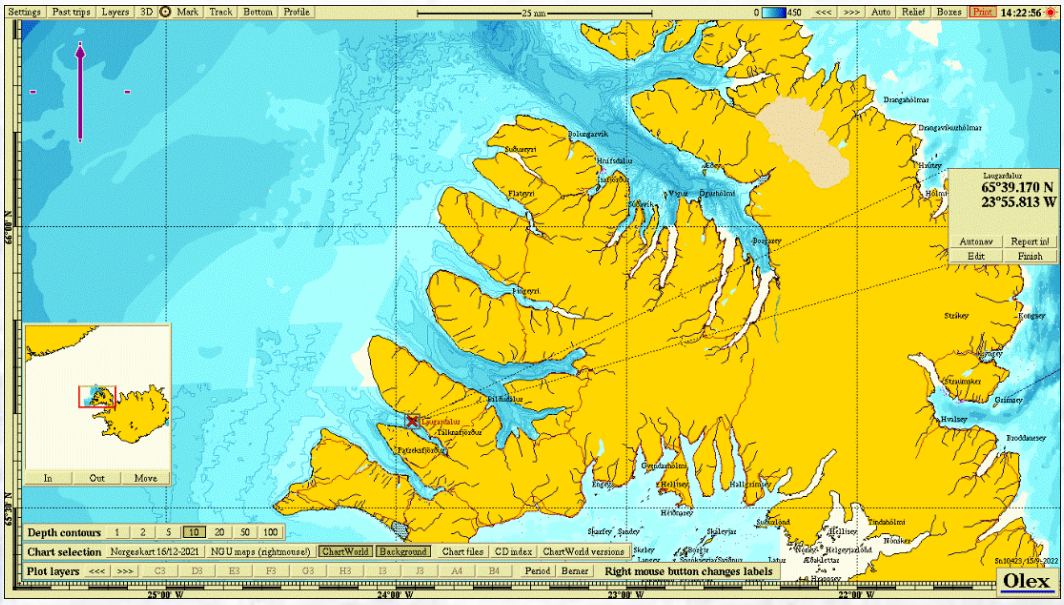
Akvaplan niva

Rapport Report

Laugardalur, Arnarlax
B survey,
July 2022
(post fallow)



NORSK
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Akvaplan-niva AS
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Information client			
Title	Laugardalur, Arnarlax. B survey (post fallow), July 2022		
Report number	APN-64189.B01		
Site name	Laugardalur	Coordinates site	65°39,170N 023°55,813V
County	Tálknafjarðahreppur	Municipality	Tálknafjörður
MTB-or estimated max biomass	6.414 tonnes	Site manager/contact	Silja Baldvinsdóttir
Client name	Arnarlax		

Biomass/production/status at date of survey			
Biomass at date of survey	0 t	Feed use	0 t
Fish type	Salmon	Amount produced	
Type/time of survey	**Mark with X**	Comments	
At maximal biomass see kap 7.9	☐	Fallow state since 5th of December 2021	
A follow up survey	☐		
Half maximal biomass	☐		
Survey prior to putting out smolt	☒		
A pre-survey new site	☐		
Other	☐		
Last fallowing period:	May 2019		

Results from B-survey according to NS 9410:2016 (main results)			
Parameters and indexes		**Parameters and site status**	
Gr. II. pH/Eh	0,00	Gr. II. pH/Eh	1
Gr. III. Sensory	0,64	Gr. III. Sensory	1
GR. II + III	0,32	GR. II+ III	1
Date fieldwork	06.07 2022	**Date report**	11.10.22
Site status (NS 9410:2016):			**1**

Report writing and project leader	Snorri Gunnarsson	Signature	
Quality control	Steinar D Eriksen	Signature	

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Preface

The survey is carried out in accordance with the Norwegian standard NS 9410:2016 - "Environmental monitoring of benthic impact from marine fish farms". Impact assessment is based on sediment condition (chemistry, sensory & presence/absence of fauna). The environmental survey is regulated by § 35 in the Norwegian "akvakulturdriftsforskriften". The survey also fulfills the requirements regarding seabed surveys outlined in the standard ISO 12878.

The primary objective of a B-survey is to assess the benthic impact beneath and in the close vicinity (near zone) of a marine fish farm by applying methods, thresholds and classifications as defined in NS9410:2016. The current survey was undertaken after fallowing and prior to the start of a new production cycle. Sampling stations in this survey are placed within the near zone of the current farm location. Laugardalur has an estimated max biomass (next generation) of 6.414 t and thus a total of 18 stations were sampled.

The following have participated in the survey:

Snorri Gunnarsson	Akvaplan-niva AS	Prosjektleder.
Snorri Gunnarsson	Akvaplan-niva AS	Fieldwork and Report. Charts (Olex).
	Akvaplan-niva AS	Quality assurance

The sampling at Laugardalur was done 06.07 2022.

Accredited survey:

The following parts of the survey are done in accordance with accreditation methods:

Sampling and treatment of sediment samples, analysis of samples and evaluations of the results. Thresholds and classifications of assessment criteria applied in this report are based on Norwegian environmental conditions as Iceland specific criteria have yet not been developed. This should be taken into consideration when reviewing site status.

NORSK AKKREDITERING TEST 079	Akvaplan-niva AS er akkreditert av Norsk Akkreditering for prøvetaking og faglig vurderinger og fortolkninger, akkrediteringsnummer TEST 079. Akkrediteringen er iht. NS-EN ISO/IEC 17025 Akkrediteringen omfatter bla. NS 9410, NS-EN ISO 5667-19 og NS-EN ISO 16665.

Akvaplan-niva AS thanks Arnarlax and their personnel for the cooperation during the conductance of this site survey.

Kópavogi 11. October 2022

Snorri Gunnarsson
Project manager

1 Introduction

Sampling was undertaken on 06.07.2022 by Akvaplan-niva AS, who has been contracted by Arnarlax in relation to the company's fish farming activity at the site Laugardalur in Tálknafjörður, Tálknafjarðahreppur municipality.

The objective of the B-survey is to document the environmental condition in the near zone of a fish farm by evaluating sediment condition (chemistry, sensory & presence/absence of fauna) as defined in NS 9410:2016 (and ISO 12878). The B-survey is a tool for trend monitoring and allows to assess the status of organic enrichment beneath the net pens at various stages of the production cycle.

The here presented survey was undertaken after fallowing and prior the start of the next production cycle. Sampling stations in this survey are placed within the near zone of the current farm location. Laugardalur has an estimated max. biomass of 6.414 t and thus a total of 18 stations were sampled.

Figure 1 shows a map of the southern part of Vestfirðir where Laugardalur is located in the fjord Tálknafjörður.

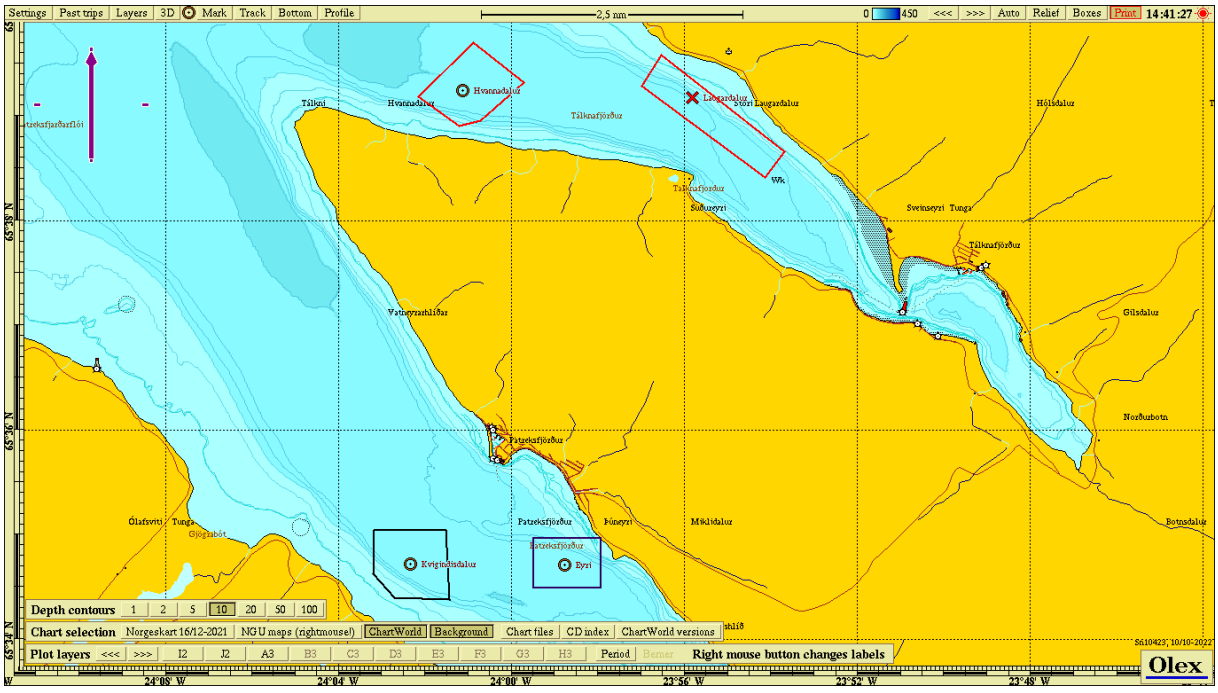


Figure 1. An overview map where Laugardalur site is marked with a red cross. Other fish farms in the nearest vicinity (Tálknafjörður and Patreksfjörður) are also shown.

2 Methods

Monitoring of the environmental impact of fish farming activities on the seabed is standardised and regulated. All fish farming sites in the sea are to be regularly assessed. Environmental monitoring in Iceland is following guidelines and methods outlined in NS 9410:2016 and ISO 12878. The Icelandic Environmental agency (Umhverfisstofnun) can also set specific requirements regarding frequency of surveys for different fish farming sites, which can overrule the above-mentioned standards.

The B survey is a trend monitoring tool with the focus on sediment condition (benthic impact) beneath and in the close vicinity of the fish cages (near zone). Sediment is collected using a grab (min 250 cm^2). Sediment condition for each sample is assessed using three indicators: sediment chemistry (pH and redox potential), sensory evaluation (gas bubbles, smell, texture, colour and thickness of sludge) and the presence or absence of fauna. The performance of these indicators against predefined thresholds categorizes the farming locations into four different site conditions (see Table 1), which are used to determine the sampling frequency.

Table 1. Frequency of category B-research for the location of the farm based on state of the defined farming area.

Site condition at the time of sampling	Sampling frequency for B-surveys (NS 9410:2016)
1-very good	At next max biomass
2-good	Prior to putting next generation into sea and again at next max biomass.
3-bad	Prior to putting next generation into sea. Based on the site condition prior to putting next generation into sea: - Condition 1 – next site survey at next max biomass - Condition 2 – next site survey at next 50% max biomass and at max biomass - Condition 3 – next site survey at next 50% max biomass and at max biomass. Some conditions should apply for farming of next generation at the site If any of the samples result in character 4 it is a sign of overload.
4-very bad	Overload

2.1 Field equipment

The following field equipment was used during the site survey:
Grab: Van Veen grab (St 1-5: 0.025 m^2; St 6-18: 0,1 m^2)
Sieve 1 mm: Akvaplan-niva
pH meter: Electrode, YSI Professional Plus
Redox-meter: Electrode, YSI Professional Plus
Position determination– Garmin GPS mapping tool.
Digital camera

3 Study site, production and survey design

3.1 Study site and production

Laugardalur is located in the northern side of Tálknafjörður, approximately 3nm northwest of the town of Tálknfjörður. The installed frame is suited for up to 14 net-pens with a circumference of 160 m. The frame is positioned in north- northwestly direction from land (297°) with depth below the cages ranging from 24 to 51 m.

Laugardalur has been fallowed since early december 2021. Four generations of fish have been reared at site and the production volume increased with each production cycle.

Table 2 shows the production and feed usage for previous generations.

Table 2. Production and feed usage at Laugardalur, data is based on info given from the fish farmer.

Generation of fish (G)	Production (tonnes)	Feed usage (tonnes)
Past generation 4	9.410	11.946
Past generation 3	9.113	8.107
Past generation 2	2.836	3.406
Past generation 1	734	959

3.2 Present and past site surveys

Table 3 provides an overview of sampling dates and results of current and historic B surveys undertaken at the site following NS 9410:2016.

Table 3. Current and historic B surveys taken at Laugardalur.

Date of sampling	Report number	Survey type	Overall site status
06.09.2022	APN 64189.B01 (Gunnarsson, 2022)	Fallow period	1
25.03.2021	APN-62334.B01 (Gunnarsson, 2021)	B survey max biomass	1
27.05.2019	APN-60938.B01 (Gunnarsson, 2019b)	Fallow period	1
03.11.2017	APN-9207 (Gunnarsson, 2019a)	B survey max biomass	1

3.3 Hydrodynamic conditions

Current measurements were undertaken in March-April 2019 at 42 m, which is the dispersing depth for Laugardalur site (Heggem, 2019). The dominating current at 42 m is in north-westerly direction (315 degrees) with a counter current in opposite direction (Figure 2). Average current speed is 4.2 cm/s. Highest current speed is measured to be 21,2 cm/s and 8.2 % of the measurements are zero current.

3.4 Survey design

The placement of the 18 sampling stations is shown in Figure 2 with positions listed in Table 4. Stations are distributed within the near zone of the frame positions following criteria outlined in NS 9410:2016. Depth beneath and in the close vicinity of the cage varies between 24– 51 m, with the deepest waters located in the southern part of the frame. Sampling stations were placed to represent the varied environmental conditions within the near zone and cover thus both the

deeper and shallower areas. The sampling stations had a depth varying from 23 to 51 m. The placement of sampling stations is regarded to be in accordance with the requirements outlined in NS 9410:2016.

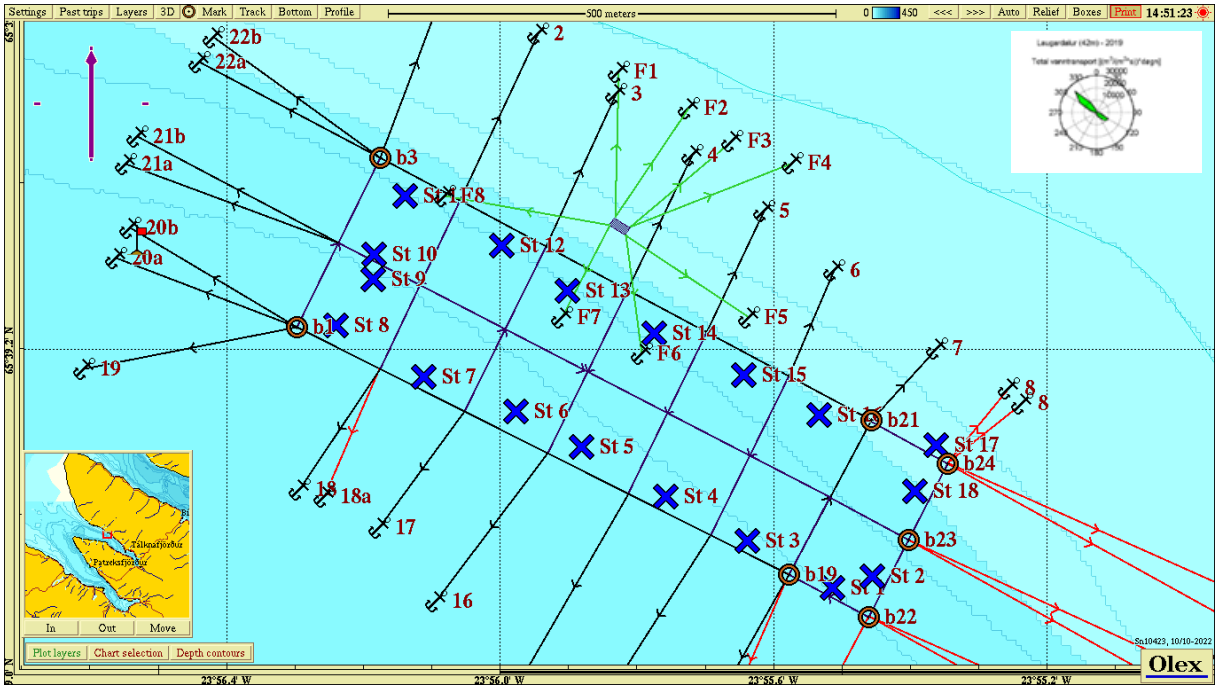


Figure 2. Site specific map of Laugardalur showing frame, mooring lines and farming area. Sampling stations st. 1 – 18 are marked with crosses. The color of each cross represents the environmental condition at the respective station following the classification as outlined in NS 9410:2016, chapter 7.11. Colour codes: Blue = very good, green = good, yellow = bad, red = very bad. Current rose placed in the top right corner shows main current direction at 42 m and red flag marks the spot for current measurmements (Heggem, 2019).

Table 4. Position and depth of the sampling stations in the B-survey.

Station number	North	West	Depth (m)
St 1	65°39,056	023°55,514	50
St 2	65°39,063	023°55,456	47
St 3	65°39,084	023°55,638	51
St 4	65°39,111	023°55,758	51
St 5	65°39,141	023°55,881	51
St 6	65°39,162	023°55,977	51
St 7	65°39,183	023°56,112	51
St 8	65°39,214	023°56,230	51
St 9	65°39,242	023°56,185	50
St 10	65°39,257	023°56,184	49
St 11	65°39,292	023°56,139	49
St 12	65°39,262	023°55,997	41
St 13	65°39,235	023°55,902	42
St 14	65°39,209	023°55,775	38
St 15	65°39,183	023°55,644	36
St 16	65°39,160	023°55,534	32
St 17	65°39,142	023°55,362	23
St 18	65°39,114	023°55,393	31

4 Results

Results for the different parameters are given in Table 5. The completed fieldwork sampling sheet with calculations for each parameter is attached in appendix.

Table 5. Results from the parameter classifications in the near zone of the fish farm.

Parameter	Condition
Group II - parameters (pH/Eh)	1
Group III – parameters, (sensory)	1
Group II + III – parameters (mean value)	1
Site condition	**1**

Substrate was collected at all 18 sampling stations (100% soft bottom). Sediment samples consisted mainly of clay and silt and partly of clay, silt and sand in the north-westerly part of the local impact zone. Fauna was recorded at all stations with polychaetes being most prominent. The substrate was partly of light grey and partly brown/black colour. Signs of out-gassing were not observed. A slight smell of H_2S was recorded at eight stations.

Based on the classification of sediment chemistry (ph/Eh) and the sensory assessments all stations of this survey received status 1 – "very good" (Figure 2). The site therefore also receives as a whole the environmental status 1 – "very good".

5 Conclusion

Applying the indicator thresholds and classification outlined in NS 9410:2016 it is shown that Laugardalur receives site status 1 – "very good" at the time of this B survey. Samples were collected with a Van Veen grab (St 1-5: 0.025 m^2; St 6-18: 0,1 m^2) at 18 stations distributed around the 14 cages, which are planned to be used for the next production cycle. Sediment was successfully collected at all stations and each station in this survey received status 1 – "very good".

The here presented survey was undertaken after fallowing and prior to the start of the next production cycle. The results from the current survey compared with results from last B-survey at max biomass in March 2021 (Gunnarsson, 2021) indicate overall improvement of the status of the bottom sediment in the local impact zone. The overall site status was 1 "very good) in both surveys. However in the 2021 survey, based on the classification of sediment chemistry (ph/Eh) and the sensory assessments, thirteen station had status "very good", three stations status "good" one stations status "bad" and one station status "very bad" contra that all eighteen stations in the current survey had the status "very good".

Following the criteria outlined in NS 9410:2016 the site receives the status 1 - "very good".

6 References

Forskrift om drift av akvakulturanlegg (akvakulturdriftsforskriften) §§ 35 og 36.

Gunnarsson, S., 2019a. Fjarðalax hf, B-undersøkelse, Laugardalur, (undersøkelse ved maksimal belastning). APN rapport nr. 9207.01. 10 s.

Gunnarsson, S., 2019b. Arnarlax, B-survey local impact zone, Laugardalur, May 2019 (fallow period). APN B rapport nr. 60938.B01. 21 s.

Gunnarsson, S., 2019b. Arnarlax, B-survey local impact zone, Laugardalur, March 2021 (Max biomass). APN rapport nr. 62334.B01. 21 s.

Heggem, T., 2019. Arnarlax hf. Strømmålinger Laugardalur. Spredningsstrøm 42 m. APN report 61178.01. 10 s.

ISO 5667-19:2004. Guidance on sampling of marine sediments.

ISO 12878:2012. Environmental monitoring of the impacts from marine finfish farms on soft bottom.

Norsk Standard NS 9410:2016. Miljøovervåking av bunnpåvirkning fra marine akvakultur-anlegg.

7 Appendix

7.1 Survey data sheet (B.1 & B.2), NS 9410:2016.

Sample scheme B.1

Company	Arnarlax	Date:	6.7.2022
Site:	Laugardalur	Site no.:	
Fieldworker:	Snorri Gunnarsson		

Gr	Parameter	Point	Sample number									
			1	2	3	4	5	6	7	8	9	10
	Bottom type: S (soft) eller H (hard)		S	S	S	S	S	S	S	S	S	S
I	Animals > 1mm	Yes (0) No (1)	0	0	0	0	0	0	0	0	0	0
II	pH	value	7,6	7,7	7,6	7,4	7,5	7,6	7,8	7,8	7,6	7,9
	Eh (mV)	ORP	-93	-45	-10	-14	14	-37	30	-8	21	63
		plus ref. verdi	107	155	190	186	214	163	230	192	221	263
	pH/Eh	from figure	0	0	0	0	0	0	0	0	0	0
	Status station		1	1	1	1	1	1	1	1	1	1
			Buffer-temp	5,0 C		Sea temp	1,1 C		Sediment temp		1,1 C	
		pH sea 8,01	ORP sea	186,5 mV		Eh sea	386,5 mV		Reference electrode		200,0 mV	
III	Gas bubbles	Yes (4) No (0)	0	0	0	0	0	0	0	0	0	0
	Colour	Light/grey (0)	0	0			0	0	0		0	0
		Brown/black (2)			2	2				2		
	Smell	None (0)	0				0	0			0	
		Light (2)		2	2	2			2	2		2
		Strong (4)										
	Consistency	Solid (0)	0	0	0	0	0	0	0	0	0	0
		Soft (2)										
		Aqueous (4)										
	Grab volume (v)	v < 1/4 (0)										
		1/4 < v < 3/4 (1)	1	1	1	1	1					
		v > 3/4 (2)						2	2	2	2	2
	Thickness of slidge (t)	t < 2 cm (0)	0	0	0	0	0	0	0	0	0	0
		2 < t < 8 cm (1)										
		t > 8 cm (2)										
		Sum	1,0	3,0	5,0	5,0	1,0	2,0	4,0	6,0	2,0	4,0
		Corrected (*0,22)	0,2	0,7	1,1	1,1	0,2	0,4	0,9	1,3	0,4	0,9
	Status station		1	1	2	2	1	1	1	2	1	1
	Average group II & III		0,1	0,3	0,6	0,6	0,1	0,2	0,4	0,7	0,2	0,4
	Status station		1	1	1	1	1	1	1	1	1	1

Grab ID	K-22
pH / Eh ID	Ysi professional plus

page 1 of 4 pages

Sample scheme B.1

Company:	Arnarlax	Date:	06.07 2022
Site:	Laugardalur	Site no.:	0
Fieldworker:	Snorri Gunnarsson		

Gr	Parameter	Point	Sample number 11	12	13	14	15	16	17	18	19	20	Index S%	H%
	Bottom type: S (soft) or H (hard)		S	S	S	S	S	S	S	S			100	0
I	Animals > 1mm	Yes (0) No (1)	0	0	0	0	0	0	0	0				
II	pH	value	7,8	7,6	7,7	7,8	7,6	7,9	7,8	7,6				
	Eh (mV)	ORP	74	71	-35	-39	-15	3	56	51				
		plus ref. verdi	274	271	165	161	185	203	256	251				
	pH/Eh	from figure	0	0	0	0	0	0	0	0			0,00	
		Status station	1	1	1	1	1	1	1	1				
		Status group II	1	Buffer temp	5,0 C		Sea temp	1,1 C		Sediment temp	1,1 C			
		pH sea 8,01	ORP sea	187 mV		Eh sea	387 mV		Reference electrode		200 mV			
III	Gas bubbles	Yes (4) No (0)	0	0	0	0	0	0	0	0				
	Colour	Light/grey (0)		0				0	0	0				
		Brown/black (2)	2		2	2	2							
	Smell	None (0)	0	0			0	0	0	0				
		Light (2)			2	2								
		Strong (4)												
	Consistency	Solid (0)	0	0	0	0	0	0	0	0				
		Soft (2)												
		Aqueous (4)												
	Grab volume (v)	v < 1/4 (0)						0	0	0				
		1/4 < v < 3/4 (1)	1	1	1	1	1							
		v > 3/4 (2)												
	Thickness of slidge (t)	t < 2 cm (0)	0	0			0	0	0	0				
		2 < t < 8 cm (1)			1	1								
		t > 8 cm (2)												
		Sum	3,0	1,0	6,0	6,0	3,0	0,0	0,0	0,0				
		Corrected (*0,22)	0,7	0,2	1,3	1,3	0,7	0,0	0,0	0,0			0,64	
		Status station	1	1	2	2	1	1	1	1				
		Status group III	1											
		Average group II & III	0,3	0,1	0,7	0,7	0,3	0,0	0,0	0,0			0,32	
		Status station	1	1	1	1	1	1	1	1				
		Status group II & III	1											

pH/Eh Corr.sum Index Average	Status
< 1,1	1
1,1 - <2,1	2
2,1 - <3,1	3
≥3,1	4

Status site: 1

Grab ID	K-22
pH / Eh ID	Ysi professional plus

Sample scheme B.2

Company:	Arnarlax		Date:	6.7.2022
Site:	Laugardalur		Site no.:	0
Fieldworker:	Snorri Gunnarsson			

Sample number		1	2	3	4	5	6	7	8	9	10
Depth (m)		50	47	51	51	51	51	51	51	50	49
Number of trials		3	1	1	1	1	4	1	1	1	1
Gas bubbles (in sample)		No	No	No	No	No	No	No	No	No	No
Sediment type	Clay	X	X	X	X	X	X	X	X	X	X
	Silt	X	X	X	X	X	X	X	X	X	X
	Sand										
	Gravel										
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count											
Crustaceans, count			1							1	
Molluscs, count											
Polychaetes, count		>10	5	>20	2	5	>20	>20	>20	>20	4
Other animals, count											
Beggiatoa											
Feed											
Faeces											
Comments		St. 6: Some dead black algae. St. 7: Some dead black algae. St. 8: Some dead black algae and broken shells. St. 9: Some dead black algae. St. 10: Some dead black algae.									
Grab		Area [m^2]		0,025		Grab ID			K-22		

Sample scheme B.2

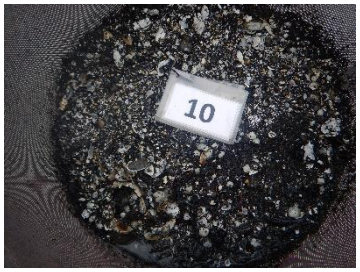
Company:	**Arnarlax**	**Date:**	**6.7.2022**
Site:	**Laugardalur**	**Site no.:**	**0**
Fieldworker:	**Snorri Gunnarsson**		

Sample number		11	12	13	14	15	16	17	18	19	20
Depth (m)		49	41	42	38	36	32	23	31		
Number of trials		1	1	1	1	1	4	1	1		
Gas bubbles (in sample)		No	No	No	No	No	No	No	No		
Sediment type	**Clay**	X	X	X	X	X	X	X	X		
	Silt	X	X	X	X	X	X	X	X		
	Sand	X	X	X	X				X		
	Gravel										
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count											
Crustaceans, count											
Molluscs, count								>10	1		
Polychaetes, count		3	>10	>50	>10	>30	>10	>10	4		
Other animals, count											
Beggiatoa											
Feed											
Faeces											
Comments		St. 11: Some dead black algae, Sediment black in color but parameters relativ ok. St. 12: Litle washed sample. St. 13: Some dead black algae, sediment oily, litle washed sample. St. 14: Some dead black algae, sediment oily, litle washed sample. St. 15: Some broken shells, sediment black in color. St. 18: Litle washed sample (shells in mouth of grab.									

Grab	**Area [m^2]**	0,025	**Grab ID**	K-22
Signature fieldworker:				page 4 of 4 pages

7.2 Pictures of samples at Laugardalur.

St 1		
St 2		
St 3		
St 4		
St 5		

St 6		
St 7		
St 8		
St 9		
St 10		

St 11		
St 12		
St 13		
St 14		
St 15		

St 16		
St 17		
St 18		

7.3 Bottom topography and 3D view

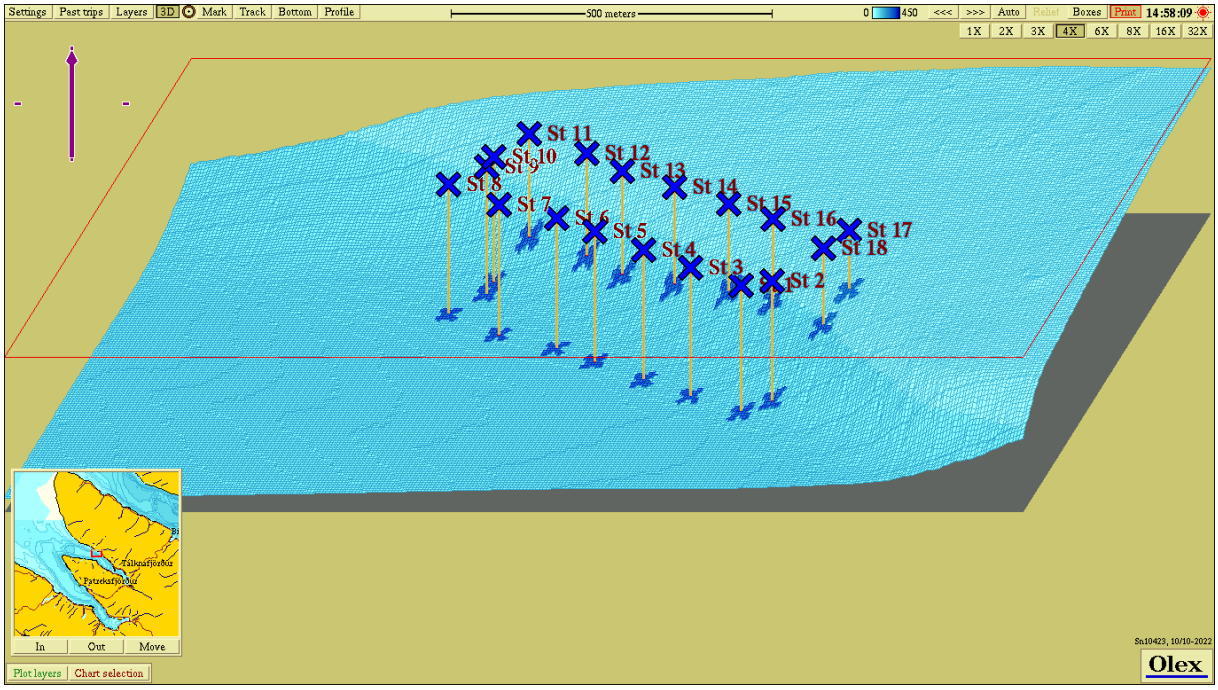


Figure 3. Bottom topography in 3D at Laugardalur with each sampling station according to info in Figure 1 and Table 4.