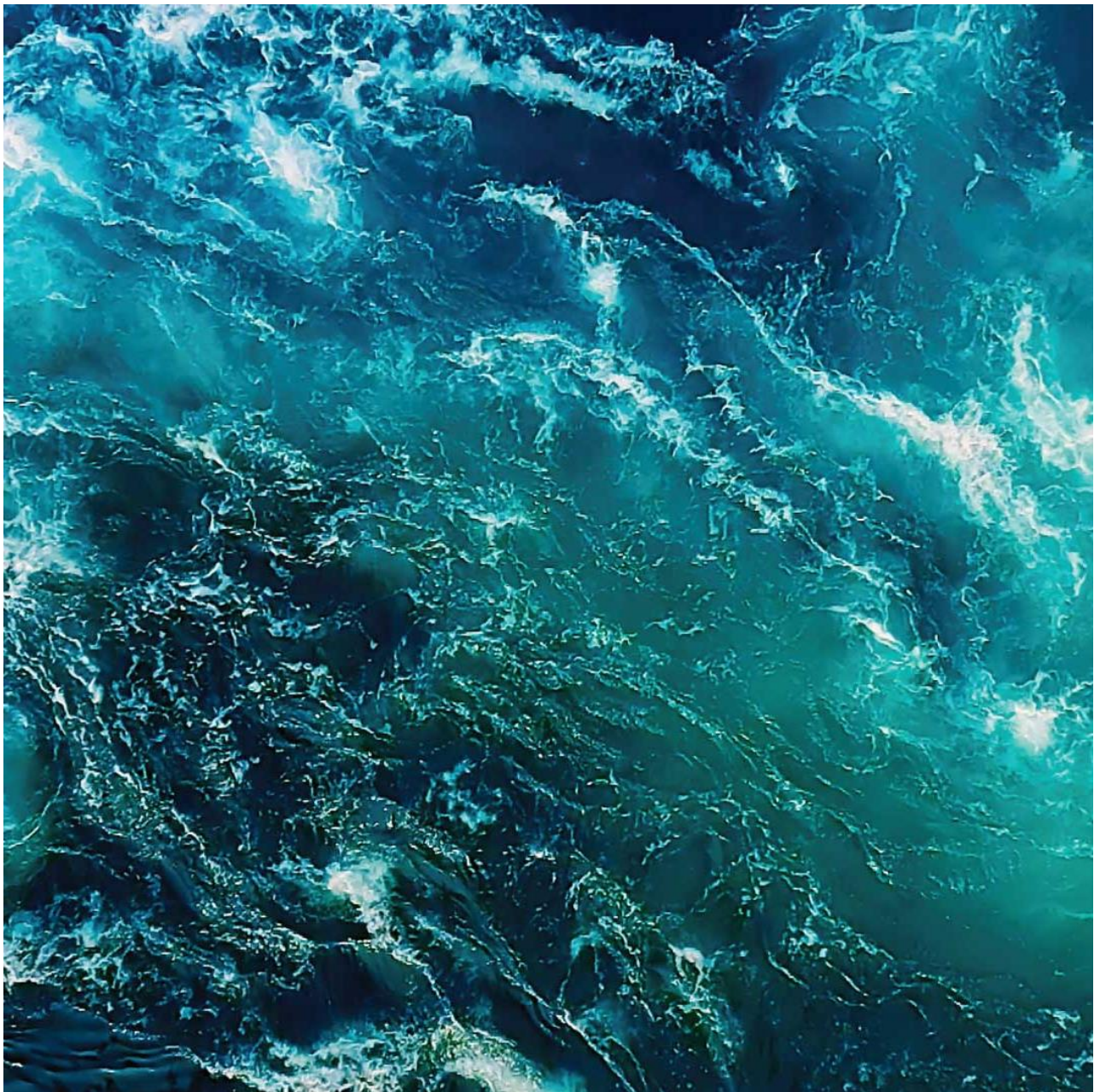


C-survey at Eyrarhlíð I, 2023

Arctic Sea Farm ehf

Akvaplan-niva AS Report: 2023 65094.02



Arctic Sea Farm ehf. C-Survey at Eyrarhlíð I, 2023.

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Summary

The results from the monitoring at the farming site Eyrarhlíð I in July 2023 showed that the sediment was somewhat loaded with organic carbon and the copper level in the sediment at C1 was slightly elevated (52.1 mg/kg) and is categorized into environmental limit II or "low values". EMB concentration at C4 is 460 ng/kg and thus exceeds the defined concentration of 272 ng/kg for stations outside the mixing zone. Accordingly, the station is not fulfilling the "good status standard" according to the SEPA standard.

Load effect was recorded in the fauna at C1 and faunal index nEQR was 0.389. At the other stations, the nEQR values were above 0.6 indicating relatively good faunal conditions at these stations. The diversity index H' was 2.17 at C1 and above 3 at the other stations which ranged from 3.25 to 3.77. The NS 9410:2016-assessment of the community in the local impact zone (C1) showed environmental condition 1 (Very good). A pollution indicator species was found at C1 and C4, but not 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 June was good in the whole water column with 90 % in the bottom water.

Approval


Project leader

Quality control

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Preface

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

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 Szybor	Akvaplan-niva	QA report, professional assessments, and interpretations.
Roger Velvin	Akvaplan-niva	Identification of bottom fauna (Various taxa).
Rune Palerud	Akvaplan-niva	Identification of bottom fauna (Crustaceans). Statistics.
Charlotte P. Ugelstad	Akvaplan-niva	Identification of bottom fauna (Polychaeta).
Jesper Hansen	Akvaplan-niva	Identification of bottom fauna (Mollusca).
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 ehf and Maria E. Chiarandini for good cooperation.

Accreditation information:

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



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.

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, 16.10.2023

Snorri Gunnarsson (Project Manager)

1 Data Summary

Client information			
Report title:	C-Survey at Eyrarhlíð I, 2023.		
Report nr.	2023 65094.02	Site:	Eyrarhlíð I
Municipality:	Ísafjarðabær	Map Coordinates (construction):	65°54,896 N 23°40,390 V
MTB permitted or estimated max biomass:	6.000	Operations manager:	Egill Ólafsson
Client:	Arctic Sea Farm ehf		

Biomass/production status at time of survey (04.07.2023)			
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)	0.389	Fauna C1 (impact zone)	2.17
Fauna C2	0.679	Fauna C2	3.25
Fauna C3	0.704	Fauna C3	3.77
Fauna C4 (deep area)	0.641	Fauna C4 (deep area)	3.66
Fauna C5	0.679	Fauna C5	3.45
Fauna C6	0.691	Fauna C5	3.33
Date fieldwork:	(04.07.2023)	Date of report:	27.09 2023
Notes to other results (sediment, pH/Eh, oxygen)			nTOC from 28.3 to 40.8 mg/g. Copper 52.1 mg/kg at C1 Eh positive at all stations O ₂ -conditions were good throughout the water column.
Responsible for field work:	Signature: SGU	Project manager Snorri Gunnarsson	Signature: SGU

2 Introduction

2.1 Background and aim of the study

On behalf of Arctic Sea Farm ehf, Akvaplan-niva completed a survey (type C) for a fish farming site at Eyrarhlíð I (Figure 1). The survey fulfils the requirements of 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 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 by Icelandic officials so it is not possible to strictly apply the classification based on Norwegian threshold values to Icelandic conditions. We do however report the results with the 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.

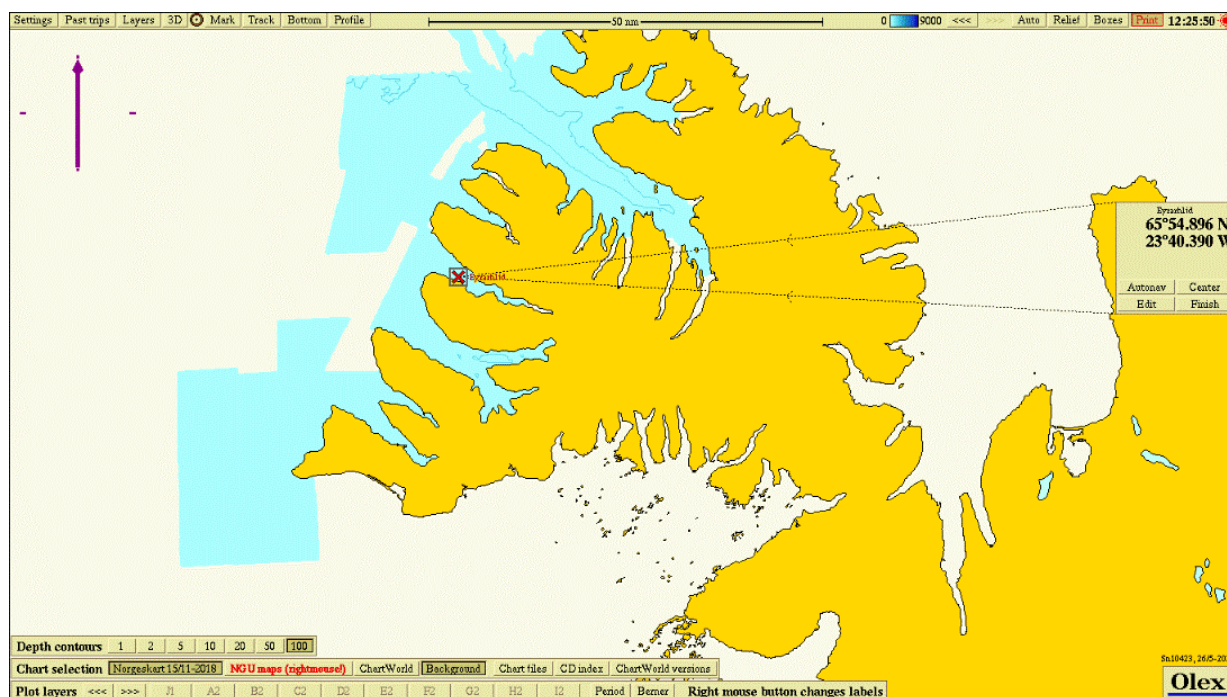


Figure 1 Overview of Dýrafjörður with the farming site Eyrarhlíð I (red cross). The map coordinates for the midpoint of the farming site are given to the right.

2.2 Site operation and feed use

The Eyrarhlíð site is located in Dýrafjörður about 9 km west from Þingeyri. The cages are lined in a northern direction from land (19 degrees). The plant is a two-frame mooring with a total of twelve 160 metre circumference cages each frame having placements for 6 cages. During the last

production cycle all twelve cages were used. There have been farmed two generations of salmon at the site prior to current fallow period.

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 one 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 6.000 tonnes, used as MTB here (Frederik Hansen, pers reference).

2.3 Previous surveys

An overview of previous C-surveys carried out at Eyrarhlíð I is shown in Table 1.

Table 1: Previous C-surveys at Eyrarhlíð I.

Survey date	Report reference (author, year)	Production (tonnes)	Type of survey
05.06 2018	Gallo, 2019	0	Baseline survey
25.03 2020	Mannvik & Gunnarsson, 2020	8.602	ASC/C survey at Max biomass
15.04 2021	Mannvik & Gunnarsson, 2021	0	C survey at Fallow period
22.11 2022	Sztybor & Gunnarsson, 2022	7.626	ASC/C survey at Max biomass

3 Materials and methods

3.1 Survey 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 2.

Akvaplan-niva is accredited for field work, analyses of samples and for the 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 (rev. 2020). *Klassifisering av miljøtilstand i vann*. Norsk klassifiseringssystem for vann i henhold til Vannforskriften. Veileder fra Direktoratgruppen.

Table 2: Survey program for the C-survey at Eyrarhlíð I, 2023. TOC = total organic carbon. GSA = grain size analysis 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. GSA, TOM. TN. Cu. pH/Eh.
C2 (transition zone outer)	Quantitative analyses of bottom fauna. TOC. GSA, TOM. TN. pH/Eh.
C3 (transition zone)	Quantitative analyses of bottom fauna. TOC. GSA, TOM. TN. pH/Eh.
C4 (transition zone, deep area)	Quantitative analyses of bottom fauna. TOC. GSA, TOM. TN. Hydrography/O ₂ . pH/Eh. Emamectinbenzoat.
C5 (transition zone)	Quantitative analyses of bottom fauna. TOC. GSA, TOM. TN. pH/Eh.
C6 (transition zone)	Quantitative analyses of bottom fauna. TOC. GSA, TOM. TN. pH/Eh.

Field work was completed on 04.07.2023.

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 6.000 tonnes (used as MTB here). According to the standard six sampling stations should be examined. Depth and position of the stations are given in Table 3 and shown in Figure 2. The stations were placed in the direction of the main oceanic current direction at 39 m depth (Gustavsson, 2019).

Table 3: Depth, distance between the nearest frame of the fish farm and sampling stations and coordinates for C-stations at Eyrarhlíð I, 2023.

Station	Depth, m	Distance from frame, m	Position	
			N	W
C1	41	25	65°54.876	23°40.057
C2	41	500	65°54.786	23°39.469
C3	42	100	65°55.069	23°40.003
C4	41	150	65°54.854	23°39.902
C5	41	250	65°54.833	23°39.780
C6	41	350	65°54.811	23°39.660

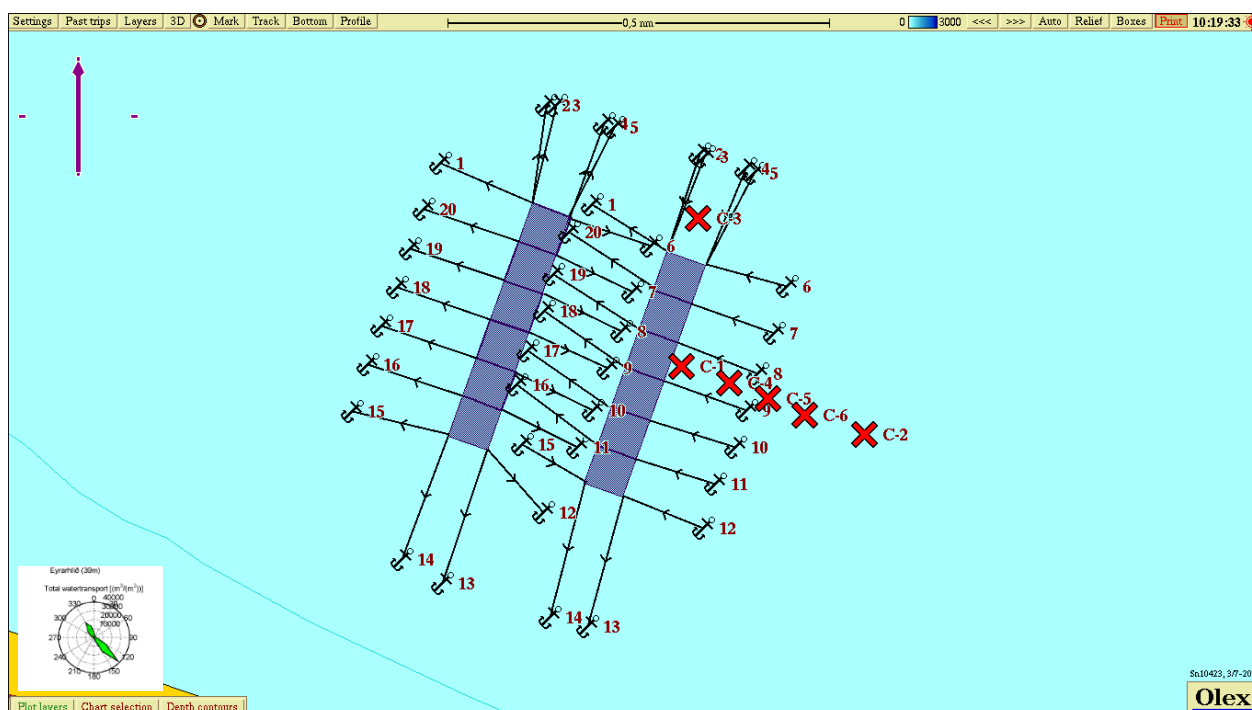


Figure 2. Map showing the sampling stations for the C-survey at Eyrarhlíð I, 2023. Current measurements used were from 39 m depth (Gustavsson, 2019).

3.2 Hydrography and oxygen

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

3.3 Soft bottom sampling and analyses

3.3.1 Fieldwork

Sediment samples were collected with a 0.1 m² 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 prior to further processing in the laboratory.

3.3.2 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 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.

3.3.3 Total nitrogen (TN)

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

3.3.4 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 (TOC₄₀₀, ROC, TIC₉₀₀)). To classify the environmental conditions based on the content of TOC, the measured concentrations are normalized for the 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).

3.3.5 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. The levels of copper are classified in accordance with Icelandic regulation 769:1999.

3.3.6 Emamectin benzoate (EMB)

The sediments were lyophilized prior to solvent extraction. The actual quantification was determined by high-resolution liquid chromatography coupled to tandem mass spectroscopy (HPLC-MS/MS). The LOD and LOQ are determined in accordance with the guidelines of the EU's reference laboratories for pesticide analyses, SANTE/2020/12830, 24/02/2021. The results are evaluated according to the Scottish Environmental Protection Agency (SEPA) standards (SEPA, 2022 & 2023).

3.3.7 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 with the manual of the instrument, 200 mV was added to the measured ORP (the Oxidation Reduction Potential) value.

3.4 Soft bottom fauna investigation

3.4.1 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, that is 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 faecal matter can, to a large degree, be attributed to changes in organic content (from the feed and faecal matter) in the sediment.

3.4.2 Sampling and fixation

All the bottom fauna samples were taken with a 0.1 m² van Veen grab. Only grab samples where the grab was completely closed and the surface undisturbed were approved. The contents were washed through a 1 mm sieve and the remaining material fixed with 4 % formalin with Bengal Rose dye added and then neutralized with borax. In the laboratory, the animals were sorted from the remaining sediment.

3.4.3 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 taxonomic level possible and quantified by specialists (taxonomists). The quantitative lists of species were statistically analysed. 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 (ES₁₀₀) – expected number of species pr. 100 individuals
- Pielou's evenness index (J)
- Sensitivities index (Ømfintlighet) (ISI₂₀₁₂), 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 July 2023 is presented in Figure 3.

Temperature dropped from 8 °C in the surface layer to around 7 °C in the bottom layer. Oxygen saturation was 112 % in the upper layer and 90 % in the bottom layer.

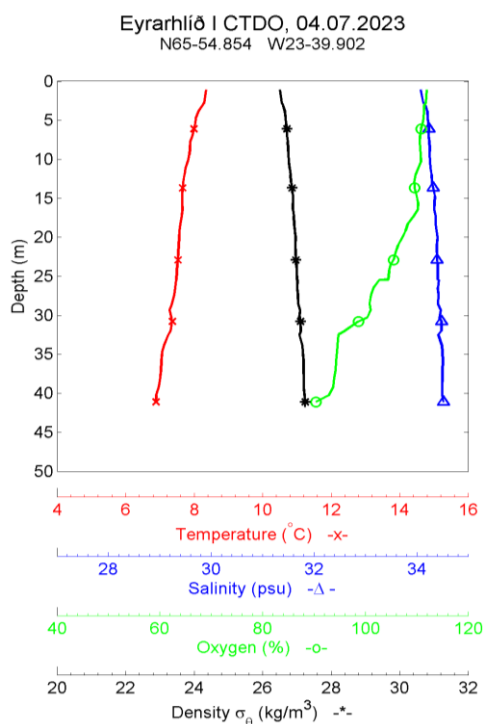


Figure 3. Vertical profiles. Temperature, salinity, density, and oxygen at C4 at Eyrarhlíð I, 2023.

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 (TOC), total nitrogen (TN), C/N-relationship, grain size distribution in sediment (pelite) and pH/Eh in the sediment are presented in Table 4.

TOM-levels varied from 9.3 to 10.3 %. TN-levels were relatively low (3.1 – 5.7 mg/g) as was the C/N-ratio. TOC was rather high at all stations and nTOC varied from 28.3 to 40.8 mg/g TS. The bottom sediments grain size was fine with a pelite ratio ranging from 82.0 to 85.6 %.

Redox measurements (pH/Eh) gave a point of 0 for all the sampling stations according to Appendix D in NS 9410:2016.

Table 4. Sediment description, TOM (%), TOC (mg/g), TN (mg/g), C/N, grain size distribution (pelite ratio % <0,063 mm) and pH/Eh. Eyrarhlíð I, 2023.

St.	Sediment description	TOM	TOC	nTOC	TN	C/N	Pelite	pH/Eh
C1	Olive green/grey mud, no smell of H ₂ S	9.3	38	40.8	3.1	12.0	82.2	7.7/188
C2	Olive green/grey mud, no smell of H ₂ S	10.3	25	28.3	5.7*	4.4	83.3	7.7/345
C3	Olive green/grey mud, no smell of H ₂ S	9.5	23	26.0	4.9	4.8	85.6	7.7/264
C4	Olive green/grey mud, no smell of H ₂ S	10.2	29	31.8	4.6	6.3	84.3	7.7/263
C5	Olive green/grey mud, no smell of H ₂ S	9.8	27	29.7	5.2*	5.2	83.2	7.8/235
C6	Olive green/grey mud, no smell of H ₂ S	9.8	28	31.6	4.4	6.5	82.0	7.7/312

*Not accredited result.

4.2.2 Copper

Levels of copper in bottom sediment at C1 are shown in Table 5. The level of copper was 52.1 mg/kg (limit II).

Table 5. Copper (Cu), mg/kg DS. Eyrarhlíð I, 2023.

St.	Cu
C1	52.1

4.2.3 Emamectin benzoate (EMB)

Concentration of emamectin benzoate in sediment at C4 is presented in Table 6. Station C4 is located 150 m from the cage edge and is thus placed outside the mixing zone (SEPA, 2022).

EMB concentration is 460 ng/kg and thus exceeds the defined concentration of 272 ng/kg for stations outside the mixing zone. Accordingly, the station is not fulfilling the "good status standard".

Table 6. Emamectin benzoate in the sediment at C4, ng/kg DS. Eyrarhlíð I, 2023.

St.	Emamectin benzoate
C4	460

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 7.

The number of individuals varied from 346 (C1) to 1181 (C3) and number of species from 21 (C1) to 57 (C3). The diversity H' varied from 2.17 to 3.77. At most of the stations, the overall index of nEQR was higher than 0.6, while at C1 below 0.6. The nEQR values indicate poor condition at C1 and better conditions at the other stations.

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 0.54 to 0.74 which indicates a somewhat uneven distribution at C1.

Table 7. Number of species and individuals pr. 0,2 m². H' = Shannon-Wiener's diversity index. ES_{100} = Hurlberts diversity index. $NQI1$ = overall index (diversity and sensitivity). ISI_{2012} = 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 Eyrarhlíð I, 2023.

St.	No. of individuals.	No. of species	H'	ES_{100}	$NQI1$	ISI_{2012}	NSI	$nEQR$	$AMBI$	J
C1	346	21	2.17	13.6	0.450	6.55	9.29	0.389	5.01	0.54
C2	1020	42	3.25	18.6	0.738	8.91	22.55	0.679	1.49	0.66
C3	1181	57	3.77	21.7	0.752	9.00	22.71	0.704	1.70	0.69
C4	379	38	3.66	24.3	0.690	7.79	18.90	0.641	2.56	0.74
C5	850	45	3.45	22.9	0.738	8.15	22.54	0.679	1.78	0.67
C6	792	47	3.33	21.0	.0754	8.84	22.80	0.691	1.63	0.64

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 are that there are at least 20 species/0.2 m² and that none of these are in numbers exceeding 65 % of the individuals (Table 8).

Table 8. Classification of the environmental status of the soft bottom fauna at station C1 at the Eyrarhlíð I site 2023.

Station	Site name	Num. species	Dominating taxa	Environmental condition-NS 9410
C1	Eyrarhlíð I	21	Capitella capitata – 63 %	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.

The curves at C1 and C4 started relatively low (≤ 10 species) and higher at the other stations and stretched out in varying degrees towards higher classes. These did not give any clear indications of fauna condition.

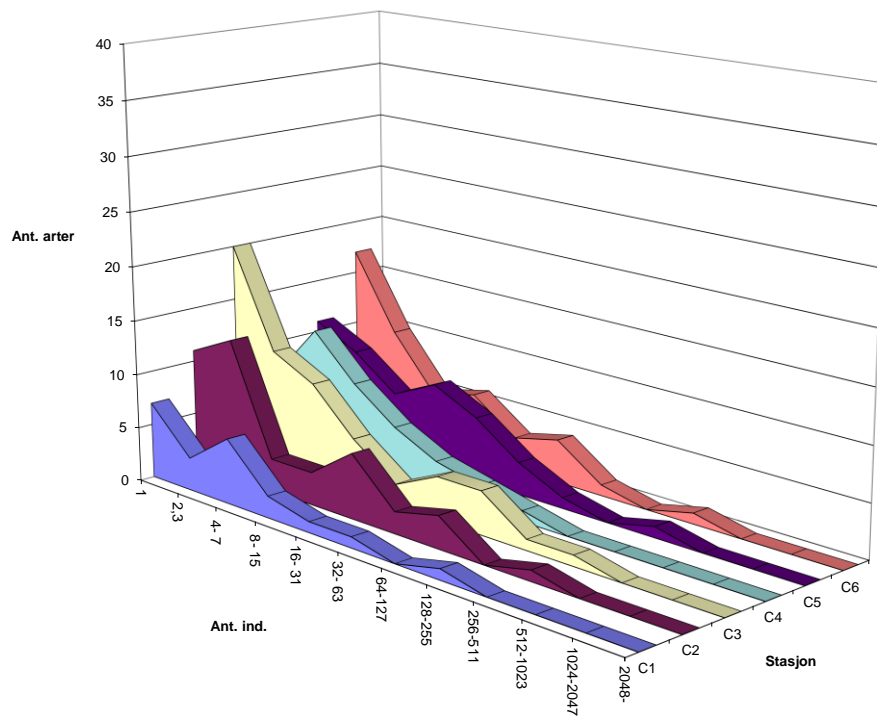


Figure 4. The soft bottom fauna shown as number of species against number of individuals pr. species in geometric classes. Eyrarhlíð I, 2023.

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 fauna composition at most of the stations was more than 60 % similar to each other while C1 was only 38 % similar to the other stations.

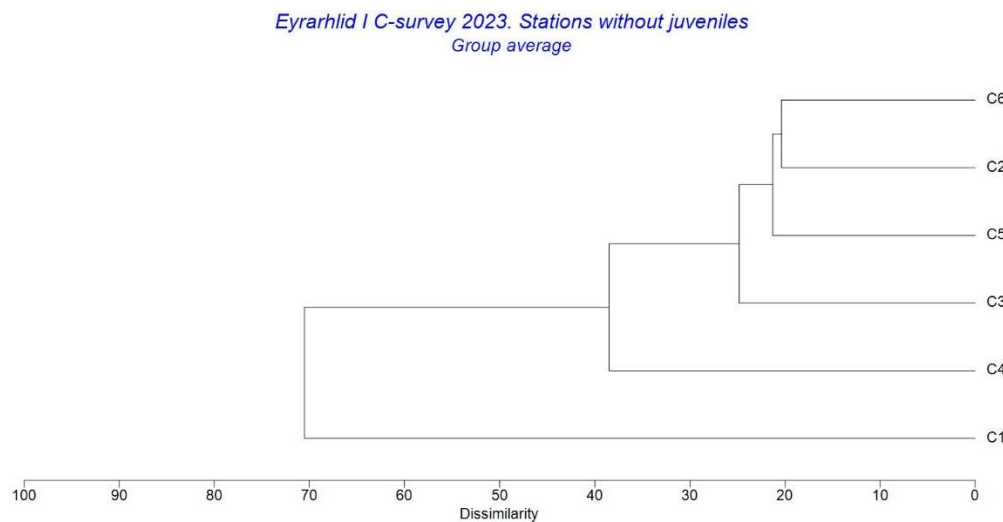


Figure 5. Cluster diagram for the soft bottom fauna at the C- sampling stations at Eyrarhlíð I, 2023.

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 9.

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 (EG I) to pollution indicators (EG V).

The fauna at C1 was dominated by the pollution indicator species *Capitella capitata* with 63 % of the individuals. The other dominating species were neutral, tolerant, and opportunistic species.

The fauna at the other stations were dominated by the neutral bivalve *Ennucula tenuis* with between 27 and 45 % of the individuals. The other most dominant species at the stations were mainly a mixture of neutral, tolerant, and opportunistic species. At C4, however, the pollution indicator species *C. capitata* was the second most dominating species.

Table 9. Number of individuals, cumulative percentage, and ecological group* for the ten most dominant species at the C stations. Eyrarhlíð I, 2023.

C1	EG	Ant. ind.	Kum.
<i>Capitella capitata</i>	V	217	63 %
<i>Malacoceros vulgaris</i>	Ik	35	73 %
<i>Mediomastus fragilis</i>	IV	29	81 %
<i>Eteone flava/longa</i>	Ik	10	84 %
<i>Ennucula tenuis</i>	II	8	86 %
<i>Thyasira sarsii</i>	IV	7	88 %
<i>Echiurus echiurus</i>	Ik	6	90 %
<i>Macoma calcarea</i>	IV	5	92 %
<i>Pholoe baltica</i>	III	5	93 %
Polynoidae indet.	II	5	95 %

C2	EG	Ant. ind.	Kum.
<i>Ennucula tenuis</i>	II	436	42 %
<i>Galathowenia oculata</i>	III	96	51 %
<i>Nuculana pernula</i>	II	77	58 %
<i>Levinsenia gracilis</i>	II	75	66 %
<i>Myriochele heeri</i>	III	55	71 %
<i>Thyasira gouldii</i>	IV	47	75 %
<i>Sternaspis scutata</i>	Ik	29	78 %
<i>Leucon sp.</i>	Ik	27	81 %
<i>Axinopsida orbiculata</i>	Ik	23	83 %
<i>Maldane sarsi</i>	IV	23	85 %

C3	EG	Ant. ind.	Kum.
<i>Ennucula tenuis</i>	II	319	27 %
<i>Levinsenia gracilis</i>	II	162	40 %
<i>Thyasira gouldii</i>	IV	100	49 %
<i>Galathowenia oculata</i>	III	95	57 %
<i>Nuculana pernula</i>	II	87	64 %
<i>Owenia sp.</i>	II	67	70 %
<i>Sternaspis scutata</i>	Ik	44	73 %
<i>Praxillella praetermissa</i>	II	40	77 %
<i>Axinopsida orbiculata</i>	Ik	37	80 %
<i>Leucon sp.</i>	Ik	33	82 %

C4	EG	Ant. ind.	Kum.
<i>Ennucula tenuis</i>	II	120	31 %
<i>Capitella capitata</i>	V	52	44 %
<i>Eteone flava/longa</i>	Ik	34	53 %
<i>Mediomastus fragilis</i>	IV	20	58 %
<i>Thyasira sarsii</i>	IV	19	63 %
Dulichidae indet.	Ik	16	67 %
<i>Axinopsida orbiculata</i>	Ik	9	70 %
<i>Macoma calcarea</i>	IV	9	72 %
<i>Echiurus echiurus</i>	Ik	8	74 %
<i>Lagis koreni</i>	IV	8	76 %

C5	EG	Ant. ind.	Kum.
<i>Ennucula tenuis</i>	II	388	45 %
<i>Levinsenia gracilis</i>	II	68	52 %
<i>Nuculana pernula</i>	II	55	59 %
<i>Galathowenia oculata</i>	III	43	64 %
<i>Axinopsida orbiculata</i>	Ik	33	67 %
<i>Leucon sp.</i>	Ik	25	70 %
Ophiuroidea indet. juv.	II	21	73 %
<i>Thyasira sarsii</i>	IV	19	75 %
<i>Euchone sp.</i>	II	18	77 %
<i>Mediomastus fragilis</i>	IV	17	79 %

C6	EG	Ant. ind.	Kum.
<i>Ennucula tenuis</i>	II	357	44 %
<i>Levinsenia gracilis</i>	II	69	52 %
<i>Galathowenia oculata</i>	III	63	60 %
<i>Leucon sp.</i>	Ik	41	65 %
<i>Nuculana pernula</i>	II	34	69 %
<i>Thyasira gouldii</i>	IV	33	74 %
<i>Axinopsida orbiculata</i>	Ik	25	77 %
<i>Sternaspis scutata</i>	Ik	21	79 %
Ophiuroidea indet. juv.	II	20	82 %
<i>Thyasira sarsii</i>	IV	17	84 %

*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 I, 2023, can be summarised as follows:

- The hydrography measurements showed good oxygen conditions throughout the water column with 90 % saturation in the bottom layer in July 2023.
- TOC was rather high at all stations and nTOC varied from 28.3 to 40.8 mg/g DS. TOM-levels varied from 9.3 to 10.3 %. TN-levels were relatively low (3.1 – 5.7 mg/g) as was the C/N-ratio. The copper level in the sediment at C1 was elevated (52.1 mg/kg) and is categorized into environmental limit II or "low values" according to environmental limits in Icelandic regulation nr. 796/1999. EMB concentration at C4 is 460 ng/kg and thus exceeds the defined concentration of 272 ng/kg for stations outside the mixing zone according to the SEPA standard. Accordingly, the station is not fulfilling the "good status standard". The bottom sediments grain size was fine with a pelite ratio ranging from 82.0 to 85.6 %. The redox measurements (pH/Eh) gave point 0 acc. Appendix D in NS 9410:2016 for all the stations.
- The number of individuals varied from 346 (C1) to 1181 (C3) and number of species from 21 (C1) to 57 (C3). The diversity H' varied from 2.17 to 3.77. At most of the stations, the overall index of nEQR was higher than 0.6, while at C1 below 0.6. The nEQR values indicate poor condition at C1 and better conditions at the other stations.

5.2 Conclusions

The results from the monitoring at the farming site Eyrarhlíð I in July 2023 showed that the sediment was somewhat loaded with organic carbon and the copper level in the sediment at C1 was slightly elevated (52.1 mg/kg) and is categorized into environmental limit II or "low values". EMB concentration at C4 is 460 ng/kg and thus exceeds the defined concentration of 272 ng/kg for stations outside the mixing zone according to the SEPA standard. Accordingly, the station is not fulfilling the "good status standard".

Load effect was recorded in the fauna at C1 and faunal index nEQR was 0.389. At the other stations, the nEQR values were above 0.6 indicating relatively good faunal conditions at these stations. The diversity index H' was 2.17 at C1 and above 3 at the other stations which ranged from 3.25 to 3.77. The NS 9410:2016-assessment of the community in the local impact zone (C1) showed environmental condition 1 (Very good). A pollution indicator species was found at C1 and C4, but not 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 June was good in the whole water column with 90 % in the bottom water.

The results from the present survey in July 2023 compared to previous C survey at fallow period in 2022 indicates similar faunal condition between the two surveys. However, the pollution indicator *Capitella capitata* that was only found at station C1 in previous survey is now among the top ten species at both C1 and C4.

6 References

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7 Appendix (in Norwegian)

7.1 Statistiske metoder

Diversitet

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 indekseen 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 , $x=0,1,2, \dots$. 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 kvadratrotransformert. 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):

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

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 tredigram (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 makrovertebratsamfunnet 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:

$$\text{NQI1 (Norwegian quality status, version 1)} = [0.5^* (1-\text{AMBI}/7) + 0.5^*(\text{SN}/2.7)^* (N/(N+5))]$$

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

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7.2 Statistical results Eyrarhlíð I, 2023

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	C6_01	C6_02
no. ind.	4568	186	160	435	585	542	639	152	227	567	283	478	314
no. spe.	79	16	17	28	34	43	44	26	36	37	34	36	38
Shannon-Wiener:		2,1	2,2	3,3	3,2	4,1	3,5	3,5	3,8	3,1	3,8	3,0	3,7
Pielou		0,53	0,54	0,68	0,64	0,75	0,63	0,74	0,74	0,60	0,75	0,58	0,70
ES100		13	14	18	19	23	21	23	25	21	24	19	23
SN		1,68	1,74	1,85	1,90	2,04	2,03	2,02	2,12	1,96	2,04	1,97	2,08
ISI-2012		5,83	7,27	8,62	9,21	8,97	9,04	7,69	7,90	8,13	8,16	9,27	8,41
AMBI		4,978	5,048	1,457	1,516	1,628	1,772	2,276	2,833	1,663	1,897	1,638	1,618
NQI1		0,45	0,45	0,73	0,74	0,76	0,75	0,70	0,68	0,74	0,74	0,74	0,76
NSI		9,1	9,5	22,4	22,7	22,4	23,0	20,0	17,8	22,7	22,4	23,0	22,6

Geometrical classes

int.	C1	C2	C3	C4	C5	C6
1	7	11	20	7	11	17
2,3	3	13	11	12	9	10
4- 7	6	3	9	8	6	5
8- 15	2	3	5	5	8	6
16- 31	1	6	2	3	6	3
32- 63	1	2	4	2	3	4
64-127	0	3	4	1	1	1
128-255	1	0	1	0	0	0
256-511	0	1	1	0	1	1
512-1023	0	0	0	0	0	0
1024-2047	0	0	0	0	0	0
2048-	0	0	0	0	0	0

7.3 Species lists

Artsliste pr stasjon

Eyrarhlíð I C-survey 2023

Rekke	Klasse	Orden	Art/Taxa	Replikat:	01	02	-	Sum		
Stasjonsnr.: C1										
ECHIURIDA										
ANNELIDA	Polychaeta	Spionida	Echiurus echiurus		3	3	-	6		
			Laonice cirrata			1	-	1		
		Capitellida	Malacoceros vulgaris		18	17	-	35		
			Spio limicola			1	-	1		
			Arenicola marina		1		-	1		
		Phyllodocida	Capitella capitata		117	100	-	217		
			Mediomastus fragilis		17	12	-	29		
			Eteone flava/longa		6	4	-	10		
			Microphthalmus szcelkowi		1	2	-	3		
			Pholoe baltica		4	1	-	5		
			Polynoidae indet.		1	4	-	5		
		Oligochaeta	Syllis hyalina		3		-	3		
			Oligochaeta indet.		1		-	1		
		CRUSTACEA								
		Malacostraca	Amphipoda	Oedicerotidae indet.		1		-	1	
				Paroediceros sp.			1	-	1	
Protomeдея fasciata					1	-	1			
MOLLUSCA										
Bivalvia	Nuculoida	Ennucula tenuis		3	5	-	8			
		Nuculana pernula		3	1	-	4			
	Mytiloida	Mytilus edulis			2	-	2			
		Veneroida	Macoma calcarea		2	3	-	5		
	Thyasira sarsii		5	2	-	7				
	Maksverdi:				117	100		217		
	Antall arter/taxa:				16	17		21		
Sum antall individ:							346			

Stasjonsnr.: C2

NEMERTINI

ECHIURIDA								
			Nemertea indet.		1	2	-	3
ANNELIDA	Polychaeta	Orbiniida	Echiurus echiurus			5	-	5
			Levinsenia gracilis		27	48	-	75
		Spionida	Chaetozone sp.		1	2	-	3
			Prionospio steenstrupi			1	-	1
			Pseudopolydora nordica			2	-	2

Rekke	Klasse	Orden	Art/Taxa	Replikat:	01	02	-	Sum
			Spio decorata			1	-	1
		Capitellida	Spio limicola			2	-	2
			Maldane sarsi		12	11	-	23
			Maldanidae indet. juv.			1	-	1
			Mediomastus fragilis		2		-	2
			Praxillella gracilis		4	3	-	7
		Phyllococida	Praxillella praetermissa		9	11	-	20
			Eteone flava/longa		1		-	1
			Nephtys ciliata		4	4	-	8
			Nephtys pente			1	-	1
		Sternaspida	Pholoe assimilis		2		-	2
			Sternaspis scutata		10	19	-	29
		Oweniida	Galathowenia oculata		39	57	-	96
			Myriochele heeri		28	27	-	55
			Owenia sp.		11	10	-	21
		Terebellida	Lagis koreni		2		-	2
			Laphania boeckii			1	-	1
			Zatsepinia rittichae			1	-	1
		Sabellida	Chone sp.			2	-	2
			Euchone sp.		2		-	2
CRUSTACEA	Malacostraca	Cumacea	Leptostylis sp.		1	1	-	2
			Leucon sp.		16	11	-	27
		Amphipoda	Bathymedon obtusifrons			1	-	1
			Dulichiiidae indet.			1	-	1
MOLLUSCA	Opisthobranchia	Cephalaspidea	Philinissima denticulata		2		-	2
	Bivalvia	Nuculoida	Ennucula tenuis		185	251	-	436
			Nuculana pernula		26	51	-	77
			Yoldia hyperborea			3	-	3
		Mytiloida	Musculus niger		1		-	1
		Veneroida	Abra nitida		3	7	-	10
			Arctica islandica		1		-	1
			Astarte montagui			1	-	1
			Axinopsida orbiculata		9	14	-	23
			Macoma calcarea			3	-	3
			Thyasira gouldii		26	21	-	47
			Thyasira sarsii		7	6	-	13
ECHINODERMATA	Ophiuroidea	Ophiurida	Ophiocten affinis		3	4	-	7
			Ophiuroidea indet. juv.		6	15	-	21
			Maksverdi:		185	251		436
			Antall arter/taxa:		29	36		44
			Sum antall individ:					1042
Stasjonsnr.: C3								
NEMERTINI								
			Nemertea indet.		2	1	-	3
ECHIURIDA								

Rekke	Klasse	Orden	Art/Taxa	Replikat:	01	02	-	Sum		
ANNELIDA	Polychaeta	Orbiniida	Echiurus echiurus			1	-	1		
		Leitoscoloplos mammosus			2	-	2			
			Levinsenia gracilis	78	84	-	162			
		Cossurida	Cossura sp.	1		-	1			
		Spionida	Chaetozone sp.	1	3	-	4			
			Dipolydora sp.		1	-	1			
			Laonice cirrata	1		-	1			
			Prionospio sp.	1		-	1			
			Prionospio steenstrupi	2	5	-	7			
			Pseudopolydora nordica	2	3	-	5			
			Spio decorata	3	4	-	7			
			Spio limicola	2	2	-	4			
			Capitellida	Euclymene lindrothi	1		-	1		
				Maldane sarsi	20	9	-	29		
		Mediomastus fragilis		2	2	-	4			
		Praxillella gracilis		6	3	-	9			
		Praxillella praetermissa		20	20	-	40			
		Phyllodocida	Eteone flava/longa	2	4	-	6			
			Nephtys ciliata	4	6	-	10			
			Pholoe baltica		3	-	3			
			Phyllodoce groenlandica	1		-	1			
			Polynoidae indet.		2	-	2			
			Syllis cornuta	3		-	3			
			Syllis hyalina		1	-	1			
			Eunicida	Parougia nigridentata	3		-	3		
		Sternaspida	Sternaspis scutata	22	22	-	44			
			Oweniida	Galathowenia oculata	50	45	-	95		
		Oweniida	Myriochele heeri	5	1	-	6			
			Owenia sp.	33	34	-	67			
			Flabelligerida	Saphrobranchia longisetosa		1	-	1		
		Terebellida	Ampharete borealis		1	-	1			
			Lagis koreni		1	-	1			
			Laphania boeckii	1		-	1			
			Terebellides sp.	1		-	1			
		Sabellida	Chone sp.		2	-	2			
			Euchone sp.	3	5	-	8			
		CRUSTACEA	Malacostraca	Cumacea	Eudorella sp.	1	1	-	2	
		Leptostylis sp.			1		-	1		
		Leucon sp.			23	10	-	33		
		Amphipoda		Bathymedon obtusifrons	1	1	-	2		
				Lysianassidae indet.	1	3	-	4		
		Decapoda		Paguridae indet.	1		-	1		
				Caudofoveata	Caudofoveata indet.	1		-	1	
		MOLLUSCA		Opisthobranchia	Cephalaspidea	Philinissima denticulata		1	-	1
						Retusa obtusa		1	-	1
				Bivalvia	Nuculoidea	Ennucula tenuis	69	250	-	319
			Nuculana pernula			70	17	-	87	

Rekke	Klasse	Orden	Art/Taxa	Replikat:	01	02	-	Sum
			Yoldia hyperborea		2	1	-	3
		Mytiloidea						
			Musculus niger			1	-	1
		Veneroidea						
			Abra nitida		7	7	-	14
			Axinopsida orbiculata		21	16	-	37
			Macoma calcarea		3		-	3
			Thyasira gouldii		50	50	-	100
			Thyasira obsoleta			1	-	1
			Thyasira sarsii		14	8	-	22
ECHINODERMATA								
	Ophiuroidea							
		Ophiurida						
			Ophiocten affinis		7	3	-	10
			Ophiuroidea indet. juv.		6	7	-	13
			Maksverdi:		78	250		319
			Antall arter/taxa:		44	45		58
			Sum antall individ:					1194

Stasjonsnr.: C4

ECHIURIDA

			Echiurus echiurus		4	4	-	8
ANNELIDA								
	Polychaeta							
		Orbiniida						
			Levinsenia gracilis		3	4	-	7
			Scoloplos armiger			2	-	2
		Spionida						
			Chaetozone sp.			2	-	2
			Spio decorata			1	-	1
			Spio limicola		2	2	-	4
		Capitellida						
			Capitella capitata		11	41	-	52
			Mediomastus fragilis		9	11	-	20
			Praxillella gracilis		1		-	1
			Praxillella praetermissa			3	-	3
		Opheliida						
			Scalibregma inflatum		2	2	-	4
		Phyllodocida						
			Eteone flava/longa		7	27	-	34
			Nephtys ciliata		1	1	-	2
			Pholoe baltica		1	2	-	3
			Polynoidae indet.		3	2	-	5
			Syllis hyalina		1	1	-	2
		Oweniida						
			Galathowenia oculata		2	1	-	3
			Owenia sp.		2	1	-	3
		Terebellida						
			Ampharete petersenae			1	-	1
			Lagis koreni		6	2	-	8
			Lanassa venusta			1	-	1
			Zatsepinia rittichae			1	-	1
		Sabellida						
			Chone sp.			2	-	2
CRUSTACEA								
	Malacostraca							
		Cumacea						
			Eudorella sp.		2		-	2
			Leptostylis sp.			1	-	1
			Leucon sp.		5	3	-	8
		Amphipoda						
			Dulichiiidae indet.			16	-	16
			Lysianassidae indet.			4	-	4
MOLLUSCA								
	Prosobranchia							
		Neogastropoda						
			Curtitoma trevilliania			1	-	1

Rekke	Klasse	Orden	Art/Taxa	Replikat:	01	02	-	Sum
	Bivalvia							
		Nuculoidea	Ennucula tenuis		63	57	-	120
			Nuculana pernula		1	1	-	2
			Yoldia hyperborea		2	1	-	3
		Veneroidea	Abra nitida		3	2	-	5
			Axinopsida orbiculata		4	5	-	9
			Macoma calcarea		3	6	-	9
			Thyasira gouldii		2	2	-	4
			Thyasira sarsii		9	10	-	19
ECHINODERMATA								
	Ophiuroidea							
		Ophiurida	Ophiocten affinis		3	4	-	7
			Ophiuroidea indet. juv.		4	4	-	8
			Maksverdi:		63	57		120
			Antall arter/taxa:		27	37		39
			Sum antall individ:					387

Stasjonsnr.: C5

ECHIURIDA

			Echiurus echiurus		3		-	3
ANNELIDA								
	Polychaeta							
		Orbiniida	Levinsenia gracilis		26	42	-	68
		Cossurida	Cossura sp.		4	2	-	6
		Spionida	Chaetozone sp.		2	6	-	8
			Dipolydora sp.			1	-	1
			Prionospio steenstrupi		2		-	2
			Pseudopolydora nordica		1		-	1
			Spio decorata			2	-	2
			Spio limicola		1	2	-	3
		Capitellida	Capitella capitata		7		-	7
			Maldane sarsi		4	7	-	11
			Mediomastus fragilis		9	8	-	17
			Praxillella gracilis			1	-	1
			Praxillella praetermissa		11	3	-	14
		Phyllodocida	Eteone flava/longa		7		-	7
			Microphthalmus szcelkowi			1	-	1
			Nephtys ciliata		4	4	-	8
			Pholoe assimilis			2	-	2
			Pholoe baltica		4	1	-	5
		Sternaspida	Sternaspis scutata		2	7	-	9
		Oweniida	Galathowenia oculata		25	18	-	43
			Myriochele heeri		2	1	-	3
			Owenia sp.		5	4	-	9
		Terebellida	Lagis koreni		3	4	-	7
			Laphania boeckii		3		-	3
			Zatsepinia rittichae		6		-	6
		Sabellida	Chone sp.		1		-	1
			Euchone sp.		6	12	-	18
CRUSTACEA								
	Malacostraca							
		Cumacea	Eudorella sp.		2	1	-	3
			Leucon sp.		18	7	-	25
		Amphipoda						

Rekke	Klasse	Orden	Art/Taxa	Replikat:	01	02	-	Sum
			Bathymedon obtusifrons			1	-	1
			Dulichidae indet.			1	-	1
			Lysianassidae indet.		1		-	1
MOLLUSCA		Caudofoveata						
			Caudofoveata indet.		1		-	1
		Opisthobranchia						
		Cephalaspidea						
			Philinissima denticulata			1	-	1
		Bivalvia						
		Nuculoida						
			Ennucula tenuis		298	90	-	388
			Nuculana pernula		38	17	-	55
			Yoldia hyperborea		8	8	-	16
		Veneroida						
			Abra nitida		9	7	-	16
			Axinopsida orbiculata		28	5	-	33
			Macoma calcarea		1	1	-	2
			Parvicardium pinnulatum		1		-	1
			Thyasira gouldii		7	4	-	11
			Thyasira sarsii		11	8	-	19
ECHINODERMATA		Ophiuroidea						
		Ophiurida						
			Ophiocten affinis		6	4	-	10
			Ophiuroidea indet. juv.		14	7	-	21
			Maksverdi:		298	90		388
			Antall arter/taxa:		38	35		46
			Sum antall individ:					871

Stasjonsnr.: C6

NEMERTINI

ECHIURIDA			Nemertea indet.		1	1	-	2
ANNELIDA			Echiurus echiurus			1	-	1
		Polychaeta						
		Orbiniida						
			Levinsenia gracilis		34	35	-	69
			Scoloplos armiger		1		-	1
		Cossurida						
			Cossura sp.			2	-	2
		Spionida						
			Chaetozone sp.		3	1	-	4
			Prionospio steenstrupi		2		-	2
			Pseudopolydora nordica		1		-	1
			Spio decorata		1	3	-	4
		Capitellida						
			Maldane sarsi		1	5	-	6
			Mediomastus fragilis		1	1	-	2
			Praxillella gracilis		2	1	-	3
			Praxillella praetermissa		8	4	-	12
		Phyllococida						
			Eteone flava/longa			1	-	1
			Nephtys ciliata		4	5	-	9
			Pholoe assimilis			1	-	1
			Pholoe baltica			1	-	1
			Polynoidae indet.			1	-	1
			Syllis hyalina			1	-	1
		Sternaspida						
			Sternaspis scutata		10	11	-	21
		Oweniida						
			Galathowenia oculata		31	32	-	63
			Myriochele heeri		8	4	-	12

Rekke	Klasse	Orden	Art/Taxa	Replikat:	01	02	-	Sum
			Owenia sp.		10	3	-	13
		Terebellida						
			Ampharete petersenae			1	-	1
			Lanassa venusta			1	-	1
			Laphania boeckii		3		-	3
			Zatsepinia rittichae		1		-	1
		Sabellida						
			Euchone sp.		4	8	-	12
CRUSTACEA								
	Malacostraca							
		Cumacea						
			Eudorella sp.		1	3	-	4
			Leptostylis sp.		1		-	1
			Leucon sp.		25	16	-	41
		Amphipoda						
			Bathymedon obtusifrons		1		-	1
			Dulichidae indet.			1	-	1
			Gammaridea indet.		1	1	-	2
			Lysianassidae indet.		2	1	-	3
			Paroedicerus sp.		1		-	1
MOLLUSCA								
	Bivalvia							
		Nuculoidea						
			Ennucula tenuis		250	107	-	357
			Nuculana pernula		14	20	-	34
			Yoldia hyperborea		3	2	-	5
		Mytiloidea						
			Musculus niger		1		-	1
			Mytilus edulis			1	-	1
		Veneroidea						
			Abra nitida		6	4	-	10
			Axinopsida orbiculata		20	5	-	25
			Macoma calcarea		2	1	-	3
			Thyasira gouldii		13	20	-	33
			Thyasira sarsii		10	7	-	17
ECHINODERMATA								
	Ophiuroidea							
		Ophiurida						
			Ophiocten affinis		1	1	-	2
			Ophiuroidea indet. juv.		12	8	-	20
				Maksverdi:	250	107		357
				Antall arter/taxa:	37	39		48
				Sum antall individ:				812

7.4 Analytical report



ANALYSERAPPORT

Kunde: Arctic Sea Farm / Arctic Fish
Kundemerking: Eyrarhlid I 2023
Kontaktperson:
Prosjektnr.: 65094

Rapport nr.: P230124
Rapportdato: 2023-09-12
Ankomst dato: 2023-07-12

Lab-id. P230124-01

Objekt Sediment Kundens ID C1 Prosjektnr. og prosjektnavn 65094 - Eyrarhlid I 2023 (fallow period) Notering Mottatt lab 2023-07-03

Analyseresultat						
Parameter	Resultat	Enhet	Analyse dato start	Analysedato slutt	Standard	Målesikkerhet
TOC	38	mg/g TS	2023-07-12	2023-07-14	Intern metode (DIN EN 17505:2022)	±3.8
TN _b	3.1	mg/g TS	2023-07-12	2023-07-14	Intern metode (NS-EN 16168:2012)	±0.9
nTOC	40.8	mg/g TS	2023-07-20	2023-07-20	Veileder 02:2018	
C/N - forhold	12.0		2023-07-18	2023-07-18		
TOM	9.3	% TS	2023-07-18	2023-07-20	Intern metode	±0.4
Vekt% 2 mm	0.4	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 1 mm	0.2	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.500 mm	0.4	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.250 mm	3.1	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.125 mm	5.6	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.063 mm	8.2	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% < 0.063 mm	82.2	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±4.1
Pelitt	82.2	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±4.1
Sand	17.4	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.1
Grus	0.4	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Kobber (Cu) ^a	52.1	mg/kg TS	2023-07-31	2023-07-31	Intern metode	

^a Prøvingen er utført av eksternt laboratorium, ALS Laboratory Group

* = Ikke akkreditert resultat

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Side 1 av 7

ANALYSERAPPORT

Kunde: Arctic Sea Farm / Arctic Fish
 Kundemerking: Eyrarhlid I 2023
 Kontaktperson:
 Prosjektnr.: 65094

Rapport nr.: P230124
 Rapportdato: 2023-09-12
 Ankomst dato: 2023-07-12

Lab-id. P230124-02

Objekt	Kundens ID	Prosjektnr. og prosjektnavn	Notering		Mottatt lab	
Sediment	C2	65094 - Eyrarhlid I 2023 (fallow period)			2023-07-03	
Analyseresultat						
Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Måleusikkerhet
TOC	25	mg/g TS	2023-07-12	2023-07-14	Intern metode (DIN EN 17505:2022)	±2.5
TNb	*5.7	mg/g TS	2023-07-12	2023-07-14	Intern metode (NS-EN 16168:2012)	±1.7
nTOC	28.3	mg/g TS	2023-07-20	2023-07-20	Veileder 02:2018	
C/N - forhold	4.4		2023-07-18	2023-07-18		
TOM	10.3	% TS	2023-07-18	2023-07-20	Intern metode	±0.4
Vekt% 2 mm	0.2	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 1 mm	0.4	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.500 mm	0.4	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.250 mm	1.2	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.125 mm	5.3	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.063 mm	9.2	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% < 0.063 mm	83.3	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±4.2
Pelitt	83.3	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±4.2
Sand	16.5	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.1
Grus	0.2	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0

* = Ikke akkreditert resultat

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Side 2 av 7

ANALYSERAPPORT

Kunde: Arctic Sea Farm / Arctic Fish
 Kundemerking: Eyrarhlid I 2023
 Kontaktperson:
 Prosjektnr.: 65094

Rapport nr.: P230124
 Rapportdato: 2023-09-12
 Ankomst dato: 2023-07-12

Lab-id. P230124-03

Objekt	Kundens ID	Prosjektnr. og prosjektnavn	Notering		Mottatt lab	
Sediment	C3	65094 - Eyrarhlid I 2023 (fallow period)			2023-07-03	
Analyseresultat						
Parameter	Resultat	Enhet	Analyse dato start	Analyse dato slutt	Standard	Måleusikkerhet
TOC	23	mg/g TS	2023-07-12	2023-07-14	Intern metode (DIN EN 17505:2022)	±2.3
TN _b	4.9	mg/g TS	2023-07-12	2023-07-14	Intern metode (NS-EN 16168:2012)	±1.5
nTOC	26.0	mg/g TS	2023-07-20	2023-07-20	Veileder 02:2018	
C/N - forhold	4.8		2023-07-18	2023-07-18		
TOM	9.5	% TS	2023-07-18	2023-07-20	Intern metode	±0.4
Vekt% 2 mm	0.4	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 1 mm	0.4	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.500 mm	0.5	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.250 mm	1.1	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.125 mm	4.0	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.063 mm	8.0	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% < 0.063 mm	85.6	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±4.3
Pelitt	85.6	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±4.3
Sand	14.0	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.1
Grus	0.4	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0

* = Ikke akkreditert resultat

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Side 3 av 7

ANALYSERAPPORT

Kunde: Arctic Sea Farm / Arctic Fish
 Kundemerking: Eyrarhlid I 2023
 Kontaktperson:
 Prosjektnr.: 65094

Rapport nr.: P230124
 Rapportdato: 2023-09-12
 Ankomst dato: 2023-07-12

Lab-id. P230124-04

Objekt	Kundens ID	Prosjektnr. og prosjektnavn	Notering		Mottatt lab	
Sediment	C4	65094 - Eyrarhlid I 2023 (fallow period)			2023-07-03	
Analyseresultat						
Parameter	Resultat	Enhet	Analyse dato start	Analyse dato slutt	Standard	Måleusikkerhet
TOC	29	mg/g TS	2023-07-12	2023-07-14	Intern metode (DIN EN 17505:2022)	±2.9
TNb	4.6	mg/g TS	2023-07-12	2023-07-14	Intern metode (NS-EN 16168:2012)	±1.4
nTOC	31.8	mg/g TS	2023-07-20	2023-07-20	Veileder 02:2018	
C/N - forhold	6.3		2023-07-18	2023-07-18		
TOM	10.2	% TS	2023-07-18	2023-07-20	Intern metode	±0.4
Vekt% 2 mm	0.1	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 1 mm	0.1	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.500 mm	0.3	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.250 mm	1.2	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.125 mm	5.1	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.063 mm	8.9	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% < 0.063 mm	84.3	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±4.2
Pelitt	84.3	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±4.2
Sand	15.6	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.1
Grus	0.1	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Emamectinbenzoat ^b	*460	ng/kg TS	2023-09-05	2023-09-05	Intern metode	

^b Prøvingen er utført av eksternt laboratorium, NIVA

* = Ikke akkreditert resultat

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ANALYSERAPPORT

Kunde: Arctic Sea Farm / Arctic Fish
 Kundemerking: Eyrarhlid I 2023
 Kontaktperson:
 Prosjektnr.: 65094

Rapport nr.: P230124
 Rapportdato: 2023-09-12
 Ankomst dato: 2023-07-12

Lab-id. P230124-05

Objekt	Kundens ID	Prosjektnr. og prosjektnavn	Notering		Mottatt lab	
Sediment	C5	65094 - Eyrarhlid I 2023 (fallow period)			2023-07-03	
Analyseresultat						
Parameter	Resultat	Enhet	Analyse dato start	Analyse dato slutt	Standard	Måleusikkerhet
TOC	27	mg/g TS	2023-07-12	2023-07-14	Intern metode (DIN EN 17505:2022)	±2.7
TNb	*5.2	mg/g TS	2023-07-12	2023-07-14	Intern metode (NS-EN 16168:2012)	±1.5
nTOC	29.7	mg/g TS	2023-07-20	2023-07-20	Veileder 02:2018	
C/N - forhold	5.2		2023-07-18	2023-07-18		
TOM	9.8	% TS	2023-07-18	2023-07-20	Intern metode	±0.4
Vekt% 2 mm	0.7	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 1 mm	0.3	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.500 mm	0.4	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.250 mm	0.9	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.125 mm	5.4	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.063 mm	9.1	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% < 0.063 mm	83.2	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±4.2
Pelitt	83.2	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±4.2
Sand	16.1	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.1
Grus	0.7	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0

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ANALYSERAPPORT

Kunde: Arctic Sea Farm / Arctic Fish
 Kundemerking: Eyrarhlid I 2023
 Kontaktperson:
 Prosjektnr.: 65094

Rapport nr.: P230124
 Rapportdato: 2023-09-12
 Ankomst dato: 2023-07-12

Lab-id. P230124-06

Objekt	Kundens ID	Prosjektnr. og prosjektnavn	Notering		Mottatt lab	
Sediment	C6	65094 - Eyrarhlid I 2023 (fallow period)			2023-07-03	
Analyseresultat						
Parameter	Resultat	Enhet	Analysestart	Analysestop	Standard	Måleusikkerhet
TOC	28	mg/g TS	2023-07-12	2023-07-14	Intern metode (DIN EN 17505:2022)	±2.8
TN _b	4.4	mg/g TS	2023-07-12	2023-07-14	Intern metode (NS-EN 16168:2012)	±1.3
nTOC	31.6	mg/g TS	2023-07-20	2023-07-20	Veileder 02:2018	
C/N - forhold	6.5		2023-07-18	2023-07-18		
TOM	9.8	% TS	2023-07-18	2023-07-20	Intern metode	±0.4
Vekt% 2 mm	0.6	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 1 mm	0.5	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.500 mm	0.5	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.250 mm	0.9	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.125 mm	6.3	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.063 mm	9.3	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% < 0.063 mm	82.0	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±4.1
Pelitt	82.0	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±4.1
Sand	17.4	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.1
Grus	0.6	wt% TS	2023-07-14	2023-07-20	Intern metode (Bale/Kenny 2005)	±0.0

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ANALYSERAPPORT

Kunde: Arctic Sea Farm / Arctic Fish
Kundemerking: Eyrarhlid I 2023
Kontaktperson:
Prosjektnr.: 65094

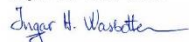
Rapport nr.: P230124
Rapportdato: 2023-09-12
Ankomst dato: 2023-07-12

Akkreditert måleområdet for TNb er fra 0.05 mg/g TS til 5.0 mg/g TS

Analyseansvarlig:

Ingar H. Wasbotten

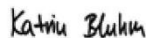
Signatur:



Katrín Bluhm

Underskriftsberettiget:

Signatur:



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

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