Post drill survey A6-A6
2014

S.T. Glorius, B.E. van der Weide and N.H.B.M. Kaag

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Institute for Marine Resources & Ecosystem Studies

Client: Wintershall Noordzee BV
Procurement Department
Postbus 1011, Rijswijk

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P.O. Box 68
1970 AB IJmuiden
Phone: +31 (0)317 48 09 00
Fax: +31 (0)317 48 73 26
E-Mail: imares@wur.nl
www.imares.wur.nl

P.O. Box 77
4400 AB Yerseke
Phone: +31 (0)317 48 09 00
Fax: +31 (0)317 48 73 59
E-Mail: imares@wur.nl
www.imares.wur.nl

P.O. Box 57
1780 AB Den Helder
Phone: +31 (0)317 48 09 00
Fax: +31 (0)223 63 06 87
E-Mail: imares@wur.nl
www.imares.wur.nl

P.O. Box 167
1790 AD Den Burg Texel
Phone: +31 (0)317 48 09 00
Fax: +31 (0)317 48 73 62
E-Mail: imares@wur.nl
www.imares.wur.nl

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Summary

A consortium, consisting of Wintershall Holding GmbH, EMPG, RWE Dea and EWE AG, has drilled a production well linked to the existing production platform A6-A. This platform is located in an 'FFH-area' with a Natura 2000 designation area. In May 2011 a baseline study was carried out by IMARES and DeepOcean B.V. These findings are reported in Glorius & Kaag 2011.

Wintershall has requested IMARES to conduct a post-drilling survey at the A6-A platform site to assess the impact of the drilling activities. The 2014 survey consisted of the same elements (including sampling of sediment, side scan sonar and video recordings from the sea floor), as well as the same sampling grid as in the baseline study in 2011. Results of the post-drilling survey (2014) are analysed and compared with the 2011 survey to assess any impact of the drilling activities.

Monitoring activities in both the survey in 2011 and the post-drilling survey in 2014 consisted of:

- Side scan sonar survey – to obtain a map showing the seafloor texture and to identify the presence of any structures (including stones) within the area.
- Sediment sampling - for determination of the benthic community, grain size distribution and chemical characteristics (mineral oil content and content of heavy metals).
- Video recording of the sea floor – to obtain a visual impression of the seafloor characteristics and larger epifaunal species present, were only made in 2011.

A box-corer was used for collection of sediment samples to be used for chemical and biological analyses. Water depth was recorded as well. Physical analysis of the sediment consisted of grain size, organic carbon and dry matter analysis. Chemical analysis included heavy metal content (barium, cadmium, copper, iron, mercury, lead and zinc) and mineral oil content. Sampled macrozoöbenthic organisms were identified to the lowest taxonomic level possible, and the number of individuals of each taxon was determined.

The 2014 data alone, show two clearly distinguished clusters of organisms. Differences in benthic species composition between clusters are subtle. Compared to the 2011 baseline survey, the benthic community composition shows only slight changes. Superimposing the 2011 clusters on the 2014 data shows that these are still present. The number of red list species found in the area, is comparable to previous surveys.

No change in morphology was visible on the side scan mosaic. The sediment is and was characterized as being sandy with limited silt content. Of the analysed metals barium (-24%), lead (-21%) and zinc (-44%) decreased significantly in 2014.

The observed changes have occurred all over the survey area and can, therefore, be considered autonomous developments that are not directly related to the drilling activities at A6-A6.

1 Introduction

A consortium, consisting of Wintershall Holding GmbH, EMPG, RWE Dea and EWE AG, has drilled a 6th production well on platform A6-A. Starting with a first attempt in the 1st quarter of 2012, the work was finished in 2014. The jack-up rig "Noble rig George Sauvageau" took care of the drilling. The drilling is linked to the existing production platform A6-A.

The coordinates of platform A6-A are: 562349.7 mE, 6183455.6 mN (UTM zone 31). The platform is situated in the north eastern part of Doggers Bank in the North Sea (Figure 1). The average water depth in the platforms' vicinity is around 47 meters with a dominant current in NW-SE direction.

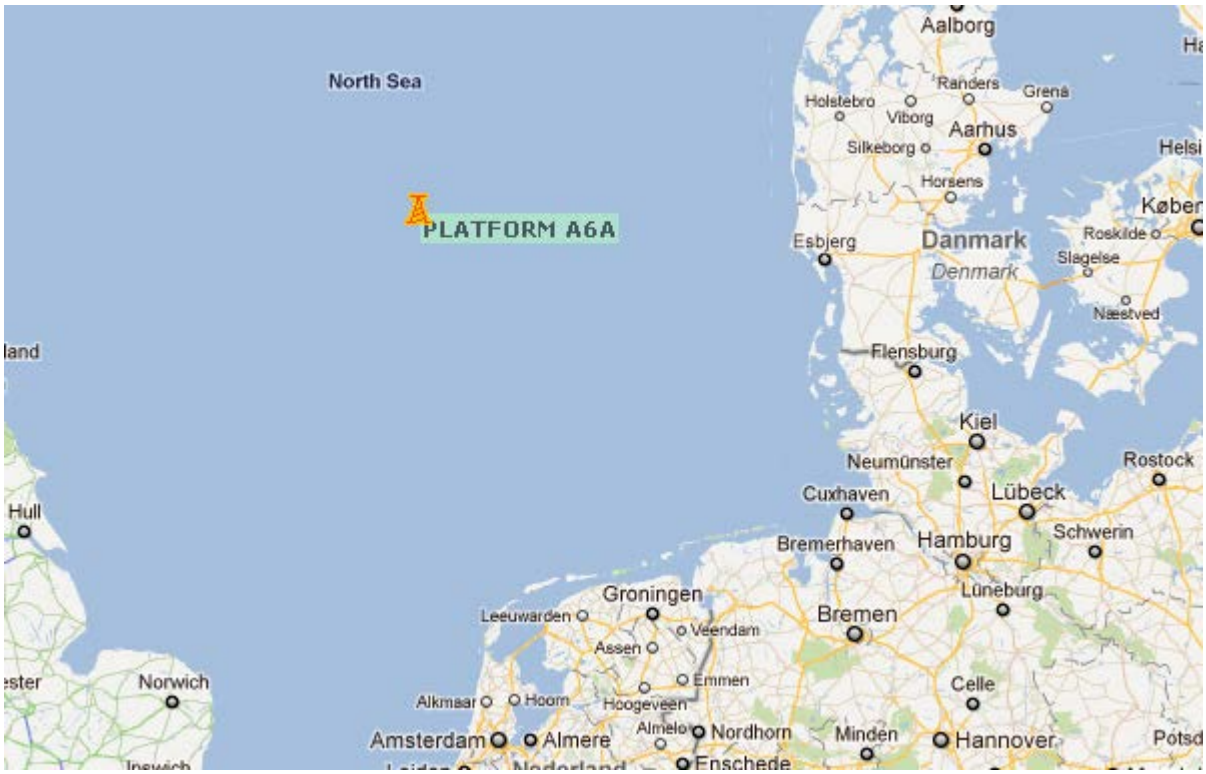

Figure 1: Location platform A6-A, source Google Maps.

The drilling site lies within an Flora, Fauna, Habitat Directive area (FFH-area) with a Natura 2000 designation, managed through a procedure in the Habitats Directive for the assessment and subsequent decisions relating to activities that possibly have an impact on designated sites. Activities need to be judged on their possible effect on the species or habitat types for which the site is being designated as a Natura 2000 site.

Studies on the long term impacts of discharges of drill cuttings on the Dutch Continental Shelf (Daan *et al.* 1990) have shown that effects of contaminated drill cuttings were traceable up to 1000 m from the discharge site, but are generally found in the close vicinity of the platform. ARSU GmbH has drawn up a document detailing the conservation status of the area and the research required. In Chapter 5 of the ARSU study outline, an overview is given of the monitoring requirements. To be able to assess the effect of the drilling activities, both prior to and after the drilling activities the environmental conditions have to be determined.

Wintershall asked IMARES to draw up a project plan for the benthos assessment and side-scan sonar analysis with reference to Par. 5.1.1 of the ARSU document. The baseline survey has been performed in 2011. Due to delay in the actual drilling activities, the post drill survey was conducted in 2014 directly after completion of the drilling activities.

This project is following up the study carried out before drilling activities took place. The baseline study was carried out by IMARES and DeepOcean B.V in 2011 (Glorius & Kaag 2011). The present report describes the results of the post drilling survey, in order to facilitate completion of the official requests for the drilling activities with the German Authorities. This report includes the results of the side-scan sonar, a description of the sediment characteristics and a benthic community analysis. Secondly the situation after the drilling activities is assessed in relation with the baseline survey conducted in 2011.

2 Materials and methods

The environmental sampling activities were carried out by personnel of IMARES and NIOZ. Fugro assisted in the environmental sampling and carried out the side-scan sonar survey. The 'Atlantic Surveyor', owned by Atlantic Marine & Aviation LLp, was charted by Fugro to assist the survey. The fieldwork took place from the 26nd of May to the sixth of June 2014, as described in Glorius & Kaag, 2014.

The following activities were carried out: side-scan sonar survey, collection of sediment samples with a box-corer and video recordings to take pictures of the seabed. The side-scan sonar was used to construct a map that shows the structure of the seabed around the platform. Sediment cores were collected to analyse the benthic community, the sediment particle size distribution and the chemical characteristics of the sediment. Video recordings were to obtain a visual impression of the seabed at the sample locations. Unfortunately no photographs of seabed could be made around platform due to deteriorating weather conditions at end of fieldtrip.

2.1 Sample locations

Similar to the baseline survey in 2011, 28 locations around the A6-A platform were sampled. The sample locations, circular orientated, are located as follows (Figure 2): at a radius of 125 meter, 250 meter and 500 meter from the platform, four stations are situated at angles of 45, 135, 225 and 315 degrees. At a distance of 1000 meter from the platform two additional stations, at angles of 90 and 180 degrees, are added to the four stations at 45, 135, 225 and 315 degrees. Again at a distance of 2000 meter from the platform two additional stations, at angles of 90 and 180 degrees, are added to the four stations at 45, 135, 225 and 315 degrees. At 4000 meter of the platform a station was located at an angle of 135 degrees. Stations are condensed in the dominant current direction. Finally three reference points were added to the sample locations. Reference points are located 10 km away from the platform, at 0, 180 and 290 degrees.

At each location five sediment samples were collected using the box-corer. An area of 2 x 2 km around the platform was scanned with side-scan sonar.

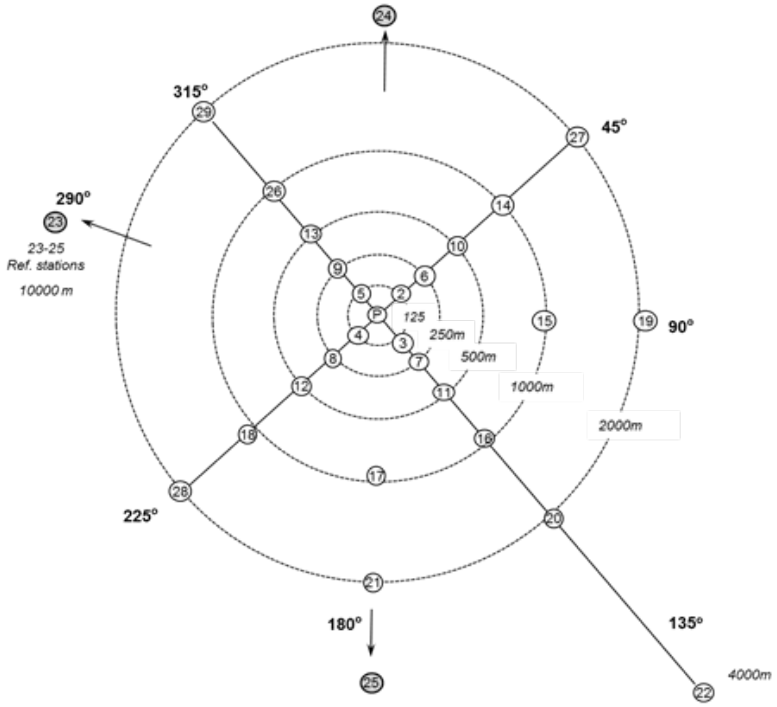

Figure 2: Schematic presentation of the sample locations. Platform A6-A is located in the centre (depicted with the symbol 'P').

2.2 Fieldwork

2.2.1 Side-scan monitoring

Side-scan sonar is a technique to image the seabed using sound. It is particularly useful if a detailed map of the seabed is required that covers a large area. Sound emitted by the sonar (usually in the frequency range of 100 – 500 kHz) is scattered against objects located on the seabed. The strength and travel time of the sound varies due to this effect. By recording both strength and travel time an image of the seabed can be constructed. The side-scan sonar survey was carried out by Fugro B.V.

The sonar itself is located in a so called 'tow fish', towed behind the vessel by a steel cable. A data cable located in the inner parts of the steel cable is connected to a computer on deck. An area of 2 by 2 km was surveyed with the side-scan sonar. An image was created from the different side-scan sonar lines that show the structure and morphology of the seabed. It will also show the position of stones, boulders or any other object when present.

2.2.2 Box-corer for sediment sampling

Sampling of the sediment was carried out by IMARES and NIOZ with assistance of Fugro B.V. The device used to collect the sediment is a so called 'box-corer' (Figure 3). A box-corer consists of a frame in which a cylindrical pot is situated in the middle. Several weights are connected to the pot to push it into the sediment once situated on the seafloor. A blade, attached to a steel plate, is moved under the pot to trap the sediment during recovering. The sampling area of the box-corer is approximately 0.07 m^2.

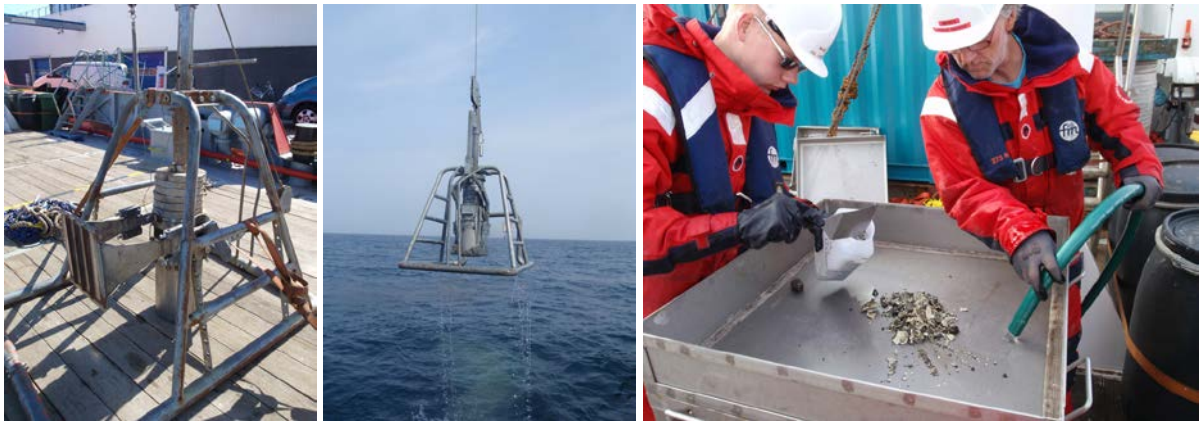

Figure 3: Box-corer on deck (left), box-corer lifted after taking a grab (middle), sieving of a sediment sample (right).

At each sample location five sediment samples were taken when possible. Three sediment samples (cores) were taken to study the macrozoobenthic community. The other two sediment samples (cores) were used to collect material for chemical analysis.

The following procedure was followed:

1. The box-corer was lowered to the seabed using the ships main crane. Once at the seabed the depth, current and global position were measured by the surveyor and recorded in an excel file. When the corer hits the seafloor a pin unhooks itself automatically and the box is pushed into the sediment with the assistance of the weights. When the corer is lifted, the plate closing it during recovery, is moved underneath the box.

2. On deck the box was removed from the corer frame and placed above a sieve with a mesh size of 1 mm. Any water standing above the sediment in the box was removed and a photograph was taken of the sediment surface together with information of the station (number and location). The distance between the top of the box and sediment surface was measured and noted. The pot was removed and the depth of the oxidized layer was measured and recorded together with some basic characteristic of the sediment.

3.1 From the three samples taken for macrozoobenthos, a small subsample (approximately 100 ml) was taken using a 3 cm^2 core. This sample was used for the determination of the sediments' particle size distribution and organic matter content. The remaining material was rinsed with sea water over a sieve with a mesh size of 1 mm, to remove sand and clay particles. From the remaining material (biota, shells, stones and other particles) a photograph was taken, after which the sample was stored in a polyethylene container. The sample was preserved with 6-10 % buffered formaldehyde in seawater solution.

3.2 From the two sediment cores taken for chemical analysis, 2 centimetre of the top layer was scraped off, homogenized and divided over two glass jars with a Teflon cap inlay. One sample was used for analysis of the metal content and one sample for analyses of the hydrocarbon content.

Leaking pots or pots with a penetration depth less than 15 cm were rejected and a new box-corer sample was taken.

All required sediment samples were taken successfully (Glorius & Kaag 2014).

2.2.3 Video sampling and recording

Unfortunately no photographs of the seabed could be made around the platform due to deteriorating weather conditions at the end of the fieldtrip and presence of a supplier within the 500 meter zone.

2.3 Laboratory work

2.3.1 Macrofauna characterisation

One out of three macrofauna samples taken from each sample location was analysed. The other two samples were stored and are available for additional examinations if needed. The samples that were analysed to study species compositions are the same as the samples that were analysed for sediment characteristics (grain size distribution).

Collected macrofauna was examined and identified by making use of a stereomicroscope. Standard taxonomic keys and references were used to identify each taxon. The sampled organisms were identified to the lowest taxonomic level possible (WoRMS Editorial Board 2014). The number of individuals of each taxon was determined. Specimen that could not easily be identified were kept aside for further examination. Juveniles, whose species-specific features were not sufficiently developed, were identified to a higher taxonomic level.

Processed samples will be stored at IMARES after enumeration for a period of 5 years after completion of the project (*i.c.* December 2020). This period can be prolonged to the client's wishes. Examples of the benthic species were taken up in the Taxonomic Reference Collection that has been maintained for several years at IMARES as part of their QA procedures.

2.3.2 Chemical & physical characterisation of the sediment

Chemical analysis was conducted for a single sample of each of the stations. The duplicate samples are stored at -20°C for maximally 1 year. Chemical analyses were performed by TNO Earth Environment and Life Sciences, Utrecht, except for the heavy metal analyses which were done by TNO Triskelion B.V., Zeist, The Netherlands. Dry weight, organic content and grain size analysis were performed at the Analytical Laboratory of the NIOZ in Yerseke.

Dry weight and organic content

Sediment was dried at 105 °C to a constant weight for determination of the dry weight. Organic content was determined by loss on ignition after incineration for 2 hours at 550 °C and measuring the weight difference; values are recorded as ash-free dry weight (ADW).

Grain size distribution

To identify sediment grain size distribution, sediment samples were analysed on a Malvern Mastersizer 2000 'particle analyser' after being freeze-dried. A Malvern apparatus measures the light dispersal pattern of sediment particles in the range of 0.02 to 2000 µm, while in suspension passing a laser beam. All sediment analyses have been executed by the Malvern. Data-outputs include the proportional distribution of sediment grains over the size classes <63 µm (silt), 63-125 µm (very fine sand), 125-250 µm (fine sand), 250-500 µm (medium sand), 500-2000 µm (coarse sand), the median and modal grain size including 0.1 and 0.9 percentile grain size values.

Hydrocarbons

In each of the selected samples, hydrocarbons (C_{10} – C_{40}) were measured using GC-FID (Gas Chromatography Flame Ionisation Detection). Detection limits for the hydrocarbon analyses are <2 mg/kg.

Metal analysis

The sediment concentration of the following metals were determined; barium, cadmium, copper, zinc, lead, mercury and iron. A part of the sample was digested with nitric acid and hydrogen peroxide according to TNO regulation LSP/108. The concentration of the heavy metals is determined in the produced solution with a ICP-MS according to TNO regulation LSP/055. Quantification takes place according to an external calibration standard. To correct for fluctuations within the apparatus an internal standard is used (rhodium).

2.4 Data analysis

2.4.1 Preparation of the dataset prior to analysis of the community structure

Organisms that could only be identified up to genus- or family level were pre-processed prior to data analyses. Especially juvenile or larval organisms are often subject to incomplete identification because species specific characteristics are not always fully developed. The following rules were applied:

- When a juvenile or larval organism could be identified up to genus level and *only one* other species belonging to the same genus was found, it was assumed that those organisms belong to the same species. In that case the larval/juveniles were added to this species.
- When a juvenile or larval organism could be identified up to genus level and *two or more* other species of this genus were found the juvenile/larval organisms were excluded.
- When a juvenile or larval organism could be identified up to genus level and *no other* species in that genus was found, the larval/juveniles were included in all analyses.
- For damaged organisms that could not be fully determined, noted as "*…SPEC*", the same rules were followed as for juveniles.

Based upon recent molecular research, the annelid formerly identified as *Scoloplos armiger* comprises a complex of species that are not clearly delimited. It is, therefore, included in the species' list as *Scoloplos agg.*

2.4.2 Abundance, richness, diversity index and evenness

For calculation of the abundance, richness, diversity index and evenness a slightly different methodology was followed.

Total abundance was calculated by dividing the total number of species found at each location by the sampled area (0.07 m^2). Numbers presented represent the average number of species per square meter.

Richness represents the amount of different taxa found. When species couldn't be determined up to species level but no other species in a genus were found, these were counted as valid taxa. When other species in a genus were present, that particular individual was not included in the analyses.

The species diversity index was calculated with the use of Shannon-Wiener Index (equation 1). This index measures the order (or disorder) within a sample taking both the evenness and the number of species into account. The number increases by an increasing number of species but is reduced when species evenness is low.

$$H = -\sum Pi(\ln Pi) \qquad \textit{Equation 1}$$

H = *Species diversity*
Pi = *Share of species compared to total amount of species*

Evenness was calculated using Pielou's evenness index, see equation 2. This is a measure of how similar the abundance is distributed over the different species.The index is expressed in a number between '0' and '1'. A low evenness indicates that the sample is numerically dominated by a single species, while the eveness value is maximal when all species are present in the same number.

$$E = \frac{H}{\ln(S)}$$ *Equation 2*

E = *Evenness*
H = *Species diversity*
S = *Number of species*

A cluster analyses was carried out to identify groups of stations that show similarity in both species presence and abundance. A similarity matrix with fourth root transformed data was constructed as input for the cluster analysis. Significant differences between clusters were examined via 'ANOSIM' function. Species that primarily provide the discrimination between the clusters were identified with the use of the 'SIMPER' function.

Diversity index, evenness, similarity matrixes and cluster analyses were calculated in R (R-Development Core – Team, 2011) with functions available within the package 'vegan' (Oksanen 2011)

The results of the post-drilling survey carried out in 2014 were compared with the baseline survey carried out in 2011. The side scan images were visually compared. The clustering of stations was compared visually. The average abundance, richness and diversity of the clusters were calculated and compared between the years. Absolute and relative differences in physical- and chemical properties between the two years were calculated per station and examined for abnormal outliers that could not be a result of heterogenic characteristics of the area or measurement uncertainties. Significant differences are checked at a confidence level of 0.05 using the ANOVA test. Boxplots were constructed for visual examination.

3 Results – 2014 post drill survey

In the following paragraphs the side-scan sonar image is given together with a description of sediment characteristics and a description of the benthic community. Unfortunately no photographs of the seabed could be made around the platform due to the presence of a supplier within the 500 meter zone and deteriorating weather conditions at the end of the fieldtrip.

3.1 General description

An area of 2 by 2 km around the platform was surveyed with the side-scan sonar. The image created from the different side-scan sonar lines shows a sandy top surface of the seabed (Figure 4). No stones or boulders could be identified, nor patches of other substrate types. Outside the 500 meter radius from the platform markings of trawl-chains can be identified, indicating fishing activities in this area. Average water depth around the platform was 49 meter. The highest water depth, 54 meter, was found at (reference) location 24, 10 km north of the platform (Table 1). Locations South-East, South and South-West from the platform were less deep with water depths around 40 and 46 meter.

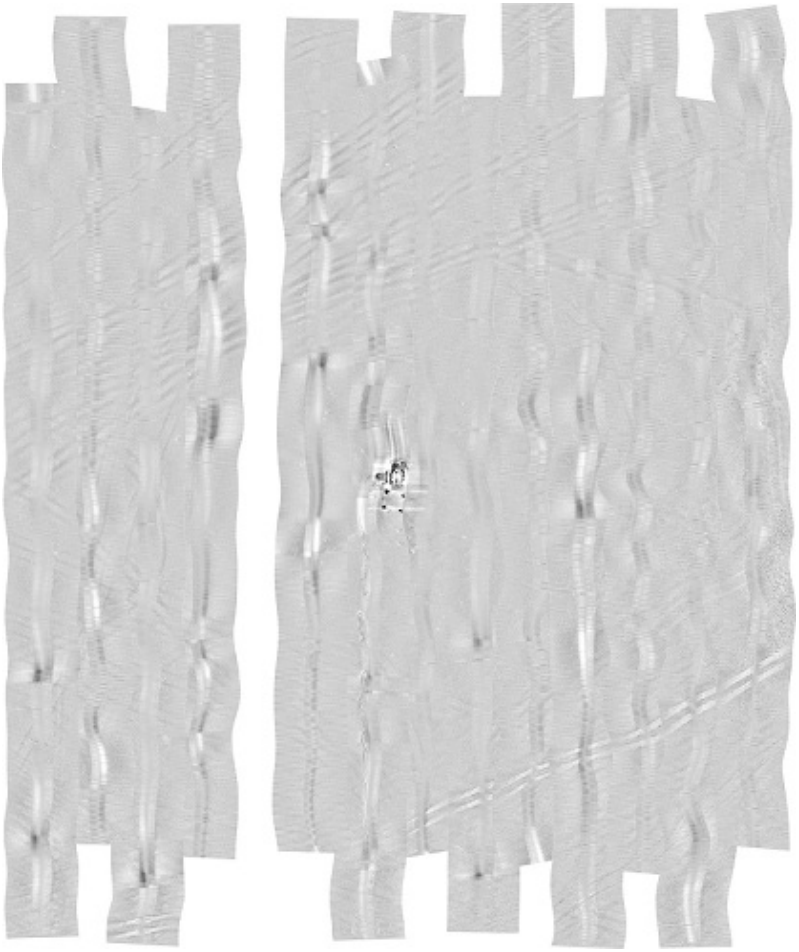

Figure 4: Side-scan sonar image, showing morphology of the seabed around the platform. Note the beam trawl tracks outside the 500m radius.

3.2 Sediment characteristics

Visual examination of the samples revealed that the top surface of the seabed indeed consisted of fine sand. At some sample locations, including sample locations near the platform, a clay layer was present below the sandy top layer.

3.2.1 Physical characteristics of the sediment

The physical characteristics of the sediment are summarized in Table 1. With an average median grain size of 181 µm the sediment can be characterized as being fine sand.

Sample location 15 differs from the other sample locations containing a relative high silt content (28%) and low median grain size (144 µm) (Figure 5 and Table 1). The total organic carbon is also relatively high (0.24 %) at this location. This location could not be sampled in 2011. In 2006 station 15 was also characterised by fine sediment, but not this extreme (Van Dalfsen & Kaag 2007).

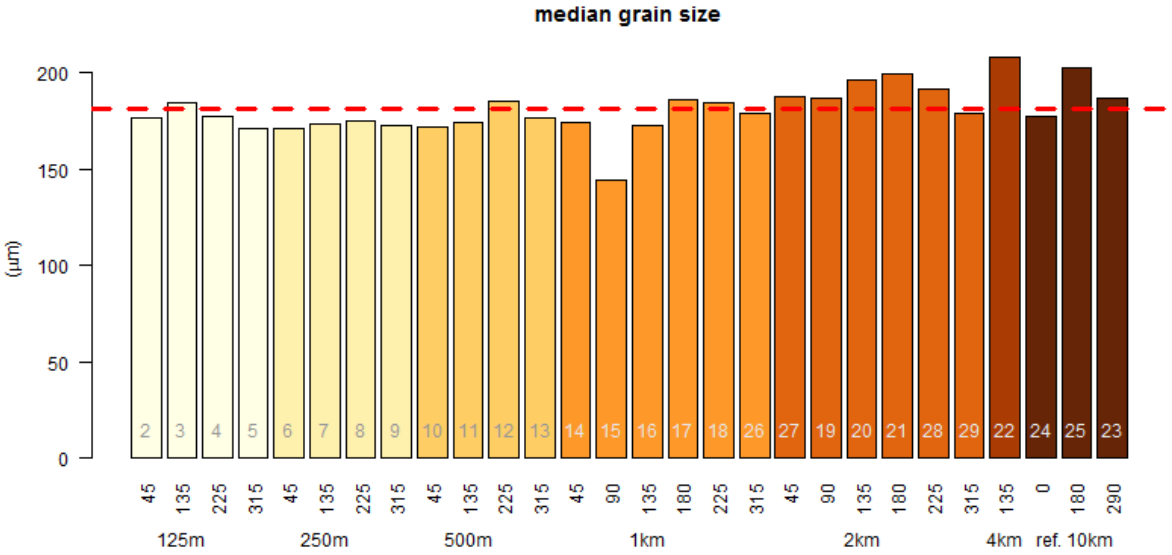

Figure 5: Median grain size of the sediment from sample locations near platform A6A in 2014. Vertical numbers represent the angle of the sample location, horizontal numbers the distance from the platform. The grey numbers within the bars are the sample location number as in Figure 2. The horizontal red dashed line marks the average median grain size. Bars of stations with equal distance from the platform are similar in colour.

Table 1: Physical characteristics of the sediment including location and water depth for sample locations near platform A6A sampled in 2014. TOC = total organic carbon. Values in bold are identified as being outliers (>1.5 interquartile distance) with the use of boxplots.

Location	Distance (m)	Angle (°)	Depth (m)	Dry m. (%)	TOC (%)	Fraction silt (%)	Median grain size (µm)
14_02	125	45	49	76.1	0.17	8.4	176
14_03	125	135	49	76.9	0.12	5.4	184
14_04	125	225	49	77.4	0.17	7.7	178
14_05	125	315	49	76.0	0.18	9.5	171
14_06	250	45	49	77.0	0.17	8.4	171
14_07	250	135	49	74.2	0.16	8.5	174
14_08	250	225	49	75.4	0.17	8.9	175
14_09	250	315	49	76.4	0.17	8.6	173
14_10	500	45	49	77.0	0.19	9.0	172
14_11	500	135	49	75.7	0.16	8.0	174
14_12	500	225	49	77.3	0.14	6.8	185
14_13	500	315	49	76.4	0.18	8.3	177
14_14	1000	45	48	77.7	0.17	8.3	174
14_15	1000	90	48	76.9	0.24	**28.8**	**144**
14_16	1000	135	47	76.7	0.17	8.2	172
14_17	1000	180	46	78.6	0.13	6.9	186
14_18	1000	225	46	77.4	0.13	6.0	184
14_26	1000	315	49	77.3	0.16	7.8	179
14_27	2000	45	46	78.5	0.10	5.0	187
14_19	2000	90	47	77.2	0.11	7.0	187
14_20	2000	135	43	76.8	0.07	3.8	196
14_21	2000	180	42	78.9	0.09	4.1	200
14_28	2000	225	44	80.6	0.09	4.2	191
14_29	2000	315	49	75.5	0.14	6.5	179
14_22	4000	135	40	78.4	0.06	**0.0**	**208**
14_24	10000 (Ref)	0	55	75.1	0.20	10.3	177
14_25	10000 (Ref)	180	42	79.4	0.11	4.8	203
14_23	10000 (Ref)	290	52	78.1	0.12	5.6	187
average			**47.5**	**77.1**	**0.15**	**7.7**	**181**
Standard deviation				**1.38**	**0.04**	**4.7**	**12.3**
Percentage sd of mean (%)				**1.8**	**28.6**	**61.1**	**6.8**

Within the 500 meter radius of the platform the sediment is a slightly finer grained with a higher silt fraction compared to stations 1000 meter South – East of the platform (Figure 6).

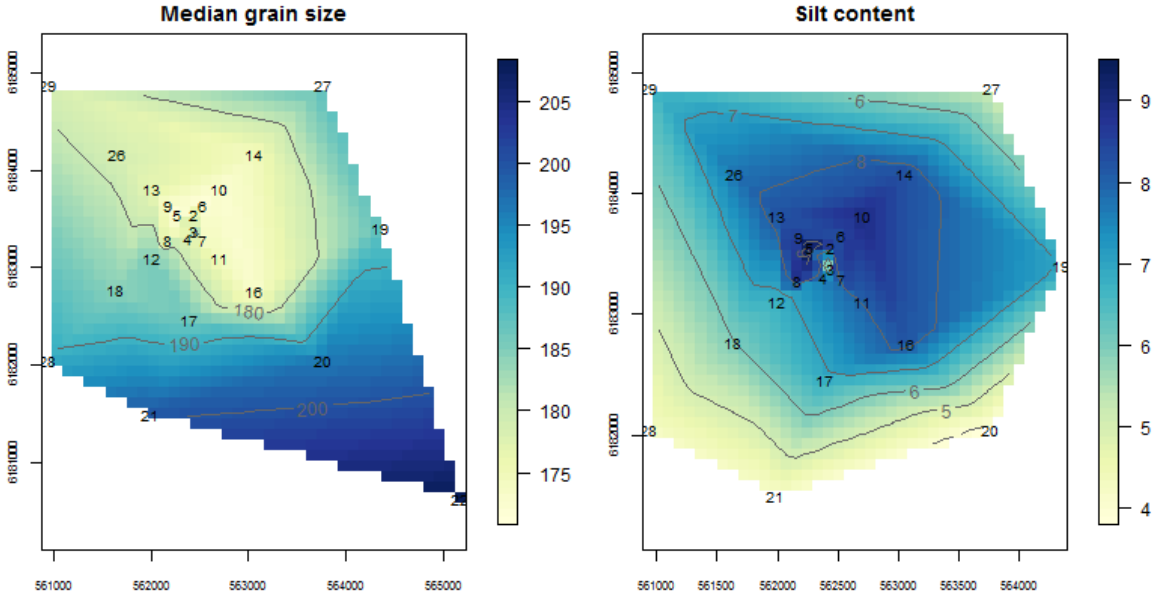

Figure 6: Interpolation of median grain size (left) and silt content (right). Sample location 22 (silt) and 15 (median grain size & silt) are excluded to aid visual interpretation.

3.2.2 Chemical characteristics of the sediment

Chemical characteristics of the sediment are summarized in Table 2. Concentrations of cadmium (Cd) and mercury (Hg) never exceeded the detection limit. Concentrations of barium (Ba) are exceeding background concentrations at all sample locations, with highest concentrations near the platform. Copper (Cu), lead (Pb) and zinc (Zn) never exceeded background concentrations. The highest concentrations of copper, iron and zinc were measured at sample location 4. This sample location is near the rig of the platform.

At most sample locations mineral oil content (MO C10-41) was not above the detection limit (Table 2). Only at six locations mineral oil content was above the detection limit. The highest concentration was measured at sample location 4 (9.9 mg/kg dry matter).

Table 2: *Sediment concentration of heavy metals and mineral oil (MO) content for sample locations near platform A6A sampled 2014. Concentrations are expressed in mg/kg dry matter. Values in bold are identified as being outliers (>1.5 interquartile distance) with the use of boxplots.*

Location	Distance (m)	Angle (°)	Ba	Cd	Cu	Fe	Hg	Pb	Zn	MO – C10-41
02	125	45	**290**	*<0.05*	0.94	3000	*<0.02*	7.1	**7.9**	2.2
03	125	135	**540**	*<0.05*	1.00	2200	*<0.02*	5.7	4.8	5.7
04	125	225	**370**	*<0.05*	**5.00**	**7600**	*<0.02*	6.8	**10.8**	9.9
05	125	315	**280**	*<0.05*	0.99	2600	*<0.02*	7.4	5.5	2.1
06	250	45	190	*<0.05*	1.10	3000	*<0.02*	6.9	6.4	*<2.0*
07	250	135	240	*<0.05*	0.82	2600	*<0.02*	6.1	4.2	*<2.0*
08	250	225	150	*<0.05*	0.81	2800	*<0.02*	6.2	4.2	*<2.0*
09	250	315	220	*<0.05*	0.78	2900	*<0.02*	6.1	4.5	2.4
10	500	45	190	*<0.05*	0.96	3200	*<0.02*	7.0	5.3	*<2.0*
11	500	135	180	*<0.05*	0.91	3000	*<0.02*	6.2	5.0	*<2.0*
12	500	225	170	*<0.05*	0.81	4100	*<0.02*	6.4	4.7	*<2.0*
13	500	315	170	*<0.05*	0.86	3000	*<0.02*	6.5	4.7	*<2.0*

Location	Distance (m)	Angle (°)	Ba	Cd	Cu	Fe	Hg	Pb	Zn	MO – C10-41
14	1000	45	170	*<0.05*	**1.60**	3100	*<0.02*	7.0	5.4	*<2.0*
15	1000	90	190	*<0.05*	1.20	5300	*<0.02*	7.3	6.4	*<2.0*
16	1000	135	160	*<0.05*	0.94	3300	*<0.02*	6.2	4.7	*<2.0*
17	1000	180	160	*<0.05*	0.98	4800	*<0.02*	6.6	6.0	*<2.0*
18	1000	225	150	*<0.05*	0.87	**6000**	*<0.02*	6.8	5.9	*<2.0*
26	1000	315	160	*<0.05*	0.95	3100	*<0.02*	6.7	4.9	*<2.0*
27	2000	45	150	*<0.05*	0.78	3300	*<0.02*	6.3	4.2	5.2
19	2000	90	160	*<0.05*	**2.90**	**6400**	*<0.02*	5.8	4.3	*<2.0*
20	2000	135	130	*<0.05*	0.71	4100	*<0.02*	6.0	4.5	*<2.0*
21	2000	180	140	*<0.05*	0.68	3500	*<0.02*	5.8	3.9	*<2.0*
28	2000	225	140	*<0.05*	0.80	4400	*<0.02*	6.4	4.9	*<2.0*
29	2000	315	160	*<0.05*	0.84	2900	*<0.02*	6.5	4.7	*<2.0*
22	4000	135	140	*<0.05*	0.67	3800	*<0.02*	6.3	4.2	*<2.0*
24	10000	0	150	*<0.05*	0.81	2700	*<0.02*	6.0	4.2	*<2.0*
25	10000	180	130	*<0.05*	0.63	2300	*<0.02*	5.3	3.4	*<2.0*
23	10000	290	150	*<0.05*	0.75	3600	*<0.02*	6.6	4.3	*<2.0*
*Background concentrations**			*20-60*	*<0.04*	*14.0*	-	*<0.025*	*21.0*	*39.0*	-

** OSPAR 1993 a,b, Groenewoud et al. 1999*

3.3 Benthos community

Prior to data analysis the data were pre-processed as described in paragraph 2.4.1.

3.3.1 Abundance, richness, diversity index and evenness

The average abundance of the macrozoobenthos at all sample locations was 7458 ind./m^2. The highest abundance was found at sample location 7 (21.107 ind./m^2) while sample location 2 was lowest in abundance (934 ind./m^2), see also Table 3.

Combining all sample locations, juvenile sea urchins (Irregularia) where the most abundant, followed by juvenile Ophiuroidea and the Polychaeta *Spiophanes bombyx* and *Scoloplos agg.* These species were found at all sample locations. The highest abundance of juvenile sea urchins was found at sample location 7, with 17.882 juveniles per square meter.

In total 186 different taxa were recorded in 2014 with an average species richness per sample of 32 species (Table 3). At sample locations 20 and 22, 55 different species were found, but only 18 species were present at sample location 2. Species richness is highest at >1000m to the southeast of the platform (Figure 7).

The Shannon-Wiener Index is not homogenously distributed over the sample locations, see Figure 7 and Table 3. The highest diversity is found at reference location 23, with a value of 3.1. In the direct vicinity of the platform, the diversity is lower than average, with values <2 for sample locations 3, 4 and 8.

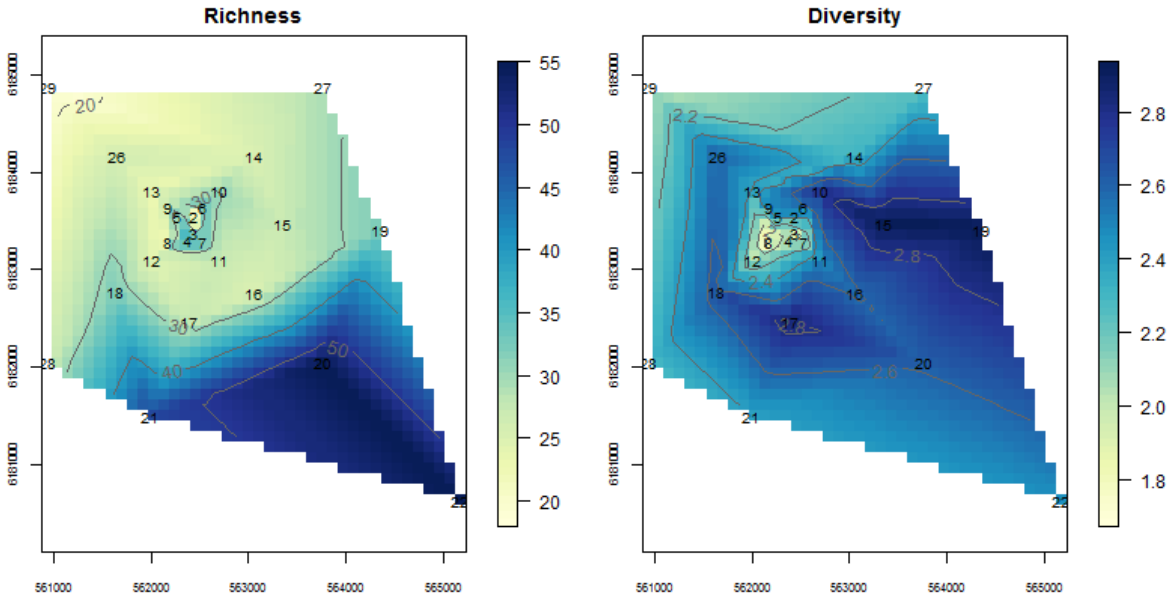

Figure 7: Interpolation of species richness (left) and diversity (right).

Table 3: Abundance, richness, diversity index and evenness for sample locations near platform A6A sampled in 2014. Values in bold are identified as being outliers (>1.5 interquartile distance) with the use of boxplots.

Location	Distance (m)	Angle (°)	Abundance (ind./m²)	Richness	Diversity index (H)	Evenness
02	125	45	934	18	2.44	0.84
03	125	135	18207	32	1.87	0.54
04	125	225	12831	37	1.98	0.55
05	125	315	5560	33	2.46	0.70
06	250	45	3169	33	2.59	0.74
07	250	135	21107	33	2.02	0.58
08	250	225	2957	23	**1.68**	0.53
09	250	315	2292	27	2.51	0.76
10	500	45	5744	30	2.80	0.82
11	500	135	5673	27	2.50	0.76
12	500	225	11063	24	2.06	0.65
13	500	315	3339	23	2.36	0.75
14	1000	45	2179	25	2.31	0.72
15	1000	90	2207	27	2.94	0.89
16	1000	135	1584	25	2.59	0.80
17	1000	180	1457	27	2.86	0.87
18	1000	225	5291	32	2.66	0.77
26	1000	315	1330	26	2.61	0.80
27	2000	45	13199	29	2.24	0.67
19	2000	90	3438	32	2.93	0.85
20	2000	135	15618	**55**	2.62	0.65
21	2000	180	14175	48	2.40	0.62
28	2000	225	6112	26	2.28	0.70
29	2000	315	2080	18	2.02	0.70

Location	Distance (m)	Angle (°)	Abundance (ind./m²)	Richness	Diversity index (H)	Evenness
22	4000	135	18122	**55**	2.47	0.62
24	10000	0	13482	38	2.29	0.63
25	10000	180	12039	38	2.66	0.73
23	10000	290	3622	47	3.10	0.80
		Average	**7458**	**32**	**2.44**	**0.72**

3.3.2 Structure of the benthic community

In Figure 8 the result of a cluster analysis is visualized in a dendrogram. Samples have a similarity of at least 35% and individual samples do not exceed a similarity of >70%. Two clusters (A & B) with a coherent species composition could be identified together with a rest group (C) that lacks consistency. Both clusters A and B have an inner similarity of around 50%. The difference between cluster A and B is small, a few percent, therefore the absolute differences in species composition between A and B are small as well.

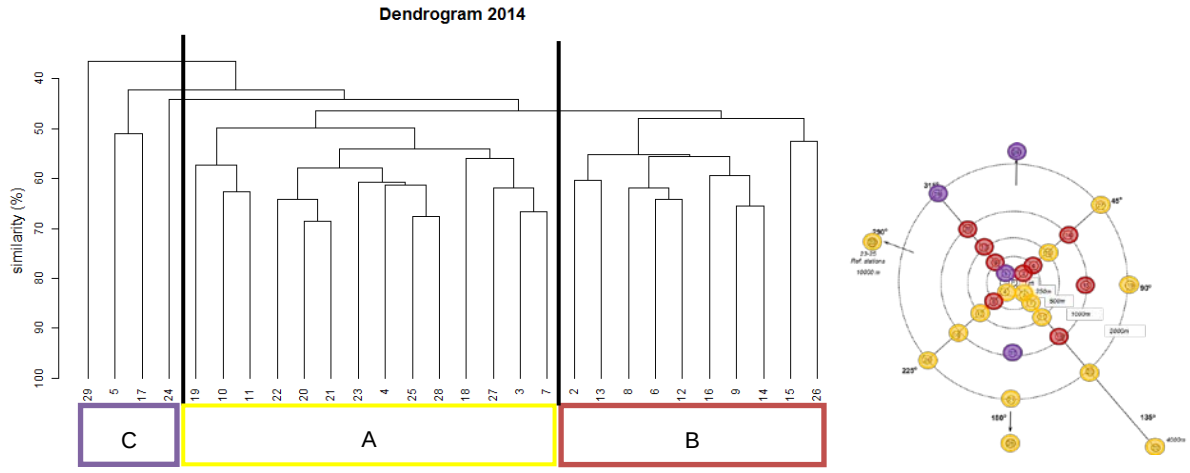

Figure 8 *Result of the cluster analysis shown in a dendrogram (left) and spatial distribution of the defined clusters on the sample grid (right). A Bray-Curtis dissimilarity matrix with double square root species density data was used as input for the cluster analysis.*

Cluster B is located to the North- and Eastern side of the platform while cluster A has a more Southern distribution (Figure 8, right). Sediment characteristics (median grain size, silt and dry matter) and lead concentration are related to the existence of the clusters ($p<0.05$). Median grain size is a bit higher in cluster A samples compared to cluster B samples and silt content lower, see Figure 9. Lead concentration is lower in cluster A samples.

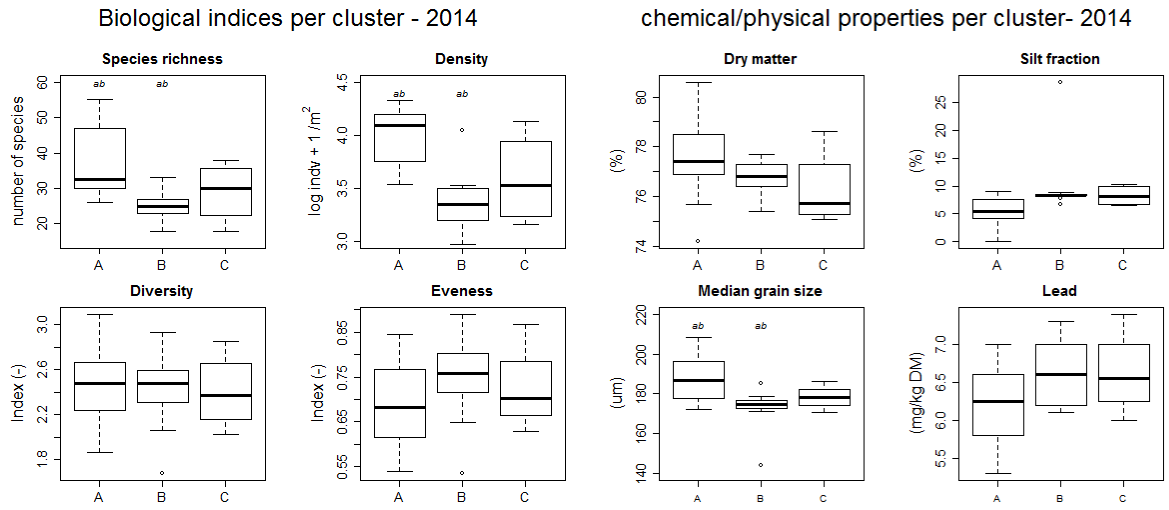

Figure 9: Boxplots of species richness, density (log ind/m^2), dry matter (%), silt fraction (< 63 µm %), diversity, evenness, median grain size (D_{50}) and lead (mg/kg dry matter) per cluster. Significant differences are indicated by letters in small font.

Using characteristic and discriminating species (Table 4), the clusters can be described as follows: Cluster A is characterized by the Polychaeta *Spiophanes bombyx*, *Scoloplos* agg., *Phyllodoce (groenlandica)* and the Amphipoda *Bathyporeia elegans*. Both *Spiophanes bombyx* and *Bathyporeia elegans* occur in highest abundances in cluster A. On average cluster A has a significant higher density and species richness (see also Figure 9).

Cluster B is characterized by the Polychaeta *Spiophanes bombyx*, *Scoloplos* agg. and *Chaetozone christiei* (Table 4). However Polychaeta *Spiophanes bombyx* is more abundant in cluster A than in cluster B. Species density is significant lower in cluster B compared to cluster A samples (see also Figure 9).

There are no significant differences between cluster A and B in diversity and evenness although spread in evenness is larger and average evenness is lower in cluster A samples compared to cluster B samples.

The rest group (cluster C) is characterized by the Polychaeta *Spiophanes bombyx, Scoloplos* agg. and *Paramphinome jeffreysii.*

The characteristic species in the area are associated with a *Tellina fabula* community, typically found in offshore fine sand areas (Rachor & Nehmer 2003). The bivalve *Tellina fabula* itself was found at about 80% of the sample locations.

Table 4: Average dissimilarity between clusters and the top-five species that contribute most to the difference between clusters. For those five species, the cluster average abundance (ind./m²) is shown.

Cluster	Avg. dissimilarity	Species	Cluster A avg. abundance	Cluster B avg. abundance	Cluster C avg. abundance
A vs. B	0.47	*Spiophanes bombyx*	1260	368	
		Scoloplos agg.	151	314	
		Phyllodoce spp.	177	68	
		Bathyporeia elegans	92	4	
		Phyllodoce groenlandica	82	20	
A vs. C	0.54	*Spiophanes bombyx*	1260		676
		Scoloplos agg.	151		216
		Phyllodoce spp.	177		74
		Paramphinome jeffreysii	14		134
		Bathyporeia elegans	92		11
B vs. C	0.49	*Spiophanes bombyx*		368	676
		Scoloplos agg.		314	216
		Paramphinome jeffreysii		3	134
		Chaetozone christiei		78	60
		Phyllodoce spp.		68	74

3.3.3 Red-list species

In total 37 species found could be classified in the red list (Bundesamt für Naturschutz, 2013). Note that 21 species are categorised 'D', meaning that data are insufficient. Seven species are categorised as 'G', danger of unknown dimension (Table 5). Four species are categorised as 'V', potential risk, and 1 species is categorised as 'R', extremely rare. One species is categorised as '2', extremely at risk and three species are categorised as '3', at risk.

Table 5: Occurrence of species in the red list (Bundesamt für Naturschutz 2013). Categories are G: danger of unknown dimension, R = extremely rare, V = potential risk/important, 2 = extremely at risk and 3 = at risk.

Phylum	**Class**	**Species**	**Category**
Mollusca	Bivalvia	*Spisula elliptica*	2
Annelida	Polychaeta	*Sigalion mathildae*	3
Mollusca	Bivalvia	*Arctica islandica*	3
Arthropoda	Malacostraca	*Cumopsis goodsir*	3
Annelida	Polychaeta	*Glyphohesione klatti*	G
Annelida	Polychaeta	*Sthenelais boa*	G
Mollusca	Bivalvia	*Ensis siliqua*	G
Mollusca	Bivalvia	*Acanthocardia echinata*	G
Mollusca	Bivalvia	*Spisula subtruncata*	G
Echinodermata	Echinoidea	*Echinocyamus pusillus*	G
Echinodermata	Echinoidea	*Echinocardium flavescens*	G
Arthropoda	Malacostraca	*Megaluropus agilis*	V
Arthropoda	Malacostraca	*Metopa alderi*	V
Arthropoda	Malacostraca	*Metopa borealis*	V
Mollusca	Gastropoda	*Acteonvtornatilis*	V
Arthropoda	Malacostraca	*Stenothoe monoculoides*	R

Phylum	Class	Species	Category
Annelida	Polychaeta	*Mediomastus fragilis*	D
Annelida	Polychaeta	*Nothria conchylega*	D
Annelida	Polychaeta	*Aphrodita aculeata*	D
Annelida	Polychaeta	*Glycera alba*	D
Annelida	Polychaeta	*Eunereis elittoralis*	D
Annelida	Polychaeta	*Malmgreniella castanea*	D
Annelida	Polychaeta	*Exogone naidina*	D
Annelida	Polychaeta	*Parexogone hebes*	D
Annelida	Polychaeta	*Magelona mirabilis*	D
Annelida	Polychaeta	*Spio decoratus*	D
Annelida	Polychaeta	*Polycirrus medusa*	D
Arthropoda	Malacostraca	*Synchelidium maculatum*	D
Arthropoda	Malacostraca	*Westwoodilla caecula*	D
Arthropoda	Malacostraca	*Hemilamprops roseus*	D
Arthropoda	Malacostraca	*Pseudocuma longicorne*	D
Mollusca	Bivalvia	*Abra prismatica*	D
Mollusca	Bivalvia	*Dosinia lupinus*	D
Mollusca	Gastropoda	*Retusa umbilicata*	D
Cnidaria	Hydrozoa	*Bougainvillia britannica*	D
Cnidaria	Hydrozoa	*Phialella quadrata*	D
Cnidaria	Hydrozoa	*Laomedea flexuosa*	D

4 Comparison with the baseline

The images created from the side-scan sonar survey showed a sandy top surface of the seabed both in 2011 and in 2014. No stones or boulders could be identified, nor patches or other substrate types.

4.1 Chemical & physical properties

The sediment characteristics median grain size and dry matter remained stable between 2011 and 2014. Silt fraction values are markedly higher in 2014 (Table 6). This difference is most likely the result of a different analytical method used in 2014 to determine the silt fraction. Reanalyzing five 2011 samples following the analytical method of 2014 showed a factor 2.74 (± sd 1.02) higher silt content in the reanalyzed samples. The five 2011 samples that were reanalyzed, do not show an increased silt content in 2014 when the same method is used (Table 7) and, therefore, it may be concluded that the increased silt content is a procedural artefact not related to the activities at A6-A.

Table 6: Median grain size (D_{50}), silt (< 63 µm %) and dry matter (%) in 2011 and 2014.

Location	**Distance (m)**	**Angle (°)**	**Median grain size**		**Silt**		**Dry matter**	
			2011	2014	2011	2014	2011	2014
02	125	45	176	176	2.62	8.39	74.5	76.1
03	125	135	181	184	2.84	5.37	74.3	76.9
04	125	225	180	178	3.30	7.64	74.6	77.4
05	125	315	177	171	2.16	9.50	74.1	76.0
06	250	45	175	171	4.29	8.35	75.1	77.0
07	250	135	-	174	-	8.53	-	74.2
08	250	225	180	175	2.54	8.91	74.9	75.4
09	250	315	177	173	2.76	8.55	74.1	76.4
10	500	45	177	172	2.31	8.98	72.0	77.0
11	500	135	-	174	-	8.00	-	75.7
12	500	225	184	185	3.15	6.76	74.8	77.3
13	500	315	180	177	2.55	8.25	74.6	76.4
14	1000	45	185	174	2.19	8.31	74.1	77.7
15	1000	90	-	144	-	28.75	-	76.9
16	1000	135	180	172	4.26	8.24	76.0	76.7
17	1000	180	184	186	5.96	6.89	75.6	78.6
18	1000	225	185	184	2.27	5.96	75.6	77.4
26	1000	315	198	179	2.48	7.76	74.7	77.3
27	2000	45	211	187	0.54	5.02	78.4	78.5
19	2000	90	192	187	0.57	6.98	76.5	77.2
20	2000	135	213	196	0.39	3.80	81.5	76.8
21	2000	180	190	200	0.60	4.14	76.1	78.9
28	2000	225	184	191	0.54	4.16	-	80.6
29	2000	315	205	179	0.67	6.54	73.3	75.5
22	4000	135	183	208	0.38	0.00	82.3	78.4
24	10000 (Ref)	0	187	177	2.67	10.25	74.5	75.1
25	10000 (Ref)	180	195	203	0.43	4.79	77.7	79.4
23	10000 (Ref)	290	195	187	0.61	5.59	74.1	78.1
		Average	**187**	**181**	**2.12**	**7.66**	**75.6**	**77.1**

Table 7: Re-analysis of silt % of some 2011 and 2014 samples compared

Station	2011 original	2011 re-analysis	2014	2014 re-analysis
15	N.A.	-	28.75	10.82
20	0.39	-	3.80	2.39
6	4.29	10.90	8.35	10.82
12	3.15	11.08	6.76	8.57
24	2.67	9.43	10.25	9.89
17	5.96	8.27	6.89	-
22	0.38	0.00	0.00	-

Table 8: Concentrations of barium (Ba), lead (Pb) and mineral oil (MO – C10-40) in mg/kg dry matter in 2011 and 2014. Values between brackets show the background concentrations (OSPAR 1993 a,b, Groenewoud et al. *1999). Values printed in bold indicate an increase.*

Location	Distance (m)	Angle (°)	Ba (*20-60*)		Pb (*21.0*)		MO – C10-40 (-)	
			2011	2014	2011	2014	2011	2014
14_02	125	45	380	290	9.1	7.1	< 2	**2.2**
14_03	125	135	640	540	8.5	5.7	16	5.7
14_04	125	225	590	370	8.1	6.8	17	9.9
14_05	125	315	390	280	9.2	7.4	< 2	2.1
14_06	250	45	290	190	8.8	6.9	< 2	< 2
14_07	250	135	-	240	-	6.1	-	< 2
14_08	250	225	240	150	8.4	6.2	< 2	< 2
14_09	250	315	250	220	8.4	6.1	< 2	**2.4**
14_10	500	45	250	190	8.6	7.0	< 2	< 2
14_11	500	135	-	180	-	6.2	-	< 2
14_12	500	225	220	170	8.2	6.4	< 2	< 2
14_13	500	315	220	170	7.9	6.5	2.9	< 2
14_14	1000	45	230	170	8.2	7.0	2.5	< 2
14_15	1000	90	-	190	-	7.3	-	< 2
14_16	1000	135	210	160	15.0	6.2	4.2	< 2
14_17	1000	180	200	160	7.9	6.6	< 2	< 2
14_18	1000	225	200	150	8.8	6.8	< 2	< 2
14_26	1000	315	200	160	7.3	6.7	< 2	< 2
14_27	2000	45	210	150	7.6	6.3	< 2	**5.2**
14_19	2000	90	200	160	7.8	5.8	< 2	< 2
14_20	2000	135	180	130	7.9	6.0	< 2	< 2
14_21	2000	180	170	140	6.5	5.8	< 2	< 2
14_28	2000	225	-	140	-	6.4	< 2	< 2
14_29	2000	315	210	160	7.9	6.5	< 2	< 2
14_22	4000	135	180	140	7.8	6.3	< 2	< 2
14_24	10000 (Ref)	0	210	150	8.0	6.0	2.1	< 2
14_25	10000 (Ref)	180	180	130	6.6	5.3	< 2	< 2
14_23	10000 (Ref)	290	190	150	7.7	6.6	< 2	< 2
		Average	**260**	**194**	**8.3**	**6.4**	**3.3**	**2.6**

The barium concentration exceeded the background concentration in all samples (Table 8). Barium (Ba) and lead (Pb) show a significant decrease in concentrations from 2011 to 2014. Both in 2011 and in 2014, the highest concentrations of barium were measured at sample locations near the platform (Table 8). In both years, mineral oil content (MO C10-41) was below the detection limit at most stations. The highest mineral oil content was measured at sample locations near the platform.

Combining all stations copper concentrations did not change on average (Table 9). However, at some sample locations copper concentration did decrease markedly (more than 50%). Iron concentrations decreased little everywhere, but increased more than 50% at two sample locations. Concentrations of zinc decreased significantly in 2014. All but one sample location show a decrease, at twelve sample locations more than 50%. All values remain below the background concentrations.
The concentration of metals in sediment collected at the three reference locations situated 10 km away from the platform show a similar decreasing trend as observed in most of the sample locations situated closer to the platform.

Table 9: Concentrations of copper (Cu), iron (Fe) and zinc (Zn) (mg/kg dry matter) in 2011 and 2014. Values between brackets show the background concentrations (OSPAR 1993 a,b, Groenewoud et al*. 1999). Values printed in bold indicate an increase.*

Location	**Distance (m)**	**Angle (°)**	**Cu (*14.0*)**		**Fe (-)**		**Zn (*39.0*)**	
			2011	2014	2011	2014	2011	2014
02	125	45	1.10	0.94	4000	3000	9.7	7.9
03	125	135	1.10	1.00	3500	2200	8.7	4.8
04	125	225	0.98	**5.00**	3600	**7600**	8.8	**10.8**
05	125	315	1.10	0.99	3700	2600	11.0	5.5
06	250	45	1.10	1.10	3800	3000	9.2	6.4
07	250	135	-	0.82	-	2600	-	4.2
08	250	225	1.00	0.81	3600	2800	10.0	4.2
09	250	315	1.10	0.78	3600	2900	9.5	4.5
10	500	45	1.00	0.96	3600	3200	11.0	5.3
11	500	135	-	0.91	-	3000	-	5.0
12	500	225	1.00	0.81	4100	4100	9.6	4.7
13	500	315	1.10	0.86	3400	3000	9.6	4.7
14	1000	45	0.99	**1.60**	3300	3100	7.7	5.4
15	1000	90	-	1.20	-	5300	-	6.4
16	1000	135	1.40	0.94	4500	3300	11.0	4.7
17	1000	180	1.00	0.98	5200	4800	9.9	6.0
18	1000	225	0.84	**0.87**	5900	**6000**	8.8	5.9
26	1000	315	0.92	**0.95**	3000	**3100**	7.9	4.9
27	2000	45	2.40	0.78	4200	3300	9.3	4.2
19	2000	90	0.82	**2.90**	3900	**6400**	9.5	4.3
20	2000	135	0.81	0.71	5600	4100	8.1	4.5
21	2000	180	0.99	0.68	4400	3500	14.0	3.9
28	2000	225	-	0.80	-	4400	-	4.9
29	2000	315	0.95	0.84	3700	2900	8.0	4.7
22	4000	135	0.88	0.67	4900	3800	9.6	4.2
24	10000 (Ref)	0	0.94	0.81	3600	2700	8.5	4.2
25	10000 (Ref)	180	1.60	0.63	2700	2300	9.7	3.4
23	10000 (Ref)	290	0.86	0.75	4100	3600	8.1	4.3
		Average	**1.10**	**1.10**	**3996**	**3664**	**9.5**	**5.1**

4.2 Benthos composition

The benthic community changed from 2011 to 2014, as is obvious from the clear separation of 2011 and 2014 samples in the left nMDS plot in Figure 10. Of the species that are important in explaining the difference between the years, some showed a decrease in density in 2014. Among these are some Echinodermata species such as *Amphiura sp*, Asteroidea and *Echinocardium cordatum* (heart-urchin) and some Mollusca species (*Abra alba* and *Tellina fabula*). Increased densities were observed for Arthropoda species belonging to the genus of *Bathyporeia*, as well as some Annelida species such as *Spiophanes bombyx*, *Scoloplos agg.* and *Phyllodoce spp.*

The variation between samples was larger in 2014, as is indicated by a large spread of the samples in the nMDS plots (Figure 10). The left nMDS plot shows that the 2011 arrangement of clusters remains in 2014, and that the direction of change is similar for both clusters and the reference locations (sample location 23 and 25) included in them. Reference location 23 is rather different from the rest of the locations in both years.

Cluster 1 samples (located close to the platform) take a more or less middle position in the nMDS plot in both years with cluster 2 samples around it. Cluster 3 samples (located South of the platform) cluster apart in both years (Figure 10, right).

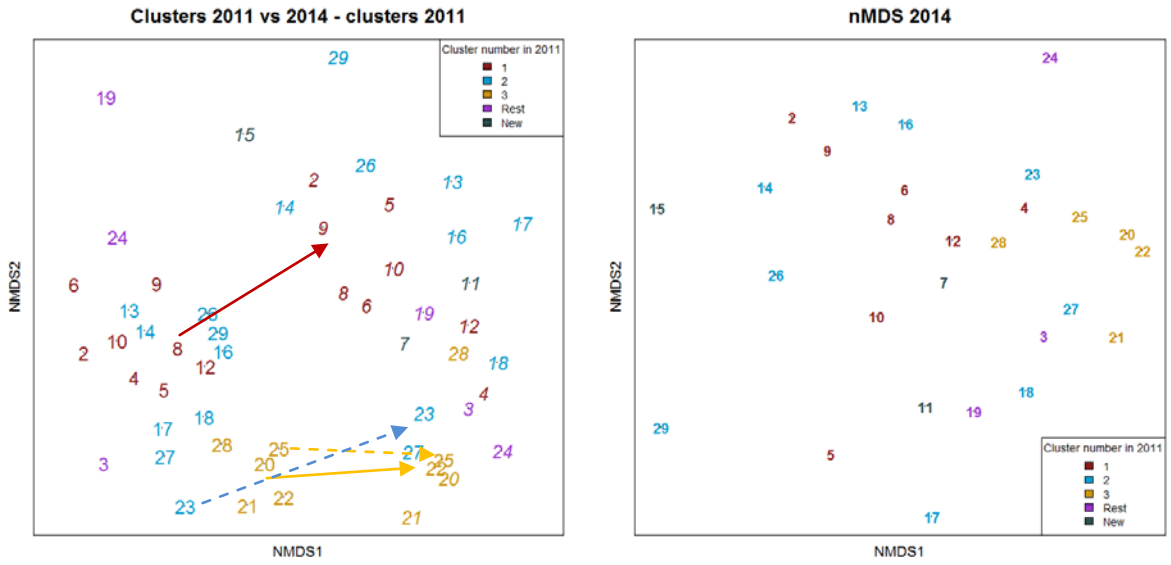

Figure 10: Left graph; nMDS (stress = 0.235) showing the orientation of the samples prior to drilling (numbers in bold in lower left corner) and after drilling in 2014 (numbers in italic upper right corner), using the 2011 clustering (Kaag & Glorius 2011). The arrows show the 'direction of change' for the clusters. This direction is the same as that for the reference locations (23 and 25; indicated with dashed arrow).
Right graph; nMDS showing situation after drilling in 2014 (stress = 0.212). A Bray-Curtis dissimilarity matrix with double square root species density data was used as input for the cluster analysis. The colouring indicates the arrangement of the samples by the clusters defined in 2011.

Red list species

In total 76 species species found in the area between 1999 and 2014 could be classified in the red list (Bundesamt für Naturschutz, 2013). Of these, 34 are categorised as 'D', meaning that data are insufficient. One species is categorised as 'not assessed'. The remaining 41 species are listed in Table 10, making explicit in which survey the species were found as well.

Most species are not quite common and abundant in the area, which means that the probability to find them every survey is low. In 2014, 16 ' Red List' species were found, which is the same number as in 2011 and comparable to the number found during other surveys since 1999.

Figure 11 *The head of* Sigalion mathildae *seem from below. This category 3 Red List species is a stable representative of the A6A benthic fauna through the years.*

Table 10: Occurrence of species in the red list (Bundesamt für Naturschutz 2013) for sample locations near platform A6A, sampled in 1999, 2000, 2001, 2006, 2011 and 2014. Categories are G: danger of unknown dimension, R = extremely rare, V = potential risk/important, 2 = extremely at risk and 3 = at risk.

Phylum	Species	Category	1999	2000	2001	2006	2011	2014
Mollusca	*Mya truncata*	2	X					
Mollusca	*Spisula elliptica*	2		X				X
Mollusca	*Buccinum undatum*	2			X			
Annelida	*Sigalion mathildae*	3	X	X	X	X	X	X
Arthropoda	*Bodotria arenosa*	3		X				
Arthropoda	*Cumopsis goodsir*	3						X
Arthropoda	*Iphimedia obesa*	3	X					
Mollusca	*Astarte montagui*	3	X					
Mollusca	*Arctica islandica*	3	X	X	X	X	X	X
Annelida	*Scalibregma inflatum*	G	X	X	X	X	X	
Annelida	*Nereimyra punctata*	G	X	X	X			
Annelida	*Glyphohesione klatti*	G		X	X	X	X	X
Annelida	*Sthenelais boa*	G						X
Annelida	*Chone duneri**	G	X	X	X			?
Annelida	*Chone infundibuliformis**	G				X	X	?
Arthropoda	*Corophium multisetosum*	G	X					
Mollusca	*Ensis siliqua*	G					X	X
Mollusca	*Acanthocardia echinata*	G	X	X	X		X	X
Mollusca	*Mactra stultorum*	G					X	
Mollusca	*Spisula solida*	G		X			X	
Mollusca	*Spisula subtruncata*	G	X	X		X	X	X
Mollusca	*Abra nitida*	G	X		X			
Echinodermata	*Astropecten irregularis*	G			X			
Echinodermata	*Echinocyamus pusillus*	G			X			X
Echinodermata	*Echinocardium flavescens**	G	?	?	?	?	?	X
Arthropoda	*Megaluropus agilis*	V		X		X	X	X
Arthropoda	*Synchelidium haplocheles*	V		X		X		
Arthropoda	*Photis longicaudata*	V				X		
Arthropoda	*Metopa alderi*	V			X			X
Arthropoda	*Metopa borealis**	V			?			X
Mollusca	*Acteon tornatilis*	V			X	X		X
Cnidaria	*Cerianthus lloydii**	V			X	X	X	?
Annelida	*Pholoe inornata*	R					X	
Annelida	*Prionospio cirrifera*	R					X	
Arthropoda	*Stenothoe monoculoides*	R				X	X	X
Arthropoda	*Diastylis boecki*	R			X			
Arthropoda	*Lamprops fasciatus*	R		X				
Mollusca	*Clausinella fasciata*	R	X	X	X			
Mollusca	*Gouldia minima*	R		X				
Mollusca	*Vitreolina philippi*	R	X		X			
Echinodermata	*Amphiura chiajei*	R				X	X	
		Total	**14**	**16**	**17**	**13**	**16**	**16**

* probably not identified correctly before

5 Conclusion

Compared to the 2011 baseline survey, the benthic community composition shows slight changes. Based upon the 2014 data alone, two groups are separated by clustering. However, superimposing the 2011 clusters on the 2014 data shows that these are still present, although somewhat more stretched. Differences in benthic species composition between clusters are subtle. The number of red list species found in the area, is comparable to previous surveys.

No change in morphology was visible on the side scan mosaic. The sediment is and was characterized as being sandy with limited silt content. Of the analysed metals barium (-24%), lead (-21%) and zinc (-44%) decreased significantly in 2014.

The observed changes have occurred all over the survey area and can, therefore, be considered autonomous developments that are not directly related to the drilling activities at A6-A6.

Quality Assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 124296-2012-AQ-NLD-RvA). This certificate is valid until 15 December 2015. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Fish Division has NEN-EN-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 1th of April 2017 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

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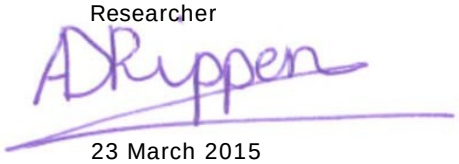
Justification

Report number : C046.15
Project number : 430.51128.01

The scientific quality of this report has been peer reviewed by a colleague scientist and the head of the department of IMARES.

Approved: Anneke Rippen MSc
Researcher

Signature: 

Date: 23 March 2015

Approved: Drs. F.C. Groenendijk
Head of department Maritime

Signature: 

Date: 23 March 2015

Appendix A. Species abundance per cluster - post drill survey

				totals 2014		Cluster A		Cluster B		Rest group	
				occ.	dens.	occ.	dens.	occ.	dens.	occ.	dens.
Phylum	**Class**	**Family**	**Latin name**	**(nr/s)**	**(indv/m^2)**	**(nr/s)**	**(indv/m^2)**	**(nr/s)**	**(indv/m^2)**	**(nr/s)**	**(indv/m^2)**
Annelida	Polychaeta	Ampharetidae	*Ampharete spp.*	1	0.5	0	0.0	0	0.0	1	3.5
Annelida	Polychaeta	Amphinomidae	*Paramphinome jeffreysii*	9	27.3	5	14.1	2	2.8	2	134.4
Annelida	Polychaeta	Aphroditidae	*Aphrodita aculeata*	1	0.5	0	0.0	1	1.4	0	0.0
Annelida	Polychaeta	Capitellidae	*Mediomastus fragilis*	6	3.0	3	3.0	2	2.8	1	3.5
Annelida	Polychaeta	Capitellidae	*Notomastus latericeus*	6	3.5	0	0.0	4	7.1	2	7.1
Annelida	Polychaeta	Cirratulidae	*Chaetozone christiei*	25	72.3	13	71.7	10	77.8	2	60.1
Annelida	Polychaeta	Cirratulidae	*Chaetozone setosa*	5	4.5	4	8.1	0	0.0	1	3.5
Annelida	Polychaeta	Cirratulidae	*Chaetozone spp.*	2	1.0	1	2.0	0	0.0	1	0.0
Annelida	Polychaeta	Glyceridae	*Glycera alba*	8	5.6	4	5.1	2	4.2	2	10.6
Annelida	Polychaeta	Glyceridae	*Glycera spp.*	7	6.6	4	8.1	1	2.8	2	10.6
Annelida	Polychaeta	Goniadidae	*Glycinde nordmanni*	8	6.1	2	4.0	3	4.2	3	17.7
Annelida	Polychaeta	Goniadidae	*Goniada maculata*	28	57.1	14	70.7	10	39.6	4	53.1
Annelida	Polychaeta	Goniadidae	*Goniadidae*	1	0.5	0	0.0	0	0.0	1	3.5
Annelida	Polychaeta	Hesionidae	*Oxydromus flexuosus*	1	0.5	1	1.0	0	0.0	0	0.0
Annelida	Polychaeta	Hesionidae	*Podarkeopsis helgolandicus*	3	1.5	0	0.0	3	4.2	0	0.0
Annelida	Polychaeta	Magelonidae	*Magelona alleni*	1	0.5	1	1.0	0	0.0	0	0.0
Annelida	Polychaeta	Magelonidae	*Magelona filiformis*	19	29.3	12	48.5	4	8.5	3	14.1
Annelida	Polychaeta	Magelonidae	*Magelona johnstoni*	3	1.5	2	2.0	1	1.4	0	0.0
Annelida	Polychaeta	Magelonidae	*Magelona mirabilis*	9	12.1	5	18.2	4	8.5	0	0.0
Annelida	Polychaeta	Magelonidae	*Magelona spp.*	3	2.0	2	4.0	0	0.0	1	0.0
Annelida	Polychaeta	Nephtyidae	*Nephtys assimilis*	11	7.6	3	2.0	5	11.3	3	17.7
Annelida	Polychaeta	Nephtyidae	*Nephtys caeca*	7	4.5	3	5.1	3	2.8	1	7.1
Annelida	Polychaeta	Nephtyidae	*Nephtys cirrosa*	6	5.1	3	7.1	2	2.8	1	3.5
Annelida	Polychaeta	Nephtyidae	*Nephtys hombergii*	3	1.5	2	2.0	1	1.4	0	0.0
Annelida	Polychaeta	Nephtyidae	*Nephtys longosetosa*	3	1.5	1	1.0	1	1.4	1	3.5

				totals 2014		Cluster A		Cluster B		Rest group	
				occ.	dens.	occ.	dens.	occ.	dens.	occ.	dens.
Phylum	**Class**	**Family**	**Latin name**	**(nr/s)**	**(indv/m^2)**	**(nr/s)**	**(indv/m^2)**	**(nr/s)**	**(indv/m^2)**	**(nr/s)**	**(indv/m^2)**
Annelida	Polychaeta	Nephtyidae	*Nephtys spp.*	15	10.6	8	13.1	5	8.5	2	7.1
Annelida	Polychaeta	Nereididae	*Eunereis elittoralis*	4	3.0	3	4.0	0	0.0	1	7.1
Annelida	Polychaeta	Nereididae	*Eunereis longissima*	2	1.0	1	1.0	1	1.4	0	0.0
Annelida	Polychaeta	Nereididae	*NEREIDINAE*	5	3.0	1	2.0	3	5.7	1	0.0
Annelida	Polychaeta	Onuphidae	*Nothria conchylega*	1	1.0	0	0.0	1	2.8	0	0.0
Annelida	Polychaeta	Opheliidae	*Ophelia neglecta*	3	2.5	3	5.1	0	0.0	0	0.0
Annelida	Polychaeta	Opheliidae	*Ophelia spp.*	7	5.6	7	11.1	0	0.0	0	0.0
Annelida	Polychaeta	Opheliidae	*Ophelina acuminata*	2	0.0	2	0.0	0	0.0	0	0.0
Annelida	Polychaeta	Orbiniidae	*Scoloplos agg.*	28	218.3	14	150.6	10	314.1	4	215.7
Annelida	Polychaeta	TEREBELLIDA (O)	TEREBELLIDA (O)	14	49.5	8	84.9	5	18.4	1	3.5
Annelida	Polychaeta	Oweniidae	*Galathowenia oculata*	4	6.1	2	3.0	1	1.4	1	28.3
Annelida	Polychaeta	Paraonidae	*Aricidea minuta*	7	9.1	5	12.1	1	1.4	1	17.7
Annelida	Polychaeta	Pectinariidae	*Amphictene auricoma*	1	0.5	0	0.0	0	0.0	1	3.5
Annelida	Polychaeta	Pectinariidae	*Lagis koreni*	1	1.0	1	2.0	0	0.0	0	0.0
Annelida	Polychaeta	Pectinariidae	*Pectinariidae*	8	4.5	5	6.1	2	2.8	1	3.5
Annelida	Polychaeta	Pholoidae	*Pholoe baltica*	7	5.1	4	6.1	2	2.8	1	7.1
Annelida	Polychaeta	Phyllodocidae	*Eteone cf. longa*	1	0.5	0	0.0	1	1.4	0	0.0
Annelida	Polychaeta	Phyllodocidae	*Hypereteone foliosa*	2	1.0	1	1.0	1	1.4	0	0.0
Annelida	Polychaeta	Phyllodocidae	*Phyllodoce groenlandica*	19	49.0	13	81.9	5	19.8	1	7.1
Annelida	Polychaeta	Phyllodocidae	*Phyllodoce rosea*	2	1.5	1	1.0	0	0.0	1	7.1
Annelida	Polychaeta	Phyllodocidae	*Phyllodoce spp.*	27	123.3	14	176.8	9	67.9	4	74.3
Annelida	Polychaeta	Phyllodocidae	*Phyllodocidae*	5	3.0	2	2.0	3	5.7	0	0.0
Annelida	Polychaeta	Pilargidae	*Glyphohesione klatti*	1	0.5	0	0.0	1	1.4	0	0.0
Annelida	Polychaeta	Poecilochaetidae	*Poecilochaetus serpens*	1	0.5	1	1.0	0	0.0	0	0.0
Annelida	Polychaeta	Polynoidae	*Gattyana cirrhosa*	1	0.5	1	1.0	0	0.0	0	0.0
Annelida	Polychaeta	Polynoidae	*Harmothoe spp.*	1	0.5	1	1.0	0	0.0	0	0.0
Annelida	Polychaeta	Polynoidae	*Malmgreniella castanea*	3	2.0	3	4.0	0	0.0	0	0.0

				totals 2014		Cluster A		Cluster B		Rest group	
				occ.	dens.	occ.	dens.	occ.	dens.	occ.	dens.
Phylum	**Class**	**Family**	**Latin name**	**(nr/s)**	**(indv/m^2)**	**(nr/s)**	**(indv/m^2)**	**(nr/s)**	**(indv/m^2)**	**(nr/s)**	**(indv/m^2)**
Annelida	Polychaeta	Polynoidae	*Malmgreniella darbouxi*	1	0.5	1	1.0	0	0.0	0	0.0
Annelida	Polychaeta	Polynoidae	*Malmgreniella ljungmani*	9	8.1	5	10.1	3	7.1	1	3.5
Annelida	Polychaeta	Polynoidae	*Malmgreniella spp.*	1	0.5	1	1.0	0	0.0	0	0.0
Annelida	Polychaeta	Polynoidae	POLYNOINAE (F)	3	2.0	1	1.0	2	4.2	0	0.0
Annelida	Polychaeta	Sabellidae	*Chone fauveli*	2	1.0	2	2.0	0	0.0	0	0.0
Annelida	Polychaeta	Sigalionidae	*Sigalion mathildae*	8	4.5	6	7.1	1	1.4	1	3.5
Annelida	Polychaeta	Sphaerodoridae	*Sphaerodorum gracilis*	1	0.5	1	1.0	0	0.0	0	0.0
Annelida	Polychaeta	Spionidae	*Aonides paucibranchiata*	9	11.6	8	22.2	1	1.4	0	0.0
Annelida	Polychaeta	Spionidae	*Scolelepis bonnieri*	1	0.5	0	0.0	1	1.4	0	0.0
Annelida	Polychaeta	Spionidae	*Scolelepis spp.*	1	0.5	1	1.0	0	0.0	0	0.0
Annelida	Polychaeta	Spionidae	*Scolelepis squamata*	1	0.5	1	1.0	0	0.0	0	0.0
Annelida	Polychaeta	Spionidae	*Spio decoratus*	8	9.6	7	18.2	0	0.0	1	3.5
Annelida	Polychaeta	Spionidae	*Spio sp.*	1	0.0	1	0.0	0	0.0	0	0.0
Annelida	Polychaeta	Spionidae	*Spiophanes bombyx*	28	857.9	14	1260.1	10	367.8	4	675.5
Annelida	Polychaeta	Spionidae	*Spiophanes kroyeri*	1	0.5	0	0.0	1	1.4	0	0.0
Annelida	Polychaeta	Syllidae	*Exogone naidina*	4	3.0	3	5.1	0	0.0	1	3.5
Annelida	Polychaeta	Syllidae	*Parexogone hebes*	1	0.5	1	1.0	0	0.0	0	0.0
Annelida	Polychaeta	Terebellidae	*Lanice conchilega*	18	12.6	10	16.2	7	11.3	1	3.5
Annelida	Polychaeta	Terebellidae	*Polycirrus medusa*	1	0.5	1	1.0	0	0.0	0	0.0
Arthropoda	Malacostraca	Ampeliscidae	*Ampelisca brevicornis*	3	1.5	1	1.0	2	2.8	0	0.0
Arthropoda	Malacostraca	Ampeliscidae	*Ampelisca spp.*	1	0.5	1	1.0	0	0.0	0	0.0
Arthropoda	Malacostraca	Ampeliscidae	*Ampelisca tenuicornis*	2	1.5	1	2.0	0	0.0	1	3.5
Arthropoda	Malacostraca	Amphilochidae	*Paramphilochoides odontonyx*	1	0.5	1	1.0	0	0.0	0	0.0
Arthropoda	Malacostraca	Aoridae	*Aoridae*	1	0.5	1	1.0	0	0.0	0	0.0
Arthropoda	Malacostraca	Argissidae	*Argissa hamatipes*	10	7.1	8	12.1	2	2.8	0	0.0
Arthropoda	Malacostraca	Atylidae	*Atylidae*	1	0.5	1	1.0	0	0.0	0	0.0
Arthropoda	Malacostraca	Atylidae	*Nototropis swammerdamei*	2	1.0	2	2.0	0	0.0	0	0.0

				totals 2014		Cluster A		Cluster B		Rest group	
Phylum	Class	Family	Latin name	occ. (nr/s)	dens. (indv/m^2)	occ. (nr/s)	dens. (indv/m^2)	occ. (nr/s)	dens. (indv/m^2)	occ. (nr/s)	dens. (indv/m^2)
Arthropoda	Malacostraca	Bodotriidae	*Cumopsis goodsir*	1	0.5	1	1.0	0	0.0	0	0.0
Arthropoda	Malacostraca	Callianassidae	*Callianassa subterranea*	3	1.5	0	0.0	1	1.4	2	7.1
Arthropoda	Malacostraca	Caprellidae	*Pariambus typicus*	1	0.5	1	1.0	0	0.0	0	0.0
Arthropoda	Malacostraca	Caprellidae	*Phtisica marina*	2	2.5	2	5.1	0	0.0	0	0.0
Arthropoda	Malacostraca	Corystidae	*Corystidae*	1	1.0	1	2.0	0	0.0	0	0.0
Arthropoda	Malacostraca	Diastylidae	*Diastylis bradyi*	2	1.0	1	1.0	1	1.4	0	0.0
Arthropoda	Malacostraca	Diastylidae	*Diastylis sp.*	1	0.5	1	1.0	0	0.0	0	0.0
Arthropoda	Malacostraca	Ischyroceridae	*Ischyroceridae*	4	2.5	2	3.0	2	2.8	0	0.0
Arthropoda	Malacostraca	Ischyroceridae	*Jassa falcata*	1	1.0	0	0.0	1	2.8	0	0.0
Arthropoda	Malacostraca	Lampropidae	*Hemilamprops roseus*	2	2.0	0	0.0	1	1.4	1	10.6
Arthropoda	Malacostraca	Leuconidae	*Eudorellopsis deformis*	6	8.1	2	8.1	2	2.8	2	21.2
Arthropoda	Malacostraca	Lysianassidae	*Hippomedon denticulatus*	2	2.5	2	5.1	0	0.0	0	0.0
Arthropoda	Malacostraca	Lysianassidae	*Tryphosites longipes*	2	1.0	1	1.0	0	0.0	1	3.5
Arthropoda	Malacostraca	Megaluropidae	*Megaluropus agilis*	3	3.0	2	5.1	0	0.0	1	3.5
Arthropoda	Malacostraca	Microprotopidae	*Microprotopus maculatus*	1	0.5	1	1.0	0	0.0	0	0.0
Arthropoda	Malacostraca	Mysidae	*Erythrops elegans*	2	1.0	2	2.0	0	0.0	0	0.0
Arthropoda	Malacostraca	Mysidae	*Hemimysis abyssicola*	1	0.5	0	0.0	0	0.0	1	3.5
Arthropoda	Malacostraca	Mysidae	*Mysidae*	2	1.0	2	2.0	0	0.0	0	0.0
Arthropoda	Malacostraca	Oedicerotidae	*Oedicerotidae*	2	1.5	2	3.0	0	0.0	0	0.0
Arthropoda	Malacostraca	Oedicerotidae	*Perioculodes longimanus*	21	36.9	14	61.6	6	9.9	1	17.7
Arthropoda	Malacostraca	Oedicerotidae	*Pontocrates altamarinus*	1	0.5	0	0.0	1	1.4	0	0.0
Arthropoda	Malacostraca	Oedicerotidae	*Pontocrates arenarius*	3	2.5	3	5.1	0	0.0	0	0.0
Arthropoda	Malacostraca	Oedicerotidae	*Pontocrates spp.*	1	0.5	1	1.0	0	0.0	0	0.0
Arthropoda	Malacostraca	Oedicerotidae	*Westwoodilla caecula*	3	1.5	1	1.0	2	2.8	0	0.0
Arthropoda	Malacostraca	AMPHIPODA (O)	AMPHIPODA (O)	11	10.6	7	18.2	2	2.8	2	3.5
Arthropoda	Malacostraca	CUMACEA (O)	CUMACEA (O)	5	3.0	4	5.1	0	0.0	1	3.5
Arthropoda	Malacostraca	DECAPODA (O)	DECAPODA (O)	7	5.1	5	8.1	2	2.8	0	0.0

				totals 2014		Cluster A		Cluster B		Rest group	
				occ.	dens.	occ.	dens.	occ.	dens.	occ.	dens.
Phylum	**Class**	**Family**	**Latin name**	**(nr/s)**	**(indv/m^2)**	**(nr/s)**	**(indv/m^2)**	**(nr/s)**	**(indv/m^2)**	**(nr/s)**	**(indv/m^2)**
Arthropoda	Malacostraca	Paguridae	*Pagurus bernhardus*	1	0.5	1	1.0	0	0.0	0	0.0
Arthropoda	Malacostraca	PAGUROIDEA	PAGUROIDEA (F)	6	3.0	4	4.0	1	1.4	1	3.5
Arthropoda	Malacostraca	Phoxocephalidae	*Harpinia antennaria*	4	2.5	2	3.0	2	2.8	0	0.0
Arthropoda	Malacostraca	Phoxocephalidae	*Harpinia serrata*	1	0.5	1	1.0	0	0.0	0	0.0
Arthropoda	Malacostraca	Phoxocephalidae	*Harpinia spp.*	3	1.5	1	1.0	1	1.4	1	3.5
Arthropoda	Malacostraca	Phoxocephalidae	*Phoxocephalidae*	1	0.5	0	0.0	1	1.4	0	0.0
Arthropoda	Malacostraca	Polybiidae	*Liocarcinus vernalis*	1	0.5	1	1.0	0	0.0	0	0.0
Arthropoda	Malacostraca	Pontoporeiidae	*Bathyporeia elegans*	18	49.0	14	92.0	2	4.2	2	10.6
Arthropoda	Malacostraca	Pontoporeiidae	*Bathyporeia guilliamsoniana*	19	43.5	11	65.7	7	28.3	1	3.5
Arthropoda	Malacostraca	Pontoporeiidae	*Bathyporeia spp.*	13	21.2	10	39.4	2	2.8	1	3.5
Arthropoda	Malacostraca	Pontoporeiidae	*Bathyporeia tenuipes*	8	6.1	5	7.1	1	1.4	2	14.1
Arthropoda	Malacostraca	Pseudocumatidae	*Pseudocuma longicorne*	12	17.2	10	32.3	2	2.8	0	0.0
Arthropoda	Malacostraca	Stenothoidae	*Metopa alderi*	1	0.5	0	0.0	1	1.4	0	0.0
Arthropoda	Malacostraca	Stenothoidae	*Metopa borealis*	2	1.0	1	1.0	1	1.4	0	0.0
Arthropoda	Malacostraca	Stenothoidae	*Stenothoe monoculoides*	1	0.5	0	0.0	0	0.0	1	3.5
Arthropoda	Malacostraca	Stenothoidae	*Stenothoidae*	1	0.5	1	1.0	0	0.0	0	0.0
Arthropoda	Malacostraca	Urothoidae	*Urothoe poseidonis*	4	8.6	4	17.2	0	0.0	0	0.0
Arthropoda	Maxillopoda	COPEPODA (sC)	COPEPODA (sC)	2	1.0	0	0.0	1	1.4	1	3.5
Bryozoa	Gymnolaemata	Alcyonidiidae	*Alcyonidium diaphanum*	1	0.5	0	0.0	1	1.4	0	0.0
Bryozoa	Gymnolaemata	Electridae	*Electra pilosa*	2	1.0	1	1.0	1	1.4	0	0.0
Chlorophyta	CHLOROPHYTA (P)	CHLOROPHYTA (P)	CHLOROPHYTA (P)	1	0.5	1	1.0	0	0.0	0	0.0
Cnidaria	Anthozoa	Edwardsiidae	*Edwardsia spp.*	17	15.2	9	15.2	7	15.6	1	14.1
Cnidaria	Anthozoa	HEXACORALLIA (sC)	HEXACORALLIA (sC)	5	3.5	4	5.1	0	0.0	1	7.1
Cnidaria	Hydrozoa	Bougainvilliidae	*Bougainvillia britannica*	4	2.0	3	3.0	0	0.0	1	3.5
Cnidaria	Hydrozoa	Bougainvilliidae	*Bougainvilliidae*	1	0.5	1	1.0	0	0.0	0	0.0
Cnidaria	Hydrozoa	Campanulariidae	*Campanulariidae*	13	6.6	5	5.1	5	7.1	3	10.6
Cnidaria	Hydrozoa	Campanulariidae	*Clytia gracilis*	1	0.5	1	1.0	0	0.0	0	0.0

				totals 2014		Cluster A		Cluster B		Rest group	
				occ.	dens.	occ.	dens.	occ.	dens.	occ.	dens.
Phylum	**Class**	**Family**	**Latin name**	**(nr/s)**	**(indv/m^2)**	**(nr/s)**	**(indv/m^2)**	**(nr/s)**	**(indv/m^2)**	**(nr/s)**	**(indv/m^2)**
Cnidaria	Hydrozoa	Campanulariidae	*Laomedea flexuosa*	1	0.5	1	1.0	0	0.0	0	0.0
Cnidaria	Hydrozoa	HYDROZOA (C)	HYDROZOA (C)	26	66.2	14	94.0	9	36.8	3	42.4
Cnidaria	Hydrozoa	Corymorphidae	*Euphysa aurata*	3	1.5	2	2.0	0	0.0	1	3.5
Cnidaria	Hydrozoa	ANTHOTHECATA (O)	ANTHOTHECATA (O)	4	2.0	1	1.0	0	0.0	3	10.6
Cnidaria	Hydrozoa	LEPTOTHECATA (O)	LEPTOTHECATA (O)	1	0.5	0	0.0	0	0.0	1	3.5
Cnidaria	Hydrozoa	Phialellidae	*Phialella quadrata*	2	1.0	2	2.0	0	0.0	0	0.0
Cnidaria	Hydrozoa	Tubulariidae	*Tubulariidae*	1	0.5	1	1.0	0	0.0	0	0.0
Echinodermata	Asteroidea	ASTEROIDEA (C)	ASTEROIDEA (C)	1	0.5	0	0.0	0	0.0	1	3.5
Echinodermata	CARINACEA (iC)	CARINACEA (iC)	CARINACEA (iC)	2	2.0	2	4.0	0	0.0	0	0.0
Echinodermata	Echinoidea	ECHINOIDEA (C)	ECHINOIDEA (C)	1	275.4	1	550.7	0	0.0	0	0.0
Echinodermata	Echinoidea	Echinocyamidae	*Echinocyamus pusillus*	1	1.0	1	2.0	0	0.0	0	0.0
Echinodermata	Echinoidea	Loveniidae	*Echinocardium cordatum*	13	7.1	5	5.1	7	11.3	1	3.5
Echinodermata	Echinoidea	Loveniidae	*Echinocardium spp.*	2	1.0	2	2.0	0	0.0	0	0.0
Echinodermata	Holothuroidea	HOLOTHUROIDEA (C)	HOLOTHUROIDEA (C)	2	1.5	1	2.0	0	0.0	1	3.5
Echinodermata	IRREGULARIA (iC)	IRREGULARIA (iC)	IRREGULARIA (iC)	26	4618.0	12	7077.6	10	1556.2	4	3664.1
Echinodermata	Ophiuroidea	Amphiuridae	*Acrocnida brachiata*	3	2.5	2	4.0	0	0.0	1	3.5
Echinodermata	Ophiuroidea	Amphiuridae	*Amphiura filiformis*	1	0.5	1	1.0	0	0.0	0	0.0
Echinodermata	Ophiuroidea	Amphiuridae	*Amphiura spp.*	5	5.6	5	11.1	0	0.0	0	0.0
Echinodermata	Ophiuroidea	OPHIUROIDEA (C)	OPHIUROIDEA	28	253.1	14	340.5	10	171.2	4	152.1
Echinodermata	Ophiuroidea	Ophiuridae	*Ophiura ophiura*	2	1.0	2	2.0	0	0.0	0	0.0
Echinodermata	Ophiuroidea	Ophiuridae	*Ophiura spp.*	2	1.0	2	2.0	0	0.0	0	0.0
Echiura	Echiuroidea	Echiuridae	*Echiurus echiurus*	2	2.5	1	1.0	1	5.7	0	0.0
Foraminifera	FORAMINIFERA (P)	FORAMINIFERA (P)	FORAMINIFERA (P)	1	0.5	1	1.0	0	0.0	0	0.0
Mollusca	Bivalvia	Arcticidae	*Arctica islandica*	9	7.1	6	8.1	1	2.8	2	14.1
Mollusca	Bivalvia	Cardiidae	*Acanthocardia echinata*	1	0.5	0	0.0	1	1.4	0	0.0
Mollusca	Bivalvia	BIVALVIA (C)	BIVALVIA (C)	25	53.6	13	73.8	9	32.5	3	35.4
Mollusca	Bivalvia	Hiatellidae	*Hiatella arctica*	2	1.5	2	3.0	0	0.0	0	0.0

				totals 2014		Cluster A		Cluster B		Rest group	
Phylum	Class	Family	Latin name	occ. (nr/s)	dens. (indv/m^2)	occ. (nr/s)	dens. (indv/m^2)	occ. (nr/s)	dens. (indv/m^2)	occ. (nr/s)	dens. (indv/m^2)
Mollusca	Bivalvia	Lucinidae	*Lucinoma borealis*	19	16.2	8	15.2	10	19.8	1	10.6
Mollusca	Bivalvia	Montacutidae	*Kurtiella bidentata*	1	0.5	1	1.0	0	0.0	0	0.0
Mollusca	Bivalvia	Montacutidae	*Montacuta substriata*	2	10.6	2	21.2	0	0.0	0	0.0
Mollusca	Bivalvia	Montacutidae	*Tellimya ferruginosa*	13	17.7	5	18.2	7	22.6	1	3.5
Mollusca	Bivalvia	Nuculidae	*Ennucula tenuis*	4	2.0	1	1.0	2	2.8	1	3.5
Mollusca	Bivalvia	Nuculidae	*Nucula hanleyi*	3	2.0	1	1.0	0	0.0	2	10.6
Mollusca	Bivalvia	Nuculidae	*Nuculidae*	3	2.0	1	1.0	0	0.0	2	10.6
Mollusca	Bivalvia	Pectinidae	*Pectinidae*	1	0.5	1	1.0	0	0.0	0	0.0
Mollusca	Bivalvia	Periplomatidae	*Cochlodesma praetenue*	3	2.0	3	4.0	0	0.0	0	0.0
Mollusca	Bivalvia	Pharidae	*Ensis siliqua*	1	0.5	1	1.0	0	0.0	0	0.0
Mollusca	Bivalvia	Pharidae	*Pharidae*	1	0.5	1	1.0	0	0.0	0	0.0
Mollusca	Bivalvia	Pharidae	*Phaxas pellucidus*	2	1.5	2	3.0	0	0.0	0	0.0
Mollusca	Bivalvia	Psammobiidae	*Gari fervensis*	3	1.5	3	3.0	0	0.0	0	0.0
Mollusca	Bivalvia	Semelidae	*Abra prismatica*	19	17.2	11	22.2	6	11.3	2	14.1
Mollusca	Bivalvia	Solenidae	*Solenidae*	1	0.5	1	1.0	0	0.0	0	0.0
Mollusca	Bivalvia	Tellinidae	*Tellina fabula*	22	26.8	12	35.4	8	22.6	2	7.1
Mollusca	Bivalvia	Tellinidae	*Tellina spp.*	4	2.0	1	1.0	0	0.0	3	10.6
Mollusca	Bivalvia	Thraciidae	*Thracia phaseolina*	4	2.5	3	3.0	0	0.0	1	7.1
Mollusca	Bivalvia	Thraciidae	*Thracia spp.*	8	4.5	5	6.1	2	2.8	1	3.5
Mollusca	Bivalvia	Thyasiridae	*Thyasira flexuosa*	11	9.1	4	6.1	6	15.6	1	3.5
Mollusca	Bivalvia	Veneridae	*Chamelea spp.*	3	2.0	3	4.0	0	0.0	0	0.0
Mollusca	Bivalvia	Veneridae	*Chamelea striatula*	2	1.0	1	1.0	1	1.4	0	0.0
Mollusca	Bivalvia	Veneridae	*Dosinia lupinus*	6	4.0	4	5.1	0	0.0	2	10.6
Mollusca	Bivalvia	Veneridae	*Mysia undata*	1	0.5	1	1.0	0	0.0	0	0.0
Mollusca	Gastropoda	Acteonidae	*Acteon tornatilis*	1	0.5	1	1.0	0	0.0	0	0.0
Mollusca	Gastropoda	GASTROPODA (C)	GASTROPODA (C)	1	0.5	1	1.0	0	0.0	0	0.0
Mollusca	Gastropoda	Cylichnidae	*Cylichna cylindracea*	7	6.1	5	10.1	1	1.4	1	3.5

				totals 2014		Cluster A		Cluster B		Rest group	
				occ.	dens.	occ.	dens.	occ.	dens.	occ.	dens.
Phylum	**Class**	**Family**	**Latin name**	**(nr/s)**	**(indv/m^2)**	**(nr/s)**	**(indv/m^2)**	**(nr/s)**	**(indv/m^2)**	**(nr/s)**	**(indv/m^2)**
Mollusca	Gastropoda	Diaphanidae	*Diaphana minuta*	1	0.5	1	1.0	0	0.0	0	0.0
Mollusca	Gastropoda	Facelinidae	*Facelina spp.*	1	0.5	1	1.0	0	0.0	0	0.0
Mollusca	Gastropoda	Naticidae	*Euspira montagui*	3	1.5	1	1.0	0	0.0	2	7.1
Mollusca	Gastropoda	Naticidae	*Euspira nitida*	6	3.5	5	6.1	0	0.0	1	3.5
Mollusca	Gastropoda	Naticidae	*Euspira spp.*	5	3.5	1	2.0	4	7.1	0	0.0
Mollusca	Gastropoda	CEPHALASPIDEA (O)	CEPHALASPIDEA (O)	3	1.5	2	2.0	1	1.4	0	0.0
Mollusca	Gastropoda	Philinidae	*Philine spp.*	3	4.0	1	4.0	0	0.0	2	14.1
Mollusca	Gastropoda	Philinidae	*Philinidae*	8	8.6	7	15.2	0	0.0	1	7.1
Mollusca	Gastropoda	Retusidae	*Retusa umbilicata*	3	1.5	3	3.0	0	0.0	0	0.0
Nemertea	NEMERTEA (P)	NEMERTEA (P)	NEMERTEA (P)	13	17.2	9	30.3	1	1.4	3	10.6
Phoronida	PHORONIDA (P)	PHORONIDA (P)	PHORONIDA (P)	17	11.1	8	10.1	7	14.1	2	7.1
Platyhelminthes	NEMERTEA (P)	NEMERTEA (P)	NEMERTEA (P)	5	4.0	0	0.0	4	9.9	1	3.5
Rhodophyta	Florideophyceae	CORALLINALES (O)	CORALLINALES (O)	2	1.0	2	2.0	0	0.0	0	0.0
Rhodophyta	RHODOPHYTA (P)	RHODOPHYTA (P)	RHODOPHYTA (P)	1	0.5	1	1.0	0	0.0	0	0.0
Sipuncula	SIPUNCULA (P)	SIPUNCULA (P)	SIPUNCULA (P)	11	7.6	6	7.1	5	11.3	0	0.0

Appendix B. Side scan sonar image- post drill survey