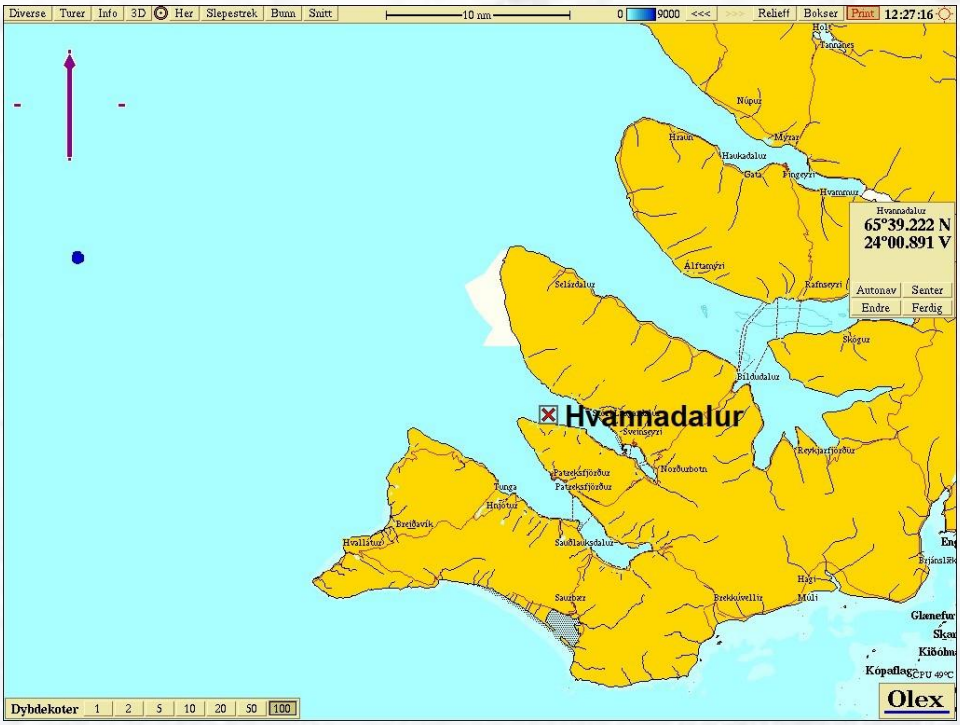
Akvaplan niva

Rapport Report

Arctic Sea Farm

Pre survey (type C)

Hvannadalur, 2019.



NORSK AKKREDITERING TEST 079

Akvaplan-niva AS Report: 61376.01

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Report title / Rapporttittel

Arctic Sea Farm. Pre survey (type C) Hvannadalur, 2019.

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Akvaplan-niva report nr / rapport no
61376.01

Date /Dato
10.10.2019

No. of pages / Antall sider
15 + appendix

Distribution / Distribusjon
Through client

Client /Oppdragsgiver
Arctic Sea Farm, Aðalstræti 20, 400 Ísafjörður, Iceland

Client's reference / Oppdragsg. referanse
Steinunn Guðný Einarsdóttir

Summary / Sammendrag
The results from the pre survey at the farming site Hvannadalur in July 2019 showed that the sediment was somewhat loaded with organic carbon and the copper concentrations were within reported natural levels for bottom sediment around Iceland (Egilsson *et al*., 1999). No load effect was recorded in the fauna and faunal index nEQR showed relatively good conditions and no impact at the stations (0.55 - 0.59). The diversity index H' varied between 2.0 and 2.6. NS 9410:2016-assessment of the community in the local impact zone (C1) showed environmental condition 1 (Very good). No pollution indicators were recorded among the top-10 species on any of the stations. The redox measurements (pH/Eh) gave point 1 at C1 and 0 acc. Appendix D in NS 9410:2016 for the other sampling stations. The oxygen saturation in May was relatively good in the whole water column with 60 % in the bottom water.

Project manager / Prosjektleder

Arnþór Gústavsson

Quality control / Kvalitetskontroll

Roger Velvin

Contents

Foreword

Akvaplan-niva completed an environmental pre-survey of the type C at the Hvannadalur site. The C-survey is carried out in accordance with NS 9410:2016, and is part of a pre-survey of new locations and is in accordance with Chapter 5.0. Accordingly a reference station about 1 km away from the fish farm was included in the study. The survey includes pH/redox measurements (Eh), hydrography, geochemical analyses and analyses of the bottom fauna at the fish farming site. Results from five stations are included in the pre-survey. This survey is done upon request from Arctic Sea Farm hf.

The following personnel have contributed in this work:

Arnþór Gústavsson	Akvaplan-niva	Field work, report, project manager.
Hans-Petter Mannvik	Akvaplan-niva	Identification of bottom fauna (Echinodermata). Report, professional assessments and interpretations.
Roger Velvin	Akvaplan-niva	Identification of bottom fauna (Varia). QS report, professional assessments and interpretations.
Rune Palerud	Akvaplan-niva	Identification of bottom fauna (Crustaceans). Statistics.
Jesper Hansen	Akvaplan-niva	Identification of bottom fauna (Mollusca and Polychaeta).
Kristine H Sperre	Akvaplan-niva	Coordination of sorting of bottom fauna.
Ingar H. Wasbotten	Akvaplan-niva	Coordination of geo-chemical analyses.

Akvaplan-niva would like to thank Steinunn Einarsdóttir, quality manager, and other staff members at Arctic Sea Farm, for good cooperation.

Accreditation information:

The survey is done by Akvaplan-niva AS with ALS Laboratory Group (Czech Republic) as a sub-contractor.

NORSK AKKREDITERING TEST 079	Akvaplan-niva AS er akkreditert av Norsk Akkreditering for feltinnsamlinger av sediment og fauna, analyser av TOC, TOM, TN, kornstørrelse, makrofauna og faglig vurderinger og fortolkninger, akkrediteringsnr. TEST 079. Akkrediteringen er i hht. NS-EN ISO/IEC 17025.
Czech Accreditation Institute (Lab nr 1163)	ALS Laboratory Group er akkreditert av Czech Accreditation Institute (Lab nr 1163) for analyser av kobber.

Kópavogur, 10.10.2019

Arnþór Gústavsson

Arnþór Gústavsson

Project manager

1 Summary of C-results

Information client			
Title :	C-survey Hvannadalur, 2019.		
Report nr.	61376.01	Site:	Hvannadalur
Site nr.	N/a	Map coordinates (construction):	65°39,222 N 24°00,891 W
		Municipal:	Vesturbyggð
MTB-permission:	3.400	Operations manager: rett navn	Stein Ove Tveiten
Client:	Arctic Sea Farm hf.		

Biomass/production status at time of survey 15.07.2019			
Fish group:	Salmon	Biomass on examination:	0
Feed input:	0	Produced amount of fish:	0
Type/time of survey			
Maximum biomass:		Follow up study:	
Fallow (resting period):		New locationi:	X

Results from the C study /NS 9410 (2016) – Main results from soft bottom fauna			
Faunal index nEQR (Veileder 02:2018)		**Diversity index H' (Shannon-Wiener)**	
Fauna C1 (inner)	0,570	Fauna C1 (inner)	2,26
Fauna C2 (outer)	0,583	Fauna C2 (outer)	2,41
Fauna C3	0,545	Fauna C3	2,03
Fauna C4 (depth layers)	0,577	Fauna C4 (depth layers)	2,36
Fauna C5	0,590	Fauna C5	2,62
Date fieldwork:	15.07.2019	**Date of report:**	10.10.2019
Notes to other results (sediment, pH/Eh, oxygen)			nTOC from 27.4 to 30.5 Copper from 37.7 to 45.4 mg/kg pH/Eh level 1 (C1) and 0 (other st.) O_2 saturation 60 % in the bottom layer.
Responsible for field work:	Arnþór Gústavsson	Signature:	Arnþór Gústavsson

2 Introduction

2.1 Background and aim of study

Akvaplan-niva on behalf of Arctic Sea Farm completed a pre-survey (type C) for a new fish farming site Hvannadalur in Tálknafjörður, Iceland (Figure 1). The survey fulfils the requirements from the Icelandic authorities regarding bottom surveys referring to the standard ISO 12878 and the requirements for environmental bottom surveys (according to Vöktunaráætlun). An environmental study was simultaneously undertaken, with reference to chapter 5.0 in NS 9410:2016 which follows the methodology for C- study. A pre-survey (type C) is aimed at studying the environmental conditions of the bottom sediments along a transect sector from the fish farm that extends from the local, to the intermediate and to the regional impact zones. The main emphasis is on the study of the soft bottom fauna which is conducted according to standards ISO 5567-19:2004 and ISO 16665:2014. The obligatory parameters that are included in the survey are described in NS 9410:2016.

A classification or threshold values for this type of survey have not been developed Icelandic officials so it is not possible to apply the classification based on Norwegian threshold values to Icelandic conditions. We do however report the results with these same indexes with reference to Norwegian threshold values but it should be emphasized that some of these (such as NSI) are developed according to Norwegian conditions. For further descriptions of these indexes see details in Appendix 1 and Miljødirektoratets Veileder 02:2018.

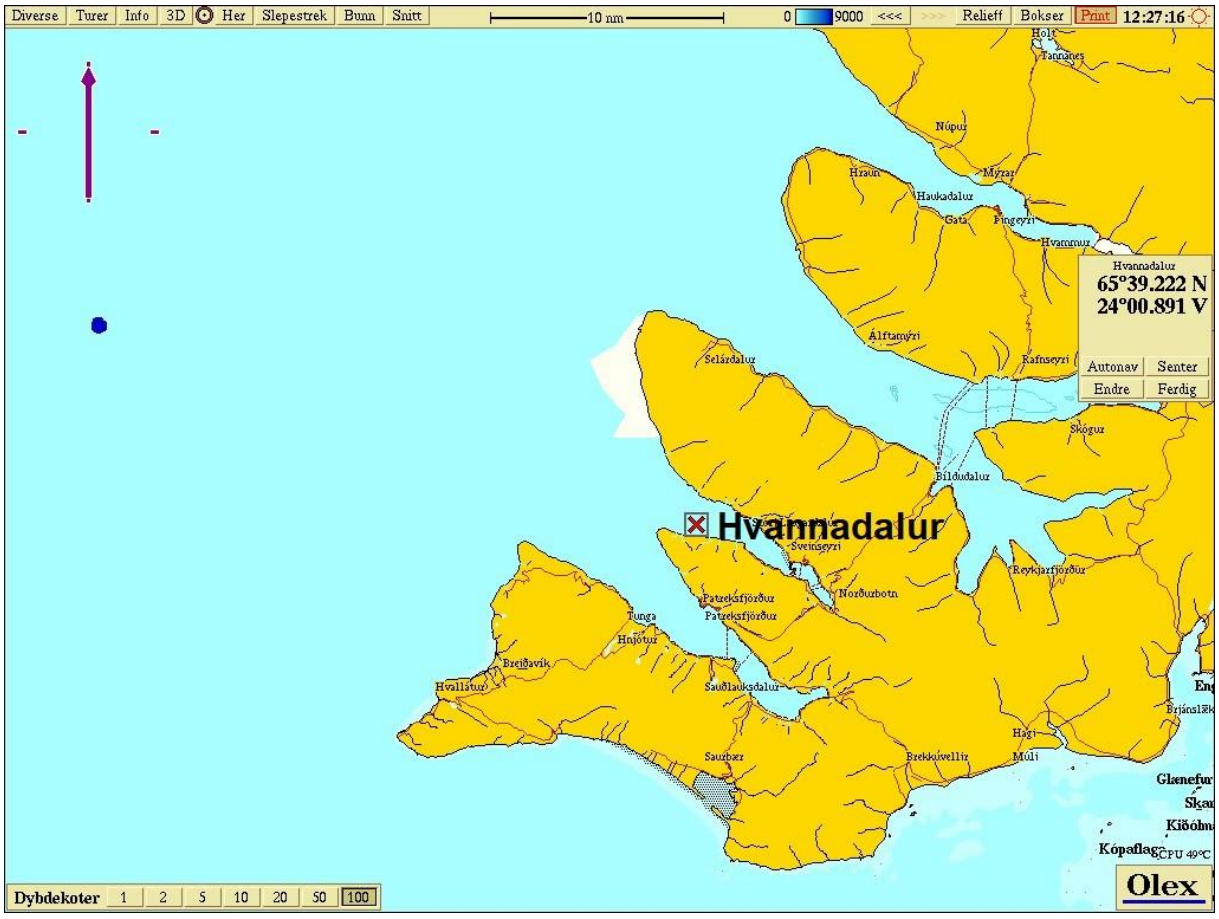

Figure 1. Overview of southern part of Westfjords with the farming site Hvannadalur (red cross). The map coordinates for the midpoint of the farming site are given at right site of the picture.

2.2 Site operation and feed use

Hvannadalur is new fish farming site and has not been in operation before. Therefore, a pre-survey is carried out for the area. The plant is a frame mooring with a total of twelve 160 meters circumference cages in a 2 x 6 configuration, in 2 independant mooring systems.

In Iceland, the MTB (maximum allowed biomass) limit is not given a site level as in Norway. The MTB limit determines how much live fish the holder of the permit can have standing in the sea at any time. In Iceland the allowed production is regulated at two levels, site level and company level. For this site the estimated maximal standing biomass for the next generation is 3400 tonnes, used as MTB here (Einarsdóttir, pers reference).

2.3 Previous surveys

Hvannadalur is a new fish farming site. Akvaplan-niva AS has not done any previous environmental surveys of the type B/C (NS 9410) at the Hvannadalur site. The contracting fish farmer has not presented any previous specific surveys for the soft bottom fauna of the site Hvannadalur. There are some other investigations that have been conducted in Tálknafjörður related to fish farming activities, but none directly affiliated with Hvannadalur.

3 Materials and methods

3.1 Professional program

The choice of study parameters, placement of sampling stations and other criteria for the study is based on descriptions in NS 9410 (C-surveys). An overview of the planned professional program is given in Table 1.

Akvaplan-niva is accredited for field work, analyses of samples and professional evaluation of results in accordance with applicable standards and guidelines (Veiledere). For implementation and follow through, the following standards and quality assurance systems were used:

- ISO 5667-19:2004: *Guidance on sampling of marine sediments.*
- ISO 16665:2014. *Water quality – Guidelines for quantitative sampling and sample processing of marine soft-bottom macro fauna.*
- NS 9410:2016. *Miljøovervåking av bunnpåvirkning fra marine oppdrettsanlegg.*
- Internal procedures. *Kvalitetshåndbok for Akvaplan-niva.*
- Veileder 02:2018. *Klassifisering av miljøtilstand i vann*. Norsk klassifiseringssystem for vann i henhold til Vannforskriften. Veileder fra Direktoratgruppen.
- M-608/2016. Grenseverdier for klassifisering av vann, sediment og biota. Miljødirektoratet, 2016.

Table 1. The planned professional program for the C-survey at Hvannadalur, 2019. TOC = total organic carbon. Korn = grain size in sediment. TOM = total organic material. TN = total nitrogen. Cu = Copper. pH/Eh = acidity and redox potential.

Station	Type analyses/parameters
C1	Quantitative analyses of bottom fauna. TOM. TOC. Korn. TN. 2 x Cu. pH/Eh.
C2	Quantitative analyses of bottom fauna. TOM. TOC. Korn. TN. 2 x Cu. pH/Eh.
C3	Quantitative analyses of bottom fauna. TOM. TOC. Korn. TN. 2 x Cu. pH/Eh.
C4	Quantitative analyses of bottom fauna. TOM. TOC. Korn. TN. 2 x Cu. Hydrography/O_2. pH/Eh.
C5/Cu-ref1	Quantitative analyses of bottom fauna. TOM. TOC. Korn. TN. 2 x Cu. pH/Eh.
Cu-ref2	2 x Cu.

Field work was completed on 15.07.2019.

3.2 Placement of stations and local conditions

The number of stations was calculated with reference to the sites estimated maximal standing biomass for the first generation which is 3.400 tonnes (used as MTB here). According to the standard, five sampling stations should be examined. Depth and position of the stations are given in Table 2 and shown in Figure 2. The stations were placed in accordance to the direction of the main oceanic current direction at 15 m depth (Heggem, 2019).

Table 2. Depth, distance between the nearest frame of the fish farm and sampling stations and coordinates for C-stations at Hvannadalur, 2019.

Station	Depth, m	Distance from frame, m	Position N	W
C1	57	44	65º39.203	24º00.469
C2	58	500	65º39.120	23º59.772
C3	58	99	65º39.187	24º00.409
C4	58	176	65º39.139	24º00.212
C5/Cu ref1	59	1000	65º39.006	23º59.173
Cu ref2	59	750	65º39.607	24º01.879

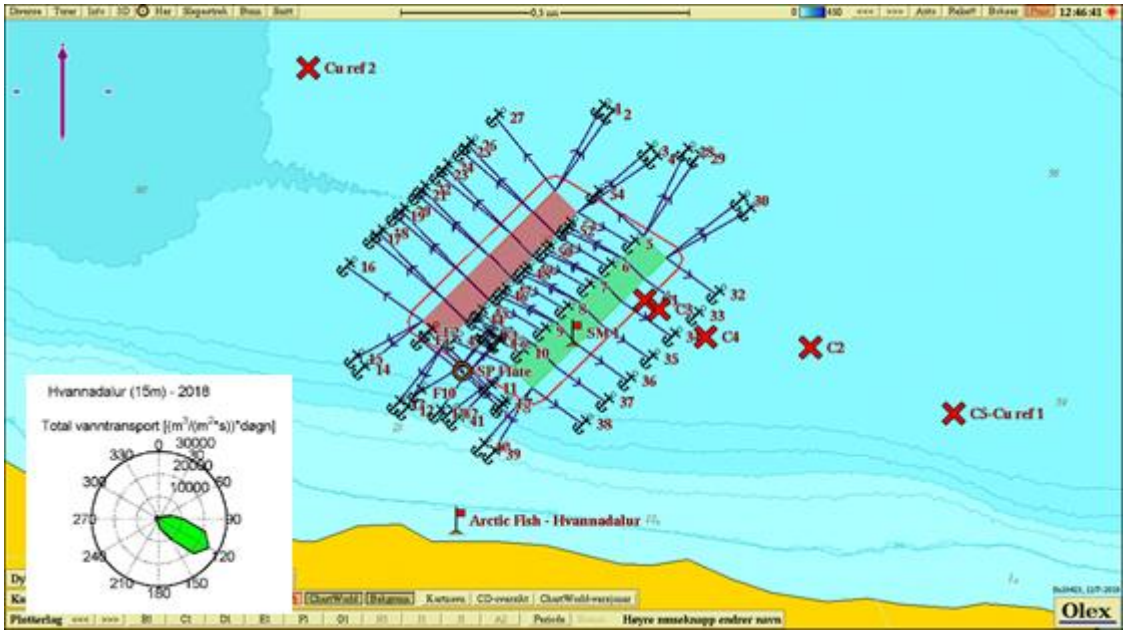

Figure 2. Map showing the sampling stations for the C-survey at Hvannadalur, 2019. Current measurements used were from 15 m depth (Heggem, 2019).

3.3 Hydrography and oxygen

At station C4, hydrographic measurements, salinity, temperature, density and oxygen saturation, were carried out for vertical profiles for from surface to bottom. These were carried out using a Sensordata CTDO 204 probe.

3.4 Soft bottom sampling and analyses

3.4.1 Fieldwork

The samples were collected with a 0.1 m^2 bottom grab (van Veen). The sample material was collected through inspection openings. Samples for TOC, TOM, TN and Cu were taken off from the top 1 cm layer of the sediment and for grain size analyses from the top 5 cm using a hollow pipe. Only samples with an undisturbed surface were approved. The samples were frozen for further processing in the laboratory.

3.4.2 Total organic material (TOM)

The amount of TOM in sediment was determined by weight loss after combustion at 495 °C. The percent weight loss was calculated. The reproducibility of the TOM analyses is checked during the analyses by using a standard household sediment that contains TOM with a known

level. Standard calcium carbonate was burned together with the samples as a control of the amount of carbonate that was not burned in the analyses process.

3.4.3 Total nitrogen (TN)

After drying the samples at 40°C, the amount of total nitrogen (TN) was quantified by electrochemical determination. The internal method is based on NS-EN 12260:2003 (Vannundersøkelse – Bestemmelse av bundet nitrogen (TNb) etter oksidasjon til nitrogenoksider).

3.4.4 Total organic carbon (TOC) and grain size

The proportion of fine material, the fraction less than 63 μm, was determined gravimetrically after wet-sieving of the samples. The results are presented as proportion of fine material on a dry weight basis.

After drying the samples at 40 °C, the content of total organic carbon (TOC) was determined by NDIR-detection in accordance with DIN19539:2016 (Investigation of solids – Temperature-dependent differentiation of total carbon (TOC_{400}, ROC, TIC_{900})). In order to classify the environmental conditions based on the content of TOC, the measured concentrations are normalized for proportion of fine substance (nTOC) using the equation: nTOC = TOC + 18 (1 – F), where TOC and F represent a measured TOC value and the proportion of fine substance (%) in the sample (Aure *et al.*, 1993).

The classification of the environment conditions for the sediment is based on normalized TOC, and was carried out according to "Veileder" 02:2018.

Classification of condition for organic content in the marine sediment.

nTOC, mg/g	< 20 I Very good	20 - 27 II Good	27 - 34 III Average	34 - 41 IV Bad	> 41 V Very bad

3.4.5 Metal analysis - copper (Cu)

The samples for metal analysis were freeze-dried before being placed in a microwave oven in a sealed Teflon container with concentrated ultrapure nitric acid and hydrogen peroxide. The concentration of copper (Cu) was determined by means of ICP-SFMS.

Classification of the environmental condition with respect to Cu is based on reference to the Norwegian Environmental Directorate's veileder M-608/2016.

Classification for copper in the marine sediment.

Cu mg/kg	< 20 Klasse I	20 - 84 Klasse II	20 - 84 Klasse III	84 - 147 Klasse IV	> 147 Klasse V

3.4.6 Redox- and pH measurements

At all the stations, a quantitative chemical examination of the sediment was carried out. Acidity (pH) and redox potential (Eh) were measured using electrodes and the YSI Professional Plus instrument. In accordance to the manual of the instrument, 200 mV was added to the measured ORP (the Oxydation Reduction Potential) value.

3.5 Soft bottom fauna investigation

3.5.1 About effect of organic material on bottom fauna

The emission of organic material from fish farms can contribute to the deterioration of conditions for many of the organisms living in the bottom sediment. Negative effects in the bottom fauna can best be assessed through quantitative bottom fauna analyses. Many soft

bottom species have low mobility, the fauna composition will largely reflect the local environmental conditions. Changes in the bottom fauna communities are a good indication of unwanted organic loads. Under natural conditions, the communities typically consist of many species. High number of species (diversity) is, amongst other things, dependent on favorable conditions for the fauna. However, moderate increases in organic load can stimulate the fauna and result in an increased number of species found. Larger organic loads can result in less favourable conditions where opportunistic species increase their individual numbers, while the species not suited are knocked out resulting in a reduced diversity of species. Changes in species diversity near emission points of feed and fecal matter can, to a large degree, be attributed to changes in organic content (from the feed and fecal matter) in the sediment.

3.5.2 Sampling and fixation

All the bottom fauna samples were taken with a 0.1 m^2 van Veen grab. Only grab samples where the grab was completely closed and the surface undisturbed were approved. After approval, the contents were washed through a 1 mm seive and the remaining material fixed with 4 % formalin with Bengal Rose dye added and neutralized with borax. In the laboratory, the animals were sorted from the remaining sediment.

3.5.3 Quantitative bottom fauna analysis

At all stations, two samples (replicates) were collected in accordance with guidelines in NS 9410 (2016). After sorting the sample material was processed quantitatively. The bottom fauna was identified to the lowest level possible, and quantified by specialists (taxonomists). The quantitative lists of species were analyzed statistically. See Appendix 1 for description of analysis methods. The following statistical methods were used to describe community structure and to assess the similarity between different communities:

- Shannon-Wiener diversity index (H')
- Hurlberts diversity index (ES_{100}) – expected number of species pr. 100 individuals
- Pielou's evenness index (J)
- Sensitivities index (Ømfintlighet) (ISI_{2012}), unsuitable at low individual/species number
- Sensitivity index (NSI)
- Composite index for diversity of species and sensitivity (NQI1)
- Sensitivities index which is included in NQI1 (AMBI)
- Normalized EQR (nEQR)
- Number of species plotted against the number of individuals in geometric arts classes
- Clusteranalyes
- The ten most dominant taxa per station (top-ten)

4 Results

4.1 Hydrography

The hydrographical profile for the deep station C4 in July 2019 is presented in Figure 3.

The temperature decreased from 10 ºC in the surface layer to 6 ºC in the bottom water and the oxygen saturation decreased from 110 % in the upper layer to 60 % in the bottom layer.

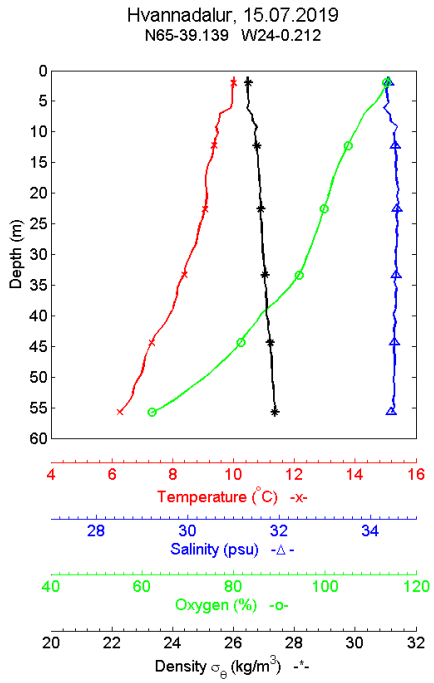

Figure 3. Vertical profiles. Temperature, salinity, density and oxygen at C4 at Hvannadalur, 2019.

4.2 TOC, TOM, TN, C/N, grain size and pH/Eh

The level of total organic material (TOM), total organic carbon (TN), C/N-relationship, grain size distribution in sediment (Pelitt) and pH/Eh in the sediment is presented in Table 3.

TOM-levels were relatively high with values between 12.9 and 14.2 %. TN-levels were low (5.6 - 6.5 mg/g) as was the C/N-relationship. TOC-levels were high at the sampling stations and nTOC varied from 27.4 to 30.5. The sediments were fine grained with pelite ratio between 79.7 and 89.8 %.

Redox measurements (pH/Eh) gave a level of 1 at C1 and 0 for the other stations according to Appendix D in NS 9410:2016.

Table 3. Sediment description, TOM (%), TOC (mg/g), TN (mg/g), C/N, grain size distribution (pelitt ratio % <0,063 mm) and pH/Eh. Hvannadalur, 2019.

St.	Sediment description	TOM	TOC	nTOC*	TN	C/N	Pelitt	pH/Eh
C1	Clay	13.6	26.5	28.3	6.5	4.1	89.8	7.7/ 65
C2	Clay	14.0	24.8	28.5	5.6	4.4	79.7	7.7/ 177
C3	Clay	14.2	25.3	27.4	5.6	4.5	87.9	7.8/ 105
C4	Clay	13.4	26.9	30.5	5.8	4.6	80.4	7.7/ 213
C5	Clay	12.9	25.9	29.4	6.4	4.1	80.5	7.7/ 235

4.3 Copper

The level of copper in the bottom sediments are shown in Table 4. The levels varied from 39.7 to 45.4 mg/kg.

Table 4. Copper (Cu), mg/kg TS. C Hvannadalur, 2019.

St.	Cu repl. 1	Cu repl. 2
C1	41.5	40.1
C2	41.6	44.9
C3	45.4	43.2
C4	41.5	43.0
C5/Curef1	43.4	41.7
Curef2	39.7	41.8

4.4 Soft bottom fauna

4.4.1 Faunal indexes and ecological classification

Results from the quantitative soft bottom faunal analyses at the C-stations are presented in Table 5. Faunal index nEQR is presented without the density index (DI) in accordance with recommendations from the Norwegian Environment Agency (Miljødirektoratet).

Number of individuals varied from 369 (C1) to 501 (C2) and number of species from 14 (C3) to 25 (C5). The diversity H' was below 3,0 at all stations. The overall index nEQR varied from 0,545 (C3) to 0,590 (C5).

J (Pielous evenness index) is a measure of how equally individuals are divided between species and will vary between 0 and 1. A station with low-value has a "crooked" individual distribution between the species, indicates a disturbed bottom fauna community. The distribution was somewhat uneven at some stations and varied from 0,56 (C3) to 0,62 (C5).

Table 5. Number of species and individuals pr. 0,2 m2. H´ = Shannon-Wieners diversity index. ES100 = Hurlberts diversity index. NQI1 = overall index (diversity and sensitivity). ISI2012 = sensitivity index. NSI = sensitivity index. J = Pielous evenness index. AMBI = AZTI marine biotic index (part of NQI1). nEQR = normalized EQR (excl. DI). C-stations at Hvannadalur, 2019.

St.	Numb. ind.	Numb. species	H´	ES_{100}	NQI1	ISI_{2012}	NSI	nEQR	AMBI	J
C1	369	21	2,26	11,78	0,647	7,74	22,29	0,570	2,13	0,57
C2	501	22	2,41	11,98	0,653	8,03	22,25	0,583	2,03	0,60
C3	398	14	2,03	10,02	0,634	7,47	22,56	0,545	1,96	0,56
C4	480	24	2,36	12,77	0,662	7,50	22,23	0,577	2,06	0,57
C5	433	25	2,62	13,25	0,664	7,60	22,01	0,590	2,14	0,62

4.4.2 NS 9410 Evaluation of the bottom fauna at station C1 (local impact zone).

According to NS 9410 the classification of the environmental status in the local impact zone can also be evaluated based on the number of species and their dominance in the bottom faunal community (see chapter 8.6.2 in NS 9410:2016).

The soft bottom communities were classified to environmental condition 1 "Very good". The criteria for condition 1 are presence of at least 20 species/0,2 m^2 and that none of them are present with more than 65 % of the individuals (Table 6). The data for number of species and dominating taxa at station C1 is given in Table 5 and Table 7.

Table 6. Classification of the environmental status of the soft bottom fauna at station C1 at the Hvannadalur site 2019.

Station	Site name	Num. species	Dominating taxa	Environmental condition-NS 9410
C1	Hvannadalur	21	Ennucula tenuis - 50 %	1 - Very good

4.4.3 Geometric classes

Figure 4 shows the number of species plotted against the number of individuals, where the number of individuals is divided into geometric classes. For an explanation of the concept of geometric classes is given in Appendix 3.

The curves for the stations started low (C3) to moderately high (other stations) and stretched in varying degrees towards higher classes. These gave no clear indications of the fauna condition of the stations.

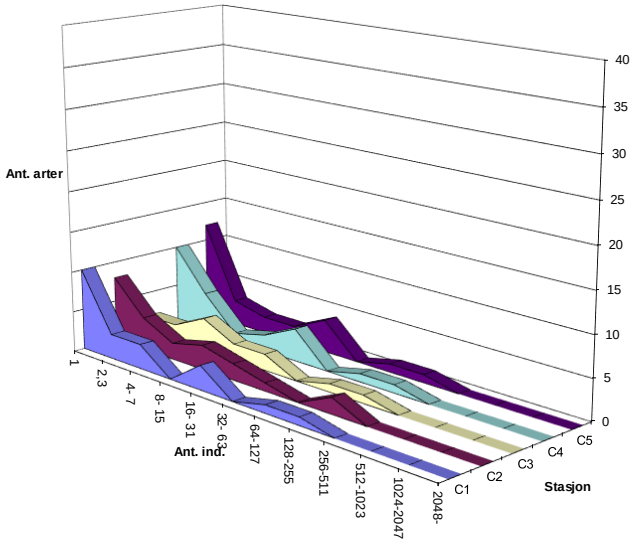

Figure 4. The soft bottom fauna shown as number of species against number of individuals pr. species in geometric classes. Hvannadalur, 2019.

4.4.4 Cluster analyses

To investigate the similarity of the faunal composition between the sampling stations, the multivariate technique cluster analysis was used. The results of this are presented in dendrogram in Figure 5.

The faunal composition was more than 65 % similar between the stations

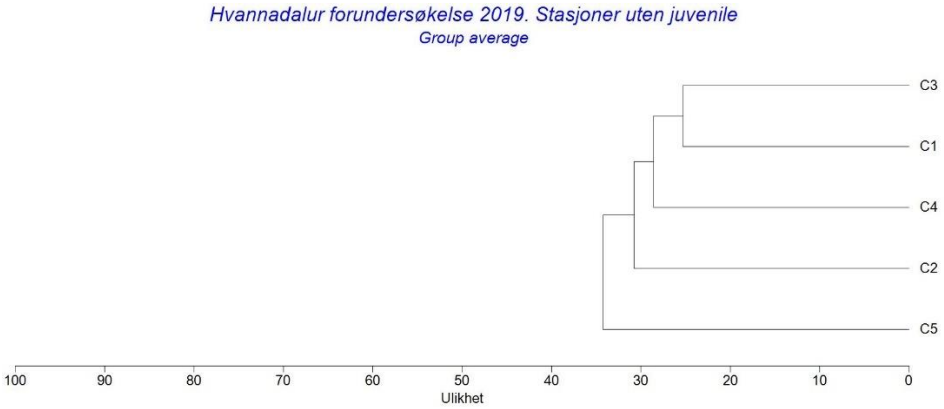

Figure 5. Cluster diagram for the soft bottom fauna at the C- sampling stations at Hvannadalur, 2019.

4.4.5 Species composition

The main features of the species composition are shown in the form of a top ten species list from each station in Table 7.

In Rygg and Norling (2013) the species are divided into five ecological groups (EG) based on the value of the sensitivity index. These groups run from sensitive species (group I) to pollution indicators (group V).

The most dominant species at all stations was the neutral bivalve *Ennucula tenuis* with 40 to 56 % of the individuals. The other most dominant species at the station were a mixture of neutral, tolerant and opportunistic species.

No pollution indicators were registered among the top-10 for any of the stations.

Table 7. Number of individuals, cumulative percentage and ecological group for the ten most dominant species on the C stations. Hvannadalur, 2019.*

C1	Numb.	Cum.	EG	C2	Numb.	Cum.	EG
Ennucula tenuis	191	50 %	II	Ennucula tenuis	219	42 %	II
Galathowenia oculata	83	72 %	III	Galathowenia oculata	142	69 %	III
Sternaspis scutata	27	79 %	Ik	Nuculana pernula	43	77 %	II
Prionospio steenstrupi	17	83 %	II	Prionospio steenstrupi	21	81 %	II
Thyasira sarsii	17	88 %	IV	Nuculana sp. juv.	19	85 %	Ik
Nuculana sp. juv.	12	91 %	Ik	Thyasira sarsii	18	89 %	IV
Nuculana pernula	7	93 %	II	Sternaspis scutata	13	91 %	Ik
Yoldia hyperborea	7	95 %	Ik	Yoldia hyperborea	11	93 %	Ik
Leucon sp.	4	96 %	Ik	Abra nitida	8	95 %	III
Abra nitida	2	96 %	III	Macoma calcarea	4	95 %	IV
C3	**Numb.**	**Cum.**	**EG**	**C4**	**Numb.**	**Cum.**	**EG**
Ennucula tenuis	232	56 %	II	Ennucula tenuis	247	51 %	II
Galathowenia oculata	78	75 %	III	Galathowenia oculata	111	73 %	III
Sternaspis scutata	25	81 %	Ik	Thyasira sarsii	22	78 %	IV
Nuculana pernula	18	85 %	II	Nuculana pernula	20	82 %	II
Nuculana sp. juv.	13	89 %	Ik	Sternaspis scutata	18	86 %	Ik
Prionospio steenstrupi	12	92 %	II	Prionospio steenstrupi	16	89 %	II
Thyasira sarsii	9	94 %	IV	Abra nitida	11	91 %	III
Macoma calcarea	5	95 %	IV	Nuculana sp. juv.	8	93 %	Ik
Yoldia hyperborea	5	96 %	Ik	Yoldia hyperborea	8	94 %	Ik
Abra nitida	4	97 %	III	Stenothoidae indet.	4	95 %	Ik
C5	**Numb.**	**Cum.**	**EG**				
Ennucula tenuis	177	40 %	II				
Galathowenia oculata	119	66 %	III				
Nuculana pernula	30	73 %	II				
Thyasira sarsii	24	78 %	IV				
Prionospio steenstrupi	19	83 %	II				
Abra nitida	18	87 %	III				
Nuculana sp. juv.	14	90 %	Ik				
Sternaspis scutata	11	92 %	Ik				
Yoldia hyperborea	9	94 %	Ik				
Leucon sp.	4	95 %	Ik				

*Ecological groups: EG I = sensitive species. EG II = neutral species. EG III = tolerant species. EG IV = opportunistic species. EG V = pollution indicator species. From Rygg and Norling, 2013. Ik = unidentified group.

4.5 Summary and conclusions – C-survey

4.5.1 Summary

The results from the environmental monitoring (type C) at Hvannadalur, 2019, can be summarized as follows:

- The hydrography measurements showed good oxygen conditions throughout the water column with 60 % saturation in the bottom layer in July 2019.
- TOM-levels were relatively high. TN-levels were low and the same was the C/N-relationship. TOC was high at the stations and nTOC varied from 27.4 to 30.5. The copper level varied from 37.7 to 45.4 mg/kg. The sediments were fine grained. The redox measurements (pH/Eh) gave points 1 (C1) and 0 (other stations).
- Number of individuals were somewhat low (369 to 501) and also the number of species were low (14 - 25). The diversity index H ' was below 3,0 at all stations. The overall index of nEQR varied from 0,545 (C3) to 0,590 (C5). The evaluation of the faunal conditions based on NS 9410;2016 in the local impact zone gave value 1 (Very good). There were not recorded any pollution indicator species among the top-10 species at of the stations.

4.5.2 Conclusion

The results from the pre survey at the farming site Hvannadalur in July 2019 showed that the sediment was somewhat loaded with organic carbon and the copper concentrations were within reported natural levels for bottom sediment around Iceland (Egilsson *et al*., 1999). No load effect was recorded in the fauna and faunal index nEQR showed relatively good conditions and no impact at the stations (0.55 - 0.59). The diversity index H' varied between 2.0 and 2.6. NS 9410:2016-assessment of the community in the local impact zone (C1) showed environmental condition 1 (Very good). No pollution indicators were recorded among the top-10 species on any of the stations. The redox measurements (pH/Eh) gave point 1 at C1 and 0 acc. Appendix D in NS 9410:2016 for the other sampling stations. The oxygen saturation in May was relatively good in the whole water column with 60 % in the bottom water.

5 References

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Appendix 1. Bunndyrstatistikk og artslister (in norwegian)

Diversitetsmål

Diversitet er et begrep som uttrykker mangfoldet i dyre- og plantesamfunnet på en lokalitet. Det finnes en rekke ulike mål for diversitet. Noen tar mest hensyn til artsrikheten (mål for artsrikheten), andre legger mer vekt på individfordelingen mellom artene (mål for jevnhet og dominans). Ulike mål uttrykker derved forskjellige sider ved dyresamfunnet. Diversitetsmål er "klassiske" i forurensningsundersøkelser fordi miljøforstyrrelser typisk påvirker samfunnets sammensetning. Svakheten ved diversitetsmålene er at de ikke alltid fanger opp endringer i samfunnsstrukturen. Dersom en art blir erstattet med like mange individer av en ny art, vil ikke det gjøre noe utslag på diversitetsindeksene.

Shannon-Wieners indeks (Shannon & Weaver, 1949) er gitt ved formelen:

$$H' = -\sum_{i=1}^{s} \frac{n_i}{N} \log_2 \left(\frac{n_i}{N} \right)$$

der n_i = antall individer av art *i* i prøven
N = total antall individer
s = antall arter

Indeksen tar hensyn både til antall arter og mengdefordelingen mellom artene, men det synes som indeksen er mest følsom for individfordelingen. En lav verdi indikerer et artsfattig samfunn og/eller et samfunn som er dominert av en eller få arter. En høy verdi indikerer et artsrikt samfunn.

Pielous mål for jevnhet (Pielou, 1966)

har følgende formel, der symbolene er som i Shannon-Wieners indeks

$$J = \frac{H'}{\log_2 s}$$

Hurlberts diversitetskurver

Grafisk kan diversiteten uttrykkes i form av antall arter som funksjon av antall individer. Med utgangspunkt i total antall arter og individer i en prøve søker man å beregne hvor mange arter man ville vente å finne i delprøver med færre individer. Diversitetsmålet blir derved uavhengig av prøvestørrelsen og gjør at lokaliteter med ulik individtetthet kan sammenlignes direkte. Hurlbert (1971) har gitt en metode for å beregne slike diversitetskurver basert på sannsynlighetsberegning.

ES_n er forventet antall arter i en delprøve på n tilfeldig valgte individer fra en prøve som inneholder total N individer og s arter og har følgende formel:

$$ES_n = \sum_{i=1}^{s} \left[1 - \frac{\binom{N-N_i}{n}}{\binom{N}{n}} \right]$$

der N = total antall individ i prøven
N_i = antall individ av art *i*
n = antall individ i en gitt delprøve (av de N)
s = total antall arter i prøven

Plott av antall arter i forhold til antall individer

Artene deles inn i grupper/klasser etter hvor mange individer som er registrert i en prøve. Det vanlige er å sette klasse I = 1 individ pr. art, klasse II = 2-3 individer, klasse III = 4-7 individer, klasse IV = 8-15 individer, osv., slik at de nedre klassegrensene danner en følge av ledd på formen 2^x, x=0,1,2, … En slik følge kalles en geometrisk følge, derfor kalles klassene for geometriske klasser. Hvis antall arter innenfor hver klasse plottes mot klasseverdien på en lineær skala, vil det fremkomme en kurve som uttrykker individfordelingen mellom artene i samfunnet. Det har vist seg at i prøver fra upåvirkede samfunn vil det være mange arter med lavt individantall og få arter med høyt individantall, slik at vi får en entoppet, asymmetrisk kurve med lang "hale" mot høye klasseverdier. Denne kurven vil være godt tilpasset en log-normal fordelingskurve.

Ved moderat forurensing forsvinner en del av de individfattige artene, mens noen som blir begunstiget, øker i antall. Slik flater kurven ut, og strekker seg mot høyere klasser eller den får ekstra topper. Under slike forhold mister kurven enhver likhet med den statistiske log-normalfordelingen. Derfor kan avvik fra log-normalfordelingen tolkes som et resultat av en påvirkning/forurensing. Det har vist seg at denne metoden tidlig gir utslag ved miljøforstyrrelse. Ved sterk forurensning blir det bare noen få, men ofte svært tallrike arter tilbake. Log-normalfordelingskurven vil da ofte gjenoppstå, men med en lavere topp og spredt over flere klasser enn for uforstyrrede samfunn.

Faunaens fordelingsmønster

Variasjoner i faunaens fordelingsmønster over området beskrives ved å sammenligne tettheten av artene på hver stasjon. Til dette brukes multivariate klassifikasjons- og ordinasjons-analyser (Cluster og MDS).

Analysene i denne undersøkelsen ble utført ved hjelp av programpakken PRIMER v5. Inngangsdata er individantall pr. art, pr. prøve. Prøvene kan være replikater eller stasjoner. Det tas ikke hensyn til hvilke arter som opptrer. Forut for klassifikasjons- og ordinasjonsanalysene ble artslistene dobbelt kvadratrot-transformert. Dette ble gjort for å redusere avviket mellom høye og lave tetthetsverdier og dermed redusere eventuelle effekter av tallmessig dominans hos noen få arter i datasettet.

Clusteranalyse

Analysen undersøker faunalikheten mellom prøver. For å sammenligne to prøver ble Bray-Curtis ulikhetsindeks benyttet (Bray & Curtis, 1957):

$$d_{ij} = \frac{\sum_{k=1}^{n} \left| X_{ki} - X_{kj} \right|}{\sum_{k=1}^{n} (X_{ki} + X_{kj})}$$

der n = antall arter sammenlignet
X_{ki} = antall individ av art k i prøve nr. i
X_{kj} = antall individ av art k i prøve nr. j

Indeksen avtar med økende likhet. Vi får verdien 1 hvis prøvene er helt ulike, dvs. ikke har noen felles arter. Identiske arts- og individtall vil gi verdien 0. Prøver blir gruppert sammen etter graden av likhet ved å bruke "group-average linkage". Forholdsvis like prøver danner en gruppe (cluster). Resultatet presenteres i et trediagram (dendrogram).

Ømfintlighet (AMBI, ISI og NSI)

Ømfintligheten bestemmes ved indeksene ISI og AMBI. Beregning av ISI er beskrevet av Rygg (2002). Sensitivitetsindeksen AMBI (Azti Marin Biotic Index) tilordner en ømfintlighetsklasse (økologisk gruppe, EG): EG-1: sensitive arter, EG-II: indifferente arter, EG-III: tolerante arter, EG-IV: opportunistiske arter, EG-V: forurensningsindikerende arter. Sammensetningen av makroevertebratsamfunnet i form av andelen av økologiske grupper indikerer omfanget av en forurensningspåvirkning.

NSI er en sensitivitetsindeks som ligner AMBI, men er utviklet med basis i norske faunadata og ved bruk av en objektiv statistisk metode. En prøves NSI verdi beregnes ved gjennomsnittet av sensitivitetsverdiene av alle individene i prøven.

Sammensatte indekser (NQI1 og NQI2)

Sammensatte indekser NQI1 og NQI2 bestemmes både ut fra artsmangfold og ømfintlighet. NQI1 er brukt i NEAGIG (den nordøst-atlantiske interkalibreringen). De fleste land bruker nå sammensatte indekser av samme type som NQI1 og NQI2.

NQI1 indeksen er beskrevet ved hjelp av formelen:

NQI1 (Norwegian quality status, version 1) = [0.5* (1-AMBI/7) + 0.5*(SN/2.7)* (N/(N+5)]

Diversitetsindeksen SN = lnS/ln(lnN), hvor S er antall arter og N er antall individer i prøven

Referanser:

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Statistikk resultater Hvannadalur, 2019:

Antall arter og individer per stasjon

st.nr.	tot.	C1	C2	C3	C4	C5
no. ind.	2181	369	501	398	480	433
no. spe.	45	21	22	14	24	25

Bunndyrindekser per replikat

st.nr.	tot.	C1_01	C1_02	C2_01	C2_02	C3_01	C3_02	C4_01	C4_02	C5_01	C5_02
no. ind.	2181	219	150	242	259	166	232	281	199	167	266
no. spe.	45	16	15	18	15	11	14	18	18	17	21
Shannon-Wiener:		2,2	2,3	2,6	2,2	2,2	1,9	2,2	2,5	2,7	2,5
Pielou		0,56	0,59	0,63	0,56	0,64	0,49	0,54	0,59	0,66	0,57
ES100		11	12	13	11	10	10	12	14	13	13
SN		1,65	1,68	1,70	1,58	1,47	1,56	1,67	1,73	1,74	1,77
ISI-2012		7,31	8,18	8,00	8,05	7,57	7,37	8,15	6,86	7,70	7,51
AMBI		2,046	2,22	1,988	2,062	1,97	1,942	2,052	2,061	2,176	2,11
NQI1		0,65	0,64	0,67	0,64	0,62	0,64	0,66	0,67	0,66	0,67
NSI		22,2	22,4	22,3	22,2	22,6	22,5	22,2	22,2	21,8	22,2

Bunndyrindekser, gjennomsnitt per stasjon

st.nr.		C1	C2	C3	C4	C5
Shannon-Wiener:		2,26	2,41	2,03	2,36	2,62
Pielou		0,57	0,60	0,56	0,57	0,62
ES100		11,8	12,0	10,0	12,8	13,2
SN		1,66	1,64	1,51	1,70	1,75
ISI-2012		7,74	8,03	7,47	7,50	7,60
AMBI		2,133	2,025	1,956	2,057	2,143
NQI1		0,65	0,65	0,63	0,66	0,66
NSI		22,29	22,25	22,56	22,23	22,01
Tilstandsklasse nEQR		0,570	0,583	0,545	0,577	0,590

Geometriske klasser

int.	C1	C2	C3	C4	C5
1	10	8	2	10	12
2,3	3	4	2	5	3
4- 7	3	2	4	1	2
8- 15	0	3	2	2	2
16- 31	3	2	2	4	4
32- 63	0	1	0	0	0
64-127	1	0	1	1	1
128-255	1	2	1	1	1
256-511	0	0	0	0	0
512-1023	0	0	0	0	0
1024-2047	0	0	0	0	0
2048-	0	0	0	0	0

Artsliste — *Hvannadalur forundersøkelse*

Rekke	Klasse	Orden	Art/Taxa	01	02	Sum
Stasjonsnr.: C1						
ANNELIDA						
	Polychaeta					
		Spionida				
			Prionospio steenstrupi	7	10	17
		Capitellida				
			Praxillella praetermissa		1	1
		Phyllodocida				
			Phyllodoce groenlandica	1		1
			Polynoidae indet.	1	1	2
			Syllis cornuta	1		1
			Nephtys ciliata	1		1
		Sternaspida				
			Sternaspis scutata	15	12	27
		Oweniida				
			Galathowenia oculata	46	37	83
		Sabellida				
			Euchone papillosa	1		1
CRUSTACEA						
	Malacostraca					
		Cumacea				
			Leucon sp.	3	1	4
		Amphipoda				
			Lysianassidae indet.		1	1
			Dulichiidae indet.	1		1
MOLLUSCA						
	Opistobranchia					
		Cephalaspidea				
			Retusa obtusa	1		1
	Bivalvia					
		Nuculoida				
			Ennucula tenuis	118	73	191
			Nuculana pernula	6	1	7
			Nuculana sp. juv.	8	4	12
			Yoldia hyperborea	4	3	7
		Mytiloida				
			Musculus sp. juv.	1		1
		Veneroida				
			Thyasira sarsii	12	5	17
			Macoma calcarea	1	1	2
			Abra nitida		2	2
ECHINODERMATA						
	Asteroidea					
		Paxillosida				
			Ctenodiscus crispatus		1	1
	Ophiuroidea					
		Ophiurida				
			Ophiocten sp.		1	1
				Maks: 118	73	191
				Antall: 18	16	23
				Sum:		382
Stasjonsnr.: C2						
NEMERTINI						
			Nemertea indet.		3	3
ANNELIDA						
	Polychaeta					
		Spionida				

Rekke	Klasse	Orden	Art/Taxa	01	02	Sum
			Prionospio steenstrupi	13	8	21
		Phyllodocida				
			Bylgides sp.		1	1
			Polynoidae indet.	1		1
			Nephtys ciliata	3	1	4
		Sternaspida				
			Sternaspis scutata	9	4	13
		Oweniida				
			Galathowenia oculata	65	77	142
		Terebellida				
			Melinna cristata	1	1	2
CRUSTACEA						
	Malacostraca					
		Cumacea				
			Leucon sp.	1		1
		Amphipoda				
			Lepidepecreum umbo	1		1
			Lysianassidae indet.	1		1
MOLLUSCA						
	Prosobranchia					
		Mesogastropoda				
			Euspira pallida	1		1
		Neogastropoda				
			Oenopota sp.	1		1
	Bivalvia					
		Nuculoida				
			Ennucula tenuis	93	126	219
			Nuculana pernula	31	12	43
			Nuculana sp. juv.	8	11	19
			Yoldia hyperborea	4	7	11
		Mytiloida				
			Crenella decussata		1	1
			Musculus sp. juv.	1		1
		Veneroida				
			Axinopsida orbiculata		2	2
			Thyasira sarsii	6	12	18
			Macoma calcarea	3	1	4
			Abra nitida	5	3	8
			Arctica islandica	3		3
ECHINODERMATA						
	Ophiuroidea					
			Ophiuroidea indet. juv.	1		1
			Maks:	93	126	219
			Antall:	21	16	25
			Sum:			522

Stasjonsnr.: C3

Rekke	Klasse	Orden	Art/Taxa	01	02	Sum
ANNELIDA						
	Polychaeta					
		Spionida				
			Prionospio steenstrupi	8	4	12
		Phyllodocida				
			Nephtys ciliata	3	1	4
		Sternaspida				
			Sternaspis scutata	18	7	25
		Oweniida				
			Galathowenia oculata	26	52	78
		Terebellida				
			Melinna cristata		1	1
		Sabellida				
			Euchone papillosa	1	1	2

Rekke	Klasse	Orden	Art/Taxa	01	02	Sum
MOLLUSCA						
	Bivalvia					
		Nuculoida				
			Ennucula tenuis	90	142	232
			Nuculana pernula	10	8	18
			Nuculana sp. juv.	5	8	13
			Yoldia hyperborea	2	3	5
		Veneroida				
			Thyasira sarsii	3	6	9
			Macoma calcarea	4	1	5
			Abra nitida		4	4
			Arctica islandica	1	1	2
ECHINODERMATA						
	Asteroidea					
			Asteroidea indet. juv.		1	1
	Ophiuroidea					
		Ophiurida				
			Ophiocten sp.		1	1
			Ophiuroidea indet. juv.		1	1
			Maks:	90	142	232
			Antall:	12	17	17
			Sum:			413

Stasjonsnr.: C4

NEMERTINI						
			Nemertea indet.	1		1
ANNELIDA						
	Polychaeta					
		Orbiniida				
			Levinsenia gracilis	1		1
			Aricidea sp.	1		1
		Spionida				
			Prionospio steenstrupi	7	9	16
			Chaetozone setosa	2	1	3
		Capitellida				
			Praxillella gracilis	1		1
			Praxillella praetermissa	1		1
		Phyllodocida				
			Syllis cornuta		2	2
			Nephtys ciliata	1	2	3
		Eunicida				
			Parougia sp.		1	1
		Sternaspida				
			Sternaspis scutata	7	11	18
		Oweniida				
			Galathowenia oculata	75	36	111
		Terebellida				
			Melinna cristata	1	1	2
		Sabellida				
			Euchone papillosa		1	1
CRUSTACEA						
	Malacostraca					
		Cumacea				
			Leucon sp.	2	1	3
		Amphipoda				
			Stenothoidae indet.		4	4
MOLLUSCA						
	Opistobranchia					
		Cephalaspidea				

Rekke	Klasse	Orden	Art/Taxa	01	02	Sum
			Retusa obtusa		1	1
	Bivalvia					
		Nuculoida				
			Ennucula tenuis	143	104	247
			Nuculana pernula	14	6	20
			Nuculana sp. juv.	6	2	8
			Yoldia hyperborea	5	3	8
		Veneroida				
			Thyasira gouldi	1		1
			Thyasira sarsii	12	10	22
			Macoma calcarea		1	1
			Abra nitida	6	5	11
			Maks:	143	104	247
			Antall:	19	19	25
			Sum:			488

Stasjonsnr.: C5

ANNELIDA						
	Polychaeta					
		Orbiniida				
			Scoloplos armiger		1	1
			Aricidea sp.	1	1	2
		Spionida				
			Prionospio steenstrupi	8	11	19
			Spio limicola		1	1
		Capitellida				
			Heteromastus filiformis		1	1
			Chirimia biceps		1	1
		Phyllodocida				
			Syllis cornuta	1	1	2
			Nephtys ciliata	1	1	2
		Eunicida				
			Parougia sp.		1	1
		Sternaspida				
			Sternaspis scutata	4	7	11
		Oweniida				
			Galathowenia oculata	50	69	119
			Myriochele malmgreni/olgae		1	1
		Terebellida				
			Lagis koreni		1	1
			Melinna cristata	1		1
		Sabellida				
			Chone sp.	1		1
CRUSTACEA						
	Malacostraca					
		Cumacea				
			Leucon sp.	1	3	4
MOLLUSCA						
	Bivalvia					
		Nuculoida				
			Ennucula tenuis	55	122	177
			Nuculana pernula	18	12	30
			Nuculana sp. juv.	6	8	14
			Yoldia hyperborea	1	8	9
		Veneroida				
			Axinopsida orbiculata	1		1
			Thyasira sarsii	13	11	24
			Thyasiridae indet.	1		1
			Abra nitida	7	11	18
			Arctica islandica		1	1

Rekke	*Klasse*	*Orden*	*Art/Taxa*		*01*	*02*		*Sum*
ECHINODERMATA								
	Ophiuroidea							
		Ophiurida						
			Ophiocten sp.		3	1		4
				Maks:	55	122		177
				Antall:	18	22		26
				Sum:				447
						TOTAL:	***Maks:***	247
							Sum:	2252

Appendix 2. Analyserapport – Geokjemiske analyser (in norwegian)

Framsenteret
Postboks 6606 Langnes, 9296 Tromsø
Foretaksnr.: NO 937 375 158 MVA
Tel: 77 75 03 00
E-post: kjemi@akvaplan.niva.no

ANALYSERAPPORT
Sedimentprøver

Kunde:	**Arctic Sea Farm hf**
Kunde referanse:	**Hvannadalur forundersøkelse Jul19**
Kontaktperson kunde:	
e-post:	
Kontaktperson Akvaplan-niva:	Arnthor Gustavsson
Dato:	18.09.2019
Rapport nr.:	**61376**
Analyseparameter(e):	Korn, TOM, TOC, TN, Cu
Kontaktperson:	Anja Sjøvoll
Analyseansvarlig:	Ida Gisela Tvedt (sign.)
Underskriftsberettiget:	Lisa Todde (sign.)

Prøvene ble sendt/levert til Akvaplan-Niva AS av oppdragsgiver, og merket som angitt i tabellen på side 2.
Resultater av analysene er gitt fra side 3.

MERKNADER:

Analysene gjelder bare for de prøver som er testet. De oppgitte analyseresultat omfatter ikke feil som måtte følge av prøvetagningen, inhomogenitet eller andre forhold som kan ha påvirket prøven før den ble mottatt av laboratoriet. Rapporten får kun kopieres i sin helhet og uten noen form for endringer. En eventuell klage skal leveres laboratoriet senest en måned etter mottak av analyseresultat. Nærmere informasjon om analysemetodene (måleusikkerhet, metodeprinsipp etc.) fås ved henvendelse til Akvaplan-Niva AS

Lab-id.	Kundens id.	Materiale	Mottatt lab	Parametere	Analyse-periode
61376/C1	C1	Frossent	29.07.2019	Korn, TOM, TOC/TN, 2xCu	31.07.19-13.09.19
61376/C2	C2	Frossent	29.07.2019	Korn, TOM, TOC/TN, 2xCu	31.07.19-13.09.19
61376/C3	C3	Frossent	29.07.2019	Korn, TOM, TOC/TN, 2xCu	31.07.19-13.09.19
61376/C4	C4	Frossent	29.07.2019	Korn, TOM, TOC/TN, 2xCu	31.07.19-13.09.19
61376/C5	C5/Cu-ref 1	Frossent	29.07.2019	Korn, TOM, TOC/TN, 2xCu	31.07.19-13.09.19
61376/Cu.ref2	Cu-ref 2	Frossent	29.07.2019	2xCu	21.08.19-28.08.19

Følgende analysemetoder er benyttet

Parameter	Metodereferanse
Kornfordeling (splitt i to)	Sikting, basert på Bale, A.J. & Kenny, A.J. 2005. Sediment analysis and seabed characterisation . In: Eleftheriou,A; McIntyre, A.D. "Methods for the study of marine benthos", 3rd ed. Blackwell Science, Oxford, UK. ISBN 0-632-05488-3, pp. 43-86
Totalt organisk materiale-TOM	Intern metode basert på NS 4764:1980
Totalt organisk karbon-TOC	NDIR-deteksjon. Intern metode basert på DIN 19539:2016
Totalt bundet nitrogen - Total-N	Elektrokjemisk deteksjon. Intern metode basert på NS-EN 12260:2003. MERK: ved TOC-verdier større enn ca 60 mg/g TS kan TN-resultater bli underestimert
Kobber-Cu / Kadmium-Cd (utført av underlev.)	EPA 200.7, ISO 11885, EPA 6010 og SM 3120

Resultater

	TOC	TN	TOM	Pelitt	> 0,063 mm	Cu*	Cu*	N TOC	C/N
Kundens id.:	mg/g TS	mg/g TS	% TS	vekt%	vekt%	mg/kg TS	mg/kg TS	mg/g TS	
C1	26,5	6,5	13,6	89,8	10,2	41,5	40,1	28,3	4,1
C2	24,8	5,6	14,0	79,7	20,3	41,6	44,9	28,5	4,4
C3	25,3	5,6	14,2	87,9	12,1	45,4	43,2	27,4	4,5
C4	26,9	5,8	13,4	80,4	19,6	41,5	43,0	30,5	4,6
C5/Cu-ref 1	25,9	6,4	12,9	80,5	19,5	43,4	41,7	29,4	4,1
Cu-ref 2	ia	ia	ia	ia	ia	39,7	41,8		

* Analysen er utført av ALS Laboratory Group, ALS Czech Republic s.r.o, Na Harfě 9/336, Praha, Tsjekkia

Akkreditering: Czech Accreditation Institute, labnr. 1163

N TOC (Normalisert TOC) = målt TOC mg/g + 18*(1-F), der F=andel finstoff (pellitt) gitt ved %pellitt/100.

ia = ikke analysert

Tilstandsklassifisering for organisk innhold i marine sedimenter ihht. Veileder 02:2018:

	< 20	20-27	27-34	34-41	> 41
Normalisert TOC, mg/g TS	I Svært god	II God	III Moderat	IV Dårlig	V Svært dårlig

Tilstandsklassifisering for kobber (Cu) i marine sedimenter (grenseverdier fra M-608/2016):

	< 20	20-84	84 - 147	> 147
Cu, mg/kg TS	Klasse I	Klasse II/III	Klasse IV	Klasse V