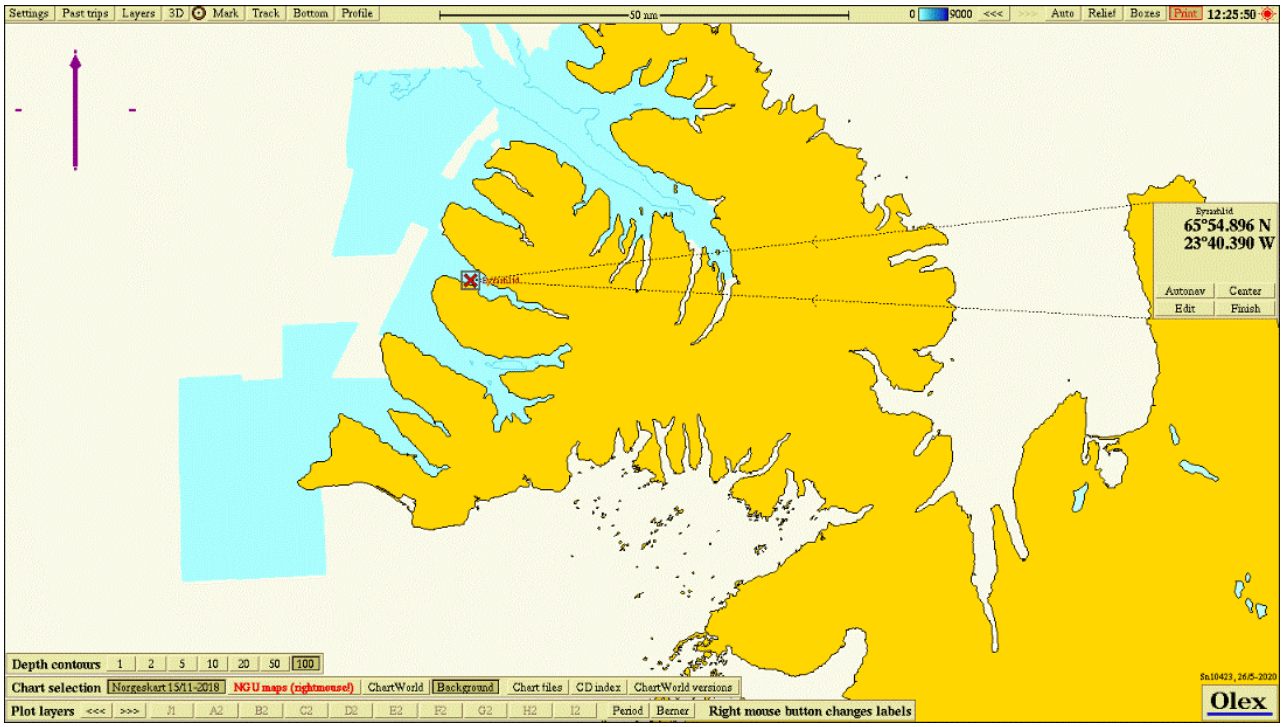
Akvaplan-niva AS Report: 2021 63090.01

Arctic Sea Farm

C-survey at Eyrarhlíð (fallow period), April 2021



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Report title
Arctic Sea Farm. C-survey at Eyrarhlíð (fallow period), April 2021.

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Summary
The results from the monitoring at the farming site Eyrarhlíð in April 2021 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 effects were recorded in the fauna and faunal index nEQR showed relatively good conditions and little or no impact at all stations (> 0.55). The diversity index H ' was above 3 at C1 and C2 and below at the other stations. NS 9410:2016-assessment of the community in the local impact zone (C1) showed environmental condition 1 (Very good). One pollution indicator was recorded among the top-10 species at C3 (9 individuals), but none at the other stations. The redox measurements (pH/Eh) gave point 0 acc. Appendix D in NS 9410:2016 for all the sampling stations. The oxygen saturation in April was good in the whole water column with 94 % in the bottom water.

Project manager
Snorri Gunnarsson

Quality controller
Kamila Sztybor
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Date: 2021.09.24 15:35:45 +02'00'

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Preface

Akvaplan-niva carried out an environmental survey of type C (NS 9410:2016) at the Eyrarhlíð site. It included pH/redox measurements (Eh), hydrography, geochemical analyses and analyses of the bottom fauna from five stations at the fish farming site. The following personnel contributed to this work:

Snorri Gunnarsson	Akvaplan-niva	Field work, report, project leader.
Hans-Petter Mannvik	Akvaplan-niva	Identification of bottom fauna (Echinodermata). Report, professional assessments, and interpretations.
Kamila Sztybor	Akvaplan-niva	Quality check
Rune Palerud	Akvaplan-niva	Identification of bottom fauna (Crustaceans). Statistics.
Thomas Hansen	Akvaplan-niva	Identification of bottom fauna (Mollusca and Varia).
Andrey Sikorski	Akvaplan-niva	Identification of bottom fauna (Polychaeta).
Stine Hermansen	Akvaplan-niva	Hydrographical vertical profiles
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 Arctic Sea Farm and Steinunn G. Einarsdóttir for good cooperation

Accreditation information:

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

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Akvaplan-niva AS is accredited under NS-EN ISO/IEC 17025 by Norwegian Accreditation for field sampling of sediments and fauna, analyses of TOC, TOM, TN, particle size and macrofauna, and for professional evaluations and interpretations. Our Accreditation number is TEST 079.

Czech Accreditation Institute (Lab nr 1163)

ALS Laboratory Group is accredited by the Czech Accreditation Institute (Lab nr 1163) for copper analyses.

Non-accredited services: Hydrographical measurements and mapping of bottom topography (Olex).

Kópavogur, 24.09 2021

Snorri Gunnarsson (Project Manager)

1 Data Summary

Client information			
Report title:	C-Survey at Eyrarhlíð (fallow period), April 2021.		
Report nr.	2021 63090.01	Site:	Eyrarhlíð
Municipality:		Map Coordinates (construction):	65°54,896 N 23°40,390 V
MTB permitted:	Site MTB	Operations manager:	Egill Ólafsson
Client:	Arctic Sea Farm		

Biomass/production status at time of survey (15.04.2021)			
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):	X	New location:	

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 (impact zone)	0.617	Fauna C1 (impact zone)	3.53
Fauna C2	0.653	Fauna C2	3.23
Fauna C3	0.596	Fauna C3	2.77
Fauna C4 (deep area)	0.584	Fauna C4 (deep area)	1.66
Fauna C5	0.659	Fauna C5	2.89
Date fieldwork:	(15.04.2021)	**Date of report:**	24.09. 2021
Notes to other results (sediment, pH/Eh, oxygen)			nTOC from 25.2 to 28.8 mg/g TS. Copper 49.7 mg/kg at C1 Eh positive at all stations O_2-conditions were good throughout the water column.
Responsible for field work:	Signature: 	Project manager Snorri Gunnarsson	Sign 

2 Introduction

2.1 Background and aim of the study

On behalf of Arctic Sea Farm, Akvaplan-niva completed a C-survey during the fallow period for the fish farming site at Eyrarhlíð in Dýrafjörður, Iceland (Figure 1). The survey fulfils the requirements from the Icelandic authorities for bottom surveys according to 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 C-survey 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 for the study is the soft bottom fauna and it is conducted according to standards ISO 5567-19:2004 and ISO 16665:2014. The parameters that are obligatory to include 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.

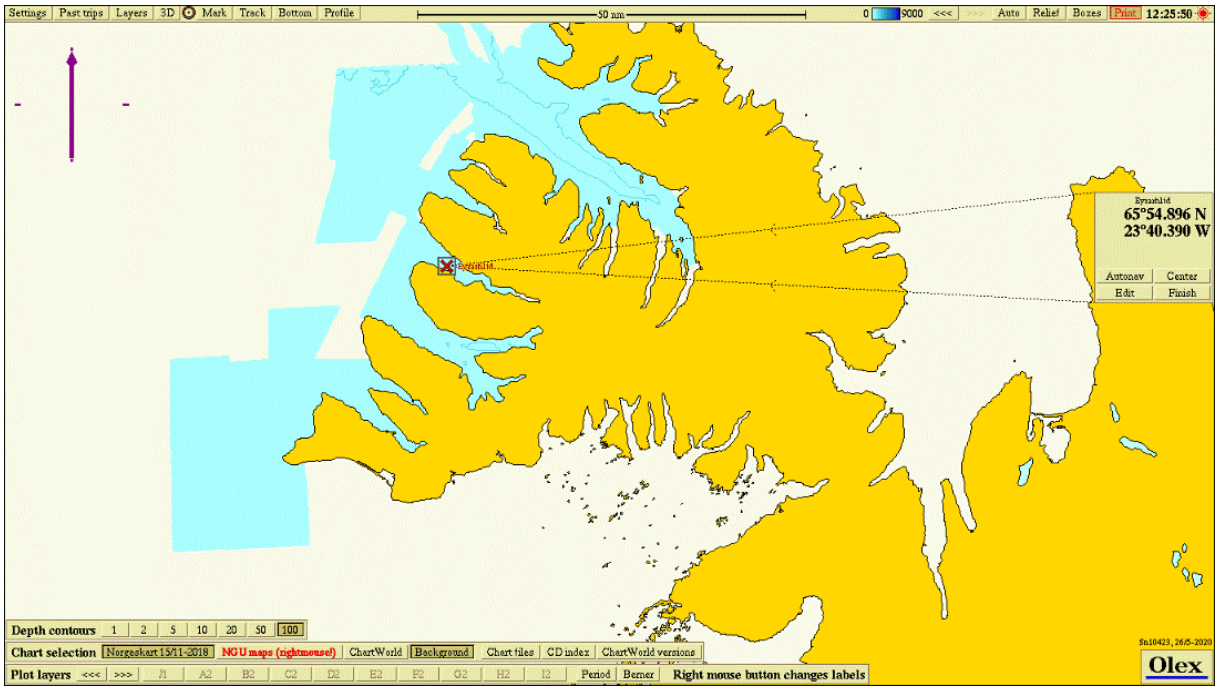

Figure 1 Overview of Dýrafjörður with the farming site Eyrarhlíð (red cross). The map coordinates for the midpoint of the farming site are given to the right.

2.2 Site operation and feed use

The Eyrarhlíð site has been in a fallow state since 16. November 2020. The previous generation was the first at the site, farmed from June 2018 until November 2021.The plant is a frame mooring with a total of twelve 160 meters circumference cages in a two-frame configuration each with a 1 x 6 cage configuration. The total production for last generation was 7.502 ton and the feed use was 8.844 ton. The planned time for setting out next generation at the site is summer 2021.

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 5.779 tonnes, used as MTB here (Einarsdóttir, pers reference).

2.3 Previous surveys

Akvaplan-niva AS has previously carried out one environmental survey of the type C (NS 9410) at the Eyrarhlíð site, at maximum biomass in March 2020 (Mannvik and Gunnarsson, 2020).

The client has provided a copy of a base-line monitoring done in accordance with ISO 12878 standard i.e., prior to any fish farming activity at the site (Gallo, 2019). The bottom was described as generally muddy at all eight sampling stations with high similarity between faunal communities between stations. Shannon-Wiener index was over 3 at all stations (3.59 – 4.16). Redox values were positive for the sediment at all stations.

3 Materials and methods

3.1 Survey program

The choice of study parameters, placement of sampling stations and other criteria for the study are 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. *Quality Manual for Akvaplan-niva.*
- Veileder 02:2018. *Klassifisering av miljøtilstand i vann*. Norsk klassifiseringssystem for vann i henhold til Vannforskriften. Veileder fra Direktoratgruppen.

Table 1. Survey program for the C-survey at Eyrarhlíð, 2021. 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 (local impact zone)	Quantitative analyses of bottom fauna. TOC. Korn. TOM. TN. Cu. pH/Eh.
C2 (transect zone outer)	Quantitative analyses of bottom fauna. TOC. Korn. TOM. TN. pH/Eh.
C3 (transect zone)	Quantitative analyses of bottom fauna. TOC. Korn. TOM. TN. pH/Eh.
C4 (transect zone, deep area)	Quantitative analyses of bottom fauna. TOC. Korn. TOM. TN. Hydrography/O_2. pH/Eh.
C5 (transect zone)	Quantitative analyses of bottom fauna. TOC. Korn. TOM. TN. pH/Eh.

Field work was completed on 15.04.2021.

3.2 Placement of stations and local conditions

The number of stations was calculated with reference to the estimated maximal standing biomass of the site for the next generation which is 5.779 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 with the direction of the main oceanic current direction at 39 m depth (distribution current) showing the main direction of oceanic flow in SE direction (125 degrees) (APN unpublished data).

Table 2. Depth, distance between the nearest frame of the fish farm and sampling stations and coordinates for C-stations at Eyrarhlíð, 2021

Station	Depth, m	Distance from frame, m	Position N	Position W
C1	41	25	65º54.876	23º40.052
C2	41	500	65º54.786	23º39.469
C3	41	25	65º54.964	23º40.681
C4	41	55	65º54.870	23º40.020
C5	41	125	65º54.859	23º39.931

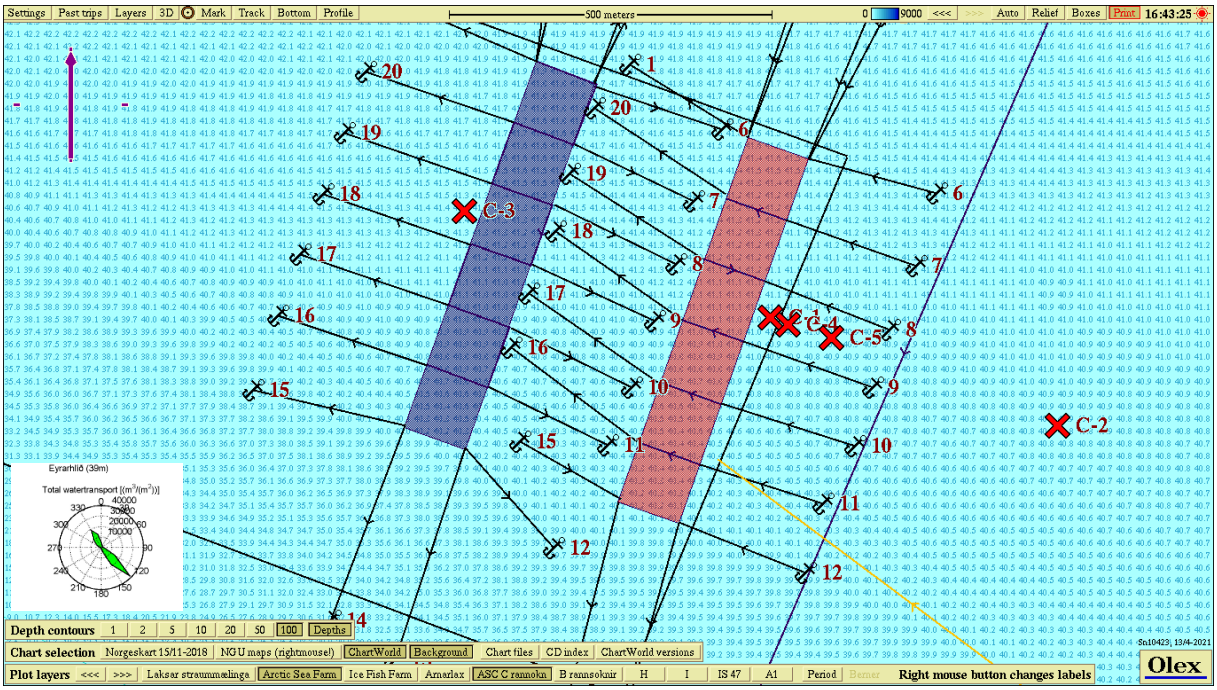

Figure 2. Map showing the sampling stations for the C-survey at Eyrarhlíð, 2021. Current measurements used were from 39 m depth (APN unpublished data).

3.3 Hydrography and oxygen

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

3.4 Soft bottom sampling and analyses

3.4.1 Fieldwork

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

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.

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 Oxidation 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 favourable 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 sieve 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
- Cluster analyses
- The ten most dominant taxa per station (top-ten)

4 Results

4.1 Hydrography and oxygen

The hydrographical profile for the deep station C4 in April 2021 is presented in Figure 3.

Temperature was around 2 ºC from top to bottom, and oxygen saturation 100 % in the upper layer and 94 % in the bottom layer.

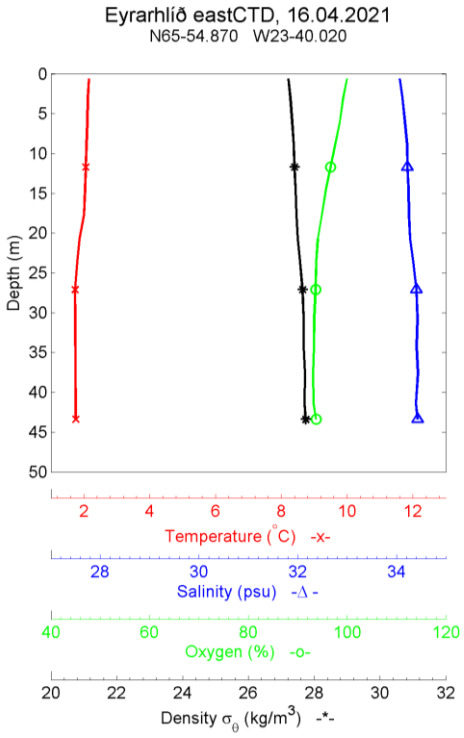

Figure 3. Vertical profiles. Temperature, salinity, density, and oxygen at C4 at Eyrarhlíð, 2021.

4.2 Sediment

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

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

TOM-levels varied from 8.4 to 10.2 %. TN-levels were low (3.7 – 4.5 mg/g) as were the C/N-ratios. TOC was rather high at all stations and nTOC varied from 25.2 to 28.8 mg/g TS. The bottom sediments grain size was fine with a pelite ratio ranging from 82.3 to 89.7 %.

Redox measurements (pH/Eh) gave a point of 0 for all the sampling 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. Eyrarhlíð, 2021.

St.	Sediment description	TOM	TOC	nTOC*	TN	C/N	Pelitt	pH/Eh
C1	Muddy, grey/olive green. Grab full of sediment.	9.4	25	28.1	4.0	6.2	82.5	7.7/ 315
C2	Muddy, grey/olive green, Grab full of sediment.	10.2	24	26,6	4,5	5.3	85.7	7.7/ 335
C3	Muddy, grey/olive green, Grab full of sediment.	8.4	23	25.2	4.2	5.6	89.7	7.8/ 307
C4	Muddy, grey/olive green, Grab full of sediment.	9.1	26	28.8	3.7	6.9	82.3	7.7/ 332
C5	Muddy, grey/olive green, Grab full of sediment.	9.2	25	27.5	4.1	6.0	84.7	7.7/ 335

4.2.2 Copper

Levels of copper in bottom sediments are shown in Table 4. The level of copper was 49.7 mg/kg.

Table 4. Copper (Cu), mg/kg TS. Eyrarhlíð, 2021.

St.	Cu
C1	49.7

4.3 Soft-bottom fauna

4.3.1 Faunal indices

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).

The number of individuals varied from 162 (C1) to 1435 (C2) and number of species from 25 (C1 and C3) to 44 (C2). The diversity H' varied from 1.66 (C4) to 3.53 (C1). At all stations, the overall index of nEQR was higher than 0.58. The nEQR values indicate relatively good conditions and little or no disturbance of the communities.

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, indicating a disturbed bottom fauna community. The index varied from 0.36 to 0.84 which indicates a somewhat uneven distribution.

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. A

St.	Numb. ind.	Numb. species	H´	ES_{100}	NQI1	ISI_{2012}	NSI	nEQR	AMBI	J
C1	162	25	3,53	18,50	0,669	7,17	20,48	0,617	2,45	0,84
C2	1435	44	3,23	15,83	0,717	8,66	21,78	0,653	1,79	0,64
C3	331	25	2,77	16,93	0,650	7,40	20,53	0,596	2,53	0,64
C4	925	31	1,66	11,83	0,717	8,66	22,90	0,584	1,46	0,36
C5	1315	42	2,89	16,91	0,735	8,64	22,47	0,659	1,54	0,57

4.3.2 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 is that there are at least 20 species/0,2 m^2 and that none of these are in numbers exceeding 65 % of the individuals (Table 6). The data for number of species and dominating taxa at station C1 is collected from Table 5 and Table 7.

Table 6. Classification of the environmental status of the soft bottom fauna at station C1 at the Eyrarhlíð site 2021.

Station	Site name	Num. species	Dominating taxa	Environmental condition-NS 9410
C1	Eyrarhlíð	25	Leucon sp. – 16 %	1 – Very good

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 1.

All curves started relatively low (≤ 15 species) and stretched out in varying degrees towards higher classes. These did not give any clear indications of fauna condition.

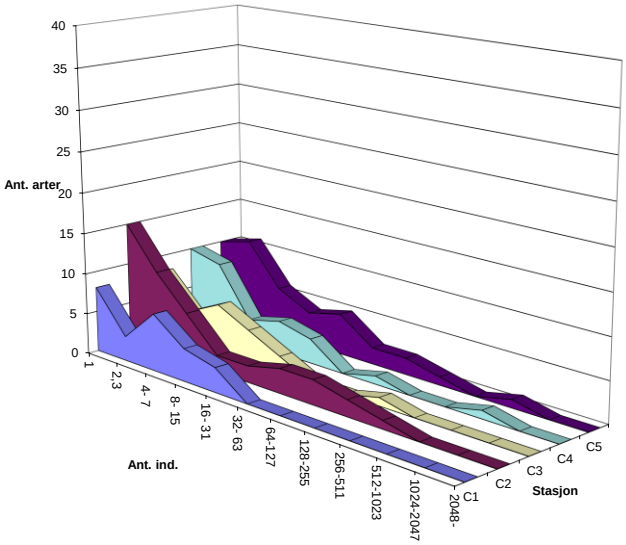

Figure 4. The soft bottom fauna shown as number of species against number of individuals pr. species in geometric classes. Eyrarhlíð, 2021.

4.3.3 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 stations were split into two main groups with C1 and C3 in one and C2, C4 and C5 in the other. The fauna at C1 and C3 had 67 % similarity while the three other stations had more than 66 % similarity. The two station groups had approximately 50 % similarity.

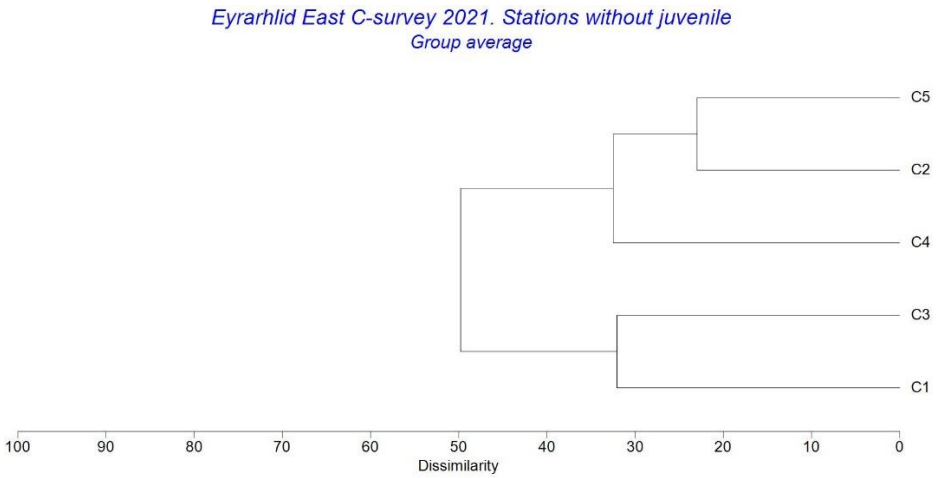

Figure 5. Cluster diagram for the soft bottom fauna at the C- sampling stations at Eyrarhlíð, 2021.

4.3.4 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 fauna at C1 was dominated by the crustacean *Leucon* sp. (EG not known) with 16 % of the individuals. The other most dominant species at this station were a mixture of neutral, tolerant, and opportunistic species.

The other stations were dominated by the neutral bivalve *Ennucula tenuis* with between 31 and 75 % of the individuals. The other most dominant species at the stations were mainly a mixture of neutral, tolerant, and opportunistic species. At C3, however, the pollution indicator species *Capitella capitata* (polychaete) was present among the top-10 species, but in relatively low individual numbers.

No pollution indicators were recorded among the top-10 at any of the four other stations.

Table 7. Number of individuals, cumulative percentage, and ecological group for the ten most dominant species on the C stations. Eyrarhlíð, 2021.*

C1	EG	Numb.	Cum.	C2	EG	Numb.	Cum.
Leucon sp.	Ik	28	16 %	Ennucula tenuis	II	456	31 %
Eteone flava/longa	Ik	22	29 %	Galathowenia oculata	III	227	47 %
Ennucula tenuis	II	17	39 %	Thyasira gouldi	IV	164	58 %
Scalibregma inflatum	III	15	47 %	Abra nitida	III	123	66 %
Ophiuroidea indet. juv.	II	12	54 %	Myriochele olgae	Ik	107	74 %
Lagis koreni	IV	11	60 %	Nuculana pernula	II	90	80 %
Macoma calcarea	IV	10	66 %	Sternaspis scutata	Ik	53	84 %
Chaetozone setosa	IV	8	71 %	Levinsenia gracilis	II	45	87 %
Levinsenia gracilis	II	7	75 %	Thyasira sarsii	IV	32	89 %
Nephtys ciliata	III	6	78 %	Maldane sarsi	IV	27	91 %
C3	**EG**	**Numb.**	**Cum.**	**C4**	**EG**	**Numb.**	**Cum.**
Ennucula tenuis	II	178	53 %	Ennucula tenuis	II	705	75 %
Lagis koreni	IV	30	62 %	Thyasira gouldi	IV	72	83 %
Leucon sp.	Ik	20	68 %	Leucon sp.	Ik	22	85 %
Eteone flava/longa	Ik	15	73 %	Levinsenia gracilis	II	22	88 %
Macoma calcarea	IV	14	77 %	Nuculana pernula	II	21	90 %
Scalibregma inflatum	III	14	81 %	Ophiuroidea indet. juv.	II	13	91 %
Capitella capitata	V	9	84 %	Lagis koreni	IV	11	92 %
Prionospio steenstrupi	II	7	86 %	Galathowenia oculata	III	9	93 %
Abra nitida	III	6	87 %	Nephtys ciliata	III	9	94 %
Chaetozone sp.	III	6	89 %	Macoma calcarea	IV	8	95 %

C5	EG	Numb.	Cum.
Ennucula tenuis	II	639	48 %
Thyasira gouldi	IV	166	60 %
Levinsenia gracilis	II	84	66 %
Nuculana pernula	II	81	72 %
Galathowenia oculata	III	56	76 %
Sternaspis scutata	Ik	43	80 %
Axinopsida orbiculata	Ik	31	82 %
Myriochele olgae	Ik	31	84 %
Abra nitida	III	30	86 %
Ophiuroidea indet. juv.	II	28	89 %

*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.

5 Summary and Conclusions

5.1 Summary

The results from the environmental monitoring (type C) at Eyrarhlíð, 2021, can be summarized as follows:

- The hydrography measurements showed good oxygen conditions throughout the water column with 94 % saturation in the bottom layer in April 2021.
- TOC was rather high at all stations and nTOC varied from 25.2 to 28.8 mg/g TS. TOM-levels varied from 8.4 to 10.2 %. TN-levels were low (3.7 – 4.5 mg/g) as was the C/N-ratio. The copper level in the sediment at C1 was 49.7 mg/kg and within reported natural levels of 55 mg/kg in Icelandic coastal areas (Egilsson *et al*. 1999). The bottom sediments grain size was fine with a pelite ratio ranging from 82.3 to 89.7 %. The redox measurements (pH/Eh) gave point 0 acc. Appendix D in NS 9410:2016 for all the stations.
- The number of individuals varied 162 (C1) to 1435 (C2) and number of species from 25 (C1 and C3) to 44 (C2). The diversity H' varied from 1.66 (C4) to 3.53 (C1). At all stations, the overall index of nEQR was higher than 0.55. The nEQR values indicate relatively good conditions and little or no disturbance of the communities.

5.2 Conclusions

The results from the monitoring at the farming site Eyrarhlíð in April 2021 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 effects were recorded in the fauna and faunal index nEQR showed relatively good conditions and little or no impact at all stations (> 0.55). The diversity index H ' was above 3 at C1 and C2 and below at the other stations. NS 9410:2016-assessment of the community in the local impact zone (C1) showed environmental condition 1 (Very good). One pollution indicator was recorded among the top-10 species at C3 (9 individuals), but none at the other stations. The redox measurements (pH/Eh) gave point 0 acc. Appendix D in NS 9410:2016 for all the sampling stations. The oxygen saturation in April was good in the whole water column with 94 % in the bottom water.

Previously there have been two bottom surveys at the Eyrahlíð site, a base line study with sampling in June 2018 (Gallo, 2019) and a C-survey at maximum biomass in March 2020 (Mannvik and Gunnarsson, 2020). The results from the current survey at fallow period compared to the previous study at maximum biomass indicates improved conditions at the site. At station C4 the diversity index H ' was 2.09 at maximum biomass and now is 1.66 but in the current study the nEQR has improved. At maximum biomass the fauna at stations C1 and C4 were dominated by the pollution indicator species *Capitella capitata* (polychaete) but in the current study at fallow no pollution indicator species were observed at those stations.

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7 Appendix (in Norwegian)

7.1 Statistical methods

7.1.1 Diversity

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.

7.1.2 Pielous mål for jevnhet (Pielou, 1966)

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

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

7.1.3 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

7.1.4 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.

7.1.5 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.

7.1.6 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).

7.1.7 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.

7.1.8 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:

7.1.9 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

7.1.10 References

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7.2 Statistical results Eyrarhlíð, 2021

7.2.1 Number of species and individuals per station

st.nr.	tot.	C1	C2	C3	C4	C5
no. ind.	4168	162	1435	331	925	1315
no. spe.	64	25	44	25	31	42

7.2.2 Benthos indices per replicate

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.	4168	64	98	706	729	94	237	612	313	776	539
no. spe.	64	17	20	32	36	22	17	27	21	40	28
Shannon-Wiener:		3,3	3,7	3,2	3,3	3,8	1,7	1,5	1,8	3,2	2,5
Pielou		0,81	0,86	0,63	0,64	0,85	0,42	0,32	0,41	0,61	0,53
ES100		17	20	15	16	22	12	11	12	19	15
SN		1,99	1,97	1,84	1,90	2,04	1,67	1,77	1,74	1,95	1,81
ISI-2012		6,38	7,97	8,29	9,03	6,90	7,90	8,77	8,54	9,04	8,25
AMBI		2,484	2,423	1,971	1,602	3,231	1,827	1,483	1,432	1,626	1,452
NQI1		0,66	0,67	0,70	0,74	0,63	0,67	0,72	0,72	0,74	0,73
NSI		20,3	20,7	21,7	21,8	18,5	22,6	23,0	22,8	22,4	22,6

7.2.3 Benthos indices, averages per station

st.nr.		C1	C2	C3	C4	C5
Shannon-Wiener:		3,53	3,23	2,77	1,66	2,89
Pielou		0,84	0,64	0,64	0,36	0,57
ES100		18,5	15,8	16,9	11,8	16,9
SN		1,98	1,87	1,85	1,76	1,88
ISI-2012		7,17	8,66	7,40	8,66	8,64
AMBI		2,454	1,787	2,529	1,458	1,539
NQI1		0,67	0,72	0,65	0,72	0,74
NSI		20,48	21,78	20,53	22,90	22,47
Tilstandsklasse nEQR		0,617	0,653	0,596	0,584	0,659

7.2.4 Geometric classes

int.	C1	C2	C3	C4	C5
1	8	15	8	10	10
2,3	3	10	4	9	11
4- 7	7	6	6	3	6
8- 15	4	2	4	4	4
16- 31	3	2	2	3	5
32- 63	0	3	0	0	2
64-127	0	3	0	1	2
128-255	0	2	1	0	1
256-511	0	1	0	0	0
512-1023	0	0	0	1	1
1024-2047	0	0	0	0	0
2048-	0	0	0	0	0

7.3 Species lists

Artsliste — *Eyrarhild East C-survey 2021*

Rekke	*Klasse*	*Art/Taxa*	*01*	*02*	*Sum*
Stasjonsnr.: C1					
NEMERTINI					
		Nemertea indet.	1		1
ANNELIDA					
	Polychaeta				
		Chaetozone setosa	1	7	8
		Eteone flava/longa	2	20	22
		Galathowenia oculata	2	2	4
		Heteromastus filiformis		1	1
		Lagis koreni	8	3	11
		Levinsenia gracilis		7	7
		Nephtys ciliata	2	4	6
		Ophelina acuminata	1		1
		Pholoe baltica		1	1
		Prionospio steenstrupi	2	2	4
		Scalibregma inflatum	15		15
		Spio limicola		1	1
		Syllis cornuta		4	4
CRUSTACEA					
	Malacostraca				
		Eudorella sp.		2	2
		Gammaridea indet.	1	2	3
		Leucon sp.	14	14	28
		Lysianassidae indet.	1		1
		Oedicerotidae indet.		5	5
MOLLUSCA					
	Bivalvia				
		Abra nitida	1		1
		Crenella decussata		1	1
		Ennucula tenuis	5	12	17
		Macoma calcarea	6	4	10
		Thyasira gouldi	1	1	2
		Thyasira sarsii	1	5	6
ECHINODERMATA					
	Ophiuroidea				
		Ophiuroidea indet. juv.	4	8	12
		Maks:	15	20	28
		Antall:	18	21	26
		Sum:			174
Stasjonsnr.: C2					
NEMERTINI					
		Nemertea indet.	1	2	3
ANNELIDA					
	Polychaeta				
		Apistobranchus tullbergi		1	1
		Diplocirrus longisetosus	2	1	3
		Eteone flava/longa	1	1	2
		Euclymeninae indet.	1	1	2
		Galathowenia oculata	176	51	227
		Gattyana amondseni		1	1
		Lagis koreni	4	7	11

Rekke	Klasse	Art/Taxa	01	02	Sum
		Laphania boecki	1		1
		Levinsenia gracilis	16	29	45
		Lumbrineris mixochaeta		1	1
		Maldane sarsi	17	10	27
		Melinna cristata	1		1
		Myriochele olgae	45	62	107
		Nephtys ciliata	2	1	3
		Owenia sp.	3	1	4
		Pholoe baltica		1	1
		Praxillella gracilis	10	3	13
		Prionospio steenstrupi	3	4	7
		Scoloplos sp.	1	1	2
		Spio limicola		1	1
		Sternaspis scutata	23	30	53
		Syllis cornuta	1		1
CRUSTACEA					
	Malacostraca				
		Bathymedon obtusifrons		2	2
		Campylaspis sp.	1		1
		Eudorella sp.		1	1
		Leptostylis sp.		1	1
		Leucon sp.	11	10	21
		Lysianassidae indet.	2		2
		Oedicerotidae indet.	1	3	4
		Pleurogonium spinosissimum	1		1
MOLLUSCA					
	Bivalvia				
		Abra nitida	51	72	123
		Arctica islandica		1	1
		Astarte sp. juv.	1	1	2
		Axinopsida orbiculata	1	1	2
		Ciliatocardium ciliatum	1		1
		Ennucula tenuis	221	235	456
		Macoma calcarea		4	4
		Musculus niger		2	2
		Mya sp. juv.	1		1
		Nuculana pernula	43	47	90
		Thyasira gouldi	42	122	164
		Thyasira sarsii	20	12	32
		Thyasiridae indet.		5	5
		Yoldia hyperborea	2	2	4
ECHINODERMATA					
	Asteroidea				
		Ctenodiscus crispatus	1		1
	Ophiuroidea				
		Ophiuroidea indet. juv.	14	9	23
		Maks:	221	235	456
		Antall:	35	38	47
		Sum:			1461

Stasjonsnr.: C3

NEMERTINI					
		Nemertea indet.	2	1	3
ANNELIDA					
	Polychaeta				

Rekke	Klasse	Art/Taxa	01	02	Sum
		Capitella capitata	9		9
		Chaetozone setosa		1	1
		Chaetozone sp.	5	1	6
		Eteone flava/longa	15		15
		Galathowenia oculata	1		1
		Heteromastus filiformis	1		1
		Lagis koreni	15	15	30
		Malacoceros vulgaris	1		1
		Nephtys ciliata	2	2	4
		Ophelina acuminata	1		1
		Phyllodoce groenlandica	1		1
		Prionospio steenstrupi	4	3	7
		Scalibregma inflatum	4	10	14
CRUSTACEA					
	Malacostraca				
		Bathymedon obtusifrons	1	4	5
		Eudorella sp.	1	1	2
		Leucon sp.	14	6	20
		Lysianassidae indet.	3		3
		Oedicerotidae indet.	2	2	4
MOLLUSCA					
	Bivalvia				
		Abra nitida	4	2	6
		Ennucula tenuis	4	174	178
		Macoma calcarea	3	11	14
		Musculus niger		1	1
		Nuculana pernula	1	2	3
		Thyasira sarsii		1	1
ECHINODERMATA					
	Ophiuroidea				
		Ophiuroidea indet. juv.	1	3	4
		Maks:	15	174	178
		Antall:	23	18	26
		Sum:			335

Stasjonsnr.: C4

Rekke	Klasse	Art/Taxa	01	02	Sum
ANNELIDA					
	Polychaeta				
		Chaetozone setosa	1	2	3
		Chaetozone sp.	1		1
		Cossura longocirrata	1		1
		Eteone flava/longa	2	1	3
		Galathowenia oculata	7	2	9
		Heteromastus filiformis	2		2
		Lagis koreni	8	3	11
		Levinsenia gracilis	14	8	22
		Maldane sarsi	2	2	4
		Myriochele olgae	2		2
		Nephtys ciliata	4	5	9
		Praxillella praetermissa	1		1
		Scoloplos sp.	2	3	5
		Spio limicola	1		1
		Sternaspis scutata	1	1	2
CRUSTACEA					
	Malacostraca				
		Bathymedon obtusifrons		1	1

Rekke	Klasse	Art/Taxa	01	02	Sum
		Eudorella sp.	2	3	5
		Leptostylis sp.	1	1	2
		Leucon sp.	8	14	22
		Lysianassidae indet.		1	1
		Oedicerotidae indet.	2	1	3
MOLLUSCA					
	Bivalvia				
		Abra nitida	1		1
		Abra prismatica	1		1
		Axinopsida orbiculata		2	2
		Ennucula tenuis	481	224	705
		Macoma calcarea	4	4	8
		Nuculana pernula	20	1	21
		Thyasira gouldi	39	33	72
		Thyasira sarsii	3		3
		Thyasiridae indet.		1	1
		Yoldia hyperborea	1		1
ECHINODERMATA					
	Ophiuroidea				
		Ophiuroidea indet. juv.	7	6	13
		Maks:	481	224	705
		Antall:	28	22	32
		Sum:			938

Stasjonsnr.: C5

NEMERTINI					
		Nemertea indet.	1	1	2
ANNELIDA					
	Polychaeta				
		Bradabyssa villosa	1		1
		Chone sp.	1		1
		Eteone flava/longa	2	1	3
		Galathowenia oculata	45	11	56
		Gattyana amondseni		2	2
		Heteromastus filiformis	1		1
		Lagis koreni	7	4	11
		Levinsenia gracilis	56	28	84
		Lumbrineris mixochaeta	1		1
		Maldane sarsi	17	3	20
		Myriochele olgae	20	11	31
		Nephtys ciliata	2	3	5
		Owenia sp.	6	6	12
		Pholoe assimilis	2		2
		Praxillella gracilis	5	1	6
		Praxillella praetermissa	1	2	3
		Prionospio steenstrupi	5	3	8
		Scoloplos sp.	4	3	7
		Spio limicola	2	1	3
		Sternaspis scutata	32	11	43
		Syllis cornuta	2		2
CRUSTACEA					
	Malacostraca				
		Bathymedon obtusifrons	1	1	2
		Dulichiidae indet.	1		1
		Eudorella sp.	1	1	2

Rekke	Klasse	Art/Taxa	01	02	Sum
		Leptostylis sp.	1		1
		Leucon sp.	7	3	10
		Lysianassidae indet.	2		2
		Oedicerotidae indet.	3	1	4
MOLLUSCA					
	Caudofoveata				
		Caudofoveata indet.		1	1
	Prosobranchia				
		Onoba semicostata	1		1
	Bivalvia				
		Abra nitida	19	11	30
		Abra prismatica	1		1
		Axinopsida orbiculata	21	10	31
		Ennucula tenuis	338	301	639
		Macoma calcarea	13	11	24
		Mytilus edulis	1		1
		Nuculana pernula	51	30	81
		Thyasira gouldi	89	77	166
		Thyasira sarsii	7		7
		Thyasiridae indet.	3	1	4
		Yoldia hyperborea	3		3
ECHINODERMATA					
	Ophiuroidea				
		Ophiuroidea indet. juv.	21	7	28
		Maks:	338	301	639
		Antall:	41	29	43
		Sum:			1343
				TOTAL:	***Maks:*** 705
					Sum: 4251

7.4 Analytical report

Akvaplan niva

NORSK AKKREDITERING TEST 079

ANALYSERAPPORT

Kunde:	Arctic Sea Farm / Arctic Fish	**Rapport nr.:**	P2100014
Kundemerking:	Eyrarhlid east	**Revisjon:**	2
Kontaktperson kunde:		**Rapportdato**	**2021-06-15**
		Ankomst dato	2021-04-26

Enkelte analyser fjernet fra rapporten i revidert versjon.

Lab-id. P2100014-01

Objekt	Kundens ID	Beskrivelse	Notering	Mottatt lab
Sediment	C1	63090 Eyrarhlid east		2021-04-26

Analyseresultat

Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Måleusikkerhet
TOC	25	mg/g TS	2021-05-05	2021-05-14	DIN 19539:2016	±2.5
TNb	4.0	mg/g TS	2021-05-05	2021-05-14	NS-EN 16168:2012	±0.6
N TOC	28.1	mg/g TS	2021-05-21	2021-05-21	Veileder 02:2018	
C/N - forhold	6.2		2021-06-15	2021-06-15		
TOM	9.4	% TS	2021-05-10	2021-05-15	Intern metode	±0.0
Vekt % 2 mm	0.3	wt% TS	2021-05-05	2021-05-15	Intern metode	±0.0
Vekt % 1 mm	0.2	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	±0.0
Vekt % 0.500 mm	0.1	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	±0.0
Vekt % 0.250 mm	3.3	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	±0.2
Vekt % 0.125 mm	6.7	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	±0.3
Vekt % 0.063 mm	7.0	wt% TS	2021-05-05	2021-05-15	Intern metode (Bale/Kenny 2005)	±0.3
Vekt % < 0.063 mm	82.5	wt% TS	2021-05-05	2021-05-15	Intern metode (Bale/Kenny 2005)	±4.1
Pelitt	82.5	wt% TS	2021-05-05	2021-05-15	Intern metode	
Sand	17.2	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	
Grus	0.3	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	
Cu (kobber) [a]	49.7	mg/kg TS	2021-05-04	2021-05-06	Intern metode	

[a] Prøvingen er utført av eksternt laboratorium, ALS Laboratory Group

* = Ikke akkreditert resultat

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Rapporten er godkjent og digitalt undertegnet av:
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ANALYSERAPPORT

Kunde:	Arctic Sea Farm / Arctic Fish	**Rapport nr.:**	P2100014
Kundemerking:	Eyrarhlid east	**Revisjon:**	2
Kontaktperson kunde:		**Rapportdato**	**2021-06-15**
		Ankomst dato	2021-04-26

Enkelte analyser fjernet fra rapporten i revidert versjon.

Lab-id. P2100014-02

Objekt	Kundens ID	Beskrivelse	Notering	Mottatt lab
Sediment	C2	63090 Eyrarhlid east		2021-04-26

Analyseresultat

Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Måleusikkerhet
TOC	**24**	mg/g TS	2021-05-05	2021-05-14	DIN 19539:2016	±2.4
TNb	**4.5**	mg/g TS	2021-05-05	2021-05-14	NS-EN 16168:2012	±0.7
N TOC	**26.6**	mg/g TS	2021-05-21	2021-05-21	Veileder 02:2018	
C/N - forhold	**5.3**		2021-06-15	2021-06-15		
TOM	**10.2**	% TS	2021-05-10	2021-05-15	Intern metode	±0.0
Vekt % 2 mm	**0.4**	wt% TS	2021-05-05	2021-05-15	Intern metode	±0.0
Vekt % 1 mm	**0.4**	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	±0.0
Vekt % 0.500 mm	**0.3**	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	±0.0
Vekt % 0.250 mm	**1.3**	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	±0.1
Vekt % 0.125 mm	**5.1**	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	±0.3
Vekt % 0.063 mm	**6.8**	wt% TS	2021-05-05	2021-05-15	Intern metode (Bale/Kenny 2005)	±0.3
Vekt % < 0.063 mm	**85.7**	wt% TS	2021-05-05	2021-05-15	Intern metode (Bale/Kenny 2005)	±4.3
Pelitt	**85.7**	wt% TS	2021-05-05	2021-05-15	Intern metode	
Sand	**13.8**	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	
Grus	**0.4**	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	

* – Ikke akkreditert resultat

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ANALYSERAPPORT

Kunde:	Arctic Sea Farm / Arctic Fish	**Rapport nr.:**	P2100014
Kundemerking:	Eyrarhlid east	**Revisjon:**	2
Kontaktperson kunde:		**Rapportdato**	**2021-06-15**
		Ankomst dato	2021-04-26

Enkelte analyser fjernet fra rapporten i revidert versjon.

Lab-id. P2100014-03

Objekt	Kundens ID	Beskrivelse	Notering	Mottatt lab
Sediment	C3	63090 Eyrarhlid east		2021-04-26

Analyseresultat

Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Måleusikkerhet
TOC	23	mg/g TS	2021-05-05	2021-05-14	DIN 19539:2016	±2.3
TNb	4.2	mg/g TS	2021-05-05	2021-05-14	NS-EN 16168:2012	±0.6
N TOC	25.2	mg/g TS	2021-05-21	2021-05-21	Veileder 02:2018	
C/N - forhold	5.6		2021-06-15	2021-06-15		
TOM	8.4	% TS	2021-05-10	2021-05-15	Intern metode	±0.0
Vekt % 2 mm	0	wt% TS	2021-05-05	2021-05-15	Intern metode	
Vekt % 1 mm	0	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	
Vekt % 0.500 mm	0.4	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	±0.0
Vekt % 0.250 mm	1.0	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	±0.1
Vekt % 0.125 mm	2.5	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	±0.1
Vekt % 0.063 mm	6.4	wt% TS	2021-05-05	2021-05-15	Intern metode (Bale/Kenny 2005)	±0.3
Vekt % < 0.063 mm	89.7	wt% TS	2021-05-05	2021-05-15	Intern metode (Bale/Kenny 2005)	±4.5
Pelitt	89.7	wt% TS	2021-05-05	2021-05-15	Intern metode	
Sand	10.3	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	
Grus	0	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	

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ANALYSERAPPORT

Kunde:	Arctic Sea Farm / Arctic Fish	**Rapport nr.:**	P2100014
Kundemerking:	Eyrarhlid east	**Revisjon:**	2
Kontaktperson kunde:		**Rapportdato**	**2021-06-15**
		Ankomst dato	2021-04-26

Enkelte analyser fjernet fra rapporten i revidert versjon.

Lab-id. P2100014-04

Objekt	**Kundens ID**	**Beskrivelse**	**Notering**	**Mottatt lab**
Sediment	C4	63090 Eyrarhlid east		2021-04-26

Analyseresultat

Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Måleusikkerhet
TOC	**26**	mg/g TS	2021-05-05	2021-05-14	DIN 19539:2016	±2.6
TNb	**3.7**	mg/g TS	2021-05-05	2021-05-14	NS-EN 16168:2012	±0.6
N TOC	**28.8**	mg/g TS	2021-05-21	2021-05-21	Veileder 02:2018	
C/N - forhold	**6.9**		2021-06-15	2021-06-15		
TOM	**9.1**	% TS	2021-05-10	2021-05-15	Intern metode	±0.0
Vekt % 2 mm	**0.2**	wt% TS	2021-05-05	2021-05-15	Intern metode	±0.0
Vekt % 1 mm	**0.2**	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	±0.0
Vekt % 0.500 mm	**0.4**	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	±0.0
Vekt % 0.250 mm	**3.9**	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	±0.2
Vekt % 0.125 mm	**6.3**	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	±0.3
Vekt % 0.063 mm	**6.6**	wt% TS	2021-05-05	2021-05-15	Intern metode (Bale/Kenny 2005)	±0.3
Vekt % < 0.063 mm	**82.3**	wt% TS	2021-05-05	2021-05-15	Intern metode (Bale/Kenny 2005)	±4.1
Pelitt	**82.3**	wt% TS	2021-05-05	2021-05-15	Intern metode	
Sand	**17.5**	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	
Grus	**0.2**	wt% TS	2021-05-05	2021-05-15	Intern metode (Buchanan 1984)	

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ANALYSERAPPORT

Kunde:	Arctic Sea Farm / Arctic Fish	**Rapport nr.:**	P2100014
Kundemerking:	Eyrarhlid east	**Revisjon:**	2
Kontaktperson kunde:		**Rapportdato**	**2021-06-15**
		Ankomst dato	2021-04-26

Enkelte analyser fjernet fra rapporten i revidert versjon.

Lab-id. P2100014-05

Objekt	**Kundens ID**	**Beskrivelse**	**Notering**	**Mottatt lab**
Sediment	C5	63090 Eyrarhlid east		2021-04-26

Analyseresultat

Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Måleusikkerhet
TOC	25	mg/g TS	2021-05-05	2021-05-14	DIN 19539:2016	±2.5
TNb	4.1	mg/g TS	2021-05-05	2021-05-14	NS-EN 16168:2012	±0.6
N TOC	27.5	mg/g TS	2021-05-21	2021-05-21	Veileder 02:2018	
C/N - forhold	6.0		2021-06-15	2021-06-15		
TOM	9.2	% TS	2021-05-10	2021-05-15	Intern metode	±0.0
Vekt % 2 mm	0.5	wt% TS	2021-05-21	2021-05-21	Intern metode	±0.0
Vekt % 1 mm	0.5	wt% TS	2021-05-21	2021-05-21	Intern metode (Buchanan 1984)	±0.0
Vekt % 0.500 mm	0.4	wt% TS	2021-05-21	2021-05-21	Intern metode (Buchanan 1984)	±0.0
Vekt % 0.250 mm	1.0	wt% TS	2021-05-21	2021-05-21	Intern metode (Buchanan 1984)	±0.0
Vekt % 0.125 mm	5.2	wt% TS	2021-05-21	2021-05-21	Intern metode (Buchanan 1984)	±0.3
Vekt % 0.063 mm	7.7	wt% TS	2021-05-21	2021-05-21	Intern metode (Bale/Kenny 2005)	±0.4
Vekt % < 0.063 mm	84.7	wt% TS	2021-05-21	2021-05-21	Intern metode (Bale/Kenny 2005)	±4.2
Pelitt	84.7	wt% TS	2021-05-21	2021-05-21	Intern metode	
Sand	14.7	wt% TS	2021-05-21	2021-05-21	Intern metode (Buchanan 1984)	
Grus	0.5	wt% TS	2021-05-21	2021-05-21	Intern metode (Buchanan 1984)	

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ANALYSERAPPORT

Kunde:	Arctic Sea Farm / Arctic Fish	**Rapport nr.:**	P2100014
Kundemerking:	Eyrarhlid east	**Revisjon:**	2
Kontaktperson kunde:		**Rapportdato**	**2021-06-15**
		Ankomst dato	2021-04-26

Enkelte analyser fjernet fra rapporten i revidert versjon.

Analyseansvarlig: Oda Sofie Bye Wilhelmsen

Signatur: Oda Sofie Bye Wilhelmsen

Underskriftsberettiget: Oda Sofie Bye Wilhelmsen

Signatur: Oda Sofie Bye Wilhelmsen

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

* – Ikke akkreditert resultat

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