Benthos community composition along pipeline trajectory A6-A – Ravn.

An environmental baseline study

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1. Introduction

Wintershall Noordzee BV has the intention to develop the offshore oil field Ravn on the Danish Continental Shelf. The field will be developed with an unmanned platform. Therefore, a pipeline and umbilical will be installed between the Ravn platform and the A6-A platform, which is located on the German Continental shelf. The distance between the two locations is 18 km and approximately 3.5 km of the pipeline is located in the German sector, which is part of the Dogger Bank. This area has been designated as a Natura 2000 area by the German authorities.

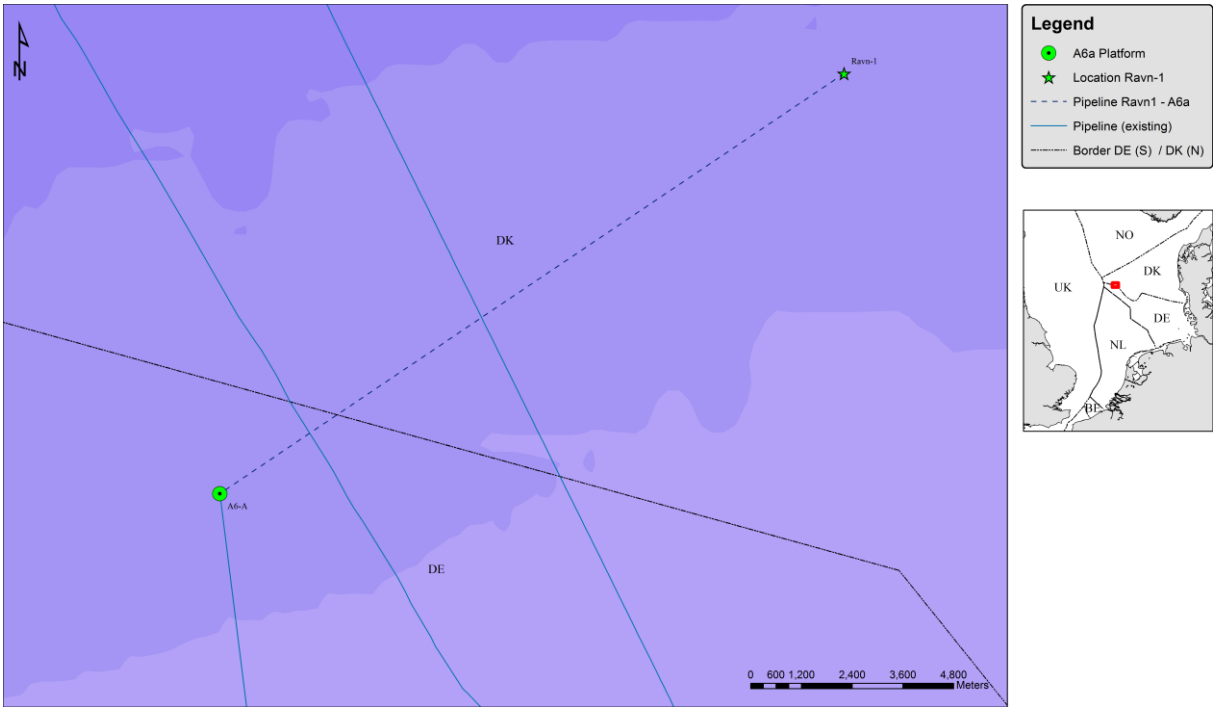


Figure 1. *Location of A6-A platform and pipeline route to Ravn. This study only comprehends the pipeline trajectory from platform A6-A up to Danish boarder.*

The conservation of areas with a Natura 2000 designation is 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 in Natura 2000 areas need to be judged regarding their possible effects on the species or habitat types for which the site is being designated as a Natura 2000 site. In this case the typical species and habitat characteristics of H1110. In November 2013, the 'Bundesamt für Seeschifffahrt und Hydrographie' (BSH) decided that a full Environmental Impact Assessment (EIA) is required, including a benthos survey along the course of the pipeline.

The 'Arbeitsgruppe für regionale Struktur- und Umweltforschung' (ARSU) has been appointed to perform the EIA. Wintershall Noordzee BV has asked IMARES to draw up a proposal for the benthos survey, based upon the scoping document prepared by ARSU and the requirements formulated by the BSH (Tender Document ITT/14/302). As a result of this the following environmental elements were included in the baseline study; mapping of the seafloor texture and identification of structures when present (stones, boulders and riff structures of biological origin), the physical (grain size and organic content) and biological (abundance and structure of endo- and epibenthic species communities) properties of the sediment.

IMARES prepared and carried out the environmental sampling, the laboratory analyses, data analysis and reporting of the biological and physical data in close collaboration with the Monitor Taskforce of the NIOZ.

Fugro chartered a vessel to assist the field campaign, carried out the side scan sonar work and assisted in the sediment sampling and shooting of the seabed photographs. Fieldwork for this campaign was combined with environmental work of a second project that investigates the possible impact of drilling activities carried out at platform A6-A. In a survey report the day to day events of the field campaign are described (Glorius and Kaag, 2014).

In this report the sampling methodology, laboratory work and data analyses are described considering the environmental work carried out along the pipeline trajectory. Results of the analyses are described and discussed.

2. Sample locations and methodology

2.1. Samples

In order to describe the physical and biological properties of the area around the pipeline trajectory according to the ARSU and BSH requirements, the following samples were taken:

- 27 sediment samples for grain size analysis and organic content
- 81 (27 x 3) sediment samples for analysis of macrobenthic (>1mm) species composition
- Six beam trawl samples for determination of epibenthic species (>5mm) composition
- Side scan sonar footages along pipeline trajectory for physical properties of the seabed and to check for presence of hard substrates such as boulders and reef structures.
- Sea bed photographs for reference purposes of the side scan results, sediment- and epibenthic samples.

Fieldwork took place end of May and beginning of June 2014. All sediment samples were taken using a standard HELCOM van Veen grabber with a sample area of 0.1 m^2. (The van Veen grab is used instead of a boxcorer as the latter one cannot be used in a follow up survey due to the risks of damaging the pipeline). *Figure 2* shows pictures of the deployment of the two meter beam trawl and the van Veen grab.

Figure 2. Deployment of the two meter beam trawl (left) and the van Veen grab (right).

2.2. Sampling grid

The sampling grid is depicted in *Figure 3*. Fifteen sample locations are situated on the pipeline trajectory (located 250 meter apart from each other). Perpendicular to the pipeline trajectory there are three transects 1000 m apart. Each transect consists of four sample locations, additional to the one (54C, 59C and 64C) on the pipeline trajectory: two reference sample locations (A, E) are situated at a distance of 1000 m and another two (B, D) at 100 m from the pipeline trajectory. At the sample locations of the 54 and 59 transect series (except sample location 59_E) seabed photographs were made as well. At sample location 59_E and at the 64_x locations, seabed photographs were planned but could not be taken because of deteriorating weather conditions; see survey report (Glorius and Kaag, 2014).

In the proximity of the three transects epifauna samples were taken with the use of a two meter beam trawl (sample positions 56_x, 61_x and 66_x, A and B). One haul was made close to the pipeline trajectory (B-series), and at a reference distance of 1000m (A-series) parallel to the pipeline trajectory. With each haul a distance of approximately 200 meter was sampled.
An area with a width of approximately 500 meters (250 m on each side) along the pipeline trajectory was surveyed with a side scan sonar.

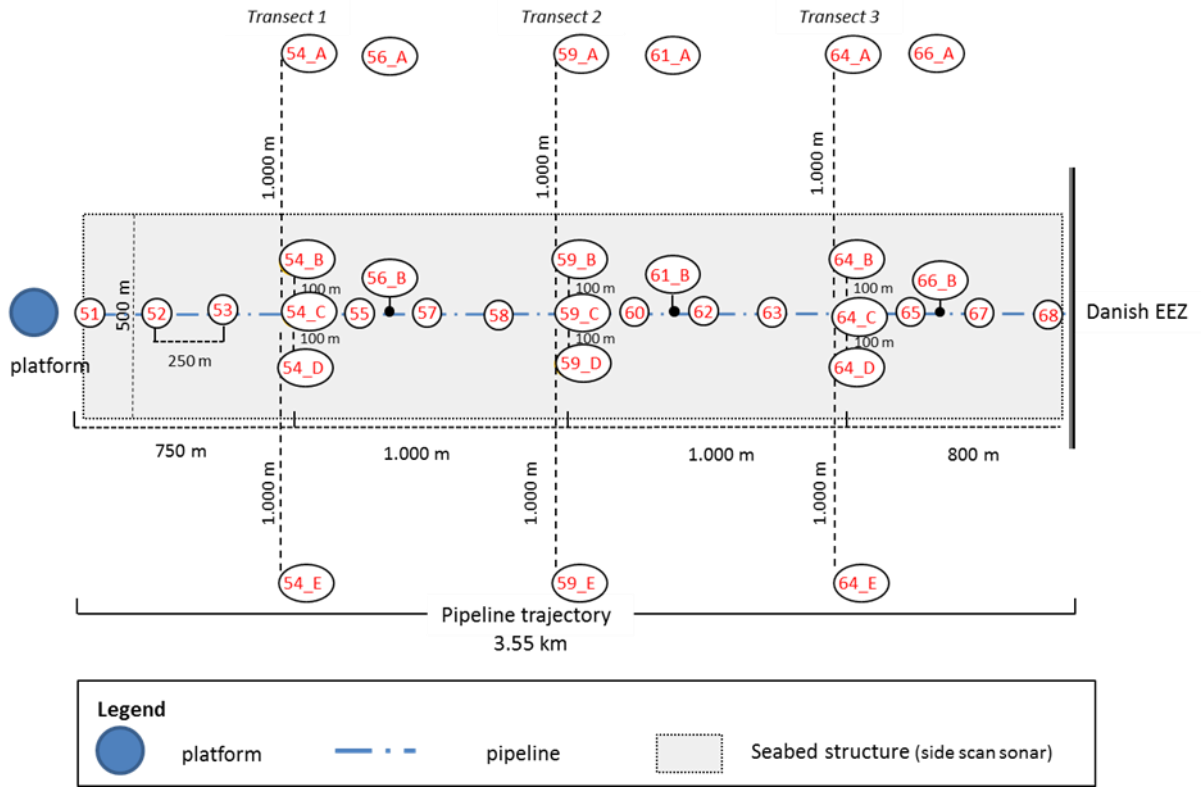


Figure 3. *Schematic layout of the sediment, beam trawl and side scan sonar sample locations along the pipeline trajectory.*

2.1. Sampling methods

Collection of the sediment samples

Sediment samples were collected using a standard HELCOM van Veen grabber with a sample area of 0.1 m^2. The van Veen grab was lowered to the seabed and restored on deck with the use of an A-frame and a winch that was welded on deck. At each sample location four samples were taken, one for grain size and organic carbon analysis and three for benthic species composition. The samples were randomly collected in an area of approximately 10 x 10 meters of the sample location.

The sample for grain size and organic carbon analyses was collected by taking a subsample of the van Veen grab sample. A syringe was used to collect a 100 ml subsample (in the first 10 cm of sediment). The sample was emptied in a plastic bag and stored in a freezer (-20 ^{0}C) prior to analysis.

For collection of the three biological samples the van Veen grab was emptied in a sieve (mesh size; 1 mm). The inner parts of the van Veen grab were gently flushed with sea water to completely empty it. Then the sieve was transported to a frame where the sample was gently rinsed with sea water to remove sand and clay particles. From the remaining material (biota, shells, stones and other particles) a photograph was taken. Then the sample was transmitted to a polyethylene container and preserved with a 6-10 % buffered formaldehyde in seawater solution for storage and transportation to the laboratory.

Collection of the epibenthos samples

For collection of the epibenthos samples a two meter beam trawl was applied. The fishing net, equipped with a net with a mesh size of 4 mm, is kept open by the beam. Two shoes are attached at the end of

the beam. The beam trawl was equipped with a tickler chain to disturb and catch fish and other biota hiding in the sediment.

The beam trawl was deployed using a steel towing wire set over board with the use of a winch and A-frame positioned on starboard side of the ship. Two times the water depth of steel wire was set overboard. For this purpose the wire was marked with small coloured ropes at 10 meter intervals. During the deployment phase the ship sailed with a speed of approximately 0.5 knots to keep phase with the winch. When the required amount of wire was set overboard the five minutes fishing started. At that point the wire was fixed, the ships speed was increased to 1 knot and a waypoint was set to store the coordinates were fishing started. After five minutes of fishing a second waypoint was made. At that point the ship stopped the engines and drifted away to starboard side while recollecting the net with the winch. Beam trawl fishing was carried out parallel to the pipeline and against the current.

The catch was sieved over a 5 mm sieve, sorted, identified and counted on board immediately after collection. Specimens that could not be identified were taken aside for determination in the laboratory.

Side scan sonar

Side scan sonar is a technique to image the seafloor with the use of sound waves. It is particularly useful, if a detailed map of the seafloor is required that covers a large area. Sound emitted by the sonar (in the frequency range of 100 – 500 kHz) is scattered and reflected against objects located on the seafloor. The strength and travel time of the sound varies due to the distance between sonar and seafloor and the scattering properties of the sediment. By recording both strength and travel time an image of the sea floor can be constructed. By compiling the individual bands recorded by the side scan, a mosaic can be created.

The side-scan sonar imaging (both scanning the different bands and construction of a mosaic from the individual bands) was carried out by Fugro. The sonar itself was located in a so called 'tow fish' towed behind the vessel by a steel cable. A data cable located in the inner part of the steel cable was connected to a computer on deck in order to store the images.

Seabed photography

A stereo underwater camera was used to make the seabed pictures. The system consists of two full colour 18 mega pixels cameras placed in an angle. The camera housing is placed in a frame to which also four underwater lamps were attached to provide additional lighting. The cameras are connected to a field computer where the pictures that were taken could be inspected (real time) and stored.

The frame was put alongside the vessel with the ship's main crane and lowered to the seabed using the winch. Once the frame was positioned above the seabed, a waypoint was set and the ship started drifting away to take random seabed photographs for about five minutes. During this time the frame rate was set at 4 pictures a second. Noticeable species were registered directly on board. Back in the office photographs were examined for presence of reef structures (by aggregations of gravel / boulders, or organically by for instance fields of *Lanice sp.*). In this way the interpretation of the seabed structure obtained from the side scan sonar images and from van Veen grab samples could be verified.

3. Laboratory and data analyses

3.1. Macrofauna characterisation

The sediment samples collected with the van Veen were transported to the laboratories of IMARES and NIOZ for identification. The three replicate samples taken at each sample location were divided in A, B and C series. Samples of each series were randomly divided between the IMARES and NIOZ laboratories.

The collected macrofauna were sorted and identified under a stereomicroscope. Standard taxonomic keys and references were used to identify each taxon. Macrofauna has been counted and identified at species level when possible. Data is presented as species-abundance data in this report. Because numbers of the sea urchin *Echinocardium cordatum* (juveniles) exceeded 1000 individuals in individual samples, these were counted in subsamples (at least 100 individuals) and the total sea urchin numbers were recalculated based on the dilution factor. Species that proved difficult in its identification were kept aside for further examination and inter-laboratory calibration. Additionally, the photographs taken were examined and species were identified from screen.

Analysed samples will be stored at IMARES after enumeration for a period of 5 years after completion of the project (i.c. Dec 2019). This period can be prolonged to the client wishes. Examples of the benthic species were taken up in the Taxonomic Reference Collections that has and will be maintained for several years at both IMARES and the NIOZ as part of their QA procedures.

3.2. Physical characterisation of the sediment

Dry weight and organic content

Sediment was dried at 105 ^{0}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).

To measure the organic nitrogen and carbon fractions a Carlo Erba elementanalyzer, type NA-1500, was used. Freeze-dried sediment samples are grinded in a ball mill, homogenized, and exactly weighted in Sn-cups. Cups are then introduced in a combustion tube (1010 °C) where under influence of catalysts (Cr_2O_3, $AgCo_3O_4$) and oxygen, the samples are combusted. The CO_2 and N_2 produced, is analyzed using gas chromatography (separation on a Haysep-Q kolom and detection using a Hot Wire Detector) (Cutter en Radford-Knoerv, 1991; Nieuwenhuize en Maas, 1993; Nieuwenhuize *et al.*, 1994).

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 research assistants of the Analytical Laboratory of the NIOZ in Yerseke. 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.

3.3. Data analysis

Abundance

Total species abundance was calculated by dividing the total number of species found at each location by the sampled area (0.1 m^2). Numbers are presented as the average number of species per square meter. Species that are not typical benthic but for instance pelagic were excluded in this calculation as the van Veen grab sampler cannot sample these species in a representable manner. In principle, only heads or hinges (in case of bivalves) are counted to identify the number of specimens per species, which is necessary when specimens are disrupted or incomplete. In case no heads or hinges of a certain species were present, but a sufficient large part of a species was found to enable identification, a number of 0.001 specimens was recorded, which makes that such species are relatively unimportant in the total numbers, but will be present in the final species list.

Preparation of the dataset prior to further analysis

To calculate diversity indicators (diversity, evenness, richness) or prepare the data set for multivariate statistics (i.e. community analyses) it is of importance that specimens that could not be identified to the species level, do not count as separate groups (which would unrealistically increase the species richness). Therefore, the taxonomic identification was adjusted before analyses by aggregating higher taxonomic identification groups (e.g. genus, family, order, etc.) with the most common species within that group in case a specific species was clearly most common within the sample. When several species were similarly common, and especially when they were all uncommon, those species were all aggregated to the higher taxonomic level group and identified as the resulting genus, family, order, etc. For certain group's specimens are never identified to the species level, but are by definition aggregated to a higher taxonomic level (e.g. Nemertea, Phoronida, Nematoda, etc.).

Diversity and evenness

The species diversity index was calculated using the equation of the Shannon-Wiener Index (Shannon, 1948), see equation 1. This index measures the order (or disorder) within a sample, taking both the evenness as the number of species into account. The number increases by an increasing number of species but also with greater species evenness.

$$H = -\sum P_i(\ln P_i) \qquad \text{Equation 1}$$

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

Evenness was calculated using Pielou's evenness index (Pielou, 1975), see equation 2. This is a measure of how similar the abundance is distributed over the different species. When evenness has the value of 1 all individuals are distributed similar over the species. The evenness value decreases with increasing dissimilarity.

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

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

Species richness

The amount of species found in each sample (= location) is used in the analyses to compare differences between sites. However, the observed number of species will always be a downward estimator of the complete species richness in an assemblage at any site, as especially rare species are subject to exclusion in individual samples. With increasing effort (samples taken) more species will be 'discovered', increasing the observed species richness. To obtain insight in the relation between effort and species richness, a Species Accumulation Curve is constructed. In this graph the accumulation of species is plotted against sample number. Calculations are carried out in R environment (R Development Core Team, 2013), making use of available functions within the vegan package (Oksanen *et al.*, 2012).

Multivariate analysis

For community analyses, it is undesirable that specimens that might belong to the same species are indicated as different groups. Therefore, identified taxa are grouped when specimens might be of the same species at which most likely aggregations are made (see above).

A cluster analyses was carried out to identify groups of stations that show similarity in both species presence and abundance. As input for the clustering of the samples, a Bray-Curtis dissimilarity matrix constructed with fourth root transformed (to downscale the importance of very abundantly present species and very rare species) species abundance data (Equation 3) was used. The Bray-Curtis metric is bound between '0' and '1'. When two samples are identical a value of '0' is obtained, when none of the species is shared a value of '1' is obtained. The Bray-Curtis dissimilarity is directly related to the Sørensen similarity index (by 1 minus the Bray-Curtis value) and can also be expressed as a percentage.

$$BC\_dis = \frac{\sum_{j-1}^{J} \left| n_{ij} - n_{i'j} \right|}{n_{i+} + n_{i'+}} \qquad \text{Equation 3}$$

Results are visualised using nMDS (non-metric Multi-Dimensional Scaling) plots in which the relative distance between locations in the plot indicates the similarity/dissimilarity in a two-dimensional way, as much as possible. The indicated stress factor (that should preferably not transgress a value of 0.2) indicates to what extent a two-dimensional representation gives a good view of identified similarities/dissimilarities between the locations. To test for significant differences between identified clusters in an nMDS, an ANOSIM (Analyses of Similarity) was used. The species composition of identified clusters and the species most distinguishing between clusters can be identified using the SIMPER (Similarity Percentages) routine. nMDS and ANOSIM analyses are executed in PRIMER v6 (*e.g.* Clarke & Gorley, 2006).

nMDS can be used to identify the relative importance of environmental factors or distinguishing parameters for groups of locations when those factors/parameters are distinguishable in a limited number of groups. If those factors/parameters are distinguishable in a range of groups, or if those factors might represent gradients of values, a Principle Component Analysis (PCA) is more straight-forward to identify relatedness between species distributions and environmental factors (including scorings of the relative positioning of sample locations). As the gradient length of the dataset appeared to be relatively short (<3) as indicated by a Detrended Correspondence Analysis (DCA); *i.e.* 2.06, a linear model can be used. As we are interested in the possible relatedness of abiotic and grouping parameters to observed patterns in species distributions, an indirect gradient analysis should be executed: *i.e.* a PCA. The DCA and PCA were done using Canoco for Windows 4.5 (Ter Braak & Smilauer, 2002).

4. Results

4.1. Morphology of the area

The top layer of the seabed along the pipeline trajectory surveyed with the side scan sonar can be characterized as homogeneous and sandy, see mosaic in *Figure 4* and Appendix C for greater detail. No sediment type different than sand could be discovered and no boulders or other (a)biotic structures were detected on the side scan sonar mosaic. In the entire area scars of beam trawl tracks can be found in the top layer indicating fishing activities.

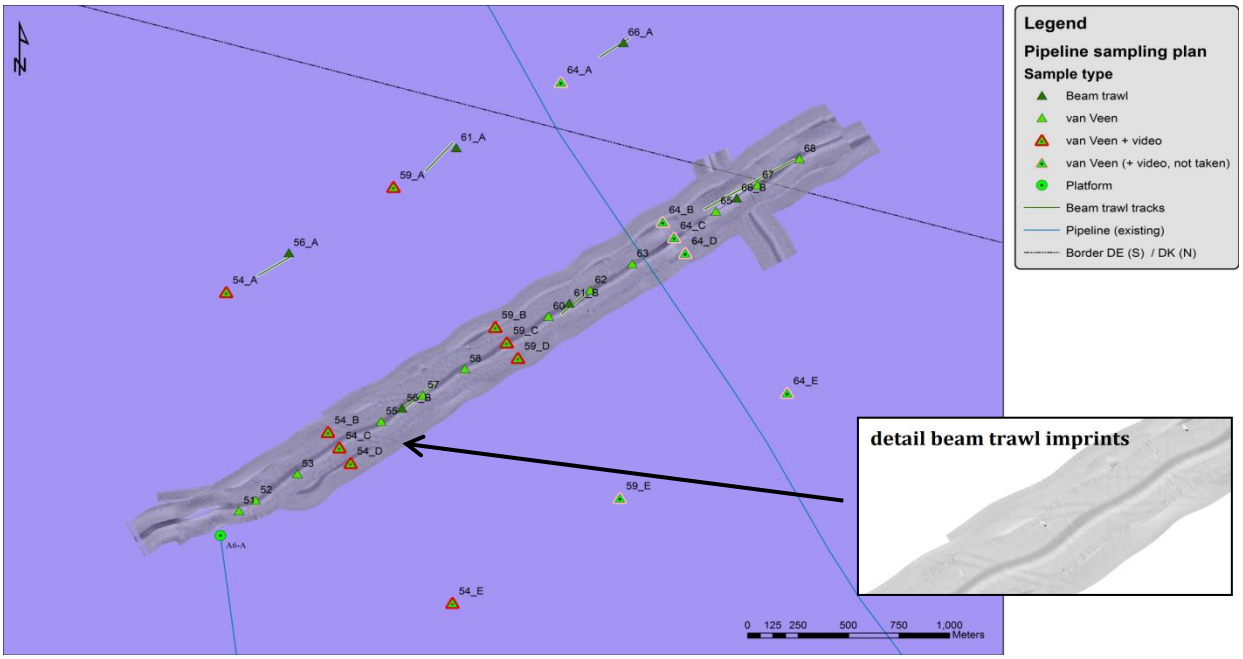


Figure 4. *Side scan mosaic showing the morphology of the area and the sample locations. Beam trawl imprints indicate fishing activities.*

The homogeneous nature of the area is supported by the photographs that were made of the sea bed. They also show coverage of the sediment with rather evenly distributed shell debris, see *Figure 5*.

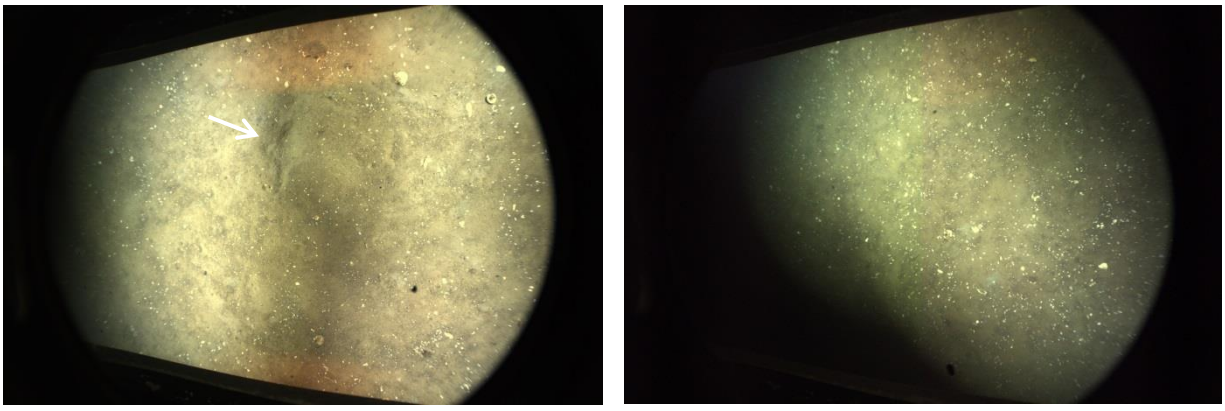


Figure 5. *Pictures showing sandy sea bed covered with shell debris. Location 54_A (ref. North, transect 1) on the left and sample location 59_C (transect 2) on the right. On the left picture the contours of a flatfish can be seen.*

Epibenthic species (species living on top of the sediment) that were detected on the photographs did not show large quantities or aggregations of species and no clear difference in species coverage was notable on the photographs taken at the different sample sites.

Species captured with the photo camera consisted of common hermit crab (*Pagurus bernhardus*), different crab species such as the swimming crab (*Liocarcinus holsatus*) and helmet crab (*Corystes cassivelaunus*), different starfish species such as the brittle starfish (*Ophiura ophiura*) and possibly sand star (*Astropecten irregularis*). Fish species were seen as well, including flatfish, ray (likely starry ray *Amblyraja radiata*) and sand-eel. Worm- and mollusc holes were detected indicating the presence of endobenthic species (species living buried in the sediment).

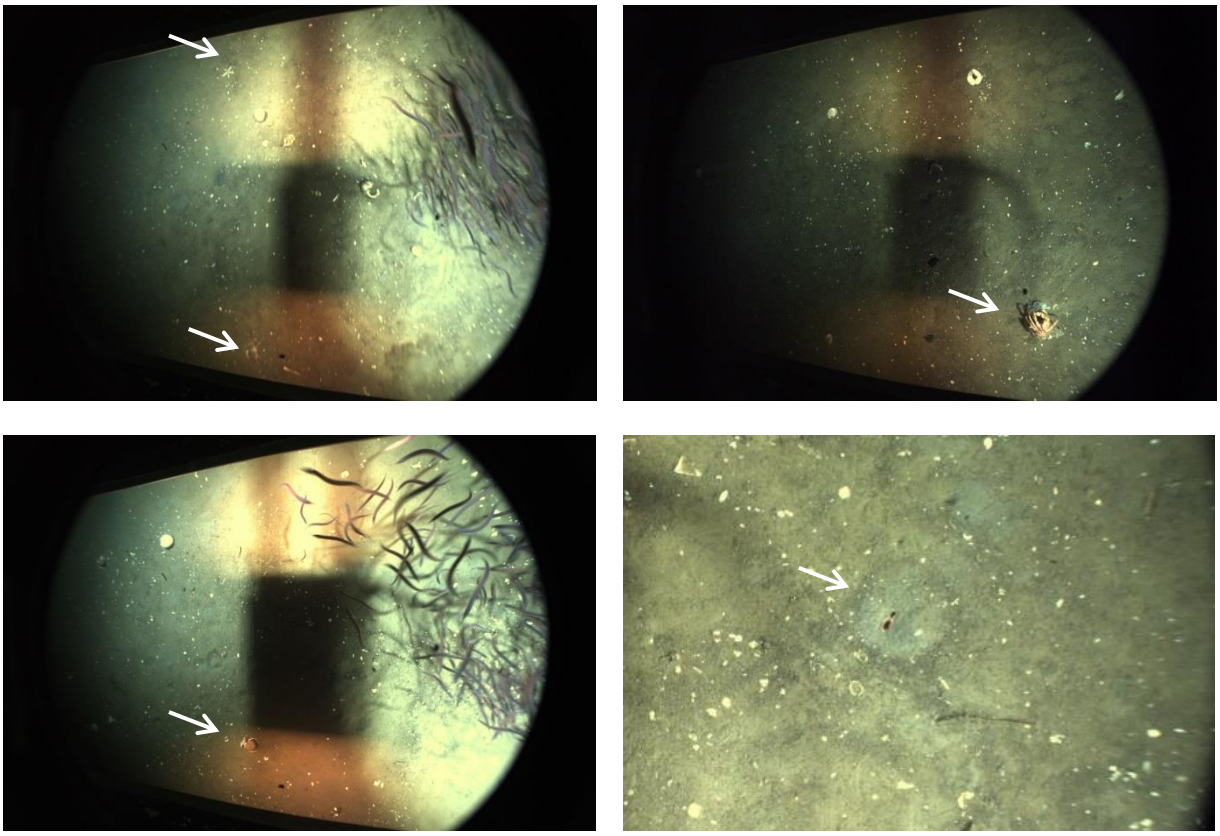


Figure 6. *Pictures showing some species and siphon marks of a mollusc. Top left, crab, starfish and sand eel (54_C, transect 1), bottom left hermit crab and sand eel (54_C, transect 1), top right hermit crab (54_D, transect 1) and bottom right detail showing inlet and outlet siphon holes of a mollusc (54_D, transect 1).*

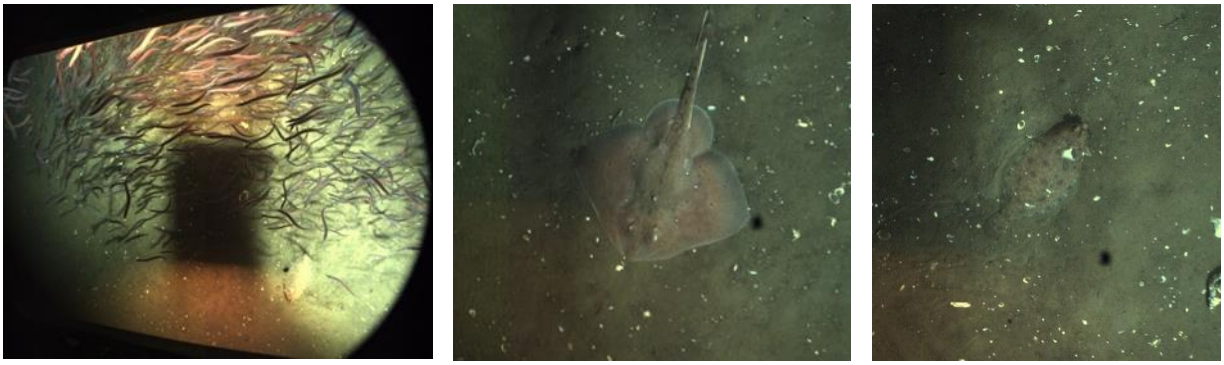


Figure 7. *Pictures showing fish species. Picture on left sand eel and flat fish (54_B, transect 1), detailed picture in the middle showing (starry) ray (54_D, transect 1) and detailed picture on the right showing flat fish, possibly lemon sole, Microstomus kitt (54_D, transect 1).*

4.2. Macro benthos community - van Veen

Community indices

At first general patterns in the community descriptors were identified. The following descriptors were taken into account:

- total number of species per sample (S),
- total densities (n),
- evenness (J')
- diversity (H')

High densities of (juvenile) *Echinocardium cordatum* were observed with a large influence on the total density, see *Figure 8*. Excluding *Echinocardium cordatum* resulted in an average sample species density of 5652 ind/m^2 ± 1129 (standard deviation). Therefore, specimens of *Echinocardium cordatum* are not included in further calculations. As these were mainly very small juveniles, they were clearly from a recent spatfall. Sampling a few weeks earlier (or later) would have resulted in markedly different calculations.

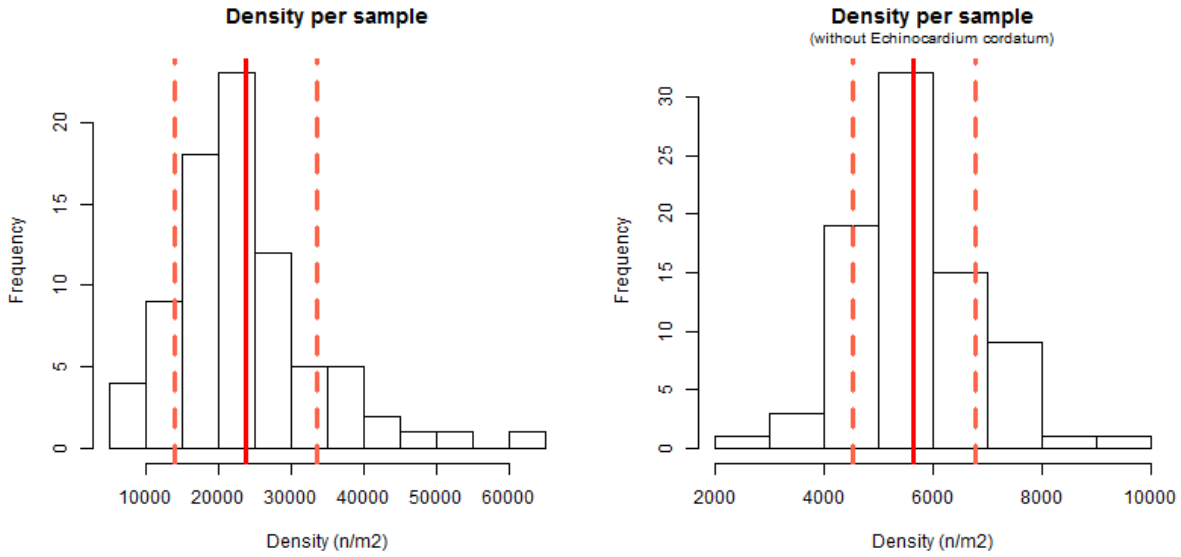


Figure 8. *Histogram of species density per sample. With Echinocardium cordatum (left figure), excluding Echinocardium cordatum (right figure). Averages are marked with vertical red lines, 1 x standard deviations with vertical red dotted lines.*

With on average 40.7 ± 9.2 species/taxa per sample and an average diversity of 2.21 ± 0.19 species richness and diversity is quite high when compared to near shore North Sea communities, but is what can be expected for the Doggersbank region, see *Figure 9*. The species richness of the area is illustrated by the species accumulation curve. This curve continues to increase with increasing sample numbers, *Figure 10*.

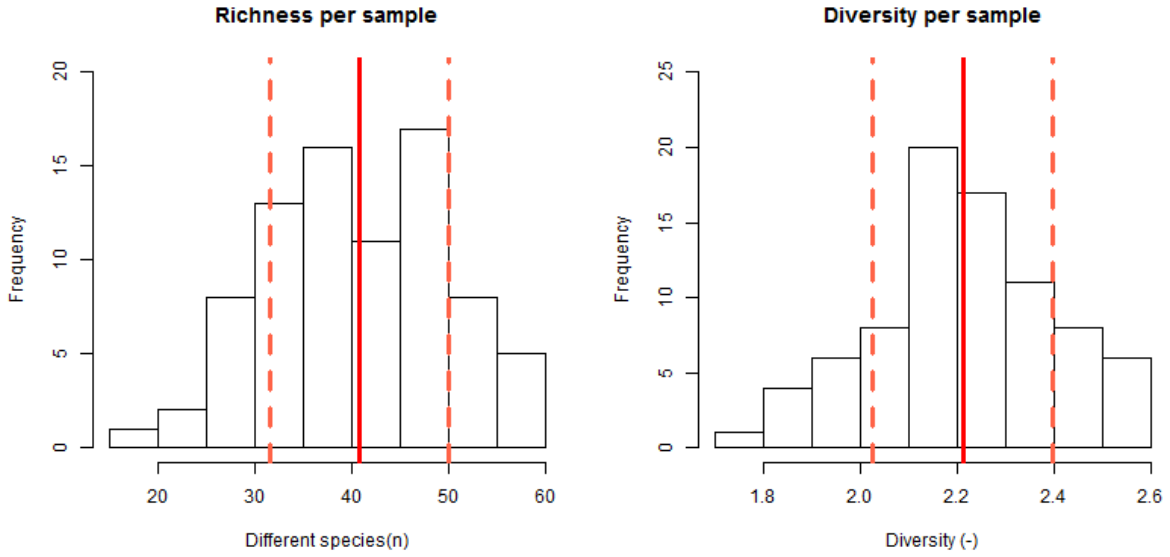


Figure 9. *Histogram of species richness (left) and diversity (right). Averages are marked with vertical red lines, 1 x standard deviations with vertical red dotted lines.*

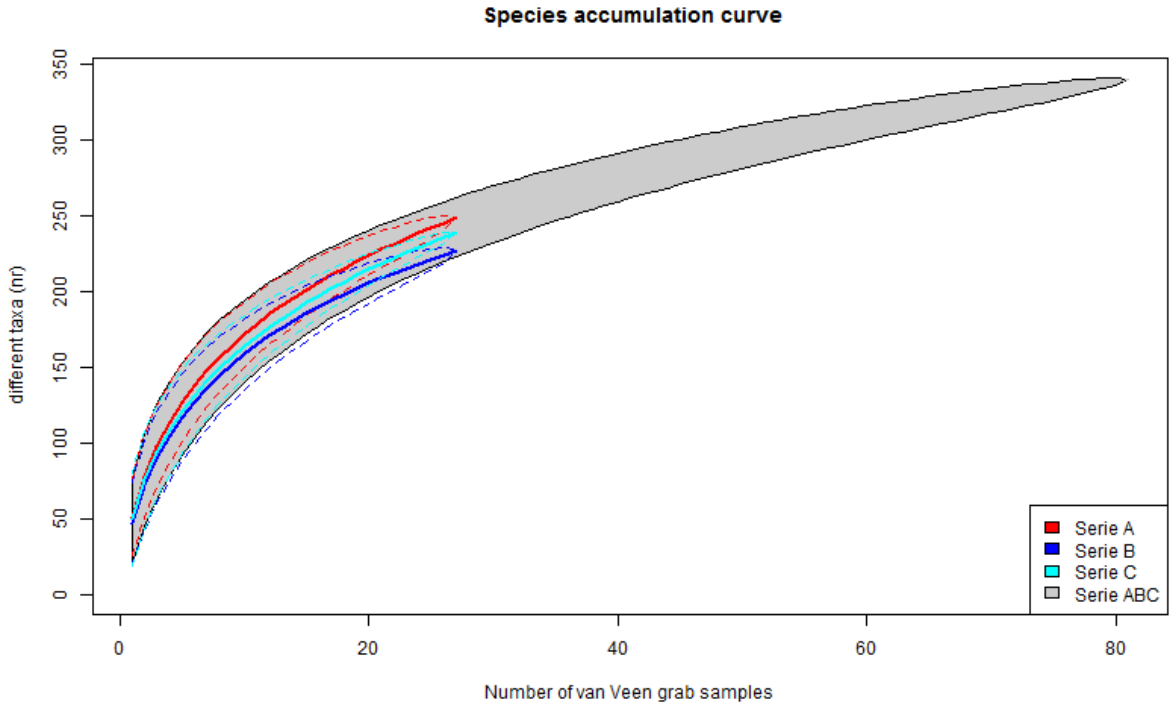
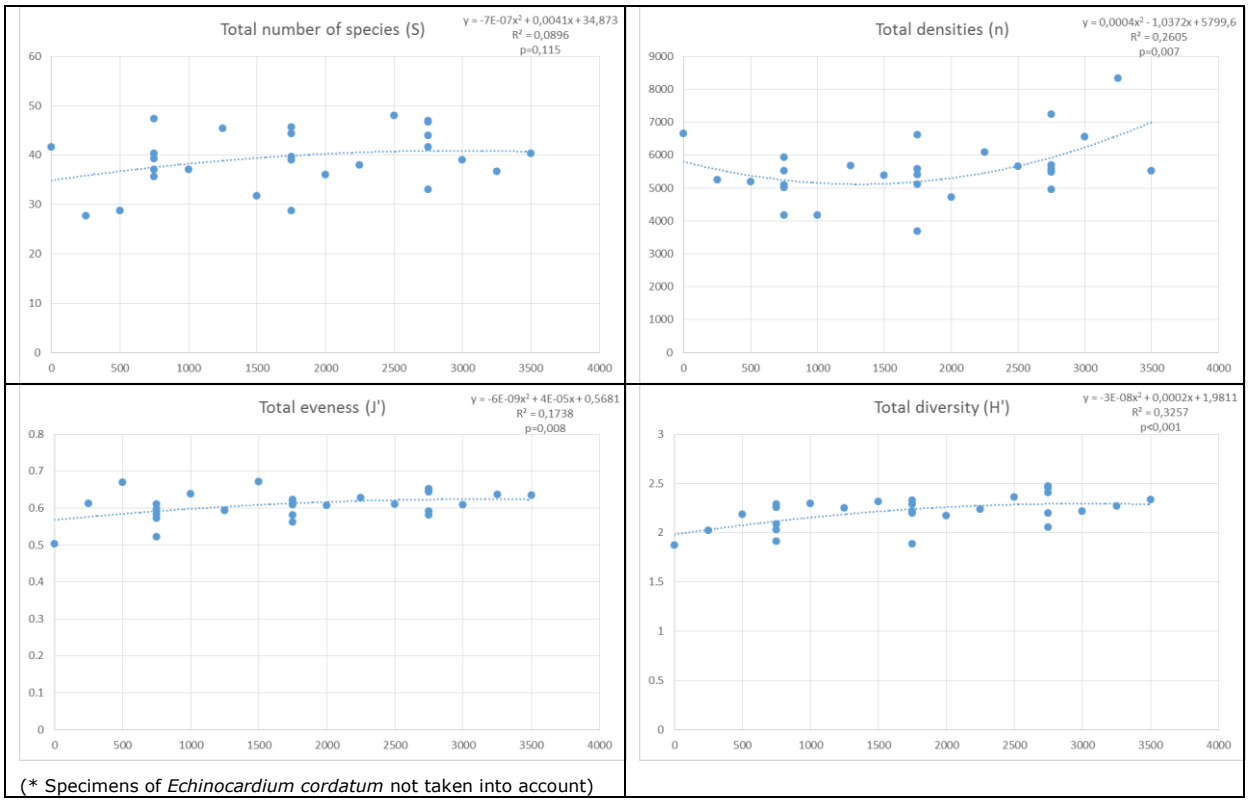


Figure 10. *Species accumulation graph showing the increase of different species with increasing sample numbers.*

As samples are situated according to a sampling grid along a pipeline trajectory at a certain distance from the platform (or to the Danish border) it can be analysed whether a gradient in one or more of these indicators is present. *Figure 11* shows the results of regression analyses of S, n, J' and H' along the pipeline trajectory (potential gradients in (South)West-(North)East direction). There is a tendency towards an increase in species richness, total densities, evenness and diversity from West to East. This trend is significant for all parameters except species richness (S).

No marked differences in species richness, density, diversity and evenness between the samples taken on the pipeline trajectory and in the samples collected at 100m and 1000m perpendicular of the pipeline could be discovered and there are no indications that a 'North-South' gradient in the benthic communities is present.



(* Specimens of *Echinocardium cordatum* not taken into account)

Figure 11. *Analyses of the presence of a gradient in community indicator values along the pipeline trajectory. Values on the x-axe indicate the relative distance from the platform starting with 0 m for location 51 to 3500 m for location 68. There is a tendency for a West-East gradient for each of the investigated indicator (Total number of species (S), total densities (n), evenness (J') and Shannon diversity (H')), this is only not significant for number of species (S).*

As is also indicated by the underwater video pictures, the communities are typical for a sandy (fine sand) environment with reasonable dynamics. Table 1 shows the most common species in occurrence and densities during the campaign. Besides the large numbers of *Echinocardium* juveniles, also *Spiophanes bombyx*, *Scoloplos* sp., *Phyllodoce groenlandica*, *Chaetozone christiei* and *Goniada maculate* (all polychaete worms), Ophiuridae (brittle stars) and the bivalve *Abra prismatica* were present at all stations. These are also among the most abundant species (*Figure 12*).

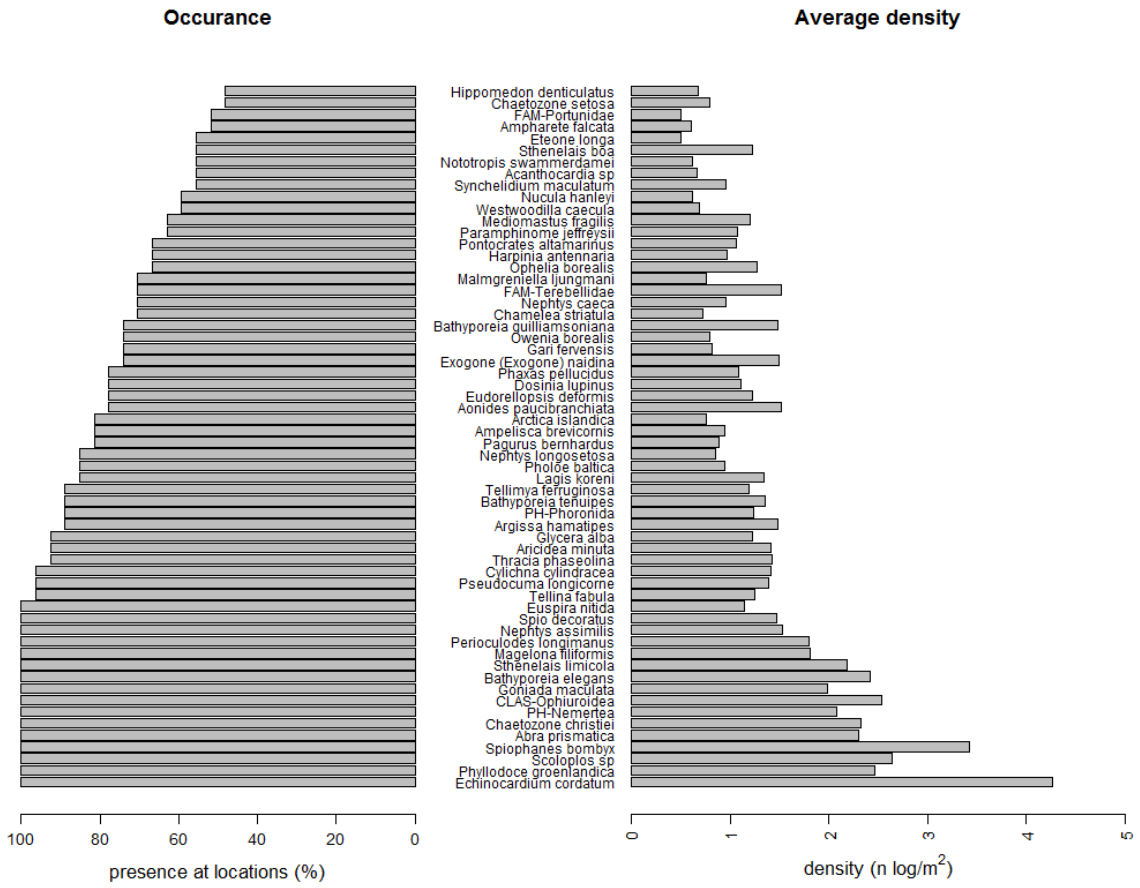


Figure 12. *Overview of the 60 most common and abundant species describing the community of the pipeline trajectory and its surroundings as percentage of occurrences at the stations (left plot) and their average density over all samples (right plot).*

Community structure

In the 81 van Veen grab samples 340 taxonomic units were identified, including incomplete individuals of unique taxa and specimens that had to be identified to higher taxonomic level. Of these 340 taxonomic units 30 were only scored as being present or absent. Species in this group belong to the phyla of the Bryozoa, Chlorophyta, Cnidaria, Foraminifera, Porifera and Rhodophyta. After aggregation (see par 3.3), 210 taxonomic units were left.

In *Figure 13* the van Veen grab samples are plotted in a two dimensional plane. The three transects are separately marked to show that samples taken at the three transects do not mix, but form different clusters (R = 0.38, p=0.001), that reflect the gradient from the platform (transect 1) to the Danish border (transect 3). There is no indication for a North to South gradient within the transects: samples collected north of the pipeline (A and B numbers) mix well with those taken South of the pipeline (D and E numbers), see Figure 3.

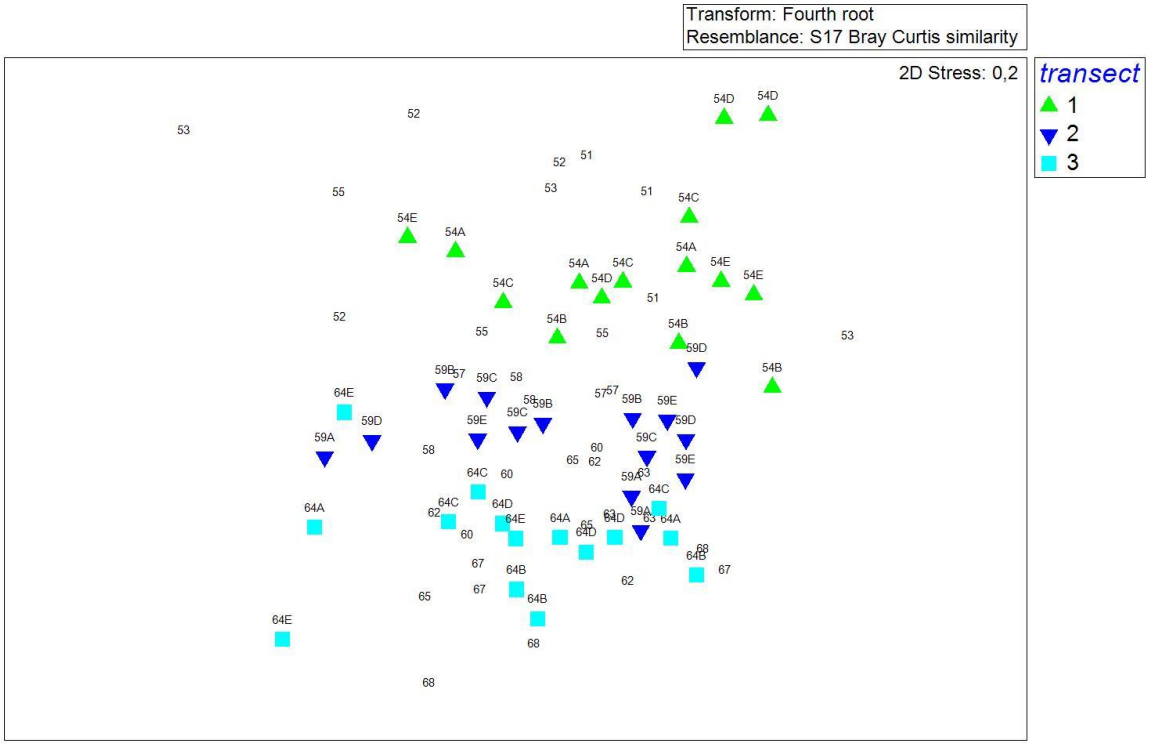


Figure 13. *nMDS plot: results of non-metric multi-dimensional scaling of the species abundance data after 4th root transformation according to the Bray-Curtis dissimilarity calculation. All sampling locations are indicated by their code whereas the samples situated in the 3 transects are stressed with coloured marks. Green symbols indicate samples located on transect close to the platform, light blue symbols indicate samples located on transect close to the Danish border and dark blue symbols indicate samples from the middle transect. Potential significant differences between clusters are tested for using ANOSIM.*

In *Figure 14* variables are included in the PCA orientation showing the influence of the South-West to North-East gradient by the factors 'distance to platform', 'median grain size', 'silt', 'POC', 'depth' (which increases gradually from platform to the Danish border), and the community indices 'richness', 'density', 'diversity' and 'evenness'.

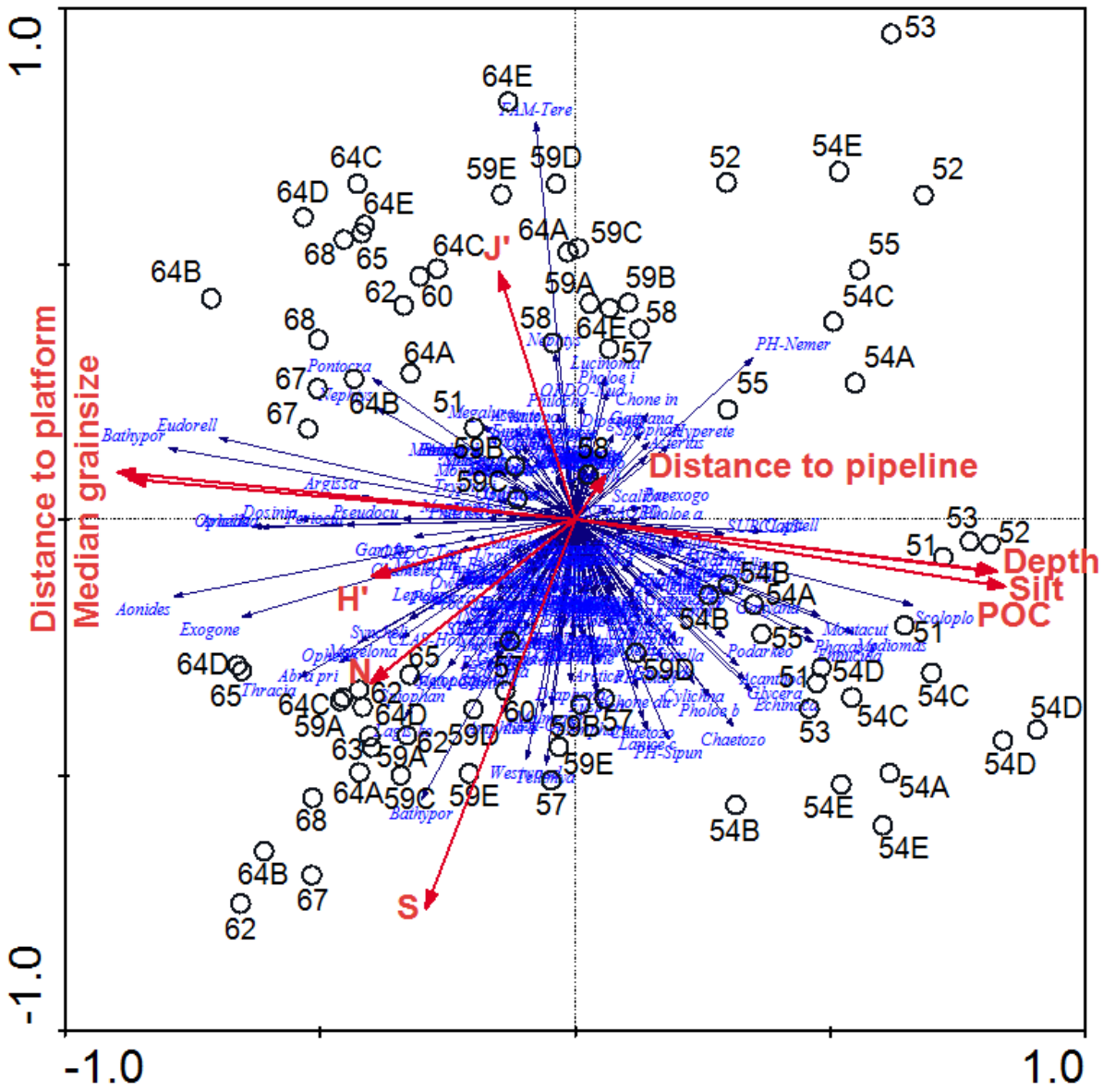


Figure 14. *Results of a PCA (Principal Component Analysis) to identify the species responsible for community differences along potential gradients (i.e. East-West gradient (distance to platform), North-South gradient (distance to pipeline), depth gradient (depth)) and sediment characteristics (Median grain size in µm; Organic Carbon (Organic C) content, Nitrogen content (N) and the proportional presence of the grain size fractions Silt (<63 µm), Very fine sand (63-125 µm), Fine sand (125-250 µm) , Medium sand (250-500 µm) and Coarse sand (500-2000 µm)). Relative positioning of sample locations (on basis of their species assemblages taking abundances into account after Y'=ln(Y+1) transformation) is indicated as well.*

Species that are important in the existence of a gradient are shown in *Table 1*. They consist of different Annelida, Mollusca and Arthropoda species. As indicated by the included environmental parameters, the species composition going from South-East to North-West (i.e in a gradient on and along the pipeline trajectory) is clearly related to gradients in sediment composition. Whereas near the platform the silt contents are higher, approaching the 8%. The silt contents are much lower, to almost zero at several locations near the Danish border, see *Figure 15*. As can be expected, the organic nitrogen and carbon content is highly correlated with the sediment silt content; e.g. significantly decreasing from the platform to the Danish border.

Besides that the silt fraction decreases from South-West to North-East, particularly the medium sand fraction increases on cost of the fine sand fraction. This results in a significantly increasing Median grain size along the pipeline trajectory from the platform to the Danish border.

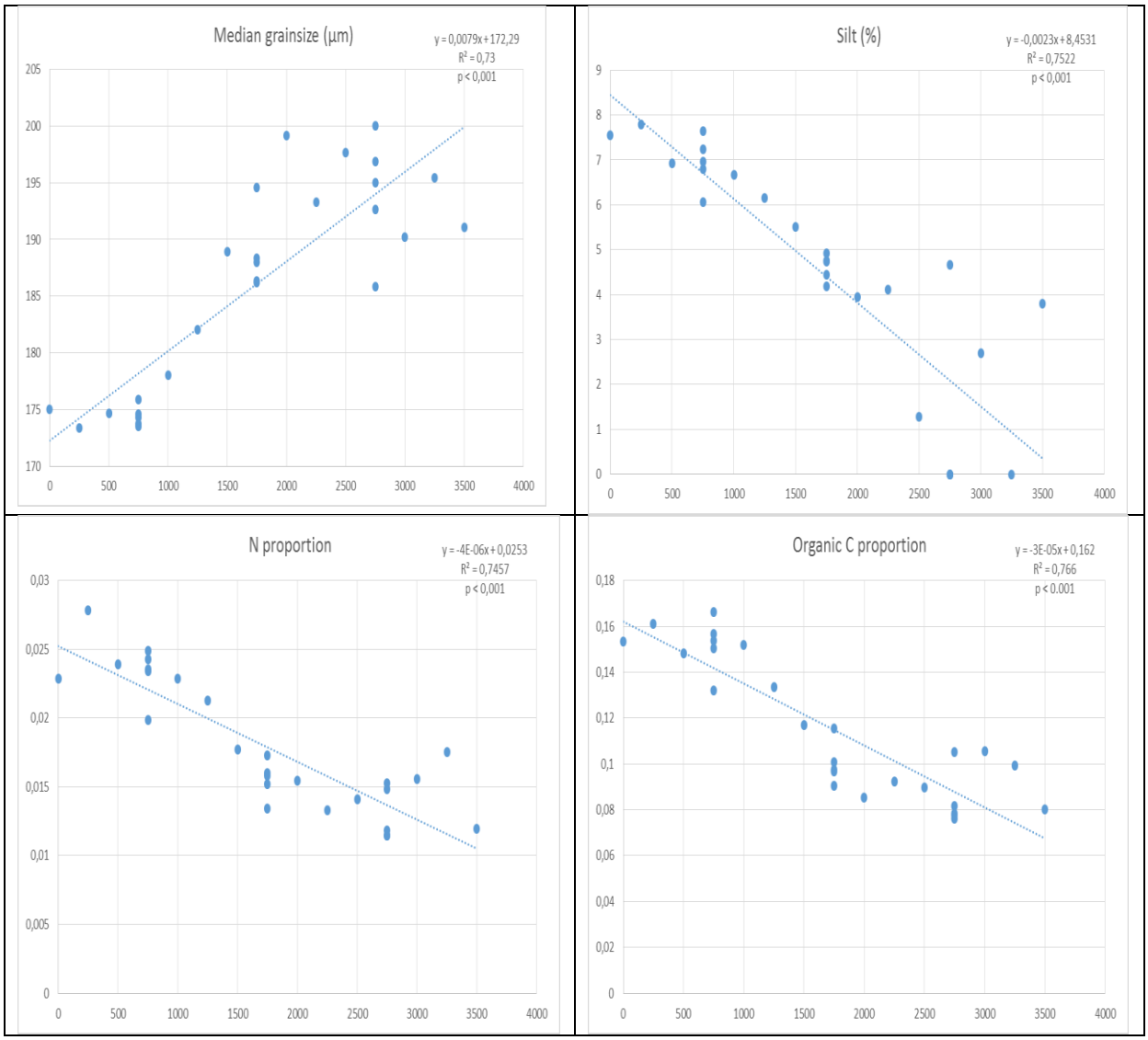


Figure 15. *Results of regression analyses of sediment characteristics in a gradient along the pipeline transect from platform to Danish border at 3500 m. Percentage silt, organic C and organic N significantly decrease from the platform to the Danish border, whereas the Median grain size significantly increases in this direction.*

Table 1. *Species contributing significantly to the West to East gradient.*

High densities in South-West		**High densities in North-East**	
Species	**Phylum**	**Species**	**Phylum**
Scoloplos sp.	Annelida	*Aonides paucibranchiata*	Annelida
Mediomastus fragilis	Annelida	*Bathyporeia elegans*	Arthropoda
Montacuta substriata	Mollusca	*Eudorellopsis deformis*	Arthropoda
Phaxas pellucidus	Mollusca	*Exogone (exogone) naidina*	Annelida
Ennucula tenuis	Mollusca	*Aricidea minuta*	Annelida
		Ophelia borealis	Annelida

4.3. Epibenthic community – Beam trawl

Community indices

In the beam trawl samples, a total of 41 species distributed over seven phyla were identified, including eight species that are taken up in the red list (Rote Liste gefahrdeter Tiere, 2013) as being endangered (so excluding species marked as 'V' and 'D'), see *Figure 16*. The following phyla are represented: Annelida (just one species, the sea mouse *Aphrodita aculeata*), Bryozoa, Cnidaria (all Hydrozoa), Mollusca, Arthropoda, Echinodermata and Chordata (*i.e.* fish), see also *Figure 17*.

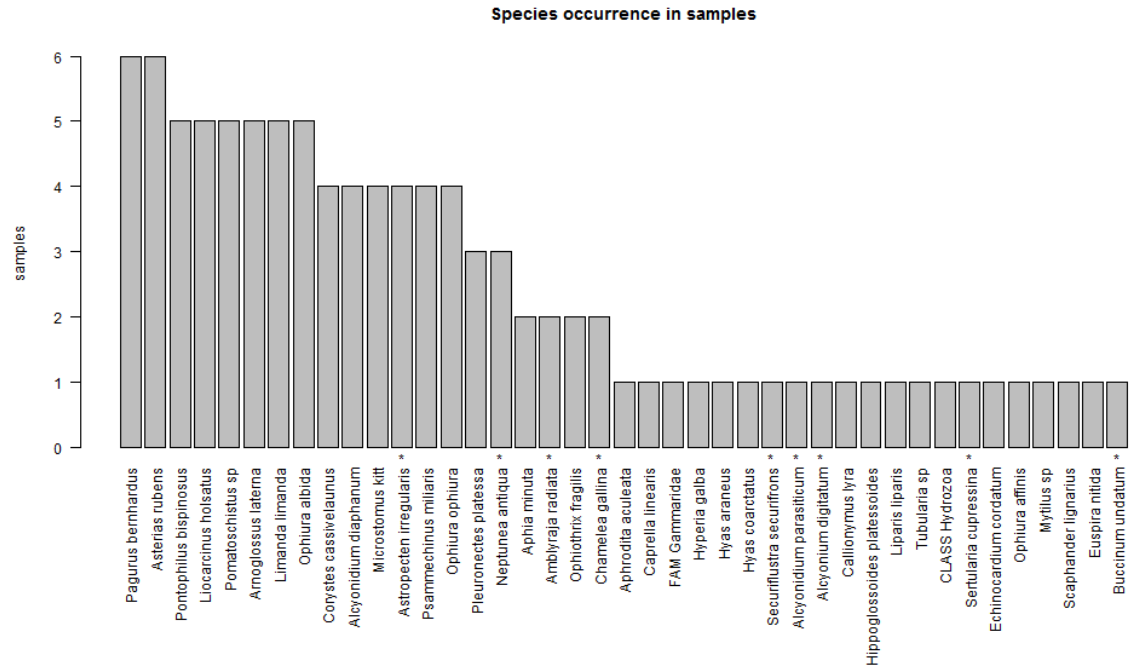


Figure 16. *Species found in the beam trawl samples and their occurrence. Species that are listed in the red list as being endangered are indicated with '*'.*

In each sample one or more individuals of the hermit crab *Pagurus bernhardus* and starfish *Asterias rubens* were found, see *Figure 17*. The swimming crab, *Liocarcinus holsatus* and the fish species goby *Pomatoschistus sp.,* scaldfish *Arnoglossus laterna* and dab *Limanda limanda* were found in almost all (*i.e.* five) beam trawl samples. A large portion of the species, approximately half of all species discovered, was found in just one sample.

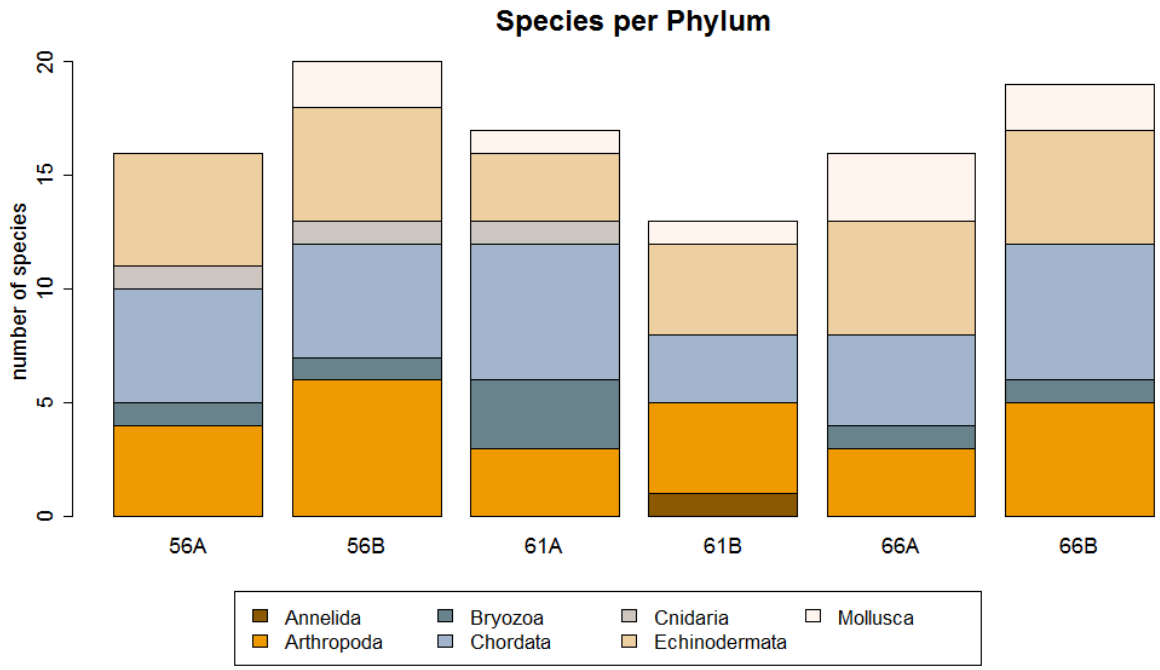


Figure 17. *The amount of different species collected in each beam trawl sample differentiated per phylum. Sample numbers indicated with xx_A are the reference points located 1000 m north of the pipeline trajectory, sample numbers indicated with xx_B are positioned along the pipeline trajectory.*

Figure 17 shows distribution of the different species per phyla for the beam trawl samples. The highest numbers of species belong to the phylum Arthropoda (including crab species), Echinodermata (including starfish species) and Chordata (including fish species), each representing approximately 25% of the total number of different species in a sample. Mollusca, Bryozoa and Cnidaria (only hydrozoa species) represent only a small portion of the total. The only Annelid species, the sea mouse *Aphrodita aculeate,* was collected in the 61B sample.

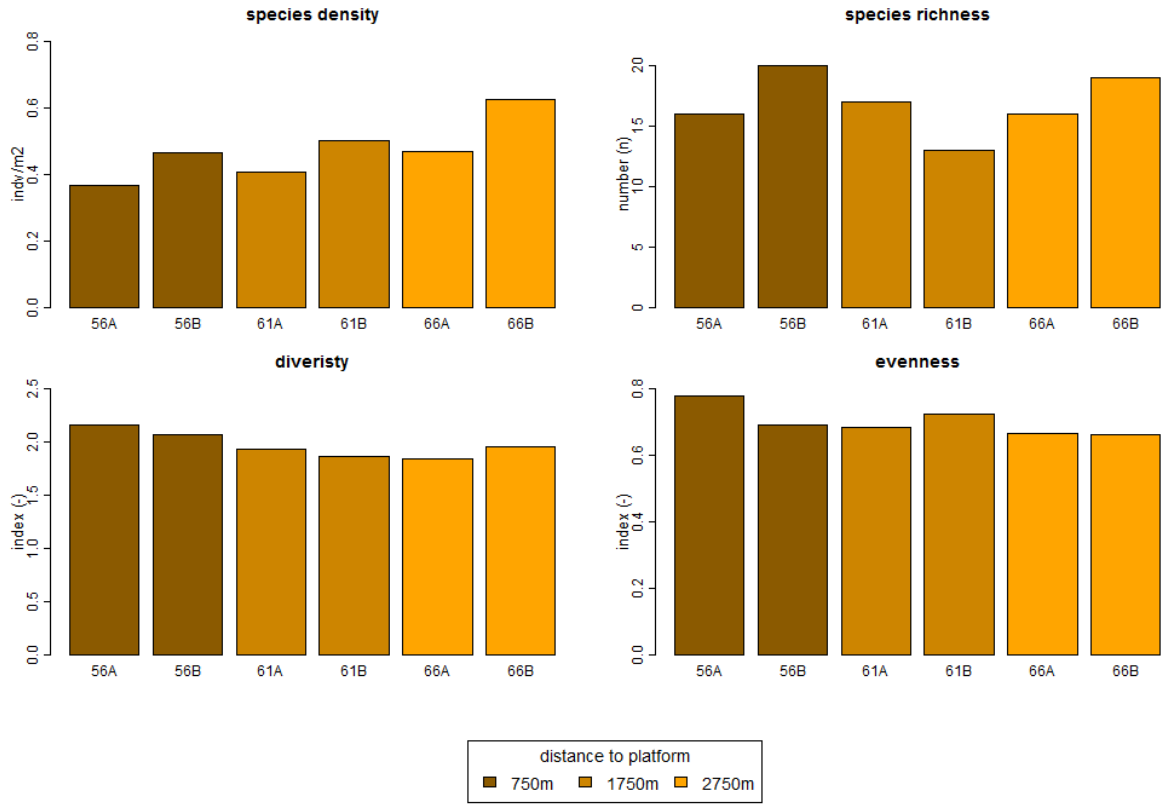


Figure 18. *Species richness, density, diversity and evenness for the beam trawl samples. Colours indicate the distance from the A6-A platform. Sample numbers indicated with xx_A are the references points located 1000 m north of the pipeline trajectory, sample numbers indicated with xx_B are positioned on the pipeline trajectory.*

In *Figure 18* species density, richness, diversity and evenness of the beam trawl samples are plotted. The average sample density is 0.47 ± 0.09 individuals per m^2. Although species density seems to increase from the platform to the Danish border, this trend is not significant (R^2=0.29, p=0.158, ANOVA). There is also no significant difference between reference- and pipeline samples (p=0.13, t test), although pipeline samples have consequent higher densities compared to their reference counterparts.

Species richness varies from 13 to 20 species per sample. No pattern in pipeline – reference samples or distance to platform can be discovered in species richness and evenness. The diversity is slightly higher at the samples collected near the platform and seems to decrease a bit going to the Danish border, however this trend does not show to be significant (R^2=0.52, p=0.064, ANOVA).

Community structure

The beam trawl samples have a similar species composition as indicated by the scattered distribution of the samples in the 2D plane of the nMDS plot, see Figure 19. The similar composition is confirmed by the ANOSIM results.

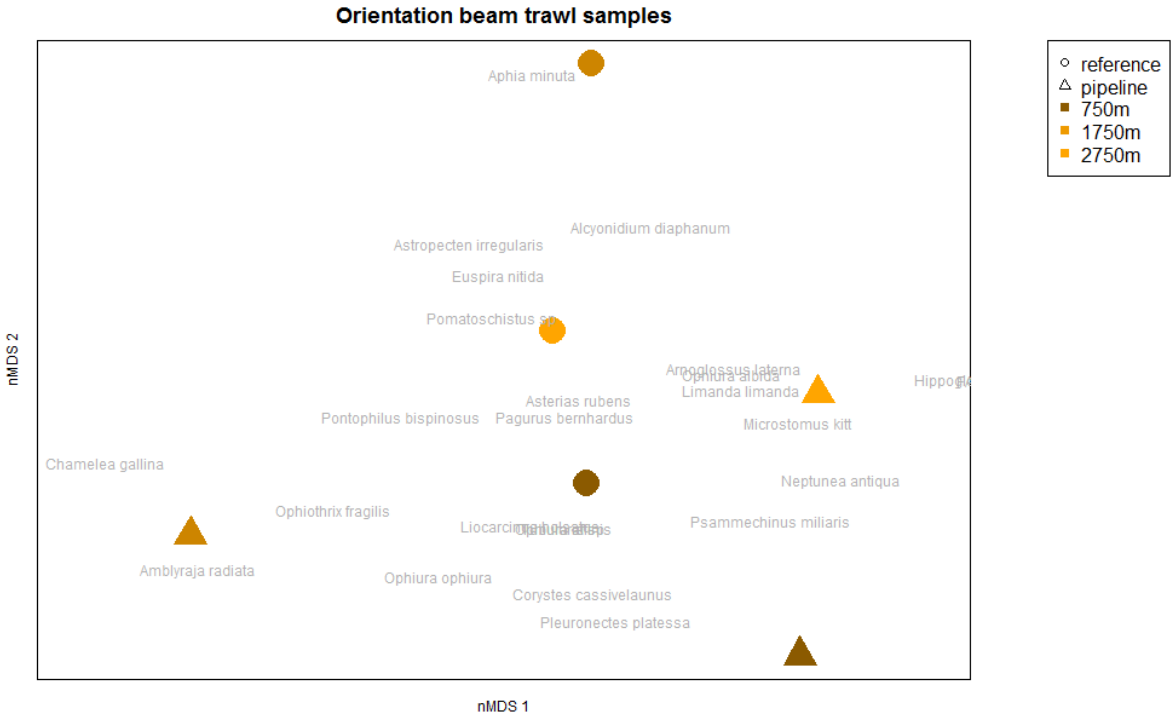


Figure 19. *nMDS plot: results of non-metric multi-dimensional scaling of the species abundances data after 4th root transformation according to the Bray-Curtis similarity calculation. Dimensions two, stress 0.02. Analysis of similarity results (ANOSIM) yield no differences between transects (R^2=0.111, p=0.399) and neither between reference and pipeline samples (R^2=0.259, p=0.218).*

4.4. Red list species

In *Table 2* a list of species that are included in the red list (Rote Liste, 2013) is given. In this list species are included that were identified in the van Veen grab samples and in the beam trawl samples.

One species, the mollusc *Macoma calcarea*, (one individual found at sample location 51), is categorised as "1" and therefore at risk to become extinct. The habitat around the pipeline transect seems suitable for this species as its occurrence is associated with a fine sand to silty sediment type and its distribution includes the North-Eastern part of the North Sea (source, Marine Species Identification Portal and WoRMS). This species, has however, not been observed this far South-wards in the North Sea, yet. This *Macoma* species has not been found before in surveys carried out by IMARES in the same area and the NIOZ in the North Sea.

The Mollusc *Buccinum undatum* (two individuals at sample location 56_B) and *Spisula elliptica* (one individual at location 59_A) are categorized as "2" and are considered to be heavily endangered. *Buccinum undatum* is associated with fine sand to silt (WoRMS) and has been found in IMARES surveys carried out in the A6 area previously (Dalfsen *et al.,* 2001).

Table 2. *List of species found in van Veen grab samples (vV) and beam trawl (BT) samples that have an indication in the red list. A table in Appendix F gives the locations where these species were found.*

Phylum	Latin name	Red list	Samples on pipeline trajectory (vV)	Samples on pipeline trajectory (BT)	Northern sample points (vV)	Northern sample points (BT)	Southern sample points (vV)
Mollusca	*Macoma calcarea*	1	1				
Mollusca	*Spisula elliptica*	2			1		
Mollusca	*Buccinum undatum*	2		1			
Chordata	*Amblyraja radiata*	3		1		1	
Mollusca	*Arctica islandica*	3	11		4		4
Annelida	*Sigalion mathildae*	3	5		4		
Arthropoda	*Cumopsis goodsir*	3	2				
Bryozoa	*Alcyonidium digitatum*	3				1	
Mollusca	*Chamelea striatula*	G	9		5		5
Mollusca	*Chamelea gallina*	G		1		1	
Mollusca	*Neptunea antiqua*	G		2		1	
Annelida	*Chone duneri*	G			3		3
Annelida	*Chone infundibuliformis*	G	2				1
Annelida	*Manayunkia aestuarina*	G			1		
Annelida	*Scalibregma inflatum*	G	1				1
Annelida	*Sthenelais boa*	G	6		4		6
Echinodermata	*Astropecten irregularis*	G	2	2	1	2	
Echinodermata	*Echinocyamus pusillus*	G					1
Echinodermata	*Echinocardium flavescens*	G	1		3		1
Cnidaria	*Sertularia cupressina*	G				1	
Bryozoa	*Alcyonidium parasiticum*	G				1	
Mollusca	*Vitreolina philippi*	R			1		
Annelida	*Hydroides norvegicus*	R	1				
Annelida	*Pholoe inornata*	R	2				
Annelida	*Prionospio cirrifera*	R	2				
Arthropoda	*Diastylis boecki*	R			1		1
Arthropoda	*Stenothoe monoculoides*	R	1				
Bryozoa	*Celleporella hyalina*	R	3				
Bryozoa	*Securiflustra securifrons*	R		1		1	
Mollusca	*Acteon tornatilis*	V	4		1		1
Mollusca	*Tellina tenuis*	V	1				
Echinodermata	*Ophiothrix fragilis*	V		2		2	
Arthropoda	*Megaluropus agilis*	V	5		2		3
Arthropoda	*Metopa alderi*	V					1
Arthropoda	*Synchelidium haplocheles*	V	2		1		
Arthropoda	*Caprella linearis*	V				1	

[1] Categories are 0 = extinct or untraceable, 1 = thread to become extinct, 2 = heavily endangered to become extinct, 3 = endangered, G = endangered at unknown severity, R = extremely rare, V= species that potentially become endangered.
[2] van Veen grab (vV) / beam trawl (BT)

Eighteen species are endangered (categories "3" and "G") including representatives of the Phyla Arthropoda, Mollusca, Chordata, Echinodermata, Cnidaria and Annelida. Most of these species have been found in the A6A area before in surveys carried out by IMARES, except the Mollusc species *Chamelea gallina* and *Neptunea antiqua*, the starry ray *Amblyraja radiata* and the Bryozoa and Hydrozoa species. The sediment type along the pipeline trajectory forms a suitable habitat for both the Mollusc species and they are known to occur in the North Sea (Marine Species Identification Portal and WoRMS). The only Chordata species in the list, the starry ray *Amblyraja radiata*, is the most common skate in the North Sea (Kulka *et al.*, 2009). The Bryozoa and Hydrozoa species in the list have not been found before in IMARES surveys due to the fact that the laboratory is only recently (since 2011) specialised in identifying species belonging to these species groups up to species level.

At a relative large number of stations, one or more species of *Sigalion mathildae* and *Arctica islandica,* categorized as "3", are found. Both species have regularly been found by IMARES during surveys carried out in the A6a and B11 area (Dalfsen *et al.*, 2002, Dalfsen *et al.*, 2006, Glorius and Kaag 2011). The sand star *Astropecten irregularis*, categorized as "G", was also present in a relatively large number of samples and has been found in the A6a area before (Dalfsen *at al.*, 2001).

Four species are extremely rare (category R) and four species are currently not threatened/endangered, but are believed to be prone to become so in the future.

5. Discussion and conclusion

No evidence for the presence of gravel, boulders, or biological reef structures in the area around the pipeline trajectory was found. The (top layer) of the sediment around the pipeline trajectory can be described as being sandy with associated benthic life. With a total of around 340 taxa identified in the 81 van Veen grab samples, an average species richness of around 40.7 and diversity of 2.2 the area can be considered to be rich in benthic life. A number of different benthic fish species were captured with the camera and caught in the beam trawl samples, including the starry ray *Amblyraja radiata*.

A broad range of phyla were discovered that are classified in the red list as being endangered / under thread to some extent. The Mollusc species *Macoma calcarea* (category 1 of red list), *Buccinum undatum* and *Spisula elliptica* (category 2 of red list) can be considered to be prone to extinction or heavily endangered.

Species density data of the van Veen samplers indicate the existence of a South-West to North-East gradient in benthic community composition for which a number of Annelida, Mollusca and Arthropoda species are responsible. The Shannon-Wiener diversity increases from South-West to North-East supporting the observation of a gradient. Species density data of the beam trawl samples are not showing evidence for the existence of a South-West to North-East gradient in species composition, however. It might be that the gradient is mainly a result of the endobenthic species composition (species buried in the sediment and sampled with the van Veen). It is also possible that the amount of beam trawl samples is not sufficient to show the gradient.

There are clear differences in the sediment composition along the pipeline trajectory, where the silt and organic C and N content is higher near the platform, and the Median grain size is significantly increasing towards the Danish border. No evidence was found for the existence of a North to South gradient, therefore transect stations (located 100 and 1000m North/South of the pipeline trajectory) are considered similar in species composition to stations on the pipeline trajectory.

Word of gratitude

We would like to thank Anke Engelberts, Angela Dekker and Daniël Blok (NIOZ – Monitor Taskforce) and Arnold Bakker, Maarten van Hoppe, Joel Cuperus and Ronald Bol (IMARES), the people from Fugro that assisted the sampling (especially Egbert Pieters and Krysztof Bos) the captain Niksa Zvonne and crew of the vessel 'the Atlantic Surveyor' for their efforts while doing the field campaign; Anke Engelberts, Angela Dekker, Daniël Blok, Olaf van Hoesel and Loran Kleine Schaars (NIOZ – Monitor Taskforce) and Babeth van der Weide, Joel Cuperus, Erica Koning, Cor Sonneveld and Felicia Arenou-Ghita (IMARES) for the species identifications and the sorting of the macrobenthos samples; thanks to the Analytical Laboratory of the NIOZ in Yerseke for doing the sediment analyses; and thanks to Vincent Escaravage for managing the project for the Monitor Taskforce during the fieldwork campaign.

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.

In autumn 2006 the Monitor Taskforce of the NIOZ acquired the ISO-EN-NEN 9001-2000 certificate (K42967/01 – Kiwa N.V.). From the beginning of 2012 the Monitor Taskforce of the NIOZ also works according to the ISO 17025 norm. Since medio 2013 the laboratory activities related to sorting, counting and identifying macrobenthic samples is accredited according to NEN-EN-ISO/IEC 17025:2005.

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Justification

Report C116.14
Project Number: 430.51134.01

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

Approved:	Dr. F.E Fey-Hofstede Researcher
Signature:	
Date:	October 20th, 2014

Approved:	Drs. F.C. Groenendijk Head Maritime Department
Signature:	
Date:	October 20th, 2014

Appendix A. Species list - van Veen grab samples

Table 3. Species in the van Veen grab samples. Average density as individuals per m^2.

Phylum	Class	Family	*Species*	N stations	Average Density
Cnidaria	Anthozoa	Edwardsiidae	*Edwardsia sp*	50	24.3
Cnidaria	Anthozoa	Edwardsiidae	*FAM-Edwardsiidae*	14	5.9
Cnidaria	Anthozoa	ORDE_ACTINARIA	*ORDO-Actiniaria*	8	2.2
Cnidaria	Anthozoa	CLAS_ANTHOZOA	*CLAS-Anthozoa*	1	0.1
Cnidaria	Anthozoa	SUBCLAS_HEXACORALLIA	*SUBCLAS-Hexacorallia*	15	2.1
Echinodermata	Asteroidea	CLAS_ASTEROIDEA	*CLAS-Asteroidea*	6	0.9
Echinodermata	Asteroidea	Asteriidae	*Asterias sp*	1	0.1
Echinodermata	Asteroidea	Astropectinidae	*Astropecten irregularis*	4	0.5
Mollusca	Bivalvia	Hiatellidae	*FAM-Hiatellidae*	2	0.7
Mollusca	Bivalvia	Hiatellidae	*Hiatella arctica*	7	1.7
Mollusca	Bivalvia	Pharidae	*Ensis sp*	3	0.9
Mollusca	Bivalvia	Pharidae	*FAM-Pharidae*	12	2.3
Mollusca	Bivalvia	Pharidae	*Phaxas pellucidus*	22	4.7
Mollusca	Bivalvia	Pharidae	*Phaxas sp*	13	4.1
Mollusca	Bivalvia	Thraciidae	*Thracia phaseolina*	45	17.0
Mollusca	Bivalvia	Thraciidae	*Thracia sp*	27	8.4
Mollusca	Bivalvia	Astartidae	*Astarte sp*	2	0.2
Mollusca	Bivalvia	CLAS_BIVALVIA	*CLAS-Bivalvia*	49	78.3
Mollusca	Bivalvia	Lucinidae	*Lucinoma borealis*	3	0.5
Mollusca	Bivalvia	Thyasiridae	*Thyasira flexuosa*	9	1.6
Mollusca	Bivalvia	SUPERFAM_Myoidea	*ORDO-Myoidea*	1	0.2
Mollusca	Bivalvia	Mytilidae	*FAM-Mytilidae*	1	0.1
Mollusca	Bivalvia	Mytilidae	*Mytilus edulis*	1	0.1
Mollusca	Bivalvia	Nuculidae	*Ennucula tenuis*	14	3.2
Mollusca	Bivalvia	Nuculidae	*FAM-Nuculidae*	5	0.9
Mollusca	Bivalvia	Nuculidae	*Nucula hanleyi*	11	1.5
Mollusca	Bivalvia	Nuculidae	*Nucula sp*	6	1.7
Mollusca	Bivalvia	Arcticidae	*Arctica islandica*	27	4.1
Mollusca	Bivalvia	Arcticidae	*FAM-Arcticidae*	3	0.7
Mollusca	Bivalvia	Cardiidae	*Acanthocardia sp*	2	0.4
Mollusca	Bivalvia	Cardiidae	*FAM-Cardiidae*	16	3.2
Mollusca	Bivalvia	Kelliidae	*Kellia suborbicularis*	4	0.6
Mollusca	Bivalvia	Mactridae	*FAM-Mactridae*	2	0.6
Mollusca	Bivalvia	Mactridae	*Spisula elliptica*	1	0.1
Mollusca	Bivalvia	Montacutidae	*Kurtiella bidentata*	2	3.1
Mollusca	Bivalvia	Montacutidae	*Montacuta substriata*	6	4.1
Mollusca	Bivalvia	Montacutidae	*Tellimya ferruginosa*	39	14.7
Mollusca	Bivalvia	ORDE_VENEROIDA	*ORDO-Veneroida*	1	0.5
Mollusca	Bivalvia	Psammobiidae	*Gari fervensis*	32	5.6
Mollusca	Bivalvia	Semelidae	*Abra prismatica*	76	43.6
Mollusca	Bivalvia	Semelidae	*Abra sp*	14	14.0

Phylum	Class	Family	*Species*	N stations	Average Density
Mollusca	Bivalvia	SUPERFAM_Tellinoidae	*SUPERFAM-Tellinoidea*	32	62.8
Mollusca	Bivalvia	Tellinidae	*Tellina fabula*	55	15.4
Mollusca	Bivalvia	Tellinidae	*Tellina sp*	6	1.5
Mollusca	Bivalvia	Tellinidae	*Tellina tenuis*	1	0.1
Mollusca	Bivalvia	Veneridae	*Chamelea striatula*	30	4.3
Mollusca	Bivalvia	Veneridae	*Dosinia lupinus*	40	11.1
Mollusca	Bivalvia	Veneridae	*Dosinia sp*	2	0.5
Mollusca	Bivalvia	Veneridae	*FAM-Veneridae*	1	0.2
Mollusca	Bivalvia	Veneridae	*Mysia undata*	9	1.4
Annelida	Clitellata	SUBCLAS_Hirudinea	*SUBCLAS-Hirudinae*	4	0.6
Porifera	Demospongiae	Clionaidae	*Cliona sp*	11	x
Echinodermata	Echinoidea	CLAS_ECHINOIDEA	*CLAS-Echinoidea*	51	10103
Echinodermata	Echinoidea	Echinocyamidae	*Echinocardium pusillus*	1	0.5
Echinodermata	Echinoidea	INFRACLAS_CARINACEA	*INFRACLAS-Carinacea*	1	0.1
Echinodermata	Echinoidea	INFRACLAS_IRREGULARIA	*INFRACLAS-Irregularia*	30	7986
Echinodermata	Echinoidea	Loveniidae	*Echinocardium flavescens*	7	0.9
Echinodermata	Echinoidea	Loveniidae	*Echinocardium cordatum*	37	7.7
Echinodermata	Echinoidea	Loveniidae	*Echinocardium sp*	20	2.5
Rhodophyta	Florideophyceae	ORDE_CORALLINALES	*ORDO-Corallinales*	19	x
Mollusca	Gastropoda	Epitoniidae	*Epitonium clathratulum*	1	0.1
Mollusca	Gastropoda	Eulimidae	*Eulima bilineata*	1	0.1
Mollusca	Gastropoda	Eulimidae	*Vitreolina philippi*	1	0.1
Mollusca	Gastropoda	Cylichnidae	*Cylichna cylindracea*	35	7.9
Mollusca	Gastropoda	Diaphanidae	*Diaphana minuta*	7	1.1
Mollusca	Gastropoda	ORDE_CEPHALASPIDEA	*ORDO-Cephalaspidea*	16	7.9
Mollusca	Gastropoda	Philinidae	*FAM-Philinidae*	6	2.0
Mollusca	Gastropoda	Philinidae	*Philine sp*	3	0.7
Mollusca	Gastropoda	Retusidae	*Retusa obtusa*	1	0.2
Mollusca	Gastropoda	Retusidae	*Retusa truncatula*	4	0.5
Mollusca	Gastropoda	Retusidae	*Retusa umbilicata*	6	1.7
Mollusca	Gastropoda	Scaphandridae	*Scaphander lignarius*	2	0.5
Mollusca	Gastropoda	Scaphandridae	*Scaphander sp*	1	0.2
Mollusca	Gastropoda	SUPERFAM_Philoidea	*SUPERFAM-Philinoidea*	11	9.1
Mollusca	Gastropoda	CLAS_GASTROPODA	*CLAS-Gastropoda*	3	0.4
Mollusca	Gastropoda	Acteonidae	*Acteon tornatilis*	6	1.2
Mollusca	Gastropoda	Naticidae	*Euspira catena*	1	0.1
Mollusca	Gastropoda	Naticidae	*Euspira montagui*	2	0.2
Mollusca	Gastropoda	Naticidae	*Euspira nitida*	46	11.5
Mollusca	Gastropoda	Naticidae	*Euspira sp*	5	1.0
Mollusca	Gastropoda	Velutinidae	*Lamellaria sp*	1	0.1
Mollusca	Gastropoda	ORDE_NUDIBRANCHIA	*ORDO-Nudibranchia*	3	1.1
Mollusca	Gastropoda	SUBCLAS_OPISTOBRANCHIA	*SUBCLAS-Opistobranchia*	1	0.1
Bryozoa	Gymnolaemata	Cribrilinidae	*Cribrilina punctata*	3	x

Phylum	Class	Family	*Species*	N stations	Average Density
Bryozoa	Gymnolaemata	Electridae	*Electra pilosa*	3	x
Bryozoa	Gymnolaemata	Hippothoidae	*Celleporella hyalina*	3	x
Bryozoa	Gymnolaemata	Alcyonidiidae	*Alcyodium condylocinereum*	1	x
Bryozoa	Gymnolaemata	Alcyonidiidae	*Alcyonidium diaphanum*	4	x
Echinodermata	Holothuroidea	CLAS_HOLOTHUROIDEA	*CLAS-Holothuroidea*	5	0.7
Cnidaria	Hydrozoa	Bougainvilliidae	*Bougainvillia britannica*	15	x
Cnidaria	Hydrozoa	Bougainvilliidae	*Bougainvillia sp*	7	x
Cnidaria	Hydrozoa	Bougainvilliidae	*FAM_Bougainvilliidae*	6	x
Cnidaria	Hydrozoa	Corymorphidae	*Corymorpha nutans*	1	x
Cnidaria	Hydrozoa	Corymorphidae	*Euphysa aurata*	9	x
Cnidaria	Hydrozoa	Eudendriidae	*Eudendrium sp*	5	x
Cnidaria	Hydrozoa	Hydractiniidae	*Hydractinia sp*	1	x
Cnidaria	Hydrozoa	ORDE_ANTHOATHECATA	*ORDO-Anthoathecata*	7	x
Cnidaria	Hydrozoa	Tubulariidae	*Ectopleura sp*	6	x
Cnidaria	Hydrozoa	Tubulariidae	*FAM-Tubulariidae*	4	x
Cnidaria	Hydrozoa	CLAS_HYDROZOA	*CLAS-Hydrozoa*	14	x
Cnidaria	Hydrozoa	Campanulariidae	*FAM-Campanulariidae*	2	x
Cnidaria	Hydrozoa	Campanulariidae	*Laomedea flexuosa*	1	x
Cnidaria	Hydrozoa	ORDE_LEPTOTHECATA	*ORDO-Leptothecata*	24	x
Cnidaria	Hydrozoa	Phialellidae	*Phialella quadrata*	12	x
Chordata	Leptocardii	Branchiostomidae	*Branchiostoma lanceolatum*	8	2.2
Chordata	Leptocardii	Branchiostomidae	*Branchiostoma sp*	1	0.1
Arthropoda	Malacostraca	Ampeliscidae	*Ampelisca brevicornis*	27	6.0
Arthropoda	Malacostraca	Ampeliscidae	*Ampelisca sp*	8	1.6
Arthropoda	Malacostraca	Ampeliscidae	*Ampelisca tenuicornis*	3	0.5
Arthropoda	Malacostraca	Ampeliscidae	*FAM-Ampeliscidae*	1	0.1
Arthropoda	Malacostraca	Amphilochidae	*Amphilochoides boecki*	1	0.2
Arthropoda	Malacostraca	Amphilochidae	*Paramphilochoides odontonyx*	3	0.5
Arthropoda	Malacostraca	Aoridae	*FAM-Aoridae*	10	4.3
Arthropoda	Malacostraca	Aoridae	*Autonoe longipes*	2	0.9
Arthropoda	Malacostraca	Aoridae	*Microdeutopus sp*	2	0.5
Arthropoda	Malacostraca	Argissidae	*Argissa hamatipes*	54	29.9
Arthropoda	Malacostraca	Atylidae	*Atylus vedlomensis*	2	0.2
Arthropoda	Malacostraca	Atylidae	*FAM-Atylidae*	1	0.1
Arthropoda	Malacostraca	Atylidae	*Nototropis falcatus*	3	0.6
Arthropoda	Malacostraca	Atylidae	*Nototropis swammerdamei*	16	3.1
Arthropoda	Malacostraca	Bathyporeiidae	*Bathyporeia elegans*	71	198
Arthropoda	Malacostraca	Bathyporeiidae	*Bathyporeia guilliamsoniana*	25	29.1
Arthropoda	Malacostraca	Bathyporeiidae	*Bathyporeia pelagica*	13	8.4
Arthropoda	Malacostraca	Bathyporeiidae	*Bathyporeia sp*	59	57.4
Arthropoda	Malacostraca	Bathyporeiidae	*Bathyporeia tenuipes*	48	21.7
Arthropoda	Malacostraca	Caprellidae	*FAM-Caprellidae*	2	0.2

Phylum	Class	Family	*Species*	N stations	Average Density
Arthropoda	Malacostraca	Caprellidae	*Pariambus typicus*	6	0.7
Arthropoda	Malacostraca	Caprellidae	*Phtisica marina*	5	0.6
Arthropoda	Malacostraca	Cheirocratidae	*Cheirocratus sp*	2	0.4
Arthropoda	Malacostraca	Cheirocratidae	*Cheirocratus sundevallii*	1	0.2
Arthropoda	Malacostraca	Dexaminidae	*Dexamine spinosa*	1	0.1
Arthropoda	Malacostraca	Gammaridae	*FAM-Gammaridae*	11	3.8
Arthropoda	Malacostraca	Hyperiidae	*Hyperia galba*	1	0.1
Arthropoda	Malacostraca	Iphimediidae	*Iphimedia minuta*	1	0.5
Arthropoda	Malacostraca	Iphimediidae	*Iphimedia sp*	1	0.1
Arthropoda	Malacostraca	Ischyroceridae	*Jassa falcata*	1	0.4
Arthropoda	Malacostraca	Ischyroceridae	*Jassa marmorata*	1	0.1
Arthropoda	Malacostraca	Ischyroceridae	*Jassa sp*	2	1.9
Arthropoda	Malacostraca	Lysianassidae	*FAM-Lysianassidae*	4	0.7
Arthropoda	Malacostraca	Lysianassidae	*Hippomedon denticulatus*	12	3.1
Arthropoda	Malacostraca	Lysianassidae	*Lepidepecreum longicornis*	3	0.5
Arthropoda	Malacostraca	Lysianassidae	*Tryphosa nana*	2	0.6
Arthropoda	Malacostraca	Lysianassidae	*Tryphosites longipes*	4	0.9
Arthropoda	Malacostraca	Megaluropidae	*Megaluropus agilis*	16	5.2
Arthropoda	Malacostraca	Melitidae	*Abludomelita obtusata*	3	1.0
Arthropoda	Malacostraca	Melitidae	*FAM-Melitidae*	1	0.5
Arthropoda	Malacostraca	Oedicerotidae	*FAM-Oedicerotidae*	3	0.5
Arthropoda	Malacostraca	Oedicerotidae	*Perioculodes longimanus*	70	62.2
Arthropoda	Malacostraca	Oedicerotidae	*Pontocrates altamarinus*	25	10.1
Arthropoda	Malacostraca	Oedicerotidae	*Pontocrates arcticus*	3	0.5
Arthropoda	Malacostraca	Oedicerotidae	*Pontocrates arenarius*	6	2.0
Arthropoda	Malacostraca	Oedicerotidae	*Pontocrates sp*	3	0.4
Arthropoda	Malacostraca	Oedicerotidae	*Synchelidium haplocheles*	3	0.6
Arthropoda	Malacostraca	Oedicerotidae	*Synchelidium maculatum*	18	7.5
Arthropoda	Malacostraca	Oedicerotidae	*Synchelidium sp*	3	0.6
Arthropoda	Malacostraca	Oedicerotidae	*Westwoodilla caecula*	19	4.0
Arthropoda	Malacostraca	ORDE_AMPHIPODA	*ORDO-Amphipoda*	15	3.1
Arthropoda	Malacostraca	Photidae	*Gammaropsis maculata*	1	0.2
Arthropoda	Malacostraca	Photidae	*Gammaropsis nitida*	1	1.1
Arthropoda	Malacostraca	Photidae	*Gammaropsis palmata*	1	0.1
Arthropoda	Malacostraca	Photidae	*Gammaropsis sp*	3	0.5
Arthropoda	Malacostraca	Phoxocephalidae	*FAM-Phoxocephalidae*	1	0.5
Arthropoda	Malacostraca	Phoxocephalidae	*Harpinia antennaria*	18	5.6
Arthropoda	Malacostraca	Phoxocephalidae	*Harpinia serrata*	6	1.0
Arthropoda	Malacostraca	Phoxocephalidae	*Harpinia sp*	13	2.2
Arthropoda	Malacostraca	Scopelocheiridae	*Scopelocheirus hopei*	1	0.1
Arthropoda	Malacostraca	Stenothoidae	*FAM-Stenothoidae*	2	0.4
Arthropoda	Malacostraca	Stenothoidae	*Metopa alderi*	1	0.1

Phylum	Class	Family	*Species*	N stations	Average Density
Arthropoda	Malacostraca	Stenothoidae	*Metopa borealis*	1	0.1
Arthropoda	Malacostraca	Stenothoidae	*Metopa pusilla*	5	0.7
Arthropoda	Malacostraca	Stenothoidae	*Stenothoe marina*	3	0.6
Arthropoda	Malacostraca	Stenothoidae	*Stenothoe monoculoides*	1	0.5
Arthropoda	Malacostraca	Urothoidae	*Urothoe poseidonis*	3	0.7
Arthropoda	Malacostraca	Urothoidae	*Urothoe sp*	1	0.1
Arthropoda	Malacostraca	Bodotriidae	*Cumopsis goodsir*	2	0.5
Arthropoda	Malacostraca	Diastylidae	*Diastylis boecki*	2	0.4
Arthropoda	Malacostraca	Diastylidae	*Diastylis bradyi*	11	1.9
Arthropoda	Malacostraca	Diastylidae	*Diastylis goodsiri*	1	0.1
Arthropoda	Malacostraca	Diastylidae	*Diastylis rugosa*	1	0.1
Arthropoda	Malacostraca	Diastylidae	*Diastylis sp*	1	0.2
Arthropoda	Malacostraca	Lampropidae	*Hemilamprops roseus*	2	0.2
Arthropoda	Malacostraca	Leuconidae	*Eudorellopsis deformis*	46	15.8
Arthropoda	Malacostraca	ORDE_CUMACEA	*ORDO-Cumacea*	10	1.5
Arthropoda	Malacostraca	Pseudocumatidae	*Monopseudocuma gilsoni*	1	1.0
Arthropoda	Malacostraca	Pseudocumatidae	*Pseudocuma longicorne*	46	22.1
Arthropoda	Malacostraca	Pseudocumatidae	*Pseudocuma similis*	6	1.4
Arthropoda	Malacostraca	Pseudocumatidae	*Pseudocuma sp*	1	0.1
Arthropoda	Malacostraca	Corystidae	*Corystes cassivelaunus*	12	2.0
Arthropoda	Malacostraca	Corystidae	*FAM-Corystidae*	1	0.1
Arthropoda	Malacostraca	Crangonidae	*Philocheras bispinosus*	1	0.1
Arthropoda	Malacostraca	Diogenidae	*Diogenes pugilator*	1	0.1
Arthropoda	Malacostraca	INFRAORDE_Brachyura	*INFRAORDO-Brachyura*	14	2.1
Arthropoda	Malacostraca	INFRAORDE_Caridea	*INFRAORDO-Caridea*	1	0.0
Arthropoda	Malacostraca	ORDE_DECAPODA	*ORDO-Decapoda*	8	2.0
Arthropoda	Malacostraca	Paguridae	*FAM-Paguridae*	8	1.5
Arthropoda	Malacostraca	Paguridae	*Pagurus bernhardus*	6	1.0
Arthropoda	Malacostraca	Paguridae	*Pagurus sp*	14	2.2
Arthropoda	Malacostraca	Polybiidae	*Liocarcinus sp*	1	0.1
Arthropoda	Malacostraca	Portunidae	*FAM-Portunidae*	1	0.1
Arthropoda	Malacostraca	Processidae	*Processa modica modica*	2	0.2
Arthropoda	Malacostraca	Munnidae	*Munna sp*	2	0.2
Arthropoda	Malacostraca	ORDE_ISOPODA	*ORDO-Isopoda*	1	0.1
Arthropoda	Malacostraca	Mysidae	*Erythrops elegans*	1	0.1
Arthropoda	Malacostraca	Mysidae	*Gastrosaccus spinifer*	1	0.1
Arthropoda	Malacostraca	Mysidae	*Mysis sp*	1	0.1
Arthropoda	Malacostraca	SUBCLAS_Copepoda	*SUBCLAS-Copepoda*	2	0.2
Arthropoda	Malacostraca	ORDE_TANIAIDACEA	*ORDO-Tanaidacea*	3	0.7
Arthropoda	Maxillopoda	Balanidae	*FAM-Balanidae*	1	0.4
Echinodermata	Ophiuroidea	CLAS_OPHIUROIDEA	*CLAS-Ophiuroidea*	80	337
Echinodermata	Ophiuroidea	Amphiuridae	*Amphiura filiformis*	6	0.7
Echinodermata	Ophiuroidea	Amphiuridae	*Amphiura sp*	5	0.7

Phylum	Class	Family	*Species*	N stations	Average Density
Echinodermata	Ophiuroidea	Ophiuridae	*FAM-Ophiuridae*	1	0.1
Echinodermata	Ophiuroidea	Ophiuridae	*Ophiocten affinis*	4	0.5
Echinodermata	Ophiuroidea	Ophiuridae	*Ophiura albida*	1	0.1
Echinodermata	Ophiuroidea	Ophiuridae	*Ophiura ophiura*	2	0.4
Arthropoda	Ostracoda	SUBCLAS_Ostracoda	*CLAS-Ostracoda*	1	x
Chlorophyta	PH_CHLOROPHYTA	PH_CHLOROPHYTA	*PH-Chlorophyta*	1	x
Foraminifera	PH_FORAMINIFERA	PH_FORAMINIFERA	*PH-Foraminifera*	4	x
Nematoda	PH_NEMATODA	PH_NEMATODA	*PH-Nematoda*	3	0.4
Nemertea	PH_NEMERTINAE	PH_NEMERTINAE	*PH-Nemertea*	80	118
Phoronida	PH_PHORONIDA	PH_PHORONIDA	*PH-Phoronida*	52	16.4
Platyhelminthes	PH_PLATYHELMINTHES	PH_PLATYHELMINTHES	*PH-Platyhelminthes*	7	0.9
Rhodophyta	PH_RHODOPHYTA	PH_RHODOPHYTA	*PH-Rhodophyta*	9	x
Sipuncula	PH_SIPUNCULA	PH_SIPUNCULA	*PH-Sipuncula*	15	3.2
Annelida	Polychaeta	Amphinomidae	*Paramphinome jeffreysii*	30	10.7
Annelida	Polychaeta	CLAS_POLYCHAETA	*CLAS-Polychaeta*	1	0.1
Annelida	Polychaeta	Capitellidae	*Capitella sp*	2	0.2
Annelida	Polychaeta	Capitellidae	*Capitella sp*	4	1.1
Annelida	Polychaeta	Capitellidae	*FAM-Capitellidae*	1	0.5
Annelida	Polychaeta	Capitellidae	*Mediomastus fragilis*	26	15.2
Annelida	Polychaeta	Capitellidae	*Notomastus latericeus*	1	0.1
Annelida	Polychaeta	Cirratulidae	*Chaetozone christiei*	80	140
Annelida	Polychaeta	Cirratulidae	*Chaetozone setosa*	15	5.3
Annelida	Polychaeta	Cirratulidae	*Chaetozone sp*	8	2.5
Annelida	Polychaeta	Opheliidae	*FAM-Opheliidae*	2	1.0
Annelida	Polychaeta	Opheliidae	*Ophelia borealis*	16	8.9
Annelida	Polychaeta	Opheliidae	*Ophelia limacina*	1	0.2
Annelida	Polychaeta	Opheliidae	*Ophelia neglecta*	13	4.7
Annelida	Polychaeta	Opheliidae	*Ophelia sp*	24	7.9
Annelida	Polychaeta	Opheliidae	*Ophelina acuminata*	9	1.4
Annelida	Polychaeta	Opheliidae	*Ophelina modesta*	1	0.1
Annelida	Polychaeta	Opheliidae	*Ophelina sp*	1	0.1
Annelida	Polychaeta	Orbiniidae	*Scoloplos sp*	81	441
Annelida	Polychaeta	Paraonidae	*Aricidea minuta*	54	24.7
Annelida	Polychaeta	Scalibregmatidae	*Scalibregma inflatum*	2	0.2
Annelida	Polychaeta	Aphroditidae	*Aphrodita aculeata*	3	0.4
Annelida	Polychaeta	Goniadidae	*FAM-Goniadidae*	2	0.7
Annelida	Polychaeta	Goniadidae	*Glycinde nordmanni*	11	2.0
Annelida	Polychaeta	Goniadidae	*Goniada maculata*	78	93.8
Annelida	Polychaeta	Hesionidae	*Oxydromus flexuosus*	5	0.7
Annelida	Polychaeta	Hesionidae	*Podarkeopsis helgolandicus*	6	1.0
Annelida	Polychaeta	Nephtyidae	*Nephtys assimilis*	53	13.2
Annelida	Polychaeta	Nephtyidae	*Nephtys caeca*	27	8.0
Annelida	Polychaeta	Nephtyidae	*Nephtys cirrosa*	11	4.0
Annelida	Polychaeta	Nephtyidae	*Nephtys hombergii*	10	2.1

Phylum	Class	Family	*Species*	N stations	Average Density
Annelida	Polychaeta	Nephtyidae	*Nephtys longosetosa*	32	6.0
Annelida	Polychaeta	Nephtyidae	*Nephtys sp*	55	19.5
Annelida	Polychaeta	Nereididae	*Eunereis elittoralis*	2	0.2
Annelida	Polychaeta	Nereididae	*Eunereis longissima*	1	0.1
Annelida	Polychaeta	Nereididae	*SUBFAM-Nereidinae*	1	0.2
Annelida	Polychaeta	Pholoidae	*FAM-Pholoidae*	1	0.2
Annelida	Polychaeta	Pholoidae	*Pholoe assimilis*	2	0.5
Annelida	Polychaeta	Pholoidae	*Pholoe baltica*	32	6.5
Annelida	Polychaeta	Pholoidae	*Pholoe inornata*	2	0.6
Annelida	Polychaeta	Pholoidae	*Pholoe sp*	5	1.1
Annelida	Polychaeta	Phyllodocidae	*Eteone longa*	7	1.0
Annelida	Polychaeta	Phyllodocidae	*Eteone sp*	8	1.2
Annelida	Polychaeta	Phyllodocidae	*Eumida sanguinea*	1	0.1
Annelida	Polychaeta	Phyllodocidae	*Hypereteone foliosa*	7	1.4
Annelida	Polychaeta	Phyllodocidae	*Phyllodoce groenlandica*	47	69.0
Annelida	Polychaeta	Phyllodocidae	*Phyllodoce rosea*	5	0.6
Annelida	Polychaeta	Phyllodocidae	*Phyllodoce sp*	80	223
Annelida	Polychaeta	Phyllodocidae	*SUBFAM-Eteoninae*	3	0.4
Annelida	Polychaeta	Polynoidae	*FAM-Polynoidae*	2	0.2
Annelida	Polychaeta	Polynoidae	*Gattyana amondseni*	2	0.6
Annelida	Polychaeta	Polynoidae	*Gattyana cirrhosa*	1	0.2
Annelida	Polychaeta	Polynoidae	*Malmgreniella castanea*	6	0.9
Annelida	Polychaeta	Polynoidae	*Malmgreniella darbouxi*	1	0.5
Annelida	Polychaeta	Polynoidae	*Malmgreniella ljungmani*	20	3.8
Annelida	Polychaeta	Polynoidae	*Malmgreniella sp*	2	0.2
Annelida	Polychaeta	Polynoidae	*SUBFAM-Polynoinae*	3	0.4
Annelida	Polychaeta	Sigalionidae	*Sigalion mathildae*	14	2.2
Annelida	Polychaeta	Sigalionidae	*Sigalion sp*	1	0.1
Annelida	Polychaeta	Sigalionidae	*Sthenelais boa*	16	15.9
Annelida	Polychaeta	Sigalionidae	*Sthenelais limicola*	58	99.0
Annelida	Polychaeta	Sigalionidae	*Sthenelais sp*	34	54.0
Annelida	Polychaeta	Syllidae	*Exogone (Exogone) naidina*	47	29.4
Annelida	Polychaeta	Syllidae	*Exogone sp*	2	0.7
Annelida	Polychaeta	Syllidae	*Parexogone hebes*	2	0.2
Annelida	Polychaeta	Terebellidae	*Lanice conchilega*	17	2.8
Annelida	Polychaeta	Dorvilleidae	*FAM-Dorvilleidae*	2	0.4
Annelida	Polychaeta	Dorvilleidae	*Ophryotrocha gracilis*	2	0.4
Annelida	Polychaeta	Fabriciidae	*Manayunkia aestuarina*	1	0.2
Annelida	Polychaeta	Glyceridae	*FAM-Glyceridae*	1	0.1
Annelida	Polychaeta	Glyceridae	*Glycera alba*	16	3.3
Annelida	Polychaeta	Glyceridae	*Glycera sp*	41	12.3
Annelida	Polychaeta	ORDE_SABELLIDA	*ORDO-Sabellida*	1	0.5
Annelida	Polychaeta	Oweniidae	*FAM-Oweniidae*	1	0.2

Phylum	Class	Family	*Species*	N stations	Average Density
Annelida	Polychaeta	Oweniidae	*Galathowenia oculata*	8	2.6
Annelida	Polychaeta	Oweniidae	*Owenia borealis*	11	1.9
Annelida	Polychaeta	Oweniidae	*Owenia sp*	15	2.7
Annelida	Polychaeta	Sabellidae	*Chone duneri*	7	0.9
Annelida	Polychaeta	Sabellidae	*Chone fauveli*	1	0.1
Annelida	Polychaeta	Sabellidae	*Chone infundibuliformis*	3	0.7
Annelida	Polychaeta	Serpulidae	*Hydroides norvegicus*	1	0.1
Annelida	Polychaeta	Serpulidae	*Serpula sp*	1	0.5
Annelida	Polychaeta	Magelonidae	*Magelona filiformis*	65	58.6
Annelida	Polychaeta	Magelonidae	*Magelona johnstoni*	11	4.1
Annelida	Polychaeta	Magelonidae	*Magelona mirabilis*	2	1.6
Annelida	Polychaeta	Magelonidae	*Magelona sp*	8	4.3
Annelida	Polychaeta	ORDE_SPIONIDA	*ORDO-Spionida*	1	0.1
Annelida	Polychaeta	Poecilochaetidae	*Poecilochaetus serpens*	5	0.9
Annelida	Polychaeta	Spionidae	*Aonides paucibranchiata*	46	31.4
Annelida	Polychaeta	Spionidae	*Aonides sp*	1	0.5
Annelida	Polychaeta	Spionidae	*FAM-Spionidae*	1	0.2
Annelida	Polychaeta	Spionidae	*Polydora sp*	1	0.2
Annelida	Polychaeta	Spionidae	*Prionospio cirrifera*	2	0.2
Annelida	Polychaeta	Spionidae	*Scolelepis bonnieri*	7	1.0
Annelida	Polychaeta	Spionidae	*Scolelepis sp*	5	1.2
Annelida	Polychaeta	Spionidae	*Scolelepis squamata*	1	0.1
Annelida	Polychaeta	Spionidae	*Scolelepis tridentata*	1	0.1
Annelida	Polychaeta	Spionidae	*Spio decoratus*	65	27.2
Annelida	Polychaeta	Spionidae	*Spio goniocephala*	1	0.1
Annelida	Polychaeta	Spionidae	*Spio martinensis*	1	0.1
Annelida	Polychaeta	Spionidae	*Spio sp*	4	1.6
Annelida	Polychaeta	Spionidae	*Spiophanes bombyx*	81	2625
Annelida	Polychaeta	Spionidae	*Spiophanes wigleyi*	4	1.2
Annelida	Polychaeta	Ampharetidae	*Ampharete falcata*	1	0.1
Annelida	Polychaeta	Ampharetidae	*Ampharete sp*	9	1.7
Annelida	Polychaeta	Ampharetidae	*FAM-Ampharetidae*	7	1.2
Annelida	Polychaeta	ORDE_TEREBELLIDA	*ORDO-Terebellida*	39	67.5
Annelida	Polychaeta	Pectinariidae	*Amphictene auricoma*	1	0.1
Annelida	Polychaeta	Pectinariidae	*FAM-Pectinariidae*	33	13.5
Annelida	Polychaeta	Pectinariidae	*Lagis koreni*	20	7.8
Annelida	Polychaeta	Pectinariidae	*Pectinaria sp*	1	0.5
Annelida	Polychaeta	Terebellidae	*FAM-Terebellidae*	27	32.5
Arthropoda	Pycnogonida	CLAS_PYCNOGONIDA	*CLAS-Pycnogonida*	1	0.1
Arthropoda	Pycnogonida	Phoxichilidiidae	*Anoplodactylus petiolatus*	4	0.7
Arthropoda	SPH_Crustacea	SPH_CRUSTACEA	*SUBPH-Crustacea*	1	0.1

Appendix B. Species list beam trawl

Table 4. Species in beam trawl samples. Abundances per square meter (m^2).

Phylum	Class	Order	Family	Latin Name	56A	56B	61A	61B	66A	66B
Annelida	Polychaeta	Phyllodocida	Aphroditidae	*Aphrodita aculeata*				0.0132		
Arthropoda	Malacostraca	Amphipoda	Caprellidae	*Caprella linearis*			0.0049			
		Amphipoda	Gammaroidea	*FAM Gammaridae*						0.0054
		Amphipoda	Hyperiidae	*Hyperia galba*						0.0054
		Decapoda		*ORDER Decapoda*					0.0057	
		Decapoda	Corystidae	*Corystes cassivelaunus*	0.0053	0.0097		0.0066		0.0054
		Decapoda	Crangonidae	*Pontophilus bispinosus*	0.0106	0.0049	0.0098	0.0527	0.0169	
		Decapoda	Oregoniidae	*Hyas araneus*		0.0049				
		Decapoda	Oregoniidae	*Hyas coarctatus*		0.0049				
		Decapoda	Paguridae	*Pagurus bernhardus*	0.0792	0.1648	0.1128	0.1714	0.0960	0.1185
		Decapoda	Polybiidae	*Liocarcinus holsatus*	0.0106	0.0049		0.0132	0.0057	0.0054
Bryozoa	Gymnolaemata	Cheilostomatida	Flustridae	*Securiflustra securifrons*		0.0049				
		Ctenostomatida	Alcyonidiidae	*Alcyonidium diaphanum*	0.0053		0.0147		0.0113	0.0054
		Ctenostomatida	Alcyonidiidae	*Alcyonidium parasiticum*			0.0049			
		Ctenostomatida	Alcyonidiidae	*Alcyonium digitatum*			0.0049			
Chordata	Actinopterygii	Perciformes	Callionymidae	*Callionymus lyra*			0.0049			
		Perciformes	Gobiidae	*Aphia minuta*			0.0049		0.0113	
		Perciformes	Gobiidae	*Pomatoschistus sp*	0.0264		0.0147	0.0066	0.0226	0.0054
		Pleuronectiformes	Bothidae	*Arnoglossus laterna*	0.0106	0.0097	0.0098		0.0057	0.0108
		Pleuronectiformes	Pleuronectidae	*Hippoglossoides platessoides*						0.0108
		Pleuronectiformes	Pleuronectidae	*Limanda limanda*	0.0158	0.0097	0.0049		0.0057	0.0162
		Pleuronectiformes	Pleuronectidae	*Microstomus kitt*	0.0106	0.0145	0.0049			0.0108
		Pleuronectiformes	Pleuronectidae	*Pleuronectes platessa*		0.0145		0.0066		0.0054
		Scorpaeniformes	Liparidae	*Liparis liparis*		0.0049				

Phylum	Class	Order	Family	Latin Name	56A	56B	61A	61B	66A	66B
	Elasmobranchii	Rajiformes	Rajidae	*Amblyraja radiata*	0.0106			0.0066		
Cnidaria	Hydrozoa			*CLASS Hydrozoa*		0.0049	0.0049			
		Anthoathecata	Tubulariidae	*Tubularia sp*	0.0053					
		Leptotheceta	Sertulariidae	*Sertularia cupressina*			0.0049			
Echinodermata	Asteroidea	Forcipulatida	Asteriidae	*Asterias rubens*	0.1320	0.1406	0.1766	0.1516	0.2202	0.2693
		Paxillosida	Astropectinidae	*Astropecten irregularis*			0.0343	0.0132	0.0113	0.0108
	Echinoidea	Camarodonta	Parechinidae	*Psammechinus miliaris*	0.0106	0.0145			0.0057	0.0054
		Spatangoida	Loveniidae	*Echinocardium cordatum*		0.0049				
	Ophiuroidea	Ophiurida	Ophiotrichidae	*Ophiothrix fragilis*				0.0264		0.0108
		Ophiurida	Ophiuridae	*Ophiura sp*						0.0215
		Ophiurida	Ophiuridae	*Ophiura affinis*	0.0053					
		Ophiurida	Ophiuridae	*Ophiura albida*	0.0317	0.0291	0.0196		0.0395	0.0215
		Ophiurida	Ophiuridae	*Ophiura ophiura*	0.0106	0.0145		0.0198	0.0057	
Mollusca	Bivalvia	Mytiloida	Mytilidae	*Mytilus sp*						0.0754
		Veneroida	Veneridae	*Chamelea gallina*				0.0132	0.0057	
	Gastropoda	Cephalaspidea	Scaphandridae	*Scaphander lignarius*			0.0049			
		Littorinimorpha	Naticidae	*Euspira nitida*					0.0057	
		Neogastropoda	Buccinidae	*Buccinum undatum*		0.0097				
		Neogastropoda	Buccinidae	*Neptunea antiqua*		0.0049			0.0057	0.0108

Appendix C. Side scan sonar

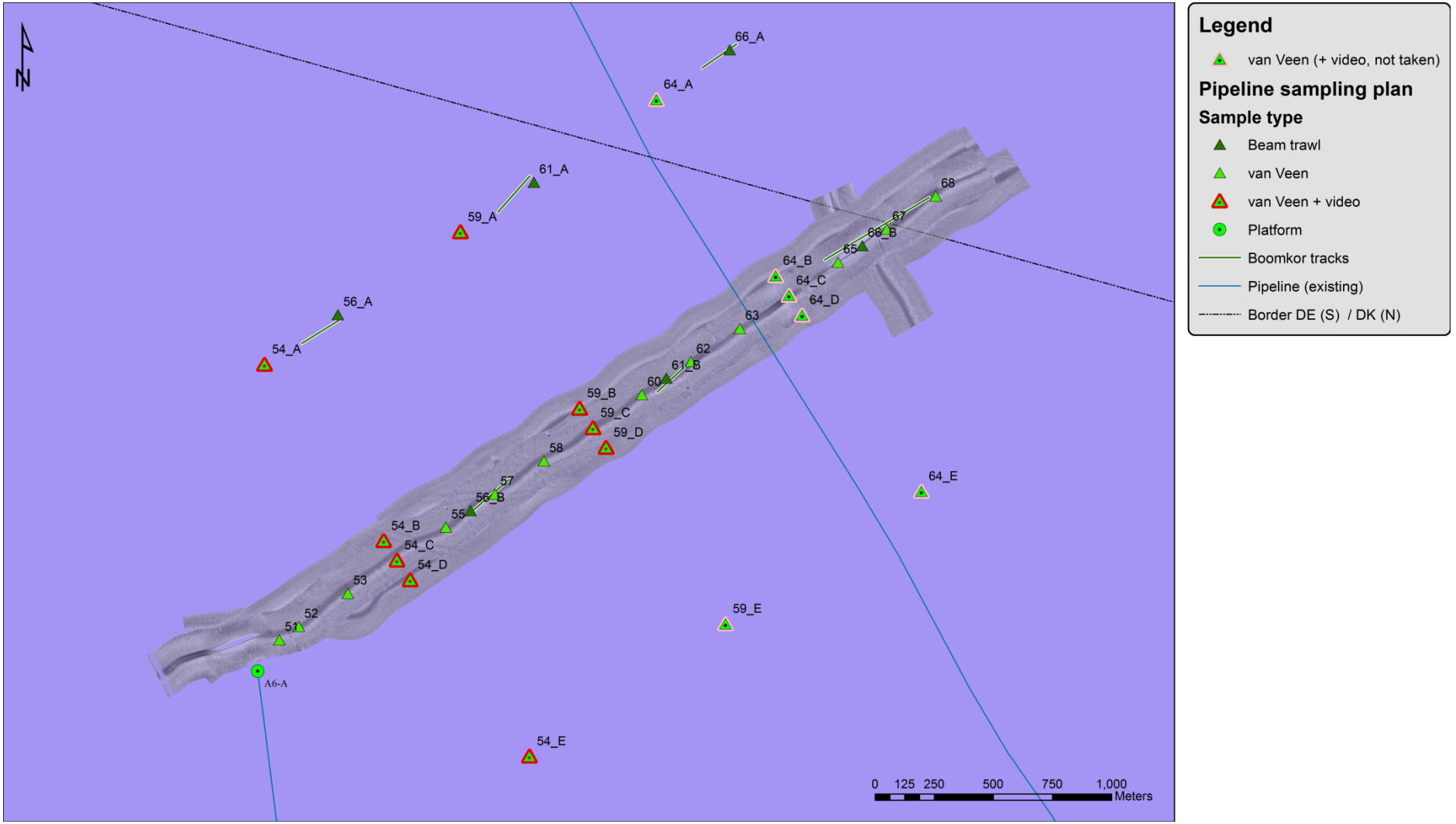


Figure 20. Side scan mosaic including sample locations.

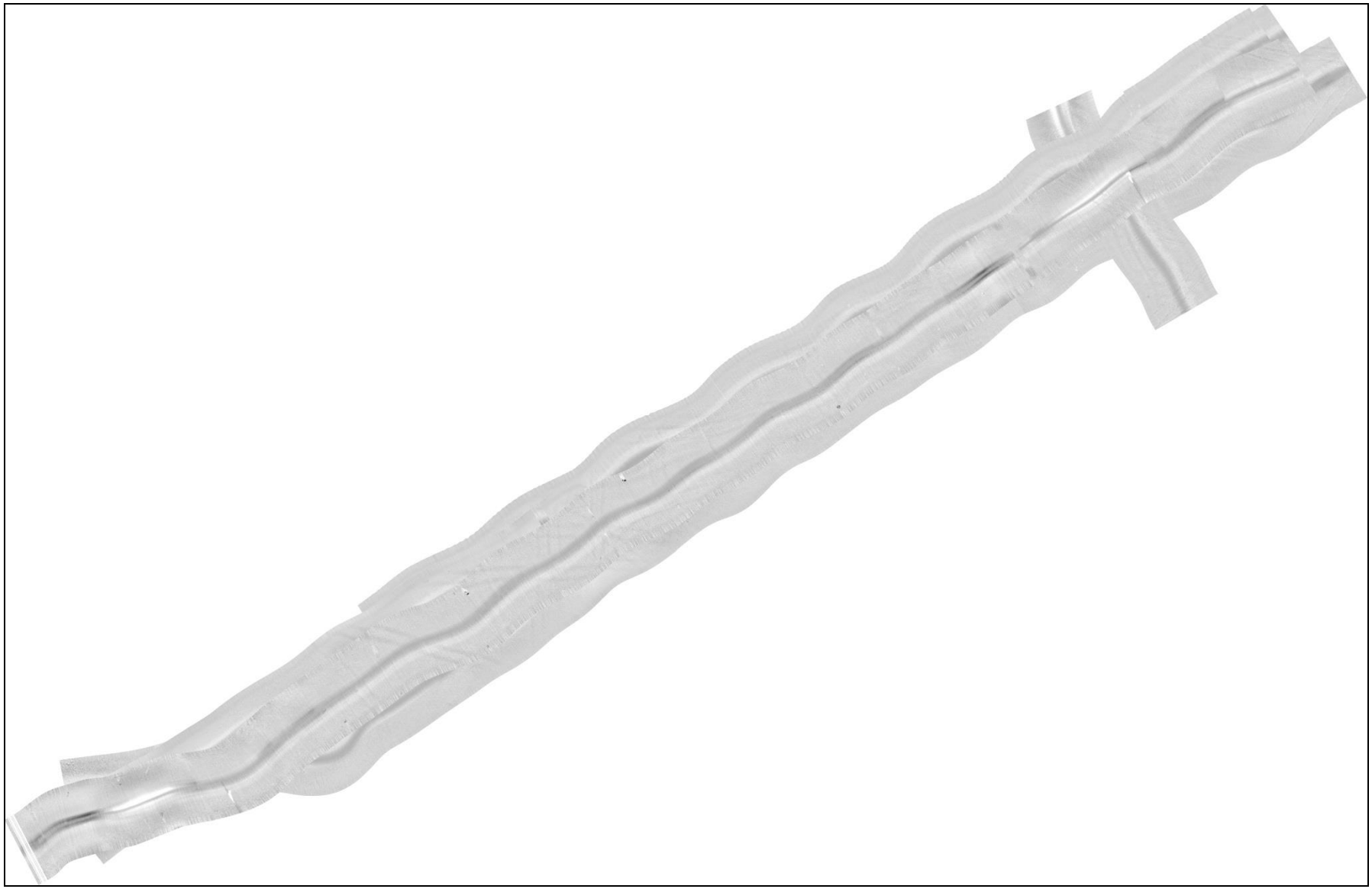
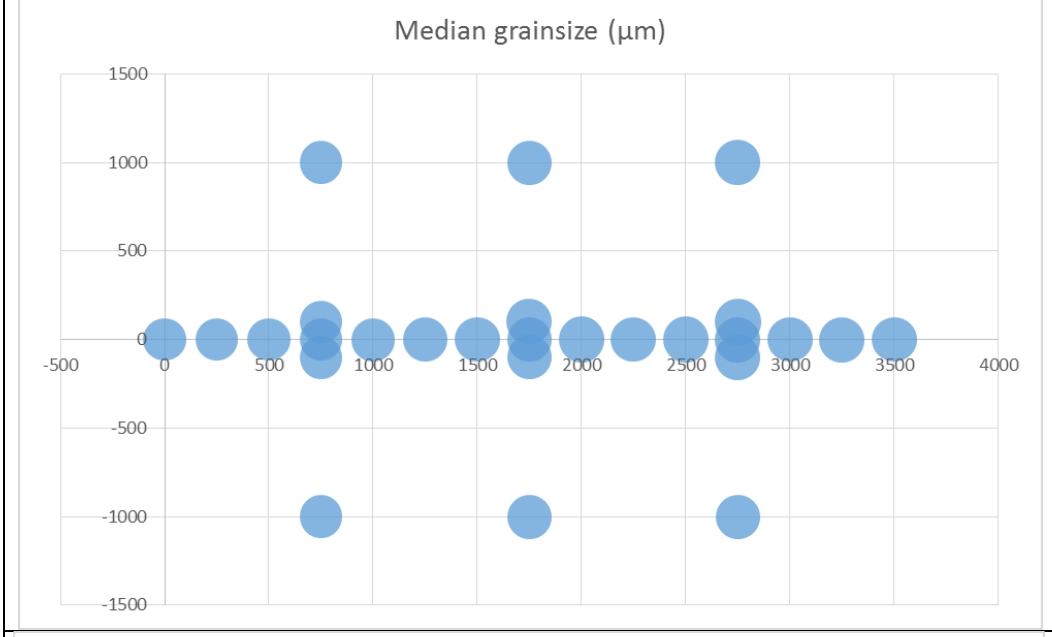


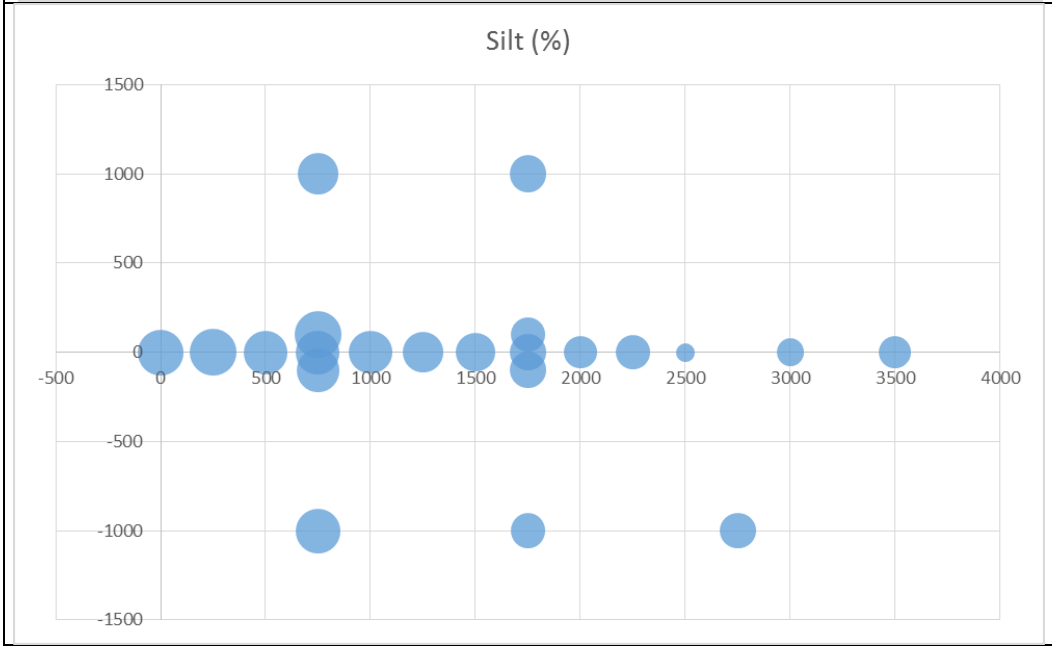
Figure 21. Side scan mosaic without sample locations.

Appendix D. Sediment descriptions - bubble plots

Figure 22 shows the values (with bubble size) of the sediment characteristics per location relative to the maximum value observed in this campaign (for the A series), which is also indicated at the right of the graphs.



Median $grainsize_{max}$ = 200.0 µm



$Silt_{max}$ = 7.8 %

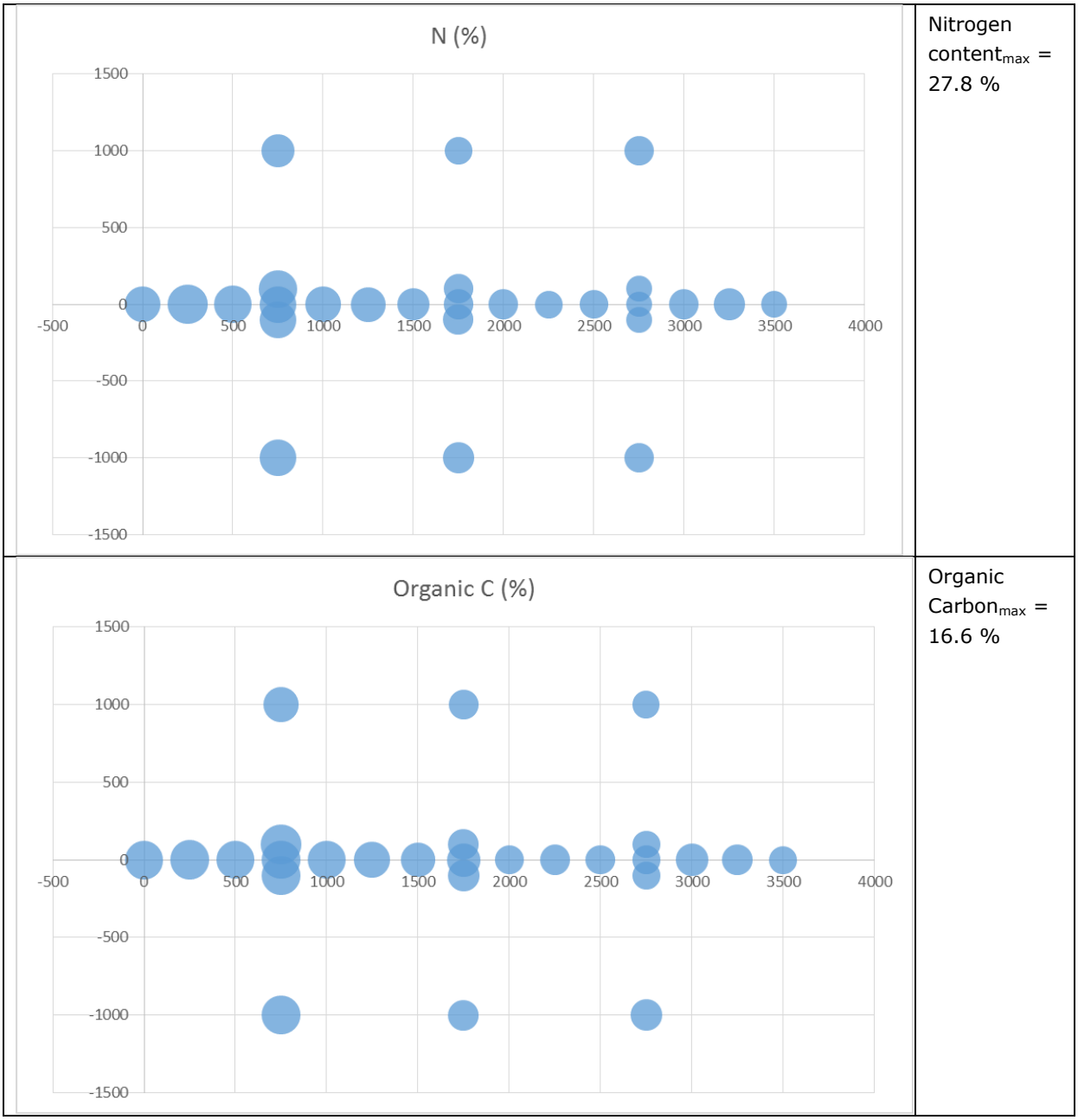


Figure 22. Comparison of the sample locations on basis of the sediment characteristics. The relative bubble size indicates the value of the factor varying from 0 (no bubble) to the maximum value observed. Locations are shown regarding their positioning as indicated by the sampling grid with on the x-axe the relative distance from the platform starting with 0 m for location 51 to 3500 m for location 68, and on the y-axe the relative distance from the pipeline trajectory with samples on the trajectory with a distances of 0 m and the reference transects at respectively +1000, +100, -100 and -1000 m for locations A, B, C and D.

Appendix E. The 60 most common species in the van Veen grab samples

Table 5. *Overview of the most common and abundant species describing the community of the pipeline trajectory and its surroundings. The top-60 most common species as indicated by the precentage occurrence in the total of samples.*

Phylum	**Class**	**Family**	**Species**	**Average density (n/m^2)**	**% samples**
Echinodermata	Echinoidea	Loveniidae	*Echinocardium cordatum*	18101	100
Annelida	Polychaeta	Phyllodocidae	*Phyllodoce groenlandica*	292	100
Annelida	Polychaeta	Orbiniidae	*Scoloplos sp*	441	100
Annelida	Polychaeta	Spionidae	*Spiophanes bombyx*	2625	100
Mollusca	Bivalvia	Semelidae	*Abra prismatica*	199	100
Annelida	Polychaeta	Cirratulidae	*Chaetozone christiei*	210	100
Nemertea	PH_NEMERTINAE	PH_NEMERTINAE	*PH-Nemertea*	118	100
Echinodermata	Ophiuroidea	CLAS_OPHIUROIDEA	*CLAS-Ophiuroidea*	337	100
Annelida	Polychaeta	Goniadidae	*Goniada maculata*	95	100
Arthropoda	Malacostraca	Bathyporeiidae	*Bathyporeia elegans*	259	100
Annelida	Polychaeta	Sigalionidae	*Sthenelais limicola*	153	100
Annelida	Polychaeta	Magelonidae	*Magelona filiformis*	63	100
Arthropoda	Malacostraca	Oedicerotidae	*Perioculodes longimanus*	63	100
Annelida	Polychaeta	Nephtyidae	*Nephtys assimilis*	33	100
Annelida	Polychaeta	Spionidae	*Spio decoratus*	29	100
Mollusca	Gastropoda	Naticidae	*Euspira nitida*	13	100
Mollusca	Bivalvia	Tellinidae	*Tellina fabula*	17	96
Arthropoda	Malacostraca	Pseudocumatidae	*Pseudocuma longicorne*	24	96
Mollusca	Gastropoda	Cylichnidae	*Cylichna cylindracea*	25	96
Mollusca	Bivalvia	Thraciidae	*Thracia phaseolina*	25	93
Annelida	Polychaeta	Paraonidae	*Aricidea minuta*	25	93
Annelida	Polychaeta	Glyceridae	*Glycera alba*	16	93
Arthropoda	Malacostraca	Argissidae	*Argissa hamatipes*	30	89
Phoronida	PH_PHORONIDA	PH_PHORONIDA	*PH-Phoronida*	16	89
Arthropoda	Malacostraca	Bathyporeiidae	*Bathyporeia tenuipes*	22	89
Mollusca	Bivalvia	Montacutidae	*Tellimya ferruginosa*	15	89
Annelida	Polychaeta	Pectinariidae	*Lagis koreni*	21	85
Annelida	Polychaeta	Pholoidae	*Pholoe baltica*	8	85
Annelida	Polychaeta	Nephtyidae	*Nephtys longosetosa*	6	85
Arthropoda	Malacostraca	Paguridae	*Pagurus bernhardus*	7	81
Arthropoda	Malacostraca	Ampeliscidae	*Ampelisca brevicornis*	8	81
Mollusca	Bivalvia	Arcticidae	*Arctica islandica*	5	81
Annelida	Polychaeta	Spionidae	*Aonides paucibranchiata*	32	78
Arthropoda	Malacostraca	Leuconidae	*Eudorellopsis deformis*	16	78
Mollusca	Bivalvia	Veneridae	*Dosinia lupinus*	12	78

Phylum	Class	Family	Species	Average density (n/m^2)	% samples
Mollusca	Bivalvia	Pharidae	*Phaxas pellucidus*	11	78
Annelida	Polychaeta	Syllidae	*Exogone (Exogone) naidina*	30	74
Mollusca	Bivalvia	Psammobiidae	*Gari fervensis*	6	74
Annelida	Polychaeta	Oweniidae	*Owenia borealis*	5	74
Arthropoda	Malacostraca	Bathyporeiidae	*Bathyporeia guilliamsoniana*	29	74
Mollusca	Bivalvia	Veneridae	*Chamelea striatula*	4	70
Annelida	Polychaeta	Nephtyidae	*Nephtys caeca*	8	70
Annelida	Polychaeta	Terebellidae	*FAM-Terebellidae*	32	70
Annelida	Polychaeta	Polynoidae	*Malmgreniella ljungmani*	5	70
Annelida	Polychaeta	Opheliidae	*Ophelia borealis*	18	67
Arthropoda	Malacostraca	Phoxocephalidae	*Harpinia antennaria*	8	67
Arthropoda	Malacostraca	Oedicerotidae	*Pontocrates altamarinus*	10	67
Annelida	Polychaeta	Amphinomidae	*Paramphinome jeffreysii*	11	63
Annelida	Polychaeta	Capitellidae	*Mediomastus fragilis*	15	63
Arthropoda	Malacostraca	Oedicerotidae	*Westwoodilla caecula*	4	59
Mollusca	Bivalvia	Nuculidae	*Nucula hanleyi*	3	59
Arthropoda	Malacostraca	Oedicerotidae	*Synchelidium maculatum*	8	56
Mollusca	Bivalvia	Cardiidae	*Acanthocardia sp*	4	56
Arthropoda	Malacostraca	Atylidae	*Nototropis swammerdamei*	3	56
Annelida	Polychaeta	Sigalionidae	*Sthenelais boa*	16	56
Annelida	Polychaeta	Phyllodocidae	*Eteone longa*	2	56
Annelida	Polychaeta	Ampharetidae	*Ampharete falcata*	3	52
Arthropoda	Malacostraca	Portunidae	*FAM-Portunidae*	2	52
Annelida	Polychaeta	Cirratulidae	*Chaetozone setosa*	5	48

Appendix F. Red list species per sample

		Samples on pipeline trajectory																		Northern sample points										Southern sample points					
Latin name	**Red list**	51	52	53	54_C	55	**56_B**	57	58	59_C	60	**61_B**	62	63	64_C	65	**66_B**	67	68	54_A	54_B	**56_A**	59_A	59_B	**61_A**	64_A	64_B	**66_A**	54_D	54_E	59_D	59_E	64_D	64_E
Macoma calcarea	1	x																																	
Spisula elliptica	2																						x												
Buccinum undatum	2						**x**																												
Amblyraja radiata	3											**x**										**x**													
Arctica islandica	3	x		x	x	x		x		x	x		x	x				x	x	x	x		x				x		x	x	x	x	x		
Sigalion mathildae	3					x					x		x	x	x					x			x	x		x									
Cumopsis goodsir	3			x									x																						
Alcyonidium digitatum	3																								**x**										
Chamelea striatula	G	x	x					x	x	x			x	x				x	x	x	x		x	x		x				x	x	x	x	x	x
Chamelea gallina	G											**x**																**x**							
Neptunea antiqua	G						**x**										**x**											**x**							
Chone duneri	G																			x				x			x			x	x	x			
Chone infundibuliformis	G		x			x																													x
Manayunkia aestuarina	G																										x								
Scalibregma inflatum	G																		x										x						
Sthenelais boa	G	x		x		x		x							x	x					x		x			x	x		x	x	x	x	x	x	x
Astropecten irregularis	G	x						x				**x**					**x**			x					**x**			**x**							
Echinocyamus pusillus	G																																		x
Echinocardium flavescens	G										x									x						x	x		x						
Sertularia cupressina	G																								**x**										
Alcyonidium parasiticum	G																								**x**										
Vitreolina philippi	R																						x												
Hydroides norvegicus	R			x																															
Pholoe inornata	R			x															x																
Prionospio cirrifera	R										x			x																					
Diastylis boecki	R																									x				x					
Stenothoe monoculoides	R								x																										
Celleporella hyalina	R	x		x	x																														
Securiflustra securifrons	R						**x**																												
Acteon tornatilis	V			x	x						x								x				x							x					
Tellina tenuis	V	x																																	
Ophiothrix fragilis	V											**x**					**x**																		
Megaluropus agilis	V			x	x						x				x	x								x			x				x	x			x
Metopa alderi	V																															x			
Synchelidium haplocheles	V									x			x								x														
Caprella linearis	V																								**x**										