



QUANTERNESS EIAR
BENTHIC BASELINE SURVEY REPORT
APPENDIX 6

1. Introduction

A baseline benthic grab survey was conducted at the proposed development location on 25/05/2023. The scope and design of the survey was in accordance with SEPA guidance (2022).

An earlier visual baseline survey was carried out at the proposed development location on 31/08/2022 (Cooke Aquaculture Scotland, 2022 – Quanterness EIAR appendix 7). Assessment of the visual baseline survey data was used to map substrate type, highlight regions of hard substrate and identify priority marine features.

The results show a relatively homogenous seabed, predominantly characterised as fine sand. No priority marine features were identified within the survey area. Some hard substrate was observed to the west and south of the survey grid (T1-1, T5-3 and T5-4). The baseline survey grid, spanning 800m (E-W) by 1000m (N-S) with a spacing of 100m, was plotted on the site plan shown in figure 1. The orientation of the sampling grid is aligned with the pen group bearing. The default NewDepomod model predicts no impacted seabed (>250g/m²).

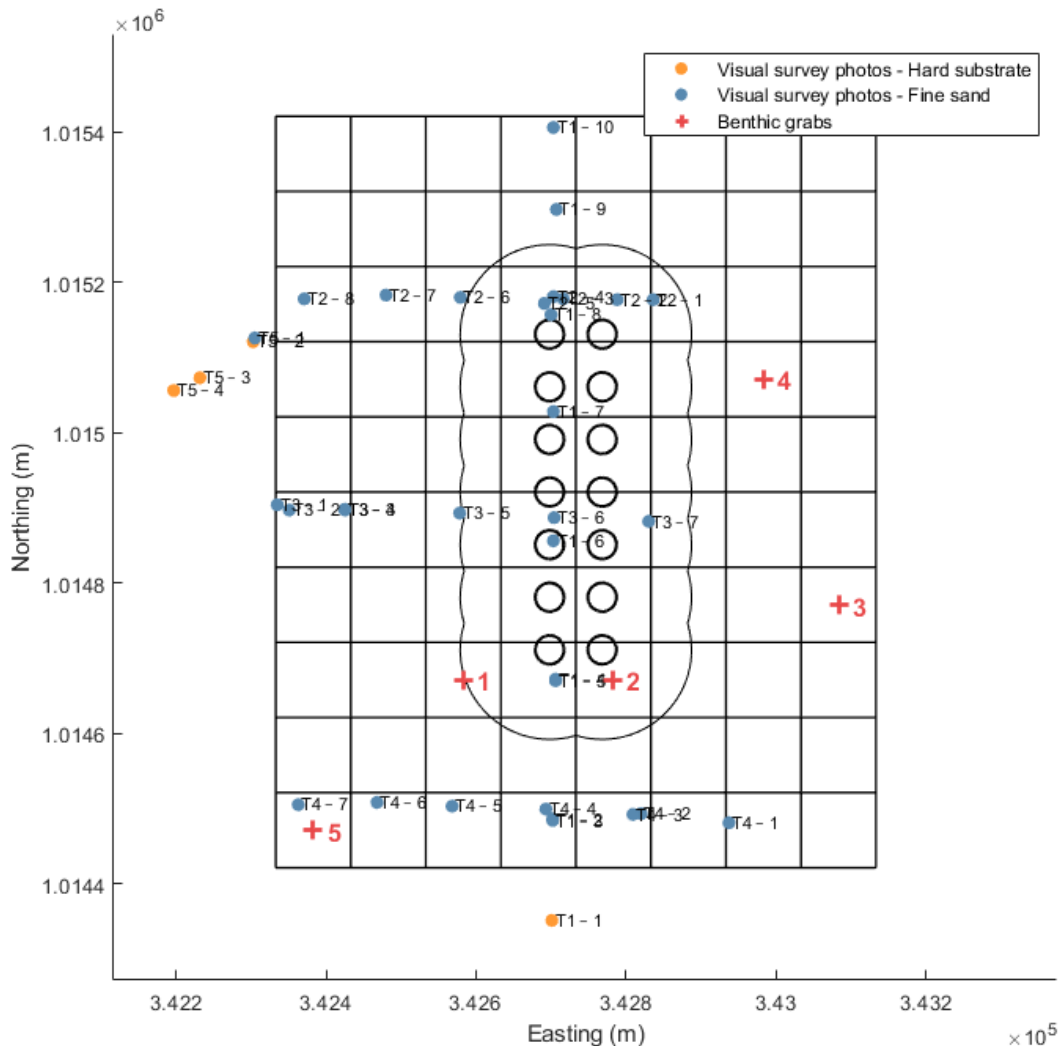


Figure 1. Baseline sampling stations. Locations of proposed pens ('o'), 100m mixing zone, benthic grabs (red '+') and visual survey photos (filled 'o') are shown.

Grab sample locations (table 1) were chosen at the central point of 5 randomly selected 100m x 100m sample grid squares for each substrate type observed in the visual survey. In this case one sampleable substrate type was identified, fine sand, therefore a total of 5 grab sample locations are provided. None of the proposed sample stations fall close to the observed hard substrate. If hard substrate is encountered during a grab sample, the sizing of the sample grid squares gives ample room to adjust the grab location, maximising the chance of locating pockets of soft sediment within the predetermined sample grid square.

Table 1. Sample station locations and additional data.

Parameter	Station 1	Station 2	Station 3	Station 4	Station 5
Easting	342599	342786	343075	342988	342384
Northing	1014669	1014666	1014766	1015062	1014473
Depth (m)	9	10.8	11.7	10.9	6.6
Date sampled	25/05/2023	25/05/2023	25/05/2023	25/05/2023	25/05/2023
Time (hh:mm)	10:45:00	10:32:00	10:15:00	10:55:00	11:05:00

2. Sampling information

2.1 Grab sampling

Samples were collected by Cooke Aquaculture Scotland (CAS) using a 0.045m² Van Veen grab. Water depths and grab fullness were recorded. All sediments were examined qualitatively for colour, consistency, texture, waste feed pellets, faeces, *Beggiatoa* spp. and H₂S smell. Positions of stations and timestamps for grabs/stations were recorded. Survey parameters included: Benthic Infauna, Particle Size Analysis (PSA), & Total Organic Carbon (TOC).

2.2 Data analysis

All faunal stations were analysed by a 3rd party consultancy. The faunal data set was analysed through PRIMER, UKTAG IQI Workbook v02 and was assessed for enrichment polychaete (EP) numbers. Results are provided in appendix 1 at the end of this report. Where appropriate, various faunal data rows (e.g. juveniles with adults of the same species) reported in the SEPA MPFF report template were combined prior to data analysis to avoid over representation of species number.

UKTAG IQI Workbook v02 was used to determine IQI values. To reduce high proportions of fauna showing as 'non assigned', row entries were ascribed (where available) their EG classification taken from UKTAG IQI Workbook v01. These changes are highlighted in the Metrics sheet.

Particle Size Analysis results were entered into the UKTAG IQI Workbook. Where station results lie at the outer limits of the Workbook design centiles, the IQI results have been reported but should be considered with caution.

3. Results

3.1 Sediment description, Particle Size Analysis (PSA) and Total Organic Carbon (TOC)

Sediment is described as fine sand with shell fragments at Station 1, and with worm casings at Station 2 and Station 3. Station 4 was medium fine sand with shell fragments and seaweed debris, and Station 5 comprised fine sand, mud and shell fragments. A strong smell of hydrogen sulphide was noted from all grabs from Station 5. A graph of Particle Size Analysis (PSA) results for each sampled station is shown below in figure 2.

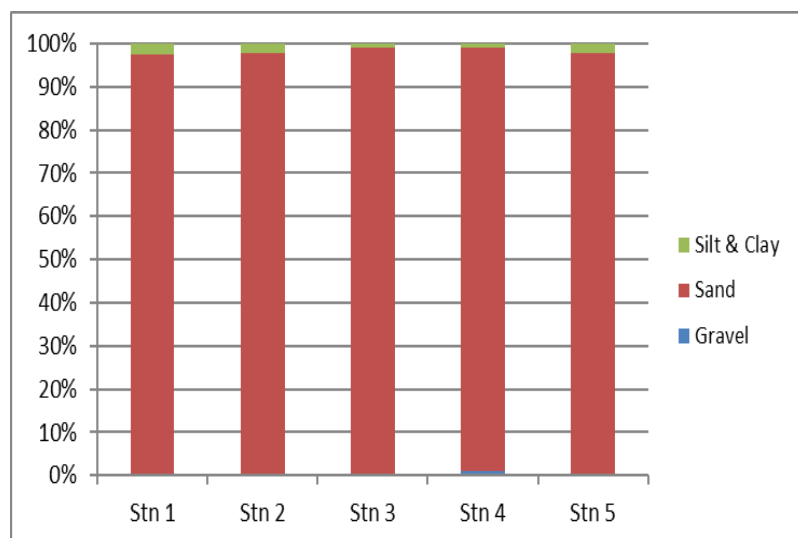


Figure 2. PSA results per station

PSA results show sediment from the five stations comprises mainly sand (97-99%), with 1-2% silt clay and $\leq 1\%$ gravel sized particles. Sediment from all stations is classed (using the simplified classification of the Folk triangle for UKSeaMap) as 'sand and muddy sand'. Carbon TOC results (table 2 below) are low for all stations, ranging from 0.42% at Station 5 to 0.57% at Station 3.

Table 2. TOC results for all stations.

Station	Total Organic Carbon (%)
Station 1	0.47
Station 2	0.56
Station 3	0.57
Station 4	0.49
Station 5	0.42

3.2 PRIMER, IQI and Enrichment Polychaetes

Table 3 below summarises PRIMER, enrichment polychaete (EP), ITI and IQI results for each station. ITI (>60) values indicating 'Normal' community status are highlighted in green. IQI (>0.64) values indicating Good or High Ecological (Eco) Status are shown in red.

Table 3. Summary of biological diversity indices at all survey stations.

	Number of taxa (S)	Abundance (N)	Margalef's Richness (d)	Pielou's Evenness (J)	S-Wiener Diversity (H' (log 2))	Number of Enrichment Polychaete (EP) Species	EP Density (/m ²)	ITI	IQI/WB v02 with IQI WBv01 EG (where available) for 'non assigned' entries	Ecological Status
Stn 1	56	358	9.35	0.74	4.32	0	0	72.55	0.740	GOOD
Stn 2	45	251	7.96	0.71	3.88	0	0	70.67	0.704	GOOD
Stn 3	48	200	8.87	0.73	4.05	0	0	72.08	0.755	HIGH
Stn 4	44	182	8.26	0.77	4.21	1	11	82.59	0.817	HIGH
Stn 5	16	53	3.78	0.70	2.80	0	0	78.62	0.693	GOOD

The top-ranking species (by abundance) for each station (taken from the UKTAG IQI Workbook) are shown in table 4 below. Enrichment polychaete densities at all stations are outlined in table 5 below.

Table 4. Most abundant species per station.

	Most abundant taxa (% of sample)	2nd Most abundant taxa (% of sample)	3rd Most abundant taxa (% of sample)	4th Most abundant taxa (% of sample)	5th Most abundant taxa (% of sample)
Station 1	Galathowenia oculata (26.3%)	Kurtiella bidentata (16%)	Dialychone dunerificta (5%)	Urothoe elegans (4.5%)	Prionospio fallax (4.2%)
Station 2	Kurtiella bidentata (39.6%)	Galathowenia oculata (7.2%)	Amphiura filiformis (6.4%)	Urothoe elegans (4%)	Prionospio fallax (3.6%)
Station 3	Kurtiella bidentata (33.7%)	Ampelisca tenuicornis (13.1%)	Urothoe elegans (5.5%)	Nephtys hombergii (4.5%)	Owenia (4.5%)
Station 4	Urothoe elegans (22.7%)	Photis longicaudata (14.4%)	Ampelisca tenuicornis (11%)	Chaetozone setosa (6.1%)	Harpinia antennaria (6.1%)
Station 5	Ampelisca tenuicornis (45.3%)	Nephtys hombergii (18.9%)	Ampelisca brevicornis (7.5%)	Chaetozone setosa (3.8%)	Urothoe elegans (3.8%)

Table 5. Total number/density of enrichment polychaete species across all stations.

	Enrichment polychaete (EP) species	Number of EP species	Overall EP density (/m ²)
	<i>Capitella</i>		
Stn 1	0	0	0
Stn 2	0	0	0
Stn 3	0	0	0
Stn 4	1	1	11
Stn 5	0	0	0

3.3 Species Diversity

IQI > 0.64 (Good or High Eco Status) is achieved at each of the five baseline stations. No Priority Marine Feature species or communities were recorded. Results from Stations 1-4 show broadly similar species numbers (44-56) and abundance (182-358). Richness index values range from 7.96-9.35, Evenness from 0.71-0.77 and Shannon Wiener values from 3.88-4.32. Enrichment polychaetes (EPs) are generally absent; a single *Capitella* (equivalent to a density of 11/m²) was recorded at Station 4. ITI scores of 70.67-82.59 place the communities comfortably in the 'Normal' category and IQI values of 0.704-0.817 class Stations 1 and 2 as Good Eco status, Stations 3 and 4 as High Eco status. Results from shallower Station 5, where a strong smell of hydrogen sulphide was noted from each grab,

show a lower species number (16) and the lowest abundance (53). Richness (3.78) is correspondingly poor, and Evenness (0.70) and Shannon Wiener (2.80) values are moderate. No EPs were recorded, and the community achieves a 'Normal' ITI (78.62) score and the IQI (0.693) classes the community as Good Eco Status. PRIMER Multivariate Bray Curtis and Ordination plots are shown below in figure 3.

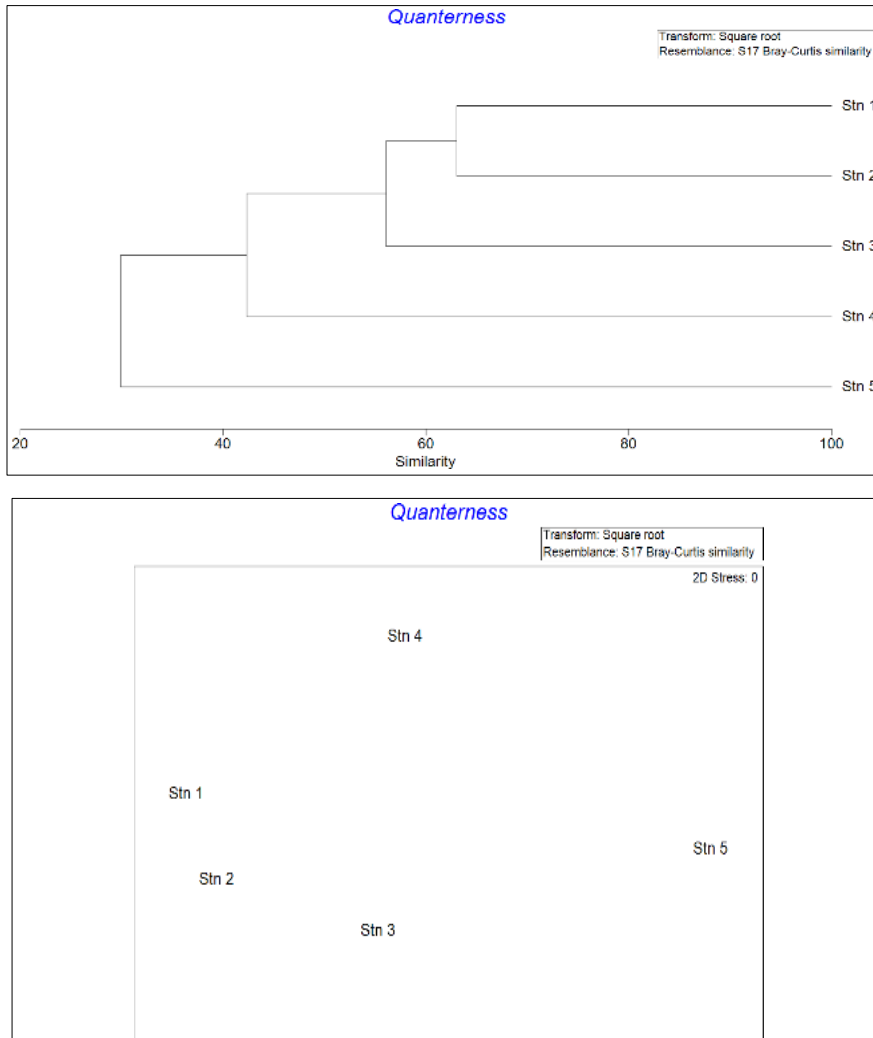


Figure 3 PRIMER, Multivariate Bray Curtis, and Ordination plots for all survey stations

The Bray Curtis and Ordination plots show Stations 1 and 2 most closely associated (at 63% similarity) and sharing four of their five most abundant species but in differing proportions, with polychaete *Galathowenia oculata* and mollusc *Kurtiella bidentata* highest ranking. Stations 3 and 4 split from the pair at 56% and 42% respectively and are more widely spaced in the ordination plot as shared trends are fewer with crustacean *Ampelisca tenuicornis* ranked higher. The five stations show 30% similarity in faunal composition. Similarities in the top 5 ranking species are highlighted below in table 6.

Table 6. Most abundant taxa per sample station at Quanterness.

	Most abundant taxa (% of sample)	2nd Most abundant taxa (% of sample)	3rd Most abundant taxa (% of sample)	4th Most abundant taxa (% of sample)	5th Most abundant taxa (% of sample)
Stn 1	Galathowenia oculata (26.3%)	Kurtiella bidentata (16%)	Dialychone dunerificta (5%)	Urothoe elegans (4.5%)	Prionospio fallax (4.2%)
Stn 2	Kurtiella bidentata (39.6%)	Galathowenia oculata (7.2%)	Amphiura filiformis (6.4%)	Urothoe elegans (4%)	Prionospio fallax (3.6%)
Stn 3	Kurtiella bidentata (33.7%)	Ampelisca tenuicornis (13.1%)	Urothoe elegans (5.5%)	Nephtys hombergii (4.5%)	Owenia (4.5%)
Stn 4	Urothoe elegans (22.7%)	Photis longicaudata (14.4%)	Ampelisca tenuicornis (11%)	Chaetozone setosa (6.1%)	Harpinia antennaria (6.1%)
Stn 5	Ampelisca tenuicornis (45.3%)	Nephtys hombergii (18.9%)	Ampelisca brevicornis (7.5%)	Chaetozone setosa (3.8%)	Urothoe elegans (3.8%)

Station 5, where species number and abundance are lowest, is least closely associated with the other stations (30%); *A. tenuicornis* dominates (making up 45.3% of total abundance). Polychaete *Nephtys hombergii* (18.9%) and crustacean *Ampelisca brevicornis* (7.5%) are ranked second and third but are not seen in the top five for the other stations.

4. Summary

The five baseline station communities (Stations 1- 5) show: ITI 'normal' (>60) is achieved at each station IQI>0.64 (Eco status Good or High) is achieved at each station Enrichment polychaetes are generally absent. No Priority Marine Features are recorded.

Stations 1, 2, 3 and 4 record similar species numbers and abundances and show the greatest similarities in faunal composition. Shallower Station 5, where a smell of hydrogen sulphide was noted, records fewer species, a lower abundance and shares the fewest trends in composition with Stations 1-4.

All raw survey data is provided in appendix 1 below.

References

Cooke Aquaculture Scotland (2022), Quanterness Visual Survey Report.

Scottish Environmental Protection Agency (2022), Baseline survey design. Version 2.

Appendix 1 – Raw data

Stations

	St-1	St-2	St-3	St-4	St-5
Easting	342599	342786	343075	342988	342384
Northing	1014669	1014666	1014766	1015062	1014473
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Data Sheet

Stations

	St-1	St-2	St-3	St-4	St-5
Easting	342599	342786	343075	342988	342384
Northing	1014669	1014666	1014766	1015062	1014473
Depth	9	11	12	11	7
Date sampled	25/05/2023	25/05/2023	25/05/2023	25/05/2023	25/05/2023

Sediment Description

	St-1	St-2	St-3	St-4	St-5
% Grab filled	90	85	85	90	95
Grab size	0.045	0.045	0.045	0.045	0.045
Colour	Grey	Grey	Grey	Grey	Grey / brown
Consistency/Texture	Fine sand, shell fragments	Fine sand, worm casings	Fine sand, worm casings	Med-fine sand, shell fragments, seaweed debris	fine sand, mud, shell fragments
Surface smell	No	No	No	No	Yes
Gas bubbling	No	No	No	No	No

Fungus	No	No	No	No	No
Waste feed pellets	No	No	No	No	No
Layer of faeces/organic waste (y/n)	No	No	No	No	No
Spare	quite a few brittlestars	quite a few brittlestars			Strong smell of H2S in all the grabs from STN 5
Spare					

Sediment Chemistry	St-1	St-2	St-3	St-4	St-5
Total Organic Carbon (%)	0.47	0.56	0.57	0.49	0.42
Moisture content (%) (optional)					
Spare					
Spare					

Particle Size Analysis	St-1	St-2	St-3	St-4	St-5
>2mm (%)	0.26	0.35	0.43	0.93	0.11
<63µm (%)	2.49	2.19	1.03	0.92	2.12
Mean (mm)	0.159	0.163	0.171	0.183	0.144
Std dev (mm)	0.002	0.002	0.001	0.001	0.002
Phi	2.653	2.613	2.546	2.448	2.797
Wentworth classification	Fine Sand	Fine Sand	Fine Sand	Fine Sand	Fine Sand
Classification description	Slightly Very Fine Gravelly Fine Sand	Slightly Very Fine Gravelly Fine Sand	Slightly Very Fine Gravelly Fine Sand	Slightly Very Fine Gravelly Fine Sand	Slightly Very Fine Gravelly Fine Sand

Faunal Summary	St-1	St-2	St-3	St-4	St-5
Number of taxa (S)	56	45	48	44	16
Abundance (N)	358	251	200	182	53
Magalef's Richness (d)	9.35	7.96	8.87	8.26	3.78

Pielou's Evenness (J)	0.74	0.71	0.73	0.77	0.70
S-Wiener Diversity H'log 2	4.32	3.88	4.05	4.21	2.80
Number of Enrichment Polychaete Species	0	0	0	1	0
Abundance of Enrichment Polychaetes (m2)	0	0	0	11	0
ITI	72.55	70.67	72.08	82.59	78.62
IQI	0.74	0.70	0.76	0.82	0.69

Residues Data Transect 1	St-1	St-2	St-3	St-4	St-5
Replicate 1 (see note 1 below)					
Replicate 2 (see note 1 below)					
Replicate 3 (see note 1 below)					
Mean (see note 1 below)					

Particle Size Analysis

	St-1	St-2	St-3	St-4	St-5
% > 8mm	2.5	2.2	1.0	0.9	2.1
% 8 - 4mm	21.5	18.5	13.0	8.9	28.6
% 4 - 2mm	60.9	63.6	73.7	73.4	61.2
% 2 - 1mm	10.8	10.4	10.4	13.8	6.5
% 1 - 0.5mm	2.6	3.2	0.9	1.2	1.0
% 0.5 - 0.25mm	1.5	1.6	0.6	0.9	0.5
% 0.25-0.125mm	0.3	0.3	0.4	0.5	0.1

% 0.125-0.063mm	0.0	0.0	0.0	0.4	0.0
% < 0.063mm	0.0	0.0	0.0	0.0	0.0
Degree of sorting	Moderately Sorted	Moderately Sorted	Moderately Well Sorted	Moderately Well Sorted	Moderately Well Sorted
Degree of skewness	Coarse Skewed	Coarse Skewed	Coarse Skewed	Symmetrical	Symmetrical
Degree of kurtosis	Very Leptokurtic	Very Leptokurtic	Leptokurtic	Leptokurtic	Leptokurtic
Folk Triangle	Fine Sand	Fine Sand	Fine Sand	Fine Sand	Fine Sand

Species Abundance Matrix

		Station	Stn 1			Stn 2			Stn 3			Stn 4			Stn 5		
		Totals	105	252	357	87	163	250	77	120	197	102	78	180	14	39	53
Taxon Name (WORMS compliant)	Comments (e.g. sp, agg, juv)	ITI Group	Rep 1	Rep 2	Total	Rep 1	Rep 2	Total	Rep 1	Rep 2	Total	Rep 1	Rep 2	Total	Rep 1	Rep 2	Total
Foraminifera				>0		>0	>0		>0	>0		>0	>0				
Hydrozoa		1								>0							
Actiniaria		3										>0					
Edwardsiidae		3		2	2	1		1		1	1						
Nemertea		3							2		2					1	1
Cerebratulus		3		1	1				1		1		1	1			
Phascolion (Phascolion) strombus strombus		2					1	1									
Harmothoe impar	aggregate	3		1	1												
Malmgrenia andreapolis		3		1	1		1	1	3		3						
Pholoe baltica	(sensu Petersen)	3		1	1	1		1									
Pholoe inornata	(sensu Petersen)	3		1	1												

Sigalionidae	juvenile	3					2	2									
Sthenelais limicola		3					2	2							1	1	
Phyllodoce longipes		3					1	1							1	1	
Eumida bahusiensis		3									1		1				
Glycinde nordmanni		3							2	2							
Goniada maculata		3							1	1							
Exogone naidina		2		1	1												
Nereididae	juvenile	3		1	1				1	1							
Nephtys	juvenile	3	1		1		1	1									
Nephtys assimilis		3				1		1									
Nephtys hombergii		3	2	5	7	3	2	5	6	3	9	4		4	3	7	10
Lumbrineris cingulata	aggregate	3		3	3		2	2	1		1						
Malacoceros girardi		2										1		1			
Dipolydora coeca	aggregate	2										1		1			
Prionospio fallax		2		15	15	3	6	9				6	6	1		1	
Spio decorata		1					1	1		1	1						
Spio symphyta		1	2	5	7	1		1	1	1	2	2	1	3	1		1
Spiophanes bombyx		1	2	4	6		3	3									
Magelona alleni		2		2	2												
Magelona filiformis		2					1	1		2	2		1	1			
Magelona filiformis		2		1	1		2	2									
Chaetozone setosa		2		2	2	1	5	6	1		1		11	11	2		2
Diplocirrus glaucus		2	7	4	11	3	6	9		2	2	2		2			
Capitella		4											1	1			
Mediomastus fragilis		3		1	1												
Notomastus		4	2	3	5		4	4		2	2	1		1			
Euclymene oerstedii		3		3	3												
Praxillella affinis		2	1		1	1		1									
Praxillura longissima		3	2	2	4												

Galathowenia oculata		2	22	72	94	10	8	18		5	5	2		2			
Owenia		1		8	8	1	1	2	5	4	9	2	2	4			
Amphictene auricoma		3	1		1												
Ampharete lindstroemi	aggregate	2	1	3	4		3	3									
Lanice conchilega		1										1		1			
Chone fauveli		1		1	1												
Chone infundibuliformis		1								1	1						
Dialychone dunerificta		1	10	8	18	2		2	1	1	2		1	1			
Dialychone longiseta		1								1	1						
Sabella	juvenile	1	1		1												
Sabella pavonina		1		5	5					1	1						
Anoplodactylus petiolatus		2										1		1			
Nebalia		3					1	1									
Perioculodes longimanus		2								1	1		1	1	1		1
Synchelidium maculatum		2	3		3					1	1						
Westwoodilla caecula		2				1		1									
Leucothoe lilljeborgi		2				1		1									
Urothoe elegans		1	4	12	16	7	3	10	1	10	11	26	15	41	1	1	2
Harpinia antennaria		2	1	7	8	1	3	4		1	1	6	5	11		1	1
Tryphosa nana		3							1		1						
Ampelisca brevicornis		1										1		1		4	4
Ampelisca tenuicornis		1	8	7	15	3	6	9	13	13	26	12	8	20	3	21	24
Ampelisca typica		1		1	1							3	1	4			
Bathyporeia tenuipes		1										4	5	9			
Cheirocratus	female	1							1		1						
Photis longicaudata		2	6	1	7				1		1	20	6	26			
Leptocheirus pectinatus		1		1	1												
Crassicorophium crassicorne		2										1		1			

Pariambus typicus		2	1		1				1	1	2				1	1
Natanolana borealis		3							1		1					
Tanaopsis graciloides		2	4		4		1	1	1		1					
Diastylis rugosa		1										1	1			
Liocarcinus depurator		3							1	1		1	1			
Steromphala tumida		2									1		1			
Turritellinella tricarinata		1	1		1	2	3	5								
Euspira nitida		3							1		1		1	1		
Odostomia unidentata		3										1	1			
Philine		3													1	1
Mytilidae	juvenile	1									1		1			
Lucinoma borealis	juvenile	3		1	1	1	1	2	1	2	3					
Thyasira flexuosa		3		2	2		2	2	1		1					
Kurtiella bidentata		2	12	45	57	30	69	99	20	47	67					
Acanthocardia	juvenile	1					1	1								
Phaxas pellucidus		1	3	1	4	2	2	4				1	1	2		
Fabulina fabula		1		5	5		1	1	1	3	4	1		1	1	1
Bosemprella incarnata		2											1	1		
Abra alba		2		1	1		2	2	2	6	8	1	1	2		
Abra prismatica		2	2	1	3	2	1	3	4	2	6	1		1		
Chamelea striatula		1				1		1				1	1	2		
Chamelea striatula	juvenile	1	1	1	2					2	2				1	1
Timoclea ovata		1											2	2		
Dosinia	juvenile	1	1		1	3	1	4				4	1	5		
Mysia undata	juvenile	1		2	2											
Varicorbula gibba		2				1		1	1		1					
Hiatella arctica		2		1	1							1		1		
Cochlodesma praetenuae		1		1	1											
Phoronis		1	2		2								1	1		

Bryozoa		1							>0	>0							
Amphiura filiformis		1	1	5	6	4	12	16	2	2	4						
Amphipholis squamata		2		1	1				1		1						
Echinocyamus pusillus		2								1	1						
Echinocardium cordatum		2					2	2									
Cucumariidae	juvenile	1	1		1												