NÁTTÚRUSTOFA VESTFJARÐA

Monitoring of the benthic community in Fossfjörður 2015

Worked for Fjarðalax

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NV nr. 19-16

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INTRODUCTION

The fish farming company Fjarðalax asked Náttúrustofa Vestfjarða (Nave) to monitor sea bottom sediment in accordance with the environmental monitoring plan (Nave 2015) of the aquaculture area located in Fossfjörður. Fossfjörður is one of 4 fjords in the south part of Arnarfjörður in NW Iceland. An operation licence was issued on February 11th, 2015 for a total of 4.500 tons of salmon (Umhverfisstofnun 2015). The first salmon production cycle (four cages) in Fossfjördur started in June 2011 and harvest was finished in May 2013. After a period of fallowing, the second production cycle was stocked into eight cages (50 meters diameter) in May 2014 (figure 1). Harvest started in October 2015 and is planned to continue until October 2016. The total amount of feed used in the entire aquaculture from stocking until sampling date was 4.085 tons of dry pellets (Jón Örn Pálsson, 3.May 2016 personal comment).

The accumulation of organic waste is a well known consequence of aquaculture practice. The effects on the benthic community are usually greatest directly under the cages and in the immediate surrounding area (Johannessen et al.1994, Karakassis et al. 1999, Kutti et al. 2007). Various factors, such as sea currents, topography, number of cages, fish density and type of feed, shape and size the area that is most affected by aquaculture organic waste.

Benthic animal communities were examined by sampling eight sites in the proximity of the mariculture system. In addition, samples were taken at a reference site 500 meters away from the cages. The interpretation of aquaculture monitoring results need to take into consideration several traits of the macrofauna community such as its composition, its diversity and the presence or absence of certain indicator species (Pearson & Rosenberg 1978, Rygg 2002, Dean 2008). Chemical analyses were also carried out at 4 of the 8 sampling sites.

Previous studies on the benthic community have been performed in Fossfjörður (Böðvar Þórisson et al. 2010; Böðvar Þórisson et al. 2015).

Figure 1. Net pens in Fossfjörður.

MATERIAL AND METHODS

Sampling

This survey intended to investigate the soft bottom animal communities at 9 sites in the proximity of the mariculture system in Fossfjörður. Sampling sites were located at varying distance from the aquaculture cages according to figure 2, and partially in accordance with Aquaculture Stewardship Council, ASC Salmon Standard version 1.0, June 2012. Sites A and B were located upstream, respectively 55 and 30 m from cage A5. Sites G and H were located downstream of the predominant sea current direction, respectively 30, 55 m from the cages. Site C was intended to be right at the cage A3 (0 m), and site D, E and F were in a transect perpendicular to the main current, towards the deepest part of the fjord respectively at 0 (cage A7), 30 and 55 m distance from the cage (figure 3). Site I at 500 m from the cages, is a reference station. Sampling at the sites A and C failed because of hard bottom conditions (Eva Dögg Jóhannesdóttir, sampling report). Geographical coordinates, depths and distances from cages can be seen in table 1.

Sampling was conducted from a boat by using a Van Veen grab with 250 cm^2 of sampling area. Three samples were taken at each site for biological parameters; sediments were described in colour, consistency and smell (table 2). Samples were then submerged with a fixative solution of formaldehyde (5-10%) and an adequate amount of borax. The formaldehyde solution was substituted with an ethanol solution (70%) after 4-5 days.

A set of triple samples was also taken to analyze chemical parameters, using the Van Veen grab at sites D, G, H and I. Samples were carefully opened over a tray and a sub-sample of circa 500 gram was collected from the surface and placed into a plastic container. The lids of those containers were sealed with tape and samples were subsequently frozen down to -24° C. Samples were sent to Rannsóknarþjónustan Sýni ehf. and analysed for total organic carbon (TOC), total nitrogen (TN), total phosphor (P) and sulphide (S).

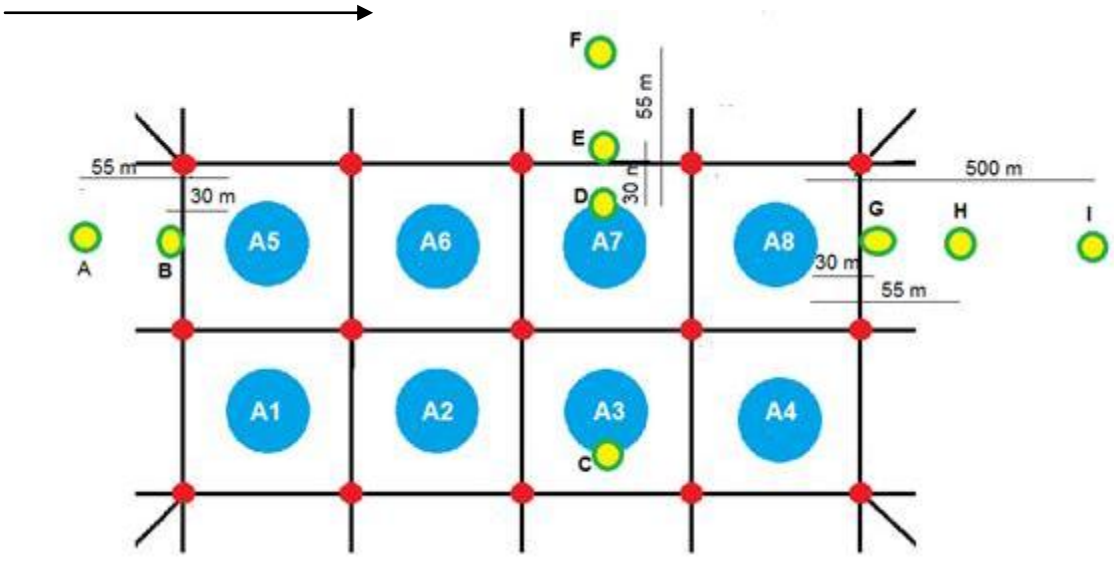

Figure 2: Scheme with locations of sampling sites in Fossfjörður.

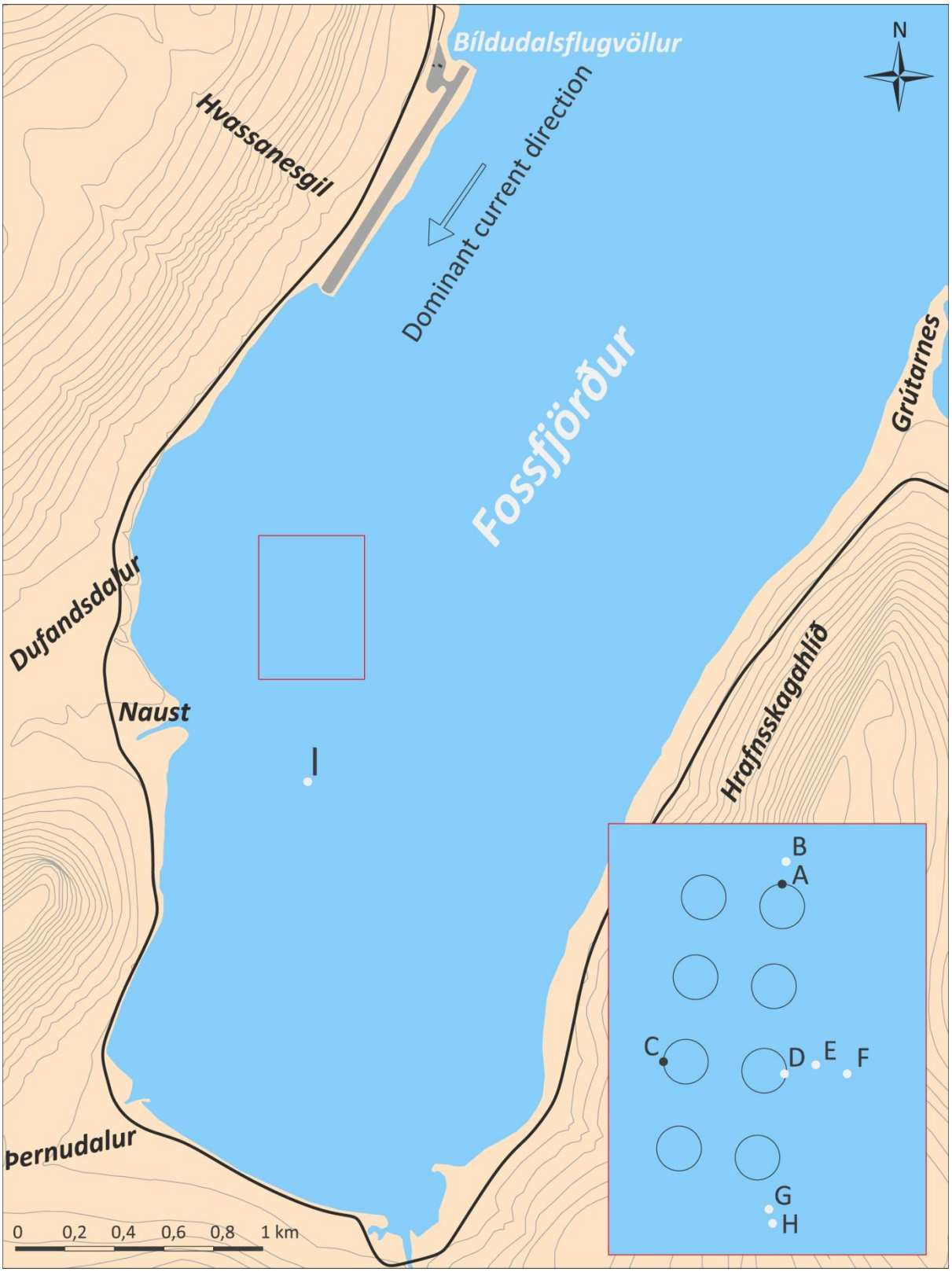

Figure 3: Map of sampled sites in Fossfjörður (white dots indicate where samples were actually taken; black dots indicate sites were sampling failed). Map: NAVE/Hulda Birna Albertsdóttir.

Table 1: Position, depth and distance from the cages for sampled sites in Fossfjörður.

Site	Gps coordinates *decimal minutes*	Depth (m)	Distance (m)
A	----------	----	55
B	N65 37.666 W23 33.042	59	30
C	----------	----	0
D	N65 37.513 W23 33.018	70	0
E	N65 37.521 W23 32.964	74	30
F	N65 37.516 W23 32.909	75	55
G	N65 37.414 W23 33.028	68	30
H	N65 37.404 W23 33.020	59	55
I	N65 37.159 W23 33.007	40	500

Table 2: Description of samples (visual, smell, cubic cm sampled, and grain size estimation) as average of 3 samples.

Site	Visual description	Smell	cm^3	Grain size estimated
B	Gray/black mud, shell fragments	Little	1.362	95%mud < 500µm 5% shell fragments > 500µm
D	Black mud, fish feed	Yes	1.362	95%mu < 500µm 5% vegetation> 500 µm
E	Gray/black mud	Little	1.655	95%mu < 500µm 5% shell fragments, vegetation > 500 µm
F	Gray/black mud	No	1.438	95%mud < 500µm 5% shell fragments, vegetation > 500 µm
G	Gray/black mud	Little	1.551	95%mud < 500µm 5% vegetation > 500 µm
H	Gray/black mud	No	1.097	95%mud < 500µm 5% vegetation > 500 µm
I	Gray/black mud	No	1.248	95%mud < 500µm 5% vegetation > 500 µm

Treatment of samples for biological parameters

The samples were sieved first through a 500 µm sieve with running water. Samples were afterwards sieved through a 1 mm sieve; therefore 2 separate biological samples were made out of each grab. This methodology was adopted in accordance with ASC salmon Standard 2012 and ISO 12878 standards. Animals were successively collected, counted and identified to the lowest feasible taxonomical level using a MZ 12 stereoscope. Foraminifera, if present, were not collected.

Statistical analyses

Univariate analysis was performed using the Primer 6 program (Clarke & Warwick 1994). The Shannon-Wiener diversity index (H') and Evenness index (J´) were calculated (Grey et. al 1992; Brage og Thélin 1993). To avoid artificial inflation of diversity, the polychaeta family Ampharetidae represented by juvenile individuals, was combined with the more common representative of the same family found in the survey (*Ampharete sp*). Nematodes worms were not included in the calculation. Table 6 used for statistical computations is in appendix 2.

Shannon-Wiener index H´:

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

where:

S = number of taxa,

pi = fraction of the entire population made up of species

Evenness index (J´) describes how close in number of individuals each species is with others. This index is based on the Shannon-Wiener index (H´) and is mathematically defined as:

Evenness index J´:

$$J' = \frac{H'}{H'_{max}}$$

Where H´max=

$$H'_{max} = -\sum_{i=1}^{S} \frac{1}{S} \, log_2 \frac{1}{S} = log_2 S$$

RESULTS

Results of benthic community identification after sieving with mesh size 1mm can be seen in table 3. A complete list of all identifiable taxa including also animals retained by a 500µm mesh size sieve can be found in Table 5 in Appendix 1. All values represent the average of three samples adapted to 1 m^2.

Table 3: Species list for sites sampled in October 2015 in Fossfjörður after 1mm mesh size sieve.

Taxa/ *species*	**Sites**						
	B	**D**	**E**	**F**	**G**	**H**	**I**
Polychaeta							
Ampharete sp	0	0	53	160	0	40	0
Ampharetidae	0	0	13	0	13	0	0
Capitella capitata	2827	13	1880	93	960	3507	13
Chaetozone setosa	53	0	133	360	0	0	133
Cossura longocirrata	107	0	53	40	0	0	67
Eteone longa	133	0	13	40	0	40	0
Euchone sp	0	0	0	13	0	0	13
Galathowenia oculata	0	0	0	0	0	0	40
Levinsenia gracilis	0	0	13	0	0	0	13
Mediomastus fragilis	53	0	53	0	0	27	13
Melinna cristata	0	0	0	27	0	0	0
Microphthalmus aberrans	160	0	13	27	53	93	0
Nephtys sp	0	0	13	40	0	0	0
Ophelina acuminata	27	0	0	120	0	0	520
Parougia nigridentata	480	0	253	93	27	120	93
Praxillella sp	0	0	0	13	0	0	0
Prionospio fallax	27	0	13	813	0	0	413
Prionospio sp	0	0	0	0	0	0	13
Scalibregma inflatum	0	0	0	0	0	0	13
Syllis sp	0	0	13	0	0	0	0
Terebellidae	0	0	0	0	0	0	13
Bivalvia							
Ennucula tenuis	80	0	107	173	0	80	307
Nuculana spp	0	0	0	107	0	0	133
Thyasira flexuosa	80	0	93	80	13	67	93
Yoldia hyperborea	0	0	0	0	13	0	0
Gastropoda							
Dendronotus frondosus	0	0	0	0	0	13	0
Crustacea							
Amphipoda	0	0	0	13	0	0	0
Leucon nasicoides	0	0	0	0	0	13	0
Mysidacea	0	13	0	0	0	0	0
Pandalus borealis	0	0	0	13	0	0	0
Nemertea	0	0	0	27	0	0	13

Site D resulted deprived of life except for 1 individual of the polychaeta species *Capitella capitata* and 1 pelagic shrimp like crustacean. Annelids Polychaeta were the most abundant class at all sites followed by Nematodes worms and Bivalvia.

Results from the 500µm mesh size sieve show annelids polychaeta, comprised of at least 21 species, and a total sum of 36.426 individuals per m^2 (ind./m^2). Among those, the species *Capitella capitata* was the only one present at all sites and the most abundant except for at site I. Bivalvia comprised at least 4 species and 1.480 ind./m^2. They were present at all sites, except for D, and their number was highest at the reference site. Crustacean and Nemertina worms were present in low number (fig.4).

Results from the 1 mm mesh size sieve sub-sample show annelids Polychaeta, comprised of 19 species, with total number of 14.480 ind./m^2. *Capitella capitata* was the most abundant animal at all sites, except for station F and I. Nematodes worms were excluded because of their small size. Bivalvia were represented by at least 4 species and in total by 1.427 ind./m^2. Crustacean and Nemertea were present in low numbers, circa 100 ind./m^2 in total (fig.5).

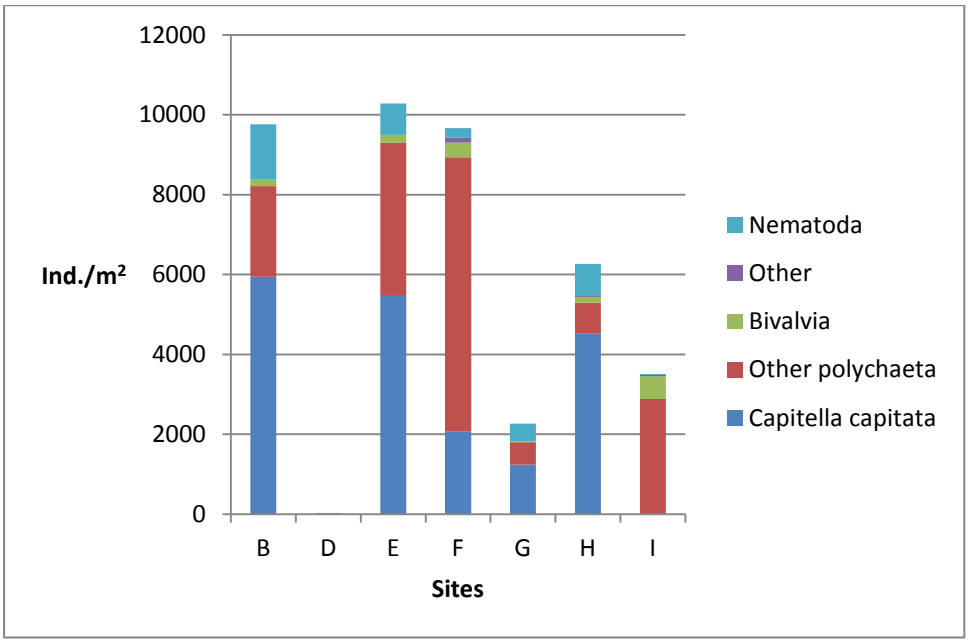

Figure 4: Abundances of 5 main groups of macrofauna communities for the sites in Fossfjörður 2015 after 500 µm mesh size sieve.

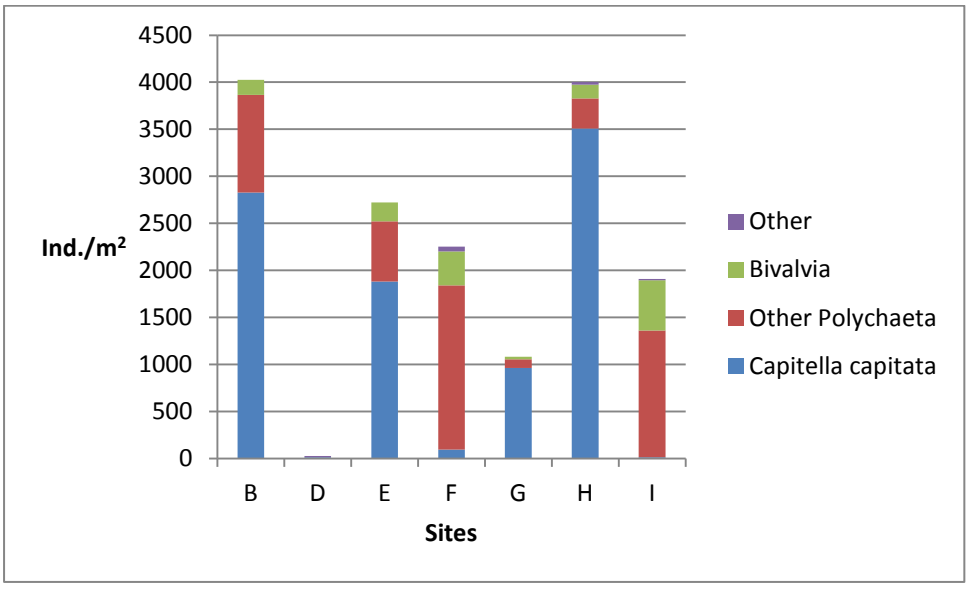

Figure 5: Abundances of 4 main groups of macrofauna community for the sites in Fossfjörður 2015 after 1 mm mesh size sieve.

Bivalves were more abundant at the reference site I (533 ind./m^2) followed by site F (360 ind./m^2) and site E (200 ind./m^2). *Ennucula tenuis* and *Thyasira flexuosa* were found at almost all sites except for D and G, and their abundance increased with increasing distance from the cages.

Results from the 1 mm mesh size sieve show that 9 species of polychaeta stand out with more than 100 ind./m2 for at least one of the sites. *Capitella capitata* was found at all sites but in high abundance at sites B, E and H (fig. 5). A chart with trends for the other 8 species can be found in figure 6. *Ampharete sp* was found at 4 sites but not right at the cages or at the reference site. The highest abundance of 160 ind./m^2 was found at site F and seems to increase away from the cages. *Chaetozone setosa* was found at 4 sites and its abundance is over hundred animals per m^2 at site E, F and I, respectively 30, 55 m and 500 meters from cages. *Cossura longocirrata* follows the same pattern but its highest presence was found at site B (107 ind./m^2). *Eteone longa* is also most abundant at B with 133 ind./m^2. *Microphthalmus aberrans* was also more present at B (160 ind./m^2) but also present at all sites except for D and I. *Ophelina acuminata* was present at 3 sites but its highest abundance was found at I (520 ind./m^2). *Parougia negridentata* was found at all stations except for D, and its abundance was highest at B (480 ind./m^2) and E (253 ind./m^2). *Prionospio fallax* is present at 4 sites but mainly at site F (813 ind./m^2) and I (426 ind./m^2).

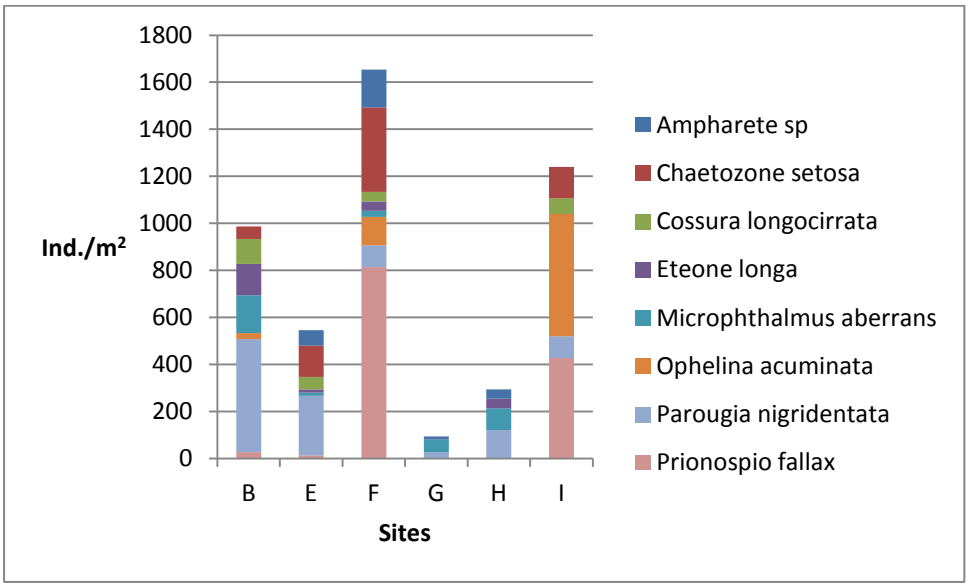

Figure 6: Distribution of 8 species of polychaeta found with an abundance > 100 ind./m2 at minimum one of the sites; *Capitella capitata* was excluded here.

Figure 7 shows the average abundance of the above mentioned 8 species in relation to its distance from the sea cages. 3 sites were 30 m away from the cages, 2 were 55 m away, plus the one reference site. The abundance of species such as *Ampharete sp, Chaetozone setosa, Ophelina acuminata* and *Prionospio fallax* is directly correlated to the distance from the cages. *Microphthalmus aberrans* and *Parougia nigridentata however* decrease in number away from cages. *Cossura longocirrata* and *Eteone longa* showed an indistinct trend. *Ophelina acuminata* and *Prionospio fallax* are almost absent at 30 m distance and *Ophelina acuminata* show a very high abundance only at the reference site.

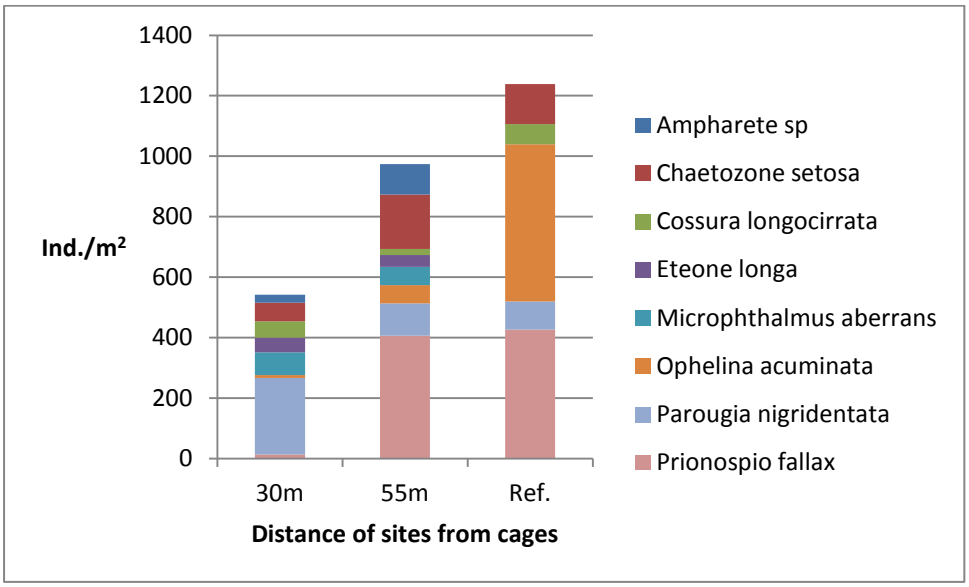

Figure 7: Average abundance of 8 most abundant polychaeta species in relation to their distance from the sea cages, *Capitella capitata* was excluded here. Reference site (Ref.) at 500 m from cages.

Locomotory and feeding habit guilds for the polychaetes found in this survey were compiled from available literature, and are presented in figure 8 and 9 (site D was exclude here). The majority of polychaetes found, are burrowing in the sediment rather than moving freely on the surface. Most of

those burrowing species are also surface deposit feeders while most of the free living species are carnivores. *Capitella capitata* was predominant at some sites and its feeding habit does not clearly fit in only one category, and was therefore (in fig. 9) categorised as a sub-surface deposit feeder. Filter feeders are almost absent in this survey and found only at the reference site.

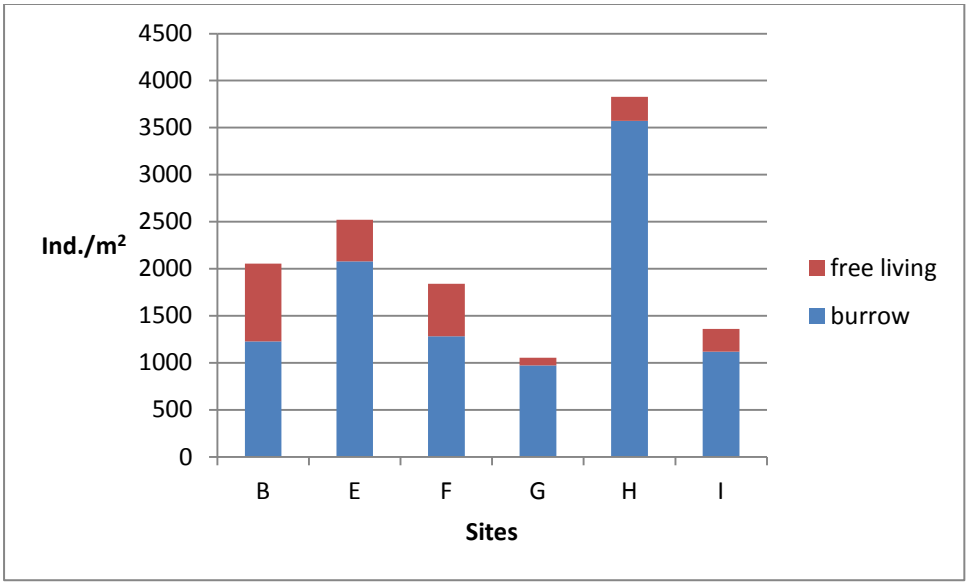

Figure 8: Polychaeta species found in this survey collected after their locomotory habit.

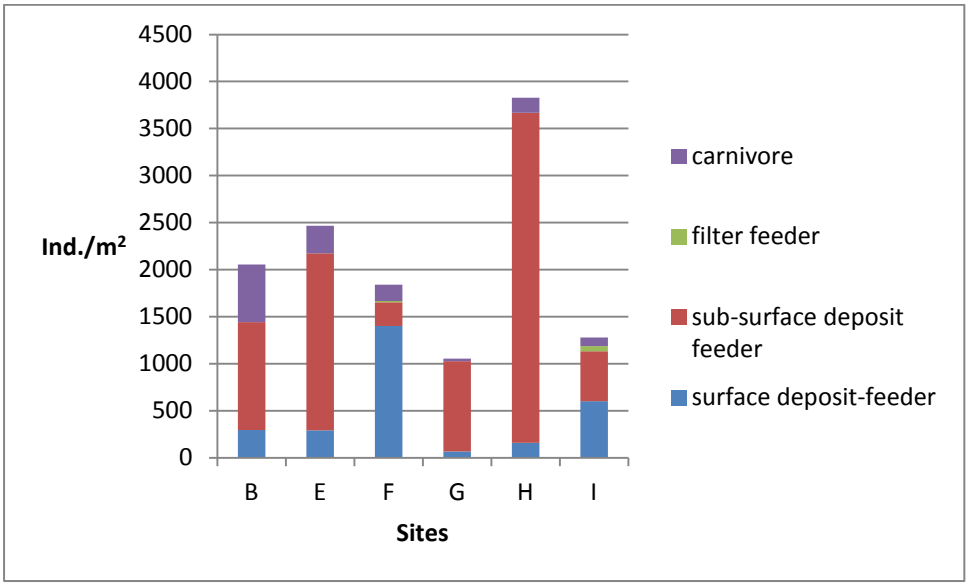

Figure 9: Polychaeta species found in this survey collected after their feeding habit.

Results from the analyses with Primer 6 show values of S (number of species or groups), N (number of individuals per m^2), evenness index (J´) and diversity index (H´log_2) for all sampled sites and for both mesh size sieves used in this survey (table 4). Nematodes are excluded from these calculations and the polychaeta family Ampharetidae represented by juvenile individuals was combined with the most common representative of the same family (*Ampharete sp*) found in the survey.

Table 4: Number of taxa (S), abundance (N), evenness index (J´) and Shannon-Wiener diversity index (H´) for the sampled sites in Fossfjörður 2015 (Nematodes are excluded from calculation) from two mesh size sieves.

Sites	Sieve 500 µm				Sieve 1 mm			
	S	N	J'	H'(log2)	S	N	J'	H'(log2)
B	11	8373	0,45	1,56	11	4027	0,49	1,70
D	2	27	--	--	2	27	--	--
E	14	9493	0,54	2,04	14	2719	0,48	1,83
F	20	9426	0,70	3,02	19	2253	0,75	3,21
G	10	1826	0,51	1,70	6	1080	0,28	0,73
H	12	5467	0,32	1,16	10	4000	0,27	0,89
I	20	3480	0,76	3,29	16	1906	0,75	3,02

The number of species varied between 2 (site D) and 20 (sites F and I) and increased away from the fish cages in both investigated directions (downstream and perpendicular), independently from the mesh size. Site F, located just 55 m from the cages in perpendicular direction, shows a number of species similar or higher than the reference site I, which is in 500 m distance downstream. Animal abundance does not follow the same pattern; it was similar between the sites E and F (respectively 30 and 55 m in perpendicular direction), but quite different for the downstream transect. The number of individuals showed a lower value at site G (30m); the value increase at site H (55 m) and then decreased towards the reference station I (500m).

Values of the evenness index show how similar in number of individuals, the community is at every sampling site. F for instance, is the only one that reaches a similar value as the reference site (I). Diversity index H' (log_2) resulted less than 1 at G and H (respectively 30 and 55 m downstream), less than 2 for B and E, and 3,21 at F (55m perpendicular direction) and I. Small differences are appreciated when comparing results from the two different mesh sizes. Noticeable is though the loss of 4 species at site G, when comparing between mesh sizes.

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Grandagarði 14
101 Reykjavík

SÝNI

NIÐURSTÖÐUR EFNA- OG ÖRVERUGREININGA

Sýni nr.: E-6689-6700-15

Gerð sýnis:	Sjávarset	**Móttekið:**	17.11.2015
Sendandi:	Fjarðalax ehf	**Rannsakað:**	23.11.2015
Sýnataka:	Fjarðalax ehf	**Verkkaupi:**	Fjarðalax ehf

Nr. sýnis	Merking sýnis	Heildar lífrænt kolefni TOC % w/w af þurrefni	Heildar köfnunarefni TN % w/w af þurrefni	Heildar fosfór P mg/g af þurrefni	Brennisteinn S µmol/g af þurrefni
E-6689	D1 – Fossfjörður A, 10.10.2015	2,8	0,38	3,3	-
E-6690	D2 – Fossfjörður A, 10.10.2015	2,8	0,39	3,1	-
E-6691	D3 – Fossfjörður A, 10.10.2015	3,6	0,48	3,6	-
E-6692	G1 – Fossfjörður A, 10.10.2015	2,8	0,37	2,3	210
E-6693	G2 – Fossfjörður A, 10.10.2015	2,9	0,41	2,4	204
E-6694	G3 – Fossfjörður A, 10.10.2015	3,1	0,47	2,8	191
E-6695	H1 – Fossfjörður A, 10.10.2015	1,8	0,28	1,0	-
E-6696	H2 – Fossfjörður A, 10.10.2015	1,6	0,24	1,1	-
E-6697	H3 – Fossfjörður A, 10.10.2015	1,8	0,24	1,1	-
E-6698	I1 – Fossfjörður A, 10.10.2015	2,6	0,42	1,2	-
E-6699	I2 – Fossfjörður A, 10.10.2015	2,6	0,41	1,4	-
E-6700	I3 – Fossfjörður A, 10.10.2015	2,6	0,42	1,3	-

Athugasemdir. Sýnin voru mæld hjá Eurofins Jena í Þýskalandi

Reykjavík, 8. desember 2015

Hörður Ólason

Hörður Ólason
Efnaverkfræðingur

Niðurstöður eiga einungis við um það sýni sem mælt var.
Upplýsingar um aðferðafræði, nákvæmni og næmni aðferða má fá hjá Rannsóknarþjónustunni Sýni hf.
Óheimilt er að afrita prófunarskýrslur nema í heilu lagi ef ekki liggur fyrir skriflegt samþykki frá Rannsóknarþjónustunni Sýni ehf.

Síða 1 af 1

RANNSÓKNARÞJÓNUSTAN SÝNI EHF. • LYNGHÁLSI 3 • 110 REYKJAVÍK • KT. 410493-2689 • SÍMI 512 3380 • FAX 512 3399

Figure 10: Values of TOC (%w/w), TN (%w/w), P (mg/gr) and Sulphide (µmol/gr) of respectively three samples for the sites D, G, H and I.

Results from chemical analyses (fig.10) show values of TOC, TN, P and S for 3 samples at 4 sites (D, G,H and I). For site D, values of TOC were between 2,8 and 3,6 % w/w with correspondent values of TN between 0,38 and 0,48 % w/w; and values of P between 3,1 and 3,6 mg/g. Site G shows levels of TOC between 2,8-3,1 % w/w, here also the total P was lower (2,3-2,8 mg/g), but the level of S was here between 191 and 210 µmol/gr. At site H (55m downstream) the value of TOC was between 1,6 and 1,8 % w/w , TN 0,24-0,28 % w/w, P 1,0-1,1 mg/g and no presence S was detected. Values of TOC, TN and P were averaged and compared with the reference site I (fig.10). Values measured at the 4 sites are close to the value found at the reference site except for P. Values that were found at H (55m from cages downstream) are actually lower than those found at the reference site I.

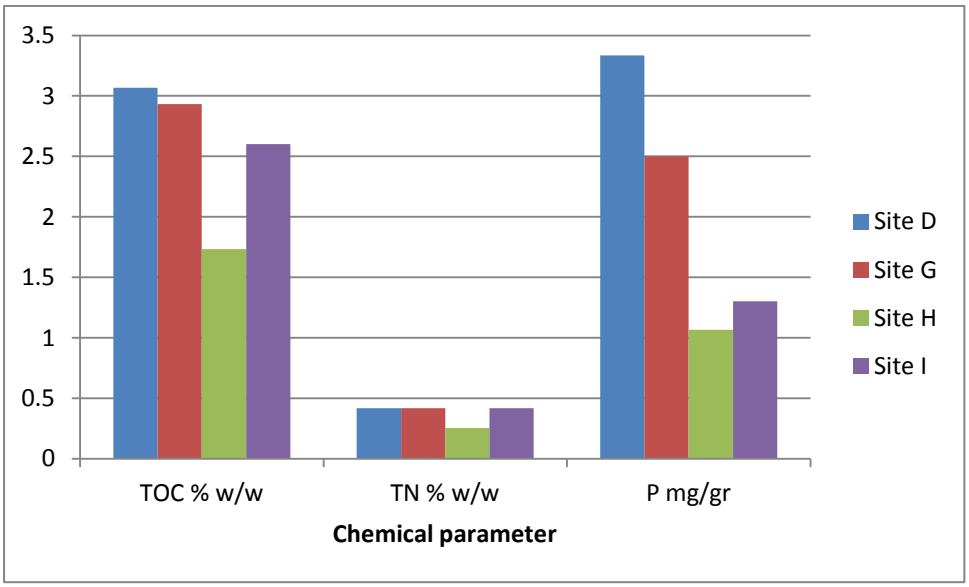

Figure 11. Comparison between values of TOC (%w/w), TN (%w/w) and P (mg/gr) for sampled sites.

DISCUSSION

This monitoring project in Fossfjörður was based on samples from 9 different locations at varying distance from the actual aquaculture cages in order to appreciate the trends imposed on the benthic community by fish farming.

Decrease in taxa numbers and diversity, together with the increased presence of the indicator species *Capitella capitata,* indicate a higher accumulation of organic matter in the proximity to the cages. *Capitella capitata* is a notorious indicator species of organic enrichment in mariculture (Pearson & Rosenberg 1978, Rygg 2002, Dean 2008). Sample site D was deprived of macrofauna; and sulphide smell evaluation (table 1) also points to the over accumulation of organic matter in the proximity to the cages.

Values of TOC, TN and P measured in proximity of cages do not differ greatly from values found at the reference site I. Sulphide values found at site G were around 200 µmol/gr but because of the applied sample preparation those results were not comparable with the threshold requirements from ASC standard set at 1.500 µmol/L.

Because of their species diversity and ability to survive in different environmental conditions, Polychaeta worms are the most represented class in this survey. Locomotory and feeding strategy of found polychaetes were investigated; however, it is rather the presence or absence of certain species

that indicates the magnitude of the organic enrichment. Sampling sites located at 30 m and 55 m from cages, proved to be rather different, due to the predominant sea current direction. Most of the species found at 30 m distance (inside the AZE area as defined by ASC standard) are considered to be able to tolerate a certain degree of organic deposition (Rygg 2002, Dean 2008, Böðvar Þórisson et al. 2010, Þorleifur Eiríksson et al. 2012). Exceptions were the polychaeta *Ampharete sp,* found at site E and G, with an abundance not over the 100 ind/m^2, and two bivalve species *Ennucula tenuis* and *Thyasira flexuosa,* found in certain abundance, but only *Ennucula tenuis* over 100 ind./m^2 in st.E.

The sampling sites that were 55 meters from cages show an improvement in number of species especially site F (perpendicular to the main current). Here species as *Ampharete sp, Ophelina acuminata, Ennucula tenuis, Nuculana spp* were found with over 100 ind./m^2.

Values of the Shannon-Wiener index were less than 1 at site G and H (respectively 30 and 55 m downstream). High abundance of *Capitella capitata,* compared to other species, is the cause of this low value of the diversity index for site H, located outside of the AZE area. At site F, at the same distance, the diversity index scored 3,21; therefore higher than 3 as defined by ASC standard. Values of faunal index outside of the AZE area (according to ASC Salmon standards and the Water Framework Directive) scored from bad to good. The difference in values is caused by the main current direction.

Results from this survey show that the aquaculture area in Fossfjörður is in a situation of distress due to the accumulation of organic matter under the cages. The environmental impact however, was restricted to an area of circa 50 m in the main current direction. Special danger due to sulphide accumulation was not detected by chemical analyses, but the area could benefit from a period of fallowing.

Figure 5. View of Fossfjörður.

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APPENDIX 1

Table 5. Benthic community in Fossfjörður2015 after 500 µm mesh size sieve in individuals/ m2.

Taxa/ *species*	**Sites**						
	B	**D**	**E**	**F**	**G**	**H**	**I**
Polychaeta							
Ampharete borealis	0	0	53	173	0	40	0
Ampharetidae	0	0	13	0	13	0	0
Capitella capitata	5947	13	5467	2067	1240	4520	13
Chaetozone setosa	107	0	1147	2000	27	53	547
Cossura longocirrata	240	0	1107	1200	13	27	360
Eteone longa	133	0	67	40	40	80	27
Euchone sp	0	0	0	120	0	0	80
Galathowenia oculata	0	0	0	0	0	0	40
Goniada maculata	0	0	0	0	0	0	13
Levinsenia gracilis	0	0	13	0	0	0	13
Mediomastus fragilis	80	0	147	40	173	53	27
Melinna cristata	0	0	0	27	0	0	0
Microphthalmus aberrans	533	0	213	147	160	213	27
Nephtys sp	0	0	13	67	0	0	0
Ophelina acuminata	27	0	0	160	0	0	520
Parougia nigridentata	1120	0	1027	1053	133	307	160
Praxillella sp	0	0	0	13	0	0	0
Prionospio fallax	27	0	13	813	0	0	413
Prionospio sp	0	0	0	1013	0	0	507
Scalibregma inflatum	0	0	0	0	0	0	13
Scoloplos armiger	0	0	0	0	0	0	40
Syllis sp	0	0	13	0	0	0	0
Terebellidae	0	0	0	0	0	0	80
Bivalvia							
Ennucula tenuis	80	0	107	187	0	80	307
Nuculana spp	0	0	0	107	0	0	133
Thyasira flexuosa	80	0	93	80	13	67	133
Yoldia hyperborea	0	0	0	0	13	0	0
Gastropoda							
Dendronotus frondosus	0	0	0	0	0	13	0
Crustacea							
Mysidacea	0	13	0	0	0	0	0
Amphipoda	0	0	0	13	0	0	0
Leucon nasicoides	0	0	0	0	0	13	0
Pandalus borealis	0	0	0	13	0	0	0
Nemertea	0	0	0	93	0	0	27
Nematoda	1387	0	787	240	440	800	27

APPENDIX 2

Table 6. Abundance (individuals/m2) for benthic community in alphabetical order after 1mm mesh size sieve for Fossfjörður 2015 used for Primer 6.

Taxa/ *species*	**Sites**						
	B	**D**	**E**	**F**	**G**	**H**	**I**
Ampharete borealis	0	0	66	160	13	40	0
Amphipoda	0	0	0	13	0	0	0
Capitella capitata	2827	13	1880	93	960	3507	13
Chaetozone setosa	53	0	133	360	0	0	133
Cossura longocirrata	107	0	53	40	0	0	67
Dendronotus frondosus	0	0	0	0	0	13	0
Ennucula tenuis	80	0	107	173	0	80	307
Eteone longa	133	0	13	40	0	40	0
Euchone sp	0	0	0	13	0	0	13
Galathowenia oculata	0	0	0	0	0	0	40
Leucon nasicoides	0	0	0	0	0	13	0
Levinsenia gracilis	0	0	13	0	0	0	13
Mediomastus fragilis	53	0	53	0	0	27	13
Melinna cristata	0	0	0	27	0	0	0
Microphthalmus aberrans	160	0	13	27	53	93	0
Mysidacea	0	13	0	0	0	0	0
Nemertea	0	0	0	27	0	0	13
Nephtys sp	0	0	13	40	0	0	0
Nuculana spp	0	0	0	107	0	0	133
Ophelina acuminata	27	0	0	120	0	0	520
Pandalus borealis	0	0	0	13	0	0	0
Parougia nigridentata	480	0	253	93	27	120	93
Praxillella sp	0	0	0	13	0	0	0
Prionospio fallax	27	0	13	813	0	0	426
Scalibregma inflatum	0	0	0	0	0	0	13
Syllis sp	0	0	13	0	0	0	0
Terebellidae	0	0	0	0	0	0	13
Thyasira flexuosa	80	0	93	80	13	67	93
Yoldia hyperborea	0	0	0	0	13	0	0

APPENDIX 3

Table 7. Abundance (individuals/m2) for benthic community in alphabetical order after 500 µm mesh size sieve for Fossfjörður 2015 used for Primer 6.

Taxa/ *species*	**Sites**						
	B	**D**	**E**	**F**	**G**	**H**	**I**
Ampharete sp	0	0	66	173	13	40	0
Amphipoda	0	0	0	13	0	0	0
Capitella capitata	5947	13	5467	2067	1240	4520	13
Chaetozone setosa	107	0	1147	2000	27	53	547
Cossura longocirrata	240	0	1107	1200	13	27	360
Dendronotus frondosus	0	0	0	0	0	13	0
Ennucula tenuis	80	0	107	187	0	80	307
Eteone longa	133	0	67	40	40	80	27
Euchone sp	0	0	0	120	0	0	80
Galathowenia oculata	0	0	0	0	0	0	40
Goniada maculata	0	0	0	0	0	0	13
Leucon nasicoides	0	0	0	0	0	13	0
Levinsenia gracilis	0	0	13	0	0	0	13
Mediomastus fragilis	80	0	147	40	173	53	27
Melinna cristata	0	0	0	27	0	0	0
Microphthalmus aberrans	533	0	213	147	160	213	27
Mysidacea	0	13	0	0	0	0	0
Nemertea	0	0	0	93	0	0	27
Nephtys sp	0	0	13	67	0	0	0
Nuculana spp	0	0	0	107	0	0	133
Ophelina acuminata	27	0	0	160	0	0	520
Pandalus borealis	0	0	0	13	0	0	0
Parougia nigridentata	1120	0	1027	1053	133	307	160
Praxillella sp	0	0	0	13	0	0	0
Prionospio fallax	27	0	13	1826	0	0	920
Scalibregma inflatum	0	0	0	0	0	0	13
Scoloplos armiger	0	0	0	0	0	0	40
Syllis sp	0	0	13	0	0	0	0
Terebellidae	0	0	0	0	0	0	80
Thyasira flexuosa	80	0	93	80	13	67	133
Yoldia hyperborea	0	0	0	0	13	0	0