C-survey at Laugardalur 2, 2024 (max biomass)

Arnarlax ehf

Akvaplan-niva AS Report: 2024 65629.02

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Arnarlax ehf. C-Survey at Laugardalur 2, 2024 (max biomass).

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Customer

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Summary

The results from the monitoring at the farming site Laugardalur 2 in January 2024 showed that the sediment was somewhat loaded with organic carbon and the copper level in the sediment at C1 was elevated (161 mg/kg) and is categorized into environmental limit III or upper limit of natural values. EMB concentration was below detection limit (50 ng/kg) and thus below the defined concentration of 272 ng/kg for stations outside the mixing zone. Accordingly, the station is fulfilling the "good status standard".

At most of the stations, the nEQR values were above 0.6 indicating relatively good faunal conditions at these stations. At C4 nEQR was just below 0.6 which might indicate somewhat poor conditions. The diversity index H' was above 3 at C1 and below at the other stations which ranged from 2.5 to 2.9. 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 among the most dominant species at C1, 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 January was good in the whole water column with 93 % in the bottom water.

Approval

Project leader

Kamila Sztybor
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Quality control

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Preface

Akvaplan-niva carried out a type C (NS 9410:2016) environmental survey at the Laugardalur 2 site. It includes pH/redox measurements (Eh), hydrography, geochemical analyses, and analyses of the bottom fauna from four 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 Sztybor	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.
Jesper Hansen	Akvaplan-niva	Identification of bottom fauna (Mollusca).
Charlotte P. Ugelstad	Akvaplan-niva	Identification of bottom fauna (Polychaeta).
Vegard Holen	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 Arnarlax ehf and Silja Baldvinsdóttir for good cooperation.

Accreditation information:

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

NORSK AKKREDITERING TEST 079

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: Analyses of emamectin benzoate, hydrographical measurements and mapping of bottom topography (Olex).

1 Data Summary

Client information			
Report title:	C-Survey at Laugardalur 2, 2024 (max biomass).		
Report nr.	2024 65629.02	Site:	Laugardalur 2
Municipality:		Map Coordinates (construction):	65°38,744 N 23°54,668 V
MTB permitted:		Operations manager:	Rolf Ørjan Nordli
Client:	Arnarlax ehf		

Biomass/production status at time of survey (23.01.2024)			
Fish group:	A. salmon	Biomass on examination:	2.176
Feed input:	3.297	Produced amount of fish:	1.573
Type/time of survey			
Maximum biomass:	X	Follow up study:	
Fallow (resting period):		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)	0.616	Fauna C1 (impact zone)	3.44
Fauna C2	0.615	Fauna C2	2.84
Fauna C3	0.621	Fauna C3	2.88
Fauna C4 (deep area)	0.594	Fauna C4 (deep area)	2.51
Date fieldwork:	(23.01.2024)	**Date of report:**	04.04 2024
Notes to other results (sediment, pH/Eh, oxygen)			nTOC from 34.6 to 38.1 mg/g. Copper 161 mg/kg at C1 Phosphorous 912 to 1060 mg/kg Eh positive at all stations O_2-conditions were good throughout the water column.

2 Introduction

2.1 Background and aim of the study

On behalf of Arnarlax ehf, Akvaplan-niva completed a pre-survey (type C) for a fish farming site at Laugardalur 2 (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 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.

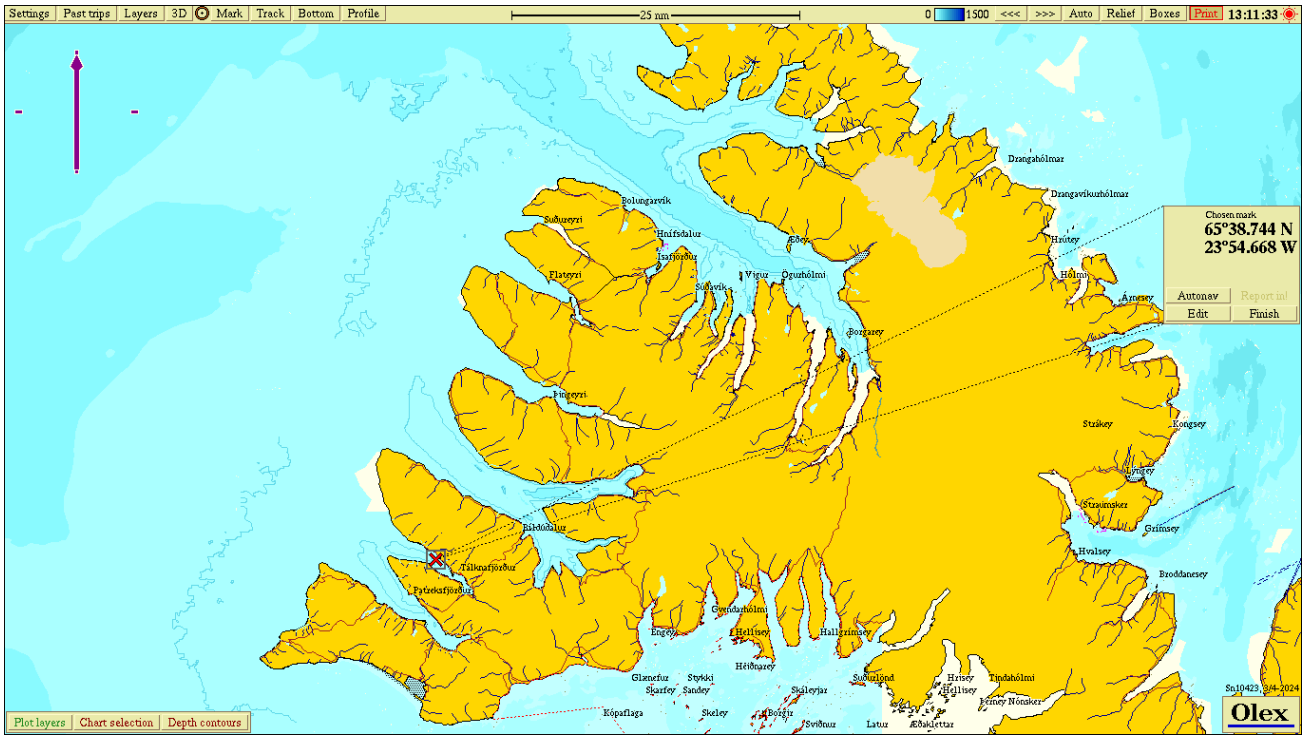

Figure 1 Overview of Vestfjords with the farming site Laugardalur 2 in the fjord Patreksfjörður (red cross). The map coordinates for the midpoint of the farming site are given to the right.

2.2 Site operation and feed use

The installed frame at the site is a 1 x 8 configuration and is suited for up to 8 net-pens with a circumference of 160 m but the current generation was produced in 6 cages (the outermost cages

were not used). This is the first-generation farmed fish at the site Laugardalur 2 after the frame was installed in summer 2022. Laugardalur 2 is placed at a farming site Laugardalur where there is and has been a fish farm referred to as Laugardalur with 14 net pens and currently the fifth generation farmed salmon is being reared there. The Laugardalur 2 frame is placed about 400 m SE from the Laugardalur frame.

The output of smolts at Laugardalur 2 was in the summer and fall 2022. At the time of the survey, the standing stock was approximately 2.176 tonnes of salmon (pers. comm. Silja Baldvinsdóttir) and the feed use was 3.297 tonnes.

In Iceland, the MTB (maximum allowable biomass) 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 2.262 tonnes, used as MTB here (Silja Baldvinsdóttir, pers. comm).

2.3 Previous surveys

Akvaplan-niva AS has not done any previous environmental surveys of the type B/C (NS 9410) at the Laugardalur 2 site. There are some B and C investigations that have been conducted at the sister site Laugardalur (about 400 m NW) from the Laugardalur 2 site, related to fish farming activities, but none directly affiliated with Laugardalur 2.

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 1.

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 1: Survey program for the C-survey at Laugardalur 2, 2024. TOC = total organic carbon. GSA = grain size analysis sediment. TOM = total organic material. TN = total nitrogen. Cu = Copper. P = phosphorus. pH/Eh = acidity and redox potential.

Station	Type analyses/parameters
C1 (local impact zone)	Quantitative analyses of bottom fauna. TOC. GSA, TOM. TN. Cu. P. pH/Eh.
C2 (transect zone outer)	Quantitative analyses of bottom fauna. TOC. GSA, TOM. TN. P. pH/Eh.
C3 (transect zone)	Quantitative analyses of bottom fauna. TOC. GSA, TOM. TN. P. pH/Eh. Emamectin benzoate.
C4 (transect zone, deep area)	Quantitative analyses of bottom fauna. TOC. GSA, TOM. TN. P. Hydrography/O_2. pH/Eh.

Field work was completed on 23.01.2024.

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 2.262 tonnes (used as MTB here). According to the standard four 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 the direction of the main oceanic current direction measured at 42 m depth (Heggem, 2019).

Table 2: Depth, distance between the nearest frame of the fish farm and sampling stations and coordinates for C-stations at Laugardalur 2, 2024.

Station	Depth, m	Distance from frame, m	Position	
			N	W
C1	50	25	65°38.881	23°55.118
C2	52	500	65°38.872	23°55.787
C3	50	180	65°38.931	23°55.276
C4	51	320	65°38.912	23°55.519

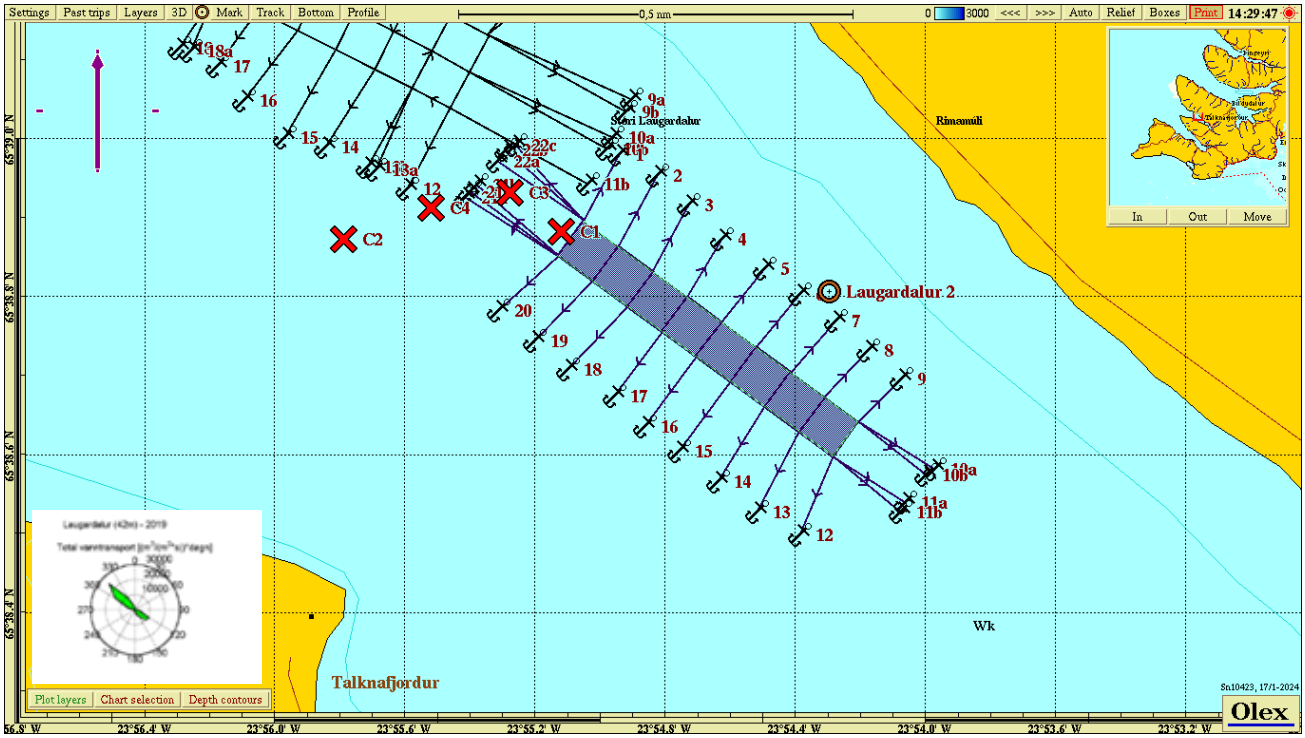

Figure 2. Map showing the sampling stations for the C-survey at Laugardalur 2, 2024. Current measurements used were from 42 m depth (Heggem, 2019).

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 Sensordata CTDO 204 probe.

3.3 Soft bottom sampling and analyses

3.3.1 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, P 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 (TOC_{400}, ROC, TIC_{900})). 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 Phosphorus (P)

Following a pre-treatment, the samples were quantified according to ČSN 720116-1 (720116) where phosphoruspentaoxide, P_2O_5 forms a phosphorusmolybden-vanadiumcomplex. 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.

3.3.8 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 m^2 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 (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 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 January 2024 is presented in Figure 3.

Temperature was 2 °C from the surface to the bottom layer. Oxygen saturation was 92 % in the upper layer and 93 % in the bottom layer.

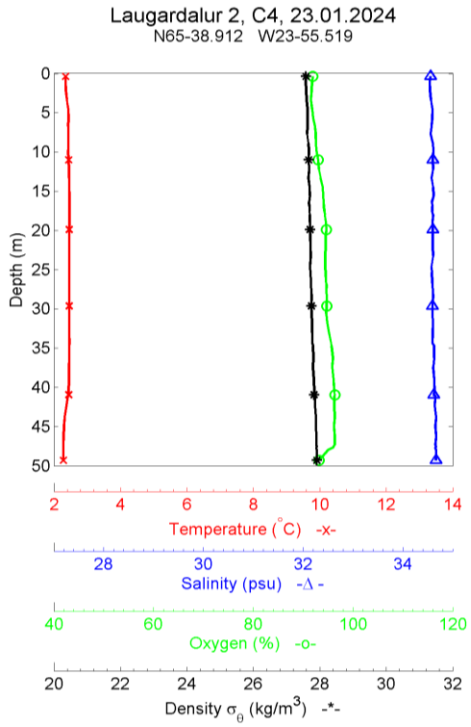

Figure 3. Vertical profiles. Temperature, salinity, density, and oxygen at C4 at Laugardalur 2, 2024.

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 3.

TOM-levels varied from 9.5 to 12.9 %. TN-levels were low (2.8 – 4.4 mg/g) as was the C/N-ratio. TOC was rather high at all stations and nTOC varied from 34.6 to 38.1 mg/g. The bottom sediments grain size was moderately fine with a pelite ratio ranging from 61.4 to 85.2 %.

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 (pelite ratio % <0,063 mm) and pH/Eh. Laugardalur 2, 2024.

St.	Sediment description	TOM	TOC	nTOC	TN	C/N	Pelite	pH/Eh
C1	Olive green mud, no smell of H_2S.	9.5	28	34.6	2.8	9.8	61.4	7.6/ 269
C2	Olive green mud, no smell of H_2S.	12.9	34	36.7	4.4	7.8	85.2	7.7/ 273
C3	Olive green mud, no smell of H_2S.	12.1	33	38.1	3.8	8.8	73.8	7.6/ 259
C4	Olive green mud, no smell of H_2S.	11.7	31	37.7	2.9	10.7	64.9	7.8/ 265

4.2.2 Copper

Level of copper in bottom sediment at C1 is shown in Table 4. The level of copper was 161 mg/kg or upper limit of natural values (limit III) according to environmental limits in Icelandic regulation nr. 796/199 (Regulation on prevention of water pollution nr. 796/1999).

Table 4. Copper (Cu), mg/kg DS. Laugardalur 2, 2024.

St.	Cu
C1	161

4.2.3 Emamectin benzoate

Concentration of emamectin benzoate in sediment at C3 is presented in Table 5. Station C3 is located 180 m from the cage edge and is thus placed outside the mixing zone (SEPA 2022).

EMB concentration is less than 50 ng/kg and thus below the defined concentration of 272 ng/kg for stations outside the mixing zone. Accordingly, the station is fulfilling the "good status standard".

Table 5. Emamectin benzoate in the sediment at C3, ng/kg. Laugardalur 2, 2024.

St.	Emamectin benzoate
C3	< 50

4.2.4 Phosphorus

Levels of phosphorus in bottom sediments at Laugardalur 2 are shown in Table 6. The level of phosphorus varied from 919 mg/kg (C3) to 1060 mg/kg (C1).

Table 6. Phosphorus (P), mg/kg DS. Laugardalur 2, 2024.

St.	P
C1	1060
C2	1000
C3	919
C4	957

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 1018 (C2) to 1675 (C3) and number of species from 39 (C4) to 48 (C1). The diversity H' varied from 2.51 to 3.44. At most of the stations, the overall index of nEQR was higher than 0.6, while at C4 below. The nEQR values indicate somewhat poor condition at C4 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 0.51 to 0.67 which indicates a somewhat uneven distribution.

Table 7. Number of species and individuals pr. 0,2 m2. H´ = Shannon-Wiener's diversity index. ES100 = Hurlberts diversity index. NQI1 = overall index (diversity and sensitivity). ISI2012 = sensitivity index. NSI = sensitivity index. J = Pielous evenness index. AMBI = AZTI marine biotic index (part of NQI1). nEQR = normalized EQR (excl. DI). C-stations at Laugardalur 2, 2024.

St.	No. of individuals.	No. of species	H´	ES_{100}	NQI1	ISI_{2012}	NSI	nEQR	AMBI	J
C1	1326	48	3.44	18.7	0.698	7.20	19.59	0.616	2.175	0.67
C2	1018	42	2.84	14.8	0.717	7.77	21.21	0.615	1.794	0.57
C3	1675	44	2.88	16.8	0.720	7.45	21.10	0.621	1.724	0.56
C4	1524	39	2.51	13.8	0.706	7.90	20.86	0.594	1.753	0.51

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 m^2 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 Laugardalur 2 site 2024.

Station	Site name	Num. species	Dominating taxa	Environmental condition-NS 9410
C1	Laugardalur 2	48	Galathowenia oculata – 32 %	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.

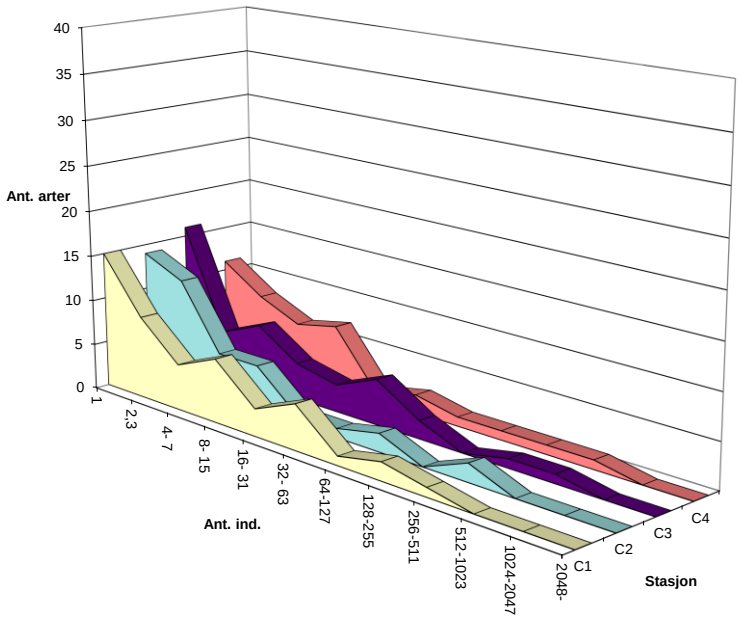

Figure 4. The soft bottom fauna shown as number of species against number of individuals pr. species in geometric classes. Laugardalur 2, 2024.

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 was more than 65 % similar for all stations in the survey.

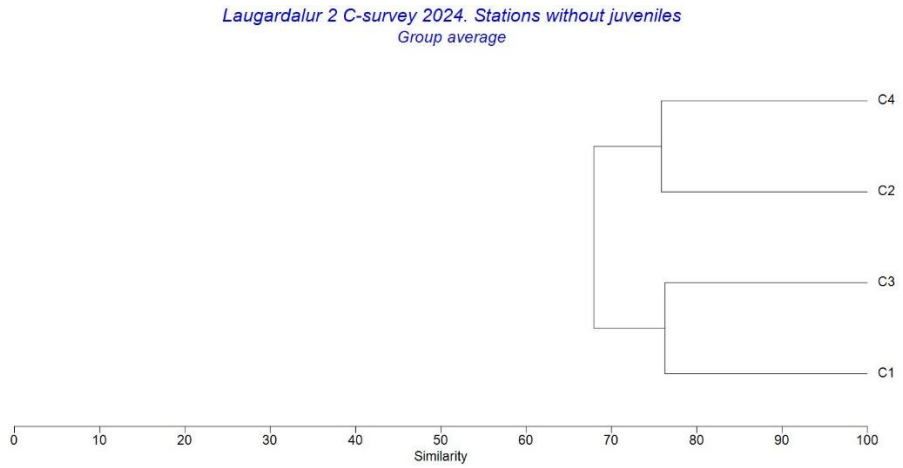

Figure 5. Cluster diagram for the soft bottom fauna at the C- sampling stations at Laugardalur 2, 2024.

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, C3 and C4 was dominated by the tolerant polychaeta *Galathowenia oculata* with between 32 and 51 % of the individuals. The other most dominant species at the stations were a mixture of neutral, tolerant, and opportunistic species together with the pollution indicator species *Capitella capitata* at station C1.

The fauna at C2 was dominated by the neutral bivalve *Ennucula tenuis* with 32 % of the individuals. The other most dominant species at the stations were a mixture of neutral, tolerant, and opportunistic species.

Table 9. Number of individuals, cumulative percentage, and ecological group for the ten most dominant species at the C stations. Laugardalur 2, 2024.*

C1	EG	Ant. ind.	Kum.
Galathowenia oculata	III	437	32 %
Owenia sp.	II	205	47 %
Ennucula tenuis	II	169	59 %
Thyasira sarsii	IV	79	65 %
Eteone flava/longa	Ik	58	69 %
Capitella capitata	V	57	74 %
Ophiuroidea indet. juv.	II	39	76 %
Lagis koreni	IV	34	79 %
Maldane sarsi	IV	32	81 %
Pholoe baltica	III	32	84 %

C2	EG	Ant. ind.	Kum.
Ennucula tenuis	II	329	32 %
Galathowenia oculata	III	318	63 %
Thyasira sarsii	IV	111	74 %
Sternaspis scutata	Ik	72	81 %
Nuculana pernula	II	46	86 %
Mediomastus fragilis	IV	17	87 %
Leucon nasica	III	15	89 %
Prionospio steenstrupi	II	15	90 %
Euchone papillosa	III	11	91 %
Yoldia hyperborea	IK	10	92 %

C3	EG	Ant. ind.	Kum.
Galathowenia oculata	III	802	46 %
Ennucula tenuis	II	292	63 %
Owenia sp.	II	101	69 %
Thyasira sarsii	IV	79	74 %
Ophiuroidea indet. juv.	II	53	77 %
Lagis koreni	IV	47	79 %
Myriochele malmgreni/olgae	Ik	47	82 %
Leucon nasica	III	41	85 %
Scoloplos armiger	III	36	87 %
Maldane sarsi	IV	35	89 %

C4	EG	Ant. ind.	Kum.
Galathowenia oculata	III	779	51 %
Ennucula tenuis	II	298	70 %
Thyasira sarsii	IV	140	79 %
Sternaspis scutata	Ik	64	84 %
Myriochele malmgreni/olgae	Ik	42	86 %
Nuculana pernula	II	34	89 %
Leucon nasica	III	25	90 %
Prionospio steenstrupi	II	15	91 %
Maldane sarsi	IV	14	92 %
Scoloplos armiger	III	14	93 %

*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 Laugardalur 2, 2024, can be summarised as follows:

- The hydrography measurements showed good oxygen conditions throughout the water column with 93 % saturation in the bottom layer in January 2024.
- TOC was rather high at all stations and nTOC varied from 34.6 to 38.1 mg/g TS. TOM-levels varied from 9.5 to 12.9 %. TN-levels were low (2.8 – 4.4 mg/g) as was the C/N-ratio. The copper level in the sediment at C1 was elevated (161 mg/kg) or at upper limit of natural values (limit III). EMB concentration at C3 was below detection limit at 50 ng/kg and thus below the defined concentration of 272 ng/kg for stations outside the mixing zone. Accordingly, the station is fulfilling the "good status standard". The phosphorus levels varied between 919 and 1060 mg/kg. The bottom sediments grain size was moderately fine with a pelite ratio ranging from 61.4 to 85.2 %. 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 1018 to 1675 and number of species from 39 to 48. The diversity H' varied from 2.51 to 3.44. At most of the stations, the overall index of nEQR was higher than 0.6, while below at station C4. The nEQR values indicate somewhat poor condition at C4 and better conditions at the other stations.

5.2 Conclusions

The results from the monitoring at the farming site Laugardalur 2 in January 2024 showed that the sediment was somewhat loaded with organic carbon and the copper level in the sediment at C1 was elevated (161 mg/kg) and is categorized into environmental limit III or upper limit of natural values. EMB concentration was below detection limit (50 ng/kg) and thus below the defined concentration of 272 ng/kg for stations outside the mixing zone. Accordingly, the station is fulfilling the "good status standard".

At most of the stations, the nEQR values were above 0.6 indicating relatively good faunal conditions at these stations. At C4 nEQR was just below 0.6 which might indicate somewhat poor conditions. The diversity index H' was above 3 at C1 and below at the other stations which ranged from 2.5 to 2.9. 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 among the most dominant species at C1, 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 January was good in the whole water column with 93 % in the bottom water.

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 indeksen er mest følsom for individfordelingen. En lav verdi indikerer et artsfattig samfunn og/eller et samfunn som er dominert av en eller få arter. En høy verdi indikerer et artsrikt samfunn.

Pielous mål for jevnhet (Pielou, 1966)

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

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

Hurlberts diversitetskurver

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

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

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

der N = total antall individ i prøven
N_i = antall individ av art i

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

Plott av antall arter i forhold til antall individer

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

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

Faunaens fordelingsmønster

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

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

Clusteranalyse

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

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

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

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

Ømfintlighet (AMBI, ISI og NSI)

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

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

Sammensatte indekser (NQI1 og NQI2)

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

NQI1 indeksen er beskrevet ved hjelp av formelen:

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

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

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7.2 Statistical results Laugardalur 2, 2024

Benthos indices per replicate

st.nr.		C1_01	C1_02	C2_01	C2_02	C3_01	C3_02	C4_01	C4_02
no. ind.		992	334	662	356	797	878	723	801
no. spe.		36	34	33	29	31	39	30	30
Shannon-Wiener:		3,1	3,8	2,8	2,9	2,9	2,8	2,5	2,5
Pielou		0,60	0,75	0,56	0,59	0,59	0,54	0,51	0,51
ES100		17	21	14	15	16	17	14	14
SN		1,86	2,00	1,87	1,90	1,81	1,91	1,80	1,79
ISI-2012		6,99	7,41	7,39	8,15	7,56	7,34	7,95	7,85
AMBI		1,718	2,632	1,84	1,747	1,738	1,709	1,676	1,829
NQI1		0,72	0,68	0,71	0,72	0,71	0,73	0,71	0,70
NSI		21,4	17,8	20,8	21,6	21,2	21,0	20,9	20,8

Geometrical classes

	0	C1	C2	C3	C4
int.	cla.				
0	0	26	32	30	35
1	1	15	14	16	11
<4	2	50	58	51	54
<8	3	55	63	58	60
<16	4	62	68	62	67
<32	5	65	69	65	68
<64	6	70	70	70	70
<128	7	71	72	72	71
<256	8	73	72	72	72
<512	9	74	74	73	73
<1024	10	74	74	74	74
<2048	11	74	74	74	74
2048-	12	0	0	0	0

7.3 Species lists

Artsliste pr stasjon

Laugardalur 2 2 C-survey 2024

Rekke	Klasse	Orden	Art/Taxa	Replikat: 01	02	-	Sum
Stasjonsnr.: C1							
CNIDARIA							
	Anthozoa						
			Edwardsia sp.		1	-	1
NEMERTINI							
			Nemertea indet.	2		-	2
PRIAPULIDA							
			Priapulus caudatus		1	-	1
ANNELIDA							
	Polychaeta						
		Orbiniida					
			Aricidea sp.	2	1	-	3
			Scoloplos armiger	11	1	-	12
		Spionida					
			Chaetozone setosa	1	3	-	4
			Prionospio steenstrupi	2		-	2
			Spio decorata	1		-	1
		Capitellida					
			Capitella capitata	1	56	-	57
			Maldane sarsi	29	3	-	32
			Mediomastus fragilis		5	-	5
			Praxillella gracilis		2	-	2
			Praxillella praetermissa	3		-	3
		Opheliida					
			Scalibregma inflatum	1	5	-	6
		Phyllodocida					
			Alitta virens		1	-	1
			Eteone flava/longa	11	47	-	58
			Microphthalmus sczelkowii		1	-	1
			Nephtys ciliata	3		-	3
			Pholoe assimilis	11	17	-	28
			Pholoe baltica	16	16	-	32
			Phyllodoce groenlandica	1		-	1
			Syllis cornuta	1	1	-	2
			Syllis sp.	1		-	1
		Eunicida					
			Dorvilleidae indet.		1	-	1
			Lumbrineridae indet. juv.	1		-	1
			Parougia nigridentata	5	3	-	8
		Sternaspida					
			Sternaspis scutata	12		-	12
		Oweniida					
			Galathowenia oculata	385	52	-	437
			Myriochele malmgreni/olgae	29		-	29
			Owenia sp.	183	22	-	205
		Terebellida					
			Cistenides hyperborea		2	-	2
			Lagis koreni	31	3	-	34
CRUSTACEA							
	Malacostraca						
		Cumacea					
			Leucon nasica	26	2	-	28
		Amphipoda					
			Caprella septentrionalis		1	-	1
			Deflexilodes sp.	1	1	-	2
			Dulichia sp.	1		-	1
			Lysianassidae indet.		1	-	1
			Metopa alderi	1		-	1

Rekke	Klasse	Orden	Art/Taxa	Replikat:	01	02	-	Sum
MOLLUSCA								
	Caudofoveata							
			Caudofoveata indet.		1		-	1
	Bivalvia							
		Nuculoida						
			Ennucula tenuis		134	35	-	169
			Nuculana pernula		13	2	-	15
			Yoldia hyperborea		4		-	4
		Veneroida						
			Abra nitida			1	-	1
			Axinopsida orbiculata		5		-	5
			Ciliatocardium ciliatum			1	-	1
			Macoma calcarea		4	7	-	11
			Thyasira gouldii		8	3	-	11
			Thyasira sarsii		49	30	-	79
ECHINODERMATA								
	Ophiuroidea							
		Ophiurida						
			Ophiocten affinis		3	6	-	9
			Ophiuroidea indet. juv.		17	22	-	39
				Maksverdi:	385	56		437
				Antall arter/taxa:	38	35		50
				Sum antall individ:				1366

Stasjonsnr.: C2

Rekke	Klasse	Orden	Art/Taxa	Replikat:	01	02	-	Sum
NEMERTINI								
			Nemertea indet.		3	1	-	4
ANNELIDA								
	Polychaeta							
		Orbiniida						
			Aricidea sp.		2	5	-	7
			Scoloplos armiger		2		-	2
		Cossurida						
			Cossura sp.		1		-	1
		Spionida						
			Chaetozone setosa		1	1	-	2
			Chaetozone sp.		2	2	-	4
			Prionospio steenstrupi		10	5	-	15
			Spio decorata		1	1	-	2
			Spio limicola		1		-	1
			Spiophanes kroyeri		1		-	1
		Capitellida						
			Maldane sarsi		5	1	-	6
			Maldanidae indet.		1	1	-	2
			Mediomastus fragilis		17		-	17
			Praxillella praetermissa			2	-	2
		Opheliida						
			Ophelina acuminata			1	-	1
		Phyllodocida						
			Microphthalmus sczelkowii			1	-	1
			Nephtys ciliata		2	1	-	3
			Pholoe baltica		1		-	1
			Polynoidae indet.		1	1	-	2
			Syllis cornuta		2	1	-	3
			Syllis sp.			1	-	1
		Sternaspida						
			Sternaspis scutata		42	30	-	72
		Oweniida						
			Galathowenia oculata		203	115	-	318
			Myriochele malmgreni/olgae			8	-	8
			Owenia sp.		2		-	2
		Terebellida						
			Ampharete borealis		1		-	1
			Lagis koreni		2		-	2
			Melinna cristata			1	-	1
		Sabellida						

Rekke	Klasse	Orden	Art/Taxa	Replikat:	01	02	-	Sum
			Euchone papillosa		10	1	-	11
			Euchone sp.		1		-	1
CRUSTACEA								
	Malacostraca							
		Cumacea						
			Leucon nasica		9	6	-	15
		Amphipoda						
			Deflexilodes sp.			1	-	1
			Dulichia sp.		2		-	2
MOLLUSCA								
	Caudofoveata							
			Caudofoveata indet.			1	-	1
	Bivalvia							
		Nuculoida						
			Ennucula tenuis		216	113	-	329
			Nuculana pernula		29	17	-	46
			Yoldia hyperborea		4	6	-	10
		Veneroida						
			Abra nitida		1		-	1
			Axinopsida orbiculata		4	1	-	5
			Macoma calcarea		1		-	1
			Thyasira sarsii		82	29	-	111
ECHINODERMATA								
	Ophiuroidea							
		Ophiurida						
			Ophiocten affinis			2	-	2
			Ophiuroidea indet. juv.		5		-	5
				Maksverdi:	216	115		329
				Antall arter/taxa:	34	29		43
				Sum antall individ:				1023

Stasjonsnr.: C3

NEMERTINI								
			Nemertea indet.			1	-	1
SIPUNCULIDA								
			Sipuncula indet.			1	-	1
ANNELIDA								
	Polychaeta							
		Orbiniida						
			Aricidea sp.		1		-	1
			Scoloplos armiger		14	22	-	36
		Spionida						
			Chaetozone setosa		3	1	-	4
			Prionospio steenstrupi		1	6	-	7
			Spio decorata		1		-	1
		Capitellida						
			Maldane sarsi		15	20	-	35
			Maldanidae indet.			1	-	1
			Praxillella praetermissa		1	6	-	7
		Opheliida						
			Scalibregma inflatum			1	-	1
		Phyllodocida						
			Bylgides groenlandicus			1	-	1
			Eteone flava/longa		7	6	-	13
			Nephtys ciliata		4	2	-	6
			Pholoe assimilis		4	3	-	7
			Pholoe baltica		1	4	-	5
			Phyllodoce groenlandica			1	-	1
			Syllis cornuta		2		-	2
		Eunicida						
			Dorvilleidae indet.		1	2	-	3
			Lumbrineridae indet. juv.		1		-	1
		Sternaspida						
			Sternaspis scutata		15	11	-	26

Rekke	Klasse	Orden	Art/Taxa	Replikat:	01	02	-	Sum
		Oweniida						
			Galathowenia oculata		341	461	-	802
			Myriochele malmgreni/olgae		23	24	-	47
			Owenia sp.		55	46	-	101
		Terebellida						
			Ampharete sp.			1	-	1
			Lagis koreni		26	21	-	47
		Sabellida						
			Euchone papillosa		1	1	-	2
			Euchone sp.			1	-	1
CRUSTACEA								
	Malacostraca							
		Cumacea						
			Leucon nasica		21	20	-	41
		Amphipoda						
			Dulichia sp.			1	-	1
			Gammaridae indet.			1	-	1
			Lysianassidae indet.			1	-	1
		Isopoda						
			Pleurogonium spinosissimum			1	-	1
MOLLUSCA								
	Caudofoveata							
			Caudofoveata indet.			1	-	1
	Bivalvia							
		Nuculoida						
			Ennucula tenuis		174	118	-	292
			Nuculana pernula		16	14	-	30
			Yoldia hyperborea		4	11	-	15
		Mytiloida						
			Mytilus edulis		2		-	2
		Veneroida						
			Abra nitida		5	1	-	6
			Axinopsida orbiculata		5	9	-	14
			Ciliatocardium ciliatum		1		-	1
			Macoma calcarea		5	5	-	10
			Thyasira gouldii		2	1	-	3
			Thyasira sarsii		37	42	-	79
ECHINODERMATA								
	Ophiuroidea							
		Ophiurida						
			Ophiocten affinis		9	8	-	17
			Ophiuroidea indet. juv.		29	24	-	53
				Maksverdi:	341	461		802
				Antall arter/taxa:	33	40		46
				Sum antall individ:				1729

Stasjonsnr.: C4

NEMERTINI								
			Nemertea indet.		1		-	1
ANNELIDA								
	Polychaeta							
		Orbiniida						
			Aricidea sp.		1	7	-	8
			Scoloplos armiger		6	8	-	14
		Cossurida						
			Cossura sp.			5	-	5
		Spionida						
			Chaetozone setosa		1	5	-	6
			Chaetozone sp.			1	-	1
			Prionospio steenstrupi		5	10	-	15
			Spio decorata			2	-	2
			Spio limicola		1	2	-	3
		Capitellida						
			Maldane sarsi		9	5	-	14
			Praxillella praetermissa		4	5	-	9
		Phyllodocida						

Rekke	Klasse	Orden	Art/Taxa	Replikat:	01	02	-	Sum
			Eteone flava/longa			1	-	1
			Microphthalmus sczelkowii		1		-	1
			Nephtyidae indet. juv.			1	-	1
			Nephtys ciliata		6	5	-	11
			Pholoe baltica			6	-	6
			Syllis cornuta		1		-	1
			Syllis sp.			2	-	2
		Eunicida						
			Parougia nigridentata		2	1	-	3
		Sternaspida						
			Sternaspis scutata		29	35	-	64
		Oweniida						
			Galathowenia oculata		385	394	-	779
			Myriochele malmgreni/olgae		32	10	-	42
			Owenia sp.		7	2	-	9
		Terebellida						
			Lagis koreni		2	3	-	5
		Sabellida						
			Euchone papillosa		2	2	-	4
CRUSTACEA								
	Malacostraca							
		Cumacea						
			Leucon nasica		10	15	-	25
		Amphipoda						
			Deflexilodes sp.			1	-	1
			Lysianassidae indet.		3		-	3
		Isopoda						
			Pleurogonium spinosissimum		1		-	1
		Decapoda						
			Decapoda indet.		1		-	1
MOLLUSCA								
	Opistobranchia							
		Cephalaspidea						
			Retusa obtusa		1		-	1
		Nudibranchia						
			Facelinidae indet.			1	-	1
	Bivalvia							
		Nuculoida						
			Ennucula tenuis		124	174	-	298
			Nuculana pernula		24	10	-	34
			Yoldia hyperborea		1	1	-	2
		Veneroida						
			Abra nitida			1	-	1
			Axinopsida orbiculata		5		-	5
			Thyasira gouldii		3		-	3
			Thyasira sarsii		54	86	-	140
ECHINODERMATA								
	Asteroidea							
			Asteroidea indet. juv.			1	-	1
	Ophiuroidea							
		Ophiurida						
			Ophiocten affinis		1	1	-	2
			Ophiuroidea indet. juv.		4	3	-	7
				Maksverdi:	385	394		779
				Antall arter/taxa:	31	33		42
				Sum antall individ:				1533

7.4 Analytical report

Akvaplan niva

NORSK AKKREDITERING TEST 079

ANALYSERAPPORT

Kunde:	Arnarlax	**Rapport nr.:**	P240009
Kundemerking:	Laugardalur 2 - 2024	**Revisjon:**	2
Kontaktperson:		**Rapportdato**	2024-04-02
Prosjektnr.:	65629	**Ankomst dato:**	2024-02-05

Lab-id. P240009-01

Objekt	Prøvestasjon/ID	Prosjektnr. og prosjektnavn	Notering	Mottatt lab
Sediment	C1	65629 - Laugardalur 2 ASC C og B undersøkelse 2024		2024-01-17

Analyseresultat

Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Måleusikkerhet
TOC	28	mg/g TS	2024-02-27	2024-02-29	Intern metode (DIN EN 17505:2022)	±2.8
TNb	2.8	mg/g TS	2024-02-27	2024-02-29	Intern metode (NS-EN 16168:2012)	±0.6
nTOC	34.6	mg/g TS	2024-03-08	2024-03-08	Veileder 02:2018	
C/N - forhold	9.8		2024-03-08	2024-03-08		
TOM	9.5	% TS	2024-02-27	2024-02-29	Intern metode	±0.4
Vekt% ≥2 mm	0.9	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 1 mm - <2 mm	0.7	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.500 mm - <1 mm	0.8	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.250 mm - <0.500 mm	6.0	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.125 mm - <0.250 mm	6.3	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.063 mm - <0.125 mm	23.9	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.1
Vekt% <0.063 mm	61.4	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±3.1
Pelitt	61.4	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±3.1
Sand	37.7	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.2
Grus	0.9	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt % > 0.063 mm	38.6	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.2
Kobber (Cu) [a]	161	mg/kg TS	2024-02-20	2024-02-20	Intern metode	
P (Fosfor) [a]	1060	mg/kg TS	2024-02-20	2024-02-20	Intern metode	

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

* = Ikke akkreditert resultat

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Analyserapporten er digitalt undertegnet av:
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ANALYSERAPPORT

Kunde:	Arnarlax	**Rapport nr.:**	P240009
Kundemerking:	Laugardalur 2 - 2024	**Revisjon:**	2
Kontaktperson:		**Rapportdato**	**2024-04-02**
Prosjektnr.:	**65629**	**Ankomst dato:**	2024-02-05

Lab-id. P240009-02

Objekt	Prøvestasjon/ID	Prosjektnr. og prosjektnavn	Notering	Mottatt lab
Sediment	C2	65629 - Laugardalur 2 ASC C og B undersøkelse 2024		2024-01-17

Analyseresultat

Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Måleusikkerhet
TOC	**34**	mg/g TS	2024-02-27	2024-02-29	Intern metode (DIN EN 17505:2022)	±3.4
TNb	**4.4**	mg/g TS	2024-02-27	2024-02-29	Intern metode (NS-EN 16168:2012)	±1.0
nTOC	**36.7**	mg/g TS	2024-03-08	2024-03-08	Veileder 02:2018	
C/N - forhold	**7.8**		2024-03-08	2024-03-08		
TOM	**12.9**	% TS	2024-02-27	2024-02-29	Intern metode	±0.4
Vekt% ≥2 mm	**1.3**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 1 mm - <2 mm	**1.5**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.500 mm - <1 mm	2.2	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.250 mm - <0.500 mm	**2.0**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.125 mm - <0.250 mm	**2.1**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.063 mm - <0.125 mm	**5.7**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% <0.063 mm	**85.2**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±4.3
Pelitt	**85.2**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±4.3
Sand	**13.4**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.1
Grus	**1.3**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt % > 0.063 mm	**14.8**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.1
P (Fosfor) [a]	**1000**	mg/kg TS	2024-02-20	2024-02-20	Intern metode	

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

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ANALYSERAPPORT

Kunde:	Arnarlax	**Rapport nr.:**	P240009
Kundemerking:	Laugardalur 2 - 2024	**Revisjon:**	2
Kontaktperson:		**Rapportdato**	**2024-04-02**
Prosjektnr.:	**65629**	**Ankomst dato:**	2024-02-05

Lab-id. P240009-03

Objekt	Prøvestasjon/ID	Prosjektnr. og prosjektnavn	Notering	Mottatt lab
Sediment	C3	65629 - Laugardalur 2 ASC C og B undersøkelse 2024		2024-01-17

Analyseresultat

Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Måleusikkerhet
TOC	33	mg/g TS	2024-02-27	2024-02-29	Intern metode (DIN EN 17505:2022)	±3.3
TNb	3.8	mg/g TS	2024-02-27	2024-02-29	Intern metode (NS-EN 16168:2012)	±0.8
nTOC	38.1	mg/g TS	2024-03-08	2024-03-08	Veileder 02:2018	
C/N - forhold	8.8		2024-03-08	2024-03-08		
TOM	12.1	% TS	2024-02-27	2024-02-29	Intern metode	±0.4
Vekt% ≥2 mm	1.0	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 1 mm - <2 mm	1.6	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.500 mm - <1 mm	3.1	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.250 mm - <0.500 mm	3.0	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.125 mm - <0.250 mm	3.9	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.063 mm - <0.125 mm	13.6	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.1
Vekt% <0.063 mm	73.8	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±3.7
Pelitt	73.8	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±3.7
Sand	25.3	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.2
Grus	1.0	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt % > 0.063 mm	26.2	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.2
P (Fosfor) [a]	919	mg/kg TS	2024-02-20	2024-02-20	Intern metode	
Emamectinbenzoat [b]	*<50	ng/kg TS	2024-03-22	2024-03-22	Intern metode	

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

[b] Prøvingen er utført av eksternt laboratorium, NIVA

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ANALYSERAPPORT

Kunde:	Arnarlax	**Rapport nr.:**	P240009
Kundemerking:	Laugardalur 2 - 2024	**Revisjon:**	2
Kontaktperson:		**Rapportdato**	**2024-04-02**
Prosjektnr.:	**65629**	**Ankomst dato:**	2024-02-05

Lab-id. P240009-04

Objekt	Prøvestasjon/ID	Prosjektnr. og prosjektnavn	Notering	Mottatt lab
Sediment	C4	65629 - Laugardalur 2 ASC C og B undersøkelse 2024		2024-01-17

Analyseresultat						
Parameter	**Resultat**	**Enhet**	**Analysedato start**	**Analysedato slutt**	**Standard**	**Måleusikkerhet**
TOC	**31**	mg/g TS	2024-02-27	2024-02-29	Intern metode (DIN EN 17505:2022)	±3.1
TNb	**2.9**	mg/g TS	2024-02-27	2024-02-29	Intern metode (NS-EN 16168:2012)	±0.6
nTOC	**37.7**	mg/g TS	2024-03-08	2024-03-08	Veileder 02:2018	
C/N - forhold	**10.7**		2024-03-08	2024-03-08		
TOM	**11.7**	% TS	2024-02-27	2024-02-29	Intern metode	±0.4
Vekt% ≥2 mm	**1.3**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 1 mm - <2 mm	**0.4**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.500 mm - <1 mm	**1.1**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.250 mm - <0.500 mm	**2.8**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.125 mm - <0.250 mm	**5.5**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.063 mm - <0.125 mm	**24.0**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.1
Vekt% <0.063 mm	**64.9**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±3.2
Pelitt	**64.9**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±3.2
Sand	**33.8**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.2
Grus	**1.3**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.0
Vekt % > 0.063 mm	**35.1**	wt% TS	2024-02-27	2024-03-05	Intern metode (Bale/Kenny 2005)	±0.2
P (Fosfor) [a]	**957**	mg/kg TS	2024-02-20	2024-02-20	Intern metode	

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

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ANALYSERAPPORT

Kunde:	Arnarlax	**Rapport nr.:**	P240009
Kundemerking:	Laugardalur 2 - 2024	**Revisjon:**	2
Kontaktperson:		**Rapportdato**	**2024-04-02**
Prosjektnr.:	**65629**	**Ankomst dato:**	2024-02-05

Analyseansvarlig:

Oda Sofie Bye Wilhelmsen

Signatur:

Oda Sofie Bye Wilhelmsen

Lisa Torske

Underskriftsberettiget:

Signatur:

Lisa Torske

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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