BioConsult SH

Interconnector NeuConnect – Benthic Report

REPORT

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1 INTRODUCTION

1.1 Background

NeuConnect Ltd. plans to connect the German and British energy markets with a high voltage cable. The NeuConnect project proposes to operate a 1,400 MW High Voltage Direct Current (HVDC) interconnector linking Germany with the United Kingdom. The interconnector will comprise HVDC submarine cables of approx. 680 km between Germany and the UK, with a section passing through Netherlands territorial waters (compare with Figure 1-1). The interconnector will be designed to transmit electrical power in both directions across the Southern North Sea, UK territorial waters, through Dutch EEZ and into German territorial waters and EEZ to link the electricity transmission systems in the UK and Germany.

A preliminary route has been developed and is subject to ongoing discussions with relevant stakeholders in each of the countries. A pair of cables will be buried in the seabed, typically to a depth of 2 to 3 meters.

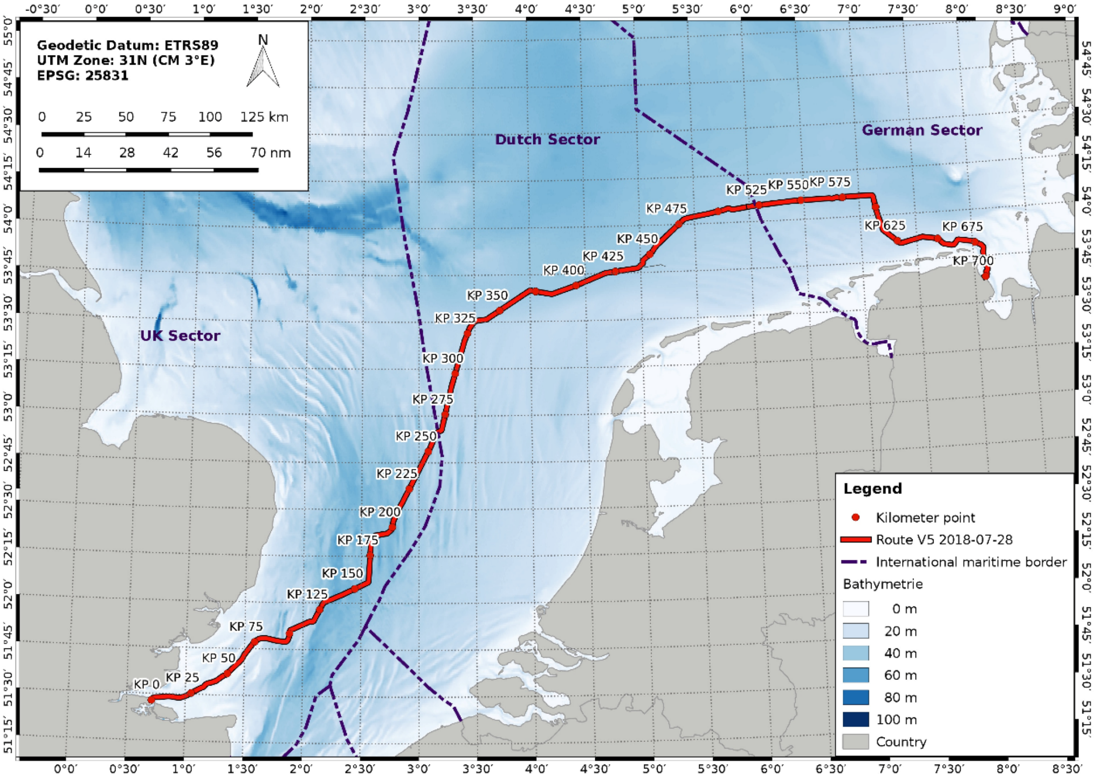

Figure 1-1: Overview of the planned HVDC submarine cable between Germany and the UK with the section of the Netherlands EEZ.

1.2 Objectives of the Benthic Investigations

The present baseline report presents the results of the benthic survey. The baseline report is part of the Environmental impact assessment (EIA) and serves to describe the status quo of the marine biotopes as well as the benthic fauna in the sea area of the preliminary route. The results of the inventory will form the baseline for the impact assessments of the project with regard to the sediment characteristics and the macrozoobenthos.

The objectives of the benthic investigation are to:

- Map benthic communities (fauna and flora);
- Acquisition of benthic grab sampling for physico-chemical analysis of sediments;
- Obtain sediment grab samples to validate potential marine biotopes identified during the geophysical survey;
- Map benthic habitats in accordance to the nature conservation legislation (Habitats Directive) and the OSPAR Convention (OSPAR Priority Habitats);
- Provide baseline data for the assessment of the benthic community along the cable trench (e.g. EIA);
- Provide baseline data for later assessment of impacts during operation for paired cables (e.g. BACI – design).

2 METHODS

2.1 Investigation Area

The investigation area is located along the proposed cable corridor in the Dutch EEZ (Figure 2-1).

2.2 Survey Design

Based on the screening of the side-scan sonar investigations, the substrate properties along the proposed cable corridor are considered to be homogeneous. Accordingly, the investigation program is oriented towards these substrate conditions.
Survey operations were performed in accordance with the procedural guidelines contained within the marine monitoring handbook (Davies et al. 2001). The cable corridor extends into the Dutch EEZ over a length of approx. 270 km. The station grid for the macrozoobenthos survey comprises 34 stations[1] with a distance of 7.7 km between each station. To cover the occurrence of biotopes and their benthic communities, video investigations, van Veen grab sampling as well as investigations with beam trawl were performed at each station (see Table 2-1).

Table 2-1: Overview of the sampling design

tasks	scope
Biotopes/Habitats	- Covering by using video equipment at 34 stations - Towing speed 1 kn; towing time 15 minutes
Infauna and Sediments	- 34 stations by using a van Veen grab sampler every 7.7 km (covering 0.1 m²) - At each station 2 parallel samples (68 van Veen samples) - first parallel sample for macrofauna analyses - second parallel sample for sediment and physico-chemical analyses
Epifauna	- 34 stations by using a 2 m beam trawl every 7.7 km - Trawling time ca. 5 minutes at the bottom; Trawling speed 1–3 kn - mesh size 1 cm

In order to record the infaunal communities and the sediment structure, 1 station per cross transect was examined. Each station consists of 2 sub-samples. The first sample at each station was processed for the macrofauna analysis. The second grab sample was used for sediment and physico-chemical investigations. Subsamples from the second grab were taken for:

- Particle size distribution (PSD) and total organic matter (TOM) analyses
- Hydrocarbon analyses
- Heavy metals and total organic carbon (TOC) analyses

[1] At station 33 investigation were not possible. Crab traps were located in the surrounding area.

For the investigation of the epibenthic communities, hauls with a 2 m beam trawl were carried out at each station. Thus, a total of 33 dredging[2] hauls were performed along the cable route in the Dutch EEZ.

The occurrence of macrophytes was examined during all investigations. However, probably mainly due to high water depth with poor light conditions, they did not occur.

During the above described investigations, measurements of salinity, temperature and oxygen concentration have been carried out at the sea surface and near the bottom in order to obtain the hydrographic situation in the area. Additionally, meteorological data were documented during the investigations. The following data were recorded:

- Air temperature
- Wind speed and direction
- Intensity of clouds
- Wave height
- Position at each beginning and end of setting
- Depth at each beginning and end of setting
- Water temperature at the surface and bottom at each setting/trawling position
- Oxygen concentration and saturation at the surface and bottom
- Salinity at the surface and bottom

The station grid has previously been coordinated with the national authorities and is based on existing data from the current cable corridor, protected biotopes are not expected. In addition, the evaluation of the results from remote sensing and biological investigations did not identify potential areas of protected habitat types in accordance with the EU-Habitats Directive and the OSPAR Convention.

The following data were analyzed and are reported here

- Total number of individuals and species per station/number of individuals, species and area (species table)
- Total biomass per station/biomass per species and station
- Dominance structure (related to number of individuals and biomass)
- Occurrence and distribution of Red List species
- Diversity/evenness for community analysis, cluster analysis or multi-dimensional scaling, univariate analyses, significance tests
- Comparison of own data with SSS investigation results of the transmission system operator
- Allocation of stations to clusters with similar sediment characteristics or similar associations of macrobenthos (Rachor & Nehmer 2003) on the basis of community analyses (cluster analysis, MDS plot)
- Documentation of physico-chemical sediment characteristics
- Documentation of hydrographic conditions in the project area
- If necessary mapping of the habitats protected by the EU-Habitats Directive within the area impacted by the cable route corridor

[2] At station 33 investigation were not possible. Crab traps were located in the surrounding area.

2.3 Hydrography

The abiotic parameters water temperature, salinity and oxygen saturation were measured at the infauna stations at the surface and in the bottom water in addition to the infaunal investigations. Water was sampled with a Ruttner Water Sampler and measured with a Hach HQ40d multimeter. Visibility depths were determined using a Secchi disc.

2.4 Epifauna

The importance of beam trawls lies in their ability to detect fast-leaping epibenthic, mostly rare, large species, which are under-represented in van Veen grab samples and are often not captured. They are an important addition to the species lists of the infauna samples. The captured species are often predators of great ecological importance as they are at the end of the food web. In principle, however, the quantitative aspect of the beam trawl catches (such as that of the underwater video) should not be overestimated either, as many of the epibenthic species are capable of rapid escape reactions, or at times can bury themselves in, or their distribution is very patchy. In addition, especially on uneven ground and with strong currents, the full ground contact of the beam trawl is not always guaranteed, so that information regarding the sampled area is not always secure.

In addition to the video observations, a standardised beam trawl with an opening width of 200 cm x 60 cm and a mesh width of 10 mm was used to record the epifauna. Sampling was carried out in daylight. The beam trawl was towed over the ground at a speed of 1 to 3 kn for 5 minutes (setting up the trawl until it was heaved), therefore, at a speed of 3 kn an area of approx. 900 m² was sampled under ideal conditions.

On board, the net bag was emptied into tubs. Fish species were sorted, counted and returned to the sea. Big species like *C. pagurus* were also counted, weighed and returned to the sea. All other species were fixed with a 4 % borax-buffered seawater-formaldehyde mixture and identified, counted and weighed later in the laboratory. Only those species that remained in the used net, with a mesh size of 10 mm, were evaluated in the multivariate analyses. Representatives of small species only remain in the net randomly, so that no meaningful data can be obtained for these groups. In addition, there is a risk of entrainment, as these animals can cling to the net, be overlooked due to their size and may only be flushed into the sample during one of the next hauls, so that misinterpretations could occur with regard to these groups.

2.5 Infauna

Infauna refers to invertebrates that are predominantly found in the substrate (e.g. in the sediment). In the investigations presented here, mainly macrozoobenthic species are considered. This part of the infauna is methodically defined as the fauna retained in a sieve with a mesh size of 1.0 mm. Individual representatives of the meiofauna (fauna of the sand gap system) were recorded occasionally, but unsystematically. Nematoda and Copepodawere not taken into account in the quantitative evaluation of the samples. Due to the sampling technique, also animals living on the sediment (epifauna) were included.

Quantitative benthic samples for the investigation of the infauna were taken using a Van Veen grab sampler (0.1 m², 45 kg, with gauze windows). The content of the grab sampler was first described visually, floating on a sieve table and then portioned over a sieve with a mesh size of 1.0 mm. The sieve residues were transferred into Kautex-bottles and conserved with a 4 % borax-buffered seawater-formaldehyde mixture for the laboratory analyses. All grab samples were processed in the laboratory. After rinsing with tap water over a mesh size of 630 µm, the samples were counted under a stereomicroscope at about 7x magnification.

The animals were separated, identified, counted and weighed from sediment and adhering substrates, such as residential tubes. The biomass was determined as wet mass. Clinging dripping wetness was removed with filter paper; mollusk mantle cavity liquid was also weighed. Weighing was carried out with an accuracy of 1 mg.

The determination of the species was mainly carried out with standard literature, current publications on the taxonomy of selected groups as well as conventions and unpublished information elaborated or exchanged at national and international workshops in past years. In difficult cases, a comparison was performed with a comparative collection. An analysis of the Cnidaria and Nemertini could only be carried out in rudimentary form, since for these groups narcotisation before killing is necessary in order to prevent contraction and fragmentation of the individuals. Additionally, juvenile individuals were omitted from determination of the animals up to the species, as the expression of their diagnostic characteristics is often insufficient.

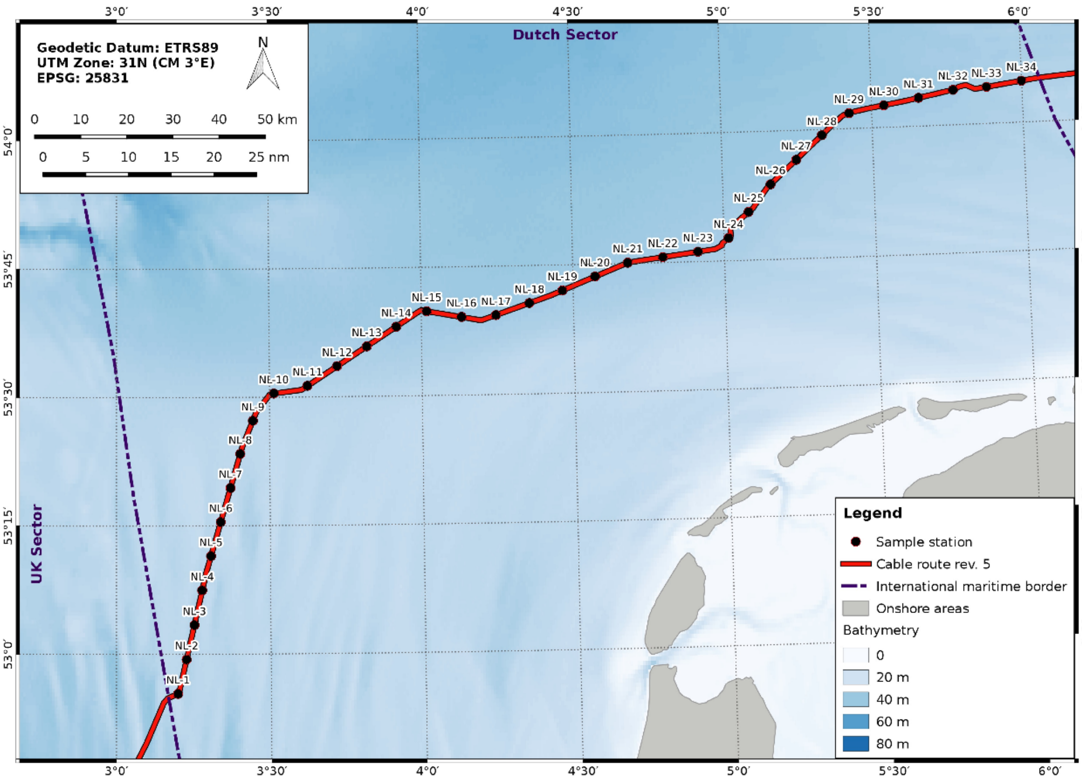

Figure 2-1: Benthic survey sampling locations

2.6 Video Observations

Video observations were performed to determine general biotope characteristics and epibenthic animals. This method is a valuable addition to sampling with van Veen grab and beam trawl, as it can be used especially in areas that are inaccessible to classical marine biology methods due to their topography (e.g. block and gravel bottoms).

A digital video device was used, coupled with a GPS device and an echo sounder, therefore date, time, coordinates and water depth are inserted on the respective video section. A digital camcorder with SD-card served as the recording device. A light source on the camera made it possible to work in water depths where no daylight was available.
The camera was lowered to the seabed off the floating or slow-moving ship (maximum speed through the water 1-1.5 kn) and pulled over the bottom. The camera and light settings were selected to ensure a view ahead. A monitor was used to control the camera and to observe the seabed during the recording.
The evaluation of the video recordings was carried out on board the ship during the recording and in a post-processing. Identified epibenthos was recorded together with the position data in a database and evaluated and displayed with QGIS. Individual scenes with characteristic biotope structures or observed species were documented as short films and still images.

2.7 Sediment Particle Size Distribution (PSD) and organic content (TOC)

Samples for the determination of important sediment parameters were taken from a second grab sample. The contents of the grab were first described with regard to color, grain size, odour, inclusions and coatings. For the sediment analysis in the laboratory, a sediment sample was taken from each grab with a puncture cylinder (puncture depth 6 cm, diameter 4.5 cm). Samples for total organic carbon (TOC) were taken also from this samples. All samples were cooled or frozen and stored on the vessel until the demobilisation and the transfer to the analysis laboratory.
The sediment determination was carried out according to DIN 4022, the grain size distribution was determined according to DIN 18123 (mesh sizes according to DIN 4188, part 1). The main series R10 was used with successive doubling of the smaller mesh size (0.063 mm → 0.125 mm → 0.25 mm → 0.5 mm → 0.1 mm → 2 mm → 4 mm). The sediment samples were dried at 105 °C and weighed after cooling. The weighing error was < 0.1 % of the sample mass. The sieve analysis was carried out as machine sieving on wire sieve trays with a diameter of 200 mm and a sieving time of 10-15 minutes. For the sediment fraction smaller 0,63 mm an additional hydrometer analysis was used. In the hydrometer analysis, the grain sizes were determined by measuring their different sinking velocities in the water. The sediment sample were stirred into a suspension and the density of the suspension was measured at fixed intervals with a hydrometer.
The organic content of the sediment was determined as loss on ignition according to the methods of the Federal Institute of Hydrology Koblenz. These deviate from DIN 38414 in that the sediment is annealed for 3 h at 500 °C (instead of 1 h at 550 °C). This is justified by the usually high proportion of carbonates in marine sediments, which oxidise at 550 °C and can lead to an overestimation of the organic content.

2.8 Data Analyses

Data analyses were performed using Microsoft Excel 2013 and the statistical package PRIMER v6 (Clarke and Gorley 2006; Clarke & Warwick 2001).The macrofaunal data sets were imported into Primer v6 and analysed by means of univariate and multivariate analyses. Prior to the analysis, the data were subject to standardised processing. Only taxa with a minimum presence of 6% (present at two stations) were included. Organisms of colony-forming epifauna

(e.g. Bryozoa, Hydrozoa) were excluded. In order to minimize the influence of strongly dominant species, the data were pretreated with a double square root transformation.
The similarities between the stations were calculated using the Bray-Curtis similarity (Bray & Curtis 1957). The results were presented as a dendrogram of a cluster analysis and as a two-dimensional image of a non-metric multidimensional scaling (nMDS). For the cluster analysis, the groups ("clusters") were linked via the "average distance" ("group average"). Further community analyses were carried out with the ANOSIM, SIMPER and BIOENV routines of the program PRIMER v6.
The combination of clustering and ordination analysis allows to check the adequacy and mutual consistency of both representations (Clarke and Warwick 2001).
The Similarity Profile (SIMPROF) test was used in conjunction with the cluster analysis in order to identify station groupings that are significantly different in statistical terms. Results are displayed by colour convention, with samples connected by red lines indicating a difference which is not statistically significant. It is noteworthy, however, that samples which may be considered statistically different, based on the SIMPROF output, may host similar faunal communities which differ e.g., in terms of abundance rather than species composition. In such case, the samples may be interpreted as being not significantly different, from an ecological point of view. The SIMPROF output was therefore always considered in terms of statistical and ecological significance, in line with Clarke et al. (2008), who indicate that creating coarser groupings is entirely appropriate, provided that the resulting clusters are always supersets of the SIMPROF groups.
The Similarity Percentage Analysis (SIMPER) was performed following the clustering analysis, in order to gauge the faunal distinctiveness of each of the identified group of samples. SIMPER provides a ranked list of species which contributes most to the similarity/dissimilarity within/between groups of samples.
Of the analyses carried out, only the part in this report which is necessary to describe the results and understand the interrelationships was reproduced.
Univariate analyses are used to extract features of communities which are not the function of specific taxa, i.e. these methods are species independent. They are not sensitive to spatio-temporal variations in species composition, so that assemblages with no species in common can theoretically have equal diversities. Univariate analyses include the primary variables: number of taxa (S) and abundance (N), together with Shannon-Wiener index of Diversity (H'Log_2) and Pielou's index of Evenness (J). The Shannon-Wiener index of diversity incorporates richness and evenness as it expresses the number of species within a sample and the distribution of abundance across these species. Following the threshold values outlined in Dauvin et al. (2012), values of H' (Log_2) greater than four indicate high diversity; values between three and four indicate good diversity; values between three and two indicate moderate diversity; values between one and two indicate poor diversity; and values less than one indicate bad diversity (Dauvin et al. 2012).
Pielou's index of evenness expresses how evenly distributed the individuals are among the different species. In general, the higher the evenness, the more balanced the sample. This indicates that the individuals are evenly distributed between the species recorded.
Correlation analysis provides an effective way of revealing the relationships between multiple variables. Correlation analysis between environmental variables was performed using the

Spearman’s correlation coefficient. This correlation analysis, based on ranks, allows characterising of the strength of relationships among a set of variables, without making assumption of linearity between variables (Hauke & Kossowski 2011).

Biotopes were identified using the European Nature Information Service (EUNIS 2016) habitat codes. After Davies et al. (2004) the EUNIS habitats are in effect biotopes. This was carried out by expert judgement. For that process, all survey data were used including macrobenthic data and multivariate analysis results, PSD analysis results and the video observational data. Further to analysis of the video data, macrofaunal species abundance data was reviewed in conjunction with the results of the sediment particle size distribution analysis, seabed imagery and depth. The list of species for a particular station was run through BioScribe, the biotope decision support tool, to cross-check whole community data against the reference samples used by the JNCC to originally describe the EUNIS habitats in the marine classification system (Hooper et al. 2011).

Based upon results from the interrogative and iterative process, each station was allocated to one biotope.

3 RESULTS

Data and samples were successfully collected at 33 of the 34 sampling stations. At the station NC_NL_33 no sampling was possible because of the occurrence of Crab traps in the surrounding area.

3.1 Hydrography and Biotopes

In autumn 2018 there was only one mass of water in the sea area. The hydrographic parameters of surface and bottom water did not differ significantly. During the infauna investigations from the 22.11.18 to the 04.12.18, salinities between 33.5 and 34.2 were measured in the water body near the ground. The water body was almost completely saturated with oxygen during the investigations. The water temperature in the bottom near water was between 9.9 – 11.7°C.

In the underwater video, all stations were indentified as homogeneous sand bottom throughout (Figure 3-1 to Figure 3-3). The formation of sand ripples was low and uneven everywhere. Unevenness in the bottom topography was often of biogenic origin. In addition to "constructions" of the heart urchin *Echinocardium cordatum*, siphon-openings of mussels, tube-building polychaetes and anthozoans living in the sediment were visible in the underwater video recordings.

According to the analysis of the sediment samples, the substrate along the route is characterized predominantly by muddy fine sand and fine sand with a median grain size of between 0.085 and 0.2 mm (Table 3-1, Figure 3-4). Only at the station NC_NL_25, a slightly higher median grain size of 0.31 mm was found. The proportion of silty sediment fractions varies considerably between the stations from 1 – 28.7 %. The organic content of the sediment was found to be variable with values from 0.3 to 2.8 % (loss on ignition). Depth influenced the distribution of sediment along the Netherlands EEZ survey route. Depth correlates significantly with the silt content (R-value 0.6722, P-value <0.0001).

Table 3-1: Results of the sediment analysis from autumn 2018

Station	Median Grain Size [mm]	Sediment Class after ISO 14688-1:2002	Loss on Ignition [%]	Silt Content [%]	Depth [m]
NC_NL_1	0.212	fine to medium sand	0.348	1.00	28.4
NC_NL_2	0.197	fine sand	0.483	2.00	34.6
NC_NL_3	0.205	fine to medium sand	0.671	2.00	32
NC_NL_4	0.199	fine sand	0.531	2.00	30.1
NC_NL_5	0.183	fine sand	0.572	1.00	28.7
NC_NL_6	0.176	fine sand	0.520	3.00	26.9
NC_NL_7	0.173	fine sand	0.725	2.13	26.5
NC_NL_8	0.171	fine sand	1.204	8.00	28.7

Station	Median Grain Size [mm]	Sediment Class after ISO 14688-1:2002	Loss on Ignition [%]	Silt Content [%]	Depth [m]
NC_NL_9	0.164	fine sand	1.201	10.00	30.7
NC_NL_10	0.101	fine sand	1.587	9.71	32.7
NC_NL_11	0.098	fine sand	1.159	11.54	31.7
NC_NL_12	0.099	fine sand	2.141	11.09	34.6
NC_NL_13	0.101	fine sand	1.604	13.27	36.8
NC_NL_14	0.107	fine sand	1.762	15.94	38.2
NC_NL_15	0.123	fine sand	1.518	9.13	40.1
NC_NL_16	0.092	fine sand	2.128	19.27	40.3
NC_NL_17	0.095	fine sand	2.248	15.35	38.6
NC_NL_18	0.091	fine sand	2.640	17.89	37.5
NC_NL_19	0.085	fine sand	1.988	19.38	37.2
NC_NL_20	0.088	fine sand	2.218	28.70	37.2
NC_NL_21	0.089	fine sand	1.980	20.42	37.3
NC_NL_22	0.089	fine sand	2.285	21.22	37.7
NC_NL_23	0.098	fine sand	2.784	22.51	37.5
NC_NL_24	0.119	fine sand	2.679	20.36	37.8
NC_NL_25	0.310	medium sand	0.553	10.00	35.8
NC_NL_26	0.163	fine sand	1.224	11.50	36.5
NC_NL_27	0.149	fine sand	0.826	9.86	37.7
NC_NL_28	0.154	fine sand	1.005	9.22	38,9
NC_NL_29	0.098	fine sand	2.249	20.24	39,7
NC_NL_30	0.147	fine sand	1.487	13.21	39.3
NC_NL_31	0.171	fine sand	0.486	4.19	37.2
NC_NL_32	0.186	fine sand	0.760	6.00	35.8
NC_NL_34	0.276	fine to medium sand	0.284	1.00	33.1

Figure 3-1: Still frames of the underwater video recordings

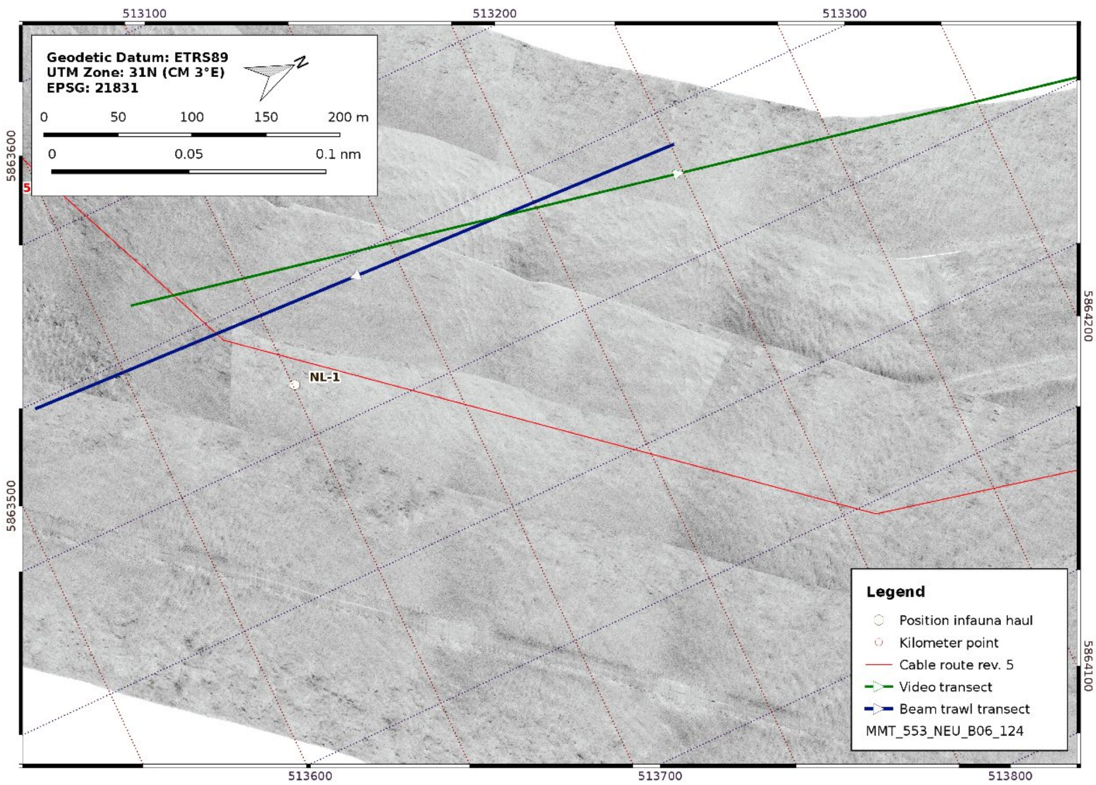

Figure 3-2: Sidescan data of station NC_NL_1

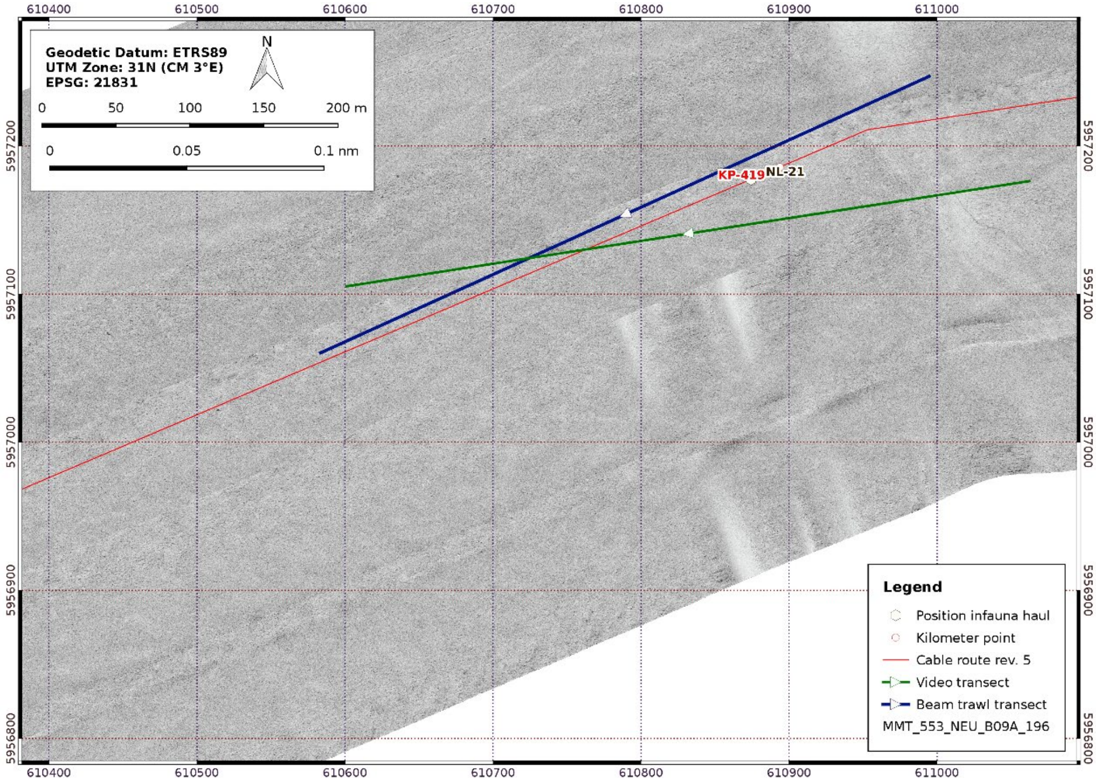

Figure 3-3: Sidescan data of station NC_NL_21

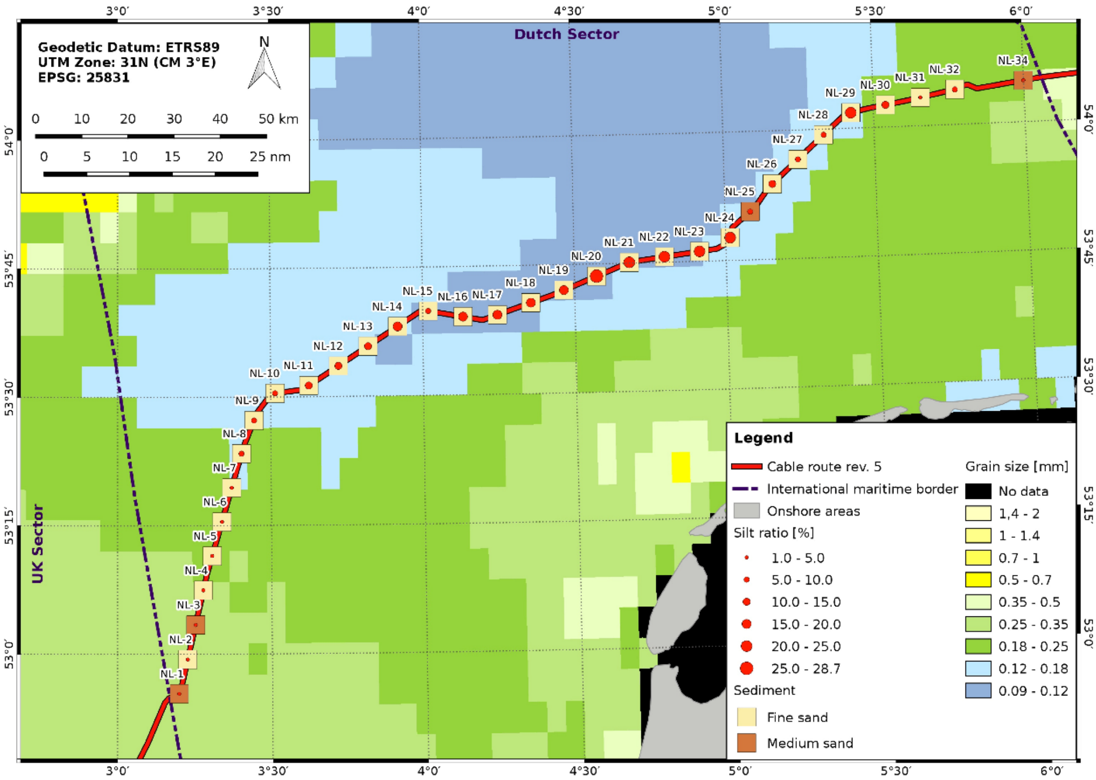

Figure 3-4: Median grain size and silt content in autumn 2018. Background: sediment distribution after HZG (2014)

Based on the sediment characters and the results of the analysis of the infauna communities' (see chapter 3.3.2) two biotopes were confirmed.
The most common biotope identified from the survey was the EUNIS level 4 habitat complex 'Circalittoral muddy sand' (A5.26) followed by the EUNIS level 4 habitat complex 'Circalittoral fine sand' (A5.25) (Figure 3-5, Table 3-2).

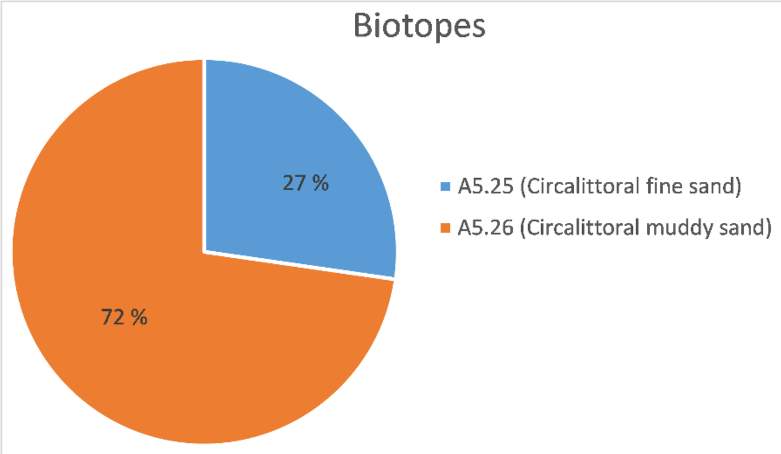

Figure 3-5: Biotopes (EUNIS level 4 habitat complexes) along the cable route within the Netherlands EEZ

Table 3-2: Biotopes recorded from the Survey within the Netherlands EEZ

Biotope	**EUNIS Code**	**Stations**	**Faunal Group after cluster analysis of the infauna (see** Figure 3-22)	**Representative Image**
Circalittoral fine sand	A5.25	NC_NL_1, _2, _3, _4, _5, _6, _7, _8, _34	h, g	
Circalittoral muddy sand	A5.26	NC_NL_9, _10, _11, _12, _13, _14, _15, _16, _17, _18, _19, _20, _21, _22, _23, _24, _25, _26, _27, _28, _29, _30, _31, _32	a, b, c, d, e, f	

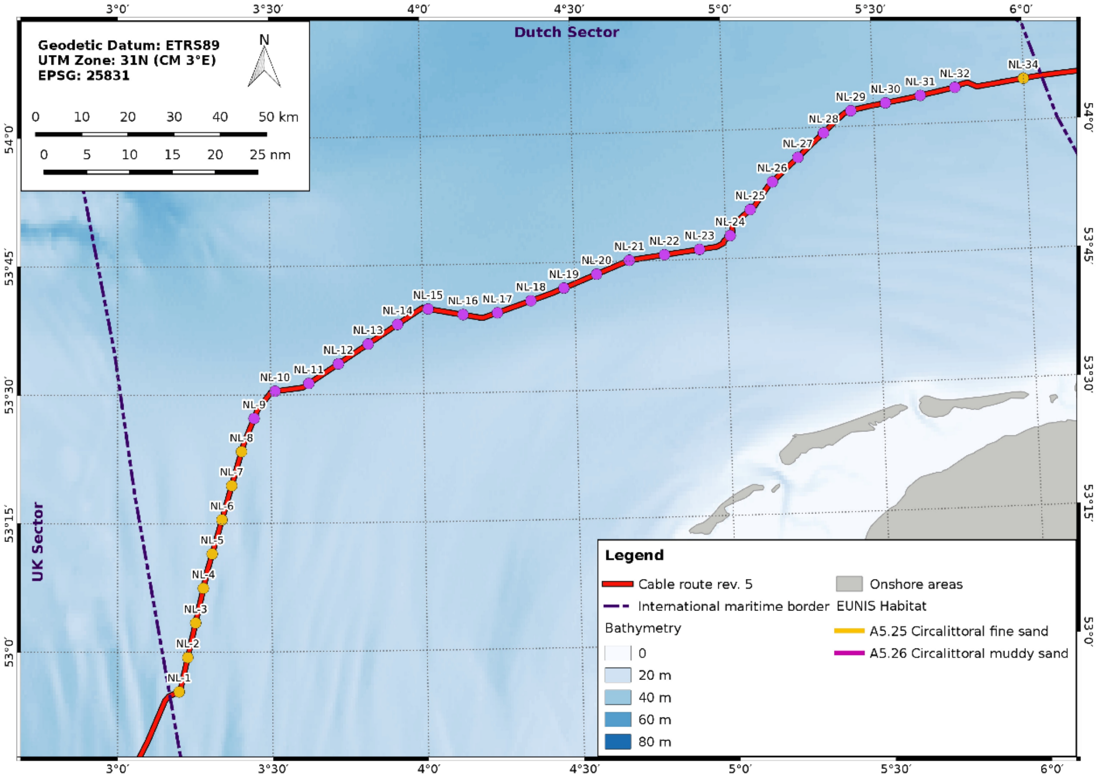

Figure 3-6: Distribution of biotopes within the Netherlands EEZ

At 24 stations muddy sand was found. Together with the infauna analyses the EUNIS level 4 habitat complex ‘Circalittoral muddy sand’ (A5.26) was identified there. This biotope is characterised by non-cohesive muddy sands with the silt content typically ranging from 5 % to 20 %. Generally found at depths of over 20 m, this biotope supports communities characterised by a wide variety of polychaetes, bivalves such as *Abra alba* and *Nucula nitidosa*, and echinoderms such as species of the genera Amphiura and Ophiura. In addition, *Astropecten irregularis* is commonly found associated with EUNIS habitats within this this EUNIS habitat complex (EEA 2014; JNCC 2015).

At 9 stations fine sand or medium sand with less silt was found. Together with the infauna analyses the EUNIS level 4 habitat complex ‘Circalittoral fine sand’ (A5.25) was indentified. This biotope is characterized by clean fine sands with less than 5% silt/clay. It is found in deeper water, either on the open coast or in tide-swept channels of marine inlets in depths of over 15 to 20 m. The biotope may also extend offshore and is characterised by a wide range of echinoderms (in some areas including the sea urchin *Echinocyamus pusillus*), polychaetes and bivalves. This biotope is generally more stable than shallower, infralittoral sands and consequently supports a more diverse community (EEA 2014; JNCC 2015).

3.2 Epifauna

3.2.1 Characterisation of the epifauna settlement in the project area

The list of epibenthic species comprises 64 taxa out of 12 taxonomic groups (Figure 3-7, Table 3-3). Most species are found within the groups of the Decapoda, Polychaeta, Bivalvia and Echinodermata. Among them are 21 species with very few records (found only in less than 10% of the stations). The number of species at the stations was between 6 at station NC_NL_1 and 31 at the stations NC_NL_11 and 12 (Figure 3-9).

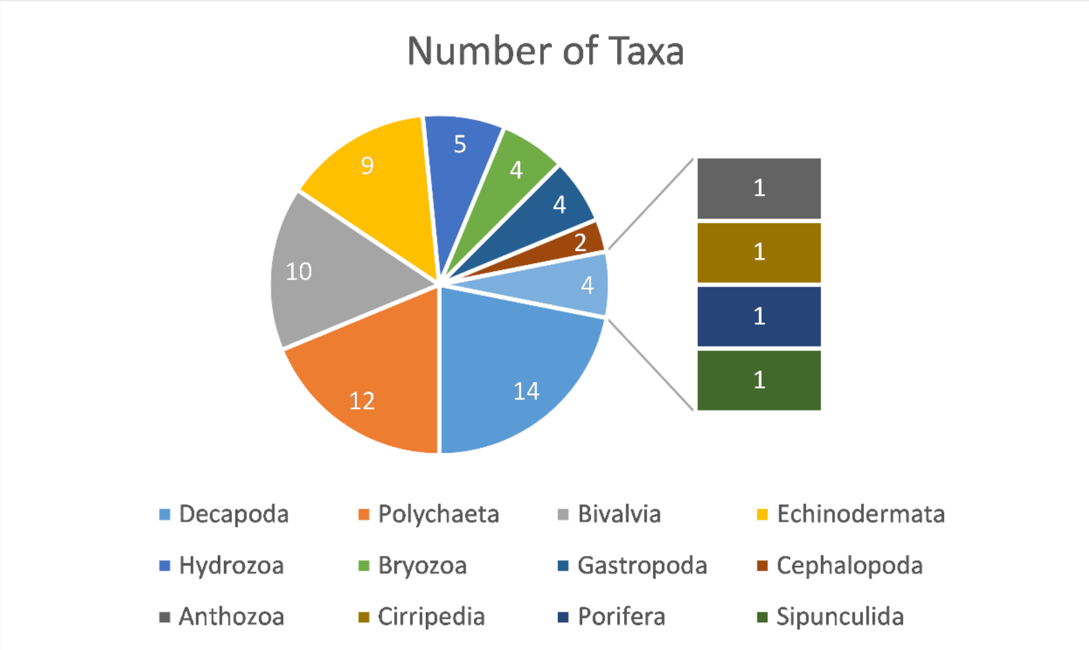

Figure 3-7: Number of taxa in the epifauna hauls

The mean number of individuals in the hauls was 1129 (Figure 3-8). Recalculated to square meters (sqm) (individuals per haul divided by catchment area – approximately 900 to 1000 sqm) the mean number of individuals was with 1.24 ind./sqm much lower and ranges from 0.06 Ind./sqm at station NC_NL_1 to 5.4 Ind./sqm at station NC_NL_22 (Figure 3-10). Overall, eight species dominate the epifauna samples according to abundance and continuity. These are *Ophiura albida* (677 ind./haul; 91% presence), *Turritella communis* (91 ind./haul; 36% presence), *Ophiura ophiura* (77 ind./haul; 94% presence), *Astropecten irregularis* (77 ind./haul; 70% presence), *Echinocardium cordatum* (51 ind./haul; 79% presence), *Liocarcinus holsatus* (32 ind./haul; 100% presence), *Crangon allmanni* (31 ind./ haul; 97% presence) and *Asterias rubens* (25 ind./haul; 73% presence) (Table 3-3, Figure 3-8).
The average biomass (wet weight) in the hauls was 2.1 kg. Recalculated to square meters the average biomass was with 2.2 g/sqm much lower and ranges from 0.32 g/sqm at station NC_NL_1 to 5.16 g/sqm at station NC_NL_22 (Figure 3-11).The biomass was dominated by *Asterias rubens* (373 g/haul), *Echinocardium cordatum* (346 g/haul), *Ophiura albida* (302 g/haul), *Liocarcinus holsatus* (274 g/haul) and *Astropecten irregularis* (240 g/haul) (Table 3-3, Figure 3-8).

Table 3-3: Species list epifauna hauls

Group	Taxon or lowest taxonomic level	Mean wet weight per haul in g	Mean number of individuals per haul	Presence along the stations in %
Porifera	Porifera	+	+	6.1
Bryozoa	*Alcyonidium gelatinosum*	+	+	3.0
	Cradoscrupocellaria ellisii	+	+	3.0
	Electra pilosa	+	+	39.4
	Flustra foliacea	+	+	12.1
Hydrozoa	*Clytia hemisphaerica*	+	+	6.1
	Hydractinia echinata	+	+	75.8
	Laomedea flexuosa	+	+	6.1
	Sertularia cupressina	+	+	3.0
	Thecata	+	+	9.1
Anthozoa	Anthozoa	+	+	21.2
Bivalvia	*Abra nitida*	0.12	0.30	12.1
	Acanthocardia echinata	3.73	0.12	12.1
	Chamelea striatula	9.62	6.06	57.6
	Corbula gibba	0.06	0.12	6.1
	Dosinia exoleta	0.09	0.03	3.0
	Gari fervensis	0.97	0.27	15.2
	Mactra stultorum	0.65	0.12	12.1
	Mysia undata	0.27	0.18	15.2
	Phaxas pellucidus	0.54	2.03	45.5
	Spisula subtruncata	0.41	0.30	24.2
Gastropoda	*Euspira catena*	0.66	0.12	12.1
	Nassarius reticulatus	8.72	2.18	15.2
	Neptunea antiqua	3.68	0.06	6.1
	Turritella communis	130.46	90.67	36.4
Cephalopoda	*Loligo subulata*	0.50	0.18	15.2
	Sepiola atlantica	1.37	0.67	33.3
Echinodermata	*Amphiura filiformis*	0.01	0.18	15.2
	Asterias rubens	373.62	25.39	72.7
	Astropecten irregularis	240.03	77.09	69.7
	Echinocardium cordatum	345.75	50.73	78.8
	Luidia sarsi	1.13	0.03	3.0
	Ophiura albida	302.46	677.42	90.9
	Ophiura ophiura	90.08	77.45	93.9
	Psammechinus miliaris	1.23	0.12	9.1
	Trachythyone elongata	1.90	0.64	24.2
Cirripedia	*Balanus crenatus*	1.45	8.67	42.4

Group	Taxon or lowest taxonomic level	Mean wet weight per haul in g	Mean number of individuals per haul	Presence along the stations in %
Decapoda	*Cancer pagurus*	68.18	0.15	12.1
	Corystes cassivelaunus	7.17	1.27	57.6
	Crangon allmanni	18.01	31.30	97.0
	Crangon crangon	11.05	7.55	84.8
	Ebalia cranchii	0.03	0.09	9.1
	Goneplax rhomboides	23.68	4.73	48.5
	Liocarcinus depurator	55.79	5.15	63.6
	Liocarcinus holsatus	274.15	31.55	100.0
	Macropodia parva	0.05	0.18	12.1
	Necora puber	1.07	0.03	3.0
	Pagurus bernhardus	49.48	8.36	97.0
	Pisidia longicornis	0.01	0.18	6.1
	Processa nouveli holthuisi	0.32	1.12	33.3
	Upogebia deltaura	1.91	0.85	24.2
Polychaeta	*Aphrodita aculeata*	27.65	1.06	45.5
	Eunereis longissima	0.10	0.09	9.1
	Nephtys assimilis	0.02	0.03	3.0
	Nephtys caeca	0.47	0.24	12.1
	Nephtys cirrosa	0.04	0.15	12.1
	Nephtys hombergii	0.62	1.06	36.4
	Owenia fusiformis	0.10	0.39	24.2
	Pectinaria auricoma	0.00	0.03	3.0
	Pectinaria koreni	0.10	0.36	24.2
	Phyllodoce groenlandica	0.00	0.03	3.0
	Sabellaria spinulosa	0.39	11.36	15.2
	Terebellides stroemi	0.02	0.06	6.1
Sipunculida	Golfingiidae	0.12	0.06	6.1

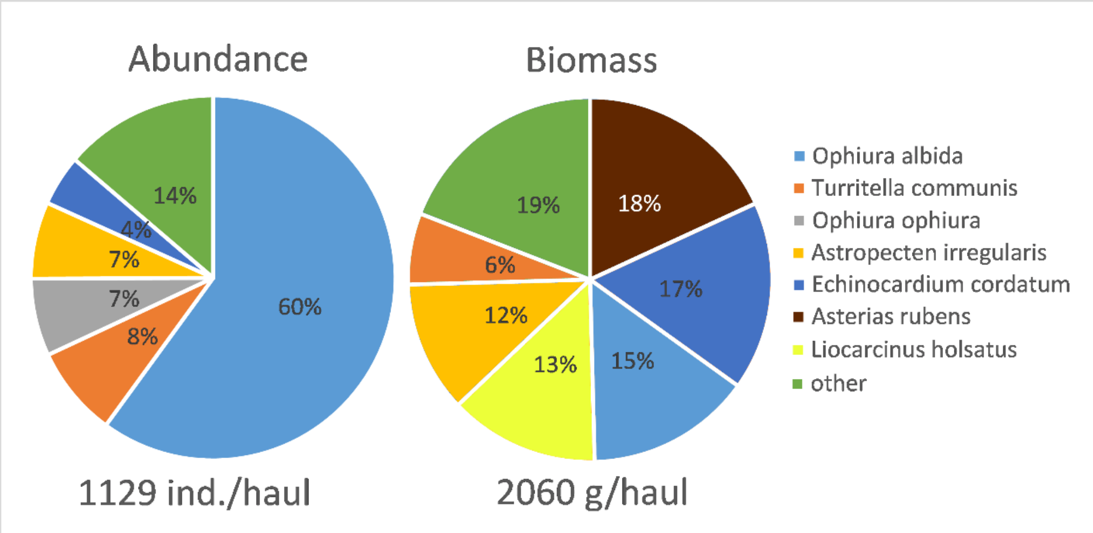

Figure 3-8: Dominant species according to abundance and biomass over all epifauna hauls

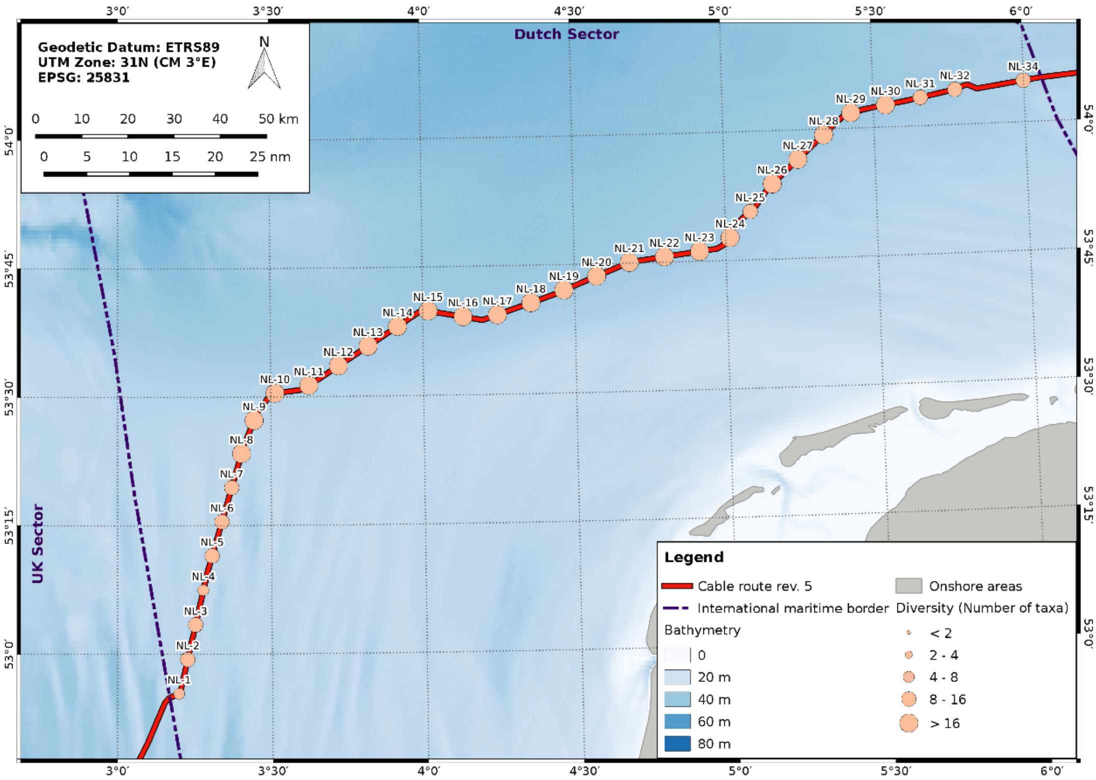

Figure 3-9: Epifauna number of taxa at the stations

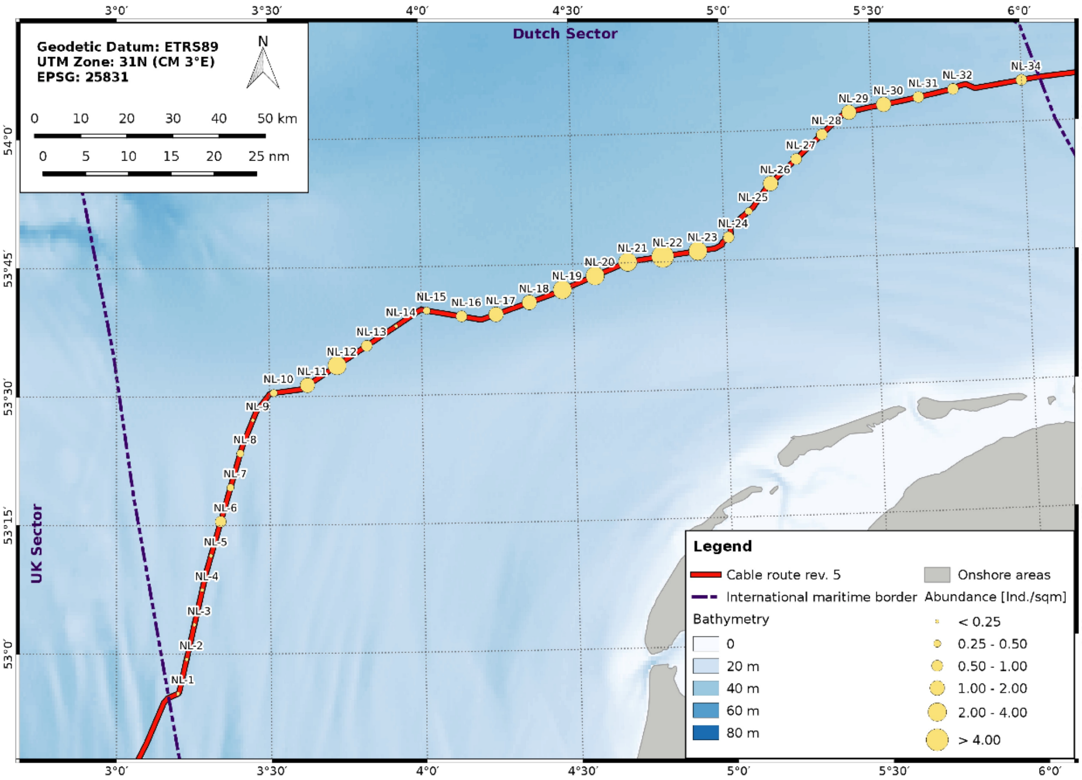

Figure 3-10: Epifauna Abundance at the stations recalculated to Ind./sqm

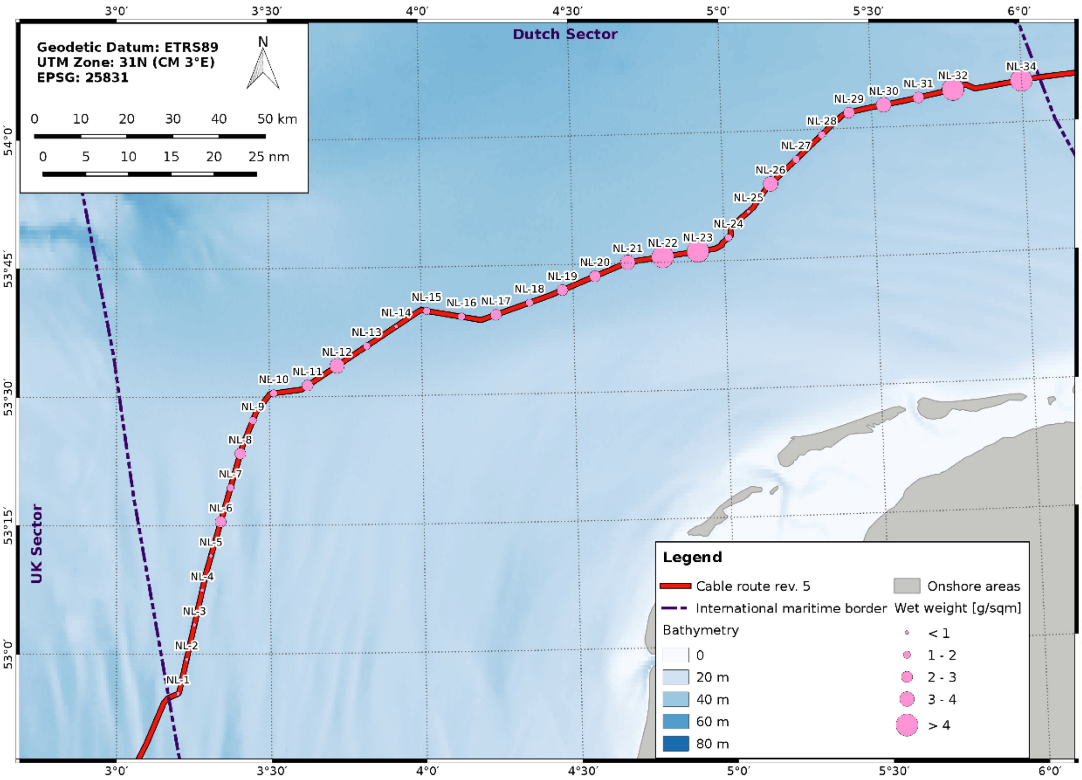

Figure 3-11: Epifauna Biomass (wet weight) at the stations recalculated to g/sqm

3.2.2 Analysis of the epifauna communities

The composition of the epifauna community differs along the cable route. Two main groups were identified in the cluster analysis (Figure 3-12) and in the following MDS plot (Figure 3-13), each with a similarity of more than 50 % within the group. The differences of the groups are significant (ANOSIM-test: R-value 0.746, significance level 0.1%).

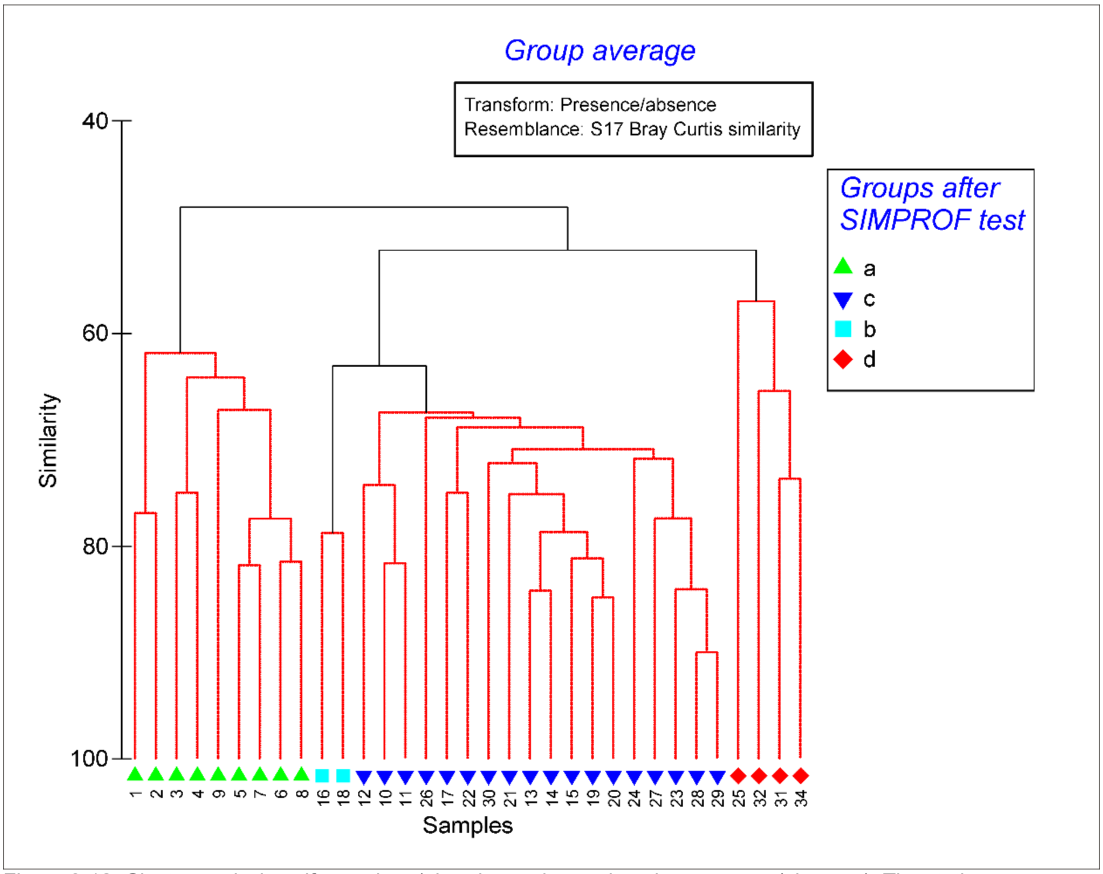

Figure 3-12: Cluster analysis epifauna data (abundance data reduced to presence/absence). The stations are shown as numbers (eg. NC_NL_1 is shown as 1)

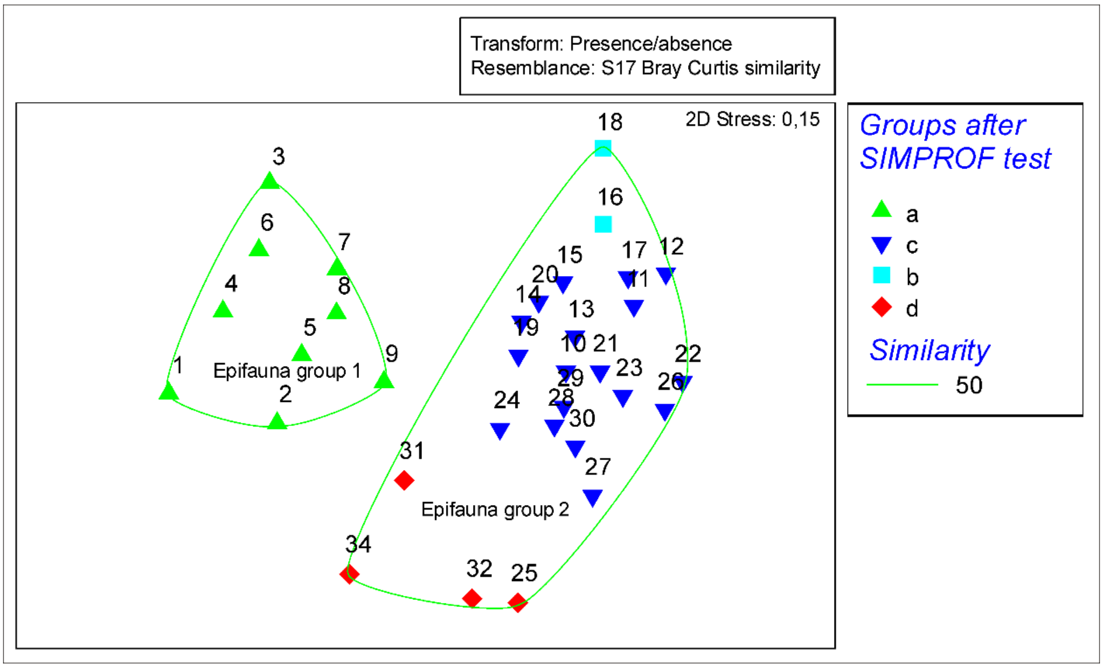

Figure 3-13: MDS plot epifauna (abundance data reduced to presence/absence) with the assignment of the two found epifauna groups. The stations are shown as numbers (eg. station NC_NL_1 is shown as 1)

A SIMPER analysis identified the species that contributed mainly to the statistical separation of the two epifauna groups (Table 3-4, Table 3-5). Six of the eight species contributing mainly to the similarity in the group 1 contribute also mainly to the similarity in the group 2 (see Table 3-4). The differences mainly result from the lower number of species in the epifauna group 1 and the lower presence of the species along the stations in group 1 (see Table 3-5). In group 1, eight species mainly describe the similarity of the group, whereas sixteen species in group 2 are responsible for the similarity.

Table 3-4: Main contributing species to the similarity within the two found epifauna groups

Epifauna group	Total/mean number of species in the group	Contribution (%) of the species to the similarity within the groups (SIMPER test)	
'**Epifauna group 1**' with an average similarity of 68.62 % (SIMPER); Stations NC_NL_1, _2; _3, _4; _5, _6, _7, _8, _9;	21/13	*Liocarcinus holsatus*	16.05
		Pagurus bernhardus	16.05
		Ophiura albida	16.05
		Ophiura ophiura	16.05
		Crangon allmanni	11.62
		Crangon crangon	8.83
		Sepiola atlantica	3.99
		Corystes cassivelaunus	3.92
	51/21	*Crangon allmanni*	8.86
		Liocarcinus holsatus	8.86

Epifauna group	Total/mean number of species in the group	Contribution (%) of the species to the similarity within the groups (SIMPER test)	
'Epifauna group 2' with an average similarity of 67.77 % (SIMPER); Stations NC_NL_10, _11; _12, _13; _14, _15, _16, _17, _18, _19; _20, _21, _22, _23, _24, _25, _26, _27, _28, _29, _30, _31; _32, _34;		*Astropecten irregularis*	8.03
		Pagurus bernhardus	8.01
		Ophiura ophiura	7.08
		Asterias rubens	6.69
		Crangon crangon	6.65
		Echinocardium cordatum	6.5
		Ophiura albida	6.29
		Liocarcinus depurator	5.1
		Chamelea striatula	4.99
		Goneplax rhomboides	3.53
		Phaxas pellucidus	3.13
		Aphrodita aculeata	3.05
		Corystes cassivelaunus	2.85
		Turritella communis	2.09

Table 3-5: Main contributing species to the dissimilarity between the two found epifauna groups

Species	Contribution (%) of the species to the dissimilarity between the groups (SIMPER test)	Presence (%) of the main contributing species to the dissimilarity between the Epifauna groups (SIMPER test)	
		Epifauna group 1	Epifauna group 2
Astropecten irregularis	7.72	-	96
Chamelea striatula	6.01	-	79
Liocarcinus depurator	5.21	22	79
Asterias rubens	5.2	33	88
Goneplax rhomboides	5.08	-	67
Phaxas pellucidus	4.81	-	63
Aphrodita aculeata	4.73	-	63
Sepiola atlantica	4.2	56	25
Corystes cassivelaunus	4.01	56	58
Turritella communis	4	-	50
Echinocardium cordatum	3.97	56	88
Balanus crenatus	3.78	22	50
Processa nouveli holthuisi	3.43	-	46
Trachythyone elongata	2.66	-	33
Upogebia deltaura	2.52	-	33
Crangon crangon	2.49	78	88

Species	**Contribution (%) of the species to the dissimilarity between the groups (SIMPER test)**	**Presence (%) of the main contributing species to the dissimilarity between the Epifauna groups (SIMPER test)**	
		Epifauna group 1	**Epifauna group 2**
Psammechinus miliaris	2.4	33	-
Spisula subtruncata	2.4	-	33
Euspira catena	2.1	22	8
Nassarius reticulatus	2.03	22	13
Gari fervensis	1.76	-	21
Loligo subulata	1.6	-	21
Pisidia longicornis	1.59	22	-
Macropodia parva	1.56	11	13
Amphiura filiformis	1.53	-	21
Ebalia cranchii	1.46	11	8
Mysia undata	1.45	-	21
Cancer pagurus	1.45	-	17

The list of epibenthic species comprises 21 taxa in the ‘Epifauna group 1’ und 51 taxa in the ‘Epifauna group 2’. The mean number of individuals in the haul in the ‘Epifauna group 1’ was 256 (Figure 3-14). Overall, six species dominate the samples in the ‘Epifauna group 1’ according to abundance and continuity. These are *Crangon allmanni* (66 ind./haul; 89% presence), *Liocarcinus holsatus* (64 ind./haul; 100% presence), *Sabellaria spinulosa* (42 ind./haul; 56% presence), *Ophiura ophiura* (30 ind./haul; 100% presence), *Echinocardium cordatum* (19 ind./haul; 56% presence) and *Ophiura albida* (16 ind./haul; 100% presence) (Figure 3-14).
The average biomass (wet weight) in the hauls of the ‘Epifauna group 1’ was 972 g. The biomass was dominated by *Liocarcinus holsatus* (555 g/haul), *Echinocardium cordatum* (250 g/haul), *Ophiura ophiura* (40 g/haul), *Crangon allmanni* (39 g/haul) and *Pagurus bernhardus* (33 g/haul) (Figure 3-14).

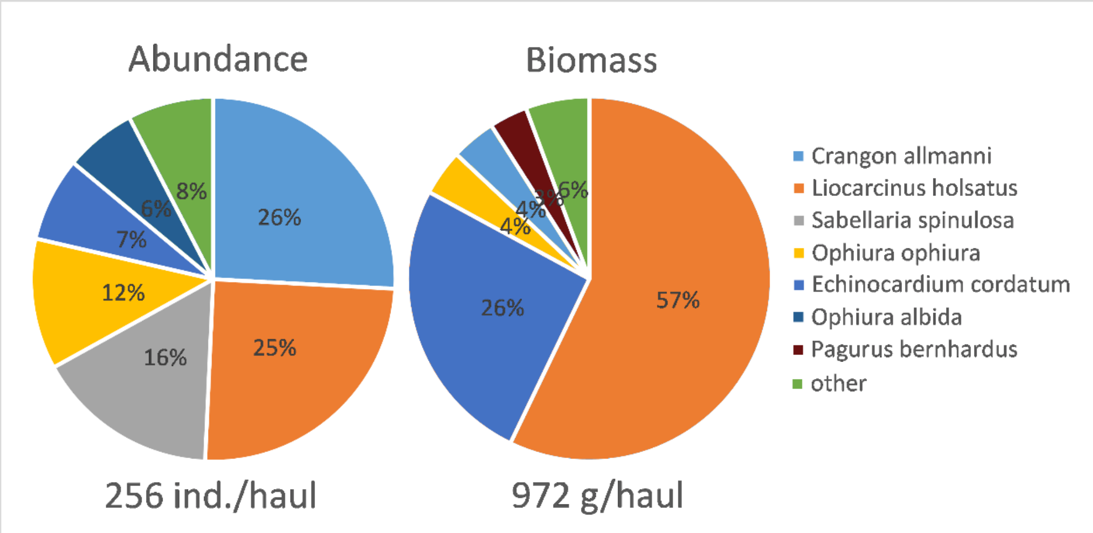

Figure 3-14: Dominant species according to abundance and biomass over all hauls of the 'Epifauna group 1'

The mean number of individuals in the hauls of the 'Epifauna group 2' was 1457 (Figure 3-15). Overall, five species dominate the epibenthos samples according to abundance and continuity. These are *Ophiura albida* (925 ind./haul; 88% presence), *Turritella communis* (124 ind./haul; 50% presence), *Ophiura ophiura* (95 ind./haul; 92% presence), *Astropecten irregularis* (106 ind./haul; 96% presence) and *Echinocardium cordatum* (63 ind./haul; 88% presence) (Figure 3-15).

The average biomass (wet weight) in the hauls of the 'Epifauna group 2' was 2468 g. The biomass was dominated by *Asterias rubens* (510 g/haul), *Ophiura albida* (413 g/hol), *Echinocardium cordatum* (382 g/haul), *Astropecten irregularis* (330 g/haul), *Turritella communis* (179 g/haul) and *Liocarcinus holsatus* (169 g/haul) (Figure 3-15).

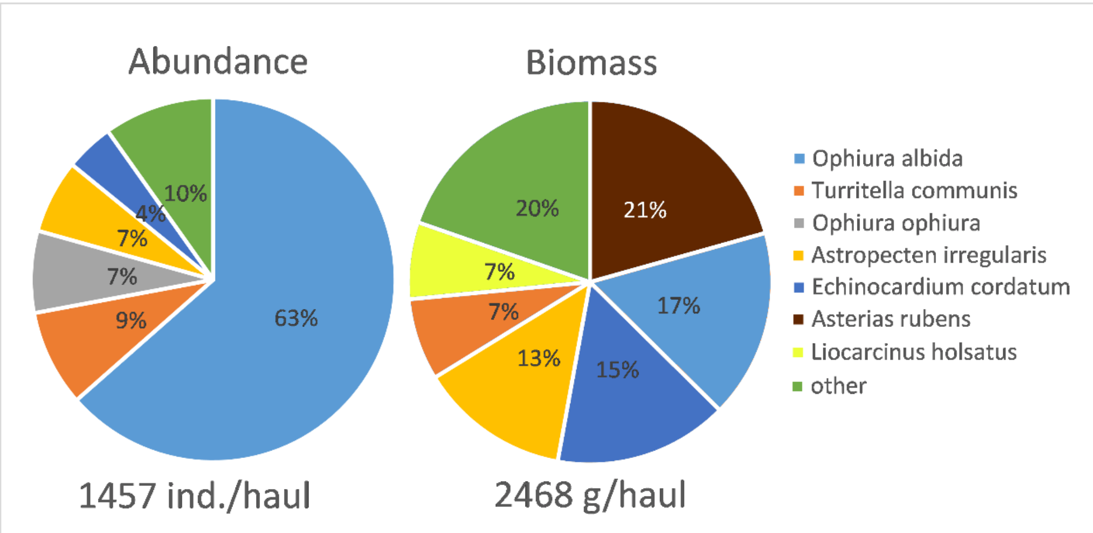

Figure 3-15: Dominant species according to abundance and biomass over all hauls of the 'Epifauna group 2'

The evaluation of the underwater videos from autumn 2018 did not provide any additional information on the epifauna.

3.3 Infauna

3.3.1 Characterisation of the infauna settlement in the project area

A total of 118 species and indefinite superior taxa were found in the samples of the infauna stations (Table 3-6). The group with the highest species diversity were the bristle worms (Polychaeta) with 45 species (Figure 3-16). Of the crustaceans (Mysidacea, Cumacea, Amphipoda and Decapoda), 27 species were found and of the molluscs (Bivalvia and Gastropoda), 23 species were found during the investigations in autumn 2018. Eight species of echinoderms (Echinodermata) and five species of hydrozoans (Hydrozoa) were present in the samples. The remaining taxa were Bryozoa (4 taxa), Sipunculida (2 taxa) and Chordata, Nemertina, Phoronida and Turbellaria with 1 taxon each. The average number of species in samples was 25 with lowest values at station NC_NL_1 (11 species) and highest values at station NC_NL_23 (38 species) (see Figure 3-18).

Of 28 species, individuals were only found at one station, and further 22 species could be detected at only two stations. This implies that sporadic species account for more than one third of the total species inventory. Only 15 of the identified taxa, on the other hand, have a presence of more than 50 % in the data sets. With the mussel species *Abra nitida*, *Nucula nitidosa* and the polychaete *Lumbrineris gracilis* only three species were found at 80% of the stations. There are no species that were found at more than 80% of the stations.

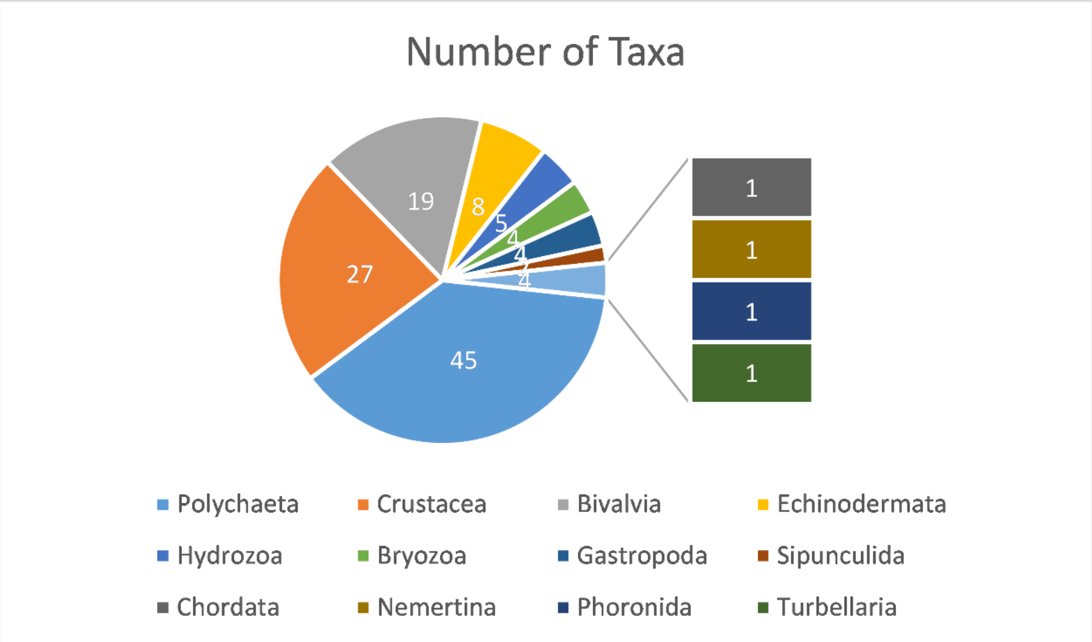

Figure 3-16: Number of taxa in the infauna samples

The mean number of individuals in the samples was 1257 Ind./sqm (Figure 3-17) and ranges from 280 Ind./sqm at station NC_NL_1 to 2660 Ind./sqm at station NC_NL_23 (Figure 3-19). Overall, five species dominate the infauna samples according to their abundance. These are *Amphiura filiformis* (245 ind./sqm; 69.7 % presence), *Lumbrineris gracilis* (134 ind./sqm; 78.8 % presence), *Corbula gibba* (85 ind./sqm; 69.7 % presence), *Scalibregma inflatum* (72

ind./sqm; 54.5 % presence) and *Spiophanes bombyx* (65 ind./sqm; 79.7 % presence), (Table 3-6, Figure 3-17).
The average biomass (wet weight) in the samples was 117 g/sqm and ranges from 3.06 g/sqm at station NC_NL_6 to 496 g/sqm at station NC_NL_9 (Figure 3-20). The high wet weight biomass at station NC_NL_9 results from the wet weight of the bivalve *Acanthocardia echinata*. This species was found at this station only. Without this species, the biomass over all stations was dominated by *Echinocardium cordatum* (57 g/sqm), *Amphiura filiformis* (10.7 g/sqm) and *Upogebia deltaura* (7.2 g/sqm) (Table 3-6, Figure 3-17).

Table 3-6: Species list infauna samples

Group	Taxon or lowest taxonomic level	Mean wet-weight per sqm in g	Mean number of individuals per sqm	Presence along the stations in %
Bryozoa	*Aspidelectra melolontha*	+	+	3.0
	Bowerbankia gracilis	+	+	15.2
	Conopeum seurati	+	+	3.0
	Electra pilosa	+	+	3.0
Hydrozoa	*Hydractinia echinata*	+	+	18.2
	Opercularella lacerata	+	+	24.2
	Sertularia cupressina	+	+	18.2
	Thecata	+	+	3.0
	Tubulariidae	+	+	3.0
Bivalvia	*Abra alba*	0.16	1.52	6.1
	Abra juv.	0.13	36.67	30.3
	Abra nitida	1.23	37.27	81.8
	Abra prismatica	0.03	2.73	12.1
	Acanthocardia echinata	14.50	0.30	3.0
	Cardiidae juv.	0.00	0.30	3.0
	Chamelea striatula	0.70	0.30	3.0
	Clausinella fasciata	0.09	4.24	27.3
	Cochlodesma praetenue	1.01	1.52	6.1
	Corbula gibba	0.95	84.55	69.7
	Gari fervensis	0.001	0.30	3.0
	Mactra stultorum	2.38	0.30	3.0
	Mysella bidentata	0.09	51.82	63.6
	Mysia undata	0.01	2.42	15.2
	Nucula nitidosa	1.25	40.30	78.8
	Phaxas pellucidus	0.27	2.12	12.1
	Spisula juv.	0.00	0.61	6.1
	Spisula subtruncata	0.01	0.91	6.1
	Tellimya ferruginosa	0.07	9.70	48.5
	Tellina fabula	0.91	26.36	27.3

Group	Taxon or lowest taxonomic level	Mean wet-weight per sqm in g	Mean number of individuals per sqm	Presence along the stations in %
	Thracia papyracea	0.21	19.09	24.2
	Thyasira flexuosa	0.04	8.48	33.3
Gastropoda	*Cylichna cylindracea*	0.06	15.45	48.5
	Euspira catena	0.05	2.73	15.2
	Hyala vitrea	0.01	4.24	24.2
	Turritella communis	0.05	1.82	9.1
Echinodermata	*Amphiura filiformis*	10.68	245.45	69.7
	Amphiura juv.	0.51	5.76	45.5
	Astropecten irregularis	1.48	0.91	6.1
	Echinocardium cordatum	56.50	22.12	69.7
	Labidoplax sp.	0.15	0.30	3.0
	Leptosynapta inhaerens	1.90	2.42	21.2
	Ophiura albida	0.34	2.12	12.1
	Ophiura juv.	0.005	2.42	12.1
	Ophiura sarsii	0.04	2.42	15.2
	Trachythyone elongata	2.11	0.91	9.1
Mysidacea	Mysidae	0.004	0.61	6.1
Cumacea	*Diastylis bradyi*	0.002	2.12	21.2
	Eudorella truncatula	0.000	1.52	12.1
	Iphinoe trispinosa	0.001	0.61	6.1
Amphipoda	*Abludomelita obtusata*	0.0001	0.30	3.0
	Ampelisca brevicornis	0.02	2.42	21.2
	Ampelisca tenuicornis	0.002	3.64	30.3
	Atylus swammerdami	0.001	0.91	3.0
	Bathyporeia elegans	0.001	1.52	6.1
	Bathyporeia guilliamsoniana	0.005	2.42	15.2
	Bathyporeia juv.	0.0002	0.61	6.1
	Bathyporeia pelagica	0.001	0.61	6.1
	Leucothoe incisa	0.003	3.64	21.2
	Lysianassidae	0.0001	0.30	3.0
	Perioculodes longimanus	0.0002	0.30	3.0
	Scopelocheirus hopei	0.0004	0.61	6.1
	Siphonoecetes krøyeranus	0.001	0.91	6.1
	Urothoe marina	0.01	3.64	3.0
	Urothoe poseidonis	0.00	1.52	6.1
Decapoda	*Callianassa subterranea*	0.71	19.39	51.5
	Corystes cassivelaunus	0.06	0.30	3.0
	Goneplax rhomboides	1.09	0.30	3.0
	Philocheras bispinosus	0.01	0.30	3.0

Group	Taxon or lowest taxonomic level	Mean wet-weight per sqm in g	Mean number of individuals per sqm	Presence along the stations in %
	Processa modica	0.001	0.30	3.0
	Processa nouveli holthuisi	0.51	4.55	15.2
	Thia scutellata	0.01	0.30	3.0
	Upogebia deltaura	7.19	5.15	30.3
Polychaeta	*Ampharete baltica*	0.01	1.21	12.1
	Aonides paucibranchiata	0.00002	0.30	3.0
	Chaetozone sp.	0.004	2.12	9.1
	Diplocirrus glaucus	0.01	2.12	15.2
	Eumida sanguinea	0.0005	0.61	6.1
	Eunereis longissima	0.53	3.94	24.2
	Glycera alba	0.46	5.45	36.4
	Glycera lapidum	0.001	0.91	6.1
	Glycinde nordmanni	0.01	2.73	15.2
	Goniada maculata	0.06	20.61	69.7
	Harmothoe glabra	0.05	1.52	12.1
	Heteromastus filiformis	0.01	0.61	6.1
	Lanice conchilega	0.01	0.30	3.0
	Lumbrineris gracilis	0.69	133.94	78.8
	Lysilla loveni	0.08	1.21	6.1
	Magelona alleni	0.03	1.21	6.1
	Magelona filiformis	0.00	0.91	6.1
	Magelona johnstoni	0.02	10.91	30.3
	Magelona mirabilis	0.001	0.30	3.0
	Nephtys assimilis	0.08	1.21	9.1
	Nephtys caeca	0.14	4.24	21.2
	Nephtys cirrosa	0.06	0.61	6.1
	Nephtys hombergii	2.33	12.12	54.5
	Nephtys juv.	0.03	7.27	33.3
	Nephtys paradoxa	0.02	0.30	3.0
	Nereididae juv.	0.001	2.12	15.2
	Notomastus latericeus	1.03	13.33	27.3
	Ophelina acuminata	0.01	0.61	6.1
	Ophiodromus flexuosus	0.16	12.73	57.6
	Orbinia armandi	0.15	0.61	6.1
	Owenia fusiformis	0.09	31.82	45.5
	Pectinaria auricoma	0.08	3.94	18.2
	Pectinaria koreni	0.09	1.21	12.1
	Pholoe baltica	0.01	8.48	48.5
	Phyllodoce groenlandica	0.17	1.21	12.1

Group	Taxon or lowest taxonomic level	Mean wet-weight per sqm in g	Mean number of individuals per sqm	Presence along the stations in %
	Phyllodoce rosea	0.00	0.91	9.1
	Podarkeopsis helgolandica	0.02	18.48	60.6
	Poecilochaetus serpens	0.003	3.64	30.3
	Polydora sp.	0.003	1.82	9.1
	Prionospio cirrifera	0.002	2.42	18.2
	Scalibregma inflatum	0.80	71.52	54.5
	Scoloplos armiger	0.03	2.42	15.2
	Sigalion mathildae	0.06	2.73	15.2
	Spio symphyta	0.01	5.45	27.3
	Spiophanes bombyx	0.18	64.85	69.7
	Sthenelais limicola	0.10	2.73	18.2
	Terebellides stroemi	0.01	0.30	3.0
Nemertina	Nemertini	0.69	22.42	63.6
Phoronida	Phoronida	0.35	53.03	48.5
Sipunculida	Golfingiidae	0.33	9.39	36.4
	Sipunculidae	0.02	0.61	3.0
Turbellaria	Turbellaria	0.06	1.52	12.1
Chordata	*Branchiostoma lanceolatum*	0.08	0.91	3.0

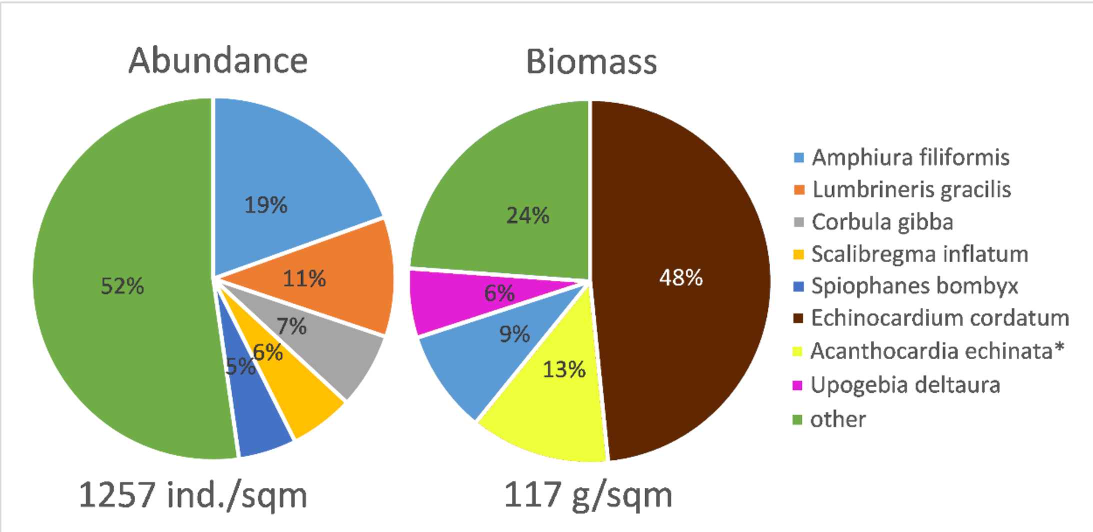

Figure 3-17: Dominant species according to abundance and biomass over all infauna samples.*this species was found only at station NC_NL_9

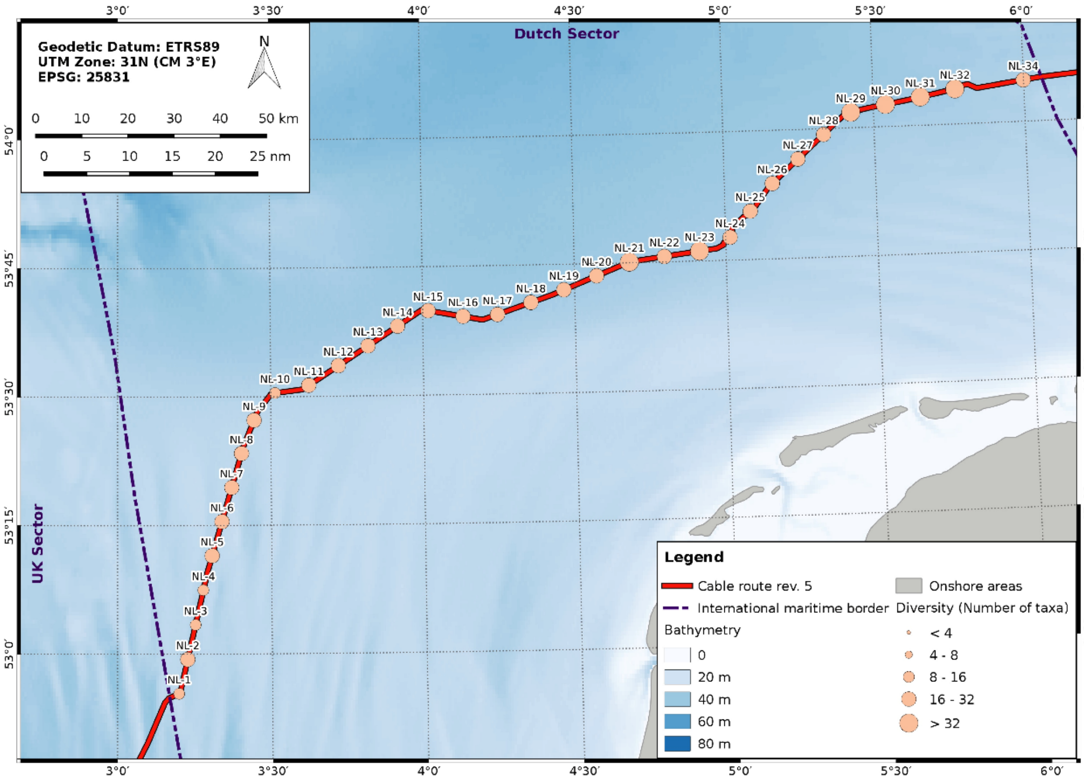

Figure 3-18: Infauna number of taxa at the stations

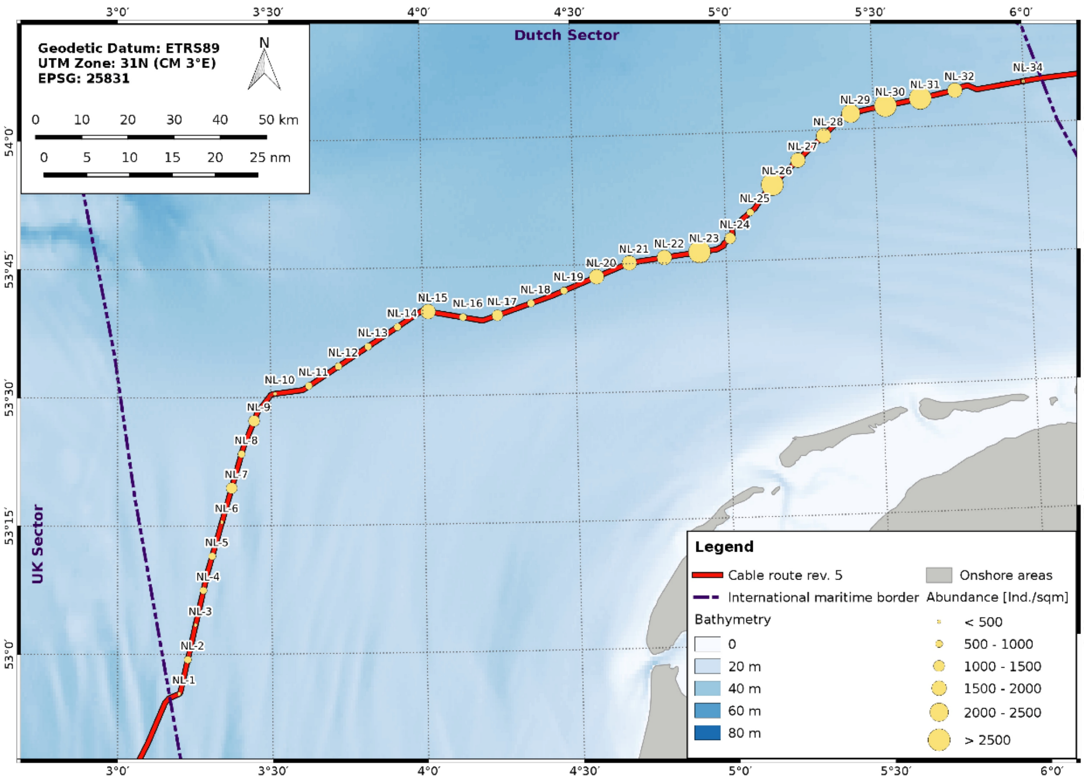

Figure 3-19: Infauna abundance at the stations

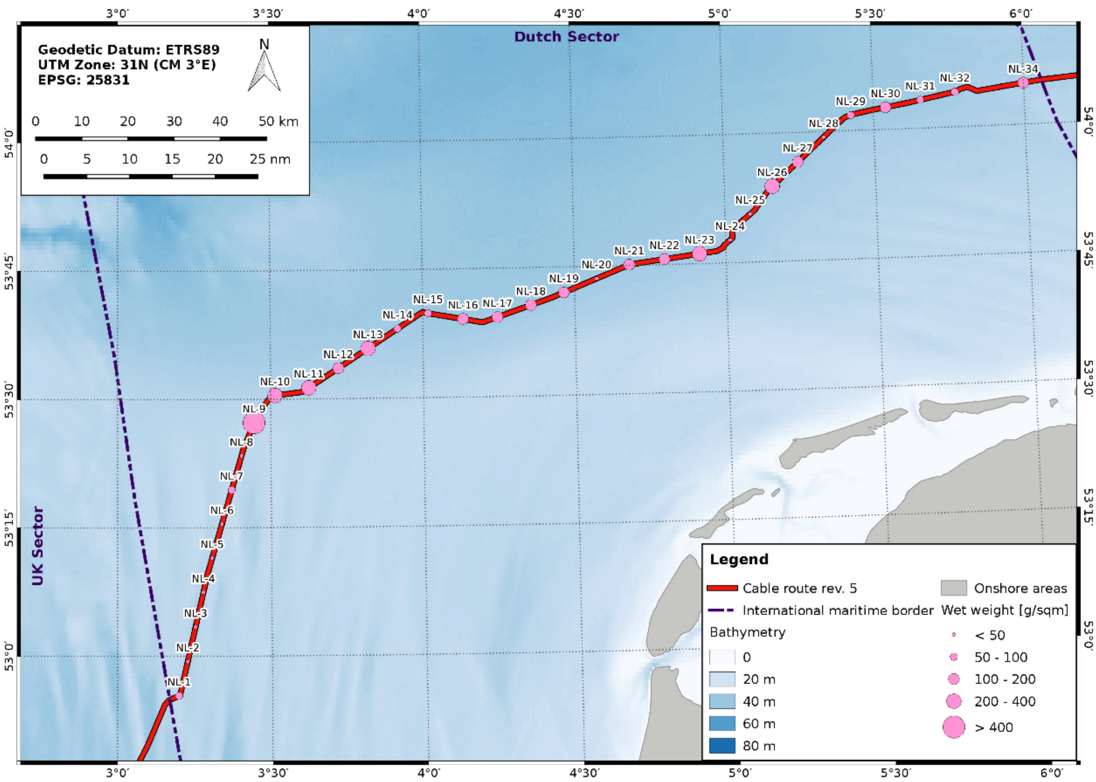

Figure 3-20: Infauna biomass (wet weight) at the stations

Figure 3-21 plots Pielou's Evenness score against the Shannon-Wiener diversity. Pielou's evenness and diversity were generally high, with a range of dominance as illustrated by the relationships between evenness and Shannon-Wiener diversity. Excluding the stations NC_NL_1 and NC_NL_2, the overall diversity was with values of three to four good at all stations.

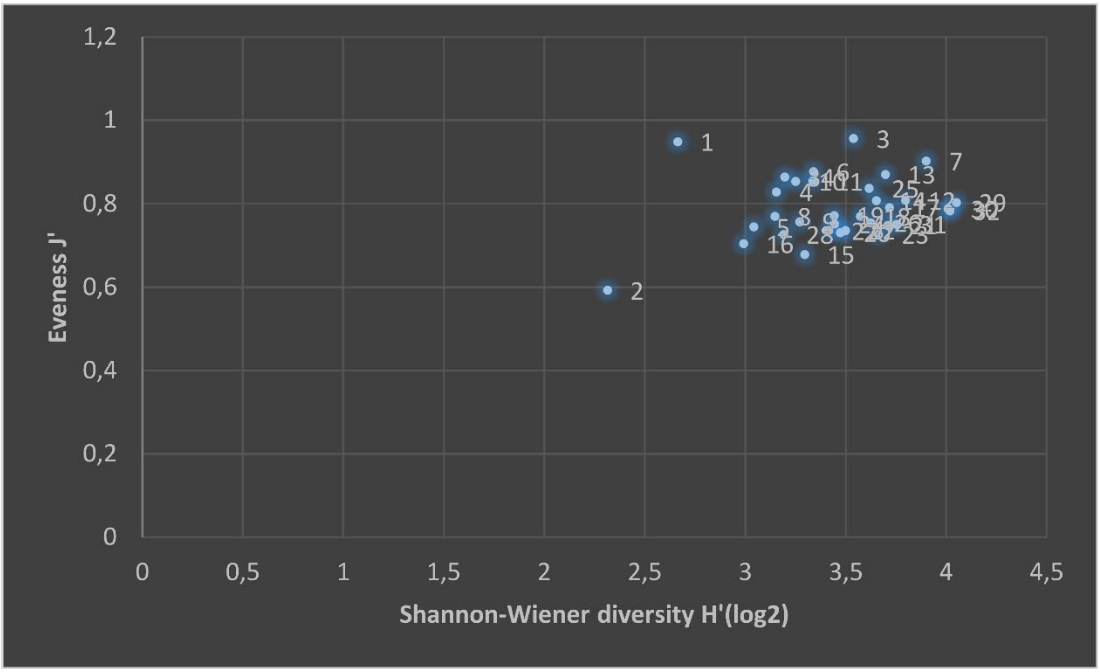

Figure 3-21: Evenness J' plotted against the Shannon-Wiener diversity H'(log2) within the Netherlands EEZ infauna samples. The stations are shown as numbers (eg. NC_NL_1 is shown as 1).

3.3.2 Analysis of the infauna communities

From the results of the sediment analyses, two groups with a relatively high homogeneity of the substrate in the area can be deduced. The first group is characterised by fine to slightly medium sands with less silt content and the second group is characterised by fine sand with higher silt content. Accordingly, a relatively uniform settlement distinguished into two main groups could be expected, which was largely already confirmed by the epifauna results.
The results of the community analysis also confirm this impression. In the dendrogram of a cluster analysis, the data set is divided into two distinct groups (Figure 3-22). Each group has an average similarity of more than 40 % within the group (SIMPER-test). The differences of the groups are significant (ANOSIM-test: R-value 0.971, significance level 0.1%).

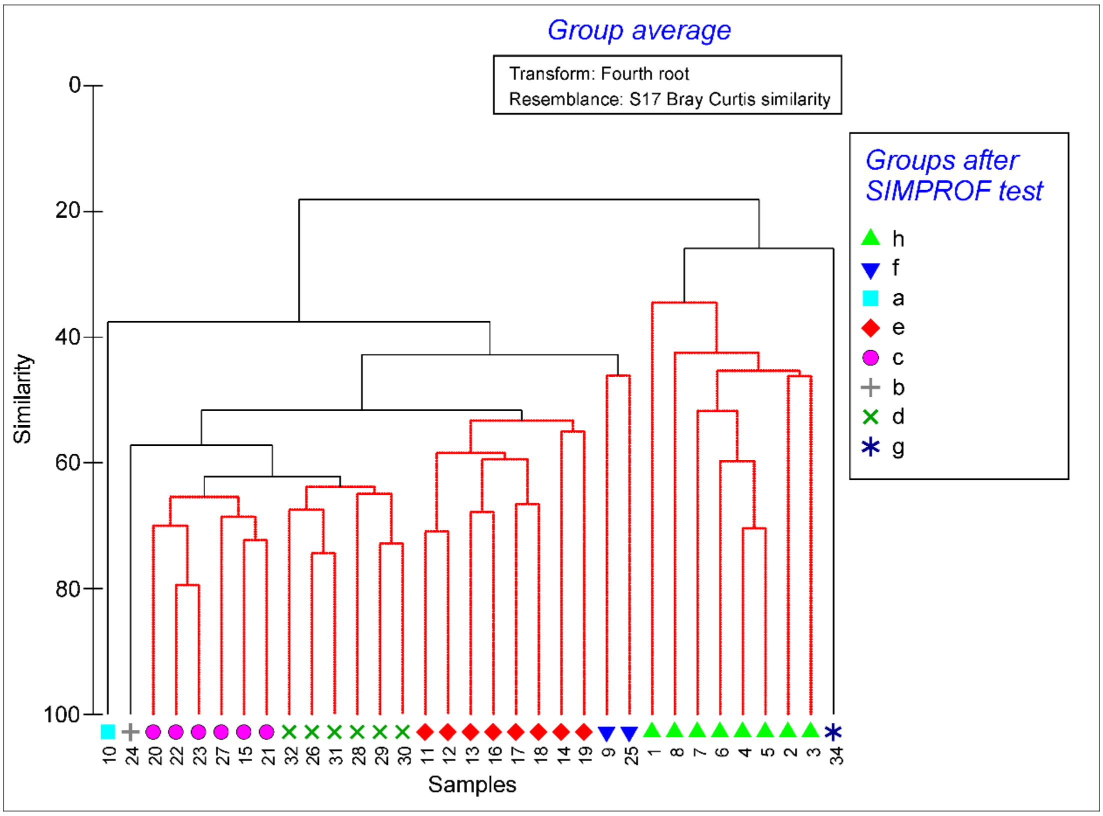

Figure 3-22: Cluster analysis infauna data (square root transformed abundance data). The stations are shown as numbers (eg. NC_NL_1 is shown as 1).

Accordingly, the two-dimensional image of a non-metric multidimensional scaling (nMDS) confirmed the separation of the two groups (Figure 3-23).

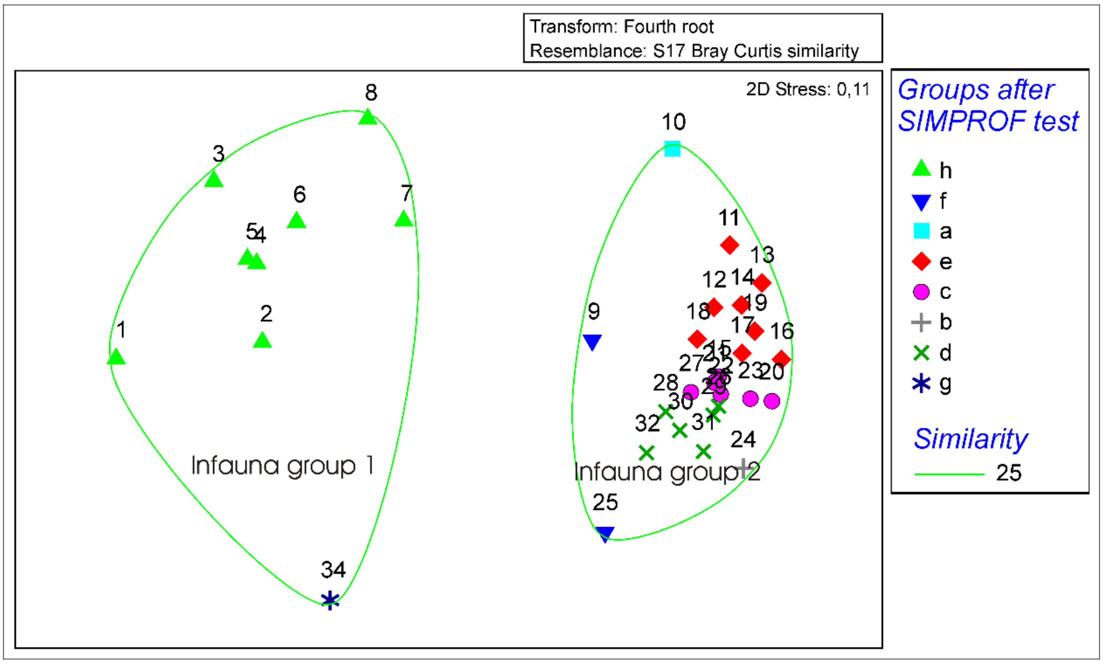

Figure 3-23: MDS plot infauna (square root transformed abundance data) with the assignment of the two found infauna groups (green line). The stations are shown as numbers (eg. station NC_NL_1 is shown as 1)

A SIMPER analysis identified the species that contributed mainly to the statistical separation of the two infauna groups (Table 3-4, Table 3-5). Four species (*Tellina fabula*, *Magelona johnstoni*, *Spiophanes bombyx* and *Abra nitida*) contributed mainly to the similarity in the 'Infauna group 1'. In the 'Infauna group 2' the species *Lumbrineris gracilis*, *Amphiura filiformis*, *Corbula gibba* and *Nucula nitidosa* contributed mainly to the similarity (see Table 3-7). The differences between the groups mainly resulted from the lower number of species at the stations of the 'Infauna group 1' (see Table 3-8).

Table 3-7: Main contributing species to the similarity within the two found infauna groups

Infauna group	**Total/mean number of species in the group**	**Contribution (%) of the species to the similarity within the groups (SIMPER test)**	
'**Infauna group 1**' with an average similarity of 40.43 % (SIMPER); Stations NC_NL_1, _2; _3, _4; _5, _6, _7, _8, _34;	71/19	*Tellina fabula*	13.9
		Magelona johnstoni	13.45
		Spiophanes bombyx	12.39
		Abra nitida	11.13
		Spio symphyta	8.18
		Nephtys caeca	7.62
		Echinocardium cordatum	4.78
		Bathyporeia guilliamsoniana	4.54
		Euspira catena	4.1
		Goniada maculata	3.83

Infauna group	Total/mean number of species in the group	Contribution (%) of the species to the similarity within the groups (SIMPER test)	
		Sigalion mathildae	2.17
		Sthenelais limicola	2.17
		Ophiura sarsii	2.07
'Infauna group 2' with an average similarity of 52.88 % (SIMPER); Stations NC_NL_9, _10, _11; _12, _13; _14, _15, _16, _17, _18, _19; _20, _21, _22, _23, _24, _25, _26, _27, _28, _29, _30, _31; _32;	99/28	*Lumbrineris gracilis*	11.65
		Amphiura filiformis	10.64
		Corbula gibba	7.73
		Nucula nitidosa	7
		Mysella bidentata	5.16
		Podarkeopsis helgolandica	5.01
		Abra nitida	4.72
		Ophiodromus flexuosus	4.3
		Echinocardium cordatum	4.14
		Scalibregma inflatum	3.95
		Goniada maculata	3.81
		Callianassa subterranea	3.49
		Nephtys hombergii	3.18
		Spiophanes bombyx	2.93
		Tellimya ferruginosa	2.81
		Cylichna cylindracea	2.7
		Pholoe baltica	2.23
		Owenia fusiformis	2.15
		Thyasira flexuosa	1.54
		Ampelisca tenuicornis	1.08

Table 3-8: Main contributing species to the dissimilarity between the two found infauna groups

Species	Contribution (%) of the species to the dissimilarity between the groups (SIMPER test)	Average abundance (ind./sqm square root transformed values) of the species (SIMPER test)	
		Infauna group 1	Infauna group 2
Amphiura filiformis	5.5	-	3.83
Lumbrineris gracilis	4.64	0.48	3.55
Corbula gibba	3.75	0.33	2.87
Tellina fabula	3.6	2.52	0.07
Magelona johnstoni	3.03	2.17	0.15
Mysella bidentata	2.96	0.23	2.25
Scalibregma inflatum	2.87	0.32	2.15

Species	Contribution (%) of the species to the dissimilarity between the groups (SIMPER test)	Average abundance (ind./sqm square root transformed values) of the species (SIMPER test)	
		Infauna group 1	Infauna group 2
Nucula nitidosa	2.87	0.97	2.31
Podarkeopsis helgolandica	2.77	-	1.89
Ophiodromus flexuosus	2.47	-	1.67
Callianassa subterranea	2.36	-	1.7
Spiophanes bombyx	2.26	2.14	1.79
Spio symphyta	2.21	1.61	0.16
Nephtys caeca	2.16	1.4	0.07
Abra nitida	2.12	2.35	1.77
Nephtys hombergii	2.03	0.2	1.5
Cylichna cylindracea	2.02	-	1.51
Tellimya ferruginosa	2.01	-	1.33
Owenia fusiformis	1.96	0.2	1.48
Echinocardium cordatum	1.86	1.19	1.73
Goniada maculata	1.84	1.24	1.7
Pholoe baltica	1.67	0.2	1.25
Bathyporeia guilliamsoniana	1.66	1.07	-
Euspira catena	1.65	1.13	-
Thyasira flexuosa	1.58	-	0.94
Glycera alba	1.36	0.67	0.71
Sthenelais limicola	1.3	0.89	0.15
Notomastus latericeus	1.3	0.28	0.8
Sigalion mathildae	1.29	0.92	0.07
Ophiura sarsii	1.21	0.83	0.1
Clausinella fasciata	1.19	0.46	0.56
Ampelisca tenuicornis	1.17	-	0.77
Scoloplos armiger	1.16	0.67	0.15
Upogebia deltaura	1.15	-	0.83
Thracia papyracea	1.12	-	0.88
Abra prismatica	1.11	0.74	0.07
Poecilochaetus serpens	1.07	0.2	0.69
Chaetozone sp.	1	0.71	-
Hyala vitrea	0.94	-	0.66
Leucothoe incisa	0.94	0.46	0.41
Eunereis longissima	0.89	-	0.66
Ophiura albida	0.85	0.5	0.15
Ampelisca brevicornis	0.82	0.2	0.46

Species	**Contribution (%) of the species to the dissimilarity between the groups (SIMPER test)**	**Average abundance (ind./sqm square root transformed values) of the species (SIMPER test)**	
		Infauna group 1	**Infauna group 2**
Diastylis bradyi	0.77	-	0.52
Leptosynapta inhaerens	0.75	-	0.53
Processa nouveli holthuisi	0.72	-	0.48
Urothoe poseidonis	0.68	0.48	-
Pectinaria auricoma	0.67	-	0.52
Glycera lapidum	0.65	0.43	-
Siphonoecetes krøyeranus	0.65	0.43	-
Glycinde nordmanni	0.64	0.2	0.35
Prionospio cirrifera	0.63	-	0.47
Iphinoe trispinosa	0.61	0.4	-

Furthermore, it was tested whether the groupings are related to the abiotic parameters, which are also characteristic for the found biotopes. A correlation test between the biotic and abiotic data sets with the routine BioENV was strongly positive (Rho = 0.715, α = 0.01) for the two variables ‘median grain size’ and ‘water depth’ together and for the three variables ‘median grain size’ ‘silt content’ and ‘water depth’ together (Rho = 0.668, α = 0.01). The strongest correlation for single variables was for ‘water depth’ (Rho = 0.653, α = 0.01) and for ‘median grain size’ (Rho = 0.549, α = 0.01). Figure 3-24 shows the MDS-plot of the similarities between the stations overlaid with the variable ‘silt content’. In the figure it is clearly visible that the ‘Infauna group 1” (left side) excluding the station NC_NL_8, contains the stations with low silt content in the sediment and the ‘Infauna group 2’ (right side) contains the stations with high silt content.

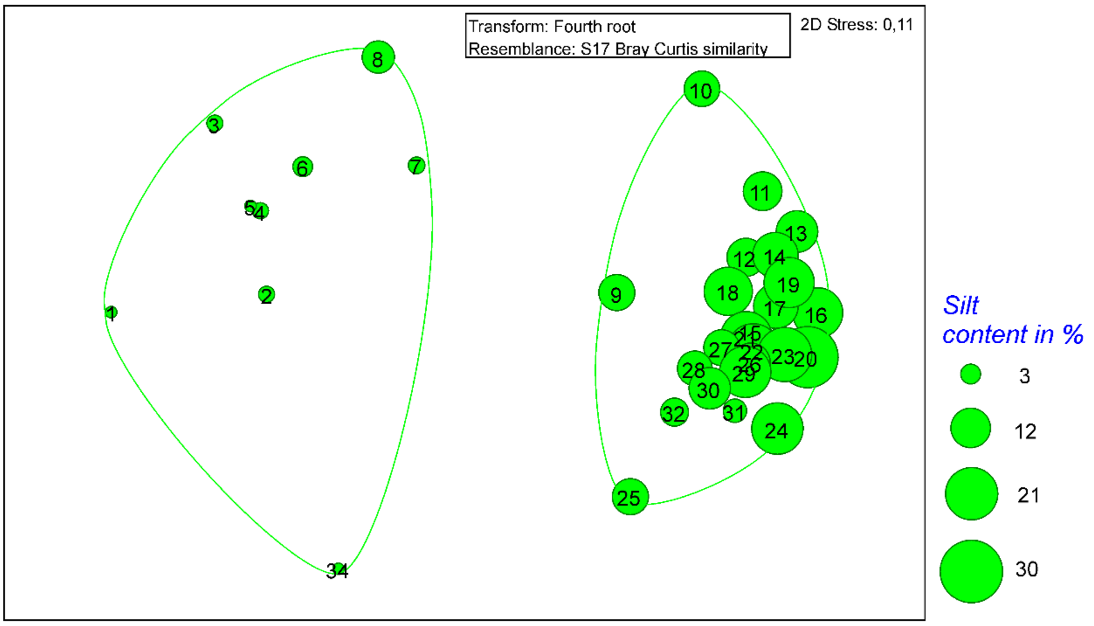

Figure 3-24: MDS plot infauna (square root transformed abundance data) with the assignment of the two found infauna groups (green line) and overplayed with the silt content of the sediment samples. The stations are shown as numbers (eg. station NC_NL_1 is shown as 1)

The list of benthic species comprises 71 taxa in the 'Infauna group 1' und 99 taxa in the 'infauna group 2'. The mean number of individuals in the samples in the 'Infauna group 1' was 671 (Figure 3-25). Overall, five species dominate the infauna samples of the 'infauna group 1' according to abundance and continuity. These are *Abra nitida* and juveniles (197 ind./sqm; 78% presence), *Tellina fabula* (96 ind./sqm; 89% presence), *Spiophanes bombyx* (41 ind./sqm; 89% presence), *Magelona johnstoni* (38 ind./sqm; 89% presence), and *Nucula nitidosa* (36 ind./sqm; 33% presence) (Figure 3-25).
The average biomass (wet weight) in the samples of the 'Infauna group 1' was 47 g. The biomass was dominated by *Echinocardium cordatum* (24 g/sqm), *Mactra stultorum* (9 g/sqm), *Nucula nitidosa* (4 g/sqm), *Tellina fabula* (3.3 g/sqm) and *Abra nitida* (2.2 g/sqm) (Figure 3-25).

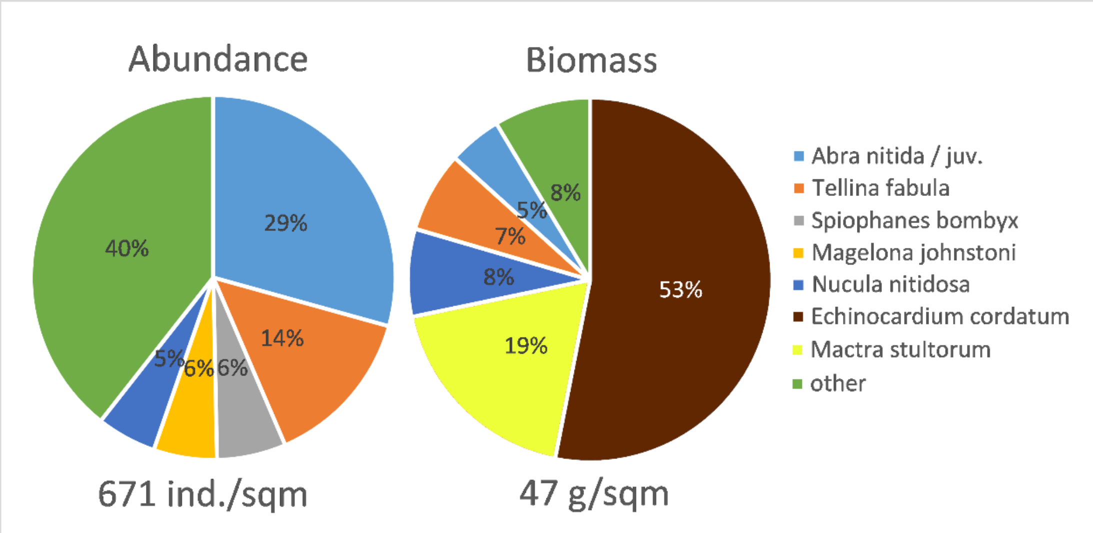

Figure 3-25: Dominant species according to abundance and biomass over all samples of the infauna group 1

The mean number of individuals per sqm in the samples in the 'Infauna group 2' was 1478 (Figure 3-26). Overall, four species dominate the infauna samples according to abundance and continuity. These are *Amphiura filiformis* (338 ind./sqm; 96% presence), *Lumbrineris gracilis* (182 ind./sqm; 100% presence), *Corbula gibba* (113 ind./sqm; 92% presence) and *Scalibregma inflatum* (95 ind./sqm; 71% presence) (Figure 3-26).
The average biomass (wet weight) per sqm in the samples of the 'Infauna group 2' was 143 g. The biomass was dominated by *Echinocardium cordatum* (68 g/sqm), *Amphiura filiformis* (15 g/sqm) and *Upogebia deltaura* (10 g/sqm) (Figure 3-26).

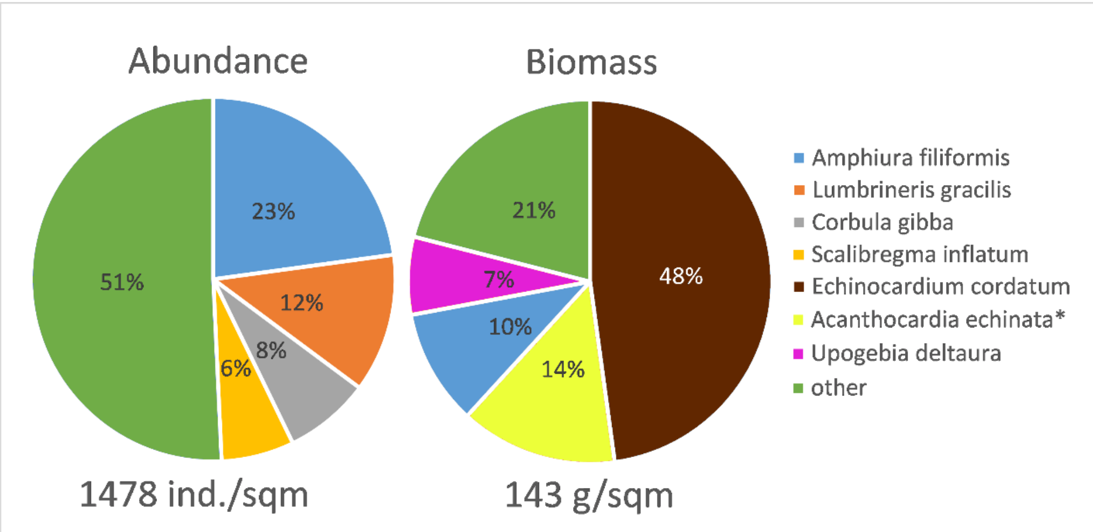

Figure 3-26: Dominant species according to abundance and biomass over all samples of the infauna group 2. *this species was found only at station NC_NL_9

Figure 3-27 plots Evenness score against the Shannon-Wiener diversity for the 2 infauna groups. Except two stations from the 'Infauna group one (stations 1 and 2) there are no differences between the groups.

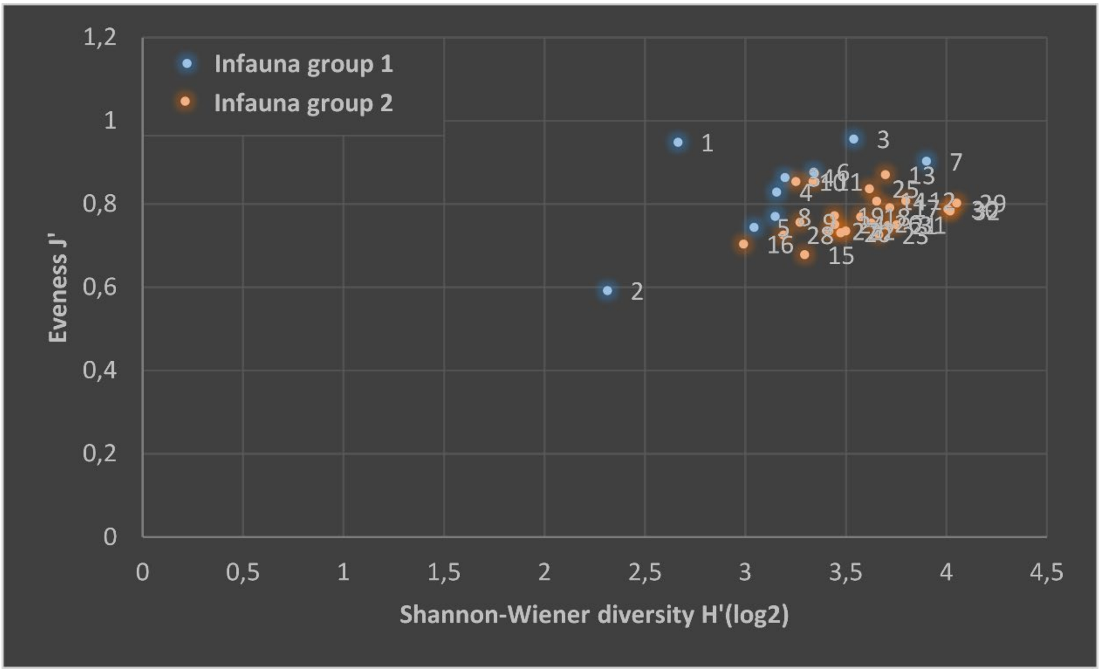

Figure 3-27: Evenness J' plotted against the Shannon-Wiener diversity H'(log2) within the Netherlands EEZ infauna samples for the two infauna groups. The stations are shown as numbers (eg. NC_NL_1 is shown as 1).

Also with regard to diversity (H' according to Shannon-Wiener) and evenness (equinity, J') there are no significant differences between the two infauna groups (each $\alpha>0.05$ in the t-test). The diversity index according to Shannon-Wiener (H') is slightly higher in the 'Infauna group 2' with an average of 3.56 compared to the 'Infauna group 1 (Figure 3-27 above), but this difference is not significant. The high values of the evenness (on average 0.83 in the 'Infauna group 1' and 0.77 in the 'Infauna group 2') indicate a relatively equal distribution of the abundance of the individual species.

3.4 Video Observations

Video observations were performed at every station. Underwater visibility was good at the majority of the video transects. At some stations, the visibility was bad because of high turbidity. The majority of the seabed consisted of silty/muddy sand with shell fragments and burrows. Less silty sand was observed along transects NC_NL_1 to 8 and NC_NL_34.8.
Observed epifauna was generally sparse throughout the Netherlands EEZ. The common starfish *Asterias rubens* was the most commonly observed species (see Figure 3-28). Except for one little plastic bag, there were no anthropogenic features visible.

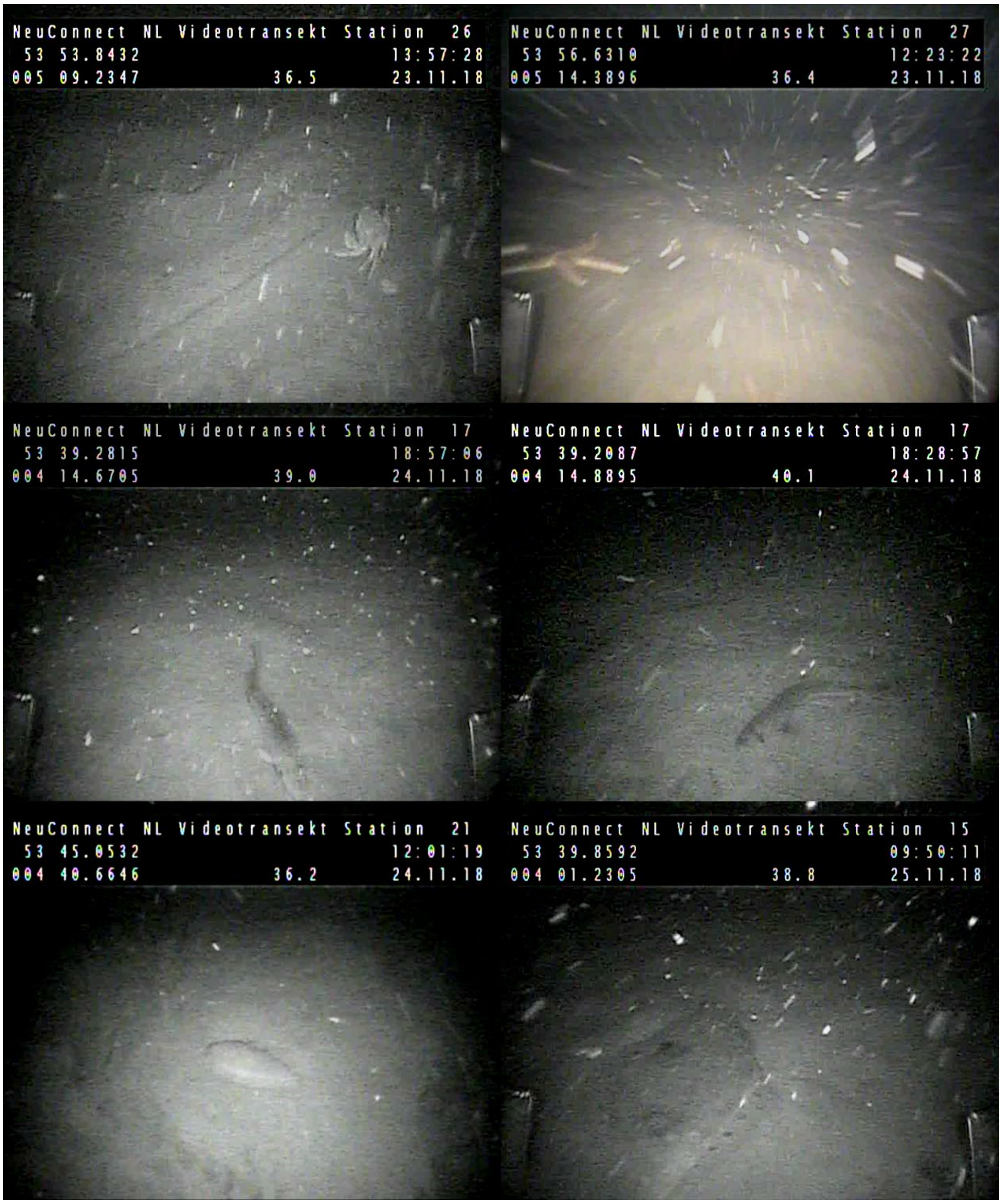

Figure 3-28: Video prints: mainly *Asterias rubens* (right side, first row), *Liocarcinus* sp (left side, first row) and several fish species (second and third row) were found during the video observations

3.5 Species and Habitats of Conservation Interest

The list of species and habitats identified by the samples and data analysis were compared against the list of Habitats Directive (92/43/EEC) (Annex I Habitats and Annex II Species) (European Commission, 2016), OSPAR List of Threatened and/or Declining Species & Habitats (OSPAR, 2008) and the IUCN Red List of Threatened Species (IUCN, 2019).

3.5.1 Infauna and Epifauna Invertebrate Species of Conservation Interest

3.5.1.1 Atlantic Bobtail Squid Sepiola atlantica

Twenty-two individuals of *Sepiola atlantica* were found in the beam trawl samples along the cable route. Atlantic Bobtails are on the 'International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species' designated as 'Data Deficient'. The species has been assessed as 'Data Deficient' because little information is available. Although the species is not targeted by commercial fisheries, it is probably caught locally and until more data are available the impact of commercial fisheries on the species cannot be assessed.

3.5.2 Habitats of Conservation Interest

3.5.2.1 Sites designations

Within the Netherlands EEZ, the proposed cable route traverses one designation, the Special Protection Area (SPA) NL2016166 'Friese Front'. The area is designated for the presence of the common guillemot (*Uria aalge*).

After the Natura 2000-standard data form for the site, the Frisian Front is part of the long physical front along the south side of the summer stratified area in the central North Sea. Due to the unique characteristics of this front, silt and nutrients are supplied from the English coast and the English part of the North Sea, allowing for increased primary production. In addition, the Dutch coastal river enters deeper, and therefore slower flowing water, causing silt and food particles to sink. All this leads to a strip with a high benthos biomass and diversity.

Higher concentrations of fish and birds are also observed here. In particular, common guillemots migrate in large numbers in late summer and autumn to this area with their young to forage. The site contains an important concentration of the ocean quahog (*Arctica islandica*), which is on the OSPAR list of Threatened and/or Declining Species & Habitats. Individuals of *A. islandica* were not found in our investigations.

3.5.2.2 Other Potential Habitats of Conservation Importance

Biotopes can also be illustrative of habitats listed for protection under the Habitats Directive (92/43/EEC) (Annex I Habitats) and OSPAR Convention (OSPAR Priority Habitats). Within the investigation area, no such habitats were identified from the analysis of the data.

4 DISCUSSION

The following section will summarise and discuss the results based on existing knowledge.

4.1 Seabed Sediment Conditions

All stations along the cable route in the Dutch EEZ were dominated by the sand fraction; at most stations with a silt content over 5%, the silt content was correlated significantly with the water depth. The median grain size was between 0.085 and 0.31 mm. At most stations the grain size was lower than 0.2 mm. Two stations showed qrain sizes slightly over 0.2 mm and another two stations showed grain sizes of 0.276 and 0.31 mm. Video analysis and sidescan data confirmed homogeneous sand biotopes at all stations.

The seabed sediments observed during the current survey are typical for the deeper, offshore areas of the Netherlands EEZ. The Dutch government characterised the commonly found sediment conditions across the Dutch North Sea, in their marine strategy from 2012 to 2020 (Noordzeeloket, 2012). Daan and Mulder (2009) conducted a monitoring study for the Dutch North Sea, including the EEZ of the Netherlands. There, the area of the Dutch North Sea was characterised by very fine sand with a proportion of silt usually greater than 2 %.

4.2 Infauna and Epifauna Communities

The highest number of recorded taxa was found in the macrofaunal phylum Annelida (38 % of the total taxa). However, the phylum Echinodermata dominated in terms of abundance and biomass (only 7 % of taxa but 19 % abundance). The dominance of Echinodermata was due to two species, *Amphiura filiformis* and *Echinocardium cordatum*.

The multivariate analysis split the Netherlands EEZ stations into two groups. Grouping corresponded to the silt content of the sediment. The dominating species in the ‘Infauna group 1’ (fine sands) are characteristic for the *Tellina-fabula*-community (Rachor & Nehmer 2003). After Rachor & Nehmer (2003) the *Tellina-fabula*-community populates the fine sandy (partly also medium sandy) areas mainly between the 20 to 30 m depth lines in the offshore areas and its characteristic species are *Tellina fabula*, *Magelona johnstoni* and *Urothoe poseidonis*. The species in the ‘Infauna group 2’ assign the group to the *Amphiura-filiformis*-community. After Rachor & Nehmer (2003) this community populates muddy areas and its characteristic species are *Amphiura filiformis*, *Mysella bidentata* and *Corbula gibba*. These species were also characteristic for the ‘Infauna group 2’.

On a broader scale, many of the most abundant species observed during the current survey are common species throughout the North Sea. *Spiophanes bombyx*, *Pholoe* sp., *Amphiura filiformis* and *Goniada maculata* are species with the highest occurrence within the entire North Sea (Heip & Craemeersch, 1995).

Two biotopes were identified in the EEZ of the Netherlands. These were the EUNIS level 4 habitat complexes ‘Circalittoral muddy sand’ (A5.26) and ‘Circalittoral fine sand’ (A5.25). ‘Circalittoral muddy sand’ (A5.26) was the most common biotope observed across the EEZ of the Netherlands, followed by ‘Circalittoral sandy mud’. The assigned biotopes represent a best fit for the stations based on all available data.

4.3 Species and Habitats of Conservation Interest

No species of conservation importance and no known habitat of conservation importance were identified. Additionally, no habitats of conservation importance were identified during the current survey.

5 CONCLUSIONS

This report describes and characterises the biotopes and the benthic communities, investigated by grab sampling, beam trawl, video observations and water conditions along the Dutch EEZ section of the NeuConnect cable route.

Based on the analysis of the results and the subsequent interpretation, the following conclusions can be drawn:

- The dominant physical seabed conditions observed throughout the Dutch EEZ are muddy sand followed by fine sand;
- Within the sand sediments, multivariate analysis identified two groups of faunal communities, one of the muddy sands and one of the fine sands;
- No protected species or biotopes were observed
- Two biotopes were assigned, based on video and grab analysis as well as on the results of the fauna data, 'Circalittoral muddy sand' (A5.26) and 'Circalittoral fine sand' (A5.25);

In conclusion, the observed species distribution as well as the observed biotopes are typical for the Dutch EEZ. Therefore, the protection value can be regarded as low.

6 REFERENCES

BRAY, J. R. & CURTIS, J. T., 1957. *An ordination of upland forest communities of southern Wisconsin.* Ecological Monographs 27, 325-349.

CLARKE, K. R. & WARWICK, R. M., 2001. *Change in Marine Communities: An Approach to Statistical Analysis and Interpretation.* Natural Environmental Research Council.

CLARKE, K. C. & GORLEY, R. N., 2006. *PRIMER v6: User Manual/Tutorial.*, Plymouth: PRIMER-E.

CLARKE, K. R., SOMERFIELD, P.J., GORLEY, N.G., 2008 *Testing of null hypotheses in exploratory community analyses: similarity profiles and biota-environment linkage.* Journal of Experimental Marine Biology and Ecology 366, 56-69.

DAAN, R., MULDER, M., 2009. *Monitoring the invertebrate benthic fauna in the Dutch sector of the North Sea 1991-2005: an overview*. NIOZ-rapport. NIOZ: The Netherlands. 20 pp.

DAUVIN. J.C., ALIZER, S., ROLET, C., BAKALEM, A., BELLAN, G., GOMEZ GESTERIA, J.L., GRIMES, S., DE-LA-OSSA-CARRETERO, J.A., DEL-PILAR-RUSO, Y., 2012. Response of different benthic indices to diverse human pressures. *Ecological Indicators 12*, 143-153.

DAVIES, J., BAXTER, J., BRADLEY, M., CONNOR, D., KHAN, J., MURRAY, E., SANDERSON, W., TURNBALL, C. AND VINCENT, M. (eds)., 2001. *Marine Monitoring Handbook*. Joint Nature Conservation Committee.

DAVIES, C. E., MOSS, D., HILL, M. O., 2004. *EUNIS HABITAT CLASSIFICATION REVISED 2004.* Report to EUROPEAN ENVIRONMENT AGENCY EUROPEAN TOPIC CENTRE ON NATURE PROTECTION AND BIODIVERSITY.

EUNIS, 2016. European Nature Information System [online] Available at: eunis.eea.europa.eu [Accessed March 2019].

EUROPEAN ENVIRONMENT AGENCY (EEA), 2014. *EUNIS habitat classification* [online] Available at http://www.eea.europa.eu/themes/biodiversity/eunis/eunis-habitat-classification last modified 10/03/2016 [Accessed March 2019].

HAUKE, J. & KOSSOWSKI, T., 2011. Comparison of values of Pearson's and Spearman's correlation coefficients of the same sets of data. *Quaestiones Geographicae*, **30**, 87-93.

HEIP, C., CRAEYMEERSCH, J.A., 1995. *Benthic community structures in the North Sea*. Helgolander Meeresunters, 49, 313-328.

HOOPER, G., BARFIELD, P., THOMAS, N., CAPASSO, E., 2011. *Redefining biotopes at a regional scale and development of a new MNCR biotope decision support tool. Final report for the MALSF (Marine Aggregate Levy Sustainability Fund).* 1/J/1/03/1552/1103. Portchester EMU.

HZG 2014. *The spatial distribution of grain-size sorting (in φ-scale) of surface sediments in the southern North Sea*. [Online Available at https://coastmap.hzg.de/coastmap/maps/data/NOAH/details/DataPages_SedimentSorting.pdf [Accessed March 2019]

IUCN., 2016. *The IUCN Red List of Threatened Species*. Version 2016-2 [online] Available at: http://www.iucnredlist.org [Accessed March 2019]

JNCC, 2015. *The Marine Habitat Classification for Britain and Ireland*. Version 15.043 [Online] Available at jncc.defra.gov.uk/MarineHabitatClassification [Accessed October 2016].

NOORDZEELOKET, 2012. *Marine Strategy for the Netherlands part of the North Sea 2012-2020*. Part I [online] Accessed at: https://www.noordzeeloket.nl/images/Marine%20Strategy%20for%20the%20Netherlands%20part%20 of%20the%20North%20Sea%202012-2020,%20Part%201_683.pdf [Accessed March 2019].

OSPAR, 2008. *OSPAR List of Threatened and/or Declining Species and Habitats.* Reference Number: 2008-06 [online] Available at: http://www.ospar.org/work-areas/bdc/species-habitats/list-of-threatened-declining-species-habitats [Accessed March 2019].

RACHOR, E. and NEHMER, P. 2003. *Erfassung und Bewertung ökologisch wertvoller Lebensräume in der Nordsee*. Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, 175 p..

7 APPENDIXES

7.1 List of Figures

7.2 List of Tables