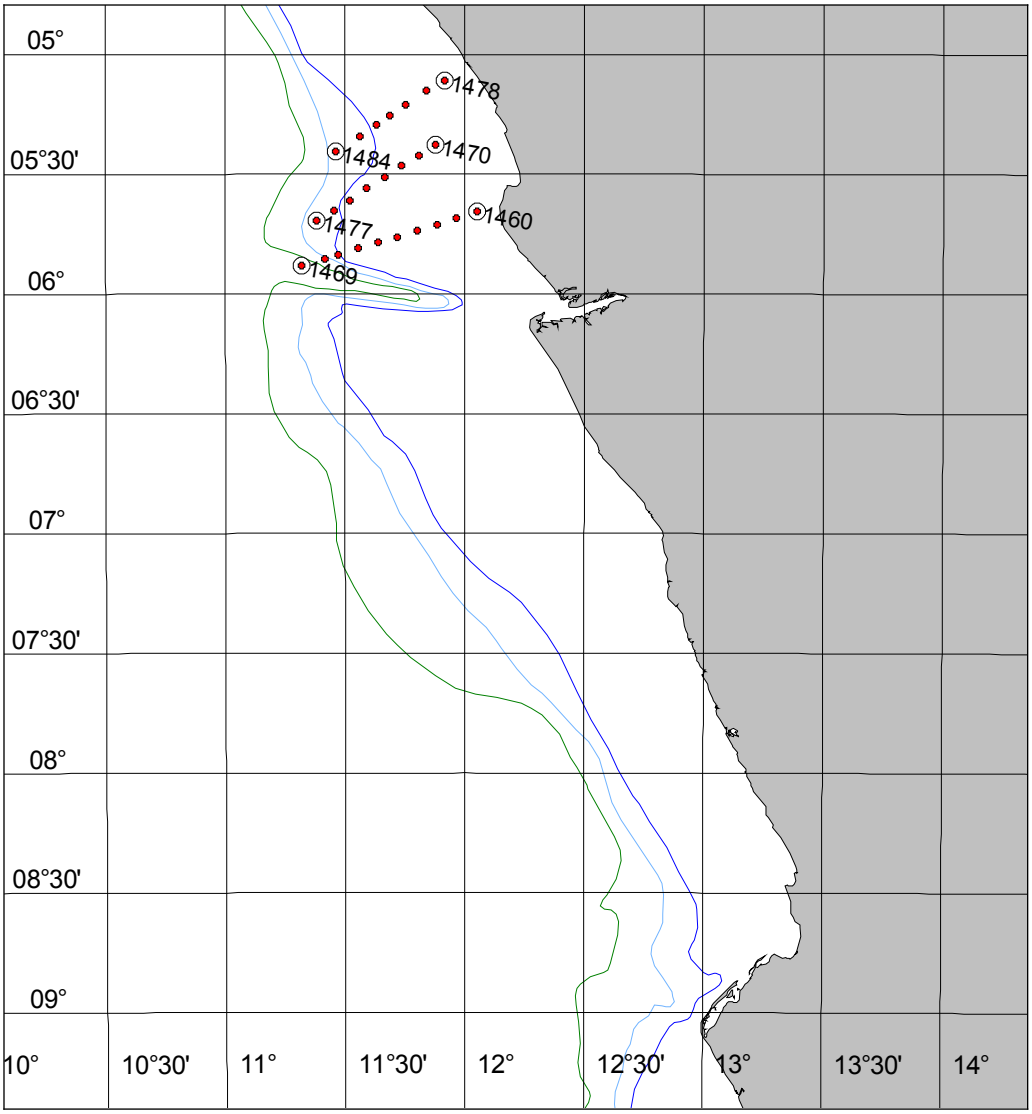


Figure 3.1 Map showing the hydrographical transects.

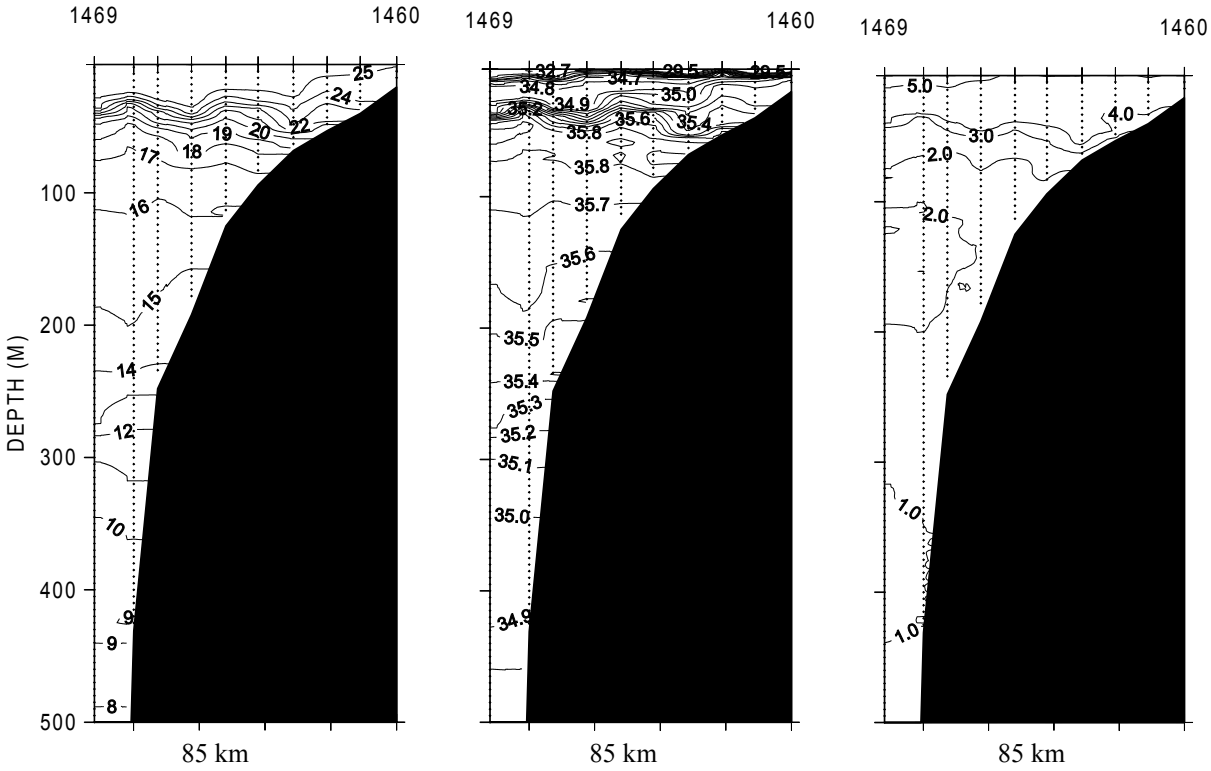


Figure 3.2. Vertical sections of temperature, salinity and oxygen in the south transect.

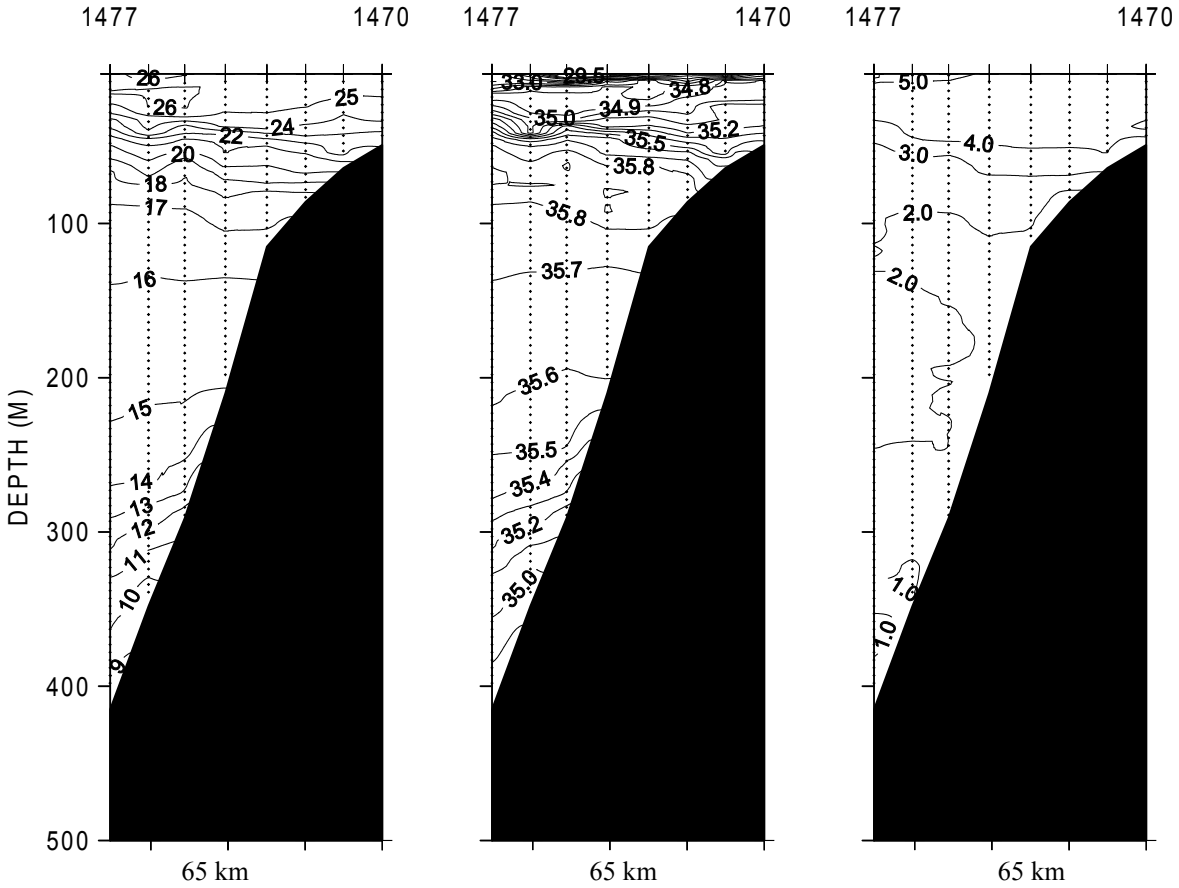


Figure 3.3. Vertical sections of temperature, salinity and oxygen in the middle transect.

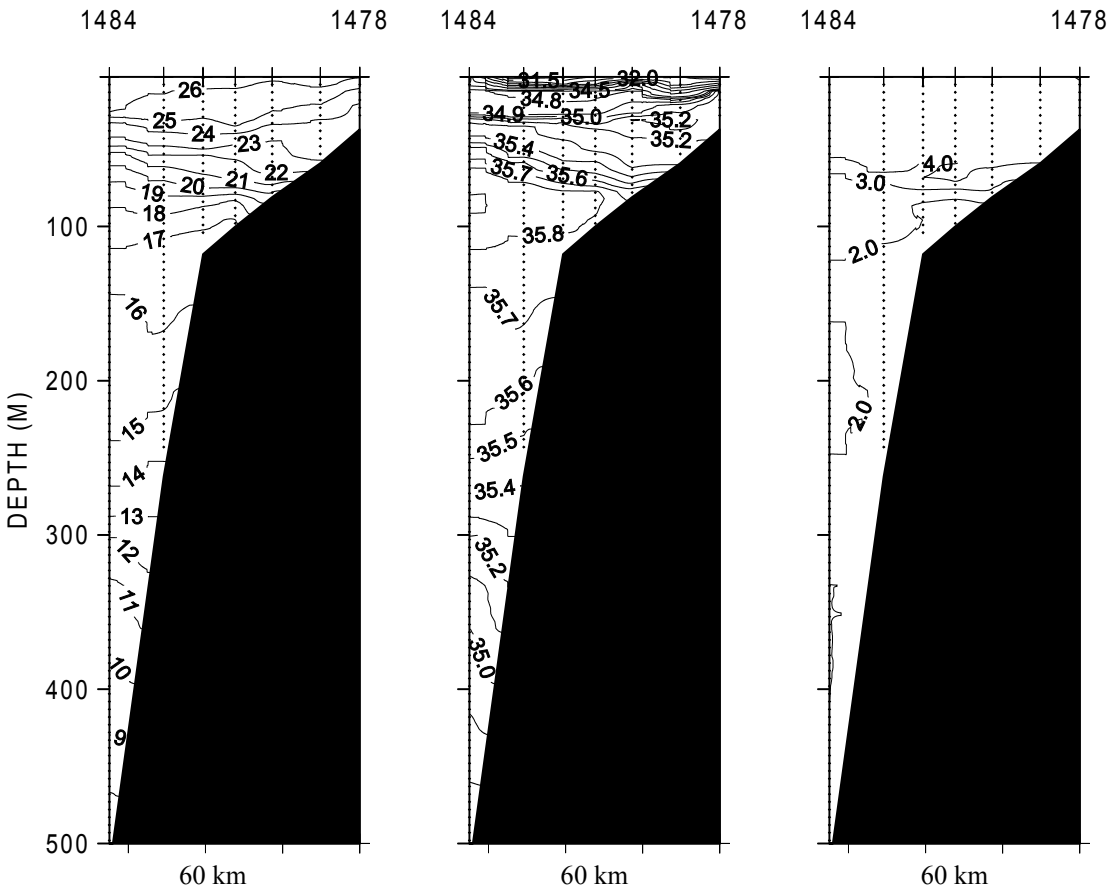


Figure 3.4. Vertical sections of temperature, salinity and oxygen in the north transect.

4. ENVIRONMENTAL CONDITION – KAMBALA JACKET 132-05

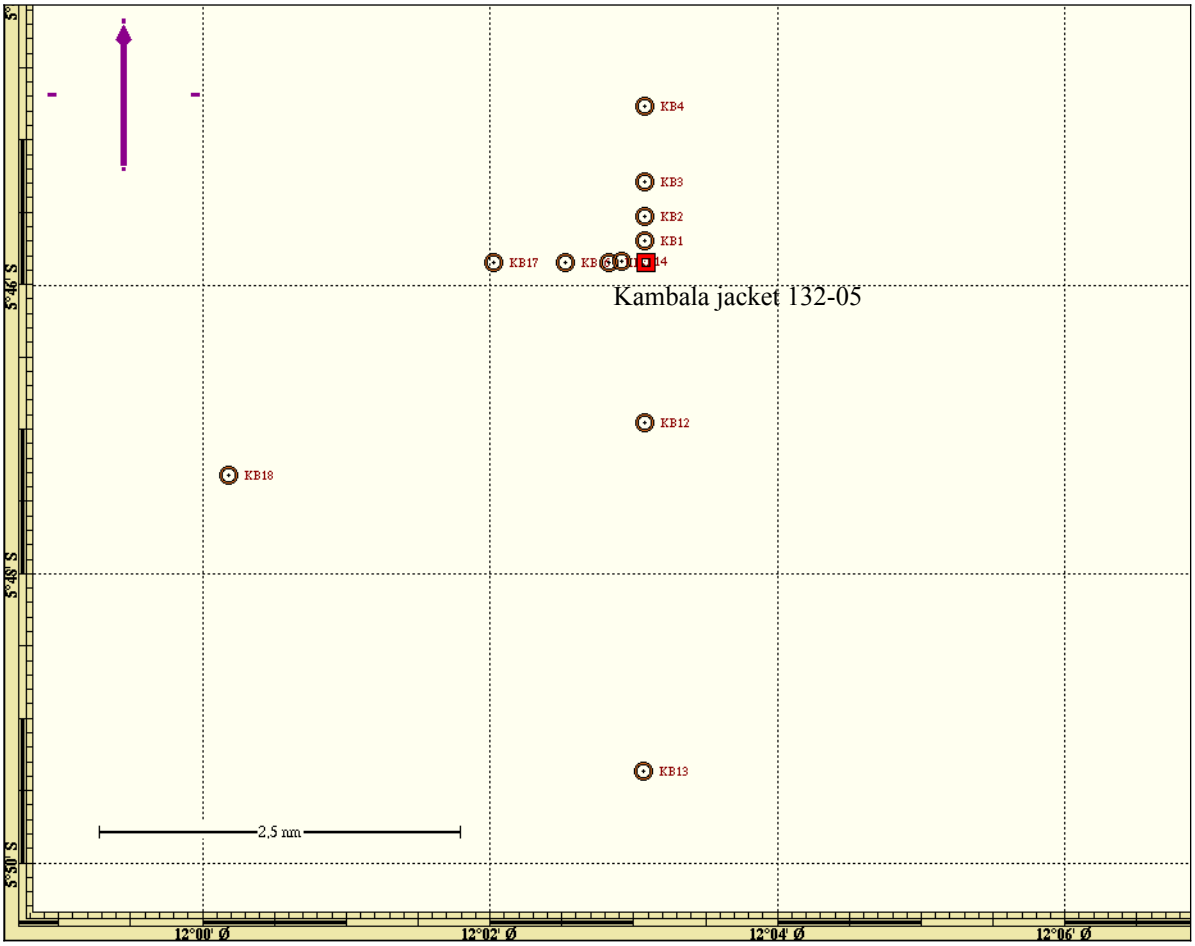
4.1. Introduction

The Kambala jacket 132-05 is situated in block 0, and is connected to Jacket 132-2 (1500 m distance, SE) and Kambala platform (5000 m distance NE). The installation was installed in 1983, and is located 14 km off the coast. Recent discharges at Kambala Jacket 132-05 are not reported.

There was a deviation in planned and real sampling. This was due to a pipeline and electrical cable going south-east from the Jacket 132-05 to Jacket 132-02, and further to Kambala platform. For security reason the sites 250 m from the platform was replaced by sites 300 m from the platform. Sampling sites are shown in Figure 4.1.

Table 4.1. Recent well drilling and discharges from operations and accidents at Kambala jacket 132-05.

No of wells drilled Barite Cuttings Water-based drilling mud Cementing chemicals Completion chemicals Accidental discharges	Not reported



Site	Distance (m) / direction (°)	Date	WGS 84		ED50 UTM zone 33		Depth
			S	E	N	E	(m)
KB1	300m/358°	15.10.06	5°45,702` S	12°03,073` E	9362190,71	173428,01	22
KB2	600m/358°	15.10.06	5°45,529` S	12°03,073` E	9362509,86	173426,36	22
KB3	1000m/358°	15.10.06	5°45,291` S	12°03,073` E	9362948,92	173424,09	22
KB4	2000m/358°	14.10.06	5°44,763` S	12°03,080` E	9363923,03	173431,00	23
KB12	2000m/180°	14.10.05	5°46,959` S	12°03,077` E	9359871,86	173447,42	23
KB13 (ref)	6000m/180°	14.10.06	5°49,364` S	12°03,064` E	9355435,04	173446,51	25
KB14	300m/270°	14.10.05	5°45,840` S	12°02,913` E	9361934,60	173133,69	23
KB15	500m/270°	14.10.05	5°45,850` S	12°02,830` E	9361915,36	172980,42	24
KB16	1000m/270°	14.10.06	5°45,848` S	12°02,572` E	9361916,58	172503,68	25
KB17	2000m/270°	14.10.06	5°45,848` S	12°02,029` E	9361911,36	171500,34	27
KB18 (ref)	6000m/242°	14.10.06	5°47,317` S	12°00,183` E	9359183,42	168103,58	34

Figure 4.1. Map showing the internal distribution of sampling sites (circles) around Kambala Jacket 132-05. Positioning according to WGS 84 and UTM ED50 zone 33. The jacket is marked with a square. KB13 and KB18 are the reference sites.

4.2. Results and discussion

4.2.1 Sediments characteristics

Total organic matter (TOM), and the amount (%) of gravel, sand, pelite, median (Φ) and sorting in the sediment is presented in Table 4.2. Additional information on colour and odour can be found in the sampling journal in the Appendix.

The bottom in the investigated area was dominated by very fine grained sediment. The median (Φ) values ranging from 8.29 to 9.31 and the amount of pelite varied from 98.4 to 99.5 %. The two reference sites KB13 and KB18 had median values from 9.25 to 9.13, and the pelite content was 94.1 and 97.6.

The content of total organic matter (TOM) varied from 10.7 to 12,8 %, the same level as at the reference sites.

Table 4.2. Total organic matter and sediment grain size at all sites near Kambala jacket 132-05 in 2006. Pelite is particles < 0,063 mm, sand from 0,063 to 2 mm.

Site	Distance/direction	TOM %	Pelite %	Sand %	Gravel %	Median (Φ)	Sorting
KB1	300m/358º	12.40	98.8	1.2	0.0	8.75	1.66
KB 2	600m/358º	12.36	99.1	0.9	0.0	8.29	1.64
KB 3	1000m/358º	12.51	99.2	0.8	0.0	8.91	1.42
KB4	2000m/358º	12.81	99.5	0.5	0.0	8.60	1.47
KB12	2000m/180º	12.57	98.4	1.6	0.0	9.05	1.39
KB14	300m/270º	11.86	98.9	1.1	0.0	8.73	1.50
KB15	500m/270º	12.77	98.8	1.2	0.0	8.99	1.72
KB16	1000m/270º	10.71	99.1	0.9	0.0	9.05	1.38
KB17	2000m/270º	12.20	99.2	0.8	0.0	9.31	1.15
Reference sites							
KB13	6000m/180º	12.12	94.1	5.4	0.5	9.25	1.62
KB18	6000m/242º	12.04	97.6	2.2	0.2	9.13	1.22

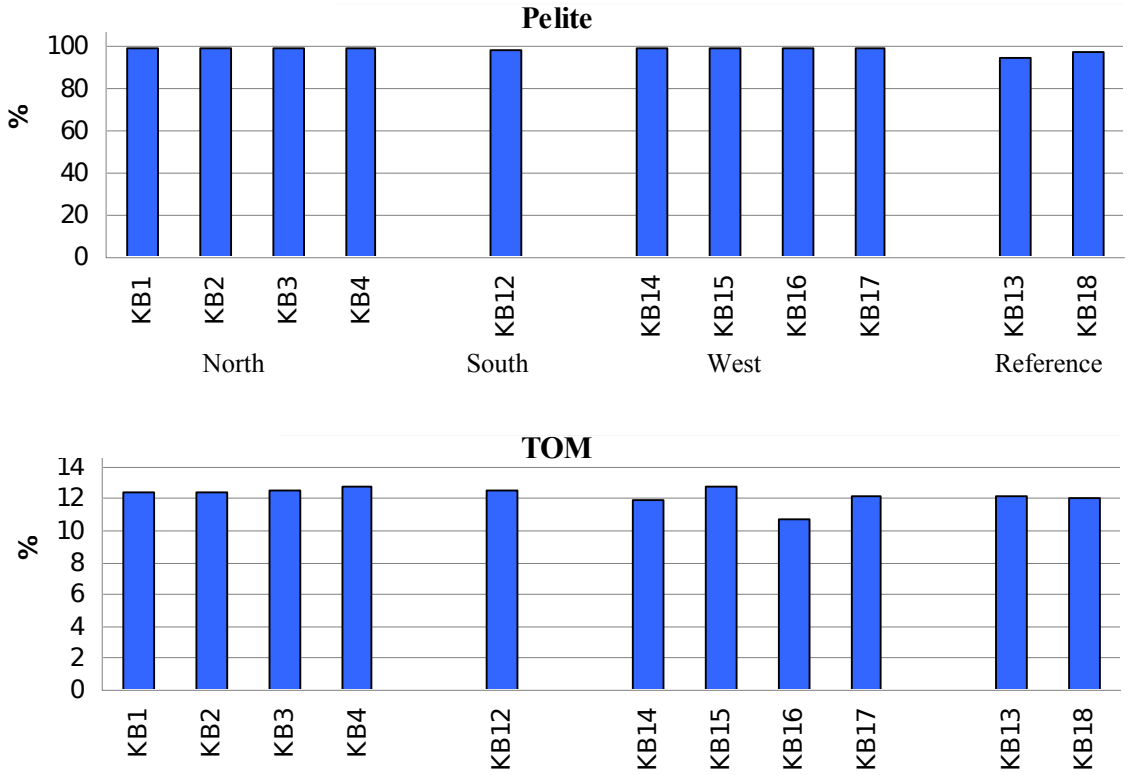


Figure 4.2. Sediment characteristics at Kambala Jacket 132-05 in 2006. The sampling sites are organised by transects and the reference site.

4.2.2 Chemical compounds

4.2.2.1 LSC

The results of the LSC (limits of significant contamination) calculations of hydrocarbons and metals are presented in Table 4.3.

Table 4.3. Limits of Significant Contamination (LSC) for the Kambala jacket 132-05 in 2006 based on data from KB13 and KB18. All values in mg/kg dry sediment.

	THC	NPD's	PAH_{16}	Ba	Cu	Cr	Zn	Pb	Cd	Hg
$LSC_{KB13,KB18}$	24	48	39	102	15	56	87	24	0.08	0.099

4.2.2.2 Hydrocarbons

Summarised results of the hydrocarbon analyses, along with the content of selected hydrocarbon compounds in the different layers (0-1, 1-3 and 3-6 cm) are given in Table 4.4 and Table 4.5. The complete data set including replicates is given in the Appendix.

THC was found in the range from 13.3 ± 1.8 mg/kg at KB12 to 91.1 ± 120 mg/kg at KB1. KB1 is located 250 m north from the jacket. One of the parallel's at KB1 elevated the mean and standard deviation. This indicates patchy distribution of THC. Concentration above the LSC occurred at KB1 and KB15.

The concentration of PAH and NPD were above the LSC at KB1. The site KB2 had concentration at the same level as the reference sites.

THC content above LSC was found in the top layer at KB2 in the vertical samples of the sediments.

Table 4.4. Average content of oil hydrocarbons in sediments from Kambala jacket 132-05 in 2006. THC values in mg/kg dry sediment, PAH and NPD in ng/g dry sediment. THC, PAH and NPD values above LSC are dark shaded. PAH and NPD only analysed at KB1, KB2, KB13 and KB18.

Site	Distance / direction	THC		PAH_{16}		NPD	
		av.	sd.	av.	sd.	av.	sd.
KB1	300m/358º	91.1	120	39.1	3.1	52.7	19.2
KB2	600m/358º	22.6	5.4	34.4	1.7	42.8	0.7
KB3	1000m/358º	14.1	2.3				
KB4	2000m/358º	14.7	1.6				
KB12	2000m/180º	13.3	1.8				
KB14	300m/270º	23.5	10.4				
KB15	500m/270º	26.3	11.4				
KB16	1000m/270º	16.5	1.9				
KB17	2000m/270º	16.5	0.7				
Reference site							
KB13	6000m/180º	15.0	1.2				
KB18	6000m/242º	20.0	0.3	37.8	0.3	43.7	1.3

Table 4.5. The content of total hydrocarbons in vertical sections of sediment from 2 sampling sites at Kambala jacket 132-05. All values in mg/kg dry sediment. Values above LSC are dark shaded.

Stasjon	Layer (cm)	THC
KB 1	0-1	21.2
	1-3	16.0
	3-6	17.5
KB 2	0-1	25.4
	1-3	11.2
	3-6	10.6

4.2.2.3 Metals

Table 4.6 summarises the results of the metal analysis at Kambala jacket 132-05. Concentrations of selected metals in the different layers (0-1, 1-3 and 3-6 cm) of sediment are given in Table 4.7, whereas the complete data set including replicates is given in the Appendix.

Barium was found in a range from 60 ± 5 mg/kg at KB4 to 375 ± 194 mg/kg at KB1. Sediments from site KB1, KB2, KB14 and KB15, which are the 300 m and 500-600 m sites in north and west, had barium content above LSC. The barium content decreased with increasing distance from the platform.

All the other metals were under the LSC value. The highest concentration was found at the reference site KB18 (Table 4.6).

Vertical sediment samples from the layer 0-1 cm and 1-3 cm from LB1 and 0-1 cm from LB2 had barium content above LSC. The concentration of copper in the 1-3 cm layer at KB1 was also above LSC (Table 4.7).

Table 4.6 Content of metals in sediments from Kambala jacket 132-05. All values in mg/kg dry sediment. Values above LSC are dark shaded.

Site	Distance / direction	Ba		Pb		Cd		Cu		Cr		Zn		Hg	
		av.	sd.	av.	sd.	av.	sd.	av.	sd.	av.	sd.	av.	sd.	av.	sd.
KB1	300m/358º	375	194	18.2	0.5	0.073	0.021	12.6	0.6	46.7	0.8	71.5	2.0	0.076	0.008
KB2	600m/358º	141	27	17.8	0.0	0.060	0.000	11.5	0.1	45.8	1.5	71.0	1.9	0.078	0.001
KB3	1000m/358º	63	8	18.7	0.4	0.057	0.006	11.3	0.3	45.8	0.5	68.8	2.7		
KB4	2000m/358º	60	5	19.1	0.4	0.053	0.006	12.0	1.3	46.4	2.2	66.0	2.3		
KB12	2000m/180º	65	9	19.4	0.3	0.053	0.006	11.3	0.7	47.2	0.8	71.3	4.0		
KB14	300m/270º	122	99	17.2	1.6	0.053	0.006	10.9	1.2	42.7	3.7	62.0	3.1		
KB15	500m/270º	205	121	19.6	0.4	0.060	0.010	11.7	1.7	46.0	2.3	67.0	5.2		
KB16	1000m/270º	68	10	19.5	0.2	0.053	0.006	11.2	0.3	45.7	0.3	70.0	3.3		
KB17	2000m/270º	60	4	20.3	0.6	0.060	0.000	12.0	0.5	48.1	0.8	66.6	1.8		
Reference site															
KB13	6000m/180º	53	2	19.9	0.1	0.050	0.000	10.6	0.6	47.2	0.8	80.8	3.1		
KB18	6000m/242º	79	13	22.2	0.5	0.070	0.000	13.2	0.2	52.1	0.7	73.3	2.0	0.092	0.002

Table 4.7. The content of metals in vertical sections of sediment from two sampling sites at Kambala jacket 132-05. All values in mg/kg dry sediment. Values above LSC are dark shaded.

Site	Layer	Ba	Pb	Cd	Cu	Cr	Zn	Hg
KB1	0-1 cm	155	18.2	0.05	12.4	47.5	71.8	0.084
	1-3 cm	552	18.4	0.08	21.9	46.5	73.8	0.064
	3-6 cm	72.5	18.1	0.06	12.4	47.3	67.8	0.076
KB2	0-1 cm	116	17.8	0.06	11.6	47.5	71.7	0.077
	1-3 cm	58.5	19.4	0.07	13.3	49.4	67.8	0.083
	3-6 cm	62.6	18.4	0.06	12.6	48.7	72.2	0.088

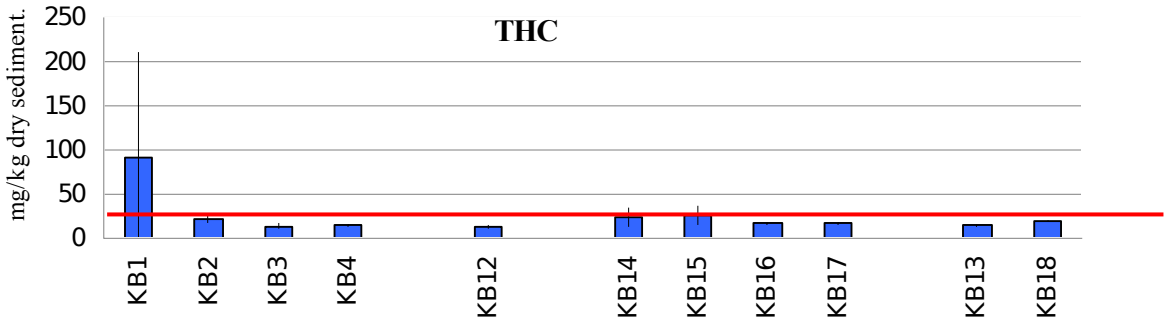


Figure 4.3. Average THC concentrations and standard deviations in sediments from Kambala jacket 132-05. Red line is LSC.

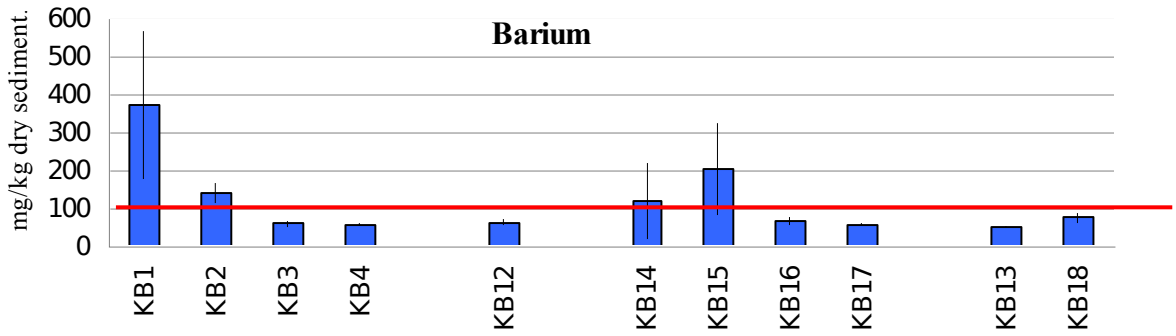


Figure 4.4. Average barium concentrations and standard deviation in sediments from Kambala jacket 132-05. Red line is LSC.

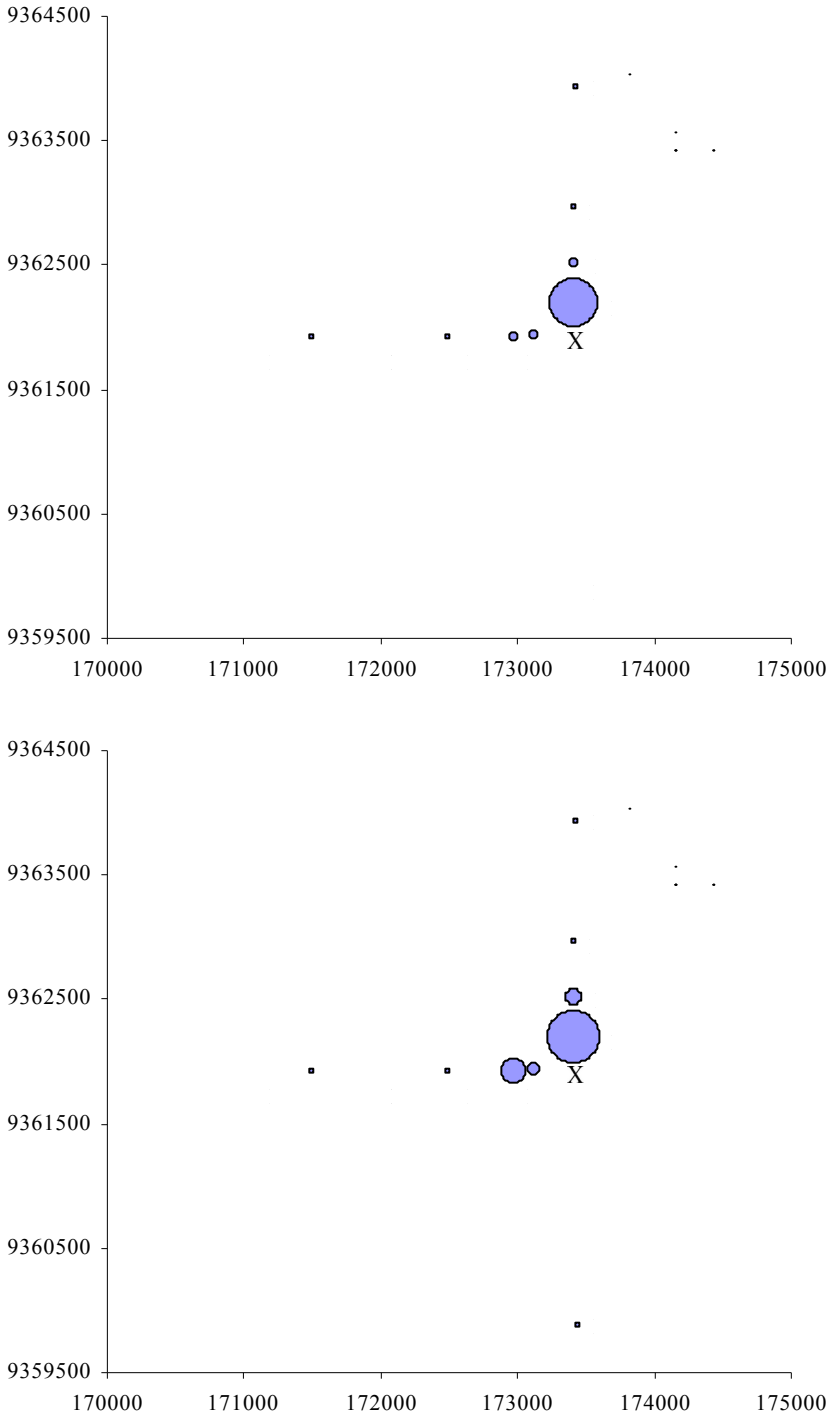


Figure 4.5. Distribution of THC and barium in sediments at the sampling sites from 300 to 2000 m distance from the platform at Kambala jacket 132-05. The size (diameter) of the circle indicate the amount of THC and Ba. The field centre is marked with an X.

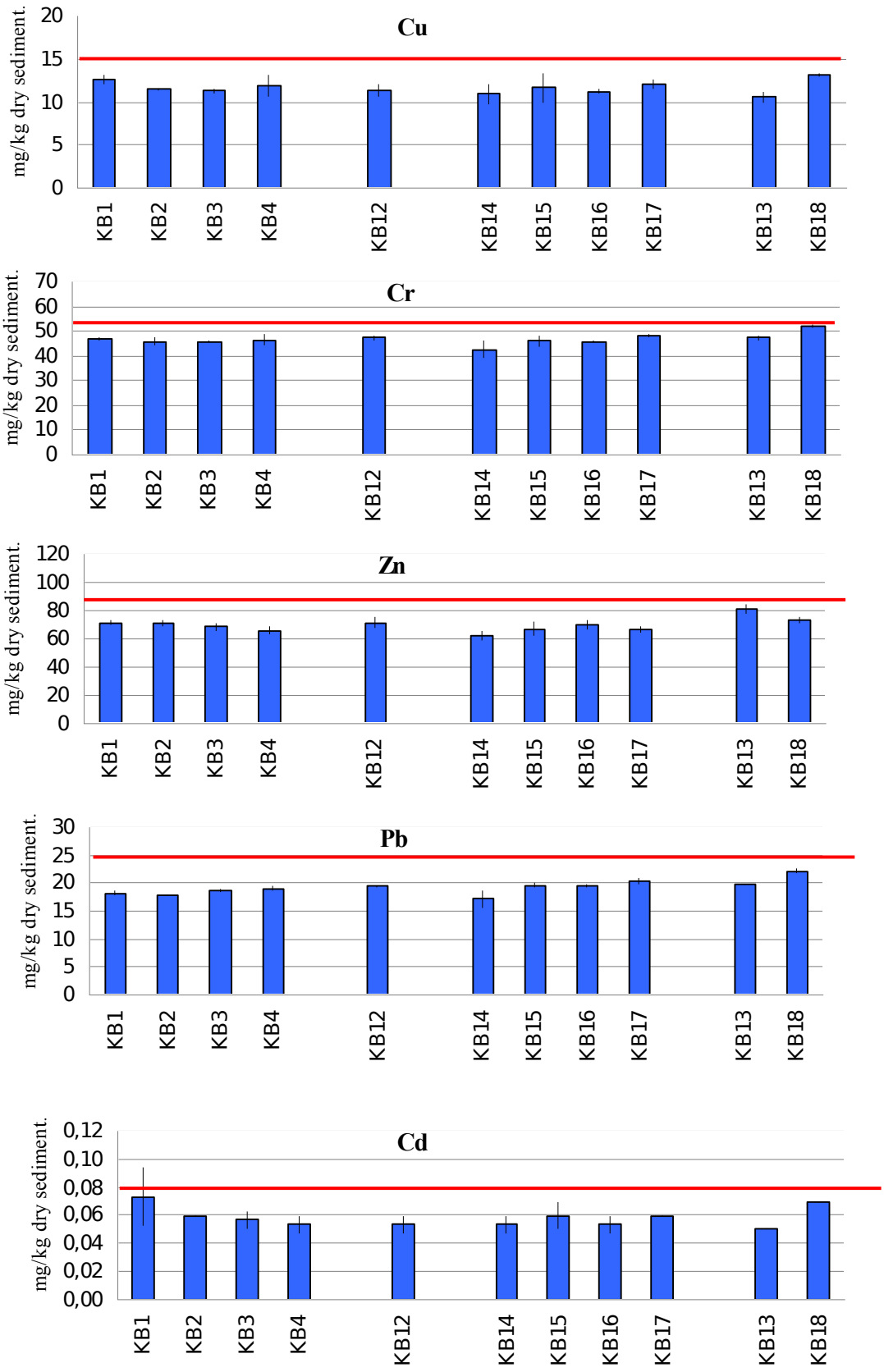


Figure 4.6. Average content and standard deviations of metals in sediment from Kambala jacket 132-05. Red line is LSC.

Due to higher content of THC and Ba in the sediments from KB1, the site close to the installation (300 m) clearly separated from the other sites at Kambala jacket 132-05 (Figure 4.7). Also the other sites out to 500 m distance from the platform separated from the other. The reference site KB18 had higher content of some other metals, and separated from the other sites.

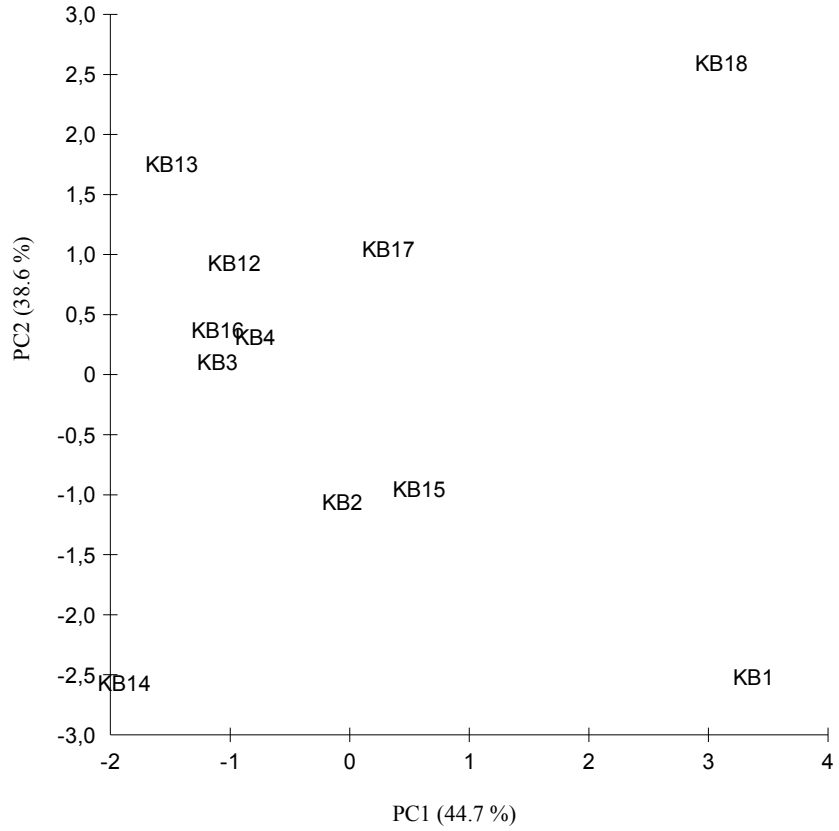


Figure 4.7. 2-D plot from the PCA analysis of environmental variables Cd, Cu, Ba, Zn, Cr, Pb and THC. Explained variation in the data 83.3 %.

4.2.3 Bottom fauna

A summary of the distribution of individuals and taxa within the main taxonomic groups is given in Table 4.8. In total, 848 individuals within 81 taxa were collected at Kambala jacket 132-05 (exclusive the reference sites). In total, 168 individuals and 33 taxa were collected at the reference sites KB13 and KB18. The fauna was numerically dominated by Sipuncula (Diverse groups) with 45 % of the individuals, but the Annelida group had most taxa (65 %). At the reference sites, 63 % of the individuals was Sipuncula and 55 % of the taxa were Annelida. A complete species list is available in the Appendix.

Table 4.8. Distribution of individuals and taxa within the main taxonomic groups at Kambala jacket 132-05.

Kambala, exlusive reference site Main taxonomic groups	Number of individuals	%	Number of taxa	%
Annelida	342	40	53	65
Arthropoda	53	6	7	9
Mollusca	62	7	13	16
Echidermata	11	1	2	3
Diverse groups	380	45	6	8
Total	848	100	81	100

Reference site KB13 and 18 Main taxonomic groups	Number of individuals	%	Number of taxa	%
Annelida	47	28	18	55
Arthropoda	2	1	2	6
Mollusca	12	7	7	21
Echidermata	1	1	1	3
Diverse groups	106	63	5	15
Total	168	100	33	100

The species/area curve for the reference sites KB13 and KB18 indicates that five replicate samples give an impression of the bottom fauna in the area (Figure 4.8). However, as more area is sampled, more taxa are collected, indicating that not even 5 replicate samples give the full species assemblage of the area.

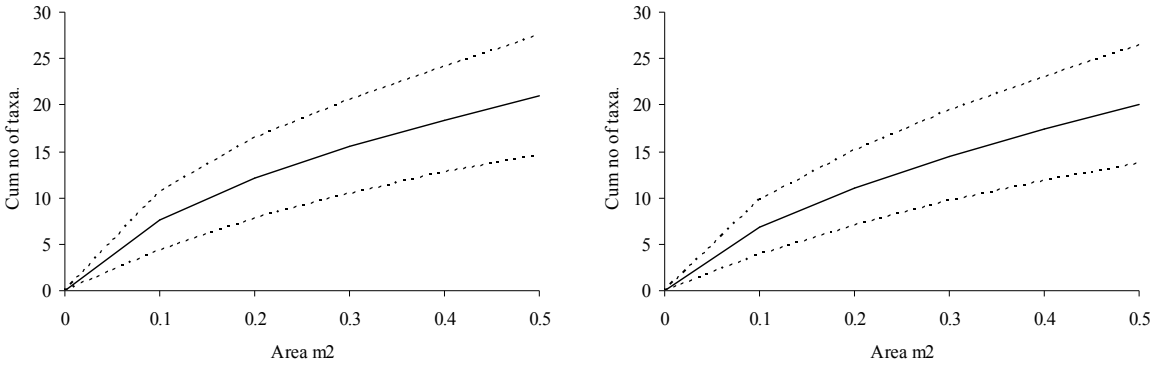


Figure 4.8. Species/area curve for the reference site at the Kambala jacket 132-05. The solid line is calculated species/area curve, and the dotted line is ± 95 % confidens interval.

The distribution of individuals and taxa are shown in Figure 4.9. Number of individuals and taxa at each site, and the calculated diversity indexes (H' and J) are given in Table 4.9 and Figure 4.10.

At the field sites, number of individuals varied from 76 (KB14) to 118 (KB2) and the number of taxa varied from 17 (KB16) to 36 (KB2). At the reference sites the numbers of individuals were 53 and 85, and the numbers of taxa were 20 and 21.

At the field sites the Shannon-Wiener diversity index (H') varied from 3.0 (KB16) to 4.4 (KB2). The evenness varied from 0.73 (KB16) to 0.86 (KB2). At the reference sites diversity varied from 2.8 to 3.0 and evenness from 0.66 to 0.68. The diversity was low at the reference sites and the field site KB16.

Table 4.9. Number of individuals, taxa and selected community indices for each site (0.5 m^2) at the Kambala jacket 132-05.

Site	Distance/ direction	Number of individuals	Number of taxa	Evenness J	Diversity H'
KB1	300m/358º	84	26	0.74	3.5
KB2	600m/358º	118	36	0.86	4.4
KB3	1000m/358º	84	26	0.84	3.9
KB4	2000m/358º	102	24	0.78	3.6
KB12	2000m/180º	109	24	0.76	3.5
KB14	300m/270º	76	22	0.84	3.7
KB15	500m/270º	92	25	0.76	3.5
KB16	1000m/270º	89	17	0.73	3.0
KB17	2000m/270º	94	22	0.80	3.6
Refererence sites					
KB13	6000m/180º	85	21	0.68	3.0
KB18	6000m/242º	83	20	0.66	2.8

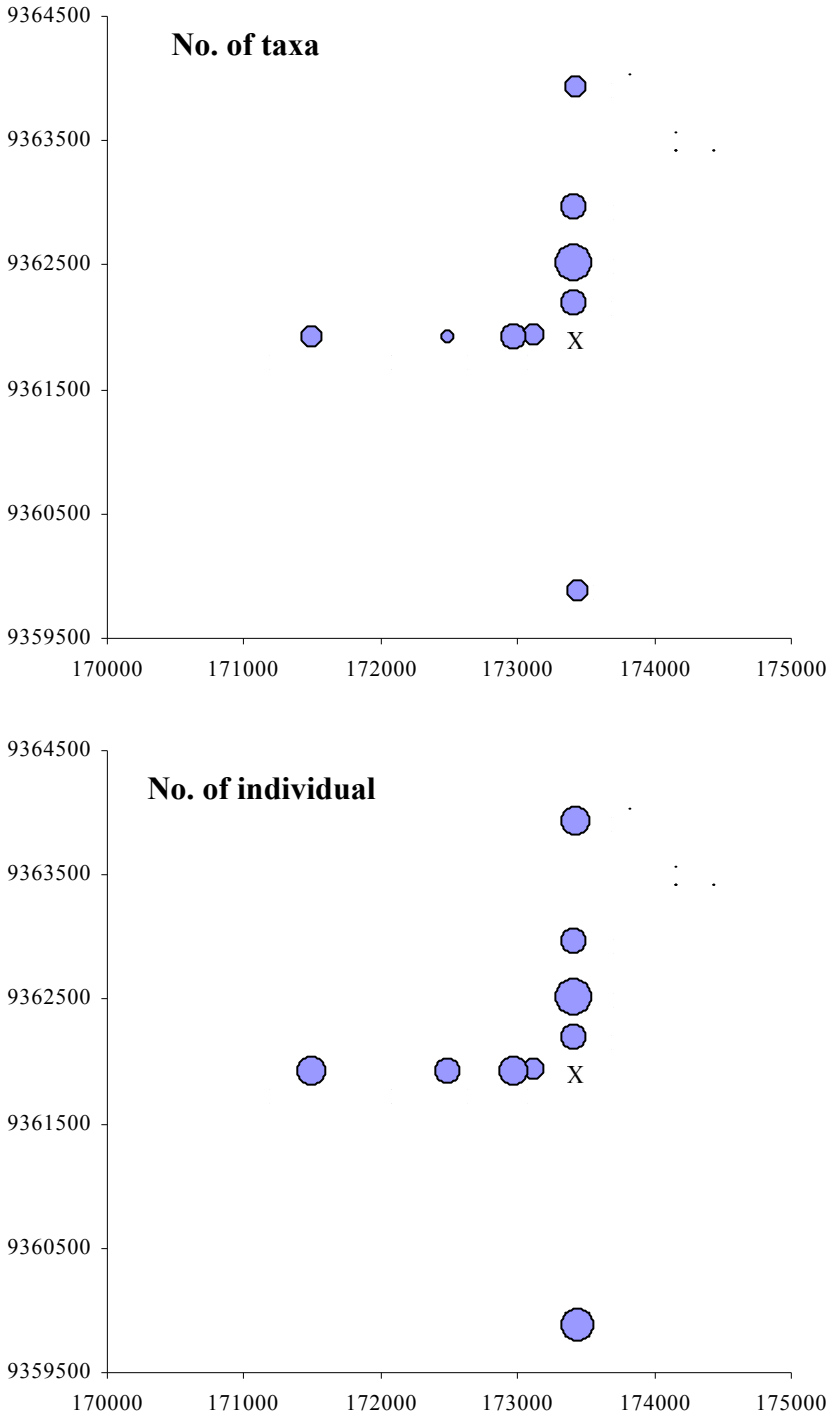


Figure 4.9. Distribution of bottom fauna (individuals and taxa) among the sampling sites out to 2000 m from the Kambala jacket 132-05. The size (diameter) of the circle indicates the number of individuals and taxa. The field centre is marked with an X.

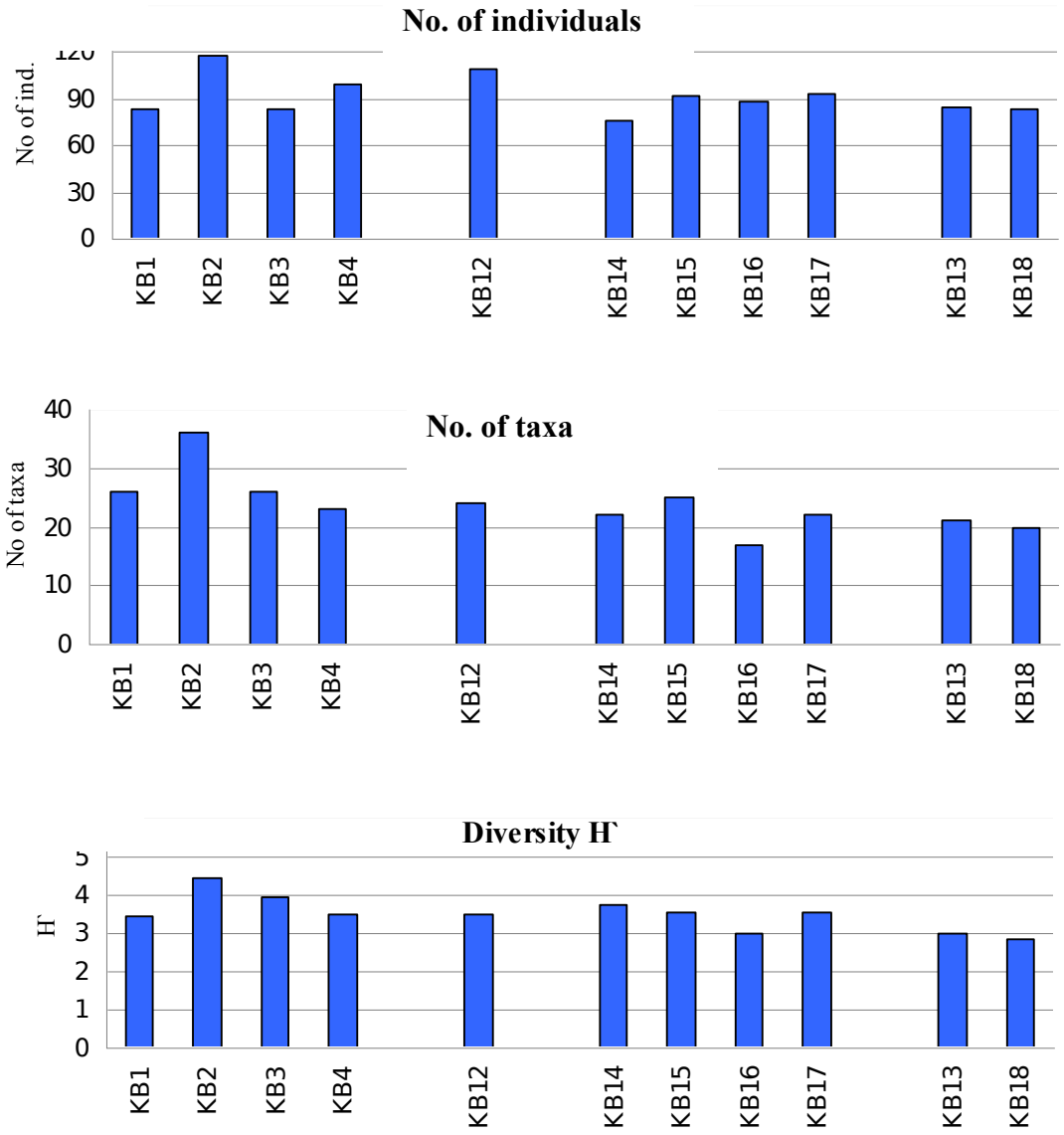


Figure 4.10. Number of individuals, taxa and selected community indices for each site (0.5 m^2) at Kambala jacket 132-05.

Distribution of taxa in geometrical classes is presented in Figure 4.11. All the sites had nearly similar distribution, except KB16 which have fewer species in the first geometric class.

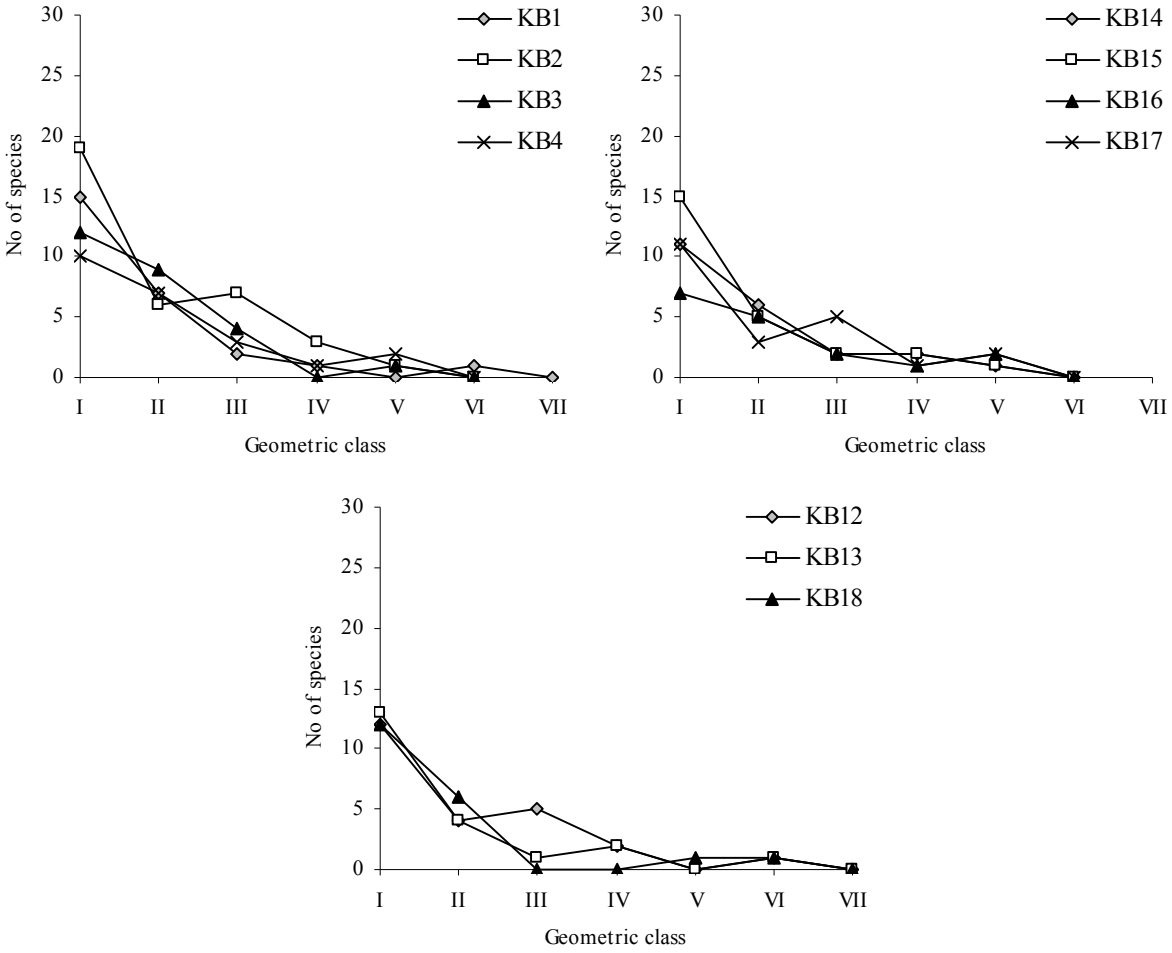


Figure 4.11. Distribution of taxa in geometrical classes for the sites at Kambala jacket 132-05.

In Table 4.10 the ten most abundant taxa are listed. Species with only one individual are excluded. The Sipuncula groups *Onchnesoma* sp. And *Aspidosiphon* sp. Dominated among the individuals at all sites. Most abundant was *Onchnesoma* sp. At the reference site KB13 with 40 individuals or 47 %. Among the bristle worms *Prionospio* sp.I was the most abundant.

Table 4.10. Number of individuals and relative abundance for the ten most abundant taxa at Kambala jacket 132-05. Taxa with only one individual are excluded.

KB1	No. of ind.	%	Cum %
Onchnesoma sp	34	40.5	40.5
Prionospio sp. I	11	13.1	53.6
Nemertini indet.	4	4.8	58.3
Aphelochaeta sp. IV	4	4.8	63.1
Sipuncula indet.	3	3.6	66.7
Aricidea sp III	3	3.6	70.2
Nephtys sp.	2	2.4	72.6
Notomastus sp. I	2	2.4	75.0
Notomastus sp. II	2	2.4	77.4
Sabellidae indet. I	2	2.4	79.8
Aspidosiphon sp	2	2.4	82.1

KB2	No. of ind.	%	Cum %
Onchnesoma sp	19	16.1	16.1
Aspidosiphon sp	15	12.7	28.8
Nephtys sp.	9	7.6	36.4
Melinna sp III	8	6.8	43.2
Scoloplos armiger	7	5.9	49.2
Prionospio sp. I	5	4.2	53.4
Notomastus sp. I	5	4.2	57.6
Ampelisca sp.	5	4.2	61.9
Nuculana sp I	5	4.2	66.1
Paguridae indet.	4	3.4	69.5
Mediomastus sp. I	4	3.4	72.9

KB3	No. of ind.	%	Cum %
Onchnesoma sp	24	28.6	28.6
Prionospio sp. I	7	8.3	36.9
Nephtys sp.	6	7.1	44.0
Nuculana sp I	5	6.0	50.0
Mediomastus sp. I	5	6.0	56.0
Aspidosiphon sp	3	3.6	59.5
Notomastus sp. I	3	3.6	63.1
Ampelisca sp.	3	3.6	66.7
Flabelligeridae indet II / Sabellaridae indet	3	3.6	70.2
Natantia indet.III	3	3.6	73.8
Sternaspis scutata	3	3.6	77.4
Amphiuridae indet. III	3	3.6	81.0

KB4	No. of ind.	%	Cum %
Onchnesoma sp	29	29.0	29.0
Aspidosiphon sp	18	18.0	47.0
Prionospio sp. I	14	14.0	61.0
Nuculana sp I	4	4.0	65.0
Notomastus sp. I	4	4.0	69.0
Lumbrineridae indet. V	4	4.0	73.0
Nephtys sp.	3	3.0	76.0
Natantia indet.III	3	3.0	79.0
Oligochaeta sp I	3	3.0	82.0
Melinna sp III	2	2.0	84.0
Veneridae indet I	2	2.0	86.0
Aphelochaeta sp. IV	2	2.0	88.0
Sipuncula indet.	2	2.0	90.0
Acnistrosyllis sp. I	2	2.0	92.0

Table 4.10 continue. Number of individuals and relative abundance.

KB12	No. of ind.	%	Cum %
Onchnesoma sp	35	32.1	32.1
Amphinomidae indet. III	15	13.8	45.9
Aspidosiphon sp	13	11.9	57.8
Prionospio sp. I	7	6.4	64.2
Nephtys sp.	6	5.5	69.7
Nuculana sp I	4	3.7	73.4
Nemertini indet.	4	3.7	77.1
Melinna sp IV	4	3.7	80.7
Paguridae indet.	3	2.8	83.5
Mediomastus sp. I	2	1.8	85.3
Scoloplos armiger	2	1.8	87.2
Cossura cf. coasta	2	1.8	89.0

KB13	No. of ind.	%	Cum %
Onchnesoma sp	40	47.1	47.1
Prionospio sp. I	9	10.6	57.6
Melinna sp IV	9	10.6	68.2
Aspidosiphon sp	4	4.7	72.9
Nephtys sp.	3	3.5	76.5
Lumbrineridae indet. VI	3	3.5	80.0
Veneridae indet I	2	2.4	82.4
Oweniidae indet.	2	2.4	84.7

KB14	No. of ind.	%	Cum %
Aspidosiphon sp	16	21.1	21.1
Onchnesoma sp	12	15.8	36.8
Prionospio sp. I	11	14.5	51.3
Melinna sp IV	5	6.6	57.9
Mediomastus sp. I	5	6.6	64.5
Nephtys sp.	3	3.9	68.4
Lumbrineridae indet. VI	3	3.9	72.4
aguridae indet.	3	3.9	76.3
Amphiuridae indet. III	3	3.9	80.3
Nuculana sp I	2	2.6	82.9

KB15	No. of ind.	%	Cum %
Aspidosiphon sp	30	32.6	32.6
Onchnesoma sp	14	15.2	47.8
Prionospio sp. I	9	9.8	57.6
Paguridae indet.	6	6.5	64.1
Melinna sp IV	4	4.3	68.5
Nephtys sp.	3	3.3	71.7
Nuculana sp I	3	3.3	75.0
Scoloplos armiger	3	3.3	78.3
Notomastus sp. I	3	3.3	81.5
Mediomastus sp. I	2	2.2	83.7

KB16	No. of ind.	%	Cum %
Aspidosiphon sp	28	31.5	31.5
Onchnesoma sp	24	27.0	58.4
Prionospio sp. I	10	11.2	69.7
Paguridae indet.	4	4.5	74.2
Nassarius elatus	4	4.5	78.7
Nuculana sp I	3	3.4	82.0
Notomastus sp. II	3	3.4	85.4
Nephtys sp.	2	2.2	87.6
Flabelligeridae indet II / Sabellaridae indet	2	2.2	89.9
Pandalidae indet. II	2	2.2	92.1

KB17	No. of ind.	%	Cum %
Aspidosiphon sp	21	22.3	22.3
Onchnesoma sp	21	22.3	44.7
Prionospio sp. I	11	11.7	56.4
Nephtys sp.	6	6.4	62.8
Amphinomidae indet. III	5	5.3	68.1
Paguridae indet.	4	4.3	72.3
Nassarius elatus	4	4.3	76.6
Melinna sp IV	4	4.3	80.9
Nemertini indet.	3	3.2	84.0
Notomastus sp. II	2	2.1	86.2
Flabelligeridae indet II / Sabellaridae indet	2	2.1	88.3

KB18	No. of ind.	%	Cum %
Onchnesoma sp	32	38.6	38.6
Aspidosiphon sp	25	30.1	68.7
Prionospio sp. I	3	3.6	72.3
Veneridae indet I	3	3.6	75.9
Nephtys sp.	2	2.4	78.3
Nemertini indet.	2	2.4	80.7
Oweniidae indet.	2	2.4	83.1
Cossura cf. coasta	2	2.4	85.5

The results of the multivariate analyses are given in the dendrogram (Figure 4.12) and the MDS plott (Figure 4.13).

The cluster dendrogram shows two group, one with the sites to the west and the south of the field center (57 % similarity) and one with the sites to the north transect (except KB1) (55 % similarity). The reference sites are linked to the group of sites to the west and south. The KB1, 300 m from the jacket, had a dissimilar fauna, and link to all other sites at 36 % similarity.

The results of the MDS analysis support the findings in the cluster analysis. Sites to the west and south comprise one group and the sites to the north (except KB1) comprise another group. The reference sites and the KB1 are separated from the other sites.

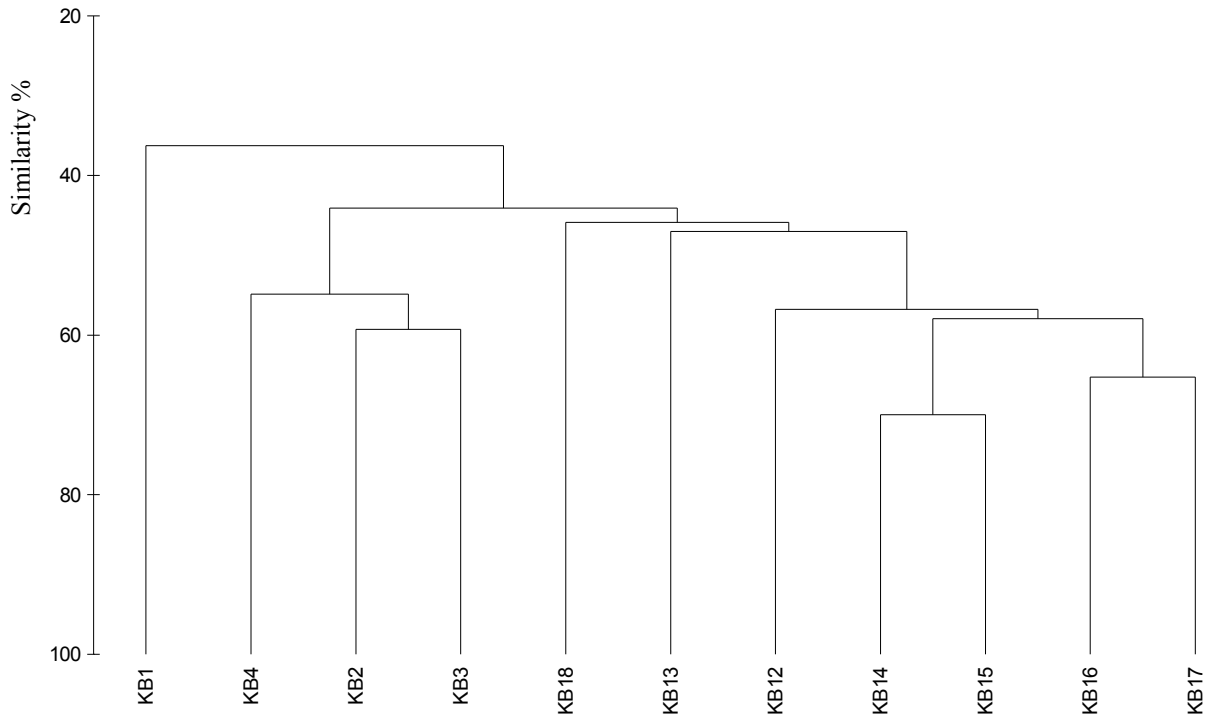


Figure 4.12. Dendrogram showing the similarity between fauna from sampling sites at Kambala jacket 132-05.

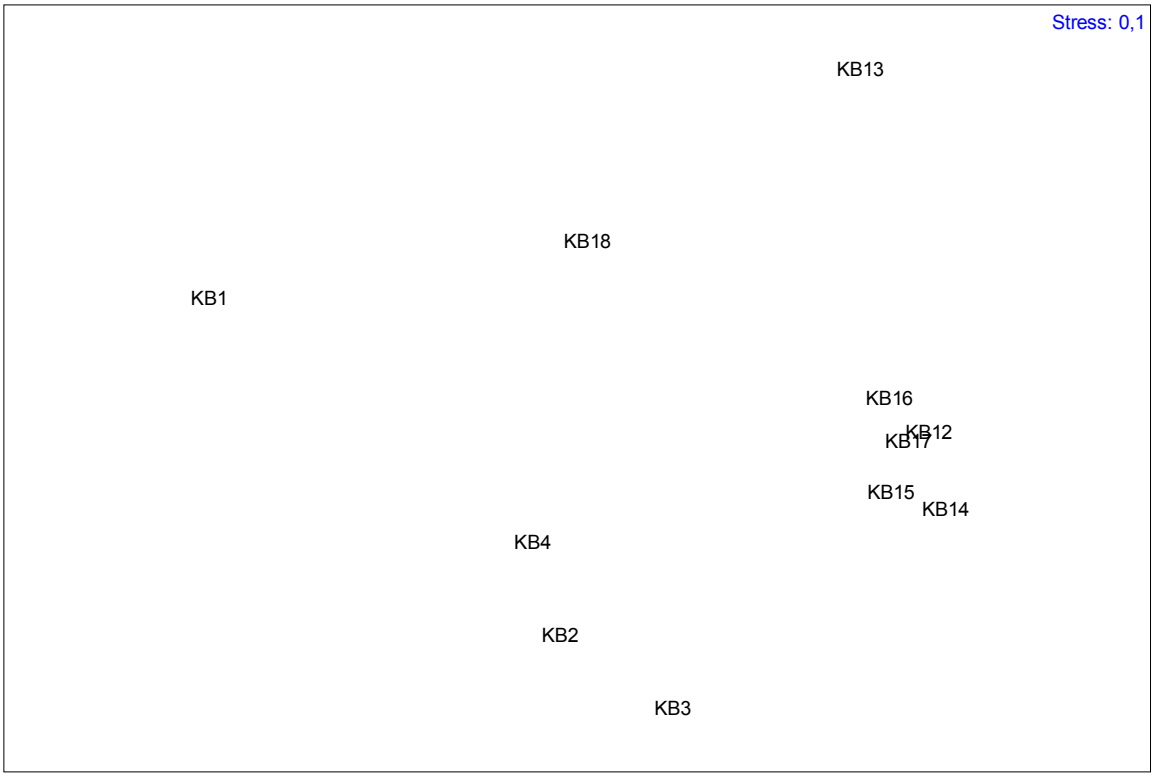


Figure 4.13. A 2-dimetional plott of the MDS analysis of the fauna data from Kambala jacket 132-05. Stress = 0,1.

There was no strong correlation between the biota and the environmental variables. Linking of biotic and environmental variables by BIOENV revealed that Cd was the single parameter best correlated to the biota at $\rho_w = 0.479$ (Table 4.11). Overall best correlated was THC, pelite and depth $\rho_w = 0.598$.

Table 4.11. Combinations of the 10 environmental variables, taken *k* at a time, yielding the best matches of biotic and abiotic similarity matrices for each *k*, as measured by weighted Spearman rank correlation ρ_w. Bold type indicates overall optimum.

Number of variables (*k*)	Correlation coefficient (ρ_w)	Environmental variables									
1	0,479	Cd									
1	0,389	Cu									
1	0,236	Pelite									
1	0,226	THC									
1	0,194	Ba									
1	0,132	Depth									
1	0,118	Zn									
1	0,074	Pb									
1	-0,061	Cr									
1	-0,182	TOM									
2	0,571	THC	Pelite								
3	**0,598**	**THC**	**Pelite**	**Depth**							
4	0,579	THC	Pelite	Depth	Cd						
5	0,577	THC	Pelite	Depth	Cd	Cu					
6	0,555	THC	Pelite	Cd	Cu	TOM	Ba				
7	0,541	THC	Pelite	Depth	Cd	Cu	TOM	Ba			
8	0,515	THC	Pelite	Depth	Cd	Cu	TOM	Ba	Zn		
9	0,479	THC	Pelite	Depth	Cd	Cu	TOM	Ba	Zn	Pb	
10	0,442	THC	Pelite	Depth	Cd	Cu	TOM	Ba	Zn	Pb	Cr

4.2.4 Estimation of influenced area

The extension of contamination along sampling transects and the minimum area of contaminated sediments for THC, barium and other metals as well as for faunal disturbance are given in Figure 4.14 and Table 4.12. A minimum area of 0.12 km^2 is contaminated of THC and minimum 0.20 km^2 is contaminated by barium. The fauna seems to be disturbed in an area of 0.04 km^2.

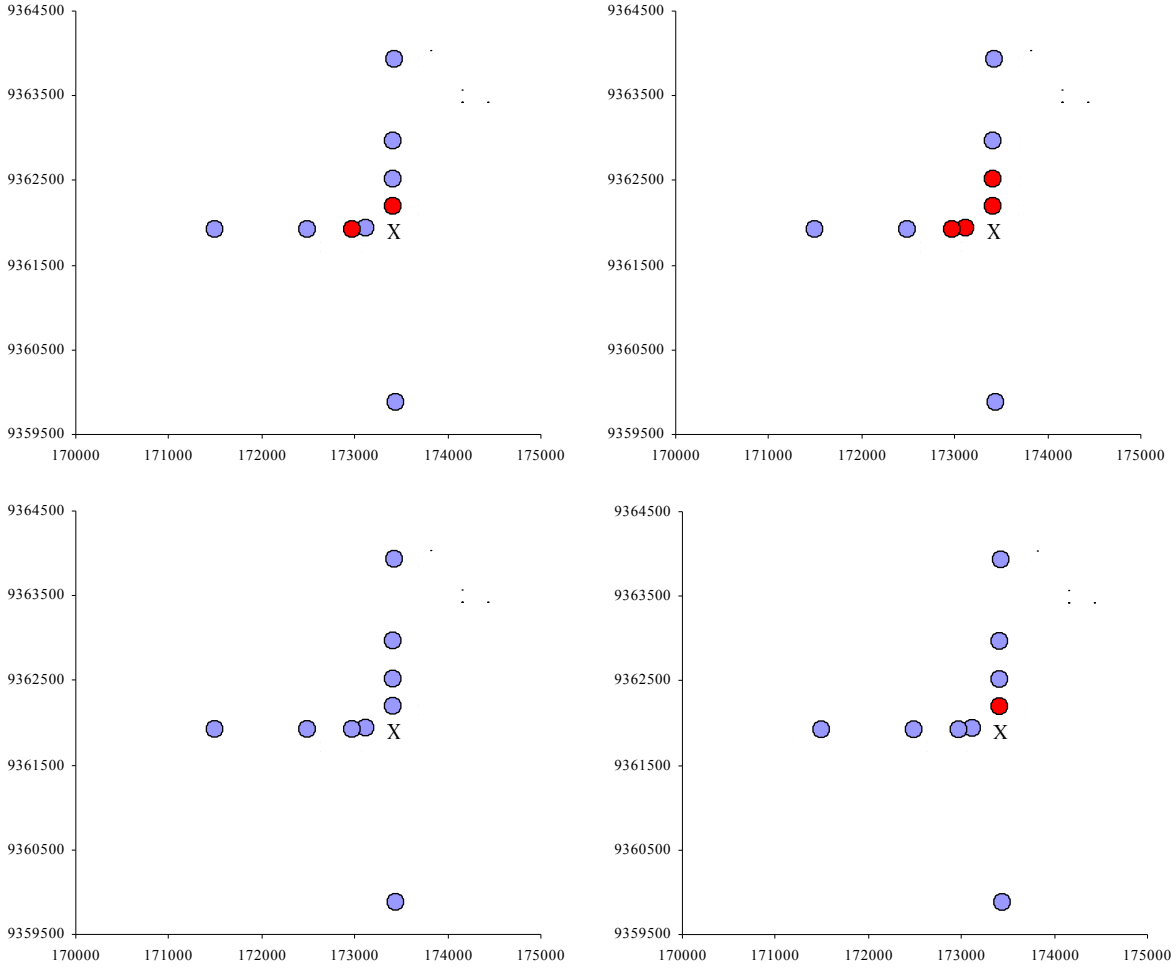


Figure 4.14. Faunal disturbance and chemical contamination of the sediments at Kambala jacket 132-05 are marked with red circles. Uncontaminated sites and sites with no faunal disturbance are marked with small blue circles. The field centre is marked with an X.

Table 4.12. Estimated distance of contamination and faunal disturbance from the installation, and estimated area of contamination and faunal disturbance around the field centre.

Kambala Jacket 132-05	N m	S m	W m	km²
THC	300	0	500	0.12
Ba	500	0	500	0.20
Other metals	0	0	0	0.00
Fauna	300	0	0	0.04

4.3 Summary and conclusions

Eleven sites were sampled at Kambala jacket 132-05. The samples were taken with increasing distance to the platform. The sediment was very fine grained (pelite) with even distribution of TOM. The site KB1, 300 m northward from the jacket, had very high amount of THC in one of the parallels and elevated concentration of PAH and NPD in the sediment. Also the site at 500 m from the platform to the west had high concentration of THC. This indicates a minimum area of THC contamination of 0.12 km^2. The concentration of barium was very high out to 500 m to the west and north. The minimum area of Ba contamination was 0.20 km^2. No contamination was detected for the other metals. There was generally few individual and taxa, but the diversity was mostly high. The site KB1 differs from the other sites in the multivariate analysis and MDS plot, indicating some fauna disturbance. The area with disturbed fauna was estimated to 0.04 km^2. There was only a weak correlation between the fauna and the environmental variables.

5. ENVIRONMENTAL CONDITION – LOMBA

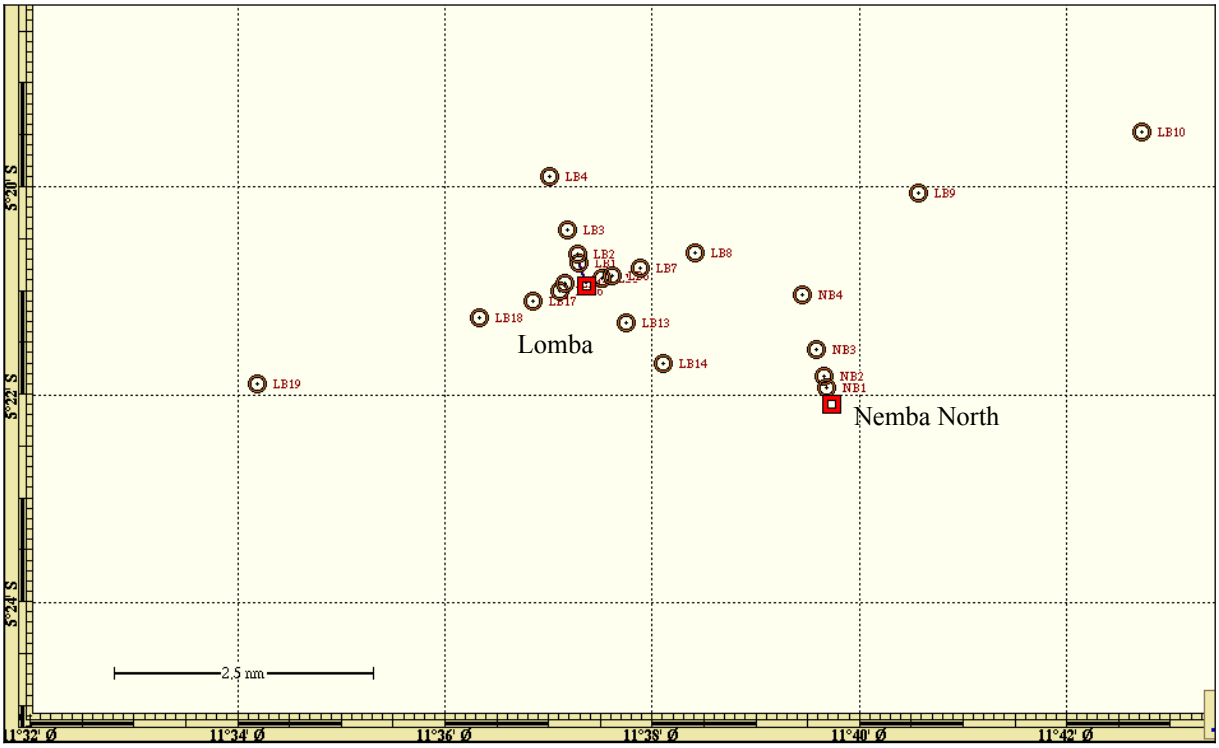
5.1. Introduction

The Lomba field is situated in block 0. The platform was installed in 1998 and is located 64 km off the coast. Recent discharges at Lomba are not reported.

There was a deviation in planned and real sampling at Lomba. Due to a pipeline and electrical cable going south from the platform and to the Nemba platform, some sites could not be sampled. For security reason the sites 250 m from the platform was replaced by sites 300 m from the platform. Sampling sites are shown in Figure 5.1.

Table 5.1. Recent well drilling and discharges from operations and accidents at Lomba.

No of wells drilled Barite Cuttings Water-based drilling mud Cementing chemicals Completion chemicals Accidental discharges Etc	Not reported



Site	Date	WGS 84		ED50 UTM Zone 33		Distance (m) / direction (º)	Depth (m)
		S	E	N	E		
LB1	16.10.06	5°20,735` S	11°37,294` E	9408003,54	125521,86	350m/340º	130
LB2	16.10.06	5°20,656` S	11°37,278` E	9408149,17	125491,46	500m/340º	130
LB3	16.10.06	5°20,417` S	11°37,185` E	9408589,31	125317,00	1000m/340º	130
LB4	16.10.06	5°19,898` S	11°37,010` E	9409545,35	124988,01	2000m/340º	130
LB5	16.10.06	5°20,884` S	11°37,517` E	9407730,83	125935,88	300m/75º	128
LB6	16.10.06	5°20,856` S	11°37,609` E	9407783,44	126105,78	500m/75º	128
LB7	16.10.06	5°20,783` S	11°37,885` E	9407920,96	126615,58	1000m/75º	125
LB8	16.10.06	5°20,640` S	11°38,410` E	9408190,19	127585,28	2000m/75º	121
LB9 (ref)	16.10.06	5°20,056` S	11°40,575` E	9409289,69	131584,18	6000m/75º	109
LB10 (ref)	16.10.06	5°19,479` S	11°42,722` E	9410375,79	135549,84	10000m/75º	97
LB13	16.10.06	5°21,318` S	11°37,744` E	9406932,19	126360,19	1000m/136º	128
LB14	17.10.06	5°21,703` S	11°38,108` E	9406225,37	127037,40	2000m/136º	125
LB15	16.10.06	5°20,932` S	11°37,160` E	9407638,61	125275,99	350m/265º	131
LB16	15.10.06	5°21,002` S	11°37,106` E	9407508,87	125176,81	500m/251º	132
LB17	15.10.06	5°21,108` S	11°36,854` E	9407310,68	124711,73	1000m/251º	134
LB18	15.10.06	5°21,259` S	11°36,330` E	9407026,64	123743,97	2000m/251º	146
LB19 (ref)	15.10.06	5°21,906` S	11°34,191` E	9405810,51	119793,81	6000m/251º	274

Figure 5.1. Map showing the internal distribution of sampling sites (circles) in Lomba and Nemba North in 2006. Positioning of Lomba according to WGS 84 and UTM ED50 zone 33. The field centre is marked with a square. Site LB9, LB10 and LB19 are reference sites.

5.2. Results and discussion

5.2.1 Sediments characteristics

Total organic matter (TOM), and the amount (%) of gravel, sand, pelite, median (Φ) and sorting in the sediment are presented in Table 5.2 and Figure 5.2. Additional information on colour and odour can be found in the sampling journal in the Appendix. There were observed some oil spots in the sediment at LB1 and LB2.

The bottom in the investigated area at Lomba was dominated by very fine grained sediment. The median (Φ) values ranging from 2.45 to 9.91, the amount of pelite varied from 40 to 98 % and the sand content varied from 2 to 60%. The two reference sites LB10 and LB19 had the highest amount of pelite.

The content of total organic matter (TOM) varied from 9.2 to 12.5 %.

Table 5.2. Total organic matter and sediment grain size at all sites at Lomba.
Pelite is particles < 0,063 mm, sand from 0,063 to 2 mm.

Site	Distance/direction	TOM %	Pelite %	Sand %	Gravel %	Median (Φ)	Sorting
LB 1	350m/340º	12.07	81	19	0.0	8.17	2.80
LB 2	500m/340º	12.45	90	10	0.0	7.99	2.38
LB 3	1000m/340º	12.12	86	14	0.0	9.91	2.08
LB4	2000m/340º	12.25	83	17	0.0	8.05	2.71
LB5	300m/75º	11.60	78	22	0.0	8.87	2.69
LB6	500m/75º	10.96	73	27	0.0	7.73	3.19
LB7	1000m/75º	12.17	85	15	0.0	7.84	2.61
LB8	2000m/75º	10.68	62	38	0.0	4.59	3.20
LB13	1000m/136º	10.62	76	24	0.0	8.24	2.79
LB14	2000m/136º	12.36	79	21	0.0	9.22	2.75
LB15	350m/265º	11.63	74	26	0.0	8.71	2.92
LB16	500m/251º	11.54	78	22	0.1	6.59	2.95
LB17	1000m/251º	9.47	40	60	0.1	2.45	2.89
LB18	2000m/251º	9.18	61	39	0.0	4.92	3.10
Reference site							
LB9	6000m/75º	10.57	72	28	0.0	7.41	3.34
LB10	10000m/75º	12.54	97	3	0.0	8.18	1.79
LB19	6000m/251º	11.33	98	2	0.0	7.83	1.98

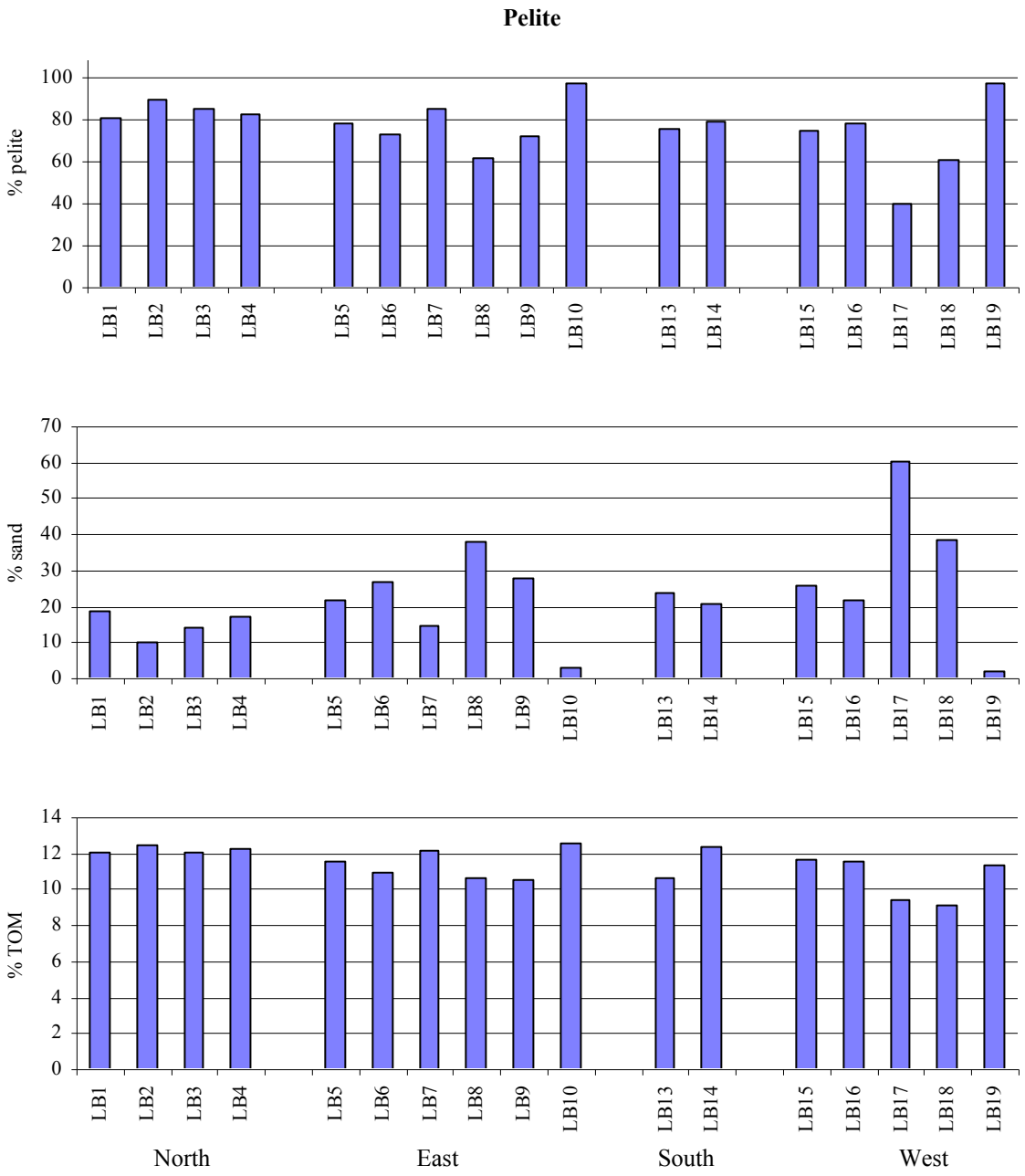


Figure 5.2. Sediment characteristics at Lomba. The sampling sites are organised by transects.

5.2.2 Chemical compounds

5.2.2.1 LSC

The results of the LSC (limits of significant contamination) calculations of hydrocarbons and metals are presented in Table 5.3.

Table 5.3. Limits of Significant Contamination (LSC) for the Lomba field in 2006 based on data from LB9, LB10 and LB19. All values in mg/kg dry sediment.

	THC	NPD's	PAH_{16}	Ba	Cu	Cr	Zn	Pb	Cd	Hg
$LSC_{LB9,LB10,LB19}$	33	63	42	245	32	130	184	43	0.12	0.069

5.2.2.2 Hydrocarbons

Summarised results of the hydrocarbon analyses, along with the content of selected hydrocarbon compounds in the different layers in the sediment (0-1, 1-3 and 3-6 cm) are given in Table 5.4 and Table 5.5. The complete data set including replicates is given in the Appendix.

THC was found in the range from 8.9 ± 2.6 mg/kg at LB7 to 170 ± 72 mg/kg at LB1. Highest concentrations were found at LB1 and LB2, which are located 350 m and 500 m to the north-west of the platform. Some black spots observed in the sediment at these two sites support the high level of THC in the sediment. Concentration above the LSC occurred also at LB5 and LB15, which are the two sites close to the platform along the north-east transect and the west transect.

Higher concentration of PAH and NPD was found at LB1 and LB2 compared to the reference site LB10 and LB19. Both sites close to the platform had concentration above LSC.

THC content above LSC was found in the vertical samples of the sediments. The 0-1 cm layer of LB1 and all layers (0-1 cm, 1-3 cm and 3-6 cm) from LB2 contained THC above LSC. Highest concentrations of THC were detected in the top layers, which indicate recent supply of THC.

Table 5.4. Average content of oil hydrocarbons in sediments from Lomba. THC values in mg/kg dry sediment, PAH and NPD in ng/g dry sediment. THC, PAH and NPD values above LSC are dark shaded. PAH and NPD only analysed at LB1, LB2, LB10 and LB19.

Site	Distance / direction	THC		PAH_{16}		NPD	
		av.	sd.	av.	sd.	av.	sd.
LB 1	350m/340º	169.6	71.8	50.6	11.2	101.2	32.5
LB 2	500m/340º	134.6	100.7	46.1	10.0	89.6	39.0
LB 3	1000m/340º	25.0	1.1				
LB4	2000m/340º	15.5	4.1				
LB5	300m/75º	37.8	12.3				
LB6	500m/75º	24.6	4.9				
LB7	1000m/75º	8.9	2.6				
LB8	2000m/75º	13.1	3.4				
LB13	1000m/136º	14.8	0.6				
LB14	2000m/136º	14.3	3.9				
LB15	350m/265º	49.5	29.0				
LB16	500m/251º	23.1	5.6				
LB17	1000m/251º	12.7	4.3				
LB18	2000m/251º	10.8	1.8				
Reference site							
LB9	6000m/75º	13.3	6.0				
LB10	10000m/75º	23.0	10.4	35.6	4.8	40.5	17.0
LB19	6000m/251º	18.1	4.7	33.0	1.9	28.7	5.7

Table 5.5. The content of total hydrocarbons in vertical sections of sediment from 2 sampling sites at Lomba. All values in mg/kg dry sediment. Values above LSC are dark shaded.

Stasjon	Layer (cm)	THC
LB 1	0-1	86.8
	1-3	31.4
	3-6	10.7
LB 2	0-1	250
	1-3	110
	3-6	116

5.2.2.3 Metals

Table 5.6 summarises the results of the metal analyses at Lomba. Concentrations of selected metals in the different layers (0-1, 1-3 and 3-6 cm) of sediment are given in Table 5.7, whereas the complete data set including replicates is given in the Appendix.

Barium was found in a range from 65 ± 26 mg/kg at LB8 to 2517 ± 2143 mg/kg at LB1. The reference sites had barium concentration from 49 ± 26 mg/kg to 151 ± 76 mg/kg. Sediments from site LB1, LB2, LB3, LB5, LB6, LB13, LB15 and LB16 had barium content above LSC. The barium content shows a gradient with decreasing content of barium with increasing distance from the platform at all transects. The site LB1 and LB2 which are close to the platform to the north-west had the highest concentration. Variation among the parallels indicates patchy distribution of barium.

All the other metals were lower than the LSC value. The highest concentrations of copper, chromium, zinc, lead were found at LB1, LB2 and the reference site LB10. For cadmium, the reference site LB19 had the highest concentration (Table 5.6). Higher amount of metals at the reference sites LB10 and LB19can be explained by the higher amount of pelite.

Vertical sediment samples (0-1, 1-3 and 3-6 cm) from LB1 and LB2 had barium content above LSC from 0-6 cm depth interval. LB2 had lead, copper, chromium and zinc above LSC at 1-6 cm and mercury at 1-3 cm depth interval.

Table 5.6 Content of metals in sediments from Lomba. All values in mg/kg dry sediment. Values above LSC are dark shaded. n.a = not analysed.

Site	Distance / direction	Ba		Pb		Cd		Cu		Cr		Zn		Hg	
		av.	sd.	av.	sd.	av.	sd.	av.	sd.	av.	sd.	av.	sd.	av.	sd.
LB 1	350m/340º	2517	2143	29.3	21.9	0.060	0.036	25.4	18.5	95.0	65.8	146.4	98.4	0.065	0.003
LB 2	500m/340º	1474	1446	25.2	16.1	0.063	0.032	23.2	15.9	86.0	54.6	124.3	77.7	0.066	0.002
LB 3	1000m/340º	267	95	16.9	0.4	0.040	0.000	14.6	1.8	55.3	2.5	80.6	10.5	n.a	
LB4	2000m/340º	88	51	15.2	1.4	0.037	0.012	13.0	1.3	53.9	4.5	82.8	11.1	n.a	
LB5	300m/75º	741	84	17.3	1.7	0.037	0.015	14.0	2.2	54.9	5.0	84.3	16.1	n.a	
LB6	500m/75º	422	16	18.0	2.6	0.060	0.026	11.8	1.7	59.4	4.3	94.4	9.0	n.a	
LB7	1000m/75º	120	45	16.2	0.7	0.037	0.006	13.0	1.7	56.2	3.9	83.2	10.6	n.a	
LB8	2000m/75º	65	26	17.9	0.6	0.040	0.010	10.9	1.0	57.9	1.0	94.8	1.9	n.a	
LB13	1000m/136º	280	127	17.8	0.8	0.037	0.012	11.4	1.5	58.4	0.5	93.0	3.5	n.a	
LB14	2000m/136º	189	148	17.8	1.2	0.050	0.000	13.8	2.7	56.4	1.9	82.2	10.1	n.a	
LB15	350m/265º	399	304	16.1	0.6	0.037	0.006	13.4	1.3	54.5	2.0	82.2	7.7	n.a	
LB16	500m/251º	513	152	16.3	0.5	0.040	0.010	12.6	0.6	55.2	2.6	87.8	5.9	n.a	
LB17	1000m/251º	154	20	24.1	2.4	0.047	0.015	7.4	0.8	67.5	6.6	101.2	7.2	n.a	
LB18	2000m/251º	174	70	19.5	0.6	0.033	0.006	9.9	1.9	60.5	1.5	92.0	4.3	n.a	
Reference site															
LB9	6000m/75º	49	26	17.9	2.0	0.030	0.010	11.7	1.3	55.1	3.6	83.5	10.8	n.a	
LB10	10000m/75º	125	68	29.2	18.1	0.047	0.021	21.5	13.7	87.1	56.2	122.6	80.2	0.061	0.005
LB19	6000m/251º	151	76	16.8	0.5	0.090	0.020	16.2	0.2	59.0	2.8	78.1	2.5	0.053	0.002

Table 5.7. The content of metals in vertical sections of sediment from 2 sampling sites at Lomba. All values in mg/kg dry sediment. Values above LSC are dark shaded.

Site	Layer	Ba	Pb	Cd	Cu	Cr	Zn	Hg
LB1	0-1 cm	1340	16.9	0.05	14.5	58.3	91.6	0.067
	1-3 cm	1320	15.5	0.04	12.8	53.6	83.1	0.057
	3-6 cm	1620	16.6	0.05	15.1	54.7	82.3	0.060
LB2	0-1 cm	1030	15.2	0.04	13.8	52.8	77.1	0.068
	1-3 cm	3010	48.1	0.12	42.6	153	219	0.071
	3-6 cm	3300	45.4	0.10	44.2	150	212	0.067

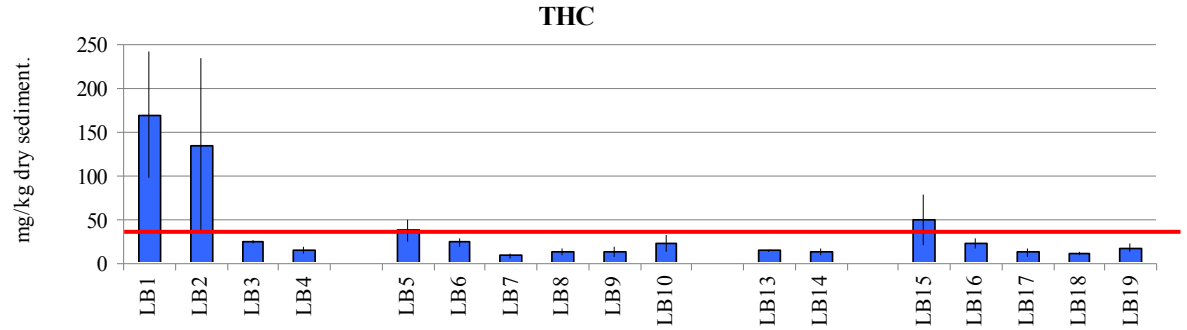


Figure 5.3. Average THC concentrations and standard deviations in sediments from Lomba. Red line is LSC.

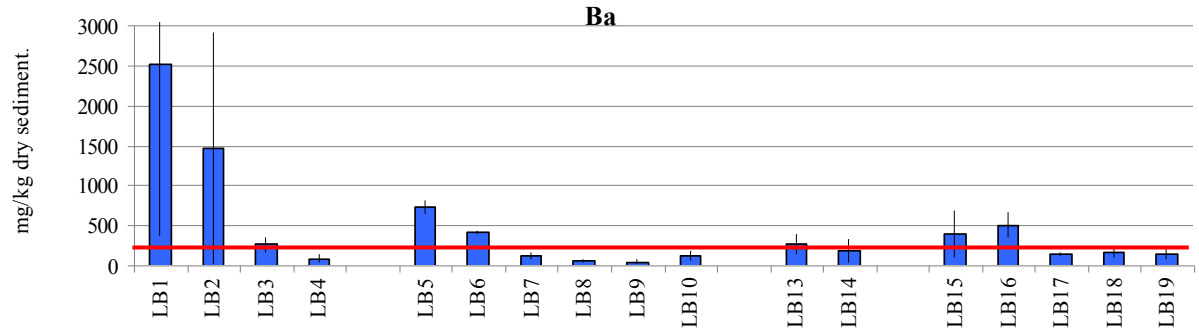


Figure 5.4. Average barium concentrations and standard deviation in sediments from Lomba. Red line is LSC

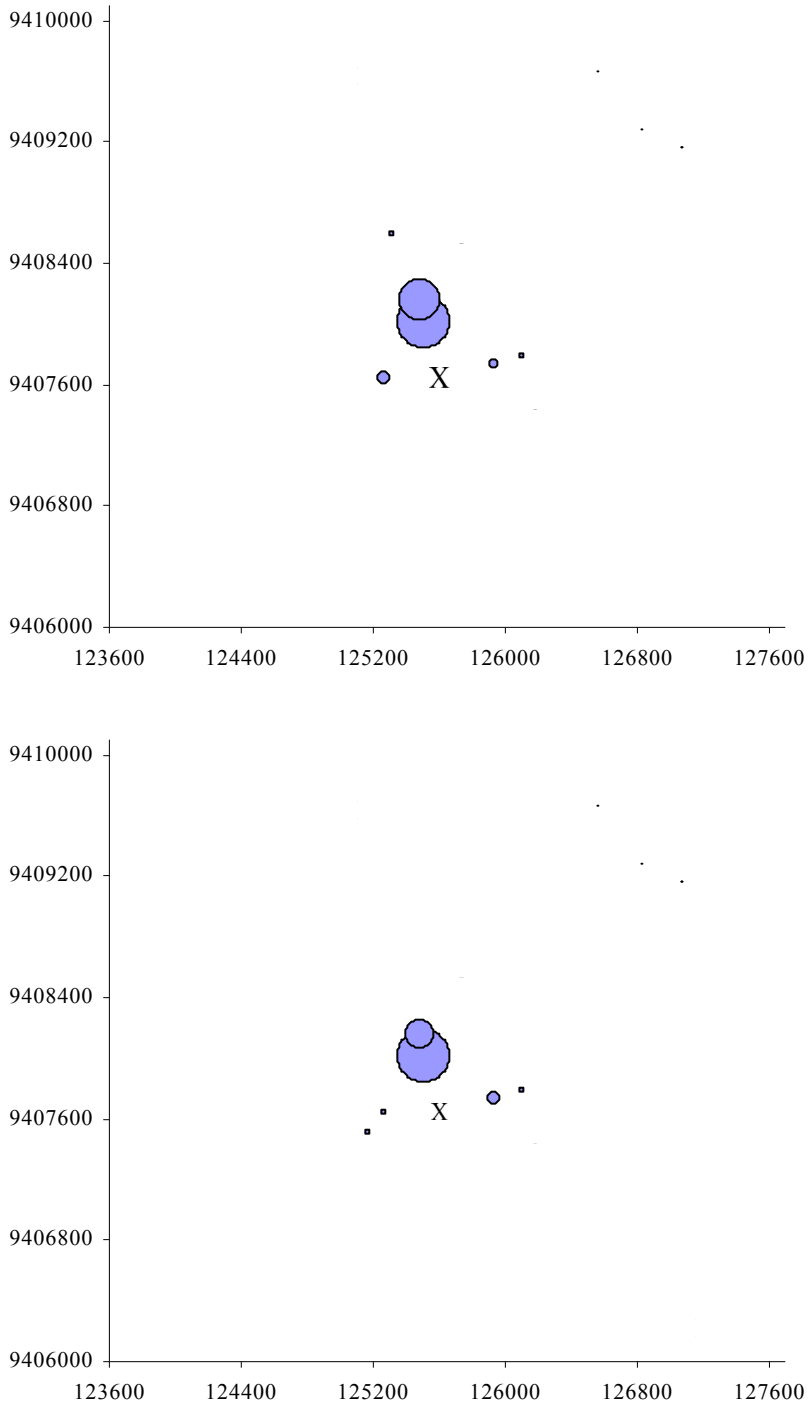


Figure 5.5. Distribution of THC and barium in sediments at the sampling sites from 300 to 2000 m distance from the platform at Lomba. The size of the circle indicate the amount of THC and Ba. The field centre is marked with an X.

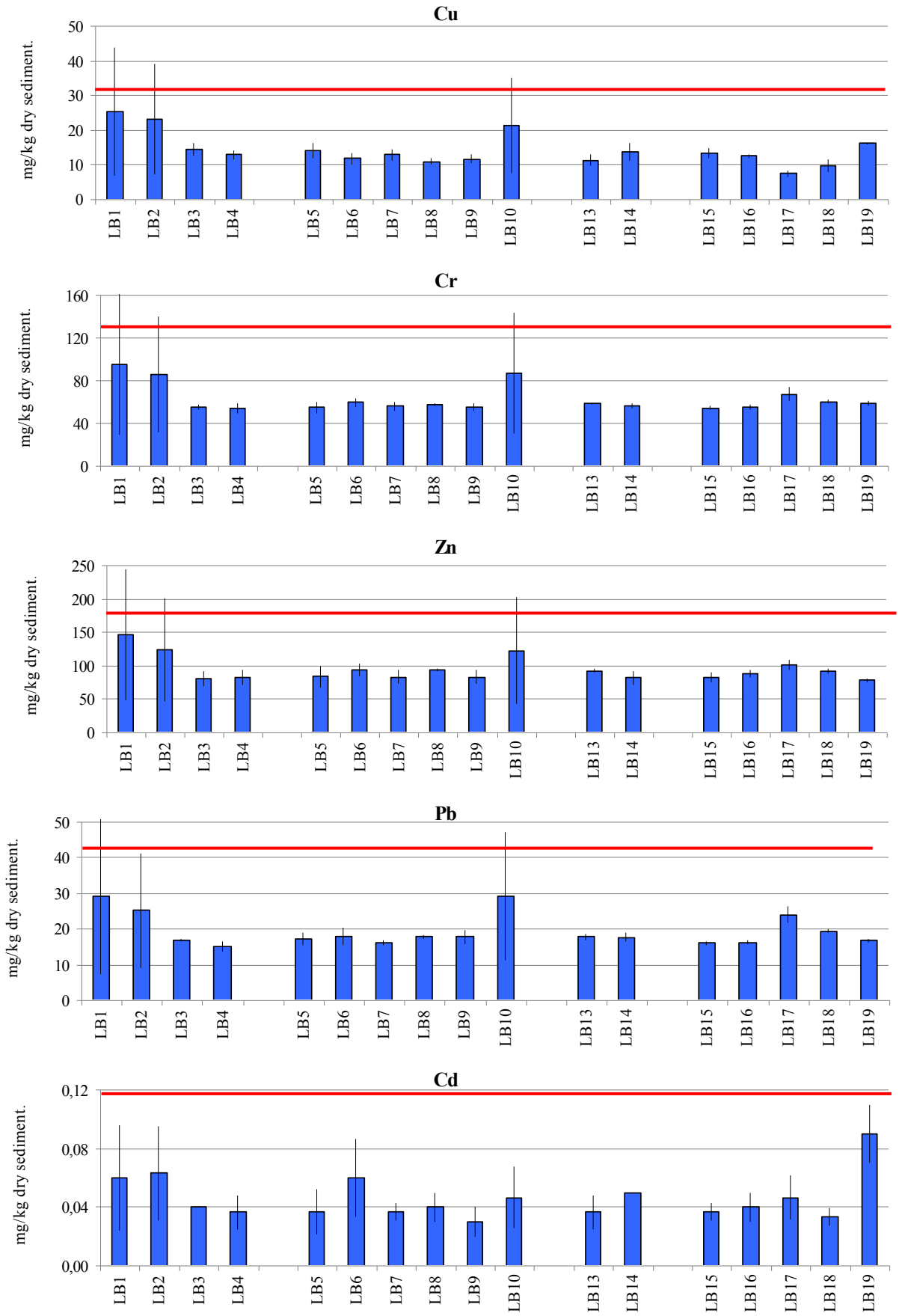


Figure 5.6. Average content and standard deviations of metals in sediment from Lomba. Red line is LSC.

Due to higher content of chemical compounds in the sediments from LB1 and LB2, the two sites clearly separated from the other sites at Lomba in the PCA-analyses (Figure 5.7). The reference site LB10 also had higher content of some metals, and separated from the other sites. All the other sites have similar level of hydrocarbon and metals and are close to each other in the plot.

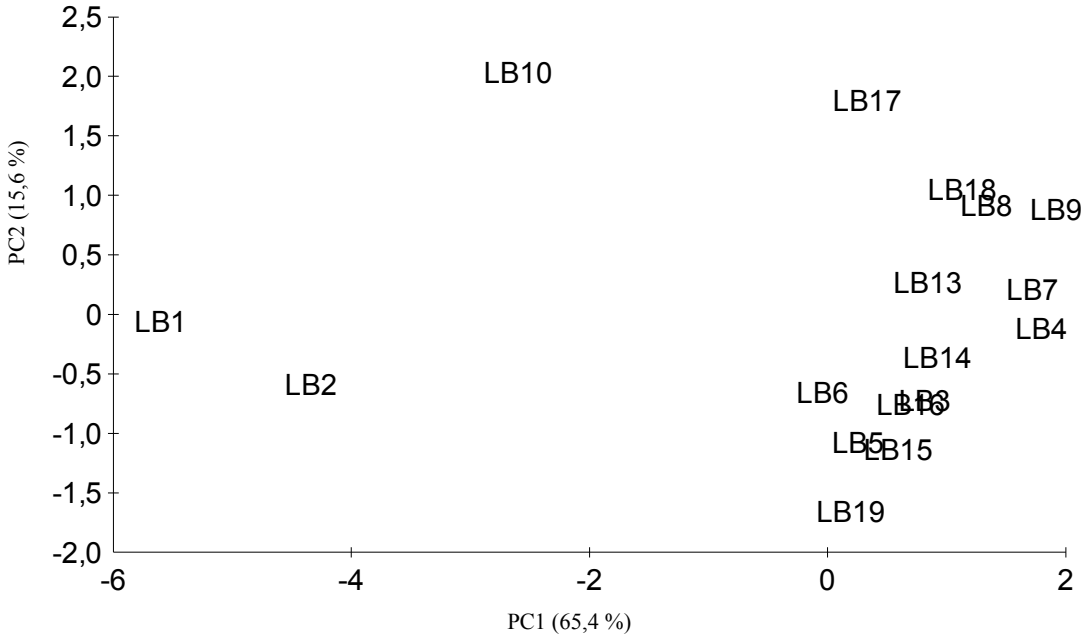


Figure 5.7. 2-D plot from the PCA analysis of environmental variables Cd, Cu, Ba, Zn, Cr, Pb and THC. Explained variation in the data 80,9 %.

5.2.3 Bottom fauna

A summary of the distribution of individuals and taxa within the main taxonomic groups are given in Table 5.8. In total, 613 individuals within 155 taxa were collected at Lomba (exclusive the reference sites). In total, 293 individuals and 86 taxa were collected at the reference sites LB9, LB10 and LB19. The fauna was numerically dominated by Annelida with 71 % the individuals and 59 % of the taxa. A complete species list is available in the Appendix.

Table 5.8. Distribution of individuals and taxa within the main taxonomic groups at Lomba.

Lomba, exlusive reference site Main taxonomic groups	**Number of individuals**	**%**	**Number of taxa**	**%**
Annelida	434	71	92	59
Arthropoda	71	12	23	15
Mollusca	49	8	27	17
Echidermata	11	2	6	4
Diverse groups	48	8	7	5
Total	613	100	155	100

Reference site LB9, 10 and 19 Main taxonomic groups	**Number of individuals**	**%**	**Number of taxa**	**%**
Annelida	208	71	55	64
Arthropoda	16	5	10	12
Mollusca	35	12	11	13
Echidermata	5	2	3	3
Diverse groups	29	10	7	8
Total	293	100	86	100

The species/area curve for LB9, LB10 and LB19 indicates that five replicate samples give a impression of the bottom fauna in the area (Figure 5.8). However, as more area is sampled, more taxa are collected, indicating that not even 5 replicate samples give the full species assemblage of the area.

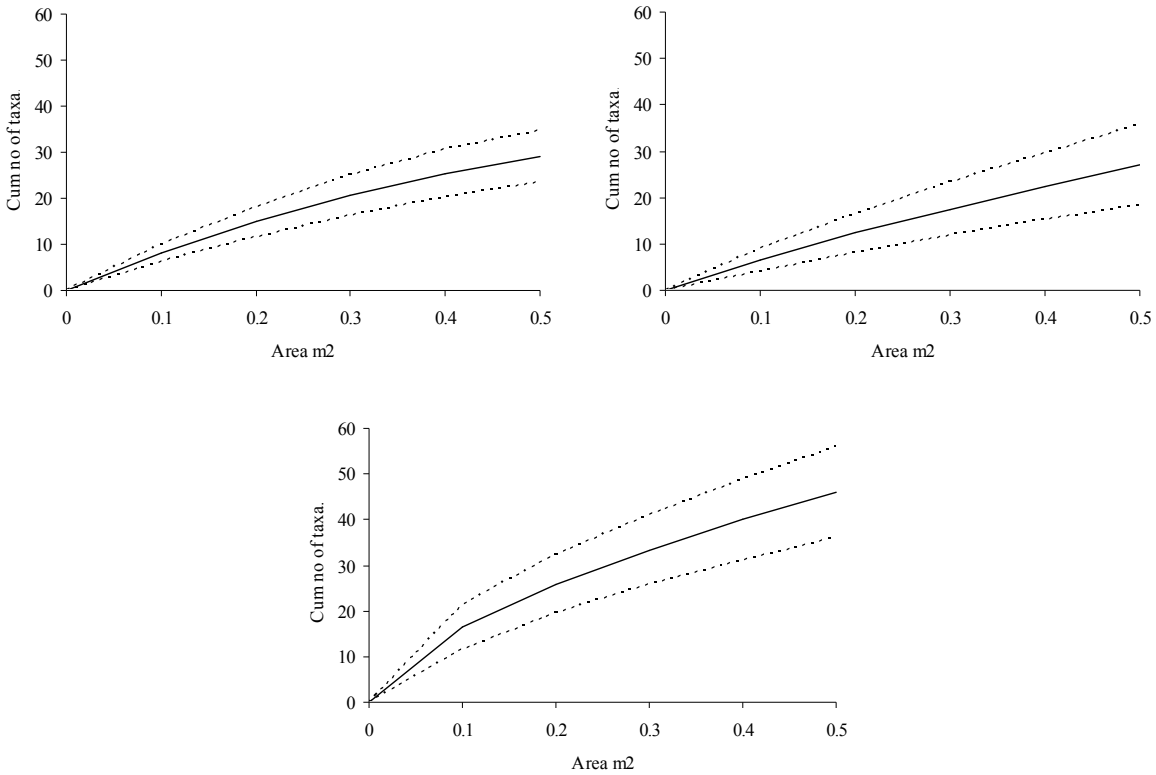


Figure 5.8. Species/area curve for the reference site at the Lomba. The solid line is calculated species/area curve, and the dotted line is ± 95 % confidens interval.

The distribution of number of individuals and taxa are shown in Figure 5.9. Number of individuals and taxa at each site, and the calculated diversity indexes (H' and J) are given in Table 5.9 and Figure 5.10.

The number of individuals at the field sites varied from 20 (LB2) to 94 (LB18) and the number of taxa varied from 15 (LB2) to 38 (LB18). Numbers of individuals and taxa increases with depth along the westerly transect, and reach 194 individuals and 46 taxa at the reference site LB19 (the deepest site). The two sites LB1 and LB2 close to the platform along the north-west transect and the LB6 had the fewest number of individuals and taxa. This might indicate some disturbance of the fauna close to the platform.

The Shannon-Wiener diversity index (H') varied from 3,8 (LB2) to 4,8 (LB7) and the evenness varied from 0,77 (LB19) to 0,98 (LB8). The diversity and evenness indicate good environmental conditions at all sites.

Table 5.9. Number of individuals, taxa and selected community indices for each site (0.5 m^2) at Lomba.

Site	Distance/ direction	Number of individuals	Number of taxa	Evenness J	Diversity H'
LB1	350m/340º	26	20	0.94	4.1
LB2	500m/340º	20	15	0.97	3.8
LB3	1000m/340º	41	26	0.95	4.5
LB4	2000m/340º	36	27	0.97	4.6
LB5	300m/75º	39	23	0.93	4.2
LB6	500m/75º	27	18	0.96	4.0
LB7	1000m/75º	55	34	0.94	4.8
LB8	2000m/75º	42	27	0.98	4.6
LB13	1000m/136º	32	23	0.95	4.3
LB14	2000m/136º	34	23	0.93	4.2
LB15	350m/265º	49	30	0.94	4.6
LB16	500m/251º	49	31	0.93	4.6
LB17	1000m/251º	70	33	0.86	4.3
LB18	2000m/251º	94	38	0.85	4.5
Reference site					
LB9	6000m/75º	51	29	0.96	4.7
LB10	10000m/75º	48	27	0.86	4.1
LB19	6000m/251º	194	46	0.77	4.3

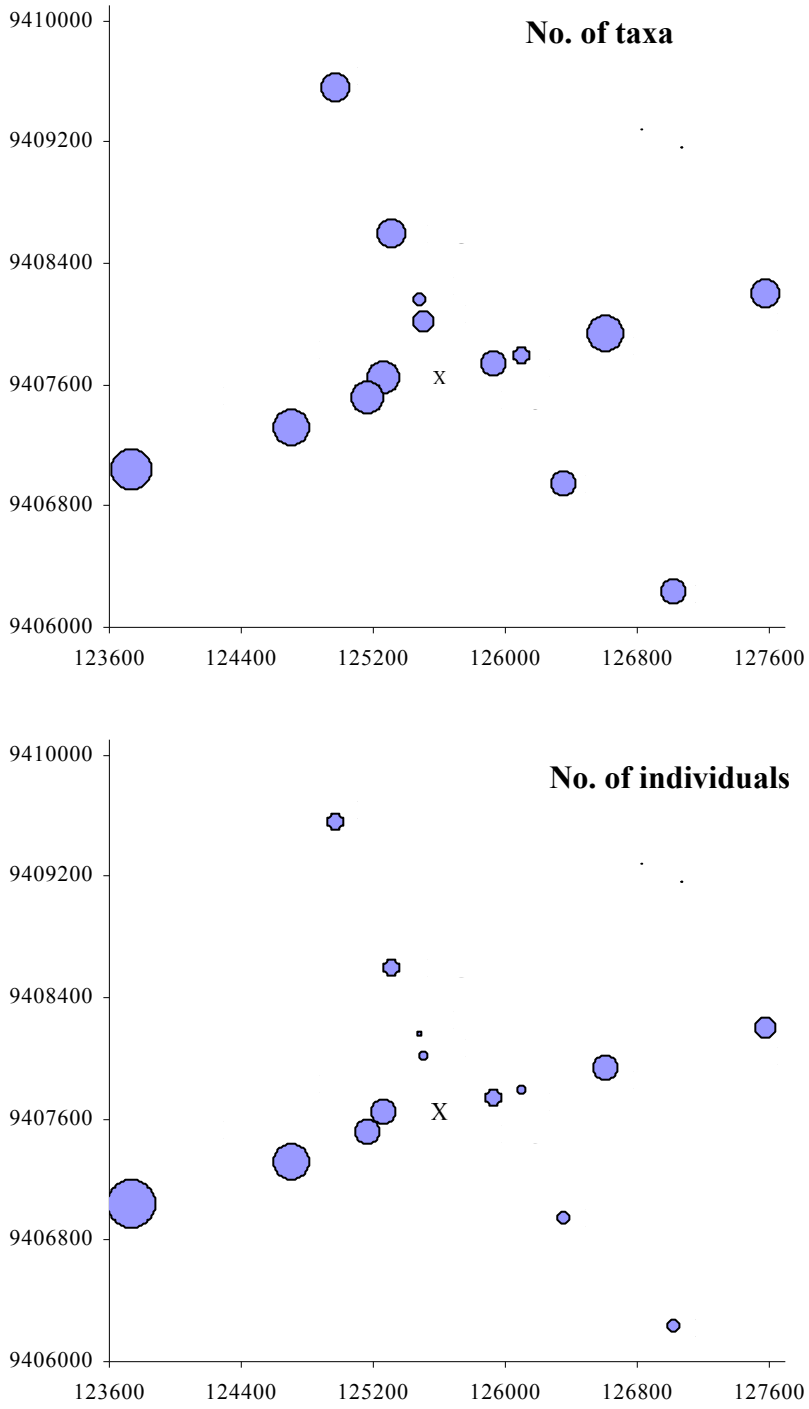


Figure 5.9. Distribution of bottom fauna (individuals and taxa) among the sampling sites out to 2000 m from the platform Lomba. The size of the circle indicates the number of individuals and taxa. The field centre is marked with an X.

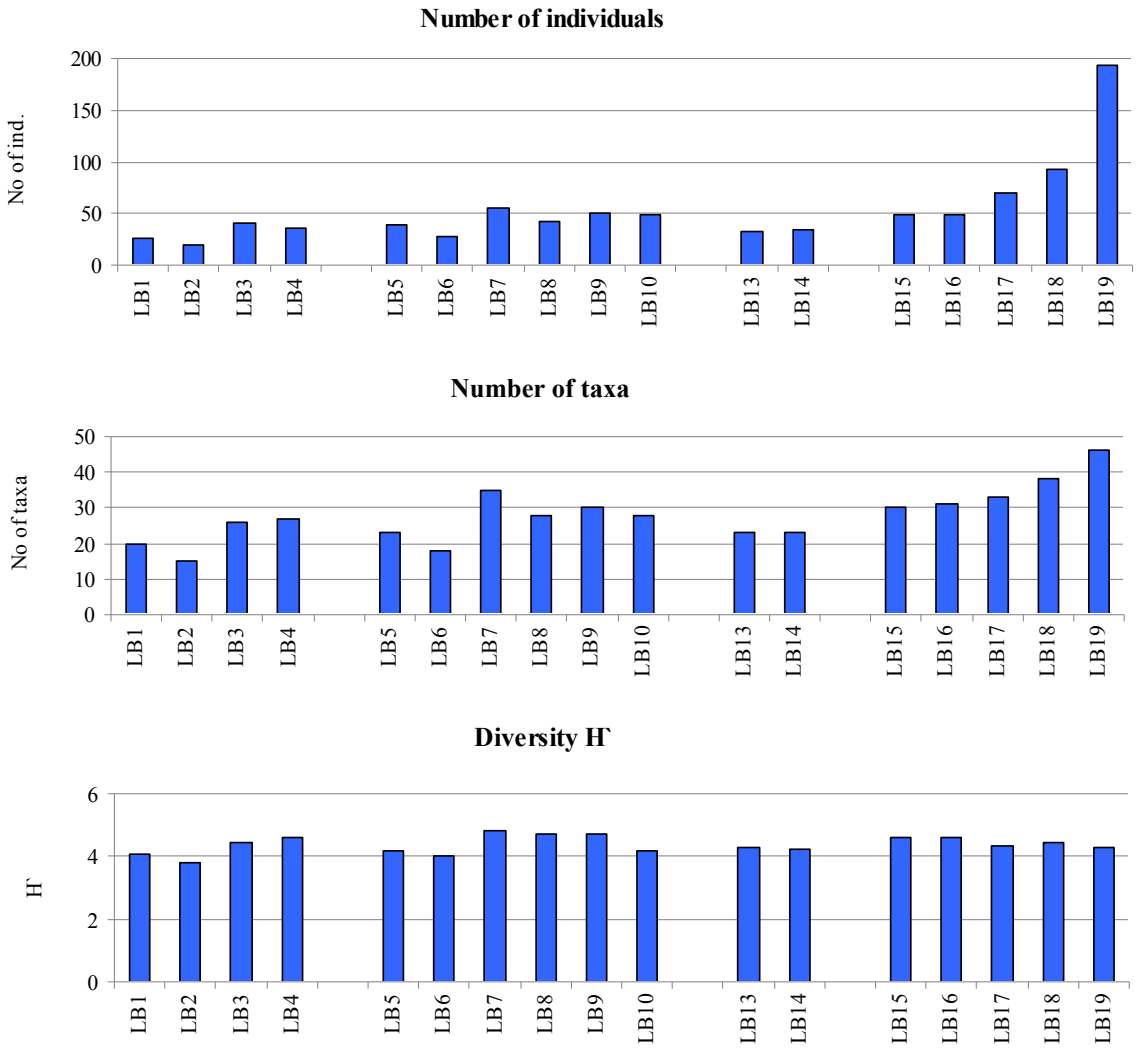


Figure 5.10. Number of individuals, taxa and selected community indices for each site (0.5 m^2) at Lomba. Site LB9, LB10 and LB19 are reference sites. The water depth increase along the transect to the west (LB15-LB19).

Distribution of taxa in geometrical classes is presented in Figure 5.11. All the sites at Lomba had nearly similar distribution, except LB2 and LB6 which have fewer species in the first geometric class, and LB19 which have more species in the geometric class I and have one species in geometric class VI.

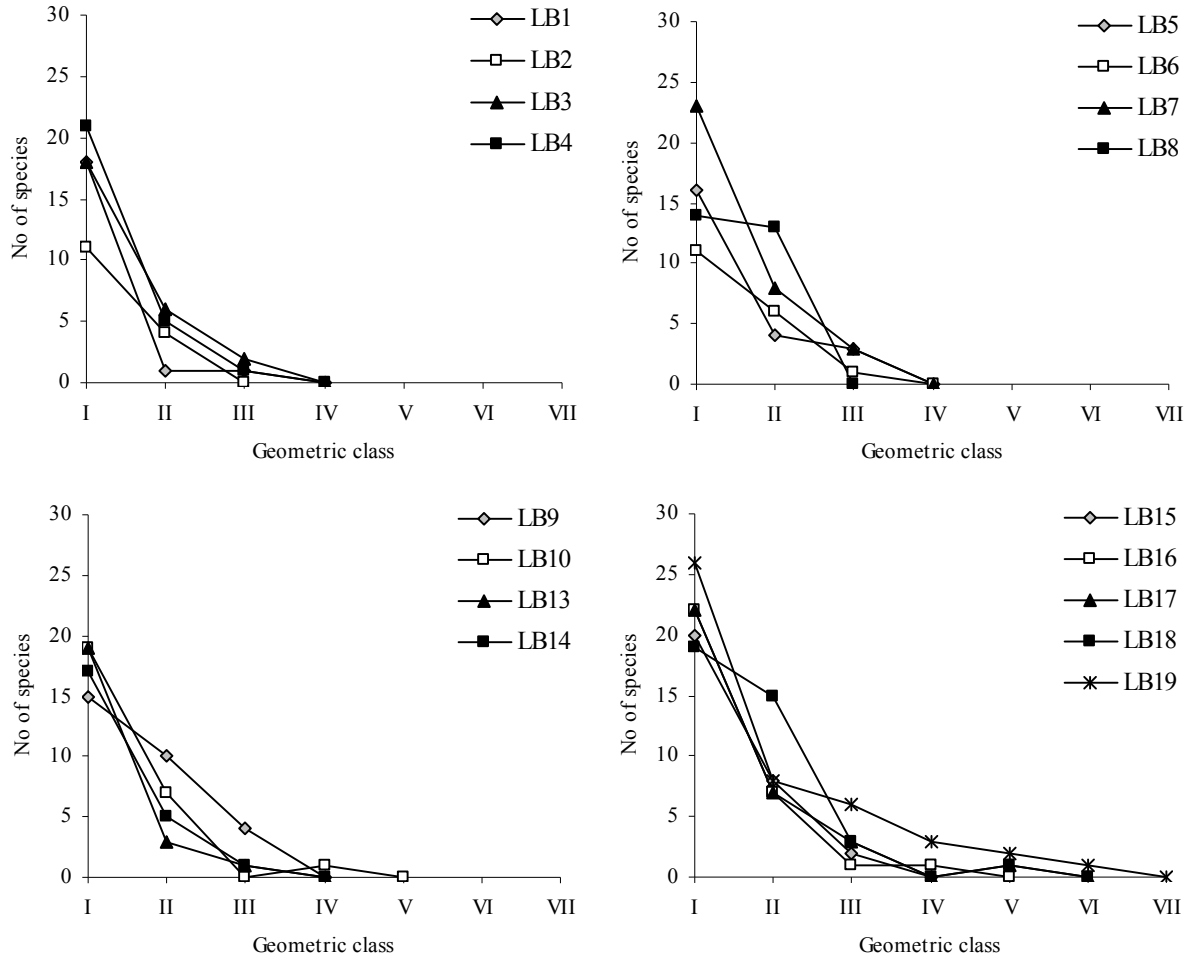


Figure 5.11. Distribution of taxa in geometrical classes for the sites at Lomba.

Because of few species and individuals, the list of the ten most abundant taxa will include, in most cases, the entire species list. A list of the ten most abundant taxa at the two most contaminated sites (LB1 and LB2) and the reference site LB10 and LB19 are listed in Table 5.10. For the other sites, only the taxon with most individuals is presented (Table 5.11). See species list in appendix for all the taxa.

No species was dominant in the sediment. The most abundant taxon was the bristle worm (Polychaeta) *Prionospio cf. dubia* with 44 individuals at LB19. The highest dominance was found at LB10 where the snail *Nassarius megalocallus* had 31 % of the individuals. Polychaeta was most numerous at 15 sites, Crustacea most numerous at 2 sites, Mollusca at 1 site and Sipuncula at 1 site.

Table 5.10. Number of individuals and relative abundance for the ten most abundant taxa at LB1, LB2, LB10 and LB19. Species with only one individual are excluded.

LB1	No. of ind.	%	Cum %
Prionospio sp. I	5	19,2	19,2
Heterospionidae indet I	3	11,5	30,8

LB2	No. of ind.	%	Cum %
Amphinomidae indet. IV	3	15,0	15,0
Nemertini indet.	2	10,0	25,0
Leanira cf. hystricis	2	10,0	35,0
Echiura indet.	2	10,0	45,0

LB10	No. of ind.	%	Cum %
Nassarius megalocallus	15	31,3	31,3
Amphiuridae indet.	2	4,2	35,4
Amphicteis gunneri	2	4,2	39,6
Nemertini indet.	2	4,2	43,8
Anobothrus sp I	2	4,2	47,9
Ampharete cf. acutifans	2	4,2	52,1
Ampharetidae indet.I	2	4,2	56,3
Ampharetidae indet.II	2	4,2	60,4

LB19	No. of ind.	%	Cum %
Prionospio cf. dubia	44	22,7	22,7
Glyphanostomum sp I	29	14,9	37,6
Onchnesoma sp	20	10,3	47,9
Cirratulidae indet. I	10	5,2	53,1
Aricidea sp I	8	4,1	57,2
Lumbrineridae indet. II	8	4,1	61,3
Hesionidae indet.I	6	3,1	64,4
Ampharete sp. II	6	3,1	67,5
Yoldiella cf philippiana	6	3,1	70,6
Prionospio sp. I	5	2,6	73,2
Cossura cf. coasta	5	2,6	75,8

Table 5.11. Number of individuals and relative abundance for the most abundant taxon at all sites.

Site	Taxa	Phylum	No. of ind.	%
LB1	Prionospio sp. I	Polychaeta	5	19,2
LB2	Amphinomidae indet. IV	Polychaeta	3	15,0
LB3	Prionospio sp. I	Polychaeta	5	12,2
LB4	Nephtys sp.	Polychaeta	4	11,1
LB5	Nephtys sp.	Polychaeta	6	15,4
LB6	Amphinomidae indet. III	Polychaeta	4	14,8
LB7	Nephtys sp.	Polychaeta	7	12,7
LB8	Aphelochaeta sp. I and Apseudidae indet I	Polychaeta Crustacea	3 3	7,1
LB9	Nephtys sp. Hesionidae indet. I Prionospio sp. II Natatolana sp.	Polychaeta Polychaeta Polychaeta Crustacea	4 4 4 4	7,8
LB10	Nassarius megalocallus	Mollusca	15	31,3
LB13	Lanice conchilega	Polychaeta	5	15,6
LB14	Onchnesoma sp	Sipuncula	7	20,6
LB15	Nephtys sp.	Polychaeta	6	12,2
LB16	Lanice conchilega	Polychaeta	9	18,4
LB17	Lanice conchilega	Polychaeta	18	25,7
LB18	Lanice conchilega	Polychaeta	25	26,6
LB19	Prionospio cf. dubia	Polychaeta	44	22,7

The results of the multivariate analyses are given in the dendrogramme (Figure 5.12) and the MDS plott (Figure 5.13).

In the cluster analysis all sites are grouped together within 13 % similarity, indicating relatively low similarity in the species assemblages within the field. The reference site LB19 had a different fauna than the other sites. This is mostly due to variation in the water depth at the sites. The site LB6 are also dissimilar the other sites. The site LB1 and LB2 in cluster with LB4 form a group different from the other sites (20 % similarity). The site LB7 and LB8 have the most similar fauna, with 52 % similarity.

The results of the MDS analysis (Figure 5.13) support the findings in the cluster analysis. The reference site LB19 is on one side of the plot. Also the two other reference sites LB9 and LB10 are located on the same side in the plot. On the opposite end are the contaminated sites LB1, LB2 and the LB4 located. The two MDS plot in Figur 5.13 is similar, but in the last one some sites are grouped together with a circle. This is not the groups linked by the cluster analyse. The circles visualise a weak gradient with sites close to the platform or downstream from the platform in one circle, the reference site in one circle and the sites 1000 m and 2000 m in between (the LB5-350 m are in this group).

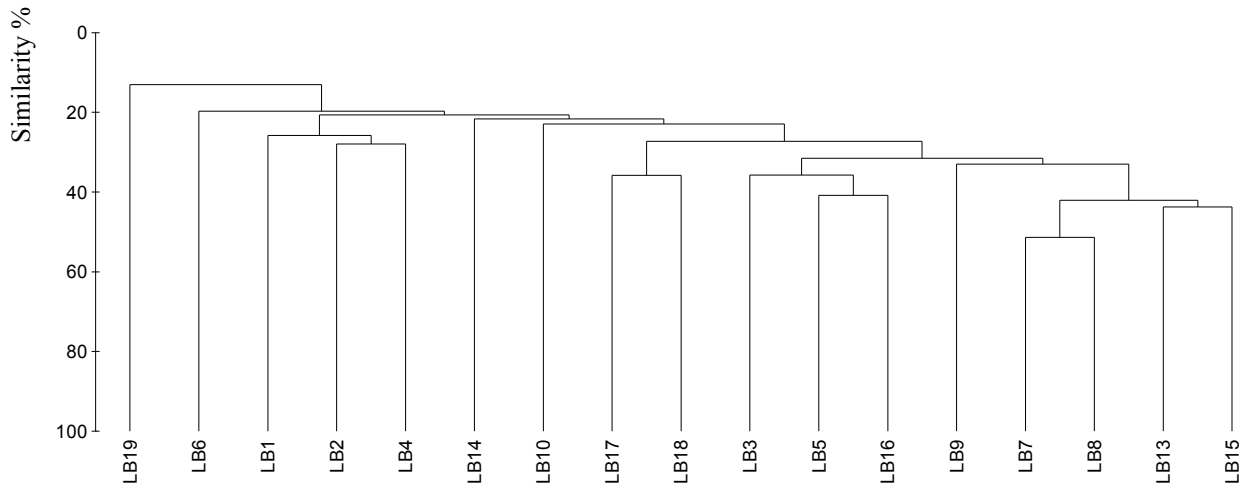
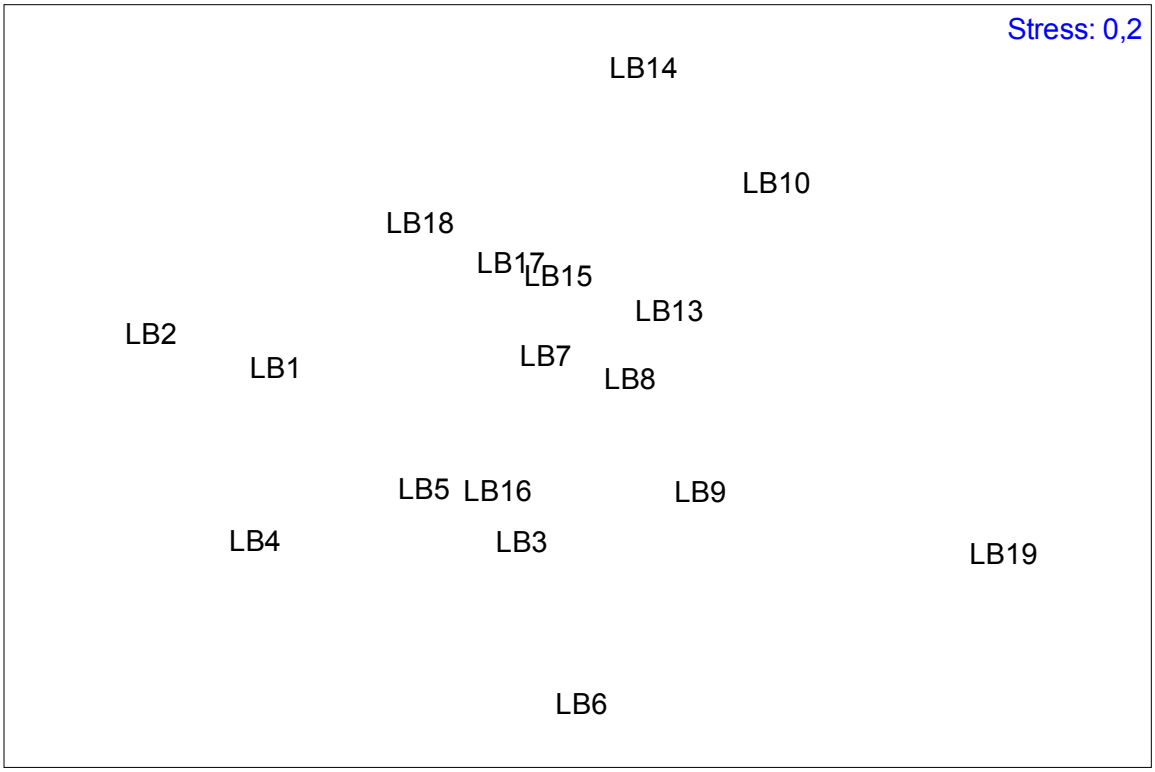


Figure 5.12. Dendrogram showing the similarity between fauna from sampling sites at Lomba.

A)



B)

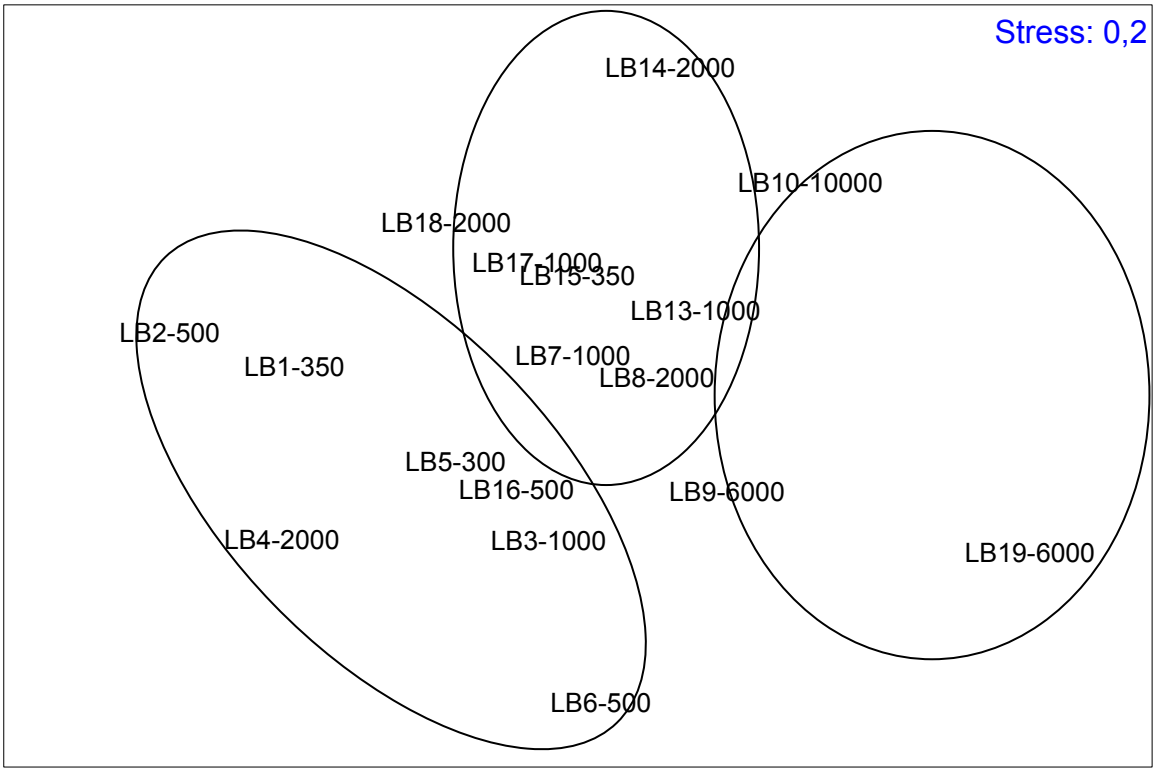


Figure 5.13. A) A 2-dimetional plott of the MDS analysis of the fauna data from Lomba. B) The distances (m) to the platform are shown, and groups of sites are enclosed by circles. Stress = 0,2.

The result of the linking of biotic and environmental variables by BIOENV is presented in Table 5.12. Only weak correlation of the bottom fauna and the environmental variables in the analyses was detected. Cd was the single parameter best correlated to the biota at $\rho_w = 0.400$. Overall best correlated had the three variables Cd, Cr and depth at $\rho_w = 0.475$.

Table 5.12. Combinations of the 10 environmental variables, taken *k* at a time, yielding the best matches of biotic and abiotic similarity matrices for each *k*, as measured by weighted Spearman rank correlation ρ_w. Bold type indicates overall optimum.

Number of variables (*k*)	Correlation coefficient (ρ_w)	Environmental variables									
1	0.400	Cd									
1	0.171	Depth									
1	0.126	Cr									
1	0.113	Cu									
1	0.065	Pb									
1	0.061	Zn									
1	0.018	Ba									
1	0.009	Pelite									
1	0.003	TOM									
1	-0.099	THC									
2	0.461	Cd	Cr								
3	**0.475**	**Cd**	**Cr**	**Depth**							
4	0.464	Cd	Cr	Depth	Pb						
5	0.435	Cd	Cr	Depth	Pb	Cu					
6	0.404	Cd	Cr	Depth	Pb	Zn	TOM				
7	0.375	Cd	Cr	Depth	Pb	Zn	TOM	THC			
8	0.350	Cd	Cr	Depth	Pb	Cu	TOM	THC	Ba		
9	0.336	Cd	Cr	Depth	Pb	Cu	TOM	THC	Ba	Zn	
10	0.295	Cd	Cr	Depth	Pb	Cu	TOM	THC	Ba	Zn	Pelite

5.2.4 Estimation of influenced area

The extension of contamination along sampling transects and the minimum area of contaminated sediments for THC, barium and other metals as well as for faunal disturbance are given in Figure 5.14 and Table 5.13. A minimum area of 0.20 km^2 is contaminated by THC and 1.57 km^2 contaminated by barium around the platform at Lomba. The fauna seems to be disturbed in an area of 0.06 km^2.

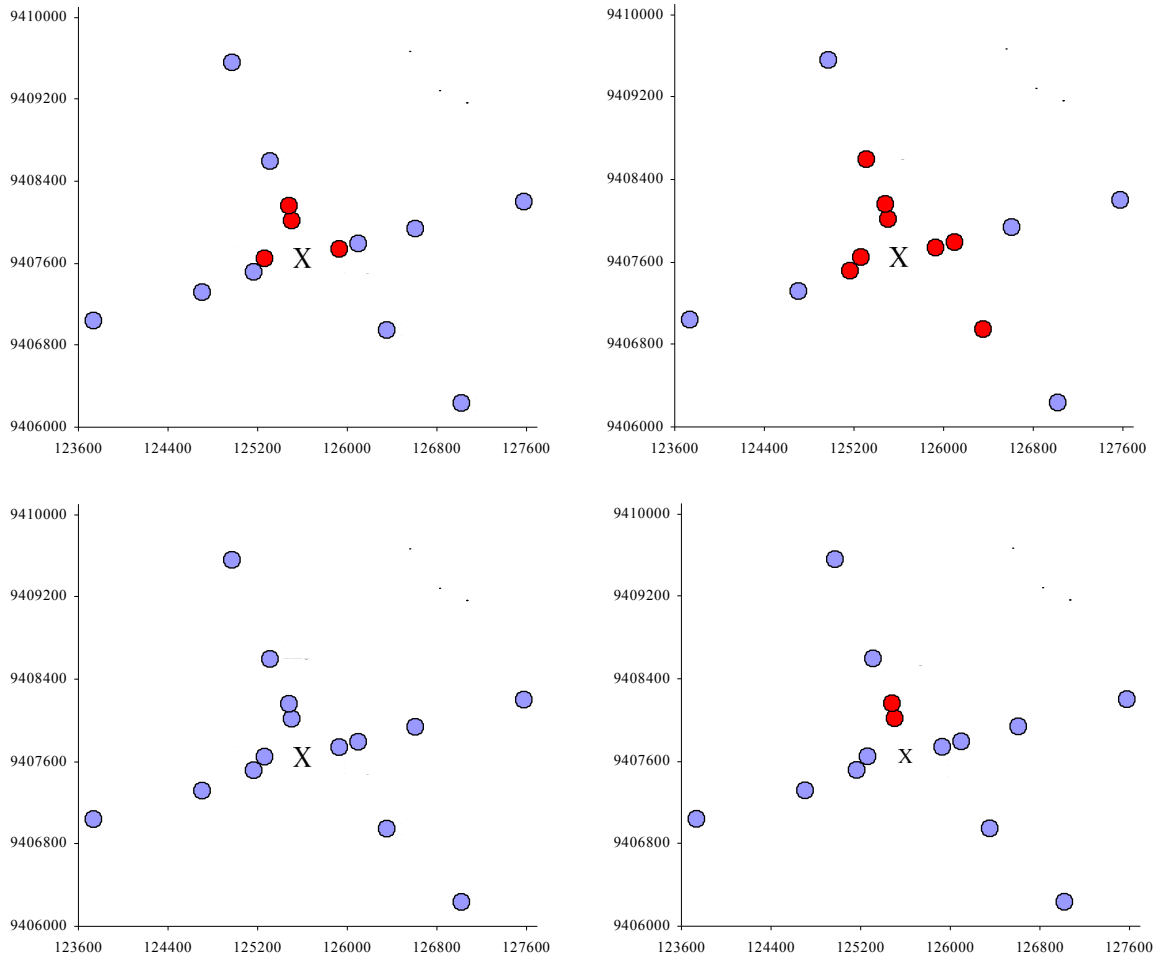


Figure 5.14. Faunal disturbance and chemical contamination of the sediments at Lomba are marked with red circles. Uncontaminated sites and sites with no faunal disturbance are marked with blue circles. The field centre are marked with an X.

Table 5.13. Estimated distance of contamination and faunal disturbance from the installation, and estimated area of contamination and faunal disturbance around the field centre.

Lomba	NW m	NE m	SE m	NW m	km²
THC	500	300	0	350	0.20
Ba	1000	500	1000	500	1.57
Other metals	0	0	0	0	0.00
Fauna	500	0	0	0	0.06

5.3 Summary and conclusions

Seventeen sites were investigated at Lomba. The samples were taken with increasing distance to the platform. The sediment was mostly fine grained (pelite) with even distribution of TOM. Some oil spots were detected in the sediment from LB1 and LB2, which are 350 and 500 m to the north-west of the platform. This support the findings that LB1 and LB2 had very high amount of THC and high concentration of PAH and NPD in the sediment. Also the two other sites at 300/350 m from the platform had high concentration of THC. This indicates a minimum area of THC contamination of 0.20 km^2. The concentration of barium was very high at LB1 and LB2. The contamination of barium reach the 1000 m site to the north-west, the 500 m site to the north-east, the 1000 m site to the south-east and the 500 site to the south-west. The minimum area of Ba contamination was 1.57 km^2. No other metal contamination was detected. There was generally few individual and taxa at Lomba, but the diversity was high. The fauna seems to be disturbed at the two sites close to the platform to the north-west. There was only a weak correlation between the fauna and the environmental variables.

6 ENVIRONMENTAL CONDITION – NEMBA NORTH

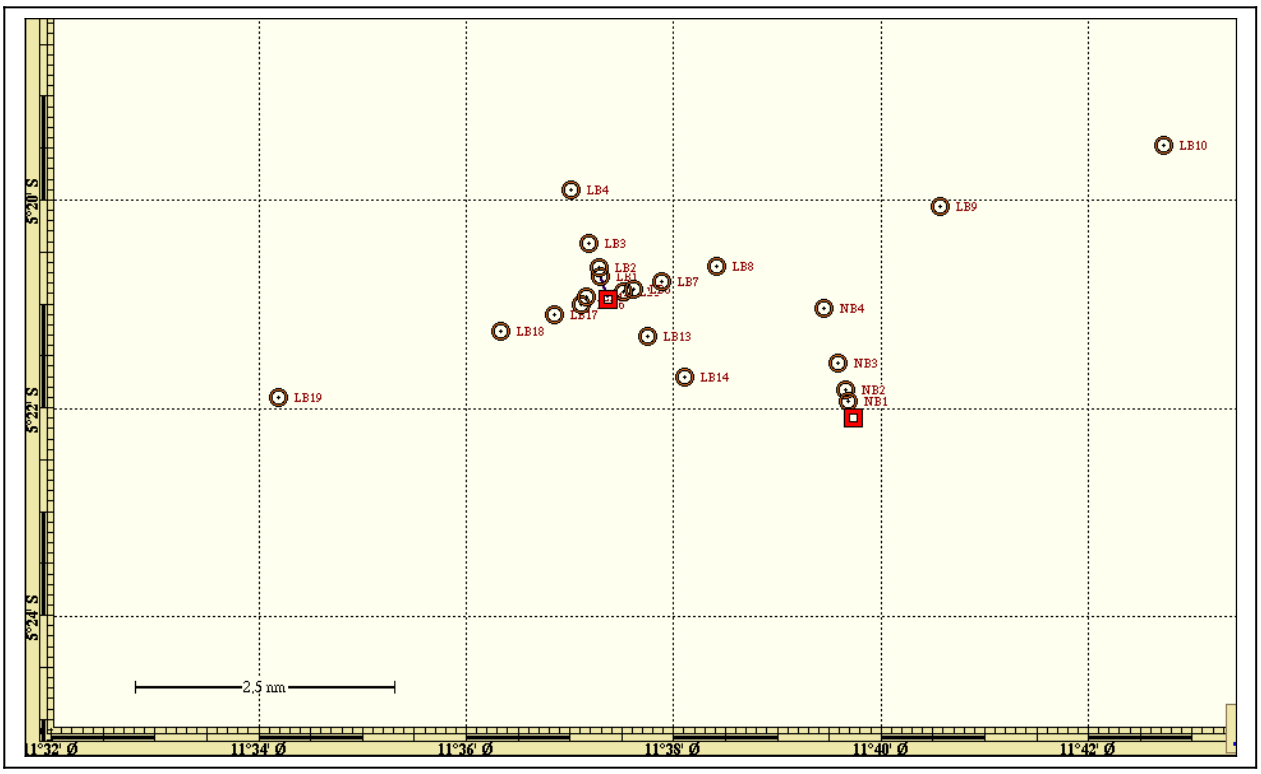
6.1. Introduction

The Nemba North is situated in block 0, approximately 5000 m distance from Lomba.
The platform was installed in 1983, and is situated 59.5 km from the coast.
Recent discharges at Nemba North are not reported.

Only one transect was investigated at Nemba North. The north-west transect was chosen because of the dominant water current direction, and therefore probably most contamination along this transect. For security reason the sites 250 m from the platform was replaced by sites 300 m from the platform. Sampling sites are shown in Figure 6.1. Because of few sites investigated at Nemba North, some of the analysis includes the Lomba sites.

Table 6.1. Recent well drilling and discharges from operations and accidents at Nemba.

No of wells drilled Barite Cuttings Water-based drilling mud Cementing chemicals Completion chemicals Accidental discharges	Not reported



Site	Date	WGS 84		ED50 UTM zone 33		Distance (m) / direction (º)	Depth (m)
		S	E	N	E		
NB1	17.10.06	5°21,940` S	11°39,687` E	9405803,99	129960,50	300m/344º	115
NB2	17.10.06	5°21,829` S	11°39,658` E	9406008,54	129905,74	500m/344º	115
NB3	17.10.06	5°21,567` S	11°39,589` E	9406491,35	129775,47	1000m/344º	115
NB4	17.10.06	5°21,046` S	11°39,445` E	9407451,38	129503,87	2000m/344º	116

Figure 6.1. Map showing the internal distribution of sampling sites (circles) in Nemba North . The sites at Lomba are shown because of the short distance between the two fields. Positioning according to WGS 84 and UTM ED50 zone 33. The field centre is marked with a square.

6.2. Results and discussion

6.2.1 Sediments characteristics

Total organic matter (TOM), and the amount (%) of gravel, sand, pelite, median (Φ) and sorting in the sediment are presented in Table 6.2. Additional information on colour and smell can be found in the sampling journal in the Appendix.

The bottom in the investigated area at Nemba North was dominated by fine grained sediment. The median (Φ) values ranging from 7.06 to 8.86, the amount of pelite varied from 67 to 87 % and the sand content varied from 13 to 33 %.

The content of total organic matter (TOM) varied from 10.4 to 11.8 %.

Table 6.2. Total organic matter and sediment grain size at all sites at Nemba North. For comparison values for the reference sites at Lomba are included. Pelite is particles < 0,063 mm, sand from 0,063 to 2 mm.

Site	Distance/direction	TOM %	Pelite %	Sand %	Gravel %	Median (Φ)	Sorting
NB1	300m/344º	10.83	80	20	0.1	8.25	2.86
NB2	500m/344º	11.76	87	13	0.0	8.86	2.30
NB3	1000m/344º	10.70	74	26	0.2	8.64	3.02
NB4	2000m/344º	10.44	67	33	0.2	7.06	3.30
Reference site							
LB9	4000m/22º	10.57	72	28	0.0	7.41	3.34
LB10	7500m/48º	12.54	97	3	0.0	8.18	1.79
LB19	10000m/271º	11.33	98	2	0.0	7.83	1.98

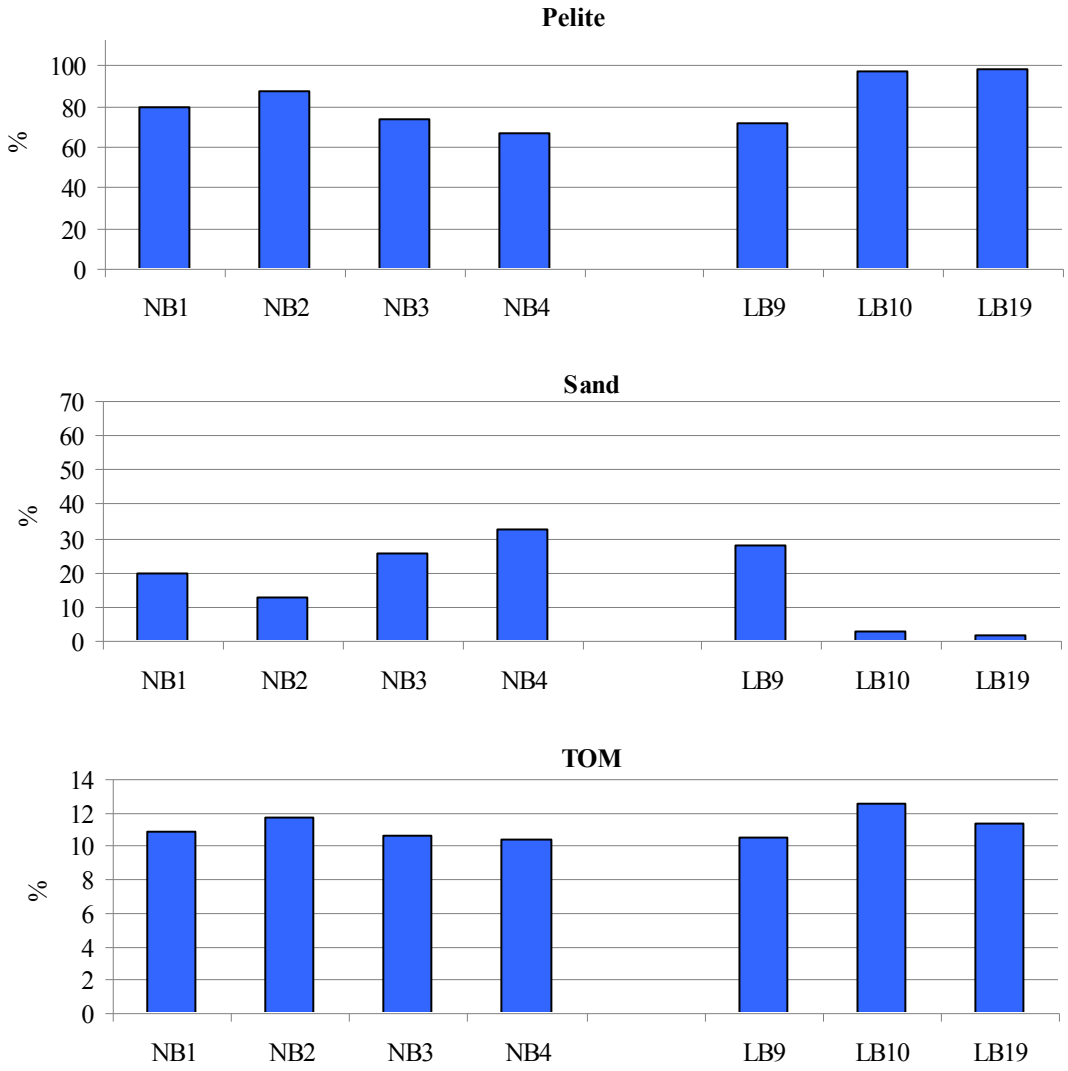


Figure 6.2. Sediment characteristics at Nemba North compared to the reference sites at Lomba.

6.2.2 Chemical compounds

6.2.2.1 LSC

The results of the LSC (limits of significant contamination) calculations of hydrocarbons and metals are presented in Table 6.3. The calculations are based on the reference sites at Lomba.

Table 6.3. Limits of Significant Contamination (LSC) based on data from LB 9, LB 10 and LB 19. All values in mg/kg dry sediment.

	THC	NPD's	PAH_{16}	Ba	Cu	Cr	Zn	Pb	Cd	Hg
$LSC_{LB9,LB10,LB19}$	33	63	42	245	32	130	184	43	0.12	0.069

6.2.2.2 Hydrocarbons

Summarised results of the hydrocarbon analyses, along with the content of selected hydrocarbon compounds in the different layers (0-1, 1-3 and 3-6 cm) are given in Table 6.4 and Table 6.5. The complete data set including replicates is given in the Appendix.

THC was found in the range from 15.7 ± 2.0 mg/kg at NB4 to 210 ± 52 mg/kg at NB1. There was a gradient in THC concentration from 300 m to 2000 m from the platform. Concentration above the LSC occurred at NB1. The concentrations at NB2-NB4 were similar to the reference sites at Lomba.

PAH and NPD was found above LSC at NB1. The site NB2 had concentration similar to the reference site LB10 and LB19.

THC content above LSC was found in all the vertical samples of the sediments at NB1. There was no difference in concentration with depth of the sediment. The NB2 had similar concentration as the reference sites.

Table 6.4. Average content of oil hydrocarbons in sediments from Nemba North. THC values in mg/kg dry sediment, PAH and NPD in ng/g dry sediment. THC, PAH and NPD values above LSC are dark shaded. Only NB1, NB2, LB10 and LB19 were analysed for PAH and NPD.

Site	Distance / direction	THC		PAH_{16}		NPD	
		av.	sd.	av.	sd.	av.	sd.
NB1	300m/344º	210,0	52,0	99.3	41.1	90.8	25.7
NB2	500m/344º	25.9	2.9	35.4	1.4	34.7	10.7
NB3	1000m/344º	23.4	9.7				
NB4	2000m/344º	15.7	2.0				
Reference site							
LB9	4000m/22º	13.3	6.0				
LB10	7500m/48º	23.0	10.4	35.6	4.8	40.5	17.0
LB19	10000m/271º	18.1	4.7	33.0	1.9	28.7	5.7

Table 6.5. The content of total hydrocarbons in vertical sections of sediment from 2 sampling sites at Nemba North. All values in mg/kg dry sediment. Values above LSC are dark shaded.

Stasjon	Layer (cm)	THC
NB 1	0-1	254
	1-3	209
	3-6	215
NB 2	0-1	24.3
	1-3	20.1
	3-6	10.5

6.2.2.3 Metals

Table 6.6 summarises the results of the metal analysis at Nemba North. Concentrations of selected metals in the different layers (0-1, 1-3 and 3-6 cm) of sediment are given in Table 6.7, whereas the complete data set including replicates is given in the Appendix.

Barium was found in a range from 105 ± 77 mg/kg at NB3 to 1874 ± 1054 mg/kg at NB1. Sediments from site NB1, NB2 and NB4 had barium content above LSC. The standard deviation was high, indicating patchy distribution of barium.

All the other metals were under the LSC value. The highest concentrations of lead, cadmium and copper at Nemba North were found at NB1. Chromium and zinc was highest at NB3 (Table 6.6). The concentrations were within the range at the reference sites at Lomba.

Vertical sediment samples (0-1, 1-3 and 3-6 cm) from NB1 and NB2 had barium content above LSC. LB1 had cadmium and mercury content above LSC at 0-1 cm depth interval and mercury also at 1-3 cm interval.

Table 6.6 Content of metals in sediments from Nemba North. All values in mg/kg dry sediment. Values above LSC are dark shaded. N.a = not analysed.

Site	Distance /	Ba		Pb		Cd		Cu		Cr		Zn		Hg	
	Direction (^{O})	av.	sd.	av.	sd.	av.	sd.	av.	sd.	av.	sd.	av.	sd.	av.	sd.
NB1	300m/344º	1874	1054	25.7	5.9	0.12	0.01	14.3	2.8	60.6	4.6	95.3	11.6	0.058	0.012
NB2	500m/344º	422	376	20.1	0.6	0.11	0.01	13.8	0.6	59.1	2.0	87.3	0.8	0.057	0.004
NB3	1000m/344º	105	77	22.3	0.2	0.09	0.01	10.2	0.7	61.9	2.5	98.0	6.4	n.a	
NB4	2000m/344º	676	569	20.7	3.1	0.09	0.01	13.0	2.6	59.7	8.5	88.8	21.3	n.a	
Reference site															
LB9	4000m/22º	49	26	17.9	2.0	0.03	0.01	11.7	1.3	55.1	3.6	83.5	10.8	n.a	
LB10	7500m/48º	125	68	29.2	18.1	0.05	0.02	21.5	13.7	87.1	56.2	122.6	80.2	0.061	0.005
LB19	10000m/271º	151	76	16.8	0.5	0.09	0.02	16.2	0.2	59.0	2.8	78.1	2.5	0.053	0.002

Table 6.7. The content of metals in vertical sections of sediment from 2 sampling sites at Nemba North. All values in mg/kg dry sediment. Values above LSC are dark shaded.

Site	Layer	Ba	Pb	Cd	Cu	Cr	Zn	Hg
NB1	0-1 cm	2930	24.3	0.13	17.4	58.3	95.0	0.072
	1-3 cm	3010	22.5	0.12	15.9	55.4	86.1	0.077
	3-6 cm	1680	20.2	0.11	14.1	56.0	81.1	0.061
NB2	0-1 cm	855	19.4	0.11	13.5	56.8	86.6	0.061
	1-3 cm	1220	21.0	0.10	13.7	57.5	85.2	0.058
	3-6 cm	955	20.2	0.11	13.9	59.8	90.0	0.056

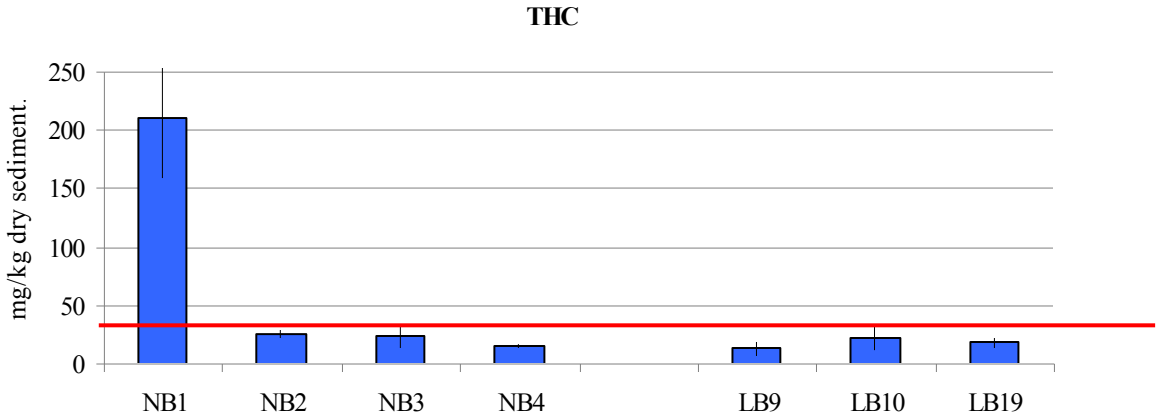


Figure 6.3. Average THC concentrations and standard deviations in sediments from Nemba North, compared to the reference sites at Lomba. Red line is LSC.

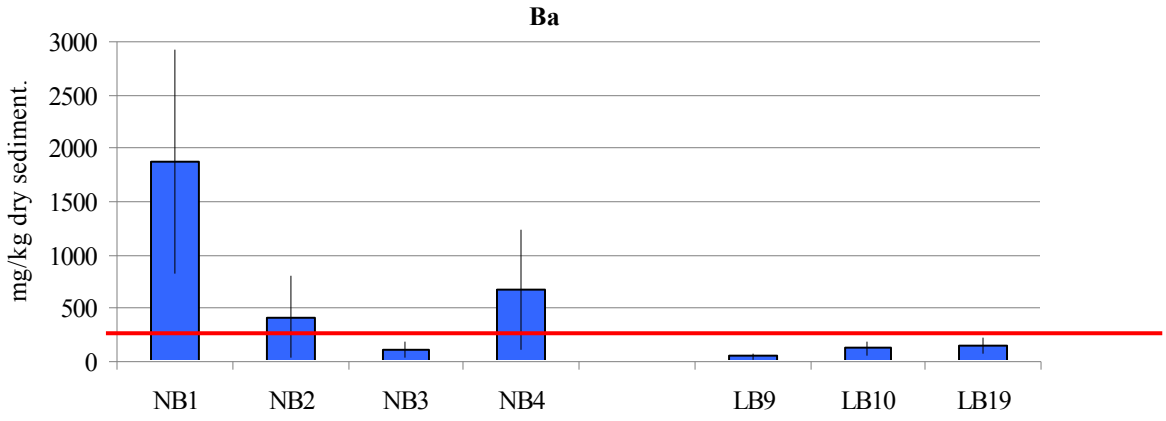


Figure 6.4. Average barium concentrations and standard deviations in sediments from Nemba North, compared to the reference sites at Lomba. Red line is LSC.

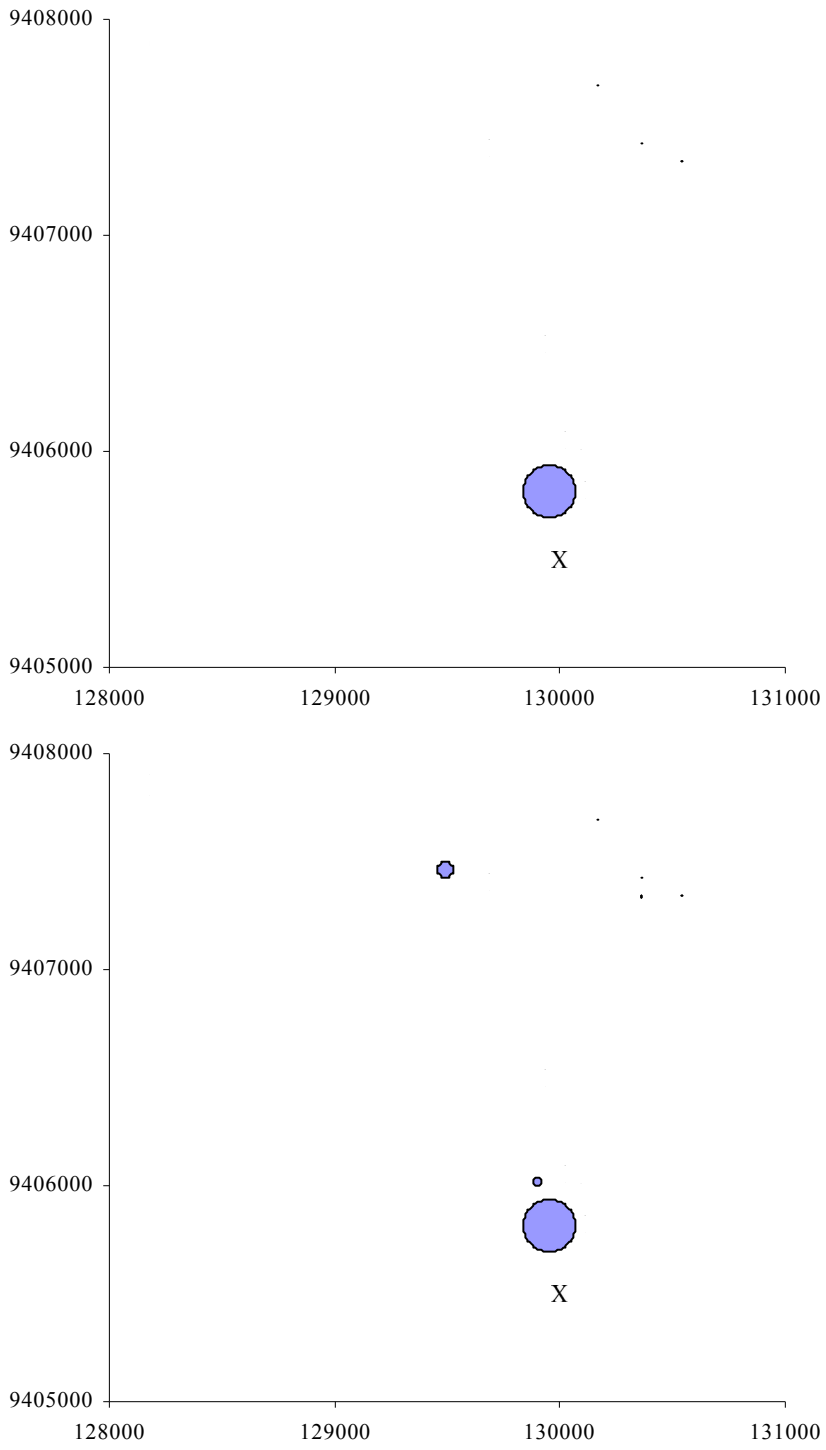


Figure 6.5. Distribution of THC and barium in sediments at the sampling sites from 300 to 2000 m distance from the platform at Nemba North. The size of the circle indicate the amount of THC and Ba. The field centre is marked with an X.

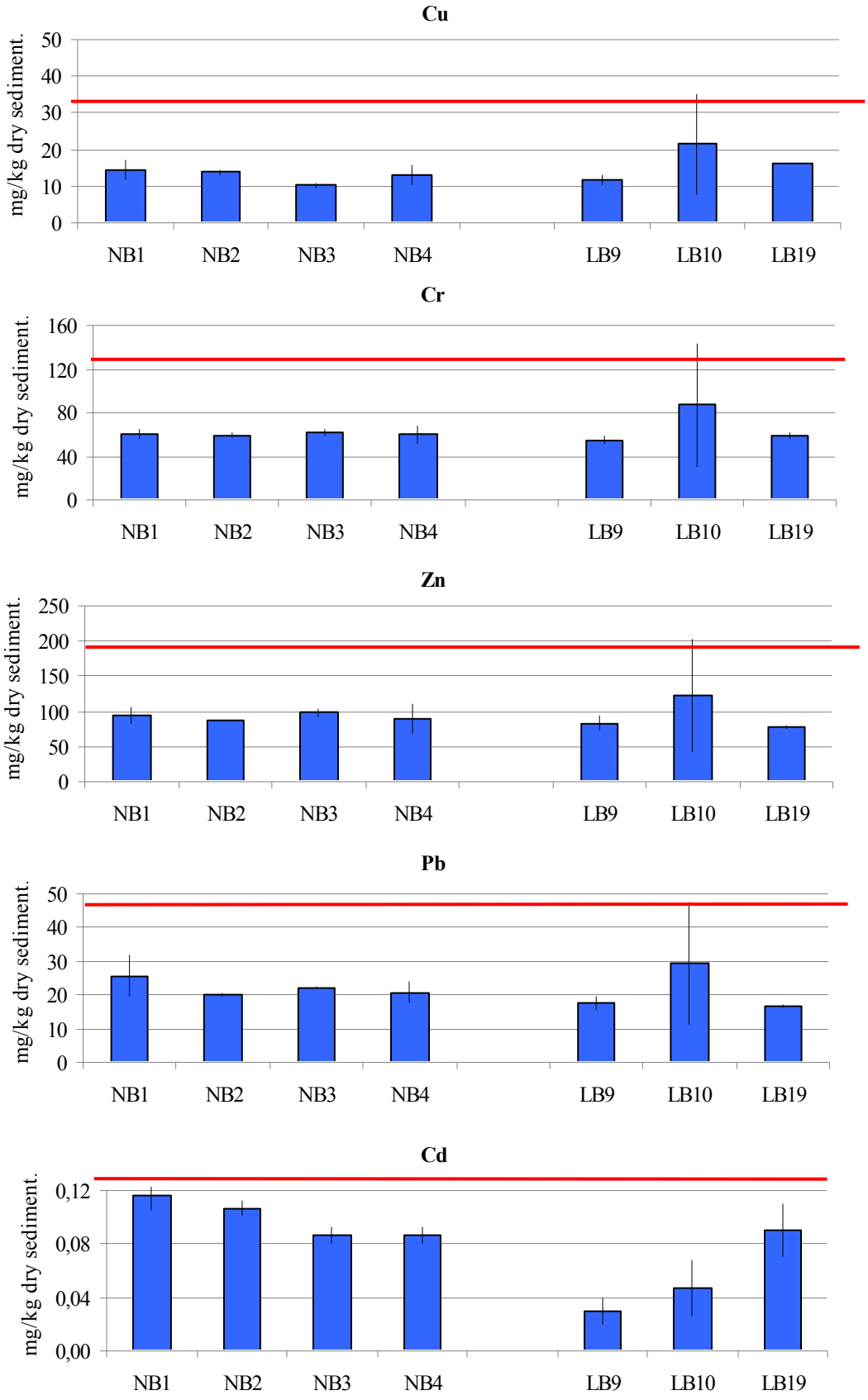


Figure 6.6. Average content and standard deviations of metals in sediment from Nemba North, compared to the refenrence sites at Lomba. Red line is LSC.

Due to higher content of chemical compounds in the sediments from NB1, the site 300 m from the platform clearly separated from the other sites at Nemba North (Figure 6.7A). The reference site LB10 also had higher content of some metals, and separated from the other sites. The sites NB2, NB3 and NB4 had similar content of the selected environmental variables as most of the sites at Lomba and the reference sites LB9 and LB19 (Figure 6.7B).

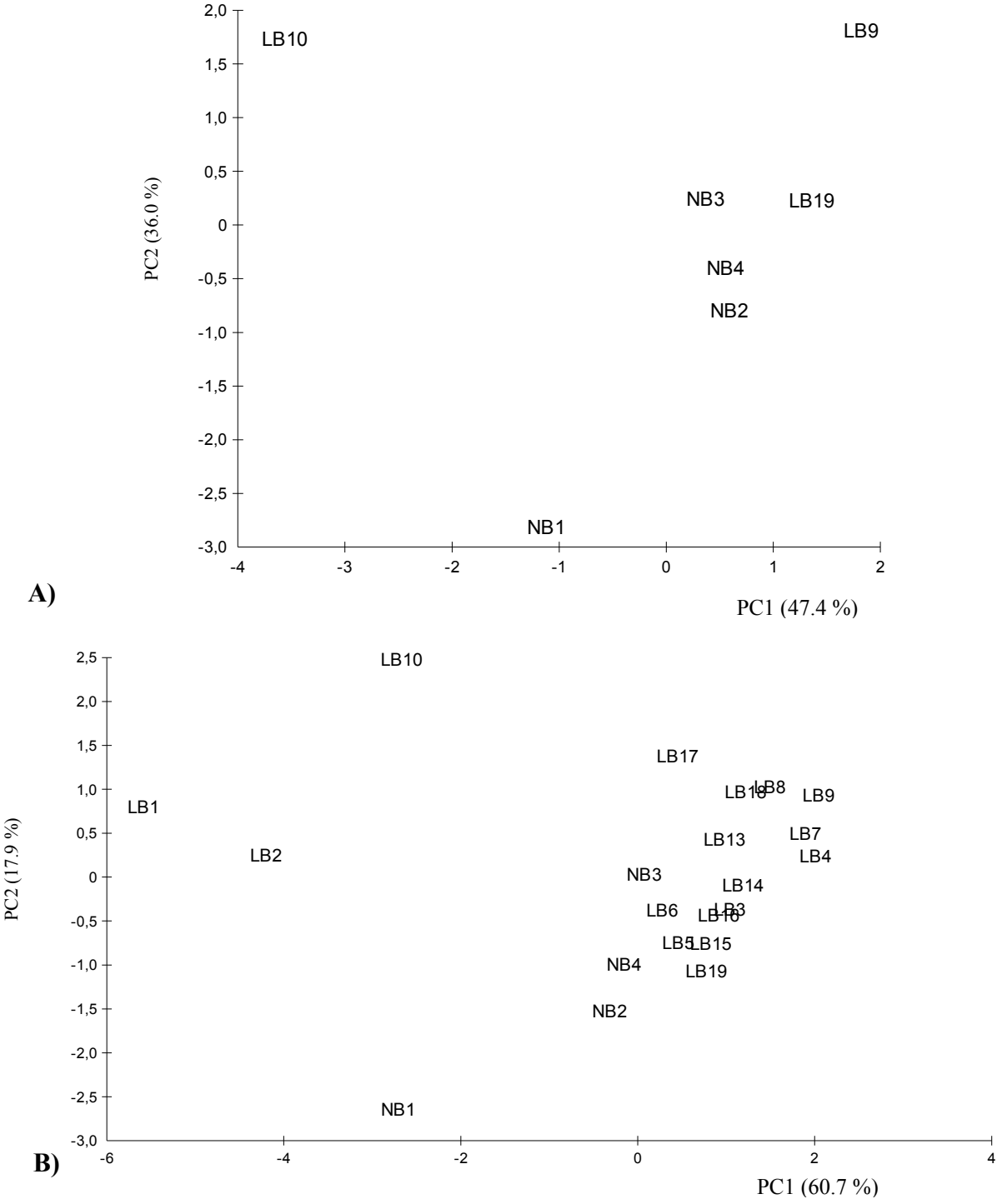


Figure 6.7. 2-D plot from the PCA analysis of environmental variables Cd, Cu, Ba, Zn, Cr, Pb and THC. A) The sites at Nemba North compared to the reference sites at Lomba. Explained variation in the data 83.4 %. B) The sites at Nemba North compared to all the sites at Lomba. Explained variation in the data 78.6 %.

PC1 (65,4 %)

6.2.3 Bottom fauna

A summary of the distribution of individuals and taxa within the main taxonomic groups are given in Table 6.8. In total, 234 individuals within 69 taxa were collected at Nemba North. The fauna was numerically dominated by Annelida with 58 % the individuals and 65 % of the taxa. A complete species list is available in the Appendix.

Table 6.8. Distribution of individuals and taxa within the main taxonomic groups at Nemba North.

Main taxonomic groups	Number of individuals	%	Number of taxa	%
Annelida	136	58	45	65
Arthropoda	44	19	12	17
Mollusca	32	14	9	13
Echidermata	9	4	1	1
Diverse groups	13	6	2	3
Total	234	100	69	100

The species/area curve for NB4 indicates that five replicate samples give an impression of the bottom fauna in the area (Figure 6.8). However, as more area is sampled, more taxa are collected, indicating that not even 5 replicate samples give the full species assemblage of the area.

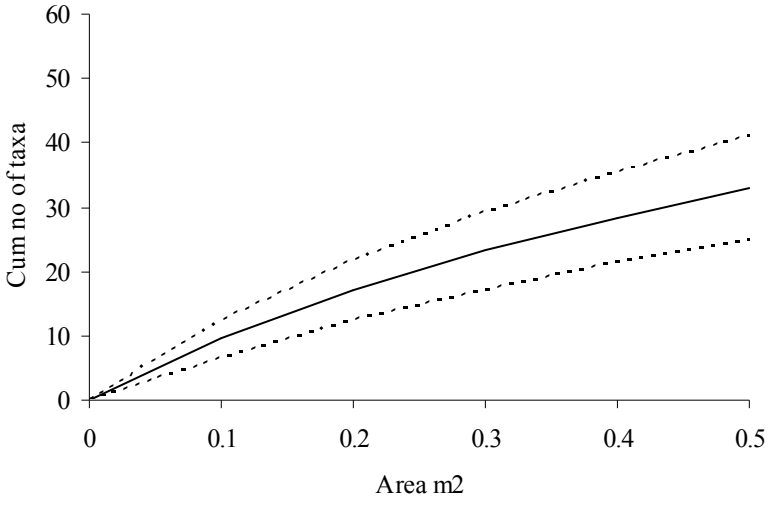


Figure 6.8. Species/area curve for the 2000m-site NB4 at the Nemba North. The solid line is calculated species/area curve, and the dotted line is ± 95 % confidens interval.

The distribution of individuals and taxa are shown in Figure 6.9. Number of individuals and taxa at each site, and the calculated diversity indexes (H' and J) are given in Table 6.9 and Figure 6.10.

The number of individuals at Nemba North varied from 40 (NB2) to 70 (NB1) and the number of taxa varied from 24 (NB2) to 33 (NB4).

The Shannon-Wiener diversity index (H') varied from 3.9 (NB1) to 4.6 (NB4) and the evenness varied from 0.83 (NB1) to 0.92 (NB4). The diversity and evenness indicate good environmental conditions at all sites.

The site NB1 and NB2 close to the platform had lower number of taxa, and the diversity (H`) was lowest at NB1. This may indicate some disturbance of the fauna close to the platform.

Table 6.9. Number of individuals, taxa and selected community indices for each site (0.5 m^2) at the Nemba North.

Site	Distance Direction	Number of individuals	Number of taxa	Evenness J	Diversity H'
NB1	300m/344º	70	27	0,83	3,9
NB2	500m/344º	40	24	0,91	4,2
NB3	1000m/344º	60	32	0,90	4,5
NB4	2000m/344º	64	33	0,92	4,6
Reference site					
LB9	4000m/22º	51	29	0,96	4,7
LB10	7500m/48º	48	27	0,86	4,1
LB19	10000m/271º	194	46	0,77	4,3

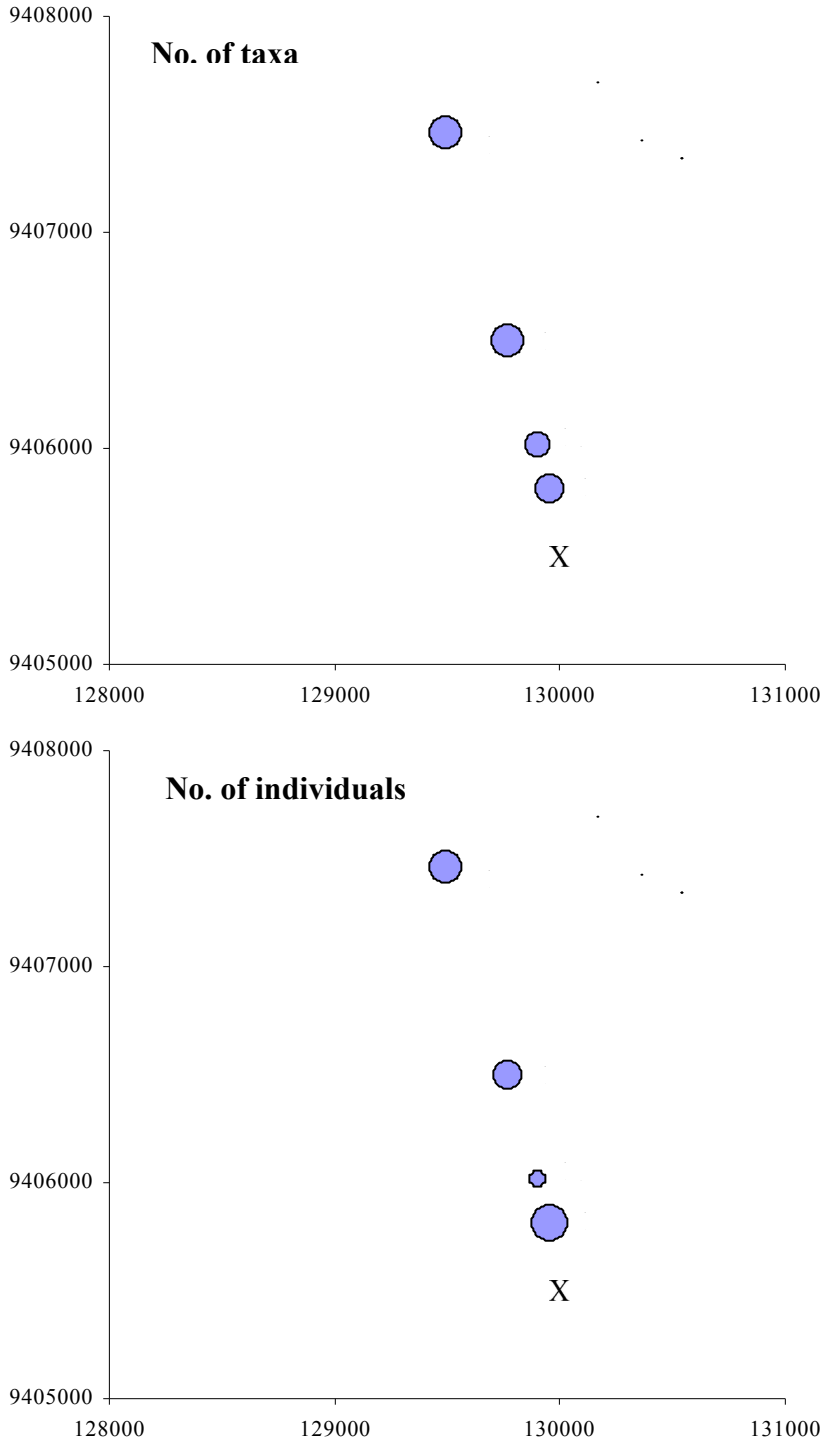


Figure 6.9. Distribution of bottom fauna (individuals and taxa) among the sampling sites out to 2000 m from the platform Nemba North. The size of the circle indicates the relative number of individuals and taxa. The field centre is marked with an X.

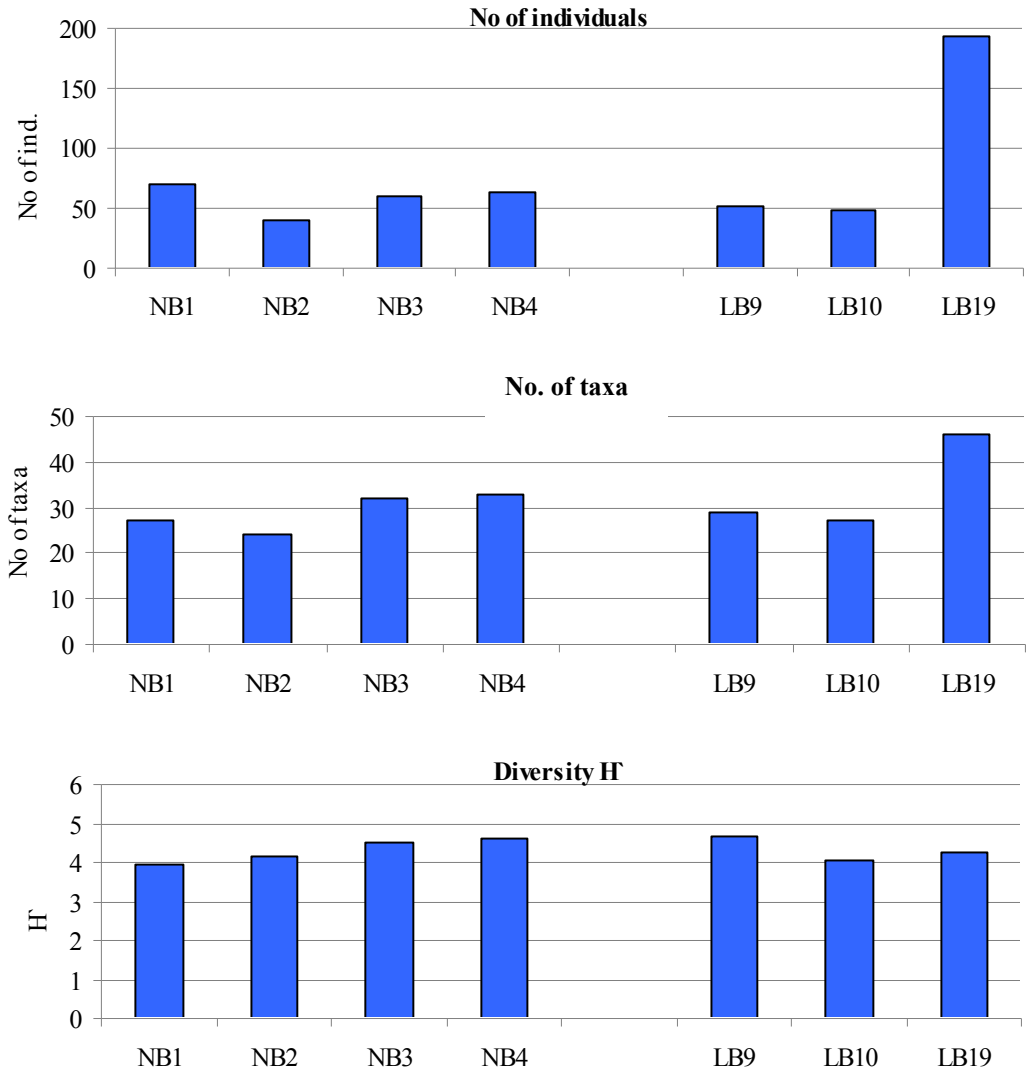


Figure 6.10. Number of individuals, taxa and selected community indices for each site (0.5 m^2) at Nemba North, compared to the reference sites at Lomba.

Distribution of taxa in geometrical classes is presented in Figure 6.11. All the sites at Nemba North had nearly similar distribution, and the curves indicate good environmental condition at all sites.

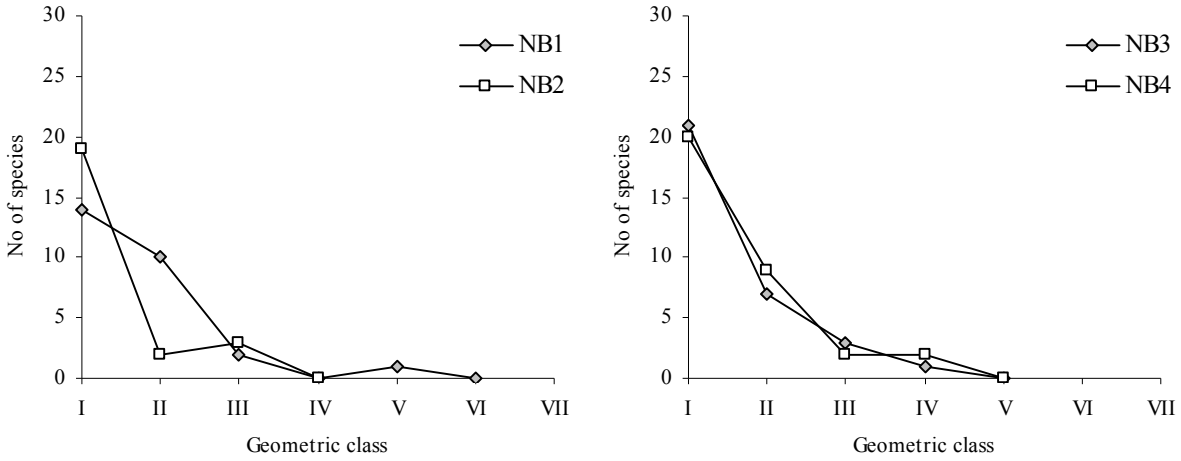


Figure 6.11. Distribution of taxa in geometrical classes for the sites at Nemba North.

Because of few species and individuals, the list of the ten most abundant taxa will include, in most cases, the entire species list. A list of these taxa are listed in Table 6.10, and taxa with only one individuals are excluded. See species list in appendix for all the taxa.

No species was dominant in the sediment. The most abundant taxon was the crustacean group Brachyura indet. with 23 individuals or 33 % of the individuals. The bristle worm *Nephtys* sp. was most abundant at NB2 (7 ind, 17.5 %), bristle worm *Amphinome rostrata* at NB3 (11 ind, 18.3 %) and the snail *Nassarius megalocallus* (Figur 1.12) and bristle worm *Lanice conchilega* at NB4 with 8 individuals and 12.5 %.

Figure 6.12. *Nassarius megalocallus*

Table 6.10. Number of individuals and relative abundance for most abundant taxa at Nemba North. Species with only one individual are excluded.

NB1	No. of ind.	%	Cum %
Brachyura indet. I	23	32,9	32,9
Nemertini indet.	4	5,7	38,6
Natantia indet.I	4	5,7	44,3
Nephtys sp.	3	4,3	48,6
Marphysa sp II	3	4,3	52,9
Leanira cf. hystricis	3	4,3	57,1
Nassarius megalocallus	3	4,3	61,4
Thyasira sp.	3	4,3	65,7
Prionospio sp. II	2	2,9	68,6
Aphelochaeta sp. I	2	2,9	71,4
Polynoidae indet.	2	2,9	74,3
Natantia indet.	2	2,9	77,1
Macrura sp. I	2	2,9	80,0

NB2	No. of ind.	%	Cum %
Nephtys sp.	7	17,5	17,5
Bucciniacea indet.	5	12,5	30,0
Amphiuridae indet. I	4	10,0	40,0
Prionospio sp. I	3	7,5	47,5
Thyasira sp.	2	5,0	52,5

NB3	No. of ind.	%	Cum %
Amphinome rostrata	11	18,3	18,3
Nephtys sp.	5	8,3	26,7
Nassarius megalocallus	5	8,3	35,0
Nemertini indet.	4	6,7	41,7
Polynoidae indet.	2	3,3	45,0
Leanira cf. hystricis	2	3,3	48,3
Natantia indet.	2	3,3	51,7
Lanice conchilega	2	3,3	55,0
Terebellides stroemi	2	3,3	58,3
Notomastus sp. I	2	3,3	61,7
Upogebia sp. I	2	3,3	65,0

NB4	No. of ind.	%	Cum %
Nassarius megalocallus	8	12,5	12,5
Lanice conchilega	8	12,5	25,0
Nephtys sp.	4	6,3	31,3
Amphiuridae indet. I	4	6,3	37,5
Terebellides stroemi	3	4,7	42,2
Prionospio sp. II	3	4,7	46,9
Amphinome rostrata	2	3,1	50,0
Nemertini indet.	2	3,1	53,1
Ampharete cf. acutifans	2	3,1	56,3
Eunice sp. I	2	3,1	59,4
Heterospionidae indet I	2	3,1	62,5
Polynoidae indet. VI	2	3,1	65,6
Ceratocephale sp II	2	3,1	68,8

The results of the multivariate analyses are given in the dendrogramme (Figure 6.13) and the MDS plott (Figure 6.14).

In the cluster analyses, the Nemba North sites NB3 and NB4 are linked together at 49 % similarity. Site NB1 join the group at 38 % similarity and finally NB2 join the group at 36 % similarity. Compared to Lomba sites, the Nemba North sites are most similar to LB17 and LB18 on the westerly transect 1000 m and 2000 m from Lomba.

The results of the MDS analysis support the findings in the cluster analysis. All of the Nemba North sites are close to each other in the MDS-plot, and indicating that the sites are more similar to each other than to the sites at Lomba. The similarity indicates no faunal disturbance at Nemba North.

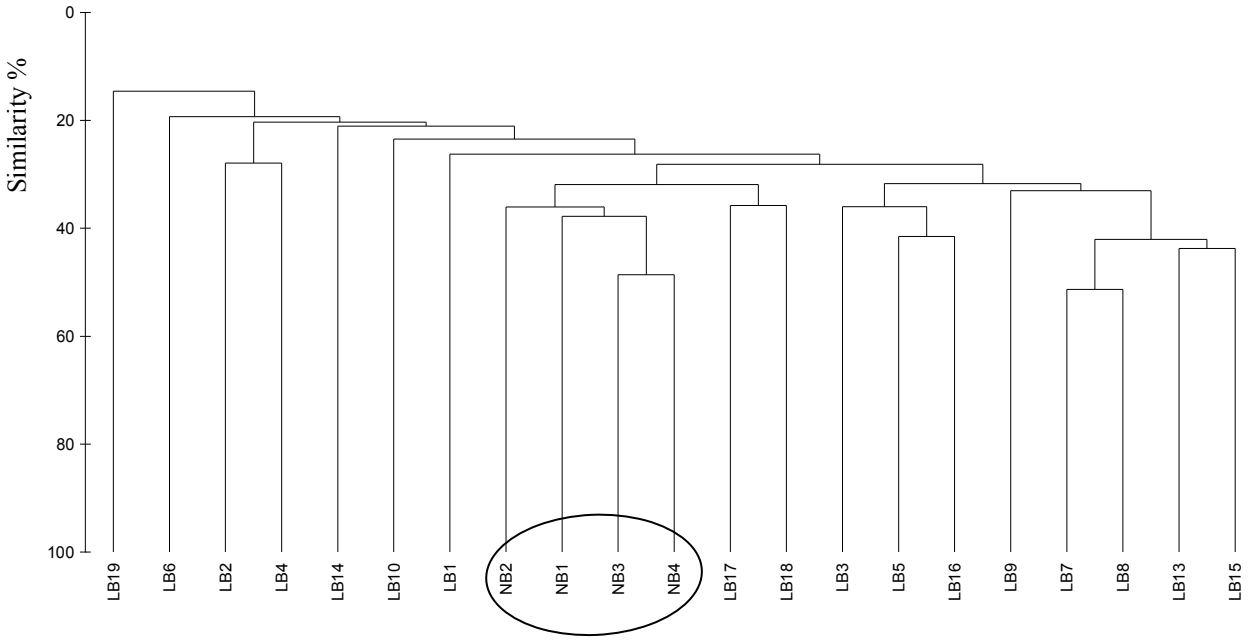


Figure 6.13. Dendrogram showing the similarity between fauna from sampling sites at Nemba North, compared to the Lomba field.

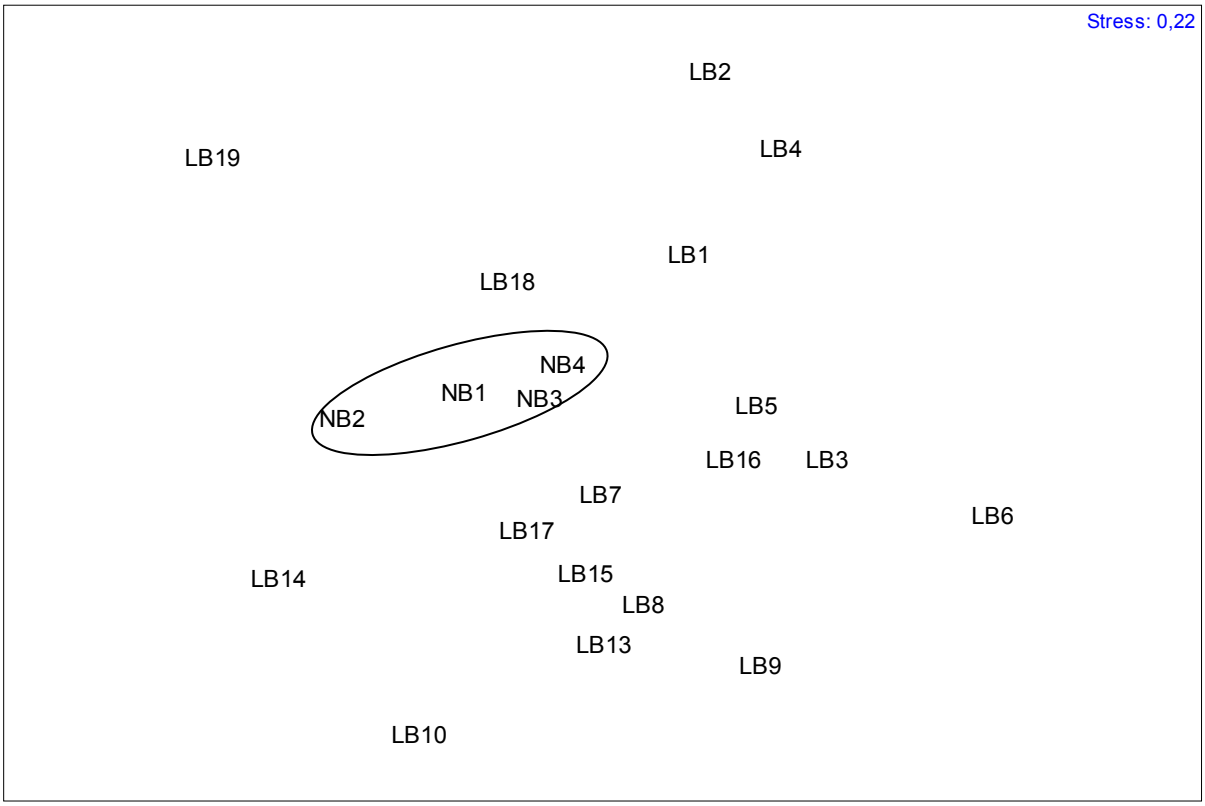


Figure 6.14. A 2-dimetional plott of the MDS analyses of the fauna data from Nemba North, compared to the sites at Lomba. Stress = 0,22.

Linking of biotic and environmental variables by BIOENV revealed there was a good correlation between the water depth and the biota at Nemba North and the reference sites LB9, LB10 and LB19 (Table 6.11). Zinc was the single chemical parameter best correlated to the biota at $\rho_w = 0.230$, but the correlation was weak. Overall best correlated was depth, Cd, pelite and Pb at $\rho_w = 0.828$. Natural variables as depth and sediment characteristics are important for the fauna composition.

Table 6.11. Combinations of the 10 environmental variables, taken *k* at a time, yielding the best matches of biotic and abiotic similarity matrices for each *k*, as measured by weighted Spearman rank correlation ρ_w. Bold type indicates overall optimum.

Number of variables (*k*)	Correlation coefficient (ρ_w)	Environmental variables									
1	0.822	Depth									
1	0.230	Zn									
1	0.223	Pb									
1	0.210	Pelite									
1	0.203	Cd									
1	0.177	TOM									
1	0.171	Cr									
1	0.072	Cu									
1	-0.365	Ba									
1	-0.385	THC									
2	0.737	Depth	Cd								
3	0.815	Depth	Cd	Pelite							
4	**0.828**	**Depth**	**Cd**	**Pelite**	**Pb**						
5	0.772	Depth	Cd	Pelite	Pb	Zn					
6	0.737	Depth	Cd	Pelite	Pb	Zn	Cr				
7	0.695	Depth	Cd	Pelite	Pb	Zn	Cr	TOM			
8	0.670	Depth	Cd	Pelite	Pb	Zn	Cr	TOM	Cu		
9	0.563	Depth	Cd	Pelite	Pb	Zn	Cr	TOM	Cu	Ba	
10	0.454	Depth	Cd	Pelite	Pb	Zn	Cr	TOM	Cu	Ba	THC

1.2.4 Estimation of influenced area

The extension of contamination along sampling transect are given in Figure 6.15. To calculate the area as a asymmetrical ellipse, we need at least two transects. Because of only one transect at Nemba North, the area are not calculated.

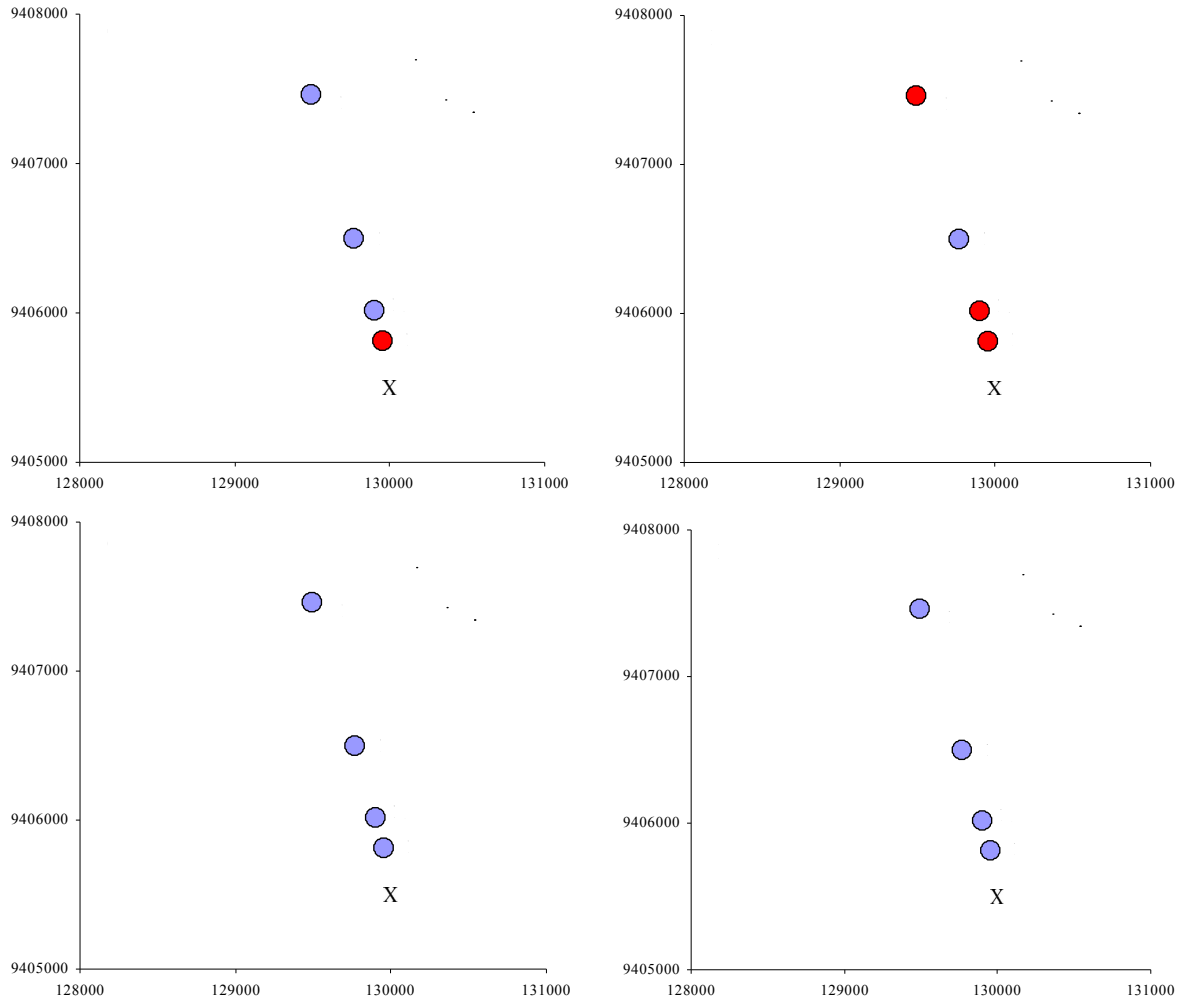


Figure 6.15. Faunal disturbance and chemical contamination of the sediments at Nemba North is marked with a red circle. Uncontaminated sites and sites with no faunal disturbance are marked with small blue circles. The field centre is marked with an X.

6.3 Summary and conclusions

Four sited were investigated at Nemba North. The samples were taken with increasing distance to the platform in one transect. The sediment was mostly fine grained (pelite) with even distribution of TOM. Some black spots were detected in the sediment from NB1 and NB2, which are 300 and 500 m north-west of the platform. This support the findings that NB1 had very high amount of THC and high concentration of PAH and NPD in the sediment. The concentration of barium was very high at 300 m distance from the platform, but also 500 m and 2000 m from the platform had barium content above LSC. No contamination was detected for the other metals. There was generally few individual and taxa at Nemba North, but the diversity was high. No faunal disturbance was detected. There is a correlation between the fauna and the environmental variable depth, but only a weak correlation with chemical variables.

7 HYDROCARBON LEVELS IN SEDIMENT (ALL FIELDS)

By Stephan Boitsov

7.1 Introduction

Petroleum hydrocarbons include polycyclic aromatic hydrocarbons (PAHs), a large group of compounds of varying molecular weights. Lighter PAHs are more water-soluble and volatile than the heavier compounds, the latter being more persistent in the marine environment. The large part of PAHs entering the marine environment from outside ends up in sediments, where it will often be adsorbed to larger organic particles and buried together with the rest of sediment material.

PAHs are highly lipophilic and can be taken up by biota. They have been shown to be toxic to many marine species (Pickering, 2000). Benzo[a]pyrene is the best-studied PAH and one of the most potent carcinogens among them (Collins et al., 1991).

PAHs may have petrogenic, pyrogenic and biogenic origin, being formed correspondingly as part of fossils, as a result of combustion, or in biological processes. Anthropogenic sources of PAHs include various industrial activities as well as domestic fires etc.

It is often difficult to determine the origin of PAHs, since PAHs from different sources may be present in the same place. Various techniques exist to solve the problem. The relative amounts of certain PAH compounds may serve to distinguish between different types of origin of the local PAH presence. Thus, for example, a predominance of alkylated homologues of naphthalene, phenanthrene and dibenzothiophene over their parent compounds indicates a petrogenic origin of PAHs, whereas low phenanthrene/anthracene ratios (below 10) signify a pyrogenic origin of the compounds (see, for example, Budzinski et al., 1997). Presence of certain PAHs may also indicate the source, such as, for example, biogenic predecessors in case of perylene (Venkatesan, 1988).

7.2 Results and discussion

7.2.1. THC.

The results of THC measurements are summarized in Figure 7.1 as box-and-whiskers plot. The boundary of the box closest to zero indicates the 25th percentile, a line within the box marks the median, and the boundary of the box farthest from zero indicates the 75th percentile. Dotted line indicates mean values. Whiskers indicate 10^{th} and 90^{th} percentile, while dots indicate all outliers. Data on the surface samples, including all parallels, has been included in the plot.

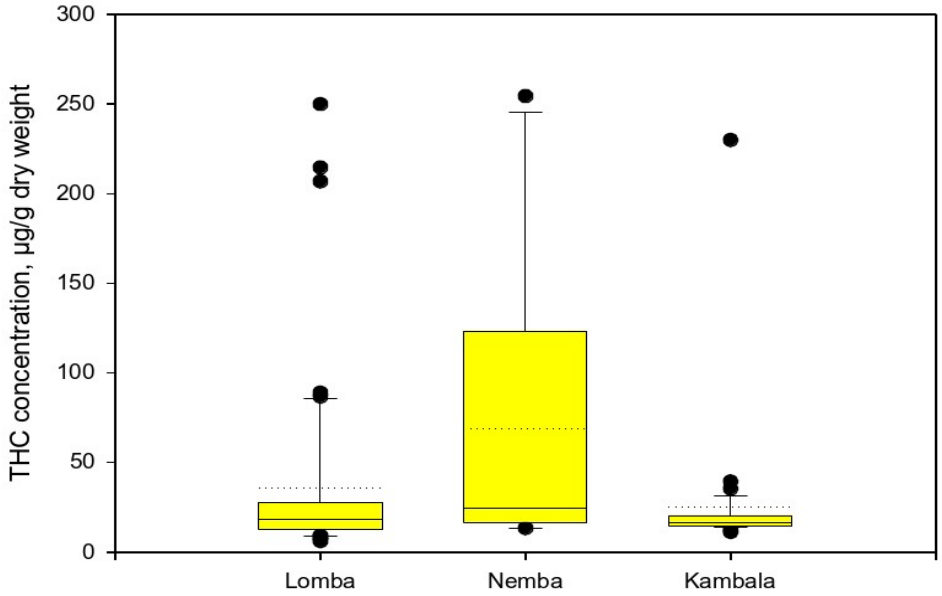


Figure 7.1. The ranges of THC concentrations (µg/g dry weight) in surface layer (0-1 cm) sediment samples from the 3 studied areas.

There is a strong variation in data, median values being relatively low while mean values being elevated in case of particularly Nemba, where the amount of data points is lower than in the other two areas. In all areas, there are important outliers signifying strongly elevated THC concentrations for a small number of samples (only 1 for Kambala and a few for two other areas). Since these samples differ strongly from parallel samples taken at the same locations, it is reasonable to suggest point contamination with oil in these areas.

7.2.1. PAH

The main results of PAH analyses are given in Table 7.1 as sums of concentrations of the PAH compounds measured in the samples, together with some additional data.

Table 7.1. PAH concentrations in sediment samples, ng/g dry weight. PHE/ANT denotes ratio of concentrations of phenanthrene and anthracene in the surface layer samples; BAP denotes the concentration of benzo[a]pyrene in the surface layer samples in ng/g dry weight; PER denotes the concentration of perylene in the surface layer samples in ng/g dry weight.

	Sum PAH, ng/g *(SD, ng/g)*						
Sample	0-1 cm*	*(0-1 cm)*	1-3 cm	3-6 cm	PHE/ANT*	BAP*	PER*
NB1	250	*(86)*	290	275	2,2	1,7	60
NB2	126	*(17)*	112	100	2,7	0,8	56
LB1	209	*(53)*	123	121	1,9	0,9	57
LB2	202	*(54)*	193	184	2,4	0,9	67
LB10	137	*(31)*			3,4	1,0	61
LB19	120	*(12)*			3,5	0,6	60
KB1	197	*(27)*	177	178	3,4	1,3	104
KB2	189	*(8,6)*	194	175	4,1	0,9	113
KB18	172	*(8,8)*			3,6	1,1	90

* - an average of 3 samplings.

Average sums of concentrations in surface sediment layers are relatively low, comparable to what was recently found in non-contaminated areas of the Barents Sea (Boitsov et al., 2007). Concentrations of the carcinogenicity marker, benzo[a]pyrene, are low at all locations, not exceeding 1,7 ng/g dry weight. However, the levels decrease in deeper sediments at 5 out of 6 locations where the sediments from below the surface layer were analyzed. This indicates a recent contamination.

The origin of hydrocarbons may be deduced from several parameters. Rather low PHE/ANT ratios (around 2 to 4) at all locations strongly suggest a pyrogenic origin of PAHs; this is further confirmed by relatively high levels of pyrene (data not shown), a PAH of pyrogenic origin, being one of the dominant compounds in most of the samples. At the same time, the prevalence of alkylated naphthalenes, phenantrenes and dibenzothiophenes over their parent compounds, though weak, but apparent at all locations, indicates a petrogenic origin of PAHs. The mixed types of origin of hydrocarbons may suggest local oil exploration activities as one possible explanation, with flaring being the source of pyrogenic hydrocarbons while oil leaks and discharges of produced water etc. may account for the petrogenic hydrocarbons.

Another PAH compound dominating in many of the samples is perylene, which is formed through biological processes or in early diagenesis. Levels are relatively high in all samples but are highest in Kambala, lying significantly over the average. This may be a manifestation of the Congo river influence, the influx of sediment matter from the river being an important contributor to the observed hydrocarbon levels.

8 **REFERENCES**

Anon 2003. Requirements for Environmental Monitoring of the Petroleum Activities on the Angolan Continental Shelf. Second Draft May 2003.

Blott SJ, Pye K. 2001. Gradistat: a grain size distribution and statistics package for the analysis of unconsolidated sediments. *Earth Surface Processes and Landforms* 26, 1237-1248.

Boitsov S., Klungsøyr J., Jensen H. "Concentrations of petroleum hydrocarbons in sediments and seawater from the Barents and Norwegian Seas 2003–2005". Fisken og havet, *IMR report nr.* 3, 2007. Pp. 46.

Bray JR, Curtis JT. 1957. An ordination of the upland forest communities of Southern Wisconsin. - *Ecological Monographs* 27:325-349.

Buchanan JB. 1984. Sediment analysis. Pp. 41-65 in: N.A. Holme & A.D. McIntyre (eds). *Methods for the study of marine benthos*. Blackwell Scientific Publications, Oxford.

Budzinski H., Jones I., Bellocq J., Piérard C. and Garrigues P. 1997. Evaluation of sediment contamination by polycyclic aromatic hydrocarbons in the Gironde estuary. *Mar. Chem.*, 58 (1-2), 85-97.

Collins J.F., Brown J.P., Dawson S.V. and Marty M.A. 1991. Risk assessment for benzo[a]pyrene. *Regul. Toxicol. Pharmacol*. 13 (2): 170-184.

Colwell RK, Mao CX Chang J. 2004. Interpolating, extrapolationg and comparing incidence-based species accumulation curves. *Ecology* 85 (110): 2717-2727.

Field, JG., KR. Clarke, & R.M. Warwick 1982. A practical strategy for analysing multispecies distribution patterns. - *Marine Ecology Progress Series* 8:37-52.

Folk RL, Ward WC. 1957. Brazos river bar: A study in the significance of grain size parameters. *Journal of sedimentary petrology* 27: 3-26.

Gray JS, Mirza FB. 1979. A possible method for the detection of pollution-induced disturbance on marine benthic communities. - *Marine Pollution Bulletin* 10:142-146.

OSPAR 2006. OSPAR convention for the protection of the marine environment of the north-east atlantic. Harmonised reporting format to compile environmental monitoring data and information related to offshore oil and gas activities. Reference number 2006-07.

Pearson TH, Gray JS, Johannessen PJ. 1983. Objective selection of sensitive species indicative of pollution-induced change in bentic communities. 2. Data analyses. - *Marine Ecology Progress Series* 12:237-255.

Petroleumstilsynet (Ptil), Statens forurensningstilsyn (SFT), Sosial- og helsedirektoratet (SHdir), 2006. Forskrift om utføring av aktiviteter i petroleumsvirksomheten (Aktivitetsforskriften). Vedlegg 1: Krav til miljøovervåking av petroleumsvirksomheten på norsk kontinentalsokkel 2: Sedimentovervåkning.

Pickering R.W. 2000. Toxicity of polyaromatic hydrocarbons other than benzo[a]pyrene: a review. *J. Toxicol. Cutaneous Ocular Toxicol.*, 19 (1): 55-67.

Pielou EC. 1966. The measurement of species diversity in different types of biological collections. - *Journal of Theoretical Biology* 13:131-144.

Shannon CE, Weaver W. 1949. *The mathematical theory of communication.* - University of Illinois Press, Urbana. 117 s.

Venkatesan M.I. 1988. Occurrence and possible sources of perylene in marine sediments-a review. *Mar. Chem.*, 25 (1), 1-27.

9 LIST OF ABBREVIATIONS

Ba	Barium
Cd	Cadmium
Cu	Copper
DP	Dynamic Positioning
ES_{100}	Expected number of species in a 100 specimens sample
Fe	Iron
GC/FID	Gas chromatography with flame ionization detector
GC/MS	Gas chromatography with mass selective detector
GPS	Global Positioning System
H’	Shannon-Wiener diversity
Hg	Mercury
IMR	Institute of Marine Research
J	Pielou’s measure of evenness
MDS	Multidimensional scaling
NPD	Naphthalene, Phenathrene/Anthracene, Dibenzothiophene and their C_1-C_3 homologues
NS	Norwegian Standard
PAH	Polycyclic Aromatic Hydrocarbons, including NPDs and 3-6 ring aromatics
Pb	Lead
SAM	Section of applied environmental research
THC	Total Hydrocarbon Content
TOM	Total Organic Material
UNIFOB	University Science of Bergen
Zn	Zinc

10 APPENDIX

By Lia Neto Sausa

10.1 Environmental Legislation

10.1.1 International Agreements

Angola is signatory part of the following:

International Convention on Maritime Rescue (SAR 79), 1972.

The 1979 Convention, adapted by the Hamburg Conference referred to rescue from vessel, crew and load under coordination of SAR Organization, 23rd November 2001 (Resolution Nº 34/01)

International Convention on Cooperation and Hydrocarbon Pollution Prevention (OPRC 90), 1990

The two participant of this convention should establish joint cooperation between neighbour's countries in the case of marine pollution, 9th November 2001 (33/01 Resolution)

International Convention on High Sea Intervention in the case of Hydrocarbon Pollution accident, 1990

This convention state that the coastal countries should intervene on high sea accident resulting in pollution to prevent or minimise possible damage in the country and in the coastal areas, 5th October 2001 (29-A Resolution)

International Convention on Creation of International Fund Compensation for damage resulting by Hydrocarbon Pollution (Fund 92), 1999

This convention offer a legal regimen of international functionality compensation fund for offshore spill victim by hydrocarbon pollution at sea all over the world, 26th October 2001 (30/01 Resolution)

United Nations Convention on Biodiversity, 4th July 1997.

Vienna Convention and Montreal Protocol on Ozone Layer, 28th August 1998.

International Convention of 1993on Pollution Prevention by ships and 1978 Protocol of United Nation (MARPOL 73/78)

This convention states the environmental standard of operational research activities and production at sea, 21st December 2002.

International Convention of 1992 on Civil Responsibility caused by damage of hydrocarbon Marine Pollution.

This convention offer legal regimen for damage compensation in case of hydrocarbon marine pollution at sea, 26th October 2001

United Nation Convention on Sea Rights (UNCLOS), 1982

This article 60º, 70º and 90º states a legal regimen of activities at sea related to environmental control, scientific marine research, commercial and economic activities, technologies transfer, 5th December 1990.

International Convention on civil responsibility and compensation of damage in case of pollution by harmful and potentially dangerous substance (HNS, 1996)

This convention offers a legal exhaustive regimen and damage compensation caused by harmful and pollution substance potentially dangerous at sea. This convention include all of the International Maritime Organization (LDC, 1979; OPRC, 1990)

Agenda 21 of United Nations Conference on Environmental and Development (UNCED), 1992.

This program establish the production and research activities comprise by statement include in the chapter 17.30 witch emphasize the needs to enforce the marine environmental degradation control relatively to the activities at sea. The coastal states should assess the existing control measures to prevent oil and gas pollution from drilling at sea, 2002

Contingency plan and Response in case of Emergency

This plan describes the planned response strategy for low, medium and high proportion spill scenery. According to article 14º (7) the Agreement Model, in case of emergency, the responsible is authorised to take all measures considered necessary for the protection of human being and joint interest, and in addition the should inform readily all the decision taken to Sonangol

10.1.2 Regional Legislation

SADC Environmental Policy and Mines Regulation Structure

The main objective is to establish cooperation, coordination and regional integration on commerce, transport, communication, energy and environmental aspects in the Southern Africa region.

10.1.3 Angola Legislation

Constitutional Law of Angola Republic, 1992

The Constitutional Law of Angola Republic was signed in 1992. The Article 12º number 2 and Article 24º numbers 1, 2 and 3 define the concepts and basic principles of protection, preservation of environment, promotion of life quality and rational uses of natural resources, and the right to live in a healthy environment.

Article 12º

All the existing resources in land and under land, territorial and in inland waters, in the continental shelf and Exclusive Economic Zone are Angolan Government property, which determine the uses, development and exploration.

The Government promote the protection and conservation of natural resources, exploration and the best uses for the population.

Land is Government property that can be transferred to individual or group of individual taking into consideration rational and integrated utilization based on the Constitution and Law.

Article 24º

All citizens are the right to live in a healthy environment and the obligation to protect and preserve the environment.

The government adopt the necessary measures to protect the environment, fauna and flora in all country, the maintenance of ecological balance, the correct localization of economic activities and the rational exploration and utilization of the natural resource to a sustainable development and respecting the future generation rights.

The law punish actions that endanger the environment preservation, namely forbidding toxic residue importation.
Environmental Framework Act, Nº 5/98 of 19th June – (Ministry of urbanism and Environment)
The article 24º number 1,2 and 3 the article 12º number 2 of Constitutional law of the Angola Republic defines the concepts and basic principles of environment protection, preservation and conservation, promotion and quality of living resources and rational utilization.

Draft of Environment Management Program

The chapter II, article 6º states that the government has the responsibility to define and implement the Environmental Management Program and to establish the following:

Responsibility to all Government members involved on environmental issues namely utilization of natural resources, production and emission of pollutants influencing the socio-economic conditions of the communities;

Responsibility of using the natural resources to all None-Governmental Agencies taking into consideration of the environmental balance and the socio-economic conditions of the communities.

Responsibility to the citizens by the incorrect use of natural resources, pollutants emissions and damage to life quality.

Environmental Impact Assessment Nº 51/04 of 23rd July (EIA)
The objective of this Decree is to establish the standard and procedures related to EIA of public and private projects. The articles 6º and 7º describe the steps, content of study as well as the technical activities.

The content of study should include the following information:
Project description
Environmental Impact Assessment Report
All technologic and localization alternatives in case of the impossibility to implement the project.
Systematic Identification and Assessment of Environmental Impact in the implementation phase of the project.
Definition of geographic area boundaries directly or indirectly affected by the project.
Take into consideration plans and programs in the Government planned areas to avoid overlapping.
Other pertinent elements or characteristics.

Territorial and Urbanism Regulation Nº 3/04 of 25th June
This Decree regulates system of norms, principles and instruments of the territorial plans. The chapter I define the objective of the decree and in the article 4º a) the integrated and rational valorisation of the land occupation and favourable condition for the development of economic, social and cultural activities protecting the territorial defence, internal security and ecological balance of the historic and cultural assets and b) recuperation and reconvention of damage areas or illegal occupation.

Sector Legislation
The Coastal Regulation Plan Decree Nº 4/01 includes coastal and inland waters, beds and edges. The plans include biophysics and coastal resources aspects, conservation of environmental, landscape values and protection of local communities.
This decree defines maritime beaches such as one subunit of coastal zone constituted by the bed and edge of the seawater and was classified as follows:
Urban beach of intensive use
None urban beach of intensive use
Equipped beach of conditioned use
Equipped beach of none conditioned use
Beach of restrict use
Beach of interdict use

Decree of Oil Activities and Environmental Protection Nº 39/00 of 10th December 2000. - (Ministry of Petroleum)

This decree regulates the environmental protection in the research and production activities and prevention against pollution by oil spill, operational discharge of hydrocarbon and other products during oil activities (from the oil companies) including protection of waters, land and air.

This decree establishes rules and procedures of management, removal of deposits and wastes resulting from oil activity to ensure prevention or minimize damage to human health in environment.

Decree Nº21/92 of August on Continental Waters, Territorial Sea and Exclusive Economic Zone of Angola - (Ministry of Fishery)

This regulation is managed by the Ministry of Fishery, establish and define Continental Waters and Territorial Sea of 12 nautical miles from the straight base line, contiguous zone until 24 nautical miles from the base line and Economic Exclusive Zone until 200 nautical miles.

Regulation of Mine and Geologic activities Nº 1/92 of 17th January- (Ministry of Geology and Mine)

The article 12º establishes that all the activities with negative impact on the environment should be licensed and foresees land and hydro resources protection and recuperation of affected flora and fauna.

Fisheries Law Nº 20/92 of 14th August – (Ministry of Fisheries)

The article 66º regulate the fisheries activities in Angola, in the continental and marine waters and consider the fisheries resources as a public belonging, the conservation measures of marine resources and bun fishery activities using explosives, fire guns and toxics substances.

Biological Resources Law - (Ministry of Fisheries**)**

The chapter II of this law establish protection measures for Biological Resources and Marine environment. The article 3 establishes principle and rules to protect biological resources, coastal and marine ecosystem. The Article 79, according to the objective of marine protected areas, includes species, ecosystem and habitat preservation and establishes the marine protected areas. The article 80 defines 5 types of protected areas including natural reserves waters, aquatic national parks, aquatic national reserves, partial reserves and natural monuments. The article 263 defines activities with negative impact on the marine environment and biological resources, crimes and penalties.

Sanitary Regulation - (Ministry of Health)

The Law Nº 5/87 of September approve the Republic of Angola sanitary regulation, the articles 102º to 107º define the prevention and environmental pollution control standard in the urban areas.

Decree Nº 495/73 of 6th October

The article 1º bun dumping of wastes, namely toxic residues resulting from oil activities or others sources, in the adjacent zone and territorial waters as well as in the harbour, docks and river mouths, beaches and others areas maritime authorities jurisdiction, unless with special license.

Contingence plan and response in case of emergency - (Ministry of Petroleum)

This plan describes the strategies of planned response for small, medium and high proportion spill scenario. According to Article 14º (7) of the Agreement Model, in case of emergency, the responsible has the authority to take all the necessary measures to protect human being people belong. In these situations the responsible should inform readily to Sonangol.

Law Nº8/98 September 11; National Assembly: Lei Quadro da Indústria

10.2 Appendix Data

Appendix Table 1. Analyse-report from the laboratory at IMR. The analyse-report are stored at UNIFOB AS.

HAVFORSKNINGSINSTITUTTET
KJEMILABORATORIET I BERGEN

NORSK AKKREDITERING
TEST 166

ANALYSEBEVIS

Nr. O-14/2007

Utstedelsesdato:03.07.07

Navn oppdragsgiver:	Havforskningsinstituttet i Bergen, Fiskerifaglig senter for utviklingssamarbeid v/Bjørn Serigstad
Adresse oppdragsgiver:	Postboks 1870 5020 Bergen
Prosjektnr.:	10590-16 (HI)
Journalnr.:	860
Mottatt dato:	17.04.07
Prøvemateriale:	Sedimenter
Antall prøver:	108
Prøvemerking:	Område,stasjonsnr., snitt
Emballasjetype:	Plastposer
Analysemetode:	O4, O2
Analysedato:	1.6.-28.06.07
Analytiker:	Grethe Tveit, Anders Fuglevik, Kjell Westrheim
Teknisk ansvarlig:	Kjell Westrheim

Resultatene gjelder kun de analyserte prøver.
Analysebeviset kan ikke gjengis i utdrag, uten skriftlig tillatelse fra Havforskningsinstituttet.

Postadresse:	**Besøksadresse:**	**Telefon:**	**Telefaks:**
Postboks 1870 Nordnes 5817 BERGEN	Nordnesgaten 50	55 23 85 00	55 23 85 31

Side 1 av 14

Analysebevis nr.
O-14 / 2007

Resultater: THC konsentrasjon i mg/kg tørrvekt

Lomba

Sample i.d.	Dato	Dyp	Analyse i.d.	Kons
LB1 sample1 0-1cm	16.10.2006	130	kw022,137	**86,8**
LB1 sample2 0-1cm	16.10.2006	130	kw022,138	**215**
LB1 sample3 0-1cm	16.10.2006	130	kw022,139	**207**
LB1 sample1 1-3cm	16.10.2006	130	kw022,15	**31,4**
LB1 sample1 3-6cm	16.10.2006	130	kw022,14	**10,7**
LB2 sample1 0-1cm	16.10.2006	130	kw022,140	**250**
LB2 sample2 0-1cm	16.10.2006	130	kw022,141	**64,6**
LB2 sample3 0-1cm	16.10.2006	130	kw022,142	**89,1**
LB2 sample1 1-3cm	16.10.2006	130	kw022,143	**110**
LB2 sample1 3-6cm	16.10.2006	130	kw022,144	**116**
LB3 sample1 0-1cm	16.10.2006	130	kw022,27	**26,0**
LB3 sample2 0-1cm	16.10.2006	130	kw022,28	**25,2**
LB3 sample3 0-1cm	16.10.2006	130	kw022,26	**23,8**
LB4 sample1 0-1cm	16.10.2006	130	kw022,25	**10,7**
LB4 sample2 0-1cm	16.10.2006	130	kw022,34	**17,6**
LB4 sample3 0-1cm	16.10.2006	130	kw022,33	**18,1**
LB5 sample1 0-1cm	16.10.2006	128	kw022,32	**24,0**
LB5 sample2 0-1cm	16.10.2006	128	kw022,31	**47,7**
LB5 sample3 0-1cm	16.10.2006	128	kw022,3	**41,8**

Resultatene gjelder kun de analyserte prøver.
Analysebeviset kan ikke gjengis i utdrag, uten skriftlig tillatelse fra Havforskningsinstituttet.

Postadresse: Postboks 1870 Nordnes 5817 BERGEN
Besøksadresse: Nordnesgaten 50
Telefon: 55 23 85 00
Telefaks: 55 23 85 31

LB6 sample1 0-1cm	16.10.2006	128	kw022,350	**19,6**
LB6 sample2 0-1cm	16.10.2006	128	kw022,356	**29,3**
LB6 sample3 0-1cm	16.10.2006	128	kw022,357	**24,9**
LB7 sample1 0-1cm	16.10.2006	125	kw022,358	**11,5**
LB7 sample2 0-1cm	16.10.2006	125	kw022,359	**6,36**
LB7 sample3 0-1cm	16.10.2006	125	kw022,887	**8,90**
LB8 sample1 0-1cm	16.10.2006	121	kw022,885	**15,6**
LB8 sample2 0-1cm	16.10.2006	121	kw022,886	**9,17**
LB8 sample3 0-1cm	16.10.2006	121	kw022,445	**14,4**
LB9 sample1 0-1cm	16.10.2006	109	kw022,934	**16,0**
LB9 sample2 0-1cm	16.10.2006	109	kw022,933	**17,4**

Analysebevis nr.
O-14 / 2007

Lomba forts.

Sample i.d.	Dato	Dyp	analyse i.d.	Kons
LB9 sample3 0-1cm	16.10.2006	109	kw022,932	**6,41**
LB10 sample1 0-1cm	16.10.2006	97	kw022,991	**27,1**
LB10 sample2 0-1cm	16.10.2006	97	kw022,990	**11,2**
LB10 sample3 0-1cm	16.10.2006	97	kw022,996	**30,8**
LB13 sample1 0-1cm	16.10.2006	128	kw022,999	**14,2**
LB13 sample2 0-1cm	16.10.2006	128	kw022,998	**14,9**
LB13 sample3 0-1cm	16.10.2006	128	kw022,997	**15,3**
LB14 sample1 0-1cm	17.10.2006	125	kw022,101	**13,8**

Resultatene gjelder kun de analyserte prøver.
Analysebeviset kan ikke gjengis i utdrag, uten skriftlig tillatelse fra Havforskningsinstituttet.

LB14 sample2 0-1cm	17.10.2006	125	kw022,102	**10,7**
LB14 sample3 0-1cm	17.10.2006	125	kw022,103	**18,4**
LB15 sample1 0-1cm	16.10.2006	131	kw022,106	**23,6**
LB15 sample2 0-1cm	16.10.2006	131	kw022,107	**80,9**
LB15 sample3 0-1cm	16.10.2006	131	kw022,108	**44,0**
LB16 sample1 0-1cm	15.10.2006	132	kw022,109	**16,8**
LB16 sample2 0-1cm	15.10.2006	132	kw022,110	**24,9**
LB16 sample3 0-1cm	15.10.2006	132	kw022,111	**27,5**
LB17 sample1 0-1cm	15.10.2006	134	kw022,112	**12,7**
LB17 sample2 0-1cm	15.10.2006	134	kw022,113	**8,4**
LB17 sample3 0-1cm	15.10.2006	134	kw022,114	**17,0**
LB18 sample1 0-1cm	15.10.2006	146	kw022,115	**12,5**
LB18 sample2 0-1cm	15.10.2006	146	kw022,116	**9,0**
LB18 sample3 0-1cm	15.10.2006	146	kw022,117	**11,0**
LB19 sample1 0-1cm	15.10.2006	274	kw022,81	**12,7**
LB19 sample2 0-1cm	15.10.2006	274	kw022,82	**20,6**
LB19 sample3 0-1cm	15.10.2006	274	kw022,83	**20,9**

Nemba

NB1 sample1 0-1cm	17.10.2006	115	kw022,145	**254**
NB1 sample2 0-1cm	17.10.2006	115	kw022,146	**225**
NB1 sample3 0-1cm	17.10.2006	115	kw022,158	**153**
NB1 sample1 1-3cm	17.10.2006	115	kw022,147	**209**

Analysebevis nr.

Resultatene gjelder kun de analyserte prøver.
Analysebeviset kan ikke gjengis i utdrag, uten skriftlig tillatelse fra Havforskningsinstituttet.

Postadresse: Postboks 1870 Nordnes 5817 BERGEN
Besøksadresse: Nordnesgaten 50
Telefon: 55 23 85 00
Telefaks: 55 23 85 31

Nemba forts.

Sample i.d.	Dato	Dyp	analyse i.d.	Kons
NB1 sample1 3-6cm	17.10.2006	115	kw022,148	**215**
NB2 sample1 0-1cm	17.10.2006	115	kw022,122	**29,3**
NB2 sample2 0-1cm	17.10.2006	115	kw022,124	**24,3**
NB2 sample3 0-1cm	17.10.2006	115	kw022,127	**24,2**
NB2 sample2 1-3cm	17.10.2006	115	kw022,125	**20,1**
NB2 sample2 3-6cm	17.10.2006	115	kw022,126	**10,5**
NB3 sample1 0-1cm	17.10.2006	115	kw022,128	**22,8**
NB3 sample2 0-1cm	17.10.2006	115	kw022,130	**33,3**
NB3 sample3 0-1cm	17.10.2006	115	kw022,131	**14,0**
NB4 sample1 0-1cm	17.10.2006	116	kw022,132	**13,4**
NB4 sample2 0-1cm	17.10.2006	116	kw022,133	**16,4**
NB4 sample3 0-1cm	17.10.2006	116	kw022,134	**17,2**
KB1 sample1 0-1cm	15.10.2006	22	kw022,167	**21,2**
KB1 sample2 0-1cm	15.10.2006	22	kw022,191	**230**
KB1 sample3 0-1cm	15.10.2006	22	kw022,169	**22,1**
KB1 sample1 1-3cm	15.10.2006	22	kw022,170	**16,0**
KB1 sample1 3-6cm	15.10.2006	22	kw022,173	**17,5**
KB2 sample1 0-1cm	15.10.2006	22	kw022,174	**25,4**
KB2 sample2 0-1cm	15.10.2006	22	kw022,175	**26,1**
KB2 sample3 0-1cm	15.10.2006	22	kw022,1	**16,4**

Resultatene gjelder kun de analyserte prøver.

Postadresse: Postboks 1870 Nordnes 5817 BERGEN
Besøksadresse: Nordnesgaten 50
Telefon: 55 23 85 00
Telefaks: 55 23 85 31

			76	
			kw022,1	
KB2 sample1 1-3cm	15.10.2006	22	79	**11,2**
			kw022,1	
KB2 sample1 3-6cm	15.10.2006	22	80	**10,6**
			kw022,1	
KB3 sample1 0-1cm	15.10.2006	22	81	**16,4**
			kw022,1	
KB3 sample2 0-1cm	15.10.2006	22	82	**11,8**
			kw022,1	
KB3 sample3 0-1cm	15.10.2006	22	95	**14,1**
			kw022,1	
KB4 sample1 0-1cm	14.10.2006	23	94	**16,5**
			kw022,1	
KB4 sample2 0-1cm	14.10.2006	23	93	**13,7**

Analysebevis nr.
O-14 / 2007

Kambala forts.

Sample i.d.	Dato	Dyp	analyse i.d.	Kons
			kw022,1	
KB4 sample3 0-1cm	14.10.2006	23	92	**13,8**
			kw022,1	
KB12 sample1 0-1cm	14.10.2006	23	99	**11,2**
			kw022,2	
KB12 sample2 0-1cm	14.10.2006	23	00	**14,4**
			kw022,2	
KB12 sample3 0-1cm	14.10.2006	23	01	**14,2**
			kw022,1	
KB13 sample1 0-1cm	14.10.2006	25	96	**16,1**
			kw022,2	
KB13 sample2 0-1cm	14.10.2006	25	04	**13,7**
			Kw022,2	
K13 sample 3 0-1cm	14.10.2006	25	05	**15,1**
			Kw022,2	
KB14 sample 1 0-1cm	14.10.2006	25	06	**35,5**
			kw022,2	
KB14 sample2 0-1cm	14.10.2006	23	07	**18,6**
KB14 sample3 0-1cm	14.10.2006	23	kw022,2	**16,5**

Resultatene gjelder kun de analyserte prøver.
Analysebeviset kan ikke gjengis i utdrag, uten skriftlig tillatelse fra Havforskningsinstituttet.

KB15 sample1 0-1cm	14.10.2006	24	08 kw022,2 10	**20,7**
KB15 sample2 0-1cm	14.10.2006	24	kw022,2 11	**39,4**
KB15 sample3 0-1cm	14.10.2006	24	kw022,2 12	**18,9**
KB16 sample1 0-1cm	14.10.2006	25	kw022,2 13	**17,8**
KB16 sample2 0-1cm	14.10.2006	25	kw022,2 16	**14,4**
KB16 sample3 0-1cm	14.10.2006	25	kw022,2 17	**17,4**
KB17 sample1 0-1cm	14.10.2006	27	kw022,2 18	**16,4**
KB17 sample2 0-1cm	14.10.2006	27	kw022,2 19	**15,9**
KB17 sample3 0-1cm	14.10.2006	27	kw022,2 22	**17,2**
KB18 sample1 0-1cm	14.10.2006	34	kw022,2 23	**20,2**
KB18 sample2 0-1cm	14.10.2006	34	kw022,2 24	**19,6**
KB18 sample3 0-1cm	14.10.2006	34	kw022,2 25	**20,1**

Postadresse: Postboks 1870 Nordnes 5817 BERGEN
Besøksadresse: Nordnesgaten 50
Telefon: 55 23 85 00
Telefaks: 55 23 85 31

Analysebevis nr.
O-14 / 2007

Resultater: PAHNPD - konsentrasjon i ng/g tørrvekt.

PAHNPD sediment	Nemba (kw599,S10): NBs1 0-1cm 171006	Nemba (kw599,S11): NB1 s2 0-1c 171006	Nemba (kw599,S12): NB1 s3 0-1c 171006	Nemba Nemba (kw599,S13): NB1 s1 1-3cm 171006	(kw599,S14): NB1 s1 3-6cm 171006
Naphtalene	1,36	1,04	0,73	1,28	1,2
C1-naphtalener	3,31	2,20	1,85	2,88	3,04
C2-naphtalener	7,73	4,59	4,72	6,74	7,24
C3-naphtalener	8,99	5,49	5,26	6,93	8,03
Acenaphtylene	0,53	< 0,5	< 0,5	0,53	0,56
Acenaphtene	< 0,5*	< 0,5	< 0,5	< 0,5	< 0,5
Fluorene	1,77	1,21	1,42	1,51	1,48
Anthracene	2,12	1,17	1,2	1,79	1,81
Phenantrene	4,8	2,79	2,31	3,71	3,98
C1-phenantrener	6,94	4,58	4,51	6,96	6,10
C2-phenantrener	20,7	12,2	11,0	17,8	15,7
C2-phenantrener	41,9	31,1	26,2	39,1	31,3
Dibenzothiophene	1,11	0,88	0,51	0,70	1,73
C1-dibenzothiofener	1,48	1,09	0,79	1,30	1,30
C2-dibenzothiofener	9,03	5,77	3,92	6,46	6,48
C3-dibenzothiofener	12,2	11,4	8,02	11,2	10,3
Fluoranthene	8,82	4,05	4,69	5,62	6,42
Pyrene	94,4	32,5	58,6	74,2	73,2
Benz(a)anthracene	2,06	2,02	1,6	2,58	1,83
Chrysene	2,57	2,00	1,81	2,14	1,77
Benzo(b,j,k)fluoranthene	12,0	8,73	7,86	9,48	8,57
Benz(e)pyrene	5,44	3,57	3,51	4,37	4,0
Benz(a)pyrene	2,29	1,15	1,52	1,7	1,54
Perylene	68,7	71,7	38,5	71,0	68,1
Indeno(1,2,3-cd)pyrene	5,47	3,47	3,51	4,74	4,25
Dibenz(a,h)anthracene	0,93	< 0,5	0,51	0,75	0,69
Benzo(g,h,i)perylene	5,27	3,83	3,72	4,86	4,55

Resultatene gjelder kun de analyserte prøver.
Analysebeviset kan ikke gjengis i utdrag, uten skriftlig tillatelse fra Havforskningsinstituttet.

Postadresse: Postboks 1870 Nordnes 5817 BERGEN
Besøksadresse: Nordnesgaten 50
Telefon: 55 23 85 00
Telefaks: 55 23 85 31

Resultatene gjelder kun de analyserte prøver.
Analysebeviset kan ikke gjengis i utdrag, uten skriftlig tillatelse fra Havforskningsinstituttet.

Postadresse:	**Besøksadresse:**	**Telefon:**	**Telefaks:**
Postboks 1870 Nordnes 5817 BERGEN	Nordnesgaten 50	55 23 85 00	55 23 85 31

Analysebevis nr.
O-14 / 2007

PAHNPD sediment	Nemba (kw599-S15): NB2 s1 0-1cm 171006	Nemba (kw599-S16): NB2 s2 0-1cm 171006	Nemba (kw599-S17): NB2 s3 0-1cm 171006	Nemba (kw599-S18): NB2 s2 1-3cm 171006	Nemba (kw599-S19): Nb2 s2 3-6cm 171006
Naphtalene	1,05	1,18	0,97	0,98	0,95
C1-naphtalener	2,31	2,6	1,71	1,21	1,18
C2-naphtalener	4,01	3,85	2,40	2,58	1,86
C3-naphtalener	3,87	2,42	2,13	2,52	1,61
Acenaphtylene	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5
Acenaphtene	< 0,5	0,80	< 0,5	< 0,5	< 0,5
Fluorene	1,02	0,80	0,63	0,58	0,50
Anthracene	0,84	0,69	0,67	0,64	0,61
Phenantrene	2,32	1,81	1,79	1,65	1,67
C1-phenantrener	3,81	2,39	2,30	2,34	2,00
C2-phenantrener	6,33	3,95	3,61	3,43	2,42
C2-phenantrener	15,3	7,97	6,71	6,51	3,69
Dibenzothiophene	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5
C1-dibenzothiofener	0,68	< 0,5	< 0,5	< 0,5	< 0,5
C2-dibenzothiofener	2,59	1,68	1,69	1,39	0,76
C3-dibenzothiofener	4,47	2,96	3,16	2,51	1,24
Fluoranthene	2,79	2,55	2,63	2,5	2,44
Pyrene	10,9	12,2	11,2	9,2	7,39
Benz(a)anthracene	1,22	1,24	1,06	1,22	0,96
Chrysene	1,15	0,95	0,82	0,75	0,72
Benzo(b,j,k)fluoranthene	6,25	6,24	6,67	6,26	5,69
Benz(e)pyrene	2,74	2,11	2,16	2,17	1,97
Benz(a)pyrene	0,81	0,87	0,83	0,79	0,75
Perylene	59,9	53,0	53,9	55,9	55,3
Indeno(1,2,3-cd)pyrene	3,36	3,38	3,39	3,2	3,13
Dibenz(a,h)anthracene	< 0,5	0,58	< 0,5	< 0,5	< 0,5
Benzo(g,h,i)perylene	3,53	3,59	3,37	3,74	3,57

Resultatene gjelder kun de analyserte prøver.
Analysebeviset kan ikke gjengis i utdrag, uten skriftlig tillatelse fra Havforskningsinstituttet.

Postadresse: Postboks 1870 Nordnes 5817 BERGEN
Besøksadresse: Nordnesgaten 50
Telefon: 55 23 85 00
Telefaks: 55 23 85 31

Analysebevis nr.
O-14 / 2007

PAHNPD sediment	Lomba (kw599-S22): LB1 s1 0-1cm 161006	Lomba (kw599-S23): LB1 s2 0-1cm 161006	Lomba (kw599-S24): LB1 s3 0-1cm 161006	Lomba (kw599-S25): LB1 s1 1-3cm 161006	Lomba (kw599-S26): LB1 s1 3-6cm 161006
Naphtalene	1,28	0,92	1,1	1,28	1,69
C1-naphtalener	2,36	1,72	2,29	2,40	2,69
C2-naphtalener	3,64	3,92	4,44	3,20	2,93
C3-naphtalener	3,57	4,63	5,80	3,06	2,31
Acenaphtylene	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5
Acenaphtene	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5
Fluorene	0,96	1,07	1,54	1,02	0,88
Anthracene	0,98	1,56	1,91	0,76	0,67
Phenantrene	2,26	3,03	3,09	2,23	2,20
C1-phenantrener	3,63	6,41	7,08	2,78	2,36
C2-phenantrener	7,70	14,3	17,6	4,37	3,15
C2-phenantrener	27,9	55,3	57,0	9,99	4,93
Dibenzothiophene	< 0,5	0,62	0,80	< 0,5	< 0,5
C1-dibenzothiofener	0,84	1,47	1,96	0,68	< 0,5
C2-dibenzothiofener	3,39	5,94	8,95	2,50	1,77
C3-dibenzothiofener	8,39	13,0	17,4	4,1	2,67
Fluoranthene	3,08	3,64	4,2	2,84	2,81
Pyrene	14,2	20,9	29,7	10,3	7,66
Benz(a)anthracene	1,31	1,69	1,81	1,14	1,11
Chrysene	1,12	1,66	2,02	0,69	0,82
Benzo(b,j,k)fluoranthene	6,47	6,38	6,35	6,52	6,87
Benz(e)pyrene	2,57	3,61	3,57	2,23	2,15
Benz(a)pyrene	0,75	1,02	0,96	0,74	0,72
Perylene	56,9	64,7	49,9	54,4	64,6
Indeno(1,2,3-cd)pyrene	3,47	4,11	4,2	2,91	2,81
Dibenz(a,h)anthracene	< 0,5	0,90	0,83	< 0,5	< 0,5
Benzo(g,h,i)perylen	3,34	4,16	3,9	3,14	3,06

Resultatene gjelder kun de analyserte prøver.
Analysebeviset kan ikke gjengis i utdrag, uten skriftlig tillatelse fra Havforskningsinstituttet.

Postadresse: Postboks 1870 Nordnes 5817 BERGEN
Besøksadresse: Nordnesgaten 50
Telefon: 55 23 85 00
Telefaks: 55 23 85 31

e

Postadresse: Postboks 1870 Nordnes 5817 BERGEN
Besøksadresse: Nordnesgaten 50
Telefon: 55 23 85 00
Telefaks: 55 23 85 31

Analysebevis nr.
O-14 / 2007

PAHNPD sediment	Lomba (kw599-S27): LB2 s1 0-1cm 161006	Lomba (kw599-S28): LB2 s2 0-1cm 161006	Lomba (kw599-S29): LB2 s3 0-1cm 161006	Lomba (kw599-S31): LB2 s1 1-3cm 161006	Lomba (kw599-S30): LB2 s1 3-6cm 161006
Naphtalene	1,47	1,18	1,65	1,6	1,4
C1-naphtalener	2,41	1,62	1,82	2,63	2,12
C2-naphtalener	5,55	3,41	4,22	5,16	3,95
C3-naphtalener	6,33	3,60	4,49	5,16	4,48
Acenaphtylene	0,59	< 0,5	0,77	0,58	0,52
Acenaphtene	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5
Fluorene	1,46	0,86	1,03	1,24	1,02
Anthracene	1,55	0,90	0,99	1,19	1,08
Phenantrene	3,38	2,17	2,83	2,79	2,68
C1-phenantrener	7,22	3,44	4,71	4,49	4,56
C2-phenantrener	17,1	7,22	11,4	11,1	9,67
C2-phenantrener	65,6	22,6	31,6	34,7	32,0
Dibenzothiophene	0,79	< 0,5	< 0,5	0,53	< 0,5
C1-dibenzothiofener	1,54	0,75	1,18	1,14	0,97
C2-dibenzothiofener	6,33	3,35	4,81	4,71	3,85
C3-dibenzothiofener	15,2	8,01	9,74	11,6	9,41
Fluoranthene	3,89	2,96	3,45	3,38	3,34
Pyrene	22,9	11,8	12,8	15,1	14,1
Benz(a)anthracene	1,74	1,47	1,72	1,57	1,73
Chrysene	2,20	1,19	1,63	1,96	1,49
Benzo(b,j,k)fluoranthene	7,95	6,34	6,69	6,99	6,27
Benz(e)pyrene	3,36	2,47	3,16	3,18	3,02
Benz(a)pyrene	1,03	0,83	0,96	1,02	0,95
Perylene	72,4	63,5	64,3	62,2	65,4
Indeno(1,2,3-cd)pyrene	4,03	3,99	4,2	4,22	4,61
Dibenz(a,h)anthracene	0,63	< 0,5	0,85	0,79	0,78
Benzo(g,h,i)perylene	4,28	3,79	4,14	4,08	4,46

Resultatene gjelder kun de analyserte prøver.
Analysebeviset kan ikke gjengis i utdrag, uten skriftlig tillatelse fra Havforskningsinstituttet.

Postadresse: Postboks 1870 Nordnes 5817 BERGEN
Besøksadresse: Nordnesgaten 50
Telefon: 55 23 85 00
Telefaks: 55 23 85 31

Resultatene gjelder kun de analyserte prøver.
Analysebeviset kan ikke gjengis i utdrag, uten skriftlig tillatelse fra Havforskningsinstituttet.

Postadresse: Postboks 1870 Nordnes 5817 BERGEN
Besøksadresse: Nordnesgaten 50
Telefon: 55 23 85 00
Telefaks: 55 23 85 31

Analysebevis nr.
O-14 / 2007

	Lomba	Lomba	Lomba	Lomba	Lomba
PAHNPD sediment	**(kw599-S38): LB10 s1 0-1cm 161006**	**(kw599-S39): LB10 s2 0-1cm ,161006**	**(kw599-S40): LB10 s3 0-1cm, 161006**	**(kw599-S41): LB19 s1 0-1cm, 151006**	**(kw599-S42): LB19 s2 0-1cm, 161006**
Naphtalene	1,86	1,02	1,93	1,49	1,86
C1-naphtalener	3,08	1,36	2,69	1,67	2,33
C2-naphtalener	3,09	1,88	3,49	2,18	2,82
C3-naphtalener	2,63	1,45	3,08	1,86	2,20
Acenaphtylene	< 0,5	< 0,5	0,62	< 0,5	0,61
Acenaphtene	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5
Fluorene	0,84	0,50	0,93	0,54	0,72
Anthracene	0,70	0,58	0,83	0,65	0,67
Phenantrene	2,48	1,85	2,85	2,17	2,44
C1-phenantrener	3,51	2,38	4,55	2,46	3,02
C2-phenantrener	5,96	3,12	7,89	2,95	4,62
C2-phenantrener	17,8	5,41	16,6	3,77	7,27
Dibenzothiophene	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5
C1-dibenzothiofener	< 0,5	< 0,5	0,70	< 0,5	< 0,5
C2-dibenzothiofener	2,41	0,86	3,19	1,35	2,12
C3-dibenzothiofener	5,34	1,76	5,42	2,22	3,77
Fluoranthene	2,99	3,15	3,6	3,27	3,54
Pyrene	7,88	6,48	8,85	7,81	7,94
Benz(a)anthracene	1,44	1,59	1,72	1,08	1,2
Chrysene	1,44	1,14	1,42	0,91	1,04
Benzo(b,j,k)fluoranthene	6,97	6,52	7,22	6,18	6,45
Benz(e)pyrene	3,49	2,47	3,8	1,97	2,23
Benz(a)pyrene	0,87	1,00	1,10	0,59	0,62
Perylene	60,7	51,6	70,3	62,9	61,5
Indeno(1,2,3-cd)pyrene	2,97	3,17	3,98	2,97	3,62
Dibenz(a,h)anthracene	0,79	0,51	1,15	< 0,5	< 0,5

Resultatene gjelder kun de analyserte prøver.
Analysebeviset kan ikke gjengis i utdrag, uten skriftlig tillatelse fra Havforskningsinstituttet.

Postadresse: Postboks 1870 Nordnes 5817 BERGEN
Besøksadresse: Nordnesgaten 50
Telefon: 55 23 85 00
Telefaks: 55 23 85 31

Benzo(g,h,i)perylene	3,77	3,55	4,45	3,11	3,24

Postadresse: Postboks 1870 Nordnes 5817 BERGEN
Besøksadresse: Nordnesgaten 50
Telefon: 55 23 85 00
Telefaks: 55 23 85 31

Analysebevis nr.
O-14 / 2007

PAHNPD sediment	Lomba Kambala Kamb (kw599-S43): LB19 s3 0-1cm 161006	Kambala (kw599-S45): KB1 s1 0-1cm 151006	Kambala (kw599-S46): KB1 s2 0-1cm 151006	Kambala (kw599-S47): KB1 s3 0-1cm 151006	(kw599-S48): KB1 s1 1-3cm 151006
Naphtalene	1,83	0,98	0,86	0,91	1,11
C1-naphtalener	1,76	2,35	1,78	1,30	1,70
C2-naphtalener	2,66	2,73	2,92	2,13	2,26
C3-naphtalener	2,53	3,52	7,82	2,93	2,74
Acenaphtylene	0,85	0,54	0,52	< 0,5	0,50
Acenaphtene	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5
Fluorene	0,68	0,92	0,85	0,62	0,66
Anthracene	0,70	0,66	0,73	0,60	0,67
Phenantrene	2,55	2,38	2,47	1,89	2,25
C1-phenantrener	2,96	4,28	5,74	3,71	3,94
C2-phenantrener	4,42	7,88	15,0	7,55	7,33
C2-phenantrener	7,46	11,3	24,0	11,5	10,9
Dibenzothiophene	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5
C1-dibenzothiofener	< 0,5	0,61	0,91	0,55	0,58
C2-dibenzothiofener	1,90	2,75	5,00	2,72	2,48
C3-dibenzothiofener	3,50	4,49	8,20	4,83	4,24
Fluoranthene	3,46	4,19	4,59	3,3	4,09
Pyrene	7,67	6,91	7,05	6,69	6,9
Benz(a)anthracene	1,27	2,06	2,15	1,83	2,23
Chrysene	1,16	1,22	1,48	0,99	1,40
Benzo(b,j,k)fluoranthene	6,28	8,29	8,28	7,46	8,36
Benz(e)pyrene	2,26	3,02	3,02	2,59	2,94
Benz(a)pyrene	0,68	1,37	1,35	1,12	1,42
Perylene	54,1	106	107	99,8	97,1
Indeno(1,2,3-cd)pyrene	3,36	5,62	5,64	5,12	5,54
Dibenz(a,h)anthracene	0,53	0,78	0,92	< 0,5	0,86
Benzo(g,h,i)perylene	3,21	5,22	5,42	4,94	5,29

Resultatene gjelder kun de analyserte prøver.
Analysebeviset kan ikke gjengis i utdrag, uten skriftlig tillatelse fra Havforskningsinstituttet.

Postadresse: Postboks 1870 Nordnes 5817 BERGEN
Besøksadresse: Nordnesgaten 50
Telefon: 55 23 85 00
Telefaks: 55 23 85 31

Analysebevis nr.
O-14 / 2007

PAHNPD sediment	Kambala (kw599-S49): KB1 s1 3-6cm 151006	Kambala (kw599-S54): KB2 s1 0-1cm 151006	Kambala (kw599-S55): KB2 s2 0-1cm 151006	Kambala (kw599-S56): KB2 s3 0-1cm 151006	Kamb (kw599-S57): KB2 s1 1-3cm 151006
Naphtalene	1,23	1,08	1,06	1,29	0,94
C1-naphtalener	2,34	1,44	1,56	2,56	1,34
C2-naphtalener	2,49	2,52	2,22	2,32	2,08
C3-naphtalener	2,90	3,66	3,13	3,12	2,75
Acenaphtylene	0,50	0,56	0,58	0,60	< 0,5
Acenaphtene	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5
Fluorene	0,78	0,74	0,68	0,70	0,62
Anthracene	0,67	0,58	0,60	0,59	0,83
Phenantrene	2,46	2,45	2,3	2,46	2,14
C1-phenantrener	4,03	4,63	4,64	4,72	4,02
C2-phenantrener	7,17	8,61	8,58	8,50	7,76
C2-phenantrener	10,4	11,0	11,1	11,2	11,2
Dibenzothiophene	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5
C1-dibenzothiofener	0,61	0,64	0,65	0,63	0,55
C2-dibenzothiofener	2,61	2,77	2,65	2,61	2,58
C3-dibenzothiofener	4,26	4,16	4,16	4,01	4,23
Fluoranthene	4,55	3,63	3,59	3,73	3,53
Pyrene	7,07	4,68	5,06	4,96	5,93
Benz(a)anthracene	2,56	1,45	1,61	1,69	1,85
Chrysene	1,77	1,10	1,41	1,25	1,24
Benzo(b,j,k)fluoran	8,55	6,94	7,44	7,70	7,75

Resultatene gjelder kun de analyserte prøver.

Postadresse: Postboks 1870 Nordnes 5817 BERGEN
Besøksadresse: Nordnesgaten 50
Telefon: 55 23 85 00
Telefaks: 55 23 85 31

tene					
Benz(e)pyrene	2,99	2,41	2,6	2,68	2,54
Benz(a)pyrene	1,49	0,83	0,95	0,95	0,97
Perylene	94,8	117	107	115	119
Indeno(1,2,3-cd)pyrene	5,7	4,25	4,7	4,56	4,7
Dibenz(a,h)anthracene	0,55	< 0,5	0,52	0,58	0,57
Benzo(g,h,i)perylene	5,27	4,23	4,54	4,58	4,67

Postadresse: Postboks 1870 Nordnes 5817 BERGEN
Besøksadresse: Nordnesgaten 50
Telefon: 55 23 85 00
Telefaks: 55 23 85 31

Analysebevis nr.
O-14 / 2007

PAHNPD sediment	Kambala (kw599-S58): KB2 s1 3-6cm 151006	Kambala (kw599-S65): KB18 s1 0-1cm 141006	Kambala (kw599-S66): KB18 s2 0-1cm 141006	Kambala (kw599-S67): KB18 s3 0-1cm 141006
Naphtalene	0,85	0,89	0,93	0,88
C1-naphtalener	1,12	1,01	1,19	1,16
C2-naphtalener	1,87	2,40	2,09	2,20
C3-naphtalener	2,33	2,98	2,51	2,66
Acenaphtylene	< 0,5	0,60	< 0,5	0,54
Acenaphtene	< 0,5	< 0,5	< 0,5	< 0,5
Fluorene	0,54	0,65	0,62	0,67
Anthracene	0,58	0,66	0,59	0,62
Phenantrene	1,97	2,27	2,19	2,2
C1-phenantrener	3,69	4,59	4,21	4,26
C2-phenantrener	7,03	8,76	7,94	8,01
C2-phenantrener	10,8	13,6	13,5	13,6
Dibenzothiophene	< 0,5	< 0,5	< 0,5	< 0,5
C1-dibenzothiofener	0,53	0,69	0,60	0,61
C2-dibenzothiofener	2,34	2,82	2,63	2,68
C3-dibenzothiofener	4,07	5,12	4,87	5,14
Fluoranthene	3,3	4,55	4,32	4,28
Pyrene	6,67	6,85	7,19	6,77
Benz(a)anthracene	1,64	1,61	1,88	1,81
Chrysene	0,96	1,34	1,11	1,09
Benzo(b,j,k)fluoranthene	7,51	7,45	7,54	7,49
Benz(e)pyrene	2,58	2,83	3,11	2,88
Benz(a)pyrene	1,00	0,89	1,25	1,11
Perylene	104	95,1	83,9	91,6
Indeno(1,2,3-cd)pyrene	4,55	4,86	4,61	4,54
Dibenz(a,h)anthracene	0,64	0,63	0,82	0,82
Benzo(g,h,i)perylene	4,54	4,83	4,76	4,72

Resultatene gjelder kun de analyserte prøver.
Analysebeviset kan ikke gjengis i utdrag, uten skriftlig tillatelse fra Havforskningsinstituttet.

Postadresse: Postboks 1870 Nordnes 5817 BERGEN
Besøksadresse: Nordnesgaten 50
Telefon: 55 23 85 00
Telefaks: 55 23 85 31

Resultatene gjelder kun de analyserte prøver.
Analysebeviset kan ikke gjengis i utdrag, uten skriftlig tillatelse fra Havforskningsinstituttet.

Postadresse:	Besøksadresse:	Telefon:	Telefaks:
Postboks 1870 Nordnes 5817 BERGEN	Nordnesgaten 50	55 23 85 00	55 23 85 31

Analysebevis nr.
O-14 / 2007

Metode: O2- Bestemmelse av PAH og NPD i sedimenter ved forsåpning og GC/MS.
Metode: O4- Bestemmelse av THC(total hydrokarboner) i sedimenter ved forsåpning og GC/FID.

Kommentarer:
* 0,5 = kvantifiseringsgrense
Alle rapporterte komponenter er akkreditert.
THC er korrigert for blankverdier.

Opplysninger om måleusikkerhet kan fås ved henvendelse til laboratoriet.

Kjell Westrheim
Signatur teknisk ansvarlig

Resultatene gjelder kun de analyserte prøver.
Analysebeviset kan ikke gjengis i utdrag, uten skriftlig tillatelse fra Havforskningsinstituttet.

Postadresse:	**Besøksadresse:**	**Telefon:**	**Telefaks:**
Postboks 1870 Nordnes 5817 BERGEN	Nordnesgaten 50	55 23 85 00	55 23 85 31

Appendix Table 2. Summary table of concentration (ng/g dry sediment) of Naphtalene, Phenanthren and Dibenzothiophen in each samples from KB1, KB2 and KB18.

Site	KB1	KB1	KB1	KB1	KB1	KB2	KB2	KB2	KB2	KB2	KB18	KB18	KB18
Sample	1	2	3	1	1	1	2	3	1	1	1	2	3
Sediment layer		0-1cm		1-3cm	3-6cm		0-1cm		1-3cm	3-6cm		0-1cm	
Naphtalene	0.98	0.86	0.91	1.11	1.23	1.08	1.06	1.29	0.94	0.85	0.89	0.93	0.88
C1-naphtalener	2.35	1.78	1.3	1.7	2.34	1.44	1.56	2.56	1.34	1.12	1.01	1.19	1.16
C2-naphtalener	2.73	2.92	2.13	2.26	2.49	2.52	2.22	2.32	2.08	1.87	2.4	2.09	2.2
C3-naphtalener	3.52	7.82	2.93	2.74	2.9	3.66	3.13	3.12	2.75	2.33	2.98	2.51	2.66
Phenantrene	2.38	2.47	1.89	2.25	2.46	2.45	2.3	2.46	2.14	1.97	2.27	2.19	2.2
C1-phenantrener	4.28	5.74	3.71	3.94	4.03	4.63	4.64	4.72	4.02	3.69	4.59	4.21	4.26
C2-phenantrener	7.88	15	7.55	7.33	7.17	8.61	8.58	8.5	7.76	7.03	8.76	7.94	8.01
C3-phenantrener	11.3	24	11.5	10.9	10.4	11	11.1	11.2	11.2	10.8	13.6	13.5	13.6
Dibenzothiophene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
C1-dibenzothiofener	0.61	0.91	0.55	0.58	0.61	0.64	0.65	0.63	0.55	0.53	0.69	0.6	0.61
C2-dibenzothiofener	2.75	5	2.72	2.48	2.61	2.77	2.65	2.61	2.58	2.34	2.82	2.63	2.68
C3-dibenzothiofener	4.49	8.2	4.83	4.24	4.26	4.16	4.16	4.01	4.23	4.07	5.12	4.87	5.14

Appendix Table 3. Summary table of concentration (ng/g dry sediment) of Naphtalene, Phenanthren and Dibenzothiophen in each samples from LB1, LB2 and LB19.

Site	**LB1**	**LB1**	**LB1**	**LB1**	**LB1**	**LB2**	**LB2**	**LB2**	**LB2**	**LB2**	**LB10**	**LB10**	**LB10**	**LB19**	**LB19**	**LB19**
Sample	**1**	**2**	**3**	**1**	**1**	**1**	**2**	**3**	**1**	**1**	**1**	**2**	**3**	**1**	**2**	**3**
Layer		**0-1 cm**		**1-3 cm**	**3-6 cm**		**0-1cm**		**1-3cm**	**3-6cm**		**0-1cm**			**0-1cm**	
Naphtalene	1.28	0.92	1.10	1.28	1.69	1.47	1.18	1.65	1.6	1.4	1.86	1.02	1.93	1.49	1.86	1.83
C1-naphtalener	2.36	1.72	2.29	2.40	2.69	2.41	1.62	1.82	2.63	2.12	3.08	1.36	2.69	1.67	2.33	1.76
C2-naphtalener	3.64	3.92	4.44	3.20	2.93	5.55	3.41	4.22	5.16	3.95	3.09	1.88	3.49	2.18	2.82	2.66
C3-naphtalener	3.57	4.63	5.8	3.06	2.31	6.33	3.6	4.49	5.16	4.48	2.63	1.45	3.08	1.86	2.2	2.53
Phenantrene	2.26	3.03	3.09	2.23	2.20	3.38	2.17	2.83	2.79	2.68	2.48	1.85	2.85	2.17	2.44	2.55
C1-phenantrener	3.63	6.41	7.08	2.78	2.36	7.22	3.44	4.71	4.49	4.56	3.51	2.38	4.55	2.46	3.02	2.96
C2-phenantrener	7.70	14.3	17.6	4.37	3.15	17.1	7.22	11.4	11.1	9.67	5.96	3.12	7.89	2.95	4.62	4.42
C3-phenantrener	27.9	55.3	57.0	9.99	4.93	65.6	22.6	31.6	34.7	32	17.8	5.41	16.6	3.77	7.27	7.46
Dibenzothiophene	< 0.5	0.62	0.8	< 0.5	< 0.5	0.79	< 0.5	< 0.5	0.53	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
C1-dibenzothiofener	0.84	1.47	1.96	0.68	< 0.5	1.54	0.75	1.18	1.14	0.97	< 0.5	< 0.5	0.7	< 0.5	< 0.5	< 0.5
C2-dibenzothiofener	3.39	5.94	8.95	2.5	1.77	6.33	3.35	4.81	4.71	3.85	2.41	0.86	3.19	1.35	2.12	1.9
C3-dibenzothiofener	8.39	13.0	17.4	4.1	2.67	15.2	8.01	9.74	11.6	9.41	5.34	1.76	5.42	2.22	3.77	3.5

Appendix Table 4. Summary table of concentration (ng/g dry sediment) of Naphtalene, Phenanthren and Dibenzothiophen in each sample from NB1 and NB2.

Site	**NB1**	**NB1**	**NB1**	**NB1**	**NB1**	**NB2**	**NB2**	**NB2**	**NB2**	**NB2**
Sample nr.	**1**	**2**	**3**	**1**	**1**	**1**	**2**	**3**	**2**	**2**
Sediment layer		**0-1 cm**		**1-3 cm**	**3-6 cm**		**0-1 cm**		**1-3 cm**	**3-6 cm**
Naphtalene	1.36	1.04	0.73	1.28	1.2	1.05	1.18	0.97	0.98	0.95
C1-naphtalener	3.31	2.2	1.85	2.88	3.04	2.31	2.60	1.71	1.21	1.18
C2-naphtalener	7.73	4.59	4.72	6.74	7.24	4.01	3.85	2.4	2.58	1.86
C3-naphtalener	8.99	5.49	5.26	6.93	8.03	3.87	2.42	2.13	2.52	1.61
Phenantrene	4.8	2.79	2.31	3.71	3.98	2.32	1.81	1.79	1.65	1.67
C1-phenantrener	6.94	4.58	4.51	6.96	6.1	3.81	2.39	2.3	2.34	2.00
C2-phenantrener	20.7	12.2	11.0	17.8	15.7	6.33	3.95	3.61	3.43	2.42
C3-phenantrener	41.9	31.1	26.2	39.1	31.3	15.3	7.97	6.71	6.51	3.69
Dibenzothiophene	1.11	0.88	0.51	0.7	1.73	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
C1-dibenzothiofener	1.48	1.09	0.79	1.3	1.3	0.68	< 0.5	< 0.5	< 0.5	< 0.5
C2-dibenzothiofener	9.03	5.77	3.92	6.46	6.48	2.59	1.68	1.69	1.39	0.76
C3-dibenzothiofener	12.2	11.4	8.02	11.2	10.3	4.47	2.96	3.16	2.51	1.24

Appendix Table 5. Summary table of concentration (ng/g dry sediment) of each PAHs in each samples from KB1, KB2 and KB18.

Site	KB1	KB1	KB1	KB1	KB1	KB2	KB2	KB2	KB2	KB2	KB18	KB18	KB18
Sample	1	2	3	1	1	1	2	3	1	1	1	2	3
Sediment layer		0-1cm		1-3cm	3-6cm		0-1cm		1-3cm	3-6cm		0-1cm	
PAH16													
Acenaphtylene	0.54	0.52	< 0.5	0.5	0.5	0.56	0.58	0.6	< 0.5	< 0.5	0.6	< 0.5	0.54
Acenaphtene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Fluorene	0.92	0.85	0.62	0.66	0.78	0.74	0.68	0.7	0.62	0.54	0.65	0.62	0.67
Anthracene	0.66	0.73	0.6	0.67	0.67	0.58	0.6	0.59	0.83	0.58	0.66	0.59	0.62
Naphtalene	0.98	0.86	0.91	1.11	1.23	1.08	1.06	1.29	0.94	0.85	4.55	4.32	4.28
Phenantrene	2.38	2.47	1.89	2.25	2.46	2.45	2.3	2.46	2.14	1.97	0.89	0.93	0.88
Fluoranthene	4.19	4.59	3.3	4.09	4.55	3.63	3.59	3.73	3.53	3.3	2.27	2.19	2.2
Pyrene	6.91	7.05	6.69	6.9	7.07	4.68	5.06	4.96	5.93	6.67	6.85	7.19	6.77
Benz(a)anthracene	2.06	2.15	1.83	2.23	2.56	1.45	1.61	1.69	1.85	1.64	1.61	1.88	1.81
Chrysene	1.22	1.48	0.99	1.4	1.77	1.1	1.41	1.25	1.24	0.96	1.34	1.11	1.09
Benzo(b,j,k)fluorantene	8.29	8.28	7.46	8.36	8.55	6.94	7.44	7.7	7.75	7.51	7.45	7.54	7.49
Benz(a)pyrene	1.37	1.35	1.12	1.42	1.49	0.83	0.95	0.95	0.97	1	0.89	1.25	1.11
Indeno(1,2,3-cd)pyrene	5.62	5.64	5.12	5.54	5.7	4.25	4.7	4.56	4.7	4.55	4.86	4.61	4.54
Dibenz(a,h)anthracene	0.78	0.92	< 0.5	0.86	0.55	< 0.5	0.52	0.58	0.57	0.64	0.63	0.82	0.82
Benzo(g,h,i)perylene	3.21	5.22	5.42	4.94	5.29	4.23	4.54	4.58	4.67	4.54	4.83	4.76	4.72
Other PAH													
Benz(e)pyren	3.02	3.02	2.59	2.94	2.99	2.41	2.6	2.68	2.54	2.58	2.83	3.11	2.88
Perylene	54.1	106	107	99.8	94.8	117	107	115	119	104	95.1	83.9	91.6

Appendix Table 6. Summary table of concentration (ng/g dry sediment) of each PAHs in each samples from LB1, LB2 and LB19.

Site	**LB1**	**LB1**	**LB1**	**LB1**	**LB1**	**LB2**	**LB2**	**LB2**	**LB2**	**LB2**	**LB10**	**LB10**	**LB10**	**LB19**	**LB19**	**LB19**
Sample	**1**	**2**	**3**	**1**	**1**	**1**	**2**	**3**	**1**	**1**	**1**	**2**	**3**	**1**	**2**	**3**
Layer		**0-1cm**		**1-3 cm**	**3-6 cm**		**0-1cm**		**1-3cm**	**3-6cm**		**0-1cm**			**0-1cm**	
PAH16																
Acenaphtylene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.59	< 0.5	0.77	0.58	0.52	< 0.5	< 0.5	0.62	< 0.5	0.61	0.85
Acenaphtene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Fluorene	0.96	1.07	1.54	1.02	0.88	1.46	0.86	1.03	1.24	1.02	0.84	0.5	0.93	0.54	0.72	0.68
Anthracene	0.98	1.56	1.91	0.76	0.67	1.55	0.9	0.99	1.19	1.08	0.7	0.58	0.83	0.65	0.67	0.7
Fluoranthene	3.08	3.64	4.2	2.84	2.81	3.89	2.96	3.45	3.38	3.34	2.99	3.15	3.6	1.49	1.86	1.83
Naphtalene	1.28	0.92	1.1	1.28	1.69	1.47	1.18	1.65	1.6	1.4	1.86	1.02	1.93	2.17	2.44	2.55
Phenantrene	2.26	3.03	3.09	2.23	2.2	3.38	2.17	2.83	2.79	2.68	2.48	1.85	2.85	3.27	3.54	3.46
Pyrene	14.2	20.9	29.7	10.3	7.66	22.9	11.8	12.8	15.1	14.1	7.88	6.48	8.85	7.81	7.94	7.67
Benz(a)anthracene	1.31	1.69	1.81	1.14	1.11	1.74	1.47	1.72	1.57	1.73	1.44	1.59	1.72	1.08	1.2	1.27
Chrysene	1.12	1.66	2.02	0.69	0.82	2.2	1.19	1.63	1.96	1.49	1.44	1.14	1.42	0.91	1.04	1.16
Benzo(b,j,k)fluorantene	6.47	6.38	6.35	6.52	6.87	7.95	6.34	6.69	6.99	6.27	6.97	6.52	7.22	6.18	6.45	6.28
Benz(a)pyrene	0.75	1.02	0.96	0.74	0.72	1.03	0.83	0.96	1.02	0.95	0.87	1	1.1	0.59	0.62	0.68
Indeno(1,2,3-cd)pyrene	3.47	4.11	4.2	2.91	2.81	4.03	3.99	4.2	4.22	4.61	2.97	3.17	3.98	2.97	3.62	3.36
Dibenz(a,h)anthracene	< 0.5	0.9	0.83	< 0.5	< 0.5	0.63	< 0.5	0.85	0.79	0.78	0.79	0.51	1.15	< 0.5	< 0.5	0.53
Benzo(g,h,i)perylene	3.34	4.16	3.9	3.14	3.06	4.28	3.79	4.14	4.08	4.46	3.77	3.55	4.45	3.11	3.24	3.21
Other PAHs																
Benz(e)pyren	2.57	3.61	3.57	2.23	2.15	3.36	2.47	3.16	3.18	3.02	3.49	2.47	3.8	1.97	2.23	2.26
Perylene	56.9	64.7	49.9	54.4	64.6	72.4	63.5	64.3	62.2	65.4	60.7	51.6	70.3	62.9	61.5	54.1

Appendix Table 7. Summary table of concentration (ng/g dry sediment) of each PAHs in each samples from NB1 and NB2.

Site	**NB1**	**NB1**	**NB1**	**NB1**	**NB1**	**NB2**	**NB2**	**NB2**	**NB2**	**NB2**
Sample nr.	**1**	**2**	**3**	**1**	**1**	**1**	**2**	**3**	**2**	**2**
Sediment layer		**0-1 cm**		**1-3 cm**	**3-6 cm**		**0-1 cm**		**1-3 cm**	**3-6 cm**
PAH16										
Acenaphtylene	0.53	< 0.5	< 0.5	0.53	0.56	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Acenaphtene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.80	< 0.5	< 0.5	< 0.5
Fluorene	1.77	1.21	1.42	1.51	1.48	1.02	0.80	0.63	0.58	0.50
Anthracene	2.12	1.17	1.2	1.79	1.81	0.84	0.69	0.67	0.64	0.61
Fluoranthene	8.82	4.05	4.69	5.62	6.42	2.79	2.55	2.63	2.50	2.44
Naphtalene	1.36	1.04	0.73	1.28	1.20	1.05	1.18	0.97	0.98	0.95
Phenantrene	4.80	2.79	2.31	3.71	3.98	2.32	1.81	1.79	1.65	1.67
Pyrene	94.4	32.5	58.6	74.2	73.2	10.9	12.2	11.2	9.20	7.39
Benz(a)anthracene	2.06	2.02	1.60	2.58	1.83	1.22	1.24	1.06	1.22	0.96
Chrysene	2.57	2.00	1.81	2.14	1.77	1.15	0.95	0.82	0.75	0.72
Benzo(b,j,k)fluorantene	12.0	8.73	7.86	9.48	8.57	6.25	6.24	6.67	6.26	5.69
Benz(a)pyrene	2.29	1.15	1.52	1.70	1.54	0.81	0.87	0.83	0.79	0.75
Indeno(1,2,3-cd)pyrene	5.47	3.47	3.51	4.74	4.25	3.36	3.38	3.39	3.20	3.13
Dibenz(a,h)anthracene	0.93	< 0.5	0.51	0.75	0.69	< 0.5	0.58	< 0.5	< 0.5	< 0.5
Benzo(g,h,i)perylene	5.27	3.83	3.72	4.86	4.55	3.53	3.59	3.37	3.74	3.57
Other PAHs										
Benz(e)pyren	5.44	3.57	3.51	4.37	4.0	2.74	2.11	2.16	2.17	1.97
Perylene	68.7	71.7	38.5	71.0	68.1	59.9	53.0	53.9	55.9	55.3

Appendix Table 8. The front page (page 1 of 28) of the analyse-report from the laboratory Analycen AS. All the analyse-reports are stored at UNIFOB AS.

Analyserapport
Moss

AnalyCen

UNIFOB AS
Helge Botnen
SAM-marin
Thormøhlensgt. 49
5006 Bergen

Rapport utført av akkreditert laboratorium

Report issued by Accredited Laboratory

NORSK AKKREDITERING TEST043

Kundenummer	8183600-1069454	**Prøvemottak**	19.04.2007	Side 1 (28)
Prøvetype	Sedimentprøve	**Analyserapport klar**	25.05.2007	
Oppdragsmarking	Stedkode: 611101, Pr.nr.218550 - Ref 06/07 (sediment Angola			

Lab.nr.		NOV009279-07	NOV009280-07	NOV009281-07	NOV009282-07
Sted for prøvetaking		Angola	Angola	Angola	Angola
Tatt ut		18.04.2007	18.04.2007	18.04.2007	18.04.2007
Merket		LB1 Prøve 1 0-1cm	LB1 Prøve 1 1-3cm	LB1 Prøve 1 3-6cm	LB1 Prøve 2
Parameter	**Enhet**				
Barium, Ba	mg/kg	1340	1320	1620	4990
Kadmium, Cd	mg/kg	0.05	0.04	0.05	0.10
Krom, Cr	mg/kg	58.3	53.6	54.7	171
Kobber, Cu	mg/kg	14.5	12.8	15.1	46.8
Bly, Pb	mg/kg	16.9	15.5	16.6	54.6
Sink, Zn	mg/kg	91.6	83.1	82.3	260
Kvikksølv, Hg	mg/kg	0.067	0.057	0.060	0.066
Kvikksølv, Hg	mg/kg TS	0.000	0.000	0.000	0.000

Kommentar:

NOV009279-07 Alle resultater er i mg/kg TS. Gjelder hele oppdraget

Anna A Kubberød

aau

Forklaring til forkortelsene og *, se baksiden.

Appendix Table 9. Summary of the metal concentration (mg/kg dry sediment) of each total hydrocarbon (from hydrocarbon analysis at IMR, see Appendix Table 1), and heavy metal in each samples from Kambala jacket 132-05. n.a = not analyced.

Site	Sample	Layer	THC	Ba	Pb	Cd	Cu	Cr	Hg	Zn
KB 1	1	0-1 cm	21.2	155	18.2	0.05	12.4	47.5	0.084	71.8
	2	0-1 cm	230	451	18.6	0.08	13.2	46.8	0.076	73.3
	3	0-1 cm	22.1	519	17.7	0.09	12.1	45.9	0.069	69.3
	1	1-3 cm	16.0	552	18.4	0.08	21.9	46.5	0.064	73.8
	1	3-6 cm	17.5	72.5	18.1	0.06	12.4	47.3	0.076	67.8
KB 2	1	0-1 cm	25.4	116	17.8	0.06	11.6	47.5	0.077	71.7
	2	0-1 cm	26.1	139	17.8	0.06	11.5	44.8	0.079	68.8
	3	0-1 cm	16.4	169	17.8	0.06	11.4	45.2	0.079	72.4
	1	1-3 cm	11.2	58.5	19.4	0.07	13.3	49.4	0.083	67.8
	1	3-6 cm	10.6	62.6	18.4	0.06	12.6	48.7	0.088	72.2
KB 3	1	0-1 cm	16.4	71.9	19	0.06	11	45.3	n.a	71.9
	2	0-1 cm	11.8	59.5	18.7	0.06	11.5	46.3	n.a	67.1
	3	0-1 cm	14.1	57	18.3	0.05	11.4	45.8	n.a	67.3
KB4	1	0-1cm	16.5	56.2	19	0.05	11.8	46.4	n.a	67.3
	2	0-1cm	13.7	65.7	18.7	0.05	10.8	44.2	n.a	67.4
	3	0-1cm	13.8	58.8	19.5	0.06	13.3	48.5	n.a	63.3
KB12	1	0-1cm	11.2	56.1	19.2	0.05	10.6	46.8	n.a	75.4
	2	0-1cm	14.4	65.7	19.3	0.05	12	48.1	n.a	67.5
	3	0-1cm	14.2	74.3	19.7	0.06	11.3	46.8	n.a	70.9
KB13	1	0-1cm	16.1	54.4	19.9	0.05	10.3	46.9	n.a	82.8
	2	0-1cm	13.7	51.8	19.9	0.05	11.3	48.1	n.a	77.2
	3	0-1cm	15.1	51.8	19.8	0.05	10.2	46.7	n.a	82.4
KB14	1	0-1cm	35.5	236	19	0.06	12.1	46.2	n.a	65.5
	2	0-1cm	18.6	59.5	16.1	0.05	10.9	42.9	n.a	61.2
	3	0-1cm	16.5	70.2	16.5	0.05	9.8	38.9	n.a	59.4
KB15	1	0-1cm	20.7	186	19.3	0.05	9.7	43.4	n.a	72.9
	2	0-1cm	39.4	334	20	0.07	12.4	46.6	n.a	65.2
	3	0-1cm	18.9	94.9	19.5	0.06	12.9	47.9	n.a	63
KB16	1	0-1cm	17.8	63.7	19.7	0.05	11.1	45.6	n.a	70.5
	2	0-1cm	14.4	79.2	19.4	0.06	11.6	45.5	n.a	66.5
	3	0-1cm	17.4	60.7	19.4	0.05	11	46.1	n.a	73
KB17	1	0-1cm	16.4	61.9	20.8	0.06	12.1	48	n.a	66.4
	2	0-1cm	15.9	55.4	20.5	0.06	12.5	48.9	n.a	65
	3	0-1cm	17.2	61.5	19.7	0.06	11.5	47.4	n.a	68.5
KB18	1	0-1cm	20.2	63.6	21.8	0.07	13.3	51.3	0.094	71.4
	2	0-1cm	19.6	88.8	22.7	0.07	13	52.3	0.092	75.3
	3	0-1cm	20.1	83.4	22.1	0.07	13.2	52.6	0.090	73.1

Appendix Table 10. Summary of the metal concentration (mg/kg dry sediment) of each total hydrocarbon (from hydrocarbon analysis at IMR, see Appendix Table 1), and heavy metal in each samples from Lomba. n.a = not analyced.

Site	Sample	Layer	THC	Ba	Pb	Cd	Cu	Cr	Hg	Zn
LB 1	1	0-1 cm	86.8	1340	16.9	0.05	14.5	58.3	0.067	91.6
	2	0-1 cm	215	4990	54.6	0.1	46.8	171	0.066	260
	3	0-1 cm	207	1220	16.4	0.03	14.9	55.7	0.061	87.7
	1	1-3 cm	31.4	1320	15.5	0.04	12.8	53.6	83.1	0.057
	1	3-6 cm	10.7	1620	16.6	0.05	15.1	54.7	82.3	0.060
LB 2	1	0-1 cm	250	1030	15.2	0.04	13.8	52.8	0.068	77.1
	2	0-1 cm	64.6	302	16.7	0.05	14.2	56.2	0.065	81.9
	3	0-1 cm	89.1	3090	43.8	0.1	41.5	149	0.064	214
	1	1-3 cm	110	3010	48.1	0.12	42.6	153	219	0.071
	1	3-6 cm	116	3300	45.4	0.10	44.2	150	212	0.067
LB 3	1	0-1 cm	26	376	17.2	0.04	16.2	54.2		73.2
	2	0-1 cm	25.2	208	17.1	0.04	12.7	58.2		92.7
	3	0-1 cm	23.8	216	16.5	0.04	14.9	53.5		76
LB4	1	0-1cm	10.7	34.9	14.4	0.05	13	56.4		87.3
	2	0-1cm	17.6	93.9	14.3	0.03	14.3	48.7		70.2
	3	0-1cm	18.1	136	16.8	0.03	11.7	56.7		90.9
LB5	1	0-1cm	24	645	19	0.04	11.6	59		100
	2	0-1cm	47.7	772	17.4	0.05	14.6	56.4		84.9
	3	0-1cm	41.8	805	15.6	0.02	15.8	49.3		67.9
LB6	1	0-1cm	19.6	440	21	0.09	9.9	63.9		104
	2	0-1cm	29.3	409	16.5	0.04	12.5	59.1		93.2
	3	0-1cm	24.9	417	16.4	0.05	13.1	55.3		86.1
LB7	1	0-1cm	11.5	171	16.8	0.04	11.1	60.3		94.9
	2	0-1cm	6.36	89.6	16.2	0.03	13.8	55.7		80.2
	3	0-1cm	8.9	98	15.5	0.04	14.1	52.6		74.4
LB8	1	0-1cm	15.6	81.1	18.1	0.04	11.9	58.3		92.7
	2	0-1cm	9.17	77.9	18.3	0.03	10	56.8		96.2
	3	0-1cm	14.4	35.2	17.2	0.05	10.9	58.6		95.5
LB9	1	0-1cm	16.0	56.5	15.9	0.02	12.3	51.9		74.5
	2	0-1cm	17.4	69.7	17.9	0.03	12.5	54.3		80.4
	3	0-1cm	6.41	20.4	19.8	0.04	10.2	59		95.5
LB10	1	0-1cm	27.1	183	50.1	0.07	37.3	152	0.059	215
	2	0-1cm	11.2	50	17.9	0.03	12.5	56.2	0.057	82
	3	0-1cm	30.8	142	19.7	0.04	14.7	53.1	0.067	70.8
LB13	1	0-1cm	14.2	223	17.1	0.05	12.6	57.9		89.5
	2	0-1cm	14.9	426	18.6	0.03	11.8	58.9		93.1
	3	0-1cm	15.3	192	17.7	0.03	9.7	58.4		96.4

Appendix Table 10 continue. The concentration of each total hydrocarbon and heavy metal in each samples from Lomba.

Site	Sample	Layer	THC	Ba	Pb	Cd	Cu	Cr	Hg	Zn
LB14	1	0-1cm	13.8	355	19.1	0.05	15.6	56.4		77.6
	2	0-1cm	10.7	72.1	17.4	0.05	10.7	58.3		93.7
	3	0-1cm	18.4	141	16.8	0.05	15	54.6		75.2
LB15	1	0-1cm	23.6	513	15.8	0.04	13.1	56.8		87.7
	2	0-1cm	80.9	629	16.8	0.03	12.3	53.4		85.6
	3	0-1cm	44	54	15.7	0.04	14.9	53.2		73.4
LB16	1	0-1cm	16.8	402	15.9	0.04	13.1	54		84.6
	2	0-1cm	24.9	450	16.9	0.03	11.9	58.1		94.6
	3	0-1cm	27.5	686	16.1	0.05	12.8	53.4		84.1
LB17	1	0-1cm	12.7	174	25.5	0.05	7.2	66.9		99.8
	2	0-1cm	8.4	135	25.5	0.06	6.8	74.3		109
	3	0-1cm	17	153	21.3	0.03	8.3	61.2		94.7
LB18	1	0-1cm	12.5	254	19.5	0.04	11.7	60.4		90.4
	2	0-1cm	9	125	18.9	0.03	9.9	59.1		88.7
	3	0-1cm	11	144	20.1	0.03	8	62.1		96.8
LB19	1	0-1cm	12.7	68.9	16.2	0.09	16.4	61.5	0.055	80.2
	2	0-1cm	20.6	220	17.1	0.07	16	56	0.052	75.4
	3	0-1cm	20.9	163	17	0.11	16.2	59.4	0.051	78.7

Appendix Table 11. Summary of the metal concentration (mg/kg dry sediment) of each total hydrocarbon (from hydrocarbon analysis at IMR, see Appendix Table 1), and heavy metal in each samples from Nemba North. n.a = not analyced.

Site	Sample	Layer	THC	Ba	Pb	Cd	Cu	Cr	Hg	Zn
NB 1	1	0-1 cm	254	2930	24,3	0,13	17,4	58,3	0,072	95
	2	0-1 cm	225	823	20,6	0,11	13,6	57,7	0,054	83,8
	3	0-1 cm	153	1870	32,2	0,11	12.0	65,9	0,049	107
	1	1-3 cm	209	3010	22,5	0,12	15,9	55,4	0,077	86,1
	1	3-6 cm	215	1680	20,2	0,11	14,1	56	0,061	81,1
NB 2	1	0-1 cm	29,3	855	19,4	0,11	13,5	56,8	0,061	86,6
	2	0-1 cm	24,3	189	20,5	0,11	14,5	60,4	0,057	87,1
	3	0-1 cm	24,2	221	20,4	0,1	13,4	60,2	0,054	88,1
	2	1-3 cm	20,1	1220	21.0	0,1	13,7	57,5	0,058	85,2
	2	3-6 cm	10,5	955	20,2	0,11	13,9	59,8	0,056	90.0
NB 3	1	0-1 cm	22,8	75,9	22,1	0,09	10,5	59,2	na	91,2
	2	0-1 cm	33,3	47,5	22,5	0,08	9,4	64.0	na	104
	3	0-1 cm	14.0	193	22,3	0,09	10,6	62,6	na	98,9
NB4	1	0-1cm	13,4	573	24,1	0,08	10.0	69.0	na	113
	2	0-1cm	16,4	165	20,1	0,09	14.0	57,7	na	80,4
	3	0-1cm	17,2	1289	18.0	0,09	15.0	52,4	na	73.0

Appendix Table 10. Akkreditation documents SAM-Marine.

NORSK
AKKREDITERING

AKKREDITERINGSDOKUMENT

TEST 157

UNIFOB AS, Seksjon for anvendt miljøforskning, marin del
Høyteknologisenteret i Bergen
5006 BERGEN

Akkrediteringen omfatter P21 Taksonomi, P30 Prøvetaking og P32 Faglige vurderinger og fortolkninger i henhold til de neste sidene i dette dokumentet.

Akkreditering er første gang innvilget 21.02.2000, og er gitt i overensstemmelse med Stortingsprop. nr. 106 (1989/90), og Norsk Akkrediterings statutter fastsatt i Kgl. resolusjon 7. oktober 1993. Laboratoriet tilfredsstiller kravene i NS-EN ISO/IEC 17025 (2005)

Akkrediteringen forutsetter regelmessig oppfølging, og er gyldig til 21.02.2009. Akkrediteringsbeslutningen innebærer at Norsk Akkreditering har funnet at organisasjonen oppfyller kravene for akkreditert virksomhet innenfor de aktuelle akkrediteringsområder. Organisasjonen står selv ansvarlig for resultatene av utførte målinger.

NORSK AKKREDITERING

05.03.2007
Dato

Gisli Laake
prosesseier

NORSK AKKREDITERING

Akkrediteringsdokument
Akkreditering nr. TEST 157

Den administrative/geografiske enheten:
UNIFOB AS, Seksjon for anvendt miljøforskning, marin del
Thormøhlensgt. 49
5006 BERGEN

Prøvetaking i felt

P30 Prøvetaking

Objekt	Parameter	Referansestandard	Intern metode identitet	Merknad
Hardbunnslitoral	Retningslinjer for marinbiologiske undersøkelser på litoral og sublitoral hardbunn	NS 9424	SF-SAM-810 SF-SAM-811 SF-SAM-812 SF-SAM-813 SF-SAM-814 SF-SAM-815 SF-SAM-816 SF-SAM-817 SF-SAM-818	Prøveinnsamling og registrering i litoral ruteanalyse, semi-kvantitativ befaring samt undersøkelser av blåskjell
Marine bunnsedimenter	Bløtbunnsfauna til sortering og identifisering	ISO 16665	SF-SAM-800 SF-SAM-801 SF-SAM-802 SF-SAM-803 SF-SAM-805 SF-SAM-806 SF-SAM-301	Kvalitative og kvantitative prøver av sublitoral bløtbunnsfauna tatt med grabb MOM-C
Marine bunnsedimenter	Sediment til biologisk, kjemisk, fysisk og geologisk analyse	NS 9410	SF-SAM-830	MOM-B
Marine bunnmenter	Sedimenter til kjemisk, fysisk og geologisk analyse	ISO 5667-19	SF-SAM-800 SF-SAM-801 SF-SAM-802 SF-SAM-803 SF-SAM-805 SF-SAM-806 SF-SAM-807 SF-SAM-808 SF-SAM-301 SF-SAM-301	Bunnprøver tatt med grabb til kjemisk, fysisk og geologisk analyse

Permanent laboratorium

P21 Taksonomi

Objekt	Parameter	Referansestandard	Intern metode identitet	Merknad
Hardbunnslitoral	Hardbunnslitoral	NS 9424	SF-SAM-906	Artsidentifisering, marine hardbunnsorganismer

05.03.2007
Dato

Eilin Laake
prosesseier

NORSK AKKREDITERING

Akkrediteringsdokument
Akkreditering nr. TEST 157

Den administrative/geografiske enheten:
UNIFOB AS, Seksjon for anvendt miljøforskning, marin del
Thormøhlensgt. 49
5006 BERGEN

Permanent laboratorium

P21 Taksonomi

Objekt	Parameter	Referansestandard	Intern metode identitet	Merknad
Marine bunnsedimenter	Bløtbunnsfauna	ISO 5667-19	SF-SAM-900 SF-SAM-901 SF-SAM-902	Sortering, bløtbunnsfauna
Marine sedimenter	Bløtbunnsfauna	ISO 5667-19	SF-SAM-905	Artsidentifisering marin bløtbunnsfauna

Permanent laboratorium

P32 Faglige vurderinger og fortolkninger

Objekt	Parameter	Referansestandard	Intern metode identitet	Merknad
Hardbunnslitoral	Biologisk, kjemisk og geologisk karakterisering		SF-SAM-506 SF-SAM-510	Vurdering av miljøforhold basert på undersøkelser av hardbunnslitoral
Marin bløtbunnsfauna	Biologisk, kjemisk og geologisk karakterisering	SFT 97:03	SF-SAM-501	Klassifisering av miljøkvalitet i fjorder og kystfarvann
Marin bløtbunnsfauna	Biologisk, kjemisk og geologisk karakterisering	NS 9410	SF-SAM-501 SF-SAM-506 SF-SAM-830	Miljøovervåking av marine matfiskanlegg. Vurdering av forhold ved oppdrettsanlegg
Marine bunnsedimenter	Biologisk, kjemisk og geologisk karakterisering av marine sedimenter	FOR 2001-09-03 nr 1157	SF-SAM-501 SF-SAM-506	Forskrift om utføring av aktiviteter i petroleumsvirksomheten (aktivitetsforskriften). Vedlegg 1: Krav til miljøovervåking av petroleumsvirksomheten på norsk kontnentalsokkel 2: Sedimentovervåking

Personell godkjent for faglige fortolkninger og vurderinger:
Per Johannessen
Per-Otto Johansen
Helge Botnen

05.03.2007
Dato

Cecilie Taake
prosesseier

Appendix Table 11. Analyse Report. Benthic fauna.

UNIVERSITETSFORSKNING BERGEN AS
Section of Applied Environmental Research (SAM)
High Technology Center, 5006 Bergen
Tef: 55 58 44 64 Fax: 55 58 45 25

Test 157

BENTHIC FAUNA SPECIES LIST

Client: Institute of Marine Research
Project nr.: 218550
Sampling site: Kambala Jacket 132-05, Cabinda, Angola
Date of sampling: 14.-15. October 2006
Responsible for sampling: Section of Applied Environmental Research
Deviations/circumstances with possible impact on the result: none
Species/taxa identified by: Per Johannessen (all groups)
Per-Otto Johansen (Amphipoda)
Jon Anders Kongsrud (Maldanida)

Methods: The material is obtained according to an accreditation (Test 157) by the Norwegian Accreditation for sampling and taxonomical analyses. This investigation follows Norwegian Standard NS 9423 and an internal quality system.

Information about marks in the species list:
Each sampling station is presented by sample numbers, and under each sample number is the animals which were found in the sample listed.

+ the species occur in the sample, but is not quantified.

/ separate adults and juveniles (example 4/2 mean 4 adults and 2 juveniles).

cf. between genus and species name indicates that identification of genus is certain but the species is uncertain.

***** in front of species or taxa indicate that species/taxa is not included in the analyses.

***** in front of sample number indicate deviation to the sample.

Other informations:

The table starts on next page and includes 6 pages.

Fragmentary copies of the species list are not allowed without written approval from SAM.

Signatur:.....
Signatur

	Stations	KB1					KB2				
	Sample number	**4**	**5**	**6**	**7**	**8**	**4**	**5**	**6**	**7**	**8**
*	**HYDROZOA indet**									+	
	NEMERTINI indet.		1	2	1						3
	POLYCHAETA										
	Amphinomidae indet. III								1		1
	Panthalis oerstedi	1									
	Nephtys sp.		1	1			2	3	3	1	
	Nephtys sp. II	1								1	
	Diopatra cf. cuprea	1									
	Lumbrineridae indet. V				1					1	
	Scoloplos armiger							0/1	2	2	0/2
	Prionospio cf. dubia								1		
	Prionospio sp. I	2	3	3	2	1	1		1	1	1/1
	Spiochaetopterus sp. III										1
	Magelona sp. II			1							
	Aricidea sp I		1								
	Aricidea sp III		3								
	Paranoidae indet. I	1									
	Paranoidae indet. II										1
	Paranoidae indet. III				1						1
	Paranoidae indet. VII	1									
	Paranoidae indet. VIII										1
	Aphelochaeta sp. IV	4						1			
	Cossura cf. coasta		1				1				
	Flabelligeridae indet II / Sabellaridae indet								2		
	Mediomastus sp. I							1	1		2
	Notomastus sp. I	2							1	2	2
	Notomastus sp. II	1	1								
	Sternaspis scutata				1				1		
	Ampharete sp. III										1
	Melinna sp II				1						
	Melinna sp III							3/1	1		3
	Sabellidae indet. I	2									
	Oligochaeta sp I								2		
	Echiurus sp.								1		
	SIPUNCULA indet.		2	1							
	Aspidosiphon sp				2		1		8	4	2
	Onchnesoma sp	16	4	3	4	7	4	3	5	3/1	3
	CRUSTACEA										
	Ampelisca sp.							2		3	
	Natantia indet.II						1				
	Natantia indet.III									2	
	Paguridae indet.				1			3	1		
	MOLLUSCA										
	Naticidae indet. V									1	
	Nassarius elatus		1								
	Bivalvia indet.				1						
	Nucula sp I									1	
	Nuculana sp I									3/2	
	Yoldiella lucida										
	Spisula sp. I								1		
	Abra sp. III										1
	Veneridae indet I								1		
	ECHINODERMATA										
	Amphiuridae indet. III								1		
	Cucumariidae indet IV						1	1			
*	**PISCES indet.**						1				
*	Pisces indet. I		1						1		

	Stations	KB3					KB4				
	Sample number	**4**	**5**	**6**	**7**	**8**	**4**	**5**	**6**	**7**	**8**
*	**PORIFERA indet**		+								
*	**HYDROZOA indet**								+		
	POLYCHAETA										
	Amphinomidae indet. III										1
	Pilargiidae indet. III							1			
	Ancistrosyllis sp. I										2
	Nephtys sp.	1		1	1	3		1	1	1	
	Nephtys sp. II			1							
	Lumbrineridae indet. V							1	1	2	
	Driloneris sp II				1						
	Scoloplos armiger		0/1								
	Prionospio sp. I	1/1		1	2	2	1	5	2	2	4
	Spiochaetopterus sp.II				1				1		
	Aricidea sp I		1								
	Aricidea cf. longobranchiata								1		
	Aphelochaeta sp. IV						1	1			
	Flabelligeridae indet II / Sabellaridae indet		1	1		1	1				
	Mediomastus sp. I		2			3					
	Notomastus sp. I	1			2			1	1	2	
	Myriochele sp.									1	
	Sternaspis scutata	1		1/1							
	Sabellides sp II					1				1	
	Melinna sp III				1	1	1			1	
	Oligochaeta sp I						1		1	1	
	SIPUNCULA indet.						2				
	Aspidosiphon sp	1		1		1	3	1	3	3	8
	Onchnesoma sp	7	1	10	3	3	2	7	7	8	5
	CRUSTACEA										
	Ampeliscidae indet.							1			
	Ampelisca sp.	1	1	1							
	Natantia indet.III	1		1		1	1	2			
	Upogebia sp. I				2						
	Paguridae indet.					1	1				
	MOLLUSCA										
	Gastropoda indet					1					
	Muricidae indet	1									
	Naticidae indet. IV		1								
	Nuculana sp I		1			3/1			3/1		
	Spisula sp. I						1				
	Abra sp. III				0/1						
	Veneridae indet I		1				1		0/1		
	ECHINODERMATA										
	Amphiuridae indet. III		1		1/1		+				
*	**PISCES indet. I**		1		1	1					

Stations	KB12					KB13				
Sample number	**4**	**5**	**6**	**7**	**8**	**4**	**5**	**6**	**7**	**8**
ANTHOZOA indet										
Pennatulacea indet.								1		
NEMERTINI indet.	**1**		**2**	**1**						
POLYCHAETA										
Amphinomidae indet. III			6	9						
Hesionidae indet.I					1					
Nephtys sp.			3	2	1		1		1	1
Glycera alba	1							1		
Lumbrineridae indet. VI				1				1	1	1
Scoloplos armiger				0/1	0/1					
Prionospio sp. I		2	3	2		4	1	2		2
Paranoidae indet. VII	1									
Paranoidae indet. VIII				1					1	
Paranoidae indet. VI/Aphelochaeta sp								1		
Chaetozone sp II								1		
Cossura cf. coasta				2						
Mediomastus sp. I	1				1					
Euclymeninae sp.							1			
Euclymene sp.						1				
Oweniidae indet.							1			1
Sternaspis scutata			0/1							
Melinna sp IV			2	1	1	2	0/1	4/1		0/1
Pista sp II										1
OLIGOCHAETA indet.	1									
SIPUNCULA indet.							1			
Aspidosiphon sp	1	3	4	4	1	2				2
Onchnesoma sp	10	4	8	4/1	8	6	11	9	7	7
CRUSTACEA										
Natantia indet.III			1							
Upogebia sp. I				1						
Paguridae indet.		2			1			1		
MOLLUSCA										
Gastropoda indet			**1**							
Nudibranchiata indet. I									1	
Nuculana sp I		2	0/1		1		1			
Abra sp. III			1							
Veneridae indet I						1			1	
Scaphopoda indet.		**1**								
ECHINODERMATA										
Cucumariidae indet V							1			

Stations	KB14					KB15				
Sample number	**4**	**5**	**6**	**7**	**8**	**4**	**5**	**6**	**7**	**8**
POLYCHAETA										
Polychaeta indet. I					1			1		
Nephtys sp.		1	1		1	1	1		1	
Glycera alba					1					1
Goniada sp. I								1		
Lumbrineridae indet. VI		2	1							
Scoloplos armiger		0/2					0/1		0/2	
Prionospio sp. I		3	2	2/1	3	1/1	1	2	1	3
Spiochaetopterus sp. III					1		1			
Chaetozone sp II										1
Cossura cf. coasta										1
Flabelligeridae indet II / Sabellaridae indet					1	1				
Capitellidae indet.			1							
Mediomastus sp. I	3				2					2
Notomastus sp. I								1		2
Euclymeninae sp.										1
Oweniidae indet.							1			
Ampharete sp. III					1					
Melinna sp IV		1		1/1	0/2					4
Serpulidae indet. I				1						
SIPUNCULA indet.					1					
Aspidosiphon sp		6	9		1	9	4	12	3	2
Onchnesoma sp	3	1	3	4	1		2	3/1	6	2
CRUSTACEA										
Ampelisca sp.										**1**
Upogebia sp. I									1	
Paguridae indet.					3		1	2	3	
MOLLUSCA										
Nassarius elatus									1	
Nuculana sp I		1	0/1				0/1		0/1	0/1
Lucinoma sp I					1			1		
Abra sp. III		1							1	
Veneridae indet I				1						
ECHINODERMATA										
Amphiuridae indet. III	1	2						1		

Stations	KB16					KB17				
Sample number	**4**	**5**	**6**	**7**	**8**	**4**	**5**	**6**	**7**	**8**
ANTHOZOA indet										
Edwardsia sp.							1			
NEMERTINI indet.						1	1			1
POLYCHAETA										
Amphinomidae indet. III				1		3	1		1	
Ophiodromus sp I						1				
Nephtys sp.			1	1		1	3	1	1	
Glycera alba										1
Goniada sp. I								1		
Paradiopatra sp I								1		
Lumbrineridae indet. VI									0/1	
Phylo sp II		1								
Scoloplos armiger				0/1		1				
Prionospio sp. I	1	3	1	3	2	3	4	2		2
Aphelochaeta sp. V						1				
Flabelligeridae indet II / Sabellaridae indet	1	1					1		1	
Mediomastus sp. I						1				
Notomastus sp. II	1		1		1		0/1			1
Melinna sp IV			1			1/1	2			
SIPUNCULA										
Aspidosiphon sp	2	11	7	6	2	8	5	6	1	1
Onchnesoma sp	4	6	6	1	6/1	8	4	6	2	1
CRUSTACEA										
Pandalidae indet. II	1		1							
Paguridae indet.	1	1			2	1		2	1	
MOLLUSCA										
Naticidae indet. IV				1						
Nassarius elatus		2	1	0/1					2	2
Nuculana sp I	1	1	0/1						1	
Abra sp. III				1						
Scaphopoda indet.				1						
ECHINODERMATA										
Amphiuridae indet. III						1				

Stations	KB18				
Sample number	**4**	**5**	**6**	**7**	**8**
ANTHOZOA indet					
Pennatulacea indet.			1		
NEMERTINI indet.					2
POLYCHAETA					
Polychaeta indet. I			0/1		
Amphinomidae indet. III			1		
Nephtys sp.			1		1
Paradiopatra sp I				1	
Prionospio sp. I			1	1	1
Aphelochaeta sp. IV			1		
Cossura cf. coasta	1			1	
Oweniidae indet.		1	1		
Sternaspis scutata				1	
SIPUNCULA					
Aspidosiphon sp	2	4		6	13
Onchnesoma sp	6	9	9	4/2	2
CRUSTACEA					
Ampelisca sp.			1		
MOLLUSCA					
Naticidae indet. V		1			
Bullia sp.					1
Nassarius elatus	1				
Nuculana sp I	1				
Abra sp. III					0/1
Veneridae indet I		1	1		0/1

Appendix Table 12. Analyse Report. Benthic fauna.

UNIVERSITETSFORSKNING BERGEN AS
Section of Applied Environmental Research (SAM)
High Technology Center, 5006 Bergen
Tef: 55 58 44 64 Fax: 55 58 45 25

Test 157

BENTHIC FAUNA SPECIES LIST

Client: Institute of Marine Research
Project nr.: 218550
Sampling site: Lomba, Cabinda, Angola
Date of sampling: 15.-17. October 2006
Responsible for sampling: Section of Applied Environmental Research
Deviations/circumstances with possible impact on the result: none
Species/taxa identified by: Per Johannessen (all groups)
Per-Otto Johansen (Amphipoda)
Jon Anders Kongsrud (Maldanida)

Methods: The material is obtained according to an accreditation (Test 157) by the Norwegian Accreditation for sampling and taxonomical analyses. This investigation follows Norwegian Standard NS 9423 and an internal quality system.

Information about marks in the species list:
Each sampling station is presented by sample numbers, and under each sample number is the animals which were found in the sample listed.

+ the species occur in the sample, but is not quantified.

/ separate adults and juveniles (example 4/2 mean 4 adults and 2 juveniles).

cf. between genus and species name indicates that identification of genus is certain but the species is uncertain.

***** in front of species or taxa indicate that species/taxa is not included in the analyses.

***** in front of sample number indicate deviation to the sample.

Other informations:

The table starts on next page and includes 9 pages.

Fragmentary copies of the species list are not allowed without written approval from SAM.

Signatur: Per Johannessen
Signatur

	Stations	LB1					LB2				
	Sample number	**4**	**5**	**6**	**7**	**8**	**4**	**5**	**6**	**7**	**8**
*	**PORIFERA indet**						+		+		
*	**HYDROZOA indet**					+					
	NEMERTINI indet.	1	+				1	1			
	ANNELIDA										
	POLYCHAETA										
	Polychaeta indet.								+		
	Amphinomidae indet. III						1				
	Amphinomidae indet. IV						3				
	Amphinome rostrata		1								
	Polynoidae indet.						1				
	Leanira cf. hystricis				1			1			1
	Leocrates sp I					1					
	Ophiodromus sp			1							
	Nephtys sp.	1								0/1	
	Marphysa sp I				1						
	Marphysa sp II				1						
	Lumbrineridae indet. I						1				
	Drilonereis sp.	1									
	Heterospionidae indet I	1		1	1						
	Prionospio sp. I	3	1	1							
	Spiochaetopterus sp.					+					
	Capitellidae indet. I									1	
	Oweniidae indet.	1									
	Ampharetidae indet.									0/1	
	Ampharete sp. I	1									
	Ampharete cf. acutifans	1									
	Amphicteis gunneri	1									
	ECHIURA indet.						1			1	
	CRUSTACEA										
	Upogebia sp.			1				1			
	MOLLUSCA										
	Caudofoveata indet.					+					
	Mangeliinae indet		1								
	Nassarius megalocallus					1		1			
	Montacutidae indet I									1	
	Pulsellidae indet I					1					
	ECHINODERMATA										
	Ophiactidae indet I									1	
	Cucumariidae indet I	1									
	Cucumariidae indet II									1	

	Stations	LB3					LB4				
	Sample number	**4**	**5**	**6**	**7**	**8**	**4**	**5**	**6**	**7**	**8**
	NEMERTINI indet.			1		1	1				
	POLYCHAETA										
	Amphinomidae indet. I		1		1						
	Amphinomidae indet. II						1				
	Amphinomidae indet. III									1	
	Amphinomidae indet. IV										2
	Polynoidae indet.I		1								
	Polynoidae indet. II	1									
	Polynoidae indet. III		1								
	Leanira cf. hystricis	2				1					
	Hesionidae indet.									2	
	Pilargiidae indet. I		1								
	Nephtys sp.									0/3	0/1
	Nephtys sp. I	2			1	1					
	Glycera alba										1
	Marphysa sp									1	
	Marphysa sp II										1
	Lumbrineridae indet. II		1								
	Orbinia sp I									0/1	
	Prionospio sp. I		0/1	0/1	1/2				1		
	Prionospio sp. II		1								
	Magelona sp. I							1			
	Pherusa sp. I										1
	Notomastus sp. I										1
	Sternaspis scutata							1			
	Sabellides sp									1	
	Amphicteis gunneri	1									
	Eupolymnia nebulosa				1			1	1	1	
	Pista sp. I									1	
	Lanice conchilega	1	1			1					
	Streblosoma cf. persia									1	
	Terebellides stroemi				1	1					2
	ECHIURA indet.										+
	SIPUNCULA indet.						1				
	Onchnesoma sp		1								
	CRUSTACEA										
*	Euchaeta sp		1								
	Apseudidae indet.I		1								
	Apseudidae indet.II		1								
	Bopyridae indet.		1								
	Natatolana sp		1								
	Leucothoidae indet									1	
	Brachyura indet. I									1	
	Upogebia sp.		2								1
	Paguridae indet.		1								
	MOLLUSCA										
	Naticidae indet.I							1			
	Nassarius megalocallus	1						1	1		
	Marginella sp. I		1								
	Marginella sp. II		1					1			
	Cylichna sp. I			1							

	Stations	LB5					LB6				
	Sample number	**4**	**5**	**6**	**7**	**8**	**4**	**5**	**6**	**7**	**8**
	NEMERTINI indet.			1	1						
	ANNELIDA										
	POLYCHAETA										
	Amphinomidae indet. III						2			2	
	Leanira cf. hystricis	1	1					2			
	Paralacydonia paradoxa			1							
	Hesionidae indet.I		1				1	1			
	Pilargiidae indet. I			1							
	Nephtys sp.	0/2	0/1	0/1	1	1					
	Lumbrineridae indet.	0/1		0/2							0/1
	Lumbrineridae indet. II				1						
	Lumbrineridae indet. III			2	1	1					
	Orbinia sp I								1		
	Heterospionidae indet I							1			
	Prionospio sp. I	0/2		2					1		
	Prionospio sp. II								1		0/1
	Spiochaetopterus sp.			1							
	Aricidea sp I						2				
	Paranoidae indet. I	1									
	Capitellidae indet. I						1				
	Pectinaria indet.								0/1		
	Ampharete sp. I								2		
	Ampharete cf. acutifans	1									
	Lanice conchilega										1
	Terebellides stroemi				1						
	ARTHROPODA										
	CRUSTACEA										
*	Euchaeta sp				1						
	Natatolana sp										2
	Caridea indet. I								1		
	Brachyura indet. I			1							
	Pinnotheridae indet.						1				
	Crangonidae indet.		1/1								
	Upogebia sp.		1								
	Paguridae indet.		1								
	MOLLUSCA										
	Caudofoveata indet.	1									
	Gastropoda indet		1								
	Naticidae indet.II					1					
*	Buccinacea (egg)	1									
	Ledella sp I		1					1			
	Cuspidaridae indet.								1		

	Stations	LB8					LB9				
	Sample number	**4**	**5**	**6**	**7**	**8**	**4**	**5**	**6**	**7**	**8**
	NEMERTINI indet.			1		1					
	ANNELIDA										
	POLYCHAETA										
	Amphinomidae indet. I						1			1	
	Amphinomidae indet. III						1				
	Polynoidae indet. IV				1			1	1		
	Leanira cf. hystricis				1					1/1	
	Paralacydonia paradoxa	2									
	Hesionidae indet.I					1			3		1
	Kefersteinia cirrata									1	
	Pilargiidae indet. I			2							
	Nephtys sp.	1							2	2	
	Goniada sp. I									1	
	Marphysa sp I					1					
	Lumbrineridae indet. II	1									
	Lumbrineridae indet. III	1		1							
	Lumbrineridae indet. IV						1			1	
	Orbinia sp II			1							
	Prionospio sp. I	1				1			1	1	
	Prionospio sp. II						2			2	
	Aricidea sp I			2							
	Paranoidae indet. III			1							
	Aphelochaeta sp. I		1			2	1			1	
	Cossura cf. coasta									1	
	Capitellidae indet. II		1								
	Maldane sarsi	1									
	Sternaspis scutata			1							
	Amphicteis gunneri			1					0/1		
	Ampharete sp. I								1		
	Lanice conchilega	1		1							
	Terebellides stroemi								1		
	CRUSTACEA	+									
	Apseudidae indet.I		1	1	1				2		
	Apseudidae indet.II									1	+
	Anthuridae indet.						1		1		
	Natatolana sp						4				
	Ampeliscidae indet.		1						1		
	Lysianassidae indet.						1				
	Caridea indet. II			1		1					
	Caridea indet. III					2					
	Crangonidae indet.								1		
	MOLLUSCA										
	Naticidae indet.II						1		1		
	Nassarius megalocallus		1			1			1	1	
	Cylichna sp. I								1		
	Abra sp									1	
	Cuspidaria sp. I					1					
	Cadulus sp. I									1	
	ECHINODERMATA										
	Ophiuroidea indet.		+			+	+	+		+	+
	Amphiuridae indet.	0/1			1				1		
*	**PISCES**										
*	Gobidae indet.					1					
*	**VARIA**									+	

	Stations	LB10					LB13				
	Sample number	**4**	**5**	**6**	**7**	**8**	**4**	**5**	**6**	**7**	**8**
	ANTHOZOA indet										
	Cerianthidae indet.				1					1	
	NEMERTINI indet.	1			1				1		
	POLYCHAETA										
	Amphinomidae indet. I						1				
	Amphinomidae indet. III		1								
	Polynoidae indet.					1					
	Polynoidae indet.I						1				
	Polynoidae indet. IV		1								
	Polynoidae indet.V		1								
	Leanira cf. hystricis						0/1				
	Ceratocephale sp II		1								
	Glycera sp.				1						
	Marphysa sp I		1					1			
	Lumbrineridae indet. II						1				
	Lumbrineridae indet. III						1	1	1		
	Lumbrineridae indet. IV					1					
	Prionospio sp. I										1
	Prionospio sp. II					1		1			
	Poecilochaetus cf. serpens						1				
	Spiochaetopterus cf. costarum								1		
	Paranoidae indet. IV		1								
	Aphelochaeta sp. I					1	1				
	Capitellidae indet. III		1								
	Dasybranchus sp. I	1									
	Sternaspis scutata						1				
	Ampharetidae indet.I					2					
	Ampharetidae indet.II	2									
	Amphicteis gunneri	2									
	Ampharete cf. acutifans				1	1					
	Sabellides octocirrata						1				
	Anobothrus sp I					2					1
	Mellinninae indet.	1									
	Lanice conchilega					1	5				
	CRUSTACEA										
	Apseudidae indet.I									2	1
	Lysianassidae indet.						1				
*	**Euphausiacea indet.**	1		1	+	6					
	Crangonidae indet.									1	
	MOLLUSCA										
	Psammobiidae I						1				
	Cochliolepis cf. jullieni		1								
	Mangelia sp. II					1					
	Nassarius megalocallus	1/1		3	4	4/2					0/1
	Devonia sp					1					
*	**BRYOZOA**										
*	Bryozoa indet. encrusted					+					
	ECHINODERMATA										
	Ophiuroidea indet.		+	+							
	Amphiuridae indet.	1			1		2				

	Stations	LB14					LB15				
	Sample number	**4**	**5**	**6**	**7**	**8**	**4**	**5**	**6**	**7**	**8**
	ANTHOZOA indet									1	
	Actinidae indet.						1				
	NEMERTINI indet.			1						1	
	POLYCHAETA										
	Amphinomidae indet. I										1
	Amphinomidae indet. II		1								
	Polynoidae indet.					1	1				
	Polynoidae indet. VI				1		1				
	Leanira cf. hystricis									2/1	
	Ceratocephale sp I		1								
	Nephtys sp.									4	2
	Nephtys sp. I							2			
	Glycera sp.					2					
	Eunice sp. I			2							
	Marphysa sp I						1				
	Lumbrineridae indet. I						1				
	Lumbrineridae indet. II							1			
	Lumbrineridae indet. III					1		1			
	Prionospio sp. I		1				1	1		1	
	Prionospio sp. II		1			1					
	Aricidea sp I					1					
	Cirratulidae indet.		1								
	Dasybranchus sp. I						1				
	Praxillella nr. gracilis				1						
	Euclymeninae sp.				1						
	Sternaspis scutata						1				1
	Ampharetidae indet.I		1								
	Ampharetidae indet.II									2	
	Amphicteis gunneri	1									
	Ampharete sp. I							1		1	
	Ampharete cf. acutifans								1		
	Anobothrus sp I									1	
	Lanice conchilega									3	2
	SIPUNCULA indet.			1							
	Onchnesoma sp			7							
	CRUSTACEA										
*	Euchaeta sp									1	
	Apseudidae indet.I		1		1		1				
	Ampeliscidae indet.							1			
*	Euphausiacea indet.		**1**								
	Caridea indet. II										1
	Brachyura indet. I					1					
	Thalasinoidae indet.						1				
	MOLLUSCA										
	Caudofoveata indet.			2					1		
	Lamellariidae I										1
	Nassarius megalocallus								1	1	
	Bivalvia indet.						**2**				
	Erycinacea indet I		1								
	Scaphopoda indet.		1								
	ECHINODERMATA										
	Ophiuroidea indet.	+	+		+	+		+	+		1
*	**VARIA**			+							

	Stations	LB16					LB17				
	Sample number	**4**	**5**	**6**	**7**	**8**	**4**	**5**	**6**	**7**	**8**
	ANTHOZOA indet						1		1		
	Cerianthidae indet.						1		1		1
	NEMERTINI indet.		1		1						
	POLYCHAETA										
	Amphinome rostrata				0/1			1			
	Polynoidae indet.							3			
	Polynoidae indet. II		1								
	Panthalis oerstedi		1					0/1	0/1		
	Leanira cf. hystricis			1					1		
	Hesionidae indet.I					1					
	Pilargiidae indet. I		1								
	Nephtys sp.		1		1		1			1	
	Glycera sp.									1	
	Paradiopatra quadricuspis									0/1	
	Marphysa sp I						1		1	1	1
	Marphysa sp II				1						
	Lumbrineridae indet. I				1				1		
	Lumbrineridae indet. II			2			1				
	Lumbrineridae indet. III		1	1							
	Lumbrineridae indet. IV									1	
	Prionospio sp. I	2		1	1		1		3		1
	Prionospio sp. II		2					1			
	Spiochaetopterus cf. costarum				1			1			
	Paranoidae indet. I	1									
	Paranoidae indet. V	1									
	Cirratulidae indet. I		1								
	Aphelochaeta sp. II				1						
	Flabelligeridae indet.				1						
	Flabelligeridae indet.I								1		
	Notomastus sp. I				0/1						
	Sternaspis scutata			1				1			
	Ampharete sp. I							1			
	Ampharete cf. acutifans						1				
	Anobothrus sp I							1			
	Lanice conchilega		2	5	1	1	6/1	5	2	3	1
	Terebellides stroemi			1						1	1
	ECHIURA indet.							3			
	SIPUNCULA indet.						1				
	CRUSTACEA										
	Apseudidae indet.II						1				
	Natatolana sp		2								
	Caridea indet. II				2						
	Caridea indet.						1				
	Brachyura indet. I						1	2	1		
	Natantia indet.							1			
	Thalasinoidae indet.									1	
	Leuchossidae indet. I									1	
	MOLLUSCA										
	Caudofoveata indet.					1					
	Nassarius sp.		0/1								
	Cylichna sp. I		1								
	Bivalvia indet.					+					
	Abra sp I									1	
	Abra sp. II		1								
	Dentalium sp.					1					
	ECHINODERMATA										
	Amphiura indet.							1			
*	**VARIA**	+				+	+				

	Stations	LB18					LB19				
	Sample number	**4**	**5**	**6**	**7**	**8**	**4**	**5**	**6**	**7**	**8**
*	**PORIFERA indet**									+	
	ANTHOZOA indet										
	Pennatulacea indet.										1
	Edwardsia sp.										1
	NEMERTINI indet.		+		1	2				1	
	ANNELIDA										
	POLYCHAETA										
	Polychaeta indet.						1				
	Amphinomidae indet. II				0/3						
	Amphinome rostrata		1	1		1					
	Polynoidae indet.	1	1								
	Polynoidae indet.I	1									
	Malmgreniella lunulata				1						
	Hesionidae indet.I						2	1	2		1
	Pilargiidae indet. II										1
	Nephtys sp.		1	1							
	Glycera alba		1		1			1			
	Glycera sp.I							1			
	Goniada sp. I					1/1					
	Paradiopatra quadricuspis		1								
	Paradiopatra sp I		1		0/1						
	Eunice sp. I		1								
	Marphysa sp I		1								
	Marphysa sp II				1						
	Lumbrineridae indet.		1			1					
	Lumbrineridae indet. I										2
	Lumbrineridae indet. II	1						2	3		3
	Scoloplos armiger									1	1
	Heterospionidae indet I			1							
	Pseudopolydora cf. socialis	1			1						
	Prionospio cf. dubia						1	14	10	5/1	6/7
	Prionospio sp. I	1		2		1/1		1	2		2
	Prionospio sp. II	2									1
	Spiophanes cf. soederstroemi										1
	Spiochaetopterus cf. costarum										1
	Magelona sp. I									1	
	Aricidea sp I	1	1		3		3		1	1	3
	Paranoidae indet. IV								1		
	Paranoidae indet. VI							1			
	Cirratulidae indet. I						1	3	2/1	3	
	Cirratulidae indet. II							1			
	Aphelochaeta sp. I									1	
	Aphelochaeta sp. III						1				
	Chaetozone sp I										1
	Cossura cf. coasta			1			1		1	1	2
	Notomastus sp. II						2				1/1
	Clymenura sp.								2		
	Euclymeninae sp.	1			1						
	Euclymene sp.				1						
	Oweniidae indet.I						1				2
	Amphicteis gunneri									1	

	Stations	LB18					LB19				
	Sample number	**4**	**5**	**6**	**7**	**8**	**4**	**5**	**6**	**7**	**8**
	Ampharete sp. II						1	3	2		
	Sabellides sp I				1						
	Glyphanostomum sp I						4/1	4	3	7	10
	Melinna sp							1			
	Melinna sp I								1		
	Pista sp.										0/1
	Pista sp. I	1									
	Lanice conchilega	6	5	1	5/1	7					
	Lanice cf. norgensis				1						
	Terebellides stroemi		1			0/1					
	SIPUNCULA indet.						1				
	Onchnesoma sp				1	1	4	4	2	7	3
	CRUSTACEA										
	Stomatopoda indet.										1
	Amphipoda indet.							1			1
	Decapoda indet.	+									
	Caridea indet.					1					
	Brachyura indet. I		2		1/2	1					
	Calocaris sp I				1						
	Thalasinoidae indet.I					1					
	Thalasinoidae indet.II				1/2						
	Thalasinoidae indet.III							1			
	Paguridae indet. I			1							
	MOLLUSCA										
	Naticidae indet. III					1					
	Yoldiella cf philippiana						1	5			
	Yoldiella sp.I							2			
	Myrtea cf. spinifera		1								
	Thyasira sp.I						2				
	ECHINODERMATA										
	Ophiuroidea indet.										
	Amphiuridae indet. II										0/1
	Cucumariidae indet III									1	
	ENTEROPNEUSTA indet.						1			1	
*	**VARIA**		+								

Appendix Table 13. Analyse Report. Benthic fauna.

UNIVERSITETSFORSKNING BERGEN AS
Section of Applied Environmental Research (SAM)
High Technology Center, 5006 Bergen
Tef: 55 58 44 64 Fax: 55 58 45 25

Test 157

BENTHIC FAUNA SPECIES LIST

Client: Institute of Marine Research, Bergen
Project nr.: 218550
Sampling site: Nemba North, Cabinda, Angola
Date of sampling: 17. October 2006
Responsible for sampling: Section of Applied Environmental Research
Deviations/circumstances with possible impact on the result: none
Species/taxa identified by: Per Johannessen (all groups)
Per-Otto Johansen (Amphipoda)
Jon Anders Kongsrud (Maldanida)

Methods: The material is obtained according to an accreditation (Test 157) by the Norwegian Accreditation for sampling and taxonomical analyses. This investigation follows Norwegian Standard NS 9423 and an internal quality system.

Information about marks in the species list:
Each sampling station is presented by sample numbers, and under each sample number is the animals which were found in the sample listed.

+ the species occur in the sample, but is not quantified.

/ separate adults and juveniles (example 4/2 mean 4 adults and 2 juveniles).

cf. between genus and species name indicates that identification of genus is certain but the species is uncertain.

***** in front of species or taxa indicate that species/taxa is not included in the analyses.

***** in front of sample number indicate deviation to the sample.

Other informations:

The table starts on next page and includes 2 pages.

Fragmentary copies of the species list are not allowed without written approval from SAM.

Signatur:.....
Signatur

	Stations	NB1					NB2				
	Sample number	**4**	**5**	**6**	**7**	**8**	**4**	**5**	**6**	**7**	**8**
	NEMERTINI indet.		1	1	2		1				+
	ANNELIDA										
	POLYCHAETA										
	Polynoidae indet.		2								1
	Leanira cf. hystricis		0/2	0/1							
	Hesionidae indet.I						1				
	Nephtys sp.			1	1	1	1	2	4		
	Glycera sp.I		1								
	Marphysa sp I		1				1				
	Marphysa sp II		0/3								
	Prionospio sp. I				1		2	1			
	Prionospio sp. II		1		1						
	Spiochaetopterus cf. costarum							1			
	Aricidea sp I						1				
	Aricidea sp II										1
	Paranoidae indet. I									1	
	Paranoidae indet. VI	1					1				
	Aphelochaeta sp. I		2					1			
	Aphelochaeta sp. III							1			
	Cossura cf. coasta	1									
	Notomastus sp. II				0/1						
	Euclymeninae sp.										1
	Amphicteis gunneri			1							
	Ampharete sp. I	1									
	Ampharete cf. acutifans	1					1				
	Anobothrus sp I						1				
	SIPUNCULA										
	Onchnesoma sp							1			
	CRUSTACEA										
	Isopoda indet. I							1			
	Macrura sp. I		2								
	Brachyura indet.			0/1							
	Brachyura indet. I		15/8								
	Natantia indet.		1/1								
	Natantia indet.I		2/2								
	Pandalidae indet. I		1								
	Calocaris sp I		1								
	Paguridae indet.		1						1		
	MOLLUSCA										
	Naticidae indet. VI			1							
	Bucciniacea indet.								2/1	2	
	Nassarius megalocallus	1/1	0/1								
	Philine sp I						1				
	Thyasira sp.		1		1	1			1		1
	Abra sp I						1				
	ECHINODERMATA										
	Amphiuridae indet. I						1	+			3
*	**VARIA**					1					

	Stations	NB3					NB4				
	Sample number	**4**	**5**	**6**	**7**	**8**	**4**	**5**	**6**	**7**	**8**
	NEMERTINI indet.				2	2		1	1		
	POLYCHAETA										
	Amphinomidae indet. II				1						
	Amphinome rostrata		1/2	2/1	0/1	4		2			
	Polynoidae indet.		1		1				1		
	Polynoidae indet. II						1				
	Polynoidae indet. VI								1	1	
	Leanira cf. hystricis	1	1								1
	Paralacydonia paradoxa				1						
	Hesionidae indet.I					1				0/1	
	Ceratocephale sp II						1	1			
	Nephtys sp.	1		2	2		4				
	Glycera alba				1				0/1		
	Eunice sp. I						1				1
	Marphysa sp I	1									
	Marphysa sp II						1				
	Lumbrineridae indet. II					1					
	Lumbrineridae indet. V			1							
	Phylo cf. capensis							1			
	Heterospionidae indet I									2	
	Prionospio cf. dubia							1			
	Prionospio sp. I					1	1				
	Prionospio sp. II				1		2	1			
	Aricidea sp II					1					
	Paranoidae indet. VI			1							
	Cirratulidae indet. I						0/1				
	Cirratulidae indet. III						1				
	Aphelochaeta sp. I							1			
	Cossura cf. coasta					1					
	Flabelligeridae indet.I							1			
	Notomastus sp. I			0/1	1		1				
	Notomastus sp. II									1	
	Euclymeninae sp.		1								
	Ampharetidae indet.II							1			
	Ampharete cf. acutifans	1					1				1
	Anobothrus sp I		1								
	Pista sp II				1						
	Lanice conchilega				2		4	2	2		
	Polycirrus sp. I							1			
	Terebellides stroemi	1		1				1		1	1
	SIPUNCULA										
	Onchnesoma sp							1			
	CRUSTACEA									+	
*	Calanoidae indet I		1								
	Isopoda indet.			1							
	Amphipoda indet.				1						
*	**Euphausiacea indet.**							1			2
	Natantia indet.				0/2						
	Upogebia sp. I	1			0/1		1				
	MOLLUSCA										
	Caudofoveata indet. I										1
	Naticidae indet.I		1								
	Nassarius megalocallus	3	1/1				0/2	2/1	0/1	1/1	
	Cylichna sp. I		1								
	ECHINODERMATA										
	Amphiuridae indet. I		1	+	+		1		2	1	

Appendix Table 14. Geometric classes at Kambala jacket 132-05.

Geometric classes	KB1	KB2	KB3	KB4	KB12	KB13	KB14	KB15	KB16	KB17	KB18
I	15	19	12	10	12	13	11	15	7	11	12
II	7	6	9	8	4	4	6	5	5	3	6
III	2	7	4	3	5	1	2	2	2	5	0
IV	1	3	0	1	2	2	2	2	1	1	0
V	0	1	1	2	0	0	1	1	2	2	1
VI	1	0	0	0	1	1	0	0	0	0	1
VII	0	0	0	0	0	0	0	0	0	0	0

Appendix Table 15. Geometric classes at Lomba.

Geometric class	LB1	LB2	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB13	LB14	LB15	LB16	LB17	LB18	LB19
I	18	11	18	21	15	11	23	14	15	19	19	17	20	22	22	19	26
II	1	4	6	5	4	6	8	13	10	7	3	5	8	7	7	15	8
III	1	0	2	1	3	1	3	0	4	0	1	1	2	1	3	3	6
IV	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	3
V	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
VI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
VII	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix Table 16. Geometric classes at Nemba North.

Geometric class	NB1	NB2	NB3	NB4
I	14	19	21	20
II	10	2	7	9
III	2	3	3	2
IV	0	0	1	2
V	1	0	0	0
VI	0	0	0	0
VII	0	0	0	0

Appendix Table 17. Sample journal. Start at the next page and contains 32 sheets.

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
KB 16	14.10.06			23 m

Weather:	Wind:	Wave hight (m):
Time Start: 09:00	Time Finish: 11:00	Duration: 2 h
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: mud	
Color: Top layer 10 YR 3/3 Dark brown, rest of the sediment 2,5Y 2,5/1 black	Odor: -
Observation of animals: Polychaeta, crustacea, mollusca	
Observation of oil, waste etc: -	No rejected samples: 1

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
KB 15	14.10.06			23 m

Weather:	Wind:	Wave hight (m):
Time Start: 13:05	Time Finish: 14:55	Duration: 1 h 55 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: mud	
Color: Top layer 10 YR 3/2 Very dark grayish brown, rest of the sediment GLEY1 2,5/N black	Odor: -
Observation of animals: Polychaeta, ophiuroidea, mollusca	
Observation of oil, waste etc: -	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	oil in the water bath for sieve
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
KB 14	14.10.06			23 m

Weather:	Wind:	Wave hight (m):
Time Start: 15:00	Time Finish: 16:45	Duration: 1 h 45 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: mud	
Color: Top layer 10 YR 3/2 Very dark grayish brown, rest of the sediment GLEY1 2,5/N black	Odor: -
Observation of animals: Polychaeta, mollusca	
Observation of oil, waste etc: -	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
KB 12	14.10.06			23 m

Weather:	Wind:	Wave hight (m):
Time Start: 17:25	Time Finish:	Duration:
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: mud	
Color: Top layer 10 YR 3/2 Very dark grayish brown, rest of the sediment GLEY1 2,5/N black	Odor: -
Observation of animals: Polychaeta, bivalve, gastropoda, crustacea	
Observation of oil, waste etc: -	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
KB 13	14.10.06			25 m

Weather:	Wind:	Wave hight (m):
Time Start: 18:28	Time Finish: 19:35	Duration: 1 h 07 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: mud	
Color: Top layer 2,5Y 3/1 very dark gray , rest of the sediment 5Y 2,5/2 black	Odor: -
Observation of animals: Polychaeta, mollusca	
Observation of oil, waste etc: -	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
KB 18	14.10.06			34 m

Weather:	Wind:	Wave hight (m):
Time Start: 20:05	Time Finish: 21:15	Duration: 1 h 10 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: mud	
Color: Top layer 2,5Y 3/3 dark olive brown, rest of the sediment 5Y 2,5/1 black	Odor: -
Observation of animals: Polychaeta	
Observation of oil, waste etc: -	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
KB 17	14.10.06			27 m

Weather:	Wind:	Wave hight (m):
Time Start: 21:37	Time Finish:	Duration:
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: mud	
Color: Top layer 10YR 2/2 very dark brown, rest of the sediment 2,5Y 2,5/1 black	Odor: -
Observation of animals: Polychaeta	
Observation of oil, waste etc: -	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
KB 4	14.10.06			23 m

Weather:	Wind:	Wave hight (m):
Time Start: 23:07	Time Finish:	Duration:
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: mud	
Color: Top layer 2,5Y 3/2 very dark grayish brown, rest of the sediment 5Y 2,5/1 black	Odor: -
Observation of animals: Polychaeta, mollusca	
Observation of oil, waste etc: -	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
KB 3	15.10.06			22 m

Weather:	Wind:	Wave hight (m):
Time Start: 06:15	Time Finish:	Duration:
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: Top layer 10YR 3/2 very dark grayish brown, rest of the sediment GLEY 1, 2,5/10Y greenish black	Odor: -
Observation of animals: Polychaeta, mollusca and crustacea	
Observation of oil, waste etc: -	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
KB 2	15.10.06			22 m

Weather:	Wind:	Wave hight (m):
Time Start: 07:16	Time Finish:	Duration:
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: Top layer 10YR 3/2 very dark grayish brown, rest of the sediment GLEY 1, 2,5/10Y greenish black	Odor: -
Observation of animals:	
Observation of oil, waste etc: -	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	3/3	3/3	1	Sectioned
2	21-0 = 21 litre	1/1	1/1		
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	The sediment was stuck to the lids in
5	21-0 = 21 litre	1	all samples
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
KB 1	15.10.06			22 m

Weather:	Wind:	Wave hight (m):
Time Start: 09:30	Time Finish:	Duration:
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: Top layer 10YR 3/2 very dark grayish brown, rest of the sediment GLEY 1, 2,5/10Y greenish black	Odor: -
Observation of animals: Polychaeta, mollusca	
Observation of oil, waste etc: -	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	3/3	3/3	1	Sectioned
2	21-0 = 21 litre	1/1	1/1		
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	The sediment was stuck to the lids in
5	21-0 = 21 litre	1	all samples
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
LB 17	15.10.06			134 m

Weather:	Wind:	Wave hight (m):
Time Start: 15:00	Time Finish: 16:40	Duration: 1 h 40 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: 2.5Y 3/2 very dark grayish brown	Odor: -
Observation of animals: Polychaeta, mollusca, crustacea, anthozoa?	
Observation of oil, waste etc: -	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	2	
7	21-0 = 21 litre	2	
8	21-0 = 21 litre	2	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
LB 16	15.10.06			132 m

Weather:	Wind:	Wave hight (m):
Time Start: 16:50	Time Finish:	Duration:
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: GLEY1, 3/10Y very dark grayish green	Odor: -
Observation of animals: Polychaeta, mollusca	
Observation of oil, waste etc: -	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
LB 18	15.10.06			146 m

Weather:	Wind:	Wave hight (m):
Time Start: 18:33	Time Finish	Duration:
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: GLEY1, 3/10Y very dark grayish green	Odor: -
Observation of animals: Polychaeta, mollusca	
Observation of oil, waste etc: -	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
LB 19	15.10.06			274 m

Weather:	Wind:	Wave hight (m):
Time Start: 20:50	Time Finish: 23:45	Duration: 2 h 55 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud and shell fragments	
Color: 5Y 3/2 dark olive gray	Odor: -
Observation of animals: Polychaeta	
Observation of oil, waste etc: -	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
LB 20	16.10.06			97 m

Weather:	Wind:	Wave hight (m):
Time Start: 01:00	Time Finish: 02:10	Duration: 1 h 10 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: 5Y 3/2 dark olive gray	Odor: -
Observation of animals: Polychaeta, mollusca	
Observation of oil, waste etc: -	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	2	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	2	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
LB 9	16.10.06			109 m

Weather:	Wind:	Wave hight (m):
Time Start: 02:45	Time Finish: 04:00	Duration: 1 h 15 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: 5Y 3/2 dark olive gray	Odor: -
Observation of animals: Crustacea, polychaeta, mollusca	
Observation of oil, waste etc: -	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	4	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	5	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
LB 4	16.10.06			130 m

Weather:	Wind:	Wave hight (m):
Time Start: 04:30	Time Finish: 06:00	Duration: 1 h 30 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: 2.5Y 3/2 very dark grayish brown	Odor: -
Observation of animals: Polychaeta, mollusca	
Observation of oil, waste etc: -	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	2	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
LB 15	16.10.06			131 m

Weather:	Wind:	Wave hight (m):
Time Start: 06:35	Time Finish:	Duration:
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud and shell fragments	
Color: 5Y 3/2 dark olive gray	Odor: -
Observation of animals: Polychaeta, mollusca	
Observation of oil, waste etc: -	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
LB 1	16.10.06			130 m

Weather:	Wind:	Wave hight (m):
Time Start: 09:05	Time Finish:	Duration:
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: 5Y 3/2 dark olive gray	Odor: -
Observation of animals: Polychaeta, mollusca	
Observation of oil, waste etc: oil spots on the sediment surface	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	3/3	3/3	1	The sediment was stuck to the lids in all samples
2	21-0 = 21 litre	1/1	1/1		
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	Oil in the sediment

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
LB 5	16.10.06			128 m

Weather:	Wind:	Wave hight (m):
Time Start: 11:15	Time Finish: 12:45	Duration: 1 h 30 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: 2.5Y 3/2 very dark grayish brown	Odor: -
Observation of animals: Polychaeta, mollusca, crustacea	
Observation of oil, waste etc:	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
LB 6	16.10.06			128 m

Weather:	Wind:	Wave hight (m):
Time Start: 13:55	Time Finish: 14:30	Duration: 1 h 35 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: 2.5Y 3/2 very dark grayish brown	Odor: -
Observation of animals: Polychaeta, mollusca, crustacea	
Observation of oil, waste etc:	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
LB 2	16.10.06			130 m

Weather:	Wind:	Wave hight (m):
Time Start: 15:00	Time Finish: 17:30	Duration: 2 h 30 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: GLEY1, 3/10Y very dark greenish gray	Odor: -
Observation of animals: Polychaeta, mollusca	
Observation of oil, waste etc: Oil in the sediment	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		Oil in all sample for chemistry

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	Oil in the sediment
5	21-0 = 21 litre	1	Oil in the sediment
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	Oil in the sediment
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
LB 3	16.10.06			130 m

Weather:	Wind:	Wave hight (m):
Time Start: 17:35	Time Finish: 19:20	Duration: 1 h 45 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: 5Y 3/2 dark olive gray	Odor: -
Observation of animals: Polychaeta, mollusca	
Observation of oil, waste etc:	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
LB 7	16.10.06			125 m

Weather:	Wind:	Wave hight (m):
Time Start: 19:40	Time Finish: 21:05	Duration: 1 h 25 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: 5Y 3/2 dark olive gray	Odor: -
Observation of animals: Polychaeta	
Observation of oil, waste etc:	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
LB 8	16.10.06			121 m

Weather:	Wind:	Wave hight (m):
Time Start: 21:45	Time Finish: 23:00	Duration: 1 h 15 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: 2.5Y 3/2 very dark grayish brown	Odor: -
Observation of animals: Polychaeta, mollusca, crustacea	
Observation of oil, waste etc:	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-0 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
LB 13	16.10.06			128 m

Weather:	Wind:	Wave hight (m):
Time Start: 23:35	Time Finish: 01:20	Duration: 1 h 45 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: 5Y 3/2 dark olive gray	Odor: -
Observation of animals: mollusca	
Observation of oil, waste etc:	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-7 = 14 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
LB 14	17.10.06			125 m

Weather:	Wind:	Wave hight (m):
Time Start: 01:40	Time Finish: 03:15	Duration: 1 h 35 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: 5Y 3/2 dark olive gray	Odor: -
Observation of animals: Polychaeta, mollusca	
Observation of oil, waste etc:	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-7 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
NB 4	17.10.06			116 m

Weather:	Wind:	Wave hight (m):
Time Start: 03:40	Time Finish: 05:10	Duration: 1 h 30 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: 5Y 3/2 dark olive gray	Odor: -
Observation of animals: Polychaeta, mollusca	
Observation of oil, waste etc:	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-7 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
NB 3	17.10.06			115 m

Weather:	Wind:	Wave hight (m):
Time Start: 06:20	Time Finish: 08:50	Duration: 1 h 30 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: 2.5Y 3/2 very dark grayish brown	Odor: -
Observation of animals: Polychaeta, mollusca	
Observation of oil, waste etc:	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	The sediment was stuck to the lids in
2	21-0 = 21 litre	1/1	1/1		all samples
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-7 = 21 litre	1	
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
NB 2	17.10.06			115 m

Weather:	Wind:	Wave hight (m):
Time Start: 09:15	Time Finish: 11:00	Duration: 1 h 45 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: 5Y 3/2 dark olive gray	Odor: -
Observation of animals: Polychaeta, mollusca	
Observation of oil, waste etc: few oil spot in the sediment	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	1/1	1/1	1	
2	21-0 = 21 litre	3/3	3/3		Sectioned 0-1, 1-3 and 3-6 cm
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-7 = 21 litre	1	The sediment was stuck to the lids in all samples
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	

Vessel: R/V Dr. Fridtjof Nansen	Area: Cabinda Angola	Project code:	Survey nr: 2006410

Grab station nr.	Date	Position		Depth (m)
		Latitude	Longitude	
NB 1	17.10.06			115 m

Weather:	Wind:	Wave hight (m):
Time Start: 11:15	Time Finish: 13:00	Duration: 1 h 45 min
Sample equipment used (name, bite area, weight): 0,1m^2 Van Veen Grab (no extra weight) and 1 mm sieve (round holes)		

Type of bottom sediment: Mud	
Color: 5Y 3/2 dark olive gray	Odor: -
Observation of animals: Crustacea	
Observation of oil, waste etc: oil spot on the sediment surface	No rejected samples: -

Sample nr	Volume (cm)	Hydrocarbons Norway/Angola	Heavy metal Norway/Angola	Sediment granulometry	Remarks:
1	21-0 = 21 litre	3/3	3/3	1	Sectioned 0-1, 1-3 and 3-6 cm
2	21-0 = 21 litre	1/1	1/1		
3	21-0 = 21 litre	1/1	1/1		

Sample nr	Volume (cm)	No containers bottom fauna	Remarks:
4	21-7 = 21 litre	1	The sediment was stuck to the lids in all samples
5	21-0 = 21 litre	1	
6	21-0 = 21 litre	1	
7	21-0 = 21 litre	1	
8	21-0 = 21 litre	1	