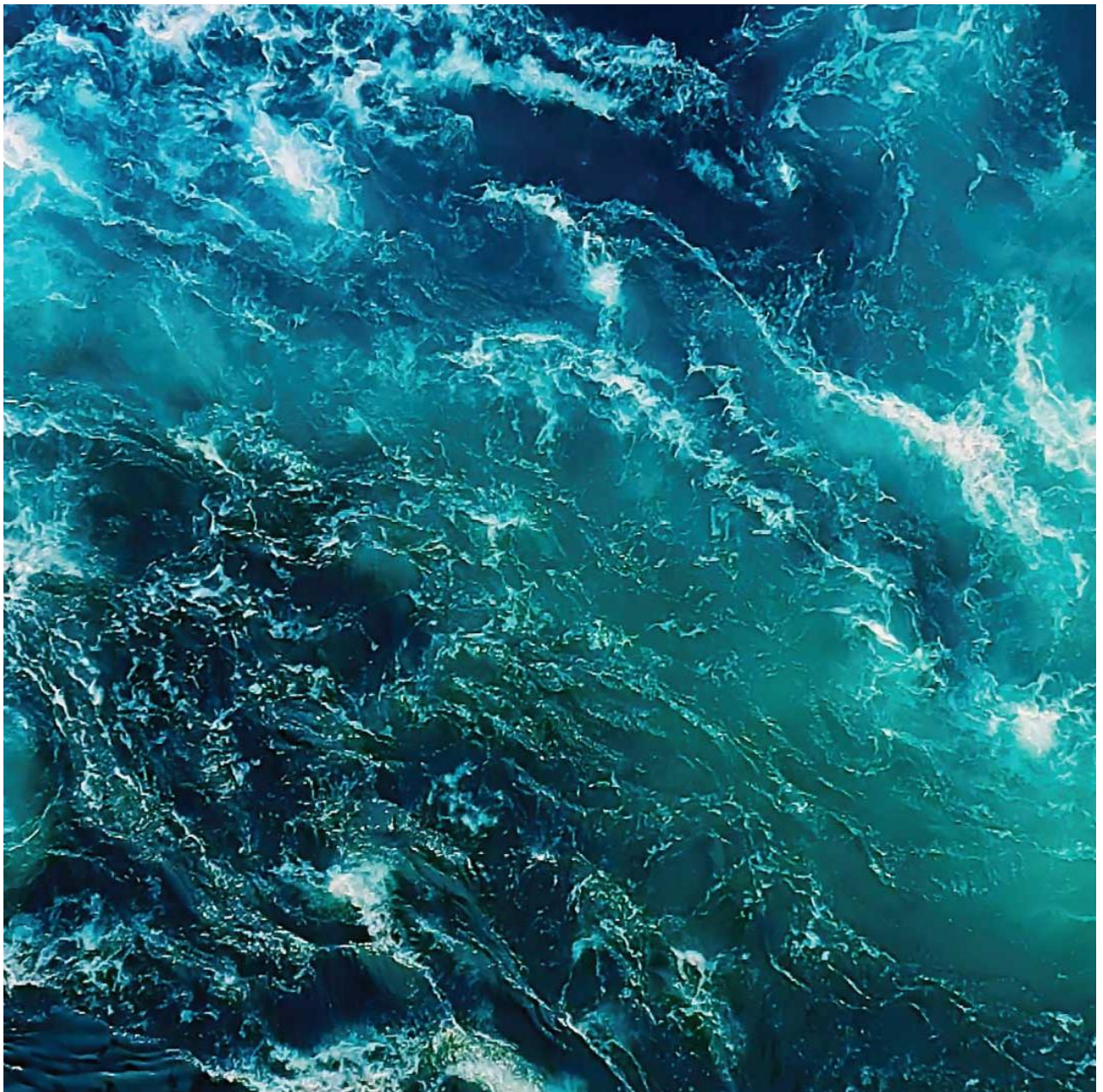


# C-survey at Laugardalur 1 (max biomass), September 2024

Arnarlax ehf

Akvaplan-niva AS Report: 2024 66115.01



# Arnarlax ehf. C-Survey at Laugardalur 1 (max biomass), September 2024.

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## Summary

The results from the monitoring at the farming site Laugardalur 1 in September 2024 showed that the sediment was somewhat loaded with organic carbon and the copper level in the sediment at C1 was somewhat elevated (52.4 mg/kg) and is categorized into environmental limit II or "low values". EMB concentration was 550 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".

Some load effects were recorded in the fauna at three stations with faunal index nEQR below 0.6. At C2 the nEQR values was above 0.6 indicating relatively good faunal conditions at this station. The diversity H' varied from 2.70 to 3.55. 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 September was good in the whole water column with 82 % in the bottom water.

## Approval

  
Project leader

Quality control

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# TABLE OF CONTENTS

TABLE OF CONTENTS.....	3
PREFACE .....	5
1 DATA SUMMARY .....	6
2 INTRODUCTION .....	7
2.1 Background and aim of the study.....	7
2.2 Site operation and feed use .....	7
2.3 Previous surveys .....	8
3 MATERIALS AND METHODS.....	9
3.1 Survey program .....	9
Placement of stations and local conditions .....	9
3.2 Hydrography and oxygen.....	10
3.3 Soft bottom sampling and analyses .....	10
3.3.1 Fieldwork.....	10
3.3.2 Total organic material (TOM).....	11
3.3.3 Total nitrogen (TN) .....	11
3.3.4 Total organic carbon (TOC) and grain size.....	11
3.3.5 Metal analysis - copper (Cu).....	11
3.3.6 Emamectin benzoate (EMB).....	11
3.3.7 Phosphorus (P) .....	11
3.3.8 Redox- and pH measurements .....	12
3.4 Soft bottom fauna investigation .....	12
3.4.1 About effect of organic material on bottom fauna .....	12
3.4.2 Sampling and fixation .....	12
3.4.3 Quantitative bottom fauna analysis.....	12
4 RESULTS .....	14
4.1 Hydrography and oxygen.....	14
4.2 Sediment .....	14
4.2.1 TOC, TOM, TN, C/N, grain size and pH/Eh .....	14
4.2.2 Copper.....	15
4.2.3 Emamectin benzoate.....	15
4.2.4 Phosphorus .....	15
4.3 Soft-bottom fauna .....	16
4.3.1 Faunal indices .....	16
4.3.2 NS 9410 Evaluation of the bottom fauna at station C1 (local impact zone).....	16
Geometric classes.....	17
4.3.3 Cluster analyses.....	17
4.3.4 Species composition.....	18

5	SUMMARY AND CONCLUSIONS.....	20
5.1	Summary.....	20
5.2	Conclusions.....	20
6	REFERENCES.....	22
7	APPENDIX (IN NORWEGIAN).....	24
7.1	Bunndyrsindekser og artslister.....	24
7.2	Statistical results Laugardalur 1, 2024.....	27
7.3	Species lists .....	28
7.4	Analytical report .....	33

## Preface

Akvaplan-niva carried out a type C (NS 9410:2016) environmental survey at the Laugardalur 1 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 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.
Jesper Hansen	Akvaplan-niva	Identification of bottom fauna (Polychaeta and Mollusca).
Vegard Holen	Akvaplan-niva	Hydrographical vertical profiles
Kristine H Sperre	Akvaplan-niva	Coordination of sorting of bottom fauna.
Lisa Torske	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.



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 1, 2024.		
Report nr.	2024 66115.01	Site:	Laugardalur 1
Municipality:		Map Coordinates (construction):	65°39,170 N 23°55,813 V
MTB permitted:	3.565 tons	Operations manager:	Rolf Ørjan Nordli
Client:	Arnarlax ehf		

Biomass/production status at time of survey (12.09.2024)			
Fish group:	Salmon	Biomass on examination:	3.565
Feed input:	5.178	Produced amount of fish:	4.320
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)	0.531	Fauna C1 (impact zone)	2.71
Fauna C2	0.656	Fauna C2	3.55
Fauna C3	0.534	Fauna C3	2.70
Fauna C4 (deep area)	0.579	Fauna C4 (deep area)	2.87
Date fieldwork:	12.09 2024	Date of report:	19.12 2024
Notes to other results (sediment, pH/Eh, oxygen)			nTOC from 37.3 to 56.3 mg/g. Copper 52.4 mg/kg at C1 Eh positive at all stations O <sub>2</sub> -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 C-survey during the time of max biomass at the fish farming site Laugardalur 1 (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 C-survey is aimed at studying the environmental conditions of the bottom sediments along a transect sector from the fish farm that extends from the local, to the intermediate and to the regional impact zones. The main emphasis 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.

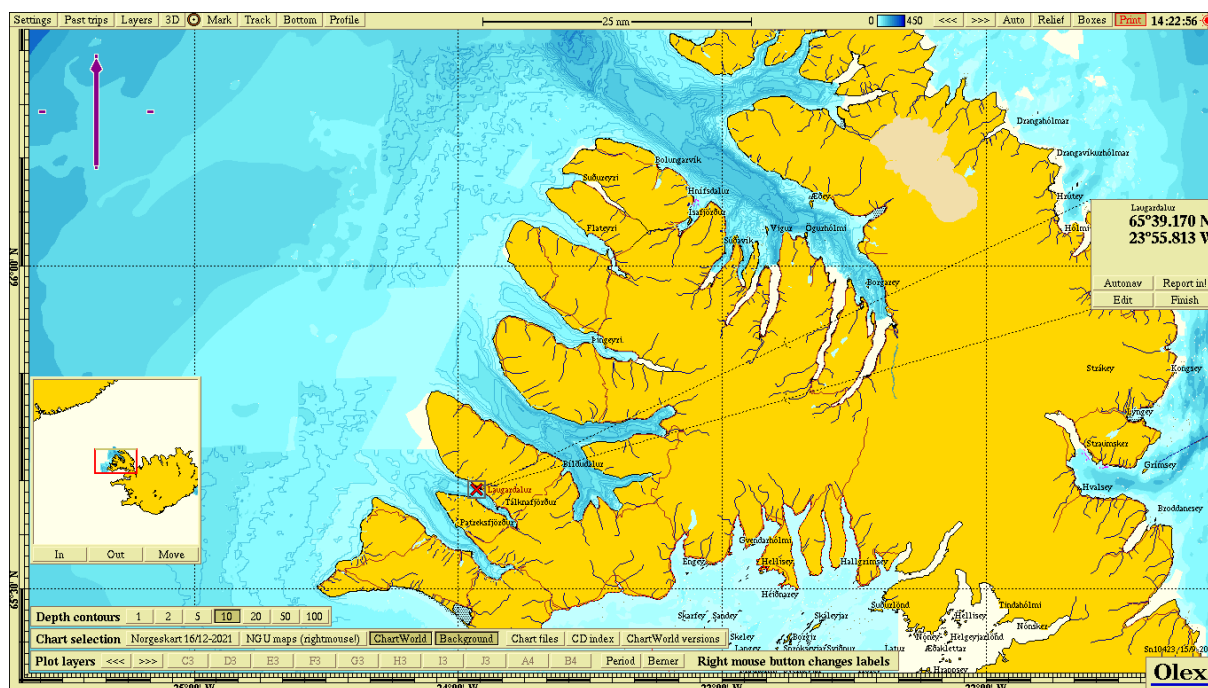


Figure 1. An overview of Westfjords Iceland with the farming site Laugardalur 1 (red cross) in Tálknafjörður. The map coordinates for the midpoint of the farming site are given to the right.

### 2.2 Site operation and feed use

Laugardalur 1 is located in the northern side of Tálknafjörður, approximately 3 nm northwest of the town of Tálknafjörður. The installed frame is suited for up to 14 net-pens with a circumference of

160 m. The frame is positioned in north-northwest direction from land (297°) with depth below the cages ranging from 24 to 51 m.

The current generation is the third being farmed at the Laugardalur 1 site (previously there were farmed two generation at the old Laugardalur site further into the fjord. At the date of the C-survey the standing biomass was 3.565 tons (pers. comm. Silja Baldvinsdóttir). In Iceland, the MTB (maximum allowed biomass) limit is not given a site level as in Norway. The MTB limit determines how much live fish the holder of the permit can have standing in the sea at any time. In Iceland the allowed production is regulated at two levels, site level and company level. For this site the estimated maximal standing biomass for the next generation is 3.565 tonnes, used as MTB here (Pers. Comm. Silja Baldvinsdóttir).

### 2.3 Previous surveys

An overview of previous and current C-surveys carried out at Laugardalur 1 is shown in Table 1.

Table 1: Previous and current C-surveys at Laugardalur 1.

Survey date	Report reference (author, year)	Production (tonnes)
12.09 2024	APN 66115.01 (Mannvik and Gunnarsson, current report)	4.320
06.07 2022	APN 64189.01 (Mannvik and Gunnarsson, 2022)	0
25.03 2021	APN 62334.01 (Mannvik and Gunnarsson, 2021)	9.410
27.05 2019	APN 60938.01 (Mannvik and Gunnarsson, 2019)	0
01.11 2017	APN 9207.01 (Velvin and Gunnarsson, 2018)	2.836



## 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 Laugardalur 1, 2024. TOC = total organic carbon. GSA = grain size analysis sediment. TOM = total organic material. TN = total nitrogen. Cu = Copper. Tot-P = total phosphorous. pH/Eh = acidity and redox potential.

Station	Type analyses/parameters
C1 (local impact zone)	Quantitative analyses of bottom fauna. TOC. GSA, TOM. TN. Tot-P. Cu. pH/Eh.
C2 (transect zone outer)	Quantitative analyses of bottom fauna. TOC. GSA, TOM. TN. Tot-P. pH/Eh.
C3 (transect zone)	Quantitative analyses of bottom fauna. TOC. GSA, TOM. TN. Tot-P. pH/Eh. Emamectin benzoate.
C4 (transect zone, deep area)	Quantitative analyses of bottom fauna. TOC. GSA, TOM. TN. Tot-P. Hydrography/O <sub>2</sub> . pH/Eh.

Field work was completed on 12.09.2024.

### 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 3.565 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 3 and shown in Figure 2. The stations were placed in the direction of the main oceanic current measured at 42 m depth (Heggem, 2019).

Table 3: Depth, distance between the nearest frame of the fish farm and sampling stations and coordinates for C-stations at Laugardalur 1, 2024.

Station	Depth, m	Distance from frame, m	Position	
			N	W
C1	51	25	65°39.248	23°56.298
C2	42	500	65°39.384	23°56.820
C3	51	125	65°39.264	23°56.417
C4	53	75	65°39.165	23°56.394

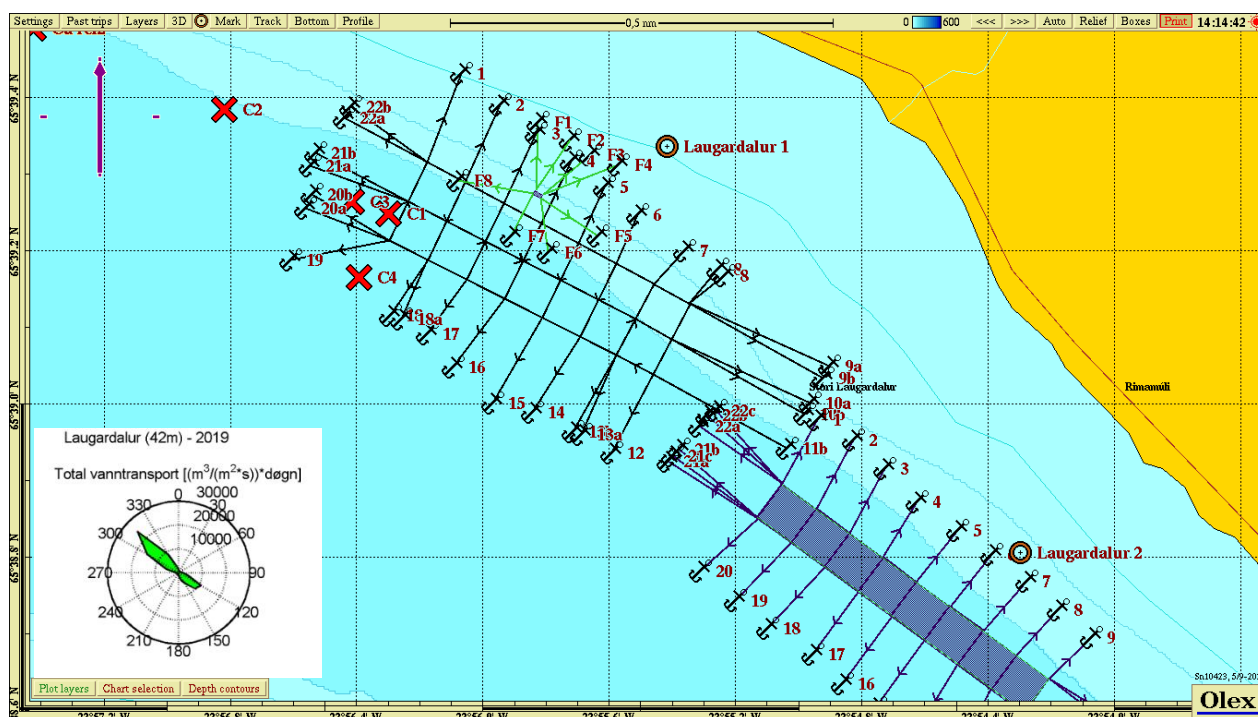


Figure 2. Map showing the sampling stations for the C-survey at Laugardalur 1, 2024. Current measurements used were from 42 m depth (Heggem, 2019).

## 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<sup>2</sup> 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 16168:2012 (Slam, behandlet organisk avfall og jord. Bestemmelse av totalnitrogen ved bruk av tørrforbrenning).

### 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 each fraction on a dry weight basis (Bale & Kenny, 2005).

After drying the samples at 40 °C, the content of total organic carbon (TOC) was determined by NDIR-detection in accordance with NS EN 17505:2022 (Investigation of solids – Temperature-dependent differentiation of total carbon (TOC<sub>400</sub>, ROC, TIC<sub>900</sub>)). 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<sub>2</sub>O<sub>5</sub> 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<sup>2</sup> 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<sub>2018</sub>), unsuitable at low individual/species number
- Sensitivity index (NSI<sub>2018</sub>)
- 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 September 2024 is presented in Figure 3.

Temperature increased from 9 °C at the surface to 10 °C in the bottom layer. Oxygen saturation was 94 % in the upper layer and 82 % in the bottom layer.

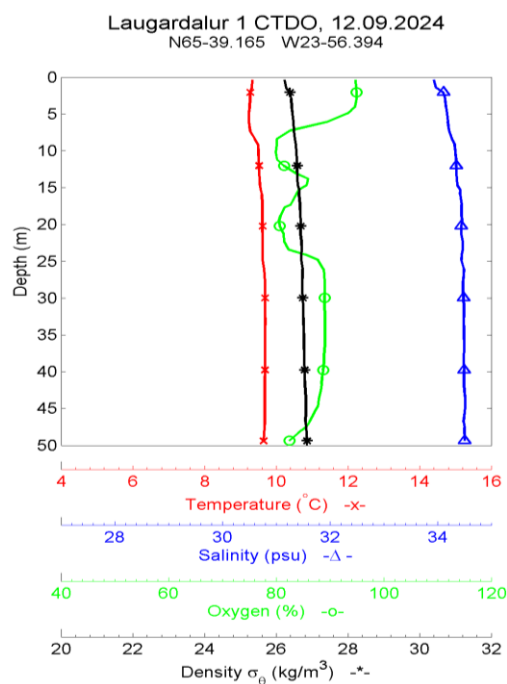


Figure 3. Vertical profiles. Temperature, salinity, density, and oxygen at C4 at Laugardalur 1, 2024.

### 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 4.

TOM-levels varied from 9.0 to 11.5 %. TN-levels were low (4.2 – 5.8 mg/g) as was the C/N-ratio. TOC was rather high at all stations and nTOC varied from 37.3 to 56.3 mg/g TS. The bottom sediments grain size was moderately fine to fine with a pelite ratio ranging from 52.6 to 81.6 %.

Redox measurements (pH/Eh) gave a point 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. Laugardalur 1, 2024.

St.	Sediment description	TOM	TOC	nTOC	TN	C/N	Pelite	pH/Eh
C1	Olive green mud and some silt.	9.0	29	37.3	4.6	6.4	55.9	7.6/258
C2	Olive green mud and some silt.	11.4	52	55.7	5.8	9.1	81.6	7.6/286
C3	Olive green mud. Some dead black algae in sample	10.3	48	56.3	4.6	10.7	52.6	7.6/258
C4	Olive green mud and some silt.	11.5	45	49.9	4.2	10.9	73.2	7.7/293

#### 4.2.2 Copper

Level of copper in bottom sediment at C1 is shown in Table 5. The level of copper was 52.4 mg/kg or low (limit II) according to environmental limits in Icelandic regulation nr. 796/199 (Regulation on prevention of water pollution nr. 796/1999).

Table 5. Copper (Cu), mg/kg DS. Laugardalur 1, 2024.

St.	Cu
C1	52.4

#### 4.2.3 Emamectin benzoate

Concentration of emamectin benzoate in sediment at C3 is presented in Table 6. Station C3 is located 125 m from the cage edge and is thus placed outside the mixing zone (SEPA 2022).

EMB concentration is 550 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 C3, ng/kg. Laugardalur 1, 2024.

St.	Emamectin benzoate
C3	550

#### 4.2.4 Phosphorus

Levels of phosphorus in bottom sediments at Laugardalur 1 are shown in Table 7. The level of phosphorus varied from 600 (C1) to 1210 mg/kg (C3).

Table 7. Phosphorus (P), mg/kg DS. Laugardalur 1, 2024.

St.	P
C1	600
C2	900
C3	1210
C4	1190

### 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 8.

The number of individuals varied from 494 (C1) to 2683 (C2) and number of species from 32 (C1 and C3) to 74 (C2). The diversity  $H'$  varied from 2.70 to 3.55. At most of the stations, the overall index of nEQR was below than 0.6, while at C2 above 0.6. The nEQR values indicate good condition at C2 and not so good 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 0.55 to 0.61 which indicates a somewhat uneven distribution.

Table 8. Number of species and individuals pr. 0,2 m<sup>2</sup>.  $H'$  = 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. C-stations at Laugardalur 1, 2024.

St.	No. of individuals.	No. of species	$H'$	$ES_{100}$	$NQI1$	$ISI_{2012}$	$NSI$	nEQR	AMBI	J
C1	494	32	2.71	15.9	0.702	4.35	21.65	0.531	1.88	0.60
C2	2683	74	3.55	21.4	0.761	6.79	23.45	0.656	1.65	0.61
C3	505	32	2.70	15.5	0.697	4.63	21.96	0.534	1.85	0.61
C4	2567	43	2.87	14.6	0.726	5.61	23.65	0.579	1.63	0.55

#### 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<sup>2</sup> and that none of these are in numbers exceeding 65 % of the individuals (Table 9).

Table 9. Classification of the environmental status of the soft bottom fauna at station C1 at the Laugardalur 1 site 2024.

Station	Site name	Num. species	Dominating taxa	Environmental condition-NS 9410
C1	Laugardalur 1	32	Galathowenia oculata – 48 %	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.

Most of the curves started relatively low ( $\leq 15$  species) while at C2 the curve started higher (20 species). All stretched out in varying degrees towards higher classes and did not give any clear indications of fauna condition.

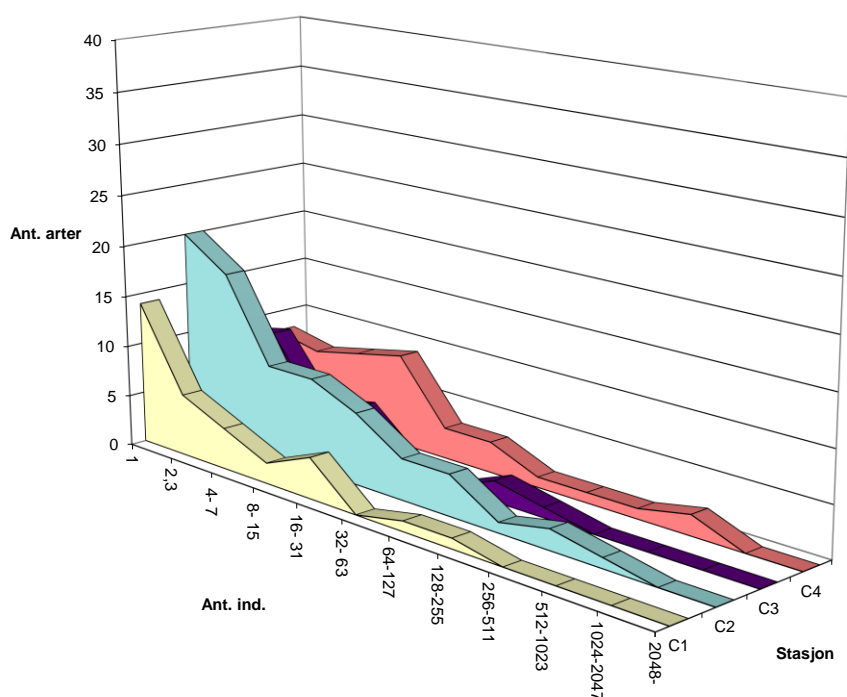


Figure 4. The soft bottom fauna shown as number of species against number of individuals pr. species in geometric classes. Laugardalur 1, 2024.

### 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 stations were separated into two main groups. The fauna composition at C1 and C3 in one of the groups was 65 % similar while C2 and C4 on the other group was 64 % similar. The two station groups were 48 % similar.

Laugardalur 1 C-survey 2024. Stations without juveniles  
Group average

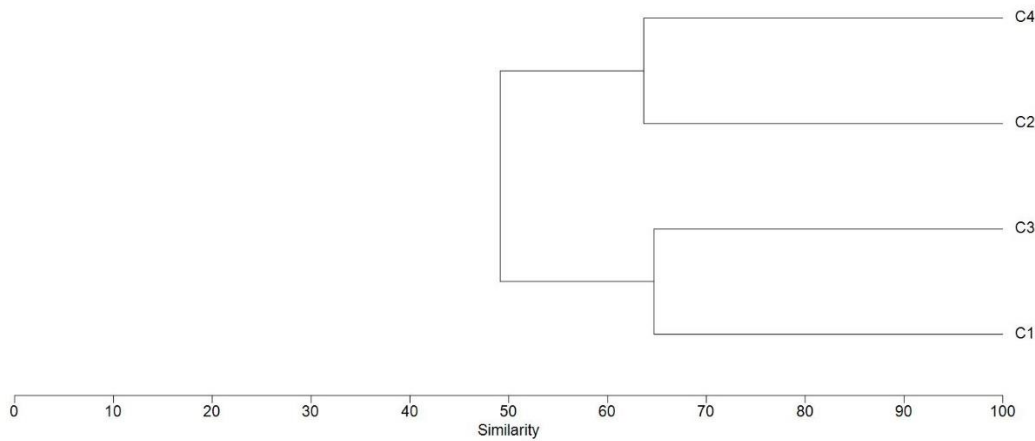


Figure 5. Cluster diagram for the soft bottom fauna at the C- sampling stations at Laugardalur 1, 2024.

#### 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 10.

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, C2 and C3 was dominated by the tolerant polychaete *Galathowenia oculata* with between 36 and 48 % of the individuals. The other most dominant species at the stations were a mixture of neutral, tolerant and opportunistic species. One pollution indicator species, the polychaete *Capitella capitata*, was recorded among the top-10 at C1, but with few individuals.

The fauna at C4 were dominated by the neutral polychaete *Owenia* sp. with 41 % of the individuals. The other most dominant species, with known EG, at the station were a mixture of sensitive, tolerant, and opportunistic species.



Table 10. Number of individuals, cumulative percentage, and ecological group\* for the ten most dominant species at the C stations. Laugardalur 1, 2024.

C1	EG	Ant. ind.	Kum.
Galathowenia oculata	III	240	48 %
Thyasira sarsii	IV	82	65 %
Ennucula tenuis	III	30	71 %
Pholoe baltica	II	27	76 %
Lagis koreni	III	26	82 %
Pholoe assimilis	II	16	85 %
Nephtys ciliata	III	11	87 %
Cistenides hyperborea	III	9	89 %
Leucon sp.	Ik	7	90 %
Capitella capitata	V	6	92 %
C3	EG	Ant. ind.	Kum.
Galathowenia oculata	III	231	45 %
Thyasira sarsii	IV	81	61 %
Ennucula tenuis	III	65	74 %
Mediomastus fragilis	IV	20	78 %
Lagis koreni	III	14	81 %
Pholoe baltica	II	13	83 %
Nephtys ciliata	III	10	85 %
Leucon sp.	Ik	9	87 %
Gattyana amondseni	II	8	89 %
Chaetozone setosa	IV	6	90 %

C2	EG	Ant. ind.	Kum.
Galathowenia oculata	III	1000	36 %
Ennucula tenuis	III	370	50 %
Praxillella praetermissa	II	260	59 %
Maldane sarsi	IV	151	65 %
Thyasira sarsii	IV	127	70 %
Owenia sp.	II	108	74 %
Pholoe assimilis	II	94	77 %
Nuculana pernula	I	79	80 %
Scoloplos armiger	III	76	83 %
Thyasira gouldii	III	59	85 %
C4	EG	Ant. ind.	Kum.
Owenia sp.	II	1068	41 %
Galathowenia oculata	III	988	80 %
Ennucula tenuis	III	375	94 %
Myriochele malmgreni/olgae	Ik	195	102 %
Thyasira sarsii	IV	113	106 %
Nuculana pernula	I	58	108 %
Sternaspis scutata	Ik	36	110 %
Leucon sp.	Ik	35	111 %
Macoma calcarea	III	28	112 %
Maldane sarsi	IV	28	113 %

\*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 1, 2024, can be summarised as follows:

- The hydrography measurements showed good oxygen conditions throughout the water column with 82 % saturation in the bottom layer in September 2024.
- TOC was rather high at all stations and nTOC varied from 37.3 to 56.3 mg/g DS. TOM-levels varied from 9.0 to 11.5 %. TN-levels were low (4.2 – 5.8 mg/g) as was the C/N-ratio. The copper level in the sediment at C1 was elevated (52.4 mg/kg) and is categorized into environmental limit II or "low values". EMB concentration at C3 was 550 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". The phosphorus levels varied between 600 and 1210 mg/kg. The sediment was moderately fine to fine grained with a pelite share between 52.6 and 81.6 %. 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 494 to 2683 and number of species from 32 to 74. The diversity H' varied from 2.70 to 3.55. At most of the stations, the overall index of nEQR was below than 0.6, while at C2 above 0.6. The nEQR values indicate good condition at C2 and not so good conditions at the other stations.

### 5.2 Conclusions

The results from the monitoring at the farming site Laugardalur 1 in September 2024 showed that the sediment was somewhat loaded with organic carbon and the copper level in the sediment at C1 was somewhat elevated (52.4 mg/kg) and is categorized into environmental limit II or "low values". EMB concentration was 550 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".

Some load effects were recorded in the fauna at three stations with faunal index nEQR below 0.6. At C2 the nEQR values was above 0.6 indicating relatively good faunal conditions at this station. The diversity H' varied from 2.70 to 3.55. 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 September was good in the whole water column with 82 % in the bottom water.

In comparison with results from previous C-survey at fallow period (Mannvik and Gunnarsson, 2022) the faunal index (nEQR) has decreased at all sampling stations except station C2. In the 2022 survey the nEQR was above 0.6 at all sampling stations but in the present survey nEQR is only above 0.6 at station C2. The diversity index  $H'$  ranged from 3.23 – 4.08 at the comparable stations in 2022 survey but are in the current survey under 3 at stations C1, C3 and C4 but at similar level for station C2. The pollution indicator species *Capitella capitata*, which was ranking 3<sup>rd</sup> among the most dominant species at C1 in 2022, is again registered among the top-10 species at C1 but now ranking in 10th place with only 6 individuals present. In both surveys no pollution indicators were registered at other stations. Overall, the environmental status seems to have somewhat declined during farming of the current generation at Laugardalur 1, based on faunal index score and diversity index values.

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## 7 Appendix (in Norwegian)

### 7.1 Bunndyrsindekser og artslister

#### Diversitetsmål

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

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

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

der  $n_i$  = antall individer av art  $i$  i prøven

$N$  = total antall individer

$s$  = antall arter

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

#### 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

#### Faunaens fordelingsmønster (Clusteranalyse)

Variasjoner i faunaens fordelingsmønster over området beskrives ved å sammenligne faunasamfunnet på hver stasjon. Til dette brukes multivariate klassifikasjons- og ordinasjons-analyser.

Analysene i denne undersøkelsen ble utført ved hjelp av programpakken PRIMER. 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.

For å sammenligne prøvene 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).

#### Sensitivitet og tetthet

**NSI** (Norwegian Sensitivity Index; Rygg og Norling 2013) er utviklet med basis i norske faunadata og innført i 2012 og oppdatert i 2018 (Borgersen *m. fl.*, 2019). Hver art av i alt 583 arter er tilordnet en sensitivitetsverdi). En prøves NSI-verdi beregnes ved gjennomsnittet av sensitivitetsverdiene av alle individene i prøven. Formelen for utregning er gitt ved:

$$NSI = \sum_i^s \left[ \frac{N_i * NSI_i}{N_{NSI}} \right]$$

**ISI<sub>2018</sub>** (Indicator Species Index; Rygg og Norling 2013) en sensitivitetsindeks. Grunnlaget for beregningen av ISI (Rygg 2002) ble utvidet og artsnomenklaturen standardisert i 2012 og oppdatert i 2018 (Borgersen *m. fl.*, 2019). Hver art er tilordnet en ømfintlighetsverdi. ISI er en kvalitativ indeks som tar hensyn til hvilke arter som er tilstede, men ikke individtallet av dem. En prøves ISI-verdi beregnes ved gjennomsnittet av sensitivitetsverdiene av artene i prøven hvor  $ISI_i$  er  $ISI_{2018}$  verdien for arten  $i$  og  $S_{ISI}$  er antall arter tilordnet sensitivitetsverdier.

$$ISI = \sum_i^s \left[ \frac{ISI_i}{S_{ISI}} \right]$$

**AMBI** (Azti Marine Biotic Index; Borja *m.fl.* 2000) er en sensitivitetsindeks (egentlig en toleranseindeks) der artene tilordnes en toleranseklasse (økologisk gruppe, EG). EG I = sensitive arter, EG II = "indifferente" arter, EG III = tolerante arter, EG IV = opportunistiske arter, EG V = forurensningsindikerende arter. I Norge brukes AMBI bare i kombinasjonsindeksen NQI1 og har derfor ingen egen klassifisering. AMBI er en kvantitativ indeks som tar hensyn til individtallet av artene.

$AMBI = (0 * EG I) + (1,5 * EG II) + (3 * EG III) + (4,5 * EG IV) + (6 * EG V)$  hvor EGI er andelen av individer som tilhører gruppe I, etc. Tallene angir toleranseverdiene.

Formelen for beregning av en prøves AMBI-verdi er gitt ved:

$$AMBI = \sum_i^S \left[ \frac{N_i * AMBI_i}{N_{AMBI}} \right]$$

### Sammensatt indeks

**NQI1** (Norwegian Quality Index; Rygg 2006) inneholder indikatorer som omfatter sensitivitet (AMBI), og artsmangfold (S = antall, N = antall individer) i en prøve. NQI1 er interkalibrert mellom alle land som tilhører NEAGIG. NQI1 er gitt ved formelen:

$$NQI1 = \left[ \left( 0,5 * \left( 1 - \frac{AMBI}{7} \right) + 0,5 * \left( \frac{\left[ \frac{\ln(S)}{\ln(\ln(N))} \right]}{2,7} \right) * \left( \frac{N}{N+5} \right) \right) \right]$$

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## 7.2 Statistical results Laugardalur 1, 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.		181	313	1226	1457	194	311	1312	1255
no. spe.		21	26	58	57	20	24	39	38
Shannon-Wiener:		2,7	2,8	3,6	3,5	2,5	2,9	2,7	3,1
Pielou		0,60	0,59	0,62	0,60	0,57	0,64	0,50	0,59
ES100		16	16	21	21	15	16	14	16
SN		1,85	1,86	2,07	2,04	1,80	1,82	1,86	1,85
ISI-2018		4,34	4,41	7,02	6,57	4,64	4,62	5,10	6,11
AMBI		1,992	1,774	1,573	1,733	1,626	2,069	1,609	1,657
NQI1		0,69	0,71	0,77	0,75	0,71	0,68	0,73	0,72
NSI		21,6	21,7	23,5	23,4	22,3	21,7	23,8	23,5

### Geometrical classes

int.	C1	C2	C3	C4
1	14	20	9	8
2,3	6	17	10	7
4-7	4	9	4	8
8-15	2	9	5	9
16-31	4	7	1	3
32-63	0	4	0	3
64-127	1	4	2	1
128-255	1	1	1	1
256-511	0	2	0	1
512-1023	0	1	0	2
1024-2047	0	0	0	0
2048-	0	0	0	0

## 7.3 Species lists

### Artsliste pr stasjon

#### Laugardalur 1 1 ASC-C-survey 2024

Stasjonsnr.: C1

NEMERTINI

SIPUNCULIDA		Nemertea indet.	1	-	1
ANNELIDA		Phascolion strombus	1	-	1
	Polychaeta				
	Orbiniida	Scoloplos armiger	1	1	2
	Spionida	Chaetozone setosa		3	3
		Laonice cirrata		1	1
		Prionospio steenstrupi		1	1
	Capitellida	Capitella capitata		6	6
		Mediomastus fragilis	1	-	1
	Opheliida	Ophelina acuminata		1	1
	Phyllodocida				
		Bylgides sarsi		3	3
		Eteone flava/longa	4	2	6
		Harmothoe sp.		1	1
		Microphthalmus szcelkowi		1	1
		Nephtys ciliata	4	7	11
		Nephtys hystericis	1	-	1
		Pholoe assimilis	4	12	16
		Pholoe baltica	5	22	27
	Oweniida	Galathowenia oculata	81	159	240
		Owenia sp.	1	1	2
	Terebellida				
		Cistenides granulata		1	1
		Cistenides hyperborea	1	8	9
		Lagis koreni	8	18	26
CRUSTACEA					
	Malacostraca				
	Cumacea	Leucon sp.	4	3	7
	Amphipoda	Acidostoma sp.	1	-	1
		Caprellidae indet.	1	-	1
	Isopoda	Idotea sp.		1	1
MOLLUSCA					
	Bivalvia				
	Nuculoida	Ennucula tenuis	11	19	30
		Yoldia hyperborea	1	1	2
	Veneroida	Abra nitida	2	1	3
		Macoma calcarea	2	3	5
		Thyasira sarsii	46	36	82
ECHINODERMATA					
	Ophiuroidea				
		Ophiuroidea indet. juv.	1	1	2
HEMICHORDATA					
		Enteropneusta indet.		1	1
		Maksverdi:	81	159	240
		Antall arter/taxa:	22	27	33
		Sum antall individ:			496

Rekke	Klasse	Orden	Art/Taxa	Replikat:	01	02	-	Sum
Stasjonsnr.: C2								
NEMERTINI								
ECHIURIDA			Nemertea indet.		1	4	-	5
SIPUNCULIDA			Echiurus echiurus		2		-	2
ANNELIDA			Phascolion strombus			1	-	1
	Polychaeta							
		Orbiniida	Aricidea sp.		1		-	1
			Levinsenia gracilis		3		-	3
			Scoloplos armiger		34	42	-	76
		Spionida	Chaetozone setosa		4	4	-	8
			Dipolydora quadrilobata			1	-	1
			Laonice cirrata			1	-	1
			Prionospio steenstrupi		1		-	1
			Spio armata		1		-	1
			Spio limicola		8	5	-	13
		Capitellida	Maldane sarsi		111	40	-	151
			Mediomastus fragilis		3	8	-	11
			Petaloproctus tenuis		1	2	-	3
			Praxillella gracilis		2	2	-	4
			Praxillella praetermissa		90	170	-	260
			Rhodine gracilior		21	13	-	34
		Phyllodocida	Bylgides sarsi			2	-	2
			Eteone flava/longa		6	6	-	12
			Eunoe nodosa		1		-	1
			Gattyana amondseni		5		-	5
			Goniada maculata		9	4	-	13
			Nephtys ciliata		7	1	-	8
			Nephtys paradoxa			1	-	1
			Pholoe assimilis		40	54	-	94
			Pholoe baltica		10	14	-	24
			Phyllodoce groenlandica			1	-	1
			Phyllodoce maculata/mucosa		1	1	-	2
			Syllis cornuta		9	10	-	19
		Eunicida	Nothria conchylega		2		-	2
			Parougia nigridentata			2	-	2
			Scoletoma fragilis		1	4	-	5
		Sternaspida	Sternaspis scutata		3	3	-	6
		Oweniida	Galathowenia oculata		420	580	-	1000
			Myriochele malmgreni/olgae		3	13	-	16
			Owenia sp.		23	31	-	54
		Terebellida	Ampharete acutifrons		1		-	1
			Ampharete borealis		1		-	1
			Ampharete petersenae		1	7	-	8
			Lagis koreni		1	14	-	15
			Laphania boeckii		2	2	-	4
		Sabellida	Euchone papillosa		6	18	-	24
			Laonome kroyeri		2		-	2
CRUSTACEA								
	Malacostraca							
		Cumacea	Brachydiastylis resima			3	-	3
			Leucon sp.		4	12	-	16
		Amphipoda	Bathymedon obtusifrons		1		-	1
			Caprellidae indet.			1	-	1
			Dulichidae indet.		1		-	1
			Oedicerotidae indet.		1		-	1
			Paroediceros lynceus		1		-	1
			Protomedeia fasciata		5	2	-	7

Rekke	Klasse	Orden	Art/Taxa	Replikat:	01	02	-	Sum
MOLLUSCA								
	Caudofoveata							
			Caudofoveata indet.		2	2	-	4
	Prosobranchia							
		Mesogastropoda						
			Euspira pallida			2	-	2
			Onoba aculeus		2		-	2
	Opisthobranchia							
		Cephalaspidea						
			Philinissima denticulata			3	-	3
			Retusa obtusa			2	-	2
	Bivalvia							
		Nuculoidea						
			Ennucula tenuis		201	169	-	370
			Nuculana pernula		45	34	-	79
		Mytiloidea						
			Crenella decussata		2	2	-	4
		Veneroidea						
			Abra nitida		11	8	-	19
			Astarte elliptica		1		-	1
			Astarte montagui		2	1	-	3
			Axinopsida orbiculata		11	11	-	22
			Macoma calcarea		15	19	-	34
			Parvicardium pinnulatum		6	6	-	12
			Thyasira gouldii		32	27	-	59
			Thyasira sarsii		44	83	-	127
		Myoidea						
			Hiatella arctica			1	-	1
		Pholadomyoidea						
			Thracia myopsis		1	1	-	2
ECHINODERMATA								
	Asteroidea							
			Asteroidea indet. juv.			1	-	1
	Ophiuroidea							
		Ophiurida						
			Ophiocten affinis		1	2	-	3
			Ophiura carnea			3	-	3
			Ophiuroidea indet. juv.		34	22	-	56
TUNICATA								
	Ascidacea							
			Pelonaia corrugata			1	-	1
			Ascidacea indet. (solit)			1	-	1
				Maksverdi:	420	580		1000
				Antall arter/taxa:	59	59		76
				Sum antall individ:				2740
Stasjonsnr.:	C3							
CNIDARIA								
	Anthozoa							
			Actiniaria indet.		1		-	1
NEMERTINI								
			Nemertea indet.			1	-	1
ANNELIDA								
	Polychaeta							
		Orbiniida						
			Scoloplos armiger			3	-	3
		Cossurida						
			Cossura longocirrata			1	-	1
		Spionida						
			Chaetozone setosa		1	5	-	6
			Spiophanes kroyeri			1	-	1
		Capitellida						
			Mediomastus fragilis			20	-	20
			Praxillella praetermissa			1	-	1
		Phyllococida						
			Eteone flava/longa			6	-	6
			Gattyana amondseni			8	-	8
			Nephtys ciliata		2	8	-	10
			Nephtys hystericis			3	-	3
			Nephtys paradoxa		1		-	1
			Pholoe assimilis		1	5	-	6
			Pholoe baltica		7	6	-	13

Rekke	Klasse	Orden	Art/Taxa	Replikat:	01	02	-	Sum
		Eunicida	Syllis cornuta			2	-	2
		Oweniida	Parougia nigridentata		1		-	1
		Terebellida	Galathowenia oculata		97	134	-	231
		Sabellida	Owenia sp.		2		-	2
			Lagis koreni		2	12	-	14
			Euchone papillosa			1	-	1
CRUSTACEA	Malacostraca	Cumacea	Leucon sp.		3	6	-	9
		Amphipoda	Acidostoma sp.			1	-	1
			Oedicerotidae indet.		2		-	2
MOLLUSCA	Bivalvia	Nuculoidea	Ennucula tenuis		35	30	-	65
			Nuculana pernula		3		-	3
			Yoldia hyperborea		3	1	-	4
		Veneroidea	Abra nitida		1	1	-	2
			Axinopsida orbiculata		2		-	2
			Macoma calcarea		1	1	-	2
			Thyasira gouldii		2		-	2
			Thyasira sarsii		27	54	-	81
ECHINODERMATA	Ophiuroidea		Ophiuroidea indet. juv.		1	2	-	3
				Maksverdi:	97	134		231
				Antall arter/taxa:	21	25		33
				Sum antall individ:				508

Stasjonsnr.: C4

NEMERTINI

			Nemertea indet.		1	2	-	3
ANNELIDA	Polychaeta	Orbiniida	Aricidea sp.		1	3	-	4
			Scoloplos armiger		7	7	-	14
		Spionida	Chaetozone setosa		1	5	-	6
			Dipolydora quadrilobata			1	-	1
			Prionospio steenstrupi		5	8	-	13
			Spio limicola		5	6	-	11
			Spiophanes kroyeri		1		-	1
		Capitellida	Maldane sarsi		11	17	-	28
			Mediomastus fragilis		1		-	1
			Praxillella gracilis		1	1	-	2
			Praxillella praetermissa		10	3	-	13
		Phyllodocida	Bylgides sarsi		1	3	-	4
			Eteone flava/longa		1	4	-	5
			Microphthalmus sczelkowi		1		-	1
			Nephtys ciliata		3	5	-	8
			Nereis zonata			1	-	1
			Pholoe assimilis		4	5	-	9
			Pholoe baltica		2		-	2
			Phyllodoce groenlandica		2	2	-	4
			Syllis cornuta		2	1	-	3
		Sternaspida	Sternaspis scutata		6	30	-	36
		Oweniida	Galathowenia oculata		536	452	-	988
			Myriochele malmgreni/olgae		78	117	-	195
			Owenia sp.		352	182	-	534
		Terebellida	Lagis koreni		2	2	-	4
		Sabellida	Euchone papillosa		6	3	-	9



Rekke	Klasse	Orden	Art/Taxa	Replikat:	01	02	-	Sum
CRUSTACEA	Malacostraca	Cumacea	Leucon sp.		14	21	-	35
		Amphipoda	Acidostoma sp.		1	1	-	2
			Dulichidae indet.		1	1	-	2
			Oedicerotidae indet.		1		-	1
MOLLUSCA	Opisthobranchia	Cephalaspidea	Retusa obtusa		1	2	-	3
	Bivalvia	Nuculoida	Ennucula tenuis		155	220	-	375
			Nuculana pernula		19	39	-	58
			Yoldia hyperborea		5	5	-	10
		Mytiloida	Musculus niger			1	-	1
		Veneroida	Abra nitida		2	4	-	6
			Axinopsida orbiculata		4	5	-	9
			Macoma calcarea		11	17	-	28
			Thyasira gouldii		3	4	-	7
			Thyasira sarsii		46	67	-	113
ECHINODERMATA	Ophiuroidea	Ophiurida	Ophiocten affinis		9	7	-	16
			Ophiura carnea			1	-	1
			Ophiuroidea indet. juv.		5	7	-	12
			Maksverdi:		536	452		988
			Antall arter/taxa:		40	39		44
			Sum antall individ:					2579

## 7.4 Analytical report



### ANALYSERAPPORT

Kunde:	Arnarlax	Rapport nr.:	P240174
Kundemerking:	Laugardalur	Rapportdato:	2024-12-10
Kontaktperson:		Ankomst dato:	2024-09-06
Prosjektnr.:	66115		

Lab-id. P240174-01

Objekt	Prøvestasjon/ID	ASC-stasjon	FU-stasjon	Prosjektnr. og prosjektnavn	Notering	Mottatt lab
Sediment	C1	ASC1		66115 - Laugardalur 1 ASC C and B survey max biomass 2024	TOC og TN er ett gjennomsnitt av to målinger. Variasjonskoeffisient for TOC er oppgitt.	2024-09-06

Analyseresultat						
Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Måleusikkerhet
TOC % variasjonskoeffisient	*31.2	%	2024-12-10	2024-12-10		
TOC	*29	mg/g TS	2024-11-18	2024-12-01	Intern metode (NS-EN 17505:2023)	±2.9
TNb	4.6	mg/g TS	2024-11-18	2024-12-01	Intern metode (NS-EN 16168:2012)	±1.0
nTOC	37.3		2024-12-10	2024-12-10	Veileder 02:2018	
C/N - forhold	*6.4		2024-12-10	2024-12-10	Beregning TOC:TN	
TOM	9.0	% TS	2024-11-19	2024-11-21	Intern metode	±0.25
Vekt% ≥2 mm	1.1	wt% TS	2024-11-19	2024-12-10	Intern metode (Bale/Kenny 2005)	±0.1
Vekt% 1 mm - <2 mm	0.6	wt% TS	2024-11-19	2024-12-10	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.500 mm - <1 mm	0.6	wt% TS	2024-11-19	2024-12-10	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.250 mm - <0.500 mm	6.0	wt% TS	2024-11-19	2024-12-10	Intern metode (Bale/Kenny 2005)	±0.2
Vekt% 0.125 mm - <0.250 mm	8.7	wt% TS	2024-11-19	2024-12-10	Intern metode (Bale/Kenny 2005)	±0.5
Vekt% 0.063 mm - <0.125 mm	27.1	wt% TS	2024-11-19	2024-12-10	Intern metode (Bale/Kenny 2005)	±2.3
Vekt% <0.063 mm	55.9	wt% TS	2024-11-19	2024-12-10	Intern metode (Bale/Kenny 2005)	±5.5
Pelitt	*55.9	wt% TS	2024-11-19	2024-12-10	Fraksjonen <0.063 mm	±5.5
Sand	*43.0	wt% TS	2024-11-19	2024-12-10	Summering av fraksjonene mellom 0.063 mm opptil 2 mm	±2.1
Grus	*1.1	wt% TS	2024-11-19	2024-12-10	Fraksjonen ≥2 mm	±0.1

Tabellen fortsetter på neste side...

\* = Ikke akkreditert resultat

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Analysereporten er digitalt undertegnet av:  
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Side 1 av 7

## ANALYSERAPPORT

Kunde: Arnarlax  
Kundemerking: Laugardalur  
Kontaktperson:  
Prosjektnr.: 66115

Rapport nr.: P240174  
Rapportdato: 2024-12-10  
Ankomst dato: 2024-09-06

Fortsettelse av tabell fra forrige side.

Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Målesikkerhet
Kobber (Cu) <sup>a</sup>	52.4	mg/kg TS	2024-12-01	2024-12-03	Intern metode	
P (Fosfor) <sup>a</sup>	600	mg/kg TS	2024-12-01	2024-12-05	Intern metode	

<sup>a</sup> Prøvingen er utført av eksternt laboratorium, ALS Laboratory Group

Lab-id. P240174-04

Objekt	Prøvestasjon/ID	ASC-stasjon	FU-stasjon	Prosjektnr. og prosjektnavn	Notering	Mottatt lab
Sediment	C2	ASC2		66115 - Laugardalur 1 ASC C and B survey max biomass 2024	Agglomerering i siktene i kornfordelingsanalysen. TNb verdier større enn 5 mg/g TS er utenfor akkreditert måleområde.	2024-09-06

Analyseresultat						
Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Målesikkerhet
TOC	52	mg/g TS	2024-11-18	2024-12-01	Intern metode (NS-EN 17505:2023)	±5.2
TNb	*5.8	mg/g TS	2024-11-18	2024-12-01	Intern metode (NS-EN 16168:2012)	±1.3
nTOC	55.7		2024-12-01	2024-12-01	Veileder 02:2018	
C/N - forhold	*9.1		2024-12-01	2024-12-01	Beregning TOC:TN	
TOM	11.4	% TS	2024-11-19	2024-11-21	Intern metode	±0.25
Vekt% ≥2 mm	0.6	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±0.1
Vekt% 1 mm - <2 mm	1.3	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±0.1
Vekt% 0.500 mm - <1 mm	3.1	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±0.1
Vekt% 0.250 mm - <0.500 mm	3.3	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±0.1
Vekt% 0.125 mm - <0.250 mm	2.3	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±0.1
Vekt% 0.063 mm - <0.125 mm	7.8	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±0.7
Vekt% <0.063 mm	81.6	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±8.1

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Side 2 av 7

Kunde: Arnarlax  
Kundemerking: Laugardalur  
Kontaktperson:  
Prosjektnr.: 66115

Rapport nr.: P240174  
Rapportdato: 2024-12-10  
Ankomst dato: 2024-09-06

Fortsettelse av tabell fra forrige side.

Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Målesikkerhet
Pelitt	+81.6	wt% TS	2024-11-19	2024-11-27	Fraksjonen <0.063 mm	±8.1
Sand	+17.9	wt% TS	2024-11-19	2024-11-27	Summering av fraksjonene mellom 0.063 mm opptil 2 mm	±0.9
Grus	+0.6	wt% TS	2024-11-19	2024-11-27	Fraksjonen ≥2 mm	±0.1
Kobber (Cu) <sup>a</sup>	46.6 45	mg/kg TS	2024-12-01	2024-12-03	Intern metode	
P (Fosfor) <sup>a</sup>	900	mg/kg TS	2024-12-01	2024-12-05	Intern metode	

<sup>a</sup> Provingen er utført av eksternt laboratorium, ALS Laboratory Group

Lab-id. P240174-07

Objekt	Prøvestasjon/ID	ASC-stasjon	FU-stasjon	Prosjektnr. og prosjektnavn	Notering	Mottatt lab
Sediment	C3	ASC3		66115 - Laugardalur 1 ASC C and B survey max biomass 2024		2024-09-06

Analyseresultat						
Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Målesikkerhet
TOC	48	mg/g TS	2024-11-18	2024-12-01	Intern metode (NS-EN 17505:2023)	±4.8
TNb	4.5	mg/g TS	2024-11-18	2024-12-01	Intern metode (NS-EN 16168:2012)	±1.0
nTOC	56.3		2024-12-01	2024-12-01	Veileder 02:2018	
C/N - forhold	+10.7		2024-12-01	2024-12-01	Beregning TOC:TN	
TOM	10.3	% TS	2024-11-19	2024-11-21	Intern metode	±0.25
Vekt% ≥2 mm	1.4	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±0.2
Vekt% 1 mm - <2 mm	0.6	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.500 mm - <1 mm	1.3	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±0.0
Vekt% 0.250 mm - <0.500 mm	13.7	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±0.4
Vekt% 0.125 mm - <0.250 mm	9.8	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±0.6

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Side 3 av 7

Kunde: Arnarlax  
Kundemerking: Laugardalur  
Kontaktperson:  
Prosjektnr.: 66115

Rapport nr.: P240174  
Rapportdato: 2024-12-10  
Ankomst dato: 2024-09-06

Fortsettelse av tabell fra forrige side.

Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Måleusikkerhet
Vekt% 0.063 mm - <0.125 mm	20.7	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±1.8
Vekt% <0.063 mm	52.5	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±5.2
Pelitt	*52.5	wt% TS	2024-11-19	2024-11-27	Fraksjonen <0.063 mm	±5.2
Sand	*46.1	wt% TS	2024-11-19	2024-11-27	Summering av fraksjonene mellom 0.063 mm opptil 2 mm	±2.3
Grus	*1.4	wt% TS	2024-11-19	2024-11-27	Fraksjonen >2 mm	±0.2
Kobber (Cu) <sup>a</sup>	45.0 53.8	mg/kg TS	2024-12-01	2024-12-03	Intern metode	
P (Fosfor) <sup>a</sup>	1210	mg/kg TS	2024-12-01	2024-12-05	Intern metode	
Emamectinbenzoat <sup>b</sup>	*550	ng/kg TS	2024-11-12	2024-11-12	Intern metode	

<sup>a</sup> Provingen er utført av eksternt laboratorium, ALS Laboratory Group

<sup>b</sup> Provingen er utført av eksternt laboratorium, NIVA

Lab-id. P240174-10

Objekt	Prøvestasjon/ID	ASC-stasjon	FU-stasjon	Prosjektnr. og prosjektnavn	Notering	Mottatt lab
Sediment	C4	ASC4		66115 - Laugardalur 1 ASC C and B survey max biomass 2024	Agglomerering i siktene i kornfordelingsanalysen.	2024-09-06

Analyseresultat						
Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Måleusikkerhet
TOC	45	mg/g TS	2024-11-18	2024-12-01	Intern metode (NS-EN 17505:2023)	±4.5
TNb	4.2	mg/g TS	2024-11-18	2024-12-01	Intern metode (NS-EN 16168:2012)	±0.9
nTOC	49.9		2024-12-01	2024-12-01	Veileder 02:2018	
C/N - forhold	*10.9		2024-12-01	2024-12-01	Beregning TOC:TN	
TOM	11.5	% TS	2024-11-19	2024-11-21	Intern metode	±0.25
Vekt% >2 mm	1.1	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±0.1
Vekt% 1 mm - <2 mm	2.1	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±0.1

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Side 4 av 7

Kunde: Arnarlax  
 Kundemerking: Laugardalur  
 Kontaktperson:  
 Prosjektnr.: 66115

Rapport nr.: P240174  
 Rapportdato: 2024-12-10  
 Ankomst dato: 2024-09-06

Fortsettelse av tabell fra forrige side.

Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Målesikkerhet
Vekt% 0.500 mm - <1 mm	4.5	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±0.1
Vekt% 0.250 mm - <0.500 mm	3.7	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±0.1
Vekt% 0.125 mm - <0.250 mm	3.6	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±0.2
Vekt% 0.063 mm - <0.125 mm	11.8	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±1.0
Vekt% <0.063 mm	73.2	wt% TS	2024-11-19	2024-11-27	Intern metode (Bale/Kenny 2005)	±7.2
Pelitt	*73.2	wt% TS	2024-11-19	2024-11-27	Fraksjonen <0.063 mm	±7.2
Sand	*25.7	wt% TS	2024-11-19	2024-11-27	Summering av fraksjonene mellom 0.063 mm opptil 2 mm	±1.3
Grus	*1.1	wt% TS	2024-11-19	2024-11-27	Fraksjonen >2 mm	±0.1
Kobber (Cu) <sup>a</sup>	42.5 41.9	mg/kg TS	2024-12-01	2024-12-03	Intern metode	
P (Fosfor) <sup>a</sup>	1190	mg/kg TS	2024-12-01	2024-12-05	Intern metode	

<sup>a</sup> Prøvingen er utført av eksternt laboratorium, ALS Laboratory Group

Lab-id. P240174-15

Objekt	Prøvestasjon/ID	ASC-stasjon	FU-stasjon	Prosjektnr. og prosjektnavn	Notering	Mottatt lab
Sediment	ASCref	ASCref		66115 - Laugardalur 1 ASC C and B survey max biomass 2024		2024-09-06

Analyseresultat						
Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Målesikkerhet
Kobber (Cu) <sup>a</sup>	37.3 39.1	mg/kg TS	2024-12-01	2024-12-03	Intern metode	

<sup>a</sup> Prøvingen er utført av eksternt laboratorium, ALS Laboratory Group

\* = Ikke akkreditert resultat

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Side 5 av 7



Kunde: Arnarlax  
Kundemerking: Laugardalur  
Kontaktperson:  
Prosjektnr.: 66115

Rapport nr.: P240174  
Rapportdato: 2024-12-10  
Ankomst dato: 2024-09-06

Lab-id. P240174-18

Objekt	Prøvestasjon/ID	ASC-stasjon	FU-stasjon	Prosjektnr. og prosjektnavn	Notering	Mottatt lab
Sediment	Cu ref 1			66115 - Laugardalur 1 ASC C and B survey max biomass 2024		2024-09-06

Analyseresultat							
Parameter	Resultat		Enhet	Analysedato start	Analysedato slutt	Standard	Målesikkerhet
Kobber (Cu) <sup>a</sup>	45.5	43.6	mg/kg TS	2024-12-01	2024-12-03	Intern metode	

<sup>a</sup> Prøvingen er utført av eksternt laboratorium, ALS Laboratory Group

Lab-id. P240174-19

Objekt	Prøvestasjon/ID	ASC-stasjon	FU-stasjon	Prosjektnr. og prosjektnavn	Notering	Mottatt lab
Sediment	Cu ref 2	Cu ref 2		66115 - Laugardalur 1 ASC C and B survey max biomass 2024		2024-09-06

Analyseresultat							
Parameter	Resultat		Enhet	Analysedato start	Analysedato slutt	Standard	Målesikkerhet
Kobber (Cu) <sup>a</sup>	33.8	38.7	mg/kg TS	2024-12-01	2024-12-03	Intern metode	

<sup>a</sup> Prøvingen er utført av eksternt laboratorium, ALS Laboratory Group

Lab-id. P240174-20

Objekt	Prøvestasjon/ID	ASC-stasjon	FU-stasjon	Prosjektnr. og prosjektnavn	Notering	Mottatt lab
Sediment	Cu ref 3	Cu ref 3		66115 - Laugardalur 1 ASC C and B survey max biomass 2024		2024-09-06

Analyseresultat							
Parameter	Resultat		Enhet	Analysedato start	Analysedato slutt	Standard	Målesikkerhet
Kobber (Cu) <sup>a</sup>	44.2	41.6	mg/kg TS	2024-12-01	2024-12-03	Intern metode	

<sup>a</sup> Prøvingen er utført av eksternt laboratorium, ALS Laboratory Group

\* = Ikke akkreditert resultat

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Side 6 av 7

## ANALYSERAPPORT

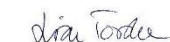
Kunde: Arnarlax  
Kundemerking: Laugardalur  
Kontaktperson:  
Prosjektnr.: 66115

Rapport nr.: P240174  
Rapportdato: 2024-12-10  
Ankomst dato: 2024-09-06

**Analyseansvarlig:**

Lisa Torske

**Signatur:**



Oda Sofie Bye Wilhelmsen

**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*

\* = Ikke akkreditert resultat

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Side 7 av 7